Monthly water situation report

England

Summary – March 2016

Rainfall totals across England were above average for a fifth consecutive month at 127% of the March long term average. Soil moisture deficits were at, or close to, zero in most areas during March. Although river flows decreased in many areas, all but one of the sites were normal or higher for the time of year. By contrast, groundwater levels increased at the majority of sites during March and month-end water levels were predominantly normal or higher for the time of year. Reservoir stocks increased, but overall storage was 93% of total capacity for March.

Rainfall

Rainfall totals for March ranged from less than 50mm in County Durham, Northumberland and Tyne and Wear, to more than 100mm in parts of Devon, Cornwall, Derbyshire and Yorkshire. Monthly rainfall totals were above the March long term average (LTA) in more than three quarters of hydrological areas across England. The Yorkshire Derwent, Hull and Humber and Ouse hydrological areas in the north-east of England received more than 160% of the March LTA rainfall (Figure 1.1).

March rainfall totals were above normal or higher for the time of year for the majority of hydrological areas, notably across central, east, south-east and parts of north-east England. Most hydrological areas across south-west, north-west and the far north-east of England received normal or lower rainfall for the time of year (Figure 1.2). Over the 3 month period to the end of March, cumulative rainfall totals were above normal or higher for the majority of areas across England.

At the regional scale, March rainfall totals ranged from 92% of the LTA in north-west England to 154% in east England. The six month period ending in March was the wettest six month period on record (since 1910) for north-east England, and the second wettest on record for north-west England. Rainfall totals across England as a whole were above average for the fifth consecutive month, at 127% of the March LTA (Figure 1.3).

Soil moisture deficit

Soil Moisture Deficits (SMDs) at the end of March were less than 10mm across the whole of England, and at, or close to, zero, in most areas. Parts of east and south-west England experienced the largest decreases in SMD of 12mm and 13mm respectively compared to the end of February. Where SMDs increased, mainly in north-east and south-east England, the increases were predominantly less than 5mm. End of month SMDs were close to the long term average (LTA) for the end of March in parts of northern and western England and lower than the LTA across much of the rest of England (Figure 2.1).

At a regional scale, SMDs increased briefly during the month in all regions. By the end of March, values were close to zero in all regions, representing only a very small change compared to the previous month. (Figure 2.2)

River flows

Monthly mean river flows for March decreased at two-thirds of indicator sites across England compared with February. All but one of our indicator sites were classed as normal or higher for the time of year, and half of the sites were above normal or notably high for the time of year (Figure 3.1).

Monthly mean river flows were classed as above normal for the time of year at 4 of the regional index sites and normal at 2 sites. The River Tyne at Hayden Bridge in Northumberland was below normal for the time of year (Figure 3.2).

Groundwater levels

Groundwater levels increased at just over two-thirds of indicator sites during March. At the end of the month, groundwater levels were normal for the time of year at just under two-thirds of indicator sites and were above normal or higher at all but two of the remaining sites. Below normal levels for the end of March were recorded at Stonor Park (South-west Chilterns chalk) and Crossley Hill (Nottinghamshire and Doncaster Permo-Triassic sandstone).

End of month groundwater levels at the major aquifer index sites were normal or higher for the time of year at all or our indicator sites. Groundwater levels recorded at Little Bucket (East Kent Stour chalk) are above normal and Dalton Holme (Hull & East Riding chalk) and Chilgrove (Chichester chalk) are notably high for the time of year. Skirwith (Carlisle Basin and Eden Valley sandstone aquifer) continues to be exceptionally high for the time of year (Figures 4.1 and 4.2)

Reservoir storage

Reservoir stocks increased at nearly a third of reported reservoirs and reservoir groups during March and decreased at nearly a quarter of reservoirs or reservoir groups. There was no change in stocks at nearly half of reservoirs or reservoir groups. The largest increase in storage was at Abberton Reservoir (11%) and the largest decrease was within the NCZ group of reservoirs (8%). End of month stocks were classed as normal or higher for the time of year at the majority of reservoirs and reservoir groups. Sites supplying parts of north-east, central and south-east England were classed as below normal or lower for the time of year (Figure 5.1)

At the regional-scale, reservoir stocks at the end of March had decreased slightly compared to February in all areas except east and central England. The largest increase of 2% was in east England and the largest decrease of 4% was in north-west England. Month-end regional stocks for the end of March, ranged from 91% of total capacity in north-east England to 99% in south-west England. Reservoir storage for England decreased to 93% of total capacity at the end of March (Figure 5.2).

Forward look

April is likely to remain unsettled with showers and longer periods of rain interspersed with drier spells. Wetter than average conditions are expected through to the start of May. For the period April-May-June as a whole, wetter conditions are slightly more probable than drier conditions[1].

Projections for river flows at key sites[2]

By the end of September 2016 nearly three quarters of sites have a greater than expected chance of above normal or higher cumulative flows. By the end of March 2017, over half of the sites have a greater than expected chance of 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 2017see 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]

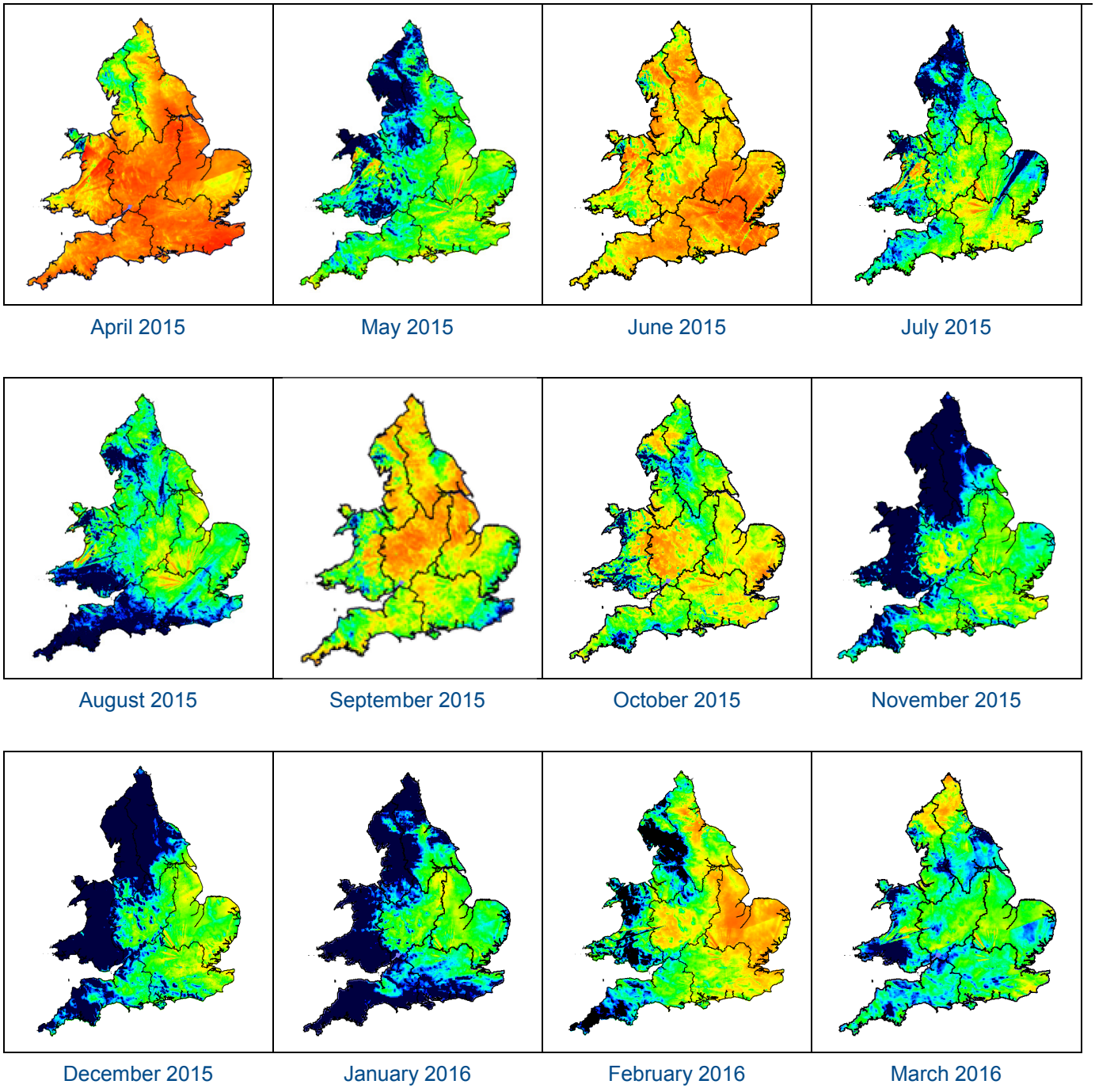
At the end of September 2016 four fifths of sites have a greater than expected chance of normal or higher groundwater levels for the time of year. At the end of March 2017 the projections show a similar picture with nearly four fifths of the sites having a greater than expected chance of normal or higher 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).

Rainfall



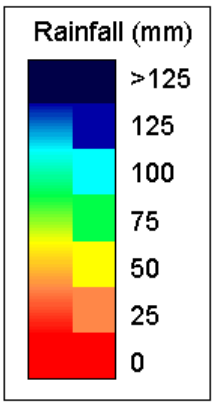


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

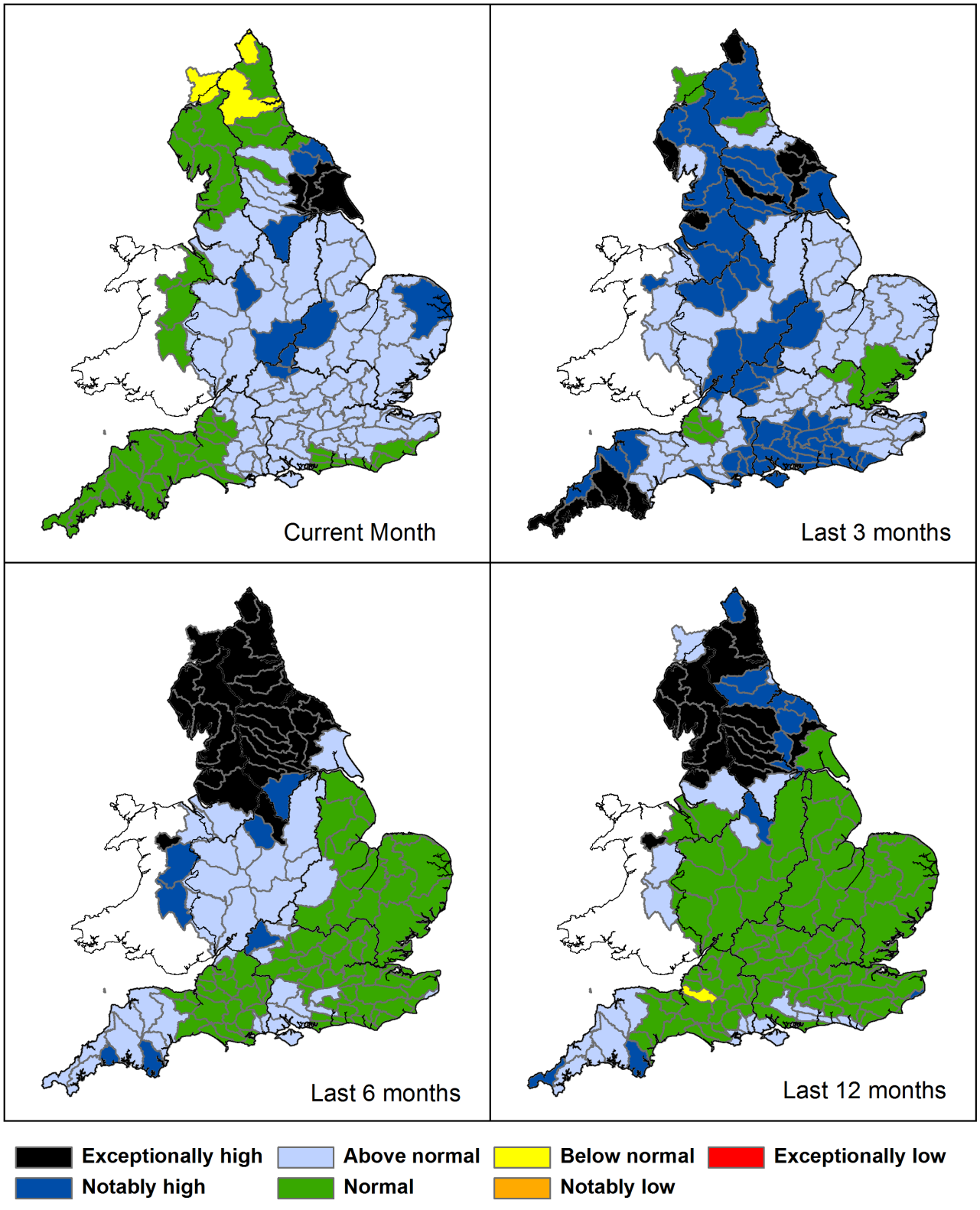


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 31 March), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the Met 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.

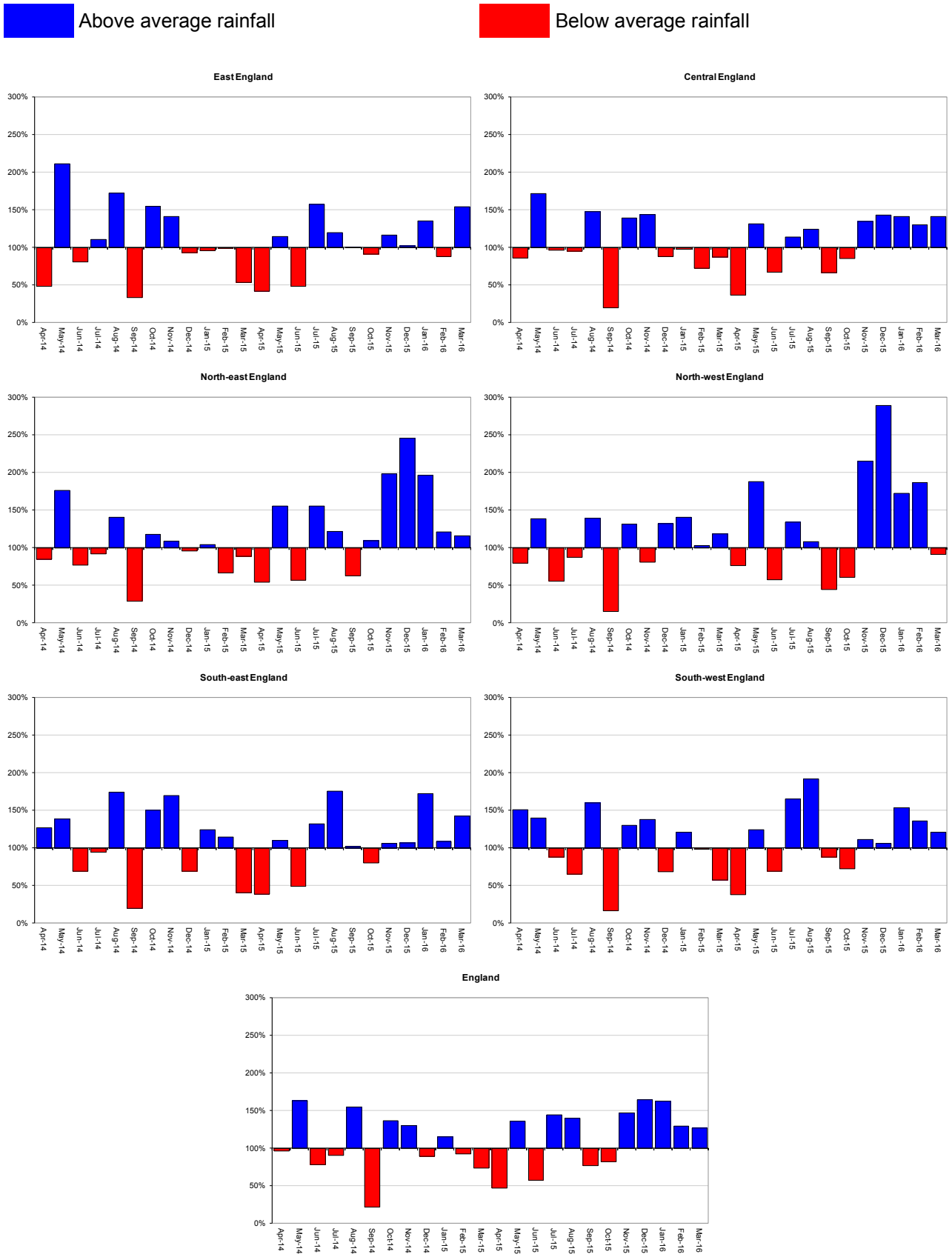


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

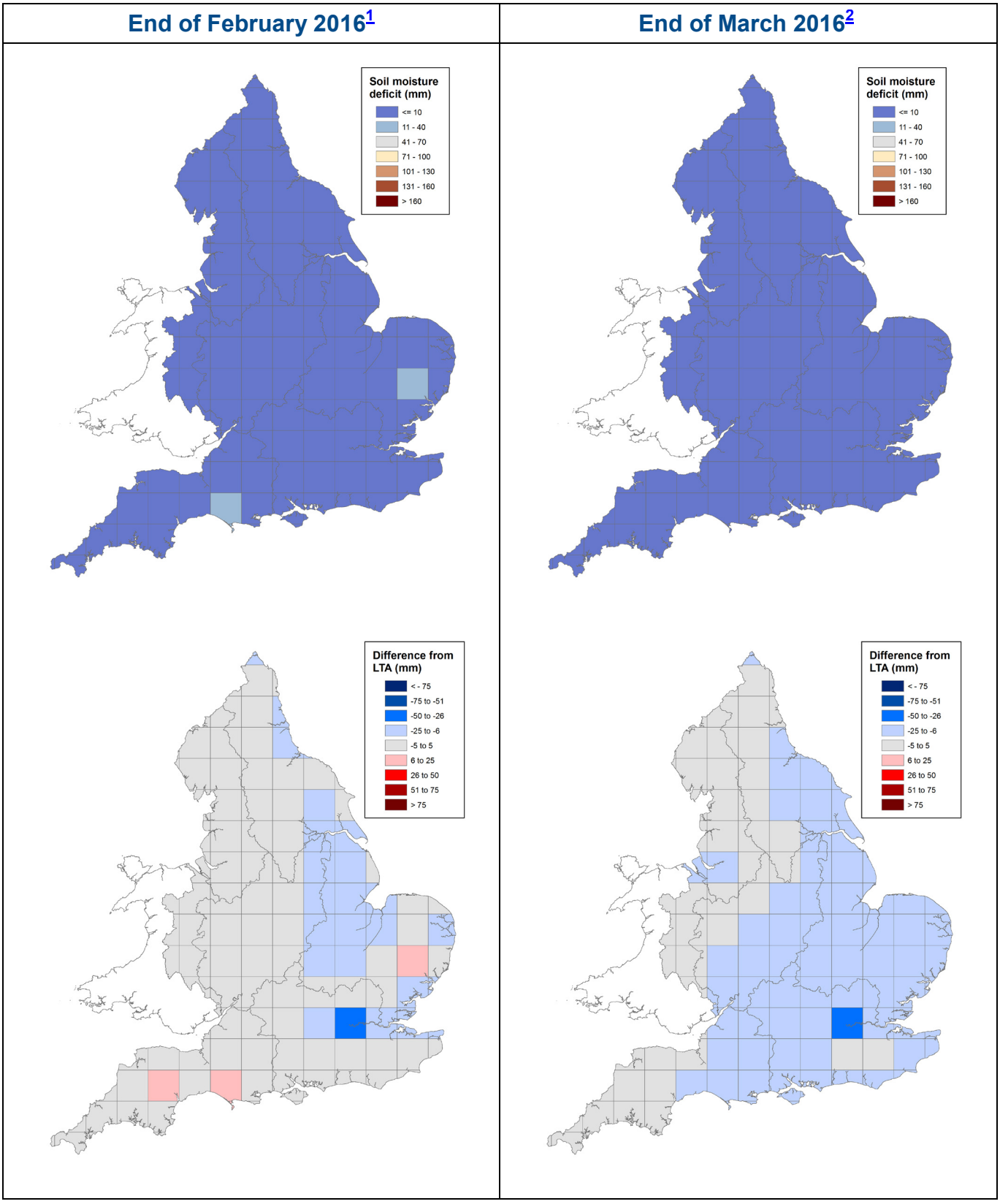


Figure 2.1: Soil moisture deficits for weeks ending 01 March 2016 [1] (left panel) and 29 March 2016 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

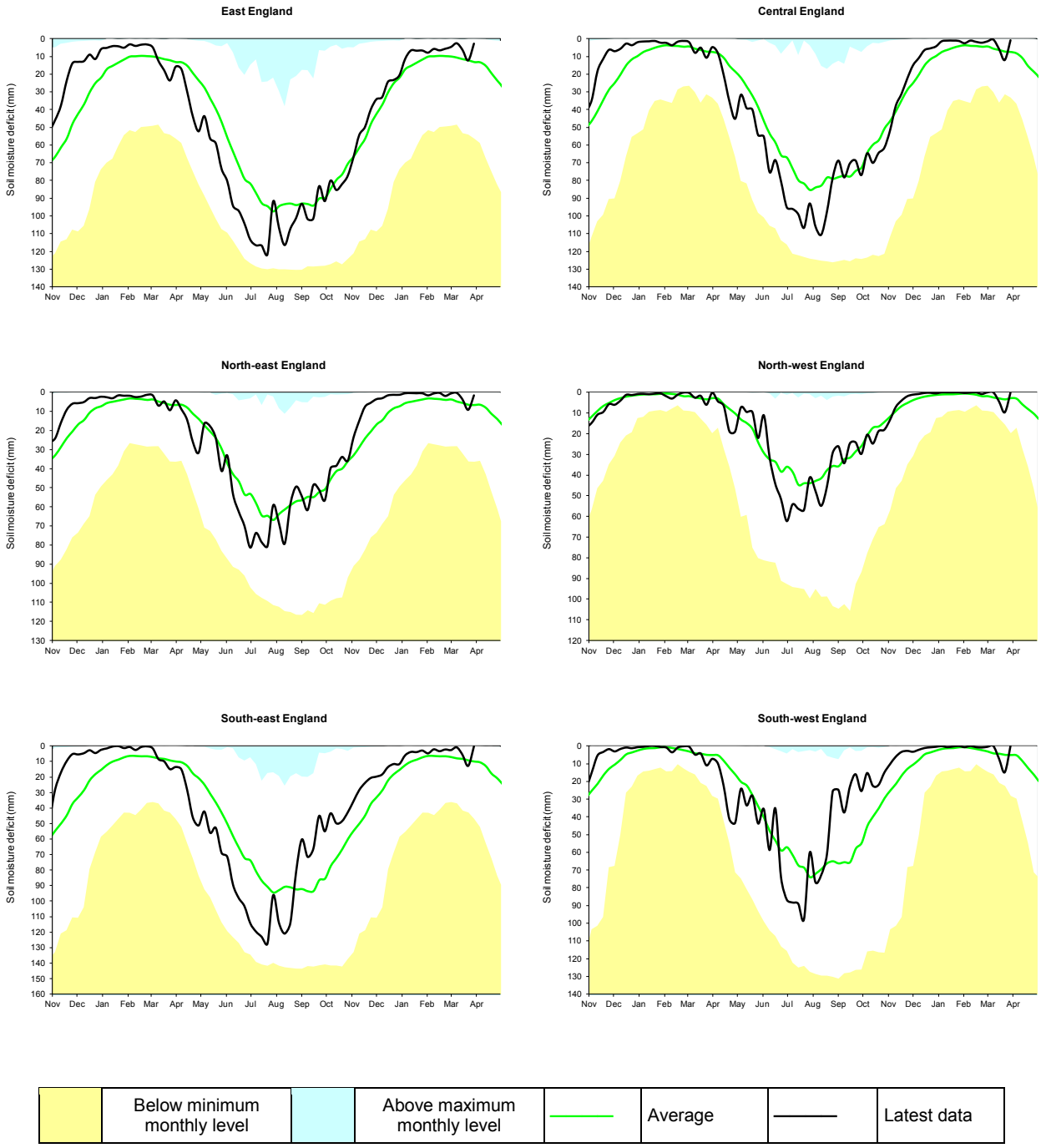
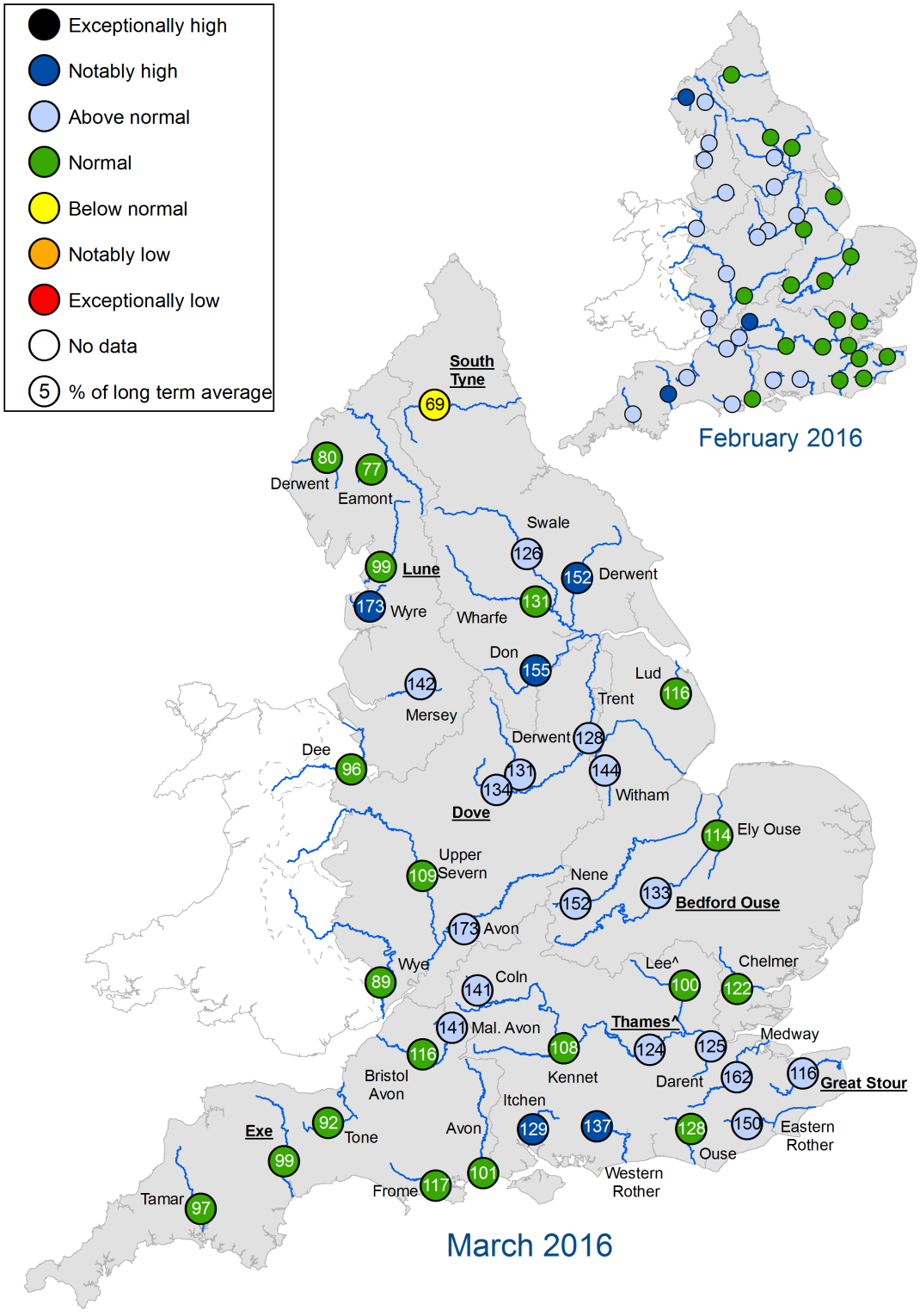


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

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 February 2016 and March 2016, expressed as a percentage of the respective long term average and classed relative to an analysis of historic February and March monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

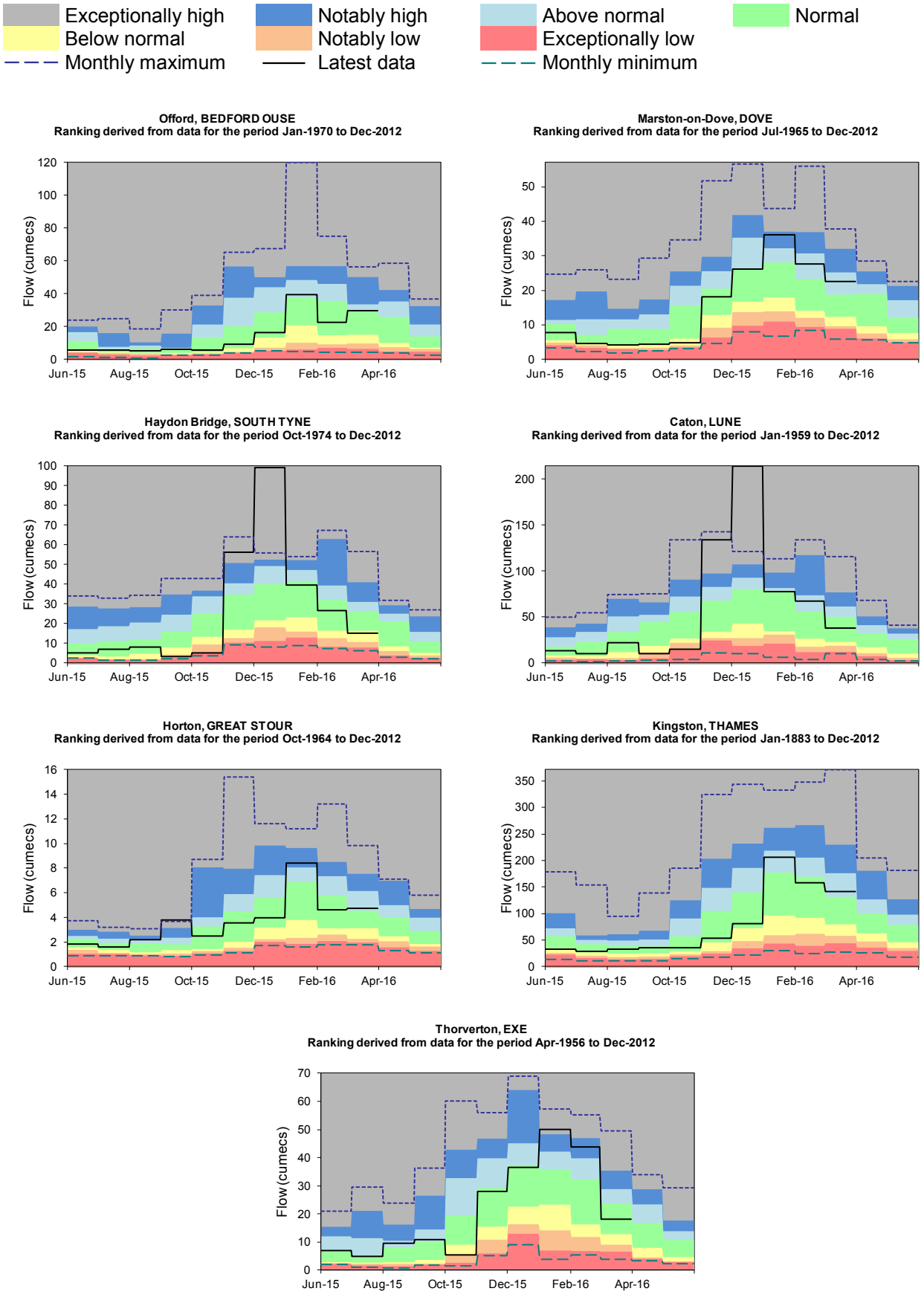
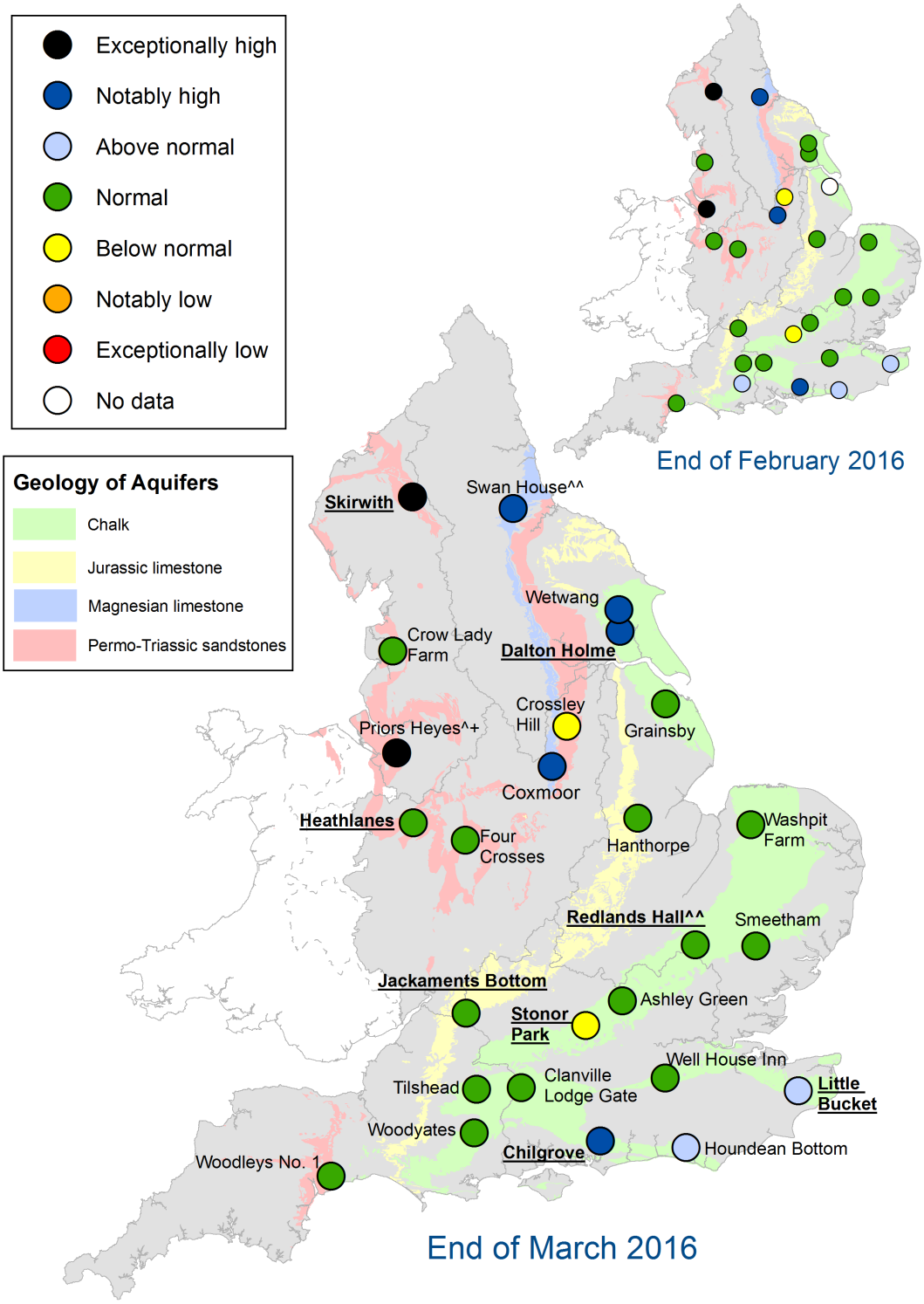


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 February 2016 and March 2016, classed relative to an analysis of respective historic February and March 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.

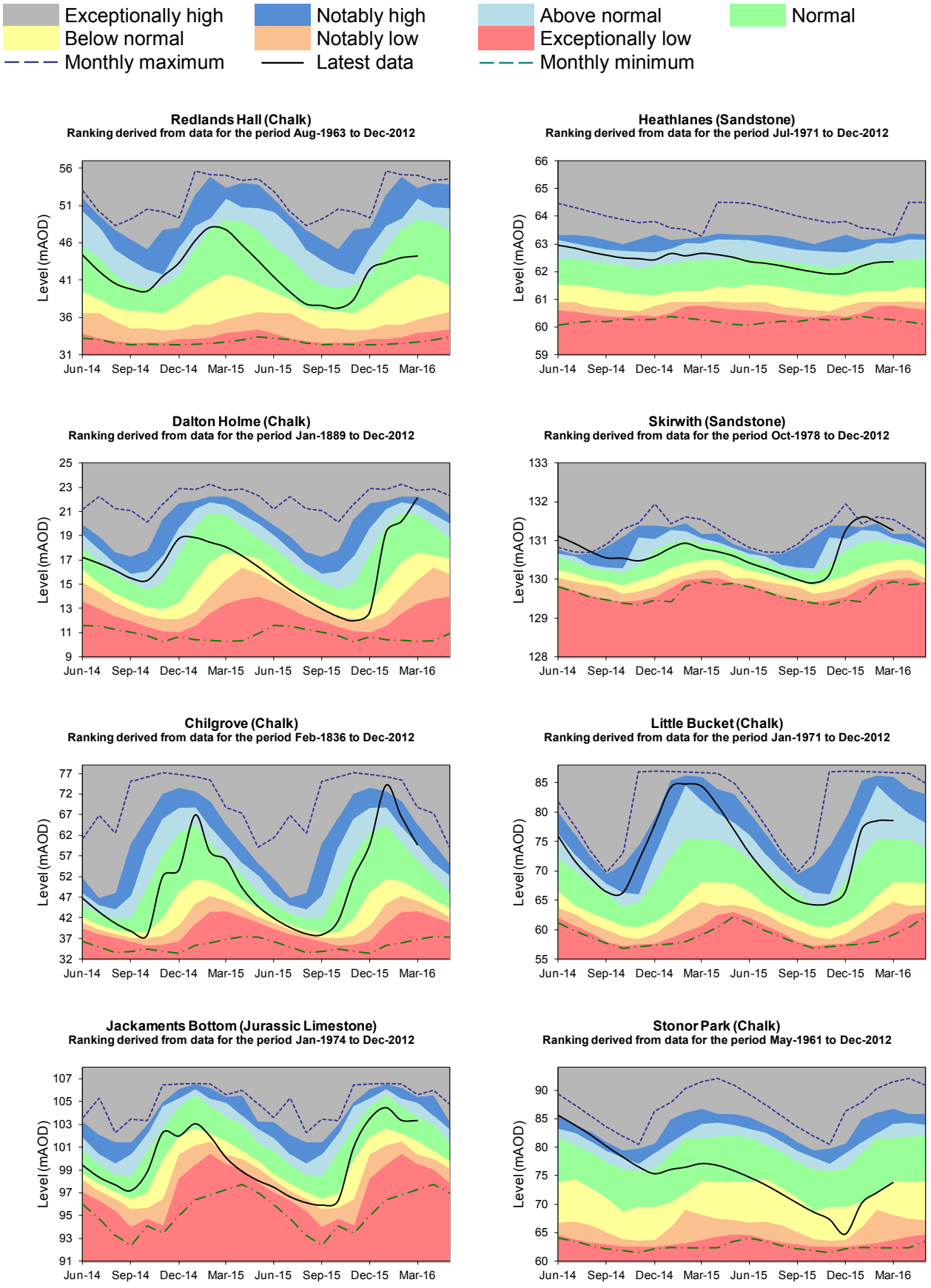
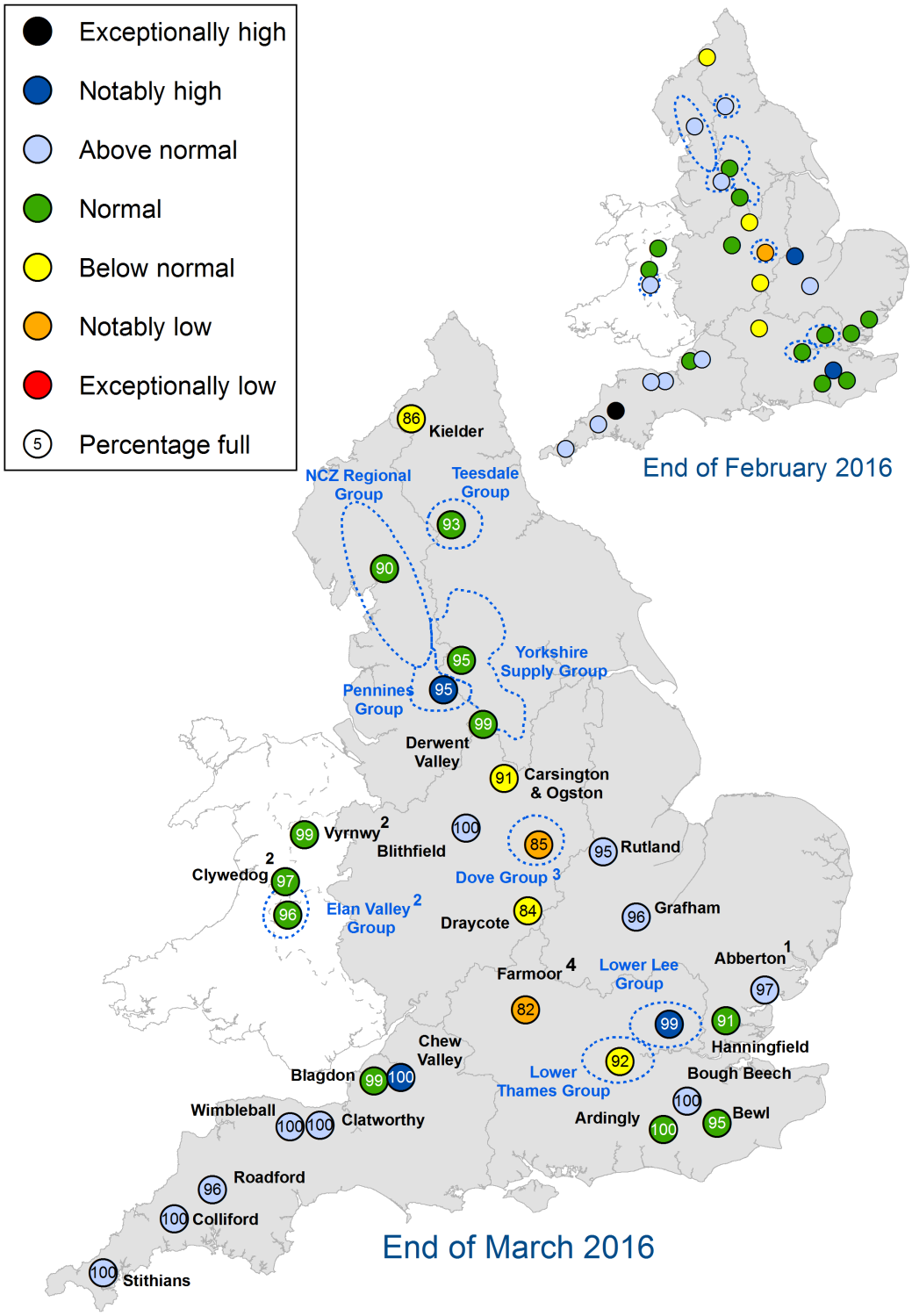


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

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
3. Levels at the Dove reservoir group are recovering after levels were lowered for operational reasons in 2015
4. Levels at Farmoor were affected by intake maintenance which has now been completed

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of February 2016 and March 2016 as a percentage of total capacity and classed relative to an analysis of historic February and March 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.

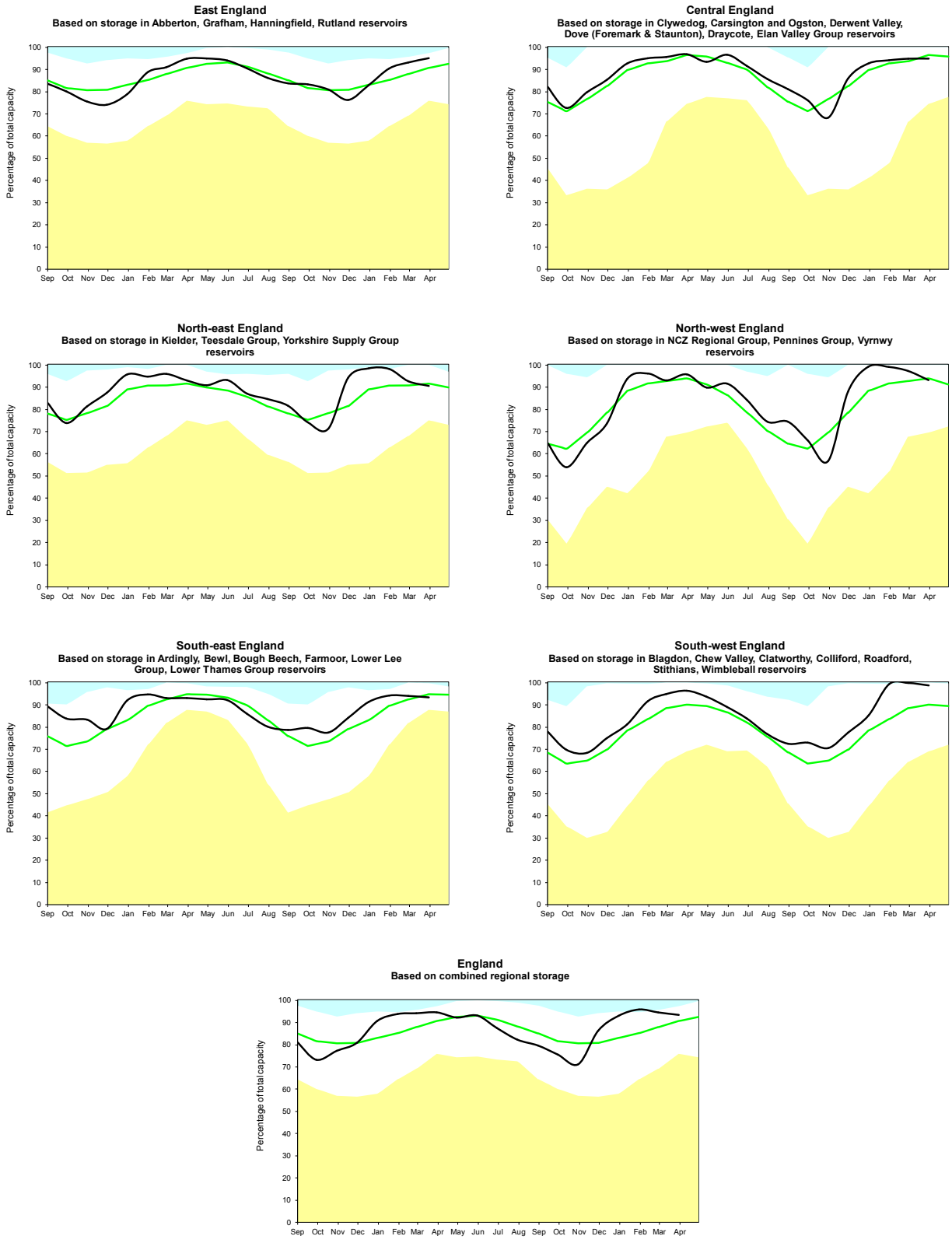


Figure 5.2: Regional reservoir stocks. End of month reservoir stocks compared to long term maximum, minimum and average stocks (Source: Water Companies). Note: Historic records of individual reservoirs/reservoir groups making up the regional values vary in length.

Forward look – river flow

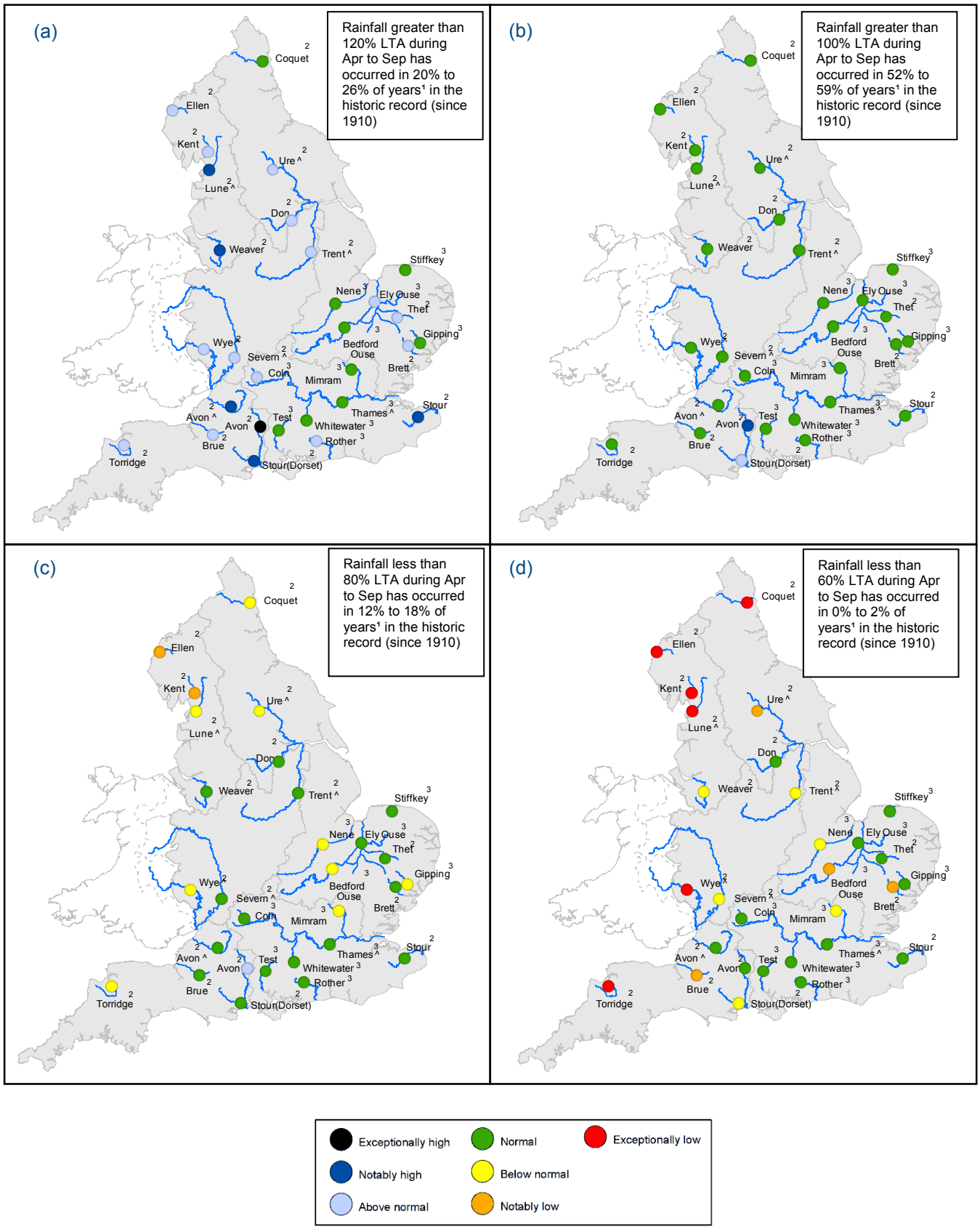
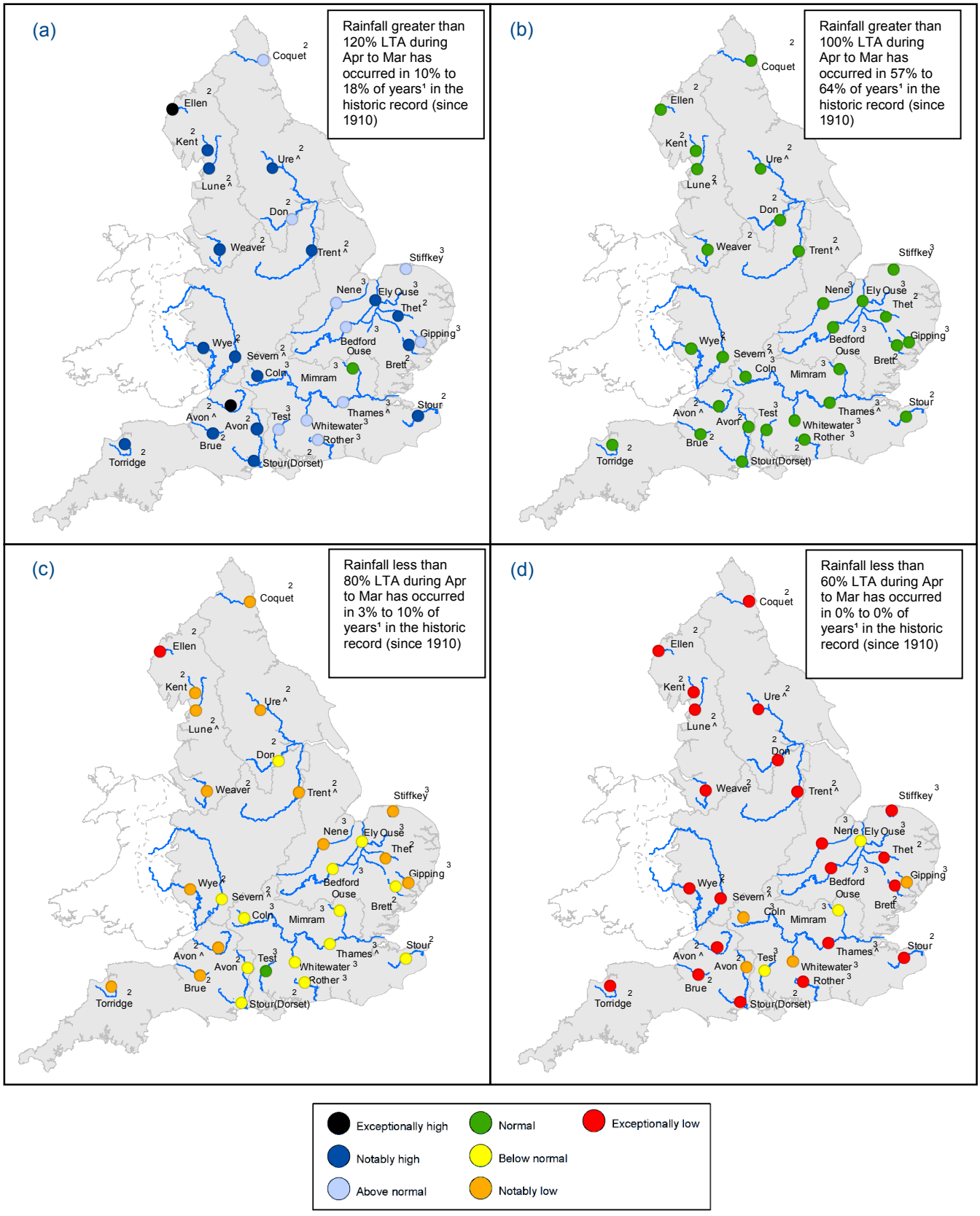


Figure 6.1: Projected river flows at key indicator sites up until the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2016 (Source: Centre for Ecology and Hydrology, Environment Agency)

[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*



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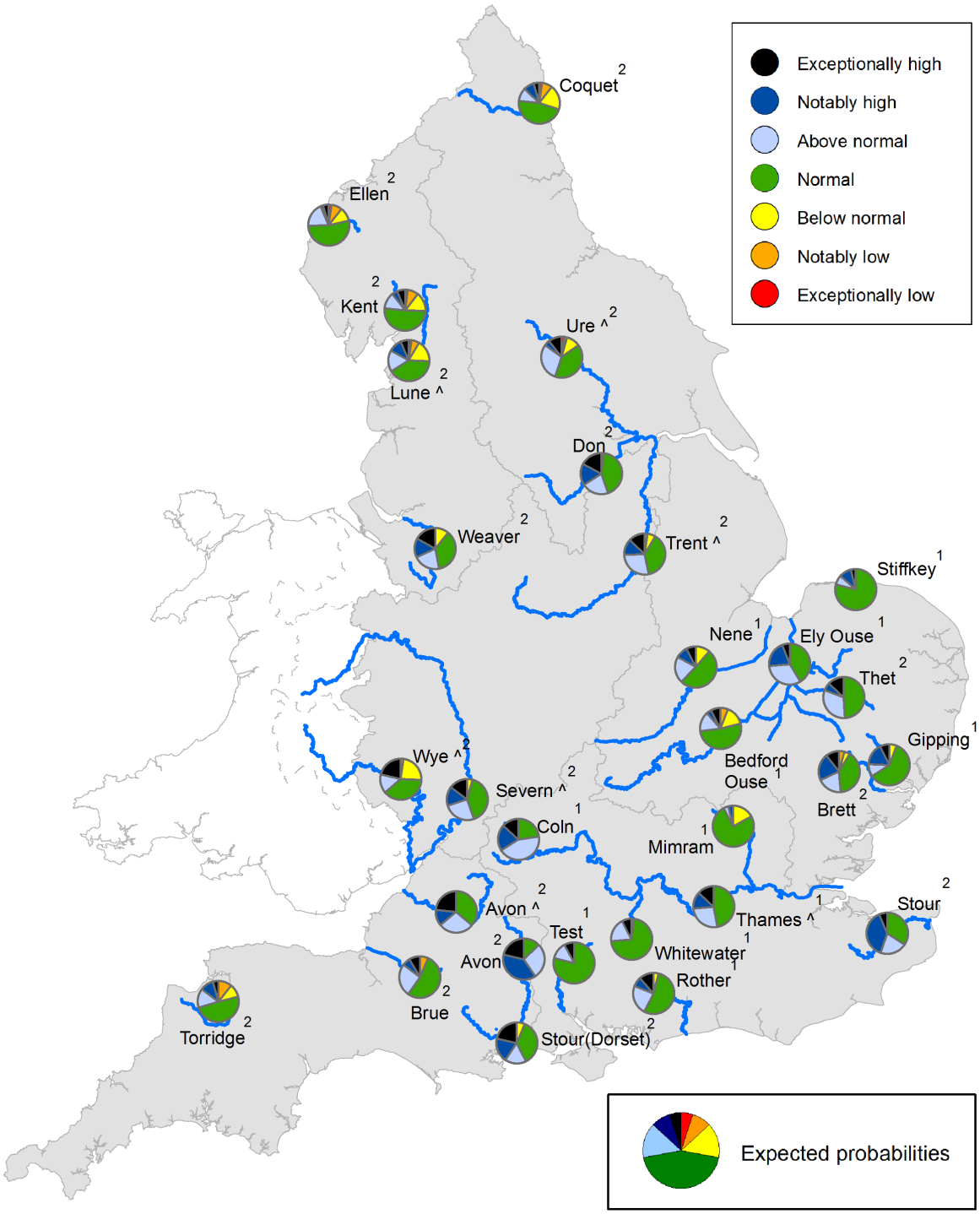

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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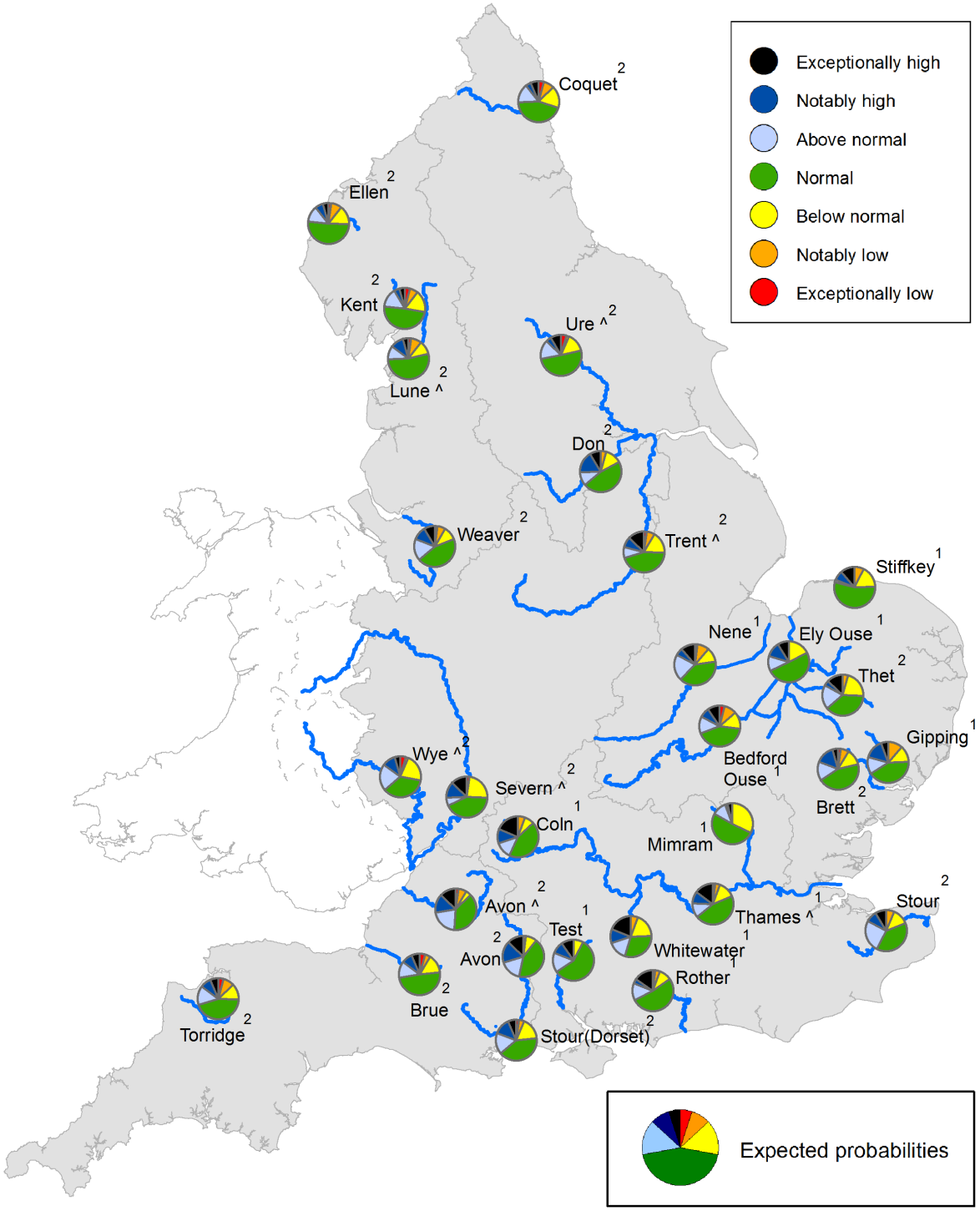

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Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2017. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the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

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

Forward look - groundwater

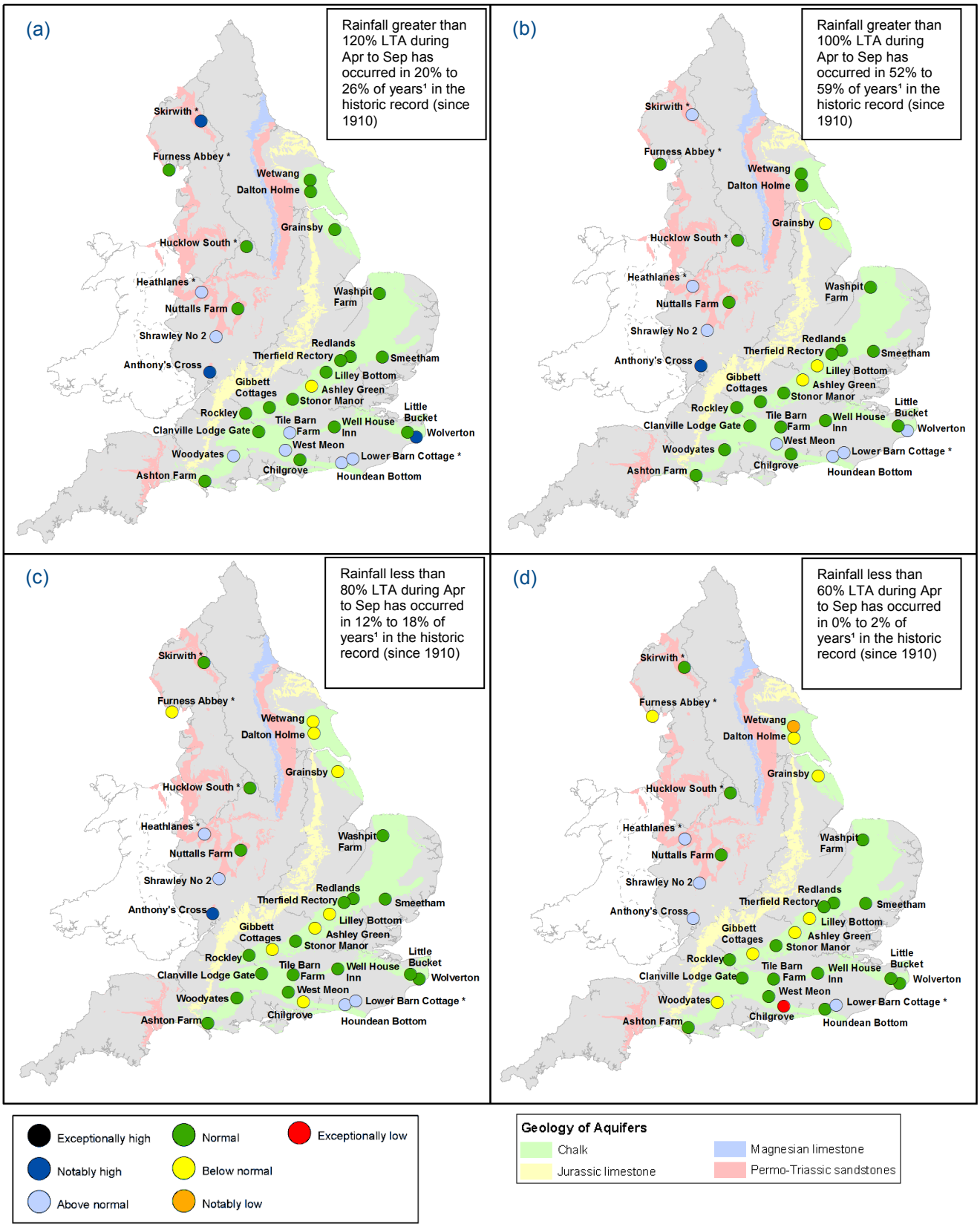

Figure 6.5: Projected groundwater levels at key indicator sites at the end of September 2016. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April and September 2016 (Source: Environment Agency) Geological map reproduced with kind permission 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

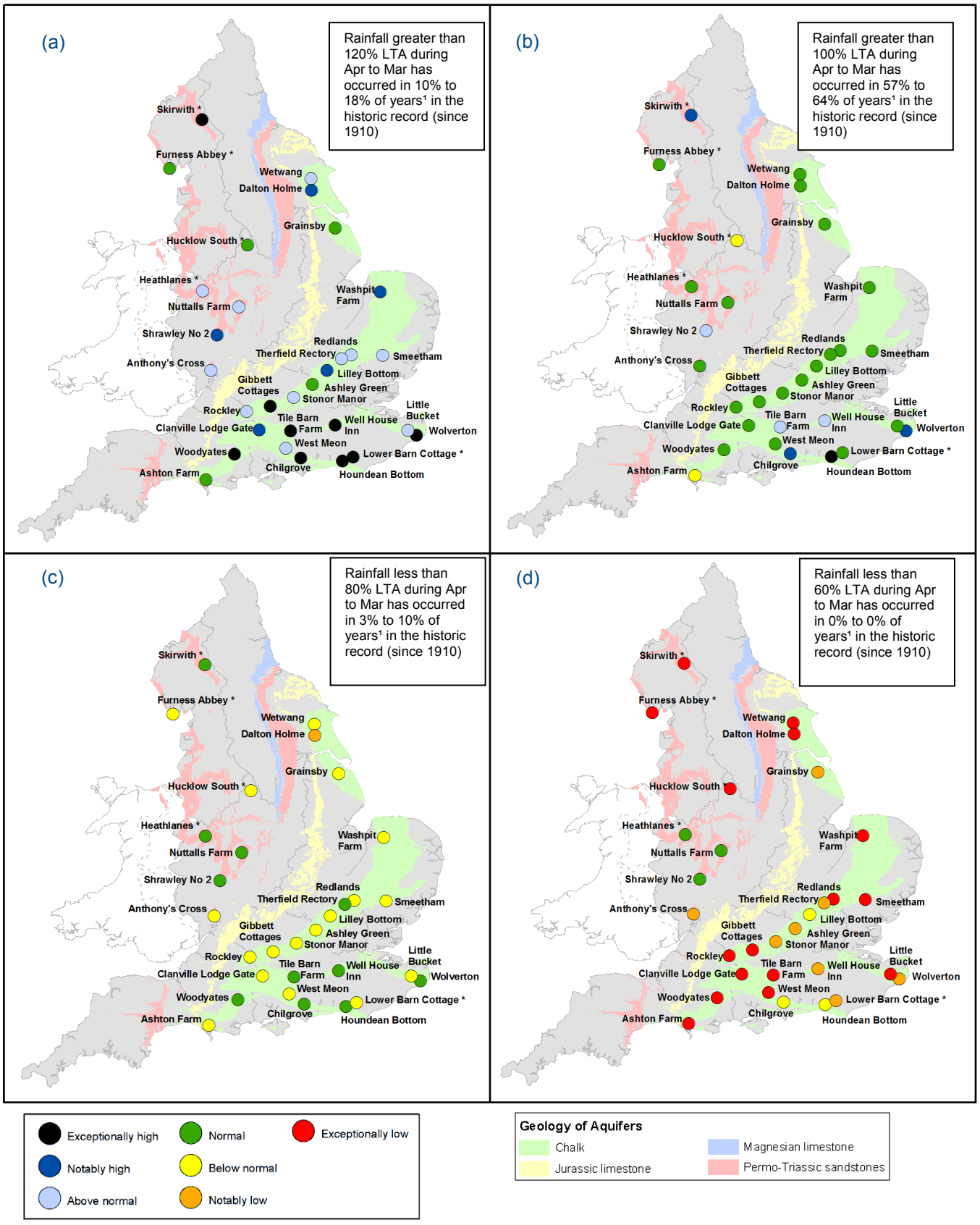

Figure 6.6: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between April 2016 and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission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

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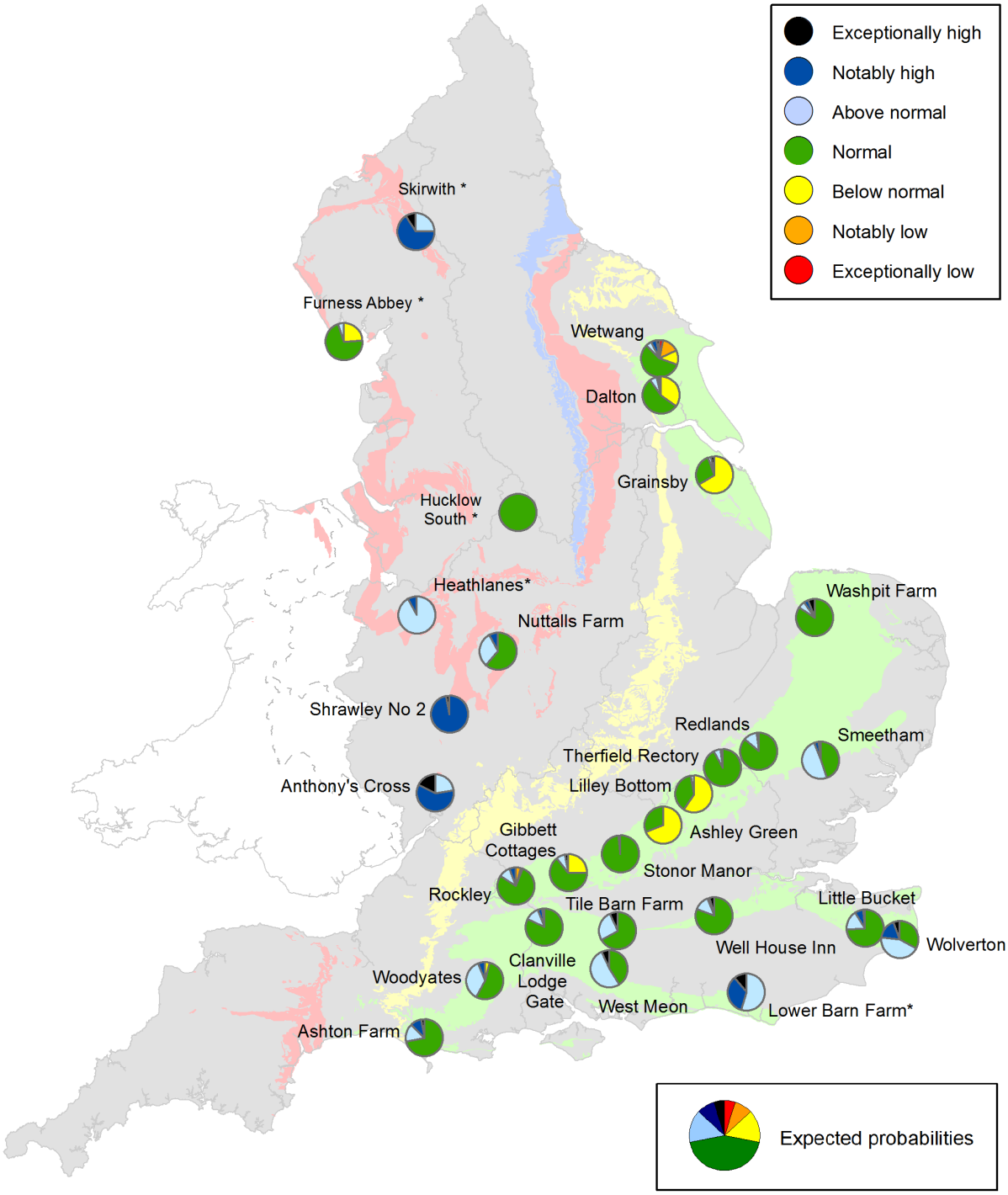

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

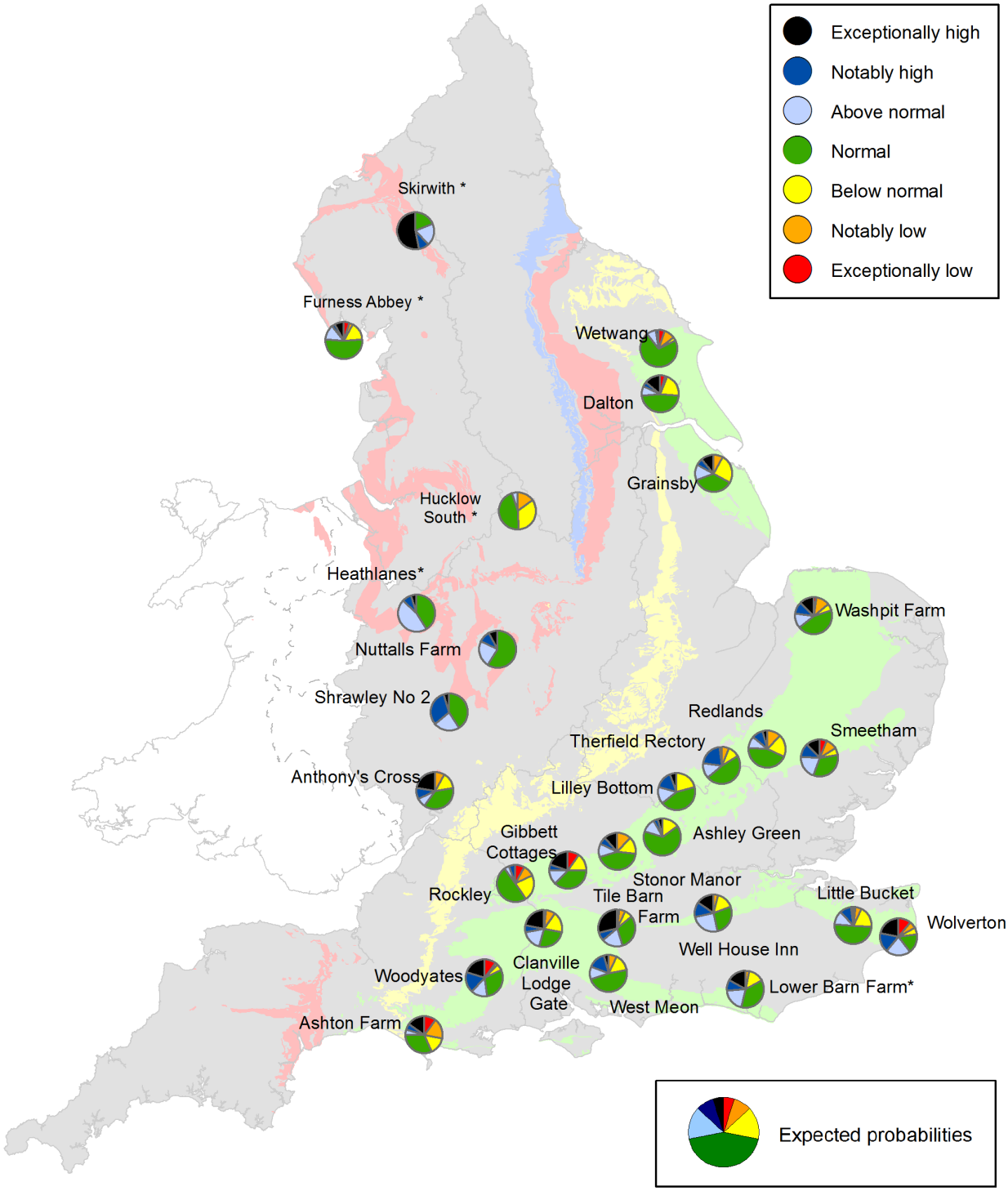

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Figure 6.8: Probabilistic ensemble projections of groundwater levels at key indicator sites at the end of March 2017. Pie charts indicate probability, based on climatology, of the groundwater level at each site being e.g. exceptionally low for the 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