



# Water stressed areas – final classification

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Developed by the Environment Agency and Natural Resources Wales

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# 1 Introduction

This report sets out the revised methodology developed by the Environment Agency and Natural Resources Wales for the classification of areas of water stress in England and Wales. The methodology updates the one previously published in 2007 (Areas of water stress: final classification. Environment Agency, 2007).

The primary aim of the revision was to provide improved, up-to-date evidence on water stress to the Secretary of State for Environment, Food and Rural Affairs for designation of areas in England which could be universally metered under the Water Industry (Prescribed Conditions) Regulation 1999 (as amended).

Under the Regulations, water companies in areas classified as seriously water stressed need to evaluate compulsory metering alongside other options when preparing water resource management plans (WRMPs).

Water companies operating wholly or mainly in Wales do not have the powers to implement universal metering. By agreement with Welsh Government, we have included the position for catchments and water companies in Wales in the new assessment. The results will be used to inform policy in Wales.

Between 29 October 2012 and 26 November 2012 the Environment Agency consulted on the revised methodology to classify areas of England and Wales according to their relative levels of water stress (Improving the classification of water stressed areas. Environment Agency, 2012). Our consultation response document has been published alongside this document.

The new methodology identifies areas of serious water stress where:

(a) The current household demand for water is a high proportion of the current effective rainfall which is available to meet that demand; or

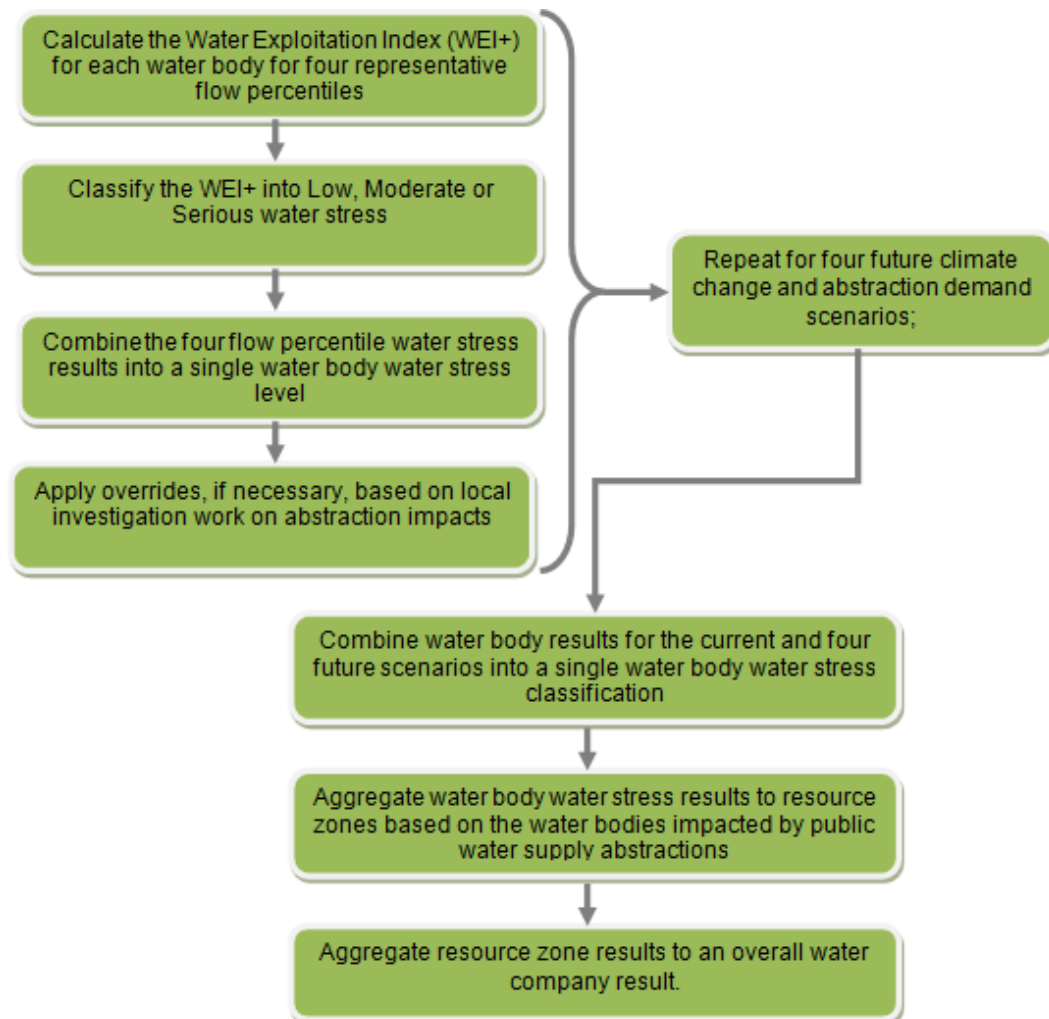
(b) The future household demand for water is likely to be a high proportion of the effective rainfall available to meet that demand.

Even in those areas designated as "not in serious water stress" under the new methodology, there should be some activity to ensure that water is used more efficiently and effectively. Water companies and water users should not disregard the environmental consequences of their abstraction.

This report is our formal advice to ministers on which areas in England and Wales are in serious water stress. A full description of the methodology is also provided in [Appendix 1](#).

## 2 Approach

The water stress methodology provides an indication of relative water stress in individual water company areas by assessing the degree to which the resources in each water body within the area are exploited. This is calculated by the proportion of rainfall reaching rivers and streams, or percolating to groundwater, that is exploited through abstraction by water companies, businesses and farmers. We have then determined whether the environment can cope with that expected level of exploitation using the approach outlined in figure 1.



**Figure 1:** Flowchart outlining the approach used to develop a revised determination of water companies classified as being at serious water stress.

The approach uses the Water Exploitation Index (WEI+) developed by the European Environment Agency, applied at a water body scale across all catchments in England and Wales. Using thresholds based on environmental screening requirements, the

WEI+ result for each water body is classified into three water stress categories: Low, Moderate and Serious, indicating the level of stress placed on the water environment by the use of water through abstraction, discharge and management of storage.

Completing the assessment using current information on available resources and demands highlights areas where action is needed now to reduce water stress. But whilst some water bodies may only be classed as low or moderate stress now, the impacts of changing demands and population growth, or a changing climate, could tip the balance in the future. We therefore looked at the areas that might become stressed in the future. We did this by identifying four future scenarios for climate change and water demand, working out the water stress status for individual water bodies under each, and combining the results.

Water bodies at high risk of environmental impacts as a result of overexploitation from abstraction were classified as being stressed. The assessment was completed at a water body scale, but to satisfy the specific purpose of the Water Industry (Prescribed Conditions) Regulation 1999 (as amended), the local stress classification was subsequently translated to water company boundaries.

Water body stress results were first aggregated to each water company resource zone, based on the stress level of the water bodies that provide the sources of water used to supply each zone. Resource zone water stress classifications were then aggregated based on the percentage of the water company population that is served by resource zones under serious stress to obtain an overall result for each water company.

The approach used to classify areas of serious water stress in England and Wales is detailed in [Appendix 1](#).

The designation resulting from the new methodology provides a more complete and realistic picture of stress on water resources, and uses the most up-to-date data sets. It has the potential to be applied to purposes other than metering, such as encouraging or supporting higher water efficiency measures in new build, or to support retrofitting initiatives.

Designating an area as seriously water stressed is not related to a water company's ability to supply its customers, or to the level of risk to public water supply, nor is it an indication of water company performance. Identification of areas of serious water stress does not reduce or remove the requirements for water companies to undertake a thorough assessment of all options to maintain an adequate supply-demand balance as part of their water resource management planning.

# 3 Final classification

To satisfy the specific purpose of the Water Industry (Prescribed Condition) Regulations 1999 (as amended), the Environment Agency and Natural Resources Wales have looked across the current and future water usage and climate change scenarios, to provide an indicative stress situation for each water company, as shown in Table 1.

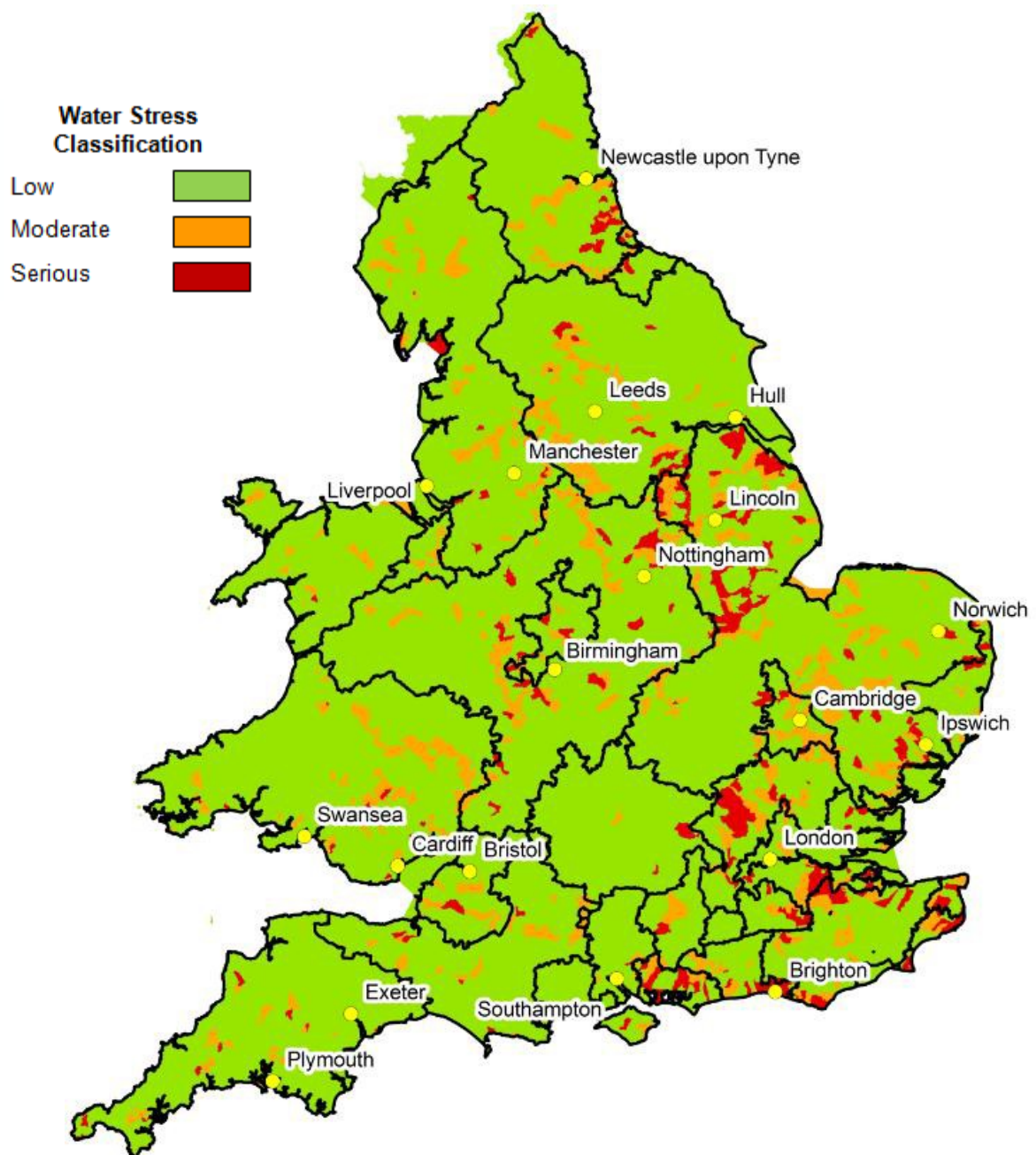
Water Company Area	2013 Classification					Final Stress
	Current Stress	Future Scenario 1	Future Scenario 2	Future Scenario 3	Future Scenario 4	
Affinity Water (formerly Veolia Water Central)	S	S	S	S	S	Serious
Affinity Water (formerly Veolia Water East)	S	S	S	S	S	Serious
Affinity Water (formerly Veolia Water South East)	S	S	S	S	S	Serious
Anglian Water	S	S	S	S	S	Serious
Bristol Water	M	M	M	M	M	Not Serious
Cambridge Water	M	M	M	M	M	Not Serious
Cholderton & District Water	M	M	M	M	M	Not Serious
Dee Valley Water	M	M	M	M	M	Not Serious
Dwr Cymru Welsh Water	M	M	M	M	M	Not Serious
Essex & Suffolk Water	S	S	S	S	S	Serious
Northumbrian Water	M	M	M	M	M	Not Serious
Portsmouth Water	M	S	M	S	M	Not Serious
Sembcorp Bournemouth Water	L	M	M	M	L	Not Serious
Severn Trent Water	M	M	M	M	M	Not Serious
South East Water	S	S	S	S	S	Serious
South Staffordshire Water	M	M	M	M	M	Not Serious
South West Water	M	M	M	M	M	Not Serious
Southern Water	S	S	S	S	S	Serious
Sutton & East Surrey Water	S	S	S	S	S	Serious
Thames Water	S	S	S	S	S	Serious
United Utilities	M	M	M	M	M	Not Serious
Veolia Water Projects	M	M	M	M	M	Not Serious
Wessex Water	M	M	M	M	M	Not Serious
Yorkshire Water	M	M	M	M	M	Not Serious

**Table 1:** Water company stress classification showing how the current and future scenarios have been combined (L = Low stress, M = Moderate Stress, S = Serious Stress).

The Environment Agency advises the Secretary of State that the areas classified as 'Serious' in Table 1 should be designated as 'Areas of serious water stress' for the purposes of Regulation 4 of the Water Industry (Prescribed Condition) Regulation 1999 (as amended).

The classification is designed to support decisions about metering at the present time. Although the classification is at a company-wide level, we would expect any justification for compulsory metering to be developed from an assessment at a resource zone level.

Figure 2 shows the water bodies at risk of stress within individual water company areas.



**Figure 2: Map** showing final water body stress classification at a water body scale.



# 4 Appendix 1

Here we set out in more detail the approach described in Section 2, which we used to develop a revised determination of water companies classified at serious water stress. The steps taken in this approach are:

1. Calculate the Water Exploitation Index (WEI+) for each water body for four representative flow percentiles;
2. Classify the WEI+ into Low, Moderate or Serious water stress;
3. Combine the four flow percentile water stress results into a single water body water stress level;
4. Apply overrides, if necessary, based on local investigation work on abstraction impacts;
5. Repeat steps 1-4 for four future climate change and abstraction demand scenarios;
6. Combine water body results for the current and four future scenarios into a single water body water stress classification;
7. Aggregate water body water stress results to resource zones based on the water bodies impacted by public water supply abstractions;
8. Aggregate resource zone results to an overall water company result.

The following sections describe each of these steps in detail.

## Step 1: Calculate Water Exploitation Index

The water body water stress calculation is based on the Water Exploitation Index (WEI+) developed by the European Environment Agency. The WEI+ equation is:

$$WEI+ = \frac{(Abs - Dis)}{(NWR - \Delta S_{art})}$$

Where:

Abs = Abstraction

Dis = Returns (Discharges)

NWR = Natural Water Resource

$\Delta S_{art}$  = Artificial storage

The Environment Agency Water Resources GIS database (WRGIS) contains the necessary datasets to calculate WEI+ for each water body. The result of the WEI+ is the net abstraction (Abs – Dis) as a percentage of the total resource (natural flow – change in storage).

This WEI+ index was calculated at four flow percentiles: Q30, Q50, Q70 and Q95, representing the flow that is exceeded for 30%, 50%, 70% and 95% of the year on average, respectively in each water body.

**Note:** The calculation for groundwater abstractions takes account of the effect of groundwater storage as part of the artificial storage component of the WEI+ equation. For groundwater abstraction, the Q50 (long term average) rate of abstraction was mapped to the abstraction component of the assessment for all four flow percentiles. The difference between the Q50 abstraction rate and the percentile-specific rates for Q95, Q70 and Q30 were mapped to the artificial storage component of the equation.

## Step 2: Classify WEI+

The WEI+ index at each flow percentile for each water body was classified into Low, Moderate and Serious water stress categories. This was done by setting thresholds to be applied to the index result. Two sets of thresholds were applied:

- Generic thresholds were applied to the majority of catchments;
- More stringent thresholds were applied in Habitats Directive (Special Areas of Conservation (SAC) rivers) catchments, where water resources are managed to a more protective environmental flow than that defined for the Water Framework Directive (WFD).

These approaches are described below:

### Generic thresholds

The general approach to applying thresholds to the WEI+ result to classify water stress is based on applying the same percentage threshold as the Environmental Flow Indicators (EFIs) used for the Water Framework Directive. Abstraction Sensitivity Band (ASB) 2, the median sensitivity band, was used as the boundary between Low and Moderate water stress. The boundary between Moderate and Serious water stress was set at an additional 25% above the Low/Moderate boundary. The thresholds used are shown in Table 2.

Water Stress category	Q30	Q50	Q70	Q95
<b>Serious</b>	>51%	>49%	>45%	>40%
<b>Moderate</b>	26% - 51%	24 - 49%	20% - 45%	15% - 40%
<b>Low</b>	<26%	<24%	<20%	<15%

**Table 2:** Generic WEI+ thresholds used to define water stress

**Note:** Although the thresholds were based on the values used in EFIs, it is important to note that the calculation of WEI+ uses a different equation so there is not an exact correspondence of flow compliance with EFIs and water stress categories. By using similar thresholds, the water stress assessment uses a corresponding threshold to EFIs to differentiate between Low and Moderate water stress, which helps to bring consistency to the different assessments. However the assessments are different, most importantly in that the final water stress results take account of the range of high

to low flows, whereas other assessments (particularly for WFD) focus on the flow exceeded 95% of the time (Q95).

### Specific approach in Habitats Directive Catchments

More stringent thresholds have been applied in Habitat Directive (Special Area of Conservation (SAC) rivers) catchments, where water resources are managed to a more protective environmental flow than that defined for the Water Framework Directive (WFD). The thresholds applied in Habitats Directive (SAC rivers) catchments were based on the Habitats Directive Ecological River Flow (HDERF) threshold to set the boundary between Low and Moderate water stress, rather than the EFI percentage. The HDERF was derived to assist Habitats Directive Review of Consents (HDRoC) assessments. The percentage was varied based on the abstraction sensitivity in these water bodies. The boundary between Moderate and Serious water stress was set at 25% above the Low/Moderate boundary. The thresholds applied are shown in Table 3.

HDERF sensitivity	Q30		Q50		Q70		Q95	
	Low/Mod	Mod/Ser	Low/Mod	Mod/Ser	Low/Mod	Mod/Ser	Low/Mod	Mod/Ser
Very High	10%	35%	10%	35%	10%	35%	5%	30%
High	15%	40%	10%	35%	10%	35%	10%	25%
Medium	20%	45%	15%	40%	15%	40%	15%	40%
Low	20%	45%	20%	45%	20%	45%	15%	40%
Very Low	20%	45%	20%	45%	20%	45%	15%	40%

**Table 3:** HDERF WEI+ thresholds to define water stress

### Step 3: Combine flow percentile assessments

Classifying the WEI+ result for each flow percentile using the thresholds described in step 2 gives a water stress category for each water body at each of the four WRGIS flow percentiles. These four results are combined into a single default result for each water body using the following rule hierarchy:

- If two or more flow percentiles are classed as Serious water stress, the overall water body result is Serious.
- If one flow percentile is classed as Serious, the overall result is Moderate.
- If two or more flow percentiles are classed as Moderate, the overall result is Moderate.
- Otherwise the overall result is Low.

As such, a water body can only be classed as Low water stress if at least three flow percentiles are at Low water stress and the remaining flow percentile is not at Serious water stress.

### Step 4: Apply water body overrides

Consultees suggested the water stress results at the water body level should include a consideration of local investigation work on abstraction impacts. In response to this

suggestion we incorporated a series of tests to override the default water stress results where appropriate.

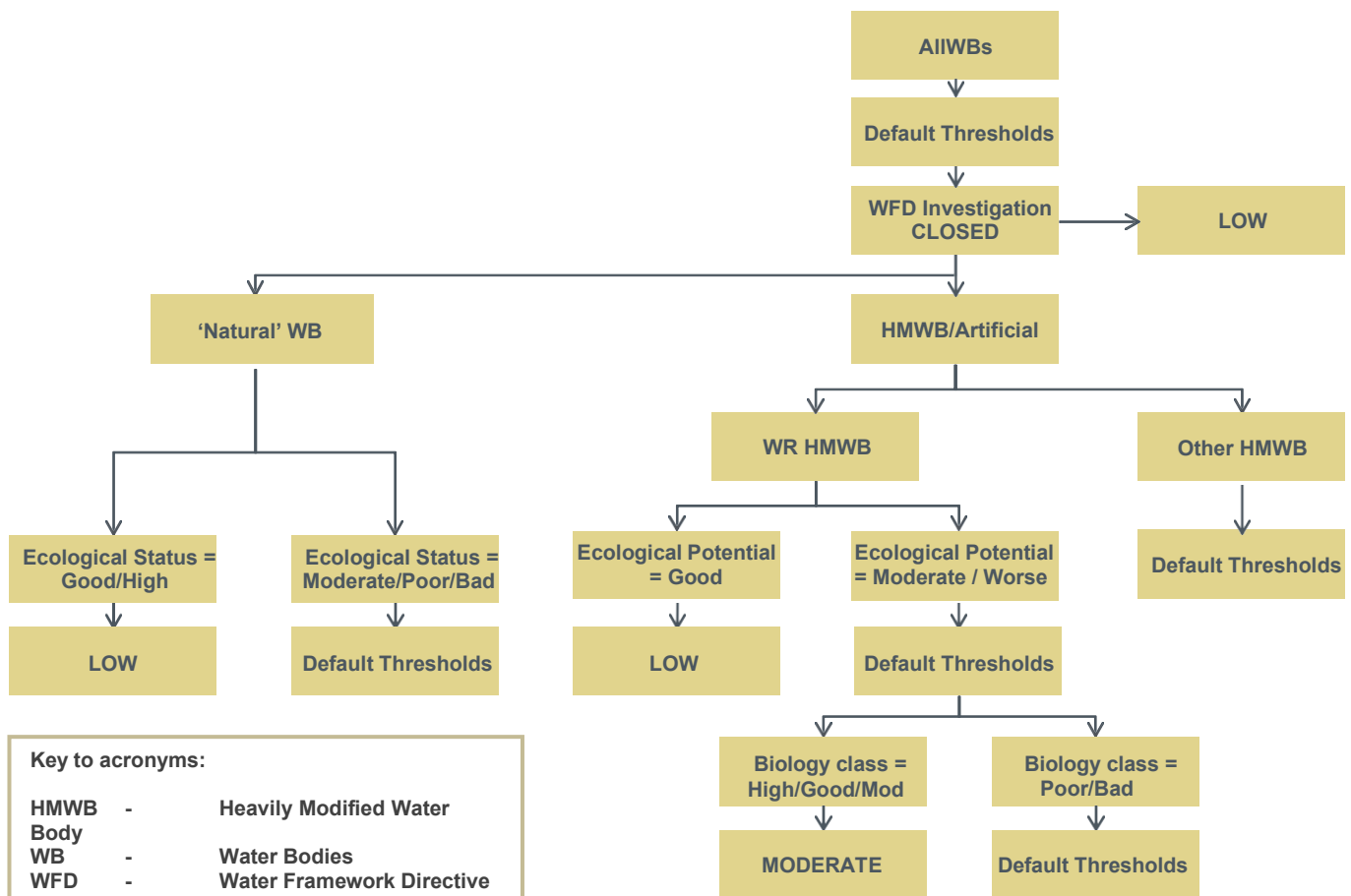
The overrides applied are:

- For all water bodies if the water body has been considered as part of the programme of water resources investigations under the Water Framework Directive (WFD) and the assessment has been closed, because no significant impact from water resources pressures on the environment has been determined, the default water stress result is overridden to Low.
- For natural water bodies, that is water bodies that are a slight variation from undisturbed natural conditions, if the WFD ecological status is Good or High, the default water stress result is overridden to Low.

For WFD Water Resources Heavily Modified Water Bodies (HMWBs), such as water bodies that have been significantly physically modified to support water supply or power generation:

- If appropriate mitigation measures are in place (Water body is achieving Good Ecological Potential (GEP)) the default water stress result is overridden to Low.
- If the biology classification is High, Good or Moderate, the default water stress result is overridden to Moderate (or remains at Low if already at Low water stress).

These overrides are summarised in Figure 3.



**Figure 3: Water Body Overrides Applied in ‘Default’ Catchments**

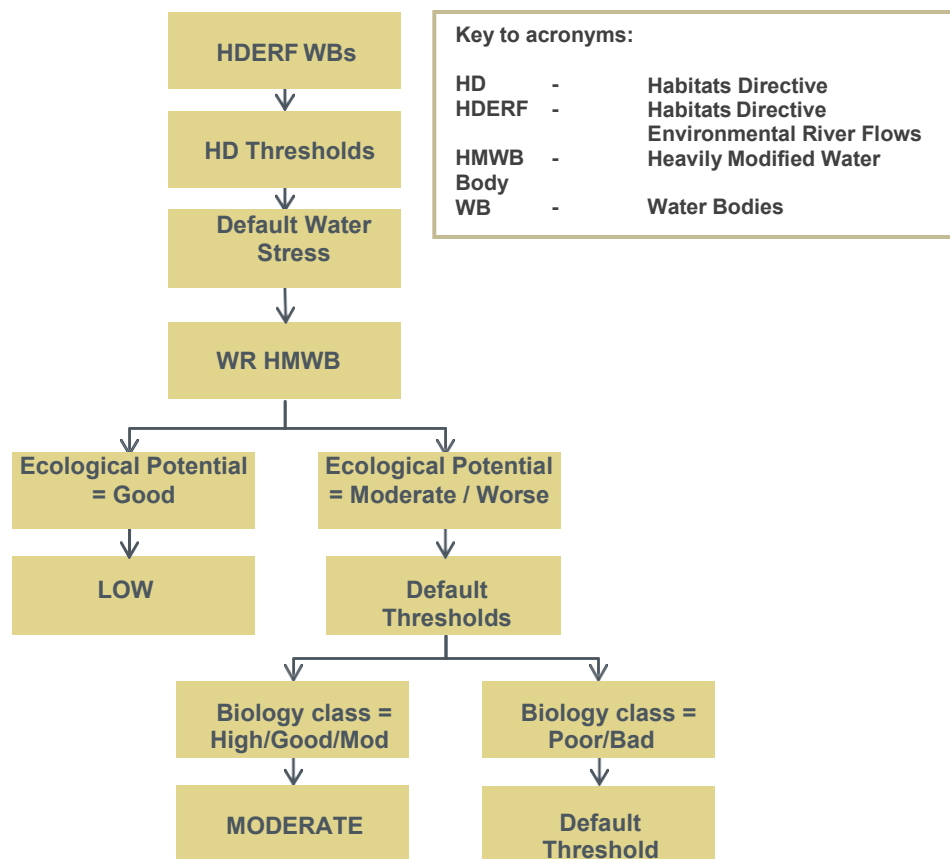
Subsets of these overrides were additionally applied in Habitats Directive (SAC rivers) catchments. The overrides applied are:

For WFD Water Resources Heavily Modified Water Bodies (HMWBs):

- If appropriate mitigation measures are in place (that is Good Ecological Potential) the default water stress result is overridden to Low.
- If the biology classification is High, Good or Moderate, the default water stress result is overridden to Moderate (or remains at Low if already at Low water stress).

The approach in these catchments excludes the override based on WFD ecological status, since these catchments are managed to deliver more stringent Habitats Directive environmental targets in addition to WFD objectives.

The overrides applied in Habitats Directive (SAC rivers) catchments where water resources are managed to a more protective environmental flow than that defined for the Water Framework Directive (WFD) are summarised in Figure 4.



**Figure 4: Water Body Overrides Applied in Habitats Directive (SAC) Catchments**

The application of these overrides to the default water stress result for each water body derives the final water stress result based on:

- The WEI+ index calculated at each of the four WRGIS flow percentiles.
- The combination of these four results into a default water stress category.
- The application of overrides to the default result.

## Step 5: Calculate future scenario water body results

Four scenarios, and the data sets behind them, representative of climate change and future demand in the 2050s, were selected from a previous Environment Agency study (Water in the 2050s. Environment Agency, 2011) to support the case for change in Defra’s Water White Paper (Water for Life. HM Government, 2011). The scenarios reflect the worst and best-case pressures on water resources from severe to moderate impacts of a changing climate and high and low water consumption, setting out the changes that could occur across the full range of scenarios.

The four future change scenarios applied are outlined in Table 4.

Scenario	Water consumption	Climate change impacts
1	High	Severe
2	High	Moderate
3	Low	Severe
4	Low	Moderate

**Table 4:** Future scenarios broken down by water consumption and climate change impact

Climate change and abstraction growth factors were applied to the WRGIS data for each water body. Steps 1 to 4 were undertaken for each of the four future scenarios, in addition to the current WRGIS database. The same WEI+ thresholds and overrides were applied in all scenarios.

## Step 6: Combine current and future water body results

The results for the current and four future scenarios were combined into a single overall result for each water body. To do this the Low, Moderate and Serious water stress result for each scenario were converted to a numerical score as shown in table 5.

Classification	Numerical score
Serious	3
Moderate	2
Low	1

**Table 5:** Numerical score attributed to water stress classification

The scores for each scenario were combined to an overall score to give a value between 3 and 9 using the equation:

$$\text{Overall Score} = (2 * \text{Current Scenario}) + \text{AVERAGE} (\text{Future Scenarios})$$

A double weighting was given to the current scenario due to its greater reliability compared to the uncertainty of future demand and climate change outlined in the four future scenarios. The overall score was converted to a final water body water stress category based on the thresholds in Table 6.

Classification	Score
Serious	Equal to or greater than 7
Moderate	Equal to or greater than 4
Low	Less than 4

**Table 6:** Thresholds used to combine current and future scenarios

The final water body stress classification at a water body scale can be seen in Figure 1.

## Step 7: Aggregate to water resource zone

The aggregation of water body results to water resource zones is based on the water stress results for those water bodies which have public water supply (PWS) abstractions that supply each zone. All of the PWS abstractions in the WRGIS database were assigned to resource zones.

### Override aggregation based on Restoring Sustainable Abstraction (RSA) investigation outcomes.

As with WFD investigations, if a licence has been investigated under the Restoring Sustainable Abstraction (RSA) programme and this investigation has been completed (either with no licence change or with an identified licence change), this indicates that the water resources issue associated with the licence has been investigated and that a solution is either in place or confirmed.

Since RSA investigations are focused on specific licences and are not mapped directly to specific water bodies, this override is applied to water company licences at the point of aggregation of water body results to resource zone results. The override for RSA investigations is:

- If an RSA investigation on the licence has been completed and the outcome determined that a definite sustainability reduction will be applied, the abstraction volume associated with this licence is aggregated as Low water stress, regardless of the water body results for the water bodies that the licence impacts.

### Calculate water resource zone water stress

The overall water stress result for each zone is calculated based on the percentage of recent actual abstraction by volume that impacts on water bodies categorised as Low, Moderate and Serious water stress.

The hierarchy of rules shown in Table 7 below was then used to determine the overall water stress result for each zone:

Classification	Water company resource zone classification
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<b>Serious</b>	If >25% by volume of the zone's supply is from water bodies under serious water stress
<b>Moderate</b>	If <25% by volume of the zone's supply is from water bodies under serious water stress or If >50% by volume of the supply is from water bodies under moderate water stress
<b>Low</b>	If none of the above conditions are met

**Table 7:** Water stress hierarchy to determine water stress for a water resource zone

#### Step 8: Aggregate to water company water stress

The final step in the methodology was to aggregate the individual resource zone results to each water company. This was done by calculating the total population served by resource zones categorised as Low, Moderate and Serious water stress. The percentage of the total population that is served from each water stress category was then used to determine the overall water company result based on the rules in Table 8 below.

Classification	Water company classification
<b>Serious</b>	If >20% of the water company population is served by resource zones that are classed as under serious stress
Not seriously stressed	If the above conditions do not apply

**Table 8:** Rules for aggregating water stress results at a water company level

**Note:** Following responses to our consultation response we have simplified the stress classification at the water company level to use only two levels of stress; 'seriously stressed' and 'not seriously stressed'.