Hydrological summary

for the United Kingdom

November 1999

General

Overall, November was another mild month with near average rainfall for the UK as a whole – but regional variations were large. These are reflected in differences in the seasonal recoveries of runoff and aquifer recharge rates, but November river flows and groundwater levels were generally well within the normal range. The late November/early December rainfall has been particularly welcome in a few eastern aquifer outcrop areas where the seasonal upturn in groundwater levels is still awaited. Stocks declined modestly in a few reservoirs but most reported an appreciable increase through November; overall stocks for England and Wales remain significantly above average for the beginning of winter.

Rainfall

November witnessed a variety of synoptic patterns allowing airmasses to cross the British Isles from many directions. Overall, westerly airflows predominated but many of the rain-bearing frontal systems followed tracks relatively remote from the English lowlands. Much of the UK experienced a dry, and cold, interlude in mid-November bracketed by wet conditions (in northern Britain especially) - vigorous depressions caused structural damage, substantial transport disruption and flooding during these very unsettled episodes. On the 5th, a slow-moving depression produced notable storm totals in parts of north-western Britain – reaching 90-100 mm in west Cumbria (e.g. at Summergrove and Ennerdale), triggering significant flooding. Storm totals exceeding 40 mm were also common on the 28th heralding a notably wet spell (East Kilbride reported 62 mm on the 28th and 52 mm in ten hours on the 30th). November rainfall totals were well above average in large parts of Scotland, particularly so in many Highland catchments. By contrast, monthly totals were only around half the average in the east Midlands and below 35% in a few southern coastal districts (e.g. Sussex). For England and Wales, only in 1995 has a similarly dry Oct/Nov been experienced since 1988. Nonetheless, a very wet September ensured that autumn (Sept-Nov) rainfall totals were well within the normal range in all regions – this is generally true of accumulations over 6 and 12 months also.

River Flows

Contrary to the normal seasonal trend, runoff from most catchments in southern Britain declined relative to the October totals. Modest flows were also widely experienced in mid-November across Scotland and Northern Ireland. However, many Scottish catchments away from the eastern coastal strip, reported well above average runoff for November – largely a consequence of notably high flows in the first and last weeks; peak flows were the highest of the year in many areas. Local flooding was common around the 5th throughout northern Britain, and extending to the Midlands. It was particularly severe in West Cumbria where low-lying parts of Whitehaven and Egremont were inundated – levels in the River Ehen (at Braystones) exceeded the previous maximum in a record from 1976. Flooding was more widespread on the 28th heralding a cluster of spates; some localities were subject to several flood episodes (e.g. Port Glasgow). The Yarrow Water (at Gordon Arms) registered its second highest flow in a 33-year record. Transport disruption was substantial and widespread, exacerbated in Scotland by landslides (e.g. at Labert, blocking the main rail link to the north from Glasgow). Localised flooding also occurred in rivers draining to Lough Foyle in Northern Ireland. By contrast, spates in the English lowland rivers were very modest and November runoff totals were appreciably below average in most catchments, notably so in the South-East where, in some catchments, the faltering seasonal recovery is reflected in autumn runoff totals of below 50%. Elsewhere, however, most are well within the normal range, and healthy over the December 1998 - November 1999 timespan.

Groundwater

The regional distribution of the November rainfall, combined with continuing soil moisture deficits in the east (East Anglia especially), resulted in the seasonal recovery being delayed or, to the west, gaining little momentum in the major aquifers. The limited late-autumn infiltration is of most significance in parts of the eastern Chalk - particularly in a zone from the North Downs to Cambridgeshire - and in a few Permo-Triassic sandstones outcrops where the 1999 recession has left groundwater levels appreciably below average. Generally however, levels throughout the Chalk and most limestone outcrops remain close to the monthly average, as they have since the early spring. The Permo-Triassic sandstones, where response times and the impact of abstractions tend to be more influential, present a far less coherent picture. Notably high groundwater levels characterise parts of the South-West and north Wales but levels remain depressed in some slow-responding eastern outcrops, particularly where exceptionally low levels were experienced towards the end of the 1995-97 drought.

Institute of Hydrology

British Geological Survey

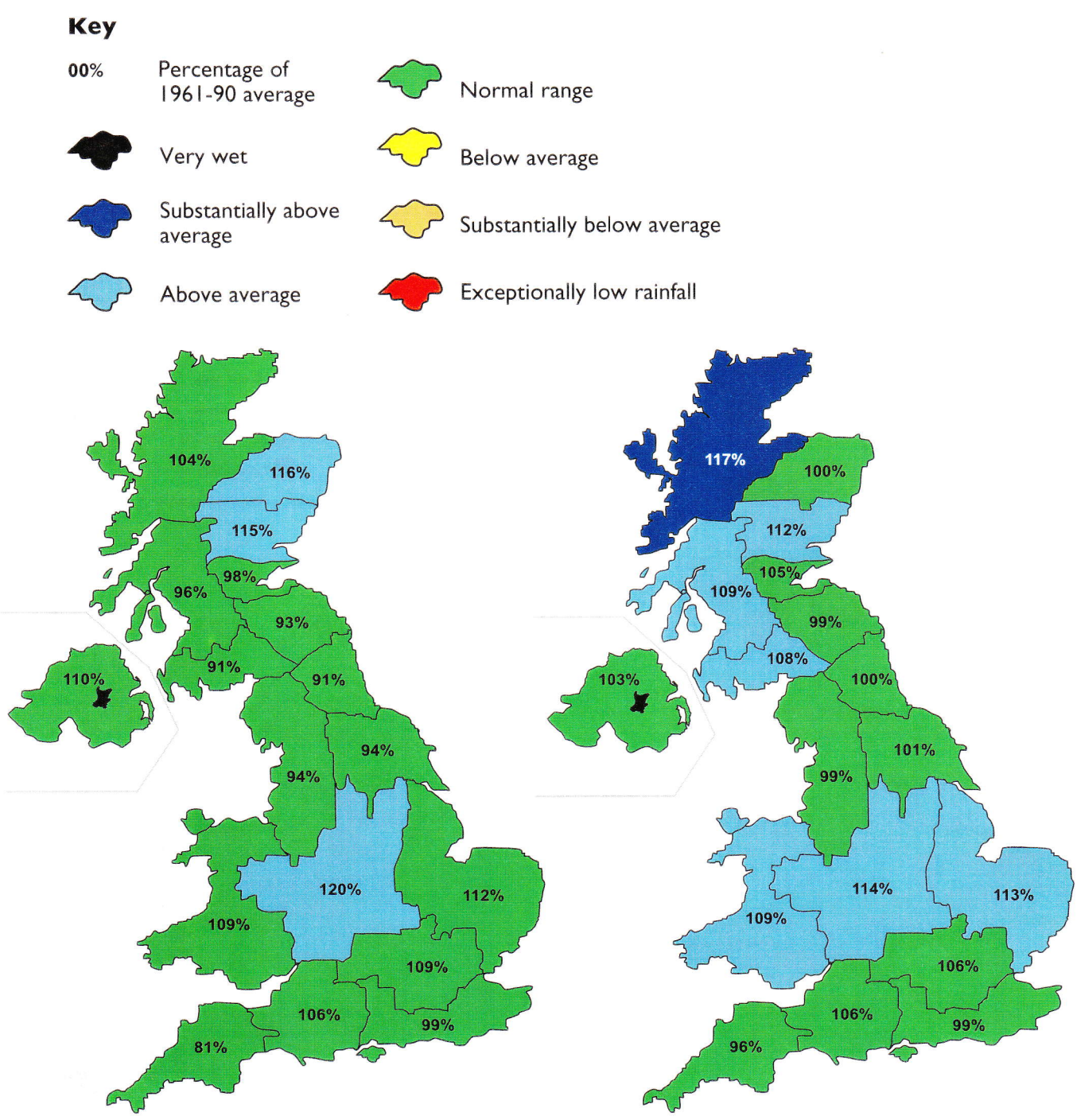
Rainfall accumulations and return period estimates

Area	Rainfall	Nov 1999	Sep 99-Nov 99	RP	Jun 99-Nov 99	RP	Mar 99-Nov 99	RP	Dec 98-Nov99	RP
England & Wales	**mm**	**65**	**257**		**460**		**648**		**907**	
	%	**72**	**102**	**2-5**	**101**	**2-5**	**100**	**<2**	**101**	**2-5**
North West	mm	99	334		568		831		1187	
	%	80	94	2-5	89	2-5	94	2-5	99	2-5
Northumbrian	mm	73	215		409		650		853	
	%	85	91	2-5	93	2-5	103	2-5	100	<2
Severn Trent	mm	54	239		426		627		861	
	%	76	120	2-5	113	2-5	113	2-5	114	5-10
Yorkshire	mm	52	207		390		631		832	
	%	65	94	2-5	94	2-5	105	2-5	101	2-5
Anglian	mm	39	177		366		505		672	
	%	67	112	2-5	117	5-10	111	2-5	113	5-10
Thames	mm	39	203		396		539		729	
	%	60	109	2-5	114	2-5	106	2-5	106	2-5
Southern	mm	43	231		407		547		772	
	%	50	99	2-5	104	2-5	97	2-5	99	2-5
Wessex	mm	56	248		446		633		889	
	%	67	106	2-5	109	2-5	107	2-5	106	2-5
South West	mm	83	271		498		751		1129	
	%	66	81	2-5	90	2-5	94	2-5	96	2-5
Welsh	mm	113	429		684		971		1430	
	%	80	109	2-5	105	2-5	106	2-5	109	2-5
Scotland	**mm**	**183**	**457**		**715**		**1050**		**1591**	
	%	**121**	**102**	**2-5**	**96**	**2-5**	**102**	**2-5**	**111**	**5-10**
Highland	mm	260	594		897		1311		2056	
	%	128	104	2-5	99	2-5	105	2-5	117	10-20
North East	mm	120	327		509		717		973	
	%	121	116	2-5	100	<2	100	<2	100	<2
Tay	mm	137	418		611		915		1381	
	%	113	115	2-5	100	<2	106	2-5	112	5-10
Forth	mm	136	329		550		800		1161	
	%	121	98	2-5	96	2-5	100	<2	105	2-5
Tweed	mm	98	259		454		684		963	
	%	105	93	2-5	90	2-5	96	2-5	99	2-5
Solway	mm	155	404		683		1040		1532	
	%	108	91	2-5	93	2-5	102	2-5	108	2-5
Clyde	mm	223	530		835		1207		1845	
	%	124	96	2-5	94	2-5	100	<2	109	2-5
Northern Ireland	**mm**	**116**	**346**		**553**		**765**		**1094**	
	%	**113**	**110**	**2-5**	**102**	**<2**	**100**	**<2**	**103**	**2-5**

RP = Return period

 All monthly totals since July 1998 are provisional (see page 12). Recent monthly rainfall figures for the Scottish regions have been 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); RP estimates for Northern Ireland are based on the tables for north-west England. 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.

Rainfall . . . Rainfall . . . Rainfall

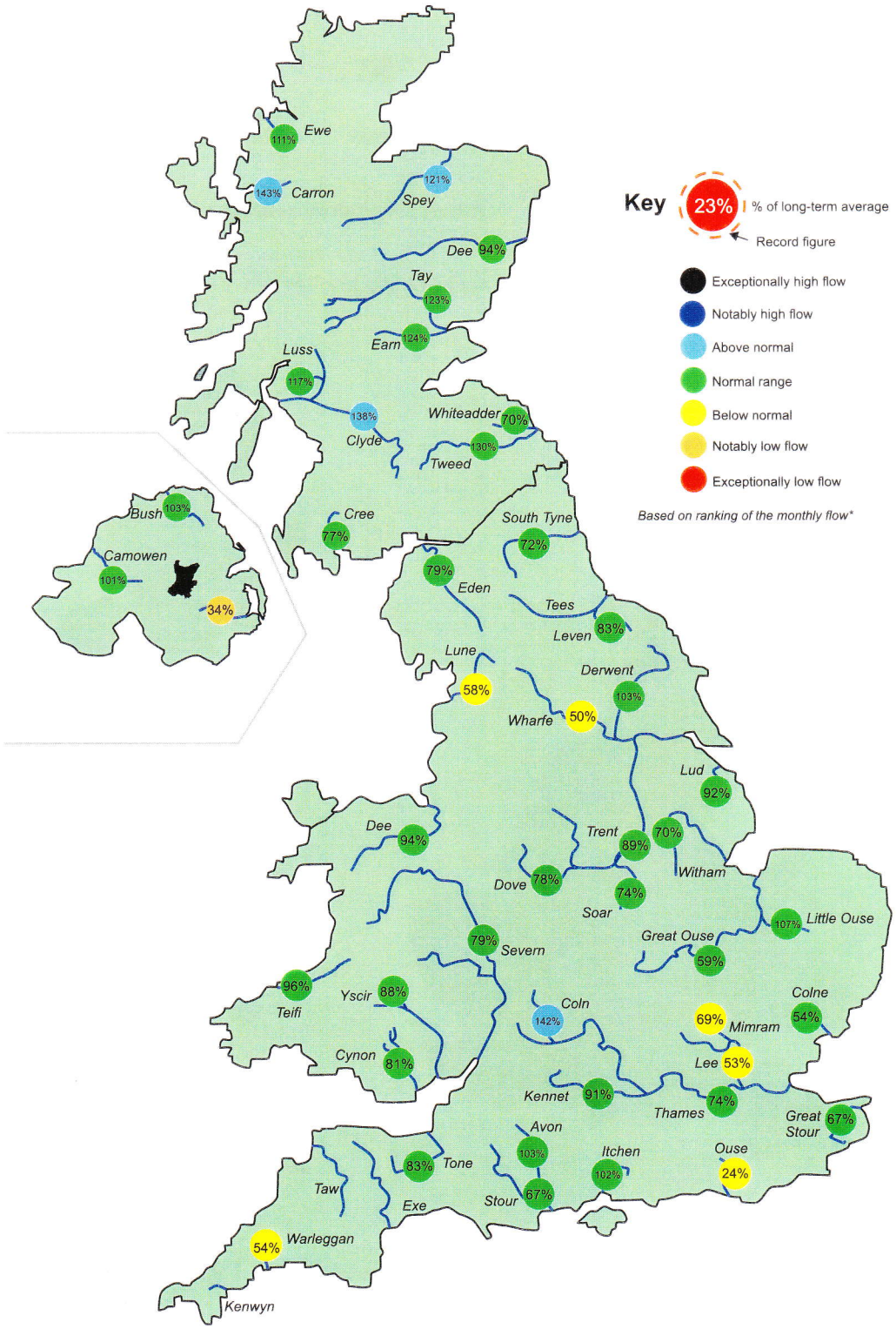


September 1999 - November 1999 **December 1998 - November 1999**

Rainfall accumulation maps

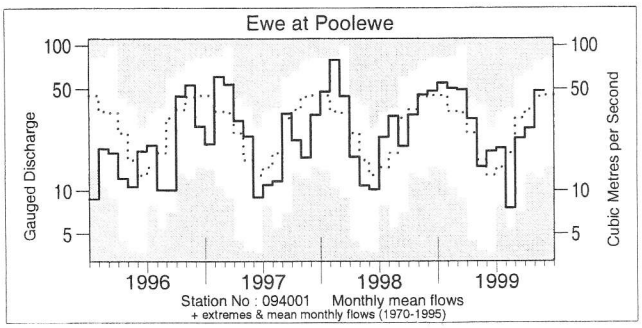
Autumn (September-November) rainfall has been well within the normal range in all regions. Similarly, for the last twelve months, once again, the December-November accumulation for Scotland is significantly above average. In this timeframe, Scottish rainfall over the last 20 years exceeds the preceding average by around 13% (a minor proportion of which is attributable to artifacts in the series which began in 1869).

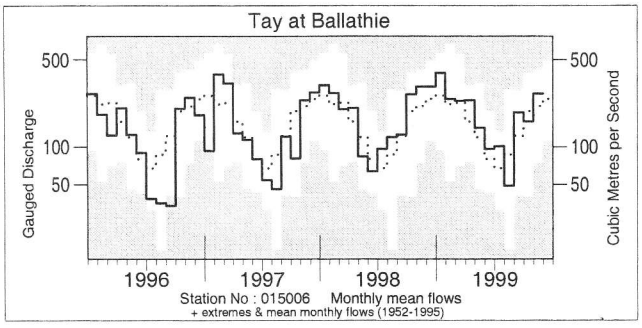
River flow. . . River flow. . .

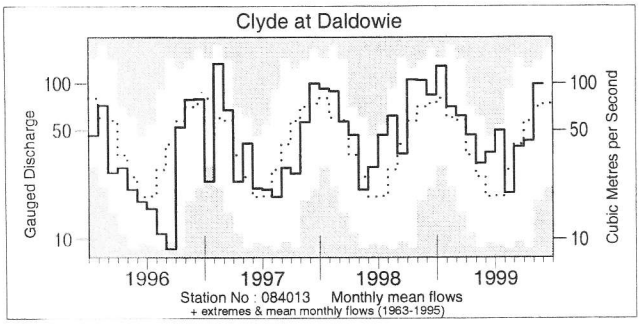


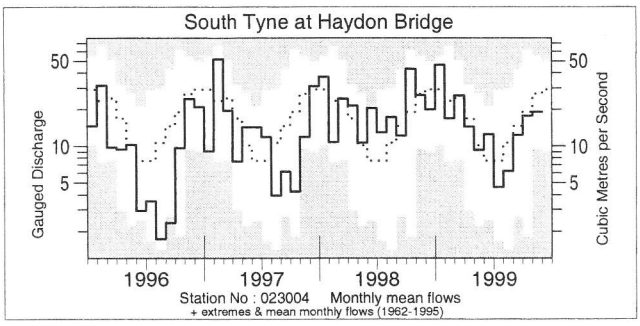
River flows - November 1999

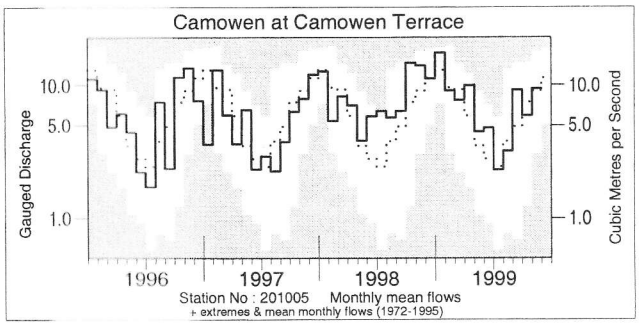
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

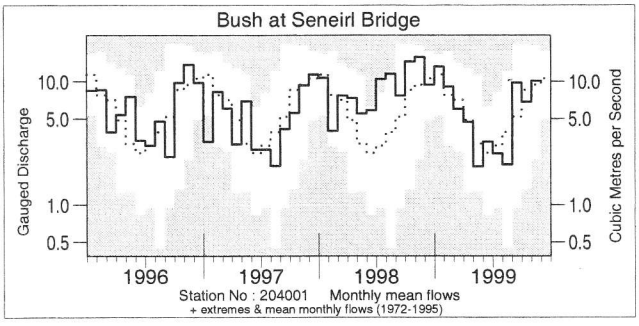


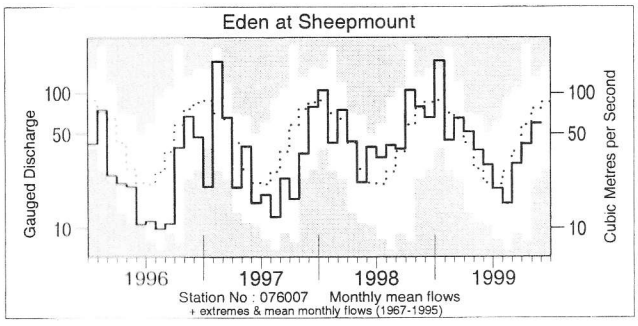


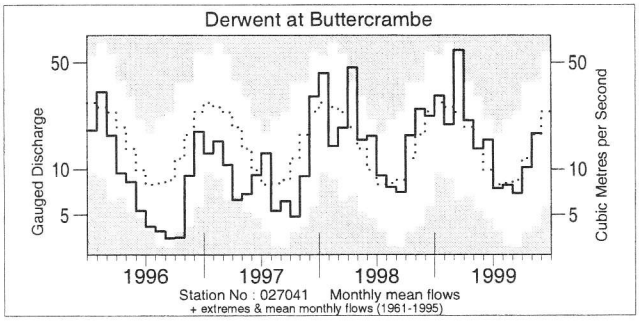


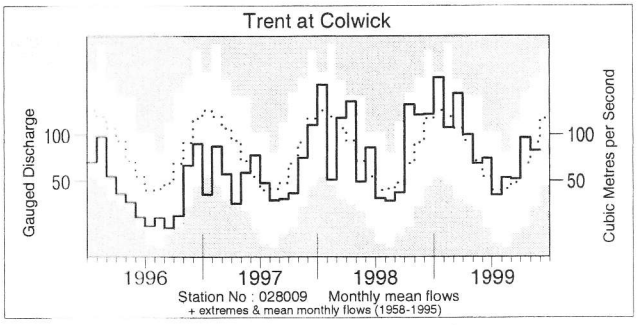


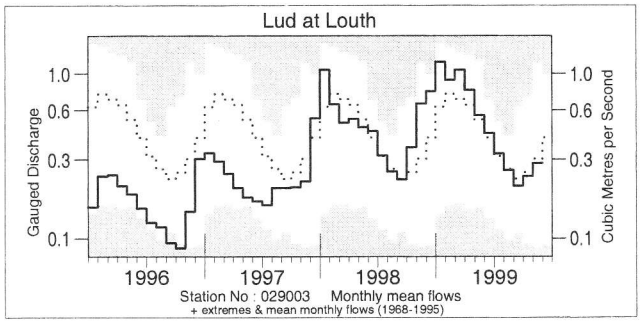








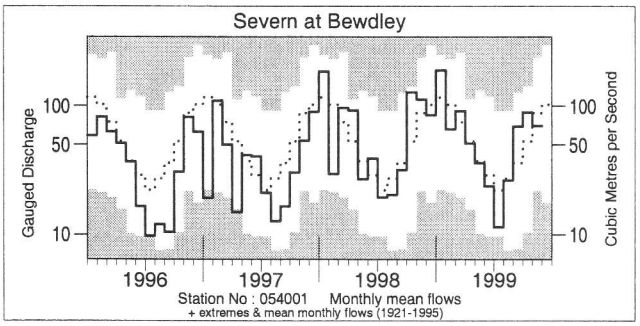


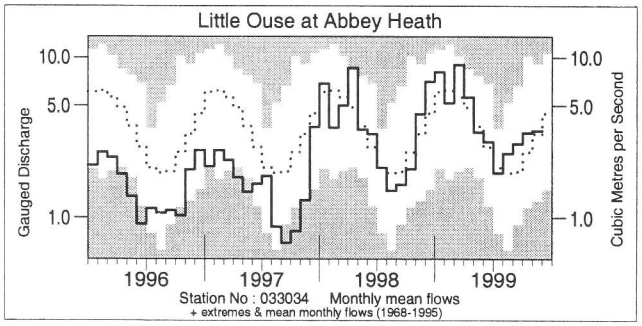


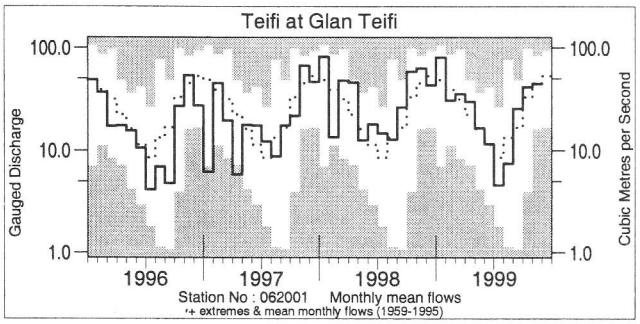
Monthly river flow hydrographs

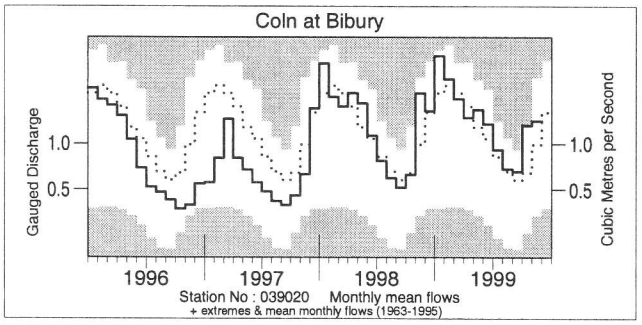
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1996 (shown by the shaded areas). Monthly flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

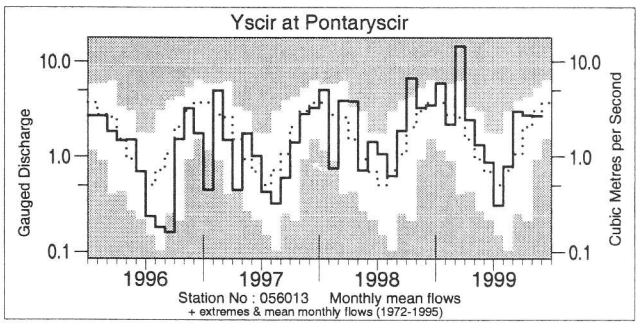
River flow . . . River flow . . .

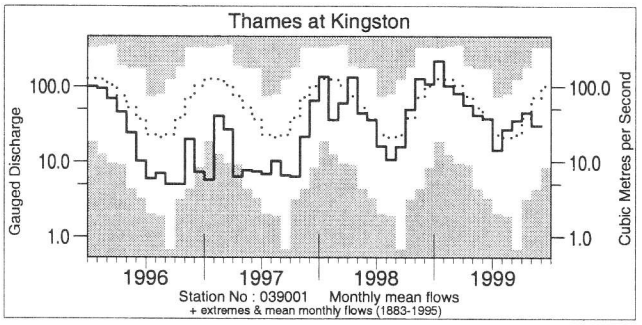


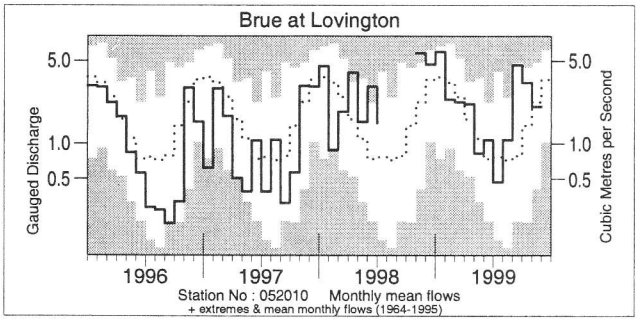


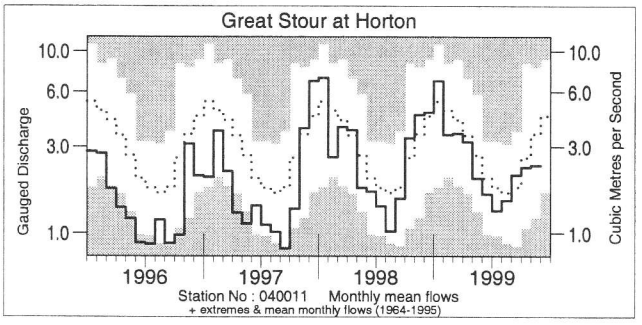


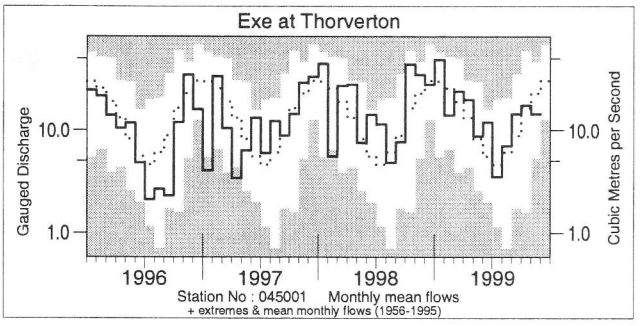


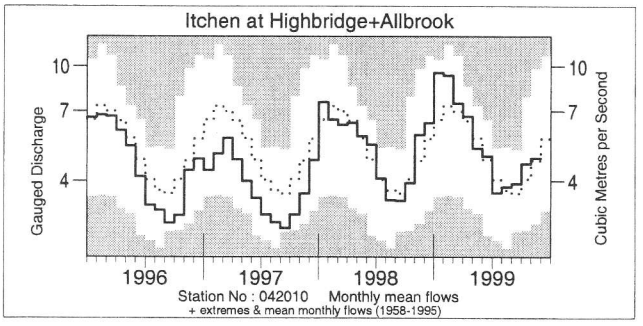










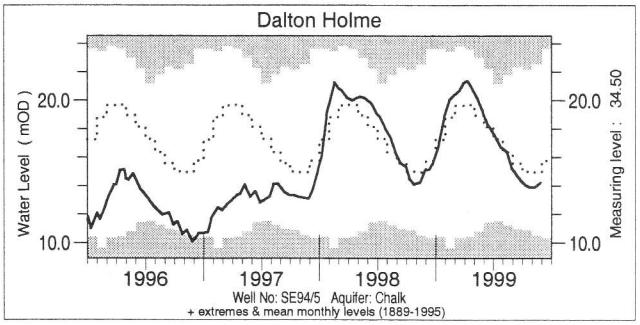


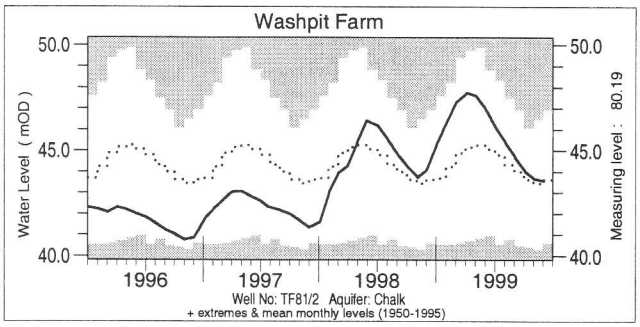
Notable runoff accumulations September 1999 - November 1999 (a); December 1998 - November 1999 (b)

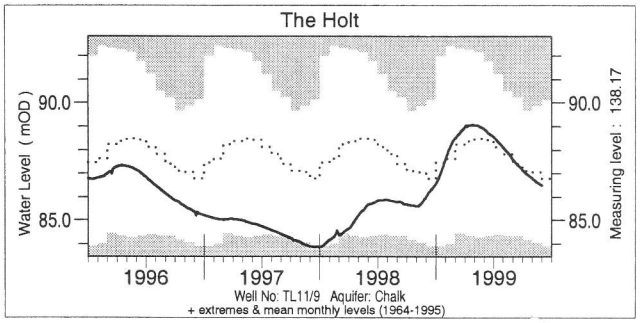
(a) River	%lta	Rank	(b) River	%lta	Rank	River	%lta	Rank
Coln	154	33/36	Witham	154	38/40	Brue	139	33/34
Brue	215	33/34	Coln	123	32/36	Yscir	167	26/26
Annacloy	75	5/20	Medway	66	6/36	Annacloy	90	5/19

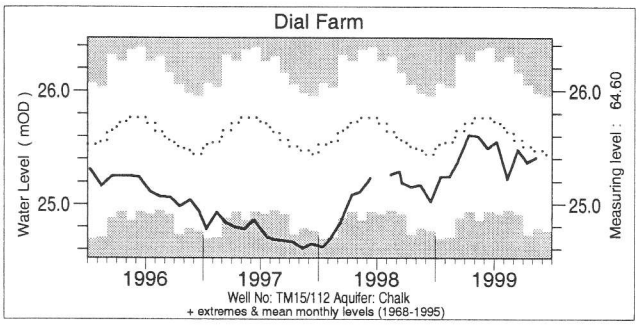
lta = long term average
Rank 1 = lowest on record

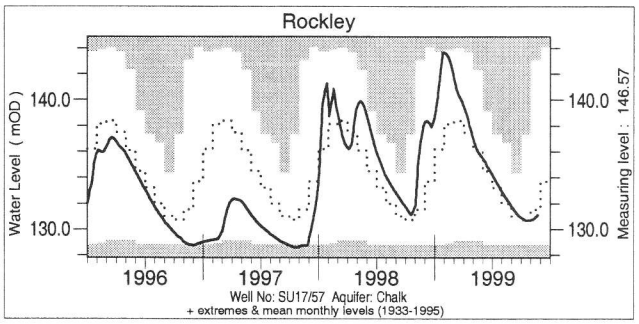
Groundwater . . . Groundwater

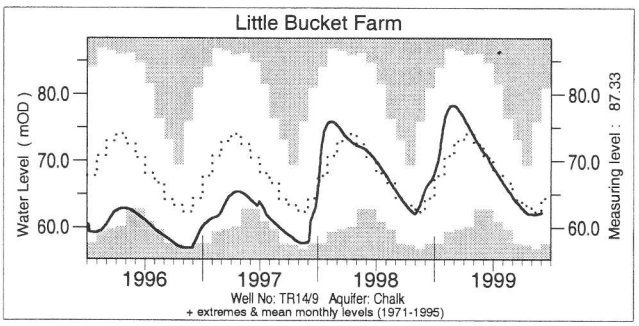


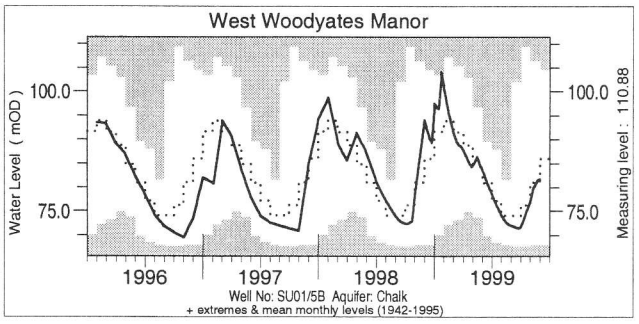


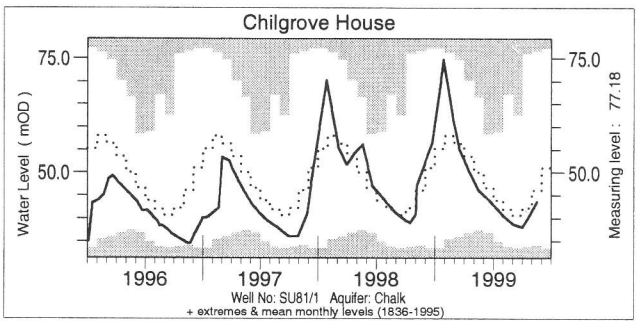


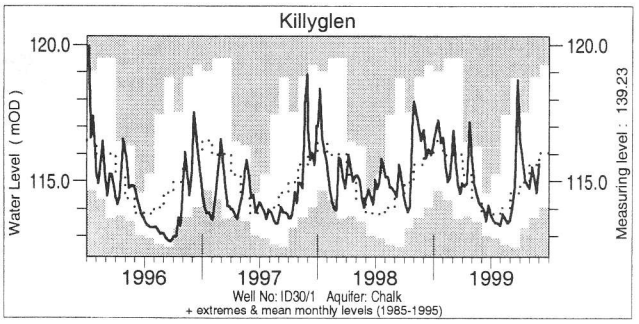


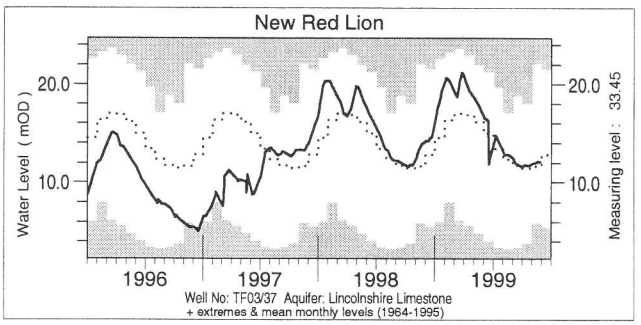








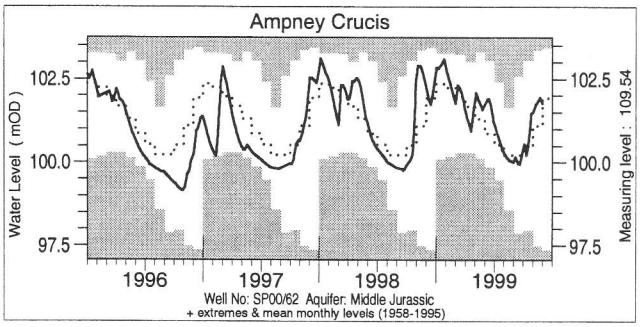


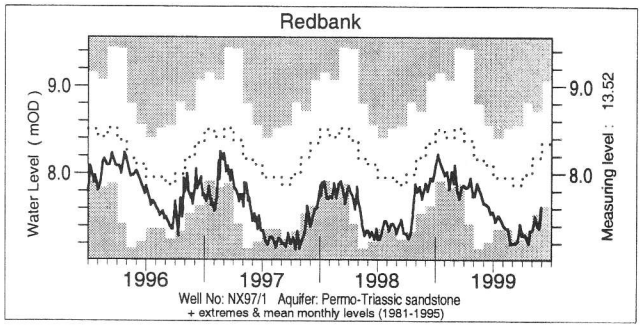


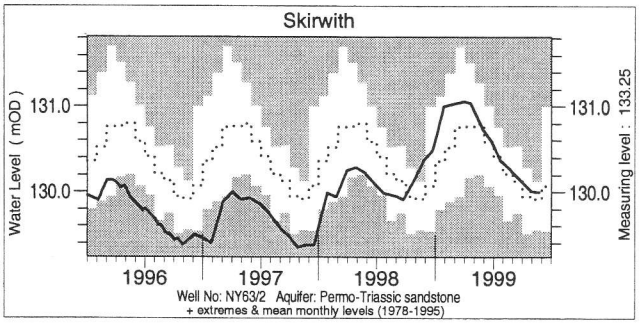
What is groundwater?

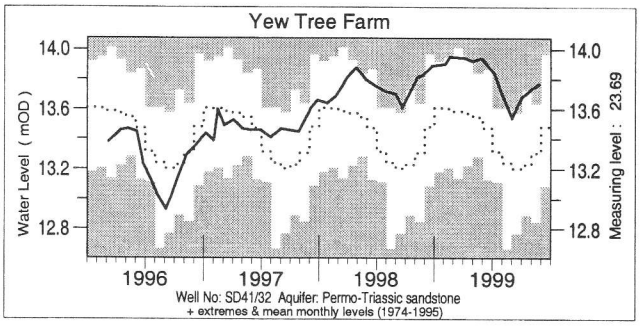
Groundwater is stored in the natural water bearing rock strata (or aquifers) which are found mostly in southern and eastern England (see page 11) where groundwater is the major water supply source. Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment 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.

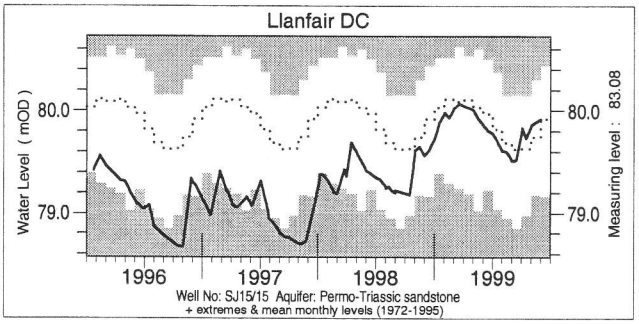
Groundwater . . . Groundwater

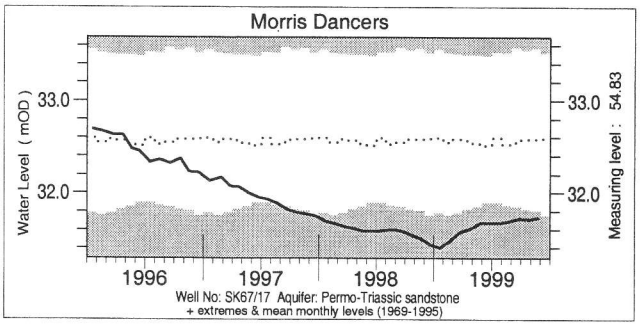


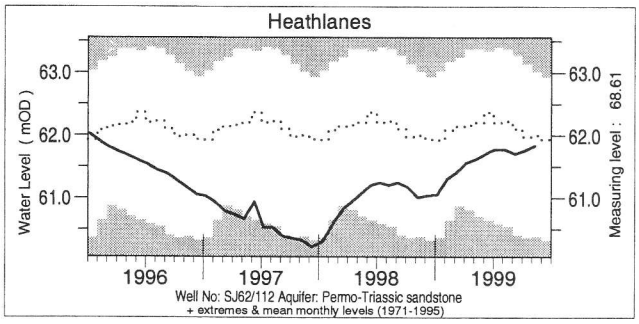


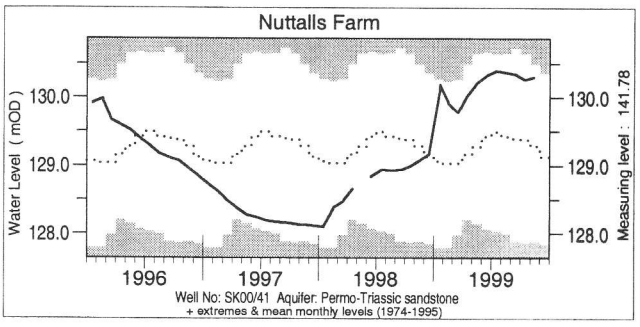


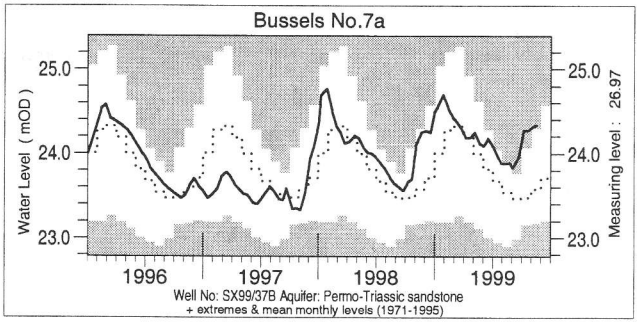


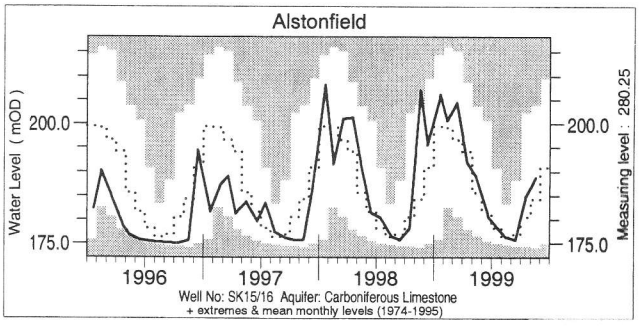












Groundwater levels November/December 1999

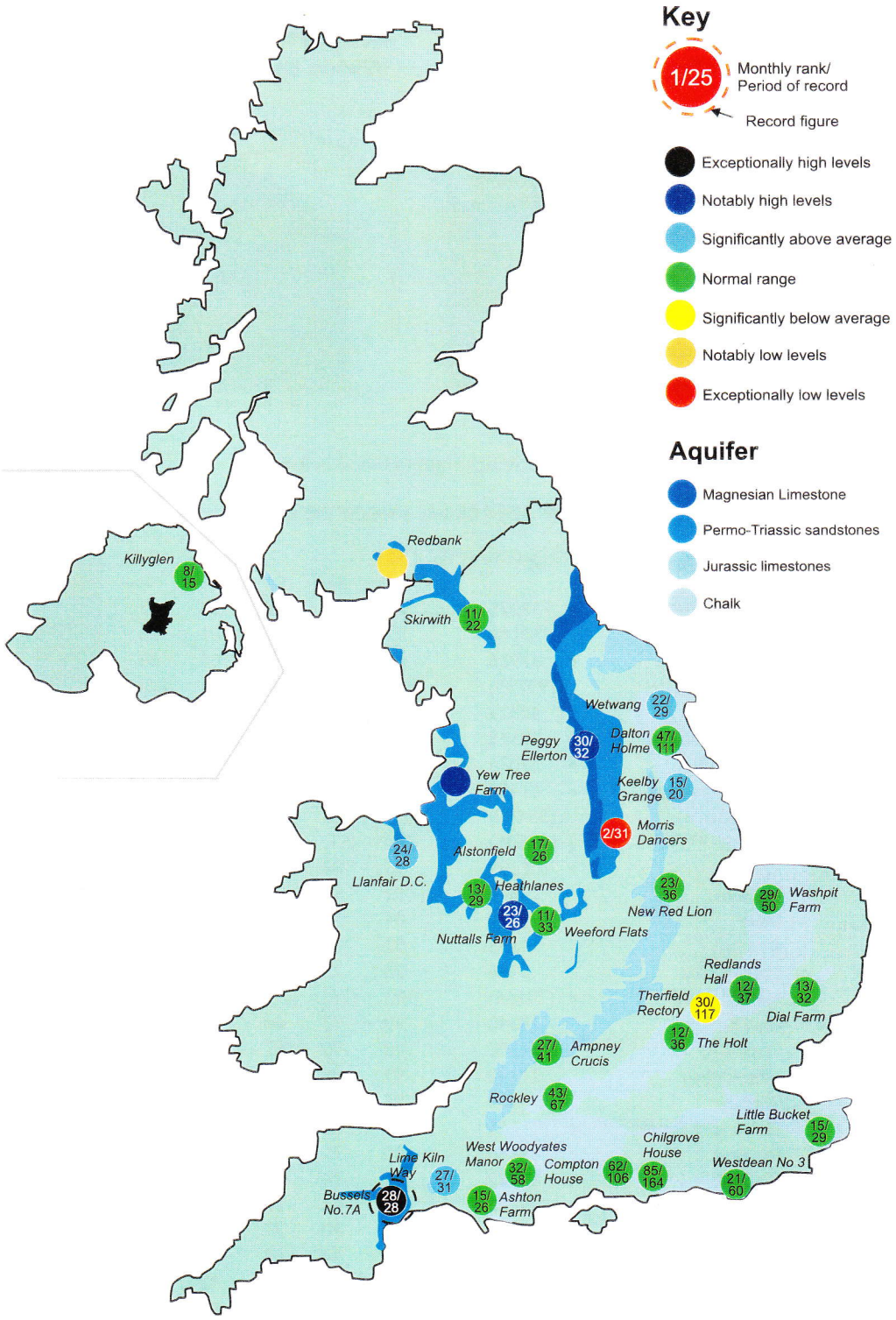
Borehole	Level	Date	Nov av.
Dalton Holme	14.23	26/11	14.79
Washpit Farm	43.57	02/12	43.17
The Holt	86.48	30/11	86.87
Dial Farm	25.41	10/11	25.43
Rockley	131.14	22/11	131.44
Little Bucket	62.31	03/12	62.32
West Woodyates	81.78	30/11	80.53

Borehole	Level	Date	Nov av.
Chilgrove	43.64	15/11	46.50
Killyglen	115.64	30/11	115.98
New Red Lion	12.13	26/11	11.66
Ampney Crucis	101.78	30/11	101.09
Redbank	7.62	28/11	8.11
Skirwith	130.00	23/11	129.85
Yew Tree Farm	13.77	25/11	13.33

Borehole	Level	Date	Nov av.
Llanfair DC	79.92	01/12	79.55
Morris Dancers	31.73	25/11	32.48
Heathlanes	61.84	09/11	61.84
Nuttalls Farm	130.30	09/11	129.34
Bussels No. 7A	24.34	17/11	23.57
Alstonfield	188.78	15/11	184.14

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater

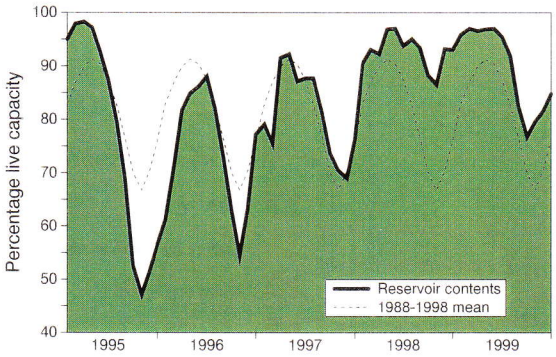


Groundwater levels - November 1999

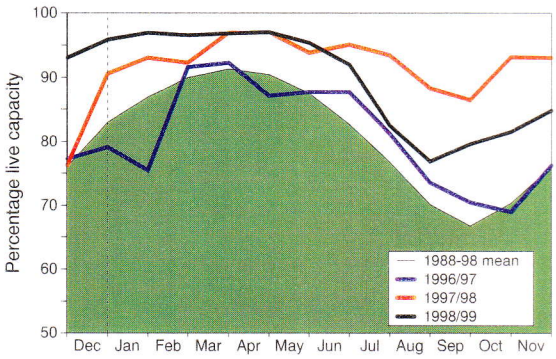
The rankings are normally based on a comparison of current levels (usually a single reading in a month) with the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different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

Reservoirs . . . Reservoirs . .

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 Jul	Aug	Sep	Oct	Nov	**Dec**	Min. Dec	Year* of min
North West	N Command Zone	•	133375	81	71	56	60	57	67	44	1993
	Vyrnwy		55146	87	82	66	81	76	82	33	1995
Northumbrian	Teesdale	•	87936	86	69	61	66	68	69	39	1995
	Kielder		(199175)	(93)	(89)	(88)	(88)	(86)	(87)	(65)	1989
Severn Trent	Clywedog		44922	98	82	83	88	82	84	43	1995
	Derwent Valley	•	39525	90	79	69	64	85	84	9	1995
Yorkshire	Washburn	•	22035	92	83	74	74	72	71	16	1995
	Bradford supply	•	41407	90	77	67	76	77	78	20	1995
Anglian	Grafham **		(55490)	(93)	(88)	(89)	(89)	(92)	(96)	(47)	1997
	Rutland **		(116580)	(88)	(83)	(82)	(79)	(81)	(83)	(57)	1995
Thames	London	•	206399	95	89	85	79	79	90	52	1990
	Farmoor	•	13843	99	97	97	95	93	98	52	1990
Southern	Bewl		28170	84	74	66	61	58	54	34	1990
	Ardingly		4685	92	81	61	57	63	65	44	1989
Wessex	Clatworthy		5364	95	75	75	75	87	91	37	1989
	Bristol WW	•	(38666)	(88)	(76)	(76)	(77)	(89)	(89)	(27)	1990
South West	Colliford		28540	99	92	84	81	81	82	42	1995
	Roadford		34500	93	90	87	91	91	90	8	1989
	Wimbleball		21320	99	88	79	81	83	88	34	1995
	Stithians		5205	96	86	77	70	63	60	29	1990
Welsh	Celyn and Brenig	•	131155	100	83	79	86	88	89	50	1995
	Brianne		62140	100	91	87	100	98	96	72	1995
	Big Five	•	69762	92	74	68	87	90	92	49	1990
	Elan Valley	•	99106	92	81	70	77	99	100	47	1995
East of Scotland	Edinburgh/Mid Lothian	•	97639	82	80	71	71	73	80	56	1998
	East Lothian	•	10206	98	94	93	86	90	98	43	1989
West of Scotland	Loch Katrine	•	111363	94	89	74	92	92	95	86	1997
	Daer		22412	91	87	73	80	93	100	87	1997
	Loch Thom	•	11840	89	90	75	82	73	84	82	1997
Northern Ireland	Silent Valley	•	20634	67	58	56	71	69	58	58	**1999**

() 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 region; this can be particularly important during droughts. The minimum storage figures relate to the 1988-1999 period only (except for West of Scotland where data commence in 1994). 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

National Hydrological Monitoring Programme

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), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

Data Sources

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

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

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.

Rainfall

Most rainfall data are provided by The Met. Office (address opposite). To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA. Since the discontinuation of The Met. Office's CARP system in July 1998, rainfall figures have been provided by differing methods. Initial rainfall estimates for Scotland and the Scottish regions were derived by IH in collaboration with SEPA. In England and Wales, between July 1998 and May 1999, provisional rainfall figures derive from MORECS*. Beginning with the June 1999 report, provisional rainfall figures for England and Wales, the EA regions and Northern Ireland (from January 1999) have been derived by the National Climate Information Centre (NCIC), formerly the UK Climate Studies Group, at The Met. Office. However, readers should note that the MORECS estimates have not been updated since July 1998. Negotiations are continuing with The Met. Office to provide more accurate areal figures and as a result, from October 1999, the rainfall estimates for the Scottish regions are derived by NCIC in a pilot collaboration with IH and SEPA. Until the negotiations are concluded the regional rainfall figures (and the return periods associated with them) should be regarded as a guide only.

*MORECS is the generic name for the Meteorological Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.

The Met. Office
Johnson House
London Road
Bracknell
RG12 2SY
Tel.: 01344 856849
Fax: 01344 854906

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

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

11/99