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PROWATER
European Regional Development Fund

Restoring pockets of heathland and chalk grassland for climate adaptation

Results of changes implemented to the 'Friston Forest' site by South East Water

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DISCLAIMER

COLOFON

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Restoring heathland & chalk grassland for climate adaptation

On the Eastbourne Chalk Block, a major groundwater chalk aquifer, close to the town of Eastbourne (South East England), South East Water developed the Interreg 2 Seas PROWATER site 'Friston Forest' to demonstrate how the region can adapt to the consequences of climate change through Ecosystem-based Adaptation.

South East Water is a water supply company only, supplying drinking water to 2.3 million customers in the South East of England. This water is abstracted from a mix of surface and groundwater resources and is distributed through a network of over 14,500 kilometres of pipework. 76 per cent of water South East Water supplies is from groundwater resources.

By implementing Ecosystem-based Adaptation measures, South East Water wants to help protect groundwater catchments for water quantity and quality. This is in line with the objectives of South East Water's 25 Environment Plan. Ecosystem-based Adaptation (EbA), a Nature-based approach to climate change adaptation, harnesses ecosystem services to increase resilience and reduce the vulnerability of human communities and natural systems to the effects of climate change. These EbA measures can be integrated into adapted agriculture, forestry and environmental management.

This publication summarises EbA measures and results of the 'Friston Forest' demonstration site. The main goal was to increase the infiltration capacity of the area, protect the landscape and enhance biodiversity. South East Water converted pockets of gorse, woodland and scrub to restore chalk grasslands and heathland in locations that would benefit groundwater recharge through increased infiltration. This helps the region cope with the consequences of climate change (increasing groundwater recharge), increases biodiversity of the site and maintains water quality for the future.

The EbA measures were monitored between 2020 and 2022 to understand the value of the different habitats for water resources. Based on monitoring results, South East Water aims to maintain a balanced mix of (preferably deciduous) woodland to improve groundwater quality, and pockets of heathland and chalk grassland to increase groundwater recharge.

The results are summarised using various steps (chapter 1 to 4) that represent the process for successful planning and implementation of climate change adaptation measures (see Output 1). Presented insights and lessons learnt can help governments (national, provincial and municipal), knowledge institutions, consultancies, managers of nature areas, drinking water companies and landowners in the design of climate change adaptation projects.

Figure 1 - The dot situates the demonstration site for Ecosystem-based Adaptation in the Interreg 2 Seas region.

1 Understanding the Catchment

1.1 Geographical and Hydrological Context

Friston Forest is situated on the Eastbourne Chalk Block, a major groundwater chalk aquifer, close to the town of Eastbourne in South East England.

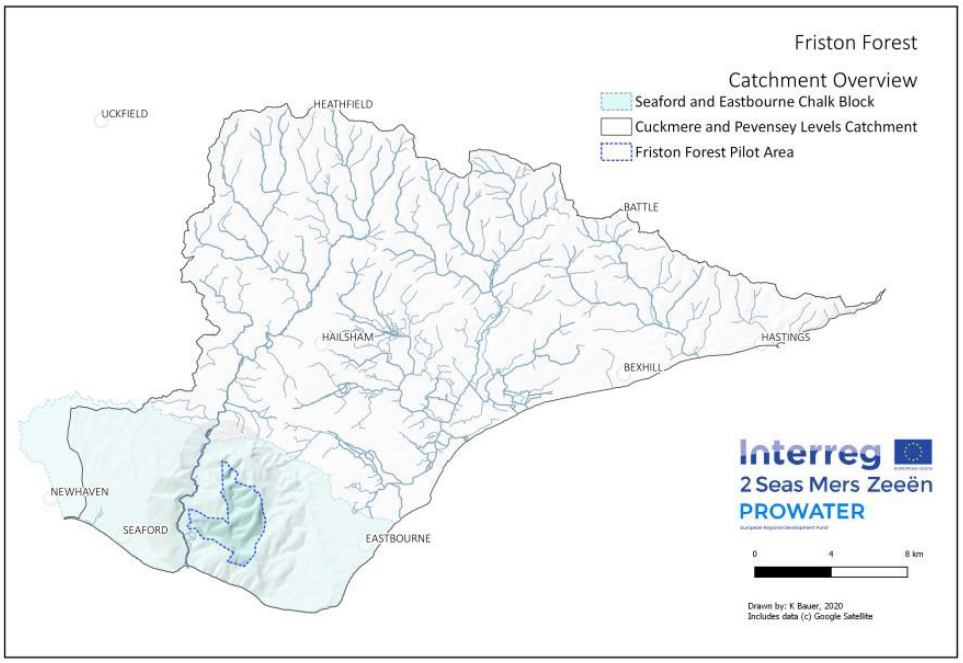


Figure 2 - Friston Forest is part of the Cuckmere and Pevensey Levels Catchment, part of which overlaps with the Seaford and Eastbourne Chalk Groundwater Body.

Much of the chalk is unconfined, however, younger impermeable Clay-with-Flints and Head deposits occur associated with the valleys, confining or semi-confining the underlying chalk. Groundwater flow occurs due to a high density of fractures and fissures enabling rapid flow of groundwater along areas of lower resistance. The geology is Cretaceous Chalk (Upper and Middle Chalk) and as a result, the soils are generally thin and free-draining. The shallow soils provide rapid infiltration to the underlying chalk aquifer. There are few areas where Clay-with-Flints outcrop and the associated soils are silty loam. The local topography influences groundwater movement in the block, encouraging preferential regional groundwater flow from the north-east to the south-south-west, towards the coastline.

Aside from the River Cuckmere to the west and spring-fed streams around the margins of the block, the only surface water is associated with artificial dewponds and localised runoff from roads and other hardstanding. Runoff following rainfall is likely to sink into the chalk via soakaways or drainage ditches.

Chalk aquifers are a key source of drinking water in the South East. South East Water operates six potable water sources abstracting from the Eastbourne Chalk Block. The focus of the 'Friston Forest' demonstration site is on two of the six public water supply abstractions: Friston and Deep Dean.

The Friston source was originally constructed from 1896 onwards and consists of a 3.6 kilometre long adit. The adit is constructed perpendicular to the direction of regional groundwater flow within the Eastbourne Chalk Block, intersecting and diverting the flow towards the abstraction point. The Deep Dean source was constructed in 1959 to provide a new supply, passing through the northern end of the Friston adit taking advantage of surplus water.

1.2 Human Context

South East Water owns 900 hectares of land across the Eastbourne Chalk Block, including Friston Forest, Lullington Heath National Nature Reserve (NNR) and nearby agricultural land (comprising of a mix of arable and grazing land use). Friston Forest covers approximately 740 hectares, within the South Downs National Park, and is managed by the Forestry Commission. The forest is enjoyed for recreation by the public for walking, cycling and horse riding. Lullington Heath NNR covers 71.7 hectares, situated close to Friston Forest, and is home to rare habitats (like chalk grassland and heathland) and native species of interest.

Friston Forest is the largest area of recently established forest in South East England. It was established in the 1930s to trial protecting the catchment from pollution and also thought at that time, to increase the rainfall (through the planting of trees). A generation ago this area would have vast chalk grassland rather than a forest plantation. Figure 3 shows the area around the Friston source before and after the plantation.

Three key industries exist in the catchment - woodland harvesting (managed by the Forestry Commission), agricultural land management and groundwater public water supply.

Figure 3 - Photos of the Friston source before and after the forest plantation.

Source Protection Zones (SPZs) are defined around large and public potable groundwater abstraction sites. The purpose of SPZs is to provide additional protection to safeguard drinking water quality through constraining the proximity of an activity that may impact upon a drinking water abstraction. Figure 4 shows the SPZs for the Friston and Deep Dean abstractions.

Water Resource Management Plans (WRMP) set out how water companies intend to achieve a secure supply of water for customer and seek to protect and ehnace the enviornemnt. This process is goverened by the Water Industry Act in England. Water companies update their WRMP every five years. Usually these plans look 25 years into the future, however, South East Water's WRMP 2019 looks 60 years ahead to 2080, because of the unique challenges faced in South East England, such as climate change. Planning the next WRMP, to cover the period 2025—2050, is well underway.

The South Downs National Park Authority are currently developing a People and Nature Network to oversee green infrastructure planning. The designated areas nearest to the PROWATER demonstration sites, including:

- **Lullington Heath NNR and SSSI** - designated for the presence of two nationally uncommon habitats: chalk heath and chalk grassland

- **Wilmington Downs SSSI** - designated for its nationally uncommon chalk grassland habitats and two nationally rare invertebrates and several notable invertebrates.

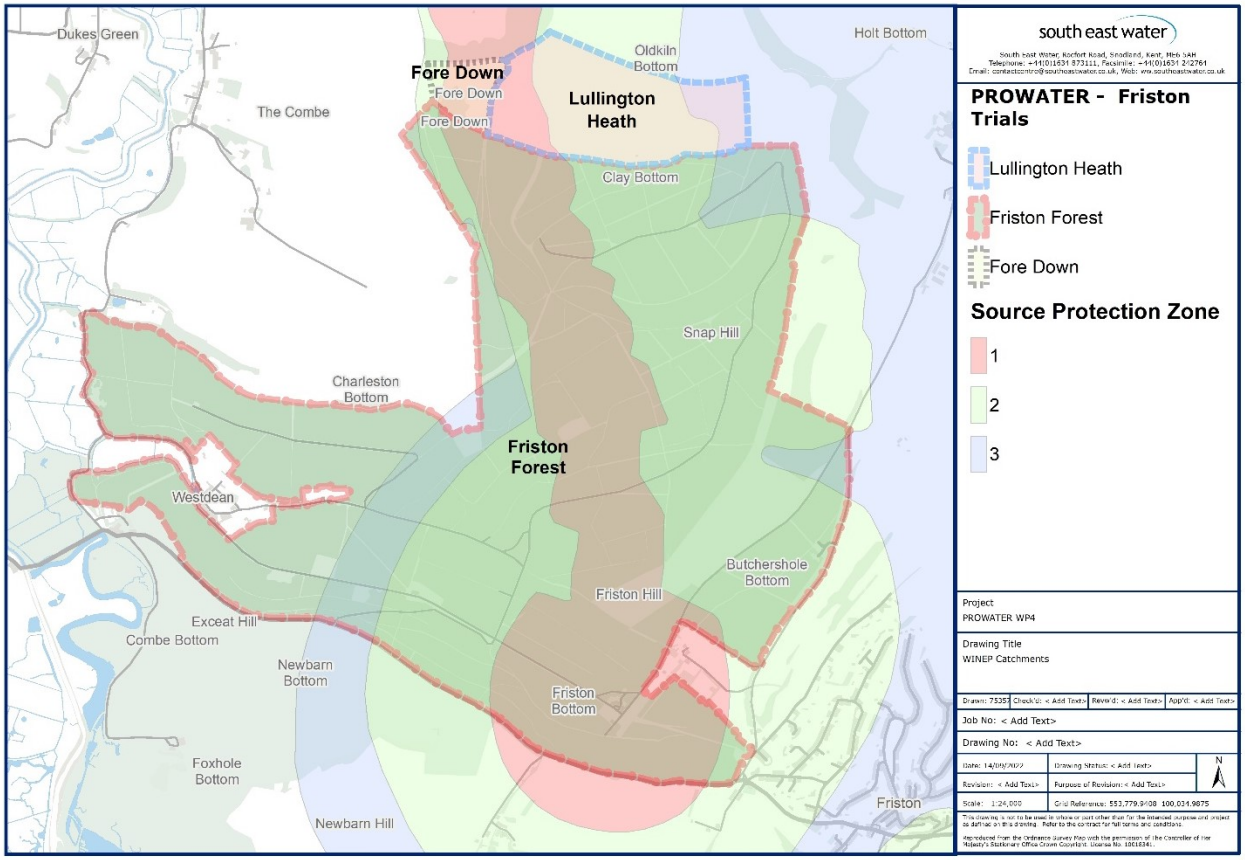


Figure 4 - Source Protection Zones (SPZ) 1 (red), 2 (green) and 3 (blue) for the Friston and Deep Dean sources. These sources are connected by an adit which also has SPZ 1 (red) designation.

1.3 Water Resource Risks and Challenges

As a potable water only company, South East Water is the only abstractor from the Seaford and Eastbourne Chalk Block. Sewage and wastewater services are provided by Southern Water.

South East Water has six abstractions in the Eastbourne Chalk and three in the neighbouring Seaford Chalk, to the west of the study area. These abstractions fall within South East Water's Water Resource Zone (WRZ) 2 and 3 in Sussex, and supply a population of approximately 420,000 in local towns and villages (e.g. Eastbourne, Polegate, Seaford).

The sources at the demonstration site (Friston and Deep Dean sources) contribute to Water Resource Zone 3. Average daily demand for water is approximately 55.5 million litres per day for WRZ 3. Thirty per cent of water supplied in WRZ 3 comes from surface water sources (e.g. Arlington reservoir), with 59 per cent from groundwater sources (e.g. Eastbourne chalk abstractions) and the remainder from transfers from other WRZs.

There are a number of risks and challenges for the provision of water resources in the South East of England. Table 1 outlines these challenges. The main risk to groundwater sources in the area is from diffuse pollution, mainly from agriculture, sewerage infiltration (both sewerage mains and domestic septic tanks) and rural land management practices. Friston and Deep Dean groundwater abstractions are also at risk from saline intrusion due to their proximity to the coast.

Table 1 - Water resource challenges in the South East of England.

Challenges	Why is it a challenge
Household water use	Peak demand in hot weather means more water is taken from the environment
Business water use	Growing demand from certain sectors such as micro-breweries and vineyards
Pesticides and nitrates	Increasing concentrations in the raw water - South East Water's abstraction requires increasing levels of treatment
Land ownership	Land use change can have a significant impact on water resources and quality
Housing growth	Finding the right balance of water resources without damaging the environment
Highways run-off	Harmful substances are either washed into water courses or directed to groundwater
Climate change	Periods of extreme weather impacting on water resources and environment
Low summer flows	Lack of water available for both water supply and the environment
Invasive non-native species	Can damage water infrastructure and contribute to water quality issues
Septic tanks	Potentially releases high levels of nutrients and bacteria to surface and groundwater
Sewer (wastewater) leakage and overflows	Potentially releases high levels of nutrients and bacteria to surface and groundwater
Saline intrusion	Reversing hydraulic gradients in the chalk blocks can induce saline intrusion impacting on water resources, quality and also the environment (e.g. WFD status of the groundwater body)

2 Identifying and engaging buyers, sellers and brokers

The basic idea behind the PES (Payment for Ecosystem Services) financing model is that investments made by 'buyers' in climate change adaptation measures result in the targeted provision of ecosystem services provided by the 'sellers' (see Output 2).

Friston Forest is owned by the water company South East Water, which can be perceived as the seller in this case. However, South East Water also acts as intermediary and consultant for buyers (Natural England and the Forestry Commission), acting as broker at the same time. It is important to note that water companies can act as anchors for other buyers to invest in EbA and promote change. South East Water customers and European citizens (through co-funding by the European Regional Development Fund), can be considered as buyers of the targeted ecosystem services, being increased infiltration to groundwater. In return, customers receive more resilient water provisions through EbA measures implemented at a landscape scale, increasing water infiltration to groundwater.

The theoretical application of the PES financing model can help identify opportunities for future financing. This is much needed to achieve a climate resilient catchment. Potential buyers, brokers and sellers in the 'Friston Forest' demonstration area include:

- Buyers (benefitting from the EbA measures):
    - Water company (and its customers)
    - Forestry Commission and independent foresters
    - Environmental bodies (Natural England / EA) and NGOs (National Trust)
    - Recreation / tourism industry
    - Timber merchants
    - Companies valuing environmental objectives (National Lottery Heritage Fund)
    - General public
- Sellers (owners / managers of the land where the EbA measures are implemented):
    - Water company
    - Forestry Commission & independent foresters
    - Environmental bodies (Natural England / EA)
- Brokers (with knowledge to assist EbA implementation, bringing buyers & sellers together):
    - Water company
    - Environmental NGOs (Rivers Trust)
    - Forestry Commission and independent foresters
    - Agricultural consultants (Farming and Wildlife Advisory Group)

3 Prioritising locations for climate adaptation measures

3.1 Prioritisation by means of the water system map

For the project PROWATER, the University of Antwerp applied the water system map to the Interreg 2 Seas area (including catchments in Flanders, the Netherlands and South England) (Output 3). This map helps prioritise where to best apply EbA measures to infiltrate and retain water, based on hydrological characteristics, soil typology and topographical information. The map identifies 'natural places' in the landscape for seepage (groundwater coming back to the surface) and infiltration.

Groundwater dominated catchment

Hill top / Plateau – infiltration area, where water can infiltrate to groundwater bodies (indicated in brown)

Valley height – infiltration area, where water can infiltrate to groundwater bodies (indicated in yellow). Water that infiltrates here will have less residence time before it emerges in streams. However, flood attenuation can be achieved by infiltration.

Hill depression / Valley depression – Temporarily wet area, where runoff can be retained and slowly infiltrate. (indicated in green)

Floodplain – Temporarily wet area, where runoff and seepage can be retained and slowly infiltrate. (indicated in blue)

Figure 5 - The red outlines indicate the location of the three sub-sites on the water system map. The map confirms the suitability to increase infiltration through restored heathland and chalk grassland (with the potential for infiltration areas indicated in brown)

Hydrological characteristics, soil typology and topography were considered when planning the EbA measures for the 'Friston Forest' demonstration site. The water system map helped identify potential pathways of water flow through the woodland, heath and the surrounding area, which would normally be difficult.

Figure 5 helps identify areas suitable for implementing EbA measures to enhance water infiltration at the demonstration site. South East Water converted pockets of gorse (Lullington Heath), woodland (Friston Forest) and scrub (Fore Down) to restore chalk grasslands and heathland in three locations that would benefit groundwater recharge through increased infiltration.

3.2 Refining spatial prioritisation and EbA opportunities

Spatial planning and the choice of EbA measures implemented also considered the following:

- The land was already owned by South East Water, facilitating implementation
- the location is important for groundwater abstraction
- adjacent land use limited the choice of EbA measure (adjacent agricultural land)
- stakeholder input influenced the choice of EbA measure (agricultural landowners, water company, Forestry Commission, environmental stakeholders)
- existing regulations influenced the choice of EbA measure (SSSI regulations and restrictions).

Due to the nature of this groundwater catchment and no surface waterbodies restoring a natural flood plain / area is not possible. Infiltrated groundwater discharges at the coast line, and provide fresh water to push back any saline intrusion and/or support coastal ecology.

3.3 The expected impact

Restoring pockets of heathland and chalk grassland in specific locations, will increase the infiltration capacity of the area, protect the landscape and enhance biodiversity while maintaining water quality through a balanced mix with (deciduous) forest.

4 Monitoring and Evaluation

4.1 Monitoring and evaluating the impact of EbA on ecosystem services

The aim of South East Water's study at Friston was to implement EbA measures to understand how different vegetation types impact on water availability in the soil and infiltration to groundwater. A secondary aim was to understand how different vegetation types could contribute to nutrient loading (primarily nitrates) to groundwater.

Woodland, gorse and scrub were converted towards chalk grassland and heathland through clearance management. The three sites were converted (using clearance management) and monitored during the study, this consisted of a woodland area (at Friston Forest), gorse (at Lullington Heath) and scrub (at Fore Down). Established chalk grassland and heathland areas were also monitored. Figure 6 shows the overview of the converted areas. Additional detailed maps and monitoring points can be found in Annex 1.

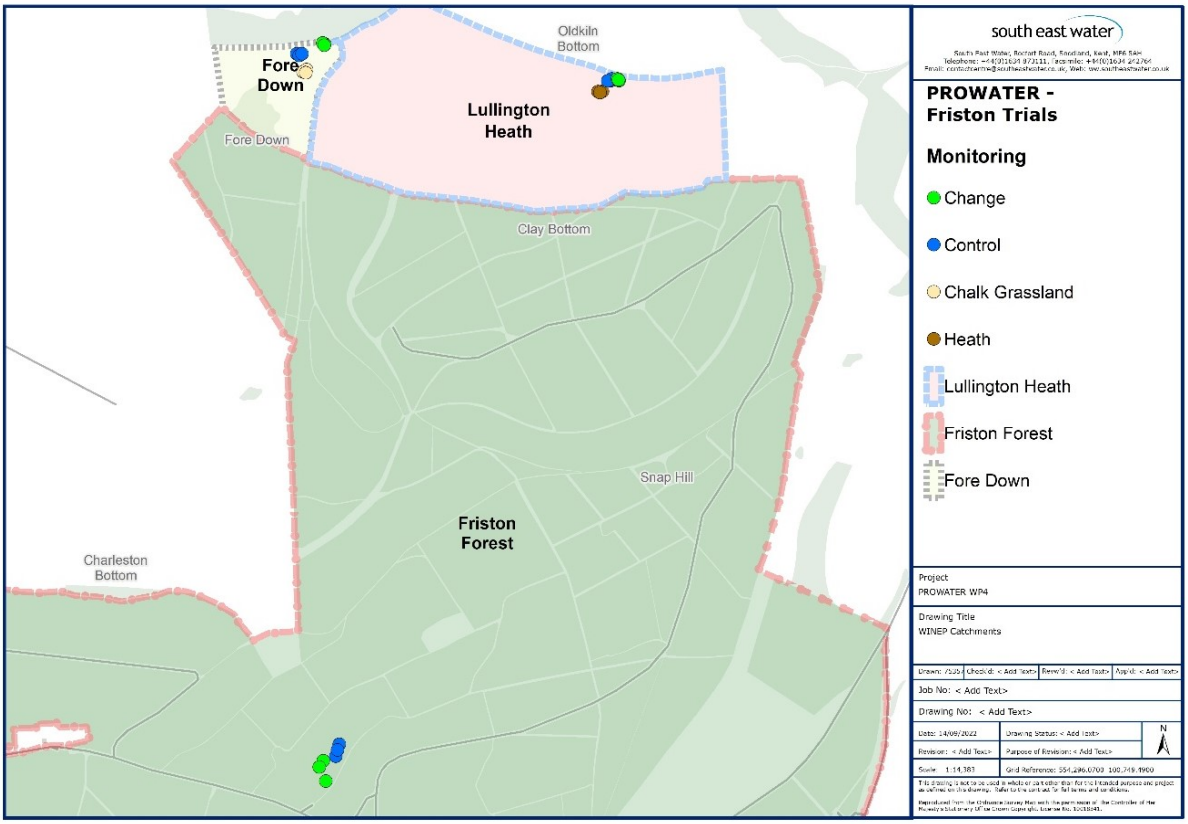


Figure 6 - Map showing overview of the control and change (conversion) areas at the demonstration site.

Monitoring at the sites included installation of:

- Soil moisture probes (measuring soil moisture to a depth of 115 centimetres) at both the control and change areas for woodland, gorse and scrub. Three soil moisture probes were installed at each location and the results averaged.

- soil moisture probes at the chalk grassland and heathland sites. Three soil moisture probes were installed at each location and the results averaged.
- three rainfall and weather stations (one at Friston, Lullington and Fore Down)
- porous pots to a depth of 90 centimetres below the root zone to capture infiltrated water. Water was collected and tested for nutrients, after rainfall events and at regular intervals.

Monitoring began in March 2020, with EbA measures implemented in 2021. Two years' worth of data has been collected at the site.

Direct groundwater recharge can be complex to measure, therefore, South East Water measured soil moisture as an indicator for groundwater recharge. Deep soil moisture probes were sourced for this work, and the probes measure soil moisture to a depth of 115 centimetres (which is below the root zone of the vegetation types being monitored). Soil moisture content was measured at regular intervals from five centimetres to 115 centimetres depths at 15 minute intervals.

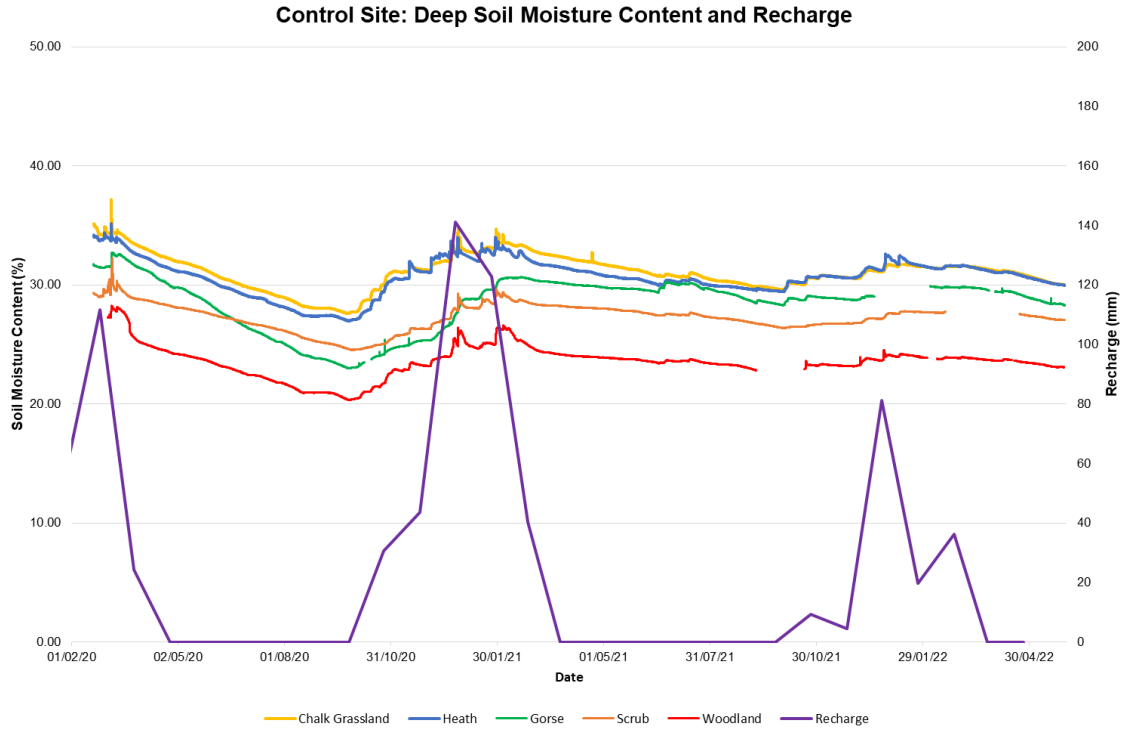


Figure 7 - Graph showing soil moisture content at 115 centimetres depth at the five control sites (woodland, gorse, scrub, chalk grassland and heathland) against recharge (calculated through Penman equations). Highest soil moisture content at depth was associated with long established chalk grassland and heathland.

Rainfall during the pre-conversion year in 2020 (control year), was fairly typical, with just above long-term average for the year. However, the rainfall in the year post-conversion was more variable - the spring of 2021 was dry, with only five per cent of long term average rainfall in April, followed by a wet summer with twice the expected rainfall in both June and July and a dry autumn and winter period, with again just five per cent of long term average rainfall in November 2021. The groundwater recharge season for 2021/2022 was short with a dry autumn and dry spring. This variability makes the data more challenging to interpret, and data collected from the conversion sites since February 2021 is less conclusive than the control sites, however, South East Water can draw some conclusions.

When comparing all the soil moisture data for the control sites (woodland, gorse, scrub, heathland and chalk grassland), over the two year monitoring period, South East Water found that the long term

established chalk grassland and heathland have the highest soil moisture content at 115 centimetre depth (approximately 31 per cent) out of all the vegetation types (Figure 7). The woodland had the lowest soil moisture content at 115 centimetre depth out of all the vegetation types, at 23 per cent. This lower moisture content is a direct result of water uptake in the trees and also due to rainfall interception from the canopy and evapotranspiration. In comparison, gorse and scrub faired at 28 per cent and 27 per cent, for soil moisture content, respectively.

The differences between the control and change areas for each of the vegetation types is best presented through bar charts which shows the average amount of soil moisture for each site along with the range of the data. The higher the average soil content the higher the likelihood of wetting and infiltration to ground during groundwater recharge periods. A lower range in the data suggests more stable water retention, which could be important during drought periods. Figure 8 indicates that all post-clearance areas have a higher average soil moisture content across five, 55 and 115 centimetre depths. The range of data at 115 centimetre depth for all three vegetation types post-clearance reduced, suggesting less uptake by vegetation and more stable soil moisture content at depth.

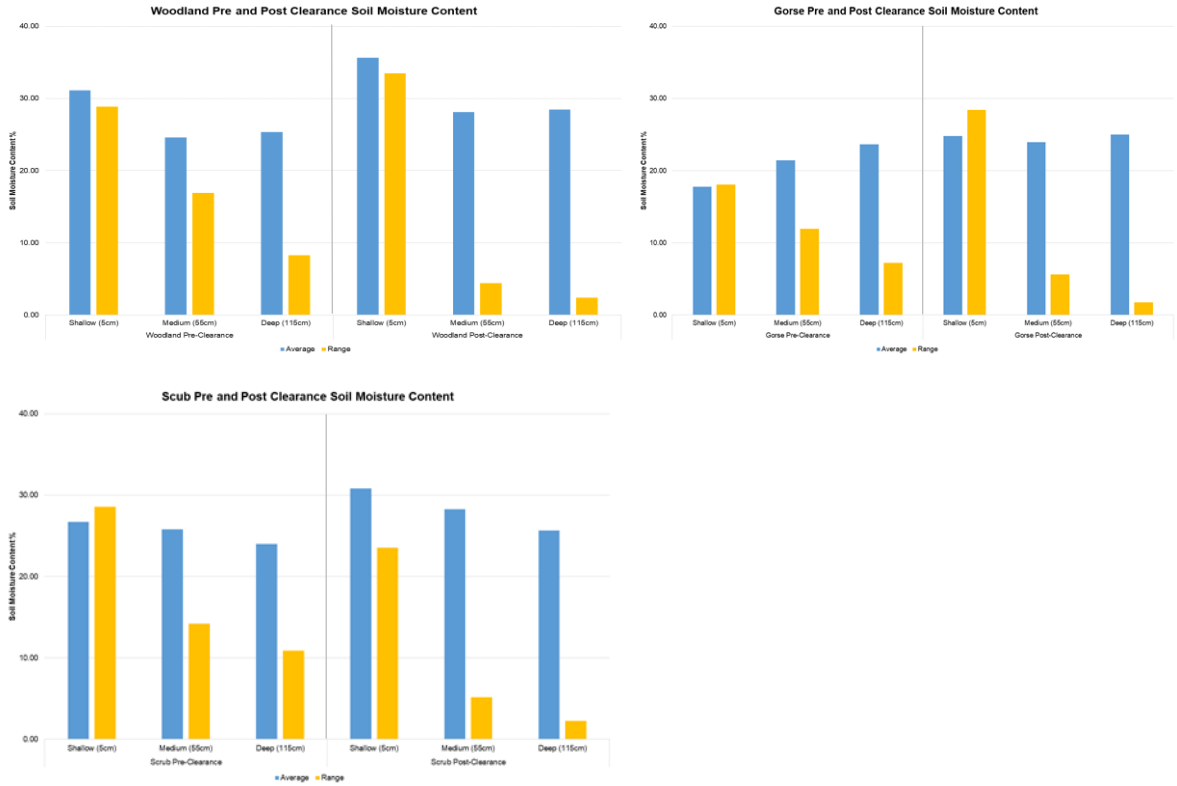


Figure 8 - Top left: Woodland data. Top right: Gorse data. Bottom left: Scrub data.

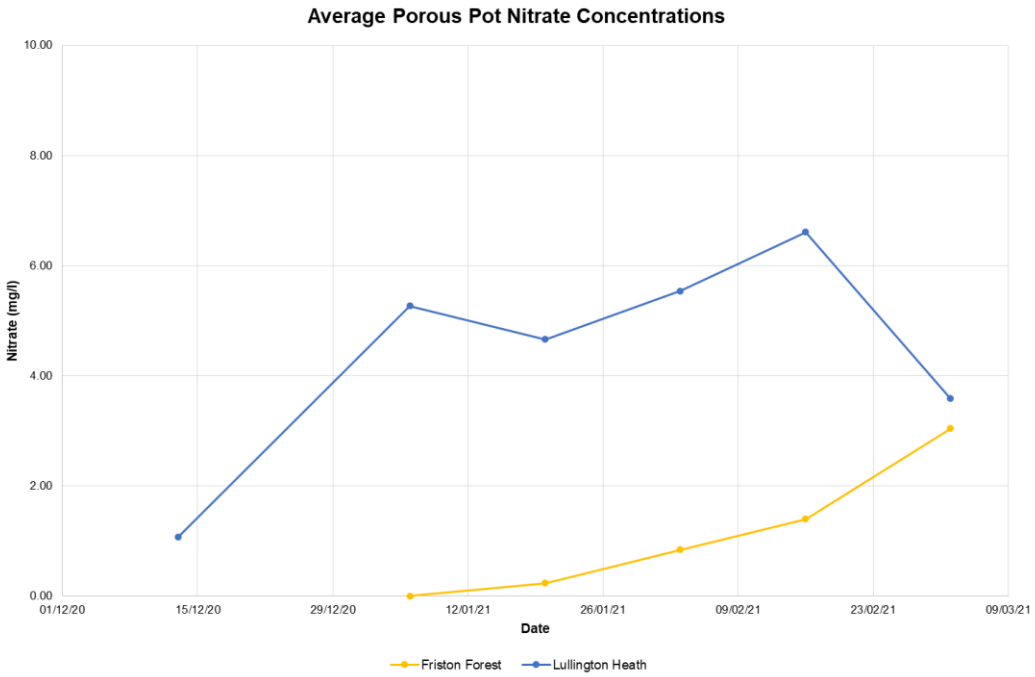


Figure 9 - Graph showing forest and scrub soil water nitrate concentrations

Porous pots were installed at Friston Forest and Lullington Heath and soil water samples were collected during the winter of 2020/2021. The samples were analysed for nitrate and the results are shown in Figure 9. The results for woodland at Friston show less nitrate leaching to ground compared with the scrub at Lullington Heath, both are low compared with land used for agriculture. The low nitrate leaching at the woodland site corroborates the fact that the forest was planted to protect water quality in the 1930s as the Friston abstraction has lower nitrate concentrations compared with other abstractions in the neighbouring chalk block (e.g. Seaford Chalk).

Overall, so far, South East Water's data has indicating that long term established chalk grassland and heathland have the greatest potential for water infiltration and groundwater recharge and could more stable during periods of drought. Data will continue to be collected from the sites to provide further evidence to support future work.

4.2 Evaluating the participatory planning and implementation process

Planning of the implementation of the EbA measures included:

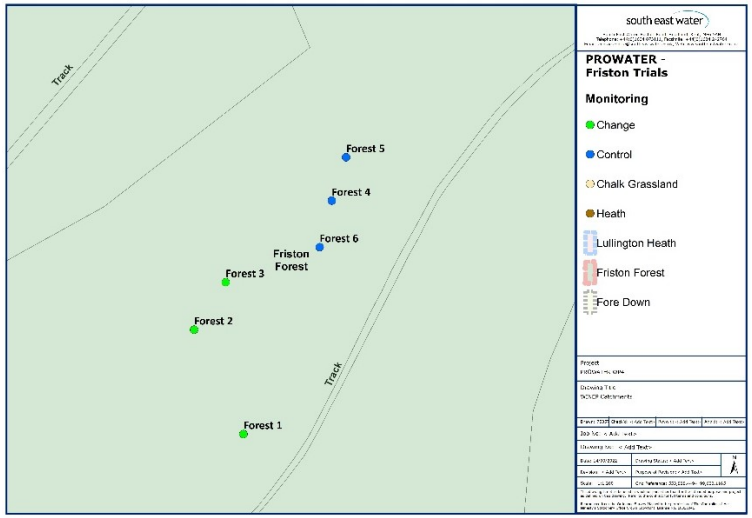
- Understanding the other stakeholders which have an interest in the site, including the Forestry Commission (for woodland management) and Natural England (for the Lullington Heath NNR).
- working with Natural England to carry out the research at the Friston demonstration site as some of the monitoring falls with a Site of Special Scientific Interest (SSSI).
- on-going working relationship with the Forestry Commission and the development of their 10 year management plan.
- managing contractors onsite for the delivery of EbA measures.

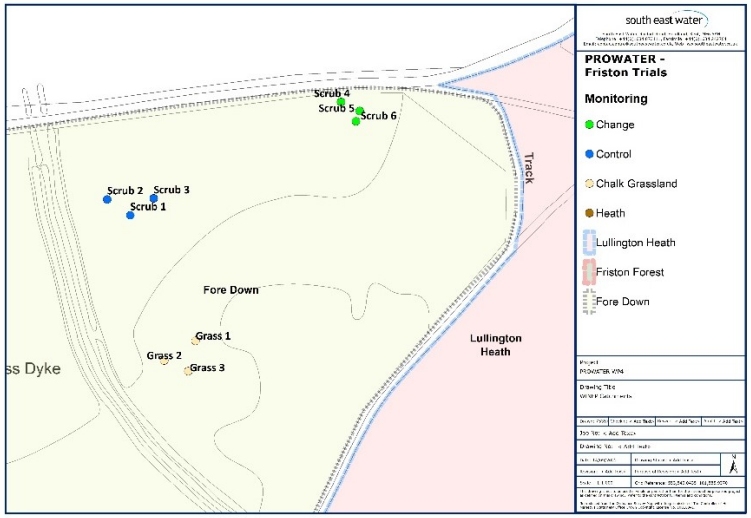
The success of the implementation of EbA measures was in-part due to South East Water owning the majority of land. The biggest challenges faced with this study was implementing the clearance work and monitoring at the SSSI, and ensuring that the soil moisture probe data was correct and calibrated.

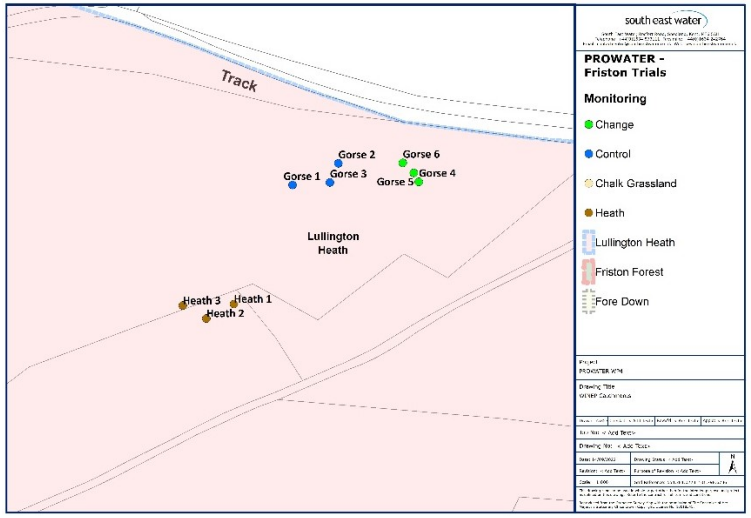
South East Water will continue with the PROWATER EbA and monitoring at the Friston Forest demonstration site after the PROWATER project has finished.

Working closely with Natural England, we at South East Water are seeking to extend Lullington Heath NNR to create a Super National Nature Reserve covering the whole of the Seaford and Eastbourne Chalk Block. This would be the first super NNR for the protection of groundwater quality, quantity and biodiversity in England. The scientific findings from PROWATER will underpin the creation of a landscape scale plan and aid the design of a blueprint for the self-sustaining super NNR. The super NNR will aim to protect water quality, quantity and biodiversity for future generations.

Annex 1 – Monitoring Location Maps







Annex 1.1: (top left) Map showing woodland management and control locations at Friston Forest

Annex 1.2: (top right) Map showing scrub management and control locations, plus the chalk grassland sites at Fore Down.

Annex 1.3: (adjacent) Map showing gorse management and control locations, plus the heathland sites at Lullington Heath.

SEW Site ID	Location	Habitat Type	Status
Forest 5	Friston North	Woodland	Control
Forest 6	Friston North	Woodland	Control
Forest 4	Friston North	Woodland	Control
Forest 3	Friston South	Woodland	Change
Forest 1	Friston South	Woodland	Change
Forest 2	Friston South	Woodland	Change
Heath 1	Lullington Heath	Heath	No Change
Heath 3	Lullington Heath	Heath	No Change
Heath 2	Lullington Heath	Heath	No Change
Grass 1	Fore Down CG	Chalk Grassland	No Change
Grass 2	Fore Down CG	Chalk Grassland	No Change
Grass 3	Fore Down CG	Chalk Grassland	No Change
Scrub 2	Fore Down Scrub West	Scrub	Control
Scrub 1	Fore Down Scrub West	Scrub	Control
Scrub 3	Fore Down Scrub West	Scrub	Control
Scrub 5	Fore Down Scrub East	Scrub	Change
Scrub 4	Fore Down Scrub East	Scrub	Change
Scrub 6	Fore Down Scrub East	Scrub	Change
Gorse 3	Lullington Gorse West	Gorse	Control
Gorse 2	Lullington Gorse West	Gorse	Control
Gorse 1	Lullington Gorse West	Gorse	Control
Gorse 4	Lullington Gorse East	Gorse	Change
Gorse 6	Lullington Gorse East	Gorse	Change
Gorse 5	Lullington Gorse East	Gorse	Change

Annex 1.4: Table showing control and change monitoring points.