Hydrological Summary
for the United Kingdom

March 2004

General
March was another relatively dry month and although winter rainfall (Oct-Mar) totals were close the average in most regions, longer term rainfall deficiencies remain very substantial across most of the UK. March rainfall totals were <70% of average over wide areas but, with very modest evaporative demands, stocks in many reservoirs increased appreciably and, as is usual by early April, most were close to capacity (see page 10 for exceptions). Overall stocks for England and Wales were around 93% of capacity, marginally above the early April average, and considerably healthier than corresponding stocks in the drought conditions of 1993 and 1996. Relative to the recent past, groundwater levels are generally low for the early spring but mostly still within the normal range; however, recessions have again begun early, in eastern aquifer units especially. As is often the case, late spring rainfall will greatly influence the water resources outlook for the summer and autumn, particularly in the English Lowlands where soil moisture deficits are beginning to build. Substantially below average rainfall over the next 4-6 weeks could, very probably, be the precursor of depressed river flows and groundwater levels by the early autumn.

Rainfall
March was, at turns, balmy and boisterous with precipitation mostly concentrated in the first three weeks. Gales produced significant rainfall and some wind damage on the 8th (e.g. on the Isle of Wight) and substantial rainfall totals were registered in northern Britain on the 19th (e.g. 60 mm at Loch Glascarnoch, Highland Region). However, many rain-bearing depressions passed to the north of the British Isles and most frontal incursions produced only modest rainfall totals. As a consequence, March rainfall was below average across the UK with the exception of a zone from the Cheviots to Northern Ireland (plus a few other localities). Large parts of eastern Britain registered less than 70% of the March average, the southern Pennines and Cheshire Plain being particularly dry. Provisional Feb-Mar totals are higher than in 2003 but still well below average in most regions, notably so in the South East; for E&W it was the 4th driest Feb-Mar since 1976. Rainfall over the winter half-year has been typified by large month-on-month variability but all regions registered Oct-Mar totals in the normal range (but for Northern Ireland it was the driest since 1986). Longer term deficiencies remain large; a few eastern catchments have reported below average rainfall in 10 of last 12 months and provisional data indicate that, for the UK as a whole, the 14-month period beginning in Feb 2003 was the driest since 1975/76.

River Flows
Many rivers reported a wide range of flows in March, in northern regions of the UK especially. During the first week the continuation of the steep February recessions produced depressed flows in impermeable catchments across northern Britain; the Forth, Tweed, Ribble and Nith were amongst many index rivers eclipsing previous daily minimum flows for the March 10-17th period. A sharp recovery in runoff rates then produced significant spates around the 19th when localised flooding was reported in the Highlands. Steep recessions resumed thereafter and many rivers were again approaching seasonal minima by early April. March runoff totals were well below average (typically, < 70%) at almost all index gauging stations. The Tay reported its second lowest March flow in the last 20 years and, in England, the Trent registered its 3rd lowest March flow in a 47-year record, and many rivers reported their lowest March runoff since 1993 (e.g. the Sussex Ouse). Flows in rivers draining permeable catchments are less responsive to limited early spring rainfall, but seasonal recessions have begun in many Chalk streams, typically from well below average spring peaks – increasing the expectation of very low late summer flows. Importantly however, for most spring-fed rivers current flow rates substantially exceed corresponding values in recent drought years (e.g. 1997, 1992, 1991and 1976).

Groundwater
Although very moist soil moisture conditions were helpful for groundwater replenishment in March, rainfall across most outcrop areas was < 75% - and infiltration rates less than half - the long term average. As importantly, winter recharge totals were well below average across almost all aquifer outcrop areas. Groundwater levels in most index wells and boreholes normally peak in the late winter/early spring. In the absence of substantial late April recharge, the spring maxima in 2004 will, over wide areas, be their lowest for seven years with most recessions commencing from below average levels. Recessions are well established in much of the southern Chalk (e.g. at Chilgrove and Rockley) but levels continue to rise at the deep Therfield well. Levels are also falling in the Limestone aquifers but rising slowly in the slowest responding Permo-Triassic sandstones. Overall groundwater resources are substantially lower than at the corresponding time in 2003 (and, generally, for the1998-2002 period). Nonetheless, most March groundwater levels were within the normal spring range; generally below average but well above the levels which characterised the early and mid-1990s, and much of the 1970s. Late-March soil moisture deficits were lower than in 2003 but a continuation of dry and warm conditions in late April may well terminate the recharge season in the east.

Centre for Ecology & Hydrology
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Mar 2004	Feb 04-Mar 04	RP	Oct 03-Mar 04	RP	Aug 03-Mar 04	RP	Feb 03-Mar 04	RP
England & Wales	**mm**	**50**	**100**		**509**		**565**		**895**	
	%	**67**	**72**	**5-10**	**101**	**2-5**	**86**	**5-10**	**85**	**5-15**
North West	mm	65	150		617		723		1177	
	%	68	87	2-5	92	2-5	81	5-10	86	5-10
Northumbrian	mm	60	117		448		512		796	
	%	86	91	2-5	98	2-5	84	5-10	81	10-20
Severn Trent	mm	38	78		363		407		700	
	%	62	67	5-10	92	2-5	77	5-15	81	10-20
Yorkshire	mm	41	94		398		477		804	
	%	60	75	2-5	90	2-5	82	10-20	85	5-10
Anglian	mm	31	64		320		347		597	
	%	66	77	2-5	107	2-5	86	2-5	88	5-10
Thames	mm	42	72		380		407		639	
	%	75	71	2-5	105	2-5	85	2-5	81	5-15
Southern	mm	40	67		453		485		715	
	%	64	57	5-15	102	2-5	85	2-5	80	10-20
Wessex	mm	56	100		485		510		805	
	%	80	74	2-5	102	2-5	83	5-10	83	5-15
South West	mm	85	150		650		703		1149	
	%	86	75	2-5	91	2-5	79	5-15	84	5-15
Welsh	mm	76	187		752		838		1333	
	%	71	92	2-5	97	2-5	84	5-10	88	5-10
Scotland	**mm**	**96**	**205**		**805**		**933**		**1427**	
	%	**77**	**90**	**2-5**	**96**	**2-5**	**85**	**5-10**	**86**	**10-20**
Highland	mm	115	287		1053		1216		1801	
	%	71	99	2-5	98	2-5	89	2-5	88	5-10
North East	mm	62	129		532		603		898	
	%	80	90	2-5	100	<2	85	5-10	80	20-35
Tay	mm	76	144		605		685		1121	
	%	70	71	5-10	83	5-10	73	20-30	78	15-25
Forth	mm	67	134		545		636		1022	
	%	72	78	2-5	87	2-5	76	10-20	80	20-35
Tweed	mm	71	131		493		556		892	
	%	89	90	2-5	94	2-5	79	5-15	80	20-30
Solway	mm	113	200		783		892		1417	
	%	96	92	2-5	95	2-5	82	5-10	86	5-10
Clyde	mm	119	210		913		1075		1683	
	%	81	79	2-5	91	2-5	81	5-15	86	5-15
Northern Ireland	**mm**	**86**	**132**		**522**		**611**		**1069**	
	%	**98**	**80**	**2-5**	**87**	**2-5**	**78**	**5-15**	**87**	**5-10**

RP = Return period

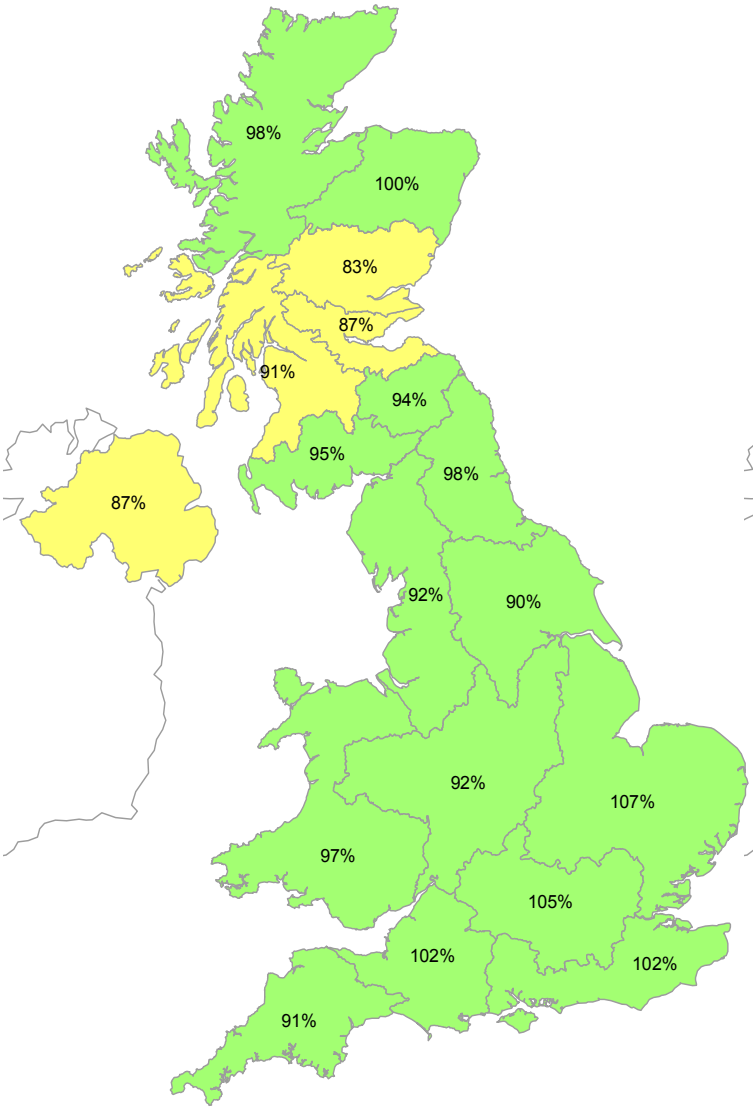
 All monthly totals since December 1998 are provisional (see page 12). The figures for England & Wales are derived by the Hadley Centre and are updates of the homogenised series developed by the Climate Research Unit; the other national figures are derived from different raingauge networks to those used to derive the CRU data series. The return period estimates are based on tables provided by The Met 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 Scottish rainfall series in particular, can exaggerate the relative wetness of the recent past.

*See page 12.

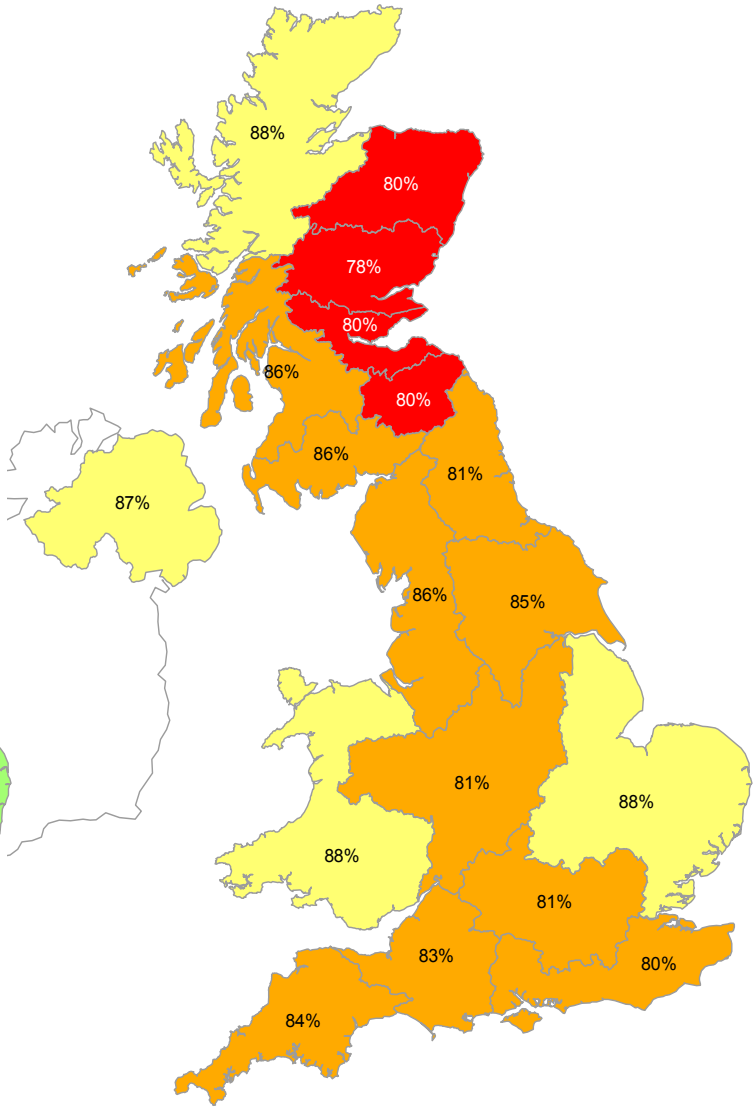
Rainfall . . . Rainfall . .

Key

00%	Percentage of 1961-90 average
	Very wet
	Substantially above average
	Above average
	Normal range
	Below average
	Substantially below average
	Exceptionally low rainfall



October 2003 - March 2004

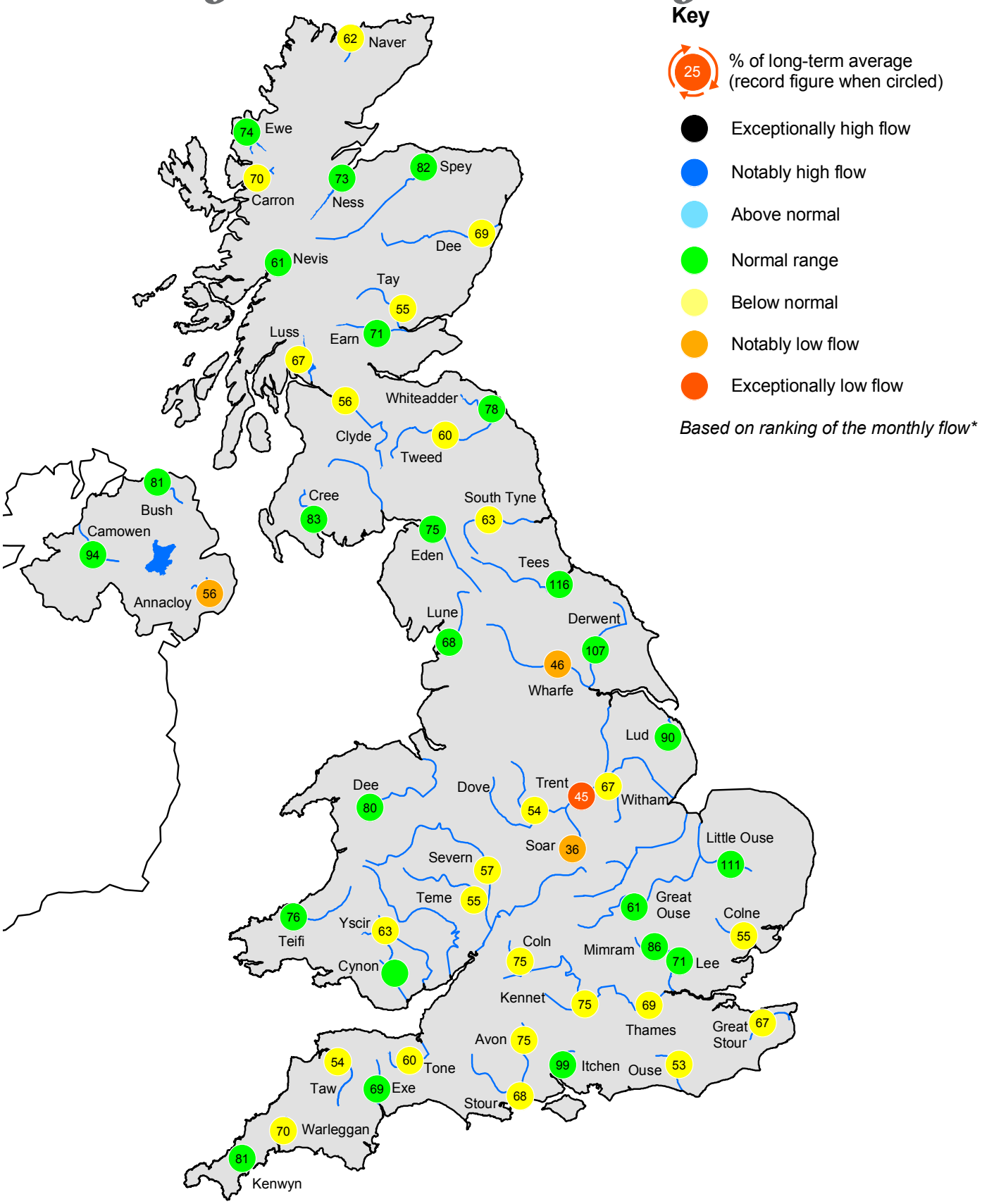


February 2003 - March 2004

Rainfall accumulation maps

Notwithstanding the substantially below average rainfall for February and March, the winter half-year rainfall totals were in the 83-105% range for all regions of the UK. A contrasting picture emerges over the 14-month timeframe: Feb 2003-March 2004 rainfall deficiencies are substantial throughout the country. In water resources terms, their significance is greatest in the English Lowlands but in a hydrological context, the deficiencies in eastern Scotland are most notable - the Tay region registering its driest such period since 1975/76.

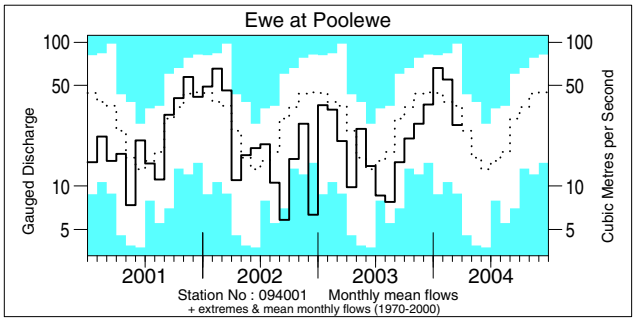
River flow . . . River flow . . .

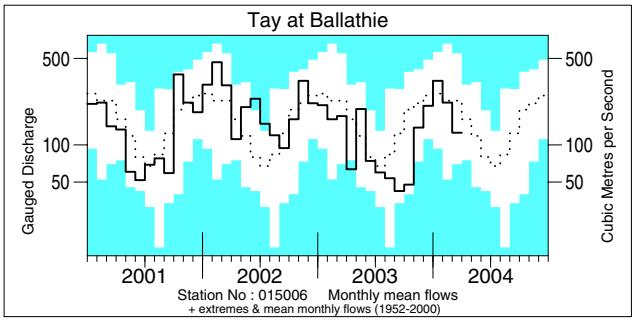


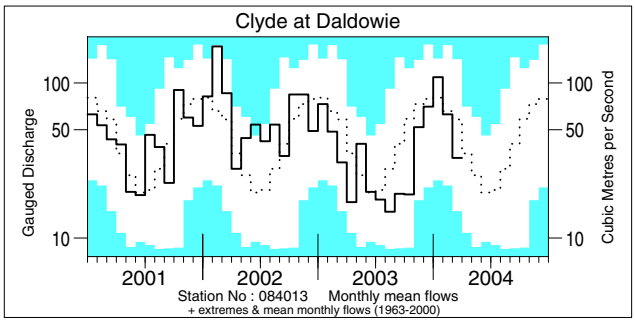
River flows - March 2004

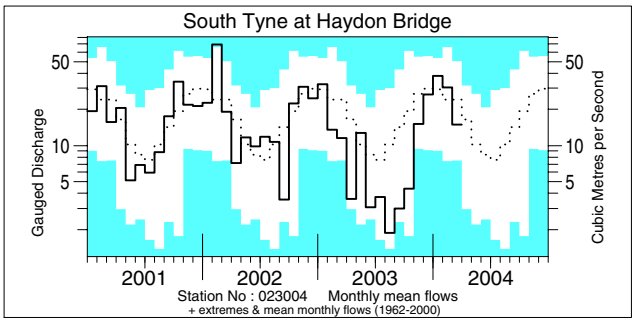
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station. Percentages may be omitted where flows are under review.

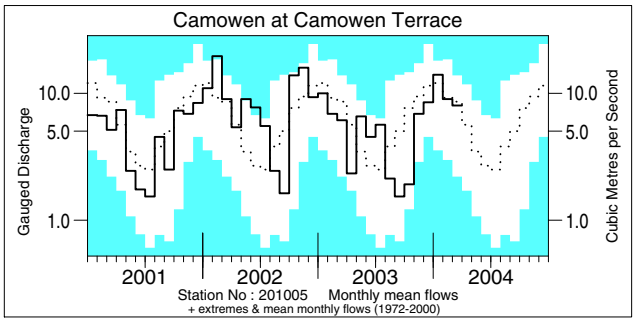
River flow . . . River flow . . .

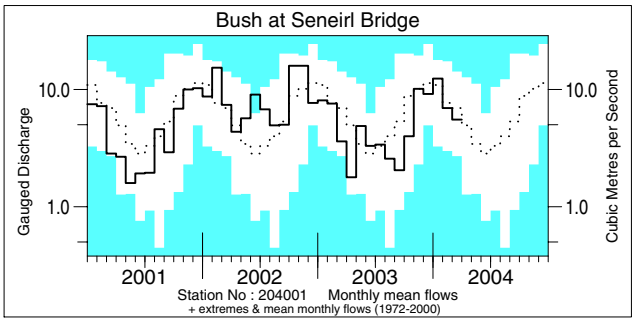


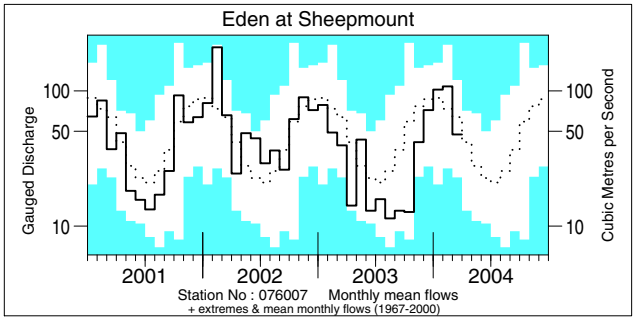


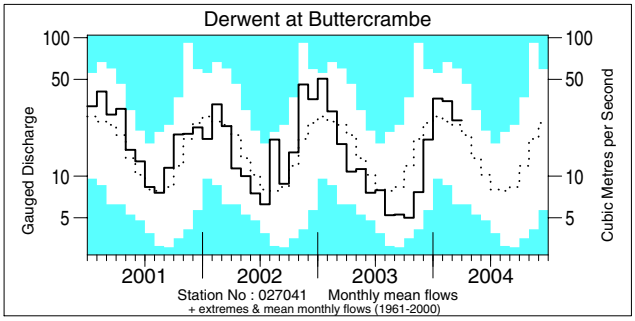


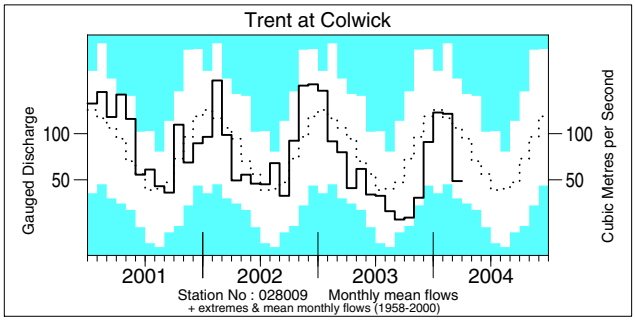


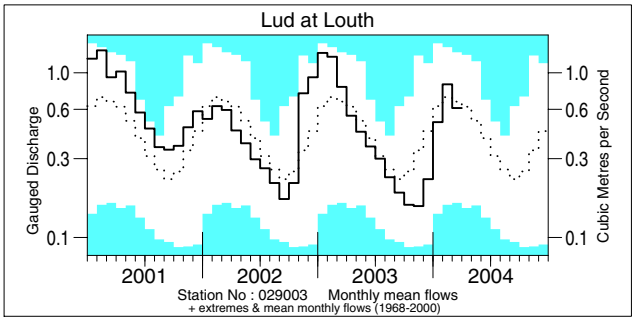








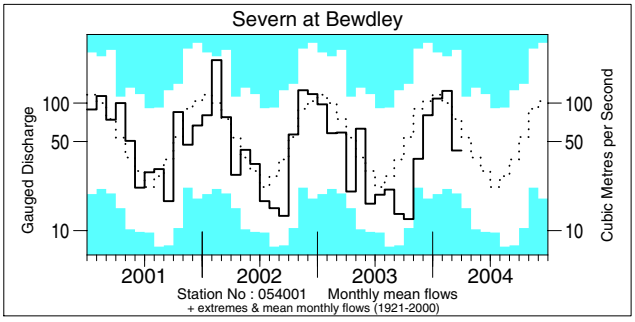


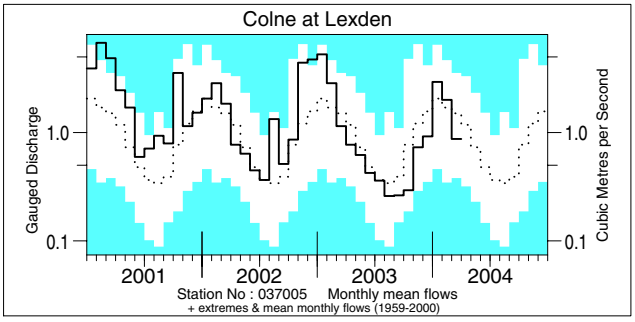


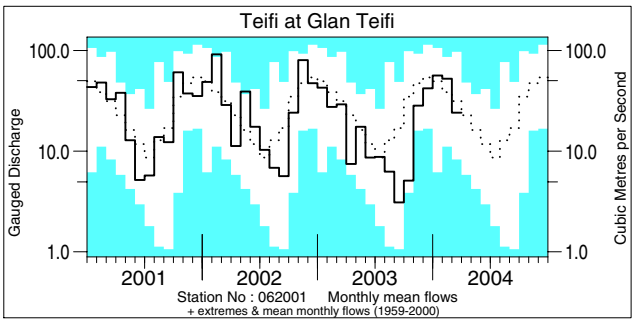
Monthly river flow hydrographs

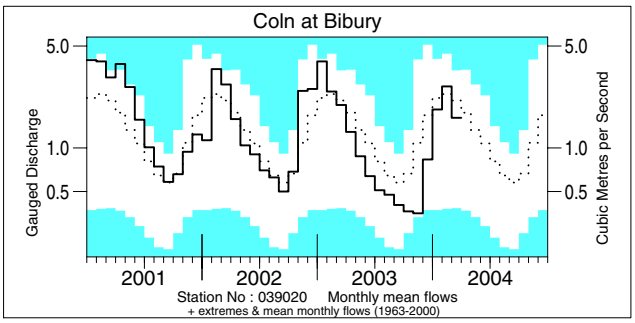
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 2001 (shown by the shaded areas). Monthly flows falling outside the maximum/ minimum range are indicated where the bold trace enters the shaded areas.

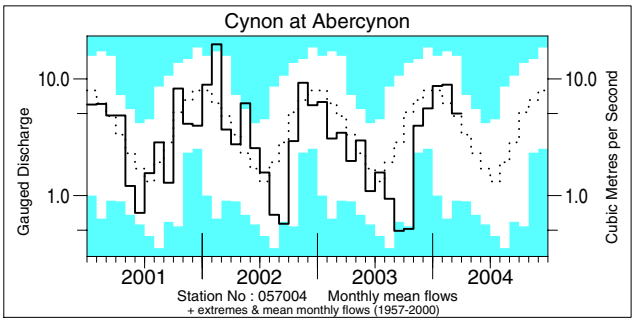
River flow . . . River flow . . .

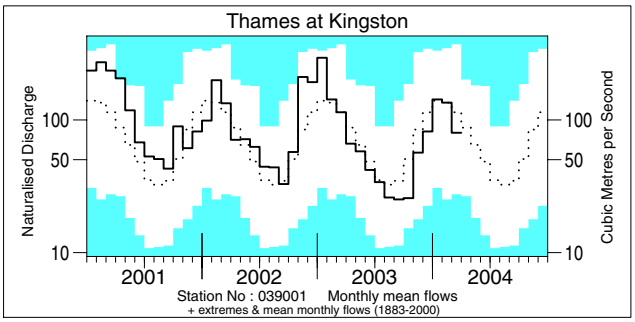


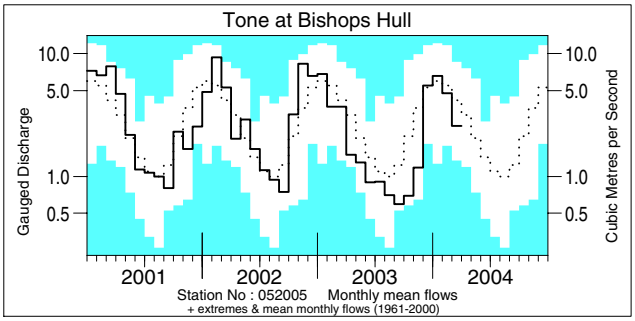


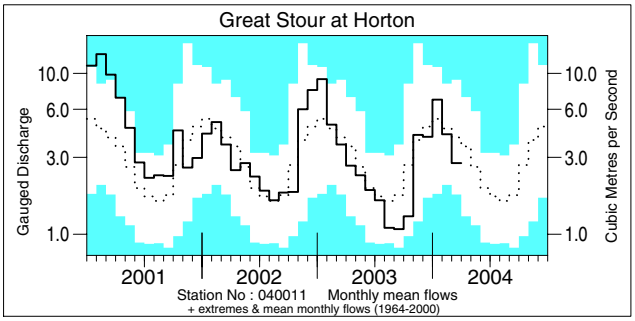


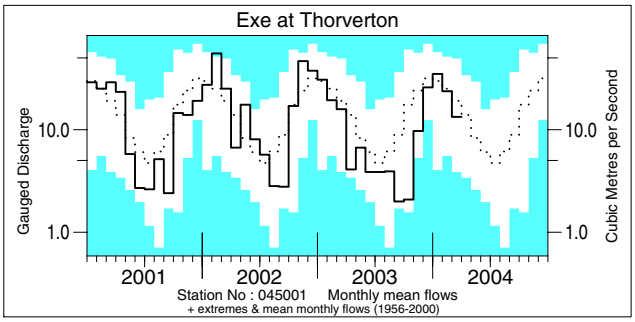


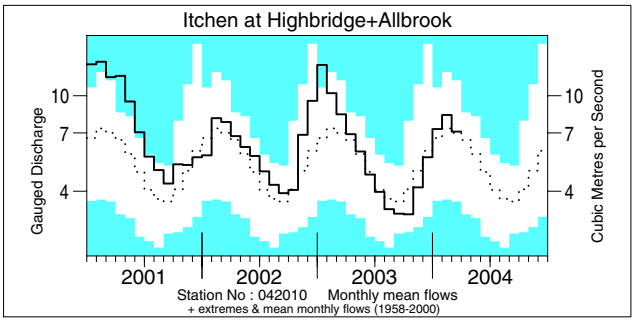












Notable runoff accumulations (a) October 2003 - March 2004, (b) April 2003 - March 2004

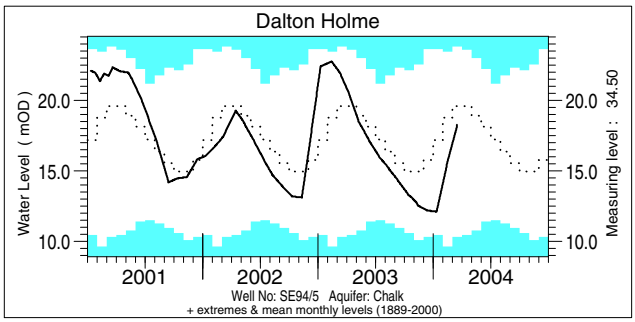
	River	%lta	Rank
a)	Dee (Park)	66	2/31
	Forth	61	1/23
	Medway	47	5/44
	Kenwyn	71	4/36
	Camowen	83	3/29
	Faughan	71	2/28
	Lower Bann	73	2/24
	Annacloy	62	1/24

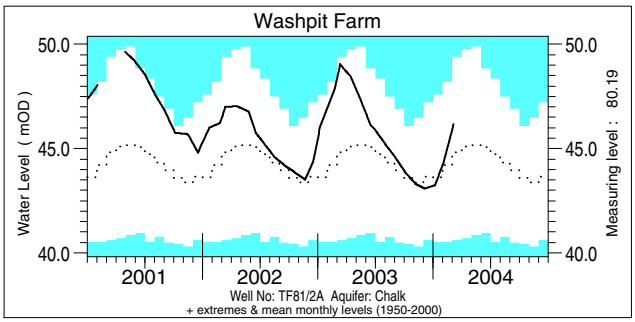
	River	%lta	Rank
b)	Spey (Boat o'Garten)	68	2/52
	Dee (Woodend)	68	1/74
	Tay	77	4/51
	Earn	71	4/56
	Tweed (Norham)	70	3/44
	S Tyne	72	3/40
	Trent	71	5/45

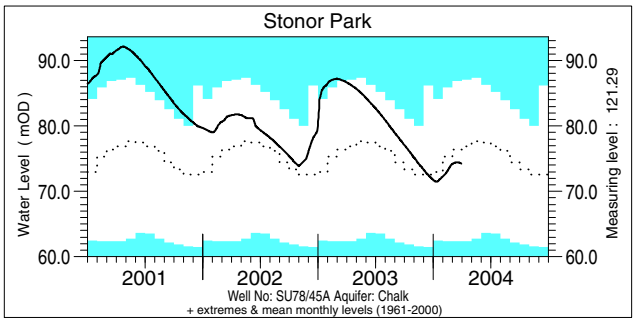
River	%lta	Rank
Exe	69	4/47
Taw	62	3/45
Wye	69	5/67
Luss	74	1/25
Naver	84	3/26
Mourne	82	3/21
Lagan	70	2/29

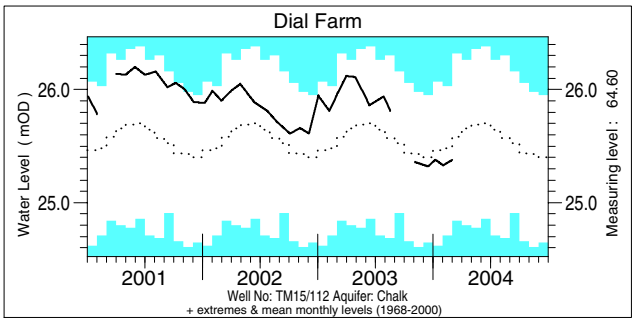
lta = long term average
Rank 1 = lowest on record

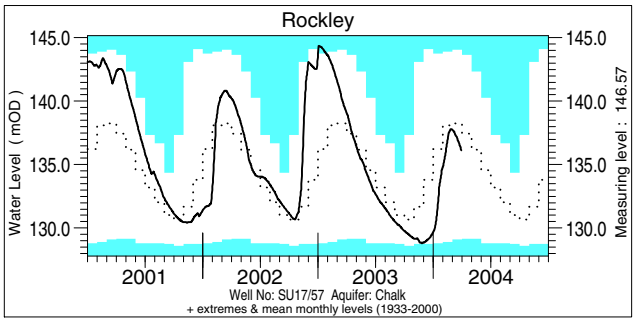
Groundwater . . . Groundwater

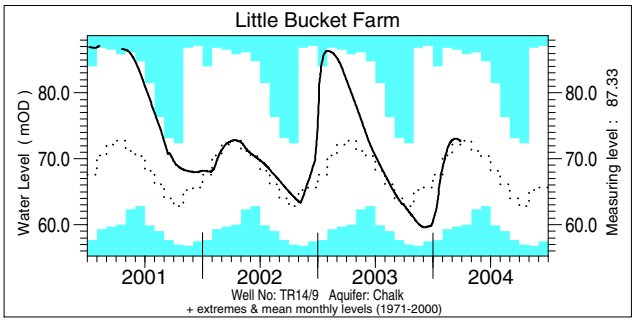


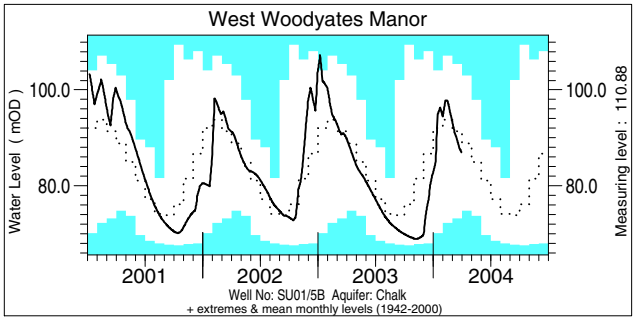


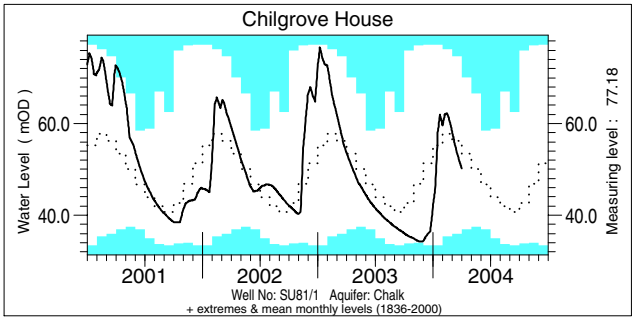


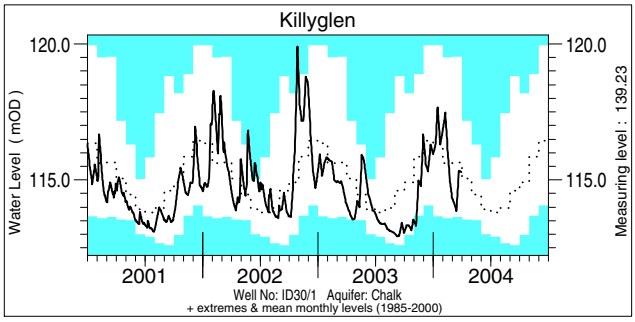


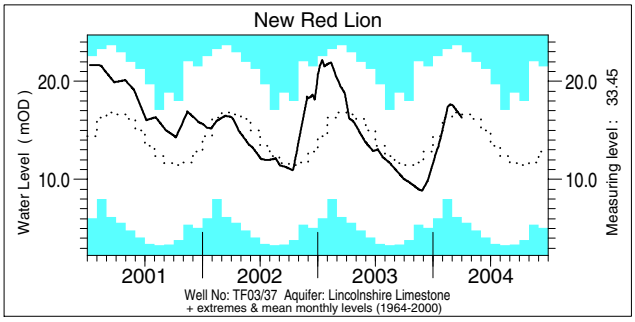






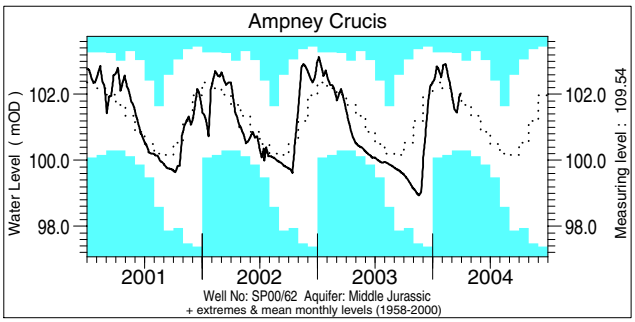


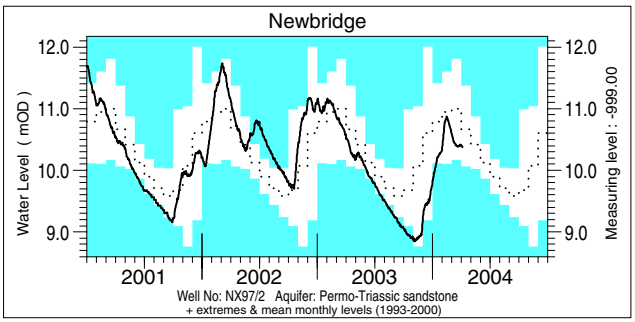


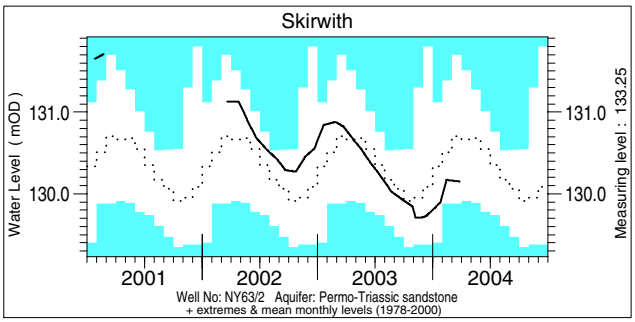


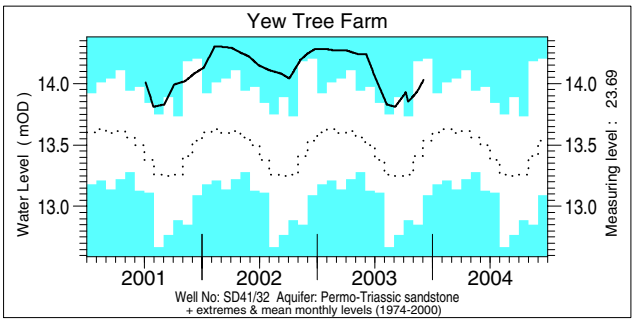
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined 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.

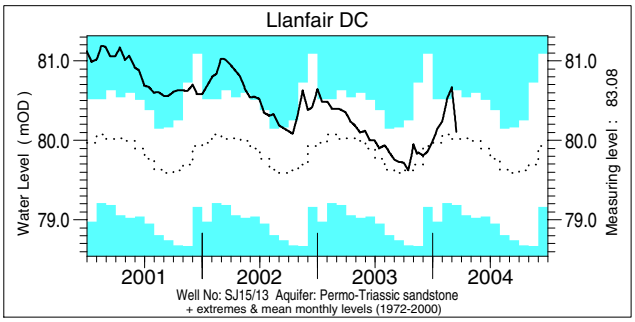
Groundwater . . . Groundwater

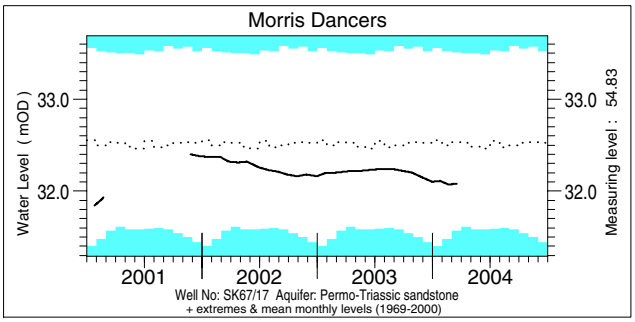


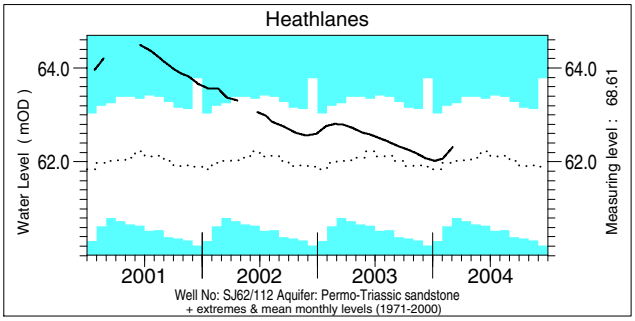


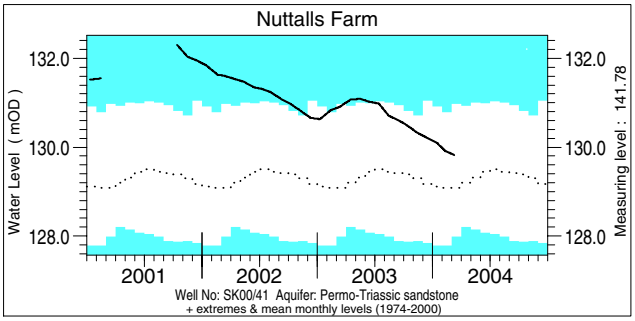


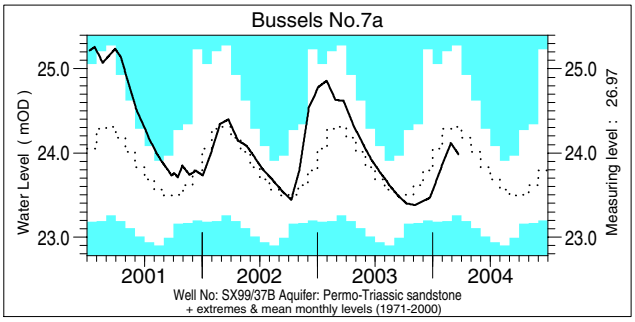


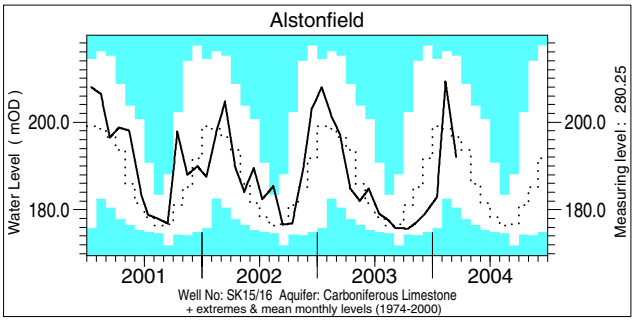










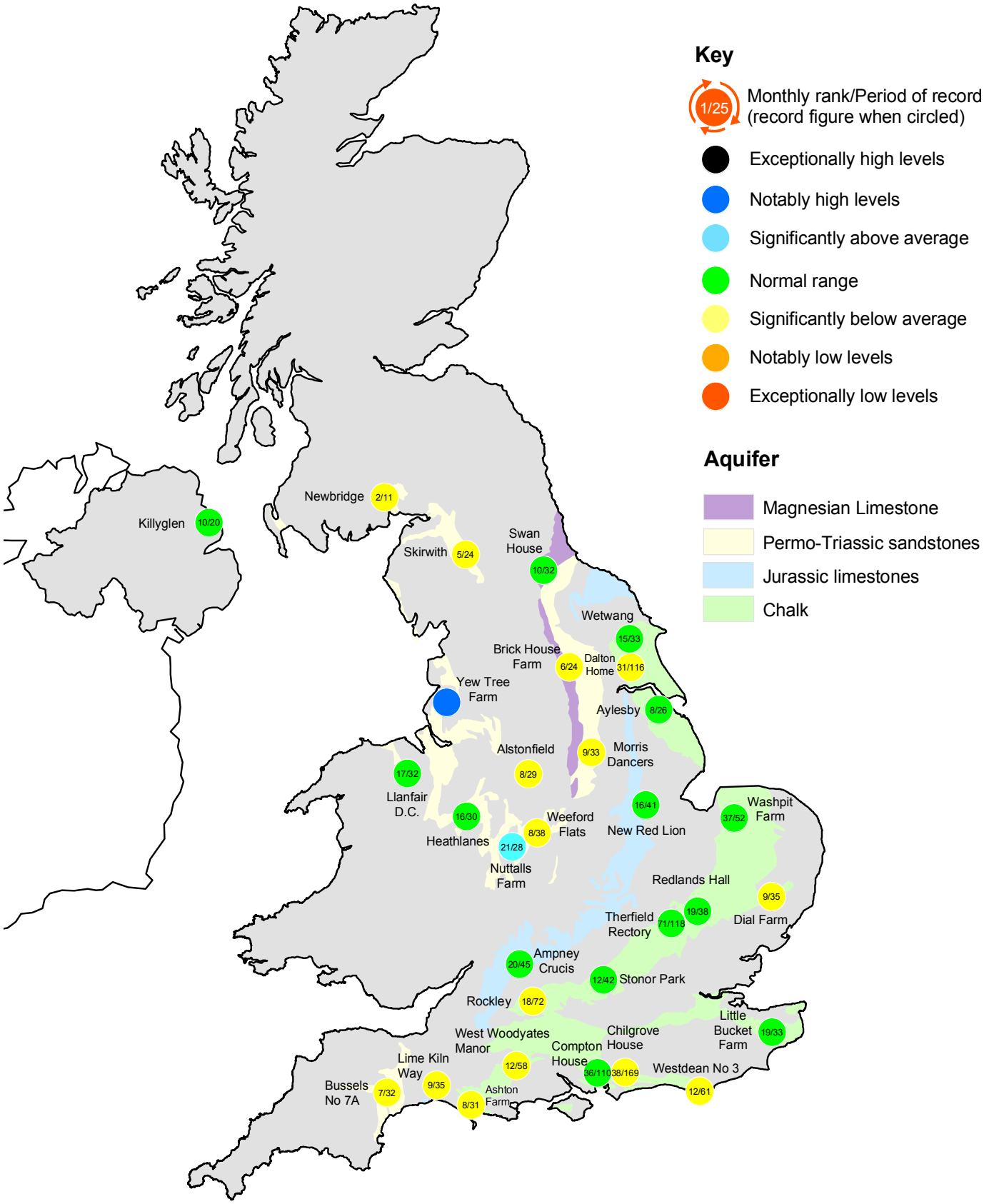


Groundwater levels March / April 2004

Borehole	Level	Date	Mar. av.	Borehole	Level	Date	Mar. av.	Borehole	Level	Date	Mar. av.
Dalton Holme	18.25	16/03	19.52	Chilgrove House	50.16	31/03	55.57	Llanfair DC	80.11	15/03	80.05
Washpit Farm	46.16	05/03	44.98	Killyglen	115.30	30/03	115.62	Morris Dancers	32.08	18/03	32.39
Stonor Park	74.28	30/03	77.17	New Red Lion	16.30	31/03	16.72	Heathlanes	62.32	04/03	62.05
Dial Farm	25.38	02/03	25.60	Ampney Crucis	102.03	30/03	102.04	Nuttalls Farm	129.82	10/03	129.39
Rockley	136.14	30/03	138.47	Newbridge	10.37	05/04	11.00	Bussels No.7a	23.98	22/03	24.35
Little Bucket Farm	72.66	28/03	72.18	Skirwith	130.15	25/03	130.68	Alstonfield	192.09	15/03	196.57
West Woodyates	86.96	31/03	90.79	Yew Tree Farm	14.30	19/03	13.66				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater

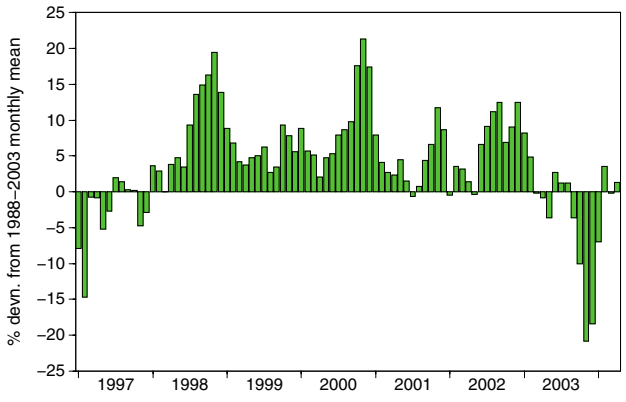


Groundwater levels - March 2004

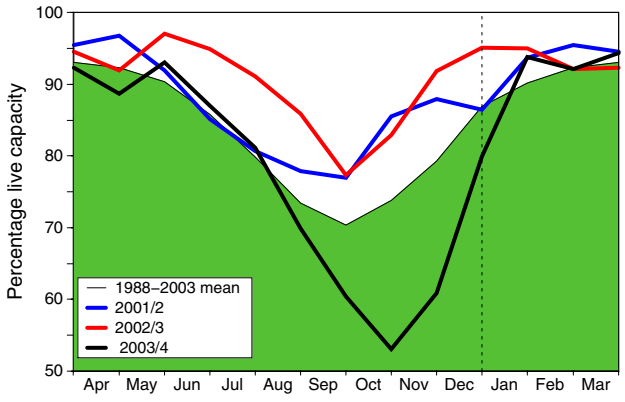
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. The Newbridge borehole supercedes Redbank (which was affected by groundwater abstraction). Yew Tree Farm levels are now received quarterly.

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.

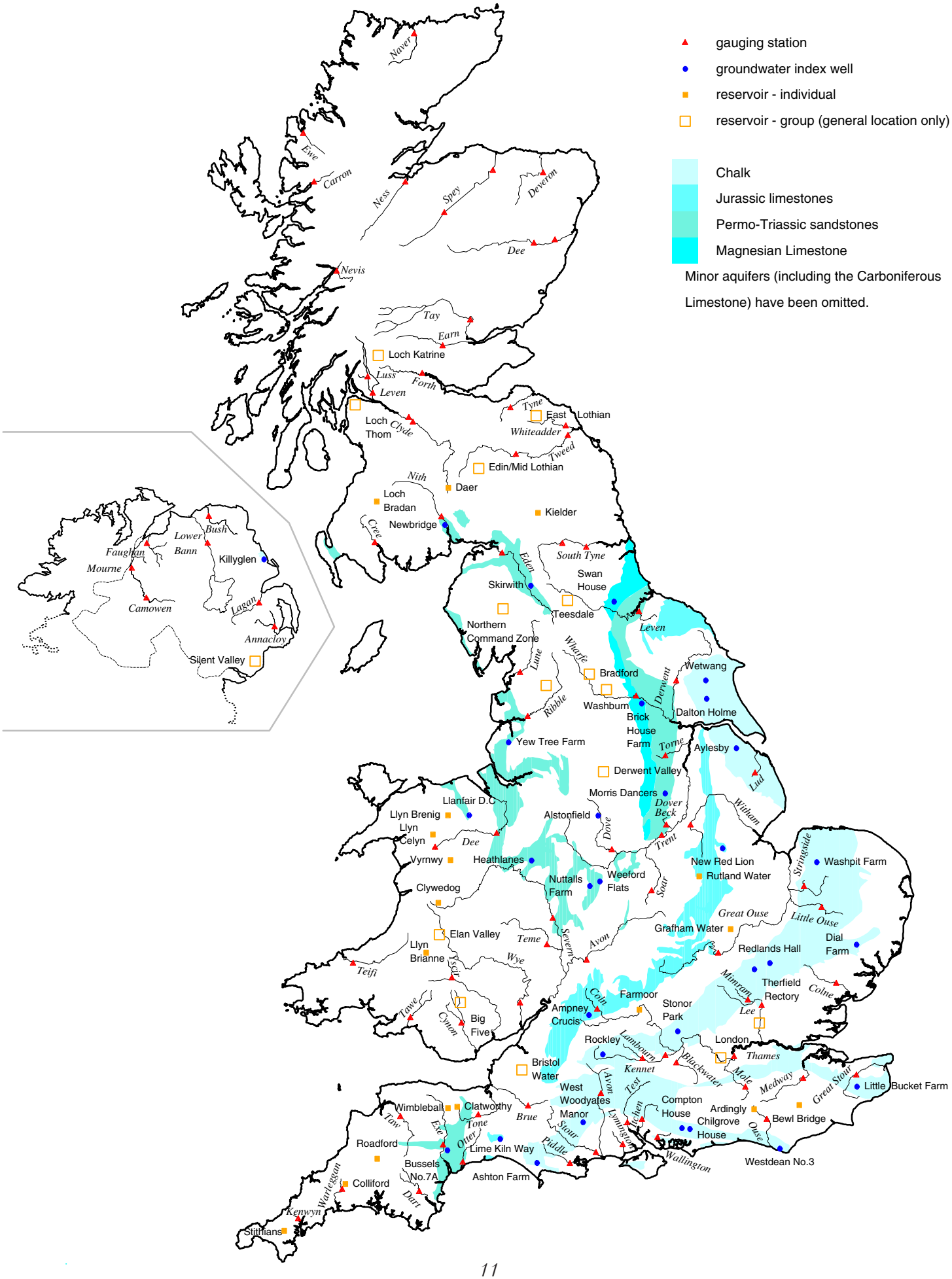
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2003 Nov	2004 Dec	Jan	Feb	Mar	Apr	Min. Apr	Year* of min.
North West	N Command Zone	• 124929	33	59	83	99	90	**88**	77	1993
	Vyrnwy	55146	60	64	86	99	92	**99**	64	1996
Northumbrian	Teesdale	• 87936	39	48	72	92	88	**96**	77	2003
	Kielder	(199175)	(66)	(64)	(78)	(96)	(90)	**(91)**	(81)	1993
Severn Trent	Clywedog	44922	61	73	90	96	90	**99**	86	1996
	Derwent Valley	• 39525	29	37	65	100	98	**96**	54	1996
Yorkshire	Washburn	• 22035	46	49	69	97	94	**92**	70	1996
	Bradford supply	• 41407	42	54	72	89	90	**92**	59	1996
Anglian	Grafham	(55490)	(64)	(67)	(74)	(82)	(88)	**(95)**	(77)	1997
	Rutland	(116580)	(66)	(65)	(71)	(81)	(91)	**(94)**	(74)	1992
Thames	London	• 202340	49	62	91	97	97	**97**	88	1990
	Farmoor	• 13830	43	59	97	96	92	**96**	84	1992
Southern	Bewl	28170	48	51	63	96	98	**100**	58	1989
	Ardingly	4685	15	23	41	95	100	**100**		
Wessex	Clatworthy	5364	14	16	54	100	100	**95**	82	1992
	Bristol WW	• (38666)	(48)	(44)	(64)	(83)	(91)	**(92)**	(71)	1992
South West	Colliford	28540	59	59	54	71	72	**75**	58	1997
	Roadford	34500	53	51	64	65	68	**68**	37	1996
	Wimbleball	21320	34	36	72	95	99	**100**	78	1996
	Stithians	5205	50	46	57	81	93	**97**	52	1992
Welsh	Celyn and Brenig	• 131155	75	81	91	100	99	**100**	72	1996
	Brianne	62140	71	81	96	100	92	**98**	90	1993
	Big Five	• 69762	38	53	76	97	96	**98**	78	1993
	Elan Valley	• 99106	41	56	88	100	94	**99**	89	1993
Scotland(E)	Edinburgh/Mid Lothian	• 97639	48	45	65	77	79	**80**	71	1998
	East Lothian	• 10206	38	38	78	100	100	**100**	95	1990
Scotland(W)	Loch Katrine	• 111363	40	66	80	98	88	**91**	88	2001
	Daer	22412	42	73	85	100	94	**100**	93	2001
	Loch Thom	• 11840	69	72	90	90	90	**94**	93	2001
Northern Ireland	Total+	•	54	59	62	78	81	**85**	83	2002
	Silent Valley	• 20634	47	47	54	59	64	**66**	57	2000

() figures in parentheses relate to gross storage • denotes reservoir groups +excludes Lough Neagh *last occurrence - see footnote

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 storage figures relate to the 1988-2004 period only (except for West of Scotland and Northern Ireland where data commence in the mid-1990's). 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 Centre for Ecology and Hydrology Wallingford (formerly 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 for Environment, Food and Rural Affairs (Defra), 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 Environment Agency, the Environment Agency Wales, the Scottish Environment Protection Agency and, for Northern Ireland, 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, Scottish Water and the Northern Ireland Water Service.

The National River Flow Archive (maintained by CEH Wallingford) 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 (see 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. Following the discontinuation of The Met Office's CARP system in July 1998, the areal rainfall figures have been derived using several procedures, including initial estimates based on MORECS*. Recent figures have been produced by The Met Office, National Climate Information Centre (NCIC), using a technique similar to CARP. An initiative is underway with The Met Office to provide more accurate areal figures and, since October 1999, to include more raingauges in the analysis. A significant number of additional monthly rainfall totals are currently being provided by the Environment Agencies. As with all regional figures based on limited raingauge networks the monthly tables and accumulations (and the return periods associated with them) should be regarded as a guide only.

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

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The National Hydrological Monitoring Programme depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged.

Subscription

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

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Selected text and maps are available on the WWW at
http://www.nerc-wallingford.ac.uk/ih/nrfa/index.htm
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