Hydrological summary

for Great Britain

August 1999

General

August was a month of stark regional contrasts. Scotland was sunny and relatively dry whilst much of the southern half of Britain experienced exceptionally rigorous weather conditions and thunderstorms triggered a number of locally severe flood events. Overall reservoir contents for England and Wales have declined steeply from the record levels of the early summer but remain substantially above average. Relative to the average, river flows and groundwater levels displayed considerable spatial variations in August but, in most areas, were well within the normal range but the dryness of lowland soils may delay the seasonal recovery in runoff and aquifer recharge rates.

Rainfall

The late-July heatwave continued into August but, in southern Britain, was rapidly superseded by exceptionally unsettled conditions. Violent hailstorms and tornadoes (e.g. in Staffordshire) were reported and thunderstorms were common - being especially severe around the 8th when Coleshill, near Birmingham recorded 46 mm of rain in three hours and Coventry's 60 mm total was the wettest August day on record. Lowestoft reported 43 mm in an hour on the 9th whilst Necton (Norfolk) registered over 114 mm in less than two days. Rainfall in parts of the Midlands and central southern England had exceeded twice the August average by the 10th. Thereafter, storms were more prevalent in the west (e.g. 68 mm at Milford Haven on 24/25th) and in northern England. From the 19th much of the English lowlands experienced a dry spell extending well into September. Nonetheless, the capricious nature of our climate was underlined in parts of the South-East where the driest July in 40 years was followed by the wettest August in more than 50. August rainfall totals approached or exceeded 150% of average throughout most of the English lowlands. By contrast, provisional data suggest that Scotland recorded its second driest August since 1984 with some areas (e.g. in the north-east) registering only around 30% of average. June-August rainfall totals were relatively close to the average throughout Britain and 12-month accumulations exceed the average in all regions.

River flows

Throughout most of Scotland late summer river flow recessions continued during August and notably low August runoff totals were reported from the Highlands where flows in the Carron (which registered its second lowest August runoff in a 21-year record) and the Ewe were only around 30%-40% of the long term mean. Similar recessions in responsive catchments in southern England would have produced exceptional depressed flow rates. In the event the frequent thunderstorms produced significant local flooding (e.g. in South Bucks, along the South Coast and in the West Midlands which has experienced a cluster of late summer flash floods), and severe traffic disruption. Surface runoff in those impermeable lowland catchments most affected by the thunderstorms (including the Colne, Blackwater and Soar) contributed to monthly runoff totals amongst the highest on record for August; however, in most such rivers recessions were firmly re-established by early September. Scotland aside, August mean flows were mostly well above those for July and well within the normal late-summer range. A few southern rivers (e.g. the Great Stour) registered their eighth below average summer runoff in the 1990s, but most June-August totals were above average. Except in a few baseflow dominated rivers in the South-East, accumulated runoff totals over the last 12 months are very healthy, notably so in parts of western and northern Britain – the September-August runoff totals for the Yscir and Clyde were unprecedented.

Groundwater

As in July, thunderstorms produced some very localised infiltration but as usual in the late summer gentle recessions continued in almost all outcrop areas. In the Chalk, levels are currently very close to average throughout most of the outcrop. Apart from the Magnesian Limestone (at Peggy Ellerton Farm) where the seasonal maximum has been closely approached, levels in the limestone aquifers were also typical of the late summer. The limited seasonal range for most Permo-Triassic sandstones index sites means that small differences in level can significantly affect ranking positions (see page 8) and exaggerate the apparent spatial variability. Nonetheless, the August levels provide evidence of large regional contrasts. Bussels, in the South-West, marginally exceeded its August maximum whilst in some northern outcrops levels remain relatively depressed; abstraction rates may be a factor in a few areas. The thundery weather in August made for large variations in late-summer soil moisture deficits in the lowlands. In a few areas (e.g. parts of Cambridgeshire) deficits are notably high and, given average rainfall, may be expected to delay the onset of the seasonal recovery in the Chalk.

Institute of Hydrology

British Geological Survey

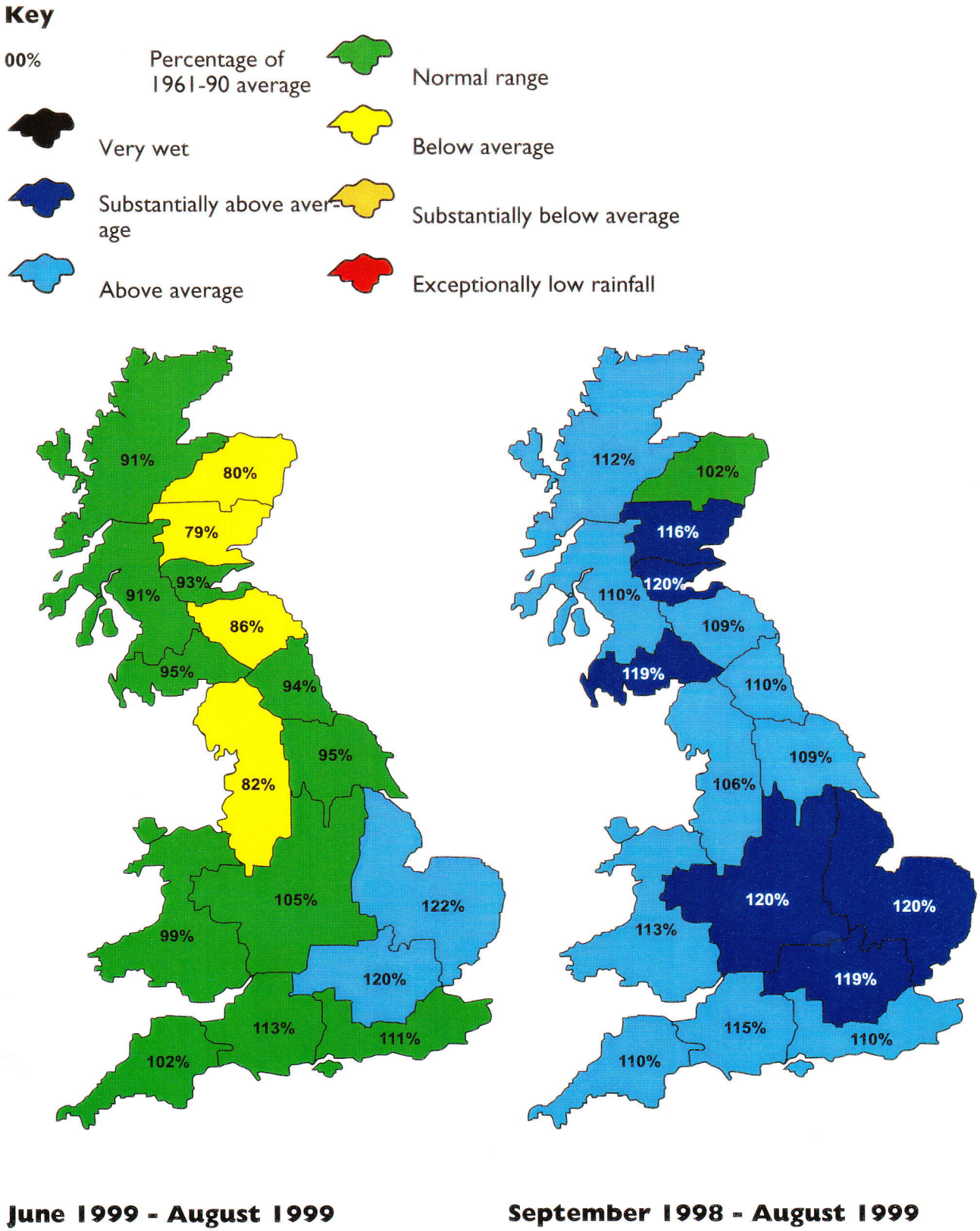
Rainfall . . . Rainfall . . . Rainfall. .

Rainfall accumulations and return period estimates

Area	Rainfall	Aug 1999	Jun 99-Aug 99	RP	Mar 99-Aug 99	RP	Sep 98-Aug 99	RP	Sep 97-Aug 99	RP
England & Wales	**mm**	**102**	**203**		**391**		**955**		**1912**	
	%	**134**	**100**	**<2**	**98**	**2-5**	**107**	**2-5**	**107**	**2-5**
North West	mm	90	224		487		1269		2527	
	%	84	82	2-5	95	2-5	106	2-5	105	2-5
Northumbrian	mm	85	194		435		939		1954	
	%	105	94	2-5	110	2-5	110	2-5	115	10-20
Severn Trent	mm	99	187		387		905		1691	
	%	148	105	2-5	109	2-5	120	10-15	112	5-10
Yorkshire	mm	77	183		424		896		1771	
	%	105	95	2-5	111	2-5	109	2-5	108	2-5
Anglian	mm	89	189		328		716		1351	
	%	162	122	2-5	111	2-5	120	10-15	113	5-15
Thames	mm	100	194		337		819		1518	
	%	172	120	2-5	104	2-5	119	5-10	110	5-10
Southern	mm	95	176		316		858		1694	
	%	167	111	2-5	96	2-5	110	2-5	109	2-5
Wessex	mm	114	198		385		967		1899	
	%	173	113	2-5	107	2-5	115	5-10	113	5-10
South West	mm	124	227		480		1297		2606	
	%	148	102	2-5	104	2-5	110	2-5	111	5-10
Welsh	mm	144	255		542		1489		2932	
	%	143	99	2-5	103	2-5	113	5-10	112	5-10
Scotland	**mm**	**59**	**258**		**593**		**1623**		**3186**	
	%	**51**	**87**	**2-5**	**102**	**2-5**	**113**	**5-10**	**111**	**10-15**
Highland	mm	69	303		716		1976		3814	
	%	54	91	2-5	106	2-5	112	5-10	108	5-10
North East	mm	36	182		390		989		2075	
	%	41	80	2-5	90	2-5	102	2-5	107	2-5
Tay	mm	42	193		497		1427		2783	
	%	45	79	2-5	100	<2	116	5-10	113	10-15
Forth	mm	44	221		471		1328		2591	
	%	47	93	2-5	101	2-5	120	10-20	117	25-40
Tweed	mm	57	195		425		1061		2128	
	%	64	86	2-5	98	2-5	109	2-5	110	5-10
Solway	mm	72	279		637		1691		3307	
	%	61	95	2-5	111	2-5	119	10-20	116	20-35
Clyde	mm	71	305		678		1869		3688	
	%	53	91	2-5	103	2-5	110	5-10	109	5-10

RP = Return period

The monthly rainfall figures* are copyright of the Met. Office and may not be passed on to any unauthorised person or organisation. **All monthly totals since July 1998 are provisional (see page 12).** Recent monthly rainfall figures for the Scottish regions have ben compiled using data provided by the Scottish Environment Protection Agency. The return period estimates are based on tables provided by the Meteorological Office (see Tabony, R.C., 1977, *The variability of long duration rainfall over Great Britain*, Scientific Paper No. 37) and relate to the specified span of months only (return periods may be up to an order of magnitude less if n-month periods beginning in any month are considered). The tables reflect rainfall over the period 1911-70 and assume a stable climate. Artifacts in the England & Wales and Scotland rainfall series can exaggerate the relative wetness of the recent past. *See page 12.



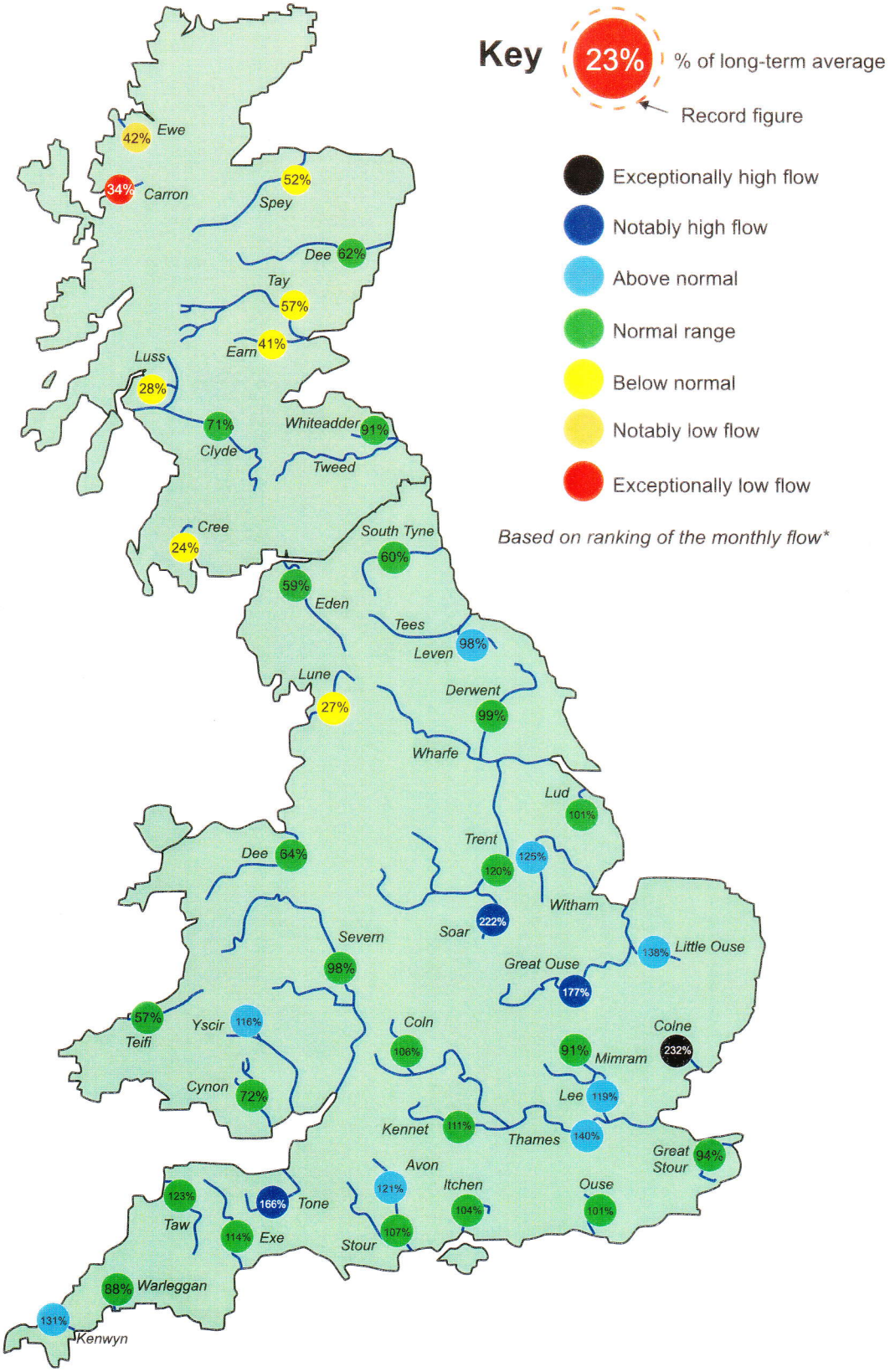
June 1999 - August 1999

September 1998 - August 1999

Rainfall accumulation maps

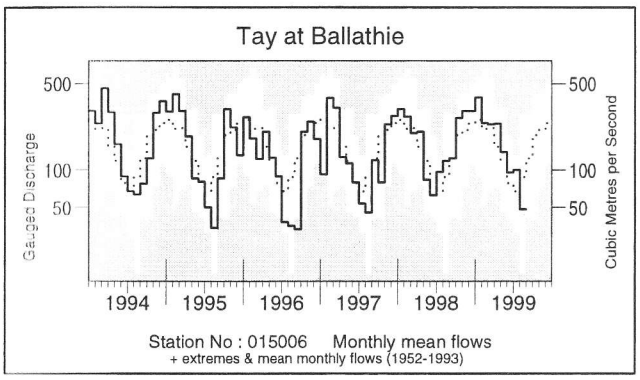
For most regions rainfall totals for each of the summer months departed widely from the long term average. However, the wet and dry interludes tended to balance each other and most summer (June-August) totals are relatively close to the 1961-90 mean; England and Wales registered its first near-average summer since 1991

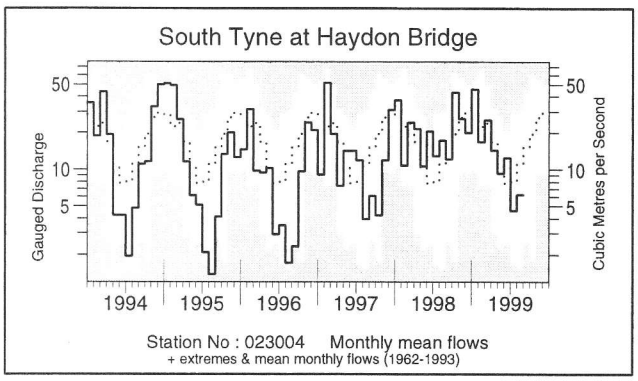
River flow. . . River flow. . .

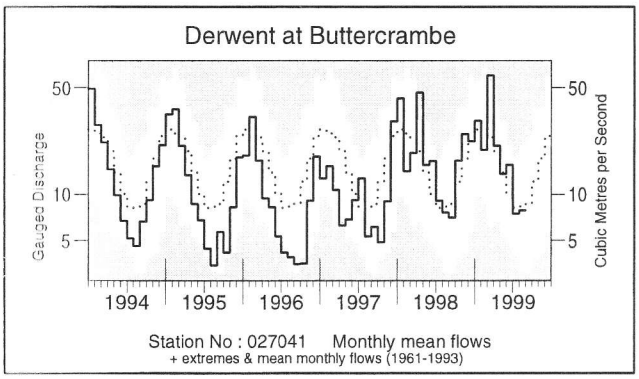


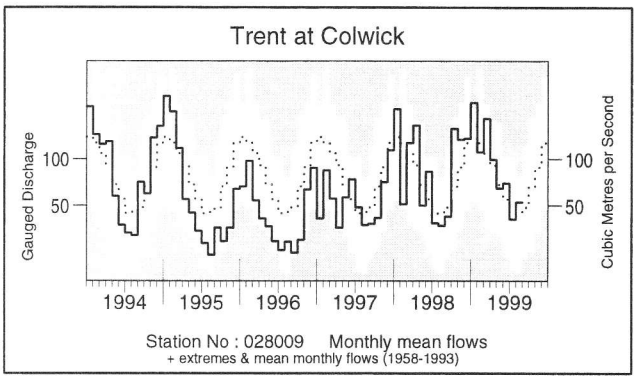
River flows - August 1999

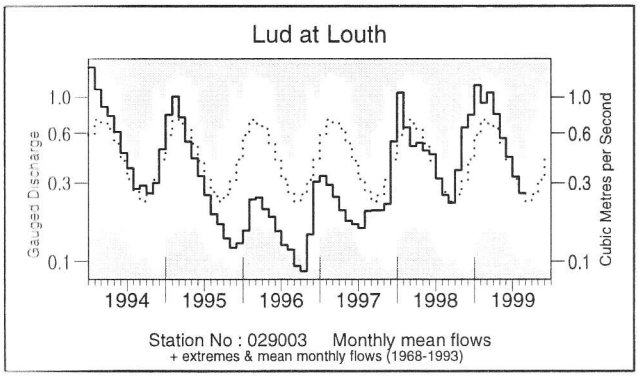
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater.

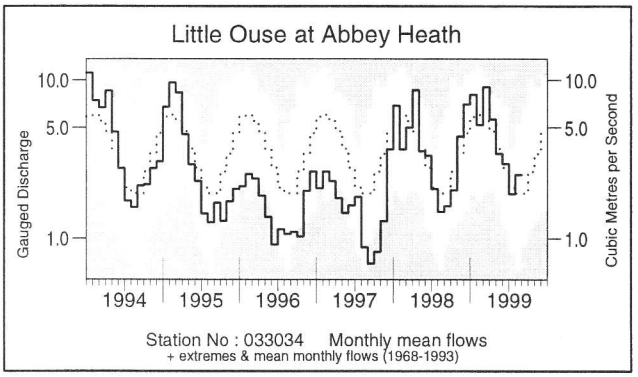


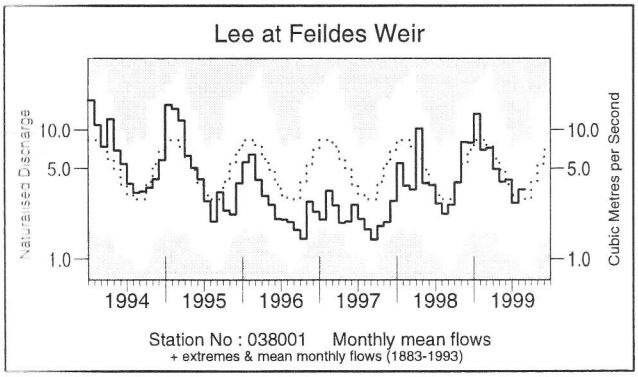


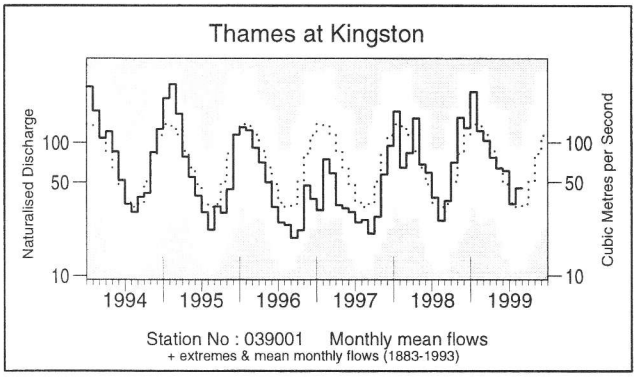








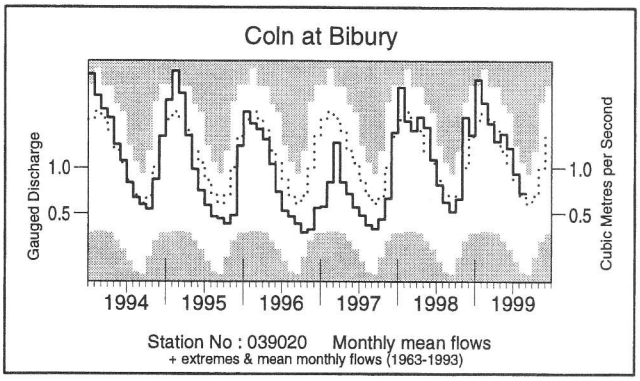


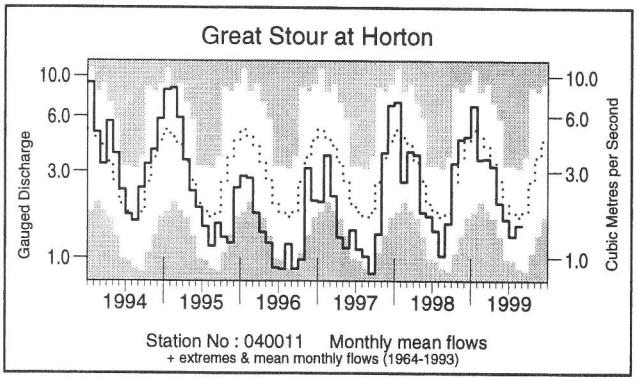


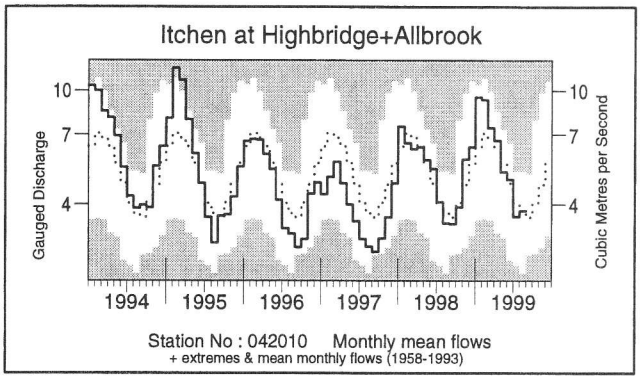
Monthly river flow hydrographs

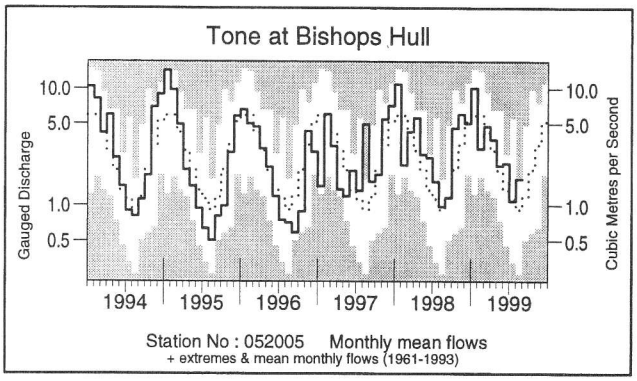
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1994 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

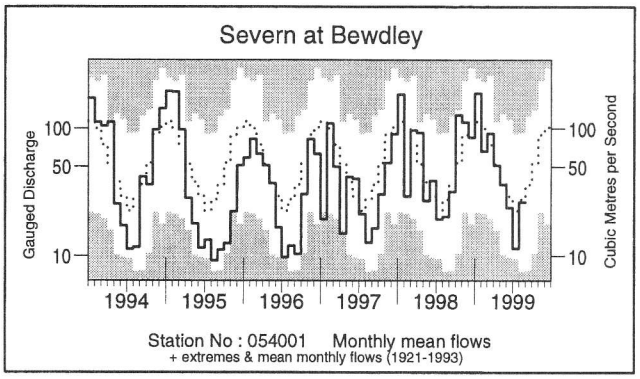
River flow . . . River flow . . .

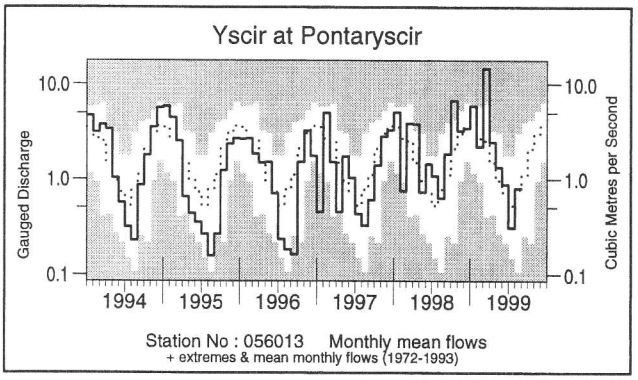


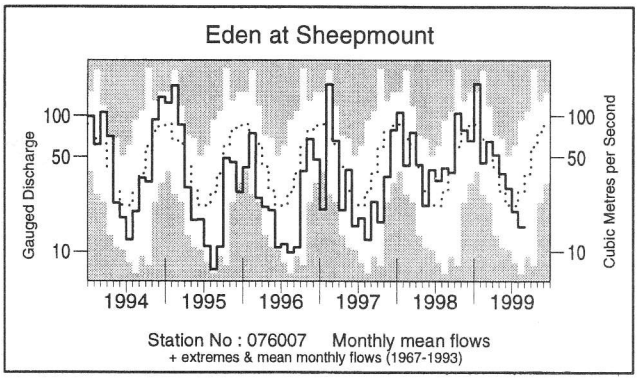


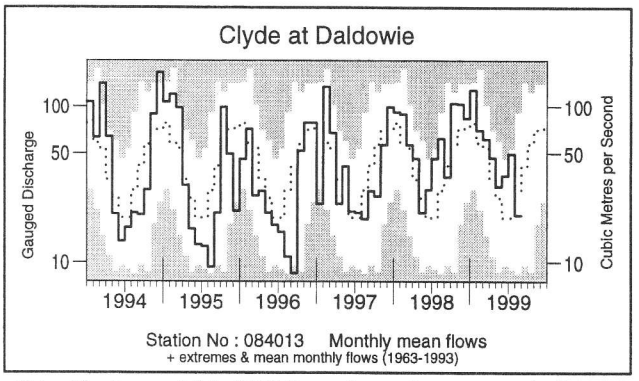












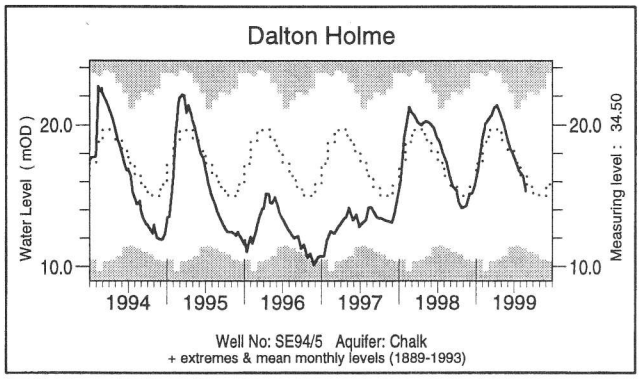
Note: The June and July 1999 flows shown above supersede those previously published for Daldowie.

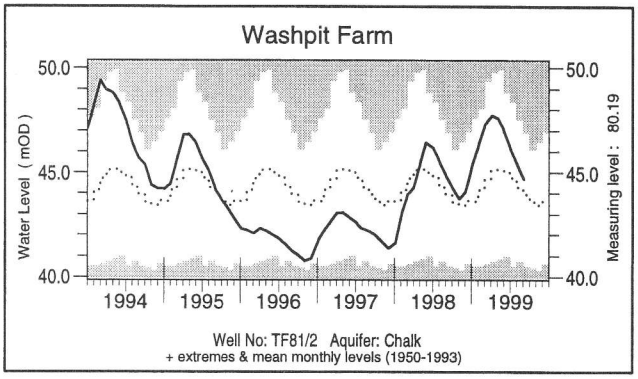
Notable runoff accumulations June 1999 - August 1999 (a); September 1998 - August 1999 (b)

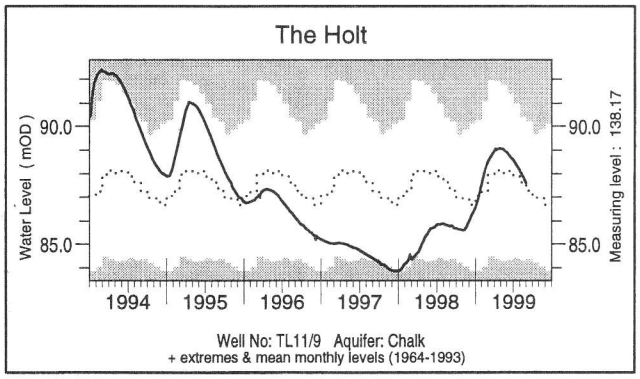
(a) River	%lta	Rank	River	%lta	Rank	(b) River	%lta	Rank
Leven	159	35/39	Tone	142	36/39	Trent	132	38/40
Soar	153	24/28	Clyde	155	34/36	Yscir	183	26/26
Colne	189	39/40	Naver	157	18/22	Clyde	134	35/35

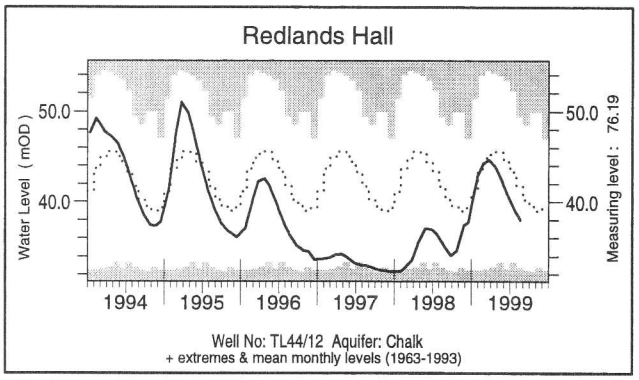
lta = long term average
Rank 1 = lowest on record

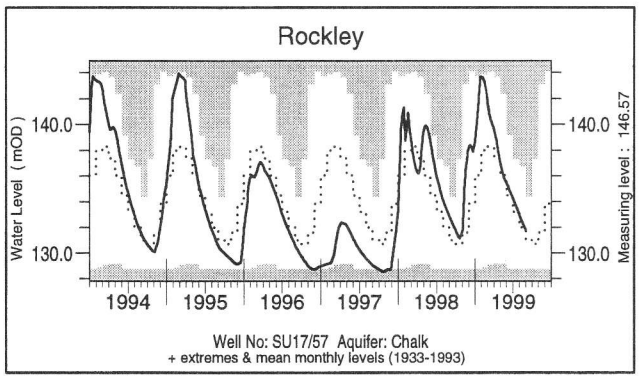
Groundwater . . . Groundwater

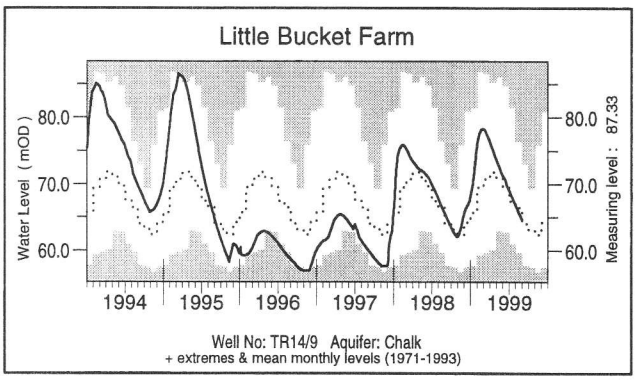


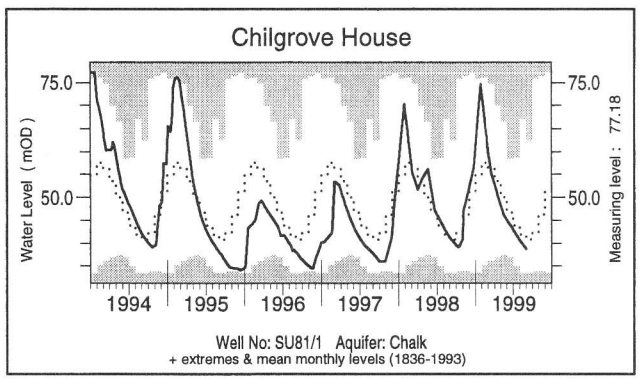


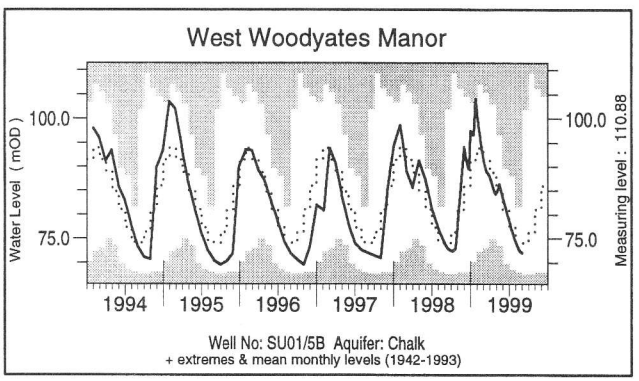






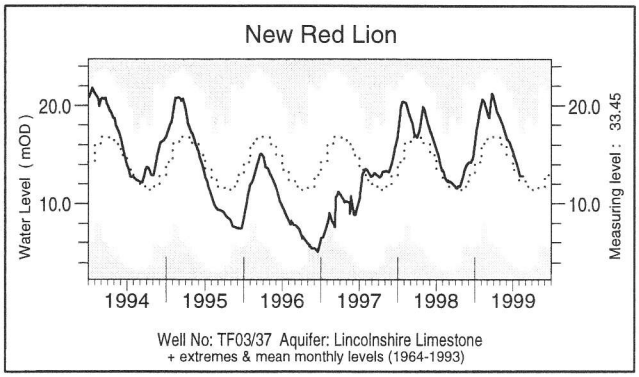


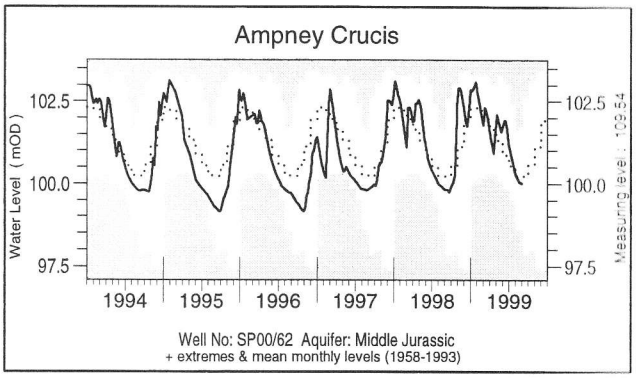


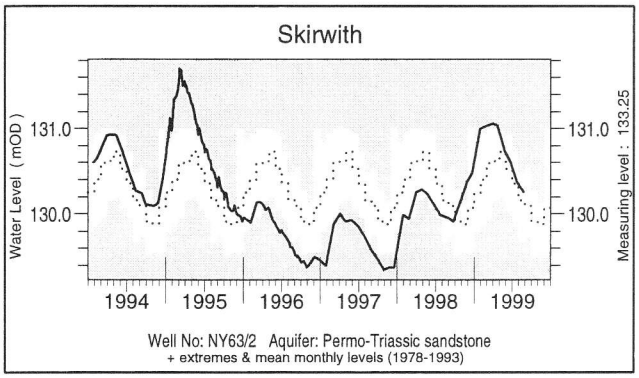


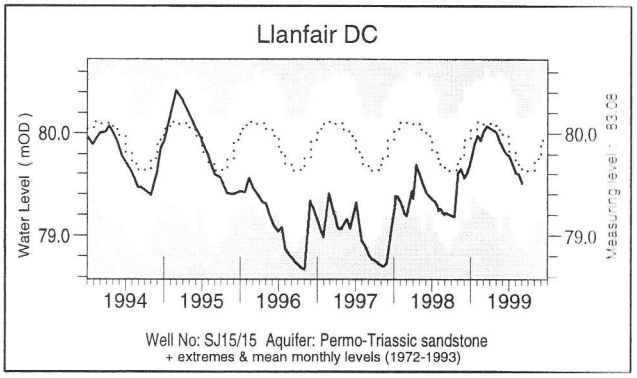
What is groundwater?

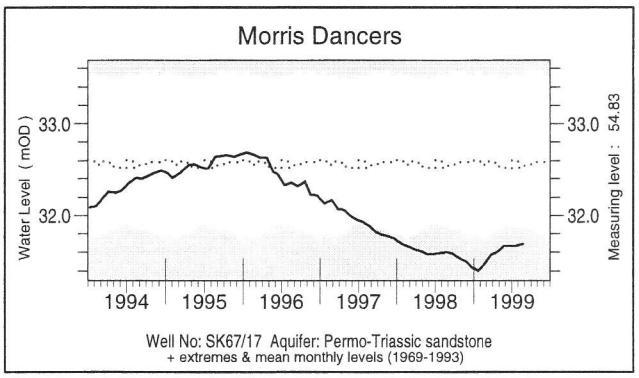
Groundwater is stored in the natural water bearing rock strata (or aquifers) which are found mostly in southern and eastern England (see page 11) where groundwater is the major water supply source. Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly max., min. and mean levels are displayed in a similar style to the river flow hydrographs, note that most groundwater levels are not measured continuously — the latest recorded levels are listed overleaf.

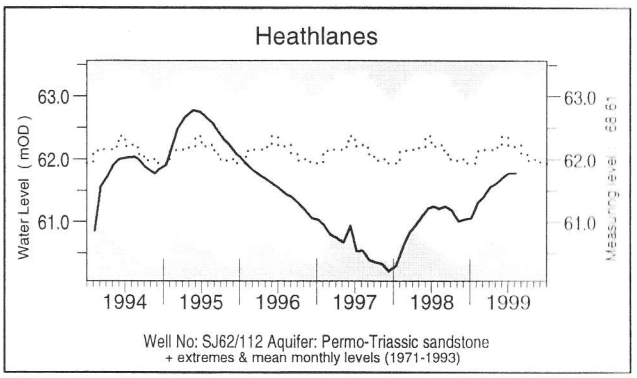


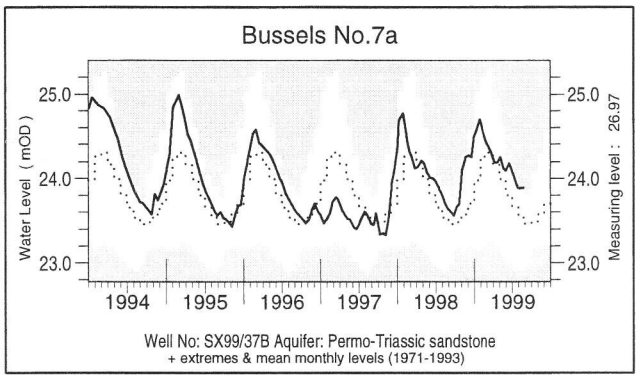


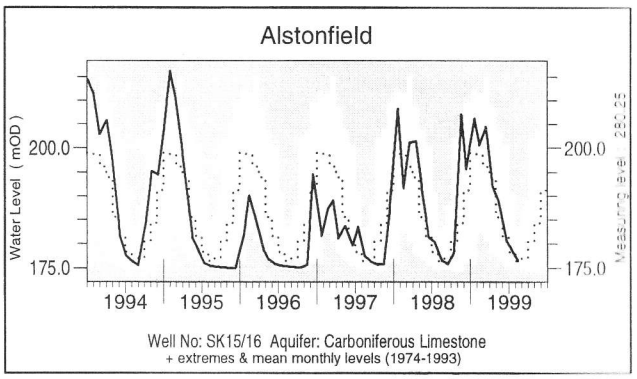










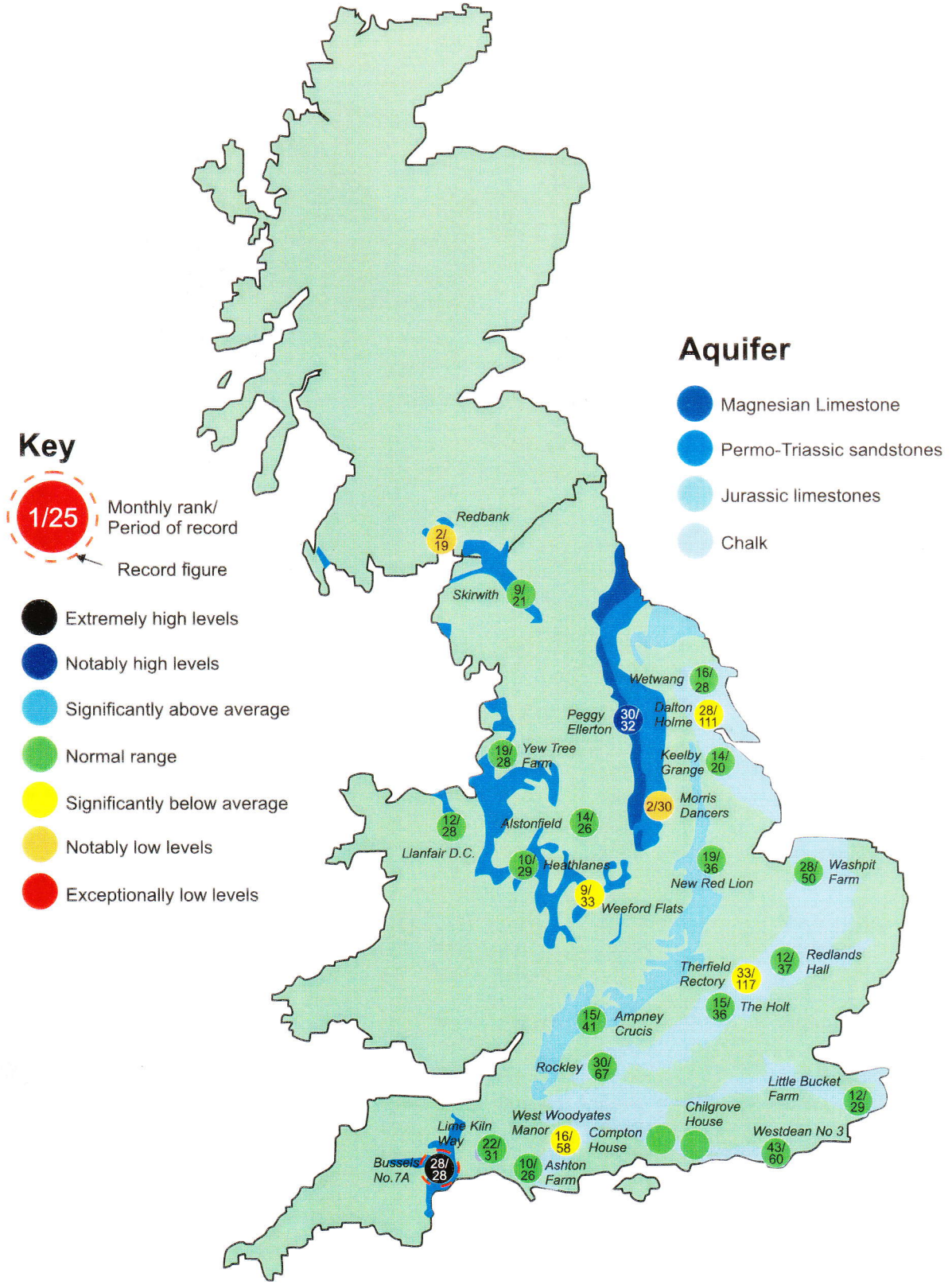


Groundwater levels August/September 1999

Borehole	Level	Date	Aug av.
Dalton Holme	15.30	26/08	16.25
Washpit Farm	44.68	03/09	44.33
The Holt	87.59	31/08	87.55
Redlands Hall	38.05	19/08	40.90
Ashton Farm	65.38	31/08	65.70
Little Bucket	64.59	31/08	66.69
Chilgrove	38.74	31/08	41.74
W Woodyates	72.01	31/08	73.90
New Red Lion	12.84	18/08	12.23
Ampney Crucis	100.01	31/08	100.18
Skirwith	130.26	24/08	130.15
Llanfair DC	79.51	01/09	79.54
Morris Dancers	31.69	24/08	32.46
Heathlanes	61.78	07/08	62.09
Bussels	23.89	25/08	23.56
Alstonfield	176.39	13/08	176.84

Levels in metres above Ordnance Datum

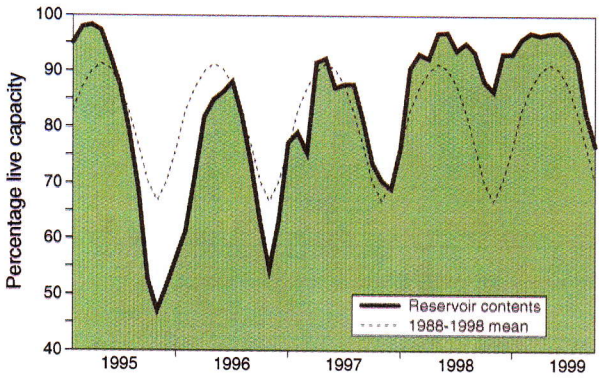
Groundwater . . . Groundwater



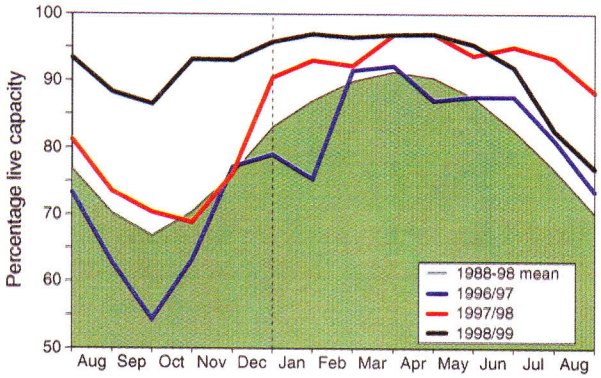
Groundwater levels - August 1999

The rankings are normally based on a comparison of current levels (usually a single reading in a month) with the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

Guide to the variation in overall reservoir stocks for England and Wales



Comparison between overall reservoir stocks for England and Wales in recent years



These plots are based on the England and Wales figures listed below.

Percentage live capacity of selected reservoirs

Area	Reservoir	Capacity (Ml)	1999 Apr	May	Jun	Jul	Aug	**Sep**	Min. Sep	Year* of min
North West	N Command Zone	• 133375	93	96	94	81	71	56	24	1995
	Vyrnwy	55146	97	98	96	87	82	66	36	1995
Northumbrian	Teesdale	• 87936	98	95	94	86	69	61	39	1991
	Kielder	(199175)	(95)	(95)	(95)	(93)	(89)	(88)	(66)	1989
Severn Trent	Clywedog	44922	94	99	99	98	82	83	38	1989
	Derwent Valley	• 39525	100	100	95	90	79	69	34	1995
Yorkshire	Washburn	• 22035	96	98	96	92	83	74	34	1995
	Bradford supply	• 41407	96	98	94	90	77	67	21	1995
Anglian	Grafham	** (55490)	(98)	(98)	(96)	(93)	(88)	(89)	(59)	1997
	Rutland	**(116580)	(97)	(96)	(92)	(88)	(83)	(82)	(66)	1995
Thames	London	• 206399	98	95	93	95	89	85	62	1995
	Farmoor	• 13843	98	95	96	99	97	97	64	1995
Southern	Bewl	28170	99	98	92	84	74	66	38	1990
	Ardingly	4685	100	100	99	92	81	61	47	1996
Wessex	Clatworthy	5364	97	99	98	95	75	75	31	1995
	Bristol WW	• (38666)	(98)	(97)	(91)	(88)	(76)	(76)	(43)	1990
South West	Colliford	28540	100	100	100	99	92	84	43	1997
	Roadford	34500	95	96	93	93	90	87	40	1995
	Wimbleball	21320	99	100	100	99	88	79	40	1995
	Stithians	5205	99	99	98	96	86	77	30	1990
Welsh	Celyn and Brenig	• 131155	100	100	100	100	83	79	49	1989
	Brianne	62140	97	99	100	100	91	87	55	1995
	Big Five	• 69762	95	97	96	92	74	68	29	1995
	Elan Valley	• 99106	97	99	98	92	81	70	46	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	76	81	82	82	80	71	45	1998
	East Lothian	• 10206	99	99	97	98	94	93	63	1989
West of Scotland	Loch Katrine	• 111363	95	93	95	94	89	74	50	1995
	Daer	22412	100	97	100	91	87	73	41	1995
	Loch Thom	• 11840	100	97	93	89	90	75	58	1997

() figures in parentheses relate to gross storage
• denotes reservoir groups
* last occurence
** updated gross capacity

Details of the individual reservoirs in each of the groupings listed above are available on request. The featured reservoirs may not be representative of the storage conditions across each area; this can be particularly important during droughts. The minimum storage figures relate to the 1988-1999 period only. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

Location map . . . Location map

Where the information comes from

The National Hydrological Monitoring Programme was instigated in 1988 and is undertaken jointly by the Institute of Hydrology (IH) and the British Geological Survey (BGS). Financial support for the production of the monthly Hydrological Summaries is provided by the Department of the Environment, Transport and the Regions, the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA) and the Office of Water Services (OFWAT).

River flow and groundwater levels

The National River Flow Archive (maintained by IH) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

River flow and groundwater level data are provided by the regional divisions of the EA (England and Wales) and SEPA (Scotland). In all cases the data are subject to revision following validation (flood and drought data in particular may be subject to significant revision).

Reservoirs

Reservoir level information is provided by the Water Service Companies, the EA and, in Scotland, the West of Scotland and East of Scotland Water Authorities.

Rainfall

Most rainfall data are provided by the Met Office. To allow better spatial differentiation the rainfall data are presented for the regional divisions of the precursor organisations of the EA and SEPA. Initial rainfall estimates for Scotland and the Scottish regions are derived by IH in collaboration with SEPA. Beginning with the June 1999 report, provisional rainfall figures for England and Wales and the EA regions, have been derived by the UK Climate Studies Group at the Met. Office. In England and Wales, earlier 1999 provisional rainfall figures derive from MORECS. MORECS is the generic name for the Meteorological Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain. The discontinuation of the CARP system used by the Met. Office to provide more definitive regional rainfall assessments means that the MORECS figures have not been updated. Negotiations are continuing with the Met. Office to provide more accurate areal figures. Until the negotiations are concluded the regional rainfall figures (and the return periods associated with them) should be regarded as a guide only.

The Meteorological Office
Sutton House
London Road
Bracknell
RG12 2SY
Tel.: 01344 856858; 01344 854024.

The cooperation of all data suppliers is gratefully acknowledged.

Subscription

Subscription to the Hydrological Summaries costs £48 per year. Orders should be addressed to:

Hydrological Summaries
Institute of Hydrology
Wallingford
Oxfordshire
OX10 8BB
Tel.: 01491 838800
Fax: 01491 692424

Selected text and maps are available on the WWW at http://www.nwl.ac.uk/ih

This document is copyright and may not be reproduced without the prior permission of the Natural Environment Research Council.

Centre for Ecology & Hydrology
Institute of Freshwater Ecology
Institute of Hydrology
Institute of Terrestrial Ecology
Institute of Virology & Environmental Microbiology
Natural Environment Research Council

08/99