Monthly water situation report

England

Summary – April 2016

Rainfall totals across England were above average for the sixth consecutive month, at 122% of the April long term average. Soil moisture deficits have increased however – as expected for the time of year. River flows decreased across much of England, but remain normal or higher for the time of year at all indicator sites. Groundwater levels also decreased at the majority of sites, with all but one being normal or higher for the time of year. Reservoir stocks remain close to full capacity and changes in storage remain small.

Rainfall

Rainfall totals for April ranged from less than 40mm in parts of Devon and Somerset to more than 120mm in parts of Cumbria. Monthly rainfall totals were above the April long term average (LTA) in nearly two thirds of hydrological areas across England. The Tweed hydrological area in Northumberland received more than 160% of the April LTA rainfall (Figure 1.1)

April rainfall totals were above normal for the time of year for most hydrological areas in the north of England and on the east coast. Most hydrological areas across central and the south of England were normal for the time of year. Over the three month period to the end of April cumulative rainfall totals were above normal for the majority of areas across England (Figure 1.2)

At the regional scale, April rainfall totals ranged from 85% of the LTA in south-west England to 143% in north-east and north-west England. Both the six month and twelve month periods ending in April were the wettest on record for north-east and north-west England. Rainfall totals across England as a whole were above average for the sixth consecutive month, at 122% of the April LTA – the six month period ending in April was the third wettest on record for England (Figure 1.3)

Soil moisture deficit

Soil Moisture Deficits (SMDs) increased across almost all of England during April, with the largest increases occurring in central, east and south-east England. At the end of April values were between 11mm and 40mm across three-quarters of England and at or close to zero elsewhere, particularly in the north of England (Figure 2.1).

End of month SMDs were close to the long term average (LTA) for the end of April in many parts of England. SMDs were higher than the LTA in parts of north and central England and lower than the LTA in parts of south-east and south-west England (Figure 2.1).

At a regional scale, SMDs increased during the month in all regions compared to the previous month. Values at the end of April ranged from 7mm in north-west England to 25mm in south-east England (Figure 2.2).

River flows

Monthly mean river flows for April decreased at almost all indicator sites across England compared with March. All of our indicator sites were classed as normal or higher for the time of year and a third of the sites were above normal for the time of year. (Figure 3.1)

Monthly mean river flows were classed as normal for the time of year at all but one of the regional index sites. The River Thames at Kingston was above normal for the time of year. (Figure 3.2)

Groundwater levels

Groundwater levels decreased at almost two-thirds of indicator sites during April. At the end of the month, groundwater levels were normal for the time of year at just over half of indicator sites and were above normal or

higher at all but one of the remaining sites. Crossley Hill (Nottinghamshire and Doncaster Permo-Triassic sandstone) continues to be below normal for the time of year. (Figure 4.1)

End of month groundwater levels at the major aquifer index sites were normal or higher for the time of year at all of our indicator sites. Groundwater levels recorded at Little Bucket (East Kent chalk) and Stonor Park (south-west Chilterns Chalk) are above normal and Dalton Holme (Hull & East Riding chalk), Chilgrove (Chichester chalk) and Skirwith (Carlisle Basin and Eden Valley sandstone) are notably high for the time of year. (Figure 4.2)

Reservoir storage

Reservoir stocks decreased at half of reported reservoirs and reservoir groups during April and increased at just over a third of reservoirs or reservoir groups. There was no change in stocks at the remaining reservoirs or reservoir groups. The largest increase in storage was at Farmoor Reservoir (16%) and the largest decrease was at Clatworthy Reservoir (10%). End of month stocks were classed as normal or higher for the time of year at almost all reservoirs and reservoir groups[3]. Sites supplying parts of north-east and central England were classed as below normal for the time of year. (Figure 5.1)

At the regional-scale, reservoir stocks at the end of April had decreased slightly compared to March in north-west, south-west and east England; elsewhere stocks increased slightly. The largest increase of 4% was in south-east England and the largest decrease of 4% was in north-west England. Month-end regional stocks for the end of April ranged from 89% of total capacity in north-west England to 98% in central England. Reservoir storage at the end of April for England remained constant compared to March, with stocks being 93% of total capacity. (Figure 5.2)

Forward look

May is likely to have changeable weather with slightly more rainfall than average; the north-west is likely to be wetter than the south-east. For the period from May to July the chances of above and below average rainfall are fairly balanced[1].

Projections for river flows at key sites[2]

By the end of September 2016 two thirds of sites have a greater than expected chance of higher than normal cumulative flows. By the end of March 2017 over three quarters of the sites have a greater than expected chance of higher than normal cumulative flows.

For scenario based projections of cumulative river flows at key sites by September 2016 see Figure 6.1
For scenario based projections of cumulative river flows at key sites by March 2017 see Figure 6.2
For probabilistic ensemble projections of cumulative river flows at key sites by September 2016 see Figure 6.3
For probabilistic ensemble projections of cumulative river flows at key sites by March 2017 see Figure 6.4

Projections for groundwater levels in key aquifers[2]

At the end of September 2016 over three quarters of sites have a greater than expected chance of normal or higher groundwater levels for the time of year. At the end of March 2017 the projections show exactly three quarters of sites have a greater than expected chance of normal or higher groundwater levels for the time of year.

For scenario based projections of groundwater levels in key aquifers in September 2016 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in March 2017 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in September 2016 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2017 see Figure 6.8

Authors: E&B Hydrology Team

1 Source: Met Office
2 Information produced by the Water Situation Forward Look group led by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office (www.hydoutuk.net).
3 Note that some reservoir stocks can change rapidly in response to fairly short periods of dry or wet weather so the end month statistics presented in this report may be quite different to the current position.

Rainfall

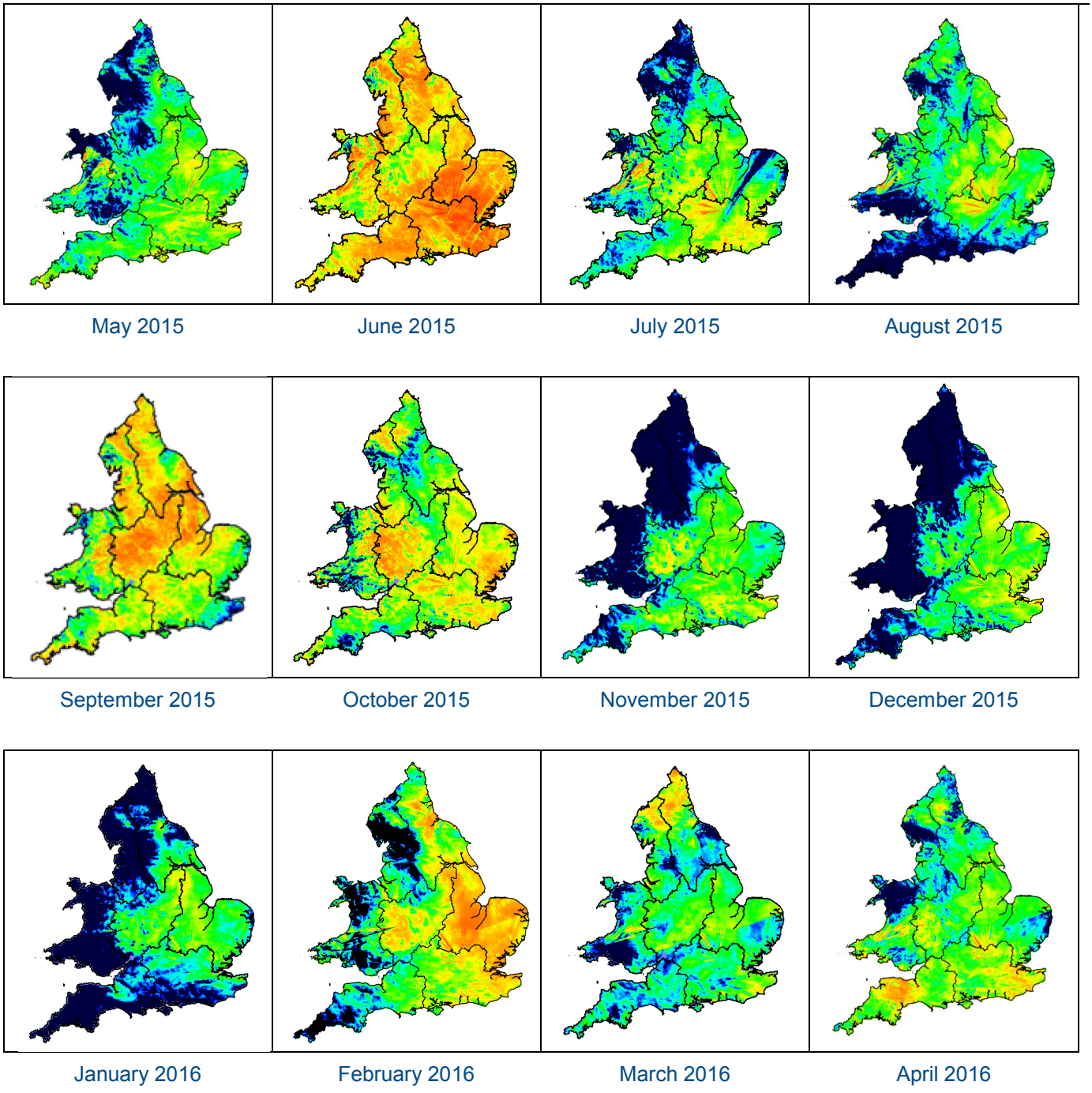
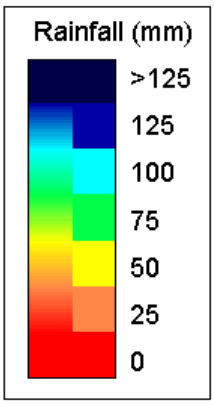


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.



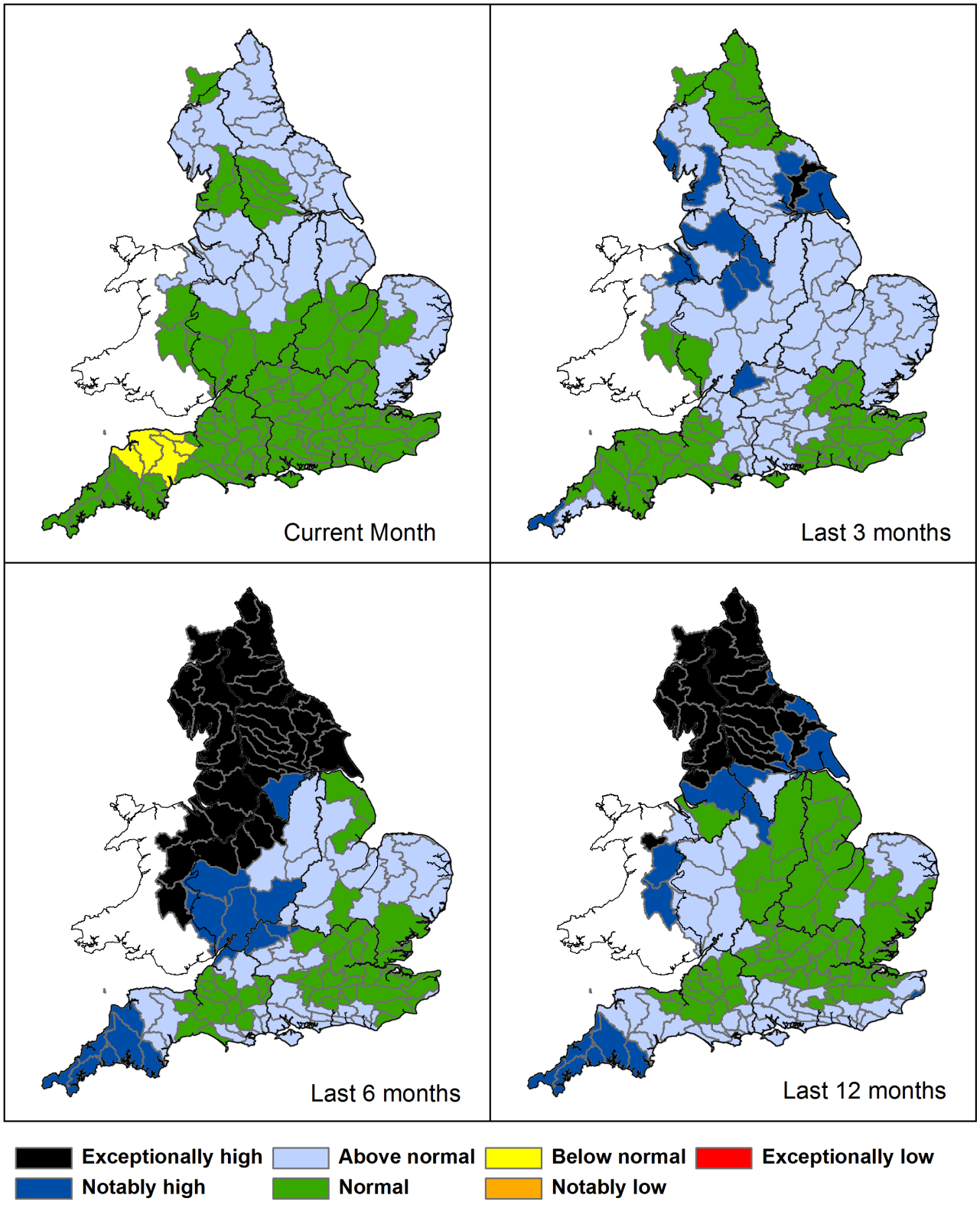


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 April), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2016)*. Provisional data based on Environment Agency 1km gridded rainfall dataset derived from Environment Agency intensity rain gauges. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

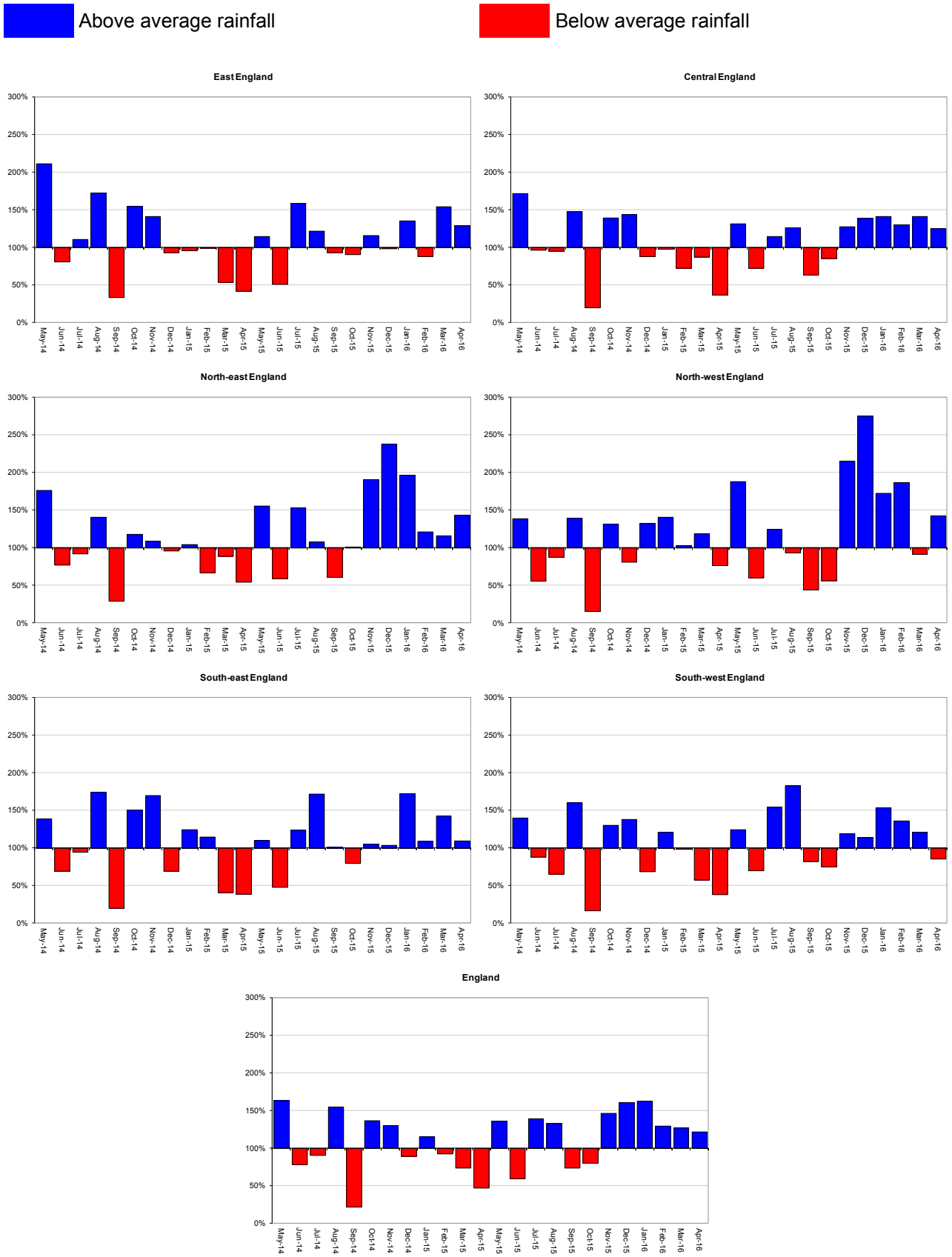


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

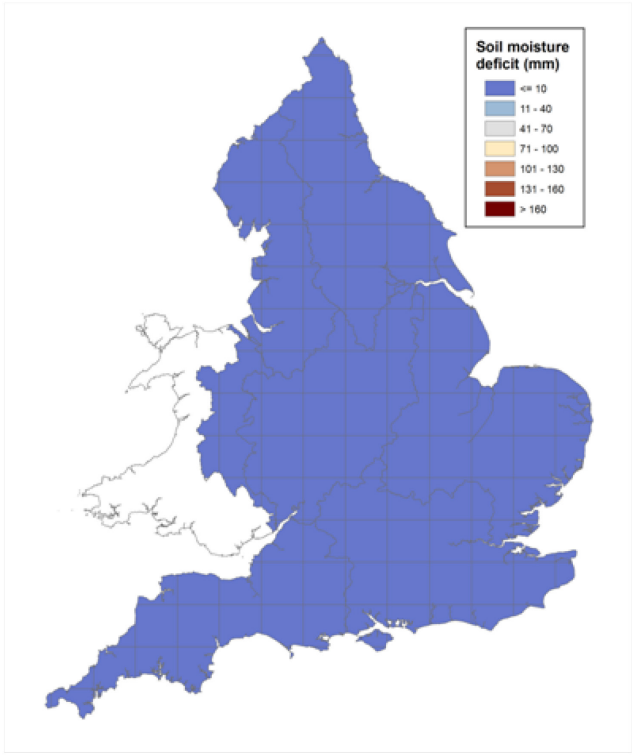
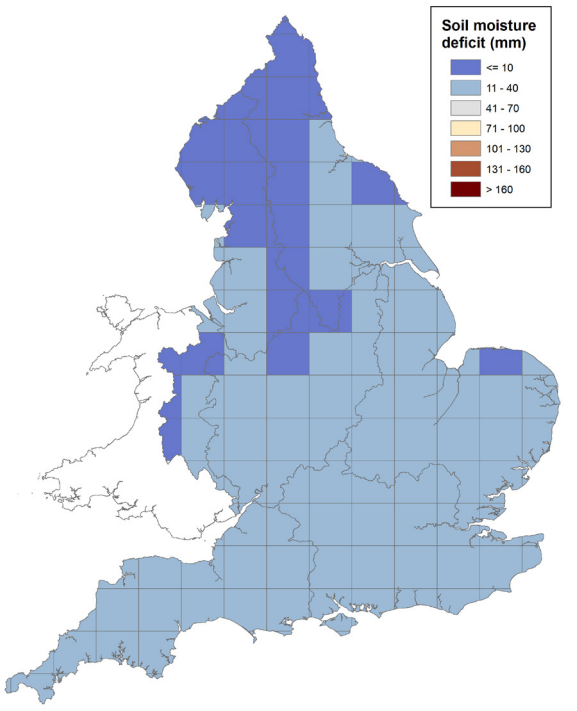
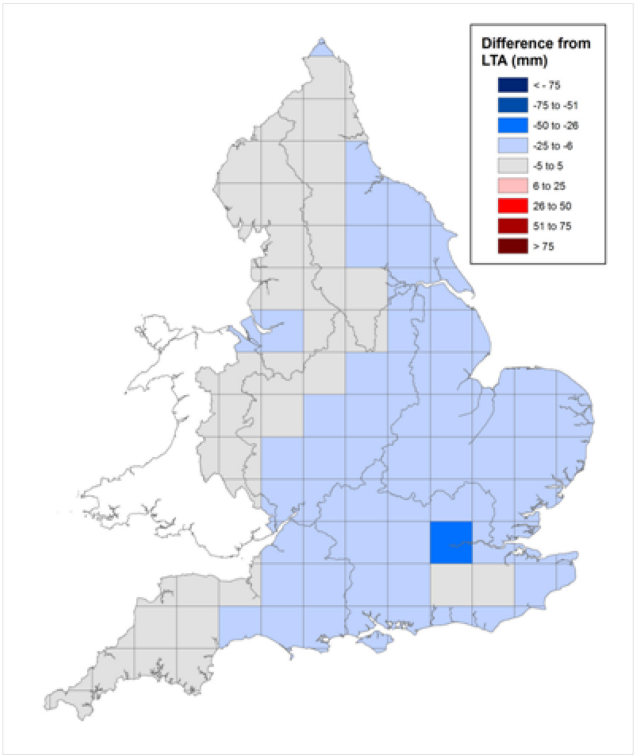
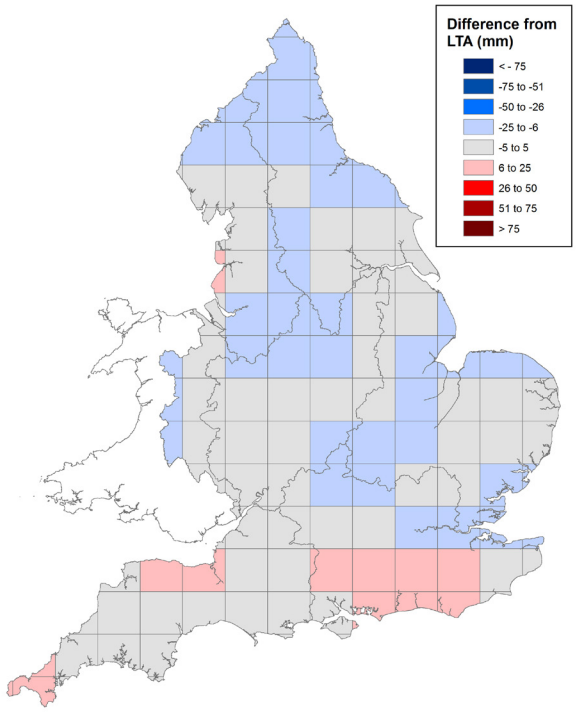
End of March 2016[1]	End of April 2016[2]
	
	

Figure 2.1: Soil moisture deficits for weeks ending 29 March 2016 [1] (left panel) and 3 May 2016 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

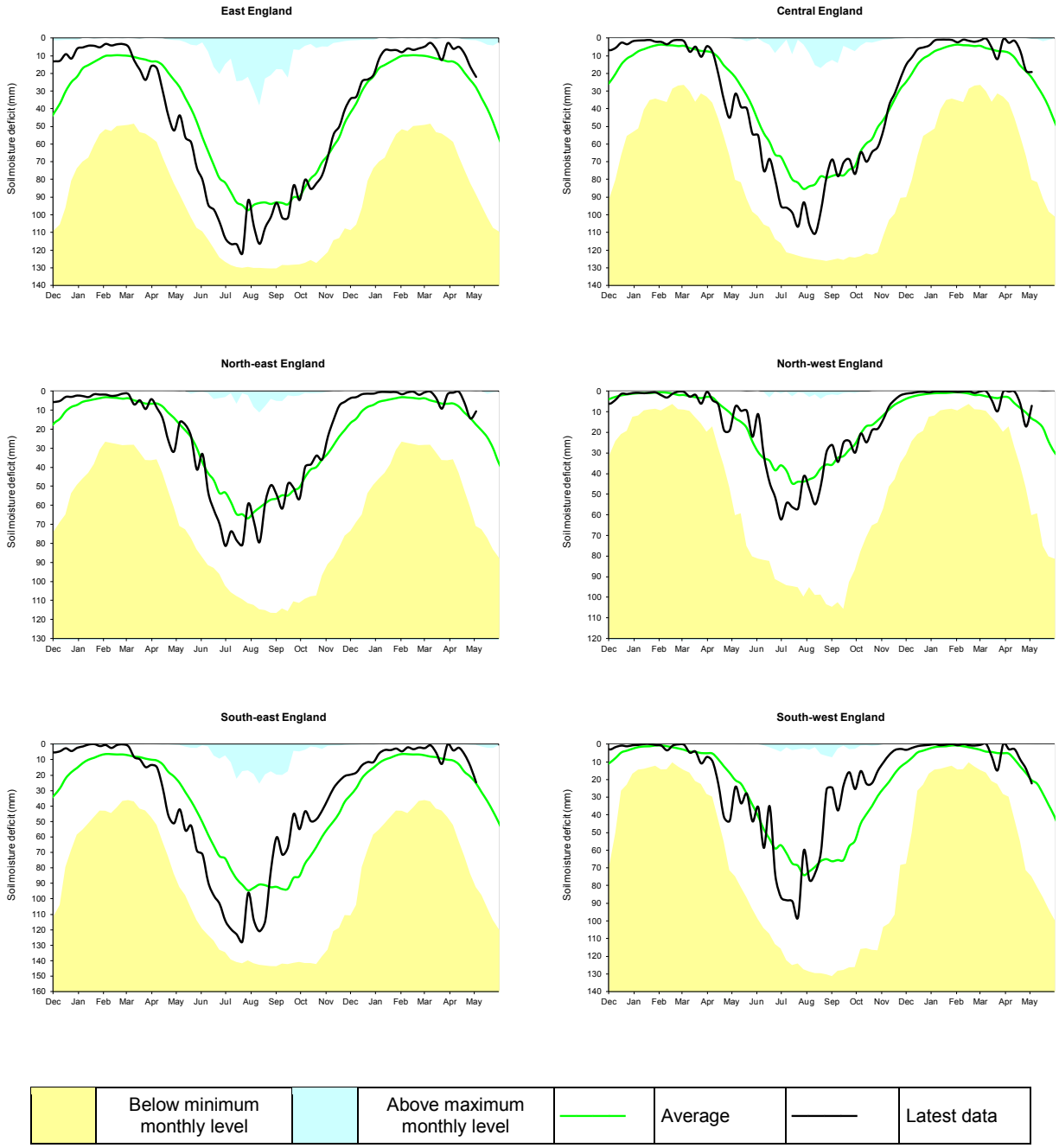
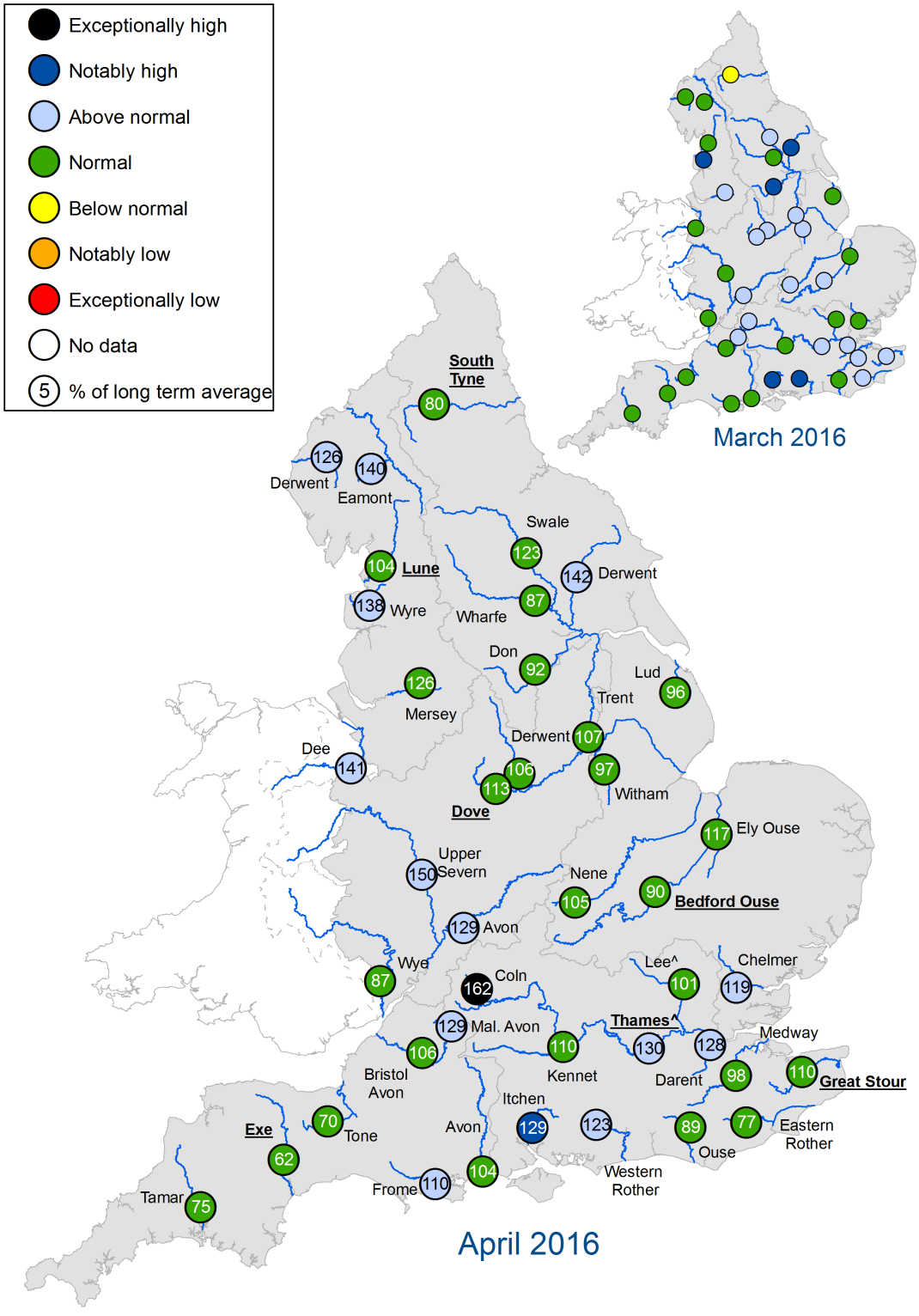


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

River flows



^ "Naturalised" flows are provided for the 'Thames at Kingston' and the 'Lee at Feildes Weir'

+/- Monthly mean flow is the highest/lowest on record for the current month (note that record length varies between sites)

Underlined sites are regional index sites and are shown on the hydrographs in Figure 3.2

Figure 3.1: Monthly mean river flow for indicator sites for March 2016 and April 2016, expressed as a percentage of the respective long term average and classed relative to an analysis of historic March and April monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

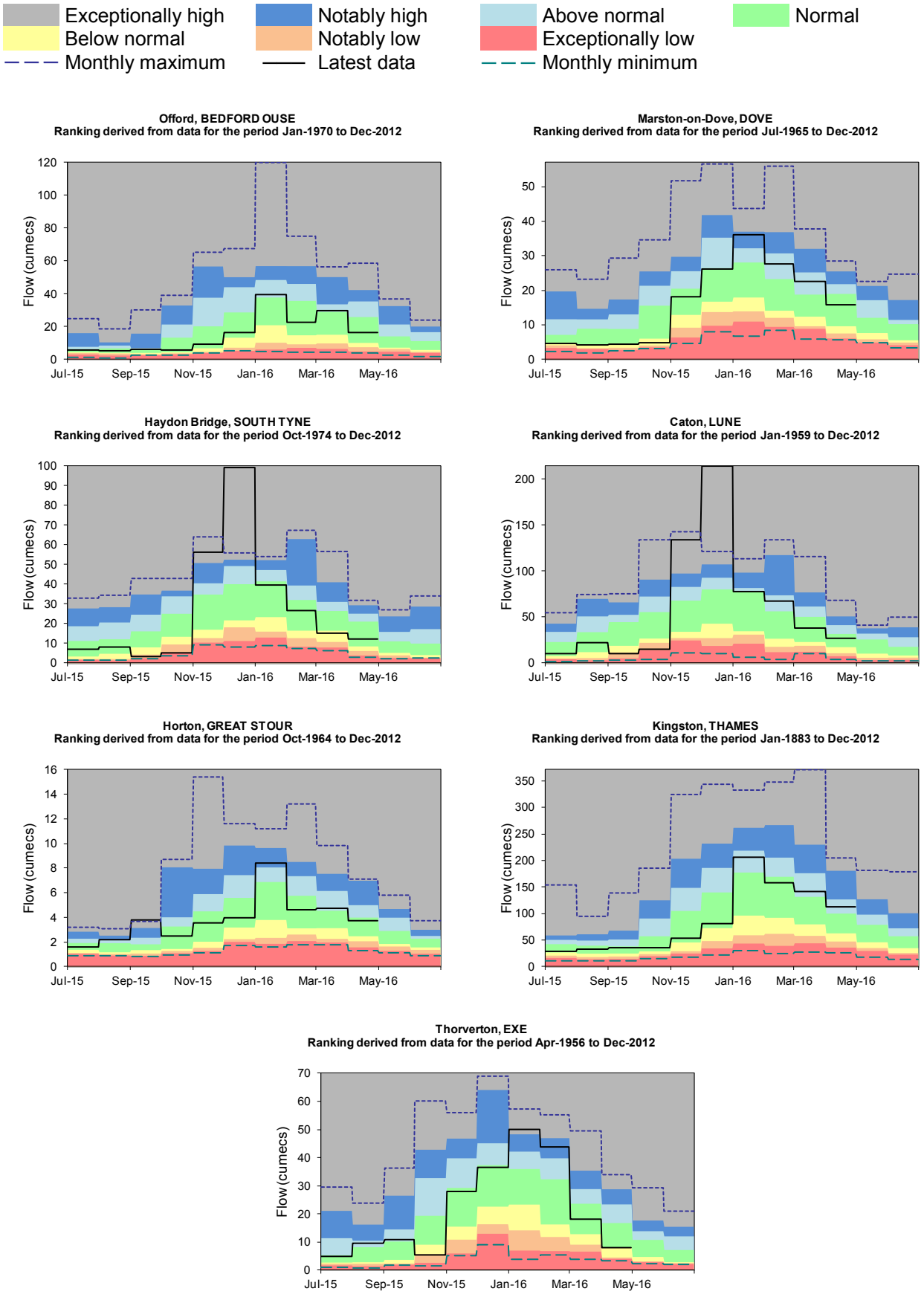
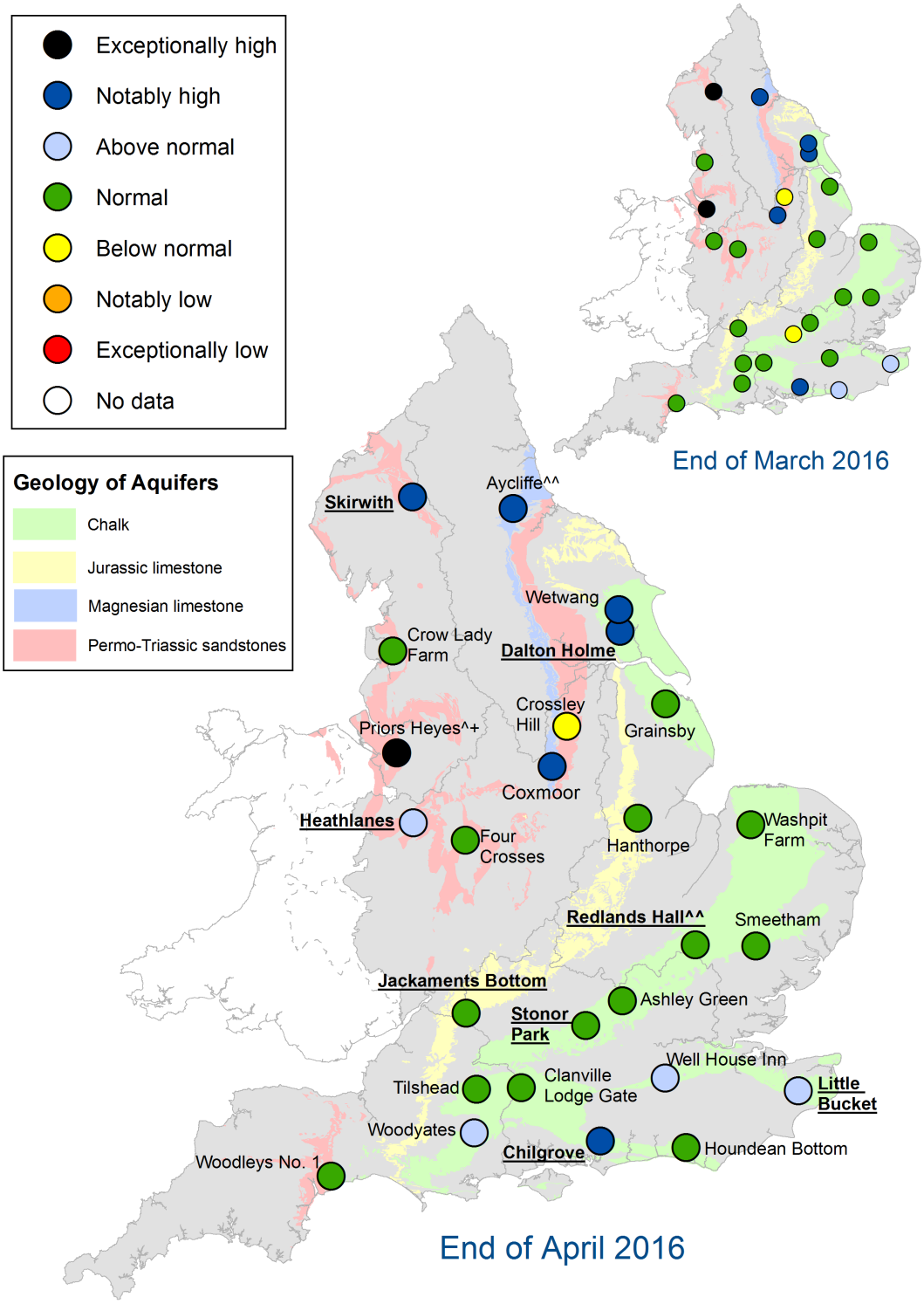


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

Groundwater levels



^ The level at Priors Heyes remains high compared to historic levels because the aquifer is recovering from the effects of historic abstraction
^^ Sites are manually dipped at different times during the month. They may not be fully representative of levels at the month end
+/- End of month groundwater level is the highest/lowest on record for the current month (note that record length varies between sites). Highlighted sites are major aquifer index sites and are shown in the groundwater level charts in Figure 4.2

Figure 4.1: Groundwater levels for indicator sites at the end of March 2016 and April 2016, classed relative to an analysis of respective historic March and April levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

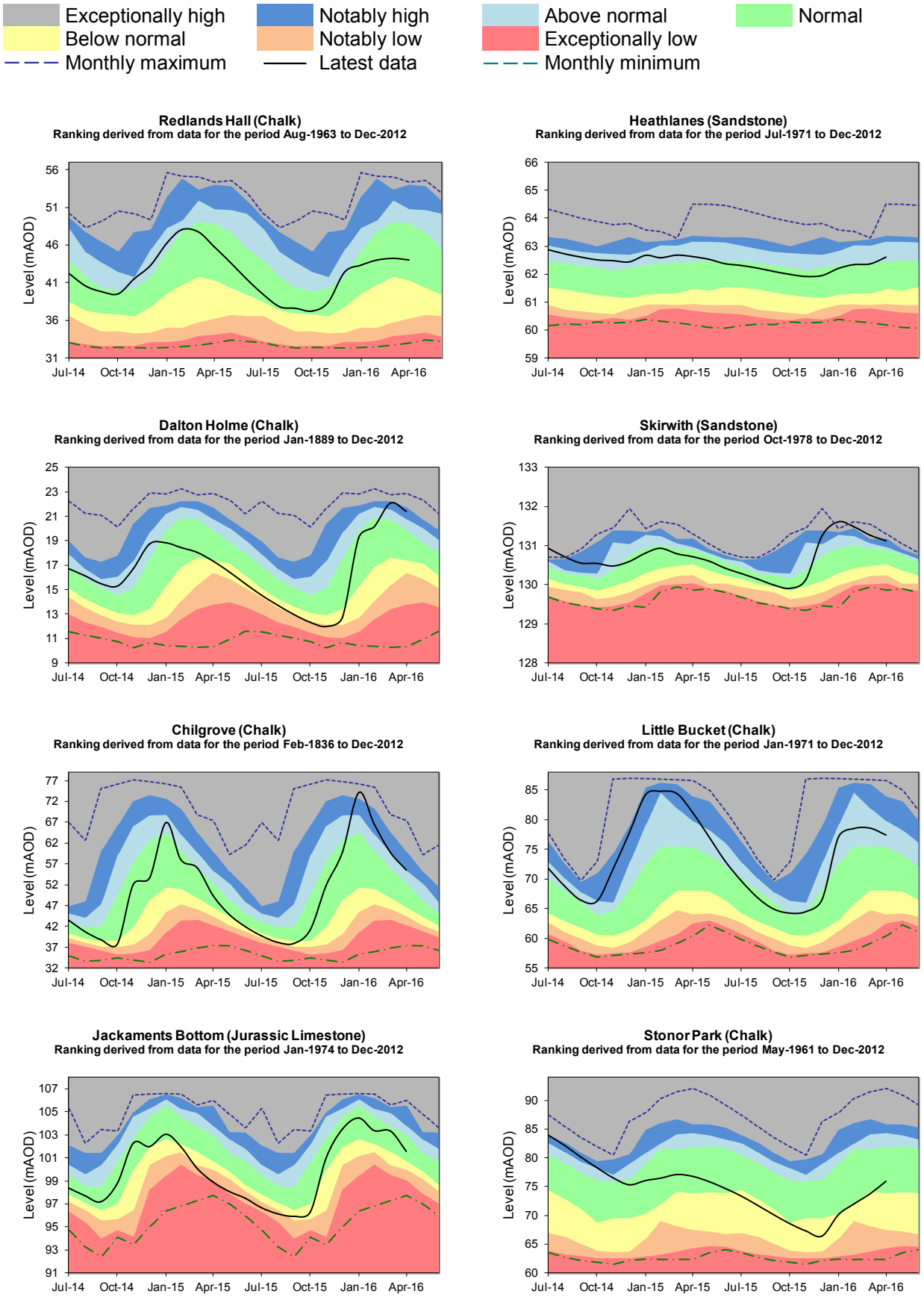
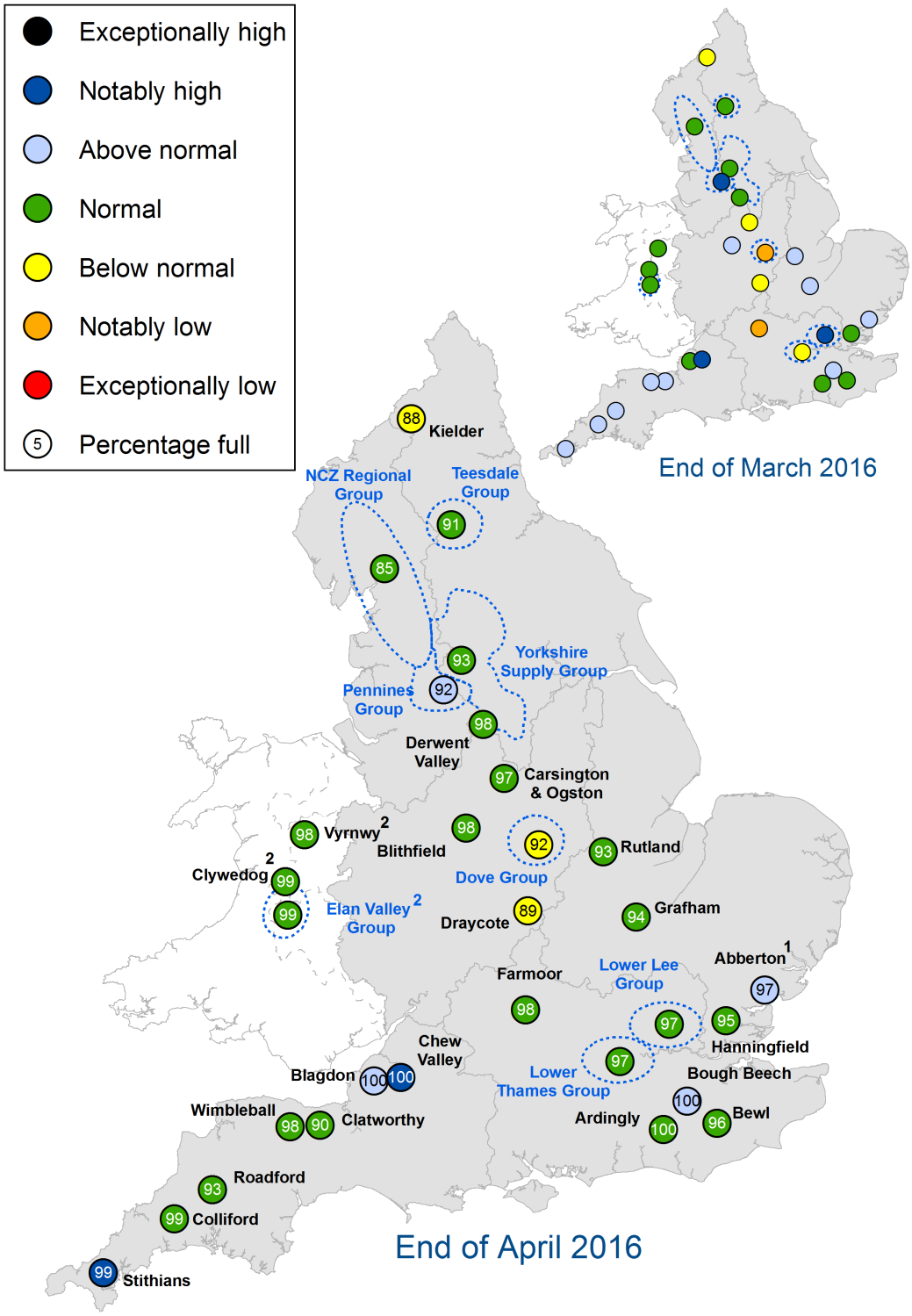


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

Reservoir storage



1. Engineering work at Abberton Reservoir in east England to increase capacity has been completed
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of March 2016 and April 2016 as a percentage of total capacity and classed relative to an analysis of historic March and April values respectively (Source: Water Companies). Note: Classes shown may not necessarily relate to control curves or triggers for drought actions. As well as for public water supply, some reservoirs are drawn down to provide flood storage, river compensation flows or for reservoir safety inspections. In some cases current reservoir operating rules may differ from historic ones.

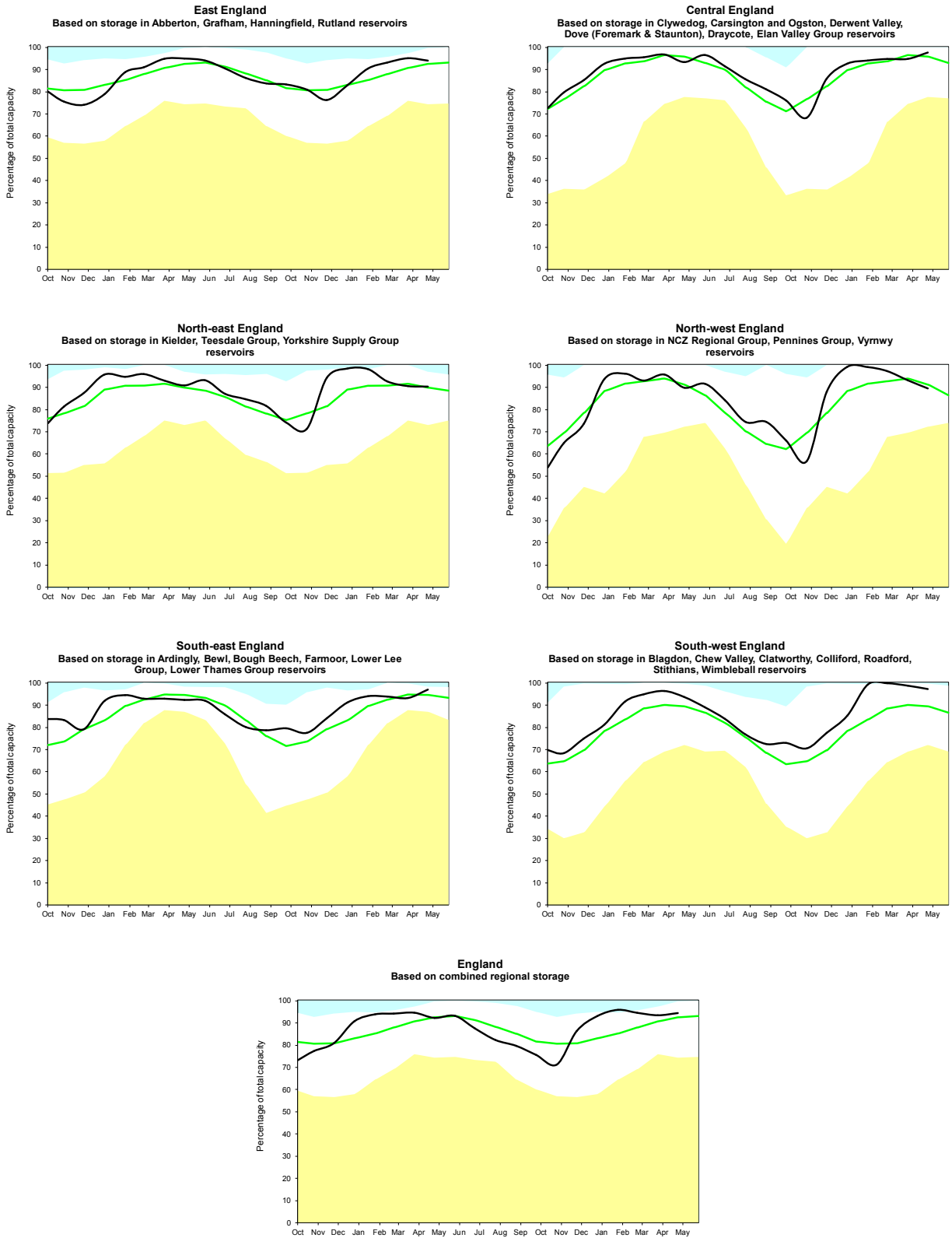


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

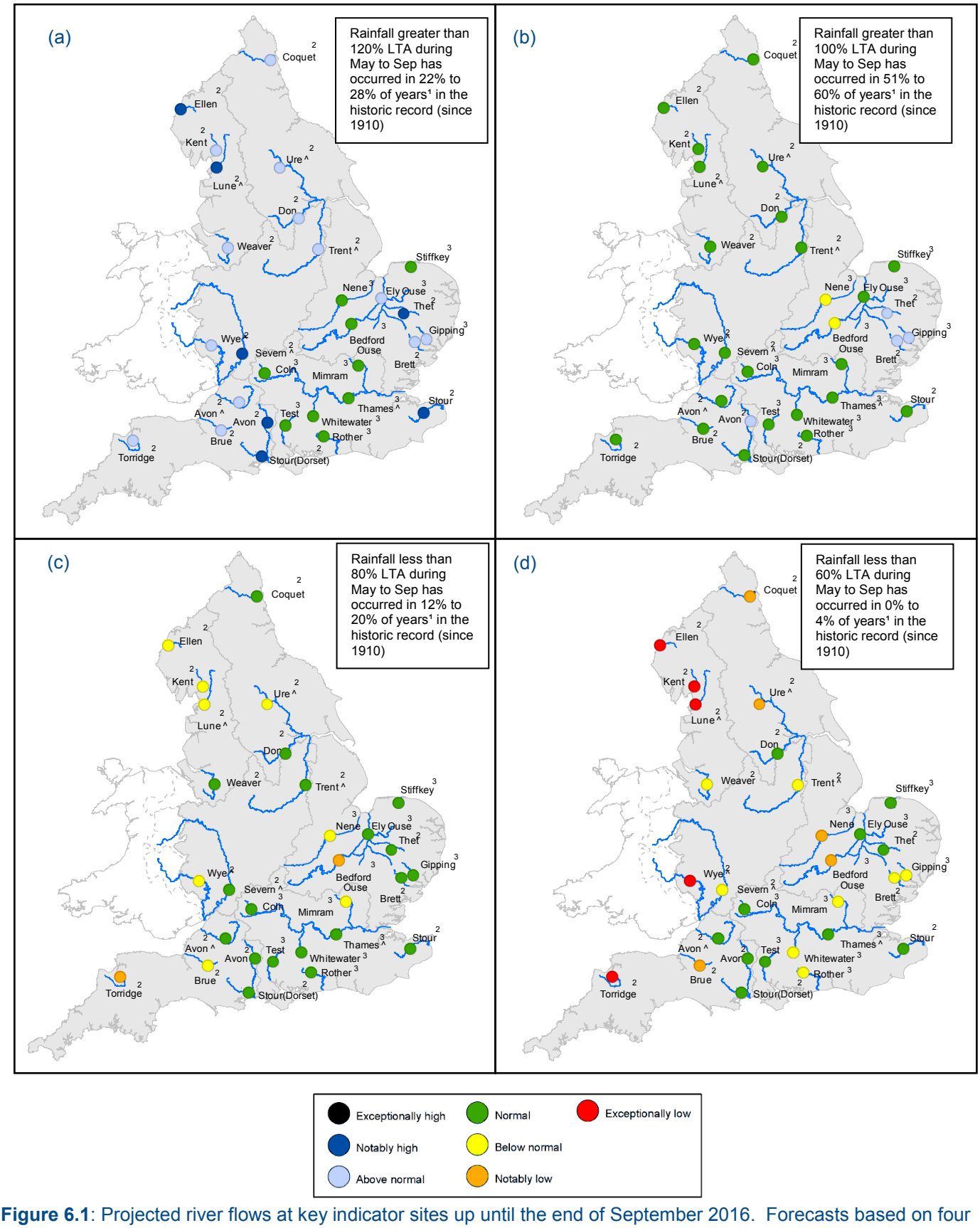


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between May and September 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

[1] This range of probabilities is a regional analysis
[2] Projections for these sites are produced by CEH
[3] Projections for these sites are produced by the Environment Agency
^ *"Naturalised" flows are projected for these sites*

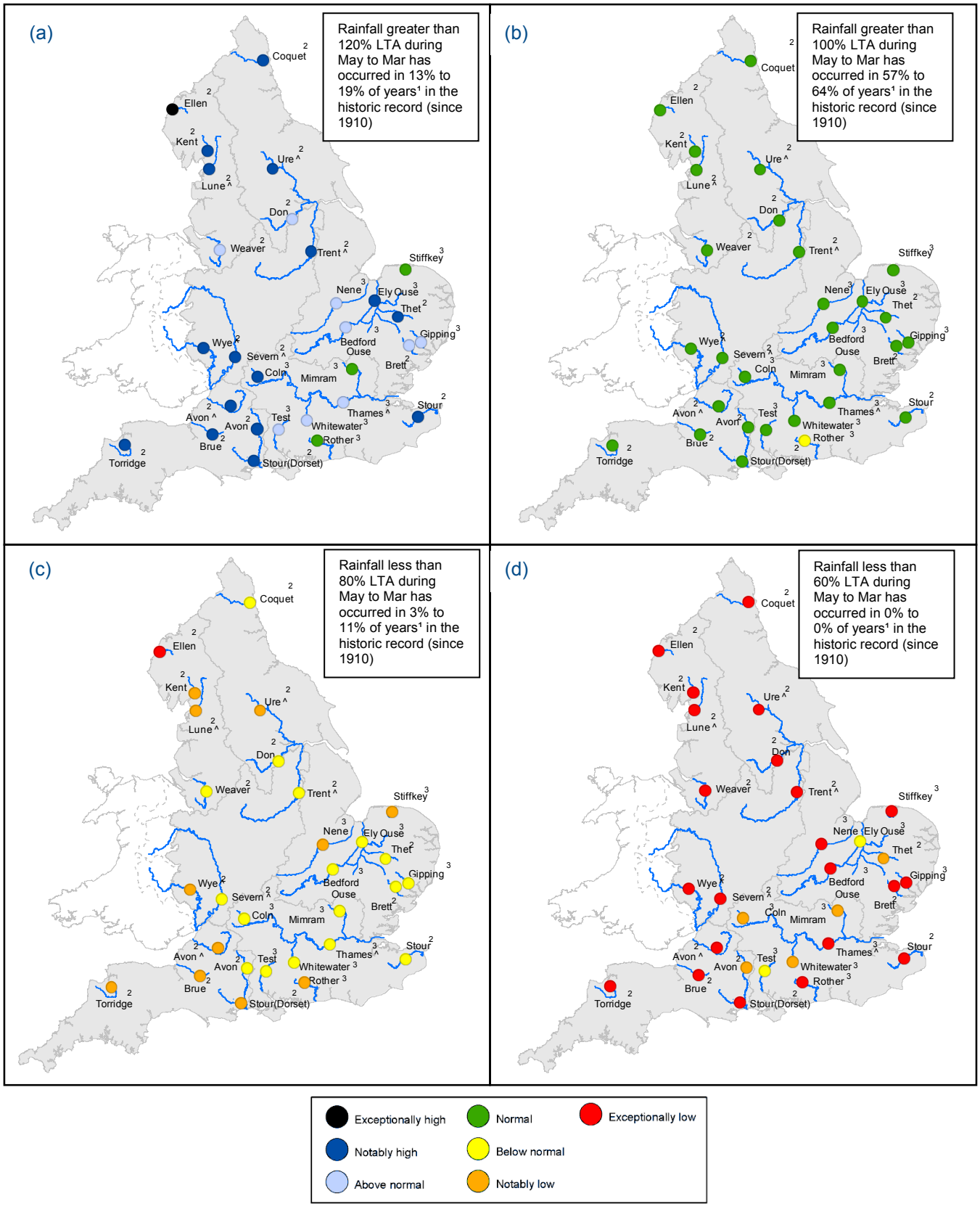


Figure 6.2: Projected river flows at key indicator sites up until the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between May 2016 and March 2017 (Source: Centre for Ecology and Hydrology, Environment Agency)

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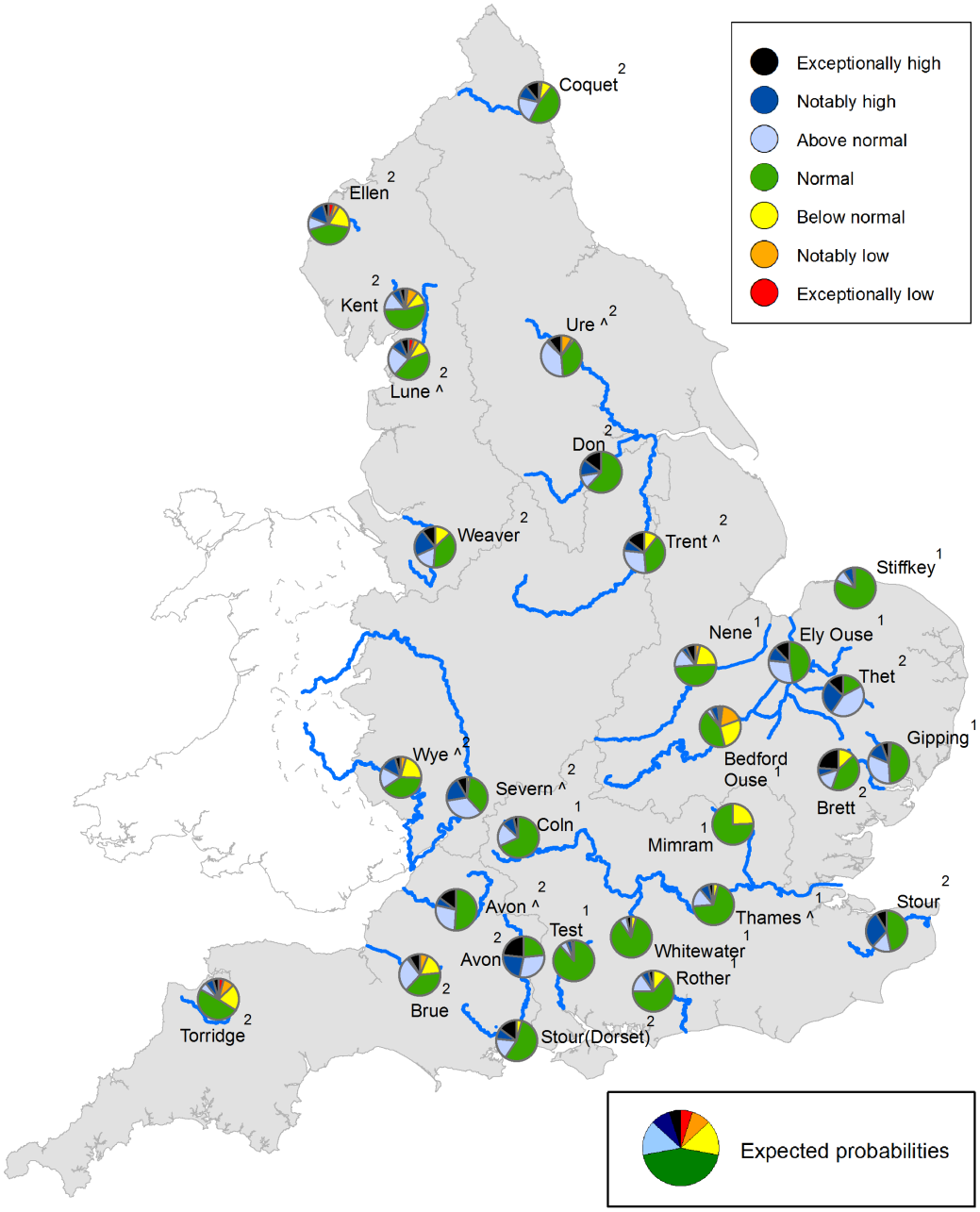

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2016. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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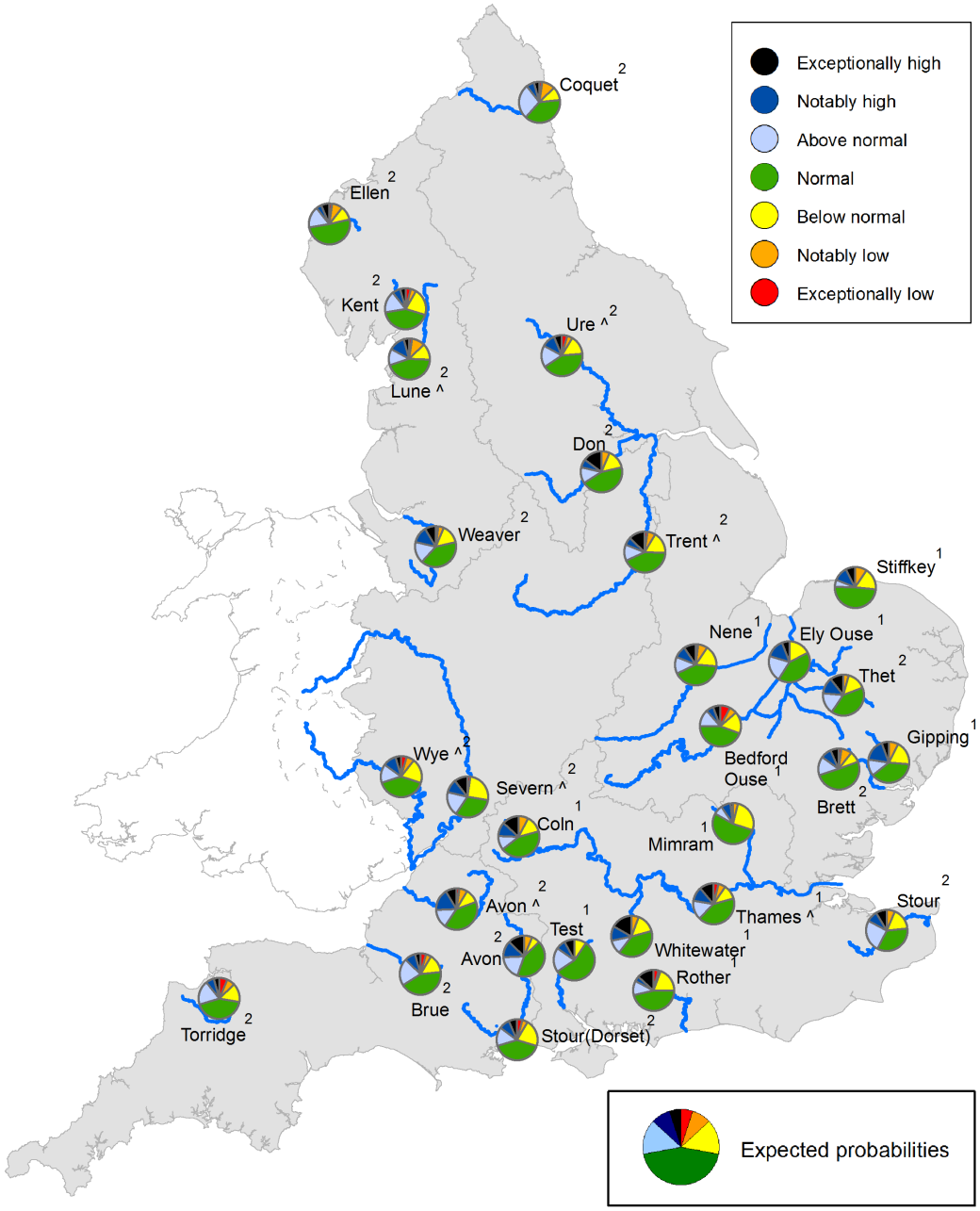

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2017. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

[1] Projections for these sites are produced by the Environment Agency
[2] Projections for these sites are produced by CEH
^"Naturalised" flows are projected for these sites

Forward look - groundwater

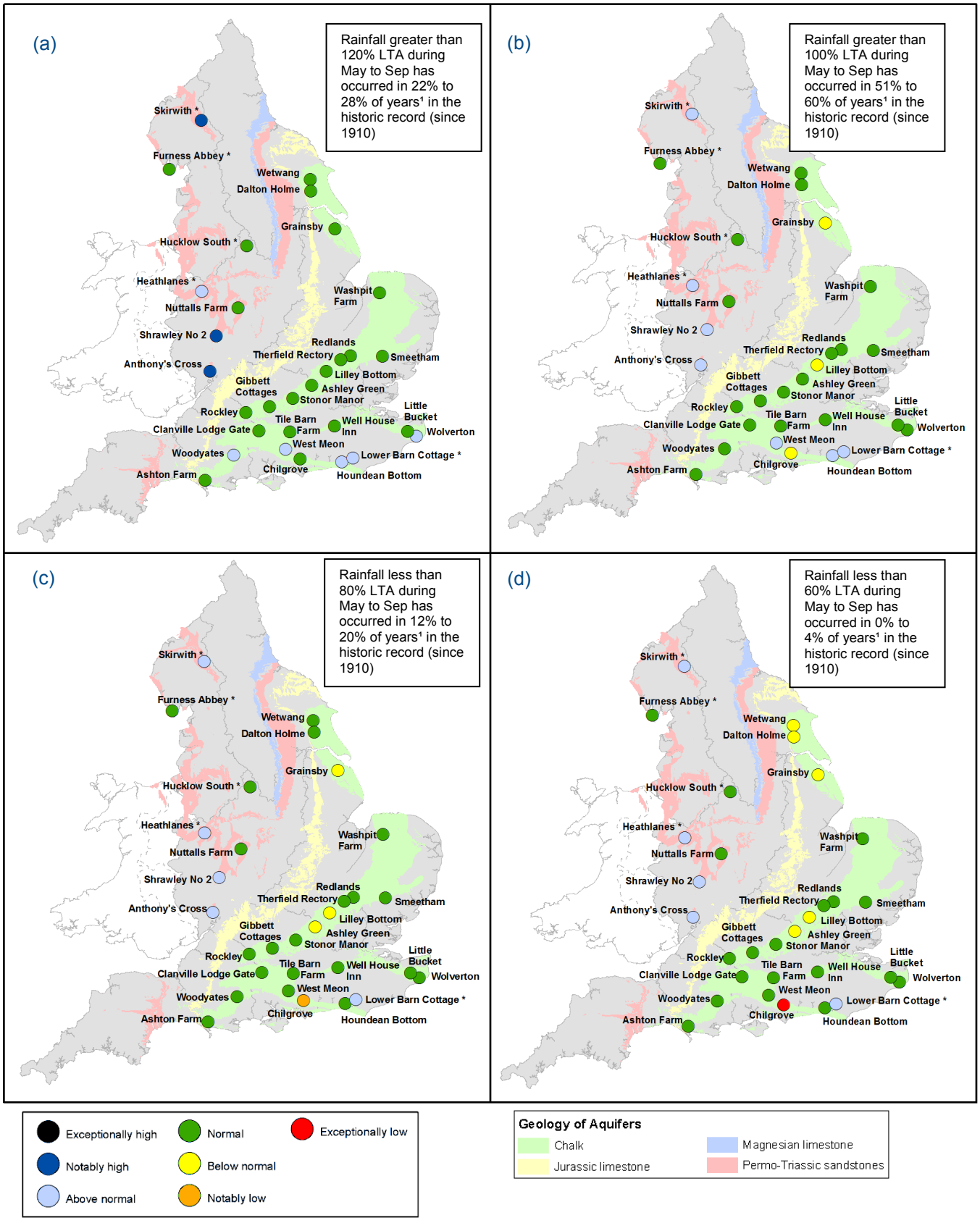

Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between May and September 2016 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2016.

* Projections for these sites are produced by BGS
[1] This range of probabilities is a regional analysis

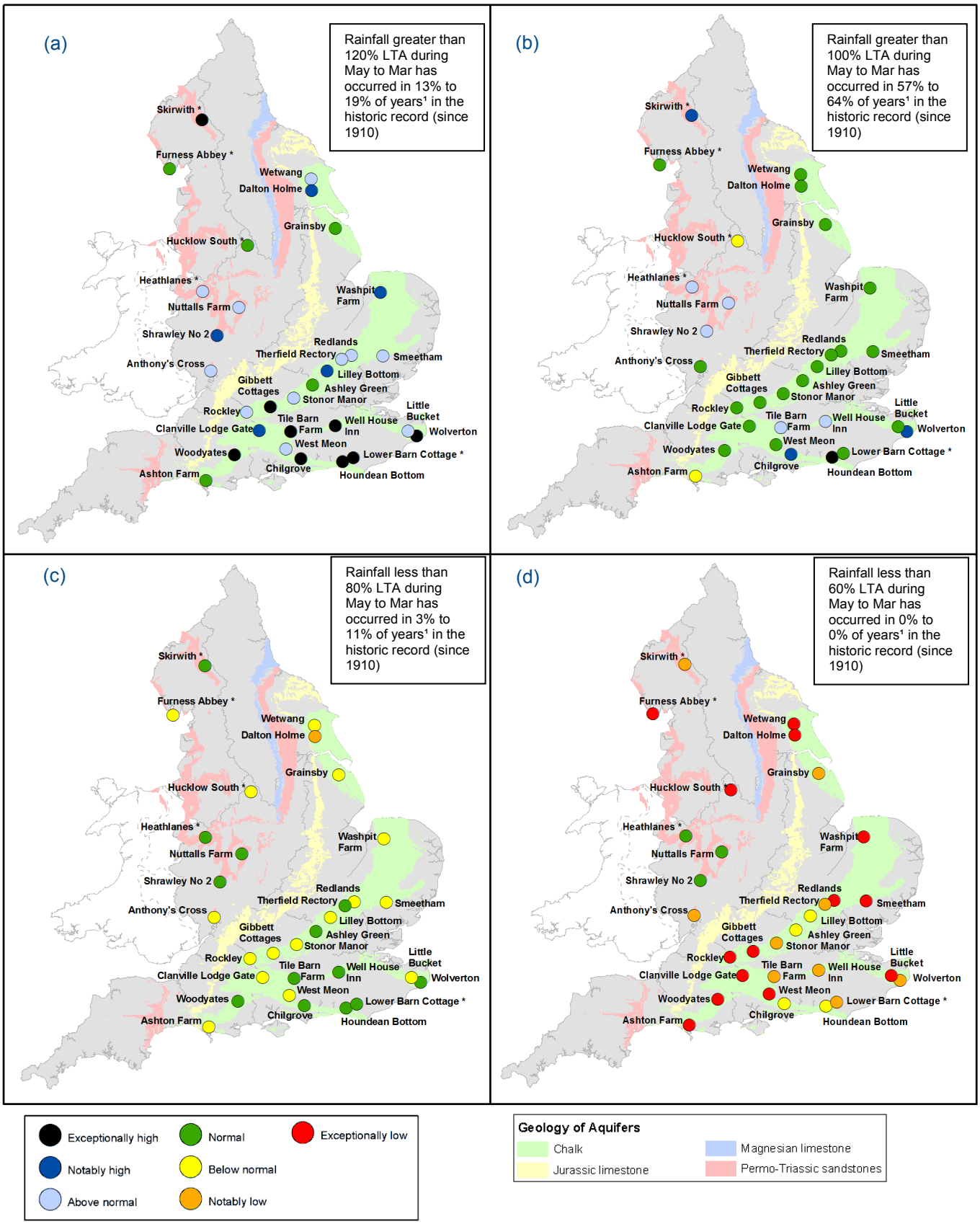

Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between May 2016 and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2016.

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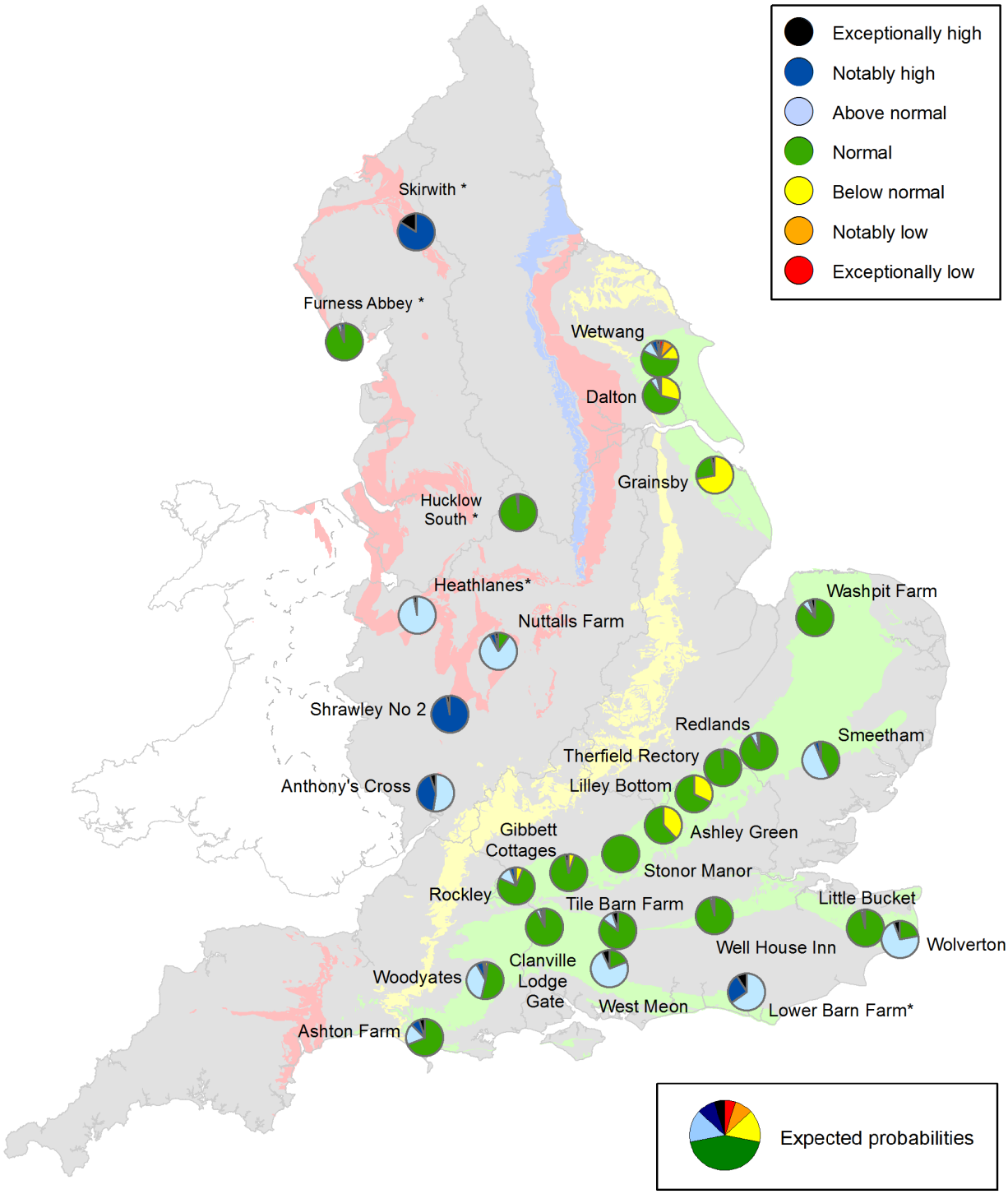
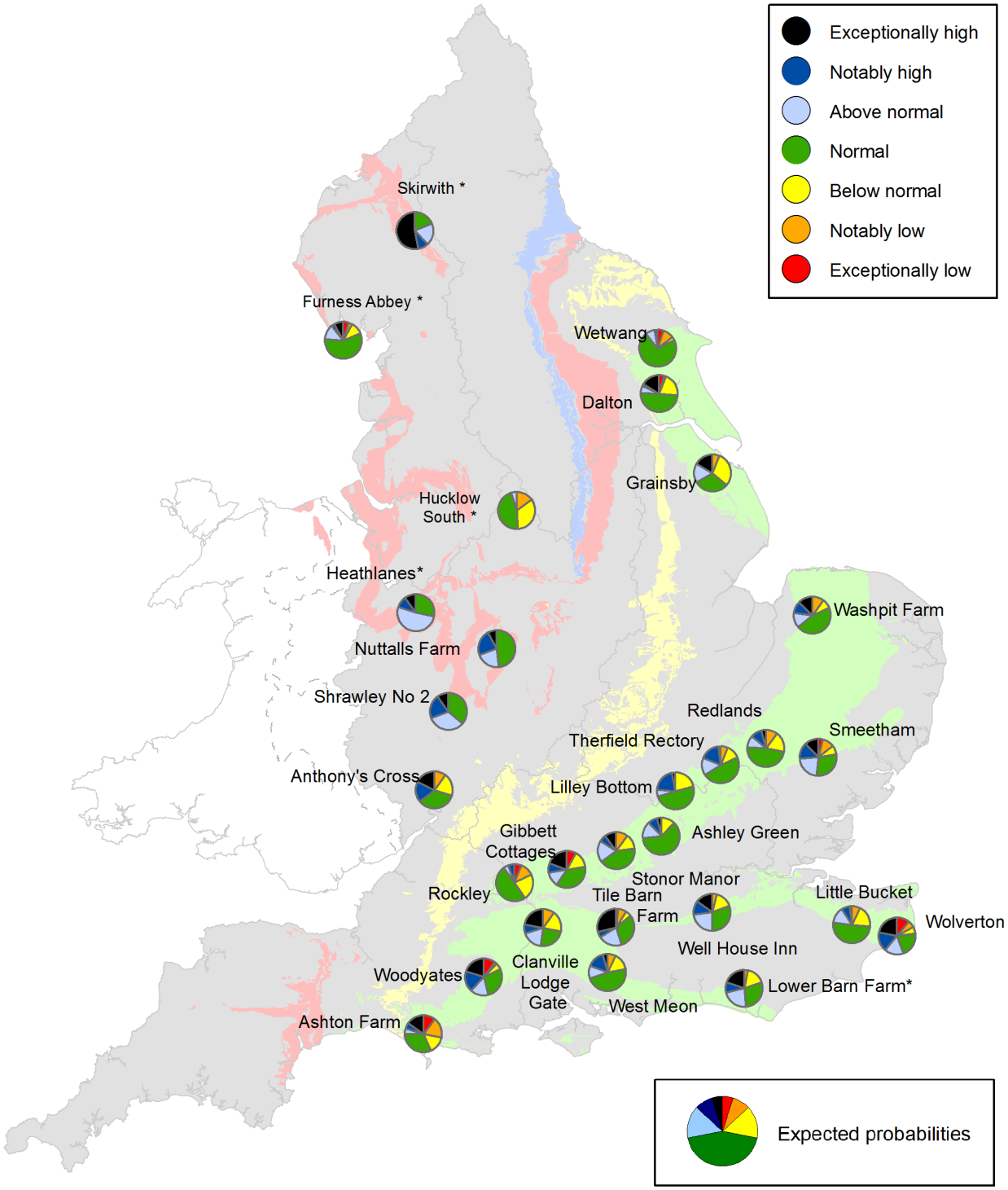


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.7: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of September 2016. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

** Projections for these sites are produced by BGS*



Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are those which would typically occur 44% of the time within the historic record.

Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of March 2017. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the time of year. (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

* Projections for these sites are produced by BGS

Figure 7.1: Geographic regions

Glossary

Term	Definition
Aquifer	A geological formation able to store and transmit water.
Areal average rainfall	The estimated average depth of rainfall over a defined area. Expressed in depth of water (mm).
Artesian	The condition where the groundwater level is above ground surface but is prevented from rising to this level by an overlying continuous low permeability layer, such as clay.
Artesian borehole	Borehole where the level of groundwater is above the top of the borehole and groundwater flows out of the borehole when unsealed.
Cumecs	Cubic metres per second (m^3s^{-1})
Effective rainfall	The rainfall available to percolate into the soil or produce river flow. Expressed in depth of water (mm).
Flood Alert/Flood Warning	Three levels of warnings may be issued by the Environment Agency. Flood Alerts indicate flooding is possible. Flood Warnings indicate flooding is expected. Severe Flood Warnings indicate severe flooding.
Groundwater	The water found in an aquifer.
Long term average (LTA)	The arithmetic mean calculated from the historic record, usually based on the period 1961-1990. However, the period used may vary by parameter being reported on (see figure captions for details).
mAOD	Metres Above Ordnance Datum (mean sea level at Newlyn Cornwall).
MORECS	Met Office Rainfall and Evaporation Calculation System. Met Office service providing real time calculation of evapotranspiration, soil moisture deficit and effective rainfall on a 40 x 40 km grid.
Naturalised flow	River flow with the impacts of artificial influences removed. Artificial influences may include abstractions, discharges, transfers, augmentation and impoundments.
NCIC	National Climate Information Centre. NCIC area monthly rainfall totals are derived using the Met Office 5 km gridded dataset, which uses rain gauge observations.
Recharge	The process of increasing the water stored in the saturated zone of an aquifer. Expressed in depth of water (mm).
Reservoir gross capacity	The total capacity of a reservoir.
Reservoir live capacity	The capacity of the reservoir that is normally usable for storage to meet established reservoir operating requirements. This excludes any capacity not available for use (e.g. storage held back for emergency services, operating agreements or physical restrictions). May also be referred to as ‘net’ or ‘deployable’ capacity.
Soil moisture deficit (SMD)	The difference between the amount of water actually in the soil and the amount of water the soil can hold. Expressed in depth of water (mm).

Categories

Exceptionally high	Value likely to fall within this band 5% of the time
Notably high	Value likely to fall within this band 8% of the time
Above normal	Value likely to fall within this band 15% of the time
Normal	Value likely to fall within this band 44% of the time
Below normal	Value likely to fall within this band 15% of the time
Notably low	Value likely to fall within this band 8% of the time
Exceptionally low	Value likely to fall within this band 5% of the time