Environmental Ambition Technical Note

Version D

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MOTT MACDONALD

Water Resources South East

Environmental ambition

Project:	WRSE Environmental ambition		
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Subject:	Sustainability reductions		

1 Introduction

Water Resources South East (WRSE) is undertaking a multi-sector, regional resilience plan to secure water supplies for the South East until 2100 while ensuring environmental resilience. Planning approaches have historically considered the environmental requirements as defined through the Water Industry National Environment Programme, but these only consider the following 5 to 15 years. In order to have a longer forecast for the environment, WRSE has committed to developing an 'over-arching environmental ambition' for the region that includes a holistic approach to environmental management.

The Environment Agency (EA) has recently completed a longer-term environmental water needs assessment as part of the Water Resources National Framework, establishing the potential licence reductions required by 2050 to meet the Environmental Flow Indicators (EFI) so that a good ecological status is achieved or maintained. The EFI is defined by an Abstraction Sensitivity Band (ASB) allocated to each waterbody. Four scenarios have been analysed:

- Business as usual (BAU): the same percentage of natural flows for the environment that currently applies continues for the future. Uneconomic waterbodies, where reducing abstraction would imply a significant investment, were initially discarded. However, an additional scenario (BAU+) including them has been subsequently incorporated.
- Enhance: a greater environmental protection for protected areas and Sites of Special Scientific Interest (SSSI) rivers and wetlands, principal salmon and chalk rivers is achieved by applying the most restrictive ASB.
- Adapt: same ASB as BAU but a recovery to a lower standard in some heavily modified waterbodies is assumed.
- Combine: balances a greater environmental protection for protected areas, SSSI rivers and wetlands and principal salmon and chalk rivers with a view that good status (as defined under the Water Framework Directive) cannot be achieved everywhere in a shifting climate. Hence, adopts the Enhance ASB with a lower recovery to the EFI in some heavily modified waterbodies.

In all cases, flow balance evolves as a proportion of natural flows as these are changed by the impacts of climate change.

Future predicted level of abstraction in 2050 for the different sectors as estimated by the EA is shown in Table 1.1. Power generation is the largest abstractor in the region. However, when consumptiveness is considered, public water supply would account for 92% of the total consumption.

Table 1.1: Distribution of licences and abstraction in Ml/d per sector in 2050

Sector	Licence	Abstraction	Consumption total	Consumption % of total
Power generation	29,190	10,680	13	0.4
Public water supply	8,028	5,108	3,287	91.8
Industry	4,499	2,747	79	2.2
Agriculture	1,893	1,489	68	1.9
Amenity/environmental	518	158	84	2.4
Other	67	49	48	1.4
Total	**44,194**	**20,231**	**3,580**	**100.0%**

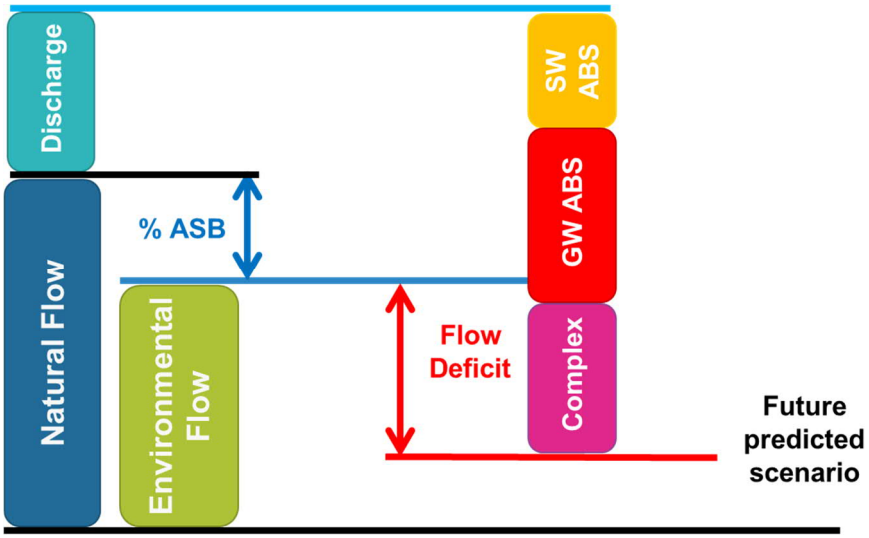
WRSE wishes to analyse the impact of the EA scenarios on the supply-demand balance of its water resources zones by establishing the potential changes in deployable output. This technical note presents the results of the analysis undertaken to feed into WRSE investment modelling.

2 Approach

In the Water Resources National Framework, the EA utilised a bespoke spreadsheet tool (Waterbody Abstraction Tool) to estimate the deficits in 2050 for each waterbody per scenario. The tool calculates the water balance at the outlet of each waterbody for four quantiles (Q30, Q50, Q70 and Q95) by (see Figure 2.1):

- Starting with the predicted natural flow in 2050 based on ensemble AFIXK of the Future Flows Hydrology project extrapolated to the outflow point of the integrated waterbodies in the WRGIS.
- Adding the future predicted discharge to each waterbody modifying the recent actual value with a growth factor based on water company demand projections.
- Subtracting the future predicted surface water abstractions based on the recent actual value with growth factors according to the sector.
- Subtracting the future predicted impact of groundwater abstractions based on the recent actual value with growth factors according to the sector, and the spatial and temporal impact factors included in WRGIS which have been calculated using regional groundwater models.
- Incorporating complex impacts associated with reservoirs, transfers or augmentation schemes.
- Comparing the resulting future predicted flow in the river with the EFI, the latter calculated by applying the maximum allowed abstraction as indicated in Table 2.1 with Abstraction Sensitivity Bands varying per scenario (see Figure 2.2 and Figure 2.3 showing how abstraction would be more restricted in the upper parts of the catchments)

Figure 2.1: Process to derive flow deficit for a certain quantile

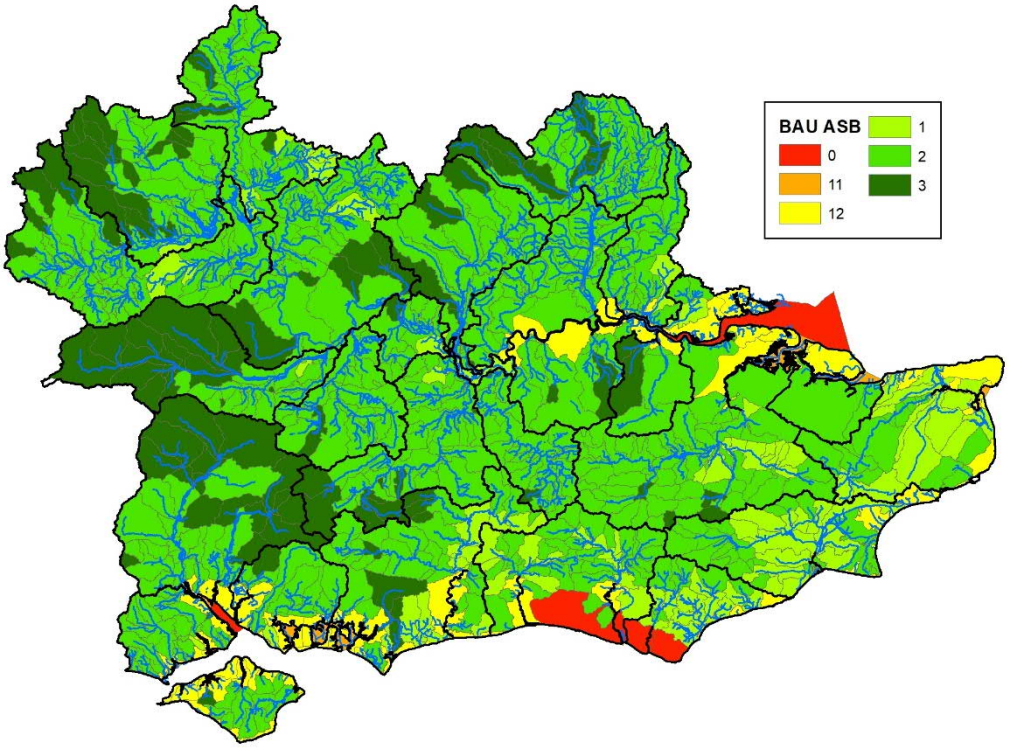


Source: Mott MacDonald

Table 2.1: Maximum allowable abstraction as a function of Abstraction Sensitivity Band

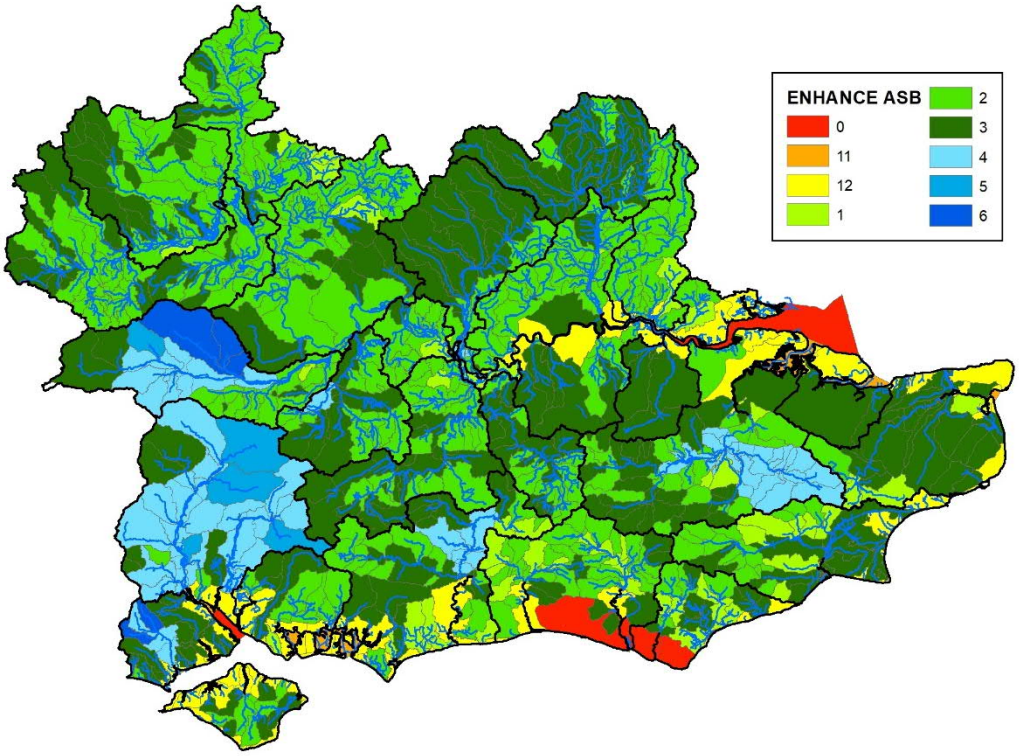
Flow quantile	Abstraction Sensitivity Band									
	0	11	12	13	1	2	3	4	5	6
Q30	100%	45%	40%	35%	30%	26%	24%	10%	15%	10%
Q50	100%	41%	36%	31%	26%	24%	20%	20%	15%	10%
Q70	100%	39%	34%	29%	24%	20%	15%	15%	10%	10%
Q95	100%	35%	30%	25%	20%	15%	10%	10%	5%	5%

Figure 2.2: Abstraction Sensitivity Bands for BAU scenario



Source: EA

Figure 2.3: Abstraction Sensitivity Bands for ENHANCE scenario



Source: EA

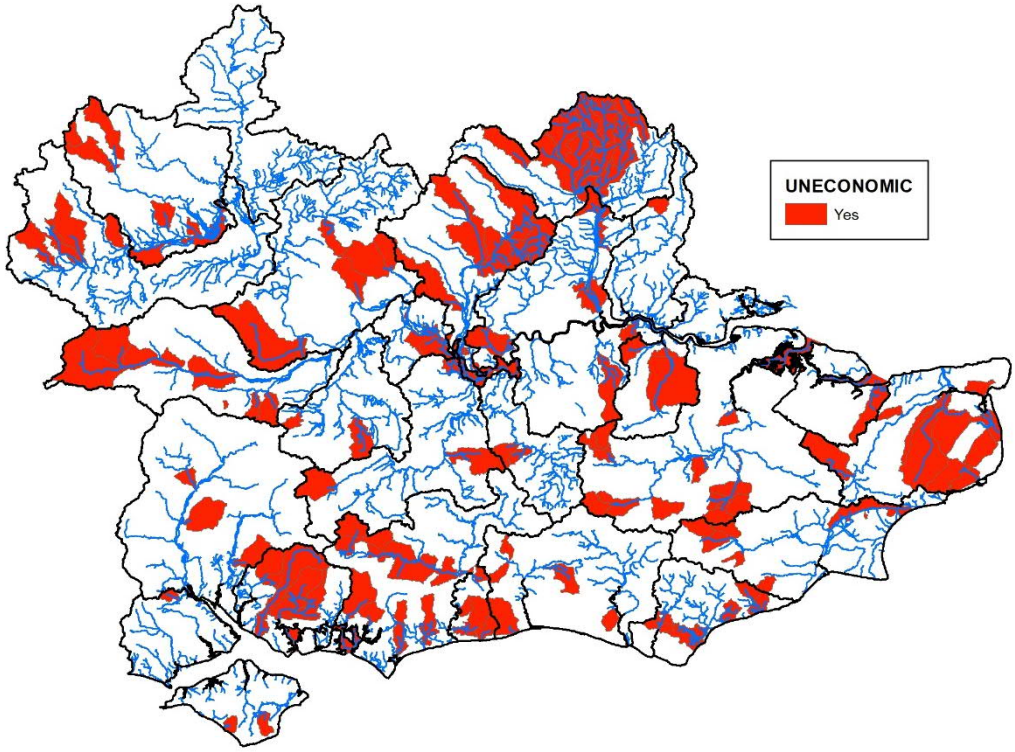
Data from the Waterbody Abstraction Tool has been transferred to a new spreadsheet tool designed to automatically derive the required sustainability reductions to remove the deficit at Q95 in 2050 in all waterbodies within the WRSE region. The logic for establishing the reductions needed has aimed to minimise the abstraction loss and hence the impact on deployable output (DO). It is as follows:

- Reductions are applied from top to bottom of each catchment so that upstream benefits (i.e. increases in river flows due to licence reductions) are considered downstream before applying the required reductions.
- Licences are reduced first to their future predicted abstraction rates as this would imply no loss of DO.
- Surface water licences are then reduced further, if existing, as they would impact DO less than reductions in groundwater licences given that availability of water for abstraction in rivers during a drought is not as guaranteed as in the case of aquifers. This reduction of abstraction from rivers during droughts is already accounted for in planning assumptions.
- Groundwater licences are subsequently reduced below future predicted abstraction rates starting from the ones that impact the deficit the most, because of either the spatial or temporal allocation of their impact.
- Licences with high consumptiveness are reduced next (licences with consumptiveness lower than 10% not adjusted).
- Licences located in the waterbody of analysis have priority in the reduction over others located upstream so as to minimise impact on DO. Thus, if for example two abstractions are causing a deficit in a certain waterbody X, one located in that waterbody X and another upstream in a different waterbody Y, and the upstream abstraction is not provoking a deficit in the waterbody Y it is located in, the reduction will be first applied to the abstraction in the waterbody X. Reducing the abstraction in waterbody Y would solve the problem in waterbody X as well but it would imply a surplus in waterbody Y.
- In equal conditions, smaller licences are reduced/removed first as they would be less economical to maintain.
- Sustainability reductions are applied at 5% steps and uniformly across the flow duration curve.

It is noted that:

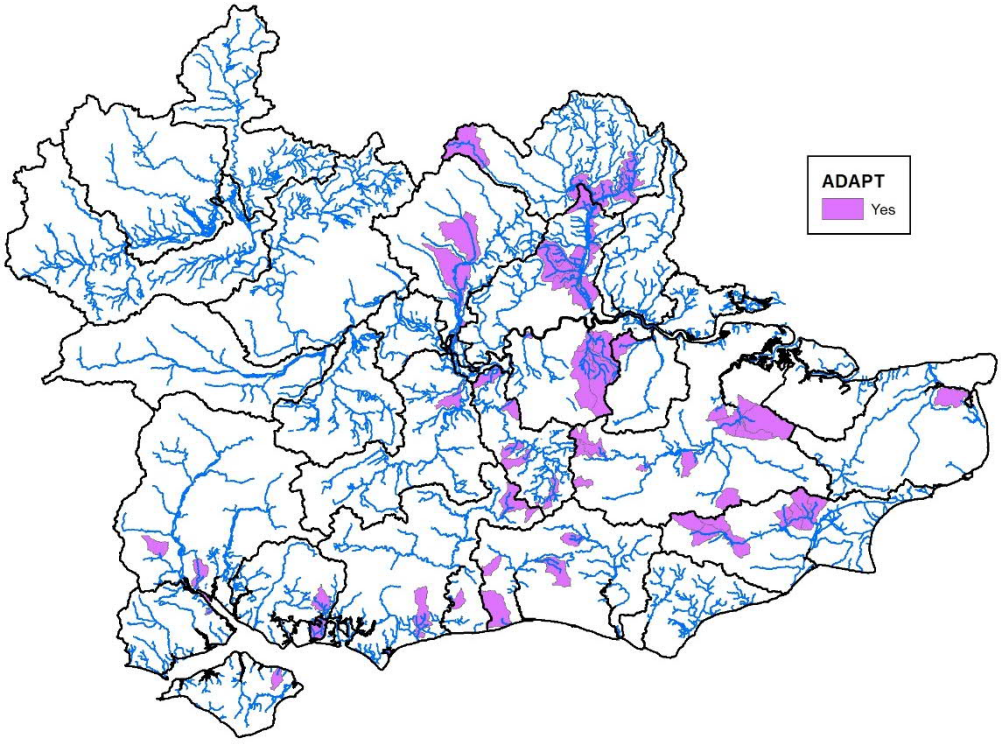
- In order to avoid PWS sustainability reductions impacting other sectors, the part of the Q95 deficit attributed to PWS abstractions was estimated and then used to derive PWS licence reductions.
- In the BAU scenario 189 waterbodies considered uneconomical were excluded from the analysis (see Figure 2.4)
- In the Adapt and Combine scenarios a 25% deficit over the EFI was allowed in 90 heavily modified waterbodies (see Figure 2.5)

Figure 2.4: Uneconomic waterbodies



Source: EA

Figure 2.5: Adapt waterbodies



Source: EA

3 Results

Table 3.1 presents the modelled reductions required in PWS licences to fulfil the objectives of the different EA scenarios. The largest reduction in abstraction corresponds to Thames Water followed by Affinity. Moving from the BAU scenario to the Enhance scenario would increase the reduction of abstraction required by 60% although there are differences between water companies, with Thames Water for instance only experiencing an increase of 14%.

Table 3.1: Required licence reductions in Ml/d by sector and scenario

Water company	Current licences	BAU	ADAPT	BAU+	COMBINE	ENHANCE
Affinity Water	988	-275	-421	-426	-504	-511
Portsmouth Water	302	-84	-133	-134	-142	-143
South East Water	825	-232	-376	-377	-416	-415
Southern Water	1179	-320	-640	-645	-694	-696
SES Water	402	-12	-99	-101	-99	-99
Thames Water	4190	-824	-878	-939	-960	-1019
Other	93	-17	-41	-42	-46	-47
Total	**7979**	**-1765**	**-2587**	**-2664**	**-2860**	**-2930**

4 Scenarios for investment model

The WRSE investment model requires DO values for different time horizons and scenarios for each water resource zone (WRZ) and return period, both for average and peak period. The EA methodology can only provide an estimated reduction of average abstraction derived from the calculated licence reduction and the future predicted abstraction. The impact on DO is likely to differ as:

- Surface water sources have Hands Off Flow conditions which would reduce the availability of water for abstraction during droughts beyond average low flow conditions,
- Storage can limit the effect of a reduced summer abstraction, or
- Groundwater sources can be operated at different rates seasonally within the annual licence.

Estimating the final impact of the modelled sustainability reductions on DO would require system simulation, with licences for each PWS source modified as established here. Likewise, the assessment undertaken following the EA approach relies on the accuracy of the prediction of future river flows as well as abstraction rates. To note, the assumptions adopted by the EA with regards to the impact of climate change and demand growth could be inconsistent with those adopted by WRSE, with an unknown impact on the results. Further work to review the methodology will be undertaken in collaboration with the EA and WRSE companies.

Based on their knowledge of the catchments, with regards the potential ecological benefit of sustainability reductions and their affordability assumptions, companies have developed two further scenarios to complement the existing five scenarios: Central and Alternative. These environmental ambition forecasts have been developed in liaison with local EA teams. In addition, companies have applied the licence reductions estimated for the EA scenarios to obtain the DO impact of some of their groundwater sources.

Four of the seven defined scenarios have been used in the WRSE investment modelling to date, to represent the range of potential future environmental ambitions: BAU+, Enhance, Central and Alternative. The adopted DO reductions for each of these four scenarios are shown in Table 4.1.

In order to develop the Central and Alternative scenarios, five of the six WRSE companies provided estimated DO losses in their WRZs. In the case of Affinity AZ3 and AZ5, the reductions incorporate some

estimates from Water Resources East (WRE), who have been undertaking a similar environmental ambition assessment. Central and Alternative scenarios for one company, Portsmouth Water, have been developed slightly differently, and represent a 50% reduction of the Adapt and BAU scenarios respectively.

Table 4.1: Adopted DO reductions per water resource zone in Ml/d

WRZ	BAU+	ENHANCE	CENTRAL	ALTERNATIVE
GUI	-11.0	-10.9	-4.5	-4.5
HAZ	-5.1	-5.1	-11.4	-11.4
HEN	-3.3	-3.3	0.0	0.0
HKZ	0.0	0.0	-2.9	-7.3
HRZ	0.0	0.0	0.0	-4.4
HSE	-22.3	-35.8	-60.0	-60.0
HSW	0.0	0.0	0.0	0.0
HWZ	0.0	0.0	-11.5	-21.4
IOW	-9.3	-11.1	-10.0	-15.3
KVZ	-9.1	-9.1	-7.3	-7.3
KME	-19.0	-19.4	-20.6	-19.4
KMW	-6.4	-8.9	0.0	-8.9
KTZ	-23.1	-29.6	-8.1	-29.6
LON	-433.5	-429.4	-22.7	-28.7
PRT	-42.1	-48.3	-21.0	-6.1
RZ1	-18.8	-19.3	-10.7	0.0
RZ2	-1.5	-1.9	-4.1	0.0
RZ3	-22.4	-22.5	-9.1	-3.6
RZ4	-16.7	-17.8	-24.9	-18.9
RZ5	-1.8	-2.6	-0.7	0.0
RZ6	-18.9	-19.7	-4.9	-2.4
RZ7	-6.0	-6.0	0.0	0.0
RZ8	-69.5	-72.2	-37.4	-18.7
SBZ	-25.3	-34.5	0.0	-15.7
SES	-12.3	-12.3	-11.5	-11.5
SHZ	0.0	0.0	0.0	0.0
SNZ	-23.1	-29.5	0.0	-2.4
SWZ	-7.9	-16.4	-1.5	-13.9
SWA	-12.0	-12.0	-9.7	-9.7
SWX	-16.8	-16.8	-11.7	-11.7
AZ1	-30.4	-33.4	-21.4	-21.4
AZ2	-89.5	-102.5	-69.5	-10.3
AZ3	-99.4	-102.4	-71.4	-71.4
AZ4	0.0	0.0	0.0	0.0
AZ5	-38.3	-39.3	-25.2	-25.2
AZ6	0.0	0.0	0.0	0.0
AZ7	-26.9	-31.5	-4.9	-4.9
Total	**-1121.4**	**--1203.3**	**-498.5**	**-465.8**

Note: Values for Southern Water WRZs correspond to 1:500yr

To further explore the investment scenarios so as to define robust adaptive pathways, the DO reductions for environmental ambition have been applied:

- To four time horizons – profiled assuming the reductions are realised in 2030, 2040, 2050 and 2060. Due to assumptions made around the wider environmental ambition decision making process, only the 2050 time horizon has been considered at this stage.
- To the average DO alone, or to the average and peak DO simultaneously, assuming in the latter that the ratio between the two is maintained.

Finally, it is important to highlight that the current analysis is necessarily simplified and conducted with the sole purpose of providing plausible possible scenarios with which to determine the preferred regional portfolio of options. More detailed investigations are needed before adopting the modelled reductions to confirm their effect on river flows, verify their ecological benefit, and establish their cost-effectiveness.

The iterative process for developing company environmental ambition forecasts is still evolving as WRSE work towards the draft regional plan. WRSE will continue to work with water companies and the EA to develop the most appropriate environmental ambition scenarios for the South East.

More information can be found in the WRSE Environmental ambition method statement