Hydrological summary *for the United Kingdom*

November 2002

General

November was an exceptionally mild but stormy month as a succession of vigorous Atlantic frontal systems swept across the British Isles. Many new November rainfall records were established, and the combined Oct/Nov rainfall was outstanding - equivalent to five months average rainfall in some southern catchments. Flood events were widely distributed across the UK - two major events occurred in NE Scotland, the South West was badly affected, flood warnings were common across much of the country and transport disruption was severe. However, the relatively even distribution of the rainfall through the month - and the rapid passage of many frontal systems - contributed to storm rainfall totals in the notable rather than extreme range. In most rivers the sustained nature of the high flows was more exceptional than the peak flows. Despite drawdown to provide additional flood storage in some impoundments, overall reservoir stocks rose smartly, and are substantially above the early winter average for England and Wales. Saturated catchments and sustained rainfall combined to produce notably high infiltration rates in most aquifer outcrop areas, generating very rapid seasonal recoveries in groundwater levels. With many rivers very vulnerable to further significant rainfall (and localised groundwater flooding reported), the anticyclonic interlude in the second week of December has provided a much-needed respite.

Rainfall

Low pressure dominated synoptic patterns across the British Isles during November. Dry days were rare - some areas (e.g. in Northern Ireland) reported none in the month. Notable rainfalls were common, including 80 mm in 12 hrs at Penzance on the 13th, 87 mm at Dublin Airport on the 14/15th and, remarkably, a provisional 50-hr rainfall total of 240 mm at Mulden (SE of Elgin) on 15-17th – estimated return period >1000 years – triggering severe flooding in Grampian Region (see below). In exposed catchments in SW Britain November rainfall totals reached three times the average and for some locations in central southern England (e.g. Wallingford) November was amongst the wettest four or five months in the last 50 years. For the second successive month, the reversal in the normal rainfall gradient across northern Scotland was remarkable: whilst much of the Grampian Region reported >200% of average rainfall, totals in the Western Isles fell below 50%. In southern England, many localities recorded appreciable rain on >40 of the 50 days from October 13th (having registered <8 over the preceding 50), over this 7-week period some areas (e.g. in the SW) reported more than 40% of their average annual rainfall. For England and Wales, the Oct/Nov total was the second highest in the last 62 years – 2000 was substantially wetter - whilst for Northern Ireland the provisional two-month total was unprecedented in a series from 1900. Despite a dry September, autumn rainfall totals were above average away from the NW of Scotland (which has been exceptionally dry) and rainfall for the year thus far is above average in all regions.

River Flow

The depressed river flows of the early autumn were succeeded by brisk recoveries in October and sustained high flows characterised most rivers throughout November. Flooding was severe in the South West around the 14th (e.g. at St Ives and Newquay) and flood warnings applied across a broad swathe of England and parts of Scotland. On the 15/16th rivers draining to the Moray Firth overtopped their banks – the Lossie exceeded its previous maximum flow in a 44-year record - resulting in severe flooding; evacuations were required in Elgin and Moray. The following week all three gauging stations on the River Don eclipsed their maximum flows rates (set only the previous month) – further flooding occurred in Brechin and other parts of Aberdeenshire. High spates were common across most of the country but, generally, the natural drainage network coped well with the sustained (rather than particularly intense) rainfall. Rivers reporting new maximum November runoff totals displayed a wide distribution (including the Deveron, Kennet, Stour, Kenwyn and Annacloy) and the combined Oct/Nov totals were easily the highest for any two-month sequence in some NE Scotland catchments (e.g. the Lossie and Don). The late-autumn upturn in groundwater levels (see below) was reflected in steep flow increases in baseflow-fed streams and rivers – a recurring feature of the last 10 years. By contrast some rivers in NW Scotland recorded their lowest Aug-Nov runoff on record (e.g. the Ewe in a series from 1970 and the Carron from 1979).

Groundwater

November rainfall across most aquifer outcrop areas was in the 150-250% range. This resulted in abundant infiltration – exceeding four times the November average in some, mostly southern, areas (including the Chilterns). Many index boreholes reported too early in the month to capture the full response to the recent exceptionally wet episode but extremely rapid groundwater level recoveries were recorded in the Chalk (e.g. at Rockley and Ashton Farm, where a new maximum November level was recorded). however, there has as yet been little response in the deepest eastern wells (e.g. Therfield). In Dorset, levels in some index wells – including Ashton Farm - exceeded corresponding levels in 2000. Locally, the water-table reached the surface - serving as a warning of the potential for protracted groundwater flooding in the event of a wet winter. November groundwater levels were well above average in most limestone aquifers – particularly so in the Lincolnshire Limestone. The generally higher storage of the Permo-Triassic sandstone aquifers makes for more sluggish hydrograph behaviour but recoveries have begun in most areas and levels remain above, to well above the long term average for the early winter. A few wells (including Nuttals) are close to pre-2000 maxima. Overall groundwater resources are well above average and, with no significant soil moisture deficits across the country, the prospects for further substantial winter recharge are very good.

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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Area	Rainfall	Nov 2002	Oct 02-Nov 02	RP	Sep02-Nov 02	RP	Jun 02-Nov 02	RP	Jan 02-Nov 02	RP
England & Wales	**mm**	**177**	**320**		**361**		**586**		**964**	
	%	**190**	**178**	**70-100**	**140**	**10-20**	**127**	**10-20**	**118**	**5-15**
North West	mm	146	315		369		671		1290	
	%	119	126	2-5	101	2-5	105	2-5	120	5-15
Northumbrian	mm	105	239		272		514		893	
	%	122	147	10-20	116	2-5	117	5-10	116	5-10
Severn Trent	mm	110	234		264		446		771	
	%	155	173	35-50	132	5-10	118	5-10	114	5-10
Yorkshire	mm	119	239		275		532		857	
	%	149	156	10-20	124	5-10	129	10-20	116	5-10
Anglian	mm	102	193		225		402		625	
	%	176	177	35-50	142	10-20	128	10-20	116	5-10
Thames	mm	147	244		270		439		761	
	%	226	192	50-80	145	10-20	126	5-10	123	10-20
Southern	mm	188	272		314		477		827	
	%	221	165	15-25	134	5-10	121	5-10	119	5-10
Wessex	mm	192	342		380		534		943	
	%	231	211	150-250	162	30-50	131	10-20	127	10-20
South West	mm	221	393		419		595		1191	
	%	177	163	20-30	125	5-10	107	2-5	115	5-10
Welsh	mm	222	431		469		681		1358	
	%	156	154	10-20	119	2-5	105	2-5	117	5-10
Scotland	**mm**	**157**	**330**		**378**		**720**		**1481**	
	%	**104**	**107**	**2-5**	**84**	**2-5**	**97**	**2-5**	**115**	**5-15**
Highland	mm	129	283		331		672		1584	
	%	64	70	5-10	58	35-50	74	15-25	101	2-5
North East	mm	172	368		407		716		1120	
	%	174	188	>200	144	20-30	141	50-80	127	35-50
Tay	mm	176	370		402		764		1499	
	%	145	147	10-20	110	2-5	125	5-15	136	110-150
Forth	mm	134	320		358		699		1314	
	%	119	141	5-15	106	2-5	122	5-10	132	70-100
Tweed	mm	113	297		334		612		1112	
	%	121	158	20-35	121	2-5	122	5-10	127	30-50
Solway	mm	217	436		497		868		1671	
	%	150	145	10-20	112	2-5	118	5-10	131	60-90
Clyde	mm	191	382		446		846		1795	
	%	106	102	2-5	81	2-5	95	2-5	118	10-20
Northern Ireland	**mm**	**178**	**367**		**407**		**679**		**1265**	
	%	**173**	**170**	**35-50**	**130**	**5-10**	**125**	**5-15**	**132**	**50-80**

RP = Return period

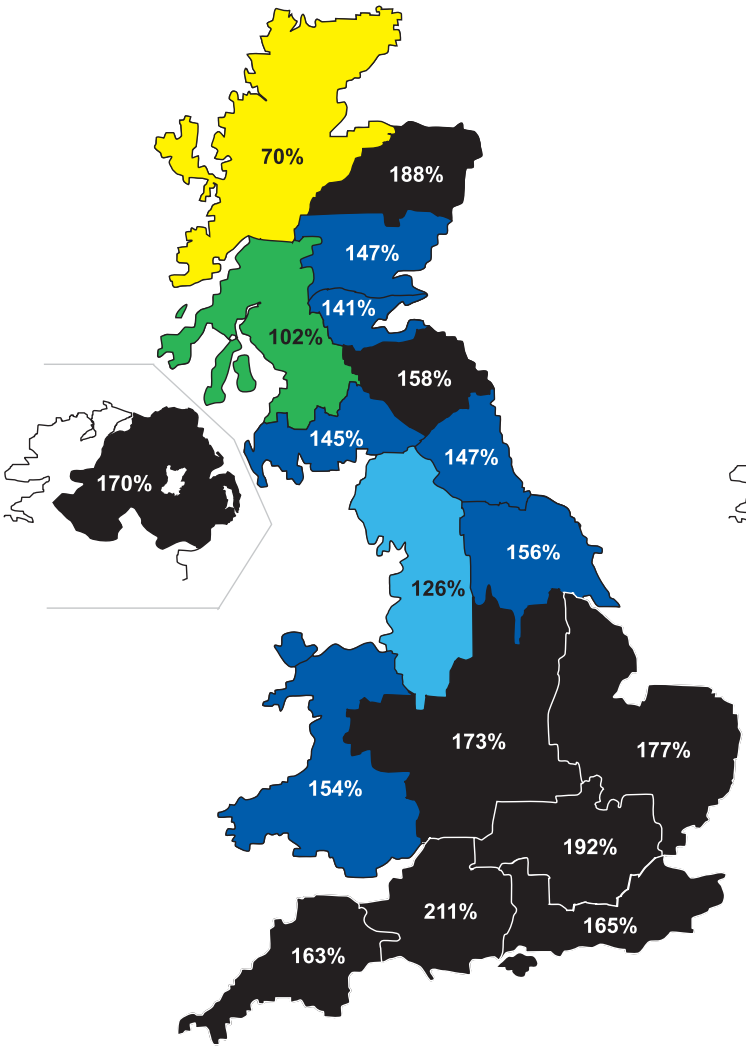
The monthly rainfall figures* are copyright of The Met Office and may not be passed on to, or published by, any unauthorised person or organisation. **All monthly totals since December 1998 are provisional (see page 12).** The figures for England & Wales are derived by the Hadley Centre and are updates 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 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 Scottish rainfall series in particular, can exaggerate the relative wetness of the recent past.

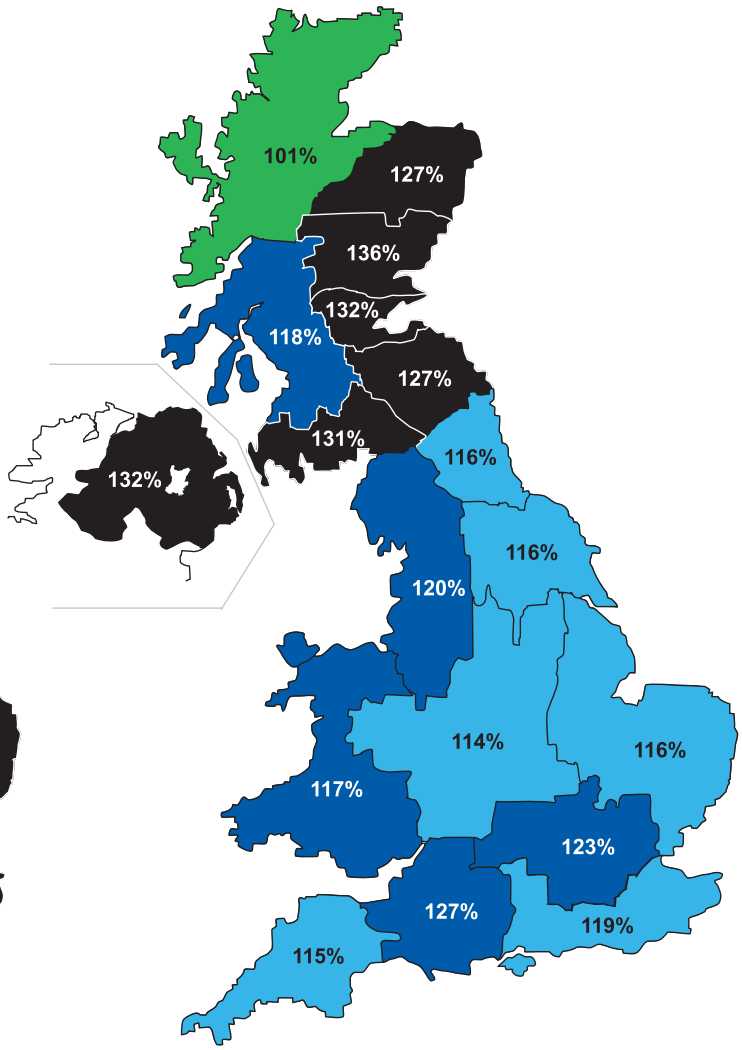
*See page 12.

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



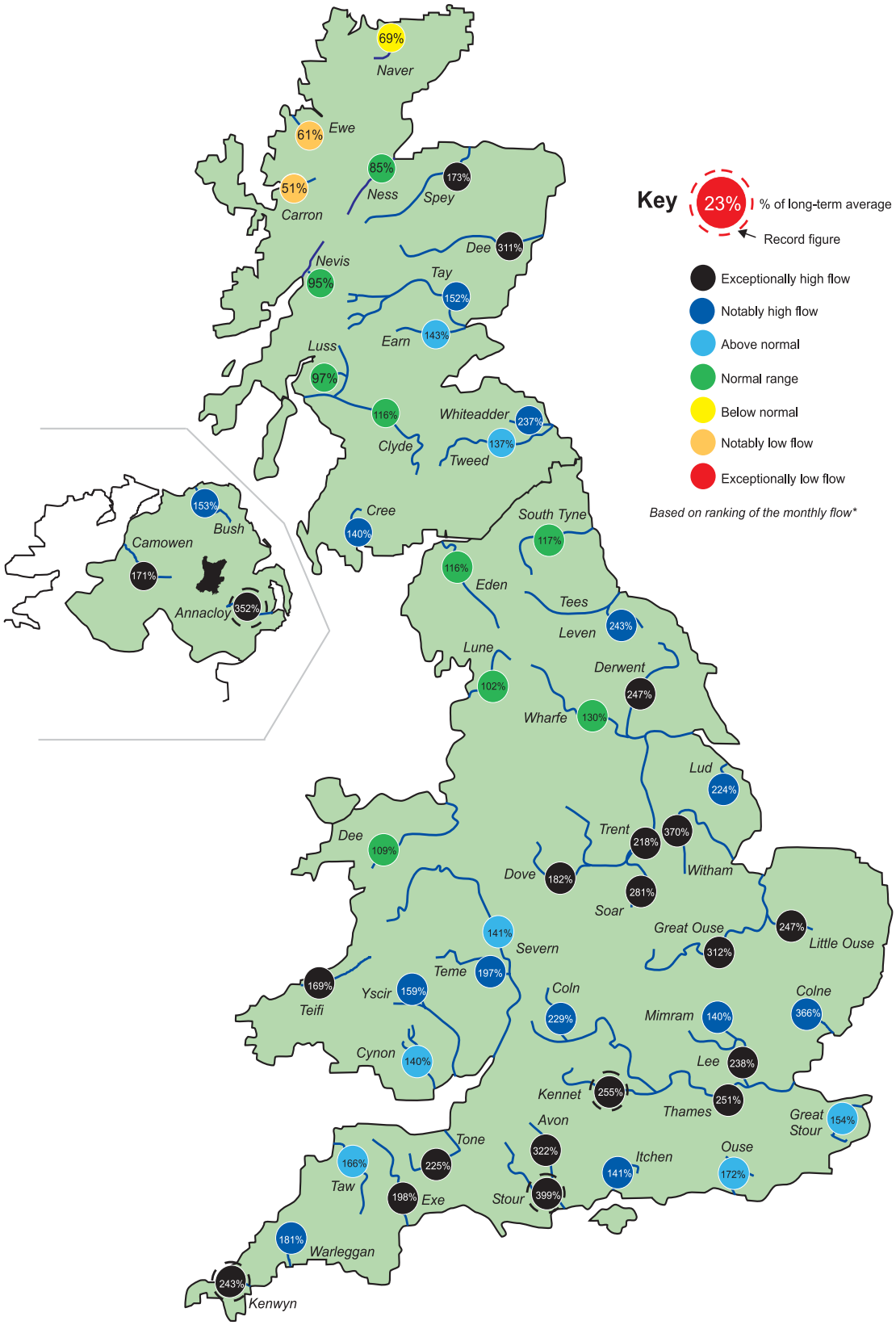


October 2002 - November 2002 **January 2002 - November 2002**

Rainfall accumulation maps

The wet climatic phase which has predominated over much of the last five years has continued in 2002. The late autumn was especially wet in north-eastern Scotland and the Wessex region where the Oct/Nov rainfall total was the highest for any 2-month sequence in at least 20 years. Regional rainfall totals for the year thus far are also exceptional: the provisional Jan-Nov rainfall is the highest on record for Northern Ireland and almost as outstanding across much of southern and eastern Scotland.

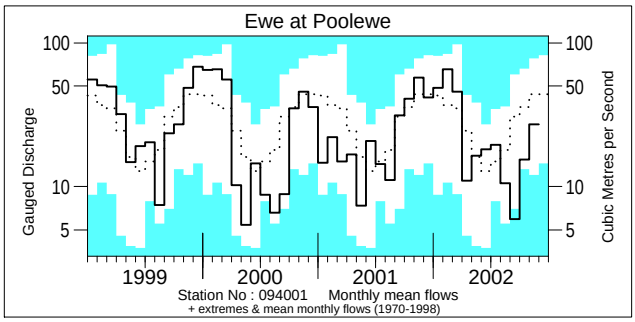
River flow . . . River flow . . .

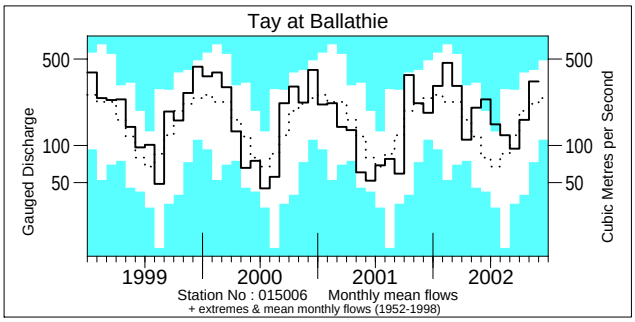


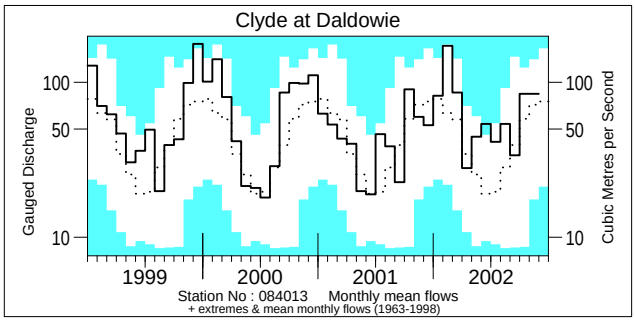
River flows - November 2002

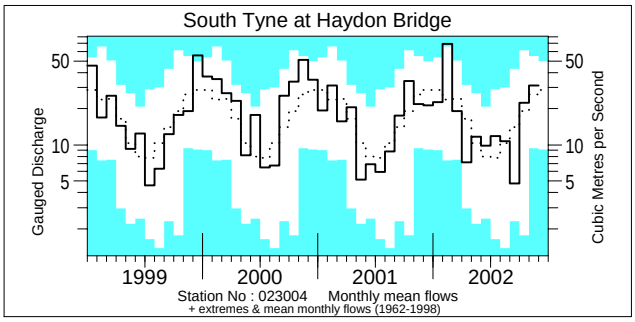
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

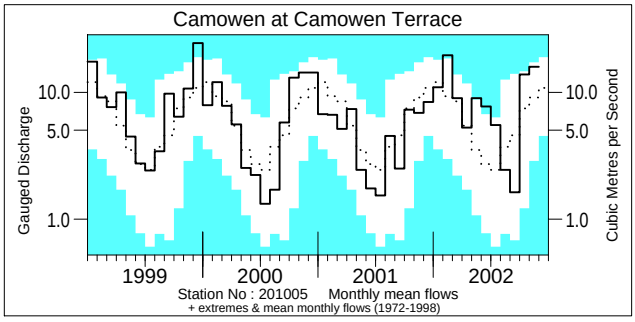
River flow . . . River flow . . .

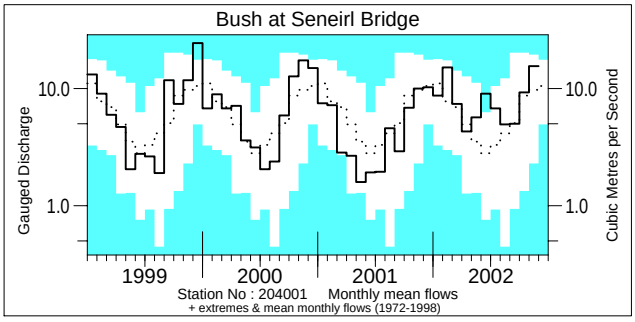


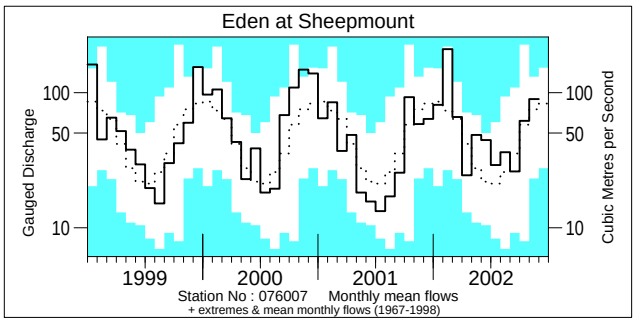


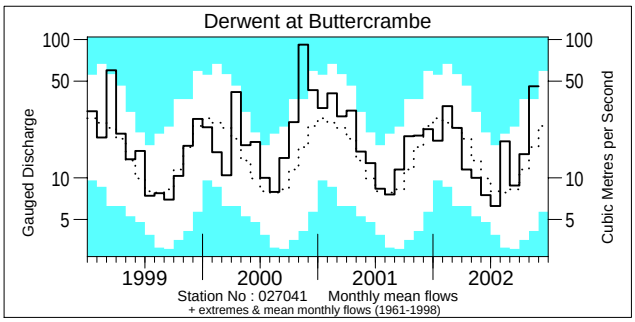


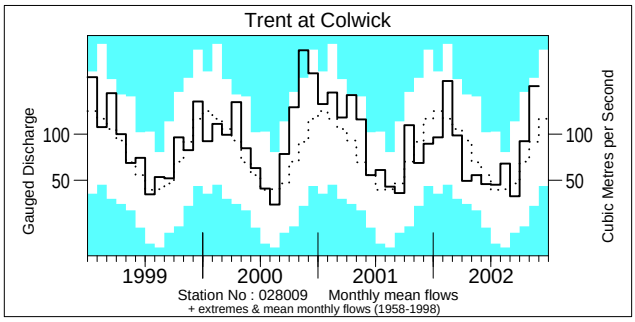


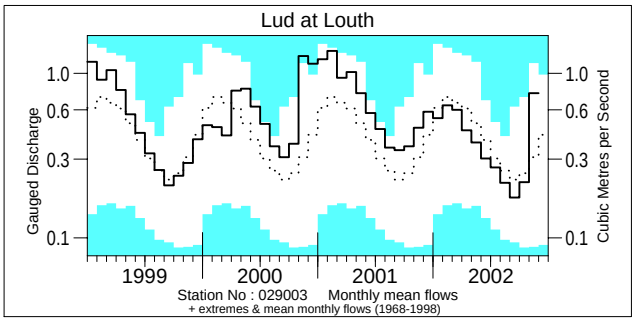








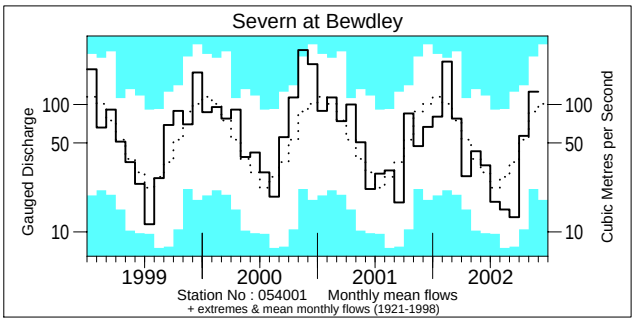


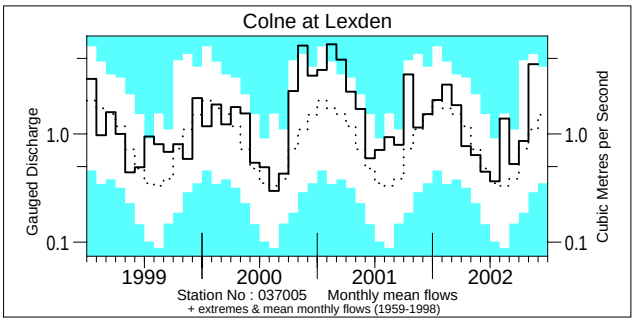


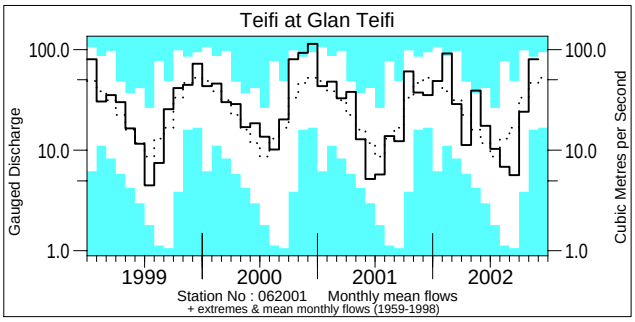
Monthly river flow hydrographs

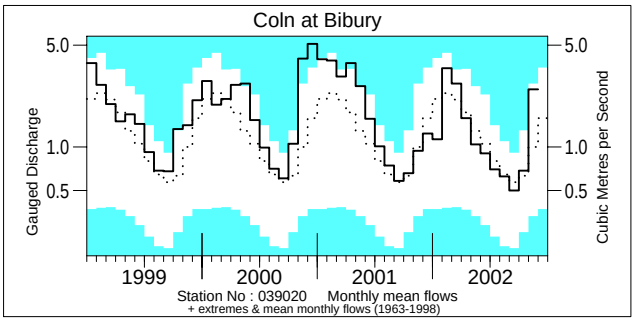
The river flow hydrographs show the monthly mean flow (bold trace), the long term average monthly flow (dotted trace) and the maximum and minimum flow prior to 1999 (shown by the shaded areas). Monthly flows falling outside the maximum/ minimum range are indicated where the bold trace enters the shaded areas.

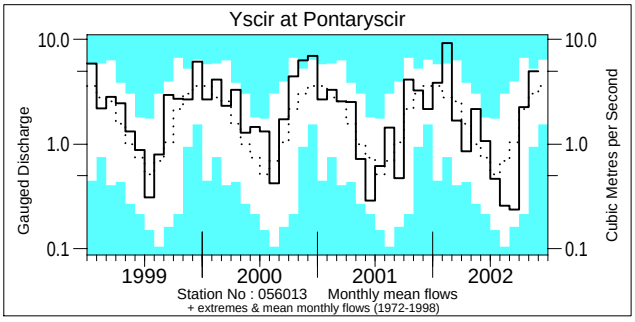
River flow . . . River flow . . .

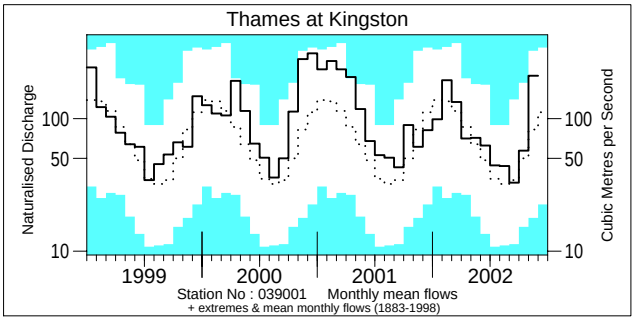


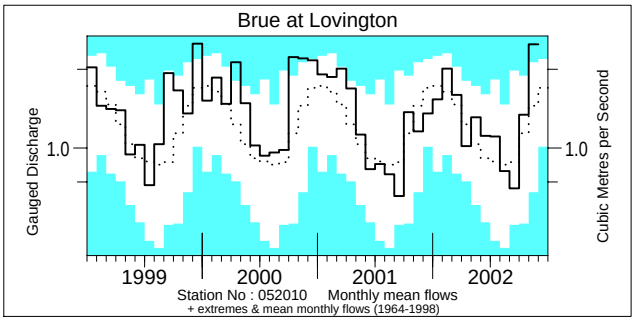


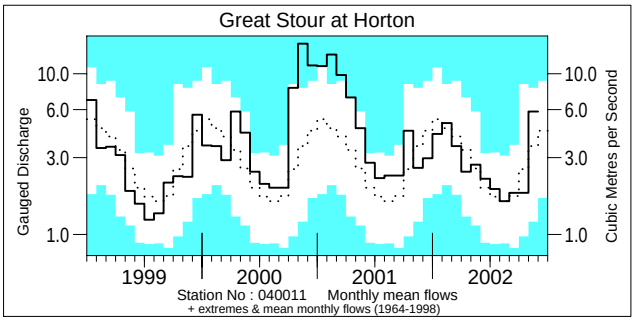


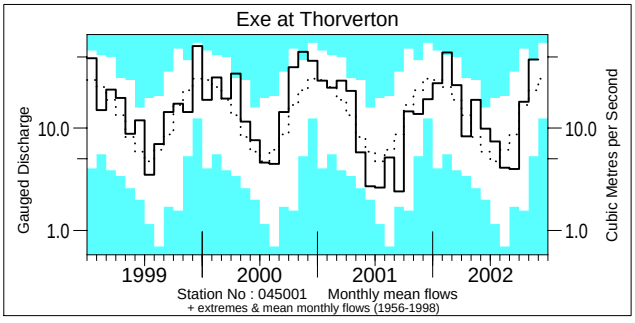


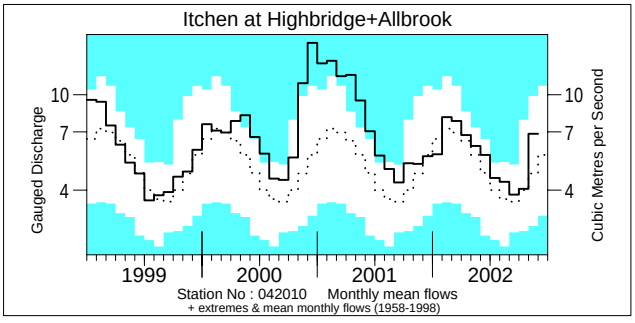










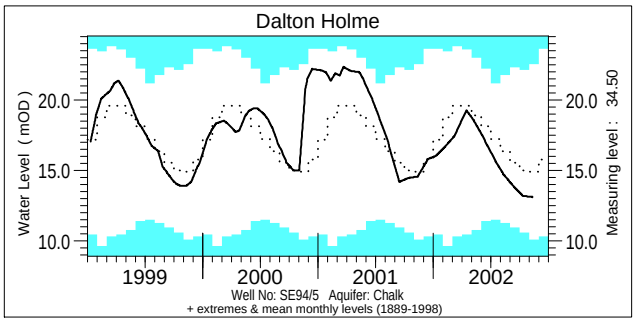


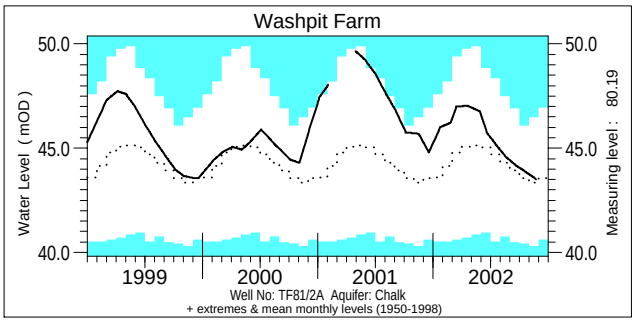
Notable runoff accumulations (a) October 2002 - November 2002, (b) January 2002 - November 2002

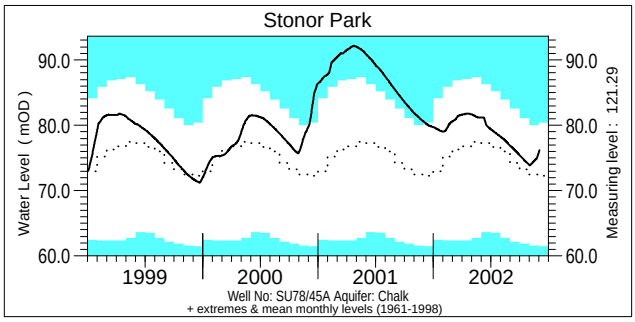
	River	%lta	Rank	River	%lta	Rank		River	%lta	Rank
a)	Lossie(Grampian)	275	40/40	Dorset Stour	278	30/30	b)	Tay	139	50/50
	Don (Grampian)	302	34/34	Otter	230	41/41		Earn	150	55/55
	Deveron	261	42/42	Luss	79	3/25		Tweed	134	42/42
	Dee	224	30/30	Carron	47	3/24		Brue	141	36/37
	Whiteadder	299	34/34	Ewe	54	3/32		Eden	132	34/35
	Torne	218	31/32	Camowen	171	31/31		Nith	130	45/45
	Dover Beck	234	27/28	Annacloy	271	23/23		Clyde	148	39/39
	Wilts. Avon	232	37/38					Leven (Glasgow)	134	38/38

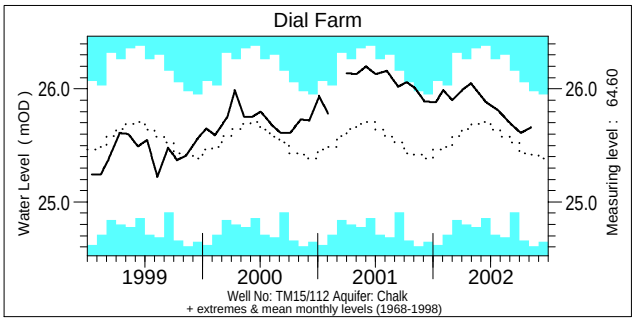
lta = long term average
Rank 1 = lowest on record

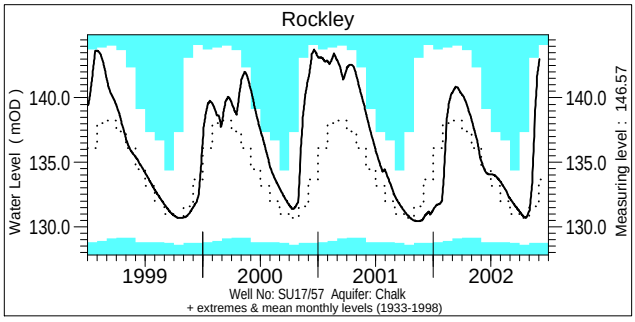
Groundwater . . . Groundwater

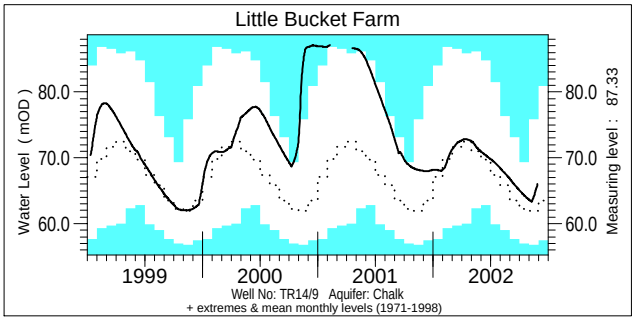


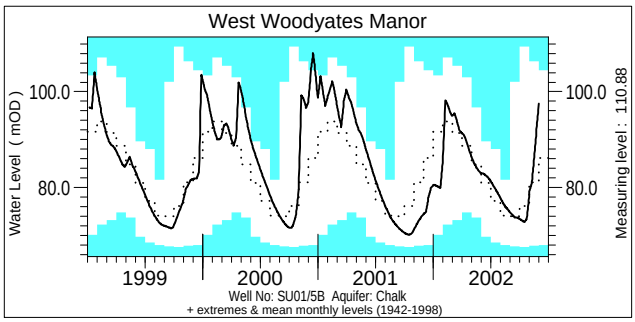


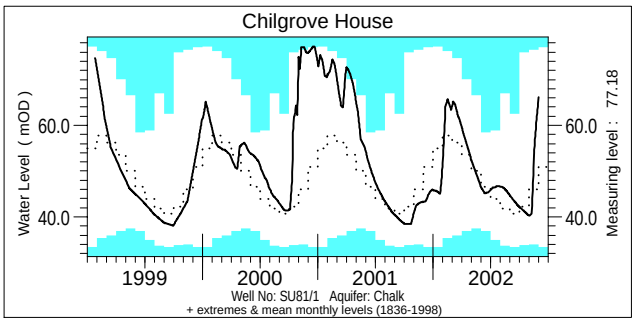


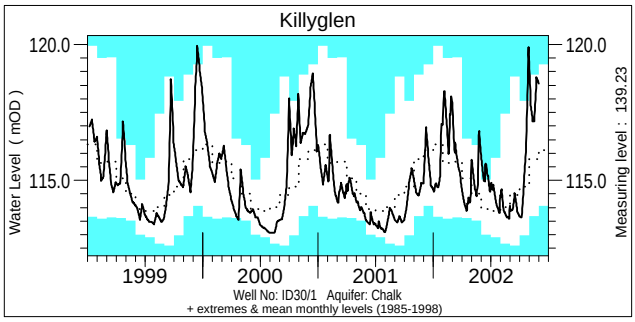


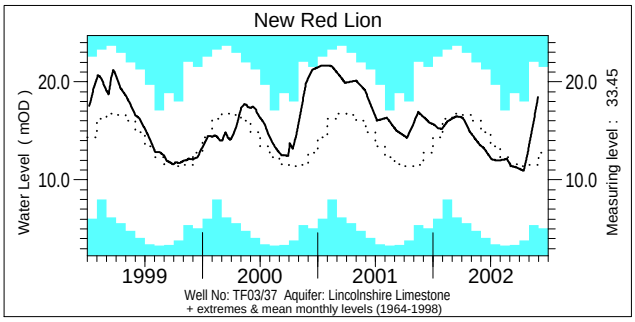






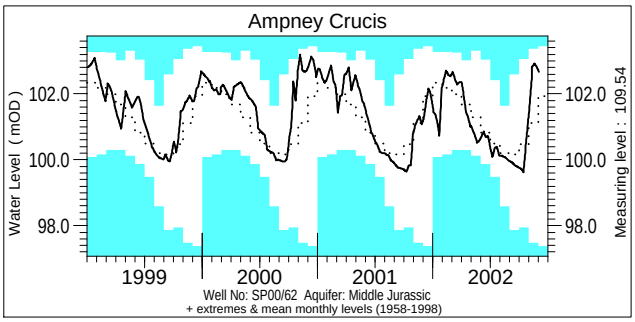


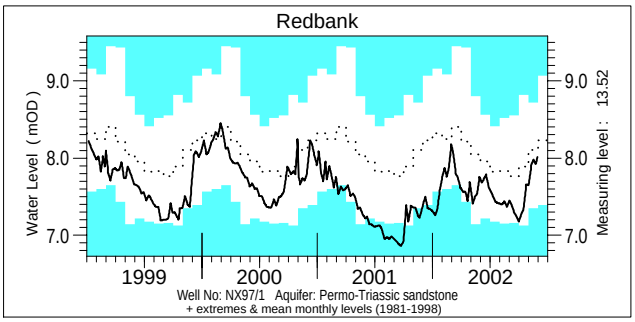


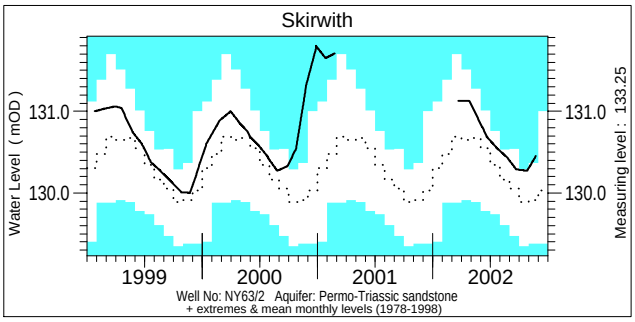


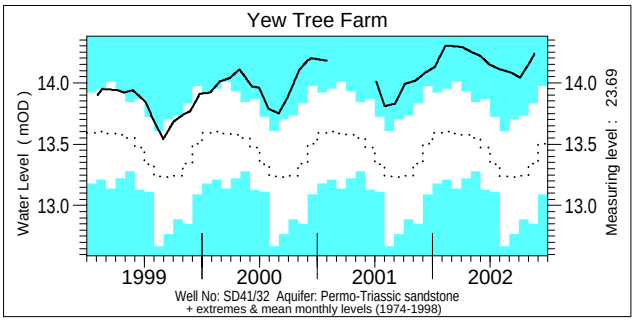
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

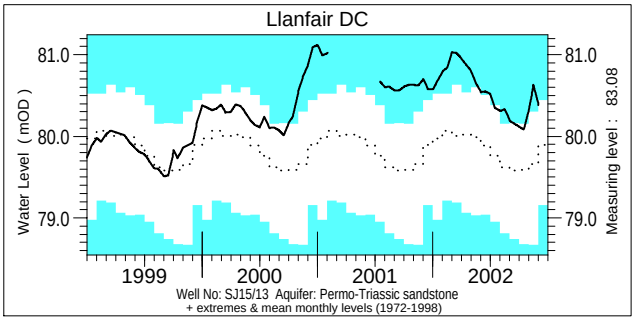
Groundwater . . . Groundwater

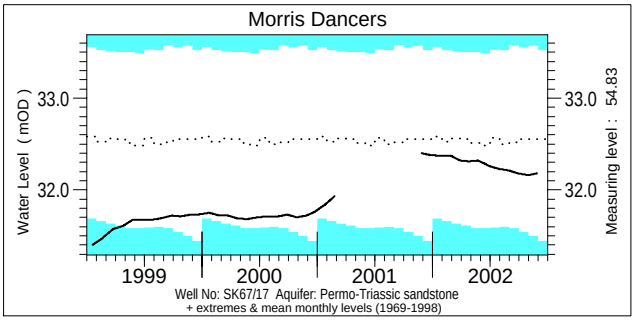


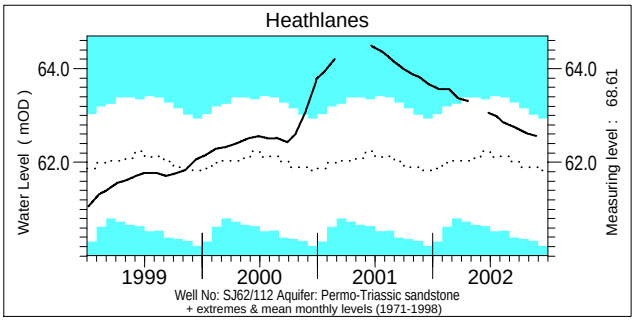


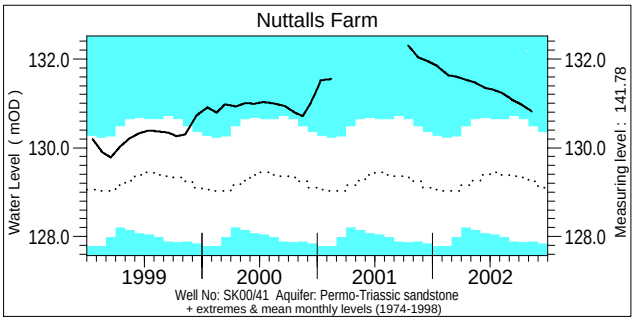


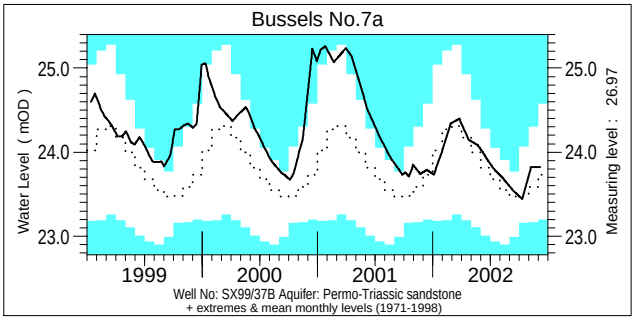


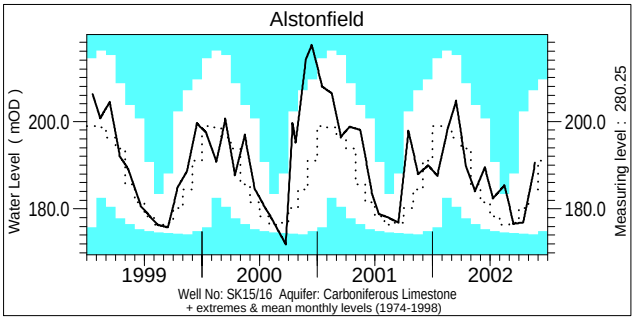








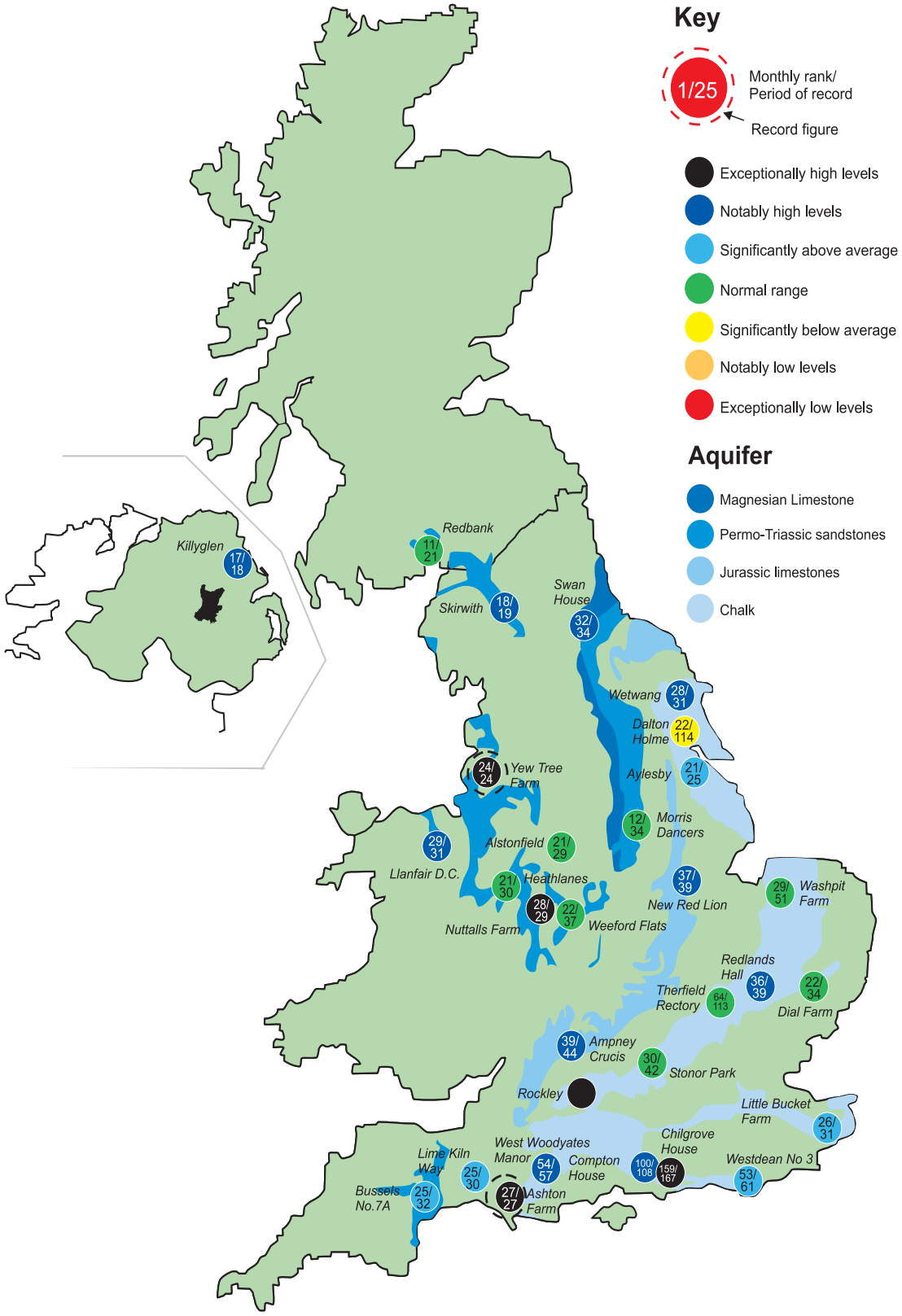




Groundwater levels November 2002 / December 2002

Borehole	Level	Date	Nov. av.	Borehole	Level	Date	Nov. av.	Borehole	Level	Date	Nov. av.
Dalton Holme	13.12	11/11	14.82	Chilgrove House	66.22	30/11	46.65	Llanfair DC	80.38	01/12	79.63
Washpit Farm	43.51	22/11	43.27	Killyglen	118.56	30/11	115.97	Morris Dancers	32.18	27/11	32.40
Stonor Park	76.19	02/12	72.62	New Red Lion	18.42	28/11	12.05	Heathlanes	62.56	25/11	61.93
Dial Farm	25.66	06/11	25.45	Ampney Crucis	102.67	02/12	101.19	Nuttalls Farm	130.82	09/11	129.51
Rockley	143.01	02/12	131.59	Redbank	8.01	28/11	8.00	Bussels No.7a	23.82	06/12	23.63
Little Bucket Farm	66.00	27/11	63.26	Skirwith	130.45	22/11	129.96	Alstonfield	190.51	20/11	186.33
West Woodyates	97.57	30/11	80.96	Yew Tree Farm	14.24	19/11	13.43				

Levels in metres above Ordnance Datum

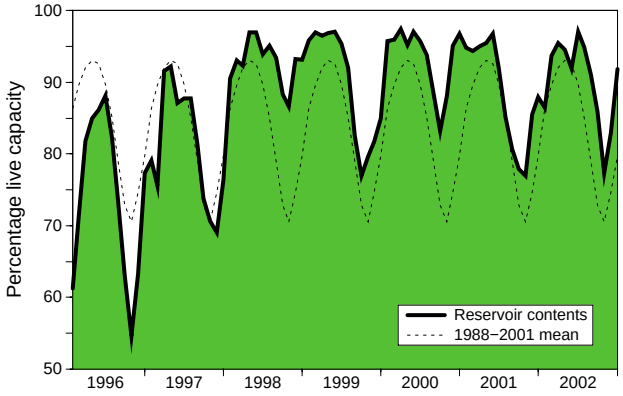


Groundwater levels - November 2002

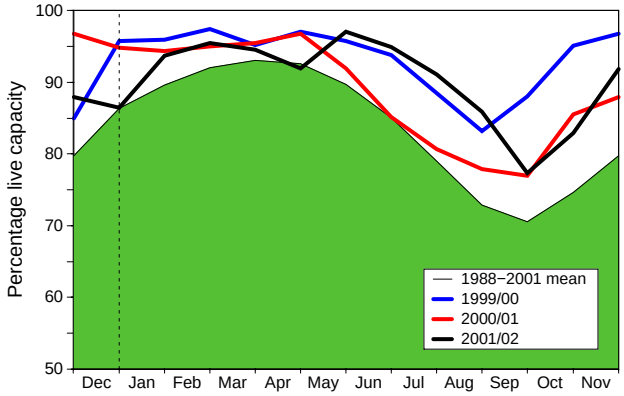
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing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

(Note: Redbank is affected by groundwater abstraction.)

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.

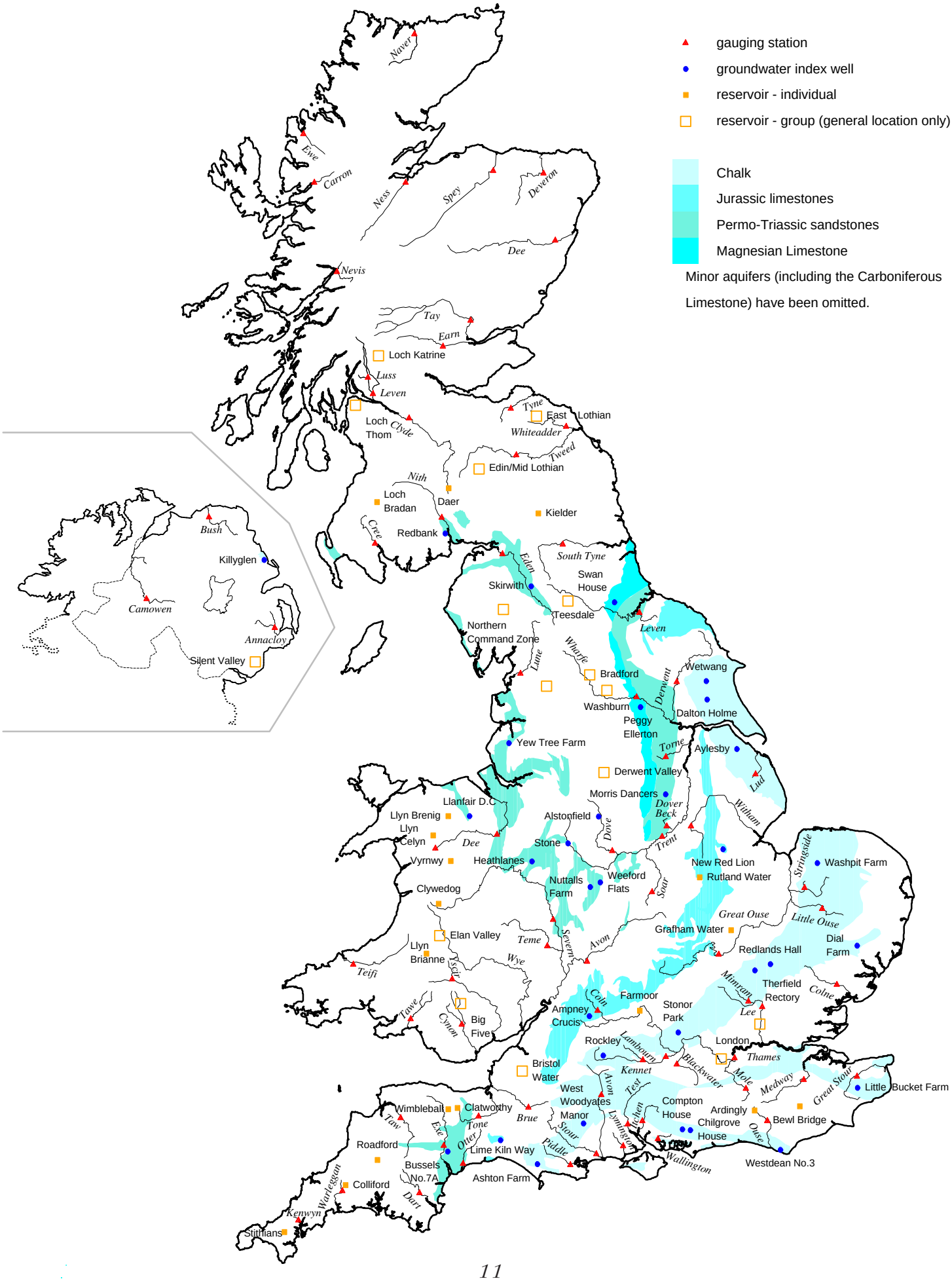
Percentage live capacity of selected reservoirs at start of month

Area	Reservoir	Capacity (Ml)	2002 Jul	Aug	Sep	Oct	Nov	Dec	Min. Dec	Year* of min
North West	N Command Zone	• 124929	97	88	78	68	66	**79**	44	1993
	Vyrnwy	55146	95	90	77	62	86	**99**	33	1995
Northumbrian	Teesdale	• 87936	95	88	87	77	89	**92**	39	1995
	Kielder	(199175)	(94)	(90)	(91)	(86)	(94)	**(90)**	(65)	1989
Severn Trent	Clywedog	44922	98	92	85	71	86	**78**	43	1995
	Derwent Valley	• 39525	81	80	84	78	95	**99**	9	1995
Yorkshire	Washburn	• 22035	89	81	84	75	89	**90**	16	1995
	Bradford supply	• 41407	95	93	92	83	95	**100**	20	1995
Anglian	Grafham	(55490)	(96)	(95)	(94)	(89)	(88)	**(90)**	(47)	1997
	Rutland	(116580)	(92)	(90)	(88)	(85)	(89)	**(94)**	(57)	1995
Thames	London	• 202340	97	94	92	81	84	**96**	52	1990
	Farmoor	• 13830	96	95	95	91	83	**94**	52	1990
Southern	Bewl	28170	93	89	85	78	73	**80**	34	1990
	Ardingly	4685	99	99	98	92	88	**100**	44	1989
Wessex	Clatworthy	5364	97	91	76	62	73	**100**	37	1989
	Bristol WW	• (38666)	(93)	(89)	(78)	(71)	(78)	**(93)**	(27)	1990
South West	Colliford	28540	84	80	74	63	63	**71**	42	1995
	Roadford	34500	93	97	90	83	82	**91**	19	1995
	Wimbleball	21320	97	94	86	73	80	**98**	34	1995
	Stithians	5205	83	76	68	54	55	**84**	29	2001
Welsh	Celyn and Brenig	• 131155	99	98	93	88	90	**94**	50	1995
	Brianne	62140	99	96	89	80	83	**98**	72	1995
	Big Five	• 69762	94	89	69	53	62	**89**	49	1990
	Elan Valley	• 99106	95	90	75	64	68	**100**	47	1995
East of Scotland	Edinburgh/Mid Lothian	• 97639	100	94	92	88	89	**94**	56	1998
	East Lothian	• 10206	98	89	96	92	100	**99**	43	1989
West of Scotland	Loch Katrine	• 111363	99	96	83	74	77	**88**	86	1997
	Daer	22412	99	99	97	94	100	**100**	87	1997
	Loch Thom	• 11840	100	95	94	87	100	**100**	82	1997
Northern Ireland	Silent Valley	• 20634	90	81	79	69	93	**100**	43	2001

() figures in parentheses relate to gross storage • denotes reservoir groups * 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 minimum storage figures relate to the 1988-2002 period only (except for West of Scotland and Northern Ireland where data commence in 1994 and 1993 respectively). 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 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, 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 (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. 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; over the coming months further monthly raingauge totals will be included for selected regions. Until the access to these additional data has stabilised the regional 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
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RG12 2SY
Tel.: 01344 856849
Fax: 01344 854906

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:

Hydrological Summaries
National Water Archive
CEH Wallingford
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB
Tel.: 01491 838800
Fax: 01491 692424

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

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NATURAL ENVIRONMENT RESEARCH COUNCIL

11/02