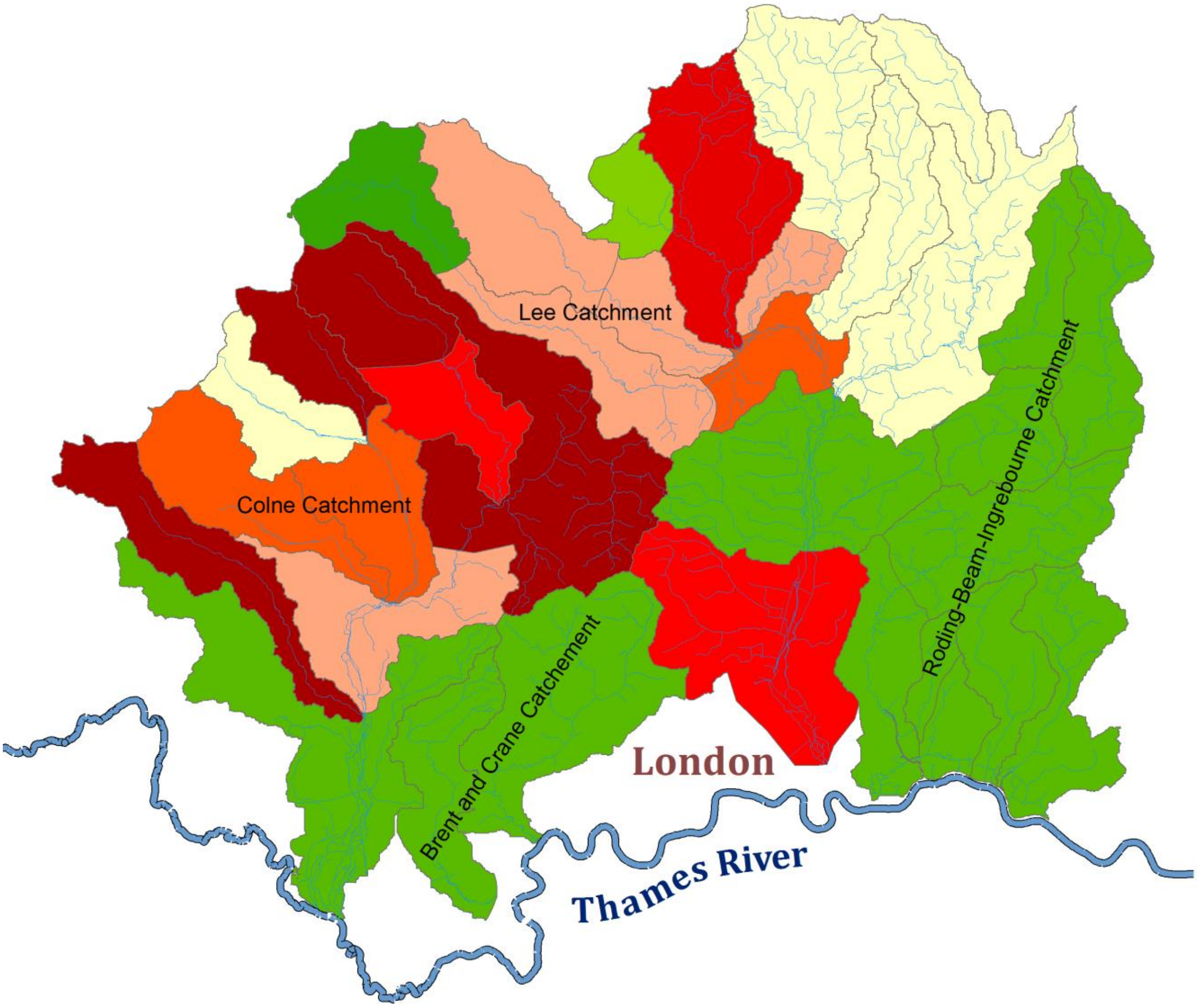

Water Footprint Assessment for the Hertfordshire and North London Area

(formerly South East Region North East Thames Area), Environment Agency, UK

Report – RESE000335

August 2014

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

Published by:

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Disclaimer

Foreword

Availability of water resources has become a key concern for the Environment Agency as population growth, changing lifestyle patterns, rapid urbanisation and industrialisation, and climate change place unprecedented pressure on limited water supplies. Water quality has suffered as industry, agriculture and households release pollutants into freshwater resources. In the context of these water challenges, there is an urgent need to review current water use and define new ways to sustainably manage our limited water resources.

The Hertfordshire and North London (HNL) Area of the Environment Agency (formerly SENET) consists of the Colne, Lee, Brent and Crane and Roding-Beam-Ingrebourne (RBI) catchments. The area is reliant on groundwater abstraction from the Chalk Aquifer for public water supply and river base flows. Abstraction impacts directly on our river flows, and groundwater resources are directly exposed to human activities, which can impact on water quality. Lack of sufficient water to absorb pollution pressures can deplete the water resources availability even further. Clear ways to explain the severity of water scarcity and pollution in the complex setting in HNL are needed.

The Water Footprint Network and Environment Agency joined together in a collaborative project to complete a Water Footprint Assessment of HNL Area. The aim of the project was to develop tools and provide results which would assist water resources and water quality regulators in managing the quantity and quality of water resources in a sustainable way and to broadly communicate the project and its outcomes to water resource regulators, stakeholders and the public.

This publication documents the Water Footprint Assessment results based on the Water Footprint Network's globally recognized methodology. This pioneering project built a comprehensive view of the amount of water consumed, water pollution, water scarcity and water pollution levels for both surface and groundwater across 35 sub-catchments within the HNL Area, supporting in a new way Integrated Water Resource Management. This work highlights the value of using Water Footprint Assessment to understand the mounting pressures on water resources, now and under climate change; it clearly demonstrates the way water consumption can contribute to poor water quality; and it confirms the critical nature of excessive water use and pollution within parts of HNL.

This collaborative project between the Water Footprint Network, a global multi-stakeholder initiative focusing on fair and smart water use of the world's freshwater resources, and the Environment Agency has provided valuable insights which can now be broadly shared. The Water Footprint Assessment brought new understanding of the local water resources under the existing regulations and could support joined water abstraction and water quality discharge consents. The results of this WFA can also be used for better communication of the issues of water scarcity and water pollution levels to water providers, water users and the public.

It is our hope that this project will inspire further use of Water Footprint Assessment within the Environment Agency and other regulators, by water users and stakeholders.

We hope you find this document of value.

Debbie Jones

Area Environment Manager

Hertfordshire and North London Area

Environment Agency

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Executive summary

Environment Agency (EA, UK) and the Water Footprint Network (WFN) undertook a collaborative project on the Water Footprint Assessment (WFA) of the South East Region, North East Thames Area (SENET), now Hertforshire and North London Area. The purpose of the study was to use WFA to elaborate the current status of water resources in the SENET Area and to provide insights into how water resource management could be improved. This pioneering project demonstrates the value of Water Footprint Assessment to water resource and water quality regulators.

The study covers a comprehensive Water Footprint Assessment for 35 sub-catchments of Colne, Lee, Brent and Crane, and Roding-Beam-Ingrebourne (RBI) catchments. The blue, green and grey water footprints on surface water and groundwater have been estimated for the domestic, industrial and agricultural sectors on a monthly basis for the baseline condition (average over 2002 – 2007). Blue water scarcity (BWS) and water pollution level (WPL) were evaluated to assess the sustainability of the blue and grey water footprint (respectively). A 'wet' and 'dry' climate change scenario for 2060 was used to estimate the projected blue, green and grey water footprints and the blue water scarcity of each sub-catchment.

Water Footprint Assessment results

Baseline water footprint

- **Blue water footprint** - Under the baseline condition, the blue water footprint of all sub-catchments in the study area sums up to 105 mm/year, about 54 % of the total effective rainfall (193 mm/year). The domestic sector is by far the largest water consumer. Groundwater abstraction accounts for approximately 55% of the total blue water footprint in the area. Ninety-five percent of the total blue water footprint is due to water transfer through sewerage systems within and beyond the study area.
- **Green water footprint** - Five major crops (wheat, barley, potatoes, sugar beet and rapeseed) cultivated in the study area were taken into account in the estimation of crop water consumption. The baseline green water footprint in the study area is 70 mm/year. The upstream sub-catchments of the study area, with more extensive agricultural lands, have a larger green water footprint than downstream sub-catchments which tend to be more urbanised.
- **Grey water footprint** - The total grey water footprint is 428 mm/year of which 30% is resulting from the point-source pollution on surface water, 48% from the point-source pollution on groundwater, and 22% from diffuse (non-point) sources, i.e. fertiliser leaching.

  The grey water footprint resulting from point-source pollution is mostly due to the release of nutrients (phosphorous and nitrogen) in the treated sewage effluent. The largest grey water footprints occur in sub-catchments where large scale and/or a high concentration of sewage treatment works are located, and when large amounts of effluent are discharged into ground and groundwater. Large grey water footprints resulting from diffuse pollution generally occur from the farm lands in the upstream sub-catchments.

Baseline water footprint sustainability

- **Blue water scarcity** – Forty-three percent of the SENET sub-catchments, mostly the Colne and Lee sub-catchments, experience moderate to severe overall blue water scarcity with their upstream sub-catchments experiencing the most severe blue water scarcity. Blue water scarcity is strongly related to the transfer of water through sewage treatment works from one sub-catchment to another with water-losing sub-catchments experiencing a higher degree of scarcity. About 51% of the SENET sub-catchments, mostly the Colne and Lee sub-catchments, have significant or severe annual average blue groundwater scarcity. Roding-Beam-Ingrebourne (RBI) catchment experiences low blue water scarcity for both surface and groundwater.

- **Water pollution level** – Thirty-four percent of the SENET sub-catchments have an annual average surface water pollution level at a significant or severe level. The primary contribution to water pollution levels is coming from the discharge of treated effluent from sewage treatment works. Three sub-catchments have a significant or severe annual average groundwater pollution level, largely due to the recharge or infiltration of treated effluent with high loads of ammonia-nitrogen.

Water footprint projection

- The 2060 projected blue water footprint increases as much as 25% compared to the baseline blue water footprint. The projected green water footprint is in average 14% lower than the baseline green water footprint, mainly due to the reduction in rainfall. The projected total grey water footprint is approximately 7% higher than the baseline total grey water footprint.
- With the “dry” climate scenario, the projected overall blue water scarcity becomes more severe across the entire study area. Even with the “wet” climate scenario, the overall blue water scarcity intensifies when compared with the baseline condition.

Key learning

- WFA can be used to integrate water quantity and quality aspects in water resources assessment, planning and management.
- The blue water footprint and blue water scarcity in the SENET catchments are highly influenced by the water transfer between sub-catchments through sewage treatment works.
- The grey water footprint is an indicator of water pollution based on the load of pollutants and the pollution assimilation capacity consumed. The results of grey water footprint highlights limitations of the current system of effluent discharge permits, which is based on pollutant concentration, in protecting water quality.
- The practice of injecting treated effluent into aquifers contributes significantly to the grey groundwater footprint and high groundwater water pollution levels. Such practices thus need to be revisited.
- Conducting a WFA at a fine scale (35 sub-catchments) for surface and groundwater explicitly shows the variations of water consumption and pollution in space and time and presents clear evidence of the relationship between water quantity and water quality, forming a basis for integrated water resource management.
- The water resources in the SENET Area need to be managed in a more sustainable way. Unless action is taken, future climate and water demand changes will exacerbate unsustainable water scarcity and water pollution levels.

Recommendations

WFA and in particular blue water scarcity and water pollution levels can form a basis for regulatory reform for water resource management. Levels of blue water scarcity in sub-catchments can inform decisions on granting water abstraction licenses. The regulatory framework for effluent discharge would be improved if it was formulated around the grey water footprint, in addition to concentration standards, for both point and diffuse source pollution and water pollution levels as this would provide stronger protection of water quality. A draft approach to this regulatory reform is presented in this report. Water management practices such as water transfers between sub-catchments and aquifer recharge will need to be re-evaluated based on this study and in light of future climate and demand changes. The results of this WFA and future elaborations can be used to open up the dialogue between regulators, water utilities and water users, providing fresh insights and creating new opportunities for understanding how water resources in the SENET area can be managed sustainably now and into the future.

Next steps

The value of WFA within the regulatory context has been clearly demonstrated through this study and additional steps should be taken to build on this initial work.

- Conduct further study on a new abstraction licensing and discharge permitting system based on WFA and integrate WFA into the implementation of the Water Framework Directive (WFD) and the Restoring Sustainable Abstraction (RSA) programme.
- Replicate WFA in all management Areas of the Environment Agency. Establish water consumption and pollution benchmarks per sector and water footprint caps per catchment to drive water use efficiency, wastewater treatment enhancement, and better water allocation to ensure that water consumption and pollution remain below the maximum sustainable level.
- Invest in improving data used in WFA and establish a catchment-scale water footprint database, e.g., update current water availability and water scarcity maps, research on groundwater sustainable yield, groundwater flows and aquifer properties, and identify methods for assessing non-point (diffuse) source pollution from impermeable surfaces such as urban areas and roads. A catchment-scale water footprint database can be an integrated element in the future update of the Catchment Abstraction Management Strategies (CAMS).

Contents

1. Introduction

1.1. Background

Changes in the environment (e.g. climate, land-use) and society (e.g. population and lifestyle), and the interactions between them are increasing the pressure on water resources and water management systems in the South East of England. The way water abstraction is currently managed is not responsive or flexible enough to address these future pressures (Environment Agency and Ofwat, 2011). The cost of abstraction licenses does not reflect the relative scarcity or abundance of water, and charges do not vary to reflect competing demands for water (Defra, 2011). Increased environmental awareness, combined with concerns about the effect of the 1995-96 drought, led the Government to review water abstraction management. It found gaps in the regulation of abstraction and impoundments and recommended changes to the management of water abstraction. Many of these recommendations were accommodated within the Water Act 2003. To deliver a more sustainable water resource management regime, the Government has therefore committed to reforming the abstraction management regime. The Environment Agency (EA) and Ofwat support the proposals set out in Defra's Water White Paper (Defra, 2011) and look forward to continuing to work with Government towards a more sustainable future (Environment Agency and Ofwat, 2011). To assist the Government in reforming water resources and abstraction management in England and Wales, it is advisable to look at water consumption and pollution in addition to water abstraction. Water Footprint Assessment (WFA) can serve this purpose since it takes a comprehensive approach to assessing the effects of human appropriation of freshwater systems by linking human consumption to water issues such as water shortages and pollution. A WFA can build understanding of the interconnection between water availability, water supply and water use and provide insight into the efficiency and sustainability of water use. With an understanding that water scarcity related to water abstraction is prevalent in the North East Thames Area[1], the EA in North East Thames Area sought a partnership with the Water Footprint Network (WFN) to carry out a WFA study for the South East Region North East Thames Area (SENET) only, to help improve the EA's management of SENET water resources.

This is a pioneering project in the field of Water Footprint Assessment on the catchment scale in a regulatory context. The study deals with a high level of complexity in a number of aspects: 1) high spatial and temporal resolution (namely sub-catchment level and monthly time scale); 2) multiple water use sectors (industry, domestic and agriculture); 3) different sources of water (surface and groundwater) for human use; 4) different types of human pressure on water resources (water consumption and pollution); 5) integrated assessment of water use sustainability (water scarcity and water pollution level); and 6) projected changes under 2060 water demand and climate change for a "wet" and "dry" scenario.

This WFA study includes four catchments: Colne Catchment, Brent and Crane (or North London) Catchment, Lee Catchment and Roding-Beam-Ingrebourne (RBI) Catchment. The sub-catchment delineation is in agreement with the Catchment Abstraction Management Strategy (CAMS) Assessment Points (AP) (Environmental Agency, 2009; 2010a; 2010b; 2011). The WFA links water consumption to water availability and identifies environmental hotspot (scarcity and pollution) sub-catchments. By holistically taking into account both water quantity and water quality it provides supporting evidence for how and where to protect and improve inland freshwater resources and ecosystems.

[1] Per 1 April 2014, "North East Thames Area" has changed to "Hertfordshire and North London Area".

1.2. Objectives and scope

The objectives of the project are to:

- develop and carry out WFA on a catchment scale for SENET and pave the way for water resources regulators to benefit and use developed tools and outcomes;
- understand where and how sectors use water within the SENET area (the term “SENET catchments” is interchangeably used throughout the report) and establish where pressures are mounting for public and business use and environment;
- calculate and map the blue water footprint, blue water availability and blue water scarcity for each sub-catchment (CAMS Assessment Point);
- communicate the WFA method and outcomes to water resource managers, stakeholders and public (both globally by WFN and locally by EA) and to other EA Areas within UK.

The study covers a WFA for the northern part of Thames River Basin consisting of 35 sub-catchments, corresponding to the 35 CAMS Assessment Points (for the sake of brevity, “AP” is used interchangeably with “sub-catchment” throughout the report). Of the 35 APs, 10 APs are in Colne Catchment, two in Brent and Crane Catchment, 15 in Lee catchment and 8 in RBI Catchment as shown in Figure 1.

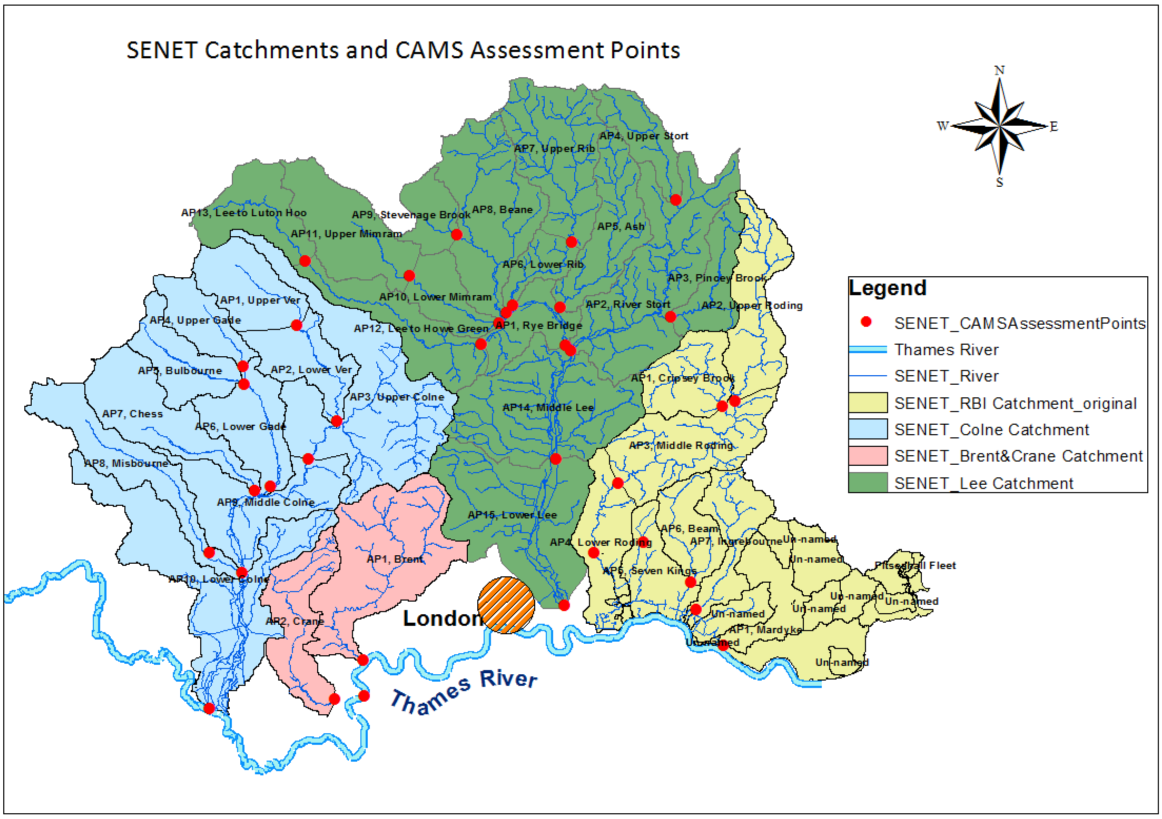

Figure 1. SENET catchments, sub-catchments and the CAMS Assessment Points.

The study area covers ca. 3,200 km^2. It is densely populated with over 6.5 million inhabitants. It is heavily urbanised in the south while the Home Counties have more rural land use (arable and grazing) with large towns. Total water abstraction is over 500 million m^3/year, mainly for public water supply. Less than 10% of the abstraction is for agriculture.

The study covers:

- water footprint accounting for the 35 APs, including blue, green and grey water footprint components with the baseline (current situation: 1999 -2007) water resources conditions;

- water footprint sustainability assessment for the 35 APs - blue water availability, blue water scarcity and water pollution level for both surface water and groundwater;
- water footprint and sustainability projection with climate change and water demand scenarios (2060); and
- recommendations for response strategies for water resources management using the WFA findings.

1.3. This report

This report documents the output of the full scope of this WFA study: baseline water footprint accounting, blue water scarcity and water pollution level assessment, projection of the WF and blue water scarcity with the climate change and future water abstraction scenarios for the 35 sub-catchments in the SENET. Chapter 1 introduces the project with the background, objective and scope of the study. Chapter 2 describes the water footprint concept and the Water Footprint Assessment approach in brief, followed by the description on the methods for water footprint accounting, water footprint sustainability assessment and the approaches and key assumptions applied in this study. Chapter 3 presents the results and findings of this Water Footprint Assessment study. Chapter 4 summarises the conclusions followed by recommendations for water footprint response strategies in Chapter 5.

2. Method and data

2.1. Water Footprint Assessment

This study follows the general methodology for Water Footprint Assessment described in the Global Water Footprint Assessment Standard as developed by WFN (Hoekstra et al., 2011). The water footprint (WF) is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer (Hoekstra et al. 2011). The WF of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in terms of water volumes consumed (evaporated) and/or polluted per unit of time. A WF can be calculated for a particular product, or any well-defined group of consumers (e.g. an individual, family, village, city, province, state or nation) or producers (e.g. a public organization, private enterprise or economic sector), or for a geographically delineated area (e.g. a river catchment). The WF is a geographically and temporally explicit indicator, showing not only the volumes of the consumptive water use and pollution, but also the locations and time. The WF is a more comprehensive indicator of freshwater resources appropriation, in contrast to the traditional measure of water withdrawal (Figure 2). This study focused on the water footprint within SENET catchment area (see Section 2.2.2) while the water footprint of the catchments from the consumption perspective was preliminarily assessed (Section 3.4).

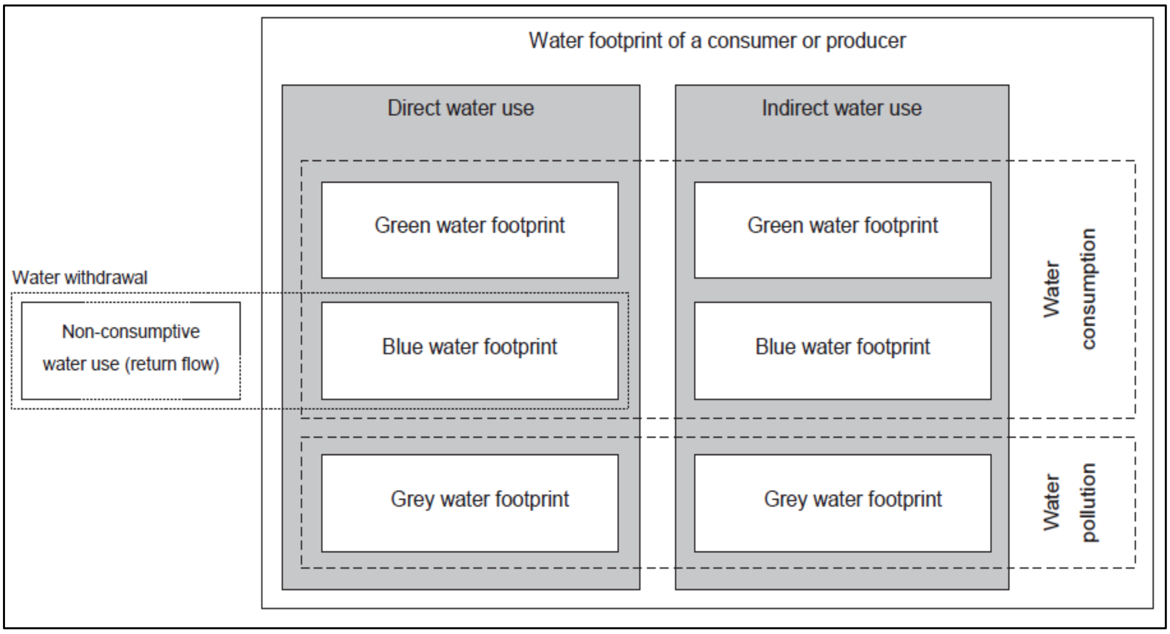

Figure 2. Schematic representation of the components of a water footprint (Hoekstra et al., 2011).

As shown in the above figure, a WF consists of three components: green WF, blue WF and grey WF.

The blue WF measures consumptive use of fresh surface and / or groundwater, the so-called blue water. The term ‘consumptive water use’ refers to one of the following four cases: 1) water evaporates; 2) water is incorporated into the product; 3) water does not return to the same catchment area, for example, it is returned to another catchment area or the sea; 4) water does not return in the same period, for example, it is withdrawn in a scarce period and returned in a wet period.

The green WF quantifies the human consumption of the so-called green water. Green water is the part of the precipitation stored in the soil or which temporarily stays on top of the soil or vegetation. The green WF is particularly relevant for agricultural and forestry products (products based on crops or wood). It refers to the total rainwater evapotranspiration (from fields and plantations) plus the water incorporated into the harvested crop or wood.

The grey WF indicates the volume of freshwater that is required to assimilate the load of pollutants based on natural background concentrations and existing ambient water quality standards.

2.2. Four phases of Water Footprint Assessment

Water Footprint Assessment is a four-phase process (Figure 3) which uses the WF accounting described above to answer specific questions of interest including, is the WF sustainable and, if not, how can possible response strategies be evaluated? The WFA places the WF within the context of the location of the water use. The four phases of the WFA are: 1) setting goals and scope, 2) WF accounting, 3) WF sustainability assessment, and 4) WF response strategies.

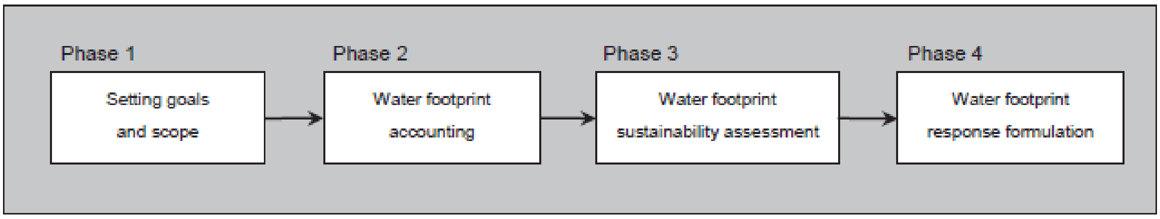

Figure 3. Four distinct phases in Water Footprint Assessment (Hoekstra et al., 2011).

2.2.1. Water footprint accounting

The blue WF of a process, WF_{proc_blue} (volume/time), is an indicator of consumptive use of blue water, namely, the fresh surface water or groundwater. The blue WF of a process step is calculated as:

$$WF_{proc\_blue} = BlueWaterEvaporation + BlueWaterIncorporation + LostReturnflow \qquad (1)$$

When surface water and groundwater are to be distinguished in blue WF quantification, the above equation can be rewritten as:

$$WF_{proc\_blue\_surf} = BlueSurfWaterEvaporation + BlueSurfWaterIncorporation + LostReturnflow \qquad (2)$$

$$WF_{proc\_blue\_ground} = BlueGroundWaterEvaporation + BlueGroundWaterIncorporation + GrWaterAbstrToSurfNotReturn \qquad (3)$$

Where $WF_{proc\_blue\_surf}$ and $WF_{proc\_blue\_ground}$ are the blue surface WF and blue groundwater footprint, respectively. *BlueSurfWaterEvaporation* is (blue) surface water evaporation; *BlueSurfWaterIncorporation* is (blue) *surface* water incorporated into the product; *LostReturnflow* is the amount of water after use which does not return to the same catchment in the same period of the water abstraction.

Similarly, *BlueGroundWaterEvaporation* and *BlueGroundWaterIncorporation* refer to the (blue) groundwater evaporation and the amount of groundwater incorporated into the product during the process, respectively. *GrWaterAbstrToSurfNotReturn* is an estimate of the amount of groundwater which does not recharge into the same groundwater system, and/or within the same period under study after abstraction.

The green WF of a process, WF_{pro_green} (volume/time), refers to the total evapotranspiration (*GreenWaterEvaporation*) of rainwater stored in soil plus the water incorporated into the harvested crop or wood (*GreenWaterIncorporation*). The green WF of a process step is calculated by:

$$WF_{proc\_green} = GreenWaterEvaporation + GreenWaterIncorporation \qquad (4)$$

The grey WF of a process, WF_{proc_grey} (volume/time), is calculated by:

$$\mathrm{WF}_{\mathrm{proc\_grey}} = \frac{\mathrm{L}}{c_{\mathrm{max}} - c_{\mathrm{nat}}} \qquad (5)$$

where L (mass/time) is the load of the pollutant under study; c_{max} (mass/volume) is the maximum acceptable concentration specified by the ambient water quality standard in consideration, and c_{nat} (mass/volume) is the natural background concentration of that pollutant in the receiving water body.

In the case of point sources of water pollution, i.e., when pollutants are directly released into a surface water body in the form of a treated or non-treated wastewater disposal, the grey WF can be estimated by:

$$\mathrm{WF}_{\mathrm{proc\_grey\_point}} = \frac{\mathrm{Effl} \cdot c_{\mathrm{effl}} - \mathrm{Abstr} \cdot c_{\mathrm{act}}}{c_{\mathrm{max}} - c_{\mathrm{nat}}} \qquad (6)$$

where *Effl* (volume/time) is the discharge rate of effluent while *Abstr* (volume/time) is the abstraction rate. c_{effl} and c_{act} are the concentrations of the pollutant under study in the effluent and in the source water of abstraction, respectively.

In the case of diffuse source pollution, the grey water footprint is estimated using

$$\mathrm{WF}_{\mathrm{proc\_grey\_diffuse}} = \frac{\alpha \cdot \mathrm{Appl}}{c_{\max} - c_{\mathrm{nat}}} \qquad (7)$$

where α is the leaching-run-off fraction. It represents the fraction of applied chemicals (e.g. fertiliser) on land eventually reaching freshwater bodies after land-soil-water interactions. *Appl* (mass/time/area) is the application of the chemicals on land or into the soil.

The above equations for grey WF can also be applied to groundwater. In such a case, the groundwater quality standards should be used in determining c_{max}, c_{act} and c_{nat} related to the groundwater system in question.

2.2.2. Water footprint within a catchment

In calculating the WF for a geographic area or a hydrological unit such as a sub-catchment, catchment or river basin, all of the processes that are conducted in that hydrological unit will be cumulatively added to determine the total WF for that hydrological unit.

The WF within a catchment (or any geographically delineated area), WF_{area} (volume/time), is calculated as the sum of the process WFs of all water using processes in the area:

$$\mathrm{WF}_{\mathrm{area}} = \sum_i \mathrm{WF}_{\mathrm{proc}}[i] \qquad (8)$$

where WF_{proc} *[i]* (volume/time) refers to the WF of a process *i* within the catchment (area). The equation sums all water-consuming or polluting processes taking place in the area.

2.2.3. Water footprint sustainability assessment

Sustainability of a WF can be assessed from an environmental, social and economic perspective. When assessing the WF sustainability, sustainability indicators and the criteria for the assessment need to be established. Blue water scarcity (BWS) and water pollution level (WPL), which are related to blue WF and grey WF, respectively, are the environmental sustainability indicators commonly applied in WFA.

Blue water scarcity

BWS in a catchment is defined as the ratio of the total of blue WF in the catchment to the blue water availability of the catchment (Hoekstra et al., 2011). It is expressed by:

$$\mathrm{WS}_{\mathrm{blue}}[x,t] = \frac{\sum \mathrm{WF}_{\mathrm{blue}}[x,t]}{\mathrm{WA}_{\mathrm{blue}}[x,t]} \qquad (9)$$

where WS_{blue} is the BWS in a catchment x in a certain period t, ΣWF_{blue} is the total blue water footprint in the catchment in that period, and WA_{blue} is the blue water availability.

The blue water availability (WA_{blue}) in a catchment x in a certain period t is quantified by the difference between the natural run-off in the catchment and the environmental flow requirement (EFR), which can be expressed by:

$$\mathrm{WA}_{\mathrm{blue}}[x,t] = \mathrm{R}_{\mathrm{nat}}[x,t] - \mathrm{EFR}[x,t] \qquad (10)$$

where R_{nat} is the natural run-off of the catchment in the period under study.

The above equations for sustainability assessment are in a general form when surface and groundwater are not distinguished within the “blue water” context. However, when evaluating water availability and scarcity for surface water and groundwater separately, the above two equations need to modified for the groundwater case.

In this study, Equation 9 will be applied in assessing the overall blue water scarcity that includes the effect of both surface water footprint and groundwater footprint on the total water availability.

Blue groundwater availability and scarcity

Blue groundwater availability can be approximated by the sustainable yield. The sustainable yield has been discussed and elaborated in a range of studies (e.g. Sophocleous, 2000; Alley and Leake, 2004; Kalf and Woolley, 2005). The sustainable yield concept has evolved from the safe yield concept. However, there is not yet a common consensus on one definition of the sustainable yield. Nevertheless, it is generally regarded as the amount of groundwater that could be abstracted without exceeding the natural recharge or harming the groundwater system from environmental, economic, or social considerations in a long-term perspective (e.g. Alley et al., 1999; Zhou, 2009). Therefore, the blue groundwater water availability is defined as:

$$WA_{blue\_ground}[x,t]=P_s[x,t] \tag{11}$$

in which

$$P_s[x,t]=R_{sn}[x,t]-O_{env}[x,t] \tag{12}$$

where WA_{blue_ground} (volume/time) is the blue groundwater availability in a catchment x in a certain period t; P_s (volume/time) is the sustainable groundwater yield; R_{sn} (volume/time) is the sustainable natural recharge, which is the sum of natural recharge and the increased recharge induced by abstraction (groundwater pumping). O_{env} (volume/time) is the residual discharge or outflow. Both R_{sn} and O_{env} in the context of "sustainable groundwater development" should take the ecological or environmental requirements into account when they are estimated. One can refer to Kalf and Woolley (2005) and Zhou (2009) for a more comprehensive description on the sustainable yield and groundwater sustainability.

The blue groundwater scarcity WS_{blue_ground} [-] is defined as the ratio of the total of blue groundwater water footprints, ΣWF_{blue_ground}, to the blue groundwater water availability in the catchment, which is described as

$$WS_{blue\_ground}[x,t]=\frac{\sum WF_{blue\_ground}[x,t]}{WA_{blue\_ground}[x,t]} \tag{13}$$

Water pollution level

Water pollution level (WPL) is defined as the fraction of the waste assimilation capacity consumed. For a WPL of surface water, $WPL_{surf}[x,t]$, it is calculated by taking the ratio of the total grey water footprints on surface water (WF_{grey_surf}) in a catchment to the actual runoff (R_{act}) of that catchment.

$$WPL_{surf}[x,t]=\frac{\sum WF_{grey\_surf}[x,t]}{R_{act}[x,t]} \tag{14}$$

When evaluating the WPL for groundwater, it can be represented by

$$WPL_{ground}[x,t]=\frac{\sum WF_{grey\_ground}[x,t]}{G_{act}[x,t]} \tag{15}$$

where WPL_{ground} (volume/time) is the groundwater WPL in a catchment x in a certain period t; WF_{grey_ground} is the groundwater grey WF in catchment x in the time t; G_{act} is the actual groundwater flow of the catchment x at the time t.

In the study, WF sustainability assessment was carried out using BWS and WPL and WF hotspots were identified. Hotspots are the areas (APs in this case) where the blue WF of the AP is larger than the blue water availability of the AP and/or the grey WF of the AP exceeds the assimilation capacity for water pollution of the AP, therefore indicating that the blue WF and/or the grey WF are unsustainable, respectively.

2.2.4. Water footprint response strategy

Based on the findings of this study, particularly the WF hotspot identification regarding BWS and WPL, suggestions and recommendations will be put forward. The suggestions are made to feed the discussion on visioning and strategising the water resources and abstraction management in the study area and even the whole EA management domain.

2.3. Data

The data used in this study were obtained from various sources. The data content and sources are summarised in Table A1 in the Annex.

2.3.1. Catchment and sub-catchment delineation

The study covers Colne Catchment, Brent and Crane (North London) Catchment, Lee Catchment and RBI Catchment. The delineation of these catchments follows closely the delineation of CAMS studies except for RBI Catchment (Figure 1). In accordance with recommendations from the EA project team, several changes in the delineation of the downstream APs of RBI Catchment to account for the complex flow network and water management practice in that region have been made (See Figure 4 and Figure 5).

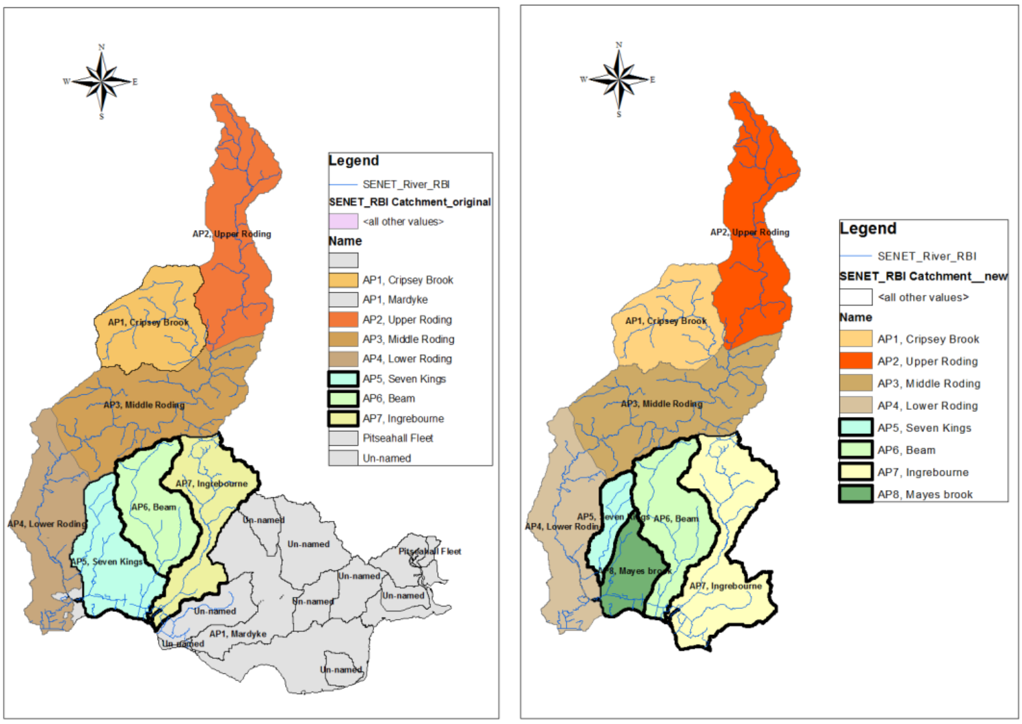

Figure 4. Re-delineation of the sub-catchments (APs) of the downstream area of RBI catchment (left: original delineation; right: re-delineation).

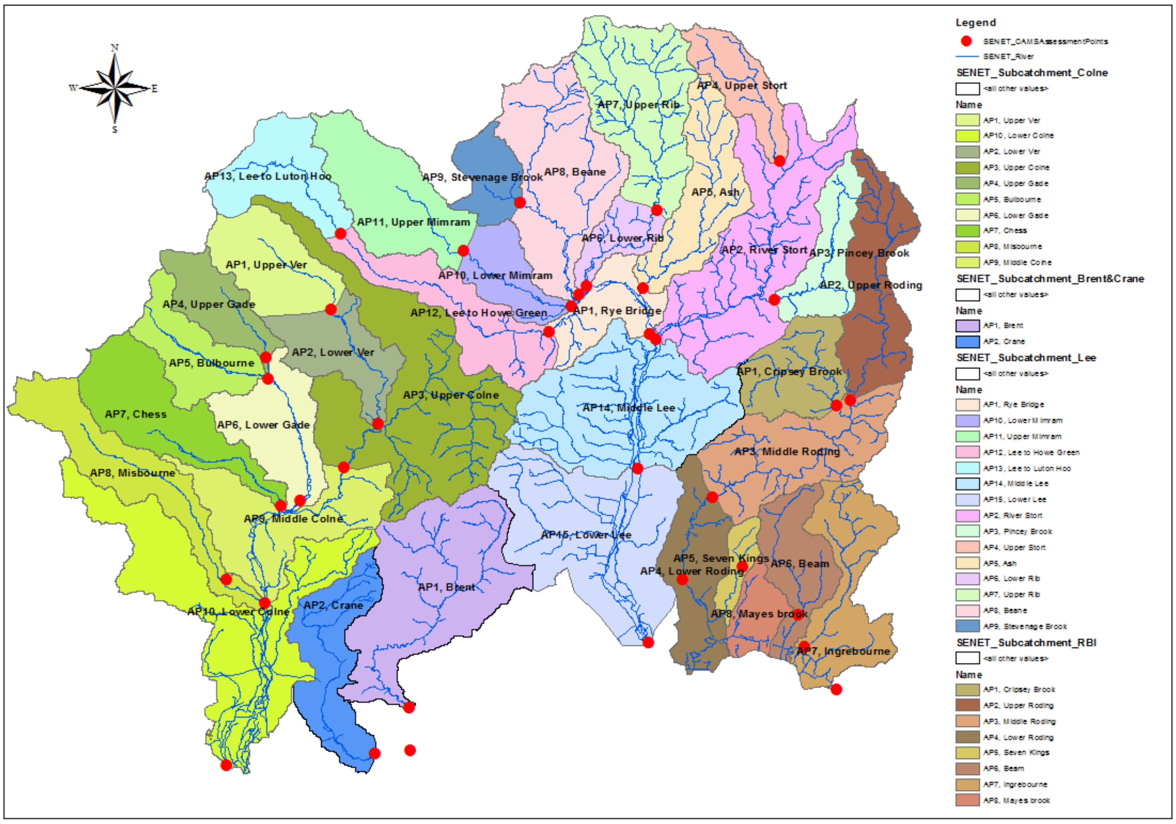

Figure 5. The SENET Catchments and APs for the Water Footprint Assessment.

2.3.2. Meteorological and hydrological data

Monthly average temperature, wind speed, humidity and sunshine data collected from one meteorological station at Royston Iceni of Metoffice SE for the period of 1999 – 2007 were used. Monthly average precipitation for this period for all APs was also available for this study.

Actual runoff (measured flow) and natural runoff (naturalised flow), which were averaged on a monthly basis for the period of 1999-2007 and for all 35 APs (original delineation) were provided by EA (Annex 1).

2.3.3. Abstraction data

Data on water abstraction (by water companies and other licensed users) for domestic, industrial and agricultural use have been collected for each of the APs and on a monthly basis. Return flows (after use, returned locally within the AP where the water was abstracted; and returned elsewhere, to other APs) were also provided by EA (Annex 1). The data spans from 2002 to 2007 and the averages of the monthly abstractions per AP were generated over this period to represent the baseline water use in the WFA.

2.3.4. Effluent discharge and water quality data

Water quality monitoring records for 60 large-scale water company sewage treatment works (STWs) and 139 small-scale STWs (private STWs and trade effluents) that are located within the SENET area were collected and provided by EA (Annex 1). Out of these, 57 large STWs and 111 smaller STWs have both effluent discharge flow data and effluent quality monitoring data directly available. The effluent discharge rates and quality were measured in the period of 2005-2007. The monthly averages (effluent discharge flow and quality data) for the 57 large STWs were calculated to serve as baseline data. For the 111 small STWs, monthly water quality data were available while only the consented daily maximum discharge volumes were available for the effluent discharge flow data. From the effluent water quality monitoring data, ammonia-nitrogen (NH^{4+}-N), arsenic (As), boron (B), cadmium (Cd), chloride (Cl^{-}), chromium (taken as Cr^{6+}), copper (Cu), lead (Pb), mercury (Hg) , nickel (Ni), total oxidised nitrogen-N and reactive orthophosphate-P are the dominant pollutants.

There are 171 point-source effluents registered within the SENET catchments that are directly or indirectly discharged to groundwater. These discharges can potentially generate a grey WF on groundwater. The data available for these discharges are the consented daily maximum discharge volumes and estimated average concentrations for ammonia-nitrogen (NH^{4+}-N).

2.3.5. Agricultural, soil and agro-chemical data

Several crops, such as wheat, barley (winter and spring barley), potato, sugar beet, rapeseed, maize, pea, beans, and vegetables and fruits are grown in the SENET catchments. Cultivation area of each of these crops was available. The yield data, however, were available for only five crops, i.e. wheat, barley potato, sugar beet and rapeseed. There are also animal farms in the study area; however, data for the animal product WF accounting is insufficient. The information on soil type was acquired (Annex 1). Nitrogen and phosphorous fertiliser application in farm lands and leaching rate of these fertilisers were derived from the data or literature (Davison et al., 2008; Mekonnen and Hoekstra, 2011).

2.3.6. Population and other data

Population data (UK 2001 census data) for each village and town in the SENET APs have been collated and aggregated to the AP level. These data were only used for consumption water footprint calculation for the SENET catchments. The WF of national consumption for UK has been taken from the Waterstat Database (http://www.waterfootprint.org/?page=files/WaterStat); see also Hoekstra and Mekonnen (2012).

2.4. Approach and key assumptions

The application of the WFA in the project catchments are described in the following sections. The assessment was carried out at the sub-catchment (AP) level and monthly time scale.

2.4.1. Baseline blue water footprint accounting

Water used for industrial, domestic and agricultural purposes is included in the WFA whether it is abstracted directly from surface water or groundwater bodies or supplied by water companies. The WF was calculated for all three sectors and with respect to the two blue water sources. For a sub-catchment (AP), the total blue WF (*WF_blue*) is the difference between the total water abstraction (*ABS*) within the AP and the total flow locally returned (*RTN_local*) within the AP, expressed as follows in a generic formula.

$$WF\_blue = ABS - RTN\_local \quad (16)$$

One can apply this general equation to the WF calculation for the above mentioned water use sectors using different sources of blue water, namely

$$WF\_blue\_surf\_indus = ABS\_surf\_indus - RTN\_local\_surf\_indus \quad (17)$$

$$WF\_blue\_surf\_domes = ABS\_surf\_domes - RTN\_local\_surf\_domes \quad (18)$$

$$WF\_blue\_grw\_indus = ABS\_grw\_indus - RTN\_local\_grw\_indus \quad (19)$$

$$WF\_blue\_grw\_domes = ABS\_grw\_domes - RTN\_local\_grw\_domes \quad (20)$$

In the above expressions, *_surf* and *_grw* stand for surface water and groundwater sources, respectively; *_indus* and *_domes* stand for “industrial” and “domestic”, respectively.

For the blue WF, evaporative water consumption and non-evaporative consumption were calculated separately. The former was estimated by

$$WF\_blue\ (evaporative) = ABS - RTN\_local - RTN\_elsewhere \quad (21)$$

where *RTN_elsewhere* refers to the flows returned to a different AP, namely the so-called "lost return flow". The non-evaporative consumption was estimated by

$$WF\_blue\ (non\text{-}evaporative) = RTN\_elsewhere \quad (22)$$

Equation 21 and 22 were applied separately for surface water and groundwater sources and for the above three water use sectors.

For agriculture, although the total water abstraction for agricultural use (irrigation) was available, the actual return flow data from the farm areas were unknown. In addition, types of crops and areas of crop growing are different from AP to AP; the consumption of water (both blue and green water) by different crops varies significantly. Consequently, a direct estimation of blue WF for agriculture is not possible. Therefore the blue WF for agriculture was evaluated using the CROPWAT model (Allen et al., 1998; Doorenbos et al., 1986; http://www.fao.org/nr/water/infores_databases_cropwat.html) with an assumption that these five crops are all cultivated using a combination of rainfall and irrigation. The calculation of the blue WF of crops with CROPWAT model is described in the section 2.4.3. The modelled blue water footprint for agriculture was adjusted using the abstraction data (i.e. water abstracted for agriculture use). The post-modelling adjustment was based on the criterion that the modelled blue WF should not be larger than the abstraction for agriculture use (irrigation).

2.4.2. Lost return flow

The lost return flow of one AP is a component of the total blue WF of the AP under study. No data was available indicating the location and volumes of water transfer between APs. The water transfers between APs were derived based on the following approach. We assumed that the lost return flows from industrial and domestic use of one AP would be captured by the sewage treatment works (STWs). To identify movement of the lost return flows between APs (i.e. identify the APs receiving the lost return flows), the sewerage catchment map of STWs that are managed by Thames Water was used. This map describes the coverage of the STW's service region and area. The proportion of the service area was used to calculate the amount of the lost return flow being received by the relevant APs. For example, if AP1 is served by the STWs in AP2 and AP3, and 50% of the service area of AP1 is covered by the STWs in AP2 and the other 50% is covered by the STWs in AP3, then the lost return flow of AP1 is to be split proportionally between these two receiving APs. This means that AP2 receives 50% of the lost return flow from AP1 and AP3 receives the other 50% of the lost return flow of AP1.

2.4.3. Baseline green water footprint accounting

Crop growth uses green water from rainfall and blue water supplied by irrigation when soil water deficit arises. Therefore, the total crop water consumption, or crop water use (*CWU*), consists of green and blue water use, i.e., crop evapotranspiration using green water (rainfall stored in soil), *ET_green*, and crop evapotranspiration using blue water (irrigation), *ET_blue*.

CWU is expressed by

$$CWU = ET\_green + ET\_blue \quad (23)$$

ET_green is generally estimated by

$$ET\_green = min\ (ET\_c, P\_eff) \quad (24)$$

Where *ET_c* is the actual crop evapotranspiration (Allen et al., 1998), *min* is minimum, and *P_eff* is the effective precipitation. Hence, the green WF for each crop can be obtained by

$$WF\_green\ (crop) = ET\_green \quad (25)$$

The blue WF for each crop can be obtained by

$$WF\_blue\ (crop) = ET\_blue \quad (26)$$

The green WF of an AP, *WF_green* (AP), is obtained by a summation of the green WF of each crop grown in that AP, namely

$$WF\_green\ (AP) = \Sigma\ [WF\_green\ (crop_i)\ ],\ (i=1,2\ldots n) \quad (27)$$

where *WF_green* $(crop_i)$ is the green WF of *ith* crop cultivated in the AP in question.

The green WF was computed by applying the CROPWAT model for each AP in the SENET catchments taking into account five crops: wheat, barley (winter and spring barley), potato, sugar beet and rapeseed, for which the cultivation area and yield data could be obtained. In the model, “irrigation scheduling” option was applied. Since no actual irrigation scheduling data for each of those crops were available, it was assumed in the model that irrigation would take place at 100% depletion and irrigate to 100% field capacity. Local meteorological data, precipitation and soil data were used in the model computation (see Annex 1).

The calculation of blue and green WF was done on a daily basis, however CROPWAT provides only daily total crop water use (CWU), i.e. the daily total evapotranspiration in the entire growing period, which includes *ET_green* and *ET_blue*. Therefore a post-model processing, applying the Equations (23) – (27), was done to generate monthly WF results for the crops.

2.4.4. Baseline grey water footprint accounting

Grey WF resulting from point source effluent discharges was estimated for both surface water and groundwater. There are 60 large-scale STWs and 139 small-scale STWs (private STW and trade effluents) distributed in the study area. For these STWs, some are lacking water quality data while some are lacking discharge quantity data. As a result, the grey WFs was estimated for 57 large-scale STWs and 111 small-scale STWs because these STWs have both discharge and water quality monitoring data in the same period. Those STWs without either discharge volume or water quality data were neglected in the grey WF assessment in this study. As a result this leads to certain underestimation of the pollution load, thus the grey WF. The grey WF was calculated by applying Equation (5) in which the load of the pollutant under study, L, is estimated by

$$L = c_{eff}\ x\ D_{effl} \quad (28)$$

where c_{eff} and D_{effl} are the concentration (mass/volume) of the pollutant in the effluent and the effluent discharge rate (volume/time), respectively.

The grey WF was estimated separately for each STW with respect to 12 pollutants (or water quality determinants) which were evaluated individually. These determinants, as described above, are ammonia nitrogen (NH^{4+}-N), arsenic (As), boron (B), cadmium (Cd), chloride (Cl^-), chromium (taken as Cr^{6+}), copper (Cu), lead (Pb), mercury (Hg) , nickel (Ni), total oxidised nitrogen (taken as dissolved inorganic nitrogen, DIN), and reactive orthophosphate (taken as dissolved reactive phosphate DRP or in another term dissolved inorganic phosphate, DIP). After this evaluation, the largest grey WF (*WF_grey*) of all 12 determinants was taken as the grey WF for the STW under study. Subsequently, the grey WFs of all the STWs located in one AP were summed up to obtain the grey WF for that AP.

This can be expressed as follows:

$$WF\_grey\ (STW_i) = Max[WF\_grey\ (p_j)], \qquad (i=1,2,\ldots n,\ j=1,2\ldots m) \quad (29)$$

$$WF\_grey\ (AP) = \Sigma[WF\_grey\ (STW_i)\ ], \qquad (i=1,2\ldots n) \quad (30)$$

where STW_i stands for the *ith* sewage treatment work (STW) and p_j stands for the *jth* pollutant.

The grey WFs for all 57 large STWs were calculated at a monthly time scale. For the 111 small STWs, the monthly effluent discharge volume was estimated with the assumption that these STWs discharge every day at the maximum consented volume. This could overestimate the grey WF. The grey WFs of the 111 small STWs were also estimated in this way on the monthly basis.

Grey WF for groundwater due to point source discharge was estimated applying the same approach as described above. The grey WF for groundwater was calculated with respect to NH^{4+}-N based on the consented maximum daily discharge volume and the consented concentration of NH^{4+}-N (10 mg/l). In this study, discharges of pollutants into groundwater were categorized as “onto land”, “into land”, “soak-away”, “underground water”, “irrigation area” and “pipe”. For the discharges with “into land”, “soak-away”, “underground water” and “pipe”, it was assumed 100% of the pollutant load would be added to the groundwater aquifers since these types of effluent directly enter the groundwater system. For those of “onto land” and “irrigation area”, it was assumed 80% of the loads would eventually reach the groundwater systems. This assumption was based on the information that in average the potential infiltration rate in this region is ca. 200 mm/year (British Geological Survey) while the average effective rainfall is 250 mm/year (Bloomfield et al., 2011). From there one can see that a maximum of 80% of the volume of water applied to land surface could potentially reach groundwater. This preliminary estimation gives a worse scenario, which is a precautionary approach. However, STWs that are not maintained properly often discharge a far worse water quality.

The grey WF non-point source pollution from agriculture, *WF_grey (agri)*, was estimated with respect to nitrogen (N) and phosphorous (P). *WF_grey (agri)* is a result of leaching of fertilisers applied in crop lands,. The estimation was done using Equation 7. In the estimation, the application rate of N and P applied to crop lands was estimated based on the modelling study of Davison et al. (2008). The assumed nutrients’ runoff-leaching rates, 10% for N and 5% for P, were based on Mekonnen and Hoekstra (2011). The calculated *WF_grey (agri)* was taken as a grey WF on surface water since the runoff-leaching rate is a lumped parameter without an explicit partition between the leaching to surface water and that to groundwater.

Maximum allowable concentration c_{max} and natural background concentration c_{nat} and the associated assumptions are presented in the following Section 2.4.4 (Table 1).

2.4.5. Chosen water quality standards and natural background concentrations

Various literature sources and legislation documents of the UK government have been studied to obtain the maximum allowable concentration (c_{max}) and natural background concentration (c_{nat}) for the above listed 12 water quality determinants. Since UK is a member country of EU and has to meet the water quality targets of the EU Water Framework Directive (WFD), the water quality standards for the determinants as stipulated in the WFD for England and Wales were applied as c_{max}. For those determinants, in this case B and Cl^-, which are not listed in the WFD standards, c_{max} values were taken from literature. Natural background concentration values of these 12 determinants were mostly sourced from the research literature relevant to UK. The values of c_{max} and c_{nat} and literature sources are presented in Table 1.

Table 1. Values of c_{max} and c_{nat} for surface water and groundwater and literature sources.

Water Quality determinants		c_{max}	Sources for c_{max}	c_{nat}	Sources for c_{nat}
NH^{4+}_N (mg/l)	Surface water	0.3	Water Frame Directive (England and Wales) 2010 (90-percentile. good. river type 1.2.4.6)	0.01	Reynolds and Edwards (1994)
	Groundwater	0.29	Water Frame Directive (England and Wales) 2010 (General quality of groundwater body)	0.14	Shand et al. (2007)

As (µg/l)	50	Water Frame Directive (England and Wales) 2010 (annual mean. good. rivers & freshwater lakes)	1.12	Peters et al. (2012) - WFD-UKTAG (average of the studies areas for 10 percentile)
B (mg/l)	0.24	Van Herwijnen and Smit (2010, a Dutch RIVM report)	0.017	Van Herwijnen and Smit (2010, a Dutch RIVM report)
Cd (µg/l)	0.6	Water Frame Directive (England and Wales) 2010 (MAC-EQS. inland surface waters. Class 3)	0.015	Law et al. (1994)
Cl^- (mg/l)	230	U.S. EPA (1988)	6.0	Neal and Kirchner (2000)
Cr^{6+} (µg/l)	3.4	Water Frame Directive (England and Wales) 2010 (annual mean dissolved. good. rivers & freshwater lakes)	0	UKTAK-WFD (2008)
Cr^{3+} (µg/l)	4.7	Water Frame Directive (England and Wales) 2010 (annual mean dissolved. good. rivers & freshwater lakes)	0.35	Pezennec (2007) (based on Salminen. 2005. De Vos and Tarvainen. 2006)
Cu (µg/l)	6	Water Frame Directive (England and Wales) 2010 (annual mean dissolved. good. rivers & freshwater lakes)	1.32	Peters et al. (2012) - WFD-UKTAG (average of the studies areas for 10 percentile)
Pb (µg/l)	7.2	Water Frame Directive (England and Wales) 2010 (AA-EQS. inland surface waters)	0.12	Law et al. (1994)
Hg (µg/l)	0.05	Water Frame Directive (England and Wales) 2010 (AA-EQS. inland surface waters)	0.003	Law et al. (1994)
Ni (µg/l)	20	Water Frame Directive (England and Wales) 2010 (AA-EQS. inland surface waters)	5.15	Tyle (2008) - European Union Risk Assessment Report - Nickel
DIN (mg/l)	12.86	Water Frame Directive (England and Wales) 2010 (medium turbidity. transitional waters. good. 180 mmol/l converted)	6.38	Prior and Johnes (2002)
DIP (mg/l)	0.25	Water Frame Directive (England and Wales) 2010 (annual means. moderate. river type 3n/4n)	0.01	Mainstonea and Parr (2002)

2.4.6. Accounting for the water footprint of consumption

The water footprint of consumption per AP, *WF_consum (AP)*, under the baseline condition, was estimated by multiplying the national average consumption water footprint per capita, *WF_consum (UK-per-capita)*, and the population of each AP, *Popul (AP)*. The equation reads:

$$WF\_consum\ (AP) = WF\_consum\ (UK\text{-}per\text{-}capita) \times Popul\ (AP) \tag{31}$$

This estimation is based on the assumption that the consumption pattern for the population in each AP is identical. This is a rough estimation due to the fact that it is very hard to trace the trade flows (import and export) and consumption data of the inhabitants at such a fine geographical unit (AP).

2.4.7. Baseline water footprint sustainability assessment: blue water scarcity for surface water and groundwater

As described in Section 2.2.3, BWS was used to evaluate the sustainability of the blue WF for each AP for both surface water and groundwater. In determining the environmental flow requirements (EFRs) for the SENET catchments, the Environmental Flow Indicator (EFI) approach (Acreman and Dunbar, 2004; Dunbar et al., 2004, Environment Agency, 2013a) was applied. The EFI is a percentage deviation from the natural river flow using the flow duration curves. The EFI depends on the river typology and ecological sensitivity to reduced flows. The ecological sensitivity of the rivers in England and Wales is classified in terms of agreed abstraction sensitivity bands (ASB) that are related to the river characteristics determined by 1) physical characterisation; (2) fisheries; 3) macrophytes; and 4) macro-invertebrates. In the Environment Agency abstraction regime, the EFI is defined for four conditions, ranging from natural low (Q95) to natural higher (Q30) flows. Table 2 shows the percentages of flow to be abstracted at three different ASB at different flows (Environment Agency, 2013a).

Table 2. Percentage allowable abstraction from natural flows at different Abstraction Sensitivity Bands.

Abstraction Sensitivity Band	River flows			
	Q30	Q50	Q70	Q95
ASB3 - high sensitivity	24%	20%	15%	10%
ASB2 - moderate sensitivity	26%	24%	20%	15%
ASB1 - low sensitivity	30%	26%	24%	20%

In this study, an EFI of 15% was applied for the entire SENET area (communication with M. Pluta from Environment Agency). This implies that 85% of natural flows in the rivers should be maintained in order to protect the river ecosystems. This application is based on the reasoning that most of the area falls into ASB2 category (Figure 6, Environment Agency, 2103b), and this area is drought prone so that many rivers often experience low flows. Therefore, the EFR was set to R_{nat}*85% to obtain the blue surface water availability (WA_{blue}). In the context of the WFA, blue water availability (WA_{blue}) is interpreted as the maximum sustainable blue WF. Due to return flows, the abstraction of blue water can be higher than WA_{blue}. As long as blue WF does not exceed WA_{blue} it is possible that blue water scarcity is below 100%.

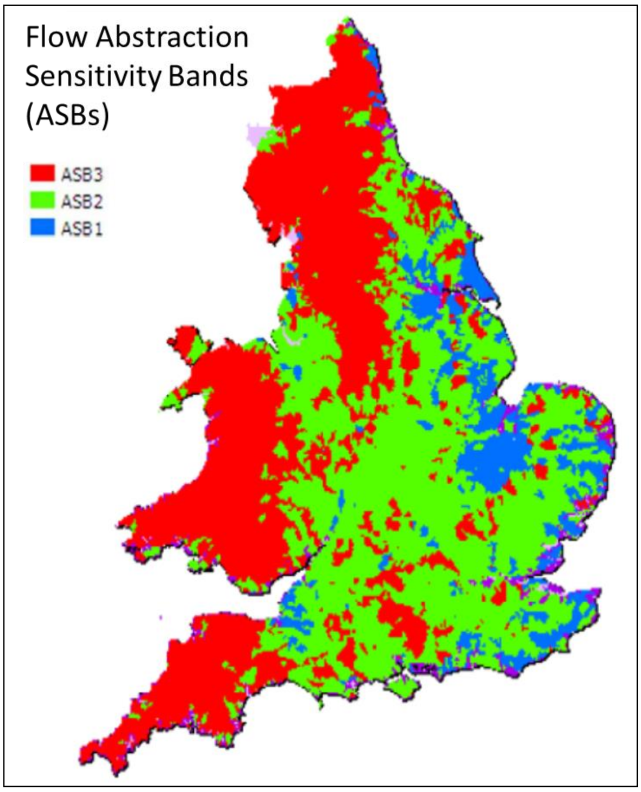

Figure 6. Spatial distribution of ASBs for water bodies across England and Wales (Environment Agency, 2013b).

Since complete EFIs for all rivers in the sub-catchments in the SENET area are lacking, the EFR percentage 85% was uniformly applied to each of the APs in the study.

With respect to groundwater availability (WA_{blue_ground}), determination of sustainable yield requires understanding of the hydrological regime and the dynamics of the groundwater development of the groundwater basin. This usually requires sophisticated groundwater modelling. In the case of this study, there was limited data and literature to inform the selection of applicable values for the parameters required in Equations 11 and 12 for determining the sustainable yield. Given such difficulty in theoretical derivation of WA_{blue_ground}, a simplified practical approach was applied to obtain WA_{blue_ground}, as expressed by:

$$WA_{blue\_ground} = R_{sn} \cdot p \qquad (32)$$

where p is a percentage. A reasonable conservative percentage of 10% (Ponce, 2007) was uniformly applied to all APs in the SENET area to calculate the groundwater availability and then estimate the groundwater scarcity. The effective rainfall of each of the APs was used as an approximation of the natural recharge (communication with M. Kehinde from Environment Agency) for all APs.

2.4.8. Baseline water footprint sustainability assessment: water pollution level

The WPL for surface water was calculated using Equation 14 with the gauged runoff R_{act} for each AP. For the groundwater pollution level WPL_{ground}, the available data do not support obtaining the actual groundwater flow G_{act} (Equation 15). Therefore, the effective rainfall (i.e. recharge) was taken to approximate the actual groundwater flow in the WPL_{ground} assessment.

2.5. Water footprint projection

2.5.1. Projection scenarios

Two climate change scenarios – "wet" and "dry" – were used in combination with projected changes in water abstraction per sector to conduct a WFA for 2060. The existing climate change scenarios and projected water abstraction for agriculture, industry and domestic supply adopted by the EA for the SENET area were the basis for this WFA (communication with C. Beales and G. Frapporti from Environment Agency). Table 3 presents a brief description of the scenarios used in the projection.

Table 3. Projection scenarios for climate change and water abstraction in SENET catchments.

Projection scenarios (2060)	Climate change for natural flows		Water abstraction		
	Wet	Dry	Agriculture	Industry	Domestic
	Modelling output with reference to Mimram (Lee AP10)	Modelling output with reference to Mimram (Lee AP10)	50% increase	25% increase	25% increase

The existing climate change modelling was done only for the Lower Mimram sub catchment (AP10 in Lee Catchment). Assuming the entire SENET area would experience the same climate change pattern, the ratio of projected natural flow to the baseline natural flow at Mimram was applied to all APs in SENET to obtain the natural flow projection. Only one scenario for water abstraction was applied in this study considering a "middle" behaviour in terms of water demand and use, which is in between the so-called "good" and "bad" behaviour (communication with C. Beales from Environment Agency). Bear in mind that the approaches taken in the projection scenarios are very simplified due to the limitation of the data on climate change scenarios and water demand scenarios.

The number of STWs was assumed to remain the same while the effluent discharge volume from each of the STWs was considered to increase in the same percentage as for abstraction. The quality of the effluent discharges was assumed to have no change with reference to the baseline effluent water quality.

2.5.2. Water footprint and sustainability projection

Based on Table 3, the blue WF of industrial and domestic sectors for surface and ground water in the future scenario (2060) were assumed to increase by 25%. The flow movement, namely the spatial distribution pattern of the WF due to lost return flow was kept the same as under the baseline condition. The blue WF for agriculture was calculated using the CROPWAT model based on the climate change scenarios and then adjusted with the water abstraction for agricultural use which was projected to increase by 50%.

Similarly as described above, the green WF was projected using the climate change parameters with the CROPWAT model.

For the grey WF projection, it was assumed that only the effluent volume from the STWs would increase by 25% while the quality of the effluents (i.e. the concentrations of the pollutants) would remain the same as under the baseline condition. This implies that the grey WF due to point-sources will be increased by 25% following the increase of the effluent volume by 25%. The grey WF due to diffuse sources was not projected since there was no available data on future cropping changes. However, it was assumed that improved environmental awareness and better technology and practices would result in no significant change in the grey WF resulting from nutrient runoff leaching even with an increase in overall agricultural production.

In the projection of blue water scarcity, the future natural flows were estimated based on the climate change modelling for the Mimram catchment (Lee AP10), as described above. It was assumed that the general characteristics of water bodies (rivers etc.) in the SENET area and their ecological sensitivity to water abstraction would not change by 2060; hence the EFRs of the rivers would remain unchanged. The WPLs were not projected due to the unavailability of projected river flows.

3. Results and findings

3.1. Blue water footprint

3.1.1. Blue water footprint of industrial sector on surface water

The blue water footprint on surface water resulting from industrial water use has been analysed for the study area. The spatial distribution of the annual blue water footprint for industry shows (Figure 7) that 12 APs have blue WF on surface water as a result of industrial water use. The summation of the annual blue WF of the industrial sector on surface water for these 12 APs amounts to 0.6 million m^3/year (hereafter also abbreviated as Mm^3/year). The industrial blue WF of these 12 APs is due to the lost return flows, namely the return flows transferred to APs other than where the water is abstracted or to outside the SENET area through STWs. The total return flows transferred to outside of the SENET area is 0.38 Mm^3/year. This can be regarded as the total blue WF of the industrial sector on surface water for the SENET area. Monthly industrial blue WF on surface water is available in Annex 2.

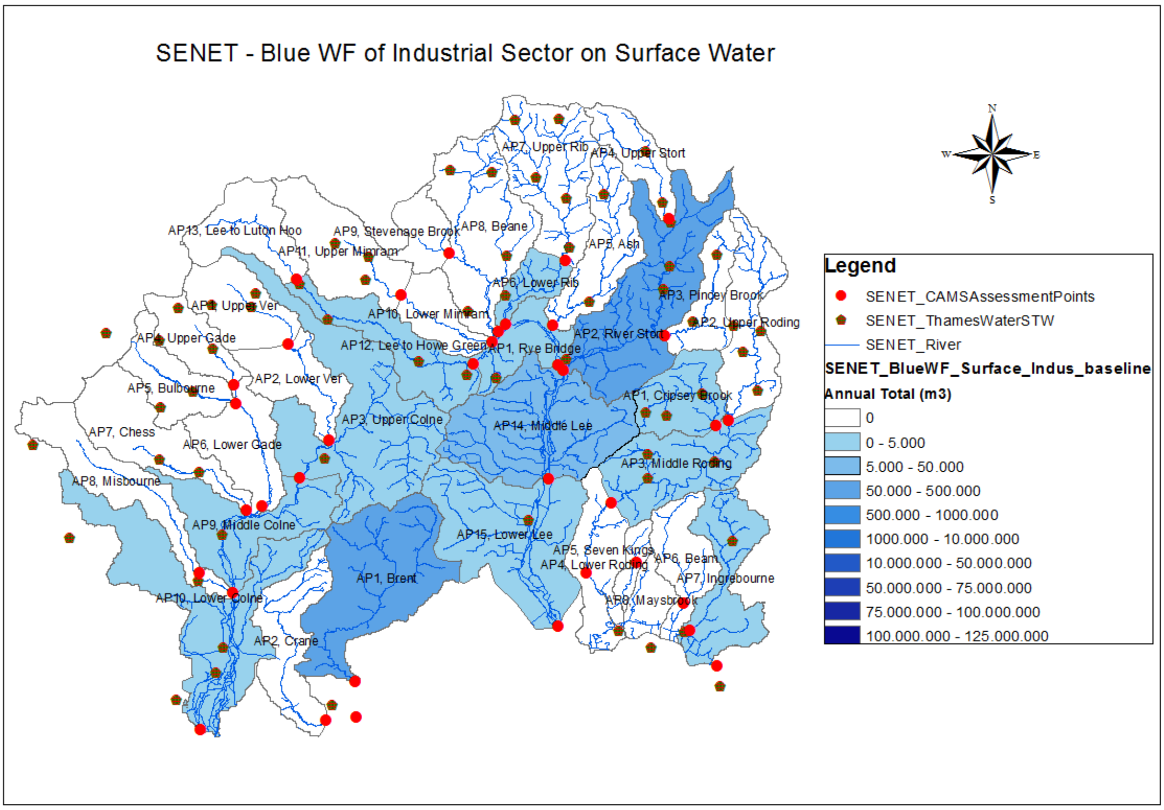

Figure 7. Annual blue water footprint of the industrial sector on surface water in the SENET catchments.

3.1.2. Blue water footprint of domestic sector on surface water

The spatial distribution of annual domestic blue water footprint in the SENET area (Figure 8) shows that only three APs have a blue WF on surface water due to domestic water use. As with the industrial WF, the domestic WF on surface water is also attributed to the lost return flow (i.e. the water transferred from one AP to another through STWs). The total amount of the annual WF of domestic sector on surface water of these three APs, 153 Mm^3/year, is over 200 times larger than that of the industrial sector. The analysis shows that no surface water abstraction used for the domestic sector is transferred to outside the SENET area.

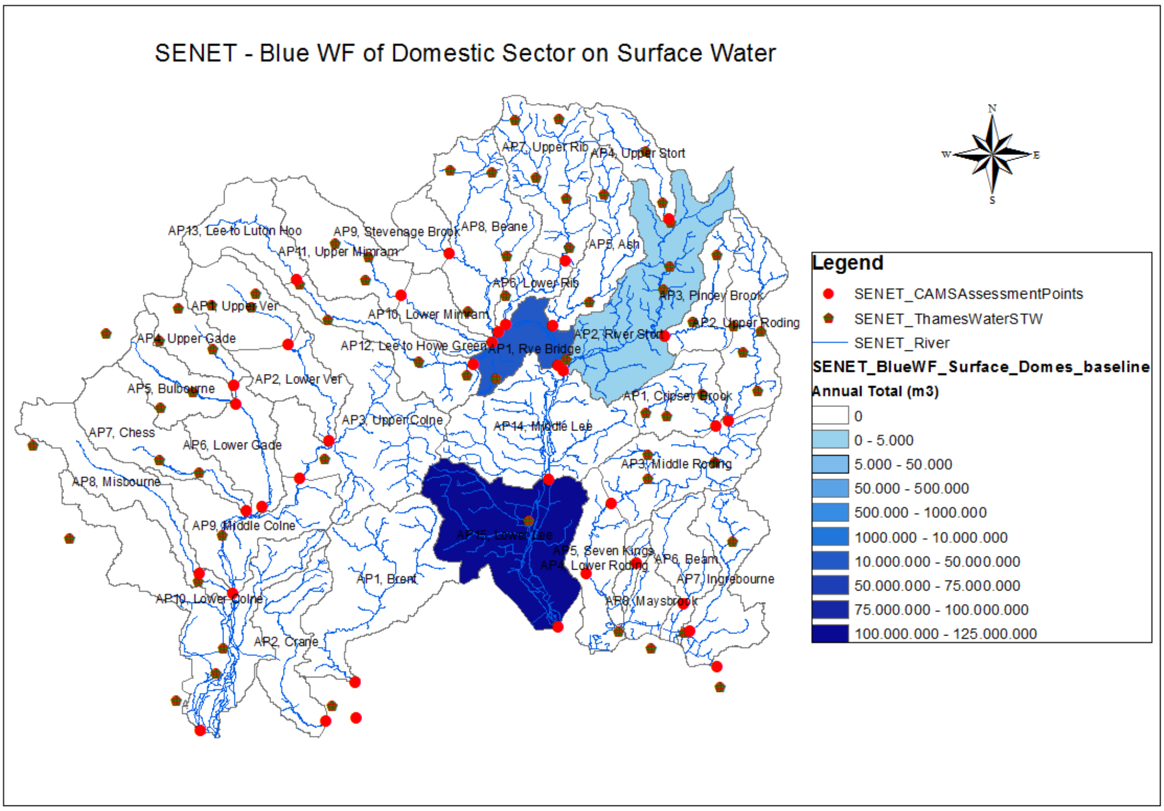

Figure 8. Annual blue water footprint of the domestic sector on surface water in the SENET catchments.

3.1.3. Blue water footprint of industrial sector on groundwater

Results show that 25 APs (11 Lee APs, 9 Colne APs, 4 RBI APs and 1 Brent and Crane AP) have a blue WF on groundwater due to industrial water use. These WFs are all resulting from lost return flow (Figure 9). The summation of the annual blue WF of the industrial sector on groundwater for these 25 APs amounts to 0.83 Mm^3/year. The total groundwater transferred to outside the SENET area after industrial use is 0.31 Mm^3/year.

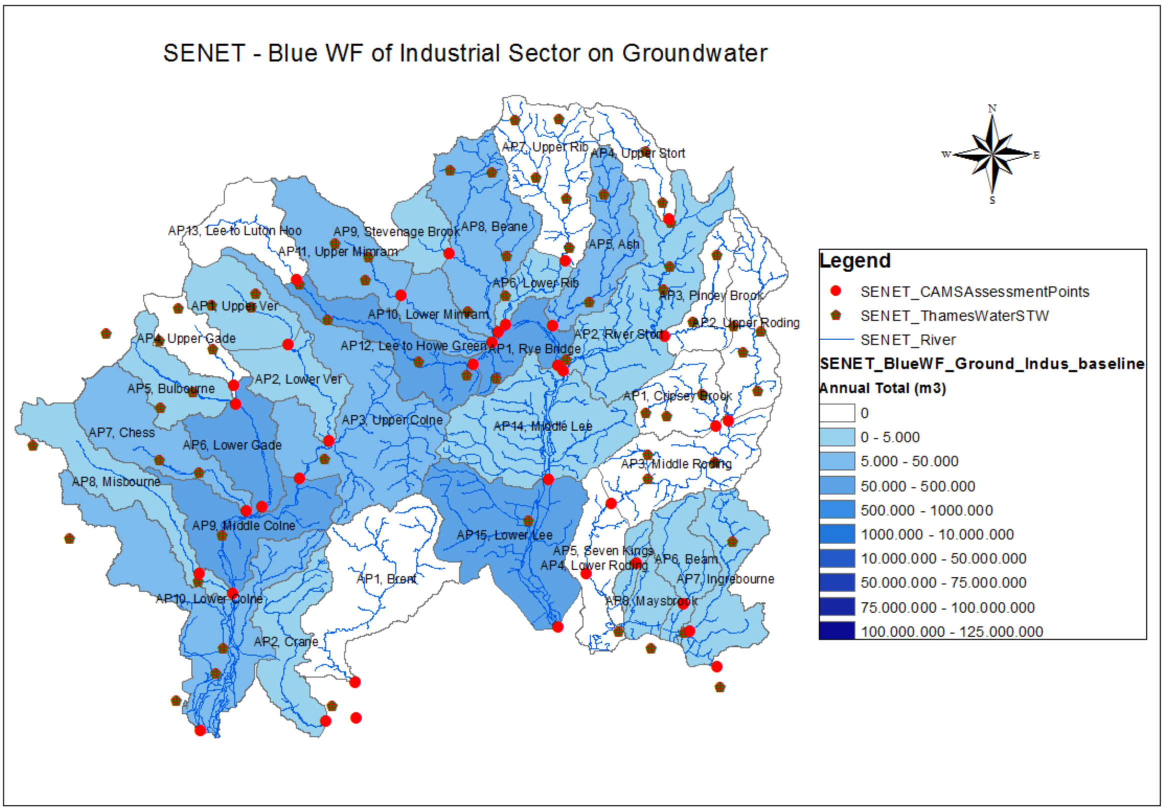

Figure 9. Annual blue water footprint of the industrial sector on groundwater in the SENET catchments.

3.1.4. Blue water footprint of domestic sector on groundwater

Sixty five percent of the SENET APs, i.e. 22 APs have a blue WF on groundwater due to domestic water use (Figure 10). Ten of these APs are in Colne catchment and 12 APs in Lee catchment. The total WF of the domestic sector on groundwater is around 181 Mm^3/year of which 13.8 Mm^3/year is due to evaporative loss and 167 Mm^3/year is resulting from the lost return flows. The return flows lost to outside the SENET area due to groundwater abstraction for domestic use is 45 Mm^3/year.

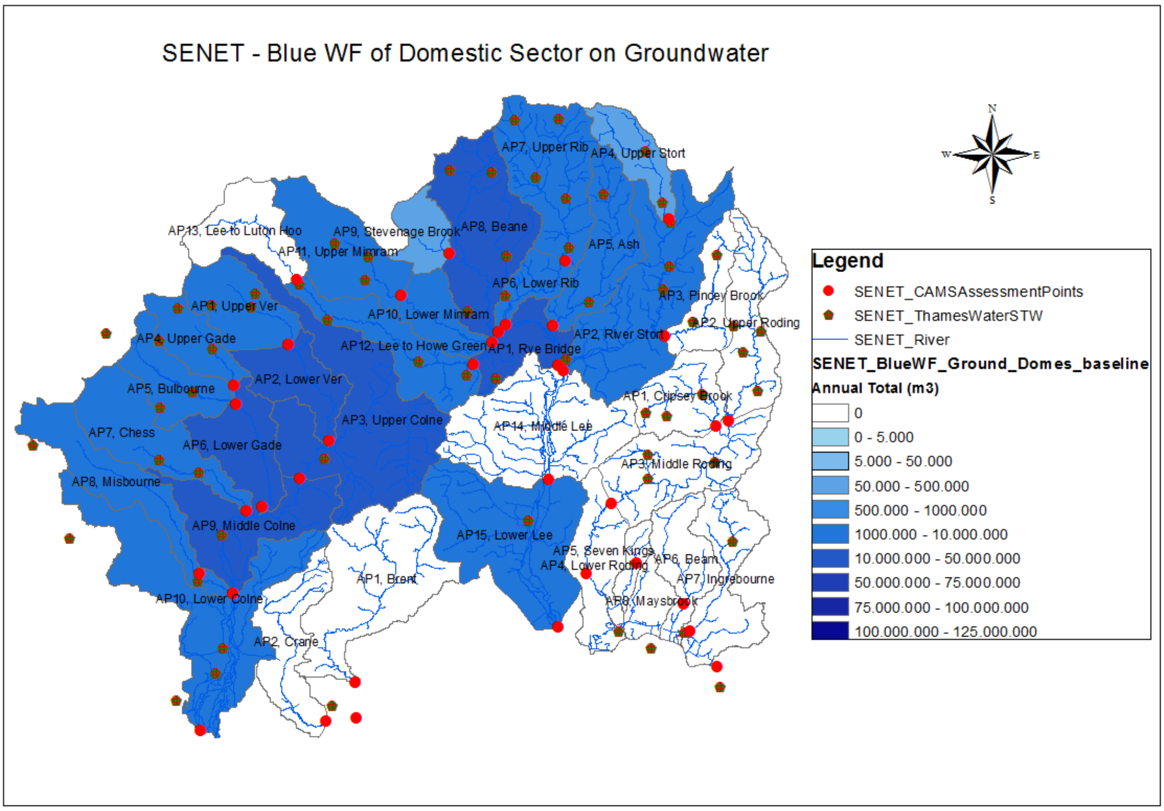

Figure 10. Annual blue water footprint of the domestic sector on groundwater water in the SENET catchments.

3.1.5. Overview of the blue water footprint of the industrial and domestic sectors

An overview of the blue WF of the industrial and domestic sectors resulting from surface water and groundwater use is presented in Table 4. The total blue WF due to industrial and domestic water use in all APs totals 336 Mm^3/year. The industrial blue WF is minor in comparison to the domestic blue WF; the industrial blue WF is only 0.4% of the total combined surface and groundwater domestic and industrial blue WF. Nearly 50% of the total blue WF for industry is lost return flow to outside the SENET area while only 14% of the total blue WF for domestic use is lost return flow outside of the SENET area. The total blue WF of the two sectors is about 1.2 times larger on groundwater than on surface water in the SENET catchments.

The blue WF of these two sectors is primarily generated by the non-evaporative lost return flows. In the case of groundwater use, the domestic sector has 13.8 Mm^3/year of evaporative blue WF, which is 4% of the total blue WF of the two sectors. No evaporative losses were attributed to the blue WF for industry. However, there is likely an underestimation of the blue WF because no data were available for accounting the detailed evaporation losses and the water incorporated into products of the individual processes in the study area. The lost return flows are the major component in the blue WF of the SENET catchments. If taking the SENET area as a whole, the blue WF of both industrial and domestic sectors on surface water and groundwater is 59.4 Mm^3/year.

Table 4. Blue water footprint of industrial and domestic sectors on surface water and groundwater.

Blue WF (Mm^3/year)	Industrial sector			Domestic sector		
	Evaporative	Non-evaporative (return flows)		Evaporative	Non-evaporative (return flows)	
		Total estimated for all APs	Return flows lost to outside SENET		Total estimated for all APs	Return flows lost to outside SENET
Surface water	0.00	0.60	0.38	0.00	152.94	0.00
Groundwater	0.00	0.83	0.31	13.76	167.59	44.99
Total	0.00	1.43	0.69	13.76	320.53	44.99

3.1.6. Mapping the lost return flows

As discussed in Section 2.2.1, the lost return flow of one AP is a component of the total blue WF of the AP under study. The lost return flows result from collecting and transporting the industrial wastewater and/or domestic sewage to the STWs located in different APs. It is similar to inter-basin water transfer in terms of water movement. This implies that those APs receiving the lost return flows will have more water available than what they would obtain by the natural rainfall-runoff processes. The transfer of the return flows by STWs will also have water quality implications for both water losing APs and the receiving APs. Therefore, mapping the lost return flows between the APs can lead to a better understanding of the current water use and management practice. Figure 11 to Figure 18 illustrate the results of mapping the lost return flows. This mapping analysis shows that 20 APs (9 from Colne catchment, 10 from Lee catchment and 1 from Brent and Crane catchment) are net water losing/exporting APs while 6 APs (4 from Lee catchment, 1 from RBI catchment and 1 from Colne catchment) are net water receiving/importing APs. These results are also presented in Annex 3.

Figure 11 and Figure 12 show that the lost return flows resulting from surface water abstraction for industrial use go primarily to Lee AP15, AP4 and AP5 and RBI AP4 within the SENET Area. Lee AP15 receives 0.07 Mm^3/year while Lee AP4, Lee AP5 and RBI AP4 receive 0.04 Mm^3/year, 0.03 Mm^3/year and 0.06 Mm^3/year, respectively. A substantial amount of water, 0.38 Mm^3/year, is transferred outside the SENET (mainly through the STW Mogden).

Figure 13 and Figure 14 show that RBI AP4 (STW Beckton) receives the lost return flow (resulting from surface water for domestic use) from Lee AP15 up to an amount of 122 Mm^3/year while Lee AP2 receives 30 Mm^3/year lost return flow from Lee AP1. There are no return flows resulting from surface water abstraction for domestic use being transferred to outside the SENET area.

The analysis for the lost return flows resulting from groundwater abstraction used for industrial and domestic sectors is presented in Figure 15 and Figure 16. The total groundwater transferred to outside the SENET area after industrial use is 0.31 Mm^3/year (STW Mogden). Ninety five percent of this return flow through STW Mogden is from or via Colne AP9. Colne AP9 also receives 0.14 Mm^3/year of the return flows from other APs, such as Colne AP6, Colne AP7, Colne AP3 and Lee AP12.

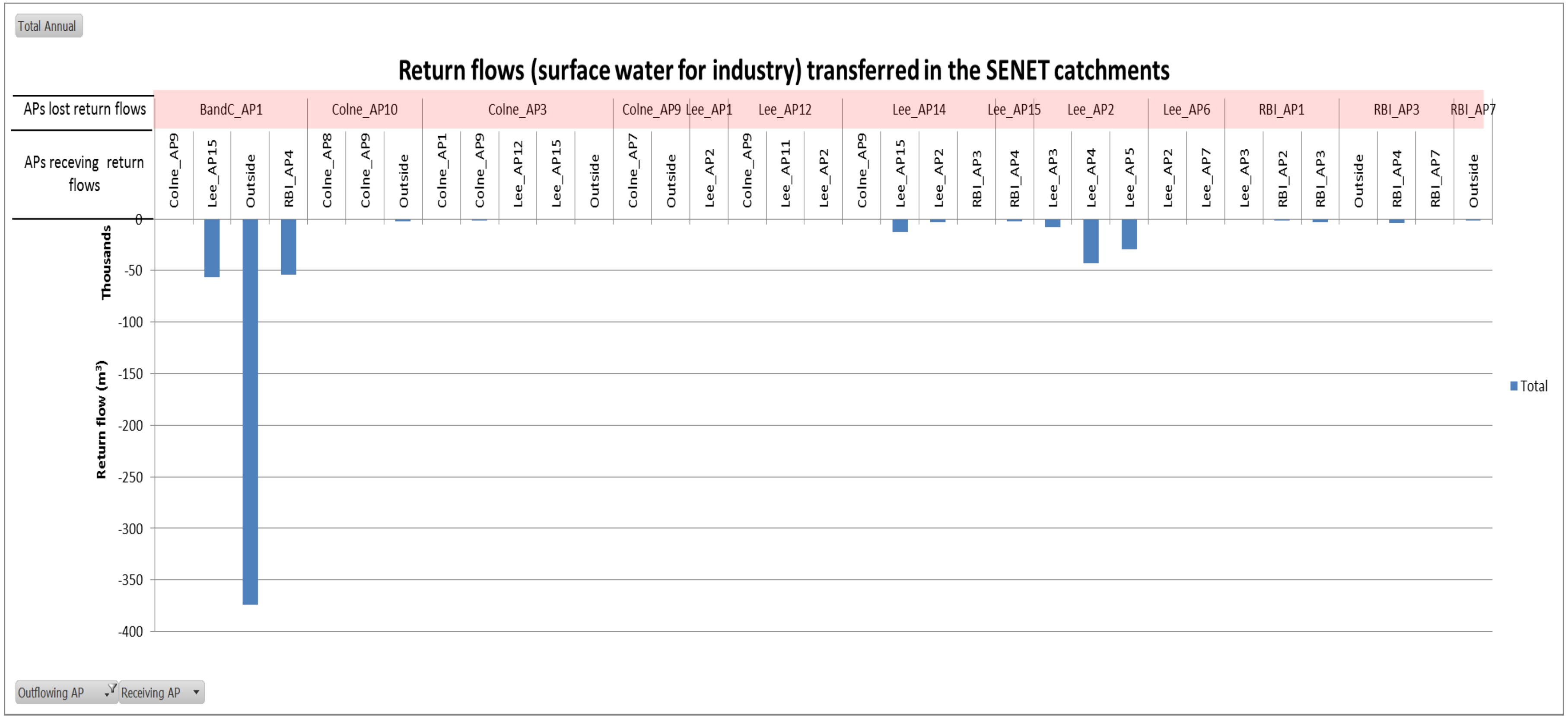

Figure 11. Annual return flows resulting from surface water abstraction for industrial use in the SENET catchments. APs in the highlighted horizontal axis are the ones losing return flows (outflowing) and the APs underneath the highlighted horizontal axis are those receiving the lost return flows.

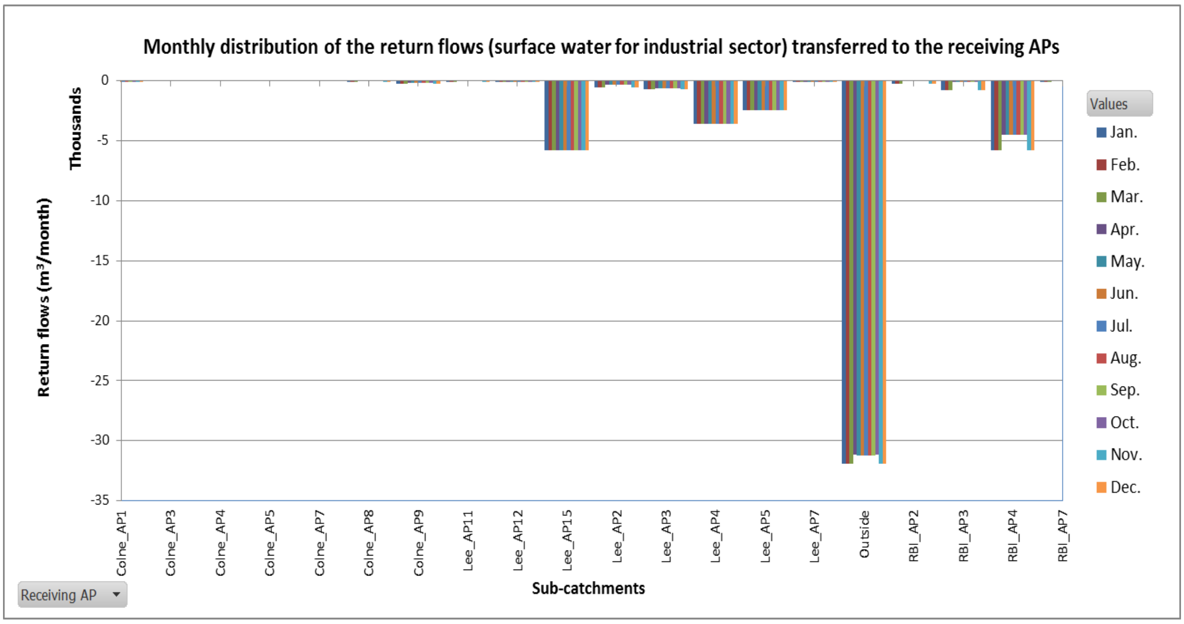

Figure 12. Monthly distribution of the lost return flows resulting from surface water abstraction for industrial sector. The APs labelled in the horizontal axis are the water receiving APs.

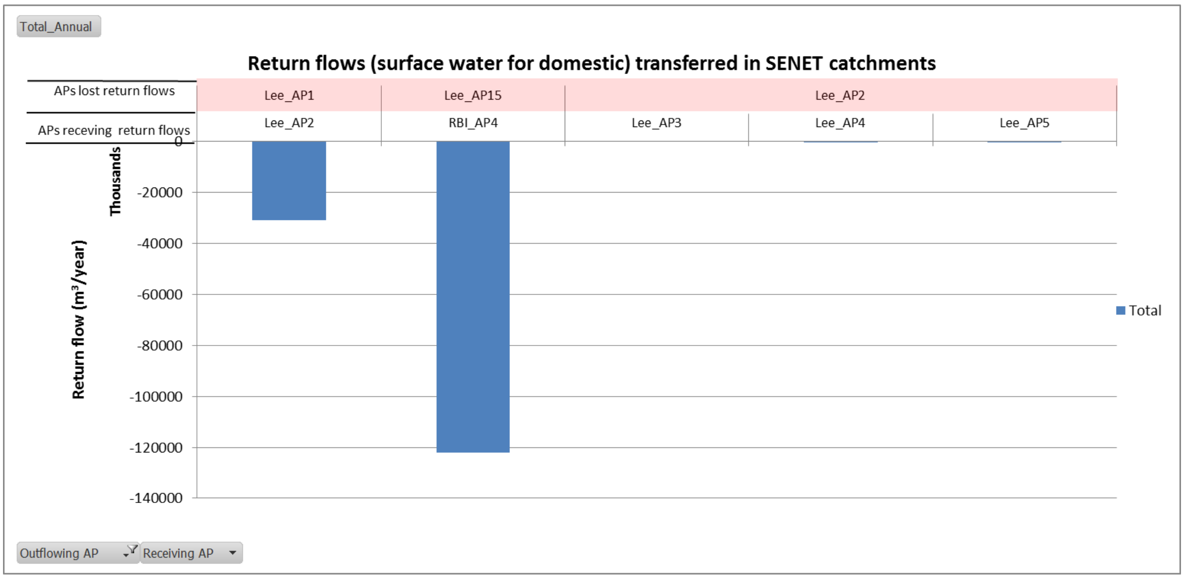

Figure 13. Annual return flows resulting from surface water abstraction for domestic use in the SENET catchments. APs highlighted in the horizontal axis are the ones losing return flow (outflowing) and the APs underneath the highlighted horizontal axis are those receiving the lost return flow.

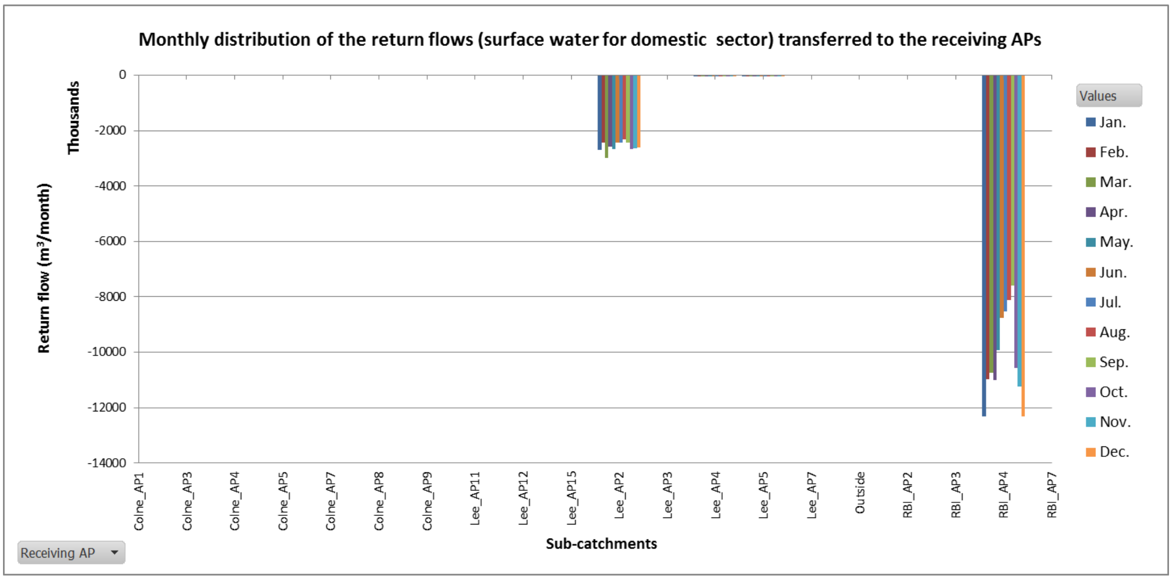

Figure 14. Monthly distribution of the lost return flows resulting from surface water abstraction for domestic use. The APs labelled in the horizontal axis are the water receiving APs.

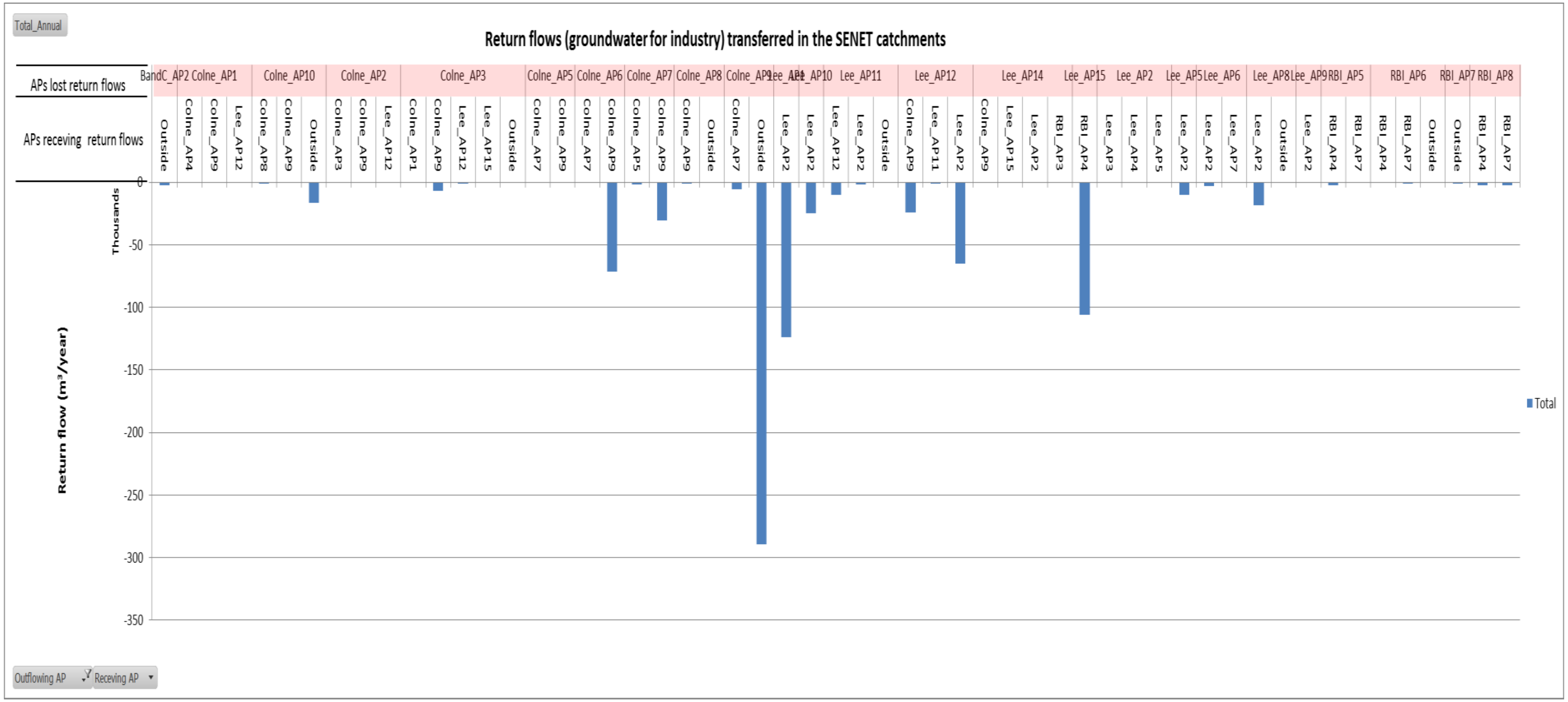

Figure 15. Annual lost return flows resulting from groundwater abstraction for industrial use in the SENET catchments. APs highlighted in the horizontal axis are the ones losing return flow and the APs underneath the highlighted horizontal axis are those receiving the lost return flow.

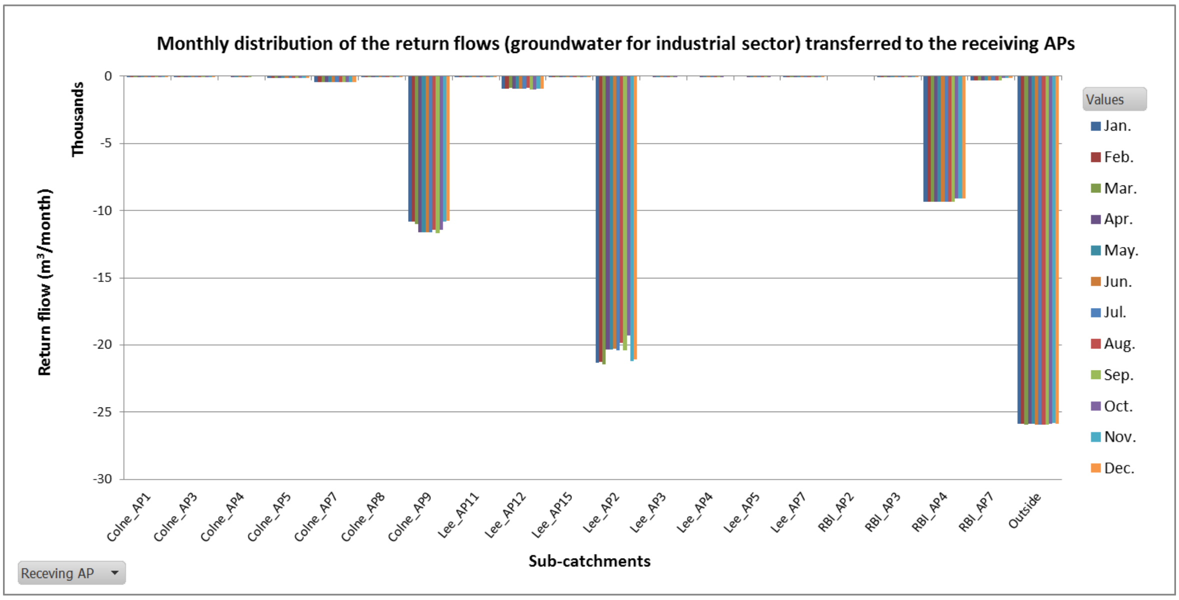

Figure 16. Monthly distribution of the lost return flows resulting from groundwater abstraction for industrial use. The APs labelled in the horizontal axis are the water receiving APs.

Forty five Mm^3/year from groundwater abstraction for domestic use is transferred to outside the SENET area through STW Mogden (Figure 17 and Figure 18). Out of this amount, 41 Mm^3/year is from or via Colne AP9. Colne AP9 (STW Maple Lodge) and Lee AP2 (STW Rye Meads) receives 100 Mm^3/year; about 60% of the total return flows as a result of the groundwater abstraction for domestic use within the SENET area. In the case of Colne AP9, it is a net water receiving AP since it receives more water than it loses through the discharges to STW Modgen.

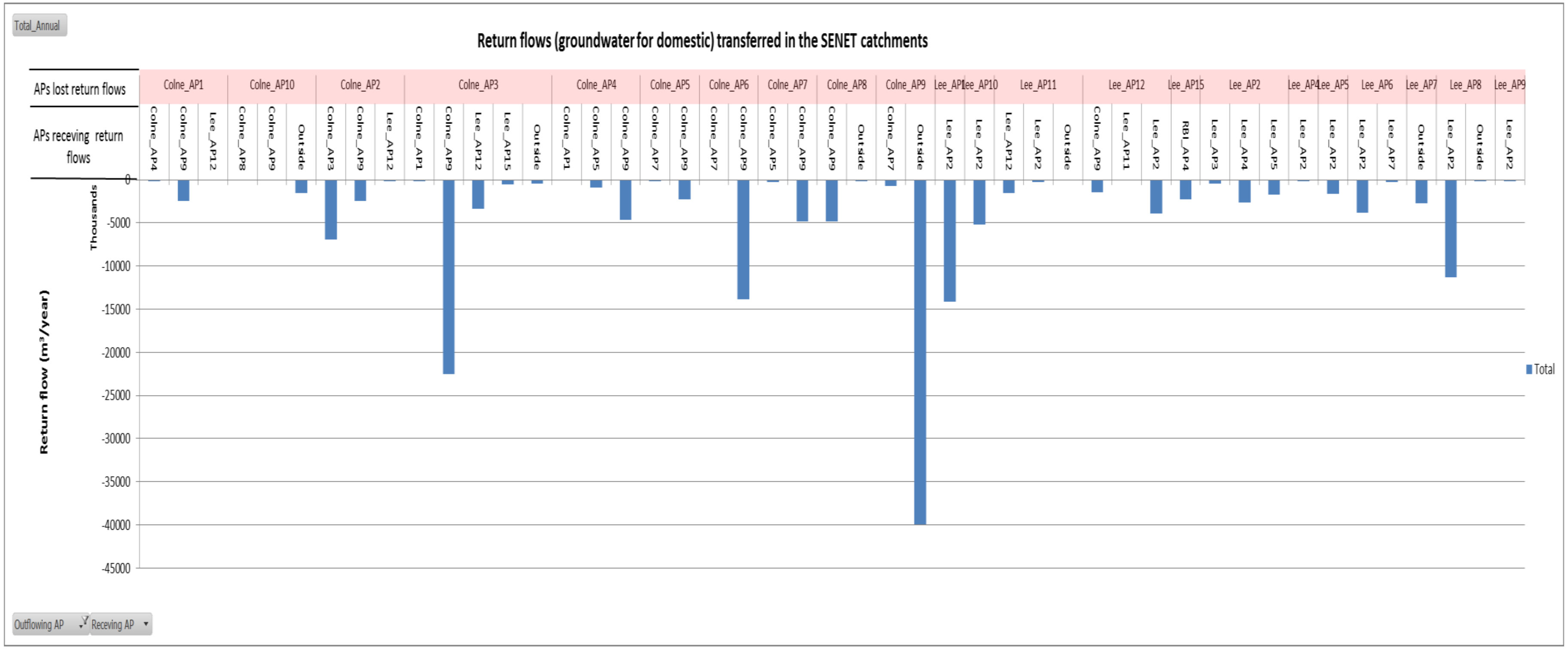

Figure 17. Annual lost return flows resulting from groundwater abstraction for domestic use in the SENET catchments. APs highlighted in the horizontal axis are the ones of lost return flow and the APs underneath the highlighted horizontal axis are those receiving the lost return flow.

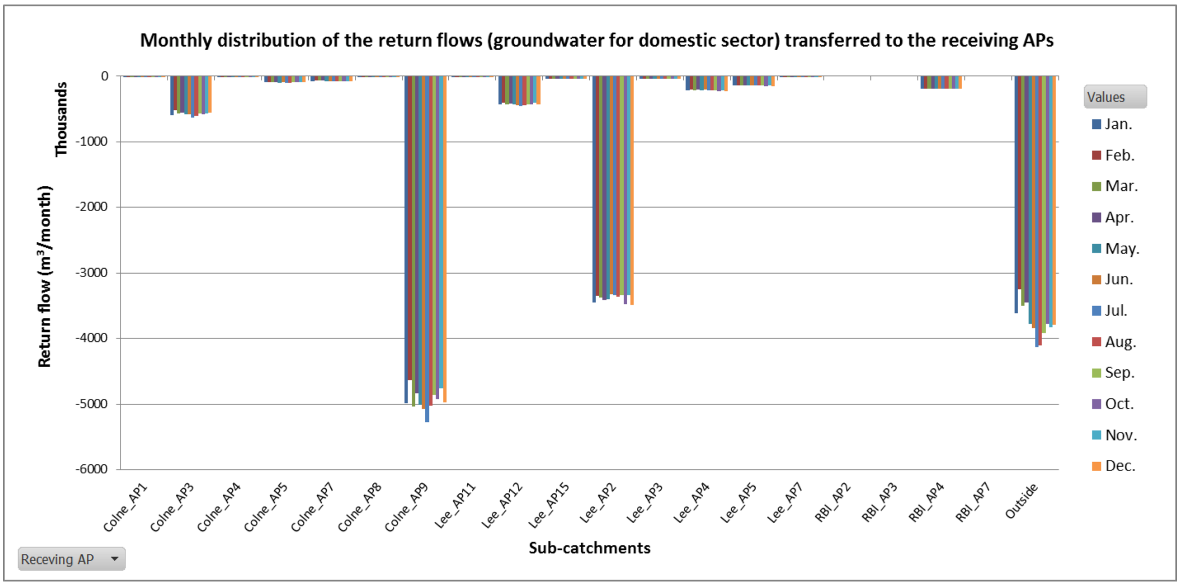

Figure 18. Monthly distribution of the lost return flows resulting from groundwater abstraction for domestic use. The APs labelled in the horizontal axis are the water receiving APs.

The analysis presented above shows that domestic water consumption supplied by both surface water and groundwater is the main contributor to the water transfers within and beyond the SENET sub-catchments, representing 99.6% of the total being transferred (see also Table 4). However, only 14% of the total return flows from domestic water use, 45.7 Mm^3/year, are transferred outside the SENET area.

3.1.7. Blue water footprint of agricultural water use

The total annual blue WF of agriculture was estimated at 2.75 Mm^3/year of which 0.64 Mm^3/year is on surface water while 2.11 Mm^3/year is on groundwater. The upstream APs have a larger blue WF than the downstream in general (Figure 19 and Figure 20, surface water and groundwater, respectively). This is due to the fact that upstream APs are agriculturally dominant while downstream APs are more urbanised. The calculation results show that crop cultivation in the study area consumes over 3 times more groundwater resources for irrigation than surface water. As pointed out in Section 2.4.2, this estimation took only five major crops into account. This implies a possible underestimation of the blue WF of agriculture in this area. Monthly blue WFs of agriculture for each AP of the SENET catchments are presented in the Annex 2 (Table A2-3) and Annex 3 (Table A3-3).

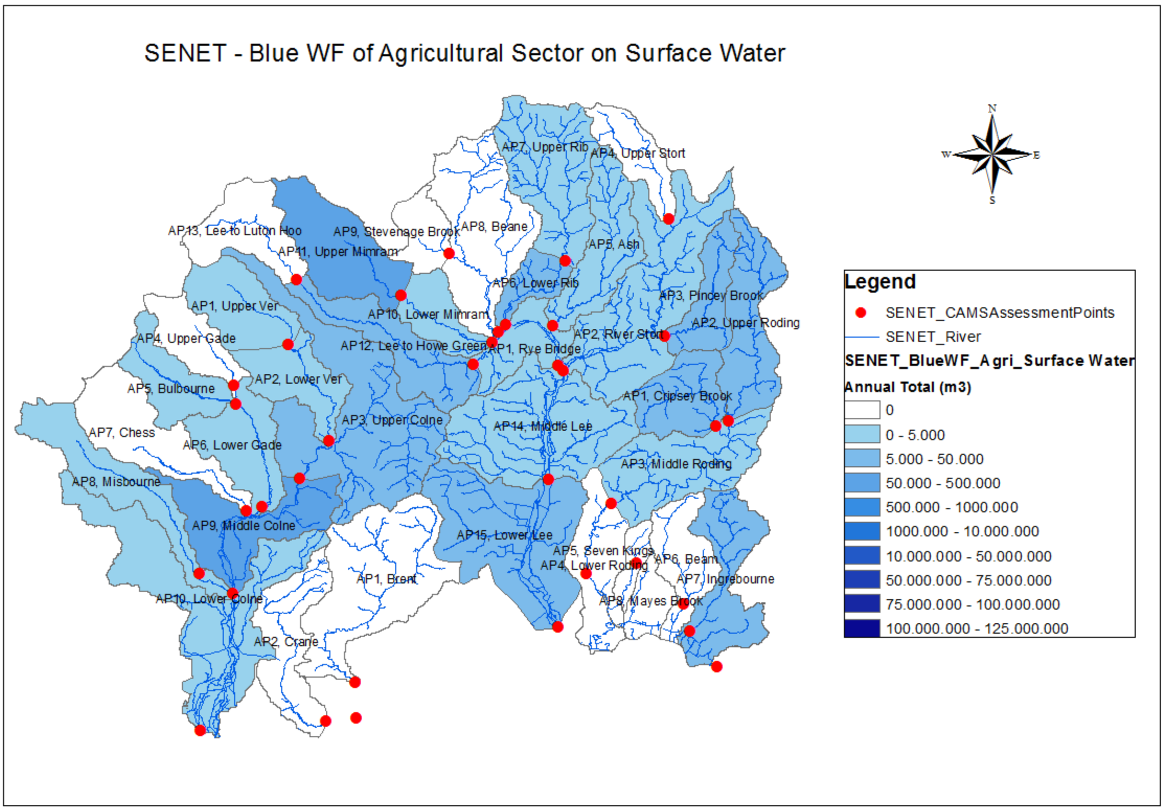

Figure 19. Annual blue water footprint of the agricultural sector on surface water in the SENET catchments.

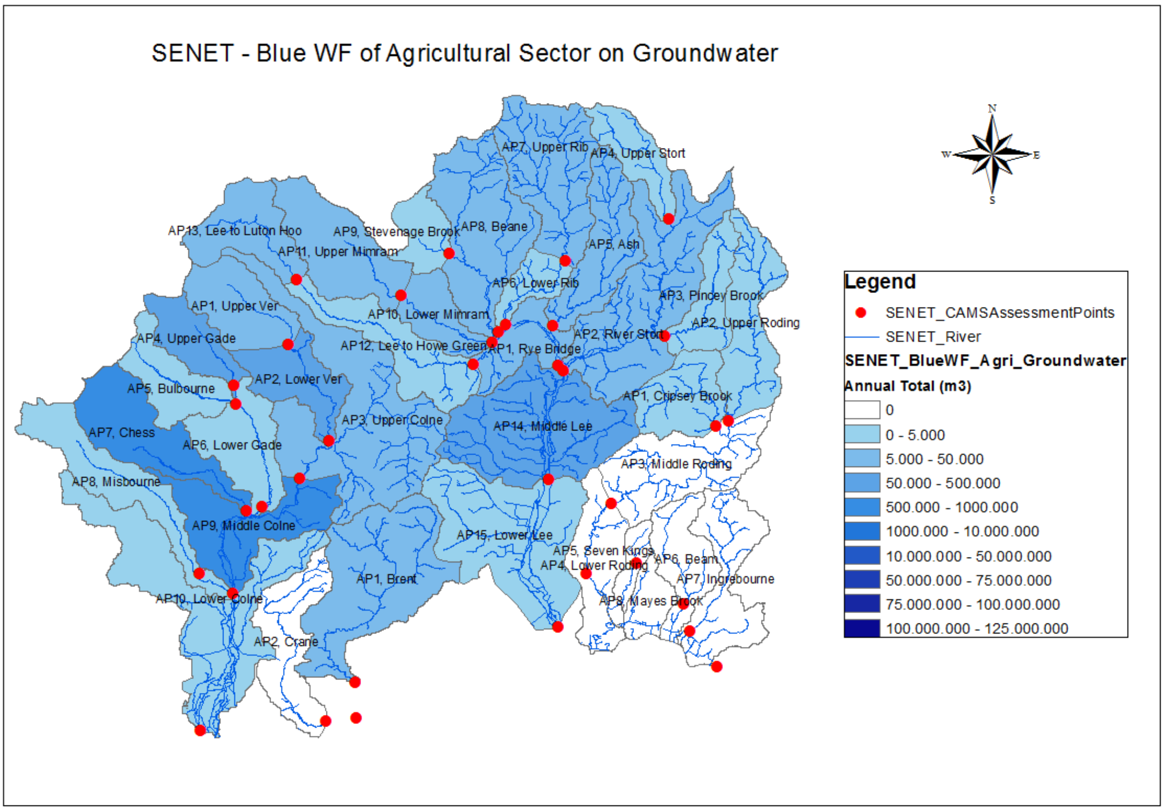

Figure 20. Annual blue water footprint of the agricultural sector on groundwater water in the SENET catchments.

3.1.8. Overview of the blue water footprint in SENET catchments

Table 5 summarises the blue WF accounting results for the SENET area as one geographical entity. The domestic sector is by far the largest blue water consuming sector although 77% of that is a result of the lost return flows. Ninety eight percent of the total consumptive use of water relies on the groundwater resources.

Table 5. Total blue water footprint of the SENET catchments for different sectors.

Blue WF (Mm^3)	Industrial sector	Domestic sector	Agricultural sector	Total
	Evaporative + Return flows lost to outside SENET	Evaporative + Return flows lost to outside SENET		
Surface water	0.38	0.00	0.64	1.02
Groundwater	0.31	58.76	2.11	61.18
Total	0.69	58.76	2.75	62.20

3.2. Green water footprint of agriculture

The green WF of agriculture (crop cultivation) in the SENET catchments was estimated at 225 Mm^3/year. The green WF is 98% of the total crop water consumption, and 100 times the blue WF of agriculture. The spatial distribution of the green WF of crop production in the study area follows that of blue WF of crop production; the upstream areas of the SENET area have a larger green WF than the urbanised downstream areas where crop cultivation is less intensive (Figure 21). As with the blue WF, in the estimation of the green WF for agriculture, only five crops were considered. This likely leads to underestimation of the green WF of agriculture in the study area.

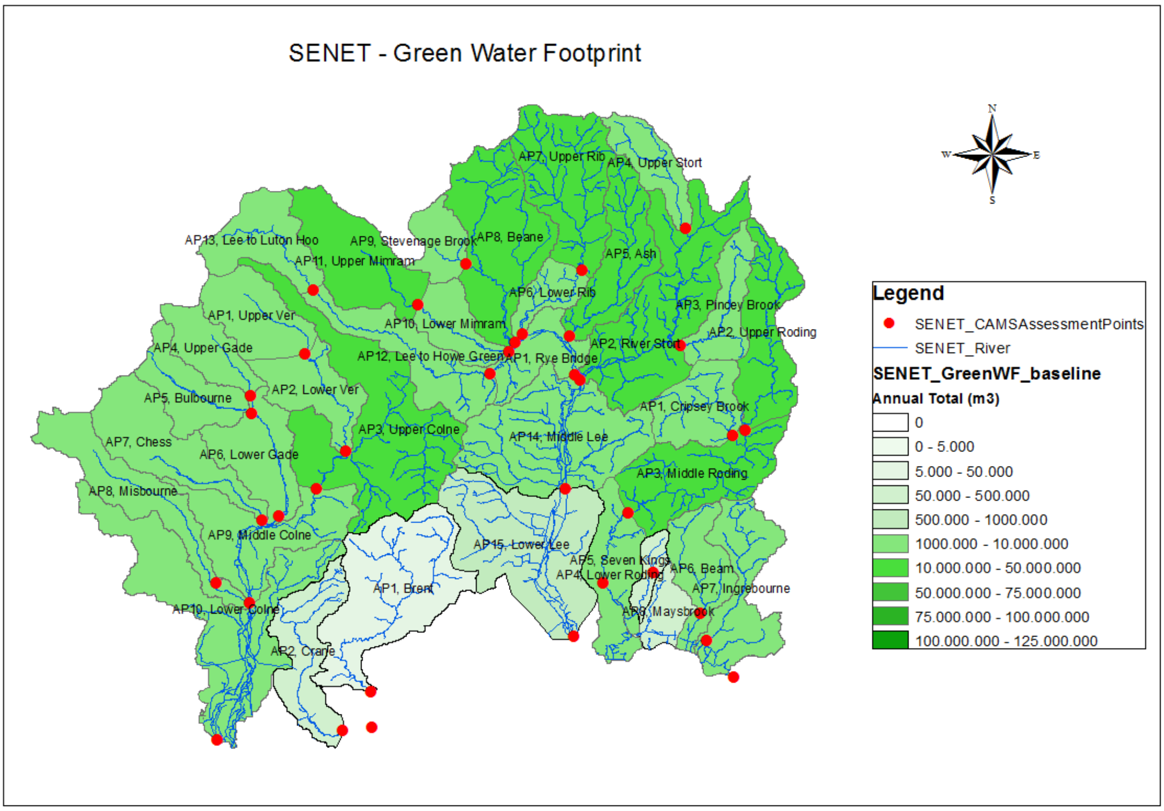

Figure 21. Annual green water footprint of the agricultural sector in the SENET catchments.

3.3. Grey water footprint

3.3.1. Grey water footprint on surface water due to point-source pollution

The total grey water footprint on surface water due to point-source pollution in the SENET area is estimated at 408 Mm^3/year. The spatial distribution of total annual grey WF on surface water due to point-source effluent discharges in the SENET catchments shows that the middle and downstream APs have a higher point-source grey WF on surface water (Figure 22). This is due to the fact that these APs have larger effluent discharges because of higher urbanisation and/or larger populations, therefore large-scale STWs are located in these APs. The results show that for most of STWs, DIP is the major contributor to the grey WF while NH^{4+}-N and DIN determine the grey WF in a number of APs. Copper, boron and lead are also worthy of attention in pollution control.

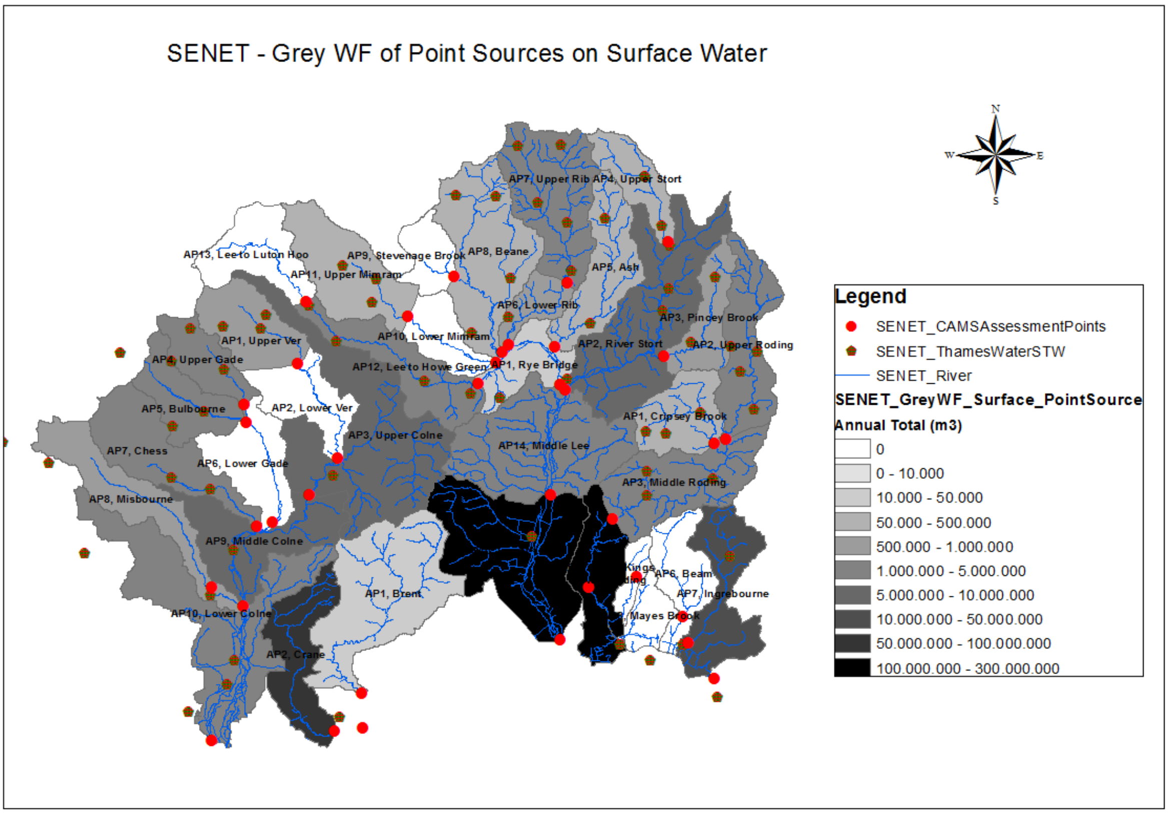

Figure 22. Annual grey water footprint on surface water due to point-source effluent discharges in the SENET catchments.

The grey WF on surface water due to point-source effluent discharges from STWs varies from month to month with the higher grey WF in the months from January to March and in the months of July, August, September and November (Figure 23). This is largely due to the relatively larger amount of effluent discharges in these months.

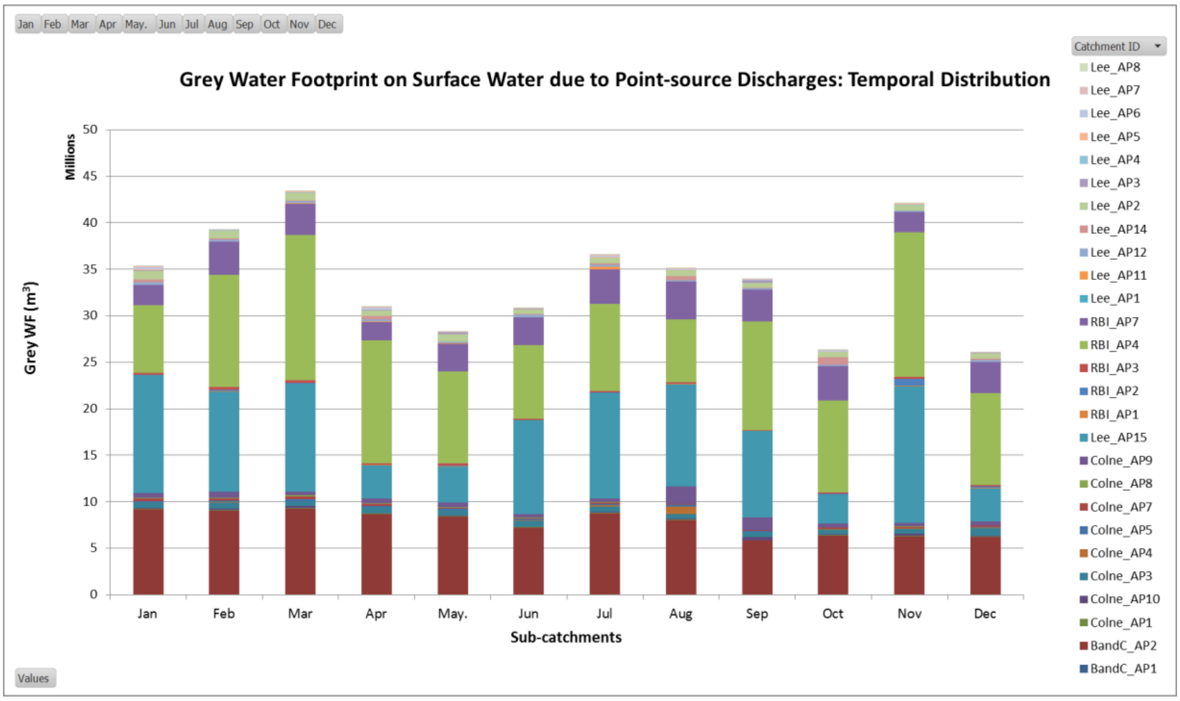

Figure 23. Temporal distribution of the grey water footprint on surface water due to point-source effluent discharges in the SENET catchments.

The grey WFs in AP2 of Brent and Crane Catchment, AP4 and AP7 of RBI catchment, and AP15 of Lee Catchment are much higher than that of the other APs (Figure 24). There are large-scale STWs located in these APs, resulting in larger effluent discharges, thus larger pollutant load. For AP2 of Brent and Crane, the STW (Modgen) lies just outside the catchment boundary. Modgen STW receives wastewater from AP2 of Brent and Crane and the surrounding areas, therefore the grey WF due to STW Modgen is assigned to this AP.

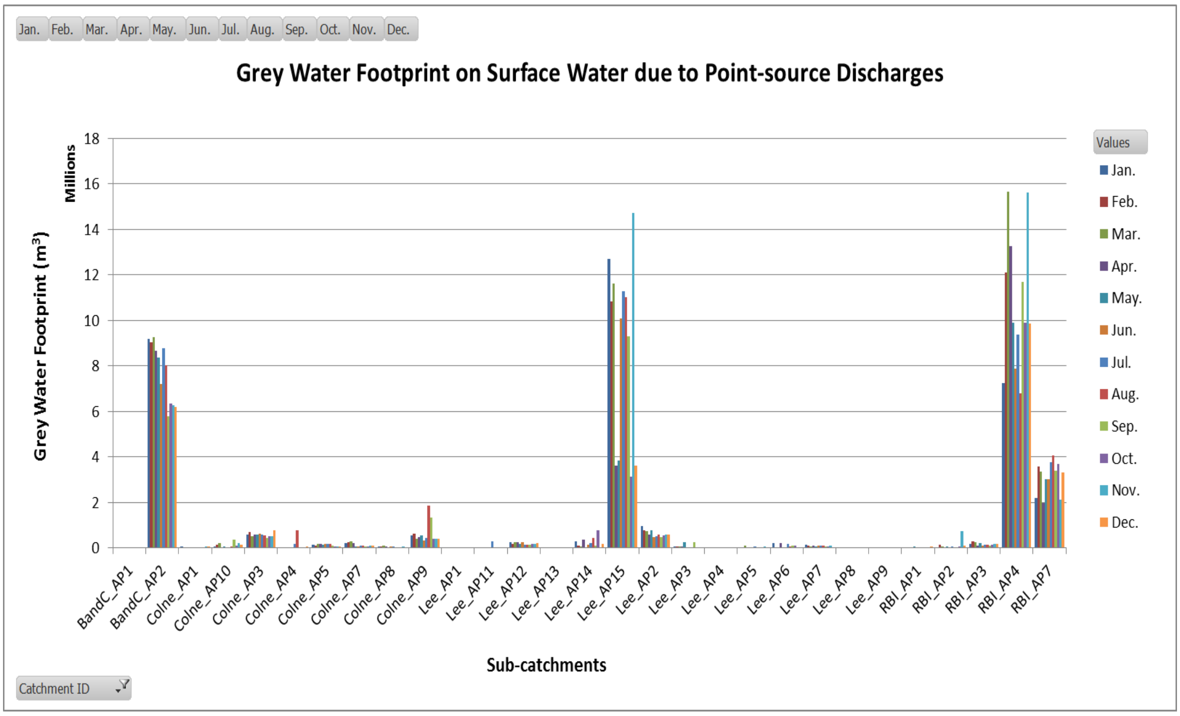

Figure 24. Monthly grey water footprint on surface water due to point-source effluent discharges in the SENET catchments.

The results indicate that the removal efficiency of nutrients (N and P) is low when comparing the concentrations of DIN and DIP in the effluents against the WFD water quality standards for England and Wales (Table 1) and it varies between STWs. For instance, in the effluent of the STW Maple Lodge in Colne AP9, the monthly average concentration of DIP (0.59 mg/l) is much lower than that of the STWs in other APs, which ranges from 1.07 mg/l to 10.34 mg/l[2]. Even though the effluent volume from the STW Maple Lodge is comparatively large, the grey WF is therefore much lower than that of other APs (see Figure 24). The DIN concentrations of most of the STWs are higher than the WFD standard.

It is worth noting that in this study the grey WF was not calculated for some STWs in the SENET catchments because the effluent water quality data were not available for these STWs. Consequently, this leads to underestimation of the point-source grey WF.

3.3.2. Grey water footprint on groundwater due to point-source pollution

The grey WF on groundwater due to point-source discharge was estimated for NH^{4+}-N only, due to limited data availability. However, ammonia is most likely to be the dominant contaminant to groundwater. The total grey WF on groundwater due to point-source effluents in the SENET catchments was estimated at 664 Mm^3/year, around 1.6 times larger than the grey WF on surface water resulting from point-source discharges. Figure 25 and Figure 26 illustrate the spatial distribution of the large threat of NH^{4+}-N pollution to the groundwater resources in the SENET. This result shows that the grey WF on groundwater is substantial. It should be pointed out, however, that this result could be overestimated because the effluent volume of each of the STWs concerned was assumed to be the daily maximum permitted. Nevertheless, even if it is an overestimation, it suggests the need for greater groundwater resources protection. Figure 25 and Figure 26 also show that AP1, AP8, AP9 and AP10 in Colne Catchment, AP14 in Lee Catchment, especially Colne 10 and Lee AP14 are vulnerable to groundwater quality degradation due to the large effluent discharge through well injection and/or soak-aways.

[2] This is the result of Urban Waste Water Directive requirement to reduce phosphate on certain STWs; all bigger STWs will have lower DIP loads today or will have in the near future.

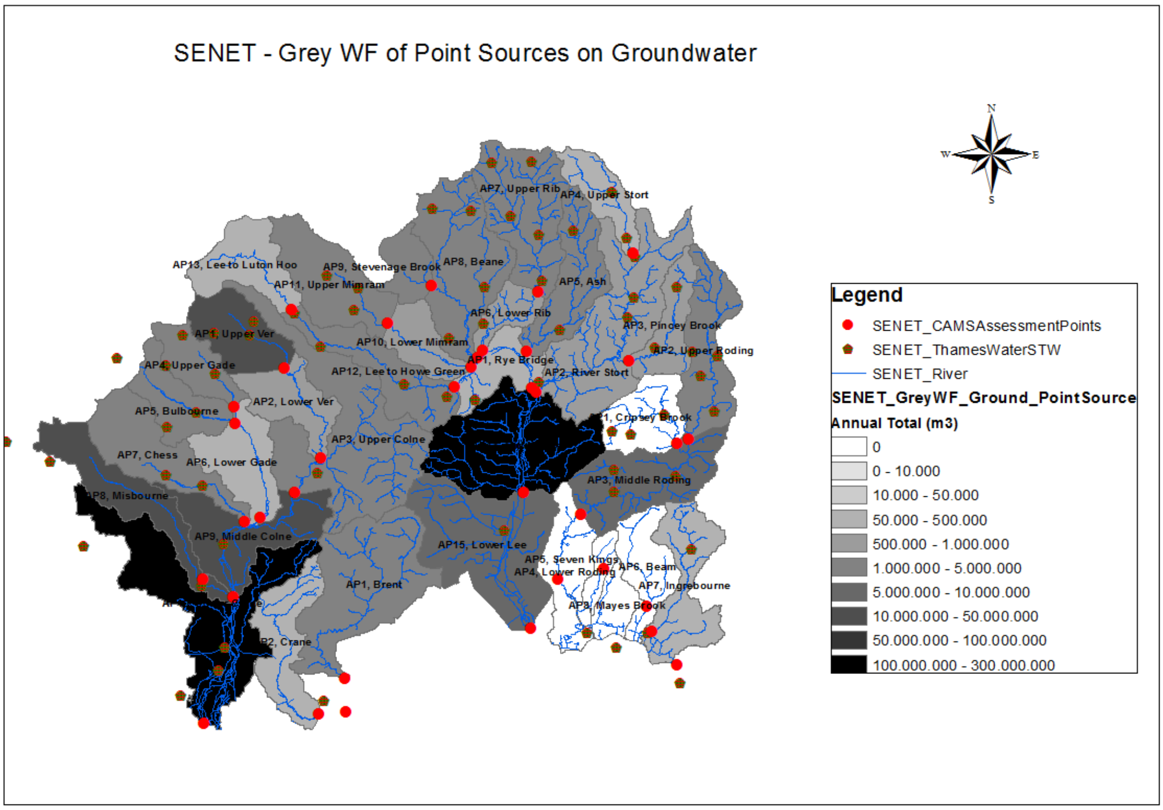

Figure 25. Annual grey WF on groundwater due to point-source effluent discharges in the SENET catchments.

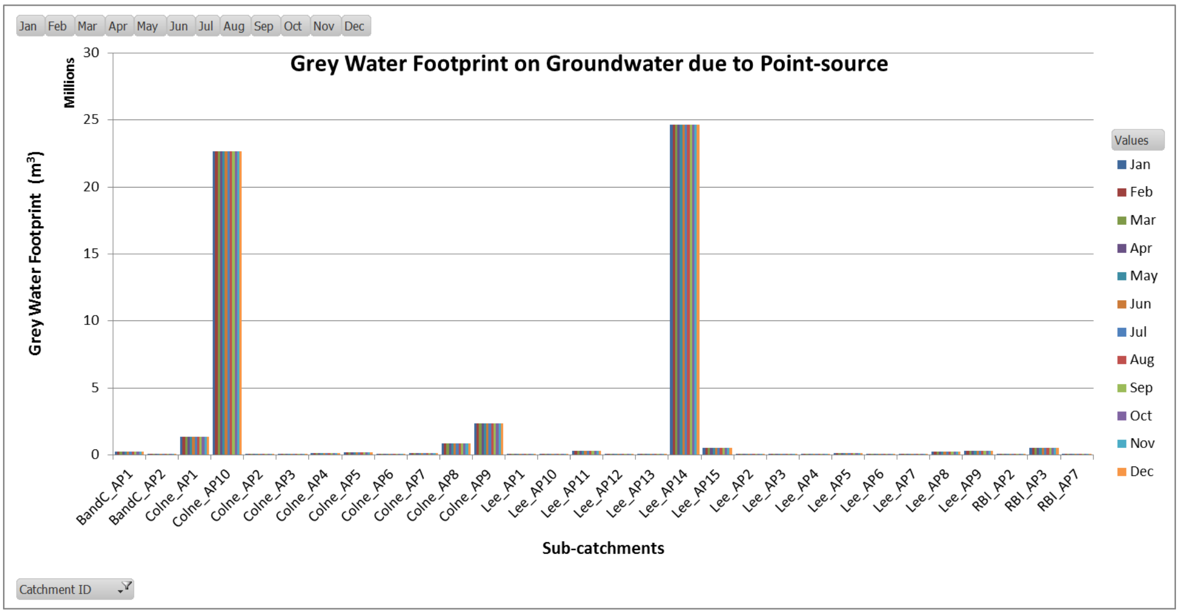

Figure 26. Monthly grey WF on groundwater due to point-source effluent discharges in the SENET catchments.

3.3.3. Grey water footprint due to non-point source pollution on surface water

The grey WF on surface water due to non-point source pollution resulting from fertiliser application in crop lands in the study area was estimated with respect to nitrogen and phosphorous. The results show that nitrogen determines the non-point source grey WF for all APs. The total non-point source grey WF in the SENET catchments is 304 Mm^3/year. The upstream APs of Lee, RBI and part of Colne catchments have larger non-point source grey WF than the downstream APs (Figure 27). The grey WFs of the upstream APs vary in the range of 10 to 30 Mm^3/year, which is in average 10 times larger than that of downstream APs. This spatial pattern is a result of the crop land distribution – agriculture is more extensive in the upstream APs than the downstream APs.

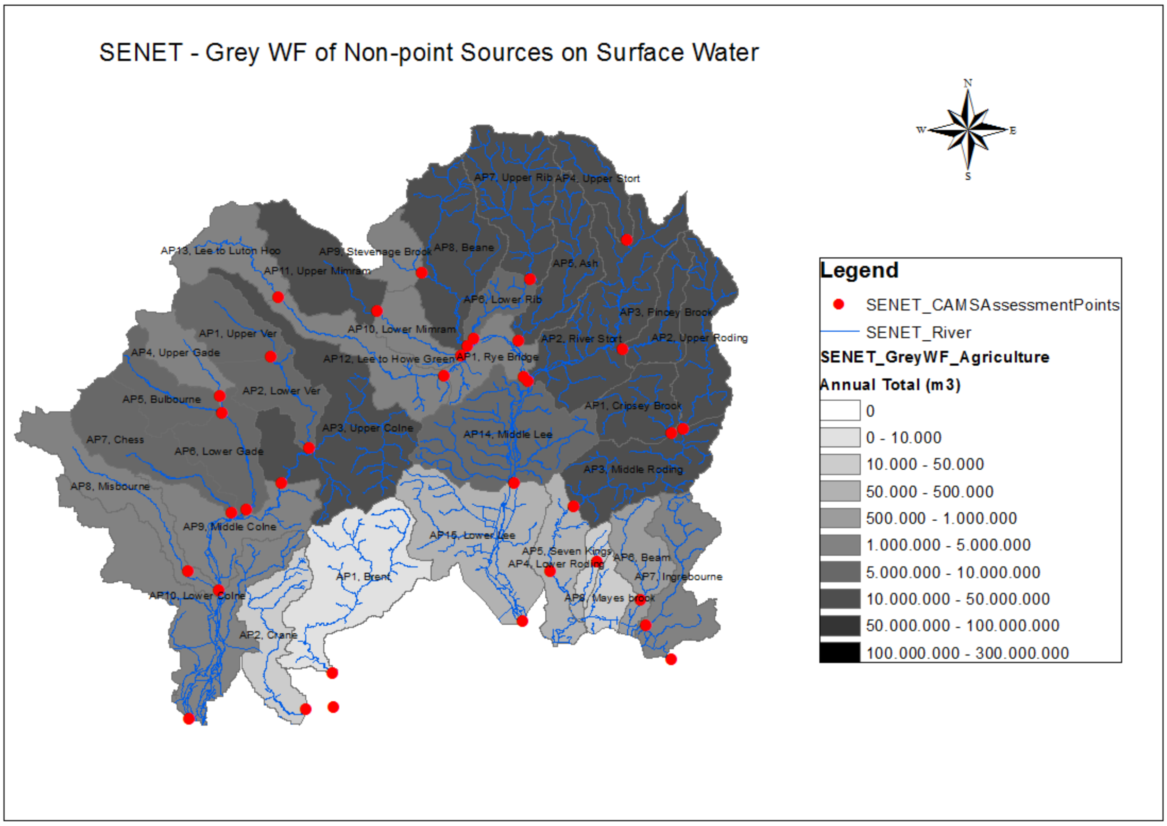

Figure 27. Annual grey water footprint due to fertiliser leaching (non-point-source) in the SENET catchments.

This study did not take into account the non-point source pollution from storm runoff and wash-away from urban areas and other built areas (e.g. roads and highways) due to limitation of the study scope. Such pollution can be substantial; neglecting it leads to underestimation of total grey WF.

3.4. Water footprint of consumption

Blue, green and grey WFs of consumption for each of the 35 APs are shown in Figures Figure 28 - Figure 30. The WF gradually increases from north (upstream) to south (downstream) of the SENET area. This is due to the fact the population density increases from rural areas upstream to urban areas downstream.

One interesting observation is that the spatial pattern of the green WF due to agricultural production (Figure 21) is opposite to that of green WF due to consumption (Figure 29). This is because from the production perspective the more the crop production in the area the larger the WF while from the consumption perspective, generally the more population the larger the water footprint.

One should bear in mind again that this estimation is based on the average national consumption WF and it is assumed that the WF of consumption per person is identical from AP to AP. However, these results provide an initial picture how the WF of consumption could be spatially distributed. Clearly, the consumption WFs of the catchments are much larger than the WFs of production i.e. the WFs within the catchments.

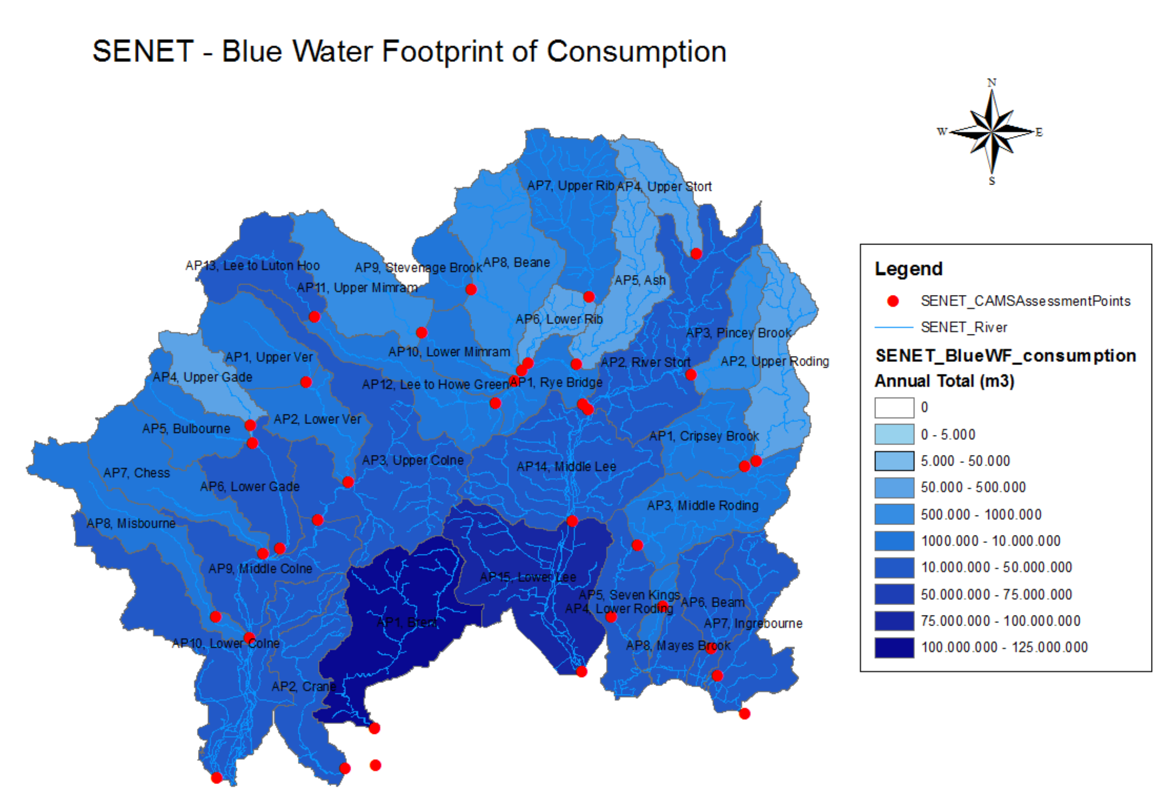

Figure 28. Annual blue water footprint of consumption per AP in the SENET catchments.

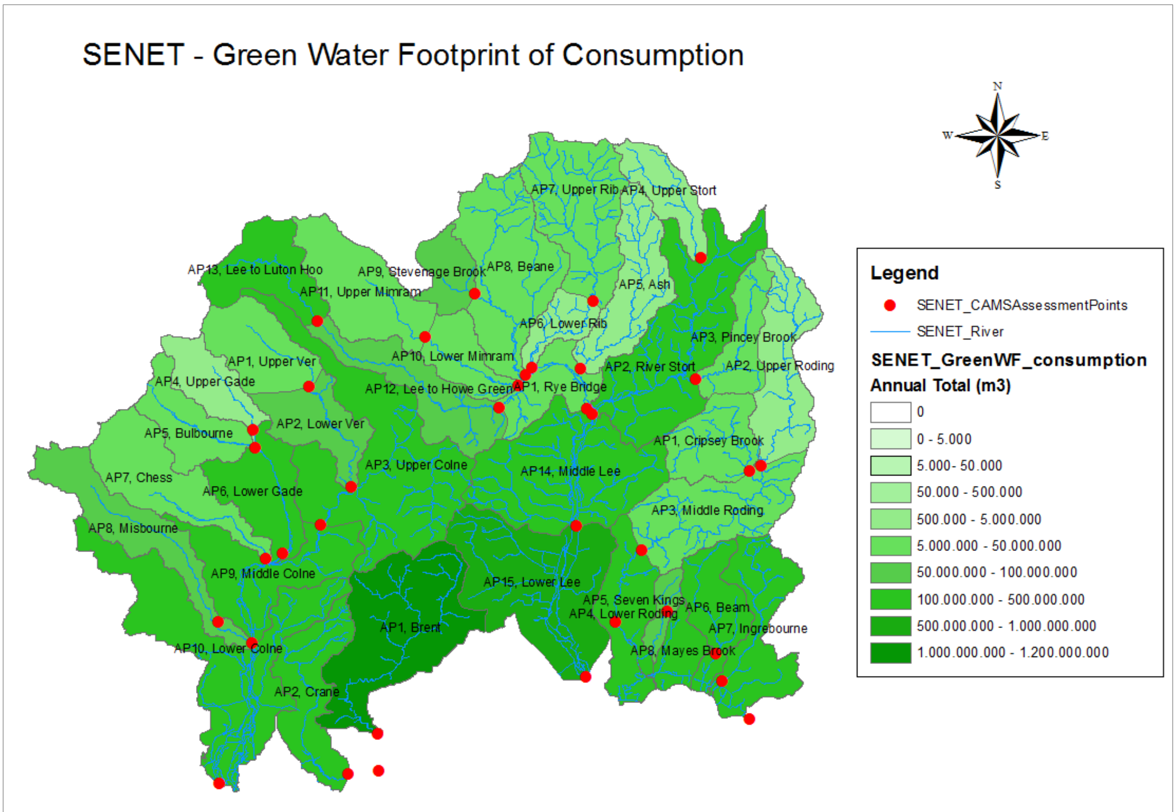

Figure 29. Annual green water footprint of consumption per AP in the SENET catchments.

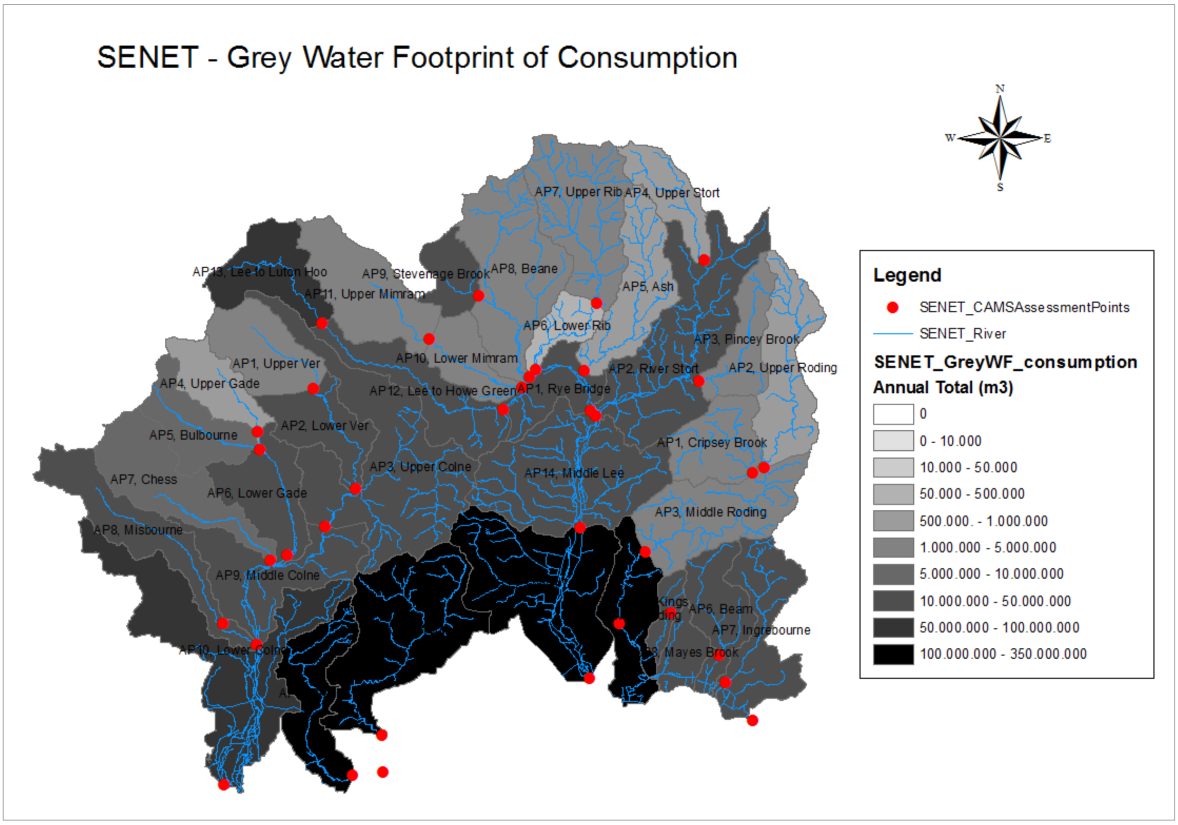

Figure 30. Annual grey water footprint of consumption per AP in the SENET catchments.

3.5. Water footprint sustainability assessment

In the baseline WF sustainability assessment, an overall BWS and blue groundwater scarcity have been analysed. The overall BWS is the ratio of total blue WF for all sectors on surface water and groundwater to the total blue water availability. The blue groundwater scarcity is the ratio of total blue WF of all sectors on groundwater to the groundwater availability (see Section 2.2.3).

The classification of overall BWS follows Hoekstra et al. (2012):

- **low** blue water scarcity (BWS<1.0): the total blue WF is lower than 15% of the natural runoff and does not exceed the blue water availability; presumed environmental flow requirements are not violated.
- **moderate** blue water scarcity (BWS=1.0 – 1.5): the blue water footprint is between 15% and 22.5% of the natural runoff; environmental flow requirements are not met.
- **significant** blue water scarcity (BWS=1.5 – 2.0): the blue water footprint is between 22.5% and 30% of the natural runoff; environmental flow requirements are not met.
- **severe** water scarcity (BWS>2.0). The blue water footprint exceeds 30% of natural runoff; environmental flow requirements are not met.

3.5.1. Overall blue water scarcity

Table 6 presents the assessment results of the overall BWS for all 35 APs. From the annual average BWS results, we can see that eight APs in the Colne catchment and seven APs in the Lee catchment have BWS values larger than 1.0 indicating that they are experiencing moderate, significant or severe blue water scarcity. The annual average BWS for all APs in the Brent and Crane and the RBI catchments is smaller than 1.0, therefore, these APs are not considered water scarce.

In general, the upstream APs are experiencing higher severity of annual average BWS than the downstream APs (Figure 31). This results from the upstream APs having lower natural flows thus less water availability and the upstream APs often transfer wastewater to the large STWs located in the downstream APs, leading to lost return flows. Lost return flow is a major component of the blue WF in many of these APs, and therefore major reason for water scarcity. In the case of Lee AP15, though it is the most downstream AP with relatively larger natural runoff, it has two months of significant blue water scarcity and 10 months of severe blue water scarcity. A large amount of water from AP15 is returned to RBI AP4 where a large STW (Beckton) is situated.

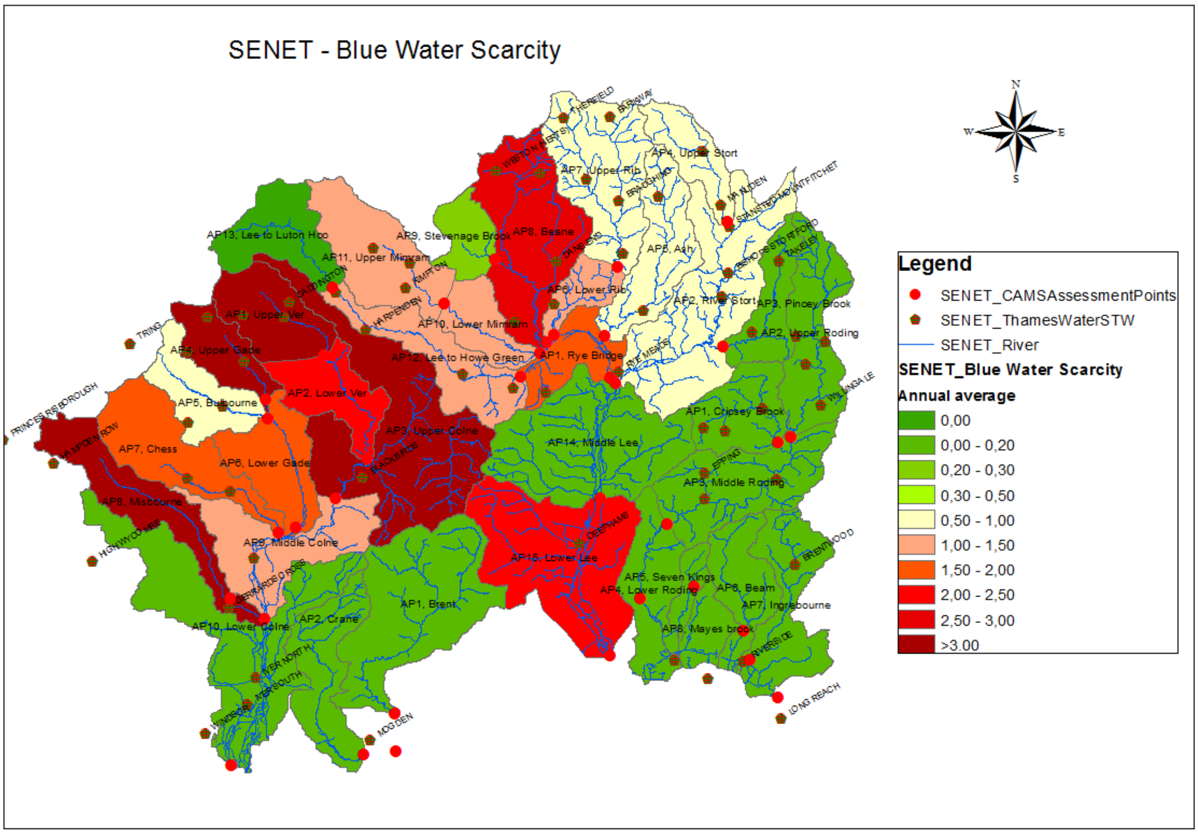

Figure 31. Annual average overall blue water scarcity in the SENET catchments.

The assessment of monthly BWS indicates that some upstream APs such as those in Colne catchment, (AP1, AP3, AP4 and AP8) and in the Lee catchment (e.g. AP8) are experiencing severe blue water scarcity all year long (Figure 32). AP6, AP7 and AP9 in the Colne catchment experience BWS at or above the moderate level for all 12 months in a year. In the Lee catchment, AP1 has two months of moderate BWS and 9 months of significant BWS. AP5, AP6, AP7, AP10, AP11 and AP12 in the Lee catchment have more than 5 months of moderate or higher BWS.

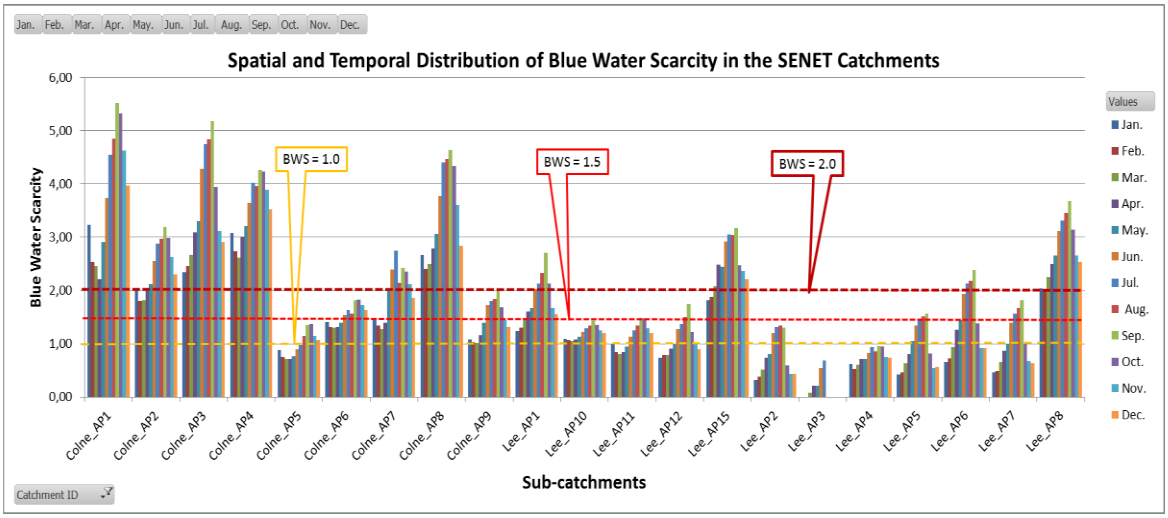

Figure 32. Spatial distribution of the monthly overall blue water scarcity in the SENET catchments (only the APs with blue water scarcity approaching or larger than 1.0 are presented in this figure).

Table 6. Monthly and annual average overall blue water scarcity for the SENET catchments.

Catchment ID	Number of months of low blue water scarcity	Number of months of moderate blue water scarcity	Number of months of significant blue water scarcity	Number of months of severe blue water scarcity	Annual average BWS	
					value	level
Brent & Crane_AP1	12	0	0	0	0,1	low
Brent & Crane_AP2	12	0	0	0	0,0	low
Colne_AP1	0	0	0	12	3,5	severe
Colne_AP2	0	0	2	10	2,4	severe
Colne_AP3	0	0	0	12	3,4	severe
Colne_AP4	0	0	0	12	3,4	severe
Colne_AP5	7	5	0	0	0,9	low
Colne_AP6	0	5	7	0	1,5	significant
Colne_AP7	0	4	1	7	1,9	significant
Colne_AP8	0	0	0	12	3,3	severe
Colne_AP9	0	7	5	0	1,4	moderate
Colne_AP10	12	0	0	0	0,1	low
RBI_AP1	12	0	0	0	0,0	low
RBI_AP2	12	0	0	0	0,0	low
RBI_AP3	12	0	0	0	0,0	low
RBI_AP4	12	0	0	0	0,0	low

RBI_AP5	12	0	0	0	0,1	low
RBI_AP6	12	0	0	0	0,0	low
RBI_AP7	12	0	0	0	0,0	low
RBI_AP8	12	0	0	0	0,0	low
Lee_AP1	0	3	9	0	1,7	significant
Lee_AP2	8	4	0	0	0,6	low
Lee_AP3	12	0	0	0	0,1	low
Lee_AP4	12	0	0	0	0,8	low
Lee_AP5	7	3	2	0	0,8	low
Lee_AP6	5	3	4	0	1,2	moderate
Lee_AP7	6	3	3	0	0,8	low
Lee_AP8	0	0	0	12	2,7	severe
Lee_AP9	12	0	0	0	0,3	low
Lee_AP10	0	12	0	0	1,2	moderate
Lee_AP11	4	8	0	0	1,1	moderate
Lee_AP12	7	3	2	0	1,0	moderate
Lee_AP13	12	0	0	0	0,0	low
Lee_AP14	12	0	0	0	0,0	low
Lee_AP15	0	0	2	10	2,4	severe

3.5.2. Blue groundwater water scarcity

Blue groundwater scarcity was classified as follows:

- **low** groundwater scarcity (groundwater BWS <1.0): the total groundwater blue WF is lower than 10% of the sustainable natural groundwater recharge.
- **significant** groundwater scarcity (groundwater BWS =1.0 – 2.0): the total groundwater WF is between 10% and 20% of the sustainable natural groundwater recharge.
- **severe** groundwater scarcity (groundwater BWS >2.0): The total groundwater WF exceeds 20% of natural groundwater recharge.

The annual average blue groundwater scarcity assessment shows that nine out of 10 APs of the Colne catchment experience significant or severe blue groundwater scarcity, the exception being Colne AP10, the most downstream sub-catchment. In the Lee catchment, out of 15 APs, four APs experience significant blue groundwater scarcity and five APs experience severe blue groundwater scarcity. Most of these APs are up- or middle-stream sub-catchments (Figure 33 and Figure 34). Brent and Crane and RBI catchments do not show any significant or severe annual average blue groundwater scarcity.

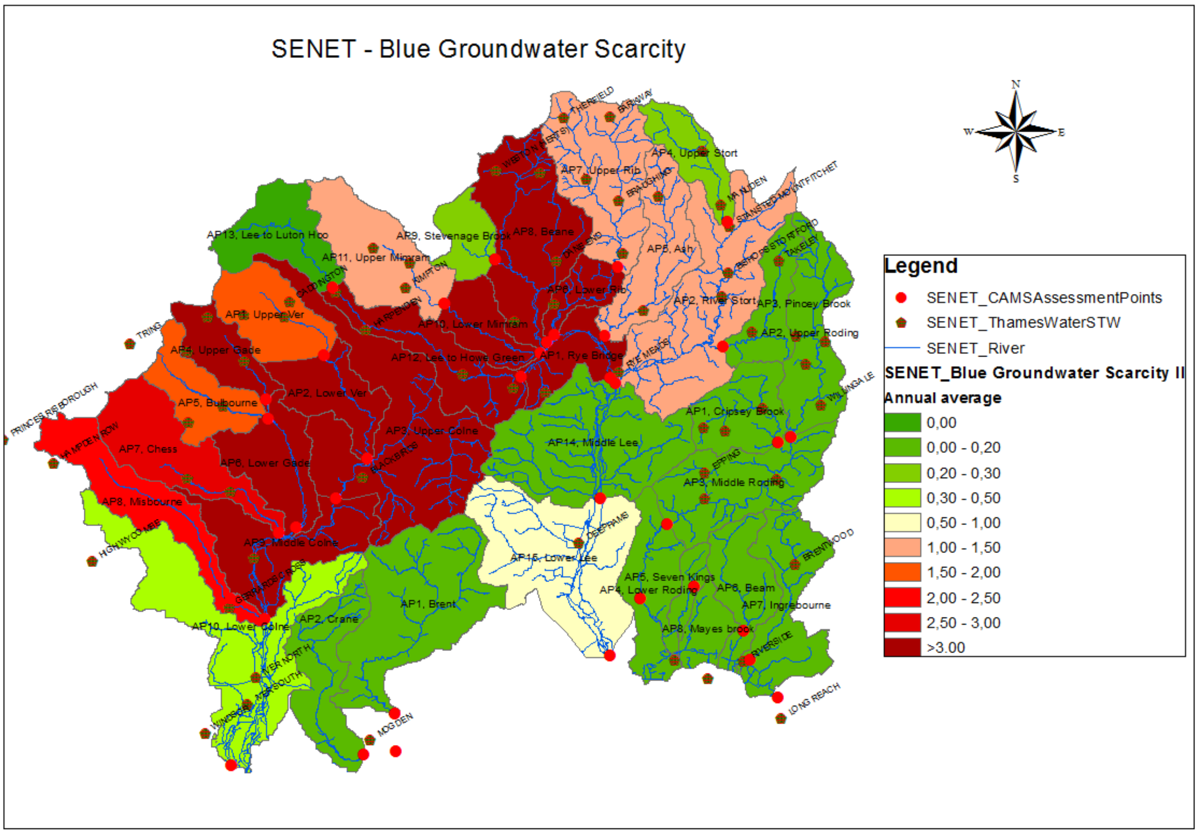

Figure 33. Annual average blue groundwater scarcity in the SENET catchments.

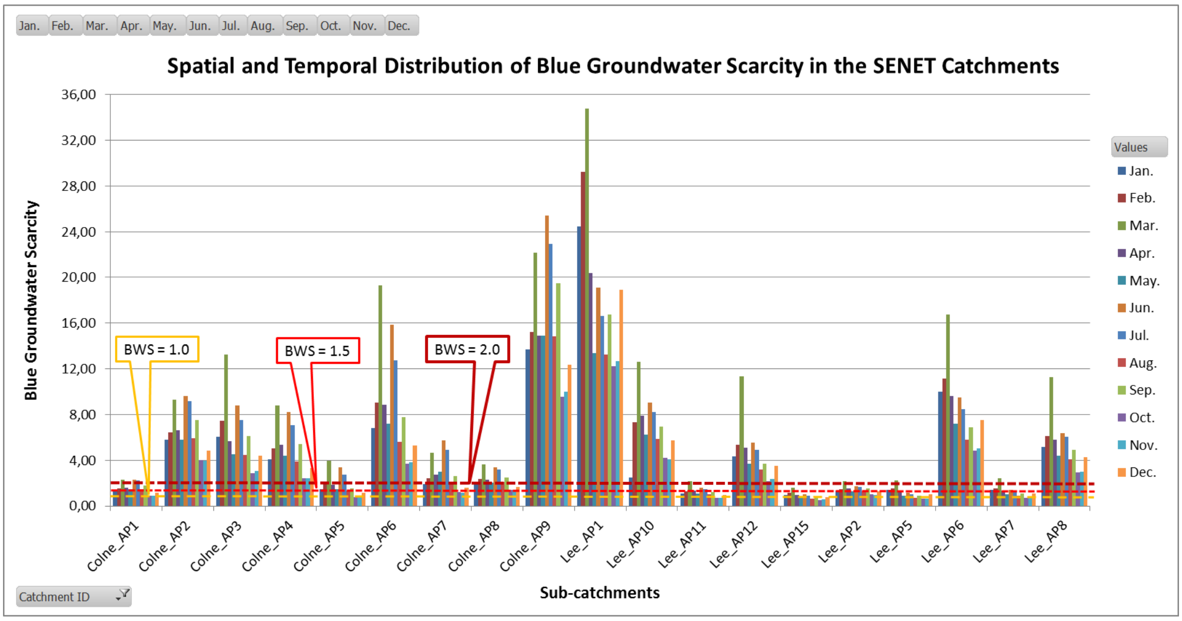

Figure 34. Spatial distribution of monthly blue groundwater scarcity in the SENET catchments (only the APs with blue groundwater scarcity approaching or larger than 1.0 are presented in this figure).

Nine APs from Colne and Lee catchments experience severe monthly blue groundwater scarcity for all months of the year (Table 7). Another eight APs of these two catchments experience significant or severe monthly blue groundwater scarcity for more than seven months per year. Some of these APs, such as Colne AP6, Colne AP9, Lee AP1, Lee AP6 and Lee AP10 have monthly blue groundwater scarcity of larger than 10 and even up to 20 in many months indicating that sustainable natural recharge has been violated by 100% -200%, namely the sustainable recharge has been fully consumed and the groundwater reserve has been overabstracted. The most severe groundwater scarcity, with a BWS value of 35, occurs in March in Lee AP1. Groundwater is the major source for all three sectors in the study area and the groundwater abstracted in many APs is not returned to the original source. For example, about 40 Mm^3/year of groundwater abstracted from Colne AP9 is transferred to outside the SENET area, leading to high blue groundwater scarcity in this AP. In the case Lee AP1, more than 80% of its blue WF on groundwater results from the lost return flows while the natural recharge of this AP is less than the average natural recharge in the study area, giving rise to very high groundwater scarcity. Detailed monthly groundwater BWS results are presented in Table A7-2 of Annex 7.

Table 7. Monthly and annual average blue groundwater scarcity for the SENET catchments.

Catchment ID	Number of months of low groundwater BWS	Number of months of significant groundwater BWS	Number of months of severe groundwater BWS	Annual average groundwater BWS	
				value	level
Brent & Crane_AP1	12	0	0	0,0	low
Brent & Crane_AP2	12	0	0	0,0	low
Colne_AP1	2	7	3	1,6	significant
Colne_AP2	0	0	12	6,6	severe
Colne_AP3	0	0	12	6,2	severe
Colne_AP4	0	0	12	5,0	severe
Colne_AP5	2	7	3	1,9	significant
Colne_AP6	0	0	12	8,8	severe
Colne_AP7	0	5	7	2,8	severe
Colne_AP8	0	3	9	2,3	severe
Colne_AP9	0	0	12	16,3	severe
Colne_AP10	12	0	0	0,4	low
RBI_AP1	12	0	0	0,0	low
RBI_AP2	12	0	0	0,0	low
RBI_AP3	12	0	0	0,0	low
RBI_AP4	12	0	0	0,0	low
RBI_AP5	12	0	0	0,1	low
RBI_AP6	12	0	0	0,0	low
RBI_AP7	12	0	0	0,0	low
RBI_AP8	12	0	0	0,0	low
Lee_AP1	0	0	12	19,3	severe
Lee_AP2	1	10	1	1,4	significant

Lee_AP3	12	0	0	0,0	low
Lee_AP4	12	0	0	0,2	low
Lee_AP5	5	6	1	1,1	significant
Lee_AP6	0	0	12	8,6	severe
Lee_AP7	3	8	1	1,3	significant
Lee_AP8	0	0	12	5,4	severe
Lee_AP9	12	0	0	0,3	low
Lee_AP10	0	0	12	6,7	severe
Lee_AP11	3	8	1	1,2	significant
Lee_AP12	0	0	12	4,6	severe
Lee_AP13	12	0	0	0,0	low
Lee_AP14	12	0	0	0,0	low
Lee_AP15	9	3	0	0,9	low

3.5.3. Baseline surface water pollution level

Surface water pollution level was classified as follows:

- **low** surface water pollution level (surface WPL <1.0): the total grey WF on surface water is less than 100% of the actual runoff; the pollution load is smaller than the critical load and the assimilation capacity of the receiving water body is not fully consumed.
- **significant** surface water pollution level (surface WPL =1.0 – 2.0): the total grey WF on surface water is between 100% and 200% of the actual runoff; the pollution load is 1 to 2 times larger than the critical load and the assimilation capacity of the receiving water body has been exceeded.
- **severe** surface water pollution level (surface WPL >2.0): the total grey WF on surface water is larger than 200% of the actual runoff; the pollution load is larger than 2 times larger than the critical load and the assimilation capacity of the receiving water body has been exceeded.

Figure 35 shows the spatial pattern of annual average surface WPL in the SENET catchments. A total of twelve APs, Brent and Crane AP1, two APs in Colne catchment, four APs in RBI catchment and six APs in Lee catchment, have an annual average surface WPL equal to or larger than 1 indicating that these APs experience a significant or severe level of surface water pollution. The analysis revealed that either a higher number of or larger scale of STWs (implying high pollution loading) are located in these APs while many of these APs are upstream sub-catchments (implying less runoff in streams).

The monthly surface WPL analysis (Figure 36 and Table 8) indicates that 18 APs are experiencing significant or severe of water pollution level in one or more months of the year. August to November is a critical period for many APs regarding the surface WPL. It is interesting to note that five RBI APs experience either significant or severe annual average or monthly surface WPL although they do not experience high blue water scarcity. These APs receive a large amount of return flows and associated high pollution loads from adjacent APs. High WPL in the Upper Lee catchment are linked to agricultural runoff.

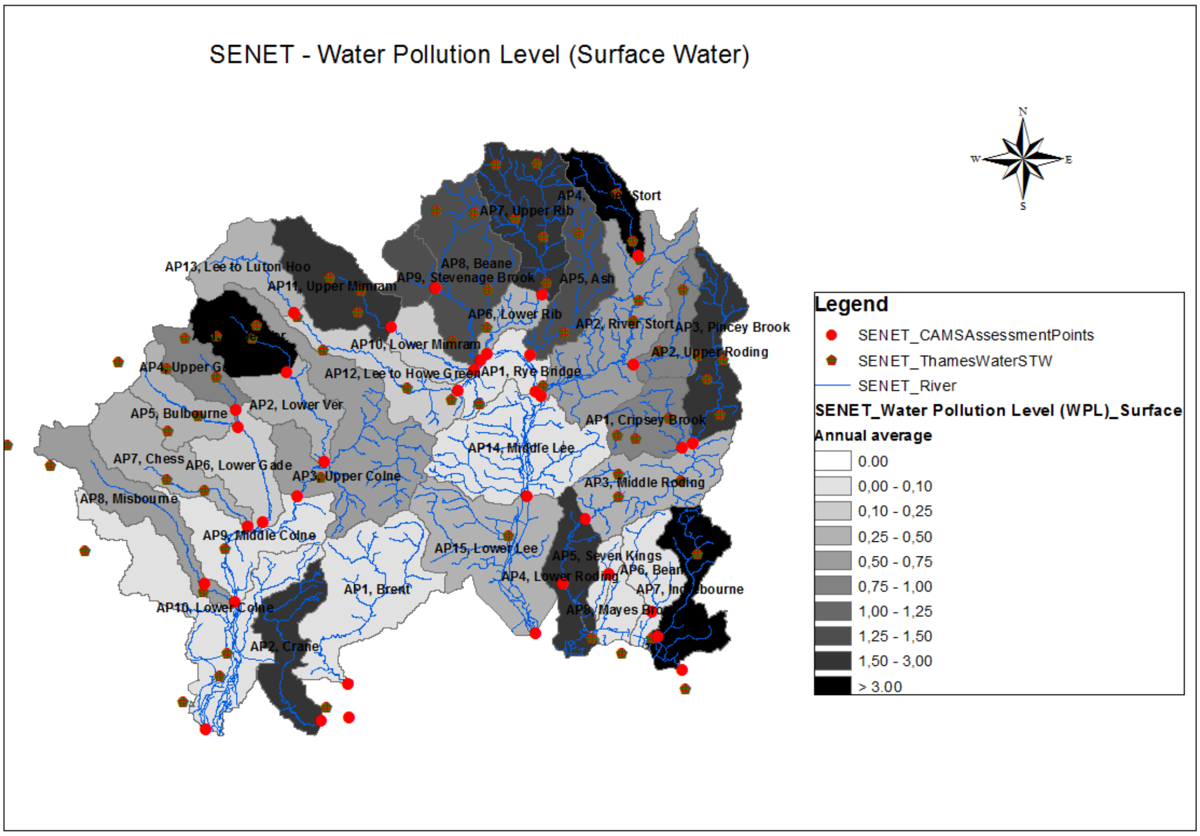

Figure 35. Annual average surface water pollution level of each AP in the SENET catchments.

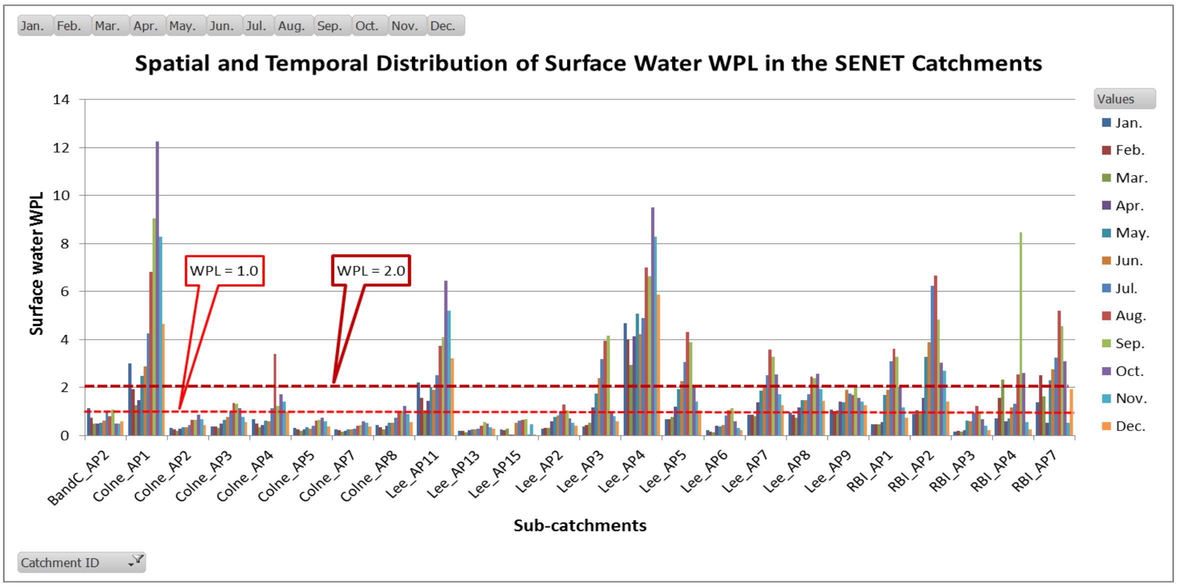

Figure 36. Spatial distribution of the monthly surface water pollution level in the SENET catchments (only the APs with surface water pollution levels approaching or larger than 1.0 are presented in this figure).

Table 8. Monthly and annual average surface water pollution level for the SENET catchments.

Catchment ID	Number of months of low surface water pollution level	Number of months of significant surface water pollution level	Number of months of severe surface water pollution level	Annual average surface water pollution level	
				value	level
Brent & Crane_AP1	12	0	0	0,0	low
Brent & Crane_AP2	0	2	10	2,6	severe
Colne_AP1	0	3	9	3,4	severe
Colne_AP2	12	0	0	0,4	low
Colne_AP3	8	4	0	0,7	low
Colne_AP4	7	4	1	0,9	low
Colne_AP5	12	0	0	0,4	low
Colne_AP6	12	0	0	0,1	low
Colne_AP7	12	0	0	0,4	low
Colne_AP8	8	4	0	0,7	low
Colne_AP9	12	0	0	0,1	low
Colne_AP10	12	0	0	0,0	low
RBI_AP1	5	3	4	1,0	significant
RBI_AP2	2	3	7	2,0	significant
RBI_AP3	9	3	0	0,4	low
RBI_AP4	1	2	9	2,4	severe
RBI_AP5	12	0	0	0,0	low
RBI_AP6	12	0	0	0,1	low
RBI_AP7	0	1	11	3,5	severe
RBI_AP8	12	0	0	0,0	low
Lee_AP1	12	0	0	0,0	low
Lee_AP2	8	4	0	0,7	low
Lee_AP3	5	3	4	0,9	low
Lee_AP4	0	0	12	5,4	severe
Lee_AP5	3	4	5	1,4	significant
Lee_AP6	10	2	0	0,3	low
Lee_AP7	3	4	5	1,6	significant
Lee_AP8	3	6	3	1,4	significant
Lee_AP9	0	11	1	1,4	significant

Lee_AP10	12	0	0	0,2	low
Lee_AP11	0	4	8	2,5	severe
Lee_AP12	12	0	0	0,2	low
Lee_AP13	12	0	0	0,3	low
Lee_AP14	12	0	0	0,0	low
Lee_AP15	12	0	0	0,4	low

3.5.4. Baseline groundwater pollution level

Similarly to the surface water pollution level, the groundwater pollution level was classified as follows:

- **low** groundwater pollution level (groundwater pollution level <1.0): the total grey WF on groundwater is smaller than 100% of the natural recharge; the pollution load is less than the critical load and the assimilation capacity of the receiving groundwater body is not fully consumed.
- **significant** groundwater pollution level (groundwater pollution level =1.0 – 2.0): the total grey WF on groundwater is between 100% and 200% of the natural recharge; the pollution load is 1 to 2 times larger than the critical load and the assimilation capacity of the receiving groundwater body has been exceeded.
- **severe** groundwater pollution level (groundwater pollution level >2.0): the total grey WF on groundwater is 200% of the actual runoff; the pollution load is larger than 2 times of the critical load and the assimilation capacity of the receiving groundwater body is exceeded.

Three APs experience annual average groundwater pollution levels greater than 1 (Figure 37 and Table 9). The groundwater pollution level of Colne AP9 is significant while that of Colne AP10 and Lee AP14 is severe. The monthly values of the groundwater pollution level (Figure 38 and Table 9) indicate that Colne AP10 and Lee AP14 have a severe WPL throughout the whole year. Colne AP9 has six months, Colne AP1 has four months and RBI AP3 has three months of significant groundwater pollution level. The high groundwater pollution level in these APs is due to the recharge of large volumes of effluent into the aquifers indicating that treated effluent still holds a large pollution load. Results indicate that Colne AP10 and Lee AP14 are exposed to high levels of ammonia-nitrogen; however, there is likely a certain level of overestimation of the grey WF on groundwater as a result of using the daily maximum load of the ammonia-nitrogen.

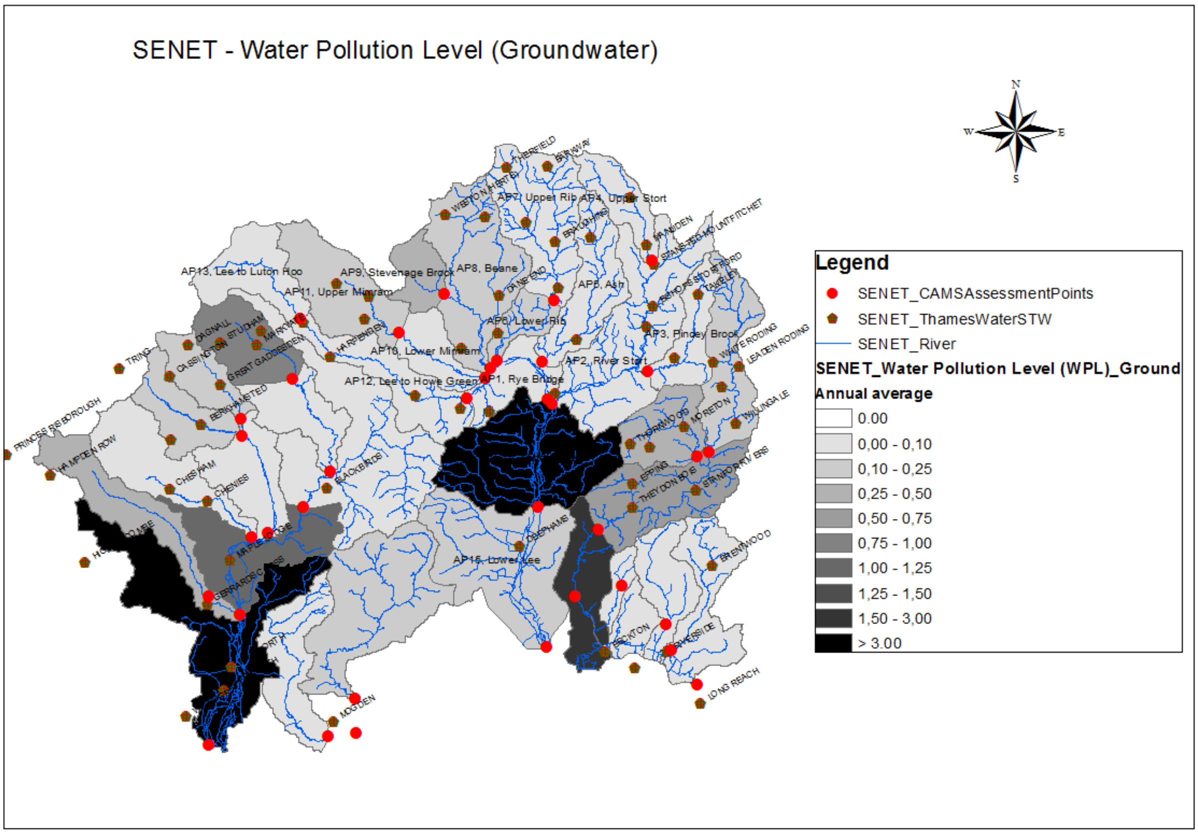

Figure 37. Annual average groundwater pollution level of the SENET catchments.

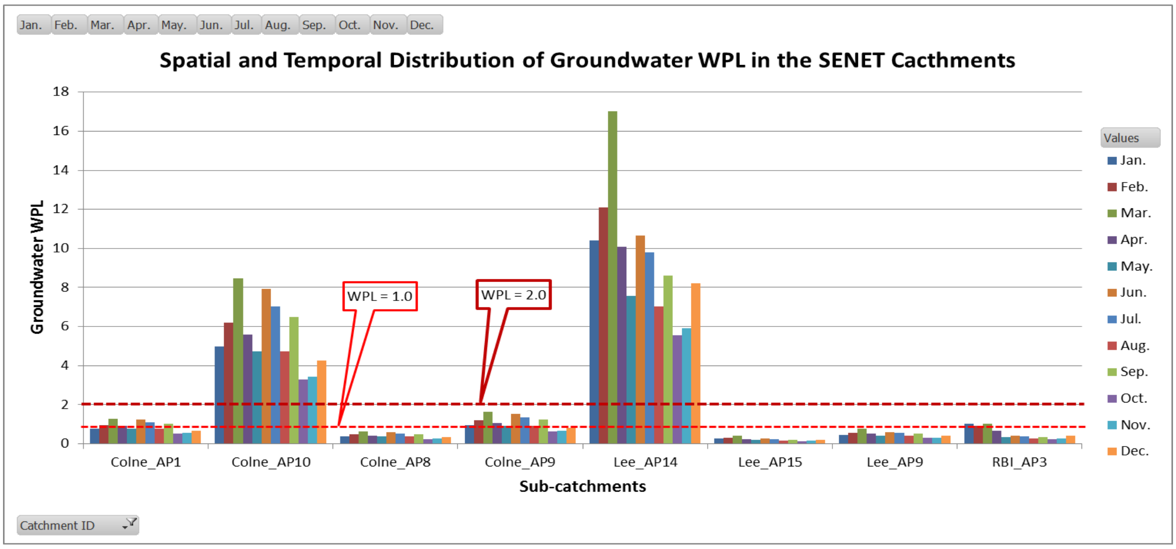

Figure 38. Spatial distribution of the monthly groundwater pollution level in the SENET catchments (only the APs with groundwater pollution level approaching or larger than 1.0 are presented in this figure).

Table 9. Monthly and annual average groundwater pollution level for the SENET catchments.

Catchment ID	Number of months of low groundwater water pollution level	Number of months of significant groundwater water pollution level	Number of months of severe groundwater water pollution level	Annual average groundwater water pollution level	
				value	level
Brent & Crane_AP1	12	0	0	0,1	low
Brent & Crane_AP2	12	0	0	0,0	low
Colne_AP1	8	4	0	0,9	low
Colne_AP2	12	0	0	0,0	low
Colne_AP3	12	0	0	0,0	low
Colne_AP4	12	0	0	0,1	low
Colne_AP5	12	0	0	0,2	low
Colne_AP6	12	0	0	0,0	low
Colne_AP7	12	0	0	0,1	low
Colne_AP8	12	0	0	0,4	low
Colne_AP9	6	6	0	1,1	significant
Colne_AP10	0	0	12	5,6	severe
RBI_AP1	12	0	0	0,0	low
RBI_AP2	12	0	0	0,1	low
RBI_AP3	10	2	0	0,5	low
RBI_AP4	12	0	0	0,0	low
RBI_AP5	12	0	0	0,0	low
RBI_AP6	12	0	0	0,0	low
RBI_AP7	12	0	0	0,0	low
RBI_AP8	12	0	0	0,0	low
Lee_AP1	12	0	0	0,1	low
Lee_AP2	12	0	0	0,0	low
Lee_AP3	12	0	0	0,1	low
Lee_AP4	12	0	0	0,0	low
Lee_AP5	12	0	0	0,1	low
Lee_AP6	12	0	0	0,1	low
Lee_AP7	12	0	0	0,1	low
Lee_AP8	12	0	0	0,1	low
Lee_AP9	12	0	0	0,5	low

Lee_AP10	12	0	0	0,1	low
Lee_AP11	12	0	0	0,2	low
Lee_AP12	12	0	0	0,1	low
Lee_AP13	12	0	0	0,0	low
Lee_AP14	0	0	12	9,4	severe
Lee_AP15	12	0	0	0,2	low

3.5.5. Summary of the water footprint sustainability assessment

Table 10 gives an overview of BWS and WPL assessment results for all 35 APs in the SENET catchments. The Brent and Crane and RBI catchments do not experience blue surface water or groundwater scarcity or high groundwater pollution levels. Brent and Crane AP2 and RBI AP2, AP4 and AP7 are affected by high surface water pollution levels. In the Colne catchment, only AP5 and AP10 are free from overall blue water scarcity. Colne AP5 has significant blue groundwater scarcity and Colne AP10 experiences severe ground water pollution levels. The remaining Colne catchment APs experience moderate to severe blue surface and groundwater scarcity. Additionally, Colne AP1 experiences severe surface WPL and Colne AP9 experiences significant groundwater pollution levels. Seven of the fifteen APs in the Lee Catchment experience moderate to severe levels of overall BWS while nine of the APs experience significant to severe blue groundwater scarcity. AP8 in the Lee catchment experiences severe blue surface and groundwater scarcity. Six of the fifteen APs in the Lee catchment experience significant or severe surface WPL of which only AP4 and AP9 do not experience overall blue water scarcity and groundwater scarcity. AP14 is the only AP in the Lee catchment with severe groundwater pollution levels.

Table 10. Overview of blue water scarcity and water pollution level of the SENET catchments.

Catchment ID	Overall Blue Water Scarcity		Blue Groundwater Scarcity		Surface Water Pollution Level		Groundwater Pollution Level	
	Annual average	number of months at moderate or higher level	Annual average	number of months at significant or higher level	Annual average	number of months at significant or higher level	Annual average	number of months at significant or higher level
Brent & Crane_AP1	low	0	low	0	low	0	low	0
Brent & Crane_AP2	low	0	low	0	severe	12	low	0
Colne_ AP1	severe	12	significant	10	severe	12	low	4
Colne_AP2	severe	12	severe	12	low	0	low	0
Colne_AP3	severe	12	severe	12	low	4	low	0
Colne_AP4	severe	12	severe	12	low	5	low	0
Colne_AP5	low	5	significant	10	low	0	low	0
Colne_AP6	significant	12	severe	12	low	0	low	0
Colne_AP7	significant	12	severe	12	low	0	low	0
Colne_AP8	severe	12	severe	12	low	4	low	0
Colne_AP9	moderate	12	severe	12	low	0	significant	6
Colne_ AP10	low	0	low	0	low	0	severe	12
RBI_AP1	low	0	low	0	low	7	low	0
RBI_AP2	low	0	low	0	significant	10	low	0

RBI_AP3	low	0	low	0	low	3	low	2
RBI_AP4	low	0	low	0	severe	11	low	0
RBI_AP5	low	0	low	0	low	0	low	0
RBI_AP6	low	0	low	0	low	0	low	0
RBI_AP7	low	0	low	0	severe	12	low	0
RBI_AP8	low	0	low	0	low	0	low	0
Lee_AP1	significant	12	severe	12	low	0	low	0
Lee_AP2	low	4	significant	11	low	4	low	0
Lee_AP3	low	0	low	0	low	7	low	0
Lee_AP4	low	0	low	0	severe	12	low	0
Lee_AP5	low	5	significant	7	significant	9	low	0
Lee_AP6	moderate	7	severe	12	low	2	low	0
Lee_AP7	low	6	significant	9	significant	9	low	0
Lee_AP8	severe	12	severe	12	significant	9	low	0
Lee_AP9	low	0	low	0	significant	12	low	0
Lee_AP10	moderate	12	severe	12	low	0	low	0
Lee_AP11	moderate	8	significant	9	severe	12	low	0
Lee_AP12	moderate	5	severe	12	low	0	low	0
Lee_AP13	low	0	low	0	low	0	low	0
Lee_AP14	low	0	low	0	low	0	severe	12
Lee_AP15	severe	12	low	3	low	0	low	0

3.6. Water Footprint Assessment 2060

3.6.1. Projection of blue, green and grey water footprint

Blue water footprint projection

The projected total blue WF for each AP increases on average by 25% (Figure 39). As in the baseline condition, the large blue WF for some of the APs (e.g. Lee AP15, Colne AP1 and Colne AP9 etc.) is mostly due to the lost return flows. In the projection of the blue WF of the agricultural sector, the “dry” and “wet” climate scenarios were applied in CROPWAT model to calculate the blue WF of crop cultivation in 2060. The projected blue WF of agriculture for the two climate scenarios do not differ much; they are on average 1.5 times larger than the baseline blue WF of agriculture.

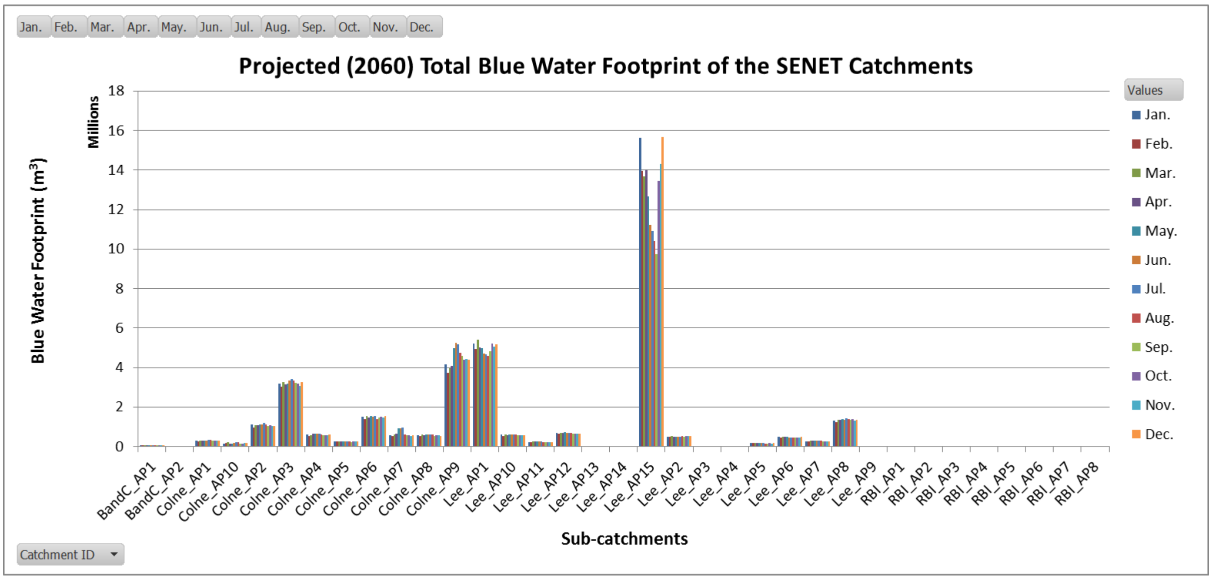

Figure 39. Projected monthly total blue water footprint for each AP in the SENET catchments.

Green water footprint projection

The green WF of agriculture is 10% and 18% lower than that of the baseline green WF in the "wet" climate scenario and the "dry" climate scenario, respectively. This is due to the fact that the annual precipitation (green water) even under the "wet" climate scenario is about 6% less than the baseline annual precipitation. The comparison between the "wet" and the "dry" climate scenarios (Figure 40) show that the green WF for the 2060 "wet" climate scenario is in average 10% higher than that for the 2060 "dry" climate scenario. This can be explained as a result of the precipitation of the "wet" climate scenario being about 19% more than that of the "dry" climate scenario. The spatial pattern of the green WF for both scenarios is illustrated in Figure 41 and Figure 42.

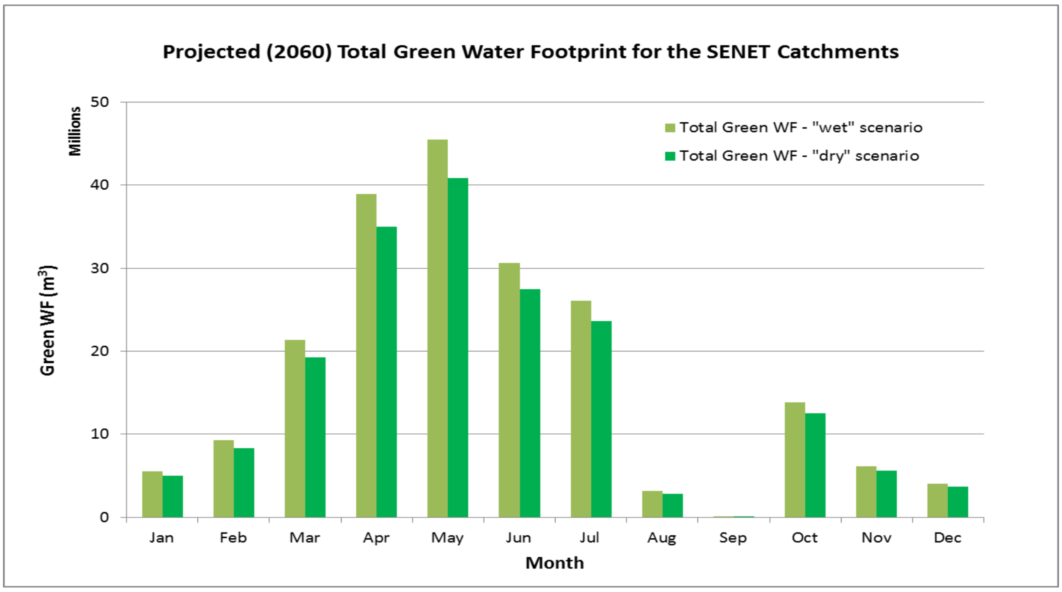

Figure 40. Projected monthly total green water footprint for the SENET catchments for the 2060 "wet" and "dry" climate scenarios.

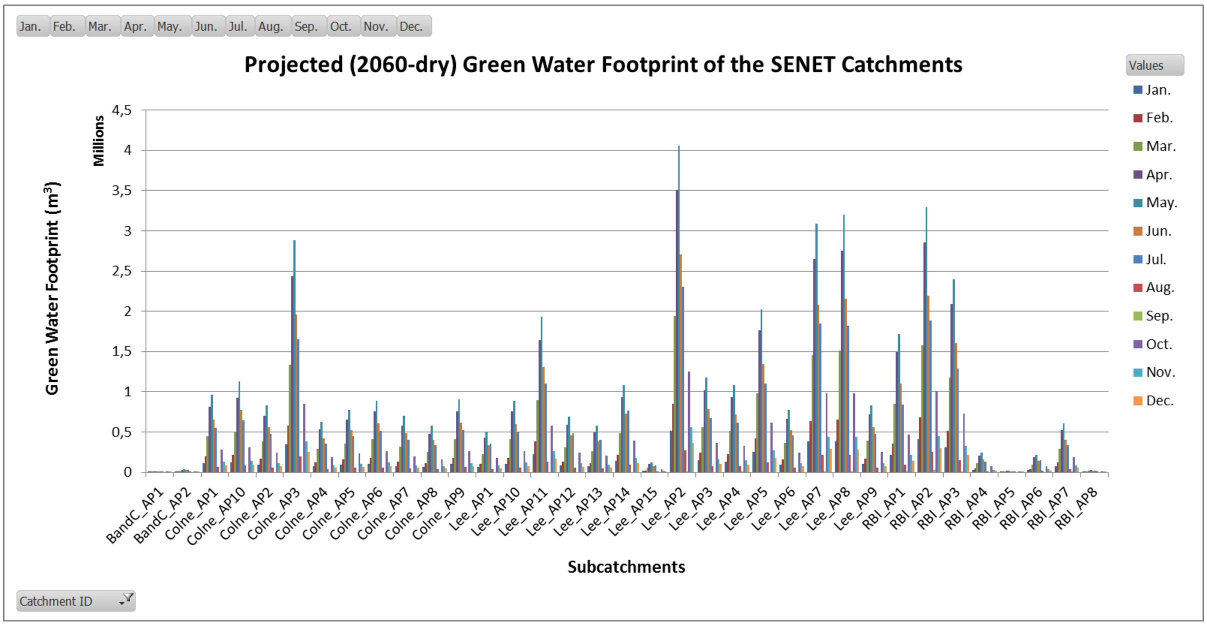

Figure 41. Projected monthly green water footprint for each AP in the SENET catchments for the 2060 “dry” climate scenario.

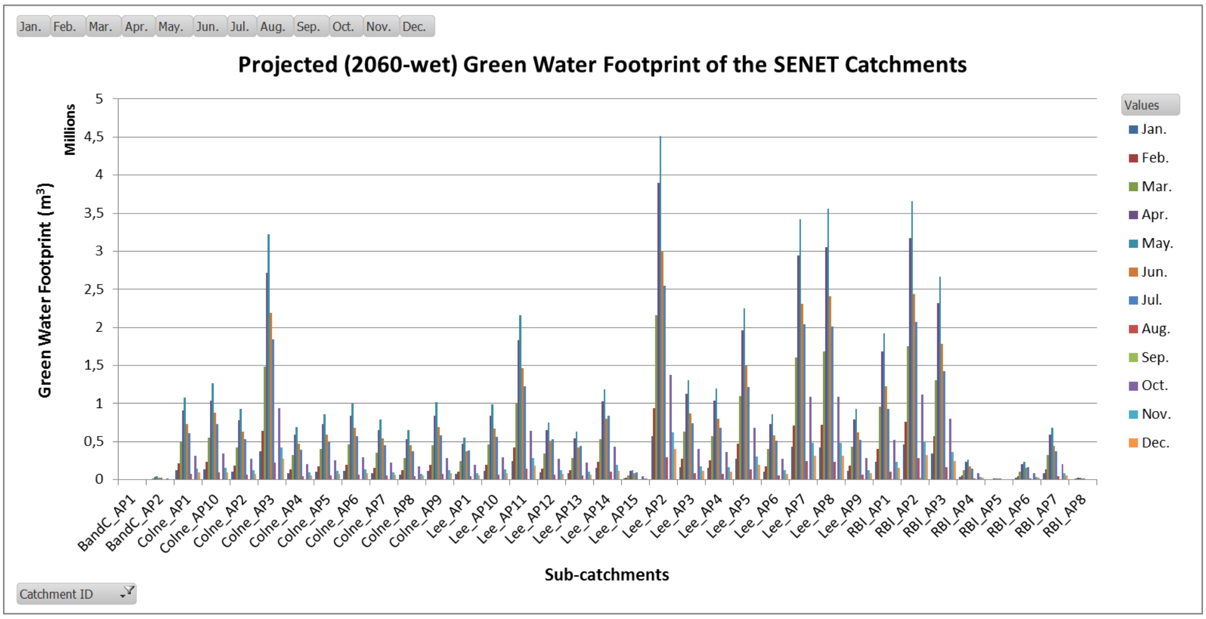

Figure 42. Projected monthly green water footprint for each AP in the SENET catchments for the 2060 “wet” climate scenario.

Grey water footprint projection

The 2060 projected total grey WF of the SENET catchments is 1480 Mm^3/year, about a 7% increase with reference to the baseline total grey WF. Figure 43 shows the spatial pattern of the projected total monthly grey WF in the SENET catchments. Similar to the baseline condition, Brent and Crane AP2, Colne AP9 and Colne AP10, Lee AP14 and Lee AP15, RBI AP4 and RBI AP7 are the APs having a larger grey WF compared to the other APs.

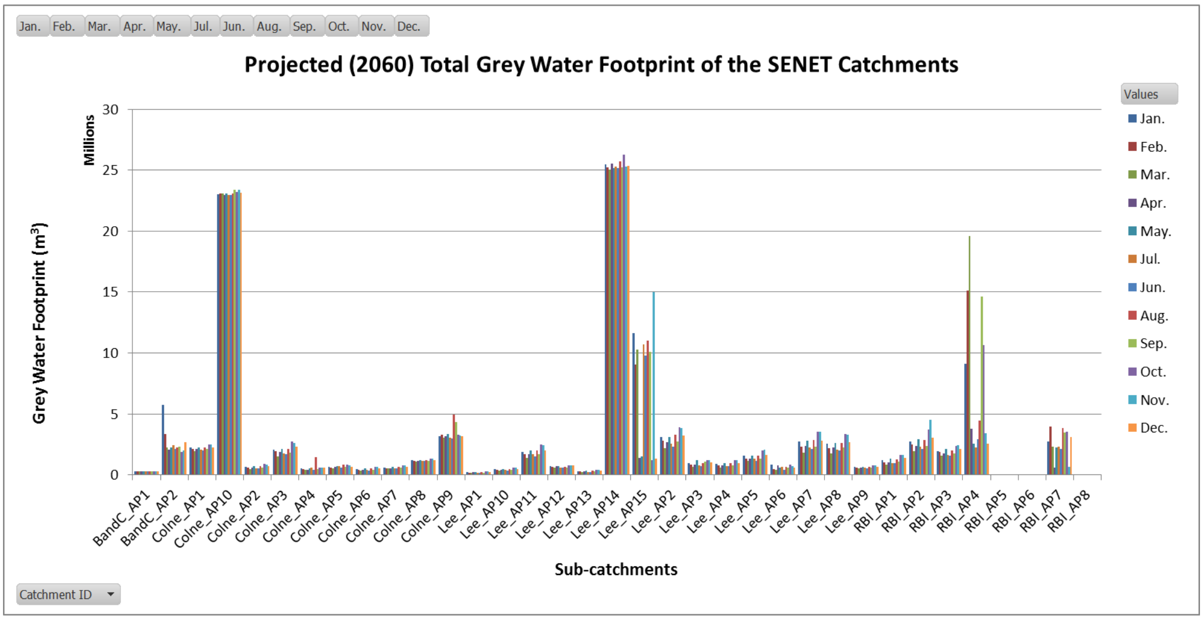

Figure 43. 2060 projected monthly total grey water footprint for each AP in the SENET catchments.

The blue, green and grey water footprint in the SENET catchments change under the projected 2060 climate change and water use scenarios (Figure 44). In 2060, the total blue WF would increase by 25%, the total green WF would decrease by 15% (average of the "dry" and "wet" scenarios) and the total grey WF would increase by 7%. Bear in mind that this projection includes uncertainties due to data limitations and the assumptions made. Nonetheless, an increase of the blue and grey WFs in the study area is likely to occur in the future.

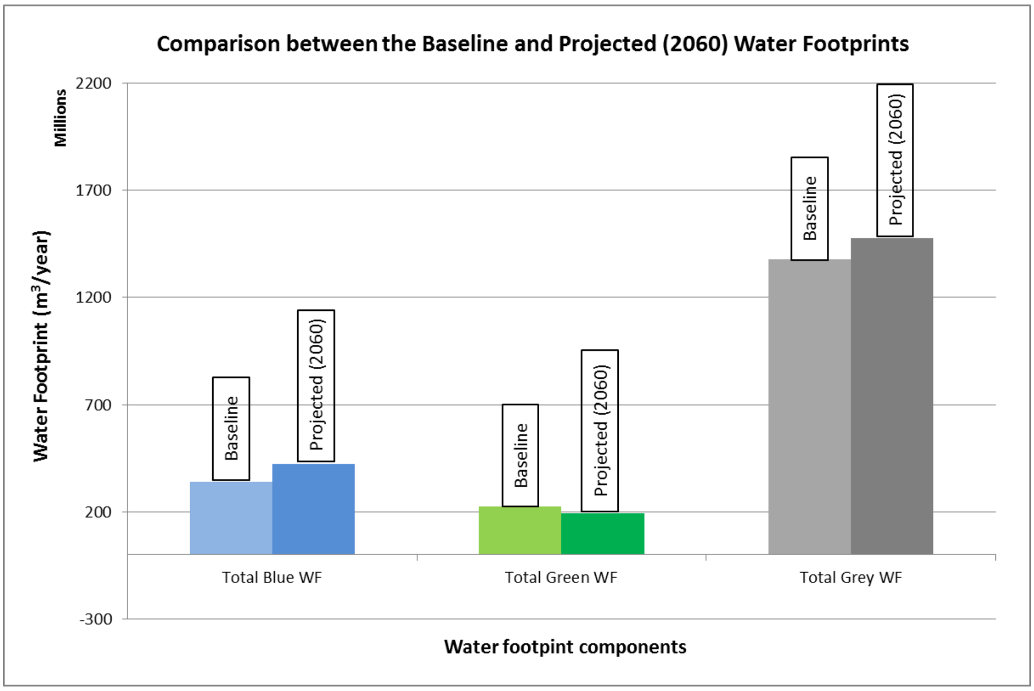

Figure 44. Comparison of the baseline and 2060 projected water footprint in the SENET area.

3.6.2. Projection of blue water scarcity

The projected increase in the blue WF under both the "wet" and "dry" climate scenarios will consequently result in an increase in overall BWS (Figure 45). The annual average overall

BWS under the “wet” climate scenario increases by 30% compared to that under the baseline condition while it increases 80% under the “dry” climate scenario. The annual average BWS under the “dry” climate scenario is 1.5 times more severe than that under the “wet” climate scenario. 2060 projections of annual average overall BWS indicate that AP5 in the Colne catchment and AP5 and AP7 in the Lee catchment will increase from a level of low to moderate or significant (Table 11). The annual average overall BWS for Lee AP10, Lee AP11 and Lee AP12 will increase from moderate to significant or severe under the “dry” climate scenario. Colne AP9 and Lee AP6 will increase from moderate to significant or severe annual average overall BWS. Lee AP1 is projected to increase from significant to severe annual average overall BWS. Under the “dry” climate scenario, seven additional APs will experience severe annual average overall BWS. Most of the upstream APs of Colne and Lee catchment will have the annual average BWS larger 2 (Figure 46).

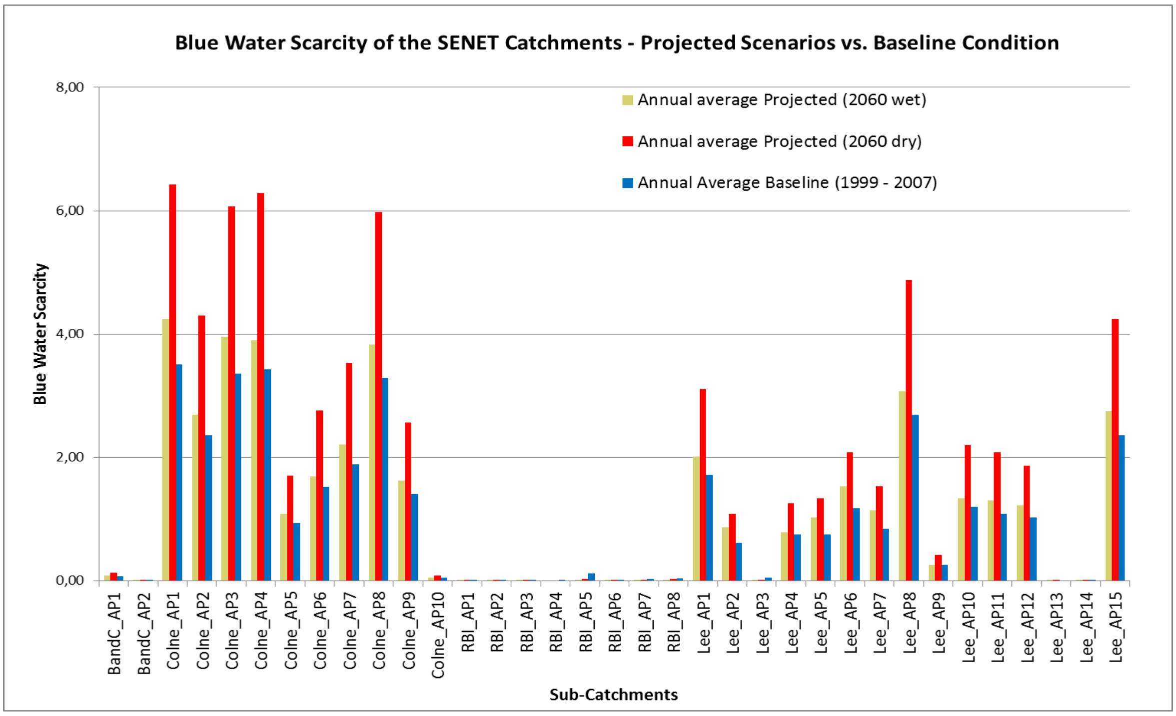

Figure 45. Comparison of the blue water scarcity of each AP in the SENET catchments under baseline condition, 2060 “wet” and 2060 “dry” scenarios.

The monthly overall blue water scarcity values under the “wet” climate scenario range from 0 to 6.3, with a BWS of 6.3 occurring in September in Colne AP1 (Figure 47). Under the “wet” climate scenario, twenty APs will experience at least one month of moderate or higher overall blue water scarcity. Five APs will experience severe overall blue water scarcity throughout the year. The monthly overall blue water scarcity values under the “dry” climate scenario range from 0 to 9.8 (Figure 48). The severity of monthly overall BWS becomes more pronounced compared to that under the “wet” scenario with 10 APs experiencing severe monthly overall BWS throughout the year.

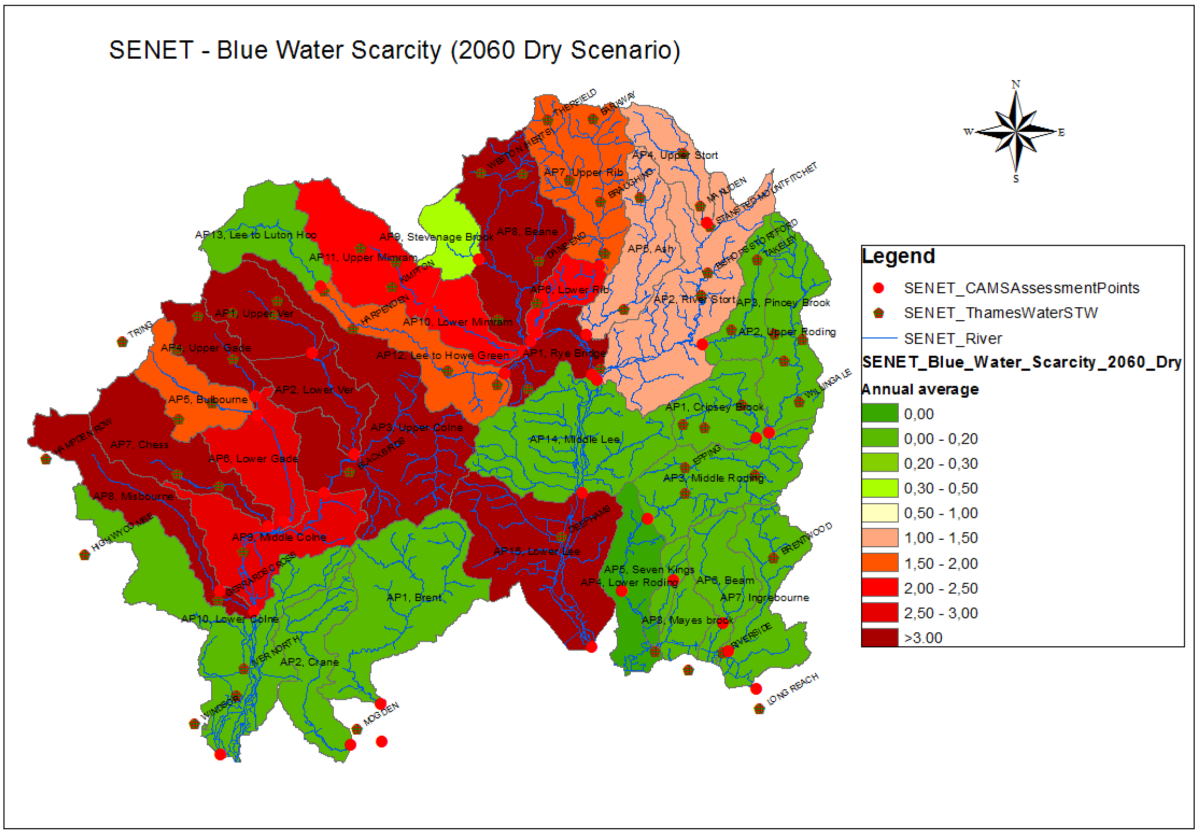

Figure 46. Annual average blue water scarcity of each AP under 2060 “dry” scenario in the SENET catchments.

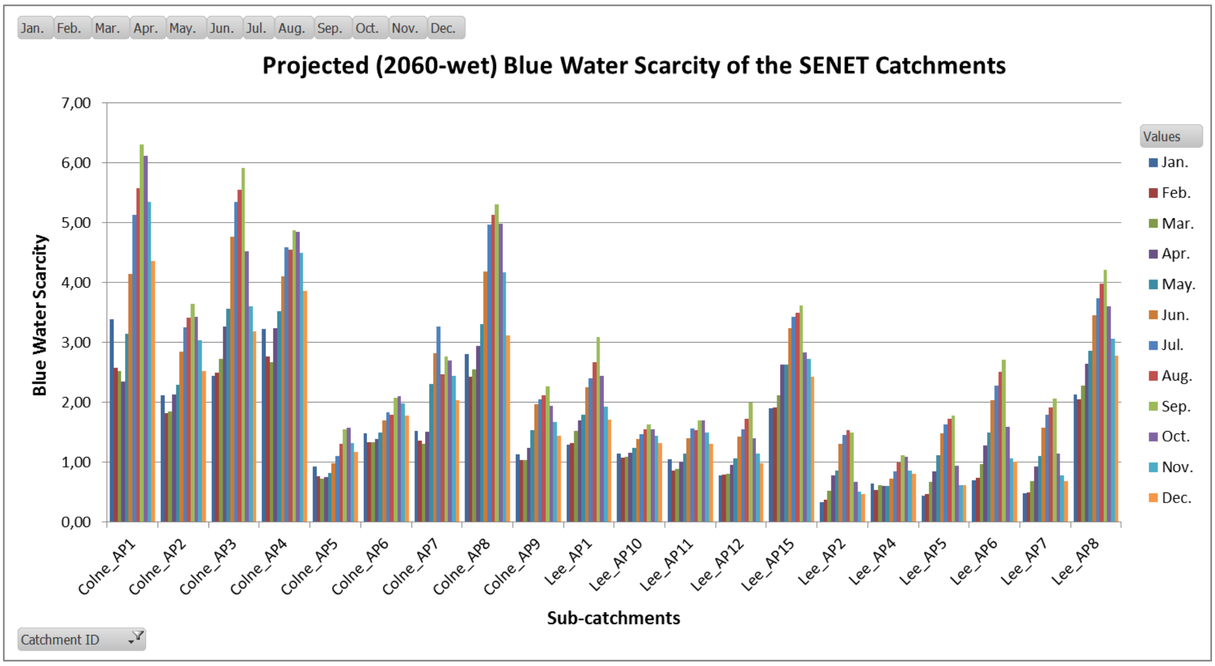

Figure 47. 2060 projected “wet” climate scenario monthly blue water scarcity in the SENET catchments (only the APs with blue water scarcity approaching or larger than 1.0 are presented in this figure).

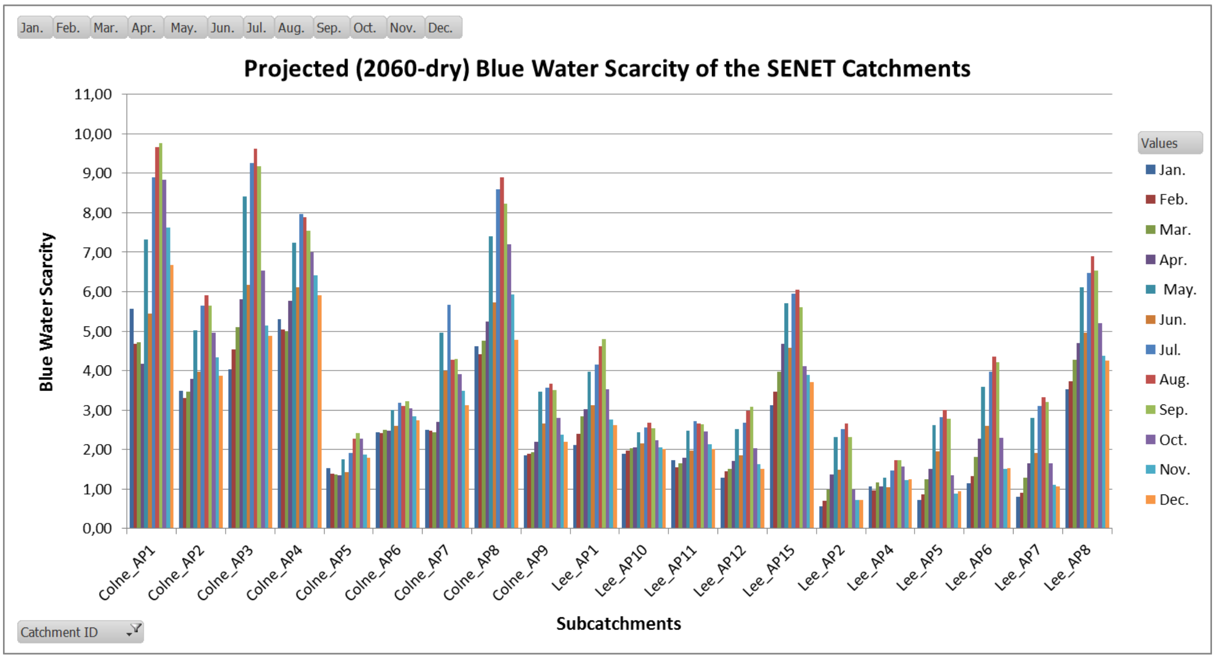

Figure 48. 2060 projected “dry” climate scenario monthly blue water scarcity in the SENET catchments (only the APs with blue water scarcity approaching or larger than 1.0 are presented in this figure).

Table 11. Comparison of the severity of blue water scarcity under different climate scenarios.

Catchment ID	Baseline		2060 (wet)		2060 (dry)	
	Annual average overall blue water scarcity	Number of months of severe overall blue water scarcity	Annual average overall blue water scarcity	Number of months of severe overall blue water scarcity	Annual average overall blue water scarcity	Number of months of severe overall blue water scarcity
Brent and Crane_AP1	low	0	low	0	low	0
Brent and Crane_AP2	low	0	low	0	low	0
Colne_AP1	severe	12	severe	12	severe	12
Colne_AP2	severe	10	severe	10	severe	12
Colne_AP3	severe	12	severe	12	severe	12
Colne_AP4	severe	12	severe	12	severe	12
Colne_AP5	low	0	moderate	0	significant	3
Colne_AP6	significant	0	significant	2	severe	12
Colne_AP7	significant	7	severe	8	severe	12
Colne_AP8	severe	12	severe	12	severe	12
Colne_AP9	moderate	0	significant	3	severe	9
Colne_AP10	low	0	low	0	low	0

RBI_AP1	low	0	low	0	low	0
RBI_AP2	low	0	low	0	low	0
RBI_AP3	low	0	low	0	low	0
RBI_AP4	low	0	low	0	low	0
RBI_AP5	low	0	low	0	low	0
RBI_AP6	low	0	low	0	low	0
RBI_AP7	low	0	low	0	low	0
RBI_AP8	low	0	low	0	low	0
Lee_AP1	significant	0	severe	5	severe	12
Lee_AP2	low	0	low	0	moderate	4
Lee_AP3	low	0	low	0	low	0
Lee_AP4	low	0	low	0	moderate	0
Lee_AP5	low	0	moderate	0	moderate	4
Lee_AP6	moderate	0	significant	4	severe	7
Lee_AP7	low	0	moderate	1	significant	4
Lee_AP8	severe	12	severe	12	severe	12
Lee_AP9	low	0	low	0	low	0
Lee_AP10	moderate	0	moderate	0	severe	10
Lee_AP11	moderate	0	moderate	0	severe	7
Lee_AP12	moderate	0	moderate	0	significant	5
Lee_AP13	low	0	low	0	low	0
Lee_AP14	low	0	low	0	low	0
Lee_AP15	severe	10	severe	10	severe	12

The projection of the blue groundwater scarcity for 2060 was not considered due to the absence of sound data to project the future groundwater availability, We can still expect an exacerbation of blue groundwater scarcity since groundwater is the major source of water for human use in the study area and future demand on groundwater from all sectors is expected to increase. Projection for WPL was not conducted in this study due to data limitations. However, we expect an increase in WPL for both surface water and groundwater, if no intervention is taken to enhance the efficiency of nutrients (N and P) removal by the STWs, since the discharge volume (thus the pollution load) will increase as the water demand increases.

4. Recommendations on water footprint response strategies

The aim of WFA is to understand where a WF is located, how large that WF is and whether the WF is sustainable or not. Results should feed into formulating response strategies. WFA can be used to identify priority places to work and provides insight into strategic actions to be taken to reduce the WF and to make it sustainable. Using the WF accounting and sustainability assessment presented in sections 3.1, 3.2, 3.3 and 3.5 APs in need of WF reduction strategies have been determined (Table 12). Response strategies can be formulated to address the key sustainability issues for each AP, for example, surface and/or groundwater scarcity and surface and/or groundwater pollution levels. This comprehensive analysis of multiple criteria also illuminates the possible interrelationships between blue water scarcity and water pollution levels. These linkages can be addressed in response formulation resulting in the optimal outcome from the actions taken.

Water footprint response strategies should be developed for each specific case to provide the most benefit¸ however, a general approach to response formulation is:

- Industrial water users: implement better or best technologies which reduce evaporation loss (blue WF) in the production processes and minimise the pollution load (grey WF);
- Agricultural water users: implement better irrigation methods and precision irrigation scheduling to reduce unproductive evaporation (blue WF); add soil treatments to more effectively use rainwater (green WF); and apply integrated crop nutrient management practices to reduce non-point source pollution (grey WF);
- Domestic water users: use low flow devices in the home, plant native plants in landscaping (blue WF) and reduce the use of chemicals in the household and in lawn and garden care (grey WF); and
- Water utilities: re-evaluate the current drinking water distribution networks and sewage treatment works and study the feasibility of re-planning both systems to avoid or reduce water transfer (return flows) therefore blue water footprint as a result of transporting water outside the sub-catchments where water is abstracted.

Regulatory agencies: aim for demand management within the constraints required to meet sustainability criteria such as blue water scarcity and water pollution levels, recognising the relationships between them. Combined together these response strategies can lead to an overall improvement in the sustainability of water use in catchments.

Table 12. APs selected for response strategy formulation to improve water footprint sustainability in the SENET catchments.

Catchment ID	**Overall blue water scarcity hotspot**		**Blue groundwater scarcity hotspot**		**Surface water pollution level hotspot**		**Groundwater pollution level hotspot**		**Response strategy formulation**			
	Annual average	Monthly	Annual average	Monthly	Annual average	Monthly	Annual average	Monthly	Improving blue water scarcity		Reducing water pollution load	
									Surface water	Groundwater	Surface Water	Groundwater
Brent and Crane_AP1	No	No	No	No	No	No	No	No				
Brent and Crane_AP2	No	No	No	No	Yes	Yes	No	No			√	
Colne_AP1	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	√	√	√	√
Colne_AP2	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Colne_AP3	Yes	Yes	Yes	Yes	No	Yes	No	No	√	√	√	
Colne_AP4	Yes	Yes	Yes	Yes	No	Yes	No	No	√	√	√	
Colne_AP5	No	Yes	Yes	Yes	No	No	No	No	√	√		
Colne_AP6	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Colne_AP7	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Colne_AP8	Yes	Yes	Yes	Yes	No	Yes	No	No	√	√	√	
Colne_AP9	Yes	Yes	Yes	Yes	No	No	Yes	Yes	√	√		√
Colne_AP10	No	No	No	No	No	No	Yes	Yes				√
RBI_AP1	No	No	No	No	No	Yes	No	No			√	
RBI_AP2	No	No	No	No	Yes	Yes	No	No			√	
RBI_AP3	No	No	No	No	No	Yes	No	Yes			√	

RBI_AP4	No	No	No	No	Yes	Yes	No	No			√	
RBI_AP5	No	No	No	No	No	No	No	No				
RBI_AP6	No	No	No	No	No	No	No	No				
RBI_AP7	No	No	No	No	Yes	Yes	No	No			√	
RBI_AP8	No	No	No	No	No	No	No	No				
Lee_AP1	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Lee_AP2	No	Yes	Yes	Yes	No	Yes	No	No	√	√	√	
Lee_AP3	No	No	No	No	No	Yes	No	No			√	
Lee_AP4	No	No	No	No	Yes	Yes	No	No			√	
Lee_AP5	No	Yes	Yes	Yes	Yes	Yes	No	No	√	√	√	
Lee_AP6	Yes	Yes	Yes	Yes	No	Yes	No	No	√	√	√	
Lee_AP7	No	Yes	Yes	Yes	Yes	Yes	No	No	√	√	√	
Lee_AP8	Yes	Yes	Yes	Yes	Yes	Yes	No	No	√	√	√	
Lee_AP9	No	Yes	No	No	Yes	Yes	No	No	√		√	
Lee_AP10	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Lee_AP11	Yes	Yes	Yes	Yes	Yes	Yes	No	No	√	√	√	
Lee_AP12	Yes	Yes	Yes	Yes	No	No	No	No	√	√		
Lee_AP13	No	No	No	No	No	No	No	No				
Lee_AP14	No	No	No	No	No	No	Yes	Yes				√
Lee_AP15	Yes	Yes	No	Yes	No	No	No	No	√	√		

Response strategies can support the objectives set by integrated water resources management (IWRM) plans and the Water Framework Directive (Figure 49). Once blue water scarcity and water pollution level hotspots are identified for surface and groundwater, a further evaluation of the current WF, both consumption (blue and green) and pollution (grey), can be used to elucidate the range of strategies which may contribute toward improved sustainability. In this step, it is necessary to review the current practices and technologies used in activities contributing to the green, blue and grey WF including, e.g., irrigation, water recycling and wastewater treatment technologies and practices and compare them to the best available technologies (BATs) and best practices (BPs). This analysis of the current technologies and practices in comparison to BATs and BPs can highlight where and how much improvement in water use and pollution is possible. Engagement with water users, water utilities and other stakeholders is essential at this point since overall improvement in sustainability will occur through a collection of individual actions.

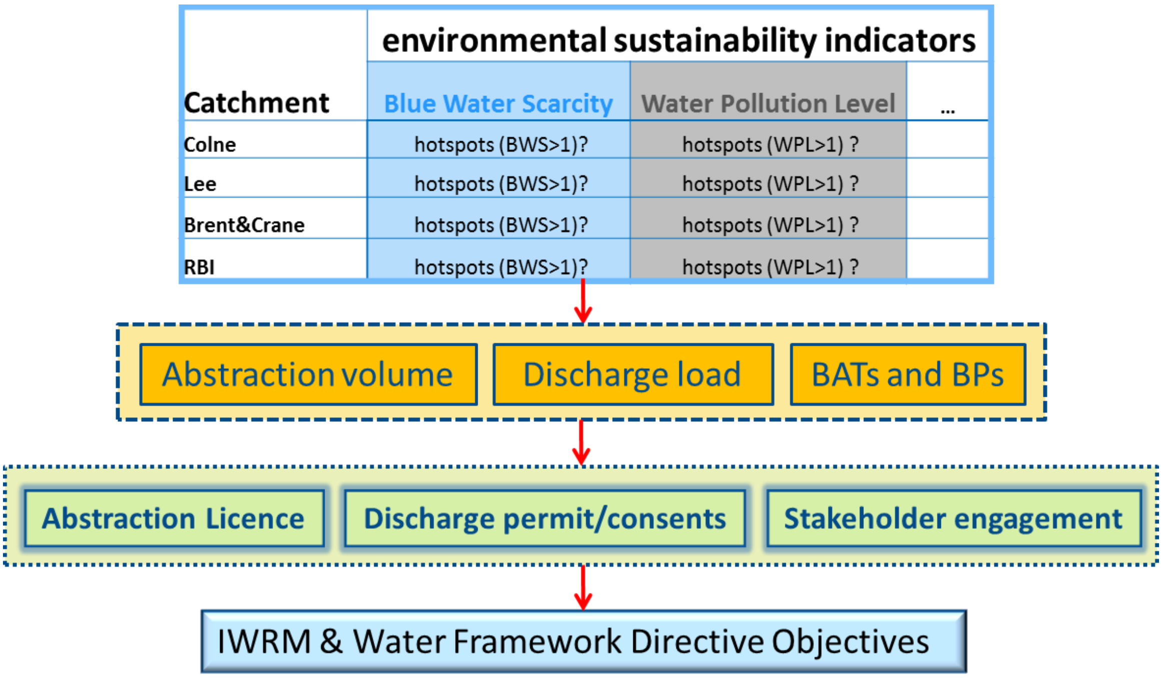

Figure 49. Water Footprint Assessment supporting IWRM and WFD objectives.

A comprehensive WFA as done in this study presents a wealth of information which can be used in determining abstraction licences and discharge permits. A decision logic such as is presented in Figure 50 incorporates the three phases of WF accounting, WF sustainability assessment and response formulation and sets up a system whereby the current status of the environmental criteria of blue water scarcity and water pollution levels for surface and groundwater indicate whether additional abstraction licences or discharge permits should be approved and with which conditions. If implemented this approach would guide the EA and other regulatory agencies in the UK and elsewhere in reaching sustainable water use and management.

With this approach, the blue water scarcity and water pollution level are the criteria against which the water abstraction licenses and discharge permits are to be reviewed or issued. In such review processes, the licences and permits should be re-evaluated considering the following aspects: 1) total demand on the consumptive water use from all users in the catchment; 2) total catchment water availability and total catchment pollution assimilation capacity; 3) seasonal/monthly variability of the catchment blue water availability and pollution assimilation capacity; 4) if the best available technologies (BATs) and/or best practices (BPs) have been applied or can be applied with reasonable costs.

Depending on the level of severity of blue water scarcity and/or water pollution level of the sub-catchment in question, different types of licenses, e.g. “time limited” or “time limited + seasonal volume conditions” would be issued to new water abstraction applicants to address the intra- and inter-annual variability of water availability. Abstraction license management done in this way will better reflect the spatial and temporal variability. This approach could also be used for revising existing licences. Based on the severity of the water pollution level and the type of pollution (i.e.

point source or non-point source), the discharge consent/permit would include conditions such as the requirement that non-point source water footprint reduction strategies be taken. In order to properly devise the new abstraction license and discharge permit scheme, the WFA results and findings can be integrated into the WFD and the Restoring Sustainable Abstraction (RSA) programme. A study on catchment maximum sustainable water footprint would be helpful for better water resources allocation.

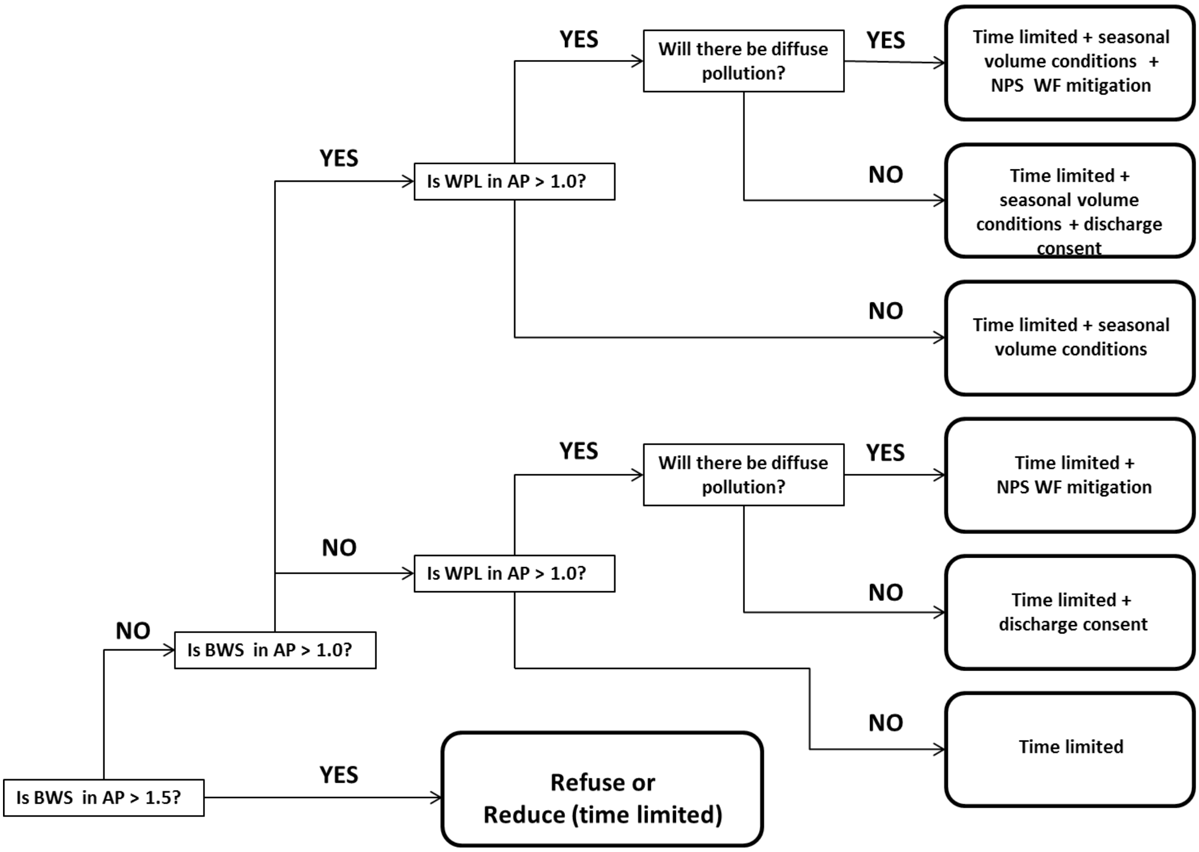

Figure 50. Framework for using Water Footprint Assessment to support new water abstraction license and discharge permit management regime.

5. Summary and conclusions

As a pioneering project, this is a first study of its kind in the field of Water Footprint Assessment on the catchment scale in a regulatory context. The study deals with a high level of complexity in a number of aspects: 1) high spatial and temporal resolution (namely sub-catchment level and monthly time scale); 2) multiple water use sectors (industry, domestic and agriculture); 3) different sources of water (surface and groundwater) for human use; 4) different types of human pressure on water resources (water consumption and pollution); 5) integrated assessment of water use sustainability (water scarcity and water pollution level); and 6) projected changes under 2060 water demand and climate change for a “wet” and “dry” scenario.

This study covers a comprehensive Water Footprint Assessment (WFA) for 35 sub-catchments of Colne, Lee, Brent and Crane and Roding-Beam-Ingrebourne (RBI) catchments in the North-eastern part of the Thames River basin. The blue, green and grey water footprints on surface water and groundwater have been estimated for the domestic, industrial and agricultural sectors on a monthly basis for the baseline condition (average over 2002 – 2007). The sustainability of blue and grey water footprints for these sub-catchments under the baseline condition was assessed using the blue water scarcity (BWS) and water pollution level (WPL) indicators. The blue, green and grey water footprints and the overall BWS of each sub-catchment were projected to 2060 based on two climate change and water demand change scenarios. WFA on a sub-catchment basis provides an excellent consolidation of site specific assessment of activities such that the cumulative effect of these activities is seen holistically and useful recommendations to improve water management can be derived. From the baseline and projected WFA results, recommendations for water footprint response strategies were put forward.

5.1. Summary of the current WFA study

5.1.1. Baseline blue water footprint

Under the baseline condition, the blue WF of all sub-catchments in the study area sums up to 338 Mm^3/year (or 105 mm/year), of which 1.43 Mm^3/year (0.4 mm/year) is for the industrial sector, 334 Mm^3/year (104 mm/year) for domestic sector and 2.75 Mm^3/year (0.9 mm/year) for the agricultural sector, respectively. The domestic sector is by far the largest water consuming sector. The blue WF of all sub-catchments resulting from groundwater use is approximately 55% of the total blue WF. Ninety five percent this total blue WF is due to the lost return flows (non-evaporative losses) within and beyond the study area. The actual total blue WF of the study area, namely the total evaporative blue WF plus the return flows lost to outside the study area as a whole, is 62 Mm^3/year (19.4 mm/year), while the evaporative blue WF is only 16.5 Mm^3/year (5.1 mm/year). Around 80% of the total return flows remain within the study area and these return flows are transferred from one sub-catchment to (an) other sub-catchment(s) via pipelines of the sewage treatment works.

5.1.2. Implications of transporting the return flows through sewage treatment works to other sub-catchments

The return flows, collected and transported to the sewage treatment works that are not situated in the sub-catchment of water abstraction, have strong implications for both water-losing and water-receiving sub-catchments in terms of the blue water availability and water pollution. In the sub-catchments losing return flows, environmental flows are violated and less water is available to assimilate waste although the pollution load is reduced. On the other hand, the sub-catchments receiving the lost return flows have more blue water available, but the pollution load is increased. Twenty sub-catchments (nine from Colne catchment and ten from Lee catchment and one from Brent and Crane catchment) are net water losing sub-catchments while six sub-catchments (four from Lee catchment, one from RBI catchment and one from Colne catchment) are net water receiving sub-catchments. Most of the net water losing sub-catchments generally have high blue water scarcity while those that are net water receiving sub-catchments generally have a high water pollution level.

5.1.3. Baseline green water footprint

In the estimation of crop water consumption, five major crops cultivated in the study area were taken into account. The baseline green WF in the study area totals 225 Mm^3/year (70 mm/year). The green WF is 99% of the total crop water consumption. The upstream sub-catchments of the study area, with more extensive agricultural lands, have a larger green WF than the more urbanised downstream sub-catchments.

5.1.4. Baseline grey water footprint

The total baseline grey WF amounts to 1380 Mm^3/year, equivalent to 428 mm/year. The total grey WF of point-source pollution on surface water is 408 Mm^3/year (127 mm/year); the total grey WF of the point-source pollution on groundwater is 664 Mm^3/year (207 mm/year); and the total grey WF of the non-point source pollution due to fertiliser leaching is 304 Mm^3/year (95 mm/year). The grey WF of the point-source pollution on groundwater, almost 50% of the total grey WF of the study area, is 1.6 times larger than that of the point-source pollution on surface water.

The grey WF is mostly due to the pollution of nutrients (phosphorous and nitrogen). High grey WF occurs in the sub-catchments where large scale and/or a higher number of sewage treatment works are located, and when large amounts of effluent are used for recharge to groundwater, resulting in high pollution loads. These sub-catchments are Brent and Crane AP2, Colne AP3, Colne AP9, Colne AP10, Lee AP2, Lee AP14, Lee AP15, RBI AP4 and RBI AP7. Large grey WFs resulting from non-point source pollution generally occur from the farm lands in the upstream sub-catchments.

5.1.5. Baseline blue water scarcity

Under the baseline condition, eight Colne sub-catchments and seven Lee sub-catchments are experiencing a moderate or higher level of overall blue water scarcity. Amongst these, the upstream sub-catchments are experiencing severe overall blue water scarcity. The blue groundwater scarcity in the sub-catchments under study is more severe than the overall blue water scarcity. Nine Colne sub-catchments and nine Lee sub-catchments have annual average blue groundwater scarcity at the significant or severe level. The blue groundwater scarcity values of many upstream sub-catchments are even larger than 5 indicating that abstraction is far exceeding renewable groundwater supplies. The majority of the sub-catchments with overall blue water scarcity or blue groundwater scarcity at the moderate or higher level are those having lost return flows. Sub-catchments in RBI experience low blue water scarcity for both surface and ground water.

5.1.6. Baseline water pollution level

Under the baseline condition, 12 sub-catchments in the study area have the annual average surface water pollution level at the significant or severe level (WPL>1). Sewage treatment works in these sub-catchments collect more wastewater than the other sub-catchments. These sewage works treat the wastewater and then discharge the effluents into streams, generating high WPL for surface water. Three sub-catchments (two in Colne catchment and one in Lee catchment) have annual average groundwater WPL at the significant or severe level. The groundwater assimilation capacity in these sub-catchments is under high pressure due to the recharge or infiltration of treated effluent with high loads of ammonia-nitrogen.

5.1.7. Water footprint projection

The blue, green and grey WF and blue water scarcity were projected to 2060 based on two climate change and water demand change scenarios. The blue WF projected for all 35 sub-catchments is 424 Mm^3/year (132 mm/year), which is a 25% increase compared to the baseline blue WF. The projected total green WF is 205 Mm^3/year (64 mm/year) for the “wet” climate scenario and 184 Mm^3/year (57 mm/year) for the “dry” climate scenario. The projected green WF is 14% lower than the baseline green WF. The projected total grey WF is 1480 Mm^3/year (460 mm/year), about 7% higher than the baseline total grey WF.

With the “dry” scenario, the projected overall blue water scarcity becomes more severe across the SENET Area. Under this condition, there are five more sub-catchments, four in the upstream of the Lee catchment and one in the upstream Colne catchment, having the blue water scarcity exceeding the moderate level, when compared to the baseline blue water scarcity situation. Even with the “wet” scenario, the blue water scarcity becomes worse when compared with the baseline condition.

5.1.8. Recommendation for response strategies

A step-wise approach using multiple environmental sustainability indicators (i.e. blue water scarcity and water pollution level) was used to identify the APs in need of WF reduction strategies to address surface and/or groundwater scarcity and surface and/or groundwater pollution levels. A new water abstraction license and discharge permit management system based on the results of this WFA was proposed as a way to meet sustainable water use and management goals as set out in the WFD and IWRM plans. A new abstraction license and discharge permit system such as this will enable a dynamic linkage to the spatial and temporal variability of blue water availability and the assimilation capacity for pollution loads.

5.2. Conclusions and recommended future work

Over-withdrawal and pollution have led to inadequate functioning of three-fourths of the rivers and lakes in England and Wales (Defra, 2011). The combined effects of climate change and growing demand on water will put more pressure on the existing water resources. The interactions between human usage, management of water and the response of nature to such human activities are complex. Therefore, we need various tools to assist us in coping with the challenges in managing these precious water resources. WFA is such a tool and is useful in helping us better understand what and where the pressures on freshwater resources are and what changes are necessary to improve the sustainability, efficiency and equitability of water use. From this WFA study, we have obtained a clear picture depicting how the surface water and groundwater are consumed by the industrial, domestic and agricultural sectors. This WFA also clearly illustrates where and when such water use creates problems: decrease of water availability (blue water scarcity) and diminishing of waste assimilation capacity (water pollution level).

On the basis of the findings of this WFA study, we can conclude the following:

- WFA is a holistic tool unifying both quantity and quality aspects in water resources assessment, planning and management.
- The choice of using the Assessment Point (AP), i.e. sub-catchment scale, provided added value by consolidating individual activities such that the aggregated or cumulative effect could be seen and the cause-effect relationships could be identified.
- WFA looks at the water quality issue from the pollution load rather than only the pollutant concentration in the effluents using the waste assimilation approach. This highlights where the assimilation capacity has been exceeded even when the pollutant concentrations meet quality standards.
- WFA uses environmental flow requirements (EFR) to evaluate how water consumption leads to freshwater (blue water) scarcity. The EFR concept agrees well with the environmental flow indicator (EFI) widely applied in the WFD of England and Wales.
- This WFA study explored the effect of return flows through sewage treatment works on both blue water scarcity and water pollution levels at the sub-catchment level. This exploration may suggest a possible strategy to cope with climate change and future water demand increases.
- The WFA results make the spatial and temporal nature of water consumption and pollution explicit. This can form a sound factual basis for reforming abstraction licences and discharge permits. The information developed in this study can also function as a platform or as an instrument for discussion and dialogue between regulators, water utilities and water users.
- The WFA study results can be the foundation for a unified water footprint database that is complementary to the existing water resources statistics and management system. A catchment-scale water footprint database can be an integrated element in the future update of the Catchment Abstraction Management Strategies (CAMS).
- The WFA concept brought together the data from multiple data sources directly available within the EA and demonstrated the added value of using combined data to understand the water resource situation in SENET.
- High overall blue water scarcity hotspots mostly lie in the upstream Colne and Lee catchments. Blue groundwater scarcity is more pronounced than the overall blue water scarcity because of the higher dependency of the water use on groundwater resources.
- Water pollution level hotspots are mostly those sub-catchments where large-scale and/or a higher number of sewage treatment works are located. The current study indicates that the nutrient (nitrogen and phosphorous) load is the major pressure on the water system from the quality perspective.
- The overall blue water scarcity under both the “wet” and “dry” climate scenarios will increase compared to that under baseline condition.
- Water footprint sustainability based demand management is an innovative approach to reforming the current water abstraction license and discharge permit scheme and can be an effective response strategy to mitigate blue water scarcity and water pollution levels.

To further improve water resources and abstraction management, a list of possible further work is recommended as follows.

- Integrate WFA into the implementation of the Water Framework Directive (WFD).
- Apply WFA to support the Restoring Sustainable Abstraction (RSA) programme and in the abstraction licence reform carried out by the Environment Agency.
- Roll out WFA studies to all management regions of the Environment Agency.
- Enhance the wastewater treatment technologies to increase nutrient removal efficiency.

- Study the feasibility of planning sewage treatment works in those sub-catchments which currently have to transport their wastewater and sewage to the treatment works located in other sub-catchments or of effluent discharges returning to the originating sub-catchment.
- Understand how drinking water distribution networks, operated by drinking water companies, can help minimise lost return flow and therefore blue water footprint.
- Improve data collection and data storage systems to facilitate data processing for easy and efficient Water Footprint Assessment and for other water resources assessment studies.
- Improve the blue water scarcity assessment by using monthly variable EFIs which take into account more detailed river flow regime variability better reflecting the relationship between flow dynamics and the ecosystem health of the water bodies. This also can be helpful for design and implementation of an abstraction incentive mechanism (e.g. Fenn, 2012).
- Establish water consumption and pollution benchmarks per sector and water footprint caps per catchment to drive water use efficiency, wastewater treatment enhancement, and better water allocation to ensure that water consumption and pollution remain below the maximum sustainable level.
- Update the current water availability and water scarcity maps using the WFA approach, i.e. applying the spatially and temporally varying EFRs (or EFIs). This can better support future water abstraction demand management and restrict unessential abstraction especially during the low flows and drought spells.
- Improve the groundwater scarcity and pollution level analysis through further research on groundwater sustainable yield, groundwater flows and aquifer properties in the study area.
- Improve grey water footprint assessment by taking into account the non-point source pollution from urban areas, roads and other built areas.
- Conduct further study on a new abstraction licencing and discharge permitting system based on the initial recommendation made in this study and how these changes would ensure the sustainable use and management of water resources.

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ANNEX 1 Data obtained for the study

Table A1. Meta data summary.

Nr.	Data	Content and purpose	Data sourced	Caveat
1	Water abstractions	Water withdrawal from reservoirs, rivers and groundwater – blue WF assessment	EA NALD database and CAMS ledger	Licensed Abstractions above 20m^3/day, submitted by license holders, data range: 2002 - 2007
2	Effluent discharges from the Water Company STWs	Discharge volumes (return flows) - pollution load and grey WF assessment	EA SENET compiled spreadsheets (Sandra Spinks), aggregated based continuous flow measurements by Water Companies	Data range: 2005-2007
3	Effluent water quality from the Water Company STWs	Water quality monitoring records for 22 determinants – pollution load and grey WF assessment	WIMS public register EA water quality data base, including grid reference discharge point	2005-2007 data as sampled by EA monitoring team
4	Effluent flows from non Water Company STWs and trades	Same as Nr. 2	Consented volume per day on WIMS	No measurements, consented volume
5	Effluent water quality from non Water Company STWs and trades	Same as Nr. 3	WIMS public register EA water quality data base, including grid reference discharge point	2005-2007 data as sampled by EA monitoring team
6	Crop types and yields	Blue and green WF assessment for crops	GIS layer on internal EA systems (I: drive) source DEFRA	Agriculture Census 1992; 2010/11 yield data for 12 selected crops
7	Soil type	Blue and green WF assessment for crops	GIS layer on internal EA systems (I: drive) source DEFRA	
8	Irrigation scheduling	Crop water use – blue WF and green WF for crops	CROPWAT model by FAO	Global database
9	Climate / Meteorological data	Precipitation, temperature, humidity, wind speed, sunshine – blue and green WF assessment	Metoffice and EA rain gauge network, available on WISKI system; Iceni Royston weather station	From selected rain gauges operated by EA; Meteo data from one location at North end of SENET

10	River flows	Naturalised and actual flows – WF sustainability assessment (blue water scarcity and water pollution level)	EA river gauges, available on WISKI system; CAMS ledger	Gauges at end of each Assessment Point (AP) catchment
11	Naturalised river flows	Water availability in rivers and blue WFA		
12	Environmental flow requirements (EFRs)	Water abstraction bands and Environmental Flow Indicator (EFI) - blue water scarcity assessment	Literature and EA website	EFR=85% naturalised flow
13	Fertiliser (N,P) application	Pollution load per 1x1 km grid cell (in kg/km^2) from agricultural fertiliser nitrogen (N) and phosphorous (P) – grey WF assessment	PSYCHIC_NEAPN model (Davison et al. 2008)	Modelled data of use, exact modelling parameters unknown. Leaching rate based on Mekonnen and Hoekstra (2011).
14	Pesticide leachate	Pollution load per 1x1 km grid cell (in kg/km^2) from agricultural fertilisers – grey WF assessment	EA modelling SE Evidence team	Modelled data of use, exact modelling parameters unknown (Davison et al 2008). Nor used in this study.
15	Population	Consumptive WF (blue, green and grey WFs) calculation.	UK census 2000, parish council level	Aggregated to AP level based on parish councils, may not full fit AP. To be combined with generic UK water footprint per capita (Hoekstra and Mekonnen and, 2012)
16	CAMS Assessment Point (APs)	Geographic unit on which the WFA is based	CAMS and Water Resources GIS EA, EA GIS layer	Part of the area (in RBI) needed new AP delineation, see this report.
17	CAMS sub-catchment delineation and river network	Geographic unit (APs) on which the WFA is based and streams.	CAMS and Water Resources GIS EA, EA GIS layer	Same as above
	Split domestic/industrial proportion sewage	Estimate proportion of sewage coming from industry (trade) and domestic using sewerage system	Water company estimate, via email	estimate
18	Thames Water sewerage catchment (STW service area coverage)	Catchment area for STWs – mapping lost return flows / water transfer, blue WF assessment	EA GIS layer	The STW catchments (STW service coverage area) do not coincide with the APs, assumptions for mapping the return flows transfer between APs, see this report.

ANNEX 2 Baseline blue water footprint on surface water in the SENET catchments

Table A2-1. Blue water footprint of industrial sector on surface water in the SENET catchments.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	40466	40466	40466	40466	40466	40466	40466	40466	40466	40466	40466	40466	485592
BandC_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP3	133	133	133	133	133	133	133	133	133	133	133	133	1592
Colne_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP9	0	0	0	0	0	0	0	0	0	0	0	0	1
Colne_AP10	487	487	487	0	0	0	0	0	0	0	487	487	2435
RBI_AP1	958	958	958	0	0	0	0	0	0	0	958	958	4791
RBI_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP3	831	831	831	0	0	0	0	0	0	0	831	831	4153
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0

RBI_AP7	277	277	277	0	19	19	19	19	19	0	277	277	1479
RBI_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP1	69	69	69	0	0	0	0	0	0	0	69	69	343
Lee_AP2	6671	6671	6671	6671	6671	6671	6671	6671	6671	6671	6671	6671	80050
Lee_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP6	46	46	46	46	46	46	46	46	46	46	46	46	547
Lee_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP9	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP10	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP11	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP12	189	189	189	0	0	0	0	0	0	0	189	189	943
Lee_AP13	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP14	1481	1481	1481	1481	1481	1481	1481	1481	1481	1481	1481	1481	17768
Lee_AP15	445	445	445	0	0	0	0	0	0	0	445	445	2226

Table A2-2. Blue water footprint of domestic sector on surface water in the SENET catchments.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
BandC_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0

Colne_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP9	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP10	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP1	2694174	2419101	2979530	2573347	2673607	2434525	2439667	2308557	2437096	2655612	2627333	2606767	30849317
Lee_AP2	15	15	15	15	15	15	15	15	15	15	15	15	181
Lee_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP9	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP10	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP11	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP12	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP13	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP14	0	0	0	0	0	0	0	0	0	0	0	0	0

Lee_AP15	12302108	10969125	10735090	10999651	9931230	8771230	8537195	8130177	7590879	10572283	11233686	12322458	122095110
Total	14996296	13388240	13714635	13573013	12604852	11205770	10976876	10438749	10027990	13227910	13861035	14929241	152944607

Table A2-3. Blue water footprint of agricultural sector on surface water in the SENET catchments (m^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
BandC_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP1	0	0	0	0	43	43	43	0	0	0	0	0	130
Colne_AP2	0	0	0	0	0	2161	2161	0	0	0	0	0	4322
Colne_AP3	0	0	782	1412	1412	1557	1559	0	0	0	0	0	6723
Colne_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP5	0	0	0	0	147	147	171	0	0	0	0	0	465
Colne_AP6	0	0	67	111	320	320	332	0	0	0	0	0	1150
Colne_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP8	0	0	95	95	95	95	95	0	0	0	0	0	474
Colne_AP9	0	0	283	18541	97609	217223	108837	0	0	0	0	0	442494
Colne_AP10	0	0	223	280	280	355	355	0	0	0	0	0	1492
Lee_AP1	0	0	5	32	32	32	32	0	0	0	0	0	133
Lee_AP2	0	0	1213	635	1019	1019	1019	15	2	0	0	0	4923
Lee_AP3	0	0	7379	683	683	1195	1195	0	0	0	0	0	11135
Lee_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP5	0	0	1278	0	0	0	0	0	0	0	0	0	1278
Lee_AP6	0	0	2744	4095	4799	4799	4799	0	0	0	0	0	21235
Lee_AP7	0	0	768	128	423	423	423	3	0	0	0	0	2169

Lee_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP9	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP10	0	0	0	0	640	640	640	0	0	0	0	0	1920
Lee_AP11	0	0	10540	16702	16702	16702	16702	0	0	0	0	0	77347
Lee_AP12	0	0	202	3120	3120	3120	3120	0	0	0	0	0	12680
Lee_AP13	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP14	0	0	17	790	790	790	790	0	0	0	0	0	3176
Lee_AP15	0	0	0	2461	2461	2461	2461	0	0	0	0	0	9845
RBI_AP1	0	0	8884	1407	1407	1407	1407	72	14	0	0	0	14599
RBI_AP2	0	0	8872	640	640	640	640	640	640	0	0	0	12713
RBI_AP3	0	0	60	720	720	720	720	720	628	0	0	0	4288
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP7	0	0	945	1281	1281	1281	1281	215	42	0	0	0	6326
RBI_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0

ANNEX 3 Baseline blue water footprint on groundwater in the SENET catchments

Table A3-1. Blue water footprint of industrial sector on groundwater in the SENET catchments (m^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
BandC_AP2	201	201	201	201	201	201	201	201	201	201	201	201	2408
Colne_AP1	0	0	0	11	11	11	11	11	11	0	0	0	67
Colne_AP2	6	6	6	6	6	6	6	6	6	6	6	6	71
Colne_AP3	216	216	216	1013	1013	1013	1013	1013	1013	1013	216	216	8169
Colne_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP5	56	56	56	56	56	56	56	56	56	56	56	56	676
Colne_AP6	5759	5759	5759	6067	6067	6067	6067	6067	6067	6067	5759	5759	71262
Colne_AP7	2682	2682	2682	2682	2711	2711	2711	2711	2711	2711	2682	2682	32356
Colne_AP8	0	0	135	135	135	135	135	135	135	135	0	0	1081
Colne_AP9	24547	24547	24547	24547	24547	24547	24547	24547	24547	24547	24547	24547	294564
Colne_AP10	1538	1538	1538	1538	1538	1538	1538	1538	1538	1538	1538	1538	18458
RBI_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	282	282	282	282	282	282	282	282	282	130	130	130	2927
RBI_AP6	141	141	141	141	141	141	141	141	141	65	65	65	1463

RBI_AP7	62	82	103	82	82	103	103	93	93	93	82	62	1040
RBI_AP8	458	458	458	458	458	458	458	458	458	211	211	211	4756
Lee_AP1	10495	10495	10495	10223	10223	10223	10223	10223	10223	10223	10495	10495	124039
Lee_AP2	0	0	0	100	100	100	100	100	100	100	0	0	700
Lee_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP5	843	843	843	843	843	843	843	843	843	843	843	843	10117
Lee_AP6	441	441	441	135	135	135	135	135	135	135	441	441	3153
Lee_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP8	1551	1551	1551	1551	1551	1551	1551	1551	1551	1551	1551	1551	18612
Lee_AP9	6	6	6	6	6	6	6	6	6	6	6	6	73
Lee_AP10	1787	1787	1787	2342	2342	2342	2342	2342	2342	1787	1787	1787	24773
Lee_AP11	1112	1108	1051	1012	1010	998	1021	915	1030	1041	1073	1100	12469
Lee_AP12	8395	8366	8615	7085	7071	6991	7147	6406	7215	6382	8124	8310	90107
Lee_AP13	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP14	44	44	44	44	44	44	44	44	44	44	44	44	524
Lee_AP15	8855	8855	8855	8855	8855	8855	8855	8855	8855	8855	8855	8855	106254

Table A3-2. Blue water footprint of domestic sector on groundwater in the SENET catchments (m^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
BandC_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP1	243572	219711	243351	230580	251778	248837	268858	262363	233622	230777	227631	234991	2896073
Colne_AP2	884527	786511	855304	829991	866097	881259	936131	901211	849512	878655	847019	845826	10362043

Colne_AP3	2565074	2436850	2622400	2517208	2541938	2662439	2745900	2682788	2580012	2539643	2455826	2601271	30951349
Colne_AP4	478010	438827	470417	471580	480719	467409	485595	479474	467982	469253	454381	476912	5640559
Colne_AP5	219159	196809	206818	200429	208593	211934	221890	215724	185044	204118	195340	216349	2482207
Colne_AP6	1213463	1119966	1229646	1162810	1224584	1217951	1246129	1104015	1161794	1204493	1178614	1224841	14288306
Colne_AP7	445602	421115	471820	441722	474894	473071	505006	485659	466112	470022	436617	456961	5548600
Colne_AP8	469406	420927	477111	462979	477290	475839	501244	488389	432179	465955	454647	434734	5560701
Colne_AP9	3320160	2952842	3154617	3162234	3486459	3539767	3778628	3777307	3636096	3501418	3526252	3487321	41323102
Colne_AP10	129449	143488	182167	121388	124435	130264	184553	164638	116873	112195	151092	159196	1719739
RBI_AP1	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP1	1464990	1514502	1345274	1421115	1301750	1323896	1275466	1360456	1405563	1510477	1424618	1517900	16866006
Lee_AP2	403028	378876	406881	392374	398227	390813	400647	408839	405957	419602	406764	421423	4833431
Lee_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP4	17620	15080	18414	15398	15239	15398	16668	17144	16985	18097	16033	18097	200173
Lee_AP5	144155	136682	147372	139388	145733	133582	128735	129165	127105	138228	126808	139864	1636819
Lee_AP6	386796	367409	396536	388631	396901	373598	368448	364997	356460	378697	358745	382130	4519348
Lee_AP7	221350	203430	227379	227967	234818	235371	236972	230896	224391	222782	215984	215499	2696840
Lee_AP8	1065897	1003892	1081447	1070118	1125579	1085655	1142495	1122437	1087273	1103263	1066192	1074048	13028296
Lee_AP9	15843	15100	16090	16076	16784	16219	17046	16471	15991	16015	15848	15772	193255

Lee_AP10	479124	437631	480893	463781	491112	480866	488975	482720	469939	471705	452076	473907	5672728
Lee_AP11	183239	166094	179800	177589	188226	189205	193296	189175	181152	181477	168488	180570	2178311
Lee_AP12	545472	525880	544966	546340	559386	551772	546540	539154	530824	518728	517673	529208	6455941
Lee_AP13	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP14	0	0	0	0	0	0	0	0	0	0	0	0	0
Lee_AP15	191094	191094	191094	191094	191094	191094	191094	191094	191094	191094	191094	191094	2293130

Table A3-3. Blue water footprint of agricultural sector on groundwater in the SENET catchments (m^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0	0	27	605	1698	1698	1698	0	0	0	0	0	5726
BandC_AP2	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne_AP1	0	0	3280	3280	3236	3236	3236	0	0	0	0	0	16268
Colne_AP2	0	0	5160	22921	23228	21067	21067	0	0	0	0	0	93443
Colne_AP3	0	0	1945	3512	3512	3872	3870	0	0	0	0	0	16711
Colne_AP4	0	0	3770	40017	40017	40017	40034	0	0	0	0	0	163854
Colne_AP5	0	0	789	789	642	642	618	0	0	0	0	0	3481
Colne_AP6	0	0	25	42	120	120	125	0	0	0	0	0	433
Colne_AP7	0	0	4466	59050	213806	213806	213806	0	0	0	0	0	704934
Colne_AP8	0	0	113	113	113	113	113	0	0	0	0	0	563
Colne_AP9	0	0	5440	58134	306052	321965	161316	0	0	0	0	0	852909
Colne_AP10	0	0	534	670	670	850	850	0	0	0	0	0	3575
Lee_AP1	0	0	209	1431	1431	1431	1431	0	0	0	0	0	5935
Lee_AP2	0	0	1943	2081	2081	2081	2081	32	7	0	0	0	10305
Lee_AP3	0	0	81	87	87	87	87	0	0	0	0	0	429

Lee_AP4	0	0	182	182	182	182	182	182	157	0	0	0	1249
Lee_AP5	0	0	3912	3909	4165	4165	4165	0	0	0	0	0	20315
Lee_AP6	0	0	227	227	227	227	227	0	0	0	0	0	1136
Lee_AP7	0	0	2354	5119	5725	5724	5724	81	16	0	0	0	24743
Lee_AP8	0	0	1459	1461	1515	1515	1515	211	41	0	0	0	7717
Lee_AP9	0	0	163	163	163	163	163	0	0	0	0	0	814
Lee_AP10	0	0	5615	7092	7732	7732	7732	0	0	0	0	0	35902
Lee_AP11	0	0	1561	2468	2468	2468	2468	0	0	0	0	0	11433
Lee_AP12	0	0	74	1149	1173	1173	1173	0	0	0	0	0	4741
Lee_AP13	0	0	162	6027	6027	6027	6027	0	0	0	0	0	24271
Lee_AP14	0	0	332	24349	24349	24349	24349	0	0	0	0	0	97729
Lee_AP15	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP1	0	0	1	1	1	1	1	0	0	0	0	0	3
RBI_AP2	0	0	380	380	380	380	380	380	380	0	0	0	2660
RBI_AP3	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP4	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP5	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP6	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP7	0	0	0	0	0	0	0	0	0	0	0	0	0
RBI_AP8	0	0	0	0	0	0	0	0	0	0	0	0	0

ANNEX 4 Net water losing and receiving APs

Table A4-1. Net water losing APs (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,04	-0,49
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	-0,21	-0,19	-0,21	-0,20	-0,21	-0,21	-0,23	-0,23	-0,20	-0,19	-0,19	-0,20	-2,46
Colne_AP2	-0,82	-0,73	-0,79	-0,77	-0,80	-0,82	-0,87	-0,84	-0,79	-0,82	-0,78	-0,78	-9,60
Colne_AP3	-1,65	-1,60	-1,71	-1,64	-1,65	-1,74	-1,77	-1,74	-1,68	-1,63	-1,57	-1,71	-20,10
Colne_AP4	-0,46	-0,42	-0,45	-0,45	-0,46	-0,44	-0,46	-0,46	-0,45	-0,45	-0,43	-0,45	-5,37
Colne_AP5	-0,12	-0,10	-0,11	-0,10	-0,11	-0,11	-0,12	-0,11	-0,08	-0,10	-0,10	-0,12	-1,28
Colne_AP6	-1,18	-1,09	-1,20	-1,13	-1,19	-1,19	-1,21	-1,08	-1,13	-1,17	-1,15	-1,19	-13,92
Colne_AP7	-0,34	-0,32	-0,36	-0,34	-0,36	-0,36	-0,38	-0,36	-0,35	-0,35	-0,32	-0,34	-4,20
Colne_AP8	-0,42	-0,37	-0,42	-0,41	-0,42	-0,42	-0,44	-0,43	-0,38	-0,41	-0,40	-0,38	-4,92
Colne_AP10	-0,13	-0,14	-0,18	-0,12	-0,12	-0,13	-0,18	-0,16	-0,11	-0,11	-0,15	-0,16	-1,68
Lee_AP1	-3,93	-3,69	-4,12	-3,78	-3,78	-3,55	-3,52	-3,45	-3,61	-3,93	-3,84	-3,90	-45,09
Lee_AP6	-0,35	-0,33	-0,36	-0,35	-0,36	-0,34	-0,33	-0,33	-0,32	-0,34	-0,32	-0,34	-4,07
Lee_AP7	-0,20	-0,18	-0,21	-0,21	-0,21	-0,22	-0,22	-0,21	-0,21	-0,20	-0,20	-0,19	-2,45
Lee_AP8	-0,94	-0,89	-0,96	-0,95	-1,00	-0,96	-1,01	-1,00	-0,96	-0,98	-0,94	-0,95	-11,55
Lee_AP9	-0,01	-0,01	-0,01	-0,01	-0,02	-0,01	-0,02	-0,01	-0,01	-0,01	-0,01	-0,01	-0,17
Lee_AP10	-0,44	-0,40	-0,44	-0,43	-0,45	-0,44	-0,45	-0,44	-0,43	-0,43	-0,41	-0,43	-5,19
Lee_AP11	-0,16	-0,14	-0,15	-0,15	-0,16	-0,16	-0,16	-0,16	-0,15	-0,16	-0,14	-0,15	-1,86
Lee_AP12	-0,04	-0,05	-0,04	-0,05	-0,05	-0,03	-0,01	-0,01	-0,03	-0,02	-0,04	-0,02	-0,38
Lee_AP14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,02

Lee_AP15	-12,46	-11,12	-10,89	-11,15	-10,08	-8,92	-8,69	-8,28	-7,74	-10,73	-11,39	-12,47	-123,93
RBI_AP1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table A4-2. Net water receiving APs (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Colne_AP9	1,70	1,71	1,92	1,71	1,57	1,58	1,54	1,30	1,26	1,46	1,28	1,53	18,56
Lee_AP2	5,75	5,41	5,97	5,60	5,69	5,38	5,39	5,28	5,39	5,73	5,57	5,69	66,85
Lee_AP3	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,47
Lee_AP4	0,20	0,19	0,20	0,20	0,20	0,20	0,20	0,21	0,21	0,21	0,21	0,21	2,45
Lee_AP5	0,00	0,00	0,00	0,00	0,00	0,01	0,02	0,02	0,02	0,02	0,02	0,01	0,14
Lee_AP13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP4	12,51	11,18	10,94	11,20	10,14	8,98	8,74	8,34	7,80	10,78	11,44	12,53	124,56
RBI_AP7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

ANNEX 5 Baseline green water footprint in the SENET catchments

Table A5. Monthly green water footprint in the SENET catchments (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,001	0,002	0,004	0,008	0,009	0,006	0,006	0,001	0,000	0,003	0,001	0,001	0,041
BandC_AP2	0,006	0,009	0,021	0,040	0,047	0,032	0,033	0,004	0,000	0,017	0,007	0,005	0,221
Colne_AP1	0,137	0,231	0,536	0,989	1,172	0,796	0,684	0,083	0,000	0,350	0,156	0,101	5,237
Colne_AP2	0,119	0,200	0,464	0,856	1,015	0,690	0,593	0,072	0,000	0,303	0,135	0,088	4,533
Colne_AP3	0,411	0,692	1,606	2,963	3,516	2,390	2,053	0,250	0,000	1,047	0,468	0,303	15,699
Colne_AP4	0,089	0,150	0,349	0,642	0,758	0,515	0,444	0,054	0,000	0,229	0,102	0,066	3,400
Colne_AP5	0,111	0,187	0,434	0,800	0,945	0,641	0,553	0,067	0,000	0,285	0,127	0,082	4,233
Colne_AP6	0,127	0,215	0,498	0,918	1,087	0,739	0,636	0,077	0,000	0,327	0,146	0,094	4,864
Colne_AP7	0,096	0,163	0,382	0,713	0,864	0,592	0,506	0,064	0,000	0,245	0,110	0,071	3,805
Colne_AP8	0,077	0,133	0,311	0,584	0,715	0,492	0,419	0,054	0,000	0,198	0,088	0,057	3,128
Colne_AP9	0,125	0,212	0,495	0,921	1,108	0,757	0,648	0,081	0,000	0,320	0,143	0,092	4,903
Colne_AP10	0,150	0,257	0,602	1,132	1,384	0,952	0,812	0,104	0,000	0,385	0,172	0,111	6,062
Lee_AP1	0,081	0,124	0,282	0,540	0,627	0,422	0,440	0,054	0,000	0,226	0,101	0,063	2,961
Lee_AP2	0,613	1,008	2,326	4,234	4,911	3,268	2,855	0,337	0,000	1,527	0,683	0,444	22,205
Lee_AP3	0,178	0,293	0,675	1,229	1,426	0,949	0,829	0,098	0,000	0,443	0,198	0,129	6,446
Lee_AP4	0,163	0,268	0,618	1,125	1,305	0,870	0,759	0,091	0,001	0,405	0,181	0,118	5,904
Lee_AP5	0,301	0,508	1,195	2,152	2,477	1,644	1,370	0,158	0,000	0,755	0,337	0,218	11,115
Lee_AP6	0,117	0,191	0,436	0,804	0,936	0,632	0,572	0,068	0,000	0,302	0,135	0,087	4,280

Lee_AP7	0,466	0,763	1,744	3,214	3,744	2,527	2,286	0,272	0,000	1,207	0,539	0,348	17,113
Lee_AP8	0,468	0,789	1,842	3,362	3,915	2,645	2,262	0,267	0,000	1,210	0,540	0,348	17,648
Lee_AP9	0,122	0,205	0,479	0,874	1,018	0,688	0,588	0,069	0,000	0,315	0,140	0,090	4,589
Lee_AP10	0,126	0,215	0,507	0,932	1,097	0,744	0,631	0,076	0,000	0,329	0,147	0,094	4,898
Lee_AP11	0,275	0,468	1,103	2,027	2,387	1,619	1,376	0,165	0,000	0,717	0,320	0,205	10,661
Lee_AP12	0,110	0,169	0,384	0,736	0,856	0,576	0,601	0,073	0,000	0,307	0,137	0,086	4,035
Lee_AP13	0,092	0,142	0,322	0,617	0,717	0,482	0,505	0,062	0,000	0,259	0,115	0,072	3,385
Lee_AP14	0,174	0,268	0,607	1,162	1,349	0,907	0,950	0,116	0,000	0,487	0,217	0,136	6,372
Lee_AP15	0,019	0,029	0,066	0,127	0,148	0,099	0,105	0,013	0,000	0,054	0,024	0,015	0,699
RBI_AP1	0,254	0,428	1,035	1,832	2,102	1,339	1,037	0,119	0,000	0,573	0,256	0,168	9,144
RBI_AP2	0,499	0,819	1,903	3,469	4,005	2,655	2,322	0,316	0,029	1,236	0,553	0,359	18,164
RBI_AP3	0,360	0,605	1,389	2,486	2,861	1,918	1,590	0,187	0,003	0,883	0,395	0,260	12,938
RBI_AP4	0,036	0,060	0,138	0,248	0,286	0,192	0,163	0,019	0,000	0,090	0,040	0,026	1,299
RBI_AP5	0,003	0,005	0,011	0,020	0,023	0,015	0,014	0,002	0,000	0,008	0,003	0,002	0,105
RBI_AP6	0,034	0,053	0,121	0,230	0,267	0,179	0,184	0,022	0,000	0,095	0,042	0,027	1,256
RBI_AP7	0,091	0,152	0,359	0,649	0,747	0,489	0,416	0,049	0,000	0,226	0,101	0,065	3,344
RBI_AP8	0,004	0,006	0,014	0,027	0,031	0,021	0,022	0,003	0,000	0,011	0,005	0,003	0,147

ANNEX 6 Baseline grey water footprint in the SENET catchments

Table A6-1. Grey water footprint of point-source pollution on surface water in the SENET catchments (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,001	0,002	0,000	0,007	0,001	0,000	0,005	0,002	0,000	0,009	0,001	0,001	0,030
BandC_AP2	9,171	9,055	9,251	8,677	8,364	7,221	8,761	8,013	5,803	6,339	6,263	6,181	93,100
Colne_AP1	0,899	0,773	0,603	0,762	0,929	0,683	0,726	0,923	0,772	1,179	1,172	0,958	10,379
Colne_AP2	0,602	0,523	0,407	0,522	0,636	0,461	0,490	0,633	0,525	0,815	0,805	0,650	7,071
Colne_AP3	2,297	2,177	1,689	2,094	2,414	1,958	1,982	2,347	1,939	2,836	2,817	2,633	27,184
Colne_AP4	0,374	0,310	0,248	0,300	0,372	0,280	0,441	1,136	0,332	0,473	0,466	0,423	5,155
Colne_AP5	0,571	0,502	0,492	0,542	0,586	0,502	0,520	0,624	0,476	0,641	0,636	0,534	6,624
Colne_AP6	0,468	0,407	0,317	0,406	0,495	0,358	0,381	0,492	0,408	0,633	0,625	0,505	5,495
Colne_AP7	0,659	0,616	0,592	0,589	0,514	0,412	0,440	0,549	0,448	0,659	0,668	0,571	6,717
Colne_AP8	0,416	0,381	0,322	0,358	0,408	0,317	0,333	0,386	0,318	0,503	0,511	0,415	4,666
Colne_AP9	0,867	0,877	0,616	0,728	0,865	0,582	0,680	2,166	1,621	0,816	0,812	0,727	11,356
Colne_AP10	0,405	0,435	0,456	0,345	0,438	0,304	0,326	0,441	0,673	0,557	0,691	0,504	5,576
RBI_AP1	1,229	1,081	0,858	1,064	1,341	0,951	1,002	1,287	1,066	1,645	1,621	1,358	14,502
RBI_AP2	2,648	2,414	1,854	2,301	2,831	2,029	2,211	2,773	2,294	3,630	4,267	2,937	32,188
RBI_AP3	1,535	1,470	1,179	1,299	1,664	1,151	1,239	1,566	1,271	1,966	2,010	1,662	18,013
RBI_AP4	7,299	12,118	15,658	13,280	9,929	7,925	9,389	6,825	11,718	9,936	15,648	9,891	129,615
RBI_AP5	0,004	0,003	0,003	0,003	0,004	0,003	0,003	0,004	0,003	0,005	0,005	0,004	0,046
RBI_AP6	0,051	0,044	0,034	0,044	0,054	0,039	0,041	0,053	0,044	0,069	0,068	0,055	0,596

RBI_AP7	2,439	3,779	3,529	2,191	3,257	3,181	3,937	4,313	3,582	4,006	2,418	3,584	40,216
RBI_AP8	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,003	0,002	0,027
Lee_AP1	0,181	0,155	0,120	0,157	0,188	0,135	0,147	0,186	0,154	0,239	0,236	0,191	2,089
Lee_AP2	3,470	2,981	2,455	2,771	3,427	2,411	2,568	3,239	2,677	3,950	3,941	3,295	37,187
Lee_AP3	0,931	0,810	0,652	0,804	1,157	0,690	0,726	0,928	1,001	1,206	1,186	0,976	11,066
Lee_AP4	0,885	0,771	0,593	0,759	0,930	0,665	0,716	0,919	0,762	1,182	1,170	0,938	10,291
Lee_AP5	1,429	1,204	1,037	1,202	1,461	1,059	1,207	1,467	1,204	1,881	1,930	1,493	16,573
Lee_AP6	0,710	0,427	0,330	0,644	0,515	0,373	0,563	0,576	0,536	0,772	0,651	0,526	6,623
Lee_AP7	2,654	2,277	1,778	2,294	2,720	2,035	2,160	2,752	2,249	3,465	3,478	2,751	30,612
Lee_AP8	2,324	2,005	1,562	2,026	2,430	1,763	1,879	2,422	2,009	3,126	3,088	2,481	27,113
Lee_AP9	0,359	0,312	0,243	0,311	0,379	0,275	0,292	0,377	0,313	0,486	0,480	0,388	4,216
Lee_AP10	0,403	0,350	0,273	0,350	0,426	0,309	0,328	0,424	0,352	0,546	0,539	0,436	4,736
Lee_AP11	1,606	1,396	1,089	1,396	1,698	1,233	1,591	1,678	1,396	2,161	2,137	1,732	19,113
Lee_AP12	0,618	0,493	0,501	0,551	0,554	0,520	0,444	0,522	0,466	0,660	0,632	0,603	6,565
Lee_AP13	0,279	0,243	0,189	0,242	0,295	0,214	0,227	0,294	0,243	0,378	0,373	0,302	3,278
Lee_AP14	0,755	0,531	0,378	0,774	0,500	0,497	0,596	0,942	0,524	1,406	0,632	0,675	8,209
Lee_AP15	12,693	10,824	11,605	3,628	3,845	10,107	11,289	11,030	9,322	3,144	14,725	3,625	105,836

Table A6-2. Grey water footprint of point-source pollution on groundwater in the SENET catchments (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,269	0,269	0,269	0,269	0,269	0,269	0,269	0,269	0,269	0,269	0,269	0,269	3,226
BandC_AP2	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,020	0,240
Colne_AP1	1,348	1,348	1,348	1,348	1,348	1,348	1,348	1,348	1,348	1,348	1,348	1,348	16,178
Colne_AP10	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,056	0,672

Colne_AP2	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	1,152
Colne_AP3	0,130	0,130	0,130	0,130	0,130	0,130	0,130	0,130	0,130	0,130	0,130	0,130	1,555
Colne_AP4	0,180	0,180	0,180	0,180	0,180	0,180	0,180	0,180	0,180	0,180	0,180	0,180	2,158
Colne_AP5	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,192
Colne_AP6	0,123	0,123	0,123	0,123	0,123	0,123	0,123	0,123	0,123	0,123	0,123	0,123	1,478
Colne_AP7	0,850	0,850	0,850	0,850	0,850	0,850	0,850	0,850	0,850	0,850	0,850	0,850	10,204
Colne_AP8	2,343	2,343	2,343	2,343	2,343	2,343	2,343	2,343	2,343	2,343	2,343	2,343	28,114
Colne_AP9	22,658	22,658	22,658	22,658	22,658	22,658	22,658	22,658	22,658	22,658	22,658	22,658	271,891
Lee_AP1	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,041	0,487
Lee_AP10	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,068	0,816
Lee_AP11	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,053	0,634
Lee_AP12	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,307
Lee_AP13	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	1,382
Lee_AP14	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,059	0,706
Lee_AP15	0,097	0,097	0,097	0,097	0,097	0,097	0,097	0,097	0,097	0,097	0,097	0,097	1,162
Lee_AP2	0,215	0,215	0,215	0,215	0,215	0,215	0,215	0,215	0,215	0,215	0,215	0,215	2,575
Lee_AP3	0,276	0,276	0,276	0,276	0,276	0,276	0,276	0,276	0,276	0,276	0,276	0,276	3,312
Lee_AP4	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,060	0,720
Lee_AP5	0,314	0,314	0,314	0,314	0,314	0,314	0,314	0,314	0,314	0,314	0,314	0,314	3,765
Lee_AP6	0,102	0,102	0,102	0,102	0,102	0,102	0,102	0,102	0,102	0,102	0,102	0,102	1,223
Lee_AP7	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,024	0,288
Lee_AP8	24,656	24,656	24,656	24,656	24,656	24,656	24,656	24,656	24,656	24,656	24,656	24,656	295,875
Lee_AP9	0,520	0,520	0,520	0,520	0,520	0,520	0,520	0,520	0,520	0,520	0,520	0,520	6,240
RBI_AP1	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RBI_AP2	0,094	0,094	0,094	0,094	0,094	0,094	0,094	0,094	0,094	0,094	0,094	0,094	1,123

RBI_AP3	0,516	0,516	0,516	0,516	0,516	0,516	0,516	0,516	0,516	0,516	0,516	0,516	6,192
RBI_AP4	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RBI_AP5	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RBI_AP6	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
RBI_AP7	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,192
RBI_AP8	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000

Table A6-3. Grey water footprint of non-point source pollution on groundwater in the SENET catchments (Mm^3).

Catchment_ID	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Aug	Sep	Oct.	Nov	Dec	Annual total
BandC_AP1	0,001	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,001	0,001	0,001	0,006
BandC_AP2	0,003	0,003	0,002	0,003	0,003	0,002	0,003	0,003	0,003	0,004	0,004	0,003	0,037
Colne_AP1	0,833	0,724	0,564	0,723	0,881	0,638	0,678	0,876	0,726	1,128	1,113	0,900	9,783
Colne_AP10	0,341	0,296	0,231	0,296	0,360	0,261	0,278	0,358	0,297	0,461	0,455	0,368	4,003
Colne_AP2	0,602	0,523	0,407	0,522	0,636	0,461	0,490	0,633	0,525	0,815	0,805	0,650	7,071
Colne_AP3	1,713	1,488	1,159	1,486	1,810	1,311	1,395	1,801	1,493	2,318	2,289	1,850	20,113
Colne_AP4	0,325	0,283	0,220	0,282	0,344	0,249	0,265	0,342	0,284	0,440	0,435	0,351	3,821
Colne_AP5	0,434	0,377	0,293	0,376	0,458	0,332	0,353	0,456	0,378	0,587	0,579	0,468	5,089
Colne_AP6	0,468	0,407	0,317	0,406	0,495	0,358	0,381	0,492	0,408	0,633	0,625	0,505	5,495
Colne_AP7	0,427	0,371	0,289	0,370	0,451	0,327	0,348	0,449	0,372	0,578	0,570	0,461	5,013
Colne_AP8	0,338	0,294	0,229	0,293	0,357	0,259	0,275	0,355	0,295	0,458	0,452	0,365	3,970
Colne_AP9	0,306	0,266	0,207	0,265	0,323	0,234	0,249	0,321	0,266	0,414	0,408	0,330	3,590
Lee_AP1	0,177	0,154	0,120	0,153	0,187	0,135	0,144	0,186	0,154	0,239	0,236	0,191	2,076
Lee_AP10	0,403	0,350	0,273	0,350	0,426	0,309	0,328	0,424	0,352	0,546	0,539	0,436	4,736
Lee_AP11	1,587	1,379	1,074	1,377	1,677	1,215	1,292	1,669	1,383	2,148	2,120	1,714	18,635

Lee_AP12	0,348	0,303	0,236	0,302	0,368	0,267	0,284	0,366	0,303	0,471	0,465	0,376	4,089
Lee_AP13	0,279	0,243	0,189	0,242	0,295	0,214	0,227	0,294	0,243	0,378	0,373	0,302	3,278
Lee_AP14	0,473	0,411	0,320	0,410	0,500	0,362	0,385	0,497	0,412	0,640	0,632	0,511	5,550
Lee_AP15	0,013	0,012	0,009	0,012	0,014	0,010	0,011	0,014	0,012	0,018	0,018	0,014	0,157
Lee_AP2	2,515	2,184	1,701	2,181	2,657	1,925	2,047	2,643	2,191	3,403	3,359	2,715	29,523
Lee_AP3	0,863	0,750	0,584	0,748	0,912	0,661	0,703	0,907	0,752	1,168	1,153	0,932	10,131
Lee_AP4	0,869	0,755	0,588	0,754	0,918	0,665	0,707	0,913	0,757	1,176	1,161	0,938	10,202
Lee_AP5	1,381	1,200	0,934	1,198	1,459	1,057	1,124	1,452	1,203	1,869	1,845	1,491	16,214
Lee_AP6	0,487	0,423	0,330	0,423	0,515	0,373	0,397	0,512	0,425	0,659	0,651	0,526	5,721
Lee_AP7	2,514	2,183	1,700	2,180	2,656	1,924	2,046	2,642	2,190	3,401	3,357	2,714	29,506
Lee_AP8	2,298	1,996	1,554	1,992	2,428	1,759	1,870	2,415	2,002	3,109	3,069	2,481	26,971
Lee_AP9	0,359	0,312	0,243	0,311	0,379	0,275	0,292	0,377	0,313	0,486	0,480	0,388	4,216
RBI_AP1	1,196	1,039	0,809	1,038	1,264	0,916	0,974	1,258	1,042	1,619	1,598	1,292	14,045
RBI_AP2	2,627	2,282	1,777	2,278	2,776	2,011	2,139	2,761	2,289	3,555	3,510	2,837	30,842
RBI_AP3	1,355	1,177	0,916	1,175	1,432	1,037	1,103	1,424	1,181	1,834	1,810	1,463	15,907
RBI_AP4	0,039	0,034	0,026	0,034	0,041	0,030	0,032	0,041	0,034	0,052	0,052	0,042	0,455
RBI_AP5	0,004	0,003	0,003	0,003	0,004	0,003	0,003	0,004	0,003	0,005	0,005	0,004	0,046
RBI_AP6	0,051	0,044	0,034	0,044	0,054	0,039	0,041	0,053	0,044	0,069	0,068	0,055	0,596
RBI_AP7	0,230	0,200	0,155	0,199	0,243	0,176	0,187	0,242	0,200	0,311	0,307	0,248	2,699
RBI_AP8	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,002	0,003	0,003	0,002	0,027

ANNEX 7 Baseline blue water scarcity

Table A7-1. Monthly overall blue water scarcity.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,05	0,06	0,07	0,08	0,08	0,13	0,12	0,09	0,12	0,06	0,05	0,05	0,07
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	3,23	2,54	2,47	2,21	2,90	3,73	4,56	4,85	5,52	5,33	4,63	3,98	3,51
Colne_AP2	2,02	1,80	1,81	2,00	2,12	2,55	2,88	2,97	3,19	2,99	2,63	2,30	2,36
Colne_AP3	2,34	2,47	2,67	3,09	3,31	4,29	4,75	4,84	5,19	3,95	3,12	2,91	3,36
Colne_AP4	3,08	2,73	2,62	3,01	3,22	3,64	4,03	3,96	4,27	4,23	3,90	3,52	3,43
Colne_AP5	0,89	0,76	0,72	0,71	0,76	0,89	0,98	1,14	1,36	1,37	1,14	1,07	0,93
Colne_AP6	1,41	1,31	1,31	1,31	1,39	1,54	1,63	1,56	1,82	1,83	1,72	1,63	1,52
Colne_AP7	1,45	1,34	1,27	1,40	2,01	2,39	2,75	2,15	2,43	2,36	2,12	1,86	1,89
Colne_AP8	2,67	2,40	2,50	2,78	3,06	3,78	4,41	4,47	4,64	4,35	3,61	2,84	3,29
Colne_AP9	1,08	1,03	1,02	1,16	1,39	1,73	1,80	1,84	1,98	1,69	1,45	1,31	1,41
Colne_AP10	0,03	0,04	0,05	0,04	0,04	0,05	0,07	0,07	0,05	0,04	0,05	0,05	0,05
RBI_AP1	0,00	0,00	0,00	0,01	0,01	0,02	0,04	0,00	0,00	0,00	0,01	0,00	0,01
RBI_AP2	0,00	0,00	0,01	0,01	0,03	0,05	0,07	0,00	0,00	0,00	0,00	0,00	0,01
RBI_AP3	0,00	0,00	0,01	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,01	0,01	0,26	0,24	0,34	0,42	0,50	0,03	0,03	0,01	0,01	0,01	0,12
RBI_AP6	0,00	0,00	0,02	0,03	0,05	0,06	0,07	0,00	0,00	0,00	0,00	0,00	0,02
RBI_AP7	0,00	0,00	0,02	0,05	0,08	0,10	0,12	0,00	0,00	0,00	0,00	0,00	0,02
RBI_AP8	0,01	0,01	0,06	0,07	0,09	0,11	0,14	0,05	0,03	0,01	0,01	0,01	0,04

Lee_AP1	1,23	1,30	1,49	1,61	1,67	2,03	2,13	2,32	2,71	2,13	1,68	1,56	1,72
Lee_AP2	0,32	0,38	0,52	0,74	0,80	1,19	1,31	1,34	1,31	0,59	0,44	0,43	0,61
Lee_AP3	0,00	0,00	0,07	0,21	0,22	0,54	0,68	0,00	0,00	0,00	0,00	0,00	0,05
Lee_AP4	0,62	0,53	0,61	0,71	0,71	0,82	0,94	0,86	0,97	0,95	0,75	0,74	0,75
Lee_AP5	0,42	0,46	0,63	0,81	1,05	1,35	1,46	1,51	1,57	0,82	0,54	0,56	0,75
Lee_AP6	0,66	0,73	0,94	1,27	1,45	1,93	2,14	2,19	2,38	1,39	0,92	0,92	1,18
Lee_AP7	0,46	0,49	0,66	0,87	1,00	1,40	1,57	1,67	1,81	1,00	0,67	0,63	0,84
Lee_AP8	2,04	2,03	2,25	2,49	2,65	3,11	3,32	3,46	3,69	3,14	2,65	2,53	2,69
Lee_AP9	0,20	0,20	0,38	0,26	0,23	0,32	0,30	0,26	0,31	0,21	0,20	0,21	0,25
Lee_AP10	1,10	1,07	1,06	1,08	1,13	1,23	1,29	1,35	1,43	1,35	1,25	1,20	1,20
Lee_AP11	1,00	0,85	0,80	0,84	0,95	1,13	1,25	1,34	1,49	1,48	1,29	1,19	1,09
Lee_AP12	0,74	0,79	0,79	0,90	0,98	1,28	1,37	1,50	1,74	1,22	0,99	0,90	1,02
Lee_AP13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP15	1,81	1,89	2,08	2,49	2,44	2,92	3,05	3,04	3,17	2,48	2,37	2,21	2,36

Table A7-2. Monthly blue groundwater scarcity.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	1,38	1,55	2,31	1,57	1,44	2,33	2,25	1,49	1,78	0,91	0,92	1,16	1,59
Colne_AP2	5,81	6,44	9,31	6,63	5,82	9,63	9,15	5,91	7,49	4,02	3,98	4,84	6,59
Colne_AP3	6,07	7,44	13,23	5,65	4,52	8,76	7,52	4,43	6,14	2,87	3,03	4,39	6,17
Colne_AP4	4,08	5,01	8,81	5,36	4,40	8,20	7,09	3,87	5,44	2,45	2,46	3,34	5,04

Colne_AP5	1,50	1,94	3,96	1,86	1,50	3,36	2,76	1,34	1,51	0,76	0,77	1,14	1,87
Colne_AP6	6,84	9,06	19,28	8,83	7,21	15,86	12,71	5,63	7,80	3,71	3,84	5,30	8,84
Colne_AP7	1,91	2,39	4,63	2,73	3,01	5,72	4,88	1,93	2,59	1,21	1,16	1,57	2,81
Colne_AP8	2,10	2,35	3,62	2,33	2,04	3,40	3,17	2,08	2,52	1,38	1,40	1,67	2,34
Colne_AP9	13,72	15,24	22,15	14,93	14,91	25,42	22,93	14,85	19,52	9,57	10,01	12,37	16,30
Colne_AP10	0,29	0,40	0,69	0,30	0,27	0,47	0,58	0,35	0,34	0,17	0,23	0,30	0,36
RBI_AP1	0,00	0,00	0,01	0,03	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,01
RBI_AP2	0,00	0,00	0,05	0,03	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,01
RBI_AP3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP4	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,03	0,03	0,50	0,33	0,17	0,21	0,20	0,01	0,01	0,00	0,00	0,01	0,13
RBI_AP6	0,01	0,00	0,01	0,01	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP7	0,00	0,00	0,06	0,08	0,04	0,06	0,05	0,00	0,00	0,00	0,00	0,00	0,03
RBI_AP8	0,03	0,03	0,14	0,09	0,05	0,06	0,06	0,01	0,01	0,00	0,00	0,01	0,04
Lee_AP1	24,48	29,20	34,75	20,39	13,37	19,08	16,64	13,22	16,76	12,20	12,65	18,94	19,31
Lee_AP2	1,33	1,47	2,15	1,54	1,25	1,75	1,66	1,28	1,53	1,00	0,98	1,31	1,44
Lee_AP3	0,00	0,00	0,03	0,03	0,02	0,03	0,03	0,00	0,00	0,00	0,00	0,00	0,01
Lee_AP4	0,22	0,23	0,37	0,24	0,19	0,28	0,28	0,21	0,25	0,17	0,15	0,22	0,23
Lee_AP5	1,40	1,53	2,22	1,21	0,91	1,17	1,02	0,73	0,88	0,65	0,66	1,02	1,12
Lee_AP6	10,00	11,12	16,73	9,60	7,17	9,51	8,45	5,79	6,89	4,83	5,03	7,49	8,55
Lee_AP7	1,44	1,54	2,40	1,33	1,00	1,41	1,28	0,92	1,09	0,71	0,76	1,06	1,25
Lee_AP8	5,18	6,15	11,28	5,81	4,38	6,40	6,05	4,07	4,92	2,95	2,99	4,25	5,37
Lee_AP9	0,27	0,30	0,46	0,31	0,26	0,36	0,35	0,26	0,30	0,18	0,19	0,24	0,29
Lee_AP10	2,48	7,33	12,63	7,92	6,25	9,03	8,24	5,89	6,96	4,20	4,08	5,72	6,73
Lee_AP11	1,11	1,26	2,14	1,37	1,08	1,61	1,48	1,04	1,21	0,73	0,69	0,99	1,23

Lee_AP12	4,35	5,37	11,32	5,08	3,73	5,55	4,88	3,20	3,72	2,18	2,36	3,53	4,61
Lee_AP13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP15	0,98	1,15	1,61	0,95	0,72	1,01	0,93	0,66	0,82	0,53	0,56	0,78	0,89

ANNEX 8 Baseline water pollution level for surface water and groundwater

Table A8-1. Monthly water pollution level for surface water.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
BandC_AP2	2,28	2,49	2,50	2,64	2,55	2,70	4,58	3,67	3,48	2,20	1,89	1,71	2,57
Colne_AP1	3,09	2,00	1,32	1,49	2,51	2,92	4,45	7,03	9,38	12,63	8,64	4,82	3,40
Colne_AP2	0,32	0,26	0,19	0,28	0,36	0,34	0,44	0,66	0,66	0,85	0,69	0,44	0,40
Colne_AP3	0,44	0,47	0,38	0,62	0,80	0,98	1,23	1,58	1,55	1,26	0,87	0,67	0,74
Colne_AP4	0,67	0,48	0,33	0,45	0,61	0,60	1,13	3,42	1,24	1,71	1,41	0,98	0,90
Colne_AP5	0,36	0,30	0,27	0,32	0,36	0,36	0,41	0,61	0,67	0,76	0,60	0,41	0,42
Colne_AP6	0,12	0,10	0,07	0,10	0,13	0,11	0,13	0,19	0,18	0,26	0,23	0,16	0,14
Colne_AP7	0,36	0,32	0,26	0,27	0,25	0,25	0,30	0,43	0,42	0,60	0,57	0,40	0,35
Colne_AP8	0,50	0,44	0,35	0,46	0,59	0,63	0,85	1,08	1,08	1,33	1,00	0,61	0,65
Colne_AP9	0,05	0,06	0,04	0,05	0,06	0,05	0,07	0,25	0,22	0,09	0,07	0,05	0,08
Colne_AP10	0,02	0,03	0,03	0,02	0,03	0,03	0,04	0,05	0,09	0,05	0,05	0,03	0,04
RBI_AP1	0,47	0,48	0,47	0,58	1,70	1,92	3,14	3,67	3,32	2,05	1,18	0,76	0,98
RBI_AP2	0,88	1,06	0,90	1,58	3,29	3,89	6,25	6,68	4,84	3,03	2,70	1,42	1,98
RBI_AP3	0,18	0,22	0,20	0,25	0,65	0,64	1,03	1,29	1,04	0,72	0,42	0,24	0,37
RBI_AP4	0,72	1,58	2,34	2,60	3,36	3,89	6,75	4,84	8,47	3,03	3,13	1,20	2,35
RBI_AP5	0,02	0,02	0,02	0,03	0,04	0,04	0,05	0,06	0,05	0,04	0,04	0,02	0,03
RBI_AP6	0,03	0,04	0,03	0,05	0,07	0,06	0,08	0,09	0,07	0,06	0,06	0,04	0,05

RBI_AP7	1,52	2,95	3,04	2,27	4,12	5,05	6,90	7,29	5,81	4,26	2,24	2,75	3,49
RBI_AP8	0,01	0,01	0,01	0,01	0,02	0,01	0,02	0,02	0,02	0,02	0,01	0,01	0,01
Lee_AP1	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,04	0,04	0,03	0,02	0,02	0,02
Lee_AP2	0,41	0,44	0,45	0,75	0,98	1,06	1,23	1,56	1,26	0,81	0,62	0,50	0,68
Lee_AP3	0,39	0,45	0,57	1,22	1,80	2,47	3,25	4,03	4,28	1,03	0,81	0,60	0,94
Lee_AP4	4,76	4,08	2,97	4,16	5,12	4,22	4,90	7,06	6,67	9,56	8,35	5,89	5,39
Lee_AP5	0,68	0,69	0,77	1,22	1,94	2,26	3,08	4,30	3,87	2,10	1,41	1,04	1,37
Lee_AP6	0,21	0,15	0,14	0,39	0,37	0,44	0,84	1,04	1,14	0,60	0,31	0,23	0,33
Lee_AP7	0,87	0,87	0,82	1,41	1,89	2,08	2,55	3,64	3,32	2,57	1,74	1,28	1,56
Lee_AP8	0,97	0,88	0,75	1,16	1,48	1,49	1,72	2,46	2,40	2,59	1,93	1,43	1,44
Lee_AP9	1,07	1,01	1,06	1,40	1,38	1,90	1,74	1,69	2,04	1,57	1,40	1,27	1,40
Lee_AP10	0,19	0,18	0,12	0,17	0,21	0,17	0,19	0,27	0,26	0,37	0,33	0,24	0,22
Lee_AP11	2,22	1,58	1,05	1,45	2,02	1,93	2,96	3,74	4,12	6,47	5,22	3,26	2,49
Lee_AP12	0,12	0,10	0,10	0,13	0,14	0,17	0,15	0,20	0,21	0,21	0,17	0,14	0,15
Lee_AP13	0,20	0,18	0,14	0,21	0,25	0,26	0,30	0,41	0,55	0,51	0,36	0,27	0,27
Lee_AP14	0,02	0,02	0,02	0,04	0,03	0,04	0,05	0,09	0,06	0,08	0,03	0,03	0,04
Lee_AP15	0,34	0,34	0,42	0,16	0,18	0,70	0,85	0,87	0,85	0,15	0,59	0,12	0,40

Table A8-2. Monthly water pollution level for groundwater.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,20	0,18	0,21	0,14	0,10	0,13	0,13	0,09	0,11	0,08	0,09	0,13	0,13
BandC_AP2	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,01	0,02	0,02
Colne_AP1	0,77	0,95	1,26	0,91	0,76	1,24	1,11	0,76	1,03	0,53	0,55	0,67	0,88
Colne_AP2	0,04	0,05	0,06	0,04	0,04	0,06	0,05	0,04	0,05	0,03	0,03	0,03	0,04

Colne_AP3	0,02	0,03	0,05	0,02	0,02	0,03	0,03	0,02	0,02	0,01	0,01	0,02	0,02
Colne_AP4	0,11	0,15	0,24	0,14	0,11	0,21	0,17	0,10	0,15	0,07	0,07	0,09	0,13
Colne_AP5	0,12	0,18	0,34	0,17	0,13	0,28	0,22	0,11	0,15	0,07	0,07	0,09	0,16
Colne_AP6	0,01	0,01	0,02	0,01	0,01	0,02	0,02	0,01	0,01	0,00	0,01	0,01	0,01
Colne_AP7	0,05	0,07	0,12	0,07	0,05	0,10	0,08	0,05	0,07	0,03	0,03	0,04	0,06
Colne_AP8	0,38	0,47	0,65	0,43	0,36	0,61	0,54	0,36	0,49	0,25	0,26	0,33	0,43
Colne_AP9	0,96	1,20	1,63	1,08	0,92	1,53	1,36	0,92	1,25	0,64	0,66	0,82	1,08
Colne_AP10	4,98	6,21	8,45	5,59	4,74	7,94	7,02	4,75	6,48	3,30	3,42	4,28	5,60
RBI_AP1	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP2	0,23	0,20	0,22	0,15	0,07	0,09	0,08	0,06	0,08	0,05	0,06	0,09	0,11
RBI_AP3	1,03	0,93	1,02	0,67	0,33	0,41	0,38	0,26	0,34	0,23	0,27	0,41	0,52
RBI_AP4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP7	0,04	0,04	0,04	0,03	0,01	0,02	0,01	0,01	0,01	0,01	0,01	0,02	0,02
RBI_AP8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP1	0,07	0,08	0,10	0,06	0,04	0,06	0,05	0,04	0,05	0,03	0,04	0,05	0,06
Lee_AP2	0,02	0,03	0,04	0,03	0,02	0,03	0,03	0,02	0,03	0,02	0,02	0,02	0,02
Lee_AP3	0,23	0,14	0,11	0,06	0,05	0,06	0,06	0,04	0,05	0,04	0,05	0,07	0,08
Lee_AP4	0,03	0,04	0,05	0,04	0,03	0,04	0,04	0,03	0,04	0,02	0,02	0,03	0,03
Lee_AP5	0,11	0,13	0,17	0,10	0,07	0,10	0,09	0,06	0,08	0,05	0,06	0,08	0,09
Lee_AP6	0,15	0,18	0,25	0,14	0,10	0,14	0,13	0,09	0,11	0,08	0,08	0,12	0,13
Lee_AP7	0,06	0,07	0,10	0,06	0,04	0,06	0,05	0,04	0,05	0,03	0,03	0,05	0,05
Lee_AP8	0,10	0,13	0,22	0,12	0,08	0,13	0,11	0,08	0,10	0,06	0,06	0,08	0,11
Lee_AP9	0,46	0,56	0,77	0,53	0,42	0,59	0,56	0,42	0,51	0,32	0,32	0,42	0,49

Lee_AP10	0,03	0,10	0,16	0,10	0,08	0,11	0,10	0,07	0,09	0,05	0,05	0,07	0,08
Lee_AP11	0,19	0,24	0,37	0,24	0,18	0,27	0,24	0,17	0,21	0,13	0,13	0,17	0,21
Lee_AP12	0,08	0,10	0,21	0,09	0,07	0,10	0,09	0,06	0,07	0,04	0,05	0,07	0,09
Lee_AP13	0,02	0,03	0,06	0,03	0,02	0,03	0,03	0,02	0,02	0,01	0,01	0,02	0,02
Lee_AP14	10,39	12,11	17,04	10,10	7,59	10,64	9,79	7,03	8,62	5,57	5,93	8,20	9,42
Lee_AP15	0,26	0,30	0,42	0,25	0,19	0,26	0,24	0,17	0,21	0,14	0,15	0,20	0,23

ANNEX 9 Projected blue water footprint, green water footprint, grey water footprint and blue water scarcity

Table A9-1. Projected (2060) monthly total blue water footprint (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,62
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	0,30	0,27	0,31	0,29	0,32	0,32	0,34	0,33	0,29	0,29	0,28	0,29	3,64
Colne_AP2	1,11	0,98	1,08	1,07	1,12	1,14	1,21	1,13	1,06	1,10	1,06	1,06	13,10
Colne_AP3	3,21	3,05	3,28	3,16	3,19	3,34	3,44	3,35	3,23	3,18	3,07	3,25	38,74
Colne_AP4	0,60	0,55	0,59	0,65	0,66	0,64	0,67	0,60	0,58	0,59	0,57	0,60	7,30
Colne_AP5	0,27	0,25	0,26	0,25	0,26	0,27	0,28	0,27	0,23	0,26	0,24	0,27	3,11
Colne_AP6	1,52	1,41	1,54	1,46	1,54	1,53	1,57	1,39	1,46	1,51	1,48	1,54	17,95
Colne_AP7	0,56	0,53	0,60	0,64	0,92	0,92	0,96	0,61	0,59	0,59	0,55	0,57	8,03
Colne_AP8	0,59	0,53	0,60	0,58	0,60	0,60	0,63	0,61	0,54	0,58	0,57	0,54	6,95
Colne_AP9	4,18	3,72	3,98	4,10	4,99	5,26	5,16	4,75	4,58	4,41	4,44	4,39	53,97
Colne_AP10	0,16	0,18	0,23	0,16	0,16	0,17	0,23	0,21	0,15	0,14	0,19	0,20	2,18
RBI_AP1	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03
RBI_AP2	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
RBI_AP3	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
RBI_AP4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

RBI_AP7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
RBI_AP8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Lee_AP1	5,21	4,93	5,42	5,01	4,98	4,71	4,66	4,60	4,82	5,22	5,08	5,17	59,81
Lee_AP2	0,51	0,48	0,52	0,50	0,51	0,50	0,51	0,52	0,52	0,53	0,52	0,54	6,17
Lee_AP3	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
Lee_AP4	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,25
Lee_AP5	0,18	0,17	0,19	0,18	0,19	0,17	0,17	0,16	0,16	0,17	0,16	0,18	2,09
Lee_AP6	0,48	0,46	0,50	0,49	0,50	0,47	0,47	0,46	0,45	0,47	0,45	0,48	5,69
Lee_AP7	0,28	0,25	0,29	0,29	0,30	0,30	0,31	0,29	0,28	0,28	0,27	0,27	3,41
Lee_AP8	1,33	1,26	1,36	1,34	1,41	1,36	1,43	1,41	1,36	1,38	1,33	1,34	16,32
Lee_AP9	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,24
Lee_AP10	0,60	0,55	0,61	0,59	0,63	0,62	0,63	0,61	0,59	0,59	0,57	0,59	7,18
Lee_AP11	0,23	0,21	0,24	0,25	0,27	0,27	0,27	0,24	0,23	0,23	0,21	0,23	2,87
Lee_AP12	0,69	0,67	0,69	0,70	0,71	0,70	0,70	0,68	0,67	0,66	0,66	0,67	8,21
Lee_AP13	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,04
Lee_AP14	0,00	0,00	0,00	0,04	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,00	0,17
Lee_AP15	15,63	13,96	13,67	14,00	12,67	11,22	10,93	10,41	9,74	13,47	14,29	15,65	155,64

Table A9-2. Projected (2060 “wet” scenario) monthly green water footprint (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,04
BandC_AP2	0,01	0,01	0,02	0,04	0,04	0,03	0,03	0,00	0,00	0,01	0,01	0,00	0,20
Colne_AP1	0,13	0,21	0,49	0,91	1,08	0,73	0,61	0,07	0,00	0,31	0,14	0,09	4,78
Colne_AP2	0,11	0,19	0,43	0,78	0,93	0,63	0,53	0,06	0,00	0,27	0,12	0,08	4,14

Colne_AP3	0,38	0,64	1,48	2,71	3,23	2,19	1,84	0,22	0,00	0,94	0,42	0,28	14,34
Colne_AP4	0,08	0,14	0,32	0,59	0,69	0,47	0,40	0,05	0,00	0,21	0,09	0,06	3,10
Colne_AP5	0,10	0,17	0,40	0,73	0,86	0,59	0,49	0,06	0,00	0,26	0,11	0,07	3,86
Colne_AP6	0,12	0,20	0,46	0,84	1,00	0,68	0,57	0,07	0,00	0,29	0,13	0,09	4,44
Colne_AP7	0,09	0,15	0,35	0,65	0,79	0,54	0,46	0,06	0,00	0,22	0,10	0,06	3,48
Colne_AP8	0,07	0,12	0,29	0,53	0,66	0,45	0,38	0,05	0,00	0,18	0,08	0,05	2,86
Colne_AP9	0,12	0,20	0,46	0,84	1,02	0,70	0,58	0,07	0,00	0,29	0,13	0,08	4,48
Colne_AP10	0,14	0,24	0,55	1,04	1,27	0,88	0,73	0,09	0,00	0,35	0,15	0,10	5,54
Lee_AP1	0,07	0,11	0,25	0,48	0,55	0,37	0,39	0,05	0,00	0,20	0,09	0,06	2,61
Lee_AP2	0,57	0,94	2,16	3,89	4,51	3,01	2,55	0,30	0,00	1,38	0,62	0,41	20,34
Lee_AP3	0,17	0,27	0,63	1,13	1,31	0,87	0,74	0,09	0,00	0,40	0,18	0,12	5,91
Lee_AP4	0,15	0,25	0,57	1,04	1,20	0,80	0,68	0,08	0,00	0,37	0,16	0,11	5,41
Lee_AP5	0,28	0,47	1,10	1,96	2,25	1,50	1,22	0,14	0,00	0,68	0,30	0,20	10,09
Lee_AP6	0,11	0,18	0,40	0,74	0,86	0,58	0,51	0,06	0,00	0,27	0,12	0,08	3,90
Lee_AP7	0,43	0,71	1,61	2,94	3,42	2,31	2,04	0,24	0,00	1,09	0,49	0,32	15,59
Lee_AP8	0,43	0,72	1,68	3,05	3,56	2,40	2,01	0,24	0,00	1,08	0,48	0,31	15,99
Lee_AP9	0,11	0,19	0,44	0,79	0,93	0,63	0,52	0,06	0,00	0,28	0,13	0,08	4,16
Lee_AP10	0,11	0,20	0,46	0,84	0,99	0,67	0,56	0,07	0,00	0,29	0,13	0,08	4,42
Lee_AP11	0,25	0,43	1,00	1,83	2,16	1,47	1,23	0,15	0,00	0,64	0,29	0,18	9,61
Lee_AP12	0,10	0,15	0,34	0,65	0,76	0,51	0,53	0,06	0,00	0,27	0,12	0,08	3,56
Lee_AP13	0,08	0,13	0,28	0,54	0,63	0,43	0,45	0,05	0,00	0,23	0,10	0,06	2,99
Lee_AP14	0,15	0,24	0,54	1,02	1,19	0,80	0,84	0,10	0,00	0,43	0,19	0,12	5,62
Lee_AP15	0,02	0,03	0,06	0,11	0,13	0,09	0,09	0,01	0,00	0,05	0,02	0,01	0,62
RBI_AP1	0,24	0,40	0,96	1,68	1,92	1,23	0,93	0,11	0,00	0,52	0,23	0,16	8,37
RBI_AP2	0,46	0,76	1,76	3,18	3,66	2,44	2,07	0,28	0,03	1,12	0,50	0,33	16,58

RBI_AP3	0,34	0,58	1,31	2,32	2,67	1,79	1,42	0,17	0,00	0,80	0,36	0,24	12,00
RBI_AP4	0,03	0,06	0,13	0,23	0,27	0,18	0,15	0,02	0,00	0,08	0,04	0,02	1,20
RBI_AP5	0,00	0,00	0,01	0,02	0,02	0,01	0,01	0,00	0,00	0,01	0,00	0,00	0,10
RBI_AP6	0,03	0,05	0,11	0,20	0,24	0,16	0,16	0,02	0,00	0,08	0,04	0,02	1,11
RBI_AP7	0,08	0,14	0,33	0,59	0,68	0,44	0,37	0,04	0,00	0,20	0,09	0,06	3,03
RBI_AP8	0,00	0,01	0,01	0,02	0,03	0,02	0,02	0,00	0,00	0,01	0,00	0,00	0,13

Table A9-3. Projected (2060 “dry” scenario) monthly green water footprint (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
BandC_AP1	0,00	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03
BandC_AP2	0,00	0,01	0,02	0,03	0,04	0,03	0,03	0,00	0,00	0,01	0,01	0,00	0,18
Colne_AP1	0,11	0,19	0,44	0,81	0,96	0,65	0,55	0,07	0,00	0,29	0,13	0,08	4,29
Colne_AP2	0,10	0,17	0,39	0,70	0,83	0,57	0,48	0,06	0,00	0,25	0,11	0,07	3,72
Colne_AP3	0,34	0,58	1,33	2,44	2,88	1,96	1,65	0,20	0,00	0,85	0,38	0,25	12,87
Colne_AP4	0,07	0,13	0,29	0,53	0,62	0,42	0,36	0,04	0,00	0,19	0,08	0,05	2,79
Colne_AP5	0,09	0,16	0,36	0,66	0,77	0,53	0,44	0,05	0,00	0,23	0,10	0,07	3,47
Colne_AP6	0,11	0,18	0,41	0,75	0,89	0,61	0,51	0,06	0,00	0,27	0,12	0,08	3,98
Colne_AP7	0,08	0,14	0,32	0,58	0,70	0,48	0,41	0,05	0,00	0,20	0,09	0,06	3,10
Colne_AP8	0,06	0,11	0,26	0,48	0,58	0,40	0,33	0,04	0,00	0,16	0,07	0,05	2,55
Colne_AP9	0,10	0,18	0,41	0,76	0,91	0,62	0,52	0,06	0,00	0,26	0,12	0,08	4,01
Colne_AP10	0,12	0,21	0,50	0,93	1,13	0,77	0,65	0,08	0,00	0,31	0,14	0,09	4,94
Lee_AP1	0,06	0,10	0,23	0,43	0,50	0,34	0,35	0,04	0,00	0,18	0,08	0,05	2,38
Lee_AP2	0,51	0,85	1,94	3,50	4,06	2,71	2,31	0,27	0,00	1,25	0,56	0,37	18,33
Lee_AP3	0,15	0,25	0,56	1,02	1,18	0,79	0,67	0,08	0,00	0,36	0,16	0,11	5,32

Lee_AP4	0,14	0,23	0,52	0,93	1,08	0,72	0,61	0,07	0,00	0,33	0,15	0,10	4,87
Lee_AP5	0,25	0,42	0,98	1,76	2,03	1,35	1,11	0,13	0,00	0,61	0,27	0,18	9,09
Lee_AP6	0,10	0,16	0,36	0,66	0,77	0,52	0,46	0,05	0,00	0,25	0,11	0,07	3,52
Lee_AP7	0,39	0,64	1,45	2,65	3,09	2,08	1,84	0,22	0,00	0,98	0,44	0,29	14,08
Lee_AP8	0,39	0,65	1,52	2,75	3,20	2,16	1,82	0,21	0,00	0,98	0,44	0,28	14,41
Lee_AP9	0,10	0,17	0,39	0,72	0,83	0,56	0,47	0,06	0,00	0,26	0,11	0,07	3,75
Lee_AP10	0,10	0,18	0,41	0,76	0,89	0,60	0,51	0,06	0,00	0,27	0,12	0,08	3,97
Lee_AP11	0,22	0,38	0,90	1,65	1,93	1,31	1,10	0,13	0,00	0,58	0,26	0,17	8,64
Lee_AP12	0,09	0,14	0,31	0,59	0,69	0,46	0,48	0,06	0,00	0,25	0,11	0,07	3,24
Lee_AP13	0,07	0,11	0,26	0,50	0,58	0,39	0,41	0,05	0,00	0,21	0,09	0,06	2,72
Lee_AP14	0,14	0,21	0,49	0,93	1,08	0,73	0,76	0,09	0,00	0,39	0,17	0,11	5,12
Lee_AP15	0,02	0,02	0,05	0,10	0,12	0,08	0,08	0,01	0,00	0,04	0,02	0,01	0,56
RBI_AP1	0,21	0,36	0,85	1,50	1,71	1,10	0,84	0,10	0,00	0,47	0,21	0,14	7,49
RBI_AP2	0,42	0,68	1,58	2,86	3,29	2,19	1,88	0,26	0,03	1,01	0,45	0,30	14,94
RBI_AP3	0,31	0,52	1,18	2,09	2,40	1,61	1,29	0,15	0,00	0,73	0,33	0,22	10,82
RBI_AP4	0,03	0,05	0,12	0,21	0,24	0,16	0,13	0,02	0,00	0,07	0,03	0,02	1,08
RBI_AP5	0,00	0,00	0,01	0,02	0,02	0,01	0,01	0,00	0,00	0,01	0,00	0,00	0,09
RBI_AP6	0,03	0,04	0,10	0,19	0,22	0,14	0,15	0,02	0,00	0,08	0,03	0,02	1,01
RBI_AP7	0,08	0,13	0,29	0,53	0,61	0,40	0,34	0,04	0,00	0,18	0,08	0,05	2,72
RBI_AP8	0,00	0,00	0,01	0,02	0,02	0,02	0,02	0,00	0,00	0,01	0,00	0,00	0,12

Table A9-4. Projected (2060) monthly total grey water footprint (Mm^3).

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
BandC_AP1	0,27	0,27	0,27	0,28	0,27	0,27	0,27	0,27	0,27	0,28	0,27	0,27	3,26
BandC_AP2	11,48	11,34	11,58	10,87	10,47	9,05	10,97	10,04	7,27	7,94	7,85	7,75	116,61
Colne_AP1	2,26	2,13	1,96	2,12	2,29	2,04	2,09	2,28	2,13	2,54	2,53	2,32	26,71
Colne_AP2	0,66	0,58	0,46	0,58	0,69	0,52	0,55	0,69	0,58	0,87	0,86	0,71	7,74
Colne_AP3	2,54	2,45	1,92	2,34	2,66	2,22	2,22	2,58	2,15	3,06	3,05	2,92	30,10
Colne_AP4	0,52	0,45	0,38	0,43	0,51	0,42	0,61	1,46	0,47	0,61	0,60	0,57	7,04
Colne_AP5	0,79	0,71	0,72	0,76	0,80	0,72	0,74	0,85	0,68	0,83	0,83	0,73	9,17
Colne_AP6	0,48	0,42	0,33	0,42	0,51	0,37	0,40	0,51	0,42	0,65	0,64	0,52	5,69
Colne_AP7	0,84	0,80	0,79	0,77	0,65	0,56	0,59	0,70	0,59	0,80	0,82	0,72	8,62
Colne_AP8	1,29	1,25	1,20	1,22	1,27	1,18	1,20	1,24	1,17	1,36	1,38	1,28	15,04
Colne_AP9	3,35	3,37	3,06	3,19	3,34	3,01	3,13	4,97	4,30	3,26	3,26	3,17	41,41
Colne_AP10	23,08	23,13	23,17	23,02	23,12	22,97	23,00	23,12	23,42	23,24	23,41	23,20	277,86
RBI_AP1	1,24	1,09	0,87	1,07	1,36	0,96	1,01	1,29	1,07	1,65	1,63	1,37	14,62
RBI_AP2	2,75	2,54	1,97	2,40	2,94	2,13	2,32	2,87	2,39	3,74	4,55	3,06	33,65
RBI_AP3	2,10	2,06	1,76	1,85	2,24	1,70	1,79	2,12	1,81	2,51	2,58	2,23	24,73
RBI_AP4	9,11	15,14	19,57	16,59	12,40	9,90	11,73	8,52	14,64	12,41	19,55	12,35	161,91
RBI_AP5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,05
RBI_AP6	0,05	0,04	0,03	0,04	0,05	0,04	0,04	0,05	0,04	0,07	0,07	0,05	0,60
RBI_AP7	3,01	4,69	4,39	2,70	4,03	3,95	4,89	5,35	4,44	4,95	2,96	4,43	49,79
RBI_AP8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03
Lee_AP1	0,22	0,20	0,16	0,20	0,23	0,18	0,19	0,23	0,19	0,28	0,28	0,23	2,58
Lee_AP2	3,78	3,25	2,71	2,99	3,69	2,60	2,77	3,46	2,87	4,16	4,15	3,51	39,92

Lee_AP3	1,00	0,88	0,72	0,87	1,27	0,75	0,79	0,99	1,12	1,27	1,25	1,04	11,93
Lee_AP4	0,91	0,80	0,62	0,79	0,96	0,69	0,74	0,95	0,79	1,21	1,20	0,96	10,62
Lee_AP5	1,56	1,32	1,18	1,32	1,58	1,17	1,34	1,59	1,32	2,00	2,07	1,61	18,04
Lee_AP6	0,82	0,49	0,39	0,76	0,57	0,43	0,66	0,65	0,62	0,86	0,71	0,58	7,55
Lee_AP7	2,79	2,40	1,89	2,42	2,83	2,16	2,28	2,88	2,36	3,58	3,61	2,86	32,05
Lee_AP8	2,55	2,22	1,78	2,25	2,65	1,98	2,10	2,64	2,22	3,34	3,31	2,70	29,72
Lee_AP9	0,64	0,59	0,52	0,59	0,66	0,55	0,57	0,65	0,59	0,76	0,76	0,66	7,53
Lee_AP10	0,46	0,41	0,33	0,41	0,49	0,37	0,39	0,48	0,41	0,61	0,60	0,50	5,46
Lee_AP11	1,92	1,71	1,41	1,71	2,02	1,55	1,98	1,99	1,71	2,48	2,45	2,05	23,00
Lee_AP12	0,79	0,64	0,67	0,71	0,70	0,69	0,59	0,66	0,61	0,81	0,78	0,76	8,41
Lee_AP13	0,30	0,27	0,21	0,27	0,32	0,24	0,25	0,32	0,27	0,40	0,40	0,33	3,57
Lee_AP14	25,48	25,22	25,05	25,52	25,16	25,19	25,31	25,71	25,21	26,25	25,29	25,37	304,75
Lee_AP15	16,38	14,05	15,02	5,05	5,32	13,15	14,63	14,30	12,17	4,45	18,92	5,05	138,50

Table A9-5. Projected (2060 “wet” scenario) overall blue water scarcity.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,05	0,06	0,07	0,09	0,09	0,14	0,14	0,11	0,13	0,07	0,06	0,05	0,09
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	3,38	2,57	2,52	2,35	3,14	4,15	5,14	5,58	6,30	6,12	5,34	4,36	4,25
Colne_AP2	2,11	1,82	1,85	2,13	2,30	2,84	3,26	3,41	3,64	3,43	3,04	2,53	2,70
Colne_AP3	2,45	2,50	2,73	3,27	3,57	4,76	5,35	5,56	5,92	4,53	3,60	3,19	3,95
Colne_AP4	3,22	2,77	2,68	3,24	3,52	4,10	4,60	4,55	4,87	4,85	4,50	3,86	3,90
Colne_AP5	0,93	0,77	0,73	0,75	0,82	0,99	1,10	1,31	1,55	1,57	1,32	1,18	1,08
Colne_AP6	1,48	1,33	1,33	1,39	1,50	1,70	1,84	1,80	2,08	2,10	1,99	1,79	1,69

Colne_AP7	1,52	1,36	1,30	1,52	2,30	2,81	3,27	2,47	2,77	2,70	2,45	2,04	2,21
Colne_AP8	2,80	2,43	2,55	2,95	3,31	4,19	4,96	5,13	5,30	4,98	4,17	3,12	3,82
Colne_AP9	1,13	1,04	1,04	1,24	1,53	1,97	2,06	2,12	2,27	1,94	1,67	1,44	1,62
Colne_AP10	0,03	0,04	0,05	0,04	0,04	0,05	0,08	0,08	0,06	0,05	0,06	0,05	0,05
RBI_AP1	0,00	0,00	0,05	0,01	0,02	0,03	0,05	0,00	0,00	0,00	0,01	0,00	0,01
RBI_AP2	0,00	0,00	0,04	0,01	0,01	0,02	0,03	0,03	0,03	0,00	0,00	0,00	0,01
RBI_AP3	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00
RBI_AP4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,01	0,01	0,01	0,02	0,02	0,03	0,04	0,04	0,03	0,01	0,01	0,01	0,02
RBI_AP6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP7	0,00	0,00	0,01	0,02	0,02	0,03	0,04	0,01	0,00	0,00	0,00	0,00	0,01
RBI_AP8	0,01	0,01	0,01	0,02	0,02	0,03	0,04	0,04	0,03	0,01	0,01	0,01	0,02
Lee_AP1	1,29	1,32	1,52	1,70	1,80	2,25	2,40	2,67	3,10	2,44	1,93	1,71	2,01
Lee_AP2	0,33	0,38	0,52	0,77	0,86	1,31	1,46	1,54	1,49	0,68	0,51	0,47	0,86
Lee_AP3	0,00	0,00	0,06	0,01	0,01	0,05	0,06	0,00	0,00	0,00	0,00	0,00	0,02
Lee_AP4	0,65	0,53	0,62	0,60	0,61	0,72	0,85	1,00	1,11	1,08	0,87	0,81	0,79
Lee_AP5	0,44	0,47	0,67	0,84	1,12	1,48	1,63	1,73	1,79	0,94	0,62	0,61	1,03
Lee_AP6	0,69	0,73	0,97	1,28	1,50	2,04	2,29	2,51	2,71	1,59	1,06	1,00	1,53
Lee_AP7	0,49	0,50	0,68	0,93	1,10	1,58	1,80	1,91	2,07	1,14	0,78	0,69	1,14
Lee_AP8	2,14	2,05	2,28	2,64	2,86	3,45	3,73	3,98	4,21	3,60	3,06	2,78	3,07
Lee_AP9	0,21	0,20	0,25	0,26	0,24	0,33	0,32	0,28	0,34	0,24	0,23	0,23	0,26
Lee_AP10	1,15	1,08	1,09	1,16	1,24	1,39	1,47	1,55	1,63	1,55	1,44	1,32	1,34
Lee_AP11	1,05	0,86	0,88	1,00	1,14	1,40	1,57	1,54	1,70	1,70	1,49	1,31	1,30
Lee_AP12	0,78	0,80	0,81	0,96	1,07	1,43	1,55	1,73	1,99	1,40	1,15	0,98	1,22
Lee_AP13	0,00	0,00	0,00	0,03	0,03	0,04	0,04	0,00	0,00	0,00	0,00	0,00	0,01

Lee_AP14	0,00	0,00	0,00	0,01	0,01	0,01	0,02	0,00	0,00	0,00	0,00	0,00	0,00
Lee_AP15	1,90	1,91	2,12	2,63	2,64	3,23	3,43	3,49	3,62	2,84	2,73	2,43	2,75

Table A9-6. Projected (2060 “dry” scenario) overall blue water scarcity.

Catchment ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
BandC_AP1	0,08	0,11	0,14	0,16	0,16	0,25	0,24	0,19	0,20	0,09	0,08	0,08	0,13
BandC_AP2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Colne_AP1	5,57	4,68	4,72	4,17	5,44	7,33	8,90	9,67	9,77	8,84	7,61	6,68	6,43
Colne_AP2	3,48	3,31	3,46	3,78	3,98	5,02	5,64	5,91	5,65	4,95	4,33	3,86	4,30
Colne_AP3	4,03	4,54	5,10	5,81	6,18	8,41	9,26	9,63	9,18	6,54	5,13	4,88	6,06
Colne_AP4	5,31	5,03	5,00	5,76	6,10	7,24	7,96	7,88	7,55	7,01	6,41	5,91	6,29
Colne_AP5	1,53	1,39	1,37	1,34	1,42	1,74	1,91	2,27	2,41	2,27	1,88	1,80	1,70
Colne_AP6	2,43	2,42	2,49	2,47	2,60	3,01	3,18	3,11	3,22	3,03	2,83	2,73	2,76
Colne_AP7	2,50	2,47	2,43	2,70	3,99	4,97	5,67	4,27	4,29	3,90	3,49	3,12	3,52
Colne_AP8	4,61	4,42	4,77	5,24	5,73	7,40	8,60	8,90	8,22	7,20	5,94	4,78	5,97
Colne_AP9	1,86	1,89	1,94	2,20	2,65	3,47	3,56	3,67	3,51	2,80	2,39	2,20	2,57
Colne_AP10	0,06	0,07	0,09	0,07	0,07	0,09	0,14	0,14	0,10	0,07	0,08	0,08	0,08
RBI_AP1	0,00	0,01	0,09	0,01	0,03	0,06	0,09	0,00	0,00	0,00	0,01	0,01	0,02
RBI_AP2	0,00	0,00	0,07	0,01	0,02	0,04	0,05	0,05	0,04	0,00	0,00	0,00	0,02
RBI_AP3	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,00	0,00	0,00	0,00
RBI_AP4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP5	0,02	0,02	0,03	0,03	0,04	0,05	0,06	0,06	0,05	0,01	0,01	0,01	0,03
RBI_AP6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RBI_AP7	0,00	0,00	0,02	0,03	0,04	0,05	0,06	0,01	0,01	0,00	0,00	0,00	0,01

RBI_AP8	0,02	0,02	0,03	0,03	0,04	0,05	0,06	0,06	0,05	0,01	0,01	0,01	0,03
Lee_AP1	2,12	2,40	2,84	3,02	3,11	3,97	4,15	4,63	4,80	3,53	2,76	2,61	3,10
Lee_AP2	0,55	0,69	0,98	1,38	1,49	2,31	2,53	2,66	2,31	0,98	0,72	0,72	1,08
Lee_AP3	0,00	0,00	0,10	0,02	0,02	0,09	0,11	0,00	0,00	0,00	0,00	0,00	0,01
Lee_AP4	1,07	0,97	1,16	1,07	1,05	1,28	1,48	1,73	1,73	1,57	1,23	1,24	1,26
Lee_AP5	0,72	0,86	1,25	1,50	1,94	2,62	2,82	3,00	2,77	1,35	0,89	0,94	1,34
Lee_AP6	1,14	1,34	1,81	2,27	2,59	3,59	3,96	4,35	4,21	2,30	1,52	1,54	2,08
Lee_AP7	0,80	0,91	1,28	1,66	1,90	2,79	3,11	3,32	3,20	1,65	1,11	1,06	1,53
Lee_AP8	3,52	3,74	4,27	4,69	4,96	6,10	6,47	6,89	6,53	5,20	4,37	4,25	4,87
Lee_AP9	0,34	0,37	0,46	0,47	0,42	0,59	0,56	0,49	0,52	0,35	0,33	0,36	0,42
Lee_AP10	1,89	1,97	2,04	2,06	2,15	2,45	2,55	2,68	2,53	2,24	2,05	2,02	2,20
Lee_AP11	1,73	1,56	1,65	1,79	1,98	2,48	2,71	2,66	2,63	2,45	2,13	2,00	2,08
Lee_AP12	1,28	1,45	1,51	1,71	1,85	2,53	2,69	2,99	3,09	2,03	1,64	1,50	1,86
Lee_AP13	0,00	0,00	0,00	0,05	0,05	0,07	0,07	0,00	0,00	0,00	0,00	0,00	0,02
Lee_AP14	0,00	0,00	0,00	0,02	0,02	0,03	0,03	0,00	0,00	0,00	0,00	0,00	0,01
Lee_AP15	3,13	3,48	3,96	4,68	4,57	5,71	5,94	6,05	5,61	4,10	3,89	3,71	4,25

Acknowledgements

This report is an outcome of partnership project carried out by the Water Footprint Network and the Environment Agency, Hertfordshire and North London, UK. The Environment Agency funded this study. The University of Twente provided technical support to this study.

List of abbreviations

AP	Assessment Point
ASB	Abstraction Sensitivity Band
BAT	Best Available Technology
BP	Best Practices
BWS	Blue Water Scarcity
CAMS	Catchment Abstraction Management Strategies
Defra	Department for Environment, Food & Rural Affairs (UK)
EA	Environment Agency (UK)
EFI	Environmental Flow Indicator
EFR	Environmental Flow Requirements
IWRM	Integrated Water Resources Management
Mm^3	Million cubic meters
RBI	Roding-Beam-Ingrebourne
RSA	Restoring Sustainable Abstraction
SENET	South East Region North East Thames Area
STW	Sewage Treatment Works
WF	Water footprint
WFA	Water Footprint Assessment
WFD	Water Framework Directive
WFN	Water Footprint Network
WPL	Water Pollution Level

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