Monthly water situation report

England

Summary – February 2014

February has been an extremely wet month, continuing the pattern of above average rainfall seen across many parts of England since December 2013. England as a whole received 212% of the February long term average (LTA) rainfall, the wettest February since 1990. Monthly rainfall totals recorded across the majority of catchments in our South East and South West Regions were classed as *exceptionally high.* The two month period ending in February 2014 has been the wettest on record (since 1910) for England. Consequently, soil moisture deficits (SMDs) have remained less than 10 mm across most of the country, and monthly mean river flows at more than two thirds of the sites reported on across England are *exceptionally high* for the time of year. Sixteen of the rivers reported on had the highest monthly mean river flow on record for February, the majority of these lie in southeast and southwest England. Groundwater levels have increased during February at three quarters of the sites reported on across England. Nearly half of all sites had *exceptionally high* levels for the end of February, and eight sites had the highest levels on record for the time of year. Overall reservoir stocks increased during February with storage in England as a whole at 98% of total capacity at the end of the month.

Rainfall

February has been extremely wet across all parts of the country. Rainfall totals for February were highest in our South West Region with 185 mm. Rainfall totals in our remaining Regions ranged from 63 mm in our Anglian Region to 163 mm in our North West Region (Figure 1.1). Locally, the highest rainfall totals (more than 240 mm) fell across Cumbria and parts of Devon and Cornwall. The lowest rainfall totals (less than 50 mm) fell across parts of Cambridgeshire, Lincolnshire and Norfolk.

Rainfall totals for February were *normal* or higher for the time of year in all hydrological areas across England, and *exceptionally high* across southeast England, the majority of southwest England, and parts of central and northwest England. Cumulative rainfall totals across these areas were also *exceptionally high* for the time of year for the past two and six months (Figure 1.2).

All of our Regions received above average rainfall for February, with three of our Regions, North West, South East and South West, as well as England as a whole, receiving more than 200% of the February LTA rainfall (Figure 1.3). Many parts of Hampshire, Kent, Surrey and Sussex had rainfall totals that were more than 300% of the February LTA.

February 2014 has been the wettest February since records began in 1910 in a number of catchments across Dorset, Hampshire, Kent and Sussex and the wettest February in South East Region as a whole since 1951. The two month period ending in February this year was the wettest January to February on record (since 1910) for our Midlands, South East and South West Regions, and for England as a whole. More than 50% of catchments experienced the wettest two month period ending in February on record. The three month period ending in February has been the wettest on record in our South East and South West Regions and England as a whole.

Soil moisture deficit

Soil moisture deficits (SMDs) increased marginally in all of our Regions during February. However, at the end of the month, SMDs were still less than 10 mm across almost all of the country. Month end SMDs were within 5 mm of the LTA across most of England, with just a few areas in our Anglian, Yorkshire and North East and South East Regions with SMDs of 6 to 25 mm less than the LTA (Figure 2.1).

At the beginning of February, SMDs ranged from zero in our North West, South East and South West Regions, to 3 mm in our Anglian Region. SMDs have either remained at or very close to zero throughout the month, as in our North West, South East and South West Regions, or have increased slightly towards the end of February as in our Anglian, Midlands and Yorkshire and North East Regions. SMDs in all our Regions were less than the LTA (Figure 2.2).

River flows

Monthly mean river flows for February increased compared to January at the majority of sites reported on across England. River flows for February were *notably high* or higher at more than 90% of sites reported on, and more than two thirds of sites had monthly mean river flows that were *exceptionally high* for the time of year (Figure 3.1). This included all but one site in our South East and South West Regions, as well as a selection of sites across all of our remaining Regions. More than half of the sites reported on in our South East region had monthly mean river flows for February that were more than 300% of the LTA for the time of year.

The monthly mean river flows at four of the seven regional index sites were *exceptionally high* for the time of year. Sixteen rivers had the highest monthly mean river flow on record for February including the River Severn at Bewdley (records began in 1921) and the River Thames (Naturalised) at Kingston (records began in 1883) (Figure 3.2). Of these sixteen, ten have had their highest monthly mean on record for any month, including the River Itchen at Allbrook and Highbridge, the River Medway at Teston and East Farleigh and the River Thames (Naturalised) at Kingston (records date from 1958, 1956, and 1883 respectively).

Groundwater levels

During February, groundwater levels increased at three quarters of the sites reported on across England. At the end of February, groundwater levels were *normal* or higher for the time of year at all of these sites, and nearly half of all sites had *exceptionally high* levels for the time of year, notably in chalk aquifers in southern England. *Exceptionally high* levels were seen at all but one of the sites in our South East and South West Regions, and two sites in our North West Region (Figures 4.1 and 4.2).

At the end of February, eight of the sites reported on had the highest recorded groundwater levels for the time of year. This included Clanville Gate Lodge (Test Chalk), Little Bucket (East Kent Chalk), Ashley Green (East Chilterns Chalk) and Well House Inn (Epsom North Downs Chalk) in our South East Region, Tilshead, which is artesian (Upper Hampshire Avon Chalk) and Woodleys (Otter Valley Sandstone) in our South West Region and Skirwith (Carlisle Basin and Eden Valley Sandstone) and Priors Heyes (West Cheshire Sandstone) in our North West Region. However, please note that levels at Priors Heyes remain high compared to historic levels as the aquifer is recovering from the effects of abstraction. Groundwater levels in the chalk at Clanville Gate Lodge, Little Bucket, Well House Inn, and Tilshead have been the highest recorded for any month on record which date from 1963, 1971, 1942 and 1966 respectively.

Reservoir storage

During February, reservoir stocks increased or remained unchanged at all but four of the reported reservoirs and reservoir groups. Stocks at four reservoirs had increases of greater than 4% of full capacity during February, including Abberton in our Anglian Region, Kielder in our Yorkshire and North East Region, and Colliford and Wimbleball in our South West Region. Fourteen reservoirs or reservoir groups, just over half of all those reported on, are full. Reservoir stocks are *normal* or higher for the time of year at all of the reported sites (Figure 5.1).

At a regional scale, reservoir stocks increased in four of our six Regions, with small decreases, less than 2% of full capacity, seen in our Midlands and South East Regions. At the end of February, regional reservoir stocks were lowest in our Anglian and Midlands Regions at 95% and highest in our South West Region at almost 100%. Overall reservoir storage for England increased during February to 98% of total capacity (Figure 5.2).

Forward look

Early March is likely to be dominated by high pressure weather patterns, with settled conditions and little precipitation. Towards mid-march a spell of more unsettled weather could dominate, particularly in northern areas. The remainder of the month is likely to be typical for the time of year, with changeable conditions and around average temperatures[1].

Scenario based projections for river flows at key sites [2]

March 2014: With average (100% of the LTA) rainfall in March 2014, river flows are likely to be *exceptionally high* at a third of our modelled sites, and *normal* to *notably high* at the other two thirds. With 120% of the LTA rainfall, river flows are likely to be *notably high* or *exceptionally high* at nearly two thirds of the modelled sites. With 80% of the LTA rainfall river flows are likely to be *normal* or higher at all of the modelled sites (see Figure 6.1).
September 2014: With average rainfall between March 2014 and the end of September 2014, river flows are likely to be *normal* or higher at all of our modelled sites. With above average rainfall (120% of the LTA), flows are

[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.

likely to be *exceptionally high* at nearly half of our modelled sites. With below average rainfall (80% of the LTA), river flows are likely to be between *normal* and *notably low* at two thirds of the modelled sites (see Figure 6.2).

Probabilistic ensemble projections for river flows at key sites [2]

March 2014: At more than four fifths of the modelled sites, there is a greater than expected chance of *exceptionally high* flows in March 2014. There is also a greater than expected chance of *notably high* flows at more than half of the modelled sites (see Figure 6.3).

September 2014: There is a greater than expected chance of *notably high* flows from March 2014 to the end of September 2014 at three quarters of the modelled sites. There is also a greater than expected chance of *above normal* flows at more than half of the modelled sites (see Figure 6.4).

Scenario based projections for groundwater levels in key aquifers[3]

March 2014: With average rainfall (100% of the LTA) in March 2014, groundwater levels are likely to be *normal* or higher for the time of year at all of the modelled sites, and *exceptionally high* at two thirds of modelled sites. With above average rainfall (120% of the LTA) groundwater levels are likely to be *exceptionally high* at nearly three quarters of the modelled sites. With 80% of the LTA rainfall, all of the modelled sites are likely to have *normal* or higher groundwater levels for the time of year (see Figure 6.5).

September 2014: With average rainfall (100% of the LTA) from March 2014 to September 2014, groundwater levels are likely to be *normal* or higher for the time of year at all but two of the modelled sites. With above average rainfall (120% of the LTA), levels are likely to be *normal* or higher for the time of year at all of the modelled sites, and *exceptionally high* at a third. With below average rainfall (80% of the LTA), groundwater levels are likely to be *normal* or higher at four fifths of our modelled sites (see Figure 6.6).

Probabilistic ensemble projections for groundwater levels in key aquifers [3]

March 2014: Nearly three quarters of all modelled sites have a greater than expected chance of *exceptionally high* groundwater levels at the end of March 2014 (see Figure 6.7).

September 2014: More than three quarters of the modelled sites have a greater than expected chance of levels being *above normal* or higher for the time of year. A third of the modelled sites have a greater than expected chance of *normal* groundwater levels for the time of year (see Figure 6.8).

Authors: Natalie Armitage and Tom Schnetler (Hydrology – Water Resources Technical Services)

[3] Information produced by the Water Situation Forward Look group lead by Environment Agency in partnership with the Centre for Ecology and Hydrology, British Geological Survey, Met Office.

Rainfall

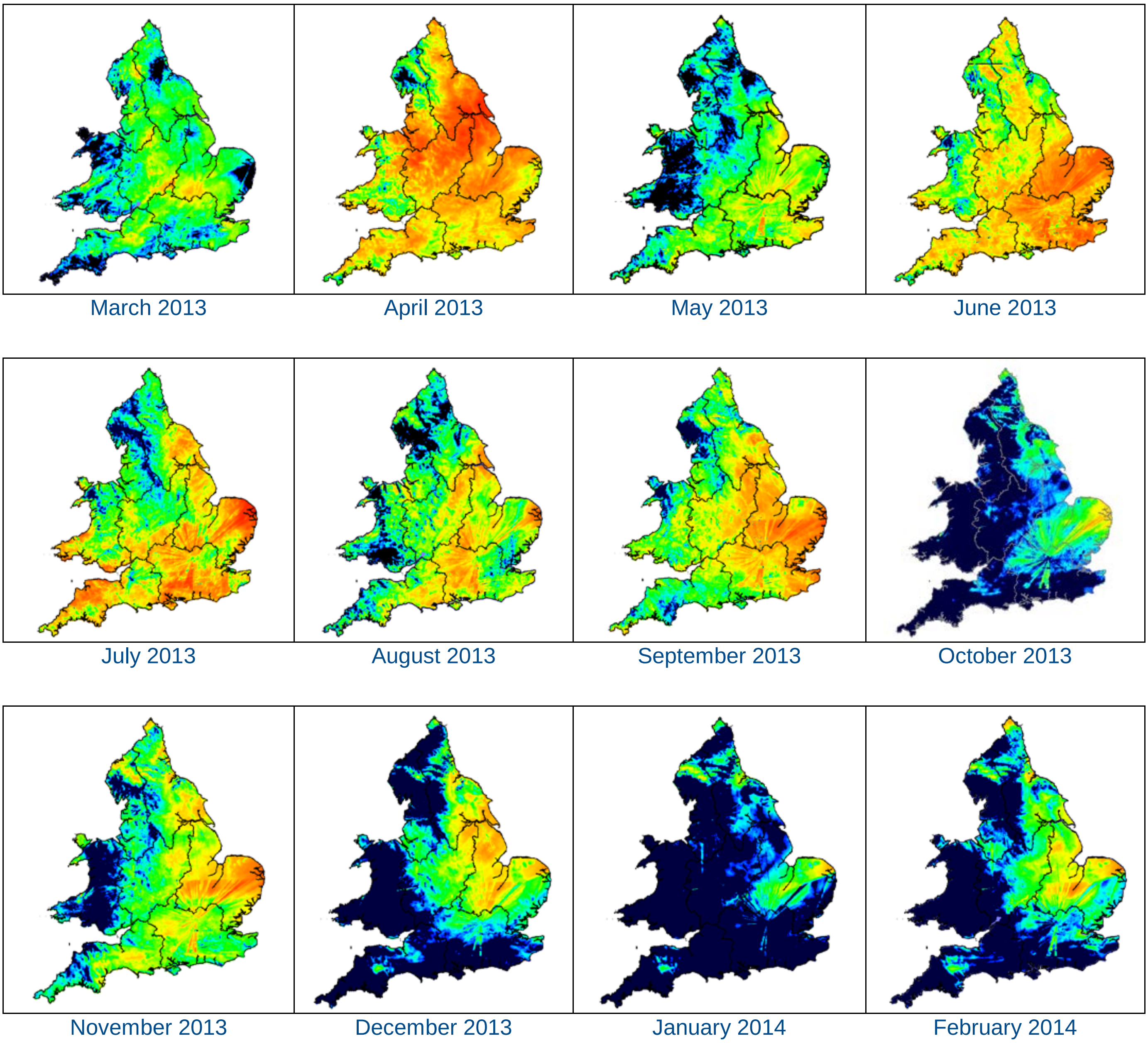
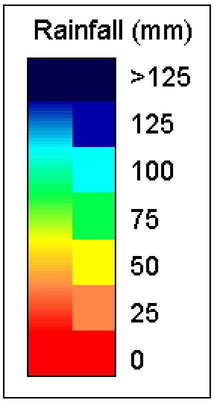


Figure 1.1: Monthly rainfall across England and Wales for the past 12 months. UKPP radar data (Source: Met Office © Crown Copyright, 2014). Note: Radar beam blockages in some regions may give anomalous totals in some areas. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.



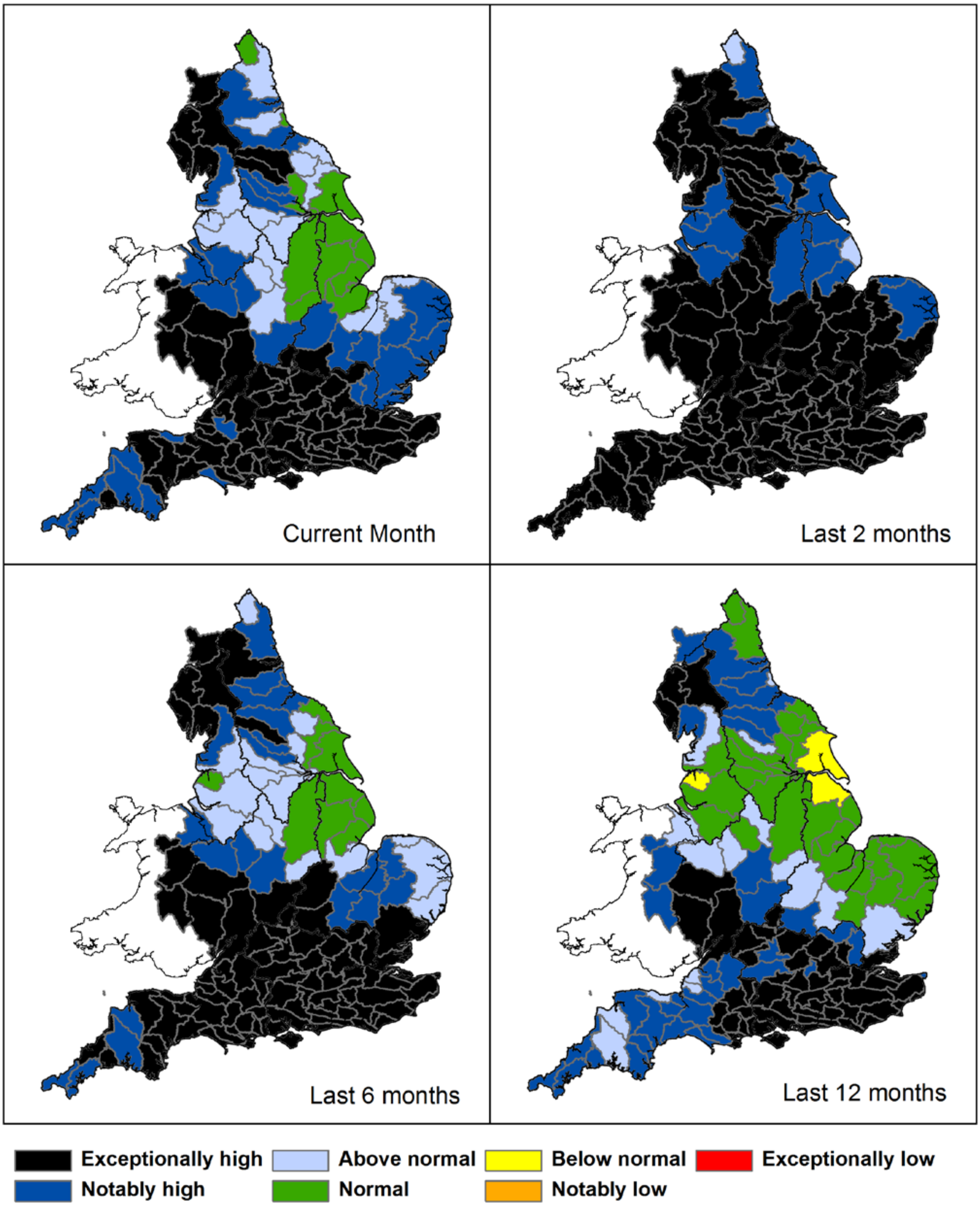


Figure 1.2: Total rainfall for hydrological areas across England for the current month (up to 28th February), the last two months, the last six months, and the last 12 months, classed relative to an analysis of respective historic totals. Final and provisional NCIC (National Climate Information Centre) data based on the Met Office 5km gridded rainfall dataset derived from rain gauges *(Source: Met Office © Crown Copyright, 2014).* Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

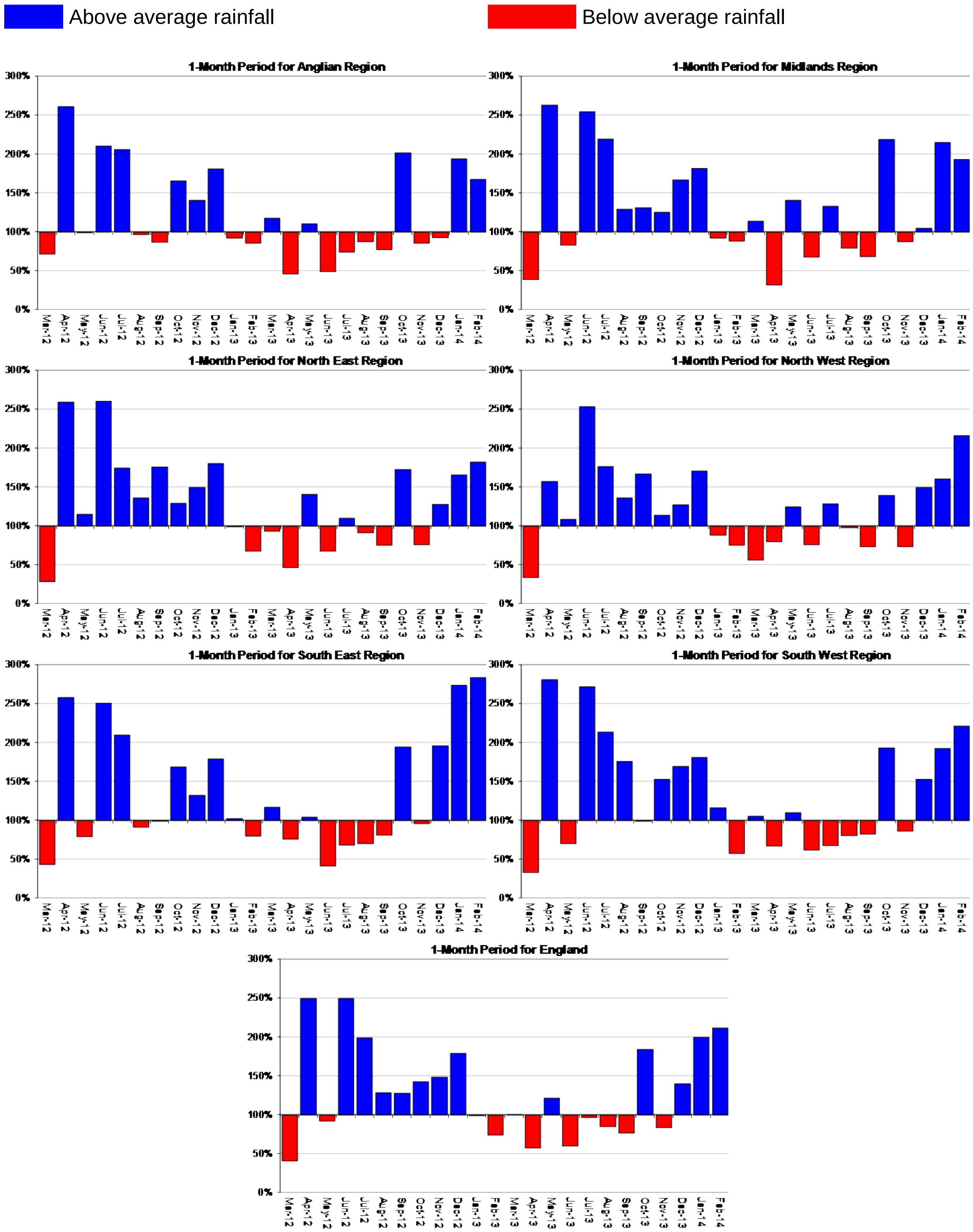


Figure 1.3: Monthly rainfall totals for the past 24 months as a percentage of the 1961 – 1990 long term average for each Environment Agency Region and for England. NCIC (National Climate Information Centre) data. (Source: Met Office © Crown Copyright, 2014).

Soil moisture deficit

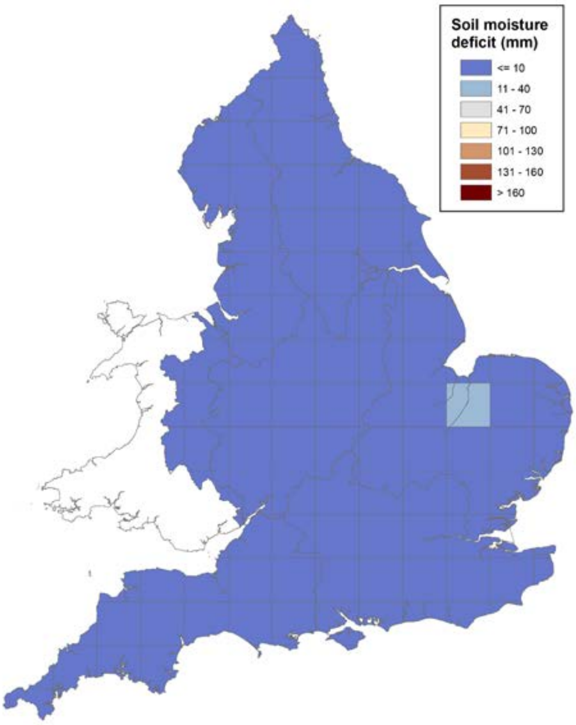
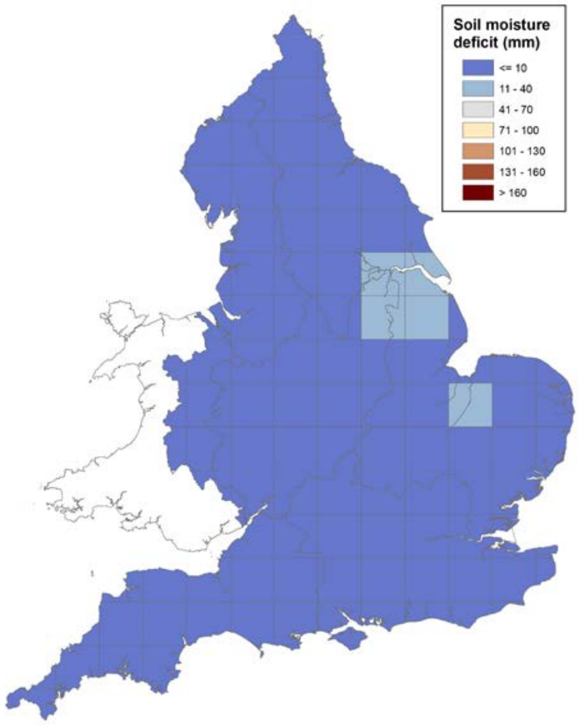
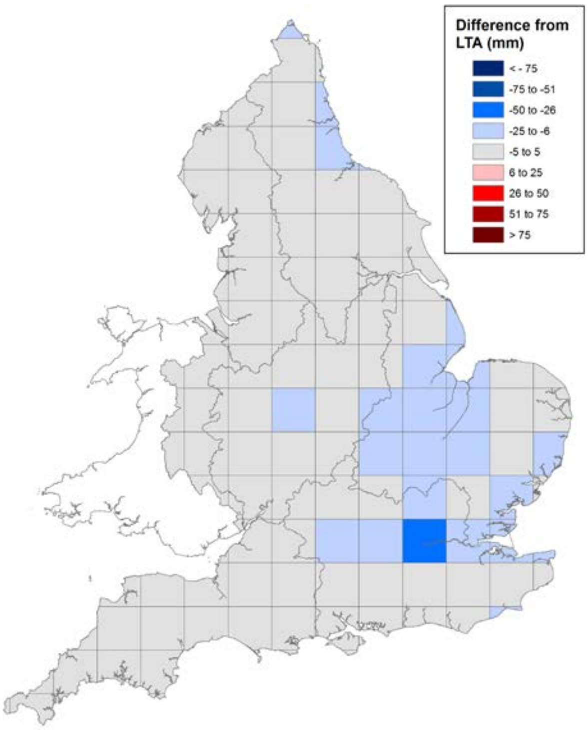
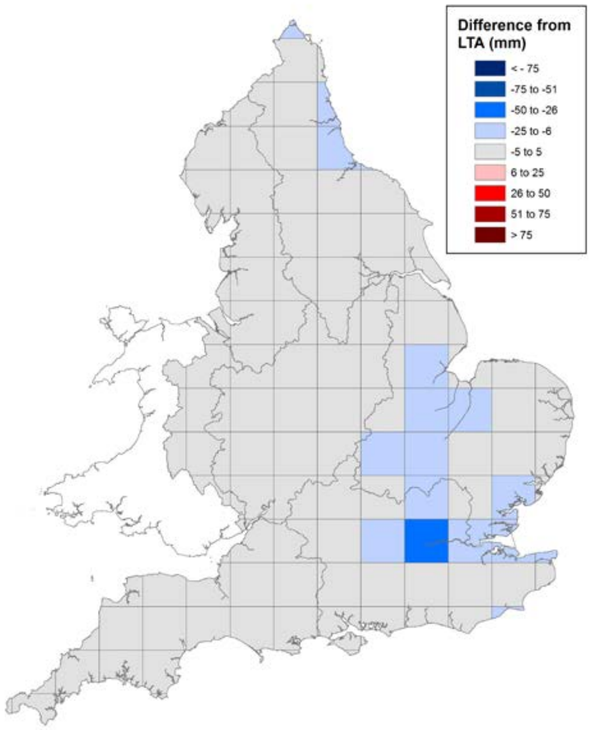
End of January 2014[1]	End of February 2014[2]
	
	

Figure 2.1: Soil moisture deficits for weeks ending 28 January 2014 [1] (left panel) and 26 February 2014 [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, 2014). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014

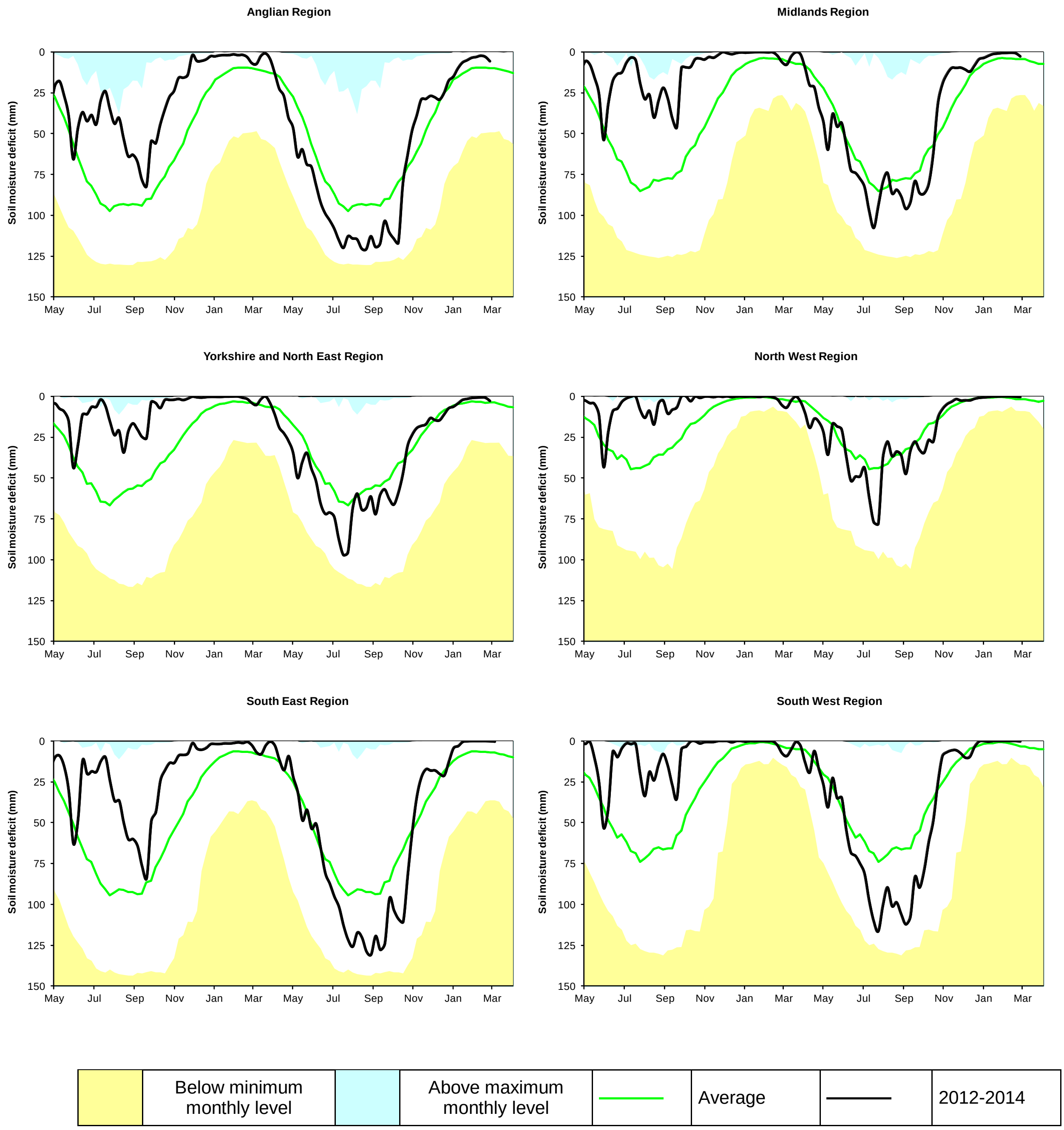
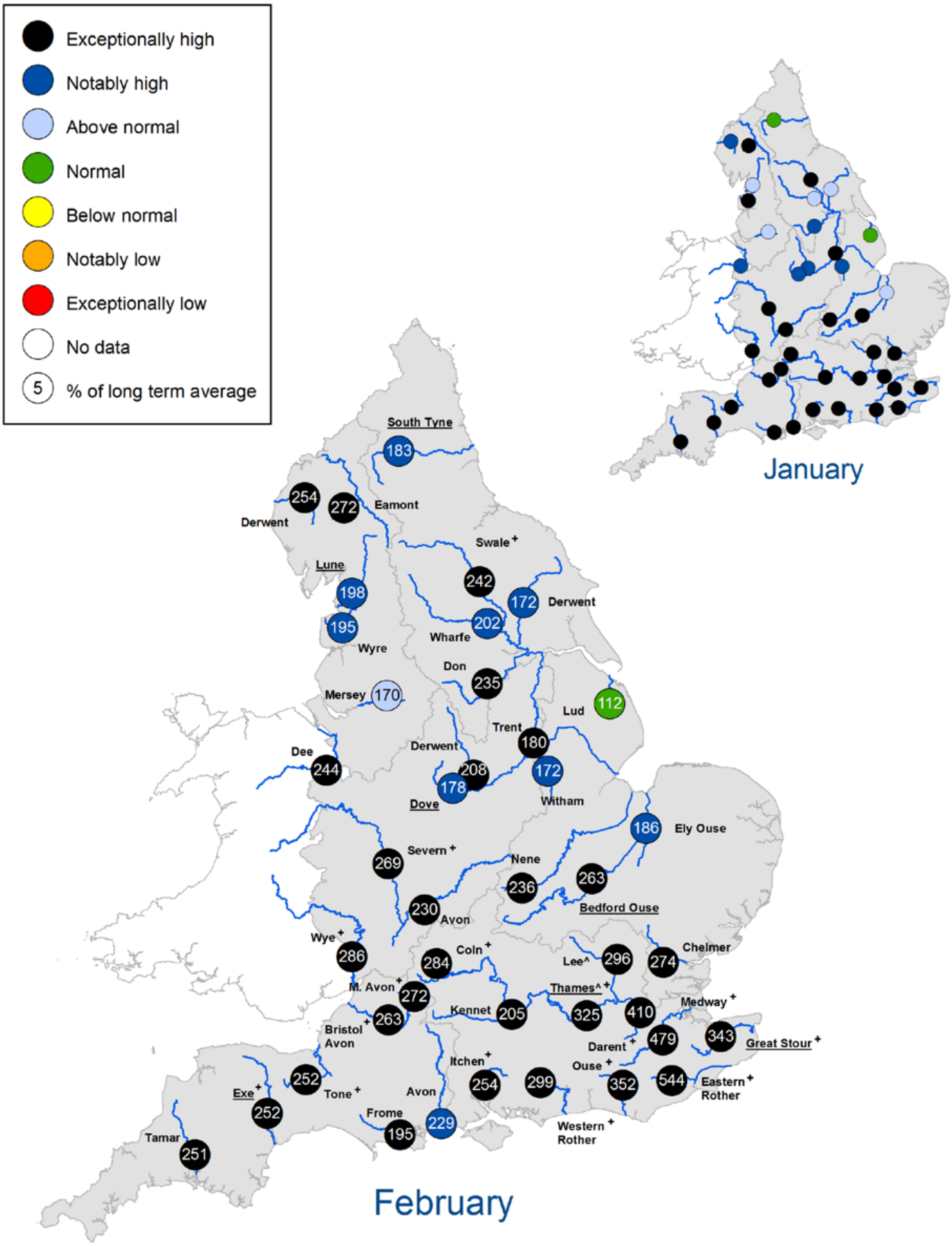


Figure 2.2: Latest soil moisture deficits for all Environment Agency Regions compared to maximum, minimum and 1961-90 long term average. Weekly MORECS data for real land use. (Source: Met Office © Crown Copyright, 2014).

River flows



^ “Naturalised” flows are provided for the ‘Thames at Kingston’ and the ‘Lee at Feildes Weir’

\+ Monthly mean flow is the highest 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 January 2014 and February 2014, expressed as a percentage of the respective long term average and classed relative to an analysis of historic January and February monthly means (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

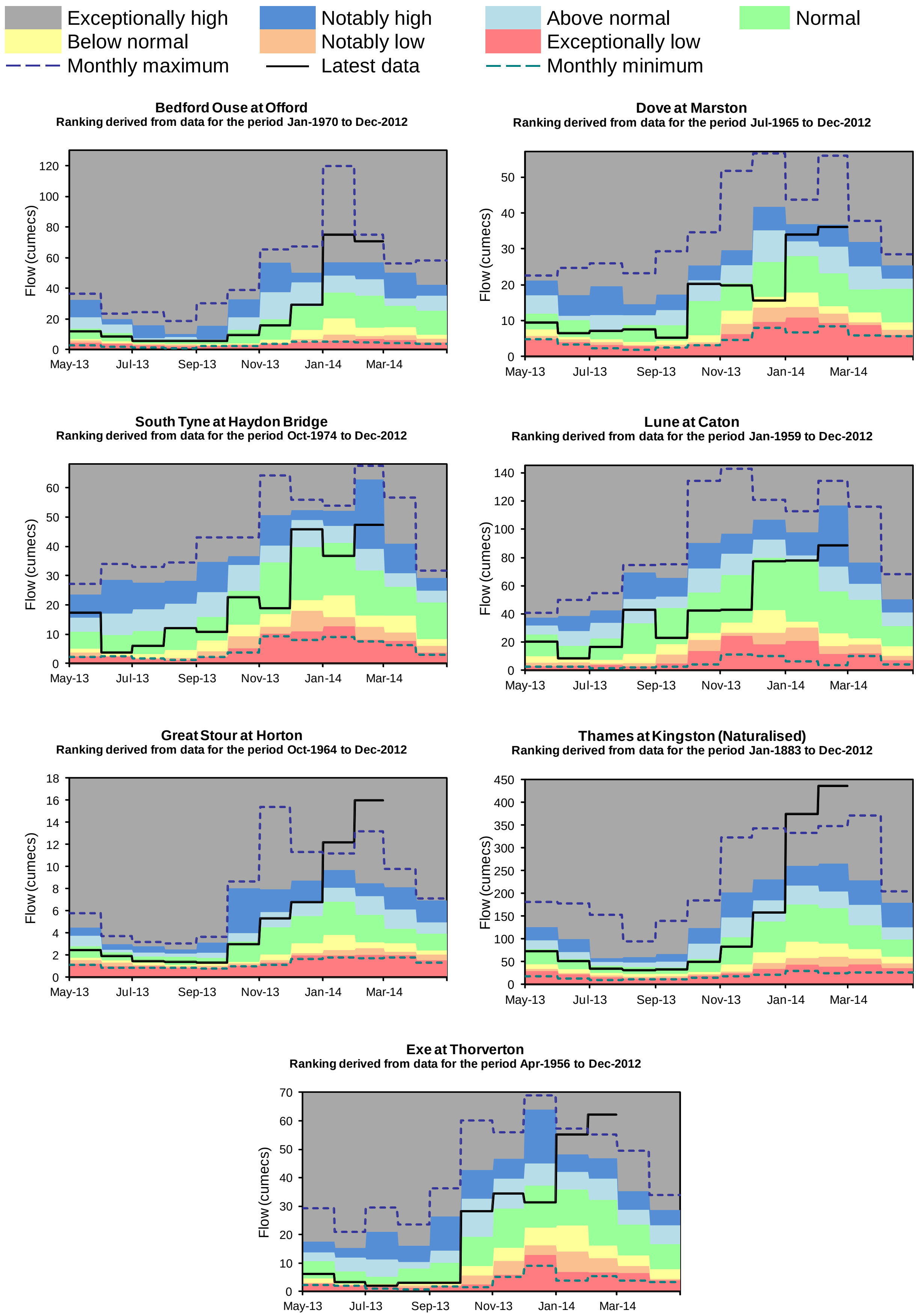
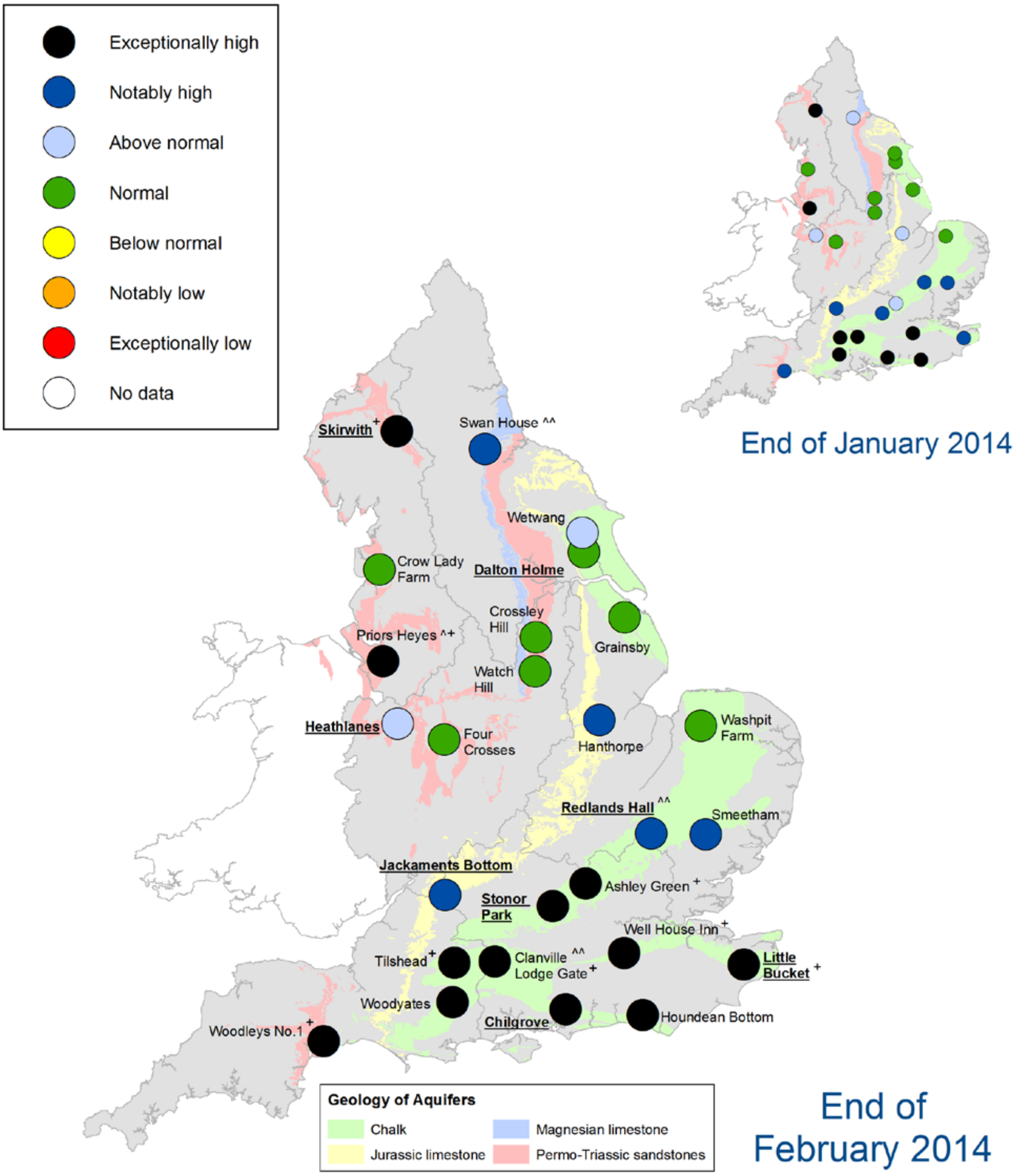


Figure 3.2: Index river flow sites for each Environment Agency Region. Monthly mean flow compared to an analysis of historic monthly mean flows, long term maximum and minimum flows. (Source: Environment Agency).

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 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 January 2014 and February 2014, classed relative to an analysis of respective historic January and February levels (Source: Environment Agency). Geological map reproduced with kind permission from UK Groundwater Forum, BGS © NERC. Crown copyright. All rights reserved. Environment Agency, 100026380, 2014.

Exceptionally high   Notably high   Above normal   Normal

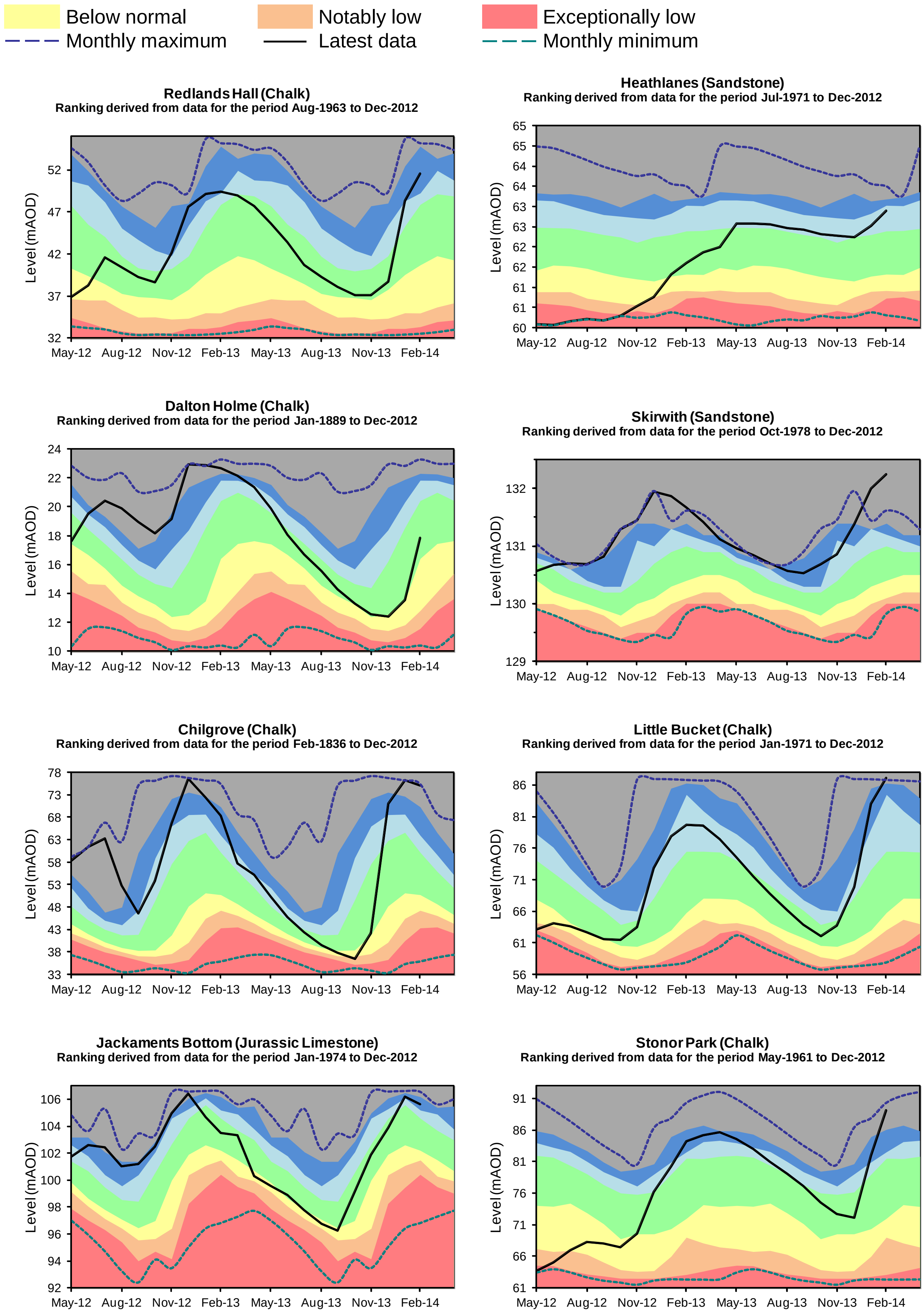
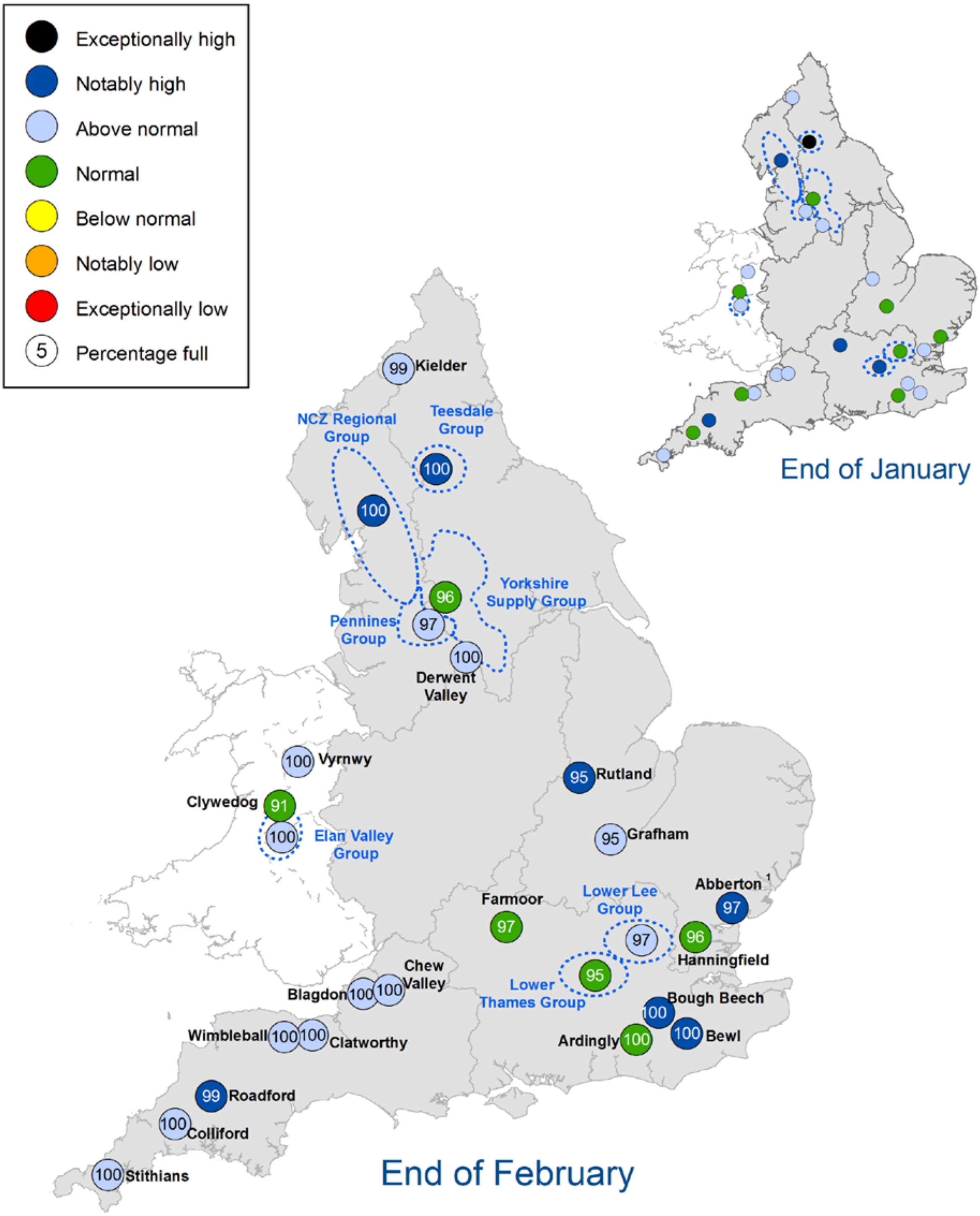


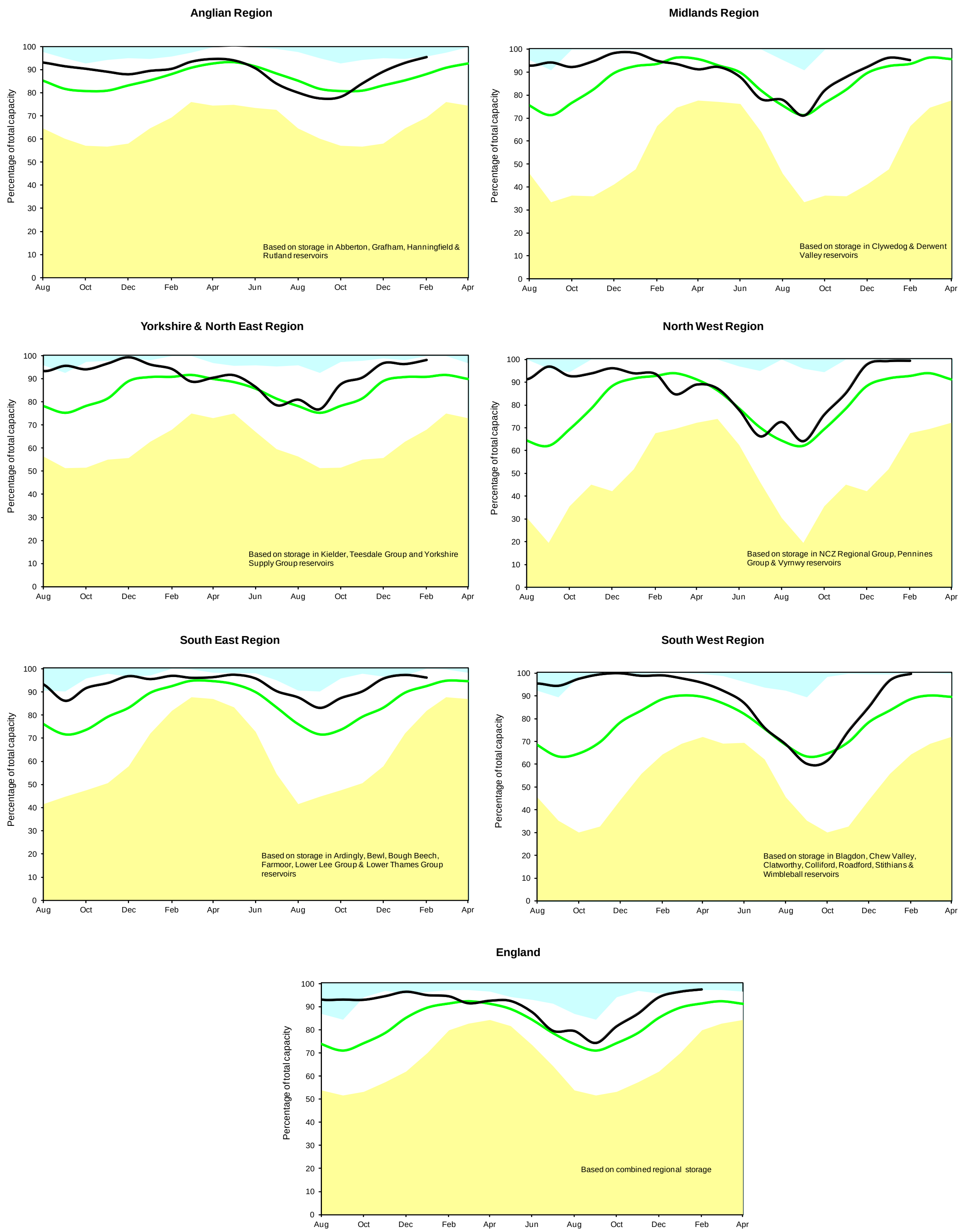
Figure 4.2: Index groundwater level sites for major aquifers. End of month groundwater levels months compared to an analysis of historic end of month levels and long term maximum and minimum levels. (Source: Environment Agency, 2014).

Reservoir storage



1. Engineering work at Abberton Reservoir in Anglian Region to increase capacity has been completed
2. Vyrnwy, Clywedog and Elan Valley reservoirs are located in Wales but provide a water resource to our Midlands and North West regions

Figure 5.1: Reservoir stocks at key individual and groups of reservoirs at the end of January 2014 and February 2014 as a percentage of total capacity and classed relative to an analysis of historic January and February 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, 2014.



	Below minimum monthly level		Above maximum monthly level		Average		2012-2014

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

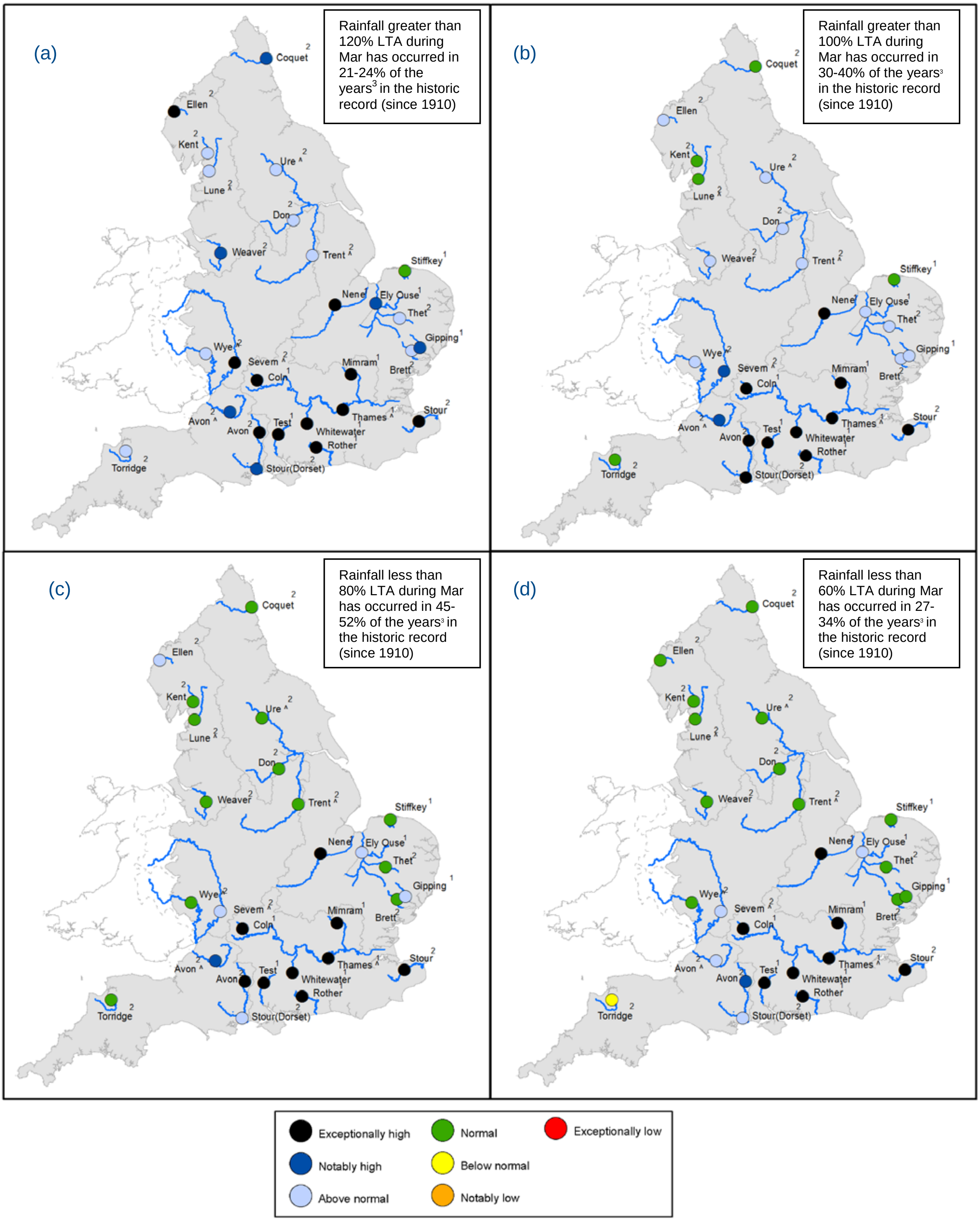


Figure 6.1: Projected river flows at key indicator sites up until the end of March 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall in March 2014 (Source: Centre for Ecology and Hydrology, Environment Agency)

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

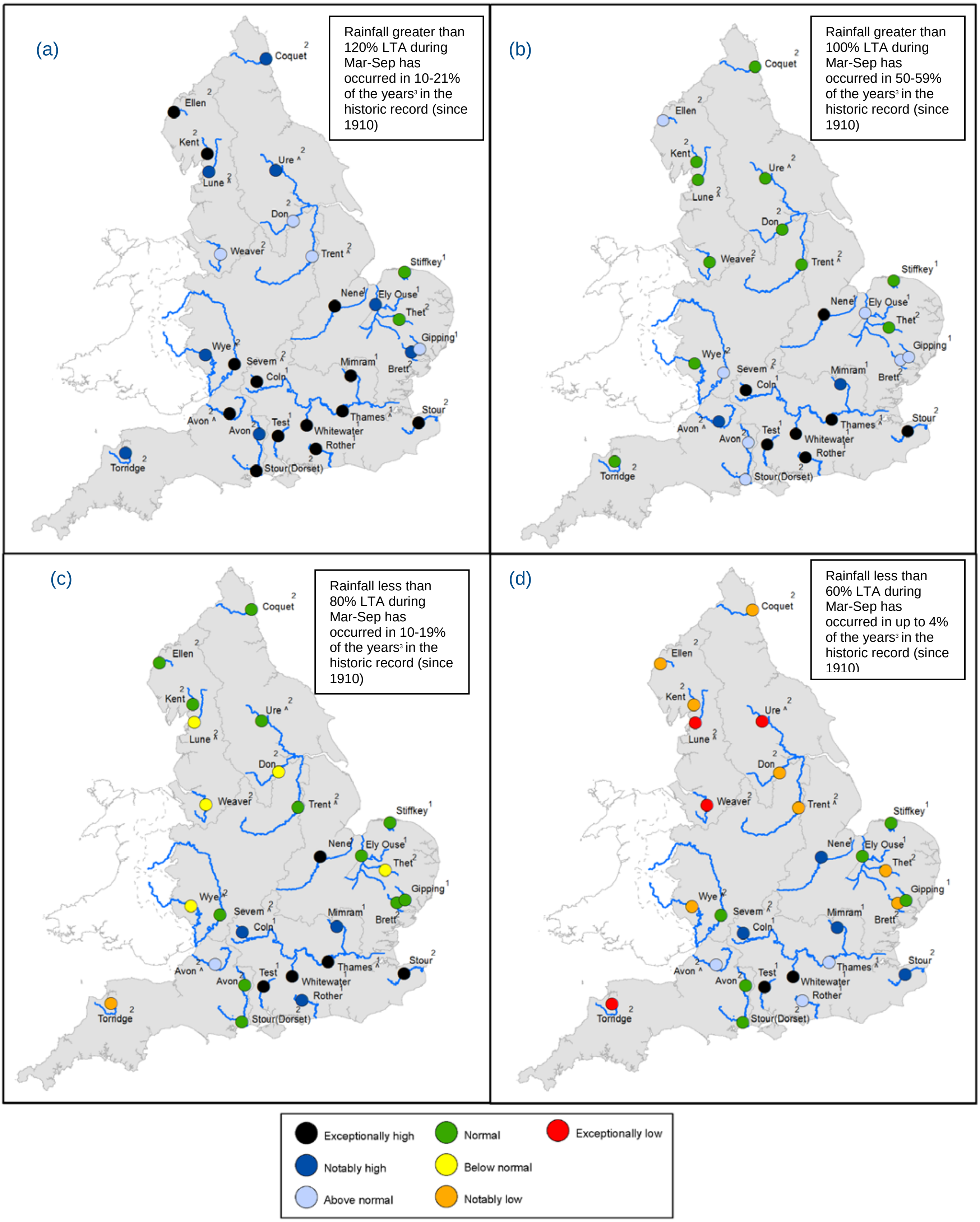


Figure 6.2: Projected river flows at key indicator sites up until the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between March 2014 and September 2014 (Source: Centre for Ecology and Hydrology, Environment Agency)

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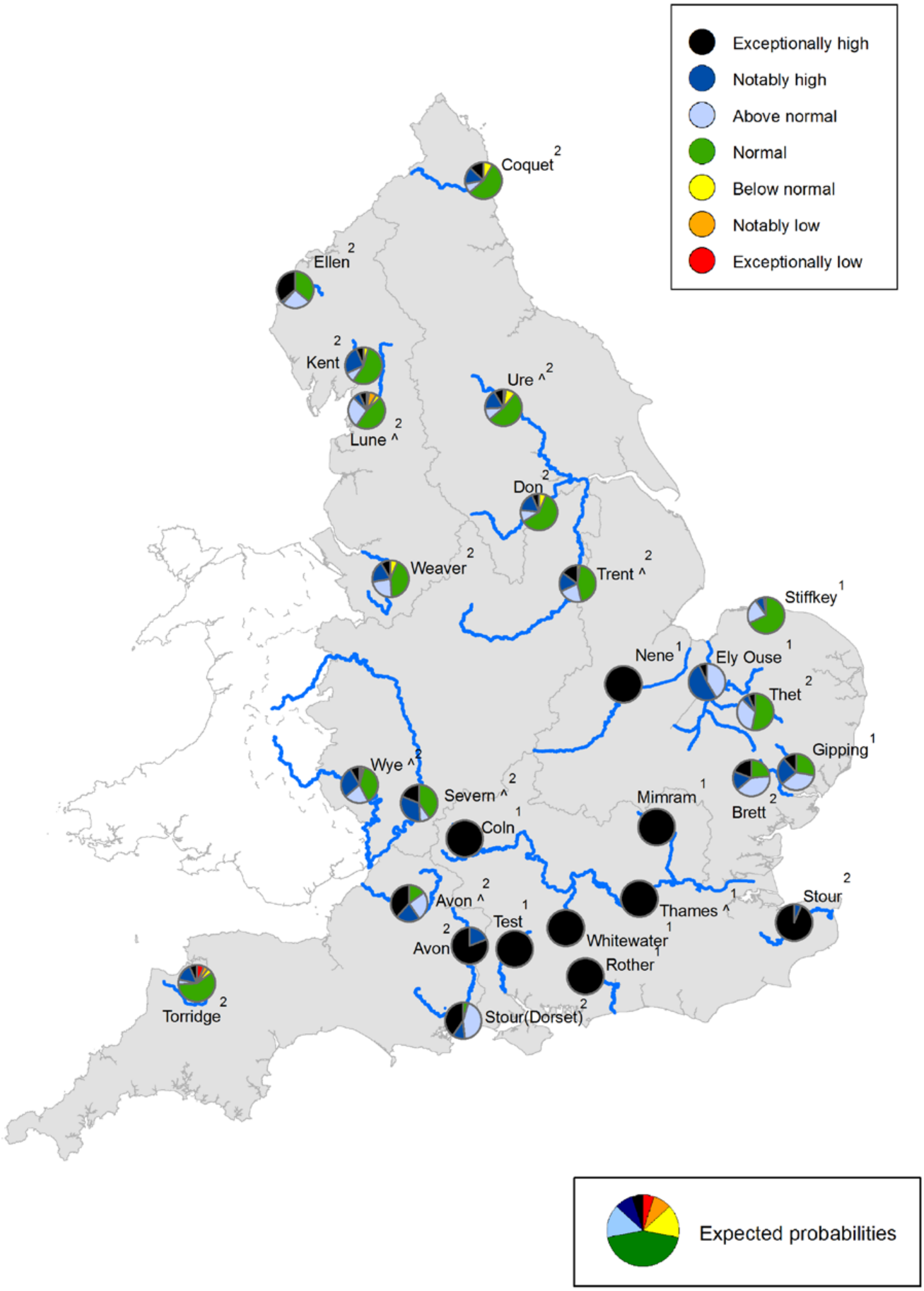


Figure 6.3: Probabilistic ensemble projections of river flows at key indicator sites up until the end of March 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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.

^ "Naturalised" flows are projected for these sites'

[1]Projections for these sites are produced by the Environment Agency,[2] Projections for these sites are produced by CEH

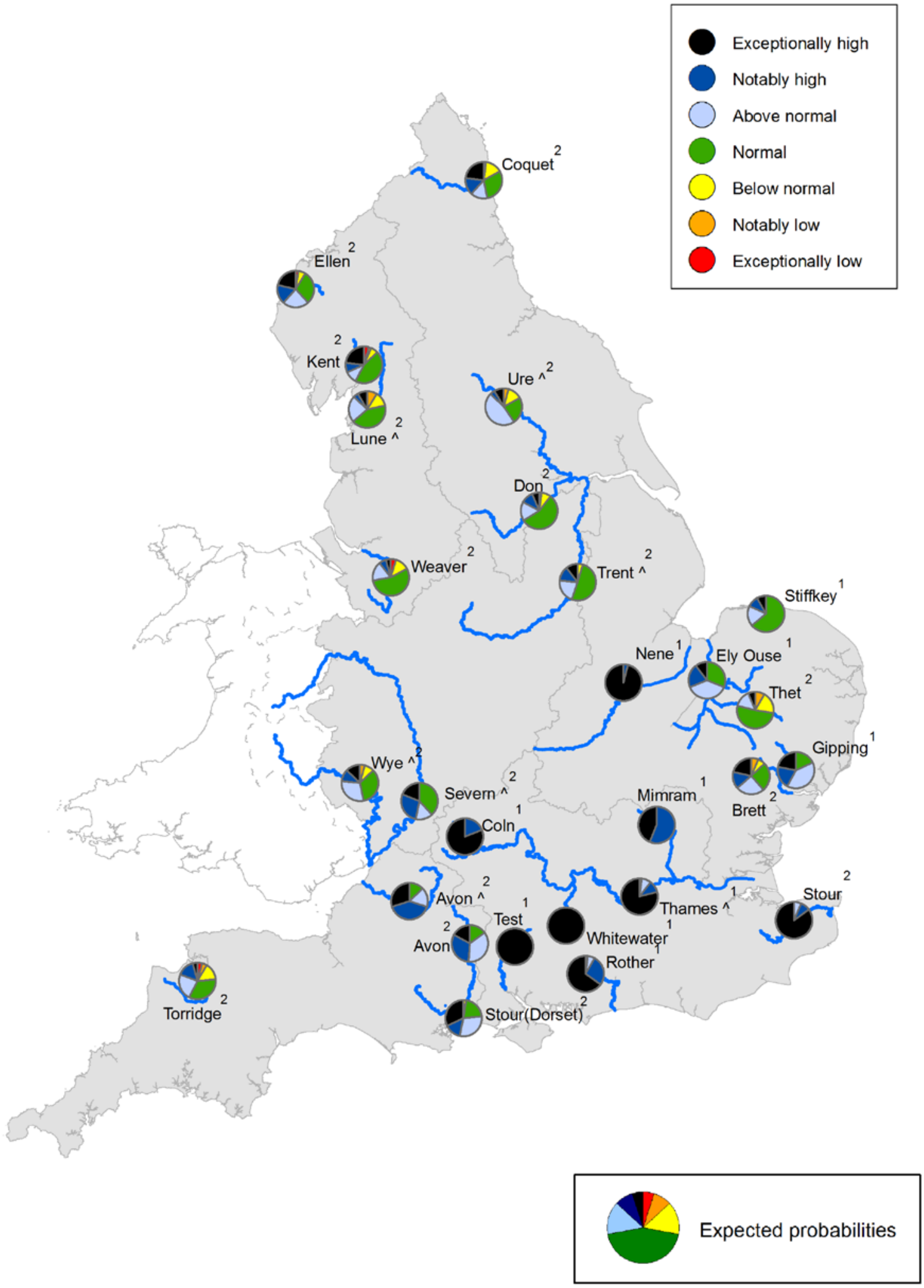


Figure 6.4: Probabilistic ensemble projections of river flows at key indicator sites up until the end of September 2014. Pie charts indicate probability, based on climatology, of the surface water flow at each site being e.g. exceptionally low for the time of year. (Source: Centre for Ecology and Hydrology, Environment Agency).

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.

^ *"Naturalised" flows are projected for these sites*

[1]*Projections for these sites are produced by the Environment Agency,*[2] *Projections for these sites are produced by CEH*

Forward look - groundwater

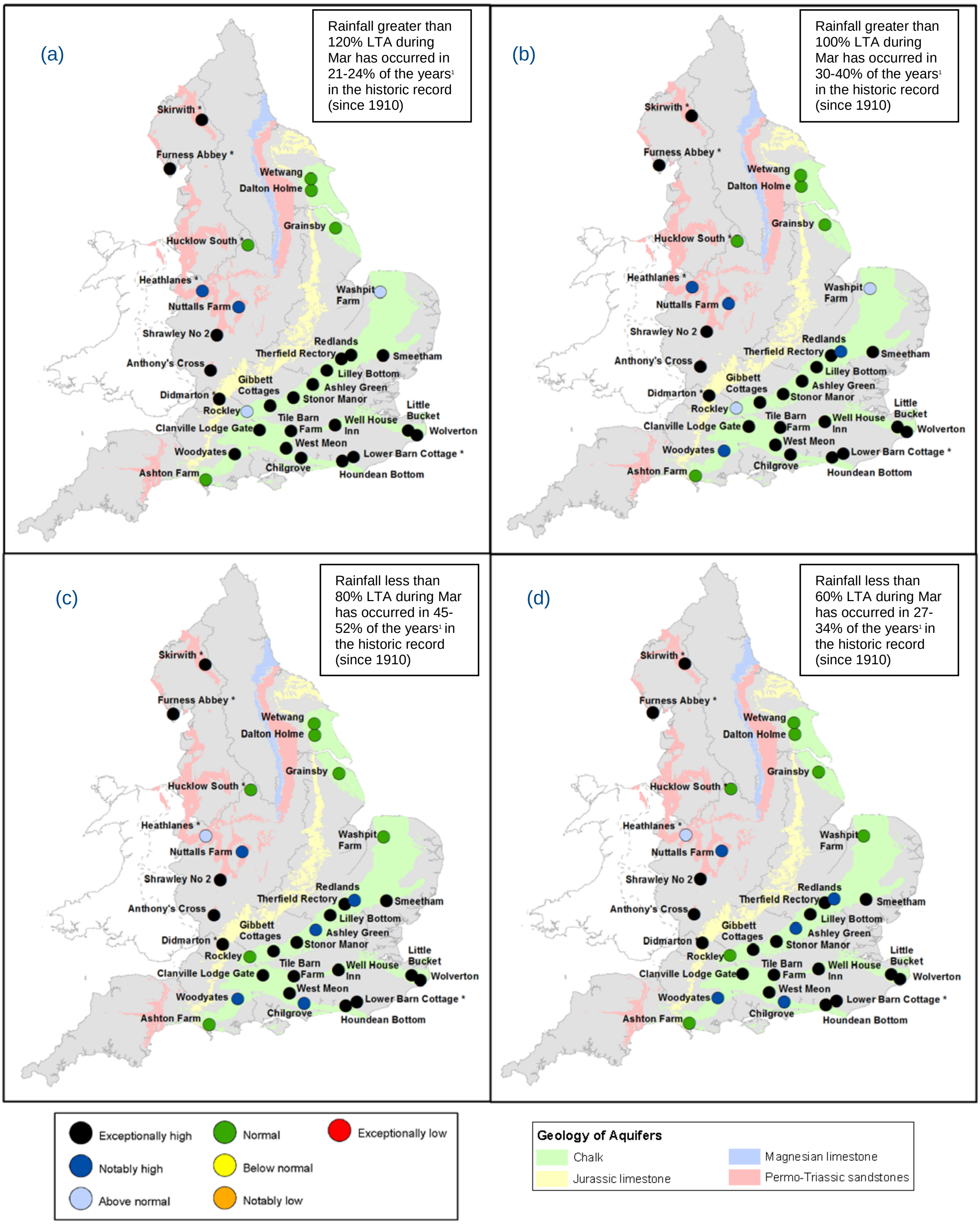


Figure 6.5: Projected groundwater levels at key indicator sites at the end of March 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall in March 2014 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC. Crown copyright all rights reserved. Environment Agency 100026380, 2014.

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

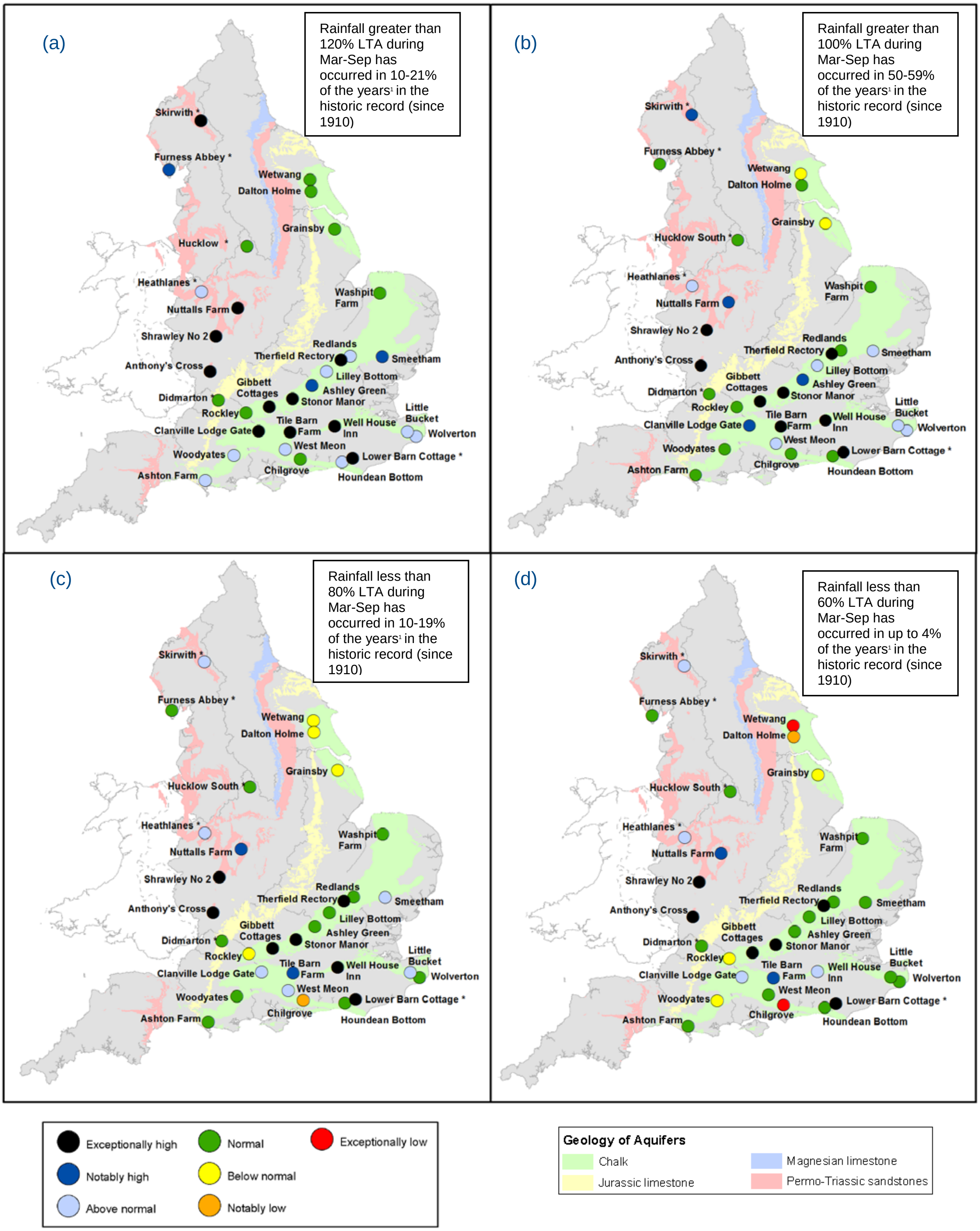
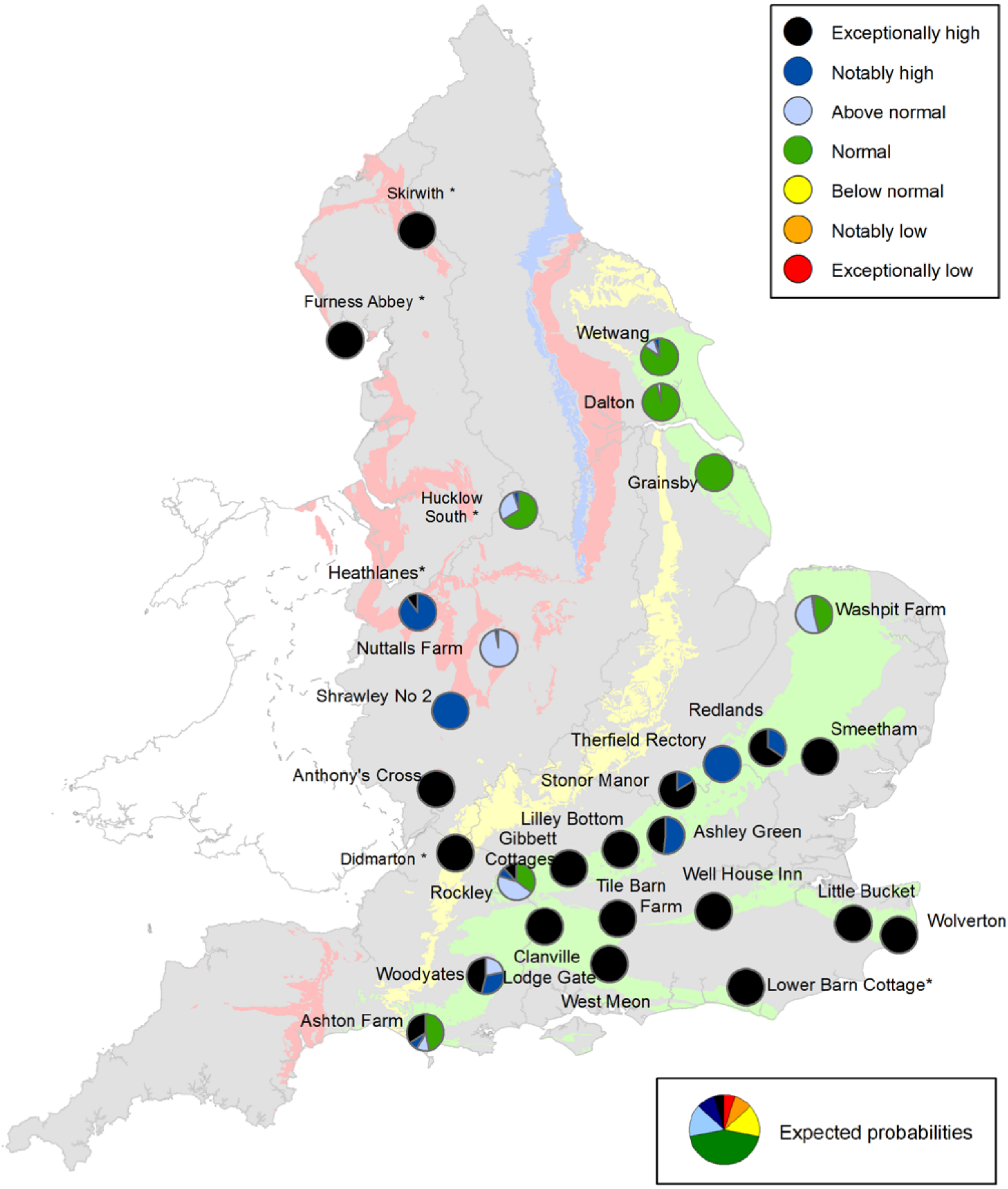


Figure 6.6: Projected groundwater levels at key indicator sites at the end of September 2014. Forecasts based on four scenarios: 120% (a), 100% (b), 80% (c) and 60% (d) of long term average rainfall between March 2014 and September 2014 (Source: Environment Agency) Geological map reproduced with kind permission from UK Groundwater Forum BGS © NERC Crown copyright. All rights reserved. Environment Agency 100026380 2014.

* Projections for these sites are produced by BGS

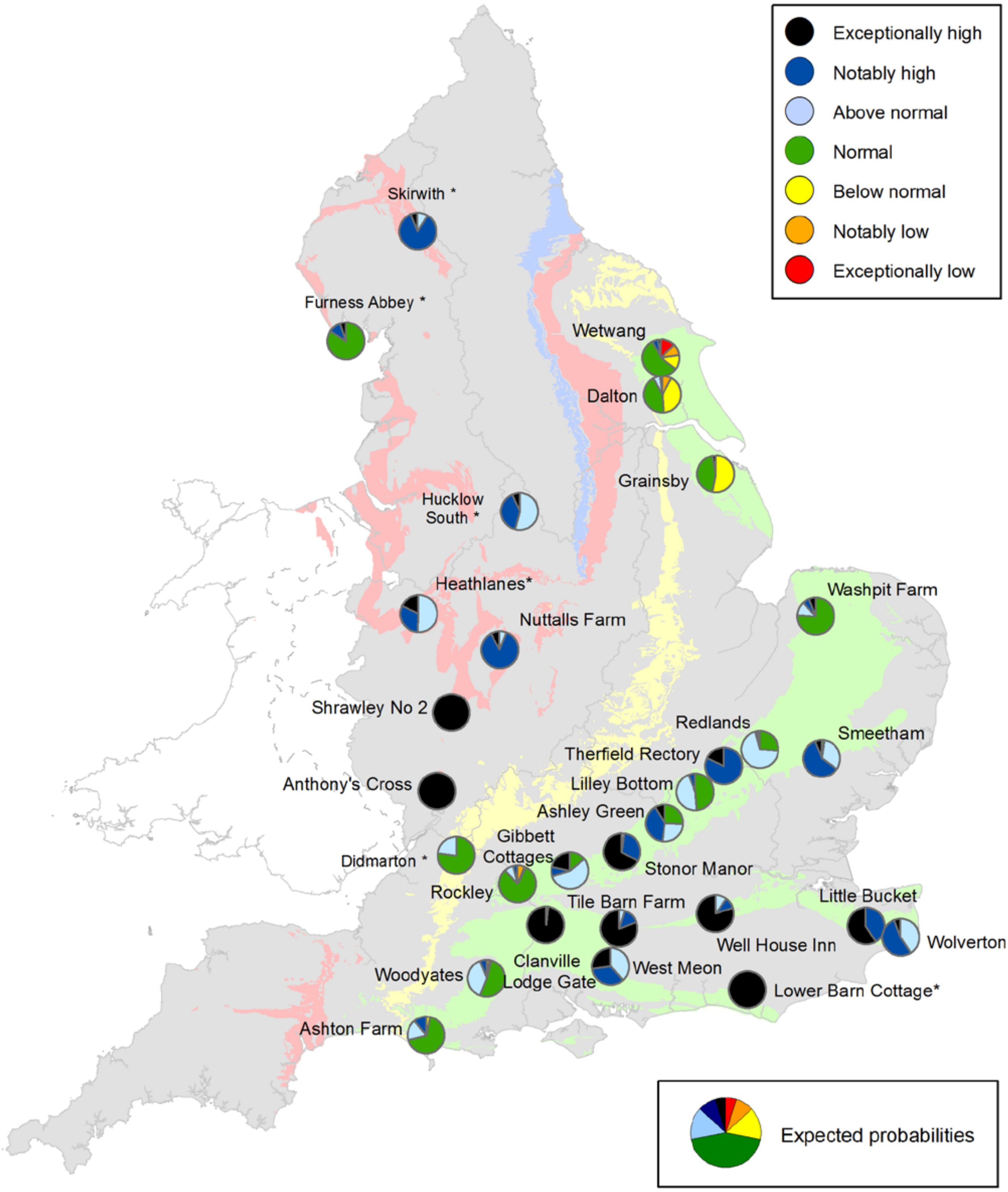
[1] This range of probabilities is a regional analysis



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 2014. 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, 2014.

** 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 2014. 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, 2014.

* Projections for these sites are produced by BGS

Figure 7.1: Environment Agency Region Location Map

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	Groundwater levels are at ground surface level
Effective rainfall	The rainfall available to percolate into the soil or produce river flow. Expressed in depth of water (mm).
Groundwater	The water found in an aquifer
Recharge	The process of increasing the water stored in the saturated zone of an aquifer. Expressed in depth of water (mm).
Reservoir live capacity	The reservoir capacity normally usable for storage to meet established reservoir operating requirements. It is the total capacity less that not available because of operating agreements or physical restrictions. Only under abnormal conditions, such as a severe water shortage might this additional water be extracted.
Soil moisture deficit (SMD)	The difference between the amount of water actually in the soil and the amount of water that 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

Units

cumecs	Cubic metres per second ($m^3 s^{-1}$)
mAOD	Metres Above Ordnance Datum (mean sea level at Newlyn Cornwall).