Monthly water situation report

England

Summary – September 2016

Although rainfall totals for September were close to, or above average, soils were drier than average. River flows generally decreased compared to August but remain within the normal range at the majority of sites. Groundwater levels decreased at all but one indicator site but remain within the normal range at all but two sites. Reservoir stocks for England are at 81% of total capacity, but are typical for the time of year.

Rainfall

Rainfall totals for September ranged from less than 20mm in parts of Kent and Essex to more than 120mm in parts of north-west and south-west England (Figure 1.1).

Monthly rainfall totals were close to, or above, the long term average (LTA) for September across a third hydrological areas. In the far west of Cornwall, rainfall was over 140% of LTA, but rainfall was less than 60% of the September LTA in parts of Kent, East Sussex and Yorkshire, with the lowest rainfall being 25% (North West Grain, North Kent). The rainfall across the far west of Cornwall was above normal or higher for the time of year, while parts of Kent and East Yorkshire were below normal or lower for the time of year. For the rest of England, rainfall totals were normal for the time of year. The 3-month accumulation to September was the driest since 1910 in the Roding, North West Grain and Darent hydrological catchments (Figure 1.2).

At the more regional scale, September rainfall totals ranged from 76% of the LTA in south-east England to 103% in south-west England and were slightly below average at 92% of the September LTA across England as a whole (Figure 1.3).

Soil moisture deficit

Soil Moisture Deficits (SMDs) at the end of September had decreased compared to August across much of England. The SMDs were smallest in south-west and north-west England and largest in east England and parts of central and south-east England. At the end of September, values were close to zero in parts of north-west, north-east and south-west England. In east and south-east England, month-end SMDs were 100 to 130mm. End of month SMDs were larger than the long term average (LTA) for the end of September across much of England, although soils were wetter than average in parts of north-east, north-west and south-west England (Figure 2.1).

At a regional scale, SMDs fluctuated during the month, with all but north-east and east England ending the month with SMDs smaller than the previous month. Values at the end of September ranged from almost 30mm in north-west England to 101mm in east England (Figure 2.2)

River flows

Monthly mean river flows for September decreased at just over two thirds of indicator sites across England compared with August. However, the majority of sites were classed as normal or higher for the time of year. Four sites across north-east, south-east and south-west England were below normal or lower for the time of year (Figure 3.1). Monthly mean river flows were classed as normal for the time of year at all the regional index sites (Figure 3.2).

Groundwater levels

At the end of September, groundwater levels had decreased at all but one indicator site compared to the end of August. Groundwater levels were normal or higher for the time of year at all but two indicator sites. Groundwater levels at Crossley Hill (Nottinghamshire and Doncaster Permo-Triassic sandstone) and at Ashley Green (Chilterns East Chalk) remained below normal for the time of year (Figure 4.1).

End of month groundwater levels at the major aquifer index sites were all normal or higher for the time of year, with exception of Heathlanes (Shropshire Sandstone) and Skirwith (Carlisle Basin and Eden Valley sandstone) which remained above normal and notably high respectively (Figure 4.2).

Reservoir storage

Reservoir stocks decreased at almost all of reported reservoirs and reservoir groups during September. Decreases of between 10 and 20% were seen at Hanningfield, Ardingly, Blagdon, Clatworthy and Draycote Water. Storage in Wimbleball increased by 8%. Almost half of the reservoirs and reservoir groups were above 80% of full capacity. End of month stocks were classed as normal or higher for the time of year at the majority of reservoirs and reservoir groups, with just under a third being above normal or higher (Figure 5.1).

At the regional scale reservoir stocks at the end of September decreased across England. Month-end regional stocks for the end of September ranged from 66% of total capacity in south-west England to 84% in central and north-east England. Reservoir storage at the end of September for England overall was 81% of total capacity, a slight decrease compared to last month but typical for the time of year (Figure 5.2).

Forward look

Weather conditions are expected to be generally settled for the remainder of October, becoming changeable towards the end of the month and into early November. For the three month period from October to December, the chances of rainfall being above-average and-below-average are equally possible.[1].

Projections for river flows at key sites[2]

By the end of March 2017 fewer than half of the modelled sites have a greater than expected chance of notably low or lower cumulative flows. By the end of September 2017 fewer than a third of the modelled sites have a greater than expected chance of notably low or lower cumulative flows.

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

Projections for groundwater levels in key aquifers[2]

At the end of March 2017 nearly three-fifths of the modelled sites have a greater than expected chance of normal or higher groundwater levels for the time of year. At the end of September 2017 more than two-thirds of the modelled 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 March 2017 see Figure 6.5
For scenario based projections of groundwater levels in key aquifers in September 2017 see Figure 6.6
For probabilistic ensemble projections of groundwater levels in key aquifers in March 2017 see Figure 6.7
For probabilistic ensemble projections of groundwater levels in key aquifers in September 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

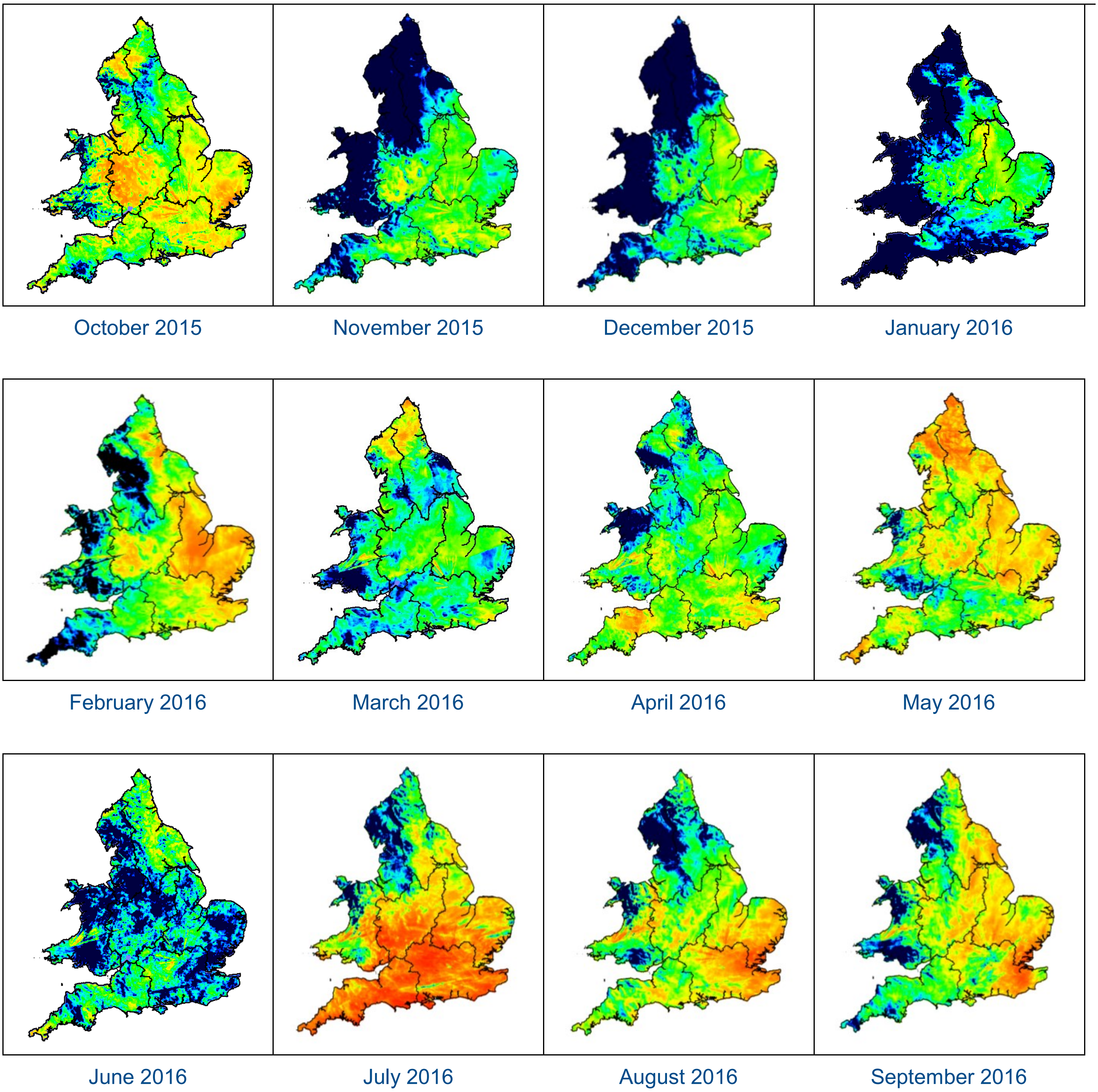
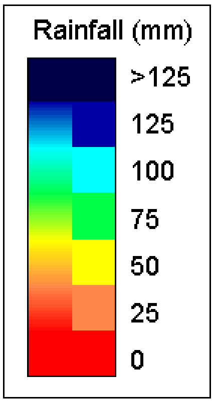


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2016). Note: Radar beam blockages in some regions may give anomalous totals in some areas.



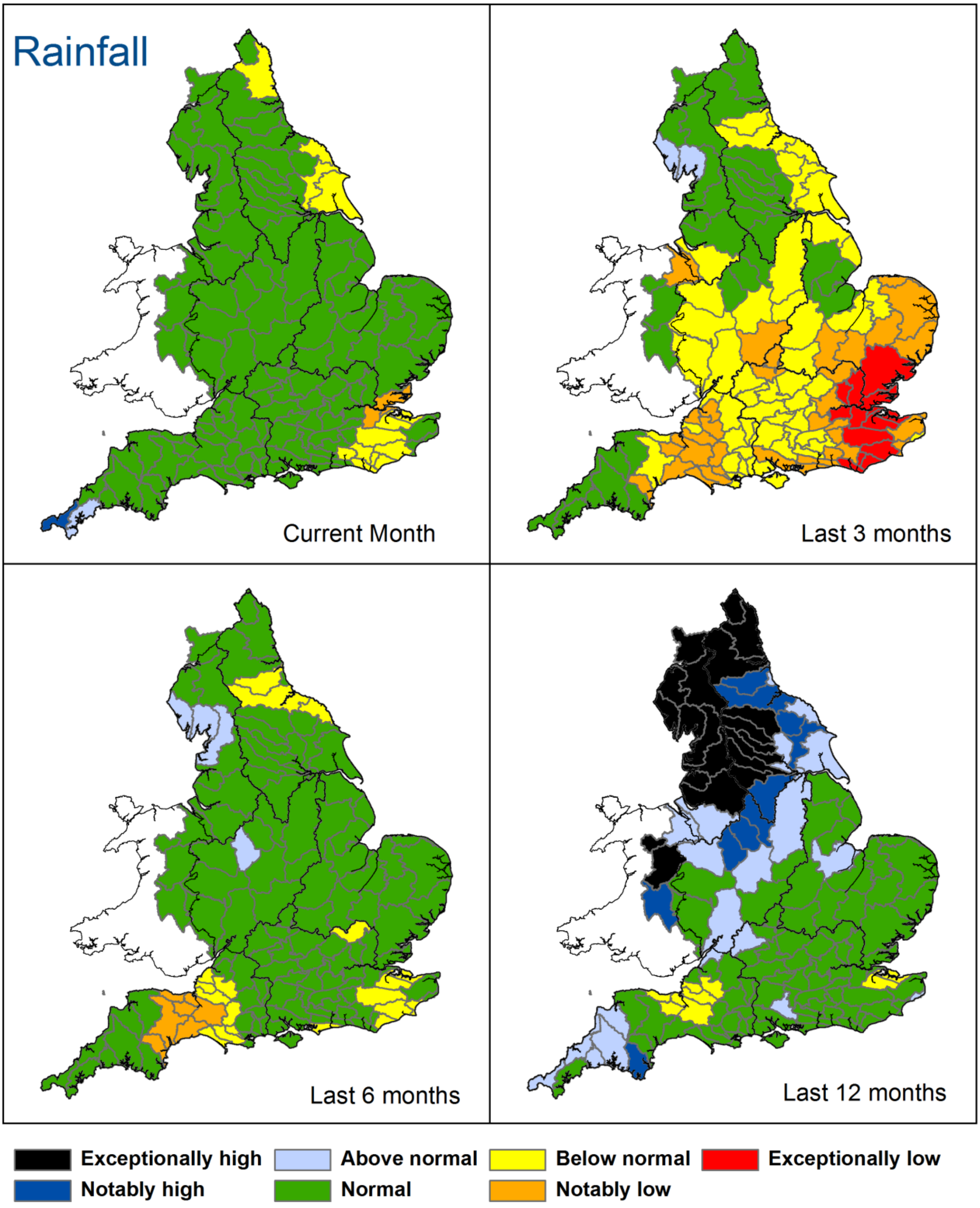


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 30 September), the last 3 months, the last 6 months, and the last 12 months, classed relative to an analysis of respective historic totals. Final NCIC (National Climate Information Centre) data based on the 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.

Rainfall charts

Above average rainfall

Below average rainfall

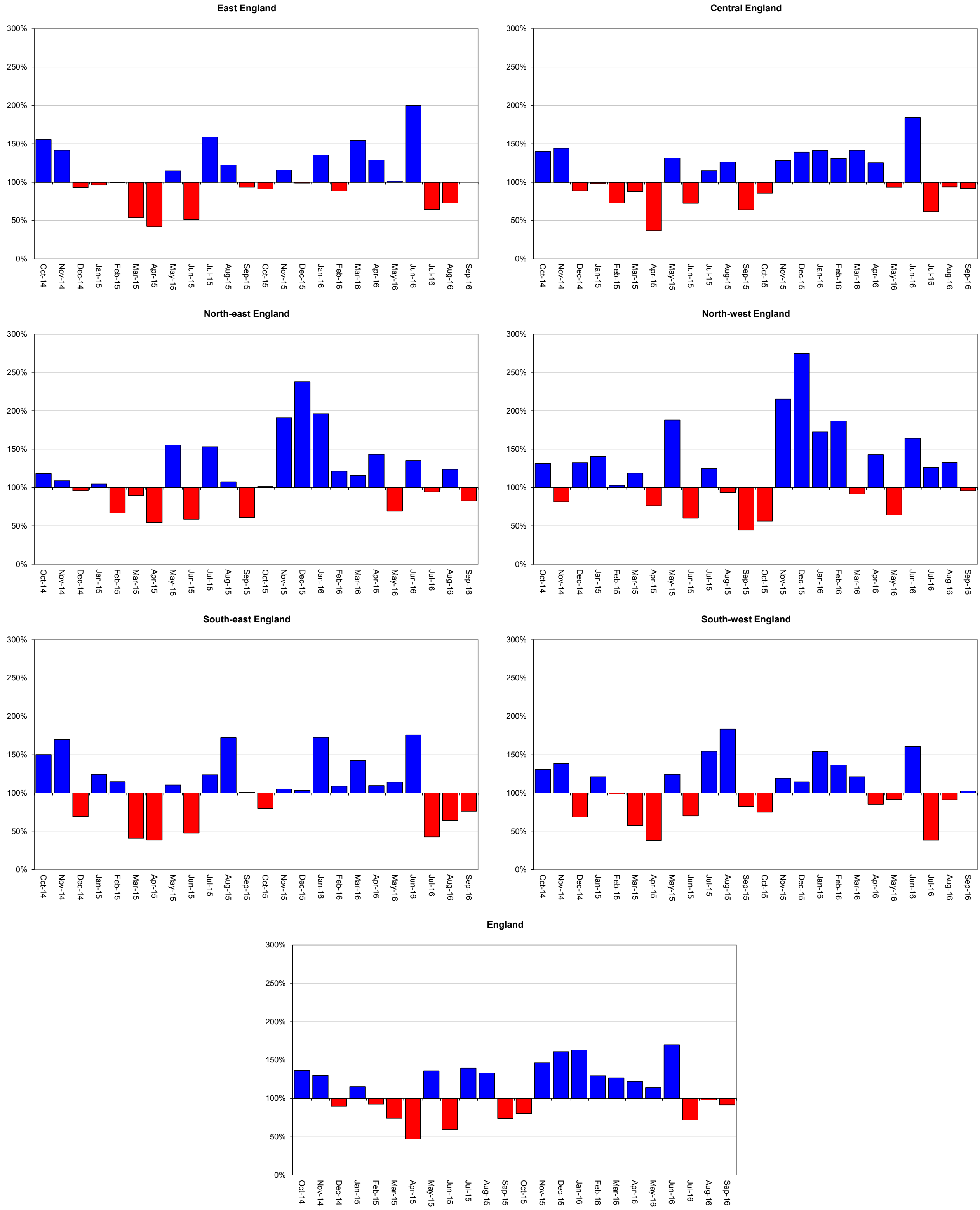


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2016).

Soil moisture deficit

End of August 2016[1]	End of September 2016[2]

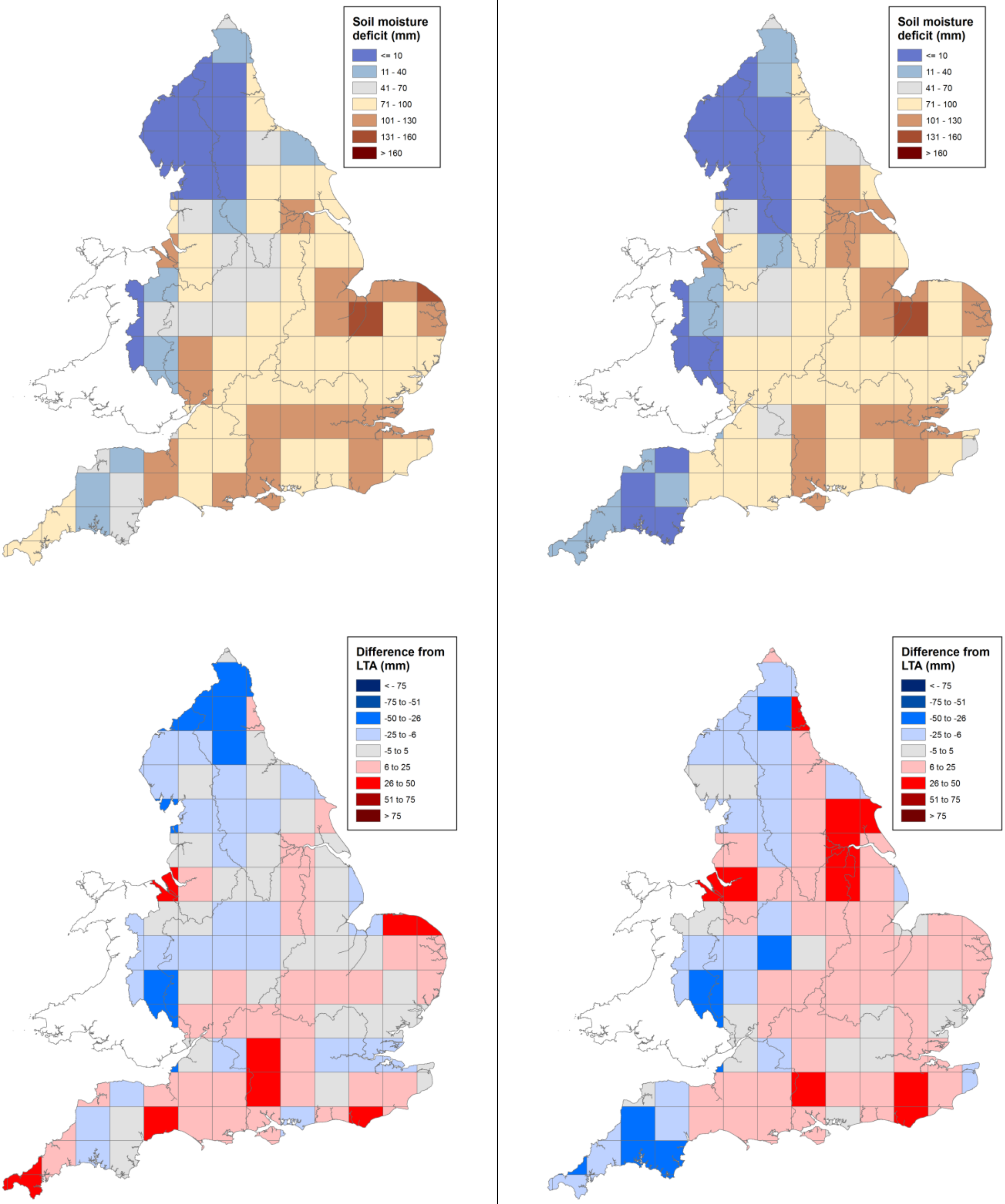


Figure 2.1: Soil moisture deficits for weeks ending 30 August 2016 [1] (left panel) and 27 September 2016 [2] (right panel). Top row shows actual soil moisture deficits (mm) and bottom row shows the difference (mm) of the actual from the 1961-90 long term average soil moisture deficits. MORECS data for real land use (Source: Met Office © Crown Copyright, 2016). Crown copyright. All rights reserved. Environment Agency, 100026380, 2016

Soil moisture deficit charts

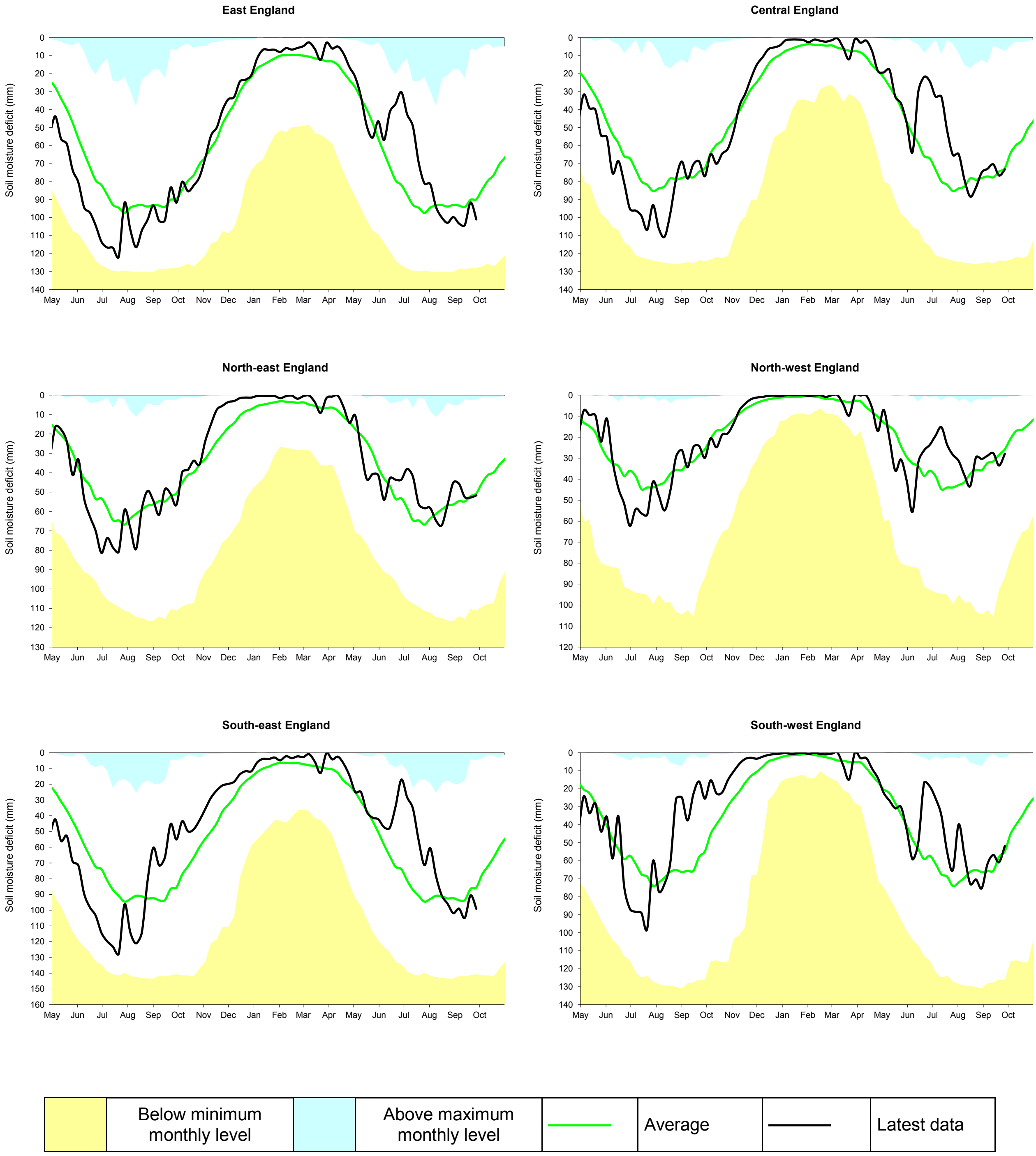
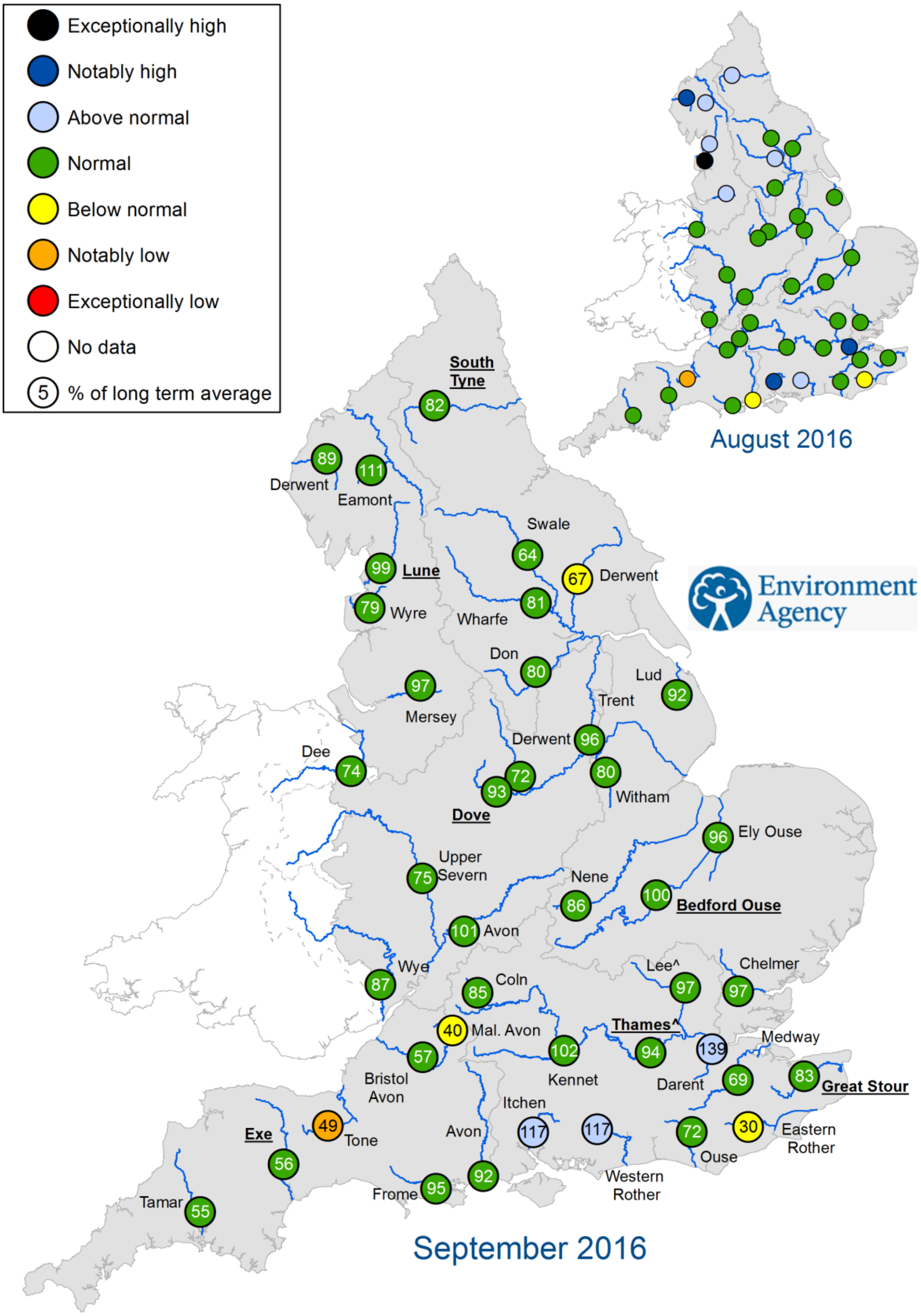


Figure 2.2: Latest soil moisture deficits for all geographic regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2016).

River flows



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

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

River flow charts

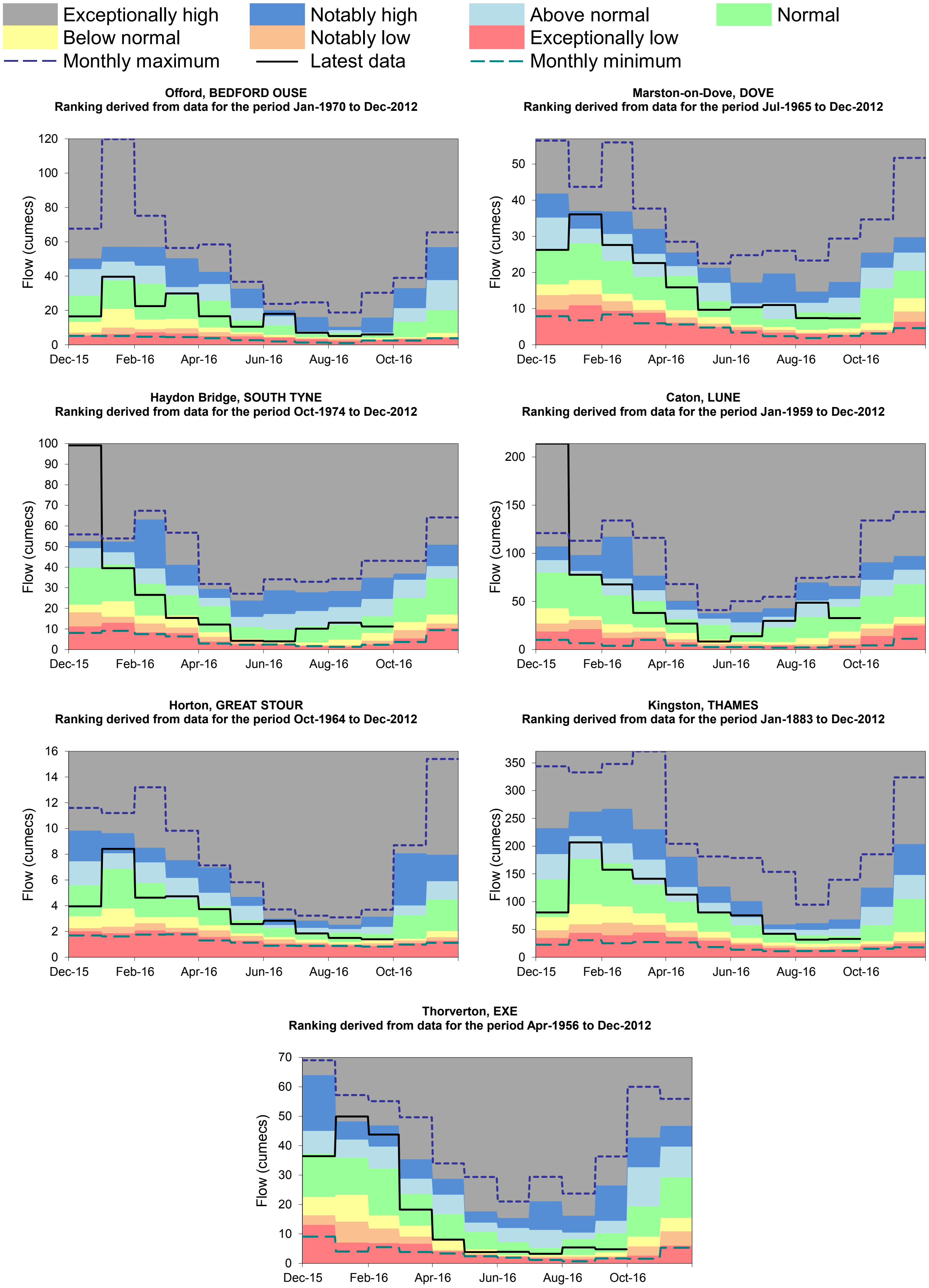
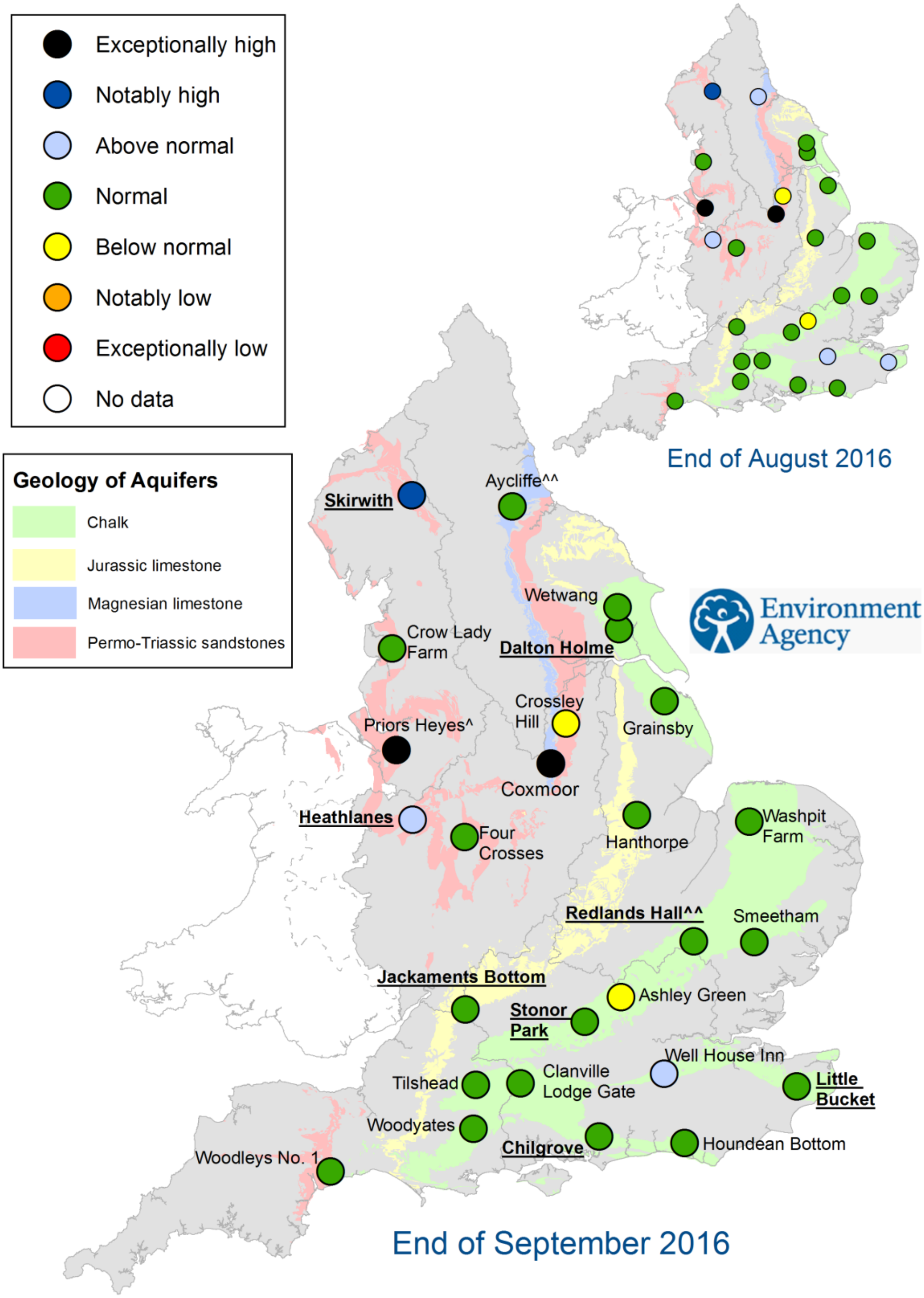


Figure 3.2: Index river flow sites for each geographic region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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
Underlined 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 August 2016 and September 2016, classed relative to an analysis of respective historic August and September 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.

Groundwater level charts

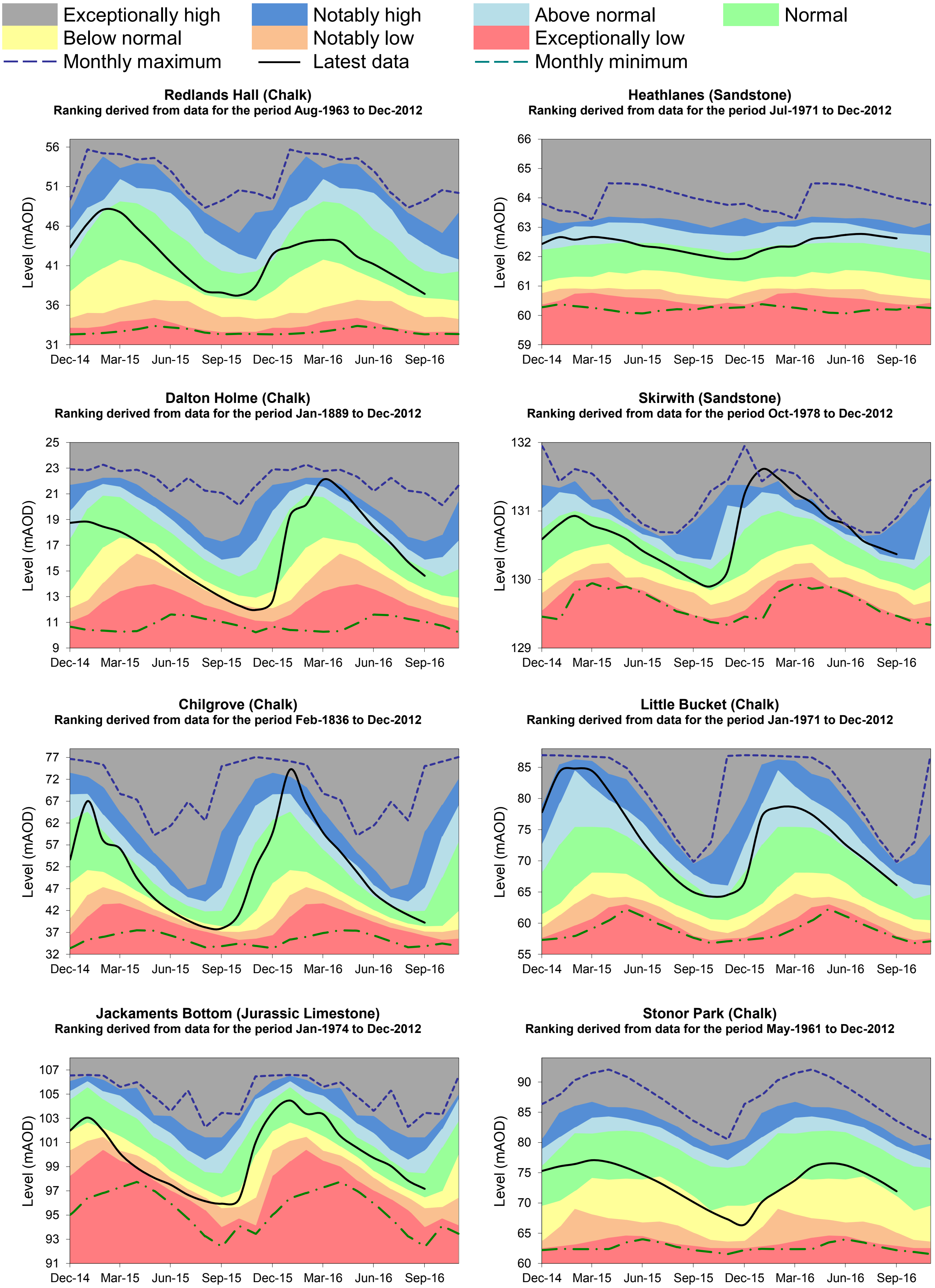
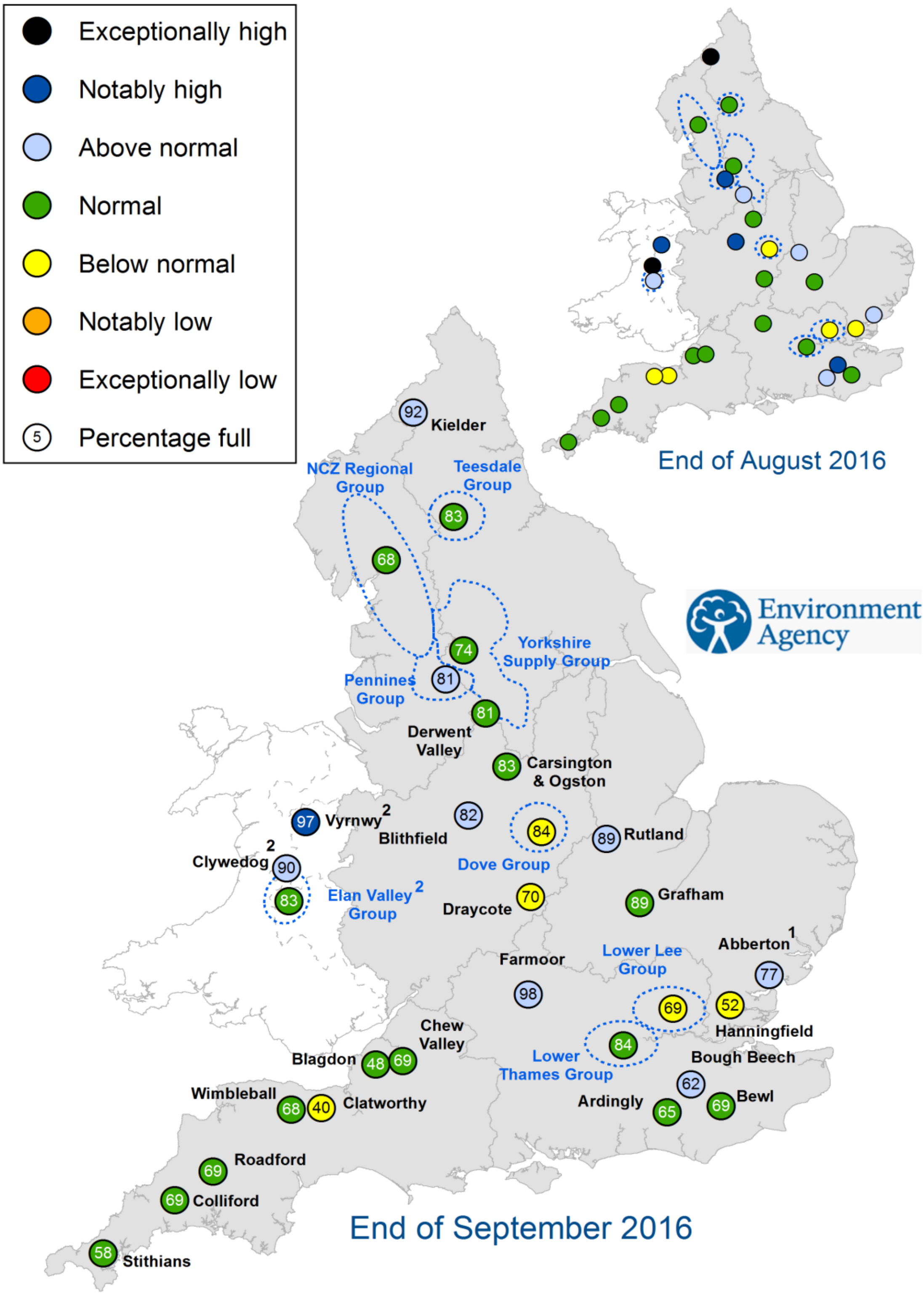


Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2016).

Reservoir storage

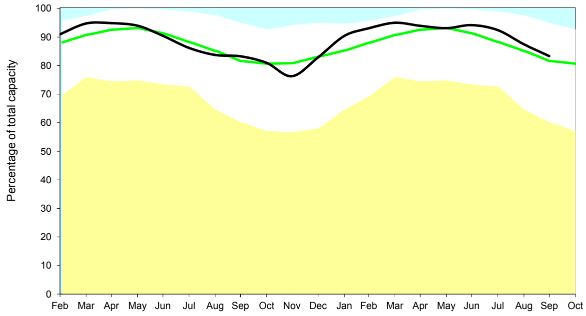


1. Engineering work at Abberton Reservoir in east England to increase capacity has been completed
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to Central and north-west England

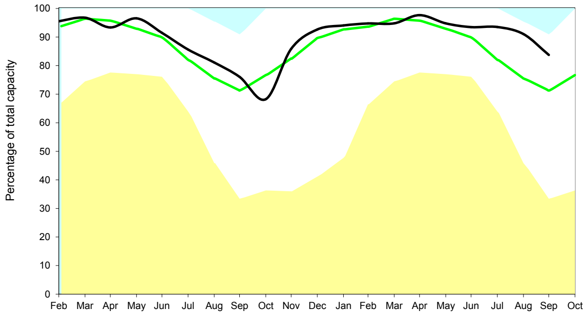
Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of August 2016 and September 2016 as a percentage of total capacity and classed relative to an analysis of historic August and September values respectively (Source: Water Companies). Note: Classes shown may not necessarily 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. Crown copyright. All rights reserved. Environment Agency, 100026380, 2016.

Reservoir storage charts

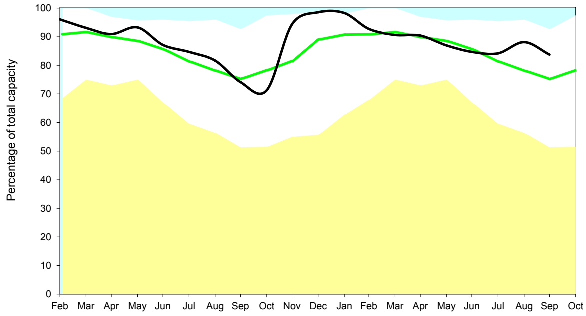
East England
Based on storage in Abberton, Grafham, Hanningfield, Rutland reservoirs



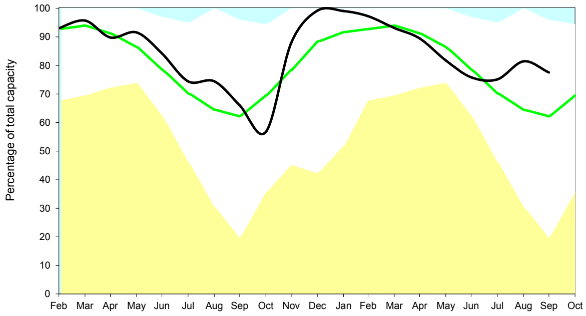
Central England
Based on storage in Clywedog, Carsington and Ogston, Derwent Valley, Dove (Foremark & Staunton), Draycote, Elan Valley Group reservoirs



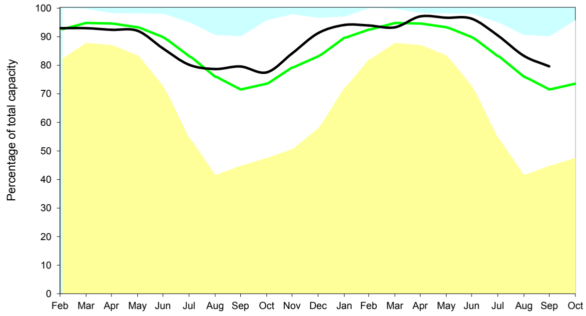
North-east England
Based on storage in Kielder, Teesdale Group, Yorkshire Supply Group reservoirs



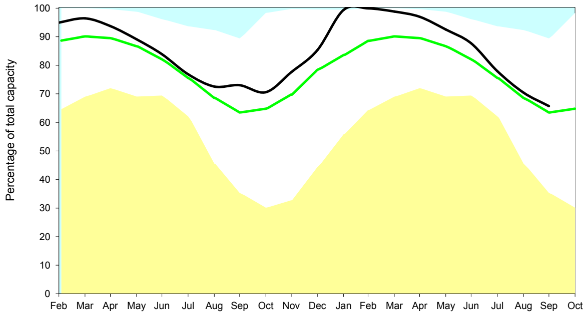
North-west England
Based on storage in NCZ Regional Group, Pennines Group, Vyrnwy reservoirs



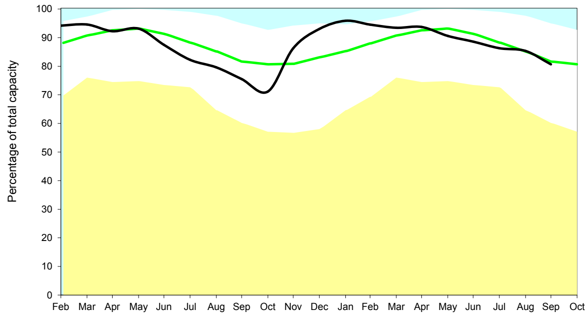
South-east England
Based on storage in Ardingly, Bewl, Bough Beech, Farmoor, Lower Lee Group, Lower Thames Group reservoirs



South-west England
Based on storage in Blagdon, Chew Valley, Clatworthy, Colliford, Roadford, Stithians, Wimbleball reservoirs



England
Based on combined regional storage



	Below minimum monthly level		Above maximum monthly level		Average		Latest data

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

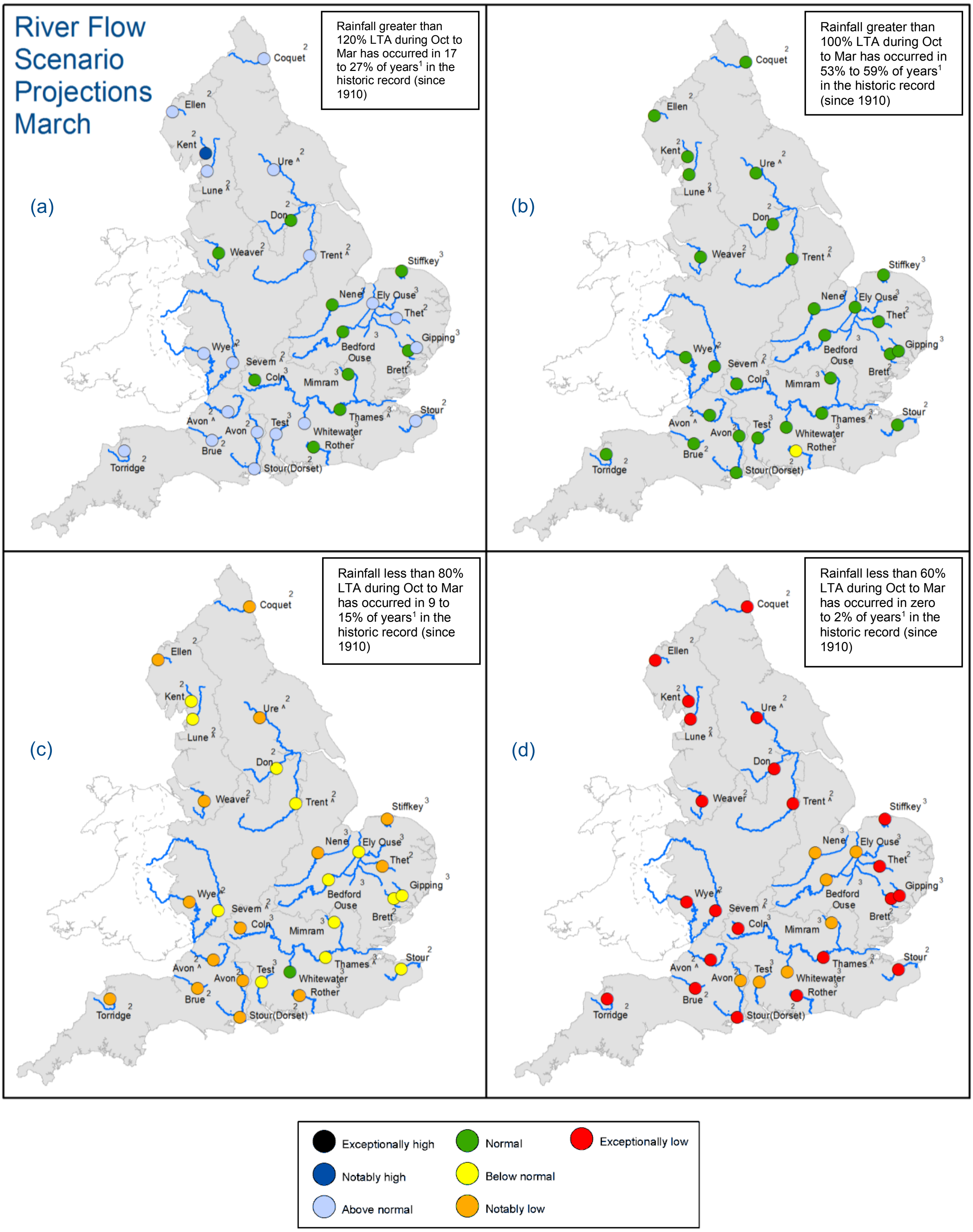


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2016 and March 2017 (Source: Centre for Ecology and Hydrology, Environment Agency).

[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*

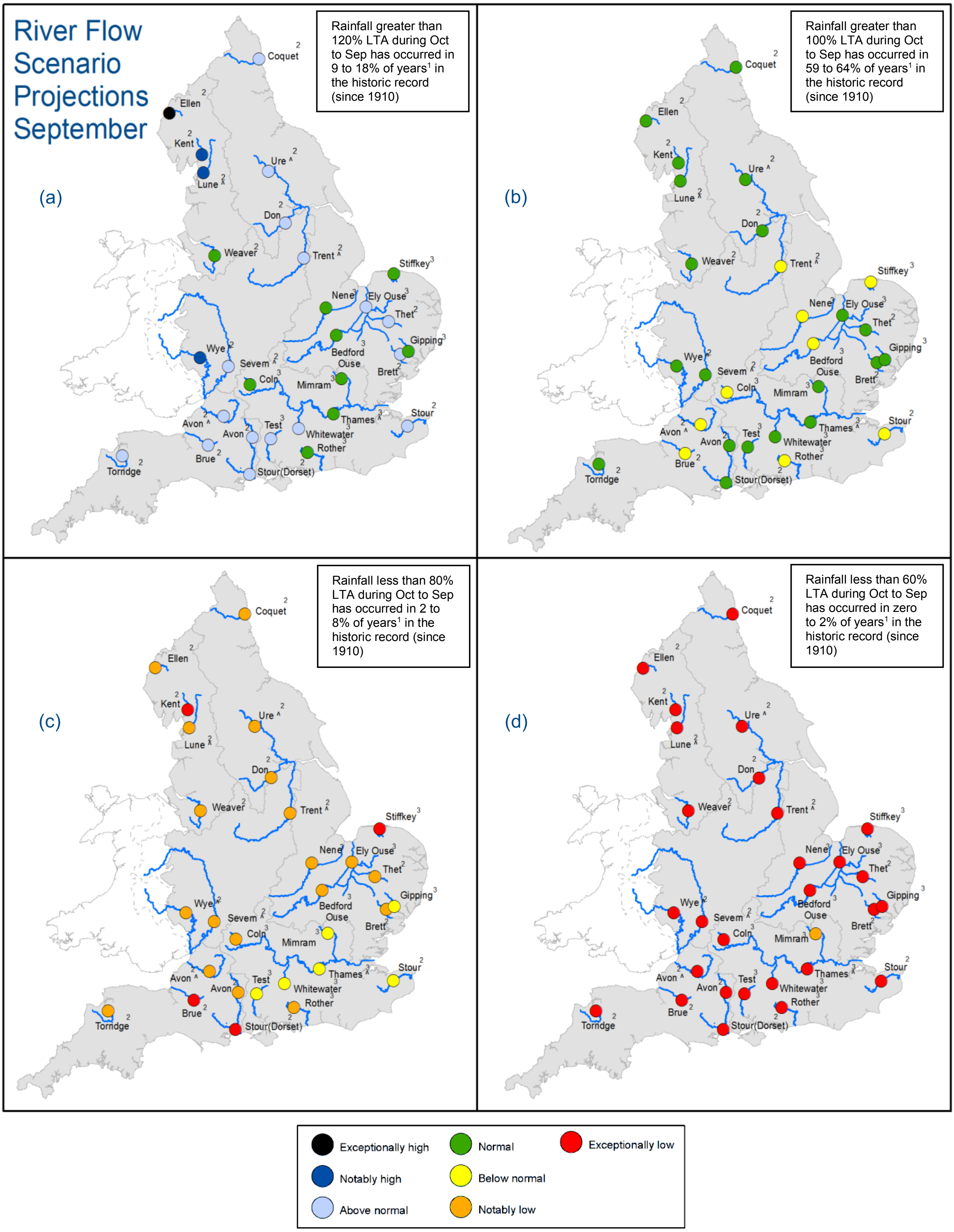


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2016 and September 2017 (Source: Centre for Ecology and Hydrology, Environment Agency)

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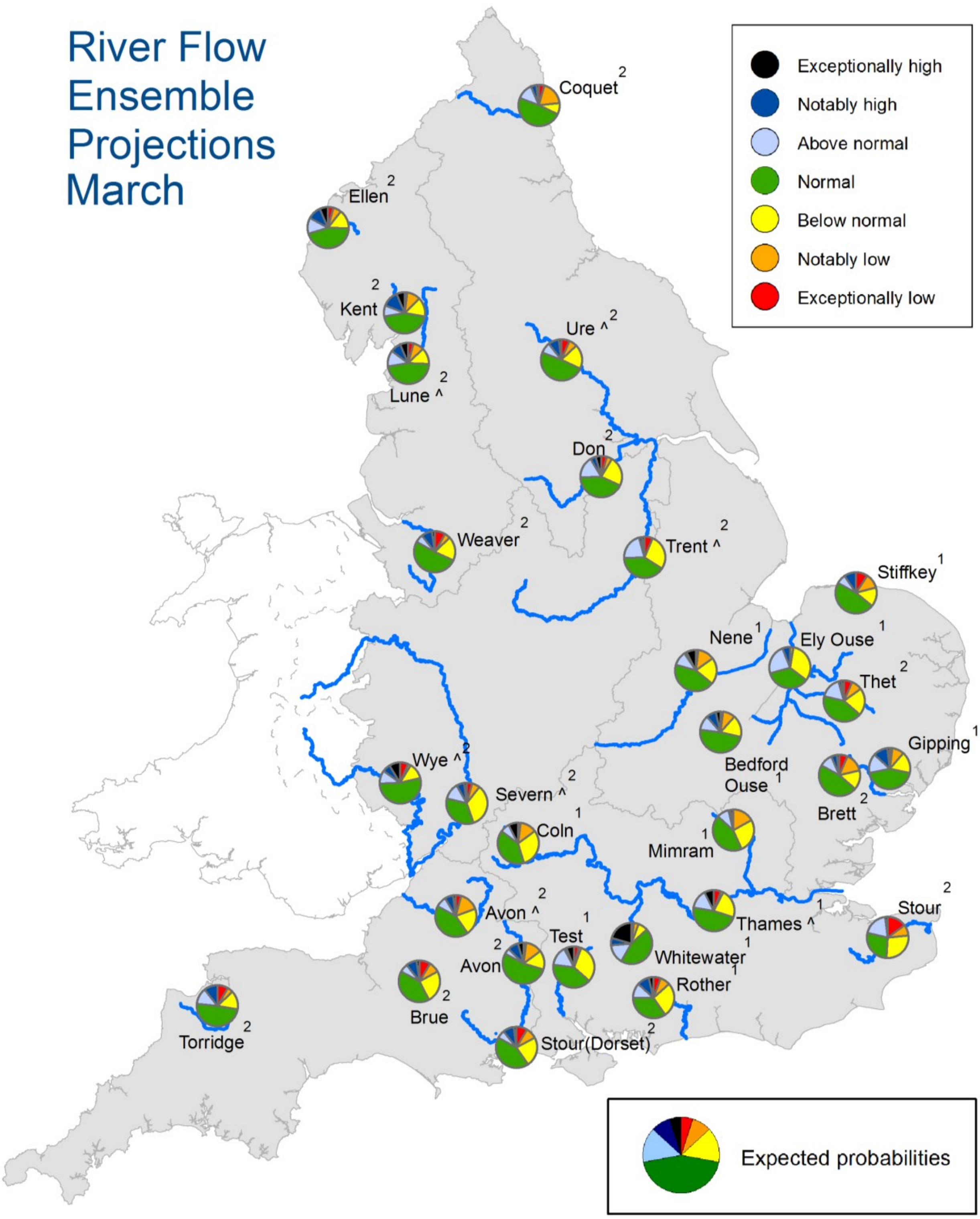

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

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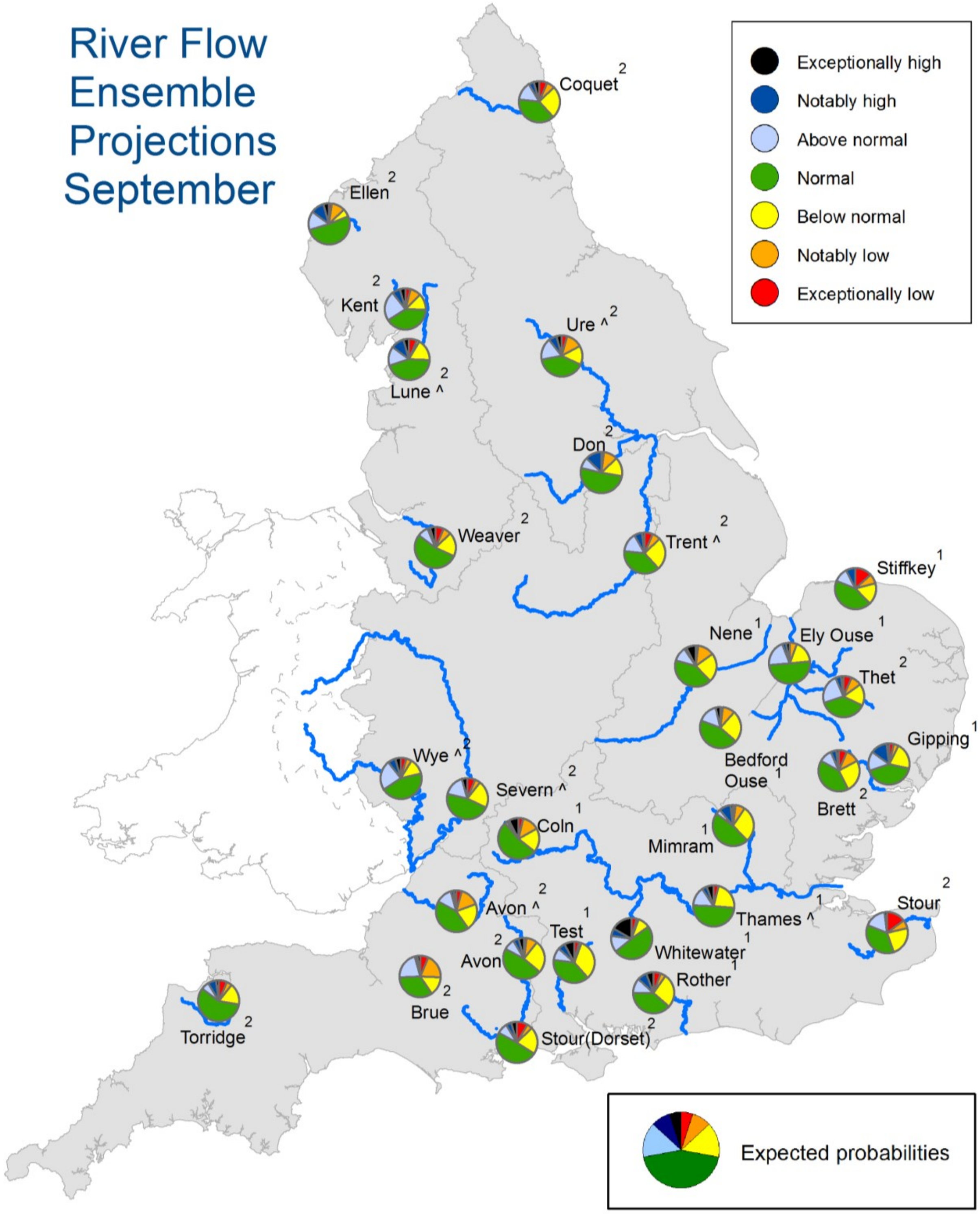

Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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

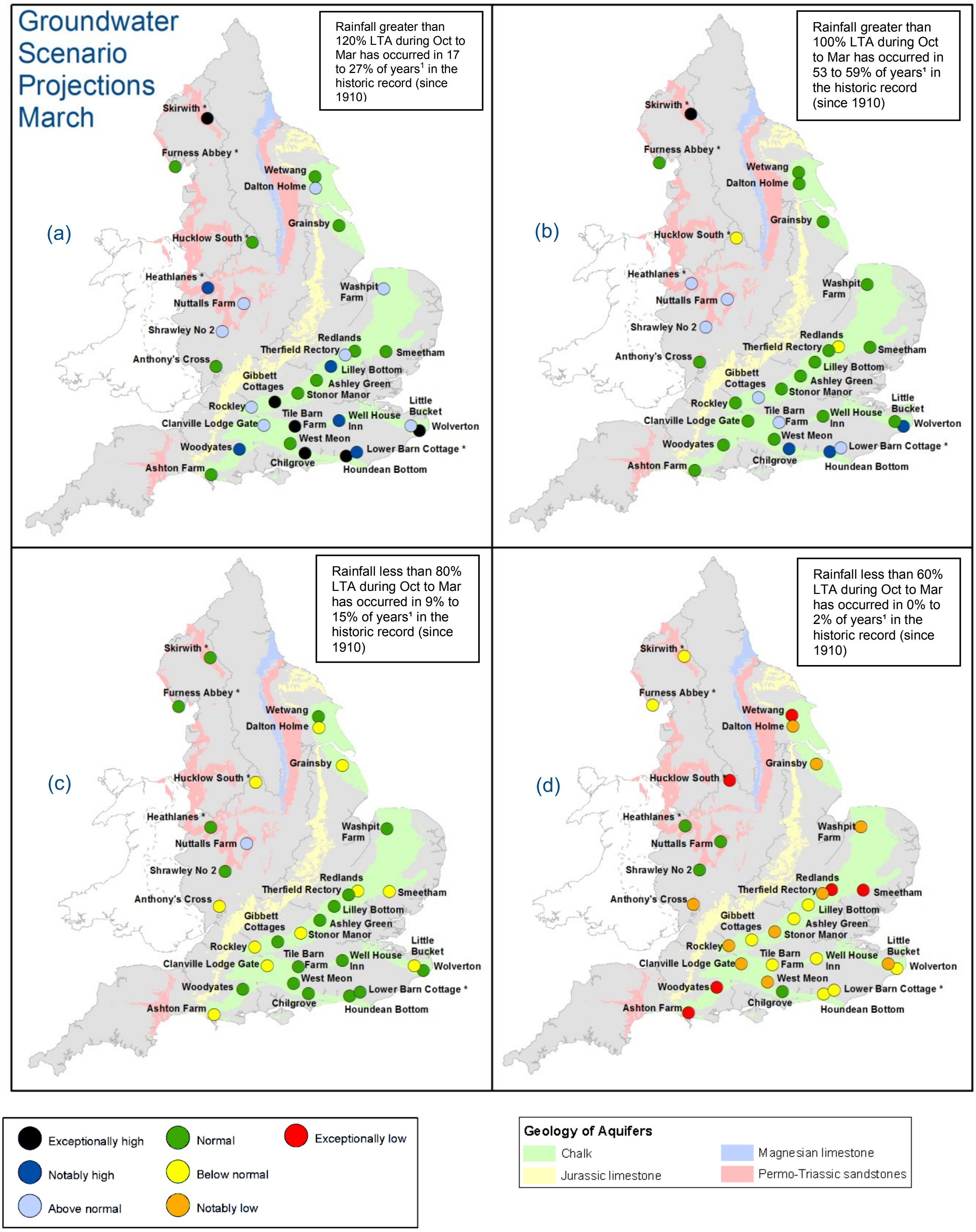

Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2016 and March 2017 (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2016.

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

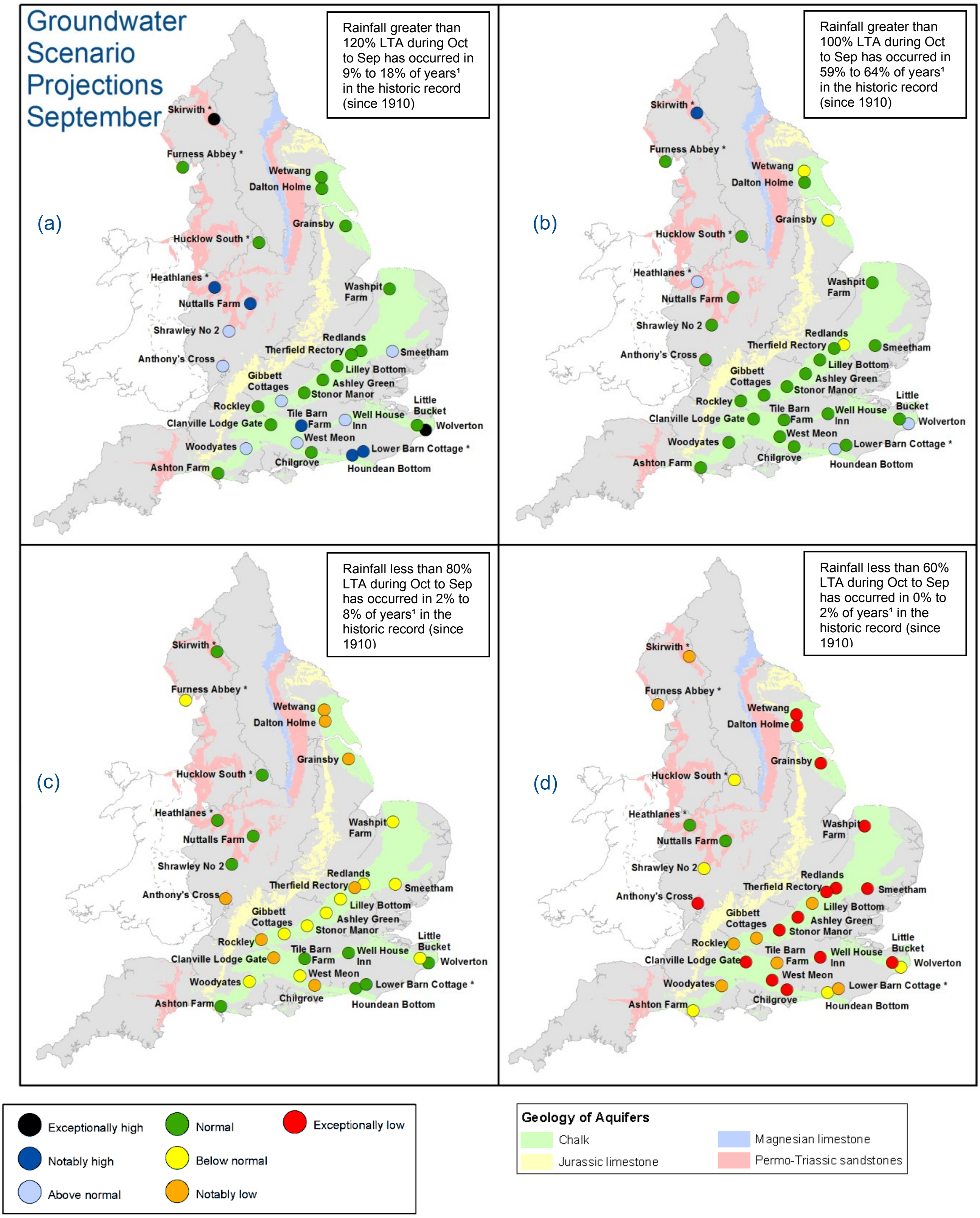

Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2017. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between October 2016 and March 2017 (Source: Environment Agency) Geological map reproduced with kind permission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

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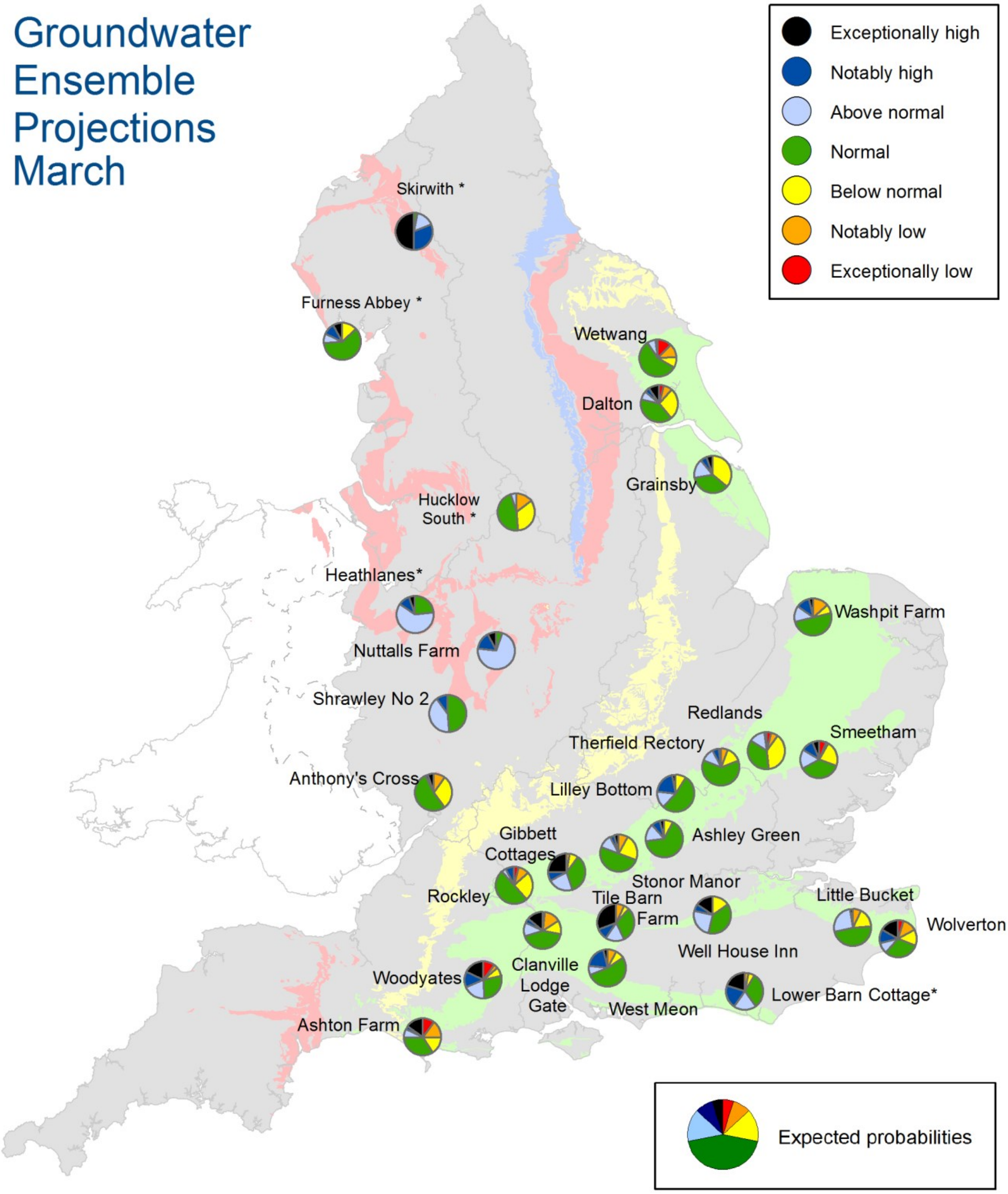
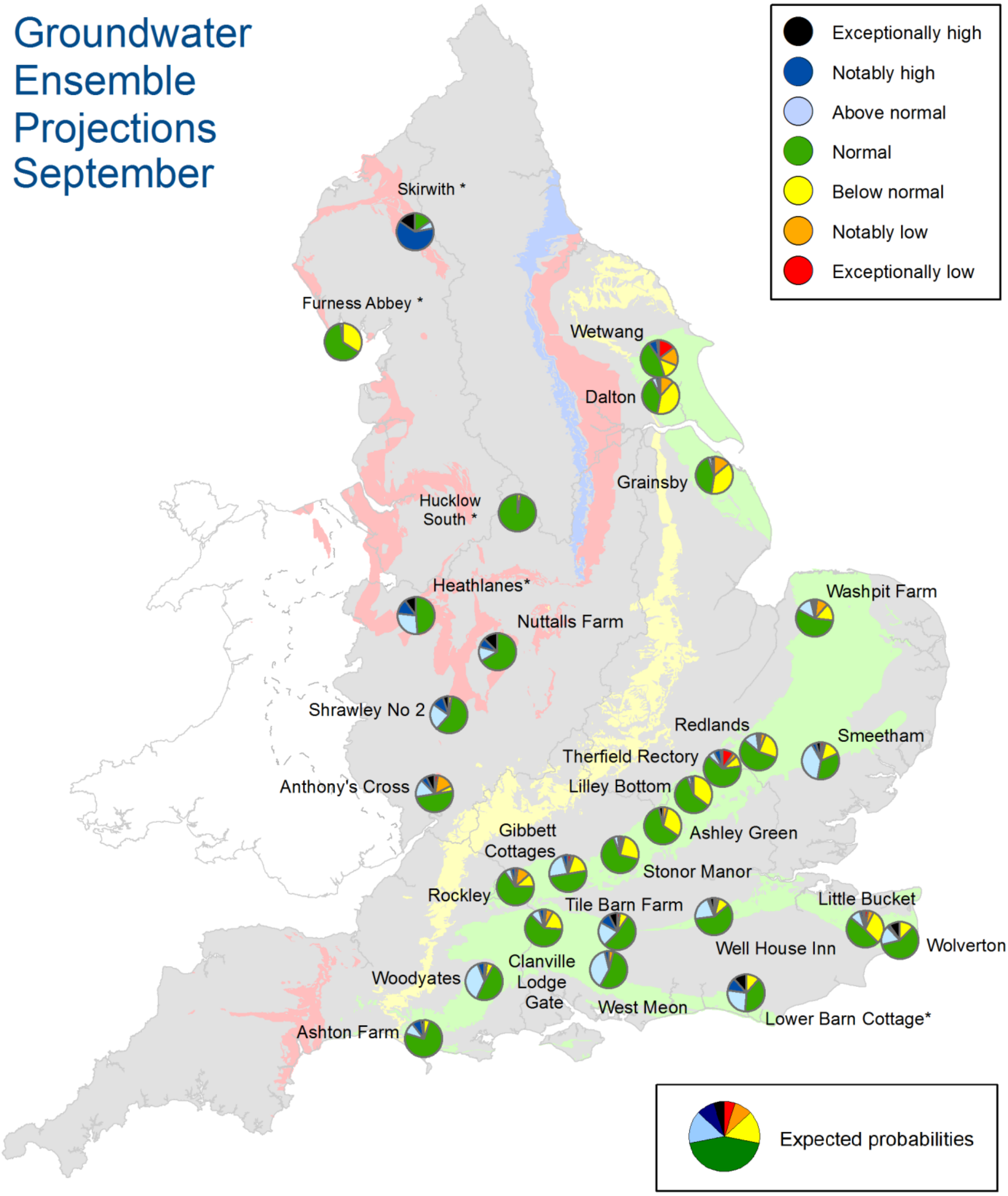


Exceptionally high or low levels are those which would typically occur 5% of the time within the historic record. Notably high or low levels are those which would typically occur 8% of the time. Above normal or below normal levels are those which would typically occur 15% of the time. Normal levels are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



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 September 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