rdWRMP24 Natural Capital and Biodiversity Net Gain Assessment (Appendix AA)

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Executive Summary

As a water company, Thames Water has a statutory obligation to produce a Water Resources Management Plan (WRMP) every five years. The WRMP sets out how a sustainable and secure supply of clean drinking water will be provided to its customers over a minimum 25-year planning period, whilst showing how its long-term vision for the environment will be achieved. Wider societal benefits, such as tourism, are also considered and balanced against the plan being affordable. This creates a 'best value' plan (BVP). The Thames Water revised draft WRMP 2024 (rdWRMP24) renews the previous WRMP published in 2019.

In developing rdWRMP24, Thames Water have undertaken a Natural Capital Assessment (NCA) and a Biodiversity Net Gain (BNG) assessment of the potential effects of options. The methodological approach to the NCA and BNG assessment developed for the Thames Water rdWRMP24 aligns with the method defined by Water Resources South East (WRSE). This alignment was considered with the ambition of delivering a consistent NCA and BNG assessment methodology across the water companies developing options which require these assessments across the WRSE region. The NCA and the BNG assessment have been produced in line with best practice and guidance available at the time the assessments were undertaken, including:

- Defra (2020) Enabling a Natural Capital Approach (ENCA)
- HM Treasury and Government Finance (2018) The Green Book: appraisal and evaluation in central government
- Natural England (2021) The Biodiversity Metric 3.0 auditing and accounting for biodiversity (JP039)
- Natural England (2020) NERR076 Natural Capital Indicators: for defining and measuring change in natural capital
- Water Resources Planning Guidelines ('Guidelines'): Working version for rdWRMP24 (version 4.2) (Environment Agency, Natural Resources Wales, Ofwat)
- Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making

The rdWRMP24 BVP (Situation 4) is the preferred pathway within the rdWRMP24. As part of the rdWRMP24, a NCA and BNG assessment were carried out on two of the alternative BVP scenarios, Situation 1 and Situation 8 (core pathway), the least cost plan (LCP) and the best environmental and societal plan (BESP). The NCA and BNG process requires a change in land use to occur for an assessment to be conducted; if any option does not require change in land use, an option is scoped out from assessment.

Furthermore, in the Draft WRMP, the environmental assessment outcomes (including from the BNG assessment and the NCA) from the regional investment modelling were reported. However, at the time of writing, all Strategic Resource Option (SRO) proposals have been submitted for Gate 2, through the RAPID gated process and have undergone stakeholder consultation. As such, Thames Water has used the NCA and BNG assessments submitted as part of Gate 2, as they will reflect the latest, most accurate information. These SROs, however, although adhering to the ENCA framework, differ substantially in their assessment compared to non-SRO (referred to as standard resource options throughout report) due to the level of detailed design progressed, subject to additional consultation, surveys and refinement as part of the RAPID gated process, and, as set out in the Environment Agency's supplementary guidance

on Environment and society in decision-making, 'The NCA methodology should be proportionate to the level of detail available for both the stage of option design and the availability of supporting environmental and social data'. Paired with the various approaches to assessment listed as acceptable in ENCA, and degrees of assumed mitigation, SRO data could not be included within the non-SRO (hereafter referred to as standard resource options) analysis but sit alongside them within this report for clarity. The exception to this is T2ST, which was identified to have followed a similar methodology to standard resource options analysis.

Natural Capital Assessment.

Natural capital stocks in the cumulative assessments includes results for all scoped in options associated with each plan, with limitations of its approach highlighted. It is important to keep in front of mind that the BNG Strategy will provide an assured framework for mitigation to be applied to the T2ST and the standard resource options, which through careful design of viable retention, enhancement, and creation of habitats, could reduce the overall losses highlighted below.

- All plans exhibit a large gain in ponds and linear features. Those plans including the larger 150Mm3 SESRO reservoir (all BVP's and LCP) estimate a gain of 653.397ha, whilst BESP Situation 4 estimates a smaller area of 391.077ha.
- There are smaller gains in Coastal and Floodplain Grazing Marsh, Lowland Fens, Other Semi-Natural Grassland and Lakes and Standing Waters across all plans.
- All plans experience large losses in arable land, ranging from losses of 1126.807ha (BESP Situation 4) to 1323.707ha (LCP Situation 4, BVP Situation's 1 and 4).
- There are smaller losses of Broadleaved, Mixed and Yew Woodland, Pastures, Urban Semi Natural Habitat, and rivers across all plans.
- All plans will experience the permanent loss of an ancient crack willow (Salix fragilis) tree, associated with the SESRO schemes, identified through a search of the Ancient Woodland Inventory. In addition to this, LCP Situation 4, BVP Situations 1 and 4, and the BESP anticipate a small area loss of Ancient Woodland (0.01ha) associated with the construction of T2ST.
- BESP Situation 4 experiences losses of Dwarf Shrub Heath (-0.551ha) with the remaining plans evidencing gains of 18.489ha.

Ecosystem Services

- Overall, ecosystem services experience a loss for the standard resource options and T2ST options, associated with the unmitigated impacts being considered within the assessment. The BVP Situation 8 has the least impact, resulting in a loss of -£181.41 £2021/year, with the losses of the other plans ranging from -£52,500.14 £2021/year to -£54,367.94 £2021/year. By retaining, enhancing, and creating additional habitats, the BNG Strategy could bring a wealth of associated ecosystem service benefits.
- SESRO brings all plans an overall positive impact on climate regulation, water purification, and recreation ecosystem service provision. Disbenefits are seen for food production, air pollutant removal, and natural hazard regulation services. The best performing plan in terms of ecosystem services for the SESRO development is the BESP, with an overall benefit of £35,334,000 £2022/year. The LCP and BVP Situations have an overall benefit of £32,005,000 £2022/year each. The positive values are related to the positive impacts the mitigation applied brings.
- All plans will experience the same environmental benefits for the Teddington DRA scheme, bringing benefits in relation to climate regulation, natural hazard regulation and

agriculture ecosystem services. The £2022/year benefit is estimated to be £22,996, related to the positive impacts the mitigation applied brings.

Biodiversity Net Gain

- The standard resource options and T2ST options display a negative BNG score due to the unmitigated approach used. The LCP, BVP Situations 1 and 4, and BESP have the least impactful results, with a total percentage change ranging from -20.98% to -21.28%, and the BVP Situation 8 being the most impactful with a total percentage change of -34.63%. The BNG Strategy is focussing on opportunities for gain to address the losses because of these developments, outlining an approach for preparation, design, construction, and management and monitoring stages to ensure BNG is embedded throughout the development process.
- Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers (LCP, BVP Situations 1, 4 and 8), and the 75Mm3 option could achieve an overall net gain in biodiversity of 51.64% for habitats, and 34.84% for rivers (included within the BESP). However, it is important to note, for both options hedgerows and woodlands cannot meet the requirements for on-site under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines; additional lengths of hedgerow linear features need to be created, retained or enhanced on site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows.
- All plans have the same impact in terms of Teddington Direct River Abstraction (Indirect Water Recycling). Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary).

1 Introduction

1.1 Background

Thames Water is the UK's largest water and wastewater services company. It supplies 2.6 billion litres of drinking water per day and treats 4.7 billion litres of wastewater per day. It is responsible for the public water supply and wastewater treatment for most of Greater London, Luton, the Thames Valley, Surrey, Gloucestershire, north Wiltshire, and west Kent. The area covered by Thames Water has a population of 15 million, which is 27% of the UK population.

This Annex presents the NCA and BNG assessment that has been undertaken as part of the environmental assessment process to support development of the Thames Water Resources Management Plan (WRMP). This report outlines the findings of the Revised Draft WRMP24 (hereafter known as rdWRMP24).

1.2 Thames Water rdWRMP24

All of Thames Water's operations sit within the Water Resources South East (WRSE) region. To support a robust evaluation of alternatives, WRSE ran the investment model multiple times to examine how the investment plan changed as the inputs to the values used in the adaptive framework changed. At a WRSE level, three alternative programmes were selected for consideration / assessment through the Strategic Environmental Assessment (SEA) process, which the NCA and BNG assessment form a part of. These programmes are set out below along with a justification for why they were progressed:

- Least Cost Plan (LCP) – The Water Resources Planning Guideline[1] (the 'Guidelines') states in Section 10.4 that:
  '*You should produce a least cost programme as a benchmark to appraise your other programmes against. The least cost plan should meet your statutory requirements and be informed by your SEA and HRA. The least cost plan should include policy expectations around demand management*.'
  This programme meets all the legal / regulatory requirements, policy expectations and objectives of the plan. It is therefore a reasonable alternative and was progressed for consideration through the SEA process.

- Best Environmental and Societal Plan (BESP) – The Guidelines state in Section 10.3 that:
  'You should present in your WRMP a programme that represents a 'Best environment and society' programme in your programme appraisal. The 'best environment and society' programme should be one that is formed using this guidance and therefore takes into account the Strategic Environmental Assessment, Habitats Regulations Assessment, Biodiversity Net Gain and Natural Capital where appropriate…You should explain in your plan how you have considered your Best Environment programme, as part of your programme appraisal, and what influence it has had on your preferred programme'.

[1] Environment Agency, Natural Resources Wales, The Water Services Regulation Authority (2022). Water Resources Planning Guideline. Available at: https://www.gov.uk/government/publications/water-resources-planning-guidelineWater resources planning guideline - GOV.UK (www.gov.uk) [Accessed August 2023]

This programme meets all the legal / regulatory requirements, policy expectations and objectives of the plan. It is therefore a reasonable alternative and was progressed for consideration through the SEA process.

- Best Value Plan (BVP) – The Guidelines state in Section 9.1 that:
  '*The aim of the regional plan and the WRMP is to present a best value plan*.'
  This programme meets all the legal / regulatory requirements, policy expectations and objectives of the plan. It is therefore a reasonable alternative and was progressed for consideration through the SEA process.

There are large uncertainties in supply, demand, and environmental policy when it comes to forecasting future conditions, particularly across such a long planning horizon. An adaptive planning approach was undertaken as part of the investment modelling to ensure that these different futures and uncertainties can be considered. A total of nine adaptive futures (hereafter referred to as 'situations') were modelled to cover these future conditions and uncertainties.

Thames Water are required to identify certain pathways within the 'situation tree' for reporting purposes, particularly within the WRMP Tables. These include a 'preferred pathway', which represents the current best view based on company and regulator expectations, and a 'core pathway' that Ofwat will use as a guide for minimum future investment.

- Preferred Pathway. 'Situation 4' has been selected as the preferred pathway. This is primarily because it aligns with the approach set out in the WRPG, which is the regulators' policy guidance as to how a WRMP should be prepared and attracts significant weight: using Local Authority housing plan-based forecasts and 'High' environmental destination (according with the approach set out in the National Framework, Regional Plan and WRPG, when read together). For Thames Water's PR24 business plan, Ofwat has set out its expectations in relation to long-term management of assets through its 'long-term delivery strategy' (LTDS) guidance. This requires that long-term plans consider a core scenario, movements from which should represent best value.
- Core Pathway. 'Situation 8' has been selected as the 'core pathway' for Ofwat reporting purposes, because it includes ONS18 mid-range growth in the medium to long-term, likely statutory minimum environmental destination and median climate change. However, this pathway is not in accordance with the WRPG.
- Furthermore, Situation 1 has additionally been selected for reporting because it represents the maximum need within the plan, as it includes maximum growth and high climate change and environmental destination scenarios.

The options selected across situations 1, 4 and 8 of the BVP fully encompass the options selected across all nine pathways. That is, there are no options selected in the other pathways that are not selected in either Situations 1, 4 or 8. These three pathways are therefore considered to be a representative range of situations within the plan. Thames Water consider that carrying out plan-based environmental assessments of these three situations for the Best Value Plan enables the accurate understanding of the environmental impacts and benefits across the adaptive plan, notwithstanding that the timing of option selection may vary in other situations.

Thames Water have chosen to assess and report on Situation 4 of the LCP and BESP as this is the preferred pathway and a good representation of the alternative plans; this approach also mirrors that taken by WRSE for its in-combination assessments of the regional plan.
Further information on the description and context for the rdWRMP can be found in Appendix B - Thames Water rdWRMP Strategic Environmental Assessment Report.

1.2.1 Natural Capital

Natural capital refers to the elements of the natural world that provide benefits to society and includes aspects such as woodland, grassland, freshwater, urban greenspace as well as marine and wetland habitats. The benefits that are provided vary from regulating services such as natural flood management to cultural services such as recreational value.

1.2.2 Biodiversity Net Gain

The UK Department of Environment, Food and Rural Affairs (Defra) describes BNG as a strategy to develop land and contribute to the recovery of nature, ensuring that habitats are left in better state post-development. Measuring BNG refers specifically to the combination of habitats present within a site and their ability to support biodiversity, summarised by a quantifiable score and a percentage change following changes in habitat. Each habitat is given a score that relates to its area, condition, distinctiveness, and connectivity. The change in habitat due to the construction and operation of the regional plan options informs the overall BNG score and whether the options are likely to contribute to a net gain in biodiversity. The Environment Act 2021[2] has now specified a requirement for developments seeking planning permission to demonstrate a minimum10% BNG. This requirement will come into force in November 2023 for Town and Country Planning Applications and 2025 for Nationally Significant Infrastructure Projects.

1.2.3 Environmental Net Gain

Environmental net gain is an approach to development that aims to leave the natural environment in a measurably better state than before the plan or scheme is implemented. There is currently no defined methodology for the incorporation of environmental net gain within regional water planning guidance. However, in line with the Guidelines, the emerging regional plan's environmental net gain will align with the Environmental Targets under the Environment Act (2021) as well as work towards achieving Goal 1 (Thriving Plants and Wildlife) under the Environmental Improvement Plan (2023)[3].

The Thames Water rdWRMP24 will aim to demonstrate whether it has achieved environmental net gain through individual assessment, such as for BNG, and wider environmental gains quantified through the NCA.

1.3 Thames Water rdWRMP24 Options

Development of approach throughout WRMP24

[2] Legislation GOV (2021). Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted [Accessed August 2023]
[3] KM Government (2023). Environment Improvement Plan 2023. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1168372/environmental-improvement-plan-2023.pdf [Accessed August 2023]

Throughout the period Thames Water has been developing its plan, there have been developments and updates to various resource options, as part of an iterative options appraisal process. Within this period of iterative options appraisal, there have been updates to the ENCA guidance[4] (ENCA Version 2.0 in August 2021, and ENCA Version 3.0 in July 2023). Based on feedback and literature, the original assessments recorded in the Draft WRMP have been updated to reflect these changes. ENCA Versions 2.0 and 3.0 include updated values within the Asset Databook and Service Databook. Within ENCA Versions 2.0 and 3.0 of the Service Databook, the carbon reduction tab includes the Department of Business, Energy, and Industrial Strategy (BEIS) 2021 carbon values – a set of values produced by the government to be used in policy appraisal and evaluation, reflecting the latest evidence. Throughout this period, there have similarly been updates to the Defra's Biodiversity Metric, which are discussed further in Section 2.6 of this report. For the purpose of the rdWRMP option assessments, The Biodiversity Metric 3.0 Version was used to align assessments to a consistent metric, the version the strategic resource options as part of RAPID Gate 2 reporting were assessed to. This approach was discussed and agreed with Natural England by WRSE, on behalf of their constituent water companies, and therefore is considered appropriate for the current stage of plan-making.

When running the investment model, whereby assessment occurs on a comparative basis, the same version of the natural capital and BNG guidance was used for consistency. Upon reporting the impacts of the options selected in the Draft WRMP, different options used different guidance, based on when options were being reported and the available guidance at the time. In preparing the rdWRMP, all assessments have been updated to consistent guidance, as detailed in the methodology.

Consistency within Assessments in rdWRMP24

The Thames Water area includes several Strategic Resource Options (SROs) which are significant strategic options providing significant volumes of water to one or more water companies. These include SESRO, London Recycling, T2ST and STT. Throughout the period Thames Water has been developing its plan, these options have continued to be developed as part of the Regulators' Alliance for Progressing Infrastructure Development (RAPID) gated process. In the Draft WRMP, the environmental assessment outcomes (including BNG and NCA) from the regional investment modelling were reported. However, now at the time of writing, all SRO proposals have been submitted for Gate 2, through the RAPID gated process and has undergone stakeholder consultation. As such, Thames Water has used the natural capital and BNG assessments submitted as part of Gate 2 as they will reflect the latest, most accurate information for these schemes.

ENCA provides a standardised framework to natural capital assessments, however, has a wide range of applications to meet the needs of various users. This is recognised and in line with the Guidance ENCA provides. Although the WRMP level options were completed in a uniform approach, the methodological approaches vary for the SROs as these options have been developed in greater detail, are subject to additional consultation and refinement as part of the RAPID gated process, and, as set out in the Environment Agency's supplementary guidance on

[4] Defra (2023). Enabling a Natural Capital Approach 2023, Defra. Available at: https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance [Accessed August 2023]

Environment and society in decision-making[5], the NCA methodology should be proportionate to the level of detail available for both the stage of option design and the availability of supporting environmental and social data.

This was flagged to be difficult to incorporate in the Cumulative Effects Assessment in consultation (Section 5). The rdWRMP24 has mitigated this as much as possible by the following actions:

- T2ST. T2ST was identified to have a comparable methodological approach, and therefore has been directly included in cumulative calculations.
- SESRO and London Recycling. These SROs were identified to have a non-comparable methodological approach. Thames Water identified an opportunity to compare natural capital stocks in the cumulative permanent gains/losses, with limitations noted with this approach. Ecosystem services and BNG have been reported separately, but alongside the cumulative assessment. Thames Water have worked to make this as digestible as possible, to grasp the full cumulative impact of each plan, and have sought feedback from SESRO and London Recycling teams to ensure the key points are apparent.

It should be noted there are limitations to summarising all natural capital stocks from different methodologies together. These include:

- Data sources. Natural capital stocks have been collated through different data sources, including open-source data sources, private sources and site surveys have been used, which will result in various degrees of accuracy. This is identified as an acceptable limitation as each methodology had justified their use of sources.
- Habitat classification. There are multiple habitat naming conventions suitable to be used with ENCA, leading to discrepancies when cumulating stocks. Habitats have been collated based on professional judgement.
- Identifying opportunities for mitigation. The SRO schemes have had greater development in terms of detailed design, and therefore further developed in terms identifying opportunities of habitat mitigation, retention, and creation. As a result, the assessments themselves have been embedded with mitigation (i.e., with a target to achieve 10% BNG). This is identified as an acceptable limitation as standard resource options elements have undergone a level of review to mitigate impacts to natural capital stocks, and supplemented with the BNG Strategy provides opportunities for habitat gain.

The Further detail on the methodological approach undertaken for each of the SROs is available in the respective Gate 2 reports[6].

1.3.1 Feasible Options

Table 1-1 summarises the feasible options scoped-in for NCA and BNG assessments, providing a general overview of the activities associated with each of them. This list is taken from Thames Water's overall 'constrained-list' of options, which are those considered as feasible for taking forward as part of their rdWRMP24, and thus required assessment (subject to scoped-in

[5] Environment Agency (2020). Water resources planning guideline supplementary guidance - Environment and society in decision-making. [Accessed: August 2023]
[6] Ofwat (2023). Gate two submissions and final decisions. Available at: https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/gate-two/ [Accessed August 2023]

status). Options were scoped-in if there were likely to be effects on Natural Capital, Ecosystem Services and/or Biodiversity.

Table 1-1: Feasible Options for the TW rdWRMP24, excluding SROs.

Option ID	Option name	Description	Scoped in status
TWU_LON_HI-LRE_WT1_ALL_copperwtwmecana200/480/680	Coppermills WTW – filtration pre-treatment 680Ml/d	Either a 200/480/680Ml/d Mecana filtration system for primary filtration of surface water at the Coppermills Water Treatment Works (WTW), including three new shaft connections, inlet pipework diversions, inlet pumping station (PS) and pipe bridge for return pipework.	Scoped in
TWU_LON_HI-OTH_ALL_ALL_didcot purchase	Didcot Power Station Licence Trading	The option extends the current agreement which is in place from AMP7 between Thames Water and RWE Npower.	Scoped out – abstraction licence trading
TWU_LON_HI-DES_ALL_CNO_beckton desal 50/100/150	Beckton Desalination	Abstraction of 187Ml/d raw water for production of 150Ml/d desalinated water (conveyance within option below). Deployable Output (DO) 142Ml/d for 150Ml/d capacity. The 50 and 100 options involve raw water abstraction for production of 50Ml/d and 100Ml/d desalinated water.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_SES_ALL_cheam-merton	Transfer from SES WTW to Merton TWRM shaft	Proposed new trunk mains to transfer water from Cheam WTW (SES) to Merton Ring Main Shaft including a new PS at Cheam WTW.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-ROC_WT1_ALL_eastlonwtwexisting	Available Treatment Capacity at Coppermills WTW	Existing drought capacity at East London WTW - 75 M/ld, limited by the Environment Agency (EA) requirement not to develop recycling options in excess of 75Ml/d. In place to allow use of Deephams and Teddington in 2030.	Scoped out – existing asset and therefore no land use change
TWU_LON_HI-ROC_WT1_ALL_existing w lon wtw	Available Treatment Capacity at West London WTWs	Existing West London spare treatment capacity	Scoped out – existing asset and therefore no land use change
TWU_LON_HI-TFR_LON_CNO_beckton-coppermills	Beckton to Coppermills tunnel (treated) - Construction	Treated desalination water is to be conveyed via tunnel from Beckton desalination works to Coppermillls WTW for blending. (Part of the Beckton Desalination Scheme with the option above.)	Scoped out – the option is not expected to generate any land use change or direct impacts on Natural Capital as the construction of the

Option ID	Option name	Description	Scoped in status
			tunnel is presumed to be underground.
TWU_LON_HI-TFR_SES_ALL_ woodwtw-epsomdowns	Transfer – Woodmansterne to Epsom – Resource Element	Proposed new trunk mains to transfer potable water from Woodmansterne (SES) to Epsom including a new PS at Woodmansterne WTW.	Scoped in
TWU_SWX_HI-GRW_ALL_ALL_ ashton Keynes	Groundwater Development – Ashton Keynes borehole pumps – Removal of Constraints to DO	Installation of larger pumps and/or lowering of the pumps in some or all of five existing boreholes, abstracting from the confined Great Oolite aquifer. Change in operational philosophy to improve peak source output.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_ nrv-groundimprov	New River Head - Ground improvements	Rehabilitation and recommissioning of disused groundwater source. This option comprises: - ground stabilisation around the New River Head borehole, comprising the grouting of the potential voids created by sand migration; - installation of four near surface ground anchors placed at convenient locations around the borehole; - installation of a turbidity meter; - recommissioning of the licensed but currently disused groundwater source.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-ROC_NET_CNO _hampton-battersea	TWRM extension – Hampton to Battersea – Construction	New ring main tunnel from Hampton to Battersea.	Scoped in
TWU_SWX_HI-TFR_KVZ_ALL_k ennet-swox2.3	Kennet Valley to SWOX transfer	The works proposed include: treated water pipeline from Pangbourne WTW to Cleeve WTW 9.4km (250dia), a PS at Pangbourne WTW (60kW), balance tank at Cleeve WTW (2 x the pipe volume), 800m (700dia) of replacement pipeline at the end of the Fobney WTW to Tilehurst Service Reservoir (SR) main, to increase flow, increased pump capacity at Fobney WTW treated water PS from 18Ml/d to 23.88Ml/d.	Scoped in
TWU_SWX_HI-TFR_KVZ_ALL_k ennet-swox6.7	Kennet Valley to SWOX – 6.7Ml/d	The works proposed include: treated water pipeline from Pangbourne WTW to Cleeve WTW 9.4km (350dia), a PS at Pangbourne WTW (150kW), balance tank at Cleeve WTW (2 x	Scoped in

Option ID	Option name	Description	Scoped in status
		the pipe volume), 800m (700dia) of replacement pipeline at the end of the Fobney WTW to Tilehurst SR main to increase flow. Increased pump capacity at Fobney WTW treated water PS from 18Ml/d to 28.34Ml/d.	
TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox	Oxford Canal to Duke's Cut (SWOX) – Construction	A supported conveyance pipeline option from Duke's Cut on the Oxford Canal to the River Thames upstream of the existing Farmoor intake with a 15Ml/d capacity.	Scoped in
TWU_UTC_HI-IMP_UTC_CNO_oxcanal-cropredy	Oxford Canal – Cropredy – Construction	15Ml/d resource option for Oxford Canal to the River Thames transfer. Option includes transfer of water to canal at Cropredy for discharge to River Cherwell and subsequent discharge into the River Thames.	Scoped in
TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor	Oxford Canal – Transfer from Duke's Cut to Farmoor	15Ml/d conveyance option from the Oxford Canal to Farmoor Reservoir, with abstraction from a point approximately 800m north of Duke's Cut on the Oxford Canal, discharging into the River Thames for subsequent re-abstraction at the existing Farmoor Reservoir intake. It has been assumed that, as the transfer will only be used in periods of low flow, no works will be required to upgrade the existing intake structure or treatment facilities at Farmoor Reservoir.	Scoped in
TWU_LON_HI-TFR_LON_ALL_lockwood ps-kgv res	Thames Lee Tunnel (TLT) extension from Lockwood PS to King George V (KGV) Reservoir intake	New connection from Lockwood PS to the intake of KGV reservoir.	Scoped in
TWU_SWX_HI-TFR_HEN_ALL_henley-swox2.4	Henley to SWOX transfer - 2.4Ml/d	The option is for a new main from New Farm service reservoir (Henley) to Nettlebed Service reservoir (SWOX). This will require a new 5.9km (250dia) main from New Farm to Nettlebed and a new PS at New Farm. 2.4Ml/d capacity.	Scoped in
TWU_SWX_HI-TFR_HEN_ALL_henley-swox5	Henley to SWOX Transfer – 5Ml/d	The option is for one new main from New Farm service reservoir (Henley) to Nettlebed service reservoir (SWOX). This will require a new 5.9km, 350mm diameter main from New Farm to Nettlebed and a new PS at New Farm. 5Ml/d capacity.	Scoped in

Option ID	Option name	Description	Scoped in status
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	Manager Aquifer Recharge – Horton Kirby ASR	Construction of pipelines between two existing ASR boreholes in the Lower Greensand aquifer to an existing WTW at Horton Kirby in Kent. Water abstracted from existing Chalk aquifer boreholes (via the mains supply) will be recharged into the two ASR boreholes during periods of water surplus and abstracted when needed and treated at the WTW.	Scoped in
TWU_SWA_HI-GRW_ALL_ALL_datchet do	Groundwater Development – Datchet Existing Source DO Increase	Increase capacity of Datchet site.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_HEN_HI-TFR_KVZ_ALL_tw(kv)to(hen)con	Transfer - Kennet Valley - Henley Conveyance Element	Potable Water Transfer – Thames Water (Kennet Valley) to Thames Water (Henley) Conveyance.	Scoped out - existing transfer with no new infrastructure involved.
TWU_LON_HI-GRW_ALL_ALL_s'fleet lic disagg	Groundwater Development – Southfleet & Greenhithe	Southfleet-Greenhithe licence disaggregation and new headworks and PS at borehole sites and new 3km main from Greenhithe to new WTW. DO benefit is 8Ml/d average, 9Ml/d peak.	Scoped in
TWU_LON_HI-GRW_ALL_ALL_addington gw	Groundwater Development - Addington	New abstraction borehole and upgrade to WTW. DO benefit 1Ml/d average, 1.5Ml/d peak.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_SWX_HI-GRW_ALL_ALL_woods farm do	Groundwater Development – Woods Farm Existing Source Increase DO	New borehole to be constructed on-site to bring DO up to licence (this is an additional 2.4Ml/d to average licence of 4.99Ml/d or an additional 2.91Ml/d to peak licence of 5.5Ml/d). The option includes a new borehole and a 1.4km raw water pipeline from the new satellite borehole to Woods Farm WTW.	Scoped in
TWU_GUI_HI-TFR_RZ5_ALL_sewtogui	Southeast Water to Guildford WRZ	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.	Scoped in
TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100/150/300	Kempton WTW	100/150/300Ml/d new capacity at WTW at Kempton treating raw reservoir water in west London.	Scoped in

Option ID	Option name	Description	Scoped in status
		Purpose is to accommodate additional future demand.	
TWU_SWX_HI-GRW_ALL_ALL_moulsford gw	Groundwater Development – Moulsford Source	Construction of an abstraction borehole in the unconfined Chalk north of Streatley on the west bank of the River Thames. Water abstracted from the borehole will be treated at the existing Cleeve WTW located on the eastern side of the River Thames. DO benefit is 3.5Ml/d peak and 2Ml/d average.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_SWA_HI-TFR_SWX_ALL_swoxswa48	Transfer from WTW in Abingdon to SWA – 48Ml/d	Abingdon WTW to Long Crendon to supply SWA.	Scoped in
TWU_SWA_HI-TFR_SWX_ALL_swoxswa72	Transfer from WTW in Abingdon to SWA – 72Ml/d	Abingdon to north SWA	Scoped in
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer – Conveyance Element	Potable Water Transfer – Thames Water (SWOX) to Thames Water (SWA) – Conveyance. Horspath to Ashenden (bidirectional).	Scoped out - existing transfer with no new infrastructure involved.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer – Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Ashenden to Horspath (bidirectional)	Scoped out - existing transfer with no new infrastructure involved.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con b	SWA to SWOX Transfer – Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Radnage to Bledlow	Scoped out - existing transfer with no new infrastructure involved.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con c	SWA to SWOX Transfer – Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Stokenchurch to Chinnor	Scoped out - existing transfer with no new infrastructure involved.
TWU_KVZ_HI-TFR_UTC_ALL_thamestofobney	River Thames to Fobney Transfer	40Ml/d raw water transfer option from River Thames to Fobney WTW to supply Kennet Valley WRZ.	Scoped in
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Abingdon Reservoir to Farmoor Reservoir Pipeline	Construction of a transfer pipeline to convey 24Ml/d of raw water between a proposed reservoir at Abingdon and the existing Farmoor reservoir, in the SWOX WRZ. (Note: Abingdon reservoir creation is not part of this option.) The engineering scope includes the provision of a booster PS at the proposed Abingdon reservoir site to facilitate the transfer. Treatment would be provided at the existing WTW.	Scoped in
TWU_GUI_HI-GRW_ALL_ALL_dapdune lic disagg	Groundwater Development – Dapdune Licence Disaggregation	Licence disaggregation. DO benefit 0Ml/d average, 2.2Ml/d peak	Scoped out - Licence Disaggregation
TWU_KVZ_HI-GRW_ALL_ALL_	Groundwater Development - Recommission	Refurbishment of two disused abstraction boreholes located on-site at the existing, but disused	Scoped out – option is not expected to generate any land

Option ID	Option name	Description	Scoped in status
mortimer recomm	Mortimer Disused Source	Mortimer WTW. Water abstracted from the boreholes will be sourced from the underlying deep confined Chalk and treated at the disused WTW which will be upgraded for ammonia and iron removal and recommissioned. DO benefit 4.5Ml/d average and peak.	use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_ crossness to beckton	Crossness to Beckton Tunnel (treated) - Construction	Transfer of 190Ml/d desalinated water to Beckton site via pipeline inside tunnel beneath the Thames.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_CNO _beckton-crossness	Beckton to Crossness tunnel - raw (Construction)	The estuarine water from the Beckton site is to be conveyed under the River Thames via a tunnel to the Crossness desalination treatment site.	Scoped out – the option is not expected to generate any land use change or direct impacts on Natural Capital as the construction of the tunnel is presumed to be underground.
TWU_LON_HI-GRW_ALL_ALL_ merton recommission	Groundwater Development – Merton Recommissioning	The option comprises the recommissioning and upgrade of the Merton Abbey WTW in order to treat the maximum peak DO of 8Ml/d from the Merton Abbey Well. DO benefit 7.86Ml/d peak, 2Ml/d average	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-REU_RE1_ALL_ deephams reuse 46.5	Deephams Reuse – 46.5Ml/d, direct to KGV – Construction	Transfer of Deephams sewage treatment works (STW) final effluent to the new water recycling works with the following technology: pre-screens, ultrafiltration (UF), reverse osmosis (RO), ultraviolet (UV) treatment, inter-process pumping, buildings and disinfection, pH adjustment chemicals. Includes conveyance to KGV.	Scoped in
TWU_KGV_HI-REU_RE1_CNO_ deephams reuse 46.5b	Deephams Reuse – 46.5Ml/d, to TLT - Construction	Transfer of Deephams STW final effluent to the new water recycling works with the following technology: pre-screens, UF, RO, UV treatment, inter-process pumping, buildings and disinfection, pH adjustment chemicals. Includes conveyance to TLT extension.	Scoped in

Option ID	Option name	Description	Scoped in status
TWU_LON_HI-GRW_ALL_ALL_london conchalk	Groundwater Development - Confined Chalk North London	New abstraction borehole. DO benefit 2Ml/d average and peak.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_GUI_HI-TFR_SES_ALL_reigatetoguildford 5/20	Reigate to Guildford 5Ml/d or 20Ml/d	Either a 5Ml/d or 20Ml/d transfer from Reigate (SES) to Guildford.	Scoped in
TWU_HON_HI-ROC_NET_CNO_cop'mills-honoroak	TWRM extension – Coppermills to Honor Oak - Construction	New ring main tunnel from Coppermills to Honor Oak.	Scoped out – the option is not expected to generate any land use change or direct impacts on Natural Capital as the construction of the tunnel is presumed to be underground.
TWU_KVZ_HI-GRW_ALL_ALL_east woodhay roc	Groundwater Development – East Woodhay borehole pumps Removal of Constraints to DO	Upgrade of pumps and pump control to increase DO. DO benefit 2.1Ml/d peak, 0 average.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-DES_ALL_ALL_crossnessdesal50/100	Crossness Desalination	Development of a 50Ml/d or 100Ml/d desalination plant located south of Crossness, using brackish estuarine feedwater from the River Thames. Transfer of treated water to Coppermills WTW for blending.	Scoped in
TWU_LON_HI-GRW_ALL_ALL_addington asr	Managed Aquifer Recharge - Addington	Two new ASR boreholes near Addington PS, and one borehole refurbishment, 300m length of sewer for conditioning discharges, booster recharge pumps due to artesian head pressures in aquifer. DO benefit 3Ml/d average, 5Ml/d peak.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-GRW_ALL_ALL_honor oak gw	Groundwater Development – Honor Oak	Two new abstraction boreholes, connections to existing WTW, DO benefit 1Ml/d average, 2.82Ml/d peak.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.

Option ID	Option name	Description	Scoped in status
TWU_LON_HI-GRW_ALL_ALL_ streatham ar	Managed Aquifer Recharge (SLARS2)	One new AR borehole at Streatham PS, and one borehole refurbishment, new 17Ml/d WTW. DO benefit is 4Ml/d average, 4.5Ml/d peak.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-GRW_ALL_ALL_ thames valley asr	Managed Aquifer Recharge Thames Valley South London	Two new ASR boreholes at Ashford WTW, 1km length of sewer for conditioning discharges, booster injection pumps due to artesian head pressures in aquifer. DO benefit 3Ml/d average, 5Ml/d peak.	Scoped in
TWU_LON_HI-GRW_ALL_CNO _kidbrooke slars	Managed Aquifer Recharge – Kidbrooke (SLARS1) Construction	The scheme comprises the upgrade of the existing borehole at the Rochester Way site, another at the Bromley Reservoir site and the construction of a new AR borehole on private land in Eltham Green. Six observation boreholes will be constructed for groundwater level monitoring, four at the Eltham Green site and two off-site the Eltham Green location. Benefit is 8.1Ml/d peak and 7Ml/d average. The scheme also includes: construction of a new 10Ml/d WTW located on the existing Kidbrooke borehole site to serve the Rochester Way, Bromley Reservoir and a new AR borehole, a 5.7km (300mm) raw water transfer main between Bromley Reservoir and new AR borehole, a 6.4km (400mm) bi-directional raw water transfer main between Rochester Way AR borehole and a new AR borehole via Kidbrooke WTW (3.5km between Rochester Way and Kidbrooke WTW, 2.6km between new borehole and Kidbrooke WTW), a 1.8km (450mm) treated water main between Kidbrooke WTW and Bermondsey (Well Hall PS).	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-GRW_ALL_CNO _merton ar	Managed Aquifer Recharge - Merton (SLARS3) Construction	The scheme comprises the upgrade of the existing well and adit system at the Merton Abbey WTW for recharge/abstraction purposes and the construction of a new AR borehole at the nearby Byegrove Road site. DO benefit is 5Ml/d average and 6Ml/d peak. The scheme also includes the	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.

Option ID	Option name	Description	Scoped in status
		construction of a new 4.5Ml/d WTW located at the existing Merton Abbey WTW site to serve the Byegrove Road AR borehole, and the installation of a 1.1km raw water main from the Byegrove Road AR borehole to the new Merton Abbey WTW.	
TWU_LON_HI-ROC_NET_ALL_barrowhillpump	Replace pump infrastructure at Barrow Hill - TWRM	Pump 6 at Barrow Hill is to be replaced.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-ROC_WT1_CNO_eastlondonwtw 100/150/200/300	East London WTW – 100/150/200/300	184Ml/d treatment works for reservoir water in London. Purpose is to accommodate additional future demand. Water discharged for treatment could result from various option types including wastewater recycling and water transfers. The capex calculations represent a 184Ml/d plant. The opex is calculated to represent a 184Ml/d opex less the saving associated with discontinuing the treatment of 84Ml/d through the slow sand filters, resulting in an opex that corresponds to 100Ml/d. There are also 150Ml/d, 200Ml/d and 300Ml/d versions of the option.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_ch'ford s intake	Intake Capacity Increase – Chingford South	Increase capacity of Chingford South intake.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_datchet int-qm	Intake Capacity Increase – Datchet	Increase capacity of Datchet PS site.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_littleton int-qm	Intake Capacity Increase – Queen Mary	Increase capacity of Littleton intake PS site by 300Ml/d capacity.	Scoped out – option is not expected to generate any land use change or direct

Option ID	Option name	Description	Scoped in status
			impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_ALL_ newriverhead pump 4	Replace New River Head Pump - TWRM	Pump 4 at New River Head is to be replaced.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_LON_HI-TFR_LON_CNO _second spine tunnel	Raw Water System Upgrade – TLT Removal of Constraints - Construction	Second Spine Tunnel from break tank to reservoir five upstream of Coppermills WTW.	Scoped out – the option is not expected to generate any land use change or direct impacts on Natural Capital as the construction of the tunnel is presumed to be underground.
TWU_LON_HI-TFR_LON_CNO _surbiton int-walton	Surbiton intake capacity increase with transfer to Walton inlet channel - Construction	Increase capacity of Surbiton intake.	Scoped in
TWU_LON_HI-TFR_LON_CNO _tlt upgrade – roc	Raw Water System Upgrade – TLT Removal of Constraints – Construction	TLT reinforcement for a section of the tunnel, a new shaft 6m diameter at a depth of 30m and a new air valve.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_STR_HI-RSR_RE1_CNO_ res_marsh gibbon	New Reservoir – Marsh Gibbon 30Mm^3 - Construction	New non-impounding bunded reservoir situated within Oxfordshire, 2km south of Marsh Gibbon with a volume of 30Mm^3/50Mm^3/70Mm^3.	Scoped in
TWU_SWA_HI-GRW_ALL_ALL_ dorney do	Groundwater Development - Dorney Existing Source DO Increase	Drilling of one new borehole and provision of two new submersible pumps (two per borehole) to increase the overall site capacity up to the source DO. DO benefit 4.3Ml/d (peak). 300m pipeline to connect to existing raw feed pipeline which runs to WTW and 100m run-to-waste pipeline.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_SWA_HI-GRW_ALL_ALL_	Groundwater Development - Taplow Existing	Aims to increase SDO up to licensed quantities. This is expected to bring peak SDO from	Scoped out – option is not expected to generate any land

Option ID	Option name	Description	Scoped in status
taplowincreased o	Source DO Increase	44Ml/d to 50Ml/d. The scope is as follows: increase Taplow to peak licence (50Ml/d) by drilling a new chalk abstraction borehole at the Dorney WTW site but added to the Taplow abstraction licence. Adding two pumps, duty/stand-by fitted with variable speed drives (VSDs). 300m rising main and 300m run to waste.	use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_SWA_HI-ROC_WT1_CNO_medmenhamwtw	Medmenham WTW	24Ml/d treatment works for river water near Medmenham (SWA). Purpose is to accommodate additional future demand. Includes a treated water PS, treated water transfer pipeline and new storage reservoir at Widdenton.	Scoped in
TWU_SWA_HI-TFR_HEN_ALL_henley-swa2.4	Henley to SWOX Transfer - 2.4Ml/d	The option is for one new main from Sheeplands WTW (Henley) to Hambleden WTW (SWA). This will require a new 9.94km main from Sheeplands WTW and a new PS at Sheeplands.	Scoped in
TWU_SWA_HI-TFR_HEN_ALL_henley-swa5	Henley to SWOX Transfer – 5Ml/d	Transfer 5Ml/d from Sheeplands WTW to Hambledon WTW.	Scoped in
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53/80	New Medmenham Surface Water Intake – 53Ml/d	The Medmenham intake element includes the construction of an intake structure on the River Thames located approximately 1.75km west of the village of Medmenham, close to the village of Mill End. In addition to the intake structure, a PS will be constructed. The intake structure, PS and raw water transfer main would supply water from the River Thames to a new water treatment works at Medmenham. The intake and all associated infrastructure will be constructed with an abstraction capacity of either 53Ml/d or 80Ml/d.	Scoped in
TWU_SWX_HI-ROC_WT1_ALL_radcotwtw	New WTW - Radcot	24Ml/d treatment works for reservoir water in Radcot (SWOX). Purpose is to accommodate additional future demand.	Scoped in
TWU_WLJ_HI-ROC_NET_CNO_twrm shaft kempton	New shaft on the TWRM at Kempton	This option includes a new shaft on the TWRM to accommodate 800Ml/d of treated water flow from the expanded Kempton WTW.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.

Option ID	Option name	Description	Scoped in status
TWU_WLJ_HI-TFR_WLJ_CNO_qm res-kempton wtw	Additional conveyance from Queen Mary Reservoir to Kempton WTW	New conveyance of raw water from Queen Mary Reservoir to Kempton WTW.	Scoped in
TWU_UTC_HI-RSR_RE1_CNO_res_chinnor_2	New Reservoir – Marsh Gibbon 30Mm^3 Construction	New non-impounding bunded reservoir situated within Oxfordshire, 5km southwest of Chinnor with a volume of 30Mm^3.	Scoped in
TWU_STT_HI-TFR_STT_ALL_stt-sesro	Dummy Option - STT-SESRO Link	Potential increase in DO by integrating the Severn to Thames Transfer (STT) pipeline and the Abingdon Reservoir Strategic Resource Options (SROs).	Scoped in
TWU_LON_HI-GRW_ALL_ALL_honoroak do	Groundwater Development – Increase DO of existing Honor Oak Source	Restore Honor Oak well and WTW back into service by refurbishing the treatment works and replacing the pump. This option would utilise the existing licence.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.
TWU_GUI_HI-GRW_ALL_ALL_dapdune roc	Groundwater Development – Removal of Constraints to Dapdune DO	Removal of constraints on the DO at the Dapdune source. Pump capacity increased at the Dapdune boreholes and rapid gravity filters used to treat at Ladymead WTW.	Scoped out – option is not expected to generate any land use change or direct impacts on Natural Capital due to the existing land cover within the option boundary.

In addition to the options set out above, several SROs were also considered. These are strategically important water resource options that could provide a large volume of water for more than one water company to use. SROs are being developed in parallel through the RAPID gated process. The SROs have been assessed under the individual SRO projects, and a summary of these assessments from the published RAPID Gate Two reports is provided in this report for completeness. The options included in the SROs are set out in Table 1-2 below.

Table 1-2: Thames Water SROs

Option ID	Option name	SRO project
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen	T2ST Culham to Speen transfer*	Thames to Southern Transfer SRO (T2ST). This option is part of the T2ST pipeline transferring water from River Thames to the south. This option is a branch of the wider T2ST scheme
TWU_STR_HI-RSR_RE1_CNO_abingdon100(lon)/125/150	New Reservoir Abingdon	South East Strategic reservoir option (SESRO). These three options form part of the SESRO project for a new reservoir in the south east. There are a number of size options that were considered : 75Mm^3 100Mm^3, 125Mm^3, 150Mm^3.
TWU_SWX_HI-ROC_WT1_CNO_abingdon wtw ph1	Abingdon WTW Ph1 – Construction	

Option ID	Option name	SRO project
TWU_SWX_HI-ROC_WT2_ALL_abingdon wtw ph2	Abingdon WTW Enhanced	
TWU_STT_HI-IMP_STT_CNO_sttpipe 500(lon)	Raw Water Transfer Deerhurst to Culham 500Ml/d (Lon only) – Construction	Severn to Thames transfer SRO. These four options all form part of the proposed transfer pipeline of 500Ml/d from the River Severn to the River Thames.
TWU_STT_HI-RAB_RE1_ALL_p9-500-vyrnwy_100_b	500: Vyrnwy Reservoir river release (75Ml/d) and 25Ml/d of Bypass (105Ml/d)	
TWU_STT_HI-REU_RE1_ALL_p5-500-neth_p35	500: Netheridge STW effluent diversion (35Ml/d) – Deerhurst Pipeline	
TWU_U7T_HI-RAB_RE1_ALL_p1-500-unsupported	500: Unsupported flow	
TWU_TED_HI-RAB_RE1_CNO_teddington dra 75	Teddington Direct River Abstraction (DRA) 75Ml/d – Construction	London Water Recycling: Teddington DRA 75Ml/d SRO. A portion of the final effluent from Mogden STW would be subject to tertiary treatment and transferred in a tunnel for discharge into the River Thames upstream of Teddington weir. Additional abstraction from the Thames upstream of the new outfall. Abstracted water would be pumped into the nearby Thames Lee Tunnel for transfer to Lockwood Reservoir, part of the Lee Valley reservoirs in East London.
TWU_LON_HI-TFR_LON_ALL_teddingtondrated/tlt	DRA – Teddington to Thames Lee Tunnel Shaft 75Ml/d	
TWU_LON_HI-TFR_LON_ALL_teddingtondramog/ted	Mogden to Teddington outfall 100Ml/d	
TWU_KEM_HI-TFR_TED_ALL_tedd-kempton*	Teddington to Kempton (displacement of water)	
TWU_KGV_HI-REU_RE1_CNO_reuse beckton 50/100/150	Reuse Beckton	London Water Recycling: Beckton Reuse SRO. Transfer of recycled water from Beckton to the new water recycling works with the following technology: pre-screens, ultra-filtration (UF), reverse osmosis (RO), ultra-violet (UV) treatment, inter-process pumping, buildings and chemical additions. DO 89Ml/d for 100Ml/d capacity. DO 130Ml/d for 150Ml/d capacity. Conveyance of treated water from Beckton to Lockwood PS. London Water Recycling: Mogden Reuse SRO. Mogden Reuse (Final Effluent) and waste stream treatment at Hydes Field - 50Ml/d. Conveyance for Mogden Reuse Treatment at Hydes Field.
TWU_KGV_HI-TFR_KGV_ALL_beckton to lockwood	Beckton to Lockwood Tunnel	
TWU_WLJ_HI-REU_RE1_CNO_reuse mogden 50/100	Reuse Mogden	
TWU_WLJ_HI-TFR_WLJ_ALL_reuse mogden/walton	Reuse Mogden to Walton	

***** T2ST is a shared Thames and Southern option, and the impacts of the full scheme have been considered within the TW WRMP. To mark this, T2ST Culham to Speen transfer hereafter referred to as T2ST Full Scheme.

Drought plan options were also included in the feasible options list, and have been considered through the Thames Water Drought Plan process[7]. Thames Water acknowledge that the treatment process of these options are at an early stage of development, and at this current

[7] Thames Water Drought Plan (2022): Our drought plan. Available at: Our drought plan | Regulation | About us | Thames Water [Accessed August 2023]

stage it is unknown what options may have a land footprint impact. Natural capital and biodiversity net gain understanding will need to build as these options develop.

These options are set out in Table 1-3 below, and not assessed further in this report.

Table 1-3: Thames Water drought plan options

Option ID	Option name	Description
TWU_SWX_RE-DRP_ALL_ALL_dp-gatehampton-swox	Gatehampton Drought Permit	The Gatehampton licence includes a flow constraint, which means abstraction must be reduced from the licence quantity of 105Ml/d to at or below 101.5Ml/d when flow in the River Thames at Reading Gauging Station falls below 400Ml/d for five days. The Gatehampton SWOX drought plan option is to change the Gatehampton licence to allow abstraction to remain at 105Ml/d even when the flow constraint is in place during drought periods.
TWU_KVZ_RE-DRP_ALL_ALL_dp-playhatch-kv	Playhatch Drought Permit	The Playhatch licence has an annual average abstraction of 7.27Ml/d and a peak abstraction of 8.2Ml/d. The Playhatch Kennet Valley drought plan option is to increase the peak licence to 12.3Ml/d during drought periods.
TWU_GUI_RE-DRP_ALL_ALL_dp-shalford-guild	Shalford Drought Permit	Drought intervention – Drought permit
TWU_HEN_RE-DRP_ALL_ALL_dp-sheep/harp-hen	Sheeplands/Harpsden-Hen Drought Permit	Drought intervention – Drought permit

1.3.2 Least Cost Plan

The Thames Water rdWRMP24 LCP includes supply-side options scoped-in as requiring BNG and NCA, including the associated SROs. The reasoning for these being scoped-in is provided in Table 1-1. The options and associated option descriptions are presented in Table 1-4: Options and descriptions scoped-in to the LCP (SROs demarked with an asterisk, and therefore Gate 2 reporting has been used) below.

Table 1-4: Options and descriptions scoped-in to the LCP (SROs demarked with an asterisk, and therefore Gate 2 reporting has been used)

Option ID	Option name	Description
TWU_GUI_HI-TFR_RZ4_ALL_sewtogui	SouthEast Water to Guildford WRZ	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.
TWU_KEM_HI-TFR_TED_ALL_tedd-kempton*	Teddington to Kempton (displacement of water)	SRO, see Table 1-2
TWU_KGV_HI-TFR_TED_ALL_teddingtondrated/tlt*	DRA – Teddington to Thames Lee Tunnel Shaft 100 Ml/d	SRO, see Table 1-2
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen*	T2ST Culham to Speen transfer	SRO, see Table 1-2

Option ID	Option name	Description
TWU_LON_HI-GRW_ALL_ALL_s'fleet lic disagg	Southfleet/Greenhithe (new WTW)	Southfleet-Greenhithe licence disaggregation and new headworks and PS at borehole sites and new 3km main from Greenhithe to new WTW. DO benefit is 8Ml/d average, 9Ml/d peak.
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	ASR Horton Kirby	Construction of pipelines between two existing ASR boreholes in the Lower Greensand aquifer to an existing WTW at Horton Kirby in Kent. Water abstracted from existing Chalk aquifer boreholes (via the mains supply) will be recharged into the two ASR boreholes during periods of water surplus and abstracted when needed and treated at the WTW.
TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100 p1	New WTW at Kempton – 100Ml/d additional phase	100/150/300Ml/d new capacity at WTW at Kempton treating raw reservoir water in west London. Purpose is to accommodate additional future demand.
TWU_STR_HI-RSR_RE1_CNO_abingdon150(lon)*	New Reservoir Abingdon 150Mm^3 – 283 Ml/d (Lon only) – Construction	SRO, see Table 1-2
TWU_SWA_HI-ROC_WT1_CNO_medmenhamwtw ph1	New Medmenham Surface Water WTW Ph1 – Construction	24Ml/d treatment works for river water near Medmenham (SWA). Purpose is to accommodate additional future demand. Includes a treated water PS, treated water transfer pipeline and new storage reservoir at Widdenton.
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53	New Medmenham Surface Water Intake – 53Ml/d	The Medmenham intake element includes the construction of an intake structure on the River Thames located approximately 1.75km west of the village of Medmenham, close to the village of Mill End. In addition to the intake structure, a PS will be constructed. The intake structure, PS and raw water transfer main would supply water from the River Thames to a new WTW at Medmenham. The intake and all associated infrastructure will be constructed with an abstraction capacity of either 53Ml/d or 80Ml/d.
TWU_SWX_HI-GRW_ALL_ALL_woodsfarm do	Groundwater Development – Woods Farm Existing Source Increase DO	New borehole to be constructed on-site to bring DO up to licence (this is an additional 2.4Ml/d to average licence of 4.99Ml/d or an additional 2.91Ml/d to peak licence of 5.5Ml/d). The option includes a new borehole and a 1.4km raw water pipeline from the new satellite borehole to Woods Farm WTW.
TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox	Oxford Canal - Duke's Cut (SWOX) – Construction	A supported conveyance pipeline option from Duke's Cut on the Oxford Canal to the River Thames upstream of the existing Farmoor intake with a 15Ml/d capacity.
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Abingdon to Farmoor Reservoir pipeline	Construction of a transfer pipeline to convey 24Ml/d of raw water between a proposed reservoir at Abingdon and the existing Farmoor reservoir, in the SWOX WRZ. (Note: Abingdon reservoir creation is not part of this option.) The engineering scope includes the provision of a booster PS at the proposed Abingdon reservoir site to facilitate the transfer. Treatment would be provided at the existing WTW.

Option ID	Option name	Description
TWU_SWX_HI-TFR_SWX_ALL_dukes cut-farmoor	Oxford Canal - Transfer from Duke's Cut to Farmoor	15Ml/d conveyance option from the Oxford Canal to Farmoor Reservoir, with abstraction from a point approximately 800m north of Duke's Cut on the Oxford Canal, discharging into the River Thames for subsequent re-abstraction at the existing Farmoor Reservoir intake. It has been assumed that, as the transfer will only be used in periods of low flow, no works will be required to upgrade the existing intake structure or treatment facilities at Farmoor Reservoir.
TWU_TED_HI-RAB_RE1_CNO_teddington dra 75*	Teddington Direct River Abstraction (Indirect Water Recycling) 75 MLD - Construction	SRO, see Table 1-2
TWU_TED_HI-TFR_TED_ALL_teddingtondramog/ted*	Transfer of Treated Effluent from Mogden to Teddington 75Ml/d	SRO, see Table 1-2

Several options within the Thames Water rdWRMP24 LCP were scoped-out of NCA and BNG assessments. Table 1-5: Summary of options scoped-out of the below outlines the scoped-out options, with the reasoning for these being scoped-out provided in Table 1-1.

Table 1-5: Summary of options scoped-out of the LCP.

Option ID	Option name	Description
TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm	Groundwater Development - Recommission Mortimer Disused Source	Refurbishment of two disused abstraction boreholes located on-site at the existing, but disused Mortimer WTW. Water abstracted from the boreholes will be sourced from the underlying deep confined Chalk and treated at the disused WTW which will be upgraded for ammonia and iron removal and recommissioned. DO benefit 4.5Ml/d average and peak.
TWU_KVZ_RE-DRP_ALL_ALL_dp-playhatch-kv	Playhatch Drought Permit	The Playhatch licence has an annual average abstraction of 7.27Ml/d and a peak abstraction of 8.2Ml/d. The Playhatch Kennet Valley drought plan option is to increase the peak licence to 12.3Ml/d during drought periods.
TWU_LON_HI-GRW_ALL_ALL_addington gw	Groundwater Development - Addington	New abstraction borehole and upgrade to WTW. DO benefit 1Ml/d average, 1.5Ml/d peak.
TWU_LON_HI-GRW_ALL_ALL_london conchalk	Groundwater Development - Confined Chalk North London	New abstraction borehole. DO benefit 2Ml/d average and peak.
TWU_LON_HI-GRW_ALL_ALL_merton recommission	Groundwater Development - Merton Recommissioning	The option comprises the recommissioning and upgrade of the Merton Abbey WTW in order to treat the maximum peak DO of 8Ml/d from the Merton Abbey Well. DO benefit 7.86Ml/d peak, 2Ml/d average
TWU_LON_HI-GRW_ALL_CNO_merton ar	Managed Aquifer Recharge - Merton (SLARS3) Construction	The scheme comprises the upgrade of the existing well and adit system at the Merton Abbey WTW for recharge/abstraction purposes and the construction of a new AR borehole at the nearby Byegrove Road site. DO benefit is 5Ml/d average

Option ID	Option name	Description
		and 6Ml/d peak. The scheme also includes the construction of a new 4.5Ml/d WTW located at the existing Merton Abbey WTW site to serve the Byegrove Road AR borehole, and the installation of a 1.1km raw water main from the Byegrove Road AR borehole to the new Merton Abbey WTW.
TWU_LON_HI-ROC_WT1_ALL_eastlonwtwexisting	Available Treatment Capacity at Coppermills WTW	184Ml/d treatment works for reservoir water in London. Purpose is to accommodate additional future demand. Water discharged for treatment could result from various option types including wastewater recycling and water transfers. The capex calculations represent a 184Ml/d plant. The opex is calculated to represent a 184Ml/d opex less the saving associated with discontinuing the treatment of 84Ml/d through the slow sand filters, resulting in an opex that corresponds to 100Ml/d. There are also 150Ml/d, 200Ml/d and 300Ml/d versions of the option.
TWU_LON_HI-ROC_WT1_ALL_existing w lon wtw	Available Treatment Capacity at West London WTWs	Existing West London spare treatment capacity
TWU_LON_HI-TFR_LON_ALL_newriverhead pump 4	Replace New River Head Pump - TWRM	Pump 4 at New River Head is to be replaced.
TWU_LON_HI-TFR_SES_ALL_cheam-merton	Transfer from SES WTW to Merton TWRM shaft	Proposed new trunk mains to transfer water from Cheam WTW (SES) to Merton Ring Main Shaft including a new PS at Cheam WTW.
TWU_SWA_HI-GRW_ALL_ALL_datchet do	Groundwater Development - Datchet Existing Source DO Increase	Increase capacity of Datchet site.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWOX) to Thames Water (SWA) – Conveyance. Horspath to Ashenden (bidirectional).
TWU_SWX_HI-GRW_ALL_ALL_moulsford gw	Groundwater Development - Moulsford Groundwater Source	Construction of an abstraction borehole in the unconfined Chalk north of Streatley on the west bank of the River Thames. Water abstracted from the borehole will be treated at the existing Cleeve WTW located on the eastern side of the River Thames. DO benefit is 3.5Ml/d peak and 2Ml/d average.
TWU_SWX_HI-TFR_HEN_ALL_henley-swox2.4	Henley to SWOX Transfer – 2.4 Ml/d	The option is for a new main from New Farm SR (Henley) to Nettlebed SR (SWOX). This will require a new 5.9km (250dia) main from New Farm to Nettlebed and a new PS at New Farm. 2.4Ml/d capacity.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Ashenden to Horspath (bidirectional)
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con b	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Radnage to Bledlow
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con c	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Stokenchurch to Chinnor

Option ID	Option name	Description
TWU_SWX_RE-DRP_ALL_ALL_dp-gatehampton-swox	Gatehampton Drought Permit	The Gatehampton licence includes a flow constraint which means abstraction must be reduced from the licence quantity of 105Ml/d to at or below 101.5Ml/d when flow in the River Thames at Reading Gauging Station falls below 400Ml/d for five days. The Gatehampton SWOX drought plan option is to change the Gatehampton licence to allow abstraction to remain at 105Ml/d even when the flow constraint is in place during drought periods.
TWU_WLJ_HI-ROC_NET_CNO_twrm shaft kempton	New shaft on the TWRM at Kempton – Construction	This option includes a new shaft on the TWRM to accommodate 800Ml/d of treated water flow from the expanded Kempton WTW.

1.3.3 Best Value Plan

The Thames Water rdWRMP24 BVP includes several supply-side options scoped-in, as requiring BNG and NCA, including the associated SROs. The reasoning for these being scoped-in is provided in Table 1-1. As discussed previously, Situations 1, 4, and 8 of the BVP has been assessed as part of this report. The BVP options and associated option descriptions for each of the selected situations are presented in Table 1-6 below.

Table 1-6: Options and option descriptions for those options scoped-in to the BVP, including Situations 1, 4, and 8 (SROs demarked with an asterisk, and therefore Gate 2 reporting has been used)

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
TWU_GUI_HI-TFR_RZ4_ALL_sewtogui	SouthEast Water to Guildford WRZ	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.	✓	✓	
TWU_KEM_HI-TFR_TED_ALL_tedd-kempton*	Teddington to Kempton Conveyance Element	SRO, see Table 1-2	✓	✓	✓
TWU_LON_HI_TFR_LON_ALL_teddingtondrated/tlt *	DRA – Teddington to Thames Lee Tunnel Shaft 100 Ml/d	SRO, see Table 1-2	✓	✓	✓
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen*	T2ST Culham to Speen	SRO, see Table 1-2.	✓	✓	
TWU_LON_HI-GRW_ALL_ALL_s'fleet lic disagg	Groundwater Development - Southfleet & Greenhithe	Southfleet-Greenhithe licence disaggregation and new headworks and PS at borehole sites, new 3km main from Greenhithe to new WTW. DO benefit is 8Ml/d average, 9Ml/d peak.	✓	✓	

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100 p1	New WTW at Kempton - 100Ml/d - Construction	100Ml/d new capacity at WTW at Kempton treating raw reservoir water in west London. Purpose is to accommodate additional future demand.	✓	✓	
TWU_STR_HI-RSR_RE1_CNO_abingdon150(lon)*	New Reservoir - SESRO 150Mm^3 - Construction	SRO, see Table 1-2	✓	✓	✓
TWU_SWA_HI-ROC_WT1_CNO_medmenhamwtw ph1	New Medmenham Surface Water WTW Ph1 - Construction	24Ml/d treatment works for river water near Medmenham (SWA). Purpose is to accommodate additional future demand. Includes a treated water PS, treated water transfer pipeline and new storage reservoir at Widdenton.	✓	✓	
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53	New Medmenham Surface Water Intake - 53 Ml/d	The Medmenham intake element includes the construction of an intake structure on the River Thames located approximately 1.75km west of the village of Medmenham, close to the village of Mill End. In addition to the intake structure, a PS will be constructed. The intake structure, PS and raw water transfer main would supply water from the River Thames to a new WTW at Medmenham. The intake and all associated infrastructure will be constructed with an abstraction capacity of 53Ml/d.	✓	✓	
TWU_SWX_HI-GRW_ALL_ALL_woods farm do	Groundwater Development - Woods Farm Existing Source Increase DO	New borehole to be constructed on-site to bring DO up to licence (this is an additional 2.4Ml/d to average licence of 4.99Ml/d or an additional 2.91Ml/d to peak licence of 5.5Ml/d). The option includes a new borehole and a 1.4km raw water pipeline from the new satellite borehole to Woods Farm WTW.	✓	✓	
TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox	Oxford Canal – Duke's Cut (SWOX) – Construction	Upgrades to the canal network to transfer 15Ml/d surplus from the Wolverhampton Levels to upstream of Duke's Cut.	✓	✓	
TWU_SWX_HI-TFR_HEN_ALL_henley-swox5	Henley to SWOX Transfer – 5Ml/d	The option is for one new main from New Farm SR (Henley) to Nettlebed SR (SWOX). This will require a new 5.9km, 350mm diameter main from New Farm to Nettlebed and a new PS at New Farm. 5Ml/d capacity.		✓	
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Abingdon Reservoir to Farmoor Reservoir pipeline	Construction of a transfer pipeline to convey 24Ml/d of raw water between a proposed reservoir at Abingdon and the existing Farmoor reservoir, in the SWOX WRZ. (Note: Abingdon reservoir creation is not part of this	✓	✓	

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
		option.) The engineering scope includes the provision of a booster PS at the proposed Abingdon reservoir site to facilitate the transfer. Treatment would be provided at the existing WTW.			
TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor	Oxford Canal - Transfer from Duke's Cut to Farmoor	15Ml/d conveyance option from the Oxford Canal to Farmoor Reservoir, with abstraction from a point approximately 800m north of Duke's Cut on the Oxford Canal, discharging into the River Thames for subsequent re-abstraction at the existing Farmoor Reservoir intake. It has been assumed that, as the transfer will only be used in periods of low flow, no works will be required to upgrade the existing intake structure or treatment facilities at Farmoor Reservoir.	✓	✓	
TWU_TED_HI-TFR_TED_ALL_teddingtondramog/ted*	Mogden to Teddington outfall 100Ml/d	SRO, see Table 1-2	✓	✓	✓
TWU_KGV_HI-REU_RE1_CNO_deephams reuse 46.5b	Deephams Reuse – 46.5Ml/d, to TLT – Construction	Transfer of Deephams STW final effluent to the new water recycling works with the following technology: pre-screens, UF, RO, UV treatment, inter-process pumping, buildings and disinfection, pH adjustment chemicals. Includes conveyance to TLT extension.	✓		
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	Manager Aquifer Recharge - Horton Kirby ASR	Construction of pipelines between two existing ASR boreholes in the Lower Greensand aquifer to an existing WTW at Horton Kirby in Kent. Water abstracted from existing Chalk aquifer boreholes (via the mains supply) will be recharged into the two ASR boreholes during periods of water surplus and abstracted when needed and treated at the WTW	✓	✓	✓
TWU_SWX_HI-TFR_HEN_ALL_henley-swox2.4	Henley to SWOX Transfer – 2.4Ml/d	The option is for a new main from New Farm SR (Henley) to Nettlebed SR (SWOX). This will require a new 5.9km (250dia) main from New Farm to Nettlebed and a new PS at New Farm. 2.4Ml/d capacity.	✓		

A total of 27 (Situation 1), 18 (Situation 4) and 12 (Situation 8) options within the Thames Water rdWRMP24 BVP were scoped-out of natural capital and BNG assessments. Table 1-7 below outlines the scoped-out options for Situations 1, 4, and 8 of the BVP. The reasoning for these being scoped-out is provided in Table 1-1.

Table 1-7: Summary of options scoped-out of the BVP, including Situations 1, 4, and 8

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
TWU_HEN_HI-TFR_KVZ_ALL_tw(kv)to(hen)con	Transfer - Kennet Valley to Henley - Conveyance Element	Potable Water Transfer – Thames Water (Kennet Valley) to Thames Water (Henley) Conveyance.	✓	✓	
TWU_GUI_RE-DRP_ALL_ALL_dp-shalford-guild	Shalford Drought Permit	Drought intervention – Drought permit		✓	✓
TWU_HEN_RE-DRP_ALL_ALL_dp-sheep/harp-hen	Sheeplands/Harpsden Drought Permit	Drought intervention – Drought permit		✓	✓
TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm	Groundwater Development - Recommission Mortimer Disused Source	Refurbishment of two disused abstraction boreholes located on-site at the existing, but disused Mortimer WTW. Water abstracted from the boreholes will be sourced from the underlying deep confined Chalk and treated at the disused WTW which will be upgraded for ammonia and iron removal and recommissioned. DO benefit 4.5Ml/d average and peak.	✓	✓	
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen*	T2ST Culham to Speen (10Ml/d)	SRO, see Table 1-2	✓	✓	
TWU_KVZ_RE-DRP_ALL_ALL_dp-playhatch-kv	Playhatch Drought Permit	The Playhatch licence has an annual average abstraction of 7.27Ml/d and a peak abstraction of 8.2Ml/d. The Playhatch Kennet Valley drought plan option is to increase the peak licence to 12.3Ml/d, during drought periods.	✓	✓	✓
TWU_LON_HI-GRW_ALL_ALL_addington gw	Groundwater Development - Addington	New abstraction borehole and upgrade to WTW. DO benefit 1Ml/d average, 1.5Ml/d peak.	✓	✓	✓
TWU_LON_HI-ROC_WT1_ALL_eastlonwtwexisting	Available Treatment Capacity at Coppermills WTW	Existing drought capacity at East London WTW is 50 Ml/d, limited by the EA requirement not to develop recycling options in excess of 50Ml/d. In place to allow use of Deephams and Teddington in 2030.	✓	✓	✓
TWU_LON_HI-ROC_WT1_ALL_existing w lon wtw	Available Treatment Capacity at West London WTWs	Existing West London spare treatment capacity.	✓	✓	✓
TWU_LON_HI-TFR_LON_ALL_newriverhead pump 4	Replace New River Head Pump - TWRM	Pump 4 at New River Head is to be replaced.	✓	✓	
TWU_SWA_HI-GRW_ALL_ALL_datchet do	Groundwater Development - Datchet Existing Source DO Increase	Increase capacity of Datchet site.	✓	✓	

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWOX) to Thames Water (SWA) – Conveyance. Horspath to Ashenden (bidirectional).	✓	✓	
TWU_SWX_HI-GRW_ALL_ALL_moulsford gw	Groundwater Development - Moulsford Groundwater Source	Construction of an abstraction borehole in the unconfined Chalk north of Streatley on the west bank of the River Thames. Water abstracted from the borehole will be treated at the existing Cleeve WTW located on the eastern side of the River Thames. DO benefit is 3.5Ml/d peak and 2Ml/d average.	✓	✓	✓
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Ashenden to Horspath (bidirectional)	✓	✓	✓
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con b	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Radnage to Bledlow	✓	✓	✓
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con c	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Stokenchurch to Chinnor	✓	✓	✓
TWU_SWX_RE-DRP_ALL_ALL_dp-gatehampton-swox	Gatehampton Drought Permit	The Gatehampton licence includes a flow constraint which means abstraction must be reduced from the licence quantity of 105Ml/d to at or below 101.5Ml/d when flow in the River Thames at Reading Gauging Station falls below 400Ml/d for five days. The Gatehampton SWOX drought plan option is to change the Gatehampton licence to allow abstraction to remain at 105Ml/d even when the flow constraint is in place, during drought periods.	✓	✓	✓
TWU_TED_HI-RAB_RE1_CNO_teddington dra 75*	Teddington DRA 75 Ml/d – Construction	SRO, see Table 1-2	✓	✓	✓
TWU_HON_HI-ROC_NET_CNO_cop'mills-honoroak	TWRM extension - Coppermills to Honor Oak - Construction	New ring main tunnel from Coppermills to Honor Oak	✓		
TWU_KGV_HI-TFR_KGV_ALL_lockwood ps-kgv res	Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intake	New connection from Lockwood PS to the intake of KGV reservoir.	✓		
TWU_LON_HI-DES_ALL_CNO_beckton desal 150	Beckton Desalination	Abstraction of 187Ml/d raw water for production of 150Ml/d desalinated water (conveyance within option	✓		

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
		below). DO 142Ml/d for 150Ml/d capacity.			
TWU_LON_HI-GRW_ALL_ALL_addington asr	Managed Aquifer Recharge - Addington	Two new ASR boreholes near Addington PS, and one borehole refurbishment, 300m length of sewer for conditioning discharges, booster recharge pumps due to artesian head pressures in aquifer. DO benefit 3Ml/d average, 5Ml/d peak.	✓		
TWU_LON_HI-GRW_ALL_ALL_london conchalk	Groundwater Development - Confined Chalk North London	New abstraction borehole. DO benefit 2Ml/d average and peak.	✓		
TWU_LON_HI-GRW_ALL_ALL_merton recommission	Groundwater Development - Merton Recommissioning	The option comprises the recommissioning and upgrade of the Merton Abbey WTW in order to treat the maximum peak DO of 8Ml/d from the Merton Abbey Well. DO benefit 7.86Ml/d peak, 2Ml/d average	✓		
TWU_LON_HI-GRW_ALL_CNO_kidbrooke slars	Managed Aquifer Recharge - Kidbrooke (SLARS1) Construction	The scheme comprises the upgrade of the existing borehole at the Rochester Way site, another at the Bromley Reservoir site and the construction of a new AR borehole on private land in Eltham Green. Six observation boreholes will be constructed for groundwater level monitoring, four at the Eltham Green site and two off-site the Eltham Green location. Benefit is 8.1Ml/d peak and 7Ml/d average. The scheme also includes: construction of a new 10Ml/d WTW located on the existing Kidbrooke borehole site to serve the Rochester Way, Bromley Reservoir and a new AR borehole, a 5.7km (300mm) raw water transfer main between Bromley Reservoir and new AR borehole, a 6.4km (400mm) bi-directional raw water transfer main between Rochester Way AR borehole and a new AR borehole via Kidbrooke WTW (3.5km between Rochester Way and Kidbrooke WTW, 2.6km between new borehole and Kidbrooke WTW), a 1.8km (450mm) treated water main between Kidbrooke WTW and Bermondsey (Well Hall PS).	✓		
TWU_LON_HI-GRW_ALL_CNO_merton ar	Managed Aquifer Recharge - Merton (SLARS3) Construction	The scheme comprises the upgrade of the existing well and adit system at the Merton Abbey WTW for recharge/abstraction purposes and the construction of a new AR	✓		

Option ID	Option name	Description	Sit 1	Sit 4	Sit 8
		borehole at the nearby Byegrove Road site. DO benefit is 5Ml/d average and 6Ml/d peak. The scheme also includes the construction of a new 4.5Ml/d WTW located at the existing Merton Abbey WTW site to serve the Byegrove Road AR borehole, and the installation of a 1.1km raw water main from the Byegrove Road AR borehole to the new Merton Abbey WTW.			
TWU_LON_HI-TFR_LON_CNO_beckton-coppermills	Beckton to Coppermills tunnel (treated) – Construction	Treated desalination water is to be conveyed via tunnel from Beckton desalination works to Coppermillls WTW for blending. (Part of the Beckton Desalination Scheme with the option above.)	✓		
TWU_LON_HI-TFR_SES_ALL_cheam-merton	Transfer from SES WTW to Merton TWRM shaft	Proposed new trunk mains to transfer water from Cheam WTW (SES) to Merton Ring Main Shaft including a new PS at Cheam WTW.	✓		
TWU_LON_HI-OTH_ALL_ALL_didcot purchase	Didcot Power Station Licence Trading	Agreement between Thames Water and RWE Npower that Npower will abstract less than the maximum amount of its abstraction licence at Didcot Power Station. This water would then be available downstream for abstraction at Thames Water intakes	✓	✓	✓
TWU_WLJ_HI-ROC_NET_CNO_twrm shaft kempton	New shaft on the TWRM at Kempton - Construction	This option includes a new shaft on the TWRM to accommodate 800Ml/d of treated water flow from the expanded Kempton WTW.	✓	✓	

1.3.4 Best Environmental and Societal Plan

The Thames Water rdWRMP24 BESP includes several supply-side options scoped-in as requiring BNG and NCA, including the associated SROs. The options and associated option descriptions are presented in Table 1-8 below.

Table 1-8. Options and descriptions scoped-in to the BESP (SROs demarked with an asterisk, and therefore Gate 2 reporting has been used)

Option ID	Option name	Description
TWU_GUI_HI-TFR_RZ4_ALL_sewtogui	SouthEast Water to Guildford WRZ	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.
TWU_KEM_HI-TFR_TED_ALL_tedd-kempton*	Teddington to Kempton Conveyance Element	SRO, see Table 1-2
TWU_KGV_HI-TFR_TED_ALL_teddingtondrated/tlt*	Direct River Abstraction – Teddington to Thames	SRO, see Table 1-2

Option ID	Option name	Description
	Lee Tunnel Shaft 100 Ml/d	
TWU_LON_HI-GRW_ALL_ALL_s'fleet lic disagg	Groundwater Development - Southfleet & Greenhithe	Southfleet-Greenhithe licence disaggregation and new headworks and PS at borehole sites, new 3km main from Greenhithe to new WTW. DO benefit is 8Ml/d average, 9Ml/d peak.
TWU_STR_HI-RSR_RE1_CNO_abingdon75(lon)*	Reservoir Abingdon 75 (Lon) – Construction	SRO, see Table 1-2
TWU_SWA_HI-ROC_WT1_CNO_medmenhamwtw ph1	New Medmenham Surface Water WTW Ph1 - Construction	24Ml/d treatment works for river water near Medmenham (SWA). Purpose is to accommodate additional future demand. Includes a treated water PS, treated water transfer pipeline and new storage reservoir at Widdenton.
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53	New Medmenham Surface Water Intake - 53 Ml/d	The Medmenham intake element includes the construction of an intake structure on the River Thames located approximately 1.75km west of the village of Medmenham, close to the village of Mill End. In addition to the intake structure, a PS will be constructed. The intake structure, PS and raw water transfer main would supply water from the River Thames to a new WTW at Medmenham. The intake and all associated infrastructure will be constructed with an abstraction capacity of 53Ml/d.
TWU_SWX_HI-GRW_ALL_ALL_woods farm do	Groundwater Development - Woods Farm Existing Source Increase DO	New borehole to be constructed on-site to bring DO up to licence (this is an additional 2.4Ml/d to average licence of 4.99Ml/d or an additional 2.91Ml/d to peak licence of 5.5Ml/d). The option includes a new borehole and a 1.4km raw water pipeline from the new satellite borehole to Woods Farm WTW.
TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox	Oxford Canal – Duke's Cut (SWOX) – Construction	Upgrades to the canal network to transfer 15Ml/d surplus from the Wolverhampton Levels to upstream of Duke's Cut.
TWU_SWX_HI-TFR_HEN_ALL_henley-swox5	Henley to SWOX Transfer – 5Ml/d	The option is for one new main from New Farm SR (Henley) to Nettlebed SR (SWOX). This will require a new 5.9km, 350mm diameter main from New Farm to Nettlebed and a new PS at New Farm. 5Ml/d capacity.
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Abingdon to Farmoor Reservoir pipeline	Construction of a transfer pipeline to convey 24Ml/d of raw water between a proposed reservoir at Abingdon and the existing Farmoor reservoir, in the SWOX WRZ. (Note: Abingdon reservoir creation is not part of this option.) The engineering scope includes the provision of a booster PS at the proposed Abingdon reservoir site to facilitate the transfer. Treatment would be provided at the existing WTW.
TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor	Oxford Canal - Transfer from Duke's Cut to Farmoor	15Ml/d conveyance option from the Oxford Canal to Farmoor Reservoir, with abstraction from a point approximately 800m north of Duke's Cut on the Oxford Canal, discharging into the River Thames for subsequent re-abstraction at the existing Farmoor Reservoir intake. It has been assumed that, as the transfer will only be used in

Option ID	Option name	Description
		periods of low flow, no works will be required to upgrade the existing intake structure or treatment facilities at Farmoor Reservoir.
TWU_TED_HI-RAB_RE1_CNO_teddington dra 75*	Teddington DRA 75 Ml/d – Construction	SRO, see Table 1-2
TWU_TED_HI-TFR_TED_ALL_teddingtondramog/ted*	Mogden to Teddington outfall 100Ml/d	SRO, see Table 1-2
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	Manager Aquifer Recharge - Horton Kirby ASR	Construction of pipelines between two existing ASR boreholes in the Lower Greensand aquifer to an existing WTW at Horton Kirby in Kent. Water abstracted from existing Chalk aquifer boreholes (via the mains supply) will be recharged into the two ASR boreholes during periods of water surplus and abstracted when needed and treated at the WTW

Several options within the Thames Water rdWRMP24 BESP were scoped-out of NCA and BNG assessments. Table 1-9 below outlines the scoped-out options along with the reasoning.

Table 1-9: Summary of options scoped-out of the BESP.

Option ID	Option name	Reason for scoping out
TWU_HEN_HI-TFR_KVZ_ALL_tw(kv)to(hen)con	Transfer - Kennet Valley to Henley - Conveyance Element	Potable Water Transfer – Thames Water (Kennet Valley) to Thames Water (Henley) Conveyance.
TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm	Groundwater Development - Recommission Mortimer Disused Source	Refurbishment of two disused abstraction boreholes located on-site at the existing, but disused Mortimer WTW. Water abstracted from the boreholes will be sourced from the underlying deep confined Chalk and treated at the disused WTW which will be upgraded for ammonia and iron removal and recommissioned. DO benefit 4.5Ml/d average and peak.
TWU_LON_HI-GRW_ALL_ALL_addington gw	Groundwater Development - Addington	New abstraction borehole and upgrade to WTW. DO benefit 1Ml/d average, 1.5Ml/d peak.
TWU_SWA_HI-GRW_ALL_ALL_datchet do	Groundwater Development - Datchet Existing Source DO Increase	Increase capacity of Datchet site
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	Thames Water Horspath (SWOX) to Thames Water Ashenden (SWA) Conveyance	Potable Water Transfer – Thames Water (SWOX) to Thames Water (SWA) – Conveyance. Horspath to Ashenden (bidirectional).
TWU_SWX_HI-GRW_ALL_ALL_moulsford gw	Groundwater Development - Moulsford Groundwater Source	Construction of an abstraction borehole in the unconfined Chalk north of Streatley on the west bank of the River Thames. Water abstracted from the borehole will be treated at the existing Cleeve WTW located on the eastern side of the River Thames. DO benefit is 3.5Ml/d peak and 2Ml/d average.

Option ID	Option name	Reason for scoping out
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – from SWA WRZ to SWOX WRZ.
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con b	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Ashenden to Horspath (bidirectional)
TWU_SWX_HI-TFR_SWA_ALL_tw(swa)to(swx)con c	SWA to SWOX Transfer - Conveyance Element	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Radnage to Bledlow
TWU_LON_HI-DES_ALL_CNO_beckton desal 100p1	Beckton Desalination	Potable Water Transfer – Thames Water (SWA) to Thames Water (SWOX) – Conveyance. Stokenchurch to Chinnor
TWU_LON_HI-GRW_ALL_ALL_london conchalk	Groundwater Development - Confined Chalk North London	New abstraction borehole. DO benefit 2Ml/d average and peak.
TWU_LON_HI-GRW_ALL_ALL_merton recommission	Groundwater Development - Merton Recommissioning	The option comprises the recommissioning and upgrade of the Merton Abbey WTW in order to treat the maximum peak DO of 8Ml/d from the Merton Abbey Well. DO benefit 7.86Ml/d peak, 2Ml/d average
TWU_LON_HI-GRW_ALL_CNO_kidbrooke slars	Managed Aquifer Recharge - Kidbrooke (SLARS1) Construction	The scheme comprises the upgrade of the existing borehole at the Rochester Way site, another at the Bromley Reservoir site and the construction of a new AR borehole on private land in Eltham Green. Six observation boreholes will be constructed for groundwater level monitoring, four at the Eltham Green site and two off-site the Eltham Green location. Benefit is 8.1Ml/d peak and 7Ml/d average. The scheme also includes: construction of a new 10Ml/d WTW located on the existing Kidbrooke borehole site to serve the Rochester Way, Bromley Reservoir and a new AR borehole, a 5.7km (300mm) raw water transfer main between Bromley Reservoir and new AR borehole, a 6.4km (400mm) bi-directional raw water transfer main between Rochester Way AR borehole and a new AR borehole via Kidbrooke WTW (3.5km between Rochester Way and Kidbrooke WTW, 2.6km between new borehole and Kidbrooke WTW), a 1.8km (450mm) treated water main between Kidbrooke WTW and Bermondsey (Well Hall PS).
TWU_LON_HI-GRW_ALL_CNO_merton ar	Managed Aquifer Recharge - Merton (SLARS3) Construction	The scheme comprises the upgrade of the existing well and adit system at the Merton Abbey WTW for recharge/abstraction purposes and the construction of a new AR borehole at the nearby Byegrove Road site. DO benefit is 5Ml/d average and 6Ml/d peak. The scheme also includes the construction of a new 4.5Ml/d WTW located at the existing Merton Abbey WTW site to serve the Byegrove Road AR borehole, and the installation of a 1.1km raw water main from the Byegrove Road AR borehole to the new Merton Abbey WTW.
TWU_LON_HI-TFR_LON_CNO_beckton-coppermills	Beckton to Coppermills tunnel (treated) – Construction	Treated desalination water is to be conveyed via tunnel from Beckton desalination works to

Option ID	Option name	Reason for scoping out
		Coppermillls WTW for blending. (Part of the Beckton Desalination Scheme with the option above.)
TWU_LON_HI-TFR_SES_ALL_cheam-merton	Transfer from SES WTW to Merton TWRM shaft	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.

2 Methodology

2.1 Natural Capital Assessment Methodology

Water companies have a statutory obligation to produce a WRMP, which sets out how a company intends to maintain the balance between supply and demand for water over a minimum 25-year period. In the development of a WRMP, companies must follow the Guidelines and consider broader government policy objectives. The Guidelines recommend that companies must consider the environment and society when developing the WRMP, stating that NCA and BNG should be used to inform decision-making. The NCA is similarly supported by the Government's ambition to deliver environmental net gain, as set out in the 25 Year Environment Plan and UK Defra's Guiding Principles.

The rdWRMP24 is therefore required to provide an NCA which aligns with the Guidelines and the wider WRSE approach undertaken at the regional scale.

The methodological approach to the NCA and BNG developed for the Thames Water rdWRMP24 aligns with the method defined by WRSE. This alignment was considered with the ambition of delivering a consistent NCA and BNG methodology across the water companies developing options requiring these assessments across the WRSE region. The NCA and BNG have been produced in line with best practice and guidance available at the time the assessments were undertaken, including:

- Defra (2020) Enabling a Natural Capital Approach (ENCA)
- HM Treasury and Government Finance (2018) The Green Book: appraisal and evaluation in central government
- Natural England (2021) The Biodiversity Metric 3.0 auditing and accounting for biodiversity (JP039)
- Natural England (2020) NERR076 Natural Capital Indicators: for defining and measuring change in natural capital
- Water Resources Planning Guidelines ('Guidelines'): Working version for rdWRMP24 (version 4.2) (Environment Agency, Natural Resources Wales, Ofwat)
- Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making

Since the assessments were undertaken, a number of the guidance documents listed above have been updated, including The Green Book[8] (2022), The Biodiversity Metric 4.0[9] (2023), and the Guidelines[10] (2023). However, the guidance available at the time of the assessments is considered appropriate to inform the Thames Water rdWRMP24 decision-making process, as it maintains alignment with the new guidance and the retention of the Biodiversity Metric 3.0 as the assessed Metric for the rdWRMP24 has been agreed with Natural England by WRSE on behalf of their constituent water companies.

[8] HM Treasury and Government Finance Function (2022). Guidance, The Green Book: appraisal and evaluation in central government. Available at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-govenent [Accessed August 2023]

[9] Defra and Natural England (2023). The Biodiversity Metric 4.0 (JP039). Available at: https://publications.naturalengland.org.uk/publication/6049804846366720 [Accessed August 2023]

[10] Environment Agency, Natural Resources Wales, Office for Water Services (2023). Guidance, Water resources planning guideline. Available at: https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline [Accessed August 2023]

2.2 Principles of the Natural Capital Assessment

Regional water resource plans taking a long-term view of water planning are currently being prepared for each region. The Thames Water rdWRMP24 SEA was undertaken in the context of these plans and falls within the WRSE regional plan. In line with the EA supplementary guidance on Environment and society in decision-making[5], the NCA methodology has been developed in accordance with the following principles:

- The assessment includes the valuation of natural capital assets and ecosystem services within the footprint of each option and their zone of influence (ZoI) (see Section 2.3).
- The assessment methodology uses the most relevant qualitative, quantitative and/or monetary valuation approaches for the NCA depending on the likely impact of the option on natural capital stocks. The assessment of the option's impact on the natural capital metrics has been undertaken in a sequential manner with an initial qualitative assessment, followed by a quantitative analysis and finally a monetised assessment if enough confidence exists in the values.
- Not all ecosystem services can be monetised within the NCA, however, those that are will be assessed against a consistent methodology. The monetised natural capital metrics will be incorporated into the cost benefit ratio as a discrete input. This monetised value will be a single figure defined by the maximum natural capital benefit, as a conservative approach for considering the greatest potential impact. The cost of the option will not be considered within this assessment as it is captured elsewhere within the multi-criteria assessment.
- Ecosystem services that are not monetised will be quantified and incorporated into the regional plan decision-making process within the SEA assessment.
- The NCA has been undertaken using open-source data in accordance with the guidance for regional assessments and to ensure that the approach is consistent across the entire study area.
- The WRSE NCA methodology aims to align the assessment of the rdWRMP natural capital and ecosystem services which has previously been undertaken using separate approaches. It is hoped that the uniform methodology will enable joint investment in strategic and catchment-based options.
- The assessment criteria have been designed to enable the maximisation of the potential benefits from the regional plan.

The BVP options have been assessed in accordance with the principles identified above and the NCA methodology set out below. The NCA principles and associated methodology developed for the regional planning process has been reviewed by Thames Water and are considered suitable for undertaking assessments to inform the rdWRMP24, ensuring a consistent assessment methodology across both the regional plan and the rdWRMP24.

2.3 Stage 1: Defining the Natural Capital Baseline

As part of the NCA of the feasible options within the regional plan a natural capital baseline has been developed for the Thames Water operational area. This baseline has been developed using open-source data as described in National Natural Capital Atlas: Mapping Indicators (NECR285)[11] to generate a natural capital account of the stocks within the Thames Water

[11] Natural England (2020) National Natural Capital Atlas: Mapping Indicators (NERC285). Available at: National Natural Capital Atlas: Mapping Indicators - NECR285 (naturalengland.org.uk) [Accessed August 2023]

region. The list of stocks considered within the accounts and the methodology for mapping them are shown in Annex A. The methodology used to map natural capital utilised the same breakdown of stocks as the NECR285 where possible. However, the list has been supplemented with additional abiotic stocks and key habitats that are vital to the Thames Water region, such as chalk streams and rivers.

The ZoI for each option is defined as the area likely to be altered or changed because of the option, resulting in a potential change to the environmental benefits that are currently being provided. To assess the likely temporary impacts from construction within the ZoI, it has been assumed that above ground and below ground infrastructure will require a working width of approximately 5m from the option footprint, and for linear below ground infrastructure, such as transfer pipelines, this would result in a working width of approximately 10m from the option footprint, assuming that temporary works could be undertaken on either side of the linear asset. It is assumed that the natural capital stocks located within the option footprint for above ground infrastructure will be permanently lost because of option construction.

2.4 Stage 2: Option Level Natural Capital Assessment

An NCA has been undertaken on the options in accordance with the Guidelines and Defra's ENCA[12]. ENCA is recommended for use by HM Treasury's Green Book: appraisal and evaluation in central government (2020) and represents supplementary guidance to the Green Book.

In August 2021 and July 2023, ENCA updated its guidance. As mentioned in Section 1.3, as a result from key stakeholder consultation, all assessments have been updated to the latest ENCA guidance. The August 2021 and July 2023 ENCA guidance (GOV.UK, 2021) includes updated values within the Asset Databook and Service Databook. Within the Service Databook, the carbon reduction tab now includes the BEIS 2021[13] carbon values – a set of values produced by the government to be used in policy appraisal and evaluation, reflecting the latest evidence.

The impact of the options on the natural capital stocks was reported for each option quantitatively. This impact was reported during construction and post-construction to give an estimation of the impact of the option's whole lifecycle. The results of the stock assessment were reported in total losses and gains within each option's ZoI, consistent for each ecosystem service.

The results of the change in natural capital stocks informed the assessment against the eight ecosystem services listed below using the Natural England logic chains, set out in Figure 2.1 below. The cost/benefit assessment was informed by the option type, option description and any embedded mitigation. The outputs of the NCA were compared to the pre-construction provision of impacted services to assess the impact of the options. Five ecosystem services were monetised (subject to the screening process set out below), and the results of the assessment reported as a discrete monetary figure; water purification and water regulation were assessed

[12] GOV.UK. (2021). Enabling a Natural Capital Approach guidance. Available online at: https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance [Accessed August 2023]

[13] GOV.UK. (2021). Valuing greenhouse gas emissions in policy appraisal https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal [Accessed August 2023]

qualitatively; and biodiversity has been assessed via The Biodiversity Metric Version 3.0[14] (with select options updated from The Biodiversity Metric Version 2.0, following consultation comments and stakeholder engagement).

Figure 2.1 Ecosystem Services valuation logic chain

The ecosystem services reviewed to assess the impact on natural capital include:

- Carbon Sequestration (Climate Regulation)
- Natural Hazard Management
- Water Purification (Qualitatively assessed)
- Water Regulation (Qualitatively assessed)
- Biodiversity and Habitats
- Air Pollutant Removal
- Recreation and Amenity Value
- Food Production

Both NCA strategies, as outlined in the Guidelines and ENCA guidance, discuss taking a proportionate approach to the assessment. It is therefore important to accommodate this when integrating a natural capital approach within the option development and assessment process. A natural capital approach is able to inform concept design and aid decision making by quantifying the relative cost benefits and disbenefits of the options on natural capital stocks and the flow of ecosystem services in order to aid the initial assessment of the identified strategic solutions.

2.4.1 Ecosystem Services Screening

During the initial phase of the NCA, the seven ecosystem services listed (excluding Biodiversity and Habitats, assessed by The Biodiversity Metric Version 3.0) were reviewed and scoped-in or out due to the geographical or socio-economic context of the option and its ZoI. Specific guidance on the screening process for individual metrics is provided below.

[14] Natural England, Defra (2021). Available at: ARCHIVE SITE for the Biodiversity Metric 2.0 and the Biodiversity Metric 3.0 (nepubprod.appspot.com) [Accessed August 2023]

2.4.2 Carbon Sequestration (Climate Regulation)

The climate regulation metric focuses on carbon sequestration, which can be defined as the capture and secure storage of carbon that would otherwise be emitted to, or remain, in the atmosphere. The carbon sequestration NCA has been undertaken in addition to construction carbon and operational carbon calculations and provides a holistic assessment of option carbon emissions.

The assessment was determined by land management within each option ZoI, which influences the carbon store for prolonged periods of time and results in changes to net emissions. The estimate of the carbon stocks for each option footprint was based on the area of broad land use types according to literature and research. The estimated carbon stocks for broad habitat types are listed below and the sequestration rates are shown in Table 2-1.

Table 2-1: Estimated carbon stocks for broad habitat types and the sequestration rates (JBA Consulting)[15, 16]

Land use type	Carbon sequestration rate (tCO2e/ha/y)
Woodland – deciduous	4.97
Woodland – coniferous	12.66
Arable land	0.107
Pastoral land	0.397
Peatland – undamaged	4.11
Peatland – overgrazed	-0.1
Peatland – rotationally burnt	-3.66
Peatland – extracted	-4.87
Grassland	0.397
Heathland	0.7
Shrub	0.7
Saltmarsh	5.188
Urban	0
Green urban	0.397

The carbon sequestration rates were converted to monetary values using standard methods and the UK BEIS Interim Non-Traded Carbon Values 2021, which sets out a revised approach to valuing greenhouse gas emissions in policy appraisal, following a cross-government review during 2020 and 2021. The 2021 high series value of £367 was used throughout the NCAs. The NCA is based on a 2021 price year, however, it is assumed that adjustments for inflation have been accounted for within the annual projections provided by BEIS and therefore the 2021 values presented in Table 2-2 below have not been adjusted. High series values were used to reflect a conservative estimate for the price of carbon.

SRO assessments report ecosystem services through a Net Present Value (NPV). NPV is a calculation technique which in terms of environmental economics, is used to estimate the value or net benefit over the lifetime of a particular project. Unlike the SRO options which have more

[15] Alonso, I., Weston, K., Gregg, R. & Morecroft, M (2012). Carbon storage by habitat - Review of the evidence of the impacts of management decisions and condition on carbon stores and sources. Natural England Research Reports, Number NERR043. Available at: http://publications.naturalengland.org.uk/file/1438141 [Accessed August 2023]

[16] Environment Agency (2020). Water resources planning guideline supplementary guidance - Environment and society in decision-making. [Accessed: August 2023]

detailed information, standard resource options lack information on construction and operational periods, meaning a Net Present Value (NPV) could not be calculated. As such, a price per year value was used.

Table 2-2: BEIS interim non-traded carbon values for policy appraisal, £/tCO2e (£2020)[13]

Year	Low series	Central series	High series
2020	120	241	361
2021	122	245	367
2022	124	248	373
2023	126	252	378
2024	128	256	384
2025	130	260	390
2026	132	264	396
2027	134	268	402
2028	136	272	408
2029	138	276	414
2030	140	280	420
2031	142	285	427
2032	144	289	433
2033	147	293	440
2034	149	298	447
2035	151	302	453
2036	155	307	460
2037	156	312	467
2038	158	316	474
2039	161	321	482
2040	163	326	489
2041	165	331	496
2042	168	336	504
2043	170	341	511
2044	173	346	519
2045	176	351	527
2046	178	356	535
2047	181	362	543
2048	184	367	551
2049	186	373	559
2050	189	378	568

The intermediate carbon sequestration rates (tCO2e) alongside the monetary valuation for each broad habitat type within each option boundary are reported in Annex B for the options that are scoped-in for assessment.

2.4.3 Natural Hazard Regulation

Different habitat types have intrinsic flood risk management values by intercepting, storing, and slowing water flows. This is known as natural flood management (NFM) and is listed as a policy within the 25-Year Environment Plan[17]. The capacity of habitats to achieve this was quantified, and then a monetary value assigned based on the damage-costs avoided from flooding or replacement costs due to their capacity to regulate flood waters and was then considered as part of this ecosystem service assessment. The capacity for a given natural capital asset to provide a flood regulation service depends on two factors:

[17] Defra (2018). A Green Future: Our 25 Year Plan to Improve the Environment. Available at: https://www.gov.uk/government/publications/25-year-environment-plan [Accessed August 2023]

- The capacity to slow overland flows
- Whether the asset is located in an area of flood risk

This ecosystem service also applies in urban areas, where vegetation can reduce surface water flooding from heavy rainfall, with benefits to sewerage capacity. Coastal flood risk, which has been predicted to increase with future climate change, is reduced by coastal margin habitats such as saltmarsh.

Options have been assessed on their ability to impact flood risk positively or negatively through the comparison of pre- and post-construction natural capital stocks and the catchment in which they are located. The assessment is restricted to catchment areas that drain to downstream communities impacted by flooding. These communities are identified using the EA's Indicative Flood Map[18], which overlays areas at risk of fluvial flooding and the National Receptor Database.

Reduced flood damage to downstream or coastal settlements because of reduced magnitude/ frequency of flood/storm events, and/or lower sewer capacity or water storage costs has been valued in line with the 'valuing flood regulation services of existing forest cover to inform natural capital accounts' methodology set out by Broadmeadow et al. 2018[19]. This assessment was developed to provide indicative national estimates of water regulation services of woodland to inform natural capital accounts and is based on modelling to estimate the potential volume of flood water regulated by woodland ecosystems in flood risk catchments. The methodology adopts a replacement-cost (rather than damage cost) approach to valuing the flood regulation service of woodland by applying annualised average capital and operating costs of the flood reservoir storage that would be required in the absence of the ecosystem service.

Values to estimate flood regulation services are identified by ENCA and based on Forest Research values[19]. The central estimate of the average annual costs of reservoir floodwater storage is £0.42/m^3. The range is from £0.10/m^3 to £1.19/m^3 per year. The central estimate was used to derive an annual average estimate for the flood regulation service of woodland in Great Britain, which was then uplifted to a 2021 price year. These 'replacement costs' can be considered a lower bound of the benefit, if it can be assumed that such expenditure would be deemed value for money by the flooding authorities within flood risk catchments in terms of avoided flood damage costs.

2.4.4 Water Purification

Based on their ecological functioning, different habitat types have varying capacities for absorbing pollutants from a given water source. This service is dependent on the location of the natural capital asset and the nature of the surrounding area. If a natural capital asset has a high capacity to remove pollutants but is not close to a water source, the service will not be provided. Due to this, valuation of the static water purification services of different natural capital assets as part of the NCA was not considered appropriate. A common value for different habitat types could not be applied due to extensive variation in local factors which determine the provisioning of this service.

[18] GOV.UK (2023). Flood map for planning – GOV.UK. Available at: www.flood-map-for-planning.service.gov.uk [Accessed August 2023]

[19] Broadmeadow, S., Thomas, H., Nisbet, T. and Valatin, G., 2018. Valuing flood regulation services of existing forest cover to inform natural capital accounts. Forest Research.

To account for the provision of this service within the NCA, the impact of an option associated with the provision or removal of woodland and semi-natural grassland, the most relevant terrestrial stocks that provide this service, was assessed qualitatively and with consideration of the Natural Environment Valuation Online (NEVO)[20] tool. The tool defines the resulting changes for the following water quality variables:

- Dissolved oxygen concentration
- Nitrogen concentration (including organic nitrogen, nitrate, nitrogen dioxide, ammonium)
- Phosphorus concentration (including organic and mineral phosphorus)
- Pesticide concentration (for 18 different pesticide types)

This qualitative approach follows the methodology that if an area of woodland were to be lost, the resultant impacts on water quality could be quantified within the option's ZoI. Any negative changes to the natural capital stocks in theory reflect the loss of this service within each option's ZoI.

However, there are areas in the east and south east of England that do not have consistent data for water quality variables available at the sub-catchment scale within the NEVO tool, and as such a consistent approach using quantitative data could not be applied and the qualitative approach set out above was applied.

2.4.5 Water Regulation

Water flow regulation is a key ecosystem service that can be directly impacted by both changes in land use and the implementation of supply options. Land uses such as agriculture are direct consumers of the water supply, while forests are known to promote higher rates of evapotranspiration and infiltration, which can affect local hydrologic cycles and change the amount of available water. The same natural capital stocks that provide the water supply, such as freshwater lakes and rivers, can also provide other services, such as recreation and amenity, especially when near residential and urban communities. In addition to land use changes, water resource options both impact and benefit from water flow regulation.

Supply-side options benefit by abstracting and providing water supply to customers, but supply options can also have varying effects on existing natural capital stocks, which in turn can affect the amount of available water. A qualitative assessment has been used to compare the positive and negative effect of each option on water flow regulation. Water regulation has only been considered qualitatively to avoid the potential double accounting of benefits with capacity-based and financial assessments, and to align with EA supplementary guidance[5]which recommends not including monetisation of water regulation benefits in decision making.

The key set out in Table 2-3: Scale of effect on water regulation ecosystem service below is used to demonstrate the scale of effect caused by the option on the water regulation ecosystem service.

[20] Luizzo, L., (2019) Natural Environment Valuation Online Tool – Chapter 6a: Water Quantity & Quality Model

Table 2-3: Scale of effect on water regulation ecosystem service

Colour	Scale of Effect	Description
+++	Major Positive	The option would result in a major improvement to the provision of water flow regulation.
++	Moderate Positive	The option would result in a moderate improvement to the provision of water flow regulation.
+	Minor Positive	The option would result in a minor improvement to the provision of water flow regulation.
0	Neutral	The option would not result in any effects on the provision of water flow regulation.
-	Minor Negative	The option would result in a minor decrease to the provision of water flow regulation.
--	Moderate Negative	The option would result in a moderate decrease to the provision of water flow regulation.
---	Major Negative	The option would result in a major decrease to the provision of water flow regulation.
?	Uncertain	From the level of information available, the effect that the option would have on the provision of water flow regulation is uncertain.

2.4.6 Air Pollutant Removal

Air pollution presents a major risk to human health, resulting in premature deaths and reduced quality of life. By removing air pollution, habitats help to lessen these impacts on health and wellbeing. The provisioning of the service is positively related to several key aspects:

- The surrounding area of the natural capital assets with regard to background pollution, especially particulate pollutant
- The quantity and type of natural capital asset, where woodland is the major service provider
- The density of population potentially benefiting from reduced exposure: because pollutants are transported, beneficiaries may be downwind of the ecosystem

Each option was screened against the provision of air pollutant removal according to the location of the option. Air pollutant removal was only considered within built up areas or when the ZoI includes Air Quality Management Areas. The impact of the option was assessed according to changes in natural capital stocks.

The value provided by natural capital assets was taken from the UK government's air quality economic assessment methodology[21]. The assessment embeds these values (based on the damage cost approach, i.e., damage to health avoided from reductions in air pollution) and estimates the present value automatically based on the quantitative estimates provided. Table 2-4 shows the average values for air pollution removal in 2015 calculated from aggregate UK values, as published in February 2019. These estimates have been uplifted for 2021.

[21]Jones L., Vieno M., Morton D., et al. (2019) Developing Estimates For The Valuation Of Air Pollution Removal In Ecosystem Accounts (published in 2017). Final Report for Office for National Statistics (published in 2019) – NERC Open Research Archive.

The value of each habitat has been combined with the changes expected in natural capital stocks to provide a value for the change in service provision. The final impact has been reported as a single value that was incorporated within the NCA metric.

Table 2-4: Air pollutant value by habitat type (£2021)

Habitat group	Value (£ per ha per year)
Urban woodland	917
Rural woodland	291
Urban grassland	177
Enclosed farmland	17
Coastal margins	31

2.4.7 Recreation and Amenity

The recreational value of green spaces can be significant. This value reflects both the natural setting and the facilities on offer at the site and often has a strong non-market element. It varies with the type and quality of habitat, location, local population density and the availability of substitute recreational opportunities. Recreational values can be beneficially affected by enhancements in green spaces, or adversely affected by new developments or infrastructure. The wider tourism and outdoor leisure sector are also dependent upon nature to varying degrees.

This metric depends on the extent to which the natural capital stocks the option provides will enhance the opportunity for recreation.

The key parameter needed to estimate in this category is the number of additional, enhanced or reduced recreational visits because of the option. This has been estimated using the Outdoor Recreation Valuation Tool[22] (ORVal). ORVal is referenced in HM Treasury Green Book. ORVaL is a random utility/travel cost model of recreational demand for all sites in England and Wales, which generates probabilistic predictions of visitor numbers for any publicly accessible outdoor recreation park, path, or beach. It takes account of scarcity of sites and substitution possibilities, as well as travel distances to sites and their attributes. This is useful for baseline initial assessment, accounting, and multiple sites. This should be seen as an estimation in the absence of site-specific data on visitor numbers.

The change in natural capital stocks and, specifically, the creation or removal of greenspace has been entered into ORVal to assess the service. The change in visitors and estimated change in value has been reported for each option using the ORVal online tool, where this service has been scoped-in for assessment. Where options have not resulted in the permanent loss of greenspace, these options have been scoped-out for assessment of this service.

2.4.8 Food Production

Food, in its various forms, is produced by a range of ecosystems. In some cases, the food for human consumption is provided directly as a benefit of the provisioning service (for example, wild fruit and fish). More often the provisioning service is a raw material (for example, wheat and other crops) that is harvested and processed by humans to produce an added-value product

[22] University of Exeter (2023). ORVal. Available at: https://www.exeter.ac.uk/research/leep/research/orval/ [Accessed August 2023]

(for example, bread). The boundary between what is provided by natural capital and the contribution of other forms of capital is often a grey area. For example, crops require agricultural management; livestock depends upon grassland ecosystems.

To calculate the quantitative impact on food production, the NEVO agricultural model has been used. NEVO is a structural model of agricultural land use and production for Great Britain using estimates from the Farm Business Survey (2005 – 2011) and June Agricultural Census data. The agricultural land use component in NEVO builds upon the approach developed by Fezzi et al. 2019[23].

NEVO has been used to assess the impact of the creation or removal of agricultural land for each option. The change in value of food provision for the footprint of each option has been calculated using this online tool and reported within the NCA metric, where this service has been scoped-in for assessment.

2.5 Price Uplifts

The monetary values used to calculate the quantitative impact on ecosystem services were adjusted using GDP deflators[24] to a consistent price reporting year of 2021, for reporting purposes after the original assessments fed into the investment model. A sensitivity analysis was conducted on these changes. As stated previously, it has been assumed that the BEIS price projections used to value the change in carbon sequestration potential have already been adjusted for inflation, and therefore price projections have not been adjusted.

2.6 Biodiversity Net Gain Assessment Methodology

The BNG requirement as outlined in the Guideline is that WRMPs should look to contribute to, and enhance, the natural environment by providing opportunities for biodiversity gain and enhancement.

For schemes undergoing the DCO process, paragraph 1.1.9 of the NPS states: 'Other matters that the Examining Authority and the Secretary of State may consider both important and relevant to its decision-making may include development plan documents or other documents in the Local Development Framework. In the event of a conflict between these or any other documents and a National Policy Statement, the National Policy Statement prevails for purposes of decision making given the national significance of the infrastructure'. The NPS section on BNG makes no reference to local authority requirements (only to 'any biodiversity statements published in respect of nationally significant infrastructure project'). As such, it is important to note that in the case where an LPA sets higher requirements than the mandatory 10%, it is not yet defined as to whether an increase beyond 10% is required for DCO schemes, as the Biodiversity Net Gain Statement for NSIPs is due to be published for consultation later this year.

The option assessments used The Biodiversity Metric Version 3.0, as stated in Section 2.4. At the time of producing the rdWRMP, The Biodiversity Metric Version 4.0 is the latest version of the metric and is the recommended approach to net gain assessments by Natural England. It is

[23] Fezzi, C., Bateman, I., Hadley, D. & Harwood, A. 2019. Natural Environment Valuation Online Tool – Chapter 1: Agriculture Model

[24] HM Treasury (2021). GDP deflators at market prices, and money GDP March 2021 (Budget). Available at: https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-march-2021-budget [Accessed August 2023]

anticipated that a future version of The Biodiversity Metric will be the version of the metric that will become statutory. However, to remain consistent with the guidance that was used for the investment model, the information within this report uses The Biodiversity Metric Version 3.0.

The SESRO and London Recycling SRO reporting also uses The Biodiversity Metric Version 3.0.

The Biodiversity Metric Version 3.0 presents significant improvements from previous versions of the metric for measuring and accounting for habitat losses and gains. Firstly, it encourages users to apply the Avoidance and Minimisation stage of the Mitigation Hierarchy to especially avoid and reduce clearance of 'very high' and 'high' distinctiveness habitats. The metric then builds in incentives for creating and enhancing both the right type and location of habitats of strategic value for local conservation priorities to help establish or improve ecological networks through rural and urban landscapes. By linking to current and future habitat plans and strategies, including the future Local Nature Recovery Strategies (LNRS), The Biodiversity Metric Version 3.0 incentivises habitat creation and enhancement in locations of locally strategic value for nature conservation. It also 'rewards' developers who create or enhance wildlife-rich habitats in advance of a development commencing, allowing them to generate more biodiversity units (BUs) from their land. Habitat condition assessment approaches have also been significantly updated and simplified for Metric 3.0 and some key changes made.

Option assessments have been updated in line with The Biodiversity Metric Version 3.0 for the purposes of reporting. In April 2022, The Biodiversity Metric Version 3.1 was released. Since the update in 2022, the metric was further superseded by The Biodiversity Metric Version 4.0, released in March 2023, after the input data had been prepared for the rdWRMP24 investment modelling. Thames Water have chosen to continue to use The Biodiversity Metric Version 3.0 for rdWRMP24 as this provides consistency with the version used by the SROs within the BNG assessments prepared for the Gate 2 reports. The Biodiversity Metric Version 3.0 is considered appropriate to inform Thames Water's rdWRMP24 decision-making process, this approach has been agreed with Natural England by WRSE on behalf of their constituent water companies.

The WRPG requires that biodiversity net gain or net loss must be considered at both the option and programme level and a biodiversity optimised programme suggested as part of wider environmental optimisation. Each option should seek to maximise BNG, and any required mitigation should be included in the option cost. The EA supplementary guidance[5] states that if there would be a significant additional cost for an option to get significant extra benefit, this could be included as a separate option for consideration.

A biodiversity baseline has been developed from spatial data sets of habitat inventories (see Table A-1) and assessed in line with The Biodiversity Metric Version 3.0. The natural capital account has been used to identify the biodiversity value of the footprint of each option prior to construction. The post-construction land use including proposed mitigation has been used to calculate the post-construction biodiversity score.

As this assessment has been carried out using only open-source data, a precautionary approach has been applied, whereby when not specifically known, habitat condition has been assigned the moderate habitat score, and the strategic significance is assumed to not within the local strategy. These assumptions have been applied for both the baseline post development

habitats. This is a suitable methodology for the strategic stage of planning that the WRMP represents.

2.7 Thames Water Biodiversity Net Gain Delivery Strategy

Thames Water commissioned a BNG Delivery Strategy, a key piece of work to enable a consistent and efficient delivery of BNG for TW projects and schemes involving land take. The strategy produced a companywide BNG strategy for TW, based on the British Standard BS 8683:2021, UK BNG Good Practice Principles and informed by the findings of the interviews and online surveys and regular discussion with TW. The BNG Strategy has focussed on looking at opportunities for gain to address the losses because of TW development, including that associated within the rdWRMP24, outlining an approach for preparation, design, construction, and management, and monitoring stages to ensure the delivery of BNG is embedded throughout the development process.

This piece of work has moved the discussion further than the BNG metric, which although important, the BNG design of wildlife-rich habitats is an equally important deliverable to plan for, especially to have early sight of whether there are suitable and sufficient locations on-site for BNG habitats, or whether off-site BNG delivery is required.

Section 6 identifies the steps TW is taking to meeting BNG requirements, detailing key guidance followed and its approach to its BNG Delivery Strategy, provided in Annex F.

2.8 Opportunities

The potential opportunities for the options to enhance natural capital and BNG were considered following the NCA and BNG assessments, utilising the data and results to inform on the most appropriate potential opportunities for enhancement of the options and wider benefits.

During the consenting of options, BNG assessments will be revisited, and mitigation or enhancement opportunities developed further to mitigate any biodiversity net losses. Additionally, where appropriate, options will aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG in line with statutory requirements for BNG (at the time of the project consenting), which would avoid a need to purchase BNG credits to achieve the mandatory level of net gain. As outlined in Section 1.2.2, this requirement will come into force in November 2023 for Town and Country Planning Applications and currently not enacted, but expected to be 2025 for options undergoing the DCO process, with the current government guidance stating it is ‘committed to legislate to introduce biodiversity net gain requirements for new nationally significant infrastructure projects in England’.

2.9 Stage 3: Reporting of Results

The changes in natural capital stocks have been reported for each plan in Section 4, with the detailed results of the ecosystem services screening and detailed assessment in Section 3. The natural capital metrics have been aggregated into a single metric that has been incorporated within the WRSE investment model. The impacts of each option against the individual natural capital metrics have also been reported to allow for further analysis and optimisation. The results for each option have been summarised in proforma that demonstrate the results of the assessment and the justification behind the assessment.

The results of the NCA and BNG assessments were used to inform option selection and feed into decision-making as part of the Best Value Planning process through the conversion of the results into metrics as described below:

- Natural capital metric: a single discrete monetised value reported in £/year generated by combining the outputs of each of the five monetised natural capital metrics to provide a single cost/benefit figure
- BNG metric: a single score for each option showing the net unit change (positive or negative) in BUs for each option according to the metric

Further to the above, the results of the NCA and BNG assessments have informed the selection of options for the Thames Water rdWRMP24. The results of the NCA and BNG assessments for the options identified in the BVP have been presented in Section 3. Following updates to the WRPG in 2023, Thames Water has estimated the cost per habitat unit to derive the wider costs associated with delivering 10% BNG as part of the rdWRMP24. The estimated change in habitat units resulting from each option have been presented in this report, while the estimated costs of delivering 10% BNG have been estimated separately.

2.10 Stage 4: Cumulative Effects Assessment

For NCA and BNG, the cumulative effects assessment considers the BVP and alternative plans. The cumulative intra-plan effects assessment for each plan considers the option assessments as a whole and the habitat units that would be required to be gained in order to achieve a 10% net gain in BNG. Section 1.3 identifies how the approach taken for combining the latest Gate 2 assessments for SRO schemes with those options that fed into the investment model.

This provides an estimate of the value of the potential mitigation or enhancement opportunities that will need to be developed further to achieve the 10% BNG required within the options. The plan aims to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG in line with statutory requirements for BNG (at the time of the project consenting) as stated as a mandatory requirement within the Environment Act 2021. Further details of how Thames Water plan to achieve this gain are available in the BNG Strategy in Annex F.

2.11 Assumptions and Limitations

The methodology for the NCA has been developed in line with Defra's ENCA guidance, as set out in Section 2.4, above. The methodology for calculating biodiversity net gain has been developed using The Biodiversity Metric Version 3.0, as set out in Section 2.6, above. The assumptions set out below in relation to these assessments have been developed to align with the stated guidance as far as possible and are considered to be reasonable and proportionate given the strategic nature of the WRMP. The following assumptions have been used within the NCA and BNG assessments in this report:

For NCAs:

- The costs for constructing, operating, and maintaining the options were not considered within the assessments.
- Natural capital stocks identified within the areas allocated for above ground infrastructure have been assumed to be completely lost as a result of the option construction.

- Natural capital stocks presumed temporarily lost are expected to be reinstated/ compensated.
- Natural Capital assessments assume a high level best practise mitigation as a standard.

For BNG assessments:

- No enhancement of biodiversity post-construction was considered, apart from where this has been explicitly included in the option description/design, for example as part of the SRO Gate 2 designs. BNG habitat units were assigned to the pre-construction land use according to the habitats present within each option boundary. The post-construction land use, including proposed mitigation, was used to calculate the post-construction biodiversity score.
- The desk-based assessment was carried out using open-source data. As such, a precautionary approach was applied, presuming that where not specifically known, habitats were assigned the moderate habitat score. Habitat identification will need to be refined with habitat survey data at later stages to refine the accuracy of the BNG calculations for each option.
- The desk-based assessment was carried out using open-source data. The baseline map does not include the location of hedgerows; therefore, hedgerow units have not been included at this stage for standard resource options – they have been considered for SRO options within the Gate 2 assessments which have been summarised within (and inform) this report. Habitat identification will need to be refined with habitat survey data at later stages of design to refine the accuracy of the BNG calculations for each option.
- The habitat Biodiversity Units (BU) fed into the investment model. River units have not been included at this stage. Habitat identification will need to be refined with habitat survey data at later stages of design to refine the accuracy of the BNG calculations for each option.
- BNG assessments assumes a high level best practise mitigation as a standard. This includes; retention of habitats with 'Any Loss Unacceptable'.
- The duration of disturbance and timeline for habitat creation has not been included in the assessment. Durations of disturbance, including proposals for creating habitats in advance of disturbance, will need to be defined with greater design detail at later stages to refine the accuracy of the BNG calculations for each option.
- Habitats are assumed to have a low/no strategic significance for the baseline and post development, this assumption is required due to the limitation of the open data used to capture this information.
- The BNG assessments cannot be certain whether trading rules can be met. This is particularly true for standard resource options which have not had a full mitigation approach applied.
- The BNG assessment has not considered 'additionality' due to the current stage of development i.e. any habitat creation required in connection with a protected species licence would not count towards 10% BNG.
- There is no inclusion of the riparian zone (within 10m of the watercourse) in the watercourse BNG assessments, as the open-source data does not provide enough granularity to identify the top of the riverbank for watercourses.
- Industry best practice for construction activities, including the use of directional drilling where possible, is assumed, based on expert judgement, to mitigate and avoid the majority of temporary adverse effects on identified watercourses.

- The open-source data used for watercourse assessments does not include canals, ditches, culverts, and primary habitat, hence there is the likelihood of underestimation of watercourse net gain or loss.

3 Feasible Options Outputs

This section displays the Natural Capital, Ecosystem Service and Biodiversity Net Gain outputs for all the feasible options considered within the latest run of the investment model.

Several assessments taken directly from the Gate 2 assessment process and has been directly copied to avoid creating an interpretation of results. These include London Recycling, SESRO and STT. These options have been reported in separate tables, but alongside other option results, to aid the comparison of options. These include:

- London Recycling summary findings have been taken directly from 'Annex B6: Biodiversity Net Gain, Natural Capital and Renewables Assessment Report, Standard Gate two submission for London Water Recycling SRO' Issue 1.2 13/10/2022[25].
- SESRO summary findings have been taken directly from both Technical Supporting Document B2 'Terrestrial Environmental Appraisal Report', Section 9 'Natural Capital' and Technical Supporting Document B6 'Biodiversity Net Gain Report'[26].
- STT summary findings have been taken directly from Strategic Regional Water Resource Solutions: Annex B3.8: Natural Capital and Biodiversity Net Gain (England) Assessment, Standard Gate Two Submission for River Severn to River Thames Transfer (STT) (November 2022)[27].

As mentioned in Section 1.3, T2ST was identified to have a comparable methodology and therefore is the only SRO option to follow a reporting approach with standard resource options.

3.1 Natural Capital

Table 3-1 identifies the predicted impacts on natural capital stocks for options fed into the investment model and T2ST. Tables 3-2 identifies the natural capital assessment for Teddington Direct River Abstraction (Indirect Water Recycling) (London Recycling). Tables 3-3 and 3-4 identifies the natural capital assessments for SESRO. Tables 3-5 and 3-6 identifies the natural capital assessments for STT.

Table 3-1: Predicted impacts on natural capital stocks for standard resource options and T2ST during and post-construction.

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Coppermills WTW - filtration pre-treatment 680Ml/d				
Active Flood Plain	0.16	0.00	0.00	-0.16
Woodmansterne to Epsom Downs				
Arable	2.83	0.00	2.83	0.00
Pastures	3.14	0.00	3.14	0.00

[25] Thames Water (2023). Water recycling (reuse) schemes in London. Available at: Water recycling (reuse) schemes in London | Thames Water [Accessed August 2023]
[26] Thames Water (2023). New reservoir in Abingdon. Available at: New reservoir in Abingdon | Water resources | Thames Water [Accessed August 2023]
[27] Thames Water (2022). Strategic Regional Water Resource Solutions: Annex B3.8: Natural Capital and Biodiversity Net Gain (England) Assessment. Available at: stt-g2-s3-118-natural-capital--biodiversity-net-gain-england-assessment.pdf (unitedutilities.com) [Accessed August 2023]

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Other Semi-Natural Grassland	1.43	0.00	1.43	0.00
Broadleaved, Mixed and Yew Woodland	0.35	0.00	0.35	0.00
Greenspace	2.46	0.00	2.46	0.00
Urban Semi Natural Habitat	1.07	0.00	1.07	0.00
Urban Woodland	0.3	0.00	0.3	0.00
TWRM extension – Hampton to Battersea – Construction				
Broadleaved, Mixed and Yew Woodland	0.13	0.00	0.00	0.00
Woodland Priority Habitat	0.05	0.00	0.05	0.00
Greenspace	0.32	0.00	0.00	-0.32
Urban Semi Natural Habitat	1.16	0.00	1.16	0.00
Urban Woodland	0.01	0.00	0.01	0.00
Active Flood Plain	0.03	0.00	0.00	-0.03
Kennet Valley to SWOX Transfer – 2.3Ml/d				
Coastal and Floodplain Grazing Marsh	0.61	0.00	0.61	0.00
Arable	8.96	0.00	7.15	-1.81
Pastures	7.65	0.00	7.04	-0.61
Broadleaved, Mixed and Yew Woodland	1.58	0.00	1.58	0.00
Ancient Woodland	1.13	1.13	1.13	0.00
Blue space	0.13	0.00	0.00	-0.13
Greenspace	0.02	0.00	0.02	0.00
Urban Woodland	0.18	0.00	0.18	0.00
Active Flood Plain	6.38	6.38	6.38	0.00
Kennet Valley to SWOX Transfer – 6.7Ml/d				
Coastal and Floodplain Grazing Marsh	0.61	0.00	0.61	0.00
Arable	8.96	0.00	7.15	-1.81
Pastures	7.65	0.00	7.04	-0.61
Broadleaved, Mixed and Yew Woodland	1.58	0.00	1.58	0.00
Ancient Woodland	1.13	1.13	1.13	0.00
Blue Space	0.13	0.00	0.00	-0.13
Greenspace	0.02	0.00	0.02	0.00
Urban Woodland	0.18	0.00	0.18	0.00
Active Floodplain	6.38	6.38	6.38	0.00
Oxford Canal to Duke's Cut (SWOX) – Construction				
Coastal and Floodplain Grazing Marsh	12.91	0.00	12.91	0.00
Lowland Fens	0.27	0.00	0.27	0.00
Arable	88.43	0.00	88.43	0.00
Pastures	81.17	0.00	81.17	0.00
Hay Meadows	0.07	0.00	0.07	0.00

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Other Semi-Natural Grassland	3.15	0.00	3.15	0.00
Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	21.15	0.00	21.15	0.00
Coniferous Woodland	0.07	0.00	0.07	0.00
Blue space	78.01	78.01	78.01	0.00
Greenspace	4.58	0.00	4.58	0.00
Urban Semi Natural Habitat	3.25	0.00	3.25	0.00
Urban Woodland	0.21	0.00	0.21	0.00
Lakes and Standing Waters	0.77	0.77	0.77	0.00
Rivers (Length)	47.43	47.43	47.43	0.00
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Ponds & Linear Features	62.05	62.05	62.05	0.00
Oxford Canal - Cropredy - Construction				
Coastal and Floodplain Grazing Marsh	0.03	0.00	0.03	0.00
Lowland Fens	0.01	0.00	0.01	0.00
Arable	82.17	0.00	82.17	0.00
Pastures	51.34	0.00	51.34	0.00
Hay Meadows	0.01	0.00	0.01	0.00
Other Semi-Natural Grassland	2.61	0.00	2.61	0.00
Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	14.40	0.00	14.40	0.00
Coniferous Woodland	0.00	0.00	0.00	0.00
Blue Space	75.79	75.79	75.79	0.00
Greenspace	3.89	0.00	3.89	0.00
Urban Semi Natural Habitat	2.17	0.00	2.17	0.00
Urban Woodland	1.04	0.00	1.04	0.00
Rivers (Length)	16.25	16.25	16.25	0.00
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Ponds & Linear Features	57.97	57.97	57.97	0.00
Oxford Canal – Transfer from Duke's Cut to Farmoor				
Coastal and Floodplain Grazing Marsh	6.72	0.00	6.72	0.00
Arable	8.40	0.00	8.40	0.00
Pastures	4.6	0.00	4.6	0.00
Hay Meadows	0.69	0.00	0.69	0.00
Active Flood Plain	11.95	11.95	11.95	0.00

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Ponds & Linear Features	0.06	0.06	0.06	0.00
Thames Lee Tunnel (TLT) extension from Lockwood PS to KGV Reservoir intake				
Broadleaved, Mixed and Yew Woodland	0.29	0.00	0.29	0.00
Woodland Priority Habitat	0.44	0.44	0.44	0.00
Greenspace	1.40	0.00	1.40	0.00
Urban Woodland	0.01	0.01	0.01	0.00
Active Flood Plain	5.88	5.88	5.88	0.00
Rivers (Length)	0.90	0.90	0.90	0.00
Ponds & Linear Features	0.09	0.09	0.09	0.00
Henley to SWOX Transfer– 2.4Ml/d				
Arable	0.63	0.00	0.63	0.00
Pastures	5.48	0.00	4.56	-0.92
Other Semi-Natural Grassland	0.03	0.03	0.03	0.00
Broadleaved, Mixed and Yew Woodland	3.54	0.00	3.54	0.00
Coniferous Woodland	0.04	0.00	0.04	0.00
Ancient Woodland	1.56	1.56	1.56	0.00
Urban Woodland	0.22	0.00	0.22	0.00
Henley to SWOX Transfer – 5Ml/d				
Arable	0.48	0.00	0.48	0.00
Pastures	7.81	0.00	7.81	0.00
Other Semi-Natural Grassland	0.01	0.00	0.01	0.00
Broadleaved, Mixed and Yew Woodland	0.48	0.00	0.48	0.00
Woodland Priority Habitat	2.84	0.00	2.84	0.00
Coniferous Woodland	0.19	0.00	0.19	0.00
Ancient Woodland	1.06	1.06	1.06	0.00
Greenspace	0.13	0.00	0.13	0.00
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastures	2.28	0.00	2.28	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active Flood Plain	1.20	1.20	1.20	0.00
Groundwater Development - Southfleet & Greenhithe				
Arable	5.68	0.00	5.68	0.00
Pastures	2.43	0.00	2.43	0.00
Broadleaved, Mixed and Yew Woodland	1.04	0.00	1.04	0.00
Ponds & Linear Features	0.02	0.02	0.02	0.00
Groundwater Development - Woods Farm Existing Source Increase DO				
Arable	3.28	0.00	3.28	0.00

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Pastures	2.48	0.00	2.48	0.00
Broadleaved, Mixed and Yew Woodland	0.71	0.00	0.71	0.00
Ancient Woodland	0.20	0.20	0.20	0.00
Active Flood Plain	0.33	0.33	0.33	0.00
SouthEast Water to Guildford				
Arable	12.56	0.00	11.96	-0.60
Pastoral	2.93	0.00	2.93	0.00
Other Semi-Natural Grassland	4.36	0.00	4.36	0.00
Broadleaved, Mixed and Yew Woodland	3.43	0.00	3.43	0.00
Coniferous Woodland	2.79	0.00	2.79	0.00
Blue Space	0.06	0.06	0.06	0.00
Greenspace	0.33	0.00	0.33	0.00
Urban Woodland	2.54	0.00	2.54	0.00
New WTW at Kempton - 100Ml/d - Construction				
Broadleaved, Mixed and Yew Woodland	0.11	0.00	0.11	0.00
Woodland Priority Habitat	0.80	0.00	0.80	0.00
Active Flood Plain	3.12	0.00	3.12	0.00
Rivers (Length)	0.38	0.00	0.38	0.00
Transfer from WTW in Abingdon to SWA - 48Ml/d				
Coastal and Floodplain Grazing Marsh	5.33	0.00	5.33	0.00
Arable	53.51	0.00	52.07	-1.44
Pastures	40.08	0.00	37.20	-2.88
Hay Meadows	0.43	0.00	0.43	0.00
Other Semi-Natural Grassland	0.56	0.00	0.56	0.00
Broadleaved, Mixed and Yew Woodland	0.89	0.00	0.89	0.00
Coniferous Woodland	0.05	0.00	0.05	0.00
Ancient Woodland	0.00	0.00	0.00	0.00
Active Flood Plain	19.62	19.62	19.62	0.00
Ponds & Linear Features	0.07	0.07	0.07	0.00
Transfer from WTW in Abingdon to SWA - 72Ml/d				
Costal and Floodplain Grazing Marsh	5.33	0.00	5.33	0.00
Arable	53.67	0.00	51.69	-1.98
Pastures	40.88	0.00	37.16	-3.72
Hay Meadows	0.43	0.00	0.43	0.00
Other Semi-Natural Grassland	0.56	0.00	0.43	0.00
Broadleaved, Mixed and Yew Woodland	0.89	0.00	0.89	0.00

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Coniferous Woodland	0.05	0.00	0.05	0.00
Active Flood Plain	19.60	19.60	19.60	0.00
Ponds & Linear Features	0.07	0.07	0.07	0.00
River Thames to Fobney Transfer				
Coastal and Floodplain Grazing Marsh	1.55	0.00	1.55	0.00
Woodland Priority Habitat	0.01	0.00	0.01	0.00
Greenspace	1.27	0.00	1.27	0.00
Urban Woodland	0.03	0.00	0.03	0.00
Active Flood Plain	4.66	4.66	4.66	0.00
Rivers (Length)	43.76	43.76	43.76	0.00
Ponds & Linear Features	0.03	0.03	0.03	0.00
Abingdon Reservoir to Farmoor Reservoir pipeline				
Coastal and Floodplain Grazing Marsh	2.29	0.00	2.29	0.00
Arable	10.51	0.00	10.51	0.00
Pastures	16.47	0.00	16.47	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Broadleaved, Mixed and Yew Woodland	0.51	0.00	0.51	0.00
Coniferous Woodland	0.22	0.00	0.22	0.00
Active Flood Plain	4.51	4.51	4.51	0.00
Ponds & Linear Features	0.01	0.01	0.01	0.00
Deephams Water Recycling – 46.5Ml/d, direct to KGV / 46.5Ml/d, to TLT				
Broadleaved, Mixed and Yew Woodland	1.19	0.00	1.19	0.00
Active Flood Plain	0.35	0.35	0.35	0.00
Ponds & Linear Features	0.03	0.03	0.03	0.00
Transfer – Reigate (SES) to Guildford 5Ml/d or 20Ml/d				
Arable	11.12	0.00		
Pastures	33.25	0.00	33.25	0.00
Broadleaved, Mixed and Yew Woodland	2.03	0.00	2.03	0.00
Coniferous Woodland	0.02	0.00	0.02	0.00
Ancient Woodland	0.01	0.01	0.01	0.00
Blue Space	0.09	0.09	0.09	0.00
Greenspace	0.59	0.00	0.59	0.00
Urban Woodland	0.20	0.00	0.20	0.00
Active Flood Plain	1.12	1.12	1.12	0.00
Ponds & Linear Features	0.05	0.05	0.05	0.00
Crossness Desalination (Blended) – 100Ml/d Enhancement				

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	8.18	0.00	8.18	0.00
Broadleaved, Mixed and Yew Woodland	0.27	0.00	0.27	0.00
Ponds & Linear Features	0.04	0.00	0.00	-0.04
Managed Aquifer Recharge - Thames Valley, South London				
Broadleaved, Mixed and Yew Woodland	2.03	0.00	2.03	0.00
Blue Space	1.07	1.07	1.07	0.00
Urban Woodland	0.52	0.00	0.52	0.00
Ponds & Linear Features	0.07	0.07	0.07	0.00
Surbiton intake capacity increase with transfer to Walton inlet channel - Construction				
Broadleaved, Mixed and Yew Woodland	0.08	0.00	0.08	0.00
Blue Space	0.05	0.05	0.05	0.00
Greenspace	1.15	0.00	1.15	0.00
Active Flood Plain	1.14	1.14	1.14	0.00
Ponds & Linear Features	0.01	0.01	0.01	0.00
New Reservoir - Marsh Gibbon 75Mm^3 - Construction				
Coastal and Floodplain Grazing Marsh	2.09	0.00	2.06	-0.03
Arable	434.84	0.00	397.90	-36.94
Pastures	192.39	0.00	23.25	-169.14
Orchards and Top Fruit	0.08	0.00	0.00	-0.08
Hay Meadows	2.65	0.00	2.65	0.00
Other Semi-Natural Grassland	4.85	0.00	1.46	-3.39
Broadleaved, Mixed and Yew Woodland	4.85	0.00	4.85	0.00
Ancient Woodland	0.37	0.37	0.37	0.00
Urban Woodland	0.42	0.00	0.42	0.00
Active Floodplain	148.01	12.00	12.04	-135.97
Modified Waters (Reservoirs)	0.00	0.00	882.00	882.00
Ponds & Linear Features	0.32	0.12	0.12	-0.20
New Reservoir - Marsh Gibbon 50Mm^3 - Construction				
Coastal and Floodplain Grazing Marsh	16.77	0.00	16.77	0.00
Arable	424.48	0.00	0.00	-424.48
Pastures	241.19	0.00	0.00	-214.19
Hay Meadows	7.47	0.00	7.47	0.00
Other Semi-Natural Grassland	8.41	0.00	0.00	-8.41

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Broadleaved, Mixed and Yew Woodland	2.85	0.00	2.85	0.00
Active Flood Plain	194.25	0.00	0.00	-194.25
Modified Waters (Reservoirs)	0.00	0.00	707.40	707.40
Ponds & Linear Features	0.58	0.00	0.00	-0.58
New Reservoir - Marsh Gibbon 30Mm^3 - Construction				
Arable	355.08	0.00	0.00	-355.08
Pastures	81.39	0.00	0.00	-81.39
Hay Meadows	1.65	0.00	1.65	0.00
Other Semi-Natural Grassland	9.09	0.00	0.00	-9.09
Broadleaved, Mixed and Yew Woodland	0.98	0.00	0.98	0.00
Active Flood Plain	74.05	0.00	0.00	-74.05
Modified Waters (Reservoirs)	0.00	0.00	448.19	448.19
Ponds & Linear Features	0.23	0.00	0.00	-0.23
New Medmenham Surface Water WTW Ph1 - Construction				
Arable	10.75	0.00	9.82	-0.93
Pastures	6.74	0.00	4.2	-2.54
Broadleaved, Mixed and Yew Woodland	0.18	0.00	0.18	0.00
Coniferous Woodland	0.01	0.00	0.01	0.00
Ancient Woodland	0.001	0.001	0.001	0.00
Henley to SWA Transfer- 2.4Ml/d				
Arable	15.96	0.00	15.96	0.00
Pastures	4.57	0.00	4.57	0.00
Broadleaved, Mixed and Yew Woodland	0.65	0.00	0.65	0.00
Coniferous Woodland	0.05	0.00	0.00	-0.05
Ancient Woodland	0.05	0.05	0.05	0.00
Urban Woodland	0.02	0.00	0.02	0.00
Active Flood Plain	1.70	1.70	1.70	0.00
Henley to SWA Transfer – 5Ml/d				
Arable	15.96	0.00	15.02	-0.94
Pastures	4.57	0.00	4.34	-0.23
Broadleaved, Mixed and Yew Woodland	0.65	0.00	0.65	0.00
Coniferous Woodland	0.05	0.00	0.05	0.00
Ancient Woodland	0.05	0.05	0.05	0.00
Urban Woodland	0.02	0.00	0.02	0.00
Active Flood Plain	1.70	1.70	1.70	0.00
New Medmenham Surface Water Intake - 53 Ml/d				
Arable	1.60	0.00	1.36	-0.24
Pastures	0.52	0.00	0.52	0.00
Active Flood Plain	0.44	0.44	0.44	0.00

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
New WTW - Radcot				
Coastal and Floodplain Grazing Marsh	0.28	0.00	0.28	0.00
Arable	24.35	0.00	21.01	-3.34
Pastures	12.50	0.00	12.50	0.00
Other Semi-Natural Grassland	0.01	0.00	0.01	0.00
Broadleaved, Mixed and Yew Woodland	0.02	0.00	0.02	0.00
Coniferous Woodland	0.05	0.00	0.05	0.00
Active Flood Plain	4.78	4.78	4.78	0.00
Ponds & Linear Features	0.01	0.01	0.01	0.00
Additional conveyance from Queen Mary Reservoir to Kempton WTW - Construction				
Pastures	3.37	0.00	3.37	0.00
Other Semi-Natural Grassland	0.04	0.00	0.04	0.00
Broadleaved, Mixed and Yew Woodland	0.78	0.00	0.78	0.00
Blue Space	0.01	0.01	0.01	0.00
Urban Woodland	0.25	0.00	0.25	0.00
Modified Water (Reservoirs)	0.02	0.02	0.02	0.00
Ponds & Linear Features	0.04	0.04	0.04	0.00
New Reservoir - Chinnor 30Mm³ - Construction				
Arable	271.34	0.00	1.41	-269.93
Pastures	191.69	0.00	8.81	-182.88
Orchards and Top Fruit	0.20	0.00	0.00	-0.20
Hay Meadows	12.91	0.00	12.91	0.00
Other Semi-Natural Woodland	4.89	0.00	0.46	-4.43
Broadleaved, Mixed and Yew Woodland	25.47	0.00	25.47	0.00
Active Flood Plain	148.45	1.00	1.00	-147.45
Modified Waters (Reservoirs)	0.00	0.00	578.00	578.00
Ponds & Linear Features	1.32	0.00	0.00	-1.32
STTSESRO Link				
Arable	3.15	0.00	3.15	0.00
Active Flood Plain	1.22	1.22	1.22	0.00
T2ST Full Scheme				
Coastal and Floodplain Grazing Marsh	5.18	0.00	5.18	0.00
Lowland Fens	0.11	0.00	0.11	0.00
Arable	625.59	0.00	580.81	-44.78
Pastures	118.63	0.00	117.08	-1.56

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Other Semi-Natural Grassland	14.34	0.00	13.01	-1.33
Broadleaved, Mixed and Yew Woodland	0.84	0.00	0.84	0.00
Woodland Priority Habitat	8.87	0.00	8.87	0.00
Coniferous Woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.07	0.00	0.07	0.00
Active Flood Plain	14.08	6.43	6.43	-7.66
Rivers (length)	0.55	0.55	0.55	0.00
Ponds & linear features	0.14	0.14	0.14	0.00

Teddington Direct River Abstraction (Indirect Water Recycling) NCA

Table 3-2: Predicted temporary and permanent impacts on natural capital stocks for the Teddington Direct River Abstraction (Indirect Water Recycling) scheme.

Broad Habitat	Temporary habitat lost during construction (ha)	Permanent habitat loss (ha)	On-site reinstatement /creation (ha)	Off-site enhancement baseline (ha)	Off-site enhancement proposed new habitat (ha)
Arable land	-1.41	-0.06	1.41	12.65	0.00
Freshwater	-0.02	-0.01	0.02	0.00	0.00
Semi-natural grassland	-0.26	-0.17	0.26	4.00	7.65
Heathland and shrub	0.00	-0.01	0.00	0.00	0.00
Marine	0.00	0.00	0.00	0.00	0.00
Urban	-3.07	-1.62	5.01	0.00	0.00
Woodland (coniferous)	0.00	0.00	0.00	0.00	0.00
Woodland (deciduous)	-0.38	-0.07	0.38	0.00	9.00
Wetlands	0.00	0.00	0.00	0.00	0.00

SESRO NCA

Table 3-3: Change in landcover associated with the SESRO options (150Mm^3 and 75Mm^3)

Natural capital asset	150Mm^3 (ha)				75Mm^3 (ha)			
	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change
Arable and horticulture	1381.87	10.44	80.36	-1291.07	1179.08	0.00	84.92	-1094.17
Built-up areas and gardens	146.24	6.75	0.00	-139.49	146.24	0.00	0.00	-146.24
Canal	0.23	0.00	35.07	34.84	0.00	0.00	0.00	0.00

Eutrophic standing waters	4.05	1.94	10.58	8.47	2.72	2.01	11.20	10.49
Floodplain Wetland Mosaic	0.00	0.00	127.58	127.58	0.00	0.00	134.83	134.83
Lowland mixed deciduous woodland	62.39	17.28	14.94	-30.17	52.25	17.96	0.00	-34.28
Mixed scrub	7.54	1.37	24.66	18.49	7.36	0.00	6.82	-0.55
Modified grassland	40.01	3.73	1.97	-34.31	29.58	0.00	2.11	-27.47
Other inland rock and scree	1.18	0.00	0.00	-1.18	1.18	0.00	0.00	-1.18
Other neutral grassland	72.23	5.32	695.12	628.21	72.4	0.00	736.11	663.74
Other rivers and streams	6.18	0.62	0.00	-5.56	5.64	0.00	0.0	-5.64
Other woodland mixed	2.35	1.20	0.00	-1.15	2.35	1.27	15.85	14.77
Standing open water and canals	0.75	0.75	653.38	653.38	0.75	0.00	391.81	391.06
Wet woodland	0.00	0.00	21.54	21.54	0.00	0.00	22.76	22.76

Table 3-4: Change in linear natural capital assets associated with the SESRO options (150Mm^3 and 75Mm^3)

Natural Capital Asset	150Mm^3 (km)				75Mm^3 (km)			
	Baseline	Retained	Created	Change	Baseline	Retained	Created	Change
Hedgerows	57.72	8.00	0.00	-49.72	50.28	8.45	0.00	-41.82
Line of trees	32.02	8.00	0.00	-24.02	30.06	8.45	0.00	-21.61
Hedgerows with trees	10.16	0.00	0.00	-10.16	10.16	0.00	0.00	-10.16
Native species-rich hedgerow with trees	0.00	0.00	42.20	42.20	0.00	0.00	44.59	44.59

STT NCA

Table 3-5: Predicted temporary and permanent impacts on natural capital stocks for STT (Terrestrial and Hedgerow)

Natural capital asset	Area (ha)			
	Temporary Habitat Loss	Temporary Habitat Loss Condition	Permanent Habitat Loss	Permanent Habitat Loss Condition
Cereal crops	3.2	N/A -Agricultural	-	-
Intensive orchards	0.01	N/A -Agricultural	-	-
Non-cereal crops	223.55	N/A -Agricultural	-	-
Floodplain Wetland Mosaic	3.27	Moderate	-	-

Natural capital asset	Area (ha)			
	Temporary Habitat Loss	Temporary Habitat Loss Condition	Permanent Habitat Loss	Permanent Habitat Loss Condition
Lowland calcareous grassland	0.22	Moderate	-	-
Modified grassland	0.15	Good	-	-
Modified grassland	135.17	Moderate	9.05	Moderate
Modified grassland	8.82	Poor	-	-
Other neutral grassland	9.4	Moderate	-	-
Other neutral grassland	5.07	Poor	-	-
Traditional orchards	0.1	Moderate	-	-
Ruderal/Ephemeral	0.38	Moderate	-	-
Artificial unvegetated, unsealed surface	0.28	N/A - Other	-	-
Built linear features	0.06	N/A - Other	-	-
Developed land; sealed surface	0.23	N/A - Other	-	-
Felled	0.1	Good	-	-
Other coniferous woodland	0.03	Moderate	-	-
Other woodland; broadleaved	0.06	Good	-	-
Other woodland; broadleaved	1.03	Moderate	-	-
Other woodland; mixed	0.09	Moderate	-	-

Table 3-6: Predicted temporary and permanent impacts on natural capital stocks for STT (Rivers)

Natural capital asset	Length (km)			
	Temporary Hedgerow Loss	Temporary Hedgerow Loss Condition	Permanent Hedgerow Loss	Permanent Hedgerow Loss Condition
Native species rich hedgerow	8.12	Moderate	-	-

3.2 Ecosystem Services

Table 3-7 and 3-8 identifies the ecosystem services assessment results for options that fed into the investment model and T2ST. Tables 3-9, Table 3-10 and Table 3-11 identifies the ecosystem service assessment results for Teddington Direct River Abstraction (Indirect Water Recycling), SESRO, and STT, respectively.

Table 3-7: Monetised assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Woodmansterne WTW to Epsom Downs					
Carbon storage	£2,118.47	£0.00	-£2,118.47	£1,822.07	-£296.40

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Natural hazard regulation	£62.31	£0.00	-£62.31	£46.73	-£15.58
Total	£2,180.78	£0.00	-£2,180.78	£1,868.80	-£311.98
TWRM extension – Hampton to Battersea – Construction					
Carbon storage	£515.57	£0.00	-£515.57	£428.93	-£86.64
Natural hazard regulation	£18.21	£0.00	-£18.21	£13.66	-£4.55
Air pollutant removal	£267.26	£0.00	-£267.26	£251.85	-£15.41
Recreation & amenity value	£76,220.98	£0.00	-£68,023.00	£0.00	-£76,220.98
Total	£77,022.02	£0.00	-£68,824.04	£694.44	-£76,327.58
Kennet Valley to Swindon and Oxfordshire (SWOX) – 2.3Ml/d					
Carbon storage	£6,737.78	£2,061.11	-£4,676.67	£5,775.27	-£962.51
Natural hazard regulation	£277.04	£108.32	-£168.71	£234.86	-£42.18
Food production	£2,272,149.99	£2,271,286.58	-£863.42	£2,271,286.58	-£863.42
Total	£2,279,164.81	£2,459,718.20	-£180,553.39	£2,277,296.70	-£1,802.69
Kennet Valley to SWOX Transfer – 6.7Ml/d					
Carbon storage	£6,737.78	£2,061.11	-£4,676.67	£5,775.27	-£962.51
Natural hazard regulation	£277.04	£108.32	-£168.71	£234.86	-£42.18
Food production	£2,272,149.99	£2,271,286.58	-£863.42	£2,271,286.58	-£863.42
Total	£2,279,164.81	£2,459,718.20	-£180,553.39	£2,277,296.70	-£1,802.69
Oxford Canal to Duke's Cut (SWOX) – Construction					
Carbon storage	£55,527.28	£0.00	-£55,527.28	£45,705.86	-£9,821.42
Air pollutant removal	£8,426.74	£0.00	-£8,426.74	£6,832.39	-£1,594.35
Total	£63,954.02	£0.00	-£63,954.02	£52,538.25	-£11,415.76
Oxford Canal – Cropredy					
Carbon storage	£39,572.34	£0.00	-£39,572.34	£32,530.25	-£7,042.09
Air pollutant removal	£6,908.68	£0.00	-£6,908.68	£5,620.10	-£1,288.58
Total	£46,481.02	£0.00	-£46,481.02	£38,150.35	-£8,330.67
Oxford Canal - Transfer from Duke's Cut to Farmoor					
Carbon storage	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Total	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intake					
Carbon storage	£1,349.75	£1,349.75	£0.00	£1,012.31	-£337.44
Natural hazard regulation	£65.64	£39.94	-£25.69	£49.23	-£16.41
Air pollutant removal	£221.94	£137.41	-£84.52	£166.45	-£55.48

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Total	£1,637.33	£1,527.11	-£110.22	£1,228.00	-£409.33
Henley to SWOX Transfer– 2.4Ml/d					
Carbon storage	£10,717.02	£2,849.80	-£7,867.22	£8,821.96	-£1,895.06
Food production	£293,756.53	£293,216.63	-£539.91	£293,216.63	-£539.91
Total	£304,473.55	£296,066.43	-£8,407.13	£302,038.59	-£2,434.97
Henley to SWOX Transfer– 5Ml/d					
Carbon storage	£10,030.07	£1,933.43	-£8,096.64	£8,295.47	-£1,734.61
Natural hazard regulation	£483.08	£101.61	-£336.47	£353.96	-£84.12
Air pollutant removal	£1,339.97	£308.95	-£1,031.02	£1,006.98	-£332.99
Total	£11,853.12	£2,343.99	-£9,464.13	£9,656.41	-£2,151.72
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard regulation	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air pollutant removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41
Groundwater Development - Southfleet & Greenhithe					
Carbon storage	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Total	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Groundwater Development - Woods Farm Existing Source Increase DO					
Carbon storage	£2,149.97	£364.80	-£1,785.17	£1,826.21	-£323.76
Natural hazard regulation	£87.23	£19.71	-£68.06	£70.22	-£17.02
Total	£2,237.20	£383.97	-£1,853.23	£1,896.43	-£340.77
SouthEast Water to Guildford					
Carbon storage	£13,270.66	£0.00	-£13,270.66	£10,410.79	-£2,859.87
Natural hazard management	£596.25	£0.00	-£596.25	£447.19	-£149.06
Air pollutant removal	£4,430.71	£0.00	-£4,430.71	£3,477.91	-£952.80
Food production	£311,200.00	£311,011.00	-£189.00	£311,011.00	-£189.00
Total	£329,497.62	£311,011.00	-£18,486.62	£325,346.89	-£4,150.73
New WTW at Kempton 100Ml/d					
Carbon storage	£1,659.83	£0.00	-£1,659.83	£1,244.87	-£414.96
Natural hazard management	£87.23	£0.00	-£87.23	£65.42	-£21.81
Air pollutant removal	£265.23	£0.00	-£265.23	£198.92	-£66.31
Total	£2,012.29	£0.00	-£2,012.29	£1,509.22	-£503.07

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
SWOX WRZ to SWA (Slough, Wycombe and Aylesbury) WRZ (Abingdon WTW to Long Crendon to supply SWA)					
Carbon storage	£9,799.18	£0.00	-£9,799.18	£8,894.48	-£904.71
Food production	£4,600,000.00	£4,598,900.00	-£1,100.00	£4,598,900.00	-£1,100.00
Total	£4,609,799.18	£4,598,900.00	-£10,899.18	£4,607,794.48	-£2,004.71
Transfer from WTW in Abingdon to SWA - 72Ml/d					
Carbon storage	£10,063.65	£0.00	-£10,063.65	£8,979.98	-£1,083.67
Natural hazard regulation	£90.11	£0.00	-£90.11	£67.58	-£22.53
Food production	£4,977,090.46	£4,975,142.90	-£1,947.56	£4,975,142.90	-£1,947.56
Total	£4,987,244.22	£4,975,142.90	-£12,101.31	£4,984,190.46	-£3,053.75
River Thames to Fobney Transfer					
Carbon storage	£71.54	£0.00	-£71.54	£53.66	-£17.89
Natural hazard regulation	£3.76	£0.00	-£3.76	£2.82	-£0.94
Air pollutant removal	£29.57	£0.00	-£29.57	£22.18	-£7.39
Total	£104.88	£0.00	-£104.88	£78.66	-£26.22
Abingdon Reservoir to Farmoor Reservoir Pipeline					
Carbon storage	£4,158.46	£0.00	-£4,158.46	£3,825.58	-£332.88
Natural hazard regulation	£115.16	£0.00	-£155.16	£86.37	-£28.79
Total	£4,273.63	£0.00	-£4,273.63	£3,911.96	-£361.67
Deephams Reuse – 46.5 Ml/d, direct to KGV					
Carbon storage	£2,170.55	£0.00	-£2,170.55	£1,627.91	-£542.64
Natural hazard regulation	£114.07	£0.00	-£114.07	£85.56	-£28.52
Air pollutant removal	£346.84	£0.00	-£346.84	£260.13	-£86.71
Total	£2,631.46	£0.00	-£2,631.46	£1,973.59	-£657.86
Transfer - Reigate (SES) to Guildford 5Ml/d or 20Ml/d					
Carbon storage	£9,459.83	£18.24	-£9,441.59	£8,419.72	-£1,040.11
Natural hazard regulation	£216.64	£0.96	-£215.69	£162.72	-£53.92
Total	£9,676.47	£19.20	-£9,657.28	£8,582.44	-£1,094.03
Crossness Desalination (Blended)					
Carbon storage	£492.48	£0.00	-£492.48	£369.36	-£123.12
Air pollutant removal	£78.69	£0.00	-£78.69	£59.02	-£19.67
Total	£571.17	£0.00	-£571.17	£428.38	-£142.79
Managed Aquifer Recharge - Thames Valley, South London					

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£4,645.70	£0.00	-£4,645.70	£3,484.28	-£1,161.43
Air pollutant removal	£1,067.74	£0.00	-£1,067.74	£800.81	-£266.94
Total	£5,713.45	£0.00	-£5,713.45	£4,285.08	-£1,428.36
Surbiton intake capacity increase with transfer to Walton inlet channel					
Carbon storage	£145.92	£0.00	-£145.92	£109.44	-£36.48
Natural hazard regulation	£7.67	£0.00	-£7.67	£5.75	-£1.92
Total	£153.59	£0.00	-£153.59	£115.19	-£38.40
New Reservoir - Marsh Gibbon 75Mm3 - Construction					
Carbon storage	£56,486.81	£0.00	-£56,486.81	£26,820.78	-£29,666.03
Natural hazard regulation	£540.65	£0.00	-£540.65	£378.89	-£161.76
Food production	£457,026.74	£384,858.93	-£72,167.81	£384,858.93	-£72,167.81
Total	£514,054.20	£384,858.93	-£129,195.27	£412,058.60	-£101,995.60
New Reservoir - Marsh Gibbon 50Mm^3 - Construction					
Carbon storage	£59,322.12	£0.00	-£59,322.12	£4,987.15	-£54,334.97
Natural hazard regulation	£273.20	£0.00	-£273.20	£204.90	-£68.30
Food production	£457,026.74	£225,159.24	-£231,867.50	£225,159.24	-£231,867.50
Total	£516,622.06	£225.159.24	-£291,462.82	£230,351.30	-£286,270.77
New Reservoir - Marsh Gibbon 30Mm^3 - Construction					
Carbon storage	£29,154.40	£0.00	-£29,154.40	£1,581.04	-£27,573.36
Natural hazard regulation	£93.94	£0.00	-£93.94	£70.46	-£23.49
Food production	£457,026.74	£304,792.69	-£152,234.05	£304,792.69	-£152,234.05
Total	£486,275.08	£304,792.69	-£181,482.39	£306,444.19	-£179,830.89
New Medmenham Surface Water WTW Ph1 - Construction					
Carbon storage	£1,780.76	£1.82	-£1,778.93	£1,280.47	-£500.29
Natural hazard regulation	£18.31	£0.10	-£18.21	£13.76	-£4.55
Food production	£1,622,964.28	£1,754,602.14	£131,637.85	£1,621,557.71	-£1,406.57
Total	£1,624,763.35	£1,754,604.06	£129,840.71	£1,622,851.93	-£1,911.41
Henley to SWA Transfer – 2.4Ml/d					
Carbon storage	£2,838.16	£91.20	-£2,746.96	£2,229.91	-£608.25
Natural hazard regulation	£73.81	£4.79	-£69.02	£52.96	-£20.85
Food production	£1,947,557.14	£2,106,799.29	£159,242.16	£2,279,506.67	£331,949.53
Total	£1,950,469.11	£2,106,895.28	£156,426.18	£2,281,789.54	£331,320.43

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Henley to SWA Transfer – 5Ml/d					
Carbon storage	£2,838.16	£91.20	-£2,746.96	£2,229.91	-£608.25
Natural hazard regulation	£73.81	£4.79	-£69.02	£52.96	-£20.85
Food production	£1,947,557.14	£2,106,799.29	£159,242.16	£2,279,506.67	£331,949.53
Total	£1,950,469.11	£2,106,895.28	£156,426.18	£2,281,789.54	£331,320.43
New Medmenham Surface Water Intake - 53 Ml/d					
Carbon storage	£138.59	£0.00	-£138.59	£129.17	-£9.42
Food production	£1,622,964.28	£1,622,879.89	-£84.39	£1,622,879.89	-£84.39
Total	£1,623,102.87	£1,622,879.89	-£222.99	£1,623,009.06	-£93.82
New WTW -Radcot					
Carbon storage	£3,047.69	£0.00	-£3,047.69	£2,849.33	-£189.36
Natural hazard regulation	£6.71	£0.00	-£6.71	£5.03	-£1.68
Food production	£980,054.03	£978,863.86	-£1,190.17	£978,863.86	-£1,190.17
Total	£983,108.43	£978,863.86	-£4,244.57	£981,718.22	-£1,390.21
Additional conveyance from Queen Mary Reservoir to Kempton WTW					
Carbon storage	£2,375.54	£0.00	-£2,375.54	£1,905.87	-£469.68
Natural hazard regulation	£98.74	£0.00	-£98.74	£74.05	-£24.68
Air pollutant removal	£456.64	£0.00	-£456.64	£342.48	-£114.16
Total	£2,930.92	£0.00	-£2,930.92	£2,322.40	-£608.52
New Reservoir - Chinnor 30Mm^3 - Construction					
Carbon storage	£87,634.76	£0.00	-£87,634.76	£38,129.74	-£49,505.02
Natural hazard regulation	£2,441.55	£0.00	-£2,441.55	£1,831.17	-£610.39
Food production	£1,190,173.81	£1,041,834.87	-£148,338.94	£1,041,834.87	-£148,338.94
Total	£1,280,250.12	£1,041,834.87	-£238,415.25	£1,081,795.78	-£198,454.34
STT-SESRO Link					
Carbon storage	£123.70	£0.00	-£123.70	£123.70	£0.00
Air pollutant removal	£52.48	£0.00	-£52.48	£52.48	£0.00
Total	£176.18	£0.00	-£176.18	£176.18	£0.00
T2ST Full Scheme					
Carbon storage	£62,907.62	£0.00	-£62,907.62	£55,974.02	-£6,933.59
Natural hazard regulation	£957.06	£0.00	-£957.06	£717.11	-£239.95
Food production	£821,436.32	£810,724.76	-£10,711.56	£810,724.76	-£10,711.56
Total	£885,300.99	£810,724.76	-£74,576.24	£867,415.89	-£17,885.11

Note: The ecosystem services only scoped in for detailed quantified assessment are summarised in Table 3-7 above. Justification for ecosystem services scoped out of assessment are:

- Carbon sequestration is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks.
- Natural hazard management is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an active floodplain.
- Air pollutant removal is scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an AQMA or urban area.
- Recreation & amenity value is scoped out when the option does not cause the permanent loss of greenspace.
- Food production is scoped out when the option does not cause the permanent loss of arable and pastoral land.

Table 3-8: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
• Oxford Canal – Duke's Cut (SWOX) – Construction • Oxford Canal - Transfer from Duke's Cut to Farmoor • Manager Aquifer Recharge - Horton Kirby ASR • Abingdon Reservoir to Farmoor Reservoir pipeline • Transfer - Woodmansterne to Epsom - Resource Element • Oxford Canal – Cropredy – Construction • SouthEast Water to Guildford • New WTW at Kempton - 100Ml/d - Construction • Transfer from WTW in Abingdon to SWA - 72Ml/d • River Thames to Fobney Transfer • Deephams Reuse – 46.5Ml/d, direct to KGV • Managed Aquifer Recharge - Thames Valley, South London • Surbiton intake capacity increase with transfer to Walton inlet channel • New WTW - Radcot • Additional conveyance from Queen Mary Reservoir to Kempton WTW • New Reservoir - Chinnor 30Mm^3 - Construction	The stocks both temporarily and permanently lost likely offer a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The provision of water purification by the associated stocks will likely be reduced due to the option.

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• New Reservoir - Marsh Gibbon 50Mm^3 - Construction • Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intake • TWRM extension – Hampton to Battersea – Construction • Henley to SWOX Transfer – 2.4Ml/d • New Medmenham Surface Water WTW Groundwater Development - Woods Farm Existing Source Increase DO • Kennet Valley to SWOX Transfer - 2.3 Ml/d • Kennet Valley to SWOX Transfer – 6.7Ml/d • Henley to SWOX Transfer – 5Ml/d • Transfer from WTW in Abingdon to SWA - 48Ml/d • Transfer - Reigate (SES) to Guildford 20Ml/d Henley to SWA Transfer– 2.4Ml/d • Henley to SWA Transfer – 5Ml/d New Reservoir - Marsh Gibbon 75Mm^3 - Construction				
• T2ST Full Scheme	The stocks both temporarily and permanently lost likely offer a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The provision of water purification by the associated stocks will likely be reduced due to the option. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.
Water Regulation				
• Oxford Canal - Duke's Cut (SWOX) – Construction	The stocks both	The provision of services	The future provision of	0

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• Oxford Canal - Transfer from Duke's Cut to Farmoor • Groundwater Development - Southfleet & Greenhithe • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal – Cropredy - Construction • New WTW at Kempton - 100Ml/d - Construction • Transfer from WTW in Abingdon to SWA - 48Ml/dSWOXSWA72 (Abingdon to north SWA) • River Thames to Fobney Transfer • Deephams Reuse – 46.5 Ml/d, direct to KGV - Construction • Transfer - Reigate (SES) to Guildford 20Ml/d Managed Aquifer Recharge - Thames Valley, South London • Surbiton intake capacity increase with transfer to Walton inlet channel • New WTW - Radcot • Additional conveyance from Queen Mary Reservoir to Kempton WTW • Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intakeT2ST Full Scheme	temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	will be retained during construction.	the ecosystem service by the associated stocks will likely remain.	
• Crossness Desalination	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on-site.	--

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• New Reservoir - Chinnor 30Mm^3 - Construction • New Reservoir - Marsh Gibbon 75Mm^3 - Construction • New Reservoir - Marsh Gibbon 50Mm^3 - Construction • New Reservoir - Marsh Gibbon 30Mm^3 - Construction	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The loss of stocks will increase negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be lost during construction. However, the addition of a reservoir will bring additional water flow regulation to the environment.	The loss of contributing stocks has the potential to impede water flow on-site. The addition of a reservoir will regulate flows, control water movement and maintain water supplies in dry periods, enabling a resilient supply of water to consumers, however, the loss of existing stocks will require a Level 2 WFD. As such, the impact of the option on water flow regulation cannot be assessed at this stage.	+++

Teddington Direct River Abstraction (Indirect Water Recycling) Ecosystem Services

Table 3-1: Summary of ecosystem service net impact (where possible) of Teddington Direct River Abstraction (£2022 / year)

Ecosystem Service	Net impact of Teddington Direct River Abstraction (£2022 / year)
Climate Regulation Value	£11,630
Natural Hazard Regulation Value	£2,783
Air quality Value	£8,695
Agriculture Value	-£20

Total	£23,088

The overall environmental benefits for Teddington Direct River Abstraction (Indirect Water Recycling) scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £485,268. The ecosystem services with Net Impacts available are identified in Table 3-9. The NC methodology does not consider the monetary cost of land acquisition and management for the required mitigation due to lack of information on mitigation sites. This can be assessed further in Gate 3. As the assessed scheme is large (200Ml/d), it will require more land and associated management costs than the smaller scheme variations. The current buffer area for the assessed components extends to the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following stakeholder engagement.

SESRO ES

New Reservoir - SESRO 150Mm^3 and 75Mm^3
The SESRO Terrestrial EAR notes in Section 9 that the option demonstrates an overall positive impact on climate regulation, water purification, and recreation ecosystem service provision. Disbenefits are seen for food production, air pollutant removal, and natural hazard regulation services. These can be identified in Table 3-10.

Table 3-10: Summary of present value benefits of ecosystem service provision for New Reservoir - SESRO 150Mm^3 (£) – 2022 prices

Ecosystem Service	Present Value Benefit	
	150Mm^3	75Mm^3
Climate Regulation	£1,922,000	£3,175,000
Natural Hazard Regulation	-£50,000	-£51,000
Water Purification	£3,028,000	£2,806,000
Food Production	-£7,934,000	-£6,717,000
Air Pollutant Removal	-£326,000	-£297,000
Recreation	£35,365,000	£36,418,000
Total	£32,005,000	£35,334,000

STT ES

Table 3-11: Summary of ecosystem service provision for STT

	Values (£2022 / year)				
Ecosystem Service	Temporary loss	Permanent loss	Net impact	30-year NPV	80-year NPV
Climate Regulation	-£13,309	-£237	£28,722	£340,752	£833,233
Natural Hazard Regulation	-£4,223	£0	£23,276	£242,724	£462,594
Recreation value	-£1,028,907	-	-	-	-
Agriculture	-£121,186	-£2,955	-£2,955	-£30,819	-£58,736

3.3 Biodiversity Net Gain

Table 3-12 identifies the BNG results for options that fed into the investment model and T2ST. Tables 3-13 and Table 3-14 identifies the BNG results for Teddington Direct River Abstraction (Indirect Water Recycling) and SESRO, respectively. STT BNG results follow.

Table 3-12: Summary of unmitigated BNG outputs

Option	On-site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit Change (Habitat BU)	Total Percentage Change (Habitat BU)
Coppermills WTW - filtration pre-treatment 680Ml/d	N/A	N/A	N/A	N/A
Transfer - Woodmansterne to Epsom - Resource Element	54.70	35.61	-34.90%	-19.09
TWRM extension – Hampton to Battersea – Construction	7.64	4.74	-37.91%	-2.90
Kennet Valley to SWOX Transfer – 2.3Ml/d	71.04	48.23	-32.11%	-22.81
Kennet Valley to SWOX Transfer – 6.7Ml/d	71.04	48.23	-32.11%	-22.81
Oxford Canal to Duke's Cut (SWOX) – Construction	3148.14	2871.69	-276.45%	-8.78
Oxford Canal – Cropredy	1684.93	1510.76	-10.35%	-174.17
Oxford Canal - Transfer from Duke's Cut to Farmoor	127.60	62.56	-65.04%	-50.97
Thames Lee Tunnel (TLT) extension from Lockwood PS to KGV Reservoir intake	24.80	18.34	-26.04%	-6.46
Henley to SWOX Transfer – 2.4Ml/d	53.78	35.08	-18.70%	-34.78
Henley to SWOX Transfer – 5Ml/d	71.52	34.60	-51.62%	-36.92
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78%	-34.63
Groundwater Development - Southfleet & Greenhithe	33.72	20.87	-12.85%	-38.11
Groundwater Development - Woods Farm Existing Source Increase DO	25.00	15.83	-36.67%	-9.17
SouthEast Water to Guildford	149.88	78.78	-47.44%	-71.10
New WTW at Kempton - 100Ml/d - Construction	15.04	6.09	-40.49%	-8.95

Option	On-site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit Change (Habitat BU)	Total Percentage Change (Habitat BU)
Transfer from WTW in Abingdon to SWA - 48Ml/d	352.78	257.55	-27.00%	-95.23
SWOXSWA72 (Abingdon to north SWA)	356.30	256.67	-27.96%	-99.63
River Thames to Fobney Transfer	549.49	534.27	-2.77%	-15.21
Abingdon Reservoir to Farmoor Reservoir pipeline	121.02	88.14	-32.88%	-27.17
Deephams Reuse – 46.5 Ml/d, direct to KGV - Construction	9.76	5.82	-40.38%	-3.94
Transfer - Reigate (SES) to Guildford 20Ml/d	176.64	150.45	-14.83%	-26.19
Crossness Desalination	150.96	24.86	-83.53%	-126.10
Managed Aquifer Recharge - Thames Valley, South London	37.64	14.13	-62.46%	-23.51
Surbiton intake capacity increase with transfer to Walton inlet channel	6.28	5.08	-19.04%	-1.20
New Reservoir - Marsh Gibbon 75Mm^3 - Construction	1810.60	4882.55	169.66%	3071.95
New Reservoir - Marsh Gibbon 50Mm^3 - Construction	2262.84	3352.36	48.15%	1089.52
New Reservoir - Marsh Gibbon 30Mm^3 - Construction	1180.88	2041.31	72.86%	860.43
Henley to SWA Transfer – 2.4Ml/d	55.76	47.18	-15.38%	-8.58
Henley to SWA Transfer – 5Ml/d	55.76	47.09	-15.55%	-8.67
New Medmenham Surface Water WTW	49.94	34.38	-15.56%	-31.16
New Medmenham Surface Water Intake - 53 Ml/d	5.28	4.43	-0.85%	-16.13
New WTW - Radcot	102.62	84.95	-17.21%	-17.67
Additional conveyance from Queen Mary Reservoir to Kempton WTW - Construction	22.76	17.19	-24.48%	-5.57
New Reservoir - Chinnor 30Mm^3 - Construction	1791.40	3000.82	67.51%	1209.42
STT-SESRO Link	6.30	6.08	-3.50%	-0.22

Option	On-site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit Change (Habitat BU)	Total Percentage Change (Habitat BU)
T2ST Full Scheme	2077.46	1596.23	-481.23	-23.16%

Teddington Direct River Abstraction (Indirect Water Recycling) BNG

Table 3-13: Summary of the Terrestrial BNG benefits for the Teddington DRA scheme.

Scheme	Habitat area lost (ha)	Biodiversity units lost	Off-site mitigation area required (ha)	Biodiversity units	Net Gain achieved through enhancement actions
BNG – Terrestrial (permanent loss)	1.94	2.35	3.65	2.67	13.52%
BNG – Terrestrial (temporary loss)	5.13	14.37	13	8.17*	14.27%

*Assumes 8.25 units delivered through habitat reinstatement, 8.17 habitat units of from off-site mitigation.

The BNG assessment of Teddington Direct River Abstraction (Indirect Water Recycling) Scheme has identified that 1.94ha of habitat will be permanently lost due to construction of new above ground infrastructure, requiring a total area of 3.65ha off-site habitat enhancement to provide 13.52% BNG. A total of 5.13ha of habitat will be lost temporarily through creation of construction compounds, however, since it is to be reinstated post-construction, the mitigation effort required to achieve 14.27% BNG is 13ha. This assumes the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved). In conclusion, a total of **16.65 ha** of off-site habitat enhancement could be required achieve a minimum of 10% net gain for both permanent and temporary terrestrial habitat loss within Teddington.

Scheme	River length potentially lost (km)	Biodiversity units lost	Off-site mitigation length required (km)	Biodiversity units	Net Gain achieved through enhancement actions
BNG – Rivers (permanent loss)	0.030	0.12	1.8*	4.79	15.74%
BNG – Rivers (temporary loss)	n/a	n/a	n/a	n/a	n/a

* In order to deliver a minimum of 10% net gain, a section of 1.8km of river assessed as 'poor condition', with major watercourse and riparian encroachment and located outside the catchment would need to be enhanced. To 'moderate condition' with a reduction to watercourse encroachment (from major to minor), to deliver a net gain, off-site of 0.13 river units (4.66 off-site baseline units and 4.79 off-site post-intervention units) and therefore, an overall net change of 0.02 river unit (+15.74%), as per workbook calculations. A minimal section of 0.05km within the waterbody directly impacted would be required to deliver a minimum of 10% net gain

The Teddington Direct River Abstraction (Indirect Water Recycling) will create a loss of -0.12 river units through the creation of permanent structures but has no temporary or operational

disbenefits. Mitigation measures to enhance off-site sections of river would be required to deliver a minimum of 10% net gain. Permanent construction impacts from Teddington Direct River Abstraction (Indirect Water Recycling) will require the enhancement of 1.8km of 'other river and stream' located outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the measures required to enhance the river from 'poor to moderate condition.'

SESRO BNG

Table 3-14: Summary of assessment results for the SESRO options (150Mm^3 and 75Mm^3)

Reservoir Option	Biodiversity Units	On-site Baseline	On-site Post Development (including retention, enhancement and creation)	Total Net Unit Change	Total % Change
150Mm^3	Habitat Units*	4923.57	6552.91	1629.34	33.09%
	Hedgerow Units*	440.24	343.79	−96.45	−21.91%
	River Units	428.16	498.41	70.26	16.41%
75Mm^3	Habitat Units*	4253.42	6449.79	2196.37	51.64%
	Hedgerow Units*	402.64	359.65	−42.99	−10.68%
	River Units	369.59	498.37	128.78	34.84%

*** Hedgerows and woodlands cannot meet the requirements for on-site under the trading rules. SESRO have commissioned further work to investigate this further.**

New Reservoir – SESRO 150Mm^3

In summary, analysis of the BNG calculations highlighted that all reservoir options exceed the required 10% net gain in biodiversity in both habitats and rivers. Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats. The 75Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 51.64% for habitats. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site under the trading rules. SESRO have commissioned further work to investigate this further.

- An ancient crack willow (*Salix fragilis*) tree is located within the scheme boundary where the proposed reservoir will be constructed. Retention of this tree is therefore not possible. As ancient trees are considered irreplaceable habitat, like-for-like mitigation for the loss of this tree is not possible. However, following best practise a bespoke compensation strategy will be developed which may require the retention of the tree as deadwood elsewhere on-site. The compensation strategy will also require a significant amount of tree planting, and retention of soils on-site will also be considered.

Under the current proposals, all SESROs will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. The 150Mm^3 option has identified a loss of 21.91%. The 75Mm^3

option has identified a loss of −10.68%. Further modifications to the masterplan design will likely identify additional areas of hedgerow and other linear features which can be retained or enhanced, and further opportunities for habitat creation are considered likely. If necessary, the loss in linear features will be mitigated through habitat creation outside the indicative scheme boundary.

SESRO could achieve ≥10% BNG for rivers and streams through the creation of wetland ditches and the realignment of rivers to meandering planforms. This would be a significant improvement from the network of agriculturally modified watercourses currently on-site and provide aquatic biodiversity benefits to a range of species and local residents.

STT BNG

A total of 391.21ha of temporary habitat loss was calculated for the whole STT scheme due to pipelines and construction compounds. In the absence of off-site mitigation, this would result in a net change of -12.14% BNG units. A total of 9.05ha of permanent habitat loss calculated for the whole STT scheme, in the absence of off-site mitigation, would result in a net change of -100% BNG units. The mitigation required to achieve a minimum of 10% BNG was calculated per county where habitat loss occurred, namely Shropshire, Oxfordshire and Gloucestershire. Approximately 98ha of land will be required to mitigate the temporary impacts from the STT scheme and achieve a 10% net gain in biodiversity. Approximately 9.05ha of land will be required to mitigate the permanent impacts from the STT scheme and achieve a 10% net gain in biodiversity. Areas of land which may be suitable for mitigation have been identified in each county using scoring criteria, with the highest scoring sites potentially offering more effective, functioning mitigation.

A total of -1.95 river unit losses were estimated for the temporary construction of the pipeline routes and -0.25 river unit losses were estimated for the installation of permanent infrastructure, such as PSs as well as abstraction and outfall locations associated with the STT Solution (excluding Minworth and Netheridge construction). In order to achieve a minimum of 10% BNG on the river unit losses caused by temporary and permanent construction, a total of 10 river PBOs were identified for enhancement from poor to fairly poor ecological condition. The required length for enhancement is 0.18km for the 10 temporary construction mitigation rivers, and 0.25km for the one permanent construction mitigation river. The rivers for enhancement are all located within 1km of the potentially affected river. No river unit losses were identified for the operation of the STT Solution and therefore no river enhancement scenarios were modelled within the metric.

4 BVP, LCP and BESP Outputs

4.1 Assessment of Reasonable Alternative Programmes

The NCA and BNG outputs for the scoped-in options of the LCP (Situation 4), BVP (Situations 1, 4 and 8) and BESP (Situation 4) are summarised in Annexes B, C and D, respectively. Annex E summarises the intermediate quantified carbon sequestration outputs for each option. The results should be read in conjunction with the full list of each plan's options that have been scoped-in and scoped-out for assessment and are presented in Table 1-4 to Table 1-9, respectively. Mitigation has only been considered when outlined in the option description, or where standard mitigation has been applied.

A summary of the tables provided in Annex B (LCP Situation 4) is set out below:

- Table B-1 shows the predicted impacts on natural capital during and post-construction.
- Table B-2 summarises the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment.
- Table B-3 summarises the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment.
- Table B-4 shows the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Table B-1.

Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

A summary of the tables provided in Annex C (BVP Situation 1, 4 and 8) are set out below:

- Table C-1, Table C-5, and Table C-9 show the predicted impacts on natural capital during and post-construction for Situations 1, 4, and 8 respectively.
- Table C-2, Table C-6, and Table C-10 summarise the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment for situations 1, 4 and 8 respectively.
- Table C-3, Table C-7, and Table C-11 summarise the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment for situations 1, 4 and 8 respectively.
- Table C-4, Table C-8, and Table C-12 show the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Table C-1, Table C-5, and Table C-9 for situations 1, 4 and 8 respectively.
- Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

A summary of the tables provided in Annex D (BESP Situation 4) is set out below:

- Table D-1 shows the predicted impacts on natural capital during and post-construction.
- Table D-2 summarises the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment.
- Table D-3 summarises the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment.
- Table D-4 shows the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Table D-1.

Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

Some stocks reported in natural capital tables are expected to be permanently lost. All woodland and high-level stocks are expected to be reinstated on-site or off-site through re-planting schemes. These natural capital stocks include:

- Coastal and floodplain grazing marsh
- Ancient woodland: this habitat is presumed irreplaceable once lost and therefore should be avoided
- Orchards and top fruit: these habitats are presumed irreplaceable once lost and therefore should be avoided
- Lowland fens
- Hay meadows
- Broadleaved, mixed and yew woodland
- Coniferous woodland
- Woodland priority habitat
- Urban woodland
- Greenspace

A summary of the cumulative effects of the overall rdWRMP24 NCA and BNG assessments is presented in Section 5. Note that one of the key differences in the updated WRPG (2023) is the requirement to consider the monetary costs of BNG within option costs prior to options appraisal. Thames Water have considered these costs for each option, using £25,000 per biodiversity unit as an indicative figure based on findings from industry research considering a broad base of stakeholders and other studies[28]. These figures have fed into the WRSE regional investment model and have informed decision-making for the rdWMRP24. It should be noted that, since the WRSE regional investment modelling and Thames Water rdWRMP24 environmental assessments have been undertaken, Defra has released guide prices and further information on calculating the costs of statutory biodiversity credits[29]. These prices are deliberately set at above market rates to deter their purchase in favour of measures with better outcomes for the environment, such as impact avoidance or on-site mitigation.

On reviewing these prices, Thames Water consider that the figure used remains representative, particularly as Thames Water intend to treat the Defra credit scheme as a last resort (as is intended by Defra); rather, Thames Water are prioritising securing effective on-site and off-site habitat creation and enhancement either alone or with local partner organisations.

[28] Defra (2021) Biodiversity Net Gain: Market analysis study. Eftec, WSP, ABP.
[29] Defra (2023) Statutory biodiversity credit prices: Guidelines. Available at: Statutory biodiversity credit prices - GOV.UK (www.gov.uk) [Last Accessed: August 2023]

5 Cumulative Effects Assessment

5.1 Introduction

The final stage in NCA is the cumulative effects assessment, including an intra-plan effects assessment, to inform Thames Water's rdWRMP24 programme appraisal. Inter-plan effects of the plans can be found in the main body of the SEA report. This section provides a summary of the outputs of the cumulative effects assessment for both the NCA and BNG of Thames Water's rdWRMP24 options.

As explained in Section 1.3, natural capital stocks in the cumulative permanent gains/losses includes results for **all scoped in options** associated with each plan, with limitations of the approach highlighted. Ecosystem services and BNG **only include standard resource options and T2ST**, with London Recycling and SESRO summarised at a high level beneath, with the reader being referred to the appropriate feasible output results in Section 3 for a more comprehensive understanding of impact.

5.2 Cumulative Intra-plan Effects Assessment

5.2.1 Least Cost Plan – Situation 4

Natural Capital

Table 5-1 lists the stocks of natural capital that are likely to be temporarily and permanently impacted by the LCP Situation 4. The predicted effect on natural capital stocks for the LCP Situation 4 are very similar to BVP Situation 4, with the LCP Situation 4 evidencing marginally more impact to pasture stocks (0.92ha).

Table 5-1: Predicted cumulative effects on natural capital stocks for the LCP Situation 4

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	27.1	0	154.68	127.58
Lowland Fens	0.38	0	21.92	21.54
Arable	2149.807	10.44	826.1	-1323.707
Pastures	243.73	0	238.72	-5.01
Hay Meadows	73.09	5.32	701.3	628.21
Other Semi-Natural Grassland	21.923	0.03	32.46	10.537
Dwarf Shrub Heath	8.021	1.37	26.51	18.489
Broadleaved, Mixed and Yew Woodland	96.29585	18.48	74.31085	-21.985
Woodland Priority Habitat	10	0	10	0
Coniferous Woodland	3.4	0	3.4	0
Ancient Woodland	1.771005	1.771005	1.761005	-0.01
Bluespace	78.07	78.07	78.07	0
Greenspace	4.98	0	4.98	0

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Urban Semi Natural Habitat	189.969	10.48	20.71	-169.259
Urban Woodland	2.97	0	2.97	0
Active Flood Plain	35.63	24.86	24.86	-10.77
Lakes and Standing Waters	4.82	2.71	13.29	8.47
Rivers (length)	48.36	48.36	48.36	0
Modified Waters (Reservoirs)	0.01	0.01	0.01	0
Ponds & linear features	63.033	63.03	716.43	653.397
Rivers (ha)	6.18	0.62	0.62	-5.56
Canal	0.23	0	35.07	34.84
Other inland rock and scree	1.18	0	0	-1.18

Ecosystem Services

Construction impacts for the LCP include the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of air pollutant removal, a reduction in food production services and a reduction in water purification (Table 5-2 and Table 5-3). The LCP Situation 4 ecosystem service impact is very similar to BVP Situation 4, with LCP Situation 4 performing marginally worse in the overall impact to ecosystem services than BVP Situation 4 (by £800). A reduction in Water Purification is expected due to the loss of a natural capital asset with a high capacity to store and absorb pollutants and the proximity of the asset to a water source. This is a high level assumption and should be reviewed together with WFD assessment to fully understand any risk posed to a waterbody. The Water Flow Regulation assessment was a qualitative assessment and as such monetary values cannot be derived. The LCP presents an opportunity to improve the existing habitats through post-construction remediation and replacement of low value habitats with higher value habitats. The plan crosses several Natural England Habitat Network Enhancement Zones and is therefore suitable for the planting of new high value habitats. These opportunities are further described within the BNG Strategy (Annex F), using the example of the BVP Situation 4.

London Recycling and SESRO

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 150Mm^3 SESRO scheme is £32,005,000. The LCP Situation 4 will experience the same environmental benefits as the BVP Situation 4 in regards to SESRO and London Recycling. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-2: Quantitative detailed assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the LCP Situation 4

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£169,608.35	£3,234.67	-£166,373.68	£142,605.96	-£27,002.39
Natural hazard management	£4,759.63	£169.77	-£4,589.86	£3,611.20	-£1,148.42
Air pollutant removal	£29,697.51	£516.18	-£29,181.34	£24,837.30	-£4,860.22
Recreation and amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£5,593,948.73	£5,706,704.30	-£148,893.55	£5,573,659.87	-£20,288.86
Total	£5,798,014.22	£5,710,624.91	-£349,038.43	£5,744,714.33	-£53,299.89

Table 5-3: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the LCP Situation 4

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
LCP	The stock likely provides a high level of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future ecosystem service provided by the stock will likely be reduced.	The water purification provided by the stock will likely be reduced due to the option. Future ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
LCP	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will	The provision of water flow regulation services of contributing stocks will be retained during construction.	The future ecosystem service provided by the stock is likely to remain.	0

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
	reduce negative impacts to the ecosystem service.			

Biodiversity Net Gain

The LCP is expected to result in -20.98% net loss of biodiversity units (Table 5-4), as a result of most options generating a net loss of biodiversity due to reporting unmitigated outputs, with the exception of high level best practise mitigation (see Section 2.10). Mitigation has been further considered within the BNG Strategy (Annex F). The LCP Situation 4 performs marginally better compared to the BVP Situation 4 (-21.28%).

It should be noted that the desk-based BNG assessments have been conducted using open-source data, as described in Section 2.6. Habitat identification will need to be refined at the project level with both habitat survey data and further development of habitat mitigation and enhancement proposals. The number of units required to achieve a 10% BNG has also been presented in Table 5-4 below.

London Recycling and SESRO

Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary). Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines, a separately reported BNG category to habitats and rivers. The 150Mm^3 option has identified a loss of 21.91%. Additional lengths of hedgerow linear features need to be created, retained, or enhanced on-site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-4: Summary of unmitigated BNG outputs for the LCP Situation 4 and the BNG habitat units required to be gained to achieve 10% BNG.

On-site Baseline (BU)	On-Site Post Intervention (BU)	Total Net Unit Change (BU)	Total Percentage Change	BNG Habitat Unit Gain required
4698.46	3712.92	-985.54	-20.98%	1455.386

5.2.2 Best Value Plan Situation 1

Natural Capital

Table 5-5 lists the stocks of natural capital that are likely to be temporarily and permanently impacted by the BVP Situation 1. The predicted effect on natural capital stocks for the BVP Situation 1 are very similar to BVP Situation 4, with the BVP Situation 1 evidencing marginally more impact to pasture stocks (0.92ha).

Table 5-5: Predicted temporary and permanent cumulative effects on natural capital stocks for the BVP Situation 1

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	27.1	0	154.68	127.58
Lowland Fens	0.38	0	21.92	21.54
Arable	2149.807	10.44	826.1	-1323.707
Pastures	243.73	0	238.72	-5.01
Hay Meadows	73.09	5.32	701.3	628.21
Other Semi-Natural Grassland	21.923	0.03	32.46	10.537
Dwarf Shrub Heath	8.021	1.37	26.51	18.489
Broadleaved, Mixed and Yew Woodland	97.775	18.48	75.79	-21.985
Woodland Priority Habitat	10.44	0.44	10.44	0
Coniferous Woodland	3.4	0	3.4	0
Ancient Woodland	1.771	1.761	1.761	-0.01
Bluespace	78.07	78.07	78.07	0
Greenspace	6.38	0	6.38	0
Urban Semi Natural Habitat	189.969	10.48	20.71	-169.259
Urban Woodland	2.98	0.01	2.98	0
Active Flood Plain	41.86	31.09	31.09	-10.77
Lakes and Standing Waters	4.82	2.71	13.29	8.47
Rivers (length)	49.26	49.26	49.26	0
Modified Waters (Reservoirs)	0.01	0.01	0.01	0

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Ponds & linear features	63.153	63.15	716.55	653.397
Rivers (ha)	6.18	0.62	0.62	-5.56
Canal	0.23	0	35.07	34.84
Other inland rock and scree	1.18	0	0	-1.18

Ecosystem Services

Construction impacts for the BVP include the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of air pollutant removal, a reduction in food production services and a reduction in water purification (Table 5-6 and Table 5-7). The BVP Situation 1 ecosystem service impact is very similar to BVP Situation 4, with BVP Situation 1 performing marginally worse in the overall impact to ecosystem services than BVP Situation 4 (by £1,867.80). A reduction in Water Purification is expected due to the loss of a natural capital asset with a high capacity to store and absorb pollutants and the proximity of the asset to a water source. This is a high level assumption and should be reviewed together with WFD assessment to fully understand any risk posed to a waterbody. The Water Flow Regulation assessment was a qualitative assessment and as such monetary values cannot be derived. The BVP presents an opportunity to improve the existing habitats through post-construction remediation and replacement of low value habitats with higher value habitats. These opportunities are further described within the BNG Strategy (Annex F), using the example of the BVP Situation 4. The plan crosses several Natural England Habitat Network Enhancement Zones and is therefore suitable for the planting of new high value habitats.

London Recycling and SESRO

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 150Mm^3 SESRO scheme is £32,005,000. The BVP Situation 1 will experience the same environmental benefits as the BVP Situation 4 in regards to SESRO and London Recycling. To review further detailed ecosystem service impacts from SESRO and London Recycling, refer to Section 3.

Table 5-6: Quantitative detailed assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the BVP Situation 1

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£173,127.09	£64,210.64	-£108,916.45	£145,245.02	-£27,882.07
Natural hazard management	£4,944.55	£211.95	-£4,732.61	£3,749.90	-£1,194.66

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Air pollutant removal	£30,266.04	£650.68	-£30,266.04	£25,263.69	-£5,002.35
Recreation and amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£5,593,948.73	£5,706,704.30	-£148,893.55	£5,573,659.87	-£20,288.86
Total	£5,802,286.41	£5,771,777.56	-£292,808.65	£5,747,918.47	-£54,367.94

Table 5-7: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BVP Situation 1

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
BVP 1	The stock likely offers a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future ecosystem service provided by the stock will likely be reduced.	The water purification provided by the stock will likely be reduced due to the option. Future ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
BVP 1	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of most stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be retained during construction.	The future ecosystem services provided by most stock will likely remain.	0

Biodiversity Net Gain

The BVP Situation 1 is expected to result in -20.99% net loss of biodiversity units (Table 5-8) as a result of most options generating a net loss of biodiversity due to reporting unmitigated outputs, with the exception of high level best practise mitigation (see Section 2.10). Mitigation has been further considered within the BNG Strategy (Annex F). The BVP Situation 1 performs marginally better compared to the BVP Situation 4 (-21.28%).

It should be noted that the desk-based BNG assessments have been carried out using open-source data. Habitat identification will need to be refined at the project level with both habitat survey data and further development of habitat mitigation/enhancement proposals. The number of units required to achieve a 10% BNG has also been presented in Table 5-8 below.

London Recycling and SESRO

Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary). Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. Additional lengths of hedgerow linear features need to be created, retained or enhanced on-site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows. The 150Mm^3 option has identified a loss of 21.91%. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-8: Summary of unmitigated BNG outputs for the BVP Situation 1 and the BNG habitat units required to be gained to achieve 10% BNG.

On-Site Baseline (BU)	On-Site Post Intervention (BU)	Total Net Unit Change (BU)	Total Percentage Change	BNG Habitat Unit Gain Required
4722.22	3731.04	-991.18	-20.99%	1463.402

5.2.3 Best Value Plan Situation 4

Natural Capital

Table 5-9 lists the stocks of natural capital that are likely to be temporarily and permanently impacted by the BVP Situation 4. All options were included in this assessment, including SROs. BVP Situation 4 is expected to produce losses within eight habitats, with the largest losses seen in Arable land (1323 ha loss). A small area (0.01ha) of the irreplaceable habitat, Ancient Woodland, is expected to be lost associated with the T2ST option.

Table 5-9: Predicted temporary and permanent cumulative effects on natural capital stocks for the BVP Situation 4

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	27.1	0	154.68	127.58
Lowland Fens	0.38	0	21.92	21.54
Arable	2149.657	10.44	825.95	-1323.707
Pastures	246.06	0	241.97	-4.09
Hay Meadows	73.09	5.32	701.3	628.21
Other Semi-Natural Grassland	21.903	0	32.44	10.537
Dwarf Shrub Heath	8.021	1.37	26.51	18.489
Broadleaved, Mixed and Yew Woodland	93.235	18.48	71.25	-21.985
Woodland Priority Habitat	12.84	0	12.84	0
Coniferous Woodland	3.55	0	3.55	0
Ancient Woodland	1.271	1.261	1.261	-0.01
Bluespace	78.07	78.07	78.07	0
Greenspace	5.11	0	5.11	0
Urban Semi Natural Habitat	189.969	10.48	20.71	-169.259
Urban Woodland	2.75	0	2.75	0
Active Flood Plain	35.63	24.86	24.86	-10.77
Lakes and Standing Waters	4.82	2.71	13.29	8.47
Rivers (length)	48.36	48.36	48.36	0
Modified Waters (Reservoirs)	0.01	0.01	0.01	0
Ponds & linear features	63.033	63.03	716.43	653.397
Rivers (ha)	6.18	0.62	0.62	-5.56
Canal	0.23	0	35.07	34.84
Other inland rock and scree	1.18	0	0	-1.18

Ecosystem Services

Construction impacts for the BVP include the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of air pollutant removal, a reduction in food production services and a reduction in water purification (Table 5-10 and 5-11). A reduction in Water Purification is expected due to the loss of a natural capital asset with a high capacity to store and absorb pollutants and the proximity of the asset to a water source. This is a high level assumption and should be reviewed together with WFD assessment to fully understand any risk posed to a waterbody. The Water Flow Regulation assessment was a qualitative assessment and as such monetary values cannot be derived. The BVP presents an opportunity to improve

the existing habitats through post-construction remediation and replacement of low value habitats with higher value habitats. The plan crosses several Natural England Habitats Network Enhancement Zones and is therefore suitable for the planting of new high value habitats. These opportunities are further described within the BNG Strategy (Annex F), using the example of the BVP Situation 4.

London Recycling and SESRO

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 150Mm^3 SESRO scheme is £32,005,000. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-10: Quantitative detailed cumulative assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the BVP Situation 4

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£168,919.85	£2,300.05	-£166,619.79	£142,078.30	-£26,841.55
Natural hazard management	£4,683.82	£120.88	-£4,562.94	£3,542.36	-£1,141.45
Air pollutant removal	£29,326.84	£367.53	-£28,959.31	£24,558.67	-£4,768.18
Recreation and amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£5,300,192.20	£5,413,487.67	-£149,433.46	£5,280,443.24	-£19,748.96
Total	£5,503,122.70	£5,416,276.13	-£349,575.51	£5,450,622.56	-£52,500.14

Table 5-11: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BVP Situation 4

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
BVP	The stock likely offers a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The water purification provided by the stock will likely be reduced due to the option. Future ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
				replicated once lost.
Water flow regulation				
BVP	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of most stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be retained during construction.	The future ecosystem service provided by most stock will likely remain.	0

Biodiversity Net Gain

The BVP is expected to result in -21.28% net loss of biodiversity units (Table 5-12), as a result of most options generating a net loss of biodiversity due to reporting unmitigated outputs, with the exception of high level best practise mitigation (see Section 2.10). Mitigation has been further considered within the BNG Strategy (Annex F).

It should be noted that the desk-based BNG assessments have been carried out using open-source data. Habitat identification will need to be refined at the project level with both habitat survey data and further development of habitat mitigation/enhancement proposals. The number of units required to achieve a 10% BNG has also been presented in Table 5-12 below.

London Recycling and SESRO

Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary). Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. Additional lengths of hedgerow linear features need to be created, retained or enhanced on-site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows. The 150Mm^3 option has identified a loss of 21.91%. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-12: Summary of unmitigated BNG outputs for the BVP Situation 4 and the BNG habitat units required to be gained to achieve 10% BNG.

On-Site Baseline (BU)	On-Site Post Intervention (BU)	Total Net Unit Change (BU)	Total Percentage Change	BNG Habitat Unit Gain Required
4716.20	3712.45	-1003.75	-21.28%	1475.37

5.2.4 Best Value Plan Situation 8

Natural Capital

Table 5-13 lists the stocks of natural capital that are likely to be temporarily and permanently impacted by the BVP Situation 8. The predicted effect on natural capital stocks for the BVP Situation 8 are more positive than BVP Situation 4, with the BVP Situation 8 evidencing lower impacts on arable, active floodplain, ancient woodland and pastoral stocks, and more gains in other semi-natural grassland stocks.

Table 5-13: Predicted temporary and permanent cumulative effects on natural capital stocks for the BVP Situation 8

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	0	0	127.58	127.58
Lowland Fens	0	0	21.54	21.54
Arable	1382.374561	10.44	105.2175607	-1277.157
Pastures	2.27840991	0	2.27840991	0
Hay Meadows	72.23	5.32	700.44	628.21
Other Semi-Natural Grassland	0.043	0	11.91	11.867
Dwarf Shrub Heath	7.541	1.37	26.03	18.489
Broadleaved, Mixed and Yew Woodland	64.78584812	18.48	42.80084812	-21.985
Woodland Priority Habitat	0.327295729	0	0.327295729	0
Urban Semi Natural Habitat	186.719	10.48	17.46	-169.259
Active Flood Plain	1.202701442	1.202701442	1.202701442	0
Lakes and Standing Waters	4.05	1.94	12.52	8.47
Ponds & linear features	0.753	0.75	654.15	653.397
Rivers (ha)	6.18	0.62	0.62	-5.56
Canal	0.23	0	35.07	34.84
Other inland rock and scree	1.18	0	0	-1.18

Ecosystem Services

Construction impacts for the BVP include the release of CO_2 due to habitat clearance, loss of natural hazard management, loss of air pollutant removal and a reduction in water purification (Table 5-14 and Table 5-15). The BVP Situation 8 ecosystem service impact is less impactful than BVP Situation 4, with BVP Situation 4 performing worse in overall impact to ecosystem services by £52,318.73. A reduction in Water Purification is expected due to the loss of a natural capital asset with a high capacity to store and absorb pollutants and the proximity of the asset to a water source. This is a high level assumption and should be reviewed together with WFD assessment to fully understand any risk posed to a waterbody. The qualitative water flow regulation assessment was scoped out because none of the associated stocks were impacted by this BVP. The BVP presents an opportunity to improve the existing habitats through post-construction remediation and replacement of low value habitats with higher value habitats. The plan crosses several Natural England Habitat Network Enhancement Zones and is therefore suitable for the planting of new high value habitats. These opportunities are further described within the BNG Strategy (Annex F), using the example of the BVP Situation 4.

London Recycling and SESRO

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 150Mm^3 SESRO scheme is £32,005,000. The BVP Situation 8 will experience the same environmental benefits as the BVP Situation 4 in regards to SESRO and London Recycling. To review further detailed ecosystem service impacts from SESRO and London Recycling, refer to Section 3.

Table 5-14: Quantitative detailed assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the BVP Situation 8

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard management	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air pollutant removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation and amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41

Table 5-15: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BVP Situation 8

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
BVP	The stock likely offers a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced.	The water purification provided by the stock will likely be reduced due to the option.
Water flow regulation				
BVP	Scoped Out	Scoped Out	Scoped Out	Scoped out

Biodiversity Net Gain

The BVP Situation 8 is expected to result in -34.63% net loss of biodiversity units (Table 5-16) due to reporting unmitigated outputs, with the exception of high level best practise mitigation (see Section 2.10). Mitigation has been further considered within the BNG Strategy (Annex F).

It should be noted that the desk-based BNG assessments have been carried out using open-source data. Habitat identification will need to be refined at the project level with both habitat survey data and further development of habitat mitigation/enhancement proposals. The number of units required to achieve a 10% BNG has also been presented in Table 5-16 below. The BVP Situation 8 performs worse compared to the BVP Situation 4 (-21.28%).

London Recycling and SESRO

Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary). Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. Additional lengths of hedgerow linear features need to be created, retained or enhanced on-site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows. The 150Mm^3 option has identified a loss of 21.91%. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-16: Summary of unmitigated BNG outputs for the BVP Situation 8 and the BNG habitat units required to be gained to achieve 10% BNG.

On-Site Baseline (BU)	On-Site Post Intervention (BU)	Total Net Unit Change (BU)	Total Percentage Change	BNG Habitat Unit Gain required
13.8	9.02	-4.78	-34.63%	6.16

5.2.5 Best Environment and Social Plan Situation 4

Natural Capital

Table 5-17 lists the stocks of natural capital that are likely to be temporarily and permanently impacted by the BESP Situation 4. All options were included in this assessment, including SROs. The predicted effect on natural capital stocks for the BESP Situation 4 different to BVP Situation 4, with the BESP Situation 4 showing fewer gains in Ponds & linear features, but greater gains in Coastal and Floodplain Grazing Marsh, Lowland Fens, Hay Meadows, Lakes and Standing Waters. In terms of loss, the BESP Situation 4 is expected to lose smaller areas of habitat compared to the BVP Situation 4.

Table 5-17: Predicted temporary and permanent cumulative effects on natural capital stocks for the BESP Situation 4

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	27.1	0	161.93	134.83
Lowland Fens	0.38	0	23.14	22.76
Arable	1946.867	0	820.07	-1126.807
Pastures	246.06	0	241.97	-4.09
Hay Meadows	73.26	0	736.97	663.74
Other Semi-Natural Grassland	21.903	0	32.44	10.537
Dwarf Shrub Heath	7.841	0	7.3	-0.551
Broadleaved, Mixed and Yew Woodland	82.985	19.23	72.8	-10.175
Woodland Priority Habitat	12.04	0	12.04	0
Coniferous Woodland	3.55	0	3.55	0
Ancient Woodland	1.271	1.261	1.261	-0.01
Bluespace	78.07	78.07	78.07	0
Greenspace	5.11	0	5.11	0
Urban Semi Natural Habitat	179.539	0	10.37	-169.169
Urban Woodland	2.75	0	2.75	0
Active Flood Plain	32.51	24.86	24.86	-7.65
Lakes and Standing Waters	3.49	2.78	13.98	10.49
Rivers (length)	47.98	47.98	47.98	0

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present during construction (ha)	Stocks present post-construction (ha)	Change (ha)
Modified Waters (Reservoirs)	0.01	0.01	0.01	0
Ponds & linear features	63.033	62.28	454.11	391.077
Rivers (ha)	5.64	0	0	-5.64
Canal	0	0	0	0
Other inland rock and scree	1.18	0	0	-1.18

Ecosystem Services

Construction impacts for the BESP include the release of CO_2 due to habitat clearance, loss of natural hazard management, a reduction in air pollutant removal, reduction in food production services, and a reduction in water purification (Table 5-18 and Table 5-19). The BESP Situation 4 ecosystem service impact is very similar to BVP Situation 4, with BVP Situation 4 performing marginally worse in the overall impact to ecosystem services by 503.08. A reduction in Water Purification is expected due to the loss of a natural capital asset with a high capacity to store and absorb pollutants and the proximity of the asset to a water source. This is a high level assumption and should be reviewed together with WFD assessment to fully understand any risk posed to a waterbody. There is no change anticipated in water flow regulation. The BESP presents an opportunity to improve the existing habitats through post-construction remediation and replacement of low value habitats with higher value habitats. The plan crosses several Natural England Habitat Network Enhancement Zones and is therefore suitable for the planting of new high value habitats. These opportunities are further described within the BNG Strategy (Annex F), using the example of the BVP Situation 4.

London Recycling and SESRO

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 75Mm^3 SESRO scheme is £35,334,000. To review further detailed ecosystem service impacts from SESRO and London Recycling, refer to Section 3.

Table 5-18: Quantitative detailed assessment of the unmitigated predicted permanent impacts on the provision of ecosystem services for the BESP Situation 4

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Carbon storage	£167,260.02	£2,300.05	-£164,959.96	£140,833.42	-£26,426.59
Natural hazard management	£4,596.58	£120.88	-£4,475.70	£3,476.94	-£1,119.64

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Air pollutant removal	£29,061.62	£367.53	-£29,061.62	£24,359.75	-£4,701.87
Recreation and amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£5,300,192.20	£5,413,487.67	-£149,433.46	£5,280,443.24	-£19,748.96
Total	£5,501,110.41	£5,416,276.13	-£347,930.75	£5,449,113.34	-£51,997.06

Table 5-19: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water flow regulation for the BESP Situation 4

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
BESP	The stock likely offers a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	Future ecosystem service provided by the stock will likely be reduced.	The water purification provided by the stock will likely be reduced due to the option. Future ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water flow regulation				
BESP	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of water flow regulation services of contributing stocks will be retained during construction.	Future ecosystem service provided by the stock will likely remain.	0

The net impact to ecosystem services for Teddington Direct River Abstraction (Indirect Water Recycling) is £23,088 (£2022/year). The present value benefit of the 75Mm^3 SESRO scheme is £35,334,000. The smaller SESRO scheme selected within the BESP produces greater ecosystem service benefit, than the larger scheme used within BVP Situation 4 (£32,005,000). To review further detailed ecosystem service impacts from SESRO and London Recycling, refer to Section 3.

Biodiversity Net Gain

The BESP Situation 8 is expected to result in -21.14% net loss of biodiversity units (Table 5-20). This is a result of most options generating a net loss of biodiversity, due to reporting unmitigated outputs, with the exception of high level best practise mitigation (see Section 2.10). Mitigation has been further considered within the BNG Strategy (Annex F).

It should be noted that the desk-based BNG assessments have been carried out using open-source data. Habitat identification will need to be refined at the project level with both habitat survey data and further development of habitat mitigation/enhancement proposals. The number of units required to achieve a 10% BNG has also been presented in Table 5-20 below. The BESP Situation 8 performs marginally better compared to the BVP Situation 4 (-21.28%).

London Recycling and SESRO

Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary). Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 75Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 51.64% for habitats, and 34.84% for rivers. However, it is important to note, hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. Additional lengths of hedgerow linear features need to be created, retained or enhanced on-site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows. The 75Mm^3 option has identified a loss of −10.68%. To review further detailed ecosystem service impacts from SESRO and London Recycling, please refer to Section 3.

Table 5-20: Summary of unmitigated BNG outputs for the BESP Situation 4 and the BNG habitat units required to be gained to achieve 10% BNG.

On-Site Baseline (BU)	On-Site Post Intervention (BU)	Total Net Unit Change (BU)	Total Percentage Change	BNG Habitat Unit Gain required
4705.72	3710.92	-994.80	-21.14%	1465.372

6 General Approach and Principles for BNG Delivery across the Plan

This Section sets out a general approach and principles to achieve BNG across the rdWRMP24 as a high-level strategy applicable to all options. Annex F provides a more detailed strategy specific to the rdWRMP24 options selected in Situation 4 of the BVP. It sets out the BNG requirements and details of BNG delivery for each selected option. This Section aligns with the Thames Water company-wide BNG strategy, especially integrating the BNG Good Practice Principles and the adoption of a Nature-based Solutions (NbS) approach.

6.1 General Approach and Principles for BNG Delivery across the Plan

As a first step towards achieving BNG, an assessment was made for all plans to estimate change in habitat units for each option and then for all options together (see Sections 3, 4 and 5). There were unknowns with the assessment, including the exact type and condition of habitats on-site, the construction programme for the options, and which options are under mandatory BNG. While the unknowns reflect the early stages of the Thames Water plans, the assessment provides the information to develop this high-level Strategy.

This BNG Strategy sets out high-level key steps for Thames Water firstly to achieve BNG in ways that could contribute towards strategic conservation priorities. Secondly, to adopt a Nature-based Solution (NbS) approach for BNG to generate wider environmental benefits, including carbon sequestration and climate resilience. High-level modelling of the habitat creation required for BNG to inform planning and programming for the delivery of BNG will be undertaken as a next step.

This BNG Strategy comprises:

- Integrating the BNG Good Practice Principles
- Adopting a NbS approach
- Planning for habitat creation requirements for BNG

Sitting alongside Thames Water's BNG Strategy for the WRMP, for AMP7 Thames Water made a commitment, with its regulator Ofwat, to enhance biodiversity over five years by 5% at 253 of its most important sites for nature. The area of land to be improved by this five-year biodiversity programme is c.4,000ha'[30].

6.1.1 Integrating the BNG Good Practice Principles

The 'Biodiversity Net Gain: Good Practice Principles for Development'[31] are the cornerstone for development to achieve BNG. There are ten principles (referred to as the 'BNG Principles') and these are applied all together as one approach.

The BNG assessment (see Sections 3, 4 and 5) embeds the BNG Principles, and the first stage of this BNG Strategy is to continue to integrate the BNG Principles within the design and

[30] Thames Water (2023). Biodiversity. Available at: https://www.thameswater.co.uk/about-us/responsibility/biodiversity [Accessed: August 2023]
[31] CIEEM (2016). Biodiversity Net Gain Principles. Available at: Biodiversity-Net-Gain-Principles.pdf (cieem.net) [Accessed August 2023]

implementation of the Thames Water BNG Strategy. In particular, core project documentation should reference both the BNG target and the BNG Principles, and BNG reports should describe implementation of the BNG Principles to-date with any barriers or constraints faced and the best resolution that could be implemented.

While all BNG Principles are applied as one approach, those that are particularly important for Thames Water are:

- Apply the Mitigation hierarchy

Identifying irreplaceable, Very High Distinctiveness and High Distinctiveness habitats on or nearby the options should be undertaken as soon as possible, for example by targeted site-surveys using the information collated for this BNG assessment. Avoiding negative impacts on these habitats should be prioritised and considered upfront and early within the programme.

- Contribute towards nature conservation

BNG should be designed in ways that contribute towards local nature conservation priorities, such as those in Local Planning Authorities' (LPAs') Local Plans and Local Nature Recovery Strategies. This especially regards any core BNG Delivery Sites, for which the location of these sites and the created and/or enhanced habitats on the sites should aim to generate strategically important outcomes for nature conservation.

- Achieve the best outcomes for biodiversity

The BNG Good Practice Principle to 'achieve the best outcomes for biodiversity', and under mandatory BNG, this is to create and enhance wildlife-rich habitats. Designs to create and enhance wildlife-rich habitats for BNG for the Thames Water BNG Strategy should be based on sound ecological principles and should be feasible and ecologically appropriate for the site and surrounds. This includes designing BNG habitats that are of a sufficient size for their intended ecological function, such as stepping stones, and can thrive given environmental conditions on-site such as soil types and drainage.

To support this, the BNG design deliverables for the Thames Water BNG Strategy should include a Biodiversity Metric calculation together with an accompanying landscape design (and associated design outputs, e.g., planting schedules) and long-term BNG management and monitoring plans. There should also be dedicated BNG handovers from design to construction and from construction to operation.

- Optimise sustainability

BNG should be designed in ways that achieve the net gain outcomes as well as wider environmental benefits. For Thames Water, this especially regards links between BNG and climate change (please see the following section on designing wildlife-rich, carbon-rich and climate resilient habitats) and, by utilising the NCA and BNG assessments, adopting a nature-based solution approach.

6.1.2 Adopting a NbS

By adopting a NbS approach, BNG can be designed to generate wider environmental benefits, including carbon sequestration and climate resilience. Key is to consider BNG at the landscape- and catchment-level, considering how habitats created for BNG can also be a solution to challenges within a specific landscape and/or catchment. Examples are carbon sequestration and climate resilience:

- Increasing carbon sequestration

It is widely acknowledged that society faces a joint climate and biodiversity crisis, whereby tackling one cannot be successful without tackling the other. Under mandatory BNG, there is a change in habitats when (by following the mitigation hierarchy) some habitats are cleared for a development and other habitats are created or enhanced to achieve BNG outcomes. As habitats sequester carbon and act as carbon sinks in the landscape, BNG will affect carbon sequestration and the presence of carbon sinks.

For Thames Water, change in carbon sequestration rates of habitats under BNG should be assessed utilising a practical and pragmatic approach. The carbon assessment should inform BNG designs, with the aim that BNG has an overall neutral impact on carbon sequestration rates as a minimum and, where possible, increases carbon sequestration, over the duration of BNG.

- Resilience to climate change

Mandatory BNG is for a minimum of 30 years. Over this time, extreme weather events will increase in frequency and severity, and there will be a change in climate conditions to warmer, wetter, winters and to hotter, drier summers. It is critical that climate resilience measures are integrated into the design and long-term management and monitoring plan for BNG.

Climate projection data should be obtained for BNG sites in order to assess climate risks to the proposed BNG habitats, and then climate resilience measures should be integrated into BNG designs. The aims should be to boost long-term resilience of the BNG-habitats and then for the resilient BNG habitats to boost resilience of nearby assets and the surrounding landscape.

An example is designing Watercourse BNG (even from several projects) at the catchment-level to align with Natural Flood Management principles and plans.

6.1.3 Planning for habitat creation requirements for BNG

The BNG assessment (see Sections 3, 4 and 5) estimates change in habitat units for each option and then for all options together at this early stage of planning. Building on this assessment and using the Biodiversity Metric, as a next step, the BNG Strategy estimates the type and amount (in ha and km) of off-site habitat creation that could be required to achieve BNG.

The aims of further work should be three-fold: to identify the key focus for avoiding and reducing clearance especially of high distinctiveness habitats; to enable planning, budgeting, and

programming of any off-site BNG requirements; and to inform the location and design of any core BNG Delivery Sites.

Modelling should be undertaken of all options in one Biodiversity Metric calculation, specifically to demonstrate how the minimum 10% increase in habitat units could be achieved by meeting the metric's trading rules. The following high-level assumptions should be made:

- Off-site BNG delivery would commence in the same year as habitat loss on-site for the options (with the Metric's advance/delay function set to zero years).

- For area-based habitats:
    - Off-site baselines would be modified grassland in poor condition of low strategic significance.
    - Off-site BNG delivery would be within the same LPA as the associated options.
    - The modelling would be based on habitat creation to a target condition of moderate.

- For rivers
    - Off-site baselines would be 'other rivers and streams' in poor condition.
    - River BNG would be achieved by enhancing the watercourse condition to good.
    - Off-site BNG delivery would be in the same catchment as the associated options.

6.1.4 Mitigation and Enhancement Opportunities

Opportunities should ensure that the natural environment is left in a better condition than pre-construction conditions for the plans. This should be achieved by mitigation and/or enhancement plans.

As a core principle, where possible, the plan would not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG. The latter could be achieved by identifying local sites of ecological interest and proposing measures. Any habitats that are created or enhanced to achieve BNG are required to be secured for 30 years, through management, maintenance, and monitoring.

A summary of the potential NCA, BNG mitigation and enhancement measures for each sub-component type of the plan is outlined in Table 6-1. Further explanation of the potential enhancement measures is provided within this Section.

Table 6-1: Summary of potential mitigation and enhancement opportunities to achieve BNG

Option element	Mitigation opportunity	Enhancement opportunity
All option elements	Option layouts to be amended to avoid the permanent loss of high value natural capital assets that, once lost, cannot be easily reinstated. Assets include ancient woodland and traditional orchards.	Creation of higher value habitat within grassland, arable and pasture natural capital assets on-site to achieve an increase in BUs and work towards a 10% uplift in BNG.
	Options to identify area for the creation and/or reinstatement of high value natural capital assets, including:	Habitat creation work within the adjacent priority habitats. Options fall

Option element	Mitigation opportunity	Enhancement opportunity
	Coastal and floodplain grazing marsh Lowland fens Lowland raised bog Reedbeds Blanket bog Hay meadows Dwarf shrub heath Broadleaved, mixed and yew woodland Coniferous woodland Blue space Greenspace	within or are in the vicinity of habitat network zones: Habitat restoration-creation Restorable habitat Fragmentation action zone Network enhancement Zones 1 and 2 Expansion zone These areas identify specific locations for a range of actions to help improve the ecological resilience for each of the habitats/habitat networks. The options should seek to identify habitat network zones and priority habitats within the near vicinity and to improve/create/ restore habitats, which would help to work towards increasing BUs and towards a 10% uplift in BNG.
	Construction practices to be considered to reduce the amount of clearance required, especially in areas that include high value natural capital assets (see above for list).	Increase the quality/quantity of freshwater assets, including lakes and ponds located in designated SSSIs, pending detailed assessment of local conditions and available space.
	Directional drilling to be used where possible to avoid loss of high value natural capital assets (see above for list).	Options to identify suitable areas off-site for the creation, enhancement and/or restoration in order to develop off-site net gains, working towards achieving a 10% uplift in BNG.
		Identify areas of local peatland restoration.
Option elements located along the canals		Possibly create floating wetland islands, enabling plants and microbes to form and attract wildlife both above and below the water's surface and create biochemical and physical processes to improve parameters such as water quality.
Wastewater treatment works, abstraction and treatment works, and other option elements that contain above ground infrastructure		Seeding of grassland within footprints of the above ground infrastructure, where possible.

As appropriate, the plan will start to consider reaching out to local non-government organisations and planning authorities who may potentially be able to conduct BNG both on-site and off-site. Early engagement may help provide further insight on local opportunities for enhancement, how this can be achieved, local priorities and limiting factors.

6.1.5 BNG Unit Purchase

When all other means of gain have been exhausted or are considered practically infeasible, BNG will be possible to achieve via a new statutory biodiversity credits scheme. This is under mandatory BNG requirement only. Credits can be bought by developers as a last resort when on-site and local off-site provision (via registered offset providers) of habitat cannot deliver the BNG required. Purchasing statutory biodiversity credits from the government will discharge their mandatory BNG requirement. The price of biodiversity credits will be set higher than prices for equivalent biodiversity gain on the market and the credits are expected to be purchased through a national register for net gain delivery sites. Indicative credit prices were announced in August 2023[32].

Credit prices vary depending on the distinctiveness of the habitat. Distinctiveness is a measure of different ecological factors, such as the rarity of the habitat and species richness within a habitat. For instance, area habitats of low distinctiveness have a price per credit of £42,000, medium distinctiveness habitats range from £42,000 to £125,000 price per credit and habitats of high distinctiveness have a price per credit range of £42,000 to £650,000. All hedgerow (linear) habitats of various distinctiveness have a price per credit of £44,000 and watercourses (linear) of various distinctiveness have a price per credit of £230,000*.

*These prices are indicative; confirmed prices will be published when biodiversity net gain becomes mandatory (expected late 2023).

[32] GOV.UK (2023). Statutory biodiversity credit prices. Available at: Statutory biodiversity credit prices - GOV.UK (www.gov.uk) [Accessed 17th August 2023]

7 Conclusions

It is important to note that by using the latest designs from the Gate 2 reporting, different methodologies have been used to calculate NCA, BNG and ecosystem service outputs. Notably, the SESRO and London Recycling Schemes are calculated on the assumption that habitats will be mitigated by additional creation enhancement off-site. T2ST and the standard resource options methodologies assume that only high value habitats that are lost on-site will be compensated for, and that there are no further enhancements beyond. Mitigation for the plan options (as selected in BVP Situation 4) has been further considered within the BNG Strategy (Annex F).

The NCA, BNG and ecosystem services outputs of the LCP, BVP and BESP identified the following:

Natural Capital:

As explained in Section 1.3, natural capital stocks in the cumulative assessments includes results for all scoped in options associated with each plan, with limitations of its approach highlighted. It is important to keep in front of mind that the BNG Strategy provides an assured framework for mitigation to be applied to the T2ST and the standard resource options, which through careful design of viable retention, enhancement, and creation of habitats, will reduce the overall losses highlighted below and ensure that required gain is met as this strategy is built upon.

- All plans exhibit a large gain in ponds and linear features. Those plans including the larger 150Mm^3 SESRO reservoir (all BVP's and LCP) estimate a gain of 653.397ha, whilst BESP Situation 4 estimates a smaller area of 391.077ha;
- There are smaller gains in Coastal and Floodplain Grazing Marsh, Lowland Fens, Other Semi-Natural Grassland and Lakes and Standing Waters across all plans;
- All plans experience large losses in arable land, ranging from losses of 1126.807ha (BESP Situation 4) to 1323.707ha (LCP Situation 4, BVP Situations 1 and 4);
- There are smaller losses of Broadleaved, Mixed and Yew Woodland, Pastures, Urban Semi Natural Habitat, and rivers across all plans;
- All plans will experience the permanent loss of an ancient crack willow (*Salix fragilis*) tree, associated with the SESRO schemes, identified through a search of the Ancient Woodland Inventory. In addition to this, LCP Situation 4, BVP Situations 1 and 4, and the BESP anticipate a small area loss of Ancient Woodland (0.01ha) associated with the construction of T2ST; and
  - BESP Situation 4 experiences losses of Dwarf Shrub Heath (-0.551ha) with the remaining plans evidencing gains of 18.489ha.

Ecosystem Services

- Overall, ecosystem services experience a loss for the standard resource options and T2ST options, associated with the unmitigated impacts being considered within the assessment. The BVP Situation 8 has the least impact, resulting in a loss of -£181.41 £2021/year, with the losses of the other plans ranging from -£52,500.14 £2021/year to -£54,367.94 £2021/year. By retaining, enhancing, and creating additional habitats, the BNG Strategy could bring a wealth of associated ecosystem service benefits.
  - SESRO brings all plans an overall positive impact on climate regulation, water purification, and recreation ecosystem service provision. Disbenefits are seen for food production, air pollutant removal, and natural hazard regulation services. The best

performing plan in terms of ecosystem services for the SESRO development is the BESP, with an overall benefit of £35,334,000 £2022/year. The LCP and BVP Situations have an overall benefit of £32,005,000 £2022/year each. The positive values are related to the positive impacts the mitigation applied brings.

- All plans will experience the same environmental benefits for the Teddington DRA scheme, bringing benefits in relation to climate regulation, natural hazard regulation and agriculture ecosystem services. The £2022/year benefit is estimated to be £22,996, related to the positive impacts the mitigation applied brings.

Biodiversity Net Gain

- The standard resource options and T2ST options display a negative BNG score due to the unmitigated approach used. The LCP, BVP Situations 1 and 4, and BESP have the least impactful results, with a total percentage change ranging from -20.98% to -21.28%, and the BVP Situation 8 being the most impactful with a total percentage change of -34.63%. The BNG Strategy is focussed on opportunities for gain to address the losses because of these developments, outlining an approach for preparation, design, construction, and management and monitoring stages to ensure BNG is embedded throughout the development process.
    - Through the creation of the reservoir, wildlife ponds, wetland mosaic with wet woodland and species rich grasslands, the 150Mm^3 option for SESRO could achieve an overall net gain in biodiversity of 33.09% for habitats, and 16.41% for rivers (LCP, BVP Situations 1, 4 and 8), and the 75Mm^3 option could achieve an overall net gain in biodiversity of 51.64% for habitats, and 34.84% for rivers (included within the BESP). However, it is important to note, for both options hedgerows and woodlands cannot meet the requirements for on-site gain under the trading rules. Under the current proposals, all sizes of SESRO will not achieve ≥10% BNG for linear features such as hedgerows and tree lines. Additional lengths of hedgerow linear features need to be created, retained, or enhanced on site or off-site in order for SESRO to reach the ≥10% net gain target for hedgerows.
    - All plans have the same impact in terms of Teddington Direct River Abstraction (Indirect Water Recycling). Through the enhancement of other neutral grassland, and creation of both Lowland mixed deciduous woodland and other woodland (broadleaved), the Teddington Direct River Abstraction (Indirect Water Recycling) could achieve an overall net gain of 13.52% and 14.27% for habitats (permanent and temporary).

Under the national mandatory requirement for BNG, LPAs can set a specific % increase in 'habitat units' for developments requiring planning permission to achieve BNG. For example, Kingston upon Thames has outlined a 30% increase for BNG. This requirement has been considered in the BNG Strategy. As mentioned in Section 2.6, in the case where an LPA sets higher requirements than the mandatory 10%, it is not yet defined as to whether an increase beyond 10% is required for DCO schemes. Thames Water will review the further guidance as and when it becomes available.

7.1 Next Steps

As mentioned in Section 6 and throughout the report, Thames Water has taken the next steps in developing the WRMP from draft to revised draft through commissioning a BNG Delivery Strategy for the WRMP24 and a companywide BNG Strategy for Thames Water. As part of finalising the WRMP24, opportunities have been considered to create and improve habitat on-

site and off-site in order to achieve a minimum 10% net gain in BNG units and, by adopting a NbS approach, generate wider environmental benefits such as increased carbon sequestration and boosting resilience to climate change. The aim is to aid the development of more resilient options for the future provision of water for the Thames Water region.

The strategies are key tools for applying mitigation to the rdWRMP24 options, adding confidence on their viability in addition to a providing a framework for the design and implementation of BNG, in a changing climate.

For projects under mandatory BNG, this will also help to identify whether BNG could be achieved on-site, close to site, or via BNG Statutory Credits, following BNG Good Practice Principles as closely as practicable. The Strategies will also provide more granularity on how BNG could be delivered for the options, providing assurance on how BNG will be secured for standard resource options and SROs.

SRO Schemes will continue to develop through G3 scheme design and new habitat survey data collected which will more accurately inform the type and scale of BNG required, to then be discussed with regulators and stakeholders as appropriate.

Thames Water will continue to build on the BNG strategy by further developing plans for achieving gain for specific options as the options progress through detailed design, at a timepoint appropriate to option selection within the plan.

Annexes

Annex A: Natural capital stocks and mapping methodology

Annex B: LCP NCA and BNG Assessment Results

Annex C: BVP NCA and BNG Assessment Results

Annex D: BESP NCA and BNG Assessment Results

Annex E: Intermediate quantified carbon sequestration outputs

Annex F: Thames rdWRMP24 BNG Strategy

Annex A: Natural capital stocks and mapping methodology

Table A-1: Natural Capital Stocks and Mapping Methodology

Broad Natural Group	Subgroup	Mapping Methodology
Freshwater	Active flood plain	Areas at high or medium risks within the Environment Agency (EA)'s Risk of Flooding from Rivers and Sea dataset.
	Blanket Bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Chalk Rivers*	Mapped using the EA chalk rivers dataset and mapping intersections with OS watercourse polygons
	Coastal and floodplain grazing marsh	Area of coastal floodplain and grazing marsh mapped using Natural England's Priority Habitat Inventory
	Lakes and standing waters	Area of lakes and reservoirs mapped using the Centre for Ecology and Hydrology (CEH)'s UK Lakes Portal dataset.
	Lowland Fens	Area of lowland fens mapped using Natural England's Priority Habitat Inventory.
	Lowland raised bog	Area of lowland raised bog mapped using Natural England's Priority Habitat Inventory
	Modified waters e.g., reservoirs	Area of reservoirs mapped by selecting Ordnance Survey (OS) surface water polygons (Vector Map District) that coincide with CEH's Inventory of UK reservoirs (points).
	Other semi-natural habitats	Area of other semi-natural habitat mapped using Natural England's Priority Habitat Inventory (including upland and lowland grasslands, heathland, and saltmarsh).
	Ponds and ditches	Mapped by selecting surface waterbodies (from OS Vector Map District) that do not intersect rivers, are smaller than 2ha in size.
	Reedbeds	Area of reedbed habitat mapped using NE's Priority Habitat Inventory
	Rivers	Length of rivers mapped using EA's Water Framework Directive (WFD) river waterbodies dataset (cycle 1, to include coastal streams
Mountain, Moor and Heath	Blanket bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Dwarf shrub heath	Mapped using Natural England's Priority Habitat Inventory ('fragmented heath,' 'lowland heathland' and 'upland heathland')
	Inland rock, scree, and pavement (AML*)	Area of inland rock and limestone pavement above the moorland line, mapped using CEH's LCM2015 ('inland rock'), Natural England's Priority Habitats Inventory ('limestone pavement') and the Rural Payment Agency (RPA)'s Moorland Line dataset.
	Lakes and Reservoirs	Area of lakes and reservoirs above the moorland line, mapped using CEH's UK Lakes

Broad Natural Group	Subgroup	Mapping Methodology
		dataset, CEH's Inventory of UK reservoirs dataset and RPA's Moorland Line dataset.
	Mountain heath and willow scrub	Area of mountain heath and willow scrub mapped using Natural England's Priority Habitat Inventory.
	Rivers (AML)	Length of rivers mapped using EA's WFD river waterbodies dataset and RPA's Moorland Line dataset.
	Semi-natural grassland (AML*)	Area of semi-natural grassland above the moorland line, mapped using Natural England's Priority Habitat Inventory and RPA's moorland line dataset.
	Upland flushes fens and swamps	Area of upland flushes, fens, and swamps, mapped using Natural England's Priority Habitat Inventory.
	Wood pasture (AML*)	Area of wood pasture above the moorland line, mapped using Natural England's provisional Wood-Pasture and Parkland BAP Priority Habitat Inventory and RPA's Moorland line dataset.
	Woodland (AML*)	Area of woodland above the moorland line, mapped using FC's National Forest Inventory and RPA's moorland line dataset.
Urban	Blue space	Mapped by intersecting OS Vector Map District Surface Water with the Office for National Statistic (ONS)'s Built-Up areas dataset.
	Green space - not semi-natural	Area of urban green space (not semi-natural), mapped using the OS Open Greenspace Layer.
	Open mosaic habitats	Area of open mosaic habitats on previously developed land, mapped using Natural England's draft Open Mosaic Habitat dataset
	Woodland, scrub, and hedge	While urban scrub and hedge are difficult to map at a national scale, the area of urban woodland is mapped here by intersecting FC's National Forest Inventory with ONS Built-Up Areas.
	Semi-natural habitats	Mapped by intersecting Natural England's Priority Habitat Inventory habitats (excluding woodland, good quality semi-improved grassland and traditional orchards) with ONS Built-Up Areas
Farmland	Arable and rotational leys	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable, and horticulture combined. Mapped using UK Land Cover 2018 Sub Classes.
	Horticulture	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable, and horticulture combined. Mapped using CEH's Land Cover Map 2015 (LCM2015).

Broad Natural Group	Subgroup	Mapping Methodology
	Improved grassland	Area of improved grassland mapped using CEH's LCM2015.
	Orchards and top fruit	Area of orchards and top fruit mapped using Natural England's Priority Habitat Inventory ('traditional orchards')
Woodland	Ancient Woodland	Mapped using Natural England's Ancient Woodland dataset.
	Broadleaved, mixed and yew woodland	Mapped using FC's National Forest Inventory.
	Coniferous woodland	Area of coniferous woodland mapped using FC's National Forest Inventory
	Woodland priority habitats	Mapped using Natural England's Priority Habitat Inventory ('deciduous woodland').
Grasslands	Hay meadows	Area of hay meadow mapped using Natural England's Priority Habitat Inventory ('upland meadow' and 'lowland meadow').
	Other semi-natural grasslands	Area of other semi-natural grassland, mapped using Natural England's Priority Habitat Inventory ('upland calcareous,' 'lowland calcareous,' 'lowland dry acid,' 'good quality semi-improved', 'grass moorland' and 'purple moor grass and rush pasture').
Coastal	Beach	Area of beach mapped using OS Vector Map District ('foreshore'). Note that this dataset includes areas of intertidal sediment as well as beaches.
	Coastal lagoons	Area of coastal lagoons mapped using Natural England's Priority Habitat Inventory ('saline lagoons').
	Mudflats	Area of intertidal mudflats mapped using the EMODnet (Natural England) Intertidal Mudflats dataset.
	Salt marsh	Area of saltmarsh mapped using EA's Saltmarsh Extent dataset.
	Sand dunes	Area of sand dunes mapped using Natural England's Priority Habitat Inventory ('coastal dunes')
	Sea Cliff	Area of sea cliff habitat mapped using Natural England's Priority Habitat Inventory ('maritime cliff and slopes').
	Shingle	Area of shingle mapped using Natural England's Priority Habitat Inventory ('coastal vegetated shingle').
Marine	Intertidal rock	Area of intertidal rock mapped using Natural England's Open Marine Evidence Base (EUNIS code A1).
	Maerl beds	Area of maerl beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A5.51).
	Reefs	Area of potential reefs mapped using JNCC's Potential Appendix 1 Reefs

Broad Natural Group	Subgroup	Mapping Methodology
	Sea grass beds	Area of seagrass beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A2.61)
	Shallow subtidal sediment	Area of shallow subtidal sediment mapped using JNCC's UK Sea Map 2018 (biozone = shallow circalittoral or infralittoral and substrate = sediment, sand, or mud).
	Shelf subtidal sediment	Area of shelf subtidal sediment mapped using JNCC's UK Sea Map 2018 (biozone = deep circalittoral and substrate = sediment, sand, or mud).
	Subtidal rock	Area of subtidal rock mapped using JNCC's UK Sea Map 2018 (substrate = rock).
Soils	Nutrient Status of Soil	Mean estimates of total nitrogen concentration in topsoil (0-15cm depth) - % dry weight of soil, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).
	Soil Carbon/Organic Matter	Mean estimates of carbon density in topsoil (0-15cm depth) – tonnes per hectare, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).
	Soil Biota	Mean estimates of total abundance of invertebrates in topsoil (0-8 cm depth), mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).
Indicators of condition	Natural Aquifer Function	Area of groundwater catchment with 'good' quantitative status for WFD 2016, mapped using EA's WFD data and groundwater catchment boundaries (C2).
	Naturalness of Flow Regime	The WFD hydrological regime classification describe the naturalness of river flows. This map shows the length of river with 'high' WFD hydrological status in 2016, mapped using EA's WFD data and river water bodies (C2).
	Lack of Physical Modifications of Water Bodies	Lack of physical modification of rivers, mapped using EA's Reasons for Not Achieving Good Status data (SWMI = 'physical modification'), 2013-2016.
	Presence and Frequency of Pollinator Food Plants	Mean estimates of number of nectar plant species for bees per 2x2m plot, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).
	Chemical status of water bodies	River chemical status for WFD 2016, mapped using EA's WFD data and river water bodies (C2).

* The list of natural capital stocks as described in NERC285 have been supplemented with additional abiotic stocks and key habitats that are vital to the Thames Water region.

Annex B: LCP NCA and BNG Assessment Results

A summary of what is included within each table is as follows:

- Table B-1 shows the predicted impacts on natural capital during and post-construction.
- Table B-2 summarises the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment.
- Table B-3 summarises the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment.
- Table B-4 shows the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Table B-1.

Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

The LCP also includes options *Reservoir New Reservoir - SESRO 150Mm^3 - Construction*, *Teddington to Kempton (displacement of water), Direct River Abstraction - Teddington to Thames Lee Tunnel Shaft 100 MLD, Teddington Direct River Abstraction (Indirect Water Recycling) Transfer of Treated Effluent from Mogden to Teddington 75Ml/d.* Please refer to Section 3 'Feasible Option Outputs' for their results.

Table B-1: Predicted impacts on natural capital stocks during and post-construction.

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present within option boundary during construction (ha)	Stocks present within option boundary post-construction (ha)	Change (ha)
SouthEast Water to Guildford WRZ				
Arable	12.56	0.00	11.96	-0.60
Pastoral	2.93	0.00	2.93	0.00
Other semi-natural grassland	4.36	0.00	4.36	0.00
Broadleaved, Mixed and Yew Woodland	3.43	0.00	3.43	0.00
Coniferous Woodland	2.79	0.00	2.79	0.00
Blue Space	0.06	0.06	0.06	0.00
Greenspace	0.33	0.00	0.33	0.00
Urban Woodland	2.54	0.00	2.54	0.00
Groundwater Development - Southfleet & Greenhithe				
Arable	5.68	0.00	5.68	0.00
Pastoral	2.43	0.00	2.43	0.00
Broadleaved, Mixed and Yew Woodland	1.04	0.00	1.04	0.00
Ponds and linear features	0.02	0.02	0.02	0.00
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastoral	2.28	0.00	2.28	0.00
Broadleaved, Mixed and Yew Woodland	0.00085	0.00	0.00085	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active flood plain	1.20	1.20	1.20	0.00

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present within option boundary during construction (ha)	Stocks present within option boundary post-construction (ha)	Change (ha)
New WTW at Kempton - 100Ml/d - Construction				
Broadleaved, Mixed and Yew Woodland	0.11	0	0.11	0.00
Woodland Priority Habitat	0.80	0.00	0.80	0.00
Active Flood Plain	3.12	0	0	-3.12
Rivers	0.38	0.38	0.38	0.00
New Medmenham Surface Water WTW Ph1 - Construction				
Arable	10.75	0.00	9.82	-0.93
Pastoral	6.74	0.00	4.20	-2.54
Broadleaved, Mixed and Yew Woodland	0.18	0.00	0.18	0.00
Coniferous Woodland	0.01	0.00	0.01	0.00
*Ancient Woodland	0.001	0.001	0.001	0.00
Medmenham intake - 53				
Arable	1.60	0.00	1.36	-0.24
Pastoral	0.52	0.00	0.52	0.00
Active Flood Plain	0.44	0.44	0.44	0.00
Groundwater Development - Woods Farm Existing Source Increase DO				
Arable	3.28	0.00	3.28	0.00
Pastoral	2.48	0.00	2.48	0.00
Other semi-natural grassland	0.00	0.00	0.00	0.00
Broadleaved, Mixed and Yew Woodland	0.71	0.00	0.71	0.00
*Ancient Woodland	0.20	0.20	0.20	0.00
Active flood plain	0.33	0.33	0.33	0.00
Oxford Canal - Duke's Cut (SWOX) - Construction				
Coastal and Floodplain Grazing Marsh	12.91	0.00	12.91	0.00
Lowland Fens	0.27	0.00	0.27	0.00
Arable	88.43	0.00	88.43	0.00
Pastoral	81.17	0.00	81.17	0.00
Hay Meadows	0.07	0.00	0.07	0.00
Other semi-natural grassland	3.15	0.00	3.15	0.00
Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	21.15	0.00	21.15	0.00
Coniferous Woodland	0.07	0.00	0.07	0.00
*Ancient Woodland	0.000005	0.000005	0.000005	0.00
Blue space	78.01	78.01	78.01	0.00
Greenspace	4.58	0.00	4.58	0.00
Urban semi-natural woodland	3.25	0.00	3.25	0.00
Urban Woodland	0.21	0.00	0.21	0.00
Lakes and Standing Waters	0.77	0.77	0.77	0.00
Rivers	47.43	47.43	47.43	0.00

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present within option boundary during construction (ha)	Stocks present within option boundary post-construction (ha)	Change (ha)
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Ponds and linear features	62.05	62.05	62.05	0.00
Henley to SWOX Transfer– 2.4Ml/d				
Arable	0.63	0	0.63	0
Pastures	5.48	0	4.56	-0.92
Other Semi-Natural Grassland	0.03	0.03	0.03	0
Broadleaved, Mixed and Yew Woodland	3.54	0	3.54	0
Coniferous Woodland	0.04	0	0.04	0
*Ancient Woodland	1.56	1.56	1.56	0
Urban Woodland	0.22	0	0.22	0
Abingdon Reservoir to Farmoor Reservoir pipeline				
Coastal and Floodplain Grazing Marsh	2.29	0.00	2.29	0.00
Arable	10.51	0.00	10.51	0.00
Pastoral	16.47	0.00	16.47	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Broadleaved, Mixed and Yew Woodland	0.51	0.00	0.51	0.00
Coniferous Woodland	0.22	0.00	0.22	0.00
Active floodplain	4.51	4.51	4.51	0.00
Ponds and linear features	0.01	0.01	0.01	0.00
Oxford Canal - Transfer from Duke's Cut to Farmoor				
Coastal and Floodplain Grazing Marsh	6.72	0.00	6.72	0.00
Arable	8.40	0.00	8.40	0.00
Pastoral	4.60	0.00	4.60	0.00
Hay Meadows	0.69	0.00	0.69	0.00
Active floodplain	11.95	11.95	11.95	0.00
Ponds and linear features	0.06	0.06	0.06	0.00
Henley to SWOX Transfer – 2.4Ml/d				
Arable	0.63	0.00	0.63	0.00
Pastures	5.48	0.00	4.56	-0.92
Other Semi-Natural Grassland	0.03	0.03	0.03	0.00
Broadleaved, Mixed and Yew Woodland	3.54	0.00	3.54	0.00
Coniferous Woodland	0.04	0.00	0.04	0.00
*Ancient Woodland	1.56	1.56	1.56	0.00
Urban Woodland	0.22	0.00	0.22	0.00
T2ST Full Scheme				

Natural capital stock	Area within option boundary pre-construction (ha)	Stocks present within option boundary during construction (ha)	Stocks present within option boundary post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	5.18	0.00	5.18	0.00
Lowland Fens	0.11	0.00	0.11	0.00
Arable	625.59	0.00	580.81	-44.78
Pastures	118.63	0.00	117.08	-1.56
Other Semi-Natural Grassland	14.34	0.00	13.01	-1.33
Broadleaved, Mixed and Yew Woodland	0.84	0.00	0.84	0.00
Woodland Priority Habitat	8.87	0.00	8.87	0.00
Coniferous Woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.07	0.00	0.07	0.00
Active Flood Plain	14.08	6.43	6.43	-7.66
Rivers (length)	0.55	0.55	0.55	0.00
Ponds & linear features	0.14	0.14	0.14	0.00

(Figures rounded to 2sp, those with '0.00*' have a very small value.)

*For these options, Ancient Woodland is presumed to be avoided during construction, including its associated root protection zone, as options have been realigned to avoid these areas, in most cases following road networks. Therefore, there is no expected loss of Ancient Woodland for all standard resource options.

Table B-2: Monetised assessment of the unmitigated predicted permanent – impacts on the provision of ecosystem services.

Ecosystem Service	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
SouthEast Water to Guildford					
Carbon storage	£13,270.66	£0.00	-£13,270.66	£10,410.79	-£2,859.87
Natural hazard management	£596.25	£0.00	-£596.25	£447.19	-£149.06
Air Pollutant Removal	£4,430.71	£0.00	-£4,430.71	£3,477.91	-£952.80
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£311,200.00	£311,011.00	-£189.00	£311,011.00	-£189.00
Total	£329,497.62	£311,011.00	-£18,486.62	£325,346.89	-£4,150.73
Groundwater Development - Southfleet & Greenhithe					
Carbon storage	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Natural hazard management	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out

Ecosystem Service	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard management	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air Pollutant Removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£1,077.59	£0.00	-£1,077.59	-£896.18	-£181.41
New WTW at Kempton - 100Ml/d - Construction					
Carbon storage	£1,659.83	£0.00	-£1,659.83	£1,244.87	-£414.96
Natural hazard management	£87.23	£0.00	-£87.23	£65.42	-£21.81
Air Pollutant Removal	£265.23	£0.00	-£265.23	£198.92	-£66.31
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,012.29	£0.00	-£2,012.29	£1,509.21	-£503.08
New Medmenham Surface Water WTW Ph1 - Construction					
Carbon storage	£1,780.76	£1.82	-£1,778.93	£1,280.47	-£500.29
Natural hazard management	£18.31	£0.10	-£18.21	£13.76	-£4.55
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£1,622,964.28	£1,754,602.14	£131,637.85	£1,621,557.71	-£1,406.57
Total	£1,624,763.35	£1,754,604.06	£129,840.71	£1,622,851.93	-£1,911.41
Medmenham intake - 53					
Carbon storage	£138.59	£0.00	-£138.59	£129.17	-£9.42
Natural hazard management	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out

Ecosystem Service	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Food production	£1,622,964.28	£1,622,879.89	-£84.39	£1,622,879.89	-£84.39
Total	£1,623,102.87	£1,622,879.89	-£222.99	£1,623,009.06	-£93.82
Groundwater Development - Woods Farm Existing Source Increase DO					
Carbon storage	£2,149.97	£364.80	-£1,785.17	£1,826.21	-£323.76
Natural hazard management	£87.23	£19.17	-£68.06	£70.22	-£17.02
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£2,237.20	£383.97	-£1,853.23	£1,896.43	-£340.77
Oxford Canal - Duke's Cut (SWOX) - Construction					
Carbon storage	£55,527.28	£0.00	-£55,527.28	£45,705.86	-£9,821.42
Natural hazard management	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Air Pollutant Removal	£8,426.74	£0.00	-£8,426.74	£6,832.39	-£1,594.35
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£63,954.02	£0.00	-£63,954.02	£52,538.25	-£11,415.76
Abingdon Reservoir to Farmoor Reservoir pipeline					
Carbon storage	£4,158.46	£0.00	-£4,158.46	£3,825.58	-£332.88
Natural hazard management	£115.16	£0.00	-£115.16	£86.37	-£28.79
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£4,273.63	£0.00	-£4,273.63	£3,911.96	-£361.67
Oxford Canal - Transfer from Duke's Cut to Farmoor					
Carbon storage	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Natural hazard management	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Air Pollutant Removal	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Total	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00

Ecosystem Service	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Henley to SWOX Transfer– 2.4Ml/d					
Carbon storage	£10,717.02	£2,849.80	-£7,867.22	£8,821.96	-£1,895.06
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£293,756.53	£293,216.63	-£539.91	£293,216.63	-£539.91
Total	£304,473.55	£296,066.43	-£8,407.13	£302,038.59	-£2,434.97
T2ST Full Scheme					
Carbon storage	£62,907.62	£0.00	-£62,907.62	£55,974.02	-£6,933.59
Natural hazard regulation	£957.06	£0.00	-£957.06	£717.11	-£239.95
Food production	£821,436.32	£810,724.76	-£10,711.56	£810,724.76	-£10,711.56
Total	£885,300.99	£810,724.76	-£74,576.24	£867,415.89	-£17,885.11

Table B-3: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water Purification				
• South East Water to Guildford • Groundwater Development - Southfleet & Greenhithe • Manager Aquifer Recharge - Horton Kirby ASR • New WTW at Kempton - 100Ml/d - Construction • New Medmenham Surface Water WTW • Enhancement Groundwater Development - Woods Farm Existing Source Increase DO • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • Henley to Transfer SWOX – 2.4Ml/d	The stock likely provides a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced	The provision of water purification provided by the stock will likely be reduced due to the option.

Option	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• Oxford Canal - Duke's Cut (SWOX) – Construction				
• T2ST Full Scheme	The stock likely provides a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced	The provision of water purification provided by the stock will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Water Regulation				
• Groundwater Development - Southfleet & Greenhithe • New WTW at Kempton - 100Ml/d - Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • T2ST Full Scheme	The stocks provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the stock will likely remain.	0

Table B-4: Summary of unmitigated BNG outputs

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change (Habitat BU)
SouthEast Water to Guildford	149.88	78.78	-71.10	-47.44
Groundwater Development - Southfleet & Greenhithe	33.72	20.87	-12.85	-38.11%

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change (Habitat BU)
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78	-34.63%
New WTW at Kempton - 100Ml/d - Construction	10.48	1.53	-8.95	-85.41%
Medmenham WTW Ph1 - Construction	49.94	34.38	-15.56	-31.16%
Medmenham intake – 53	5.28	4.43	-0.85	-16.13%
Groundwater Development - Woods Farm Existing Source Increase DO	25.00	15.83	-9.17	-36.67%
Oxford Canal - Duke's Cut (SWOX) - Construction	2037.74	1761.29	-276.45	-13.57%
Abingdon Reservoir to Farmoor Reservoir pipeline	121.02	88.14	-32.88	-27.17%
Oxford Canal - Transfer from Duke's Cut to Farmoor	127.60	62.56	-65.04	-50.97%
Henley to SWOX Transfer – 2.4Ml/d	53.78	35.08	-18.70	-34.78%
T2ST Full Scheme	2077.46	1596.23	-481.23	-23.16%

Annex C: BVP NCA and BNG Assessment Results

A summary of what is included within each table is as follows:

- Tables Table C-1, Table C-5, and Table C-9 show the predicted impacts on natural capital during and post-construction for Situations 1, 4, and 8 respectively.
- Table C-2, Table C-6, and Table C-10 summarise the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment for situations 1, 4 and 8 respectively.
- Table C-3, Table C-7, and Table C-11 summarise the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment for situations 1, 4 and 8 respectively.
- Table C-4, Table C-8, and Table C-12 show the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Tables Table C-1, Table C-5, and Table C-9 for situations 1, 4 and 8 respectively.

Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

Situation 1

The BVP Situation 1 also includes options *Reservoir Abingdon 150*, *TWU_KEM_HI-TFR_TED_ALL_tedd-kempton, DRA – Teddington to Thames Lee Tunnel Shaft 100Ml/d, Teddington Direct River Abstraction (DRA) 75Ml/d – Construction* and *Mogden to Teddington outfall 100Ml/d.* Please refer to Section 3 'Feasible Option Outputs' for their results.

Table C-1: Predicted impacts on natural capital stocks during and post-construction.

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
SouthEast Water to Guildford				
Arable	12.56	0.00	11.96	-0.60
Pastures	2.93	0.00	2.93	0.00
Other Semi-Natural Grassland	4.36	0.00	4.36	0.00
Broadleaved, Mixed and Yew Woodland	3.43	0.00	3.43	0.00
Coniferous Woodland	2.79	0.00	2.79	0.00
Blue Space	0.06	0.06	0.06	0.00
Greenspace	0.33	0.00	0.33	0.00
Urban Woodland	2.54	0.00	2.54	0.00
Groundwater Development - Southfleet & Greenhithe				
Arable	5.68	0.00	5.68	0.00
Pastures	2.43	0.00	2.43	0.00
Broadleaved, Mixed and Yew Woodland	1.04	0.00	1.04	0.00
Pond & Linear Features	0.02	0.02	0.02	0.00
New WTW at Kempton - 100Ml/d - Construction				

Broadleaved, Mixed and Yew Woodland	0.11	0.00	0.11	0.00
Woodland Priority Habitat	0.80	0.00	0.80	0.00
Active Flood Plain	3.12	0.00	0.00	-3.12
Rivers (length)	0.38	0.38	0.38	0.00
New Medmenham Surface Water WTW Ph1 - Construction				
Arable	10.75	0.00	9.82	-0.93
Pastures	6.74	0.00	4.2	-2.54
Broadleaved, Mixed and Yew Woodland	0.18	0.00	0.18	0.00
Coniferous Woodland	0.01	0.00	0.01	0.00
*Ancient Woodland	0.001	0.001	0.001	0.00
Medmenham intake – 53				
Arable	1.60	0.00	1.36	-0.24
Pastures	0.52	0.00	0.52	0.00
Active Flood Plain	0.44	0.44	0.44	0.00
Groundwater Development - Woods Farm Existing Source Increase DO				
Arable	3.28	0.00	3.28	0.00
Pastures	2.48	0.00	2.48	0.00
Broadleaved, Mixed and Yew Woodland	0.71	0.00	0.71	0.00
*Ancient Woodland	0.20	0.20	0.20	0.00
Active Flood Plain	0.33	0.33	0.33	0.00
Oxford Canal - Duke's Cut (SWOX) - Construction				
Coastal and Floodplain Grazing Marsh	12.91	0.00	12.91	0.00
Lowland Fens	0.27	0.00	0.27	0.00
Arable	88.43	0.00	88.43	0.00
Pastures	81.17	0.00	81.17	0.00
Hay Meadows	0.07	0.00	0.07	0.00
Other Semi-Natural Grassland	3.15	0.00	3.15	0.00
Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	21.15	0.00	21.15	0.00
Coniferous Woodland	0.07	0.00	0.07	0.00
Blue Space	78.01	78.01	78.01	0.00
Greenspace	4.58	0.00	4.58	0.00
Urban Semi Natural Habitat	3.25	0.00	3.25	0.00
Urban Woodland	0.21	0.00	0.21	0.00
Lakes and Standing Waters	0.77	0.77	0.77	0.00
Rivers (length)	47.43	47.43	47.43	0.00
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Pond & Linear Features	62.05	62.05	62.05	0.00
Abingdon Reservoir to Farmoor Reservoir pipeline				

Coastal and Floodplain Grazing Marsh	2.29	0.00	2.29	0.00
Arable	10.51	0.00	10.51	0.00
Pastures	16.47	0.00	16.47	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Broadleaved, Mixed and Yew Woodland	0.51	0.00	0.51	0.00
Coniferous Woodland	0.22	0.00	0.22	0.00
Active Flood Plain	4.51	4.51	4.51	0.00
Pond & Linear Features	0.01	0.01	0.01	0.00
Oxford Canal - Transfer from Duke's Cut to Farmoor				
Coastal and Floodplain Grazing Marsh	6.72	0.00	6.72	0.00
Arable	8.40	0.00	8.40	0.00
Pastures	4.6	0.00	4.6	0.00
Hay Meadows	0.69	0.00	0.69	0.00
Active Flood Plain	11.95	11.95	11.95	0.00
Pond & Linear Features	0.06	0.06	0.06	0.00
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastures	2.28	0.00	2.28	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active Flood Plain	1.20	1.20	1.20	0.00
Henley to SWOX Transfer– 2.4Ml/d				
Arable	0.63	0.00	0.63	0.00
Pastures	5.48	0.00	4.56	-0.92
Other Semi-Natural Grassland	0.03	0.03	0.03	0.00
Broadleaved, Mixed and Yew Woodland	3.54	0.00	3.54	0.00
Coniferous Woodland	0.04	0.00	0.04	0.00
*Ancient Woodland	1.56	1.56	1.56	0.00
Urban Woodland	0.22	0.00	0.22	0.00
Deephams Reuse – 46.5 Ml/d, direct to KGV - Construction				
Broadleaved, Mixed and Yew Woodland	1.19	0.00	1.19	0.00
Active Flood Plain	0.35	0.35	0.35	0.00
Ponds & Linear Features	0.03	0.03	0.03	0.00
Thames Lee Tunnel extension from Lockwood PS to KGV Reservoir intake				
Broadleaved, Mixed and Yew Woodland	0.29	0.00	0.29	0.00
Woodland Priority Habitat	0.44	0.44	0.44	0.00
Greenspace	1.40	0.00	1.40	0.00
Urban Woodland	0.01	0.01	0.01	0.00
Active Flood Plain	5.88	5.88	5.88	0.00
Rivers (length)	0.90	0.90	0.90	0.00

Ponds & Linear Features	0.09	0.09	0.09	0.00
T2ST Full Scheme				
Coastal and Floodplain Grazing Marsh	5.18	0.00	5.18	0.00
Lowland Fens	0.11	0.00	0.11	0.00
Arable	625.59	0.00	580.81	-44.78
Pastures	118.63	0.00	117.08	-1.56
Other Semi-Natural Grassland	14.34	0.00	13.01	-1.33
Broadleaved, Mixed and Yew Woodland	0.84	0.00	0.84	0.00
Woodland Priority Habitat	8.87	0.00	8.87	0.00
Coniferous Woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.07	0.00	0.07	0.00
Active Flood Plain	14.08	6.43	6.43	-7.66
Rivers (length)	0.55	0.55	0.55	0.00
Ponds & linear features	0.14	0.14	0.14	0.00

*For these options, Ancient Woodland is presumed to be avoided during construction, including its associated root protection zone, as options have been realigned to avoid these areas, in most cases following road networks. Therefore, there is no expected loss of Ancient Woodland for all standard resource options.

Table C-2: Monetised assessment of the unmitigated predicted permanent - impacts on the provision of ecosystem services.

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
SouthEast Water to Guildford					
Carbon storage	£13,270.00	£0.00	-£13,270.66	£10,410.79	-£2,859.87
Natural hazard regulation	£596.25	£0.00	-£596.25	£447.19	-£149.06
Air Pollutant Removal	£4,430.71	£0.00	-£4,430.71	£3,477.91	-£952.80
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£311,200.00	£311,011.00	-£189.00	£311,011.00	-£189.00
Total	£329,497.62	£311,011.00	-£18,486.62	£325,346.89	-£4,150.73
Groundwater Development - Southfleet & Greenhithe					
Carbon storage	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out

Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
New WTW at Kempton - 100Ml/d - Construction					
Carbon storage	£1,659.83	£0.00	-£1,659.83	£1,244.87	-£414.96
Natural hazard regulation	£87.23	£0.00	-£87.23	£65.42	-£21.81
Air Pollutant Removal	£265.23	£0.00	-£265.23	£198.92	-£66.31
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,012.29	£0.00	-£2,012.29	£1,509.22	-£503.07
New Medmenham Surface Water WTW Ph1 - Construction					
Carbon storage	£1,780.76	£1.82	-£1,778.93	£1,280.47	-£500.29
Natural hazard regulation	£18.31	£0.10	-£18.21	£13.76	-£4.55
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,754,602.14	£131,637.85	£1,621,557.71	-£1,406.57
Total	£1,624,763.35	£1,754,604.06	£129,840.71	£1,622,851.93	-£1,911.41
Medmenham intake – 53					
Carbon storage	£138.59	£0.00	-£138.59	£129.17	-£9.42
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,622,879.89	-£84.39	£1,622,879.89	-£84.39
Total	£1,623,102.87	£1,622,879.89	-£222.99	£1,623,009.06	-£93.82
Oxford Canal - Duke's Cut (SWOX) - Construction					
Carbon storage	£55,527.28	£0.00	-£55,527.28	£45,705.86	-£9,821.42
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	£8,426.74	£0.00	-£8,426.74	£6,832.39	-£1,594.35

Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£63,954.02	£0.00	-£63,954.02	£52,538.25	-£11,415.76
Abingdon Reservoir to Farmoor Reservoir pipeline					
Carbon storage	£4,158.46	£0.00	-£4,158.46	£3,825.58	-£332.88
Natural hazard regulation	£115.16	£0.00	-£155.16	£86.37	-£28.79
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£4,273.63	£0.00	-£4,273.63	£3,911.96	-£361.67
Oxford Canal - Transfer from Duke's Cut to Farmoor					
Carbon storage	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard regulation	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air Pollutant Removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41
Henley to SWOX Transfer– 2.4Ml/d					
Carbon storage	£10,717.02	£2,849.80	-£7,867.22	£8,821.96	-£1,895.06
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£293,756.53	£293,216.63	-£539.91	£293,216.63	-£539.91

Total	£304,473.55	£296,066.43	-£8,407.13	£302,038.59	-£2,434.97
Deephams Reuse – 46.5 Ml/d, direct to KGV - Construction					
Carbon storage	£2,170.55	£0.00	-£2,170.55	£1,627.91	-£542.64
Natural hazard regulation	£114.07	£0.00	-£114.07	£85.56	-£28.52
Air Pollutant Removal	£346.84	£0.00	-£346.84	£260.13	-£86.71
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,631.46	£0.00	-£2,631.46	£1,973.59	-£657.86
Thames Lee Tunnel extension from Lockwood PS to KGV Reservoir intake					
Carbon storage	£1,349.75	£1,349.75	£0.00	£1,012.31	-£337.44
Natural hazard regulation	£65.64	£39.94	-£25.69	£49.23	-£16.41
Air Pollutant Removal	£221.94	£137.41	-£84.52	£166.45	-£55.48
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,637.33	£1,527.11	-£110.22	£1,228.00	-£409.33
T2ST Full Scheme					
Carbon storage	£62,907.62	£0.00	-£62,907.62	£55,974.02	-£6,933.59
Natural hazard regulation	£957.06	£0.00	-£957.06	£717.11	-£239.95
Food production	£821,436.32	£810,724.76	-£10,711.56	£810,724.76	-£10,711.56
Total	£885,300.99	£810,724.76	-£74,576.24	£867,415.89	-£17,885.11

Table C-3: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
• SouthEast Water to Guildford • Groundwater Development - Southfleet & Greenhithe • New WTW at Kempton - 100Ml/d – Construction • Medmenham WTW Ph1 – Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor	The stocks both temporarily and permanently lost likely provide a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced	The provision of water purification provided by the associated stocks will likely be reduced due to the option.

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• Manager Aquifer Recharge - Horton Kirby ASR • Henley to SWOX Transfer – 2.4Ml/d • Deephams Reuse – 46.5 Ml/d, direct to KGV • Thames Lee Tunnel extension from Lockwood PS to KGV Reservoir intake	source.			
• T2ST Full Scheme	The stocks both temporarily and permanently lost likely offer a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The provision of water purification by the associated stocks will likely be reduced due to the option. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.
Water Regulation				
• Groundwater Development - Southfleet & Greenhithe • New WTW at Kempton - 100Ml/d – Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • Deephams Reuse – 46.5 Ml/d, direct to KGV Thames Lee Tunnel extension from Lockwood PS to KGV Reservoir intake • T2ST Full Scheme	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the associated stocks will likely remain.	0

Table C-4: Summary of unmitigated BNG outputs

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change (Habitat BU)
SouthEast Water to Guildford	149.88	78.78	-47.44%	-71.10
Groundwater Development - Southfleet & Greenhithe	33.72	20.87	-12.85%	-38.11
New WTW at Kempton - 100Ml/d – Construction	15.04	6.09	-8.95%	-59.50
New Medmenham Surface Water WTW Ph1 – Construction	49.94	34.38	-15.56%	-31.16
Medmenham intake – 53	5.28	4.43	-0.85%	-16.13
Oxford Canal - Duke's Cut (SWOX) - Construction	3148.14	2871.69	-276.45%	-8.78
Abingdon Reservoir to Farmoor Reservoir pipeline	121.02	88.14	-32.88%	-27.17
Oxford Canal - Transfer from Duke's Cut to Farmoor	127.60	62.56	-65.04%	-50.97
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78%	-34.63
Henley to SWOX Transfer – 2.4Ml/d	53.78	35.08	-18.70%	-34.78
Deephams Reuse – 46.5 Ml/d, direct to KGV – Construction	9.76	5.82	-40.38%	-3.94
Thames Lee Tunnel extension from Lockwood PS to KGV Reservoir intake	24.80	18.34	-26.04%	-6.46
T2ST Full Scheme	2077.46	1596.23	-481.23	-23.16%

Situation 4

The BVP Situation 4 also includes options *Reservoir Abingdon 150*, *TWU_KEM_HI-TFR_TED_ALL_tedd-kempton, DRA – Teddington to Thames Lee Tunnel Shaft 100Ml/d, Teddington Direct River Abstraction (DRA) 75Ml/d – Construction* and *Mogden to Teddington outfall 100Ml/d.* Please refer to Section 3 'Feasible Option Outputs' for their results.

Table C-5: Predicted impacts on natural capital stocks during and post-construction.

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)

SouthEast Water to Guildford				
Arable	12.56	0.00	11.96	-0.60
Pastures	2.93	0.00	2.93	0.00
Other Semi-Natural Grassland	4.36	0.00	4.36	0.00
Broadleaved, Mixed and Yew Woodland	3.43	0.00	3.43	0.00
Coniferous Woodland	2.79	0.00	2.79	0.00
Blue Space	0.06	0.06	0.06	0.00
Greenspace	0.33	0.00	0.33	0.00
Urban Woodland	2.54	0.00	2.54	0.00
Groundwater Development - Southfleet & Greenhithe				
Arable	5.68	0.00	5.68	0.00
Pastures	2.43	0.00	2.43	0.00
Broadleaved, Mixed and Yew Woodland	1.04	0.00	1.04	0.00
Pond & Linear Features	0.02	0.02	0.02	0.00
New WTW at Kempton - 100Ml/d - Construction				
Broadleaved, Mixed and Yew Woodland	0.11	0.00	0.11	0.00
Woodland Priority Habitat	0.80	0.00	0.80	0.00
Active Flood Plain	3.12	0.00	0.00	-3.12
Rivers (length)	0.38	0.38	0.38	0.00
New Medmenham Surface Water WTW Ph1 - Construction				
Arable	10.75	0.00	9.82	-0.93
Pastures	6.74	0.00	4.2	-2.54
Broadleaved, Mixed and Yew Woodland	0.18	0.00	0.18	0.00
Coniferous Woodland	0.01	0.00	0.01	0.00
*Ancient Woodland	0.001	0.001	0.001	0.00
Medmenham intake – 53				
Arable	1.60	0.00	1.36	-0.24
Pastures	0.52	0.00	0.52	0.00
Active Flood Plain	0.44	0.44	0.44	0.00
Groundwater Development - Woods Farm Existing Source Increase DO				
Arable	3.28	0.00	3.28	0.00
Pastures	2.48	0.00	2.48	0.00
Broadleaved, Mixed and Yew Woodland	0.71	0.00	0.71	0.00
*Ancient Woodland	0.20	0.20	0.20	0.00
Active Flood Plain	0.33	0.33	0.33	0.00
Oxford Canal - Duke's Cut (SWOX) - Construction				
Coastal and Floodplain Grazing Marsh	12.91	0.00	12.91	0.00
Lowland Fens	0.27	0.00	0.27	0.00
Arable	88.43	0.00	88.43	0.00
Pastures	81.17	0.00	81.17	0.00
Hay Meadows	0.07	0.00	0.07	0.00
Other Semi-Natural Grassland	3.15	0.00	3.15	0.00

Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	21.15	0.00	21.15	0.00
Coniferous Woodland	0.07	0.00	0.07	0.00
Blue Space	78.01	78.01	78.01	0.00
Greenspace	4.58	0.00	4.58	0.00
Urban Semi Natural Habitat	3.25	0.00	3.25	0.00
Urban Woodland	0.21	0.00	0.21	0.00
Lakes and Standing Waters	0.77	0.77	0.77	0.00
Rivers (length)	47.43	47.43	47.43	0.00
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Pond & Linear Features	62.05	62.05	62.05	0.00
Abingdon Reservoir to Farmoor Reservoir pipeline				
Coastal and Floodplain Grazing Marsh	2.29	0.00	2.29	0.00
Arable	10.51	0.00	10.51	0.00
Pastures	16.47	0.00	16.47	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Broadleaved, Mixed and Yew Woodland	0.51	0.00	0.51	0.00
Coniferous Woodland	0.22	0.00	0.22	0.00
Active Flood Plain	4.51	4.51	4.51	0.00
Pond & Linear Features	0.01	0.01	0.01	0.00
Oxford Canal - Transfer from Duke's Cut to Farmoor				
Coastal and Floodplain Grazing Marsh	6.72	0.00	6.72	0.00
Arable	8.40	0.00	8.40	0.00
Pastures	4.6	0.00	4.6	0.00
Hay Meadows	0.69	0.00	0.69	0.00
Active Flood Plain	11.95	11.95	11.95	0.00
Pond & Linear Features	0.06	0.06	0.06	0.00
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastures	2.28	0.00	2.28	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active Flood Plain	1.20	1.20	1.20	0.00
Henley to SWOX Transfer – 5Ml/d				
Arable	0.48	0.00	0.48	0.00
Pastures	7.81	0.00	7.81	0.00
Other Semi-Natural Grassland	0.01	0.00	0.01	0.00
Broadleaved, Mixed and Yew Woodland	0.48	0.00	0.48	0.00
Coniferous Woodland	0.19	0.00	0.19	0.00

Woodland Priority Habitat	2.84	0.00	2.84	0.00
*Ancient Woodland	1.06	1.06	1.06	0.00
Greenspace	0.13	0.00	0.13	0.00
T2ST Full Scheme				
Coastal and Floodplain Grazing Marsh	5.18	0.00	5.18	0.00
Lowland Fens	0.11	0.00	0.11	0.00
Arable	625.59	0.00	580.81	-44.78
Pastures	118.63	0.00	117.08	-1.56
Other Semi-Natural Grassland	14.34	0.00	13.01	-1.33
Broadleaved, Mixed and Yew Woodland	0.84	0.00	0.84	0.00
Woodland Priority Habitat	8.87	0.00	8.87	0.00
Coniferous Woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.07	0.00	0.07	0.00
Active Flood Plain	14.08	6.43	6.43	-7.66
Rivers (length)	0.55	0.55	0.55	0.00
Ponds & linear features	0.14	0.14	0.14	0.00

*For these options, Ancient Woodland is presumed to be avoided during construction, including its associated root protection zone, as options have been realigned to avoid these areas, in most cases following road networks. Therefore, there is no expected loss of Ancient Woodland for all standard resource options.

Table C-6: Monetised assessment of the unmitigated predicted permanent - impacts on the provision of ecosystem services.

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
SouthEast Water to Guildford					
Carbon storage	£13,270.00	£0.00	-£13,270.66	£10,410.79	-£2,859.87
Natural hazard regulation	£596.25	£0.00	-£596.25	£447.19	-£149.06
Air Pollutant Removal	£4,430.71	£0.00	-£4,430.71	£3,477.91	-£952.80
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£311,200.00	£311,011.00	-£189.00	£311,011.00	-£189.00
Total	£329,497.62	£311,011.00	-£18,486.62	£325,346.89	-£4,150.73
Groundwater Development - Southfleet & Greenhithe					
Carbon storage	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out

Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
New WTW at Kempton - 100Ml/d – Construction					
Carbon storage	£1,659.83	£0.00	-£1,659.83	£1,244.87	-£414.96
Natural hazard regulation	£87.23	£0.00	-£87.23	£65.42	-£21.81
Air Pollutant Removal	£265.23	£0.00	-£265.23	£198.92	-£66.31
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,012.29	£0.00	-£2,012.29	£1,509.22	-£503.07
New Medmenham Surface Water WTW Ph1 – Construction					
Carbon storage	£1,780.76	£1.82	-£1,778.93	£1,280.47	-£500.29
Natural hazard regulation	£18.31	£0.10	-£18.21	£13.76	-£4.55
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,754,602.14	£131,637.85	£1,621,557.71	-£1,406.57
Total	£1,624,763.35	£1,754,604.06	£129,840.71	£1,622,851.93	-£1,911.41
Medmenham intake – 53					
Carbon storage	£138.59	£0.00	-£138.59	£129.17	-£9.42
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,622,879.89	-£84.39	£1,622,879.89	-£84.39
Total	£1,623,102.87	£1,622,879.89	-£222.99	£1,623,009.06	-£93.82
Oxford Canal - Duke's Cut (SWOX) - Construction					
Carbon storage	£55,527.28	£0.00	-£55,527.28	£45,705.86	-£9,821.42
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	£8,426.74	£0.00	-£8,426.74	£6,832.39	-£1,594.35
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£63,954.02	£0.00	-£63,954.02	£52,538.25	-£11,415.76
Abingdon Reservoir to Farmoor Reservoir pipeline					
Carbon storage	£4,158.46	£0.00	-£4,158.46	£3,825.58	-£332.88
Natural hazard regulation	£115.16	£0.00	-£155.16	£86.37	-£28.79
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out

Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£4,273.63	£0.00	-£4,273.63	£3,911.96	-£361.67
Oxford Canal - Transfer from Duke's Cut to Farmoor					
Carbon storage	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard regulation	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air Pollutant Removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41
Henley to SWOX Transfer – 5Ml/d					
Carbon storage	£10,030.07	£1,933.43	-£8,096.64	£8,295.47	-£1,734.61
Natural hazard regulation	£483.08	£101.61	-£336.47	£353.96	-£84.12
Air Pollutant Removal	£1,339.97	£308.95	-£1,031.02	£1,006.98	-£332.99
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£11,853.12	£2,343.99	-£9,464.13	£9,656.41	-£2,151.72
T2ST Full Scheme					
Carbon storage	£62,907.62	£0.00	-£62,907.62	£55,974.02	-£6,933.59
Natural hazard regulation	£957.06	£0.00	-£957.06	£717.11	-£239.95
Food production	£821,436.32	£810,724.76	-£10,711.56	£810,724.76	-£10,711.56
Total	£885,300.99	£810,724.76	-£74,576.24	£867,415.89	-£17,885.11

Table C-7: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
• SouthEast Water to Guildford • Groundwater Development - Southfleet & Greenhithe	The stocks both temporarily and permanently lost likely provide a high provision of	The provision of services will be lost during construction.	The future provision of the ecosystem service	The provision of water purification provided by the associated

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
• New WTW at Kempton - 100Ml/d – Construction • New Medmenham Surface Water WTW Ph1 – Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • Manager Aquifer Recharge - Horton Kirby ASR • Henley to SWOX Transfer – 5Ml/d	the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.		provided by the stock will likely be reduced	stocks will likely be reduced due to the option.
• T2ST Full Scheme	The stocks both temporarily and permanently lost likely offer a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The provision of water purification by the associated stocks will likely be reduced due to the option. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.
Water Regulation				
• Groundwater Development - Southfleet & Greenhithe • New WTW at Kempton - 100Ml/d – Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • T2ST Full Scheme	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the associated stocks will likely remain.	0

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
	impacts to the ecosystem service.			

Table C-8: Summary of unmitigated BNG outputs

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change (Habitat BU)
SouthEast Water to Guildford	149.88	78.78	-47.44%	-71.10
Groundwater Development - Southfleet & Greenhithe	33.72	20.87	-12.85%	-38.11
New WTW at Kempton - 100Ml/d – Construction	15.04	6.09	-8.95%	-59.50
New Medmenham Surface Water WTW Ph1 – Construction	49.94	34.38	-15.56%	-31.16
Medmenham intake – 53	5.28	4.43	-0.85%	-16.13
Oxford Canal - Duke's Cut (SWOX) - Construction	3148.14	2871.69	-276.45%	-8.78
Abingdon Reservoir to Farmoor Reservoir pipeline	121.02	88.14	-32.88%	-27.17
Oxford Canal - Transfer from Duke's Cut to Farmoor	127.60	62.56	-65.04%	-50.97
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78%	-34.63
Henley to SWOX Transfer – 5Ml/d	71.52	34.60	-18.70%	-34.78
T2ST Full Scheme	2077.46	1596.23	-481.23	-23.16%

Situation 8

The BVP Situation 1 also includes options *Reservoir Abingdon 150*, *TWU_KEM_HI-TFR_TED_ALL_tedd-kempton, DRA – Teddington to Thames Lee Tunnel Shaft 100Ml/d, Teddington Direct River Abstraction (DRA) 75Ml/d – Construction* and *Mogden to Teddington outfall 100Ml/d.* Please refer to Section 3 'Feasible Option Outputs' for their results.

Table C-9: Predicted impacts on natural capital stocks during and post-construction.

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastures	2.28	0.00	2.28	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active Flood Plain	1.20	1.20	1.20	0.00

Table C-10: Monetised assessment of the unmitigated predicted permanent - impacts on the provision of ecosystem services.

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard regulation	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air Pollutant Removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41

Table C-11: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				
• Manager Aquifer Recharge - Horton Kirby ASR	The stocks both temporarily and permanently lost likely provide a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced	The provision of water purification provided by the associated stocks will likely be reduced due to the option.
Water Regulation				
n/a	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will reduce negative impacts to the ecosystem service.	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the associated stocks will likely remain.	0

Table C-12: Summary of the unmitigated BNG outputs

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change

				(Habitat BU)
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78%	-34.63

Annex D: BESP NCA and BNG Assessment Results

A summary of what is included within each table is as follows:

- Table D-1 shows the predicted impacts on natural capital during and post-construction.
- Table D-2 summarises the predicted monetised impacts to the provision of ecosystem services scoped in for detailed assessment.
- Table D-3 summarises the predicted qualitative impacts to the provision of water purification for the options scoped-in for assessment.
- Table D-4 shows the unmitigated BNG outputs for the options which have been informed using the predicted permanent impacts on natural capital in Table D-1.

Note: At this stage, the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the option's description.

The BESP also includes options *Reservoir Manager Aquifer Recharge - Horton Kirby ASR*, *Teddington to Kempton Conveyance Element, Direct River Abstraction - Teddington to Thames Lee Tunnel Shaft 100 MLD* and Transfer of Treated Effluent from Mogden to Teddington 100Ml/d . Please refer to Section 3 'Feasible Option Outputs' for their results.

Table D-1: Predicted impacts on natural capital stocks during and post-construction.

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
SouthEast Water to Guildford				
Arable	12.56	0.00	11.96	-0.60
Pastoral	2.93	0.00	2.93	0.00
Other semi-natural grassland	4.36	0.00	4.36	0.00
Broadleaved, Mixed and Yew Woodland	3.43	0.00	3.43	0.00
Coniferous Woodland	2.79	0.00	2.79	0.00
Blue Space	0.06	0.06	0.06	0.00
Greenspace	0.33	0.00	0.33	0.00
Urban Woodland	2.54	0.00	2.54	0.00
Groundwater Development - Southfleet & Greenhithe				
Arable	5.68	0.00	5.68	0.00
Pastures	2.43	0.00	2.43	0.00
Broadleaved, Mixed and Yew Woodland	1.04	0.00	1.04	0.00
Pond & Linear Features	0.02	0.02	0.02	0.00
New Medmenham Surface Water WTW Ph1 – Construction				
Arable	10.75	0.00	9.82	-0.93
Pastures	6.74	0.00	4.2	-2.54
Broadleaved, Mixed and Yew Woodland	0.18	0.00	0.18	0.00
Coniferous Woodland	0.01	0.00	0.01	0.00
*Ancient Woodland	0.001	0.001	0.001	0.00
Medmenham intake - 53				
Arable	1.60	0.00	1.36	-0.24

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Pastures	0.52	0.00	0.52	0.00
Active Flood Plain	0.44	0.44	0.44	0.00
Groundwater Development - Woods Farm Existing Source Increase DO				
Arable	3.28	0.00	3.28	0.00
Pastures	2.48	0.00	2.48	0.00
Broadleaved, Mixed and Yew Woodland	0.71	0.00	0.71	0.00
*Ancient Woodland	0.20	0.20	0.20	0.00
Active Flood Plain	0.33	0.33	0.33	0.00
Oxford Canal – Duke's Cut (SWOX) – Construction				
Coastal and Floodplain Grazing Marsh	12.91	0.00	12.91	0.00
Lowland Fens	0.27	0.00	0.27	0.00
Arable	88.43	0.00	88.43	0.00
Pastures	81.17	0.00	81.17	0.00
Hay Meadows	0.07	0.00	0.07	0.00
Other Semi-Natural Grassland	3.15	0.00	3.15	0.00
Dwarf Shrub Heath	0.48	0.00	0.48	0.00
Broadleaved, Mixed and Yew Woodland	21.15	0.00	21.15	0.00
Coniferous Woodland	0.07	0.00	0.07	0.00
Blue Space	78.01	78.01	78.01	0.00
Greenspace	4.58	0.00	4.58	0.00
Urban Semi Natural Habitat	3.25	0.00	3.25	0.00
Urban Woodland	0.21	0.00	0.21	0.00
Lakes and Standing Waters	0.77	0.77	0.77	0.00
Rivers (length)	47.43	47.43	47.43	0.00
Modified Waters (Reservoirs)	0.01	0.01	0.01	0.00
Pond & Linear Features	62.05	62.05	62.05	0.00
Henley to SWOX Transfer – 5Ml/d				
Arable	0.48	0.00	0.48	0.00
Pastures	7.81	0.00	7.81	0.00
Other Semi-Natural Grassland	0.01	0.00	0.01	0.00
Broadleaved, Mixed and Yew Woodland	0.48	0.00	0.48	0.00
Woodland Priority Habitat	2.84	0.00	2.84	0.00
Coniferous Woodland	0.19	0.00	0.19	0.00
*Ancient Woodland	1.06	1.06	1.06	0.00
Greenspace	0.13	0.00	0.13	0.00
Abingdon Reservoir to Farmoor Reservoir pipeline				

Natural capital stock	Stocks present within option ZoI pre-construction (ha)	Stocks present within option ZoI during construction (ha)	Stocks present within option ZoI post-construction (ha)	Change (ha)
Coastal and Floodplain Grazing Marsh	2.29	0.00	2.29	0.00
Arable	10.51	0.00	10.51	0.00
Pastures	16.47	0.00	16.47	0.00
Hay Meadows	0.10	0.00	0.10	0.00
Broadleaved, Mixed and Yew Woodland	0.51	0.00	0.51	0.00
Coniferous Woodland	0.22	0.00	0.22	0.00
Active Flood Plain	4.51	4.51	4.51	0.00
Pond & Linear Features	0.01	0.01	0.01	0.00
Oxford Canal - Transfer from Duke's Cut to Farmoor				
Coastal and Floodplain Grazing Marsh	6.72	0.00	6.72	0.00
Arable	8.40	0.00	8.40	0.00
Pastures	4.6	0.00	4.6	0.00
Hay Meadows	0.69	0.00	0.69	0.00
Active Flood Plain	11.95	11.95	11.95	0.00
Pond & Linear Features	0.06	0.06	0.06	0.00
Manager Aquifer Recharge - Horton Kirby ASR				
Arable	0.36	0.00	0.36	0.00
Pastures	2.28	0.00	2.28	0.00
Woodland Priority Habitat	0.33	0.00	0.33	0.00
Active Flood Plain	1.20	1.20	1.20	0.00
T2ST Full Scheme				
Coastal and Floodplain Grazing Marsh	5.18	0.00	5.18	0.00
Lowland Fens	0.11	0.00	0.11	0.00
Arable	625.59	0.00	580.81	-44.78
Pastures	118.63	0.00	117.08	-1.56
Other Semi-Natural Grassland	14.34	0.00	13.01	-1.33
Broadleaved, Mixed and Yew Woodland	0.84	0.00	0.84	0.00
Woodland Priority Habitat	8.87	0.00	8.87	0.00
Coniferous Woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.07	0.00	0.07	0.00
Active Flood Plain	14.08	6.43	6.43	-7.66
Rivers (length)	0.55	0.55	0.55	0.00
Ponds & linear features	0.14	0.14	0.14	0.00

*For these options, Ancient Woodland is presumed to be avoided during construction, including its associated root protection zone, as options have been realigned to avoid these areas, in most cases following road networks. Therefore, there is no expected loss of Ancient Woodland for all standard resource options.

Table D-2: Monetised assessment of the unmitigated predicted permanent – impacts on the provision of ecosystem services.

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
SouthEast Water to Guildford					
Carbon storage	£13,270.66	£0.00	-£13,270.66	£10,410.79	-£2,859.87
Natural hazard regulation	£596.25	£0.00	-£596.25	£447.19	-£149.06
Air Pollutant Removal	£4,430.71	£0.00	-£4,430.71	£3,477.91	-£952.80
Recreation & amenity value	Scoped Out	Scoped Out	Scoped Out	Scoped Out	Scoped Out
Food production	£311,200.00	£311,011.00	-£189.00	£311,011.00	-£189.00
Total	£329,497.62	£311,011.00	-£18,486.62	£325,346.89	-£4,150.73
Groundwater Development - Southfleet & Greenhithe					
Carbon storage	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,470.40	£0.00	-£2,470.40	£1,997.07	-£473.33
New Medmenham Surface Water WTW Ph1 – Construction					
Carbon storage	£1,780.76	£1.82	-£1,778.93	£1,280.47	-£500.29
Natural hazard regulation	£18.31	£0.10	-£18.21	£13.76	-£4.55
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,754,602.14	£131,637.85	£1,621,557.71	-£1,406.57
Total	£1,624,763.35	£1,754,604.06	£129,840.71	£1,622,851.93	-£1,911.41
Medmenham intake – 53					
Carbon storage	£138.59	£0.00	-£138.59	£129.17	-£9.42

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£1,622,964.28	£1,622,879.89	-£84.39	£1,622,879.89	-£84.39
Total	£1,623,102.87	£1,622,879.89	-£222.99	£1,623,009.06	-£93.82
Groundwater Development - Woods Farm Existing Source Increase DO					
Carbon storage	£2,149.97	£364.80	-£1,785.17	£1,826.21	-£323.76
Natural hazard regulation	£87.23	£19.71	-£68.06	£70.22	-£17.02
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£2,237.20	£383.97	-£1,853.23	£1,896.43	-£340.77
Oxford Canal to Duke's Cut (SWOX) – Construction					
Carbon storage	£55,527.28	£0.00	-£55,527.28	£45,705.86	-£9,821.42
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	£8,426.74	£0.00	-£8,426.74	£6,832.39	-£1,594.35
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£63,954.02	£0.00	-£63,954.02	£52,538.25	-£11,415.76
Henley to SWOX Transfer - 5Ml/d					
Carbon storage	£10,030.07	£1,933.43	-£8,096.64	£8,295.47	-£1,734.61
Natural hazard regulation	£483.08	£101.61	-£336.47	£353.96	-£84.12
Air Pollutant Removal	£1,339.97	£308.95	-£1,031.02	£1,006.98	-£332.99
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£11,808.12	£2,343.99	-£9,464.13	£9,656.41	-£2,151.72
Abingdon Reservoir to Farmoor Reservoir Pipeline					
Carbon storage	£4,158.46	£0.00	-£4,158.46	£3,825.58	-£332.88

Ecosystem services	Baseline value (£/year)	Estimated value post-construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Natural hazard regulation	£115.16	£0.00	-£155.16	£86.37	-£28.79
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£4,273.63	£0.00	-£4,273.63	£3,911.96	-£361.67
Oxford Canal - Transfer from Duke's Cut to					
Carbon storage	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Natural hazard regulation	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,100.61	£0.00	-£1,100.61	£1,100.61	£0.00
Manager Aquifer Recharge - Horton Kirby ASR					
Carbon storage	£944.53	£0.00	-£944.53	£794.90	-£149.63
Natural hazard regulation	£31.46	£0.00	-£31.46	£23.59	-£7.86
Air Pollutant Removal	£101.60	£0.00	-£101.60	£77.69	-£23.91
Recreation & amenity value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Total	£1,077.59	£0.00	-£1,077.59	£896.18	-£181.41
T2ST Full Scheme					
Carbon storage	£62,907.62	£0.00	-£62,907.62	£55,974.02	-£6,933.59
Natural hazard regulation	£957.06	£0.00	-£957.06	£717.11	-£239.95
Food production	£821,436.32	£810,724.76	-£10,711.56	£810,724.76	-£10,711.56
Total	£885,300.99	£810,724.76	-£74,576.24	£867,415.89	-£17,885.11

Table D-3: Qualitative assessment of the unmitigated predicted impacts on the provision of water purification and water regulation

Option ID	Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Water purification				

• SouthEast Water to Guildford • New Medmenham Surface Water WTW Ph1 – Construction • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline • Oxford Canal - Transfer from Duke's Cut to Farmoor • Manager Aquifer Recharge - Horton Kirby ASR • Groundwater Development - Woods Farm Existing Source Increase DO • Henley to SWOX Transfer – 5Ml/d	The stocks both temporarily and permanently lost likely provide a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced	The provision of water purification provided by the associated stocks will likely be reduced due to the option.
• T2ST Full Scheme	The stocks both temporarily and permanently lost likely offer a high provision of the ecosystem service due to the natural capital asset's high capacity to store and absorb pollutants and the proximity of the asset to a water source.	The provision of services will be lost during construction.	The future provision of the ecosystem service by the stock will likely be reduced.	The provision of water purification by the associated stocks will likely be reduced due to the option. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.
Water Regulation				
• Groundwater Development - Southfleet & Greenhithe • Oxford Canal - Duke's Cut (SWOX) – Construction • Abingdon Reservoir to Farmoor Reservoir pipeline Oxford Canal - Transfer from Duke's Cut to Farmoor • T2ST Full Scheme	The stocks both temporarily and permanently lost provide a regulation of water flow, both retaining water within the catchment and providing water to local communities. The preservation of stocks will	The provision of services will be retained during construction.	The future provision of the ecosystem service provided by the associated stocks will likely remain.	0

	reduce negative impacts to the ecosystem service.			

Table D-4: Summary of unmitigated BNG outputs

Option	On-Site Baseline (Habitat BU)	On-Site Post Intervention (Habitat BU)	Total Net Unit change (Habitat BU)	Total Percentage Change (Habitat BU)
SouthEast Water to Guildford	149.88	78.78	-47.44%	-71.10
Groundwater Development - Southfleet & Greenhithe	33.72	20.87	-12.85%	-38.11
New Medmenham Surface Water WTW Ph1 – Construction	49.94	34.38	-15.56%	-31.16
Medmenham intake - 53	5.28	4.43	-0.85%	-16.13
Groundwater Development - Woods Farm Existing Source Increase DO	25.00	15.83	-36.67%	-9.17
Oxford Canal - Duke's Cut (SWOX) - Construction	3148.14	2871.69	-276.45%	-8.78
Henley to SWOX Transfer – 5Ml/d	71.52	34.60	-18.70%	-34.78
Abingdon Reservoir to Farmoor Reservoir pipeline	121.02	88.14	-32.88%	-27.17
Oxford Canal - Transfer from Duke's Cut to Farmoor	127.60	62.56	-65.04%	-50.97
Manager Aquifer Recharge - Horton Kirby ASR	13.80	9.02	-4.78%	-34.63
T2ST Full Scheme	2077.46	1596.23	-481.23	-23.16%

Annex E: Intermediate quantified carbon sequestration outputs

Table E-1: Intermediate results for each feasible option: natural capital stock within the option boundary of tCO2e and £/year for the quantified ecosystem service carbon sequestration

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during constructio n	Future value (£/year)	Future tCO2e
SouthEast Water to Guildford						
Broadleaved mixed woodland	£6,256.29	17.05	£0.00	0.00	£4,692.21	12.79
Woodland Priority Habitat	£5,088.93	13.87	£0.00	0.00	£3,816.70	10.40
Arable	£493.22	1.34	£0.00	0.00	£469.66	1.28
Pasture	£426.90	1.16	£0.00	0.00	£426.90	1.16
*Grassland	£635.25	1.73	£0.00	0.00	£635.25	1.73
**Green urban	£370.08	1.01	£0.00	0.00	£370.08	1.01
Total	£13,270.66	36.16	£0.00	0.00	£10,410.79	28.37
Groundwater Development - Southfleet & Greenhithe						
Broadleaved mixed woodland	£1,893.30	5.16	£0.00	0.00	£1,419.98	3.87
Arable	£223.05	0.61	£0.00	0.00	£233.05	0.61
Pasture	£354.05	0.96	£0.00	0.00	£354.05	0.96
Total	£2,470.40	6.73	£0.00	0.00	£1,997.07	5.44
New WTW at Kempton - 100Ml/d						
Broadleaved mixed woodland	£200.64	0.55	£0.00	0.00	£150.48	0.41
Woodland priority habitat	£1459.19	3.98	£0.00	0.00	£1,094.39	2.98
Total	£1,659.83	4.52	£0.00	0.00	£1,244.87	3.39
New Medmenham Surface Water WTW Ph1 – Construction						
Broadleaved mixed woodland	£328.32	0.89	£0.00	0.00	£246.24	0.67
Coniferous and mixed woodland	£46.46	0.13	£0.00	0.00	£34.85	0.09
Ancient Woodland	£1.82	0.00	£1.82	0.00	£1.82	0.00
Arable	£422.14	1.15	£0.00	0.00	£385.62	1.05
Pasture	£982.01	2.68	£0.00	0.00	£611.94	1.67
Total	£1,780.76	4.85	£1.82	0.00	£1,280.47	3.49
Groundwater Development - Woods Farm Existing Source Increase DO						
Broadleaved mixed woodland	£1,295.03	3.53	£0.00	0.00	£971.27	2.65
Ancient Woodland	£364.80	0.99	£364.80	0.99	£364.80	0.75
Arable	£128.80	0.35	£0.00	0.00	£128.80	0.35

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Pasture	£361.33	0.98	£0.00	0.00	£361.33	0.98
Total	£2,149.97	5.86	£364.80	0.99	£1,826.21	4.73
Oxford Canal to Duke's Cut (SWOX)						
Broadleaved mixed woodland	£38,577.39	105.12	£0.00	0.00	£28,933.04	78.84
Coniferous and mixed woodland	£325.24	0.89	£0.00	0.00	£243.93	0.66
Urban woodland	£383.04	1.04	£0.00	0.00	£287.28	0.78
Arable	£3,472.56	9.46	£0.00	0.00	33,472.56	9.46
Pasture	£11,826.39	32.22	£0.00	0.00	£11,826.39	32.22
*Grassland	£469.15	1.28	£0.00	0.00	£469.15	1.28
**Green urban	£473.52	1.29	£0.00	0.00	£473.52	1.29
Total	£55,527.28	151.30	£0.00	0.00	£45,705.86	124.54
Henley to SWOX Transfer– 5Ml/d						
Broadleaved mixed woodland	£875.52	2.39	£0.00	0.00	£656.64	1.79
Woodland priority habitat	£5,180.13	14.11	£0.00	0.00	£3,885.10	10.59
Coniferous and mixed woodland	£882.78	2.41	£0.00	0.00	£662.09	1.80
Ancient woodland	£1,933.43	5.27	£1,933.43	5.27	£1,933.43	3.95
Arable	£18.85	0.05	£0.00	0.00	£18.85	0.05
Pasture	£1,137.91	3.10	£0.00	0.00	£1,137.91	3.10
*Grassland	£1.46	0.00	£0.00	0.00	£1.46	0.00
Total	£10,030.08	27.33	£1,933.43	5.27	£8,295.48	21.28
Abingdon Reservoir to Farmoor Reservoir Pipeline						
Broadleaved mixed woodland	£930.23	2.53	£0.00	0.00	£697.68	1.90
Woodland priority habitat	£401.28	1.09	£0.00	0.00	£300.96	0.82
Arable	£412.72	1.12	£0.00	0.00	£412.72	1.12
Pasture	£2,399.66	6.54	£0.00	0.00	£2,399.66	6.54
Grassland	£14.57	0.04	£0.00	0.00	£14.57	0.04
Total	£4,158.46	11.33	£0.00	0.00	£3,825.58	10.42
Oxford Canal - Transfer from Duke's Cut to Farmoor						
Arable	£329.86	0.90	£0.00	0.00	£329.86	0.90
Pasture	£670.22	1.83	£0.00	0.00	£670.22	1.83
*Grassland	£100.53	0.27	£0.00	0.00	£100.53	0.27
Total	£1,100.61	3.00	£0.00	0.00	£1,100.61	3.00
Manager Aquifer Recharge - Horton Kirby ASR						

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Broadleaved mixed woodland	£1.55	0.00	£0.00	0.00	£1.16	0.00
Woodland priority habitat	£596.98	1.63	£0.00	0.00	£447.74	1.22
Arable	£14.04	0.04	£0.00	0.00	£14.04	0.04
Pasture	£331.96	0.90	£0.00	0.00	£331.96	0.90
Total	£944.53	2.57	£0.00	0.00	£794.90	2.17
Henley to SWOX Transfer– 2.4Ml/d						
Broadleaved mixed woodland	£6,456.92	17.59	£0.00	0.00	£4,842.69	13.20
Coniferous and mixed woodland	£185.85	0.51	£0.00	0.00	£139.39	0.38
Ancient woodland	£2,845.42	7.75	£2,845.42	7.75	£2,845.42	5.81
Urban woodland	£401.28	1.09	£0.00	0.00	£300.96	0.82
Arable	£24.74	0.07	£0.00	0.00	£24.74	0.07
Pasture	£798.43	2.18	£4.37	0.00	£664.39	1.81
*Grassland	£4.37	0.01	£0.00	0.01	£4.37	0.01
Total	£10,717	29.2	£2,850	7.76	£8,822	22.1
Transfer - Reigate (SES) to Guildford 5Ml/d or 20Ml/d						
Broadleaved mixed woodland	£3,702.70	10.09	£0.00	0.00	£2,777.02	7.57
Coniferous and mixed woodland	£92.92	0.25	£0.00	0.00	£69.69	0.19
Ancient Woodland	£18.24	0.05	£18.24	0.05	£18.24	0.04
Urban Woodland	£364.80	0.99	£0.00	0.00	£273.60	0.75
Arable	£436.67	1.19	£0.00	0.00	£436.67	1.19
Pasture	£4,844.49	13.20	£0.00	0.00	£4,884.49	13.20
Total	£9,459.82	25.77	£18.24	0.05	£8,459.71	22.94
River Thames to Fobney Transfer						
Woodland Priority Habitat	£18.66	0.05	£0.00	0.00	£13.99	0.04
Urban Woodland	£52.88	0.14	£0.00	0.00	£39.66	0.11
Total	£71.54	0.19	£0.00	0.00	£53.66	0.15
Crossness Desalination						
Broadleaved mixed woodland	£492.48	1.34	£0.00	0.00	£369.36	1.01
Total	£492.48	1.34	£0.00	0.00	£369.36	1.01
Managed Aquifer Recharge - Thames Valley, South London						

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Broadleaved mixed woodland	£3,697.23	10.07	£0.00	0.00	£2,772.92	7.56
Urban Woodland	£948.47	2.58	£0.00	0.00	£711.36	1.94
Total	£4,645.70	12.66	£0.00	0.00	£3,484.28	9.49
TWRM extension - Hampton to Battersea – Construction						
Broadleaved mixed woodland	£237.12	0.65	£0.00	0.00	£177.84	0.48
Woodland Priority Habitat	£91.20	0.25	£0.00	0.00	£68.40	0.19
Urban Woodland	£18.24	0.05	£0.00	0.00	£13.68	0.04
**Green Urban	£169.01	0.46	£0.00	0.00	£169.01	0.46
Total	£515.57	1.40	£0.00	0.00	£428.93	1.17
Deephams Reuse – 46.5Ml/d, direct to KGV / 46.5Ml/d						
Broadleaved mixed woodland	£2,170.55	5.91	£0.00	0.00	£1,627.91	4.44
Total	£2,170.55	5.91	£0.00	0.00	£1,627.91	4.44
Thames-Lee Tunnel extension from Lockwood PS to King George V Reservoir intake						
Broadleaved mixed woodland	£528.96	1.44	£528.96	0.00	£296.72	1.08
Woodland Priority Habitat	£802.56	2.19	£802.56	2.19	£601.92	1.64
Urban Woodland	£18.24	0.05	£18.24	0.05	£13.68	0.04
Total	£1,349.75	3.68	£1,349.75	2.24	£1,012.31	2.76
Surbiton intake capacity increase with transfer to Walton inlet channel						
Broadleaved mixed woodland	£145.92	0.40	£0.00	0.00	£109.44	0.30
Total	£145.92	0.40	£0.00	0.00	£109.44	0.30
Woodmansterne WTW to Epsom Downs						
Broadleaved mixed woodland	£638.40	1.74	£0.00	0.00	£478.80	1.30
Urban Woodland	£547.20	1.49	£0.00	0.00	£410.40	1.12
Arable	£111.13	0.30	£0.00	0.00	£111.13	0.30
Pasture	£457.49	1.25	£0.00	0.00	£457.49	1.25
*Grassland	£208.35	0.57	£0.00	0.00	£208.35	0.57
**Green Urban	£155.90	0.42	£0.00	0.00	£155.90	0.42
Total	£2,118.47	5.77	£0.00	0.00	£1,822.07	4.96
New Reservoir - Marsh Gibbon 75Mm^3 - Construction						

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Broadleaved mixed woodland	£8,846.35	17.05	£0.00	0.00	£6,634.76	18.08
Ancient Woodland	£674.88	1.84	£0.00	0.00	£0.00	0.00
Urban Woodland	£766.08	2.09	£0.00	0.00	£574.56	1.57
Arable	£17,075.73	46.53	£0.00	0.00	£15,625.14	42.58
Pasture	£28,031.03	76.38	£0.00	0.00	£3,387.50	9.23
*Grassland	£1,092.74	2.98	£0.00	0.00	£598.82	1.63
Total	£56,486.81	146.86	£0.00	0.00	£26,820.78	73.08
New Reservoir - Marsh Gibbon 50Mm3 - Construction						
Broadleaved mixed woodland	£5,198.37	14.16	£0.00	0.00	£3,898.78	10.62
Arable	£16,668.91	45.42	£0.00	0.00	£0.00	0.00
Pasture	£35,141.14	95.75	£0.00	0.00	£0.00	0.00
*Grassland	£2,313.70	6.30	£0.00	0.00	£1,088.37	2.97
Total	£59,322.12	161.64	£0.00	0.00	£4,987.15	13.59
New Reservoir - Marsh Gibbon 30Mm3 - Construction						
Broadleaved mixed woodland	£1,787.51	4.87	£0.00	0.00	£1,340.63	3.65
Arable	£13,943.64	37.99	£0.00	0.00	£0.00	0.00
Pasture	£11,858.44	32.31	£0.00	0.00	£0.00	0.00
*Grassland	£1,564.81	4.26	£0.00	0.00	£240.40	0.66
Total	£29,154.40	79.44	£0.00	0.00	£1,581.04	4.31
STT-SESRO Link						
Arable	£123.70	0.34	£0.00	0.00	£123.70	0.34
Total	£123.70	0.34	£0.00	0.00	£123.70	0.34
Henley to SWA Transfer - 2.4Ml/d						
Broadleaved mixed woodland	£1,185.59	3.23	£0.00	0.00	£889.20	2.42
Coniferous and mixed woodland	£232.31	0.63	£0.00	0.00	£0.00	0.00
Ancient Woodland	£91.20	0.25	£91.20	0.25	£91.20	0.19
Urban Woodland	£36.48	0.10	£0.00	0.00	£27.36	0.07
Arable	£626.73	1.71	£0.00	0.00	£589.82	1.61
Pasture	£665.84	1.81	£0.00	0.00	£632.33	1.72
Total	£2,838.15	7.73	£91.20	0.25	£2,229.91	6.01
Henley to SWA Transfer – 5Ml/d						
Broadleaved mixed woodland	£1,185.59	3.23	£0.00	0.00	£889.20	2.42
Coniferous and mixed woodland	£232.31	0.63	£0.00	0.00	£174.23	0.47

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Ancient Woodland	£91.20	0.25	£91.20	0.25	£91.20	0.19
Urban Woodland	£36.48	0.10	£0.00	0.00	£27.36	0.07
Arable	£626.73	1.71	£0.00	0.00	£589.82	1.61
Pasture	£665.84	1.81	£0.00	0.00	£632.33	1.72
Total	£2,838.15	7.73	£91.20	0.25	£2,229.91	6.01
Transfer from WTW in Abingdon to SWA - 48Ml/d						
Broadleaved mixed woodland	£1,623.04	4.42	£0.00	0.00	£1,217.28	3.32
Woodland Priority Habitat	£85.29	0.23	£0.00	0.00	£63.97	0.17
Coniferous and mixed woodland	£5.85	0.02	£5.85	0.02	£4.39	0.01
Arable	£2,101.31	5.73	£0.00	0.00	£2,044.77	5.57
Pasture	£5,840.12	15.91	£0.00	0.00	£5,420.51	14.77
*Grassland	£143.56	0.39	£62.13	0.17	£143.56	0.39
Total	£9,799.18	26.70	£67.97	0.19	£8,894.48	24.24
Transfer from WTW in Abingdon to SWA - 72Ml/d						
Broadleaved mixed woodland	£1,623.35	4.42	£0.00	0.00	£1,217.51	3.32
Coniferous and mixed woodland	£232.31	0.63	£0.00	0.00	£174.23	0.47
Arable	£2,107.57	5.74	£0.00	0.00	£2,029.81	5.53
Pasture	£5,956.18	16.23	£0.00	0.00	£5,414.17	14.75
*Grassland	£144.24	0.39	£0.00	0.00	£144.24	0.39
Total	£10,063.65	27.42	£0.00	0.00	£8,979.98	24.47
Medmenham intake – 53						
Arable	£62.83	0.17	£0.00	0.00	£53.41	0.15
Pasture	£75.76	0.21	£0.00	0.00	£75.76	0.21
Total	£138.59	0.38	£0.00	0.00	£129.17	0.35
New WTW - Radcot						
Broadleaved mixed woodland	£36.48	0.10	£0.00	0.00	£27.36	0.07
Coniferous and mixed woodland	£232.31	0.63	£0.00	0.00	£174.23	0.47
Arable	£956.20	2.61	£0.00	0.00	£825.04	2.25
Pasture	£1,821.24	4.96	£0.00	0.00	£1,821.24	4.96
*Grassland	£1.46	0.00	£0.00	0.00	£1.46	0.00
Total	£3,047.69	8.30	£0.00	0.00	£2,849.33	7.76
Kennet Valley to SWOX Transfer – 2.3Ml/d						
Broadleaved mixed woodland	£2,881.90	7.85	£0.00	0.00	£2,161.43	5.89

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Ancient Woodland	£2,061.11	5.62	£2,061.11	5.62	£2,061.11	4.21
Urban Woodland	£328.32	0.89	£0.00	0.00	£246.24	0.67
Arable	£351.85	0.96	£0.00	0.00	£280.77	0.77
Pasture	£1,114.60	3.04	£0.00	0.00	£1,025.72	2.79
Total	£6,737.78	18.36	£2,061.11	5.62	£5,775.27	14.33
Kennet Valley to SWOX Transfer– 6.7Ml/d						
Broadleaved mixed woodland	£2,881.90	7.85	£0.00	0.00	£2,161.43	5.89
Ancient Woodland	£2,061.11	5.62	£2,061.11	5.62	£2,061.11	4.21
Urban Woodland	£328.32	0.89	£0.00	0.00	£246.24	0.67
Arable	£351.85	0.96	£0.00	0.00	£280.77	0.77
Pasture	£1,114.60	3.04	£0.00	0.00	£1,025.72	2.79
Total	£6,737.78	18.36	£2,061.11	5.62	£5,775.27	14.33
Oxford Canal – Cropredy						
Broadleaved mixed woodland	£26,264.08	71.56	£0.00	0.00	£19,698.06	53.67
Coniferous and mixed woodland	£0.18	0.00	£0.00	0.00	£0.13	0.00
Urban Woodland	£1,904.11	5.19	£0.00	0.00	£1, 428.08	3.89
Arable	£3,226.61	8.79	£0.00	0.00	£3,226.61	8.79
Pasture	£7,479.62	20.38	£0.00	0.00	£7,479.62	20.38
*Grassland	£380.92	1.04	£0.00	0.00	£380.92	1.04
**Green Urban	£316.82	31.63	£0.00	30.09	£316.82	31.63
Total	£39,572.34	138.59	£0.00	30.09	£32,530.25	119.41
New Reservoir - Chinnor 30Mm3						
Broadleaved mixed woodland	£46,457.03	126.59	£0.00	0.00	£34,842.77	94.94
Arable	£10,655.25	29.03	£0.00	0.00	£55.37	0.15
Pasture	£27,929.04	76.10	£0.00	0.00	£1,283.61	3.50
*Grassland	£2,593.44	7.07	£0.00	0.00	£1,948.00	5.31
Total	£87,634.76	238.79	£0.00	0.00	£38,129.74	103.90
Additional conveyance from Queen Mary Reservoir to Kempton WTW						
Broadleaved mixed woodland	£1,422.71	3.88	£0.00	0.00	£1,067.03	2.91
Urban Woodland	£456.00	1.24	£0.00	0.00	£342.00	0.93
Pasture	£491.01	1.34	£0.00	0.00	£491.01	1.34
*Grassland	£5.83	0.02	£0.00	0.00	£5.83	0.02
Total	£2,375.54	6.48	£0.00	0.00	£1,905.87	5.20
T2ST Full Scheme						

Natural capital stock	Baseline value (£/year)	Baseline tCO2e	Provision during construction (£/year)	tCO2e during construction	Future value (£/year)	Future tCO2e
Broadleaved mixed woodland	£1,532.67	4.18	£0.00	0.00	£1,149.50	3.13
Woodland Priority Habitat	£16,171.47	44.06	£0.00	0.00	£12,128.60	33.05
Coniferous and mixed woodland	£1,245.60	3.39	£0.00	0.00	£934.20	2.55
Ancient Woodland	£17.39	0.05	£0.00	0.00	£0.00	0.00
Arable	£24,566.32	248.36	£0.00	0.00	£22,807.69	230.58
Pasture	£17,284.76	115.07	£0.00	0.00	£17,057.93	113.56
Grassland	£2,089.41	5.69	£0.00	0.00	£1,896.10	5.17
Green Urban	£0.00	71.63	£0.00	0.00	£0.00	65.04
Total	£62,907.62	492.44	£0.00	0.00	£55,974.02	453.08

*Grassland – all grassland has been combined, including hay meadows and other semi-natural grassland
**Urban grassland – all urban grassland has been combined, including greenspace and urban semi-natural habitat

Annex F: Thames rdWRMP24 BNG Strategy

Annex F Thames rdWRMP24 BNG Strategy

1 Introduction

This Annex sets out a Biodiversity Net Gain (BNG) Strategy for the Thames rdWRMP24 to meet requirements of mandatory BNG, the Water Resource Planning Guideline and the Thames Water commitment to achieve BNG.

Regarding mandatory BNG, the Environment Act 2021 was granted Royal Assent on 9th November 2021 and mandates developments to achieve a minimum 10% increase in 'habitat units', as measured by the statutory biodiversity metric, with the biodiversity improvements being secured for at least 30 years (UK Parliament, 2021). These provisions are expected to come into effect in November 2023 for most developments seeking planning permission and in 2025 for Nationally Significant Infrastructure Projects (NSIPs).

The Water Resources Planning Guideline (WRPG) requires that WRMPs should contribute to, and enhance, the natural environment by providing opportunities for biodiversity gain and enhancement. Section 9.4.4 of the WRPG states that, for options requiring planning permission, legal BNG requirements will likely apply and biodiversity gain should be incorporated into the design where reasonable or provided off-site. The Thames Water biodiversity and invasive non-native species policy sets a key principle to 'Protect and enhance biodiversity during our activities by:

- Continued investment at our sites, demonstrating a 5% net gain on our 253 sites of biodiversity interest and a 10% net gain on engineering projects.
- Implementing best practice solutions to retain trees and hedgerows on new developments and prevent the use of netting intended to stop birds from nesting.
- Ensuring 99% of our Sites of Special Scientific Interest reach 'favourable' or 'unfavourable recovering' status and that at least 50% of those are in favourable condition.
- Good management of the wildlife within our landholding.'[1]

For Thames Water, the rdWRMP24 demonstrates how BNG can be delivered across the plan. Selected options will likely require a minimum 10% increase in habitat units (or higher depending on the Local Planning Authority (LPA) requirements) in order to obtain planning permission and to meet the Thames Water BNG policy commitment.

BNG and Natural Capital (NC) assessments for the Thames Water options have been undertaken as part of the WRSE Regional Plan environmental assessments and Thames Water rdWRMP24 environmental assessments. The headline figures were used in the investment model to aid optimisation and decision-making for the Best Value Plan (BVP). However, further analysis of the BVP options was required to develop a strategy for delivering BNG requirements of the rdWRMP24 (the BVP).

This BNG Strategy provides an overview of BNG delivery across the rdWRMP24 and sets out the actions to refine delivery of BNG as each option goes through detailed design and planning. The key principles of the BNG Strategy are to follow the BNG mitigation hierarchy to avoid and reduce habitat loss as far as possible,

[1] Thames Water (May 2023) Biodiversity and invasive non-native species policy

and then prioritise delivery of BNG on-site where possible before investigating off-site opportunities within the same LPA.

2 Links with the Thames Water BNG Strategy

Thames Water have developed a company-wide strategy for consistent and efficient delivery of BNG. This company-wide BNG Strategy applies to projects required to achieve BNG from either a mandatory requirement and/or the Thames Water commitment to BNG.

The company-wide BNG Strategy contains a process to assess, design and implement BNG. This process is based on the British Standard 8683[2] and developed specifically for Thames Water. The company-wide BNG Strategy also sets out delivery of BNG on-site or off-site via strategic BNG offsetting sites on Thames Water land, or via third party / local authority land that meets specific BNG delivery requirements of Thames Water's projects, especially in terms of habitat type and the potential to support local nature recovery networks.

The rdWRMP24 BNG Strategy aligns with the Thames Water company-wide BNG Strategy. For example, several of the strategic BNG offsetting sites are within the same Local Planning Authority as the rdWRMP24 options and could be used to support BNG delivery for those options (this is set out in Section 5.3).

3 Thames rdWRMP24

The Thames rdWRMP24 consists of many elements including supply options, demand options, and drought options. The supply side options are most likely to be subject to mandatory BNG requirements, as they will require planning permission and fall under the Thames Water BNG policy commitment, and so are the focus of this BNG Strategy. The rdWRMP24 BNG Strategy covers the BVP Situation 4 for options selected up to, and including, 2045 (see Table 3.1). Options beyond this point were not considered because of the uncertainty of these future options.

Table 3-1: rdWRMP24 BNG strategy options

Option ID	Option Name	Option Description
TWU_GUI_HI-TFR_RZ4_ALL_sewtogui	South East Water to Guildford	10Ml/d transfer from South East Water (Hogsback) to Mount SR Guildford.
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen	Interzonal transfer (T2ST): Kennet Valley spurt o Speen (10Ml/d)	T2ST SRO - Thames to Southern Transfer SRO (T2ST). This option is part of the T2ST pipeline transferring water from the River Thames to the south of England. This option is a branch of the wider T2ST scheme.
TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100 p1	Kempton - 100 Phase 1 - Construction	100Ml/d new capacity at WTW at Kempton treating raw reservoir water in west London. Purpose is to accommodate additional future demand
TWU_STR_HI-RSR_RE1_CNO_abingdon150(lon)	New Reservoir Abingdon 150 Mm3 - 283 MLD (Lon only) - Construction	Abingdon Reservoir (SESRO) SRO. New reservoir in the South East of England

[2] The British Standards Institutions (2021). Process for designing and implementing Biodiversity Net Gain – Specification. BS 8682:2021.

Option ID	Option Name	Option Description
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53	Medmenham intake - 53	The Medmenham intake element includes the construction of an intake structure on the River Thames located approximately 1.75km west of the village of Medmenham, close to the village of Mill End. In addition to the intake structure, a pumping station will be constructed. The intake structure, pumping station and raw water transfer main would supply water from the River Thames to a new water treatment works at Medmenham. The intake and all associated infrastructure will be constructed with an abstraction capacity of 53Ml/d.
TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox	Oxford Canal - Duke's Cut (SWOX) - Construction	Upgrades to the canal network to transfer 15Ml/d surplus from the Wolverhampton Levels to upstream of Duke's Cut
TWU_SWX_HI-TFR_HEN_ALL_henley-swox5	Henley to SWOX – 5 Ml/d	The option is for one new main from New Farm service reservoir (Henley) to Nettlebed service reservoir (SWOX). This will require a new 5.9km, 350mm diameter main from New Farm to Nettlebed and a new pumping station at New Farm. 5Ml/d capacity.
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Abingdon to Farmoor Reservoir pipeline	Construction of a transfer pipeline to convey 24Ml/d of raw water between a proposed reservoir at Abingdon and the existing Farmoor reservoir, in the SWOX WRZ. (Note: Abingdon reservoir creation is not part of this option.). The engineering scope includes the provision of a booster pump station at the proposed Abingdon Reservoir site to facilitate the transfer. Treatment would be provided at the existing WTW.
TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor	Dukes Cut to Farmoor	15Ml/d conveyance option from the Oxford Canal to Farmoor Reservoir, with abstraction from a point approximately 800m north of Duke's Cut on the Oxford Canal, discharging into the River Thames for subsequent re-abstraction at the existing Farmoor Reservoir intake. It has been assumed that, as the transfer will only be used in periods of low flow, no works will be required to upgrade the existing intake structure or treatment facilities at Farmoor Reservoir.
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	ASR Horton Kirby	Construction of pipelines between two existing ASR boreholes in the Lower Greensand aquifer to an existing WTW at Horton Kirby in Kent. Water abstracted from existing aquifer boreholes (via the mains supply) will be recharged into the two ASR boreholes during periods of water surplus and abstracted when needed and treated at the WTW.
TWU_TED_HI-RAB_RE1_CNO_teddington dra 75	Teddington DRA 75 MLD - Construction	London Water Recycling SRO: Teddington DRA 75 Ml/d SRO. A portion of the final effluent from Mogden STW would be subject to tertiary treatment and transferred in a tunnel for discharge into the River Thames upstream of Teddington weir. An equal volume of water would be abstracted from the Thames upstream of the new outfall. Abstracted water would be pumped into the nearby Thames Lee Tunnel for transfer to Lockwood Reservoir, part of the Lee Valley reservoirs in East London.
TWU_TED_HI-TFR_TED_ALL_teddingtondra mog/ted	Mogden to Teddington outfall 100 Ml/d	
TWU_KGV_HI-TFR_TED_ALL_teddingtondra ted/tlt	Direct River Abstraction - Teddington to Thames Lee Tunnel Shaft 100 MLD	

Four options in the BVP Situation 4 selected 2045 or before were scoped out due to the nature of the option and their location within existing Thames Water sites on hardstanding areas:

- Mortimer Disused Source (recommissioning)
- Replace New River Head Pump

- Moulsford Groundwater
- Addington Groundwater

4 Methodology

4.1 Methodology

The rdWRMP24 BNG Strategy was developed from undertaking the following tasks:

Review the biodiversity metric habitat types for selected options

The Biodiversity Metric 3.0[3] assessments already undertaken were reviewed to assess the likely metric habitat types, i.e. area based, linear or river habitats, for each option. The findings provided the first guide for delivering BNG, as the 10% minimum increase in units is required for each habitat type present within the option boundary and cannot be averaged or offset with another type.

Note: the completed metrics were based on desk-based assessments of the sites. They can therefore only assess the likely habitat types present.

Review of Metric Trading Rules and Local Planning BNG Requirements

The Biodiversity Metric 3.0 assessments already undertaken were reviewed and completed to meet the Metric's trading rules. This involved reviewing and analysing the likely type and distinctiveness of assumed habitat loss in order to estimate the type and amount of habitat needed to deliver BNG in ways that satisfy the Metric's trading rules.

Note: use of the Biodiversity Metric 3.0 was agreed with Natural England for the rdWRMP24. However, once BNG requirements become mandatory for developments requiring planning permission in November 2023, the statutory Biodiversity Metric and User Guide will be published and must be used for new applications for planning permission. It is likely that the BNG assessments and design will require updating to the statutory Biodiversity Metric for options taken forward to detailed design.

Each option was mapped to identify which Local Planning authority (LPA) it is located within. Using this map, first the LPA's Local Plan was reviewed to identify any specific BNG delivery requirements for developments requiring planning permission, especially whether more than the minimum 10% increase in habitat units is required. Second, the location of each option in relation to each other (i.e. whether in the same LPA) and in relation to Thames Water's strategic BNG delivery sites, in order to ascertain possibilities for combining BNG delivery requirements from multiple options if this meets good practice.

Note: the National Policy Statement for Water Resources Infrastructure does not refer to LPA requirements for BNG, only to 'any biodiversity statements published in respect of nationally significant infrastructure project'[4]. Therefore, where the LPA sets a higher BNG requirement than 10% in their Local Plan, this requirement is for developments seeking planning permission, and NSIPs requiring DCO consent are not required to meet this. Requirements for NSIPs have been provisionally specified via the Environment Act 2021 and will be further

[3] Natural England, 2021. *The Biodiversity Metric 3.0 (JP039).* Available at: https://publications.naturalengland.org.uk/publication/5850908674228224

[4] DEFRA, 2023. *National Policy Statement for Water Resources Infrastructure*. Available at: National Policy Statement for Water Resources Infrastructure (publishing.service.gov.uk)

confirmed via the Biodiversity Net Gain Statement for NSIPs due to be published for consultation in November 2023. The requirement for NSIPs is expected to become mandatory in 2025.

The trading rules and BNG requirements for each option were reviewed and amended where required, using the following stages:

- Habitat units for the option baselines were based on the already completed metric calculations. These baselines were checked and amended to be in line with the assumptions in section 3.2, unless they had been produced with an associated report.
- The Local Planning Authority (LPA) BNG requirements within the adopted or emerging Local Plan were checked for each option. If no net gain % was mentioned, then a default target of a minimum 10% BNG was used. If the option was within multiple LPAs, the highest % BNG requirement was used.
- The Multi-agency Geographic Information for the Countryside[5] (MAGIC) was checked for possible presence of ancient woodland, Very High Distinctiveness habitats (as listed in Metric 3.0), and statutory designated sites for nature conservation that were in proximity to or within the options. This information was used to inform on strategic significance and noted as if the works impact on them, then BNG cannot be achieved on the site.
- The trading rules and the total % BNG within the Metrics were checked, and off-site habitat baselines and creation was subsequently added to meet the required BNG % and trading rules.
- The off-site baseline and off-site habitat creation followed the assumptions in section 3.2, with habitat types and areas selected in order to meet the Metric 3.0 trading rules for the option and the required % increase in habitat units.
- The total off-site habitat areas were then calculated for each option, along with the habitat types and distinctiveness.
- Strategic significance of the habitat types at both on-site and off-site baseline and habitat creation, was assessed via a desk-based assessment, including the use of aerial imagery, with no site visit undertaken. Local strategies, plans or policies produced by the LPAs were checked for each option, for any further BNG guidance or guidance on strategic significance. The strategic significance was assigned based on the following methodology:
    - **Low** – Location not identified in a local strategy, plan, or policy and not ecologically desirable, or no local strategy in place.
    - **Medium** – Habitat type (not location) is mentioned in the local strategy, plan or policy, or it provides connectivity between areas of high strategic significance. Ecological desirability can be based on functional traits that the habitats have within that location such as connecting habitats, buffering habitats, and forming part of a core area of habitat within a locality. Most high and very high distinctiveness habitats will be of at least medium strategic significance.
    - **High** - Habitat type and location formally identified in local strategy, plan, or policy.

Habitat requirements mapping

Using desk-based mapping, the habitat requirement identified as part of the above task was mapped with the habitats present within the option boundary, within the LPA, and within Thames Water owned/managed nature reserves (within the relevant LPAs). This was used to identify where BNG requirements could be delivered and mapped against LPA nature recovery networks/habitats to assess the Strategic Significance of these within the Metric.

[5] MAGIC, 2023. Magic Map Application. [online] Magic.defra.gov.uk. Available at: Magic Map Application (defra.gov.uk).

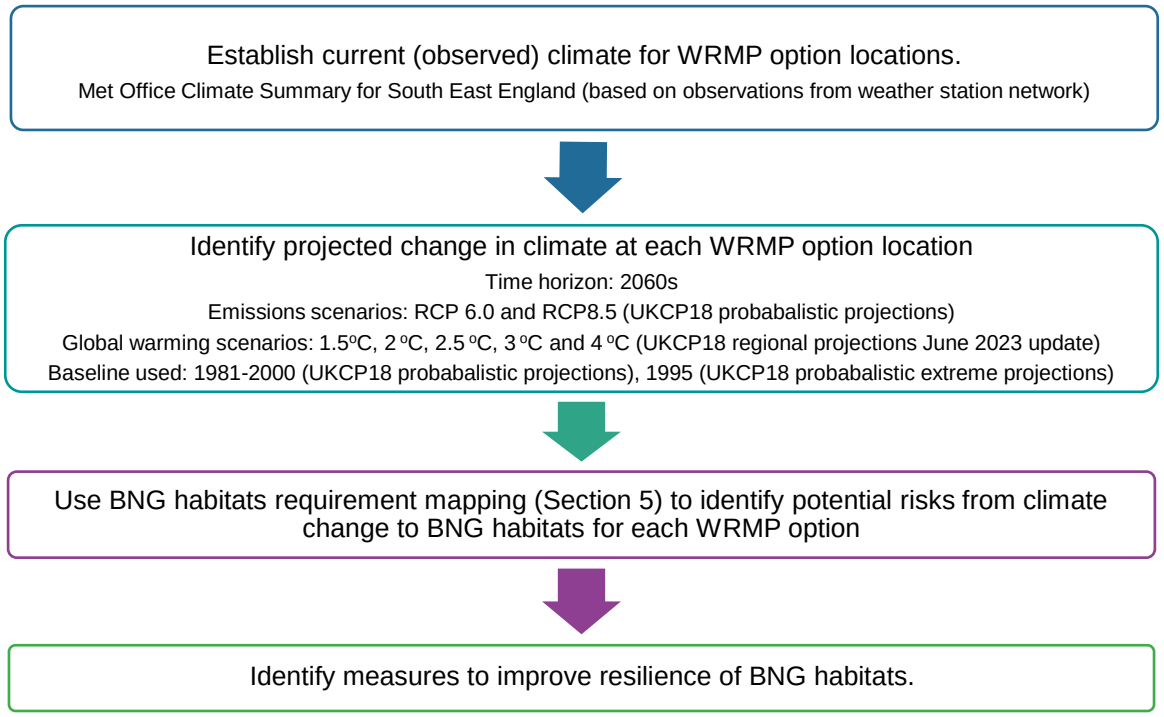
Climate resilience scoping assessment

The aims of this Climate Resilience Scoping Assessment (CRSA) were to:

- Identify current climate at the option locations and obtain data on projected change in climate variables (covering change in average conditions and extreme weather) from the United Kingdom Climate Projections 2018 (UKCP18).
- Assess trends in extreme weather events and average climatic conditions over the 30-year duration of BNG for the locations of the WRMP24 options.
- Using the site-specific climate projection data, assess likely climate risks to habitat creation for WRMP24 options to achieve BNG.
- Identify possible climate resilience measures for the design and long-term management of BNG.
- Set out the details to refine and update this CRSA as BNG for rdWRMP24 options progresses through detailed design.

Figure 4.1 provides a high-level overview of the methodology developed for this assessment.

Figure 4.1: Climate Risk to BNG Methodology



The following climate projection data was collected for the rdWRMP24 option locations:

- **UKCP18 Probabilistic projections**: 25km grid cells, baseline period 1981-2000, time horizon 2060s (2050-2069), RCP6.0 and RCP8.5[6], 50th percentile values

[6] Representative Concentration Pathways (RCP) are prescribed trajectories for GHG and aerosol concentrations and are used to project a range of climate scenarios. There are four main RCP scenarios with RCP8.5 describing a worst case scenario and RCP6.0 a high GHG emissions scenario.

  - Climate variables include seasonal (winter and summer) mean, maximum and minimum air temperature and precipitation rate. These variables describe change in average conditions.
- **UKCP18 Probabilistic extreme projections**: 25km grid cells, baseline year 1995, time horizon 2065, 50- and 100-year return periods.

  Climate variables include maximum air temperature and 5-day total precipitation. These variables provide absolute extreme climate values.
- **UKCP18 Regional Projections (June 2023 update)**: 12km grid cells, baseline periods 1981-2000 and 2001-2020, annual, future warming levels above pre-industrial (1.5ºC, 2 ºC, 2.5 ºC, 3 ºC and 4 ºC).
  - Climate variables include:
    - Annual Count of Tropical Nights- Projections (12km)
    - Annual Count of Frost Days - Projections (12km)
    - Annual Count of Extreme Summer Days - Projections (12km)
    - Annual Count of Hot Summer Days - Projections (12km)
    - Growing Degree Days - Projections (12km)
    - Drought Severity Index 12-month accumulation (projections)

It should be noted that climate projections are not predictions or forecasts but simulations of potential scenarios of future climate under a range of hypothetical emissions scenarios and assumptions. The results, therefore, from the experiments performed by climate models cannot be treated as exact or factual, but projection options. The projections have been used to identify trends in future climate conditions of each of the WRMP options rather than predict the absolute values for the climate variable.

For further details on the methodology, refer to appendix A.

Link with nutrient neutrality

The estimated BNG requirements and locations in relation to Site of Special Scientific Interest (SSSI) catchments that trigger requirements for Nutrient Neutrality (NN) were mapped. This was used to identify likely overlaps between BNG delivery for the rdWRMP24 and locations that trigger NN requirements for developments, in order to identify possible NN considerations for the design and long-term management of BNG, especially opportunities for BNG to support NN.

Link with natural capital

A mapping exercise was undertaken to check overlap between the habitats required to deliver BNG and the ecosystem services those habitats provide. The natural capital assessments were used to identify the level of protection of ecosystem services that may be delivered through the BNG requirements and provide recommendations on enhancing provision of priority ecosystem services from BNG delivery.

Develop the rdWRMP24 BNG Strategy

The information gathered from the above tasks was used to develop a strategy for the rdWRMP24 to meet requirements of mandatory BNG, the WRPG and the Thames Water commitment to achieve BNG.

This BNG Strategy was based on desk-based habitat mapping and, subsequently, provides an outline of the likely BNG habitat creation required to deliver BNG. However, at this early developmental stage for the options, this BNG Strategy also sets out the actions to refine and update the BNG assessment as the options progress through detailed design.

The significant opportunity highlighted in this BNG Strategy is to adopt a Nature-based Solution (NbS) approach to the design and implementation of BNG. NbS measures can enhance biodiversity in ways that

increase carbon sequestration, boost our resilience to climate change, mitigate flood risk, improve air quality and deliver other multiple benefits for the environment and for people.

4.2 Assumptions

Habitat and Linear (hedgerow) Units

- Unless stated otherwise within associated reports (if available), it was assumed that on-site habitats were in Good condition.
- It was assumed that there will be a construction delay to on-site habitat creation. These delays were added into the metric calculations.
- Unless stated otherwise within associated reports (if available), it was assumed that where habitats were identified for loss, like-for-like habitat type replacement was undertaken to achieve BNG, i.e. the BNG will be achieved by the same broad habitat type.
- Some Metrics assumed that ponds and Very High distinctiveness habitats were retained (SouthEast Water to Guildford, Oxford Canal - Duke's Cut (SWOX) – Construction, Dukes Cut to Farmoor and Abingdon to Farmoor Reservoir pipeline)
- It was conservatively assumed that all created habitats are to be created in poor condition, unless otherwise specified in an associated report.
- It was assumed that where an off-site area is required, this will be a hypothetical baseline of modified grassland in a poor condition, in an area of low strategic significance.
- Habitat creation in advance of works was assumed to be ‘0’ years.
- For all offsite habitat creation, the spatial risk category ‘Compensation is inside LPA or NCA, or deemed to be sufficiently local, to site of biodiversity loss’ was assumed.
- It was assumed that BNG will be achieved all through habitat creation. If the metric had an associated report that proposed habitat enhancement, then this was included in the metric, using the conditions and areas set out in the report.

River Units

- The baseline for river units was based on the already completed metric calculations. As a precautionary assumption, the baseline conditions and encroachment were not changed (conditions were all Moderate).
- On-site enhancement was applied as the first measure used to reach net gain for rivers units. It was assumed that river enhancement measures were possible from a baseline condition of moderate to a post-works condition of good.
- For the on-site enhancement, it was assumed that there would be no encroachment on the watercourse or riparian zone.
- Where there was no on-site retention of watercourse habitat (and so on-site river condition enhancement would not be possible), off-site watercourse enhancement would be required. However, given the difficulties of off-site watercourse BNG, it was not possible to model this at this stage.

Notes:

The use of the Biodiversity Metric 3.0 was agreed with Natural England for the rdWRMP24. However, once BNG requirements become mandatory in November 2023, the statutory Biodiversity Metric and User Guide will be published and must be used for new applications for planning permission. It is likely that the BNG assessments and design will require updating to the statutory Biodiversity Metric for options taken forward to detailed design.

To achieve BNG, post-works habitats must not be in a lower condition than the baseline habitats (apart from the creation of High distinctiveness woodland where the approach set out by Natural England in the Biodiversity Metric 4.0 User Guide has been followed). In addition, off-site BNG delivery should be in locations where habitats can be created or enhanced to achieve moderate or good condition at least.

4.3 Limitations

This assessment of modelling BNG delivery for area-based habitats adopted a worst-case scenario of on-site area-based habitats being in good condition and post-works habitats being in poor condition. Also, off-site BNG delivery was modelled on the basis of habitat creation in poor condition – to emphasise that in practice, this could be the situation for high distinctiveness habitats although off-site BNG delivery should include the creation and/or enhancement of habitats into moderate or good condition. Consequently, the results are an estimated worst-case of BNG delivery (especially noting the large areas of habitat creation involved). However, at this early stage of the options, modelling BNG delivery on a precautionary worst-case basis is critical for BNG to be central to decision-making, especially to apply the Mitigation Hierarchy to avoid and reduce habitat clearance as far as possible.

The baseline metric calculation was based on limited desk-based assessment, with no site visit undertaken. Site survey data is required to update these calculations and inform the detailed design of the options.

5 rdWRMP24: Modelling BNG Delivery

5.1 Mapping BNG Requirements

The mapping of options and LPAs identified that five LPAs contained more than one rdWRMP24 option (as set out in Table 5.1) and therefore, where BNG requirements cannot be met on-site, combined off-site delivery may be an option. There are also three LPAs, where rdWRMP24 options are located, that have a BNG requirement above the 10% minimum (see Table 5.2).

Table 5-1: Local Planning Authorities with more than one rdWRMP24 option

Local Planning Authority	rdWRMP24 Option
West Berkshire	TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm
	TWU_SWX_HI-GRW_ALL_ALL_moulsford gw
	TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen
Hounslow	TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100 p1
	TWU_TED_HI-RAB_RE1_CNO_teddington dra 75
	TWU_TED_HI-TFR_TED_ALL_teddingtondramog/ted
Vale of White Horse	TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe
	TWU_STR_HI-RSR_RE1_CNO_abingdon150(lon)
South Oxfordshire	TWU_SWX_HI-TFR_HEN_ALL_henley-swox5
	TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe
Cherwell	TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor
	TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox

Table 5-2: Local Planning Authorities with rdWRMP24 options requiring higher than 10% minimum BNG

Local Planning Authority	LPA Minimum BNG Requirement	rdWRMP24 options located within the LPA
Kingston upon Thames	30%	TWU_KGV_HI-TFR_TED_ALL_teddingtondrated/tlt
Richmond upon Thames	20%	TWU_TED_HI-TFR_TED_ALL_teddingtondramog/ted
Guildford	20%	TWU_GUI_HI-TFR_RZ4_ALL_sewtogui
Surrey Heath	20%	TWU_GUI_HI-TFR_RZ4_ALL_sewtogui
Lichfield	20%	TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox

As part of the company wide BNG Strategy, eleven 'super' BNG delivery sites have been identified. These are areas of land that Thames Water own which could be managed to deliver BNG opportunities. Five of these sites are within LPAs with rdWRMP24 options located in them (see Table 5.3). Therefore, where these rdWRMP24 options cannot fully delivery BNG on-site, the super BNG sites could be utilised.

Table 5-3: Alignment with Thames Super BNG Delivery Sites

'Super' BNG Delivery Site	Local Planning Authority	Applicable rdWRMP24 options
Land outside of Grimsbury Reservoir	Cherwell	TWU_SWX_HI-TFR_SWX_ALL_dukescut-farmoor
		TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox
Littlemore pumping station	South Oxfordshire	TWU_SWX_HI-TFR_HEN_ALL_henley-swox5
		TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe
Speen, Moor Land Newbury pumping station	West Berkshire	TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm
		TWU_SWX_HI-GRW_ALL_ALL_moulsford gw
		TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen
Aylesbury sewage treatment works	Buckinghamshire	TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53
Land outside of Godalming sewage treatment works	Guildford	TWU_GUI_HI-TFR_RZ4_ALL_sewtogui

5.2 Climate Observations and Implications for BNG Delivery

5.2.1 Climate Observations

This section provides the climate observations for Southern England. The Met office regional summary for Southern England presents climate observations over a 30-year averaging period[7] between 1981-2010[8] using observations from the UK weather station network. A summary for trends across the South of England are presented in Table 5.4 and this was used as the climate baseline for the CRSA of BNG which is presented in Section 5.3 for each rdWRMP24 option.

[7] Met Office *What is climate?* [online]. Available at: What is climate? - Met Office

[8] Met Office *Southern England: Climate* [online]. Available at: southern-england -climate---met-office.pdf (metoffice.gov.uk)

Table 5-4: Observed climatic conditions for Southern England: a 30-year average between 1981-2010[9]

Climatic Conditions	Climate Observations
Temperature	Mean annual temperatures vary from 11.5ºC in central London and along the south coast to about 9.5ºC over higher ground well inland. January is the coldest month with minimum temperatures in London and along the coast varying from 3 ºC to about 0.5 ºC over higher ground. Extreme minimum temperatures usually occur in December or January with temperatures in some areas dropping to -18.2 ºC. July is the warmest month. London mean daily temperatures can reach 23.5 ºC, the highest in the UK. Generally, across the rest of Southern England mean daily temperatures reach 21 ºC. Extreme maximum temperatures are usually associated with heat waves lasting several days, occurring in July or August. In Southern England, the average number of days with air frost in Southern England varies from less than 30 a year in London and in areas bordering the Thames Estuary to more than 50 a year over higher ground. There is an urban heat-island effect associated with London- temperatures in central London can be over 5 ºC higher in late autumn to early spring compared to the outer suburbs and surrounding rural areas.
Rainfall	The Thames Valley, London and the north Kent coast normally receive less than 650mm of rain per year, and less than 550mm around the Thames Estuary. Rainfall is well distributed throughout the year. In London and the Thames Valley, there is also significant precipitation associated with showery, convective rainfall. In winter and early spring when soils are usually neat saturation, periods of prolonged rainfall can lead to widespread flooding. Southern England is also susceptible to summer thunder storms, especially at inland locations. However, the region can also be subject to dry periods that place demand upon water supplies.
Wind	Southern England is one of the more sheltered parts of the UK, The strongest winds are associated with the passage of depressions close to or across the UK. The frequency and depth of these areas of low pressure is greatest in the winter half of the year, especially from December to February, and this is when mean speeds and gusts (short duration peak values) are strongest. Mean wind speeds are between 6 and 9 knots throughout the year. Gales (when wind reaches >34knots for 10+ minutes) occur on approximately 1-2 days per year.
Sunshine	Southern England has some of the sunniest places in mainland UK. The highest monthly sunshine total in the region occurs along the coast. In the dullest winter months, less than 20 hours have been recorded with none at all in central London.
Snowfall	Snowfall is normally confined to the months from November to April. Snow rarely lies outside the period from December to March. On average, the number of days with snow falling is about 12-15 per year and the number of days with snow lying is approximately 5 days per year in most inland areas.

5.2.2 Climate Projections

The climate projection data is presented for each rdWRMP24 option in Section 5.3. In summary, the projection data shows that, for the 30-year duration of BNG monitoring requirements, all rdWRMP24 sites are likely to experience:

- Warmer summers and winters
- Wetter winters
- Drier summers
- Extreme precipitation events during the summer
- Extreme temperatures in summer (increase in tropical days, summer days, hot summer days, extreme summer days)

[9] Met Office *Southern England: Climate* [online]. Available at: southern-england -climate---met-office.pdf (metoffice.gov.uk)

- Increased growing degree days.
- More severe drought (Drought Severity Index (DSI))

While future climate trends suggest there will be an increase in the frequency of extreme weather events, such as heatwaves, droughts and flooding, the extreme probabilistic projections indicate that they are also projected to be more severe when they occur.

The Met Office released further climate projections in July 2023 for additional climate variables. The projections have been calculated for global warming levels of 1.5ºC, 2.0 ºC. 2.5ºC, 3.0 ºC, and 4.0 ºC against the baseline 1981-2000. The table below indicates the overall trends across all rdWRMP24 options for these climate projections for tropical nights, frost days, summer days, extreme summer days, hot summer days, growing degree days and drought severity index.

Table 5-5: Additional Climate Data Trends

Climate variable	Description	Future trends
Tropical Nights	A tropical night is defined where the minimum daily temperature does not fall below 20ºC. Data shows the number of times the threshold is exceeded in a year[10]	Current baselines indicate between 0 and 1.3 median tropical nights have been recorded between 1981 and 2010. All projections indicate that there will likely be an increase in the number of annual tropical nights experienced. For some areas of the TW basin, should global temperatures increase by 4ºC the number of tropical nights could be between 1.0 - 22.4 days annually compared to a 1981-2000 and 2001- 2010 modelled baseline.
Frost Days	Annual count of frost days is the number of days per year where the minimum daily temperature is below 0ºC. It measures how many times the threshold is exceeded in a year. The results are an approximation of the projected number of days when the threshold is exceeded[11].	Current baselines indicate that there have been between 18.4 and 56.4 median frost days recorded between 1981 and 2010. All projections indicated that there will likely be a decrease in the number of annual frost days (a decrease in the number of times temperatures will likely be below 0ºC). For some areas of the TW basin, in particular those closer to London the median number of frost days could be as low as 1.3 compared to a 1981-2000 and 2001- 2010 modelled baseline.
Summer Days	The Annual Count of Summer Days is the number of days per year where the maximum daily temperature (the hottest point in the day) is above 25°C. Note, the term 'Summer Days' refers to any day where temperatures exceed 25ºC[12].	Current baselines indicate that there have been between 14.2 and 36 median summer days recorded between 1981 and 2010. All projections indicate that there will likely be an increase in the count of annual summer days. Annual summer days for the WRMP sites could be between 64.5 and 97.9, should global temperatures increase by 4ºC compared to a 1981-2000 and 2001- 2010 modelled baseline.

[10] Met Office (2023) Annual Count of Tropical Nights- Projections (12km) [Online]- Annual Count of Tropical Nights - Projections (12km) | The Met Office climate data portal

[11] Met Office (2023) *Annual Count of Frost Days- Projections (12km)* [Online]. Available at: Annual Count of Frost Days - Projections (12km) (metoffice.gov.uk)

[12] Met Office (2023) *Annual Count of Summer Days- Projections (12km)* [Online] Available at: Annual Count of Summer Days - Projections (12km) | The Met Office climate data portal

Climate variable	Description	Future trends
Hot Summer Days	The Annual Count of Hot Summer Days is the number of days per year where the maximum daily temperature is above 30°C. It measures how many times the threshold is exceeded (not by how much) in a year. Note, the term 'hot summer days' is used to refer to the threshold and temperatures above 30°C outside the summer months also contribute to the annual count[13].	Current baselines indicate that there have been between 0 and 3.1 median hot summer days between 1981 and 2010. All projections indicate an overall increase in the count of annual hot summer days. Extreme summer days for WRMP sites are likely to be between 2.1 and 29.5 days per year depending on location, should global temperatures increase by 4ºC compared to a 1981-2000 and 2001- 2010 modelled baseline.
Extreme Summer Days	The Annual Count of Extreme Summer Days is the number of days per year where the maximum daily temperature is above 35°C. It measures how many times the threshold is exceeded (not by how much) in a year. Note, the term 'extreme summer days' is used to refer to the threshold and temperatures above 35°C outside the summer months also contribute to the annual count[14].	Current baselines indicate that there have been between 0 and 0.3 median extreme summer days between 1981 and 2010. All projections indicate an overall increase in the count of annual extreme summer days. Extreme summer days for WRMP sites are likely to be between 0 and 4.7 days per year depending on location, should global temperatures increase by 4ºC compared to a 1981-2000 and 2001- 2010 modelled baseline.
Growing Degree Days	A Growing Degree Day (GDD) is a day in which the average temperature is above 5.5°C. It is the number of degrees above this threshold that counts as a Growing Degree Day. For example, if the average temperature for a specific day is 6°C, this would contribute 0.5 Growing Degree Days to the annual sum, alternatively an average temperature of 10.5°C would contribute 5 Growing Degree Days. Given the data shows the annual sum of Growing Degree Days, this value can be above 365 in some parts of the UK. Annual Growing Degree Days indicate if conditions are suitable for plant growth[15].	Current baselines indicate there has been on average, 2152.9 growing days between 1981 and 2010. All projections indicate an overall increase in the count of growing degree days. For WRMP sites there is likely to be between 2821.4 and 3609.9 growing days per year depending on location, should global temperatures increase by 4ºC compared to a 1981-2000 and 2001-2010 modelled baseline.
Drought Severity Index (DSI)	The DSI is not threshold based- it measures the severity of a drought not frequency and is based on 12-month rainfall deficits. Higher values indicate more severe drought[16].	Compared to baseline (modelled 1981-2000 and 2001-2010) DSI values, all climate projections indicate an overall increase in the severity of drought.

5.2.3 Potential impacts of climate projections on habitats

The potential impacts of climate projections on habitats are summarised below and in Table 5.6.

- **Temperature**: Warmer summers with greater extreme temperatures are likely to result in more frequent, severe, and prolonged heatwave events. When prolonged periods of warm weather are combined with drought events, the risk of wildfire may increase. Options that are within woodland areas are likely to be

[13] Met Office (2023) *Annual Count of Hot Summer Days- Projections (12km)* [Online] Available at: Annual Count of Hot Summer Days - Projections (12km) (metoffice.gov.uk)

[14] Met Office (2023) *Annual Count of Extreme Summer Days- Projections (12km)* [Online] Available at: Annual Count of Extreme Summer Days - Projections (12km) | The Met Office climate data portal

[15] Met Office (2023) *Annual Growing Degree Days- Projections (12km)* [Online] Available at: Annual Growing Degree Days - Projections (12km) | The Met Office climate data portal

[16] Met Office (2023) *Drought Severity Index, 12-Month Accumulations – Projections* [Online] Available at: Drought Severity Index, 12-Month Accumulations - Projections | The Met Office climate data portal

more vulnerable to wildfire. With droughts predicted to increase in severity, climate risks associated with drier conditions may be further exacerbated. Increasing winter temperatures could potentially alter and shorten the hibernation season for mammals and insects as well decrease the occurrence of frost days and snow events. Increasing temperatures throughout the year may also lead to an increase in the plant growing season leading to taller and denser sward of native and invasive non-native species. Although not specifically captured by climate data, options within urban areas are likely to experience exacerbated impacts of Urban Heat Island effect.

- **Precipitation**: Wetter winters may result in increased flood risk through greater surface run-off and increased water levels in rivers and other water courses. Options within current flood zones and adjacent to rivers are likely to more vulnerable to flooding events. Drier summers may increase the frequency and severity of drought events which in turn may also exacerbate the severity of flooding. In some areas, extreme projections predict extreme precipitation events in summer. Drier and drought conditions paired with extreme summer precipitation could lead to flash flood events. This is due to reduced soil moisture which decreases the ability of soils to absorb water and increases surface run off. Extreme summer precipitation is more likely after periods of warmer temperatures as warmer air has greater ability to hold more moisture, which can lead to sudden heavy precipitation.
- **Wind and Storms:** Confidence in projected wind speed and storminess is lower than projections for temperature and precipitation. Based on observations, the Met Office found no trends in maximum wind speeds over the last four decades. However, global projections over the UK have shown increases in near surface wind speeds during the latter half of the 21st century and found that, for the winter season, when more significant impacts of wind are experienced, this is accompanied by an increase in frequency of winter storms over the UK[17]. An increase in storm intensity and volume of precipitation is likely to disrupt habitats, potentially destroying them.

Table 5-6: Potential Risk to Habitats and Species from Climate Projections

Future climate conditions	Potential risks
Hotter summers and warmer winters More severe and frequent heatwaves	– Increased coverage of invasive non-native species (INNS) and pests, which may cause disturbance to, and displacement of, native species. – Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. – Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. – Desiccation and loss of habitats. – Increased risk of wildfire, which may destroy habitats and be a risk to species survival. – Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc. – Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET. – Increase in water temperature of water features such as ponds can lead to algal blooms and drying out of these features. In turn this can affect species depending on water features for shelter, foraging and so on. – Longer growing season and increased vegetation growth which will require specific management requirements. – Disparities in individual species hibernation seasons. Certain species could come out of hibernation before their food source is available.
Drier summers Drought	– Dying out and loss of habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers) – Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought.

[17] Met Office (2019) *UKCP18 Factsheet: Wind.* [Online] Available at: ukcp18-fact-sheet-wind_march21.pdf (metoffice.gov.uk).

Future climate conditions	Potential risks
	– Increase risk of wildfires, which may destroy habitats and risk species survival. – Low water flows leading to reduced dilution of pollution and nutrient enrichment. – Drying out of wet areas and ponds reliant on rainfall. May lead to death of species from lack of water.
Wetter winters and summer precipitation Flooding	– Potential increase in water-logged conditions, which may affect the composition of habitats (those favouring inundation becoming dominant) which knock-on effects for species who depend on these habitats. – Species at risk of drowning. – Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. – Increased potential of invasive non-native species (INNS) and pests, which may disturbance to, and displacement of, native species. – Flooding could increase soil erosion, which may lead to loss in habitat extent. – Disturbance to water features from drying-out in summer droughts and then flooding after extreme rainfall events, which means they no longer provide viable habitats for species. – Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition. Increase in nitrogen deposition can lead to eutrophication in ponds and reduce water quality. – Increase in surface water runoff and erosion may lead to reductions in water quality in the nearby surrounds including ponds. – There may be beneficial effects as wetter conditions and flooding provides opportunities to restore or create wet habitats. – Reduced rooting depth for species intolerant of winter waterlogging.
Winds and storms	– Disturbances to habitats from wind and storms with potential for feeding areas to be compromised. – Potential for short term deterioration in water quality due to windblown debris in ponds. – Increase in soil erosion may lead to loss in habitat extent. – Destruction to woodlands through tree fall uprooting and leaf loss. Potential for damage to tree shape and form and impact growth.

5.2.4 Implications for habitat types

Warming temperatures throughout the year, changing precipitations patterns, and extreme climate conditions are likely to pose a significant threat and lead to a loss of current and future habitats and species or force them to adapt to new climate conditions. To explore the potential risks to habitats and resilience measures the following habitats have been reviewed which correspond with habitat type requirements within the rdWRMP24 options:

- Calcareous grassland
- Woodland (broadleaved and other)
- Neutral grassland
- Mixed scrub
- Lowland mixed deciduous woodland
- Ponds
- Floodplain wetland mosaic
- Lowland meadow

Tables 5.7 to 5.14 detail the potential risks to the habits listed above as a result of future climate conditions. Potential resilience measures to be implemented during the planning, design, implementation and

maintenance for BNG to address the risks posed by climate change to habitats are also explored. A range of resilience measures, which include nature-based solutions (NbS), are discussed below and should be considered as part of the development of all rdWRMP24 options.

Table 5-7: Calcareous Grassland potential future climate risks and resilience measures

Future Climate conditions	Potential risks	Potential resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Increased coverage of invasive non-native species (Invasive Non-Native Species) and pests, which may cause disturbance to, and displacement of, native species. • Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Longer growing season and increased vegetation growth which will require specific management requirements. • Increased risk of wildfires, which may destroy habitats and risk species survival. • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc.	• Increase the area of existing habitat through targeted re-creation and restoration[18]. • Only in limited areas and with very careful management to control growth, very small patches of scrub could be considered as part of mosaic-edge habitats bordering the grassland if beneficial on sites prone to heat stress or drought, due to scrub providing shade and refugia for invertebrates[18]. • Ensure areas that might act as potential refugia from climate change are under optimal management, such as areas with north facing slopes, complex micro-topography, low nitrogen levels, and high species diversity[18]. • Design measures to reduce soils from drying out and retain water during summer droughts. • Develop an INNS and pest management plan. • If relevant, restrict public access and build designated footpaths to avoid damage to habitats and reduce risk of wildfire in the wider area. • Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more sheltered locations or areas with secure water supply. • Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift.
Drier Summers Drought	• Changed community composition due to increased dominance of some species and reduced adaptability of others in drier conditions. • Increased soil erosion (particularly at risk from more extreme/ heavy rainfall events during drier summers). • Increased risk of wildfires, which may destroy habitats and risk species survival.	
Wetter winters and summer precipitation Flooding	• Due to increased competition and a reduction in broad-leaved herbaceous species (characterise calcareous grasslands), wetter conditions could lead to an increased dominance of grasses in the sward[18]. • Species risk of drowning • Potential risk in water-logged conditions, which may affect the composition of habitats. • Increase in soil erosion. • Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition. Increase in nitrogen deposition can lead to eutrophication in ponds and reduce water quality. • Reduced rooting depth for species intolerant of winter waterlogging.	
Winds and storms	• Disturbances to habitats from wind and storms with potential for feeding areas to be compromised. • Increase in soil erosion may lead to loss in habitat extent.	

[18] Natural England (2020) *Climate Change Adaptation Manual: 21. Lowland Calcareous Grassland* [Online] Available at: https://publications.naturalengland.org.uk/file/4715999289147392

Table 5-8: Woodland (broadleaved and other) potential future climate risks and resilience measures

Future Climate conditions	Potential risks	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Longer growing season and increased vegetation growth which will require specific management requirements. • Increased coverage and survival of invasive non-native species (INNS) and pests, which may cause disturbance to, and displacement of, native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc.	• Design measures to reduce soils from drying out and retain water during summer droughts. • Develop an INNS and pest management plan. • If relevant, restrict public access and build designated footpaths to avoid damage to habitats and reduce risk of wildfire in the wider area. • Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more sheltered locations or areas with secure water supply. • Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift. • Maximise diversity of woodland edge habitats especially by creating ecotones to boost resilience of the inner woodland core
Drier Summers Drought	• Potential for widespread tree mortality in years of extreme drought. • Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought. • Increase risk of wildfires, which may destroy habitats and risk species survival	
Wetter winters and summer precipitation Flooding	• Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Reduced rooting depth for species intolerant of winter waterlogging.	
Winds and storms	• Destruction to woodlands through tree fall uprooting and leaf loss. Potential for damage to tree shape and form, impact growth, and losses of mature and veteran trees.	

Table 5-9: Neutral grassland potential future climate risks and resilience measures

Future Climate conditions	Potential risks	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Longer growing season and increased vegetation growth which will require specific management requirements. • Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species.	• Design measures to reduce soils from drying out and retain water during summer droughts. • Develop an INNS and pest management plan.

Future Climate conditions	Potential risks	Resilience measures
	• Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc. • Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET.	• If relevant restrict public access and build designated footpaths to avoid damage to habitats and reduce risk of wildfire in the wider area. • Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more sheltered locations or areas with secure water supply. • Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift.
Drier Summers Drought	• Dying out and loss of habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers). • Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought.	
Wetter winters and summer precipitation Flooding	• Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Increased potential of invasive non-native species (INNS) and pests, which may disturbance to, and displacement of, native species. • Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition.	
Winds and storms	• Increase in soil erosion may lead to loss in habitat extent.	

Table 5-10: Mixed Scrub potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Longer growing season and increased vegetation growth which will require specific management requirements. • Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc. • Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET.	• Design measures to reduce soils from drying out and retain water during summer droughts. • Develop an INNS and pest management plan. • If relevant, restrict public access and build designated footpaths to avoid damage to habitats and reduce risk of wildfire in the wider area. • Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more

Future Climate conditions	Potential impacts	Resilience measures
Drier Summers Drought	• Dying out and loss of habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers). • Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought.	sheltered locations or areas with secure water supply. • Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift.
Wetter winters and summer precipitation Flooding	• Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Increased potential of invasive non-native species (INNS) and pests, which may disturbance to, and displacement of, native species. • Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition.	
Winds and storms	• Increase in soil erosion may lead to loss in habitat extent.	

Table 5-11: Lowland mixed deciduous woodland potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Earlier bud burst, with potential for increased risk of frost damage[19]. • Reduced seed germination and natural regeneration of some species due to reduced winter chilling[19]. • Longer growing season and increased vegetation growth which will require specific management requirements. • Increased coverage and survival of invasive non-native species (INNS) and pests, which may cause disturbance to, and displacement of, native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Increased grazing pressures due to the greater survival of mammal pests[19] • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc.	• In southern and eastern England, with more free-draining soils, select more drought- tolerant species[19]. • Use new planting to increase the patch size of small woods and reduce edge effects[19]. • Include a mix of species within new native woodland planting[19]. • Consider planting to assist adaptation in other areas such as windbreaks, and flood alleviation[19]. • Design measures to reduce soils from drying out and retain water during summer droughts. • Develop an INNS and pest management plan. • If relevant, restrict public access to some habitats and build designated footpaths to controlled habitats that the public can
Drier Summers Drought	• Potential for widespread tree mortality in years of extreme drought[19]. • Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought. • Increase risk of wildfires, which may destroy habitats and risk species survival. • A potential decline in canopy cover and changes in canopy characteristics[19].	

[19] Natural England (2020) *Climate Change Adaptation Manual: 1 Lowland mixed deciduous woodland* [Online] Available at: https://publications.naturalengland.org.uk/file/5545563565326336

Future Climate conditions	Potential impacts	Resilience measures
Wetter winters and summer precipitation Flooding	• Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Reduced rooting depth for species intolerant of winter waterlogging.	access to avoid damage to habitats and reduce risk of wildfire in the wider area. • Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more sheltered locations or areas with secure water supply. • Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift.
Winds and storms	• Destruction to woodlands through tree fall uprooting and leaf loss. Potential for damage to tree shape and form, impact growth, and losses of mature and veteran trees.	

Table 5-12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET. • Changes to the phenology within the plankton community, leading to changes in the relative abundance of species[20]. • Increased coverage of riparian and aquatic invasive non-native species (INNS) and pests due to improved survival rates, which may cause disturbance to, and displacement of, native species.	• Manage access and leisure activities to minimise impacts and increase resilience[20]. • Promote good biosecurity to slow the spread of invasive non-native species and minimise their chances of colonising the water body and control damaging species already present[20]. • Establish and maintain water retaining features[20].
Drier Summers Drought	• Drying out of wet areas and ponds reliant on rainfall. May lead to death of species from lack of water. • Loss of physical connection with other freshwater and wetland habitats[20]. • Drying out of shallow/small water bodies is detrimental to some species, however other species such as the tadpole shrimp thrive in these conditions[20]. • Potential for changes in pH due to changes in hydrological conditions[20]. • Increased nutrient concentrations within water bodies which may lead to difficulties in ponds recovering from eutrophication[20].	
Wetter winters and summer precipitation Flooding	• Increase in surface water runoff and erosion may lead to reductions in water quality in the nearby surrounds including ponds. • Disturbance to water features from drying-out in summer droughts and then flooding after extreme rainfall events, which means they no longer provide viable habitats for species. • Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition. Increase in nitrogen deposition can lead to eutrophication in ponds and reduce water quality.	

Future Climate conditions	Potential impacts	Resilience measures
Winds and storms	• Eutrophication and sedimentation from increased run-off of sediment and nutrients. Eutrophication has the potential to impact upon the entire food web[20]. • Fluctuation in water levels[20]. • Potential for short term deterioration in water quality due to windblown debris in ponds.	

Table 5-13: Floodplain wetland mosaic potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Increased coverage of invasive non-native species (INNS) and pests, which may cause disturbance to, and displacement of, native species. • Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures. This could affect species who rely on these habitats for shelter, foraging etc. • Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET. • Increase in water temperature of water features such as ponds can lead to algal blooms and drying out of these features. In turn this can affect species depending on water features for shelter, foraging and so on. • Longer growing season and increased vegetation growth which will require specific management requirements.	• Design measures to reduce soils from drying out and retain water during summer droughts. • Establish and maintain water retaining features such as ponds. • Leaky barriers on run-off pathways. • Drainage pathways to reduce flood risk with consideration of climate change allowances. • Design measures to reduce soil compaction during winter.
Drier Summers Drought	• Dying out and loss of habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers) • Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought. • Low water flows leading to reduced dilution of pollution and nutrient enrichment. • Drying out of wet areas and ponds reliant on rainfall. May lead to death of species from lack of water.	
Wetter winters and summer precipitation Flooding	• Potential increase in water-logged conditions, which may affect the composition of habitats (those favouring inundation becoming dominant) which knock-on effects for species who depend on these habitats. • Species at risk of drowning.	

[20] Natural England (2020) *Climate Change Adaptation Manual: 11. Standing open water* [Online] Available at: https://publications.naturalengland.org.uk/file/6406800339632128

Future Climate conditions	Potential impacts	Resilience measures
	• Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Increased potential of invasive non-native species (INNS) and pests, which may disturbance to, and displacement of, native species. • Flooding could increase soil erosion, which may lead to loss in habitat extent. • Disturbance to water features from drying-out in summer droughts and then flooding after extreme rainfall events, which means they no longer provide viable habitats for species. • Flooding may lead to changes in nutrient levels such as phosphorus in soil, changing plant composition. Increase in nitrogen deposition can lead to eutrophication in ponds and reduce water quality. • Increase in surface water runoff and erosion may lead to reductions in water quality in the nearby surrounds including ponds. • There may be beneficial effects as wetter conditions and flooding provides opportunities to restore or create wet habitats.	
Winds and storms	• Potential for short term deterioration in water quality due to windblown debris in ponds. • Increase in soil erosion may lead to loss in habitat extent.	

Table 5-14: Lowland meadow potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Phenology may change, with certain species flowering and seed setting earlier[21]. • Increased coverage of invasive non-native species (INNS) and pests, which may cause disturbance to, and displacement of, native species. • Increased insect outbreaks, which could degrade habitats and cause disturbance to native species. • Increased temperature stress throughout the year, which may risk survival of habitats and cause the displacement of native species. • Changes in species composition where certain habitats and species may no longer be viable with warmer temperatures.	• Increased flexibility of site management (e.g. vary the timing of the hay cut) to respond to the increased variation in seasonal growing conditions[21]. • Maintain or restore water level management such as restoring ditch networks to increase the water holding capacity of sites[21]. • Monitor and ensure the control of potential invasive species e.g., biosecurity measures and surveillance[21]. • Restore semi-improved grasslands and re-create lowland meadows on improved
Drier Summers Drought	• Drier conditions will favour stress tolerant and ruderal species, however species which are between stress tolerant and competitive will be constrained[21] . • Dying out and loss of habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers)	

[21] Natural England (2020) *Climate Change Adaptation Manual: 22. Lowland Meadow Grassland* [Online] Available at: https://publications.naturalengland.org.uk/file/6721023804440576

Future Climate conditions	Potential impacts	Resilience measures
	• Habitats unable to survive in prolonged drought conditions; this is a particular risk for newly planted habitats that are more vulnerable to drought. • Increase risk of wildfires, which may destroy habitats and risk species survival. • Where the lowland meadow is wetter, increased evapotranspiration and abstraction during water weather could lead to reduced water tables and water availability. This could result in a shift in the botanical composition of the habitat and ultimately a decline in more wetland species[21] . • Drier conditions could favour a transition to hay making from silage, which has the potential for biodiversity benefits[21].	grasslands and arable land to expand the area of lowland meadows. These sites should also be linked[21]. • Vary the type and timing of management interventions to increase the structural heterogeneity of meadows[21].
Wetter winters and summer precipitation Flooding	• Potential increase in water-logged conditions, which may affect the composition of habitats (those favouring inundation becoming dominant) which knock-on effects for species who depend on these habitats. • Loss of habitat from extreme precipitation and flood events; this is a particular risk for newly planted habitats that are more vulnerable. • Increase summer flood events could lead to the replacement of floodplain-meadow plant communities with swamp communities[21]. • Increased deposition of phosphorous in soils leading to alteration of plant community composition [21]. • Increased pollution risk[21]. • Flooding could increase soil erosion, which may lead to loss in habitat extent.	
Winds and storms	• Increase in soil erosion may lead to loss in habitat extent. • Disturbances to habitats from wind and storms with potential for feeding areas to be compromised.	

Table 5-15 River habitat potential future climate risks and resilience measures

Future Climate conditions	Potential impacts	Resilience measures
Hotter summers and warmer winters Most severe and frequent heatwaves	• Decline in certain species including plants, invertebrates and fish due to increasing water temperatures. Species are likely to migrate upstream where cooler waters exist (assuming that upstream reaches are within the hydraulic and hydrological tolerances of each species)[22]. • Increase in water temperature of water features can lead to the drying out of these features. In turn this can affect species depending on water features for shelter, foraging and so on. • Increased potential evapotranspiration (PET) may affect water availability and this could in turn affect ecosystem health if habitats cannot extract water fast enough before it is lost through PET. • Some aquatic and riparian non-native species may spread more easily[22].	With increased severity of prolonged drought periods, as well as summer flash flooding exacerbated by drought conditions and increase in winter flood risk, it is crucial to embed resilience measures into the design, immediate aftercare and long-term management of river habitats enhanced or created for BNG. Depending on the site and river enhancement / creation, resilience measures could include: • Taking a catchment-based approach especially to integrate natural flood management measures e.g. Leaky barriers on run-off pathways. • Enhancing existing rivers with a long-history of presence (as these well-established habitats will be more resilient than newly created habitats). • Strict INNS monitoring and control measures. • Alongside the river, creating depressions and ponds to reduce soils from drying out and retain water during summer droughts – Drainage pathways to reduce flood risk with consideration of climate change allowances. – Design measures to reduce soil compaction during winter. • Improve the natural infiltration of catchment soils and percolation to groundwater by restoring soil organic matter[22].
Drier Summers Drought	• Dying out and loss of river habitats with potential for increased soil erosion (this soil erosion risk is particularly at risk from more extreme / heavy rainfall events during drier summers) • Low water flows leading to reduced dilution of pollution and nutrient enrichment. • Prolonged low flows and associated temporary reductions in habitat extent and quality will lead to increased competition and predation[22].	
Wetter winters and summer precipitation Flooding	• Increased potential of invasive non-native species (INNS) and pests, which may lead to disturbance to, and displacement of, native species. This can be exacerbated if there is increased connectivity in flooding events[22]. • Disturbance to water features from drying-out in summer droughts and then flooding after extreme rainfall events, which means they no longer provide viable habitats for species. • Increase in surface water runoff and erosion may lead to reductions in water quality in the nearby surroundings including ponds and rivers. • There may be beneficial effects as wetter conditions and flooding provides opportunities to restore or create wet habitats. •	
Winds and storms	• Potential for short term deterioration in water quality due to windblown debris in watercourses. • Increased potential for erosion leading to increased loads of fine sediments and nutrients, causing siltation and eutrophication[22]	

[22] Natural England (2020) *Climate Change Adaptation Manual: 10 Rivers and Streams* [Online] Available at: https://publications.naturalengland.org.uk/file/5558226472927232

Future Climate conditions	Potential impacts	Resilience measures
		• Slow surface water run-off and aid infiltration of water into the soil by planting semi-natural vegetation such as woodland and grassland along run-off pathways[22]. • Minimise impacts on the natural regime of rivers by managing water demand, impoundment and abstraction. [22]. • Avoid altering natural river processes by adding hard engineering such as weirs and hard bank protection[22]. • Actively restore the riparian environment by utilising measures such as bed-raising, bank re-profiling, and riparian tree planting[22]

5.3 BNG Delivery for rdWRMP24 options

5.3.1 South East Water to Guildford

5.3.1.1 BNG and Habitat Requirements

The South East Water to Guildford option is within the Guildford District and Surrey Heath District LPAs. These LPAs both require a 20% BNG within the emerging Local Plans. The on-site habitats that are likely present are cereal crops, modified grassland, lowland calcareous grassland, other woodland; broadleaved, other coniferous woodland, and ponds (non-priority habitat). There are no Very High distinctiveness habitats within the on-site baseline. Following the assumptions in section 4.2, Table 5.15 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.16 provides the details of the estimated hectares of off-site habitat needed to achieve a 20% BNG and meet the trading standards.

Table 5-16: BNG Metric 3.0 Summary

On-site baseline	Habitat units	244.10
On-site post-intervention	Habitat units	60.89
Off-site baseline	Habitat units	392.00
Off-site post-intervention	Habitat units	627.47
Total net unit change	Habitat units	52.26
Total on-site net % change plus off-site surplus	Habitat units	21.41%

Table 5-17: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (ha)	Habitat Units
TWU_GUI_HI-TFR_RZ4_ALL_sewtogui	Other neutral grassland	Medium	110	409.74
	Lowland calcareous grassland	High	46	83.84
	Other woodland; broadleaved	Medium	40	133.89
		Total:	181	627.47

Part of the site is within the Thames Basin Heaths Biodiversity Opportunity Area (BOA)[23]. It was assumed that all on-site habitat, both baseline and creation, has High strategic significance on a precautionary basis, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. The option baseline includes area-based habitat types only. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site. As a precautionary approach, the off-site habitat was assumed to not be within a BOA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site created Lowland calcareous grassland was assigned Medium strategic significance, as it was assessed to be ecologically desirable, as a priority habitat within the Biodiversity and Planning in Surrey[24] document.

This would result in a total on-site net % change plus off-site surplus of **21.41%.**

[23] Surrey Wildlife Trust, 2023. *Biodiversity Opportunity Areas*. Available at: Biodiversity Opportunity Areas | Surrey Wildlife Trust

[24] Surrey Nature Partnership, 2019. Biodiversity & Planning in Surrey. Available at: Oxford cc biodiversity ppg 2010 – adaptation for Surrey (wordpress.com)

It should be noted that Element 1 is approximately 100m south of the Broadmoor to Bagshot Woods and Heaths SSSI, and Element 2 is approximately 80m west of Colony Bog and Bagshot Heath SSSI, Thursley, Ash, Pirbright & Cobham SAC, and 100m east of Basingstoke Canal SSSI (note there is uncertainty as to where pipeline will be located). Impacts on the SSSIs or SAC should be avoided, especially as then the option cannot achieve an overall BNG.

5.3.1.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.17.

Table 5-18: South East Water to Guildford Climate Projection Summary

South East Water to Guilford (Grid Square ID: 487500, 162500)	
Temperature	Air temperatures for the South East Water to Guildford option is projected to increase throughout the year under both emission scenarios in the 2060s, compared to a 1981 – 2010 baseline. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19.5 ºC during summer** and **2 ºC to 6.6 ºC during winter,** compared to a 1981-2001 modelled baseline. In winter, temperatures are unlikely to drop below **3.7 ºC** and could potentially reach a maximum temperature of **9 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **24.9 ºC and 14.1 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the South East Water to Guildford option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.5% to 6.86mm/day in winter** compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.7% to 3.85mm/day** compared to a 1981-2001 modelled baseline.
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39 ºC in summer** and reaching **20.4 ºC in winter** compared to 1995 modelled baseline**.** • Extreme 5-day total precipitation percentage increase of 2.2% to **92.1 (5-day accumulated) mm/day in summer** and a 9.4% percentage increase to **98.8 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline**.**

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.18 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-19: South East Water to Guildford - Climate Implications and Resilience Measures for Habitats

Habitat Type	**Climate Implications**	**Recommended Resilience Measures**
Onsite: Cereal crops, modified grassland, lowland calcareous grassland, other woodland; broadleaved, other coniferous woodland, and ponds (non-priority habitat).	See the following tables: • Table 5.7: Calcareous Grassland potential future climate risks and resilience measures • Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures	

Habitat Type	Climate Implications	Recommended Resilience Measures
Off site: Neutral Grassland, Lowland calcareous grassland, Broadleaved woodland.	• Table 5.9: Neutral grassland potential future climate risks and resilience measures • Table 5.12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures	

5.3.1.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed. There appears to be no additional Thames Water owned land suitable for BNG delivery adjacent to this option to supplement the habitat reinstatement.

Where off-site habitat is required, there are several Thames Water land holdings within the Guildford LPA which could be further investigated for off-site BNG delivery including:

- Lightwater STW – approx. 4.8ha of habitat area surrounding the STW comprising lowland mixed deciduous woodland, mixed scrub, modified grassland, other grassland.
- Camberly STW – approx. 4.7ha of habitat area surrounding the STW comprising lowland mixed deciduous woodland, ruderal and ephemeral, other improved and semi-improved grassland and modified grassland.
- This option is within the same LPA as one of the super BNG delivery sites: Land outside of Godalming STW in Guildford LPA.

5.3.2 Interzonal transfer (T2ST): Kennet Valley spur to Speen (10Ml/d)

5.3.2.1 BNG and Habitat Requirements

The Interzonal transfer (T2ST): Kennet Valley spur to Speen (10Ml/d) option is within the West Berkshire LPA, which requires a 10% BNG within the emerging Local Plan. The on-site habitats that are likely present are modified grassland, other woodland; broadleaved and lowland mixed deciduous woodland. There are no Very High distinctiveness habitats within the on-site baseline. Following the assumptions in section 4.2, Table 5.19 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.20 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-20: BNG Metric 3.0 Summary

On-site baseline	Habitat units	16.97
On-site post-intervention	Habitat units	3.23
Off-site baseline	Habitat units	24.00
Off-site post-intervention	Habitat units	40.11
Total net unit change	Habitat units	2.36
Total on-site net % change plus off-site surplus	Habitat units	13.92%

Table 5-21: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen	Other neutral grassland	Medium	9.5	35.39
	Other woodland; broadleaved	Medium	0.5	1.67
	Lowland mixed deciduous woodland	High	2	3.05
		Total:	13.5	40.11

The site is within the Kennet Valley West Berkshire BOA[25]. It was assumed that all on-site habitat, both baseline and creation, has High strategic significance on a precautionary basis, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present. As a precautionary approach, the off-site habitat was assumed to not be within a BOA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site created Lowland calcareous grassland was assigned Medium strategic significance, as it was assessed to be ecologically desirable, as a priority habitat within the Berkshire Biodiversity Strategy[26].

This would result in a total on-site net % change plus off-site surplus of **13.92% habitat units.**

It should be noted that the site is approximately 290m north of the River Thanet SSSI. Any adverse impact on the SSSI and the option will not be able to achieve BNG.

5.3.2.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.21.

Table 5-22: Interzonal Transfer (T2ST): Kennet Valley spur to Speen (10Ml/d) Climate Projection Summary

Interzonal transfer (T2ST): Kennet Valley spurt o Speen (10Ml/d) (Grid Square ID: 437500, 162500)	
Temperature	Air temperatures for the Cul to Speen, Kennet Valley Spurt option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 18.8 ºC during summer** and **2 ºC to 6.1 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.3 ºC** and could potentially reach a maximum temperature of **9 ºC** compared to a 1981-2001 modelled baseline**.** In summer

[25] Berkshire Local Nature Partnership, 2023. *Kennet Valley West*. Available at: 3. Kennet Valley West - Berkshire LNP.

[26] Berkshire Local Nature Partnership, 2014. *The Natural Environment in Berkshire: Biodiversity Strategy 2014 – 2020*. Available at: https://berkshirelnp.org/images/Biodiversity%20Strategy%20Small.pdf

Interzonal transfer (T2ST): Kennet Valley spurt o Speen (10Ml/d) (Grid Square ID: 437500, 162500)	
	temperatures are projected to be between **13.4 ºC and 24.3 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.4% to 8.99mm/day in** winter compared to a 1981-2001 modelled baseline. In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.6% to 4.34mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **38.4 ºC in summer** and reaching **19.6 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 1.9% to **89.6 (5-day accumulated) mm/day in summer** and a 9.2% percentage increase to **101.1 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.22 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-23: Interzonal Transfer (T2ST): Kennet Valley spur to Speen - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: Modified grassland, other woodland; broadleaved and lowland mixed deciduous woodland	See the following tables: • Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures • Table 5.9: Neutral grassland potential future climate risks and resilience measures • Table 5.11: Lowland mixed deciduous woodland potential future climate risks and resilience measures	
Off site: Neutral grassland, broadleaved woodland, deciduous woodland		

5.3.2.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. If the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed. Where further habitat is required, Thames Water have a land holding at Speen WPS, at the end of this option, which is also one of the identified super BNG delivery sites. The habitat area around the WPS is approx. 15.20ha and comprises native hedgerow, modified grassland, other neutral and semi-improved grassland, mixed scrub, lowland fens and other neutral grassland. The area provides opportunities for additional BNG delivery.

5.3.3 Kempton WTW

5.3.3.1 BNG and Habitat Requirements

The Kempton WTW (100ml/d) option is within the Hounslow London Borough and on the border of Spelthorne LPA. Hounslow London Borough's Local Plan does not mention BNG, so the 10% minimum applies. The on-site habitats that are likely present are other woodland; broadleaved and lowland mixed deciduous woodland.

There are no Very High distinctiveness habitats present within the on-site baseline. Following the assumptions in section 4.2, Table 5.23 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.24 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-24: BNG Metric 3.0 Summary

On-site baseline	Habitat units	17.16
	River units	4.56
On-site post-intervention	Habitat units	1.33
	River units	5.67
Off-site baseline	Habitat units	54.00
	River units	0.00
Off-site post-intervention	Habitat units	72.16
	River units	0.00
Total net unit change	Habitat units	2.33
	River units	1.11
Total on-site net % change plus off-site surplus	Habitat units	13.55%
	River units	24.31%

Table 5-25: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_LON_HI-ROC_WT1_CNO_kemptonwtw100 p1	Other woodland; broadleaved	Medium	17	56.90
	Lowland mixed deciduous woodland	High	10	15.25
		Total:	27	72.16

The location was not identified in a local strategy, plan, or policy, therefore the Other woodland; broadleaved was given Low strategic significance for both the on-site baseline and creation. The on-site Lowland mixed deciduous woodland was mapped as Priority Habitat on MAGIC, therefore was assigned Medium strategic significance at both baseline and creation. As a precautionary approach, and due to the lack of a biodiversity strategy, the off-site baseline was assigned Low strategic significance, as per the assumptions in section 4.2. the off-site created Lowland mixed deciduous woodland was assigned Medium strategic significance.

This would result in a total on-site net % change plus off-site surplus of **13.55% habitat units.**

From the desk-based assessment, it was estimated that no hedgerow habitat was present. River habitat was estimated to be present within the site. Following the assumptions in section 4.2, enhancement of the retained length of river from Moderate to Good condition was proposed to reach the required River Units for 10% BNG. See Table 5.25 for the details of this.

Table 5-26: Estimated River Units from the proposed river enhancement at Kempton WTW

Proposed River Type	Post development condition	Distinctiveness	Length (km)	River Units
Other Rivers and Streams	Good	High	0.38	5.67
		Total:	0.38	5.67

This would result in a total on-site net % change plus off-site surplus of **24.31% river units.**

It should be noted that the site is directly adjacent to Kempton Park Reservoirs SSSI. Any adverse impact on the SSSI and the site will not be able to achieve BNG.

5.3.3.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.26.

Table 5-27: Kempton WTW Climate Projection Summary

Kempton- 100 Phase 1- Construction (Grid Square ID: 512500, 162500)	
Temperature	Air temperatures for the Kempton-100 option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19.9 ºC during summer** and **2 ºC to 6.9 ºC during winter** compared to a 1981-2001 modelled baseline. In winter, temperatures are unlikely to drop below **4.1 ºC** and could potentially reach a maximum temperature of **9.9 ºC** compared to a 1981-2001 modelled baseline. In summer temperatures are projected to be between **14.6 ºC and 25.2 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.3% to 6.51mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 18.6% to 3.91mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 predict: • Extreme temperatures reaching **38.3 ºC in summer** and **20.1 ºC in winter** compared to 1995 modelled baseline**.** • Extreme 5-day total precipitation percentage increase of 1.1% to **83.2 (5-day accumulated) mm/day in summer** and a 9.1% percentage increase to **105.6 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.27 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

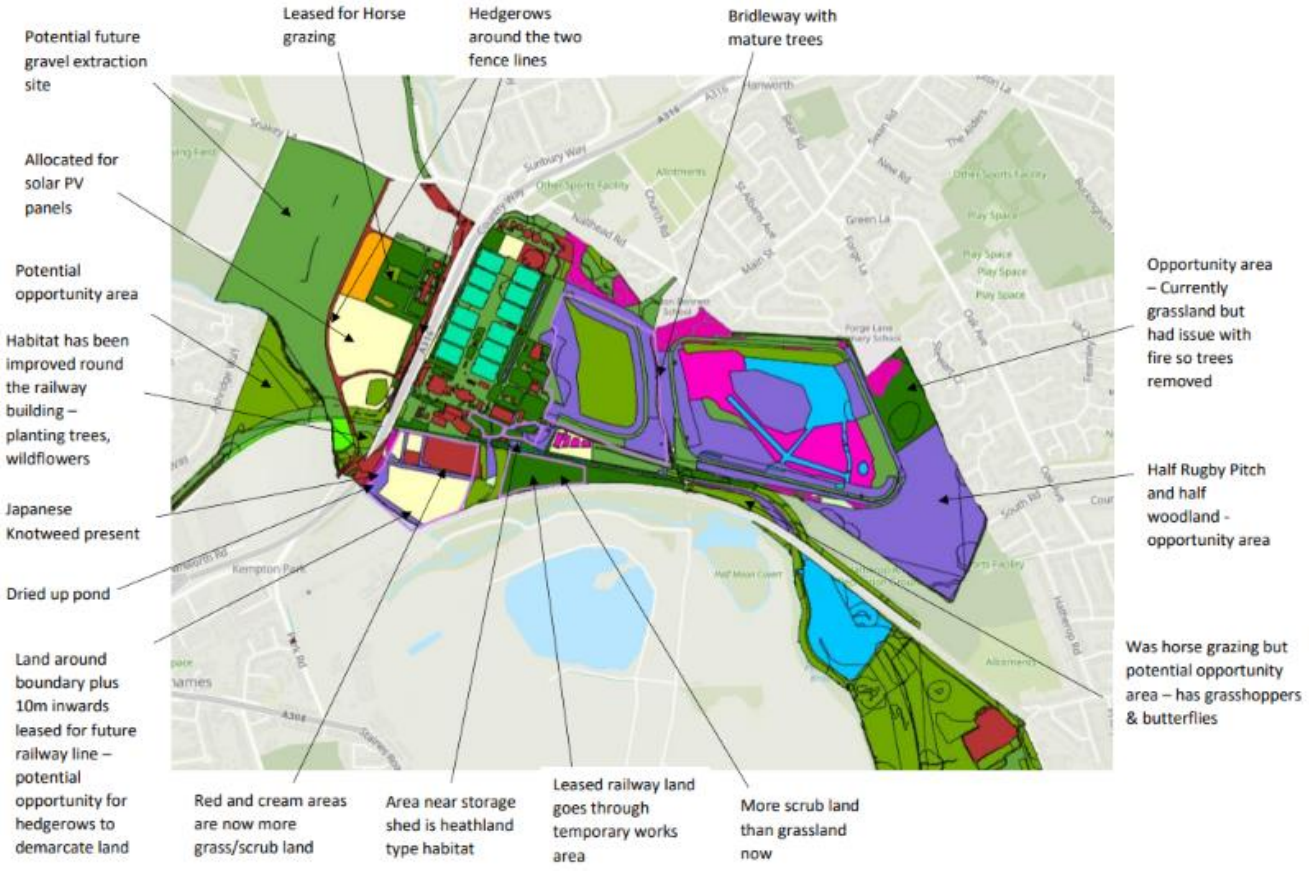
Table 5-28: Kempton WTW - Climate Implications and Resilience Measures for Habitats

Habitat Type	**Climate Implications**	**Recommended Resilience Measures**
Onsite: Woodland; broadleaved and lowland mixed deciduous woodland River habitat	See the following tables: • Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures • Table 5.11: Lowland mixed deciduous woodland potential future climate risks and resilience measures • Table 5.15: River habitat potential future climate risks and resilience measures	
Off site: Other woodland broadleaved woodland, lowland mixed deciduous woodland		

5.3.3.3 BNG Delivery

Thames Water own a large area of land surrounding the existing Kempton WTW. Discussions have been undertaken with the land manager and the site represents a good opportunity area for BNG delivery. BNG delivery needs to be balanced with existing and committed uses and leases, for example an area of site is allocated for solar PV panels, there is a potential future gravel extraction site and an area around the southern boundary is leased for future railway line development. There are areas on the site that could be improved to provide BNG delivery including areas of grassland, scrub land, and a dried-up pond (see Figure 5.1).

Figure 5.1: Kempton WTW and nature reserve BNG opportunities



5.3.4 Medmenham intake – 53

5.3.4.1 BNG and Habitat Requirements

The Medmenham intake – 53 option is within the Buckinghamshire LPA. This LPA requires BNG within the merging Local Plan, however it does not have a required % net gain. Therefore, the minimum 10% BNG applies. The on-site habitats that are likely present are cereal crops and modified grassland. No Very High distinctiveness habitats are likely to be present within the on-site baseline. Following the assumptions in section 4.2, Table 5.28 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.29 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-29: BNG Metric 3.0 Summary

On-site baseline	Habitat units	7.27
On-site post-intervention	Habitat units	3.49
Off-site baseline	Habitat units	6.00
Off-site post-intervention	Habitat units	11.17
Total net unit change	Habitat units	1.40
Total on-site net % change plus off-site surplus	Habitat units	19.24%

Table 5-30: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_SWA_HI-TFR_UTC_ALL_medmenham intake 53	Other neutral grassland	Medium	3	11.17
		Total:	3	11.17

Part of the site is within the Hambleden & Wormsley Valleys BOA. It was assumed that all on-site habitat, both baseline and creation, has High strategic significance on a precautionary basis, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. The option baseline includes area-based habitat types only. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site. As a precautionary approach, the off-site habitat was assumed to not be within a BOA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site created Other neutral grassland was assigned Low strategic significance, as it was assessed it is assumed that the off-site habitat will not be within a BOA, and it is not a priority habitat within Buckinghamshire[27].

This would result in a total on-site net % change plus off-site surplus of **19.24% habitat units.**

There are no statutory designated sites in proximity to the site.

5.3.4.2 Climate Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.30.

Table 5-31: Medmenham Intake 53 Climate Projection Summary

Medmenham intake- 53 (Met Office Grid Square ID: 487500, 187500)	
Temperature	Air temperatures for the Medmenham option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19.3 ºC during summer** and **2 ºC to 6.4 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.6 ºC** and could potentially reach a maximum temperature of **9.3 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **13.9 ºC and 24.7 ºC** compared to a 1981-2001 modelled baseline**.**

[27] Buckinghamshire Council, 2023. *Interim Strategic Significance & Spatial Risk Guidance for Biodiversity Net Gain in Buckinghamshire Council's Local Planning Authority Area.* Available at: Interim Strategic Significance and Spatial Risk Guidance (buckinghamshire-gov-uk.s3.amazonaws.com).

Medmenham intake- 53 (Met Office Grid Square ID: 487500, 187500)	
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.3% to 7.19 mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.2% to 4.12 mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39.5 ºC in summer** and reaching **20.9 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 1.3% to **85.3 (5-day accumulated) mm/day in summer** and a 11.5% percentage increase to **85.3 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.31 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-32: Medmenham Intake 53 - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: Cereal crops and modified grassland	See the following tables: • Table 5.9: Neutral grassland potential future climate risks and resilience measures	
Off site: Neutral grassland		

5.3.4.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed. There appears to be no additional Thames Water owned land suitable for BNG delivery adjacent to this option to supplement the habitat reinstatement. However, there are several Thames Water land holdings within the Buckinghamshire LPA which could be further investigated for off-site BNG delivery if required including:

- Widdenton Park Reservoir – approx. 1.04ha of habitat area comprising bare ground, mixed scrub, lowland dry acid grassland, coniferous woodland and other neutral grassland.
- Little Marlow STW – approx. 5.31ha of habitat area surrounding the STW ruderal and ephemeral, improved and semi-improved grassland and other neutral grassland.
- This option is within the same LPA as one of the super BNG delivery sites: Aylesbury STW in Buckinghamshire LPA.

5.3.5 Oxford Canal to Duke's Cut (SWOX)

5.3.5.1 BNG and Habitat Requirements

The Oxford Canal to Duke's Cut (SWOX) option is within 16 different LPAs: Cherwell, boundary of West Oxfordshire, Stratford on Avon, Rugby, West Northamptonshire, Coventry, Nuneaton and Bedworth, Tamworth, Birmingham, Sandwell, Dudley, Wolverhampton, Walsall, Cannock Chase and Lichfield. The highest % BNG requirement was for Lichfield LPA, which requires a 20% BNG. Therefore, the option as a whole was assumed to require a 20% net gain. The on-site habitats that are likely present are floodplain wetland mosaic, modified grassland, cereal crops, lowland meadows and ponds (priority habitat). The lowland meadow is a Very High distinctiveness habitat and is assumed to be retained. Parts of the canal are within strategic areas shown within the Local Plans, e.g., the mid-way point is within the Rigby Strategic Green Infrastructure Network[28].

The site boundary provided includes the whole canal system. However, there will only be minor works along the canal. It was not possible to undertake a BNG assessment that provided a true reflection of the option BNG requirements as individual areas for works on the canal were not available.

5.3.5.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.32.

Table 5-33: Oxford Canal to Duke's Cut Climate Projection Summary

Oxford Canal - Duke's Cut (SWOX) – Construction (Met Office Grid Square IDs: 437500, 212500 (southern extent); 437500, 262500 (middle), 387500, 312500 (northern extent))	
Temperature	Air temperatures for the Oxford Canal- Duke's Cut option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by between **2.7ºC and 3.1ºC to between 19.1 ºC and 18.7 ºC during summer** and between 1.9**ºC and 2ºC during to between 5.9 ºC and 6.2 ºC in winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.1 ºC** at the northern extent (Birmingham) of the option and could potentially reach a maximum temperature of **9.1 ºC at** the southern extent (Oxford) compared to a 1981-2001 modelled baseline**.** In summer, temperatures are projected to be between **23.3 ºC** (northern extent of canal-Birmingham) **and 24.4 ºC** (southern extent of canal- Oxford) compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Oxford Canal- Duke's Cut option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by between 9.6% and 12.6% to between 6.47mm/day and 6.87mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by between 19.4% and 21.6% to between 3.86 mm/day and 4.63mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching between **38.4 ºC** and **39 ºC in summer** and reaching between **19.6 ºC and 20 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increases of between 1.4% and 2.7% to between **96.8 and 112.7 (5-day accumulated) mm/day in summer** and between a 11.8% and 13.7% percentage increase to **76.2 and 81.4 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

[28] Rugby Borough Council, 2016. *Green Infrastructure Proposals Map*. Available at: Local Plan - Examination Library | Rugby Borough Council.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.33 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-34: Oxford Canal to Duke's Cut - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: floodplain wetland mosaic, modified grassland, cereal crops, lowland meadows and ponds (priority habitat)	See the following tables: ● Table 5.7: Calcareous Grassland potential future climate risks and resilience measures ● Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures ● Table 5.9: Neutral grassland potential future climate risks and resilience measures ● Table 5.12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures ● Table 5.13: Floodplain wetland mosaic potential future climate risks and resilience measures ● Table 5.14: Lowland meadow potential future climate risks and resilience measures ● Table 5.15: River habitat potential future climate risks and resilience measures	
Off site: Floodplain wetland mosaic, Lowland Heath, Calcareous grassland Woodland (broadleaved) Neutral Grassland		

5.3.5.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. It is likely that both habitat and river units will be required. Due to the complex nature of this option spanning multiple LPAs and only involving works in certain sections of the canal, the BNG requirements and delivery strategy will be identified and developed as part of the option development and planning process.

5.3.6 Henley to SWOX – 5 Ml/d

5.3.6.1 BNG and Habitat Requirements

The Henley to SWOX – 5 Ml/d option is within the South Oxfordshire District LPA, and requires a 10% BNG minimum. The on-site habitats that are likely present are cereal crops, modified grassland, lowland calcareous grassland, other woodland; broadleaved, lowland mixed deciduous woodland and other coniferous woodland. No Very High distinctiveness habitats are likely to be present within the on-site baseline. Following the assumptions in section 4.2, Table 5.34 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.35 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-35: BNG Metric 3.0 Summary

On-site baseline	Habitat units	122.82
On-site post-intervention	Habitat units	21.30
Off-site baseline	Habitat units	230.00
Off-site post-intervention	Habitat units	344.70
Total net unit change	Habitat units	13.17
Total on-site net % change plus off-site surplus	Habitat units	10.72%

Table 5-36: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_SWX_HI-TFR_HEN_ALL_henley-swox5	Other neutral grassland	Medium	76	283.09
	Lowland mixed deciduous woodland	High	37	56.43
	Lowland calcareous grassland	High	1	1.82
	Other Woodland; broadleaved	Medium	1	3.35
		Total:	115	344.70

It was assumed that all habitats within the site have High strategic significance on a precautionary approach, as the site is within an Oxfordshire Conservation Target Area (CTA), Chilterns Disploe and Plateau CTA[29], although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. As a precautionary approach, the off-site habitat was assumed to not be within a CTA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site creation of Lowland mixed deciduous woodland and Lowland calcareous grassland was assessed to be ecologically desirable. They were therefore assigned Medium strategic significance, as are listed as priority habitat types within Oxfordshire[30]. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site.

This would result in a total on-site net % change plus off-site surplus of **10.72% habitat units**.

The option has been re-routed to avoid ancient woodland areas. The option runs along a B road which is adjacent to an area of ancient woodland. Mitigation measures have identified as part of the Strategic Environmental Assessment to ensure the works do not encroach on the ancient woodland boundary. If works caused loss of ancient woodland then BNG would not be able to be achieved.

5.3.6.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.36.

[29] Wild Oxfordshire, 2022. *Chilterns Dipslope and Plateau CTA*. Available at: Chilterns Dipslope and Plateau Map Portrait.png (webflow.com).

[30] Wild Oxfordshire, 2023. Priority Habitats. Available at: Priority Habitats (wildoxfordshire.org.uk).

Table 5-37: Henley to SWOX Climate Projection Summary

Henley to SWOX- 5 Ml/d (Met Office Grid Square ID: 462500, 187500)	
Temperature	Air temperatures for the Henley to SWOX option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19.1 ºC during summer** and **2 ºC to 6.3 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.4 ºC** and could potentially reach a maximum temperature of **9.3 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **13.5 ºC and 24.6 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.5% to 6.64 mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.3% to 3.95 mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39.3 ºC in summer** and reaching **20.5ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 1.4% to **92.4 (5-day accumulated) mm/day in summer** and a 12% percentage increase to **81.1 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.37 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-38: Henley to SWOX - Climate Implications and Resilience Measures for Habitats

Habitat Type	**Climate Implications**	**Recommended Resilience Measures**
Onsite: Cereal crops, modified grassland, lowland calcareous grassland, other woodland; broadleaved, lowland mixed deciduous woodland and other coniferous woodland	See the following tables: • Table 5.7: Calcareous Grassland potential future climate risks and resilience measures • Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures • Table 5.9: Neutral grassland potential future climate risks and resilience measures • Table 5.11: Lowland mixed deciduous woodland potential future climate risks and resilience measures	
Off site: Other neutral grassland Lowland mixed deciduous woodland Lowland calcareous grassland Other Woodland; broadleaved		

5.3.6.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed. There appears to be no additional Thames Water owned land suitable

for BNG delivery adjacent to this option to supplement the habitat reinstatement. The option is within the same LPA as one of the super BNG delivery sites: Littlemore pumping station in South Oxfordshire LPA which could provide opportunities for off-site delivery if required.

5.3.7 Abingdon to Farmoor Reservoir pipeline

5.3.7.1 BNG and Habitat Requirements

The Abingdon to Farmoor Reservoir Pipeline option is within two LPAs: South Oxfordshire District and Vale of White Horse. Neither of these LPAs have a BNG% requirement, so the default of a 10% BNG minimum is applied. The on-site habitats that are likely present are floodplain wetland mosaic, cereal crop, modified grassland, lowland meadow, other woodland; broadleaved, other coniferous woodland and ponds (non-priority habitat). The lowland meadow is a Very High distinctiveness habitat and is assumed to be retained. Following the assumptions in section 4.2, Table 5.38 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.39 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-39: BNG Metric 3.0 Summary

On-site baseline	Habitat units	196.67
On-site post-intervention	Habitat units	58.66
Off-site baseline	Habitat units	280.00
Off-site post-intervention	Habitat units	441.62
Total net unit change	Habitat units	23.60
Total on-site net % change plus off-site surplus	Habitat units	12.00%

Table 5-40: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat units
TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe	Floodplain Wetland Mosaic (CFGM)	High	30	72.90
	Other Woodland; broadleaved	Medium	5	33.47
	Other neutral grassland	Medium	120	335.24
		Total:	140	441.62

The strategic significance for the baseline habitats was assigned as High as a precautionary approach, as parts of the site are within Oxfordshire CTAs; Oxford Meadows CTA and Wytham Hill CTA, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. As a precautionary approach, the off-site habitat was assumed to not be within a CTA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site creation of other woodland; broadleaved and other neutral grassland were assigned Low strategic significance, as assumed to not be within a CTA, and the floodplain wetland mosaic was assigned High, as it is a priority habitat in Oxfordshire[31]. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site.

This would result in a total on-site net % change plus off-site surplus of **12% habitat units**.

[31] Wild Oxfordshire, 2023. Priority Habitats. Available at: Priority Habitats (wildoxfordshire.org.uk).

5.3.7.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.40.

Table 5-41: Abingdon to Farmoor Climate Projection Summary

Abingdon to Farmoor Reservoir pipeline (CON-RWS-ABI-FMR) (Met Office Grid Square ID: 427500, 212500)	
Temperature	Air temperatures for the Abingdon to Farmoor option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19 ºC during summer** and **2 ºC to 6.2 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.4 ºC** and could potentially reach a maximum temperature of **9.1 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **13.5 ºC and 24.4 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.4% to 6.97 mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.5% to 3.86 mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39 ºC in summer** and reaching **20 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 2.7% to **96.8 (5-day accumulated) mm/day in summer** and a 11.8% percentage increase to **81.4 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.41 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-42: Abingdon to Farmoor - Climate Implications and Resilience Measures for Habitats

Habitat Type	**Climate Implications**	**Recommended Resilience Measures**
Onsite: Floodplain wetland mosaic, cereal crop, modified grassland, lowland meadow, other woodland; broadleaved, other coniferous woodland and ponds (non-priority habitat)	See the following tables: • Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures • Table 5.9: Neutral grassland potential future climate risks and resilience measures • Table 5.12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures • Table 5.13: Floodplain wetland mosaic potential future climate risks and resilience measures • Table 5.14: Lowland meadow potential future climate risks and resilience measures	
Off site: Floodplain Wetland Mosaic (CFGM) Woodland (broadleaved) Neutral Grassland		

5.3.7.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed.

Where off-site habitat is required, there are several Thames Water land holdings within the LPAs which could be further investigated for off-site BNG delivery including:

- Thames Water own land at Farmoor WTW and reservoir site, in the Vale of White Horse. which may provide opportunities for additional BNG delivery.
- The option is within the same LPA as one of the super BNG delivery sites: Littlemore pumping station in South Oxfordshire LPA which could provide opportunities for off-site delivery if required.

5.3.8 Dukes Cut to Farmoor

5.3.8.1 BNG and Habitat Requirements

The Dukes Cut to Farmoor option is within three LPAs: West Oxfordshire, Cherwell and Vale of White Horse. West Oxfordshire LPA requires a minimum of 10% BNG, whilst Cherwell and Vale of White Horse LPAs do not specify a BNG % requirement in their Local Plans. Therefore, a default of 10% BNG is required for this option. The on-site habitats that are likely present are floodplain wetland mosaic, modified grassland, cereal crops, lowland meadows and ponds (priority habitat). No Very High distinctiveness habitat is likely to be present. Following the assumptions in section 4.2, Table 5.42 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.43 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-43: BNG Metric 3.0 Summary

On-site baseline	Habitat units	210.45
On-site post-intervention	Habitat units	55.15
Off-site baseline	Habitat units	362.00
Off-site post-intervention	Habitat units	539.14
Total net unit change	Habitat units	21.84
Total on-site net % change plus off-site surplus	Habitat units	10.38%

Table 5-44: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_SWX_HI-TFR_SWX_ALL_dukes cut-farmoor	Floodplain Wetland Mosaic (CFGM)	High	71	129.41
	Other neutral grassland	Medium	110	409.74
		Total:	181	539.14

The strategic significance for the baseline habitats was assigned as High as a precautionary approach, as parts of the site are within Oxfordshire CTAs; Oxford Meadows and Farmoor and Wytham Hill, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types.

As a precautionary approach, the off-site habitat was assumed to not be within a CTA, and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site creation of floodplain wetland mosaic was assigned Medium strategic significance, as listed as a priority habitat in Oxfordshire. The offsite created neutral grassland was assigned Low strategic significance as is not a priority habitat in Oxfordshire. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site.

This would result in a total on-site net % change plus off-site surplus of **10.38% habitat units**. Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.44.

Table 5-45: Duke's Cut to Farmoor Climate Projection Summary

Dukes Cut to Farmoor (Met Office Grid Square ID: 437500, 212500)	
Temperature	Air temperatures for the Dukes Cut option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.1 ºC to 19.1 ºC during summer** and **2 ºC to 6.2 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.4 ºC** and could potentially reach a maximum temperature of **9.1 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **13.9 ºC and 24.4 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.6% to 6.87 mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.6% to 3.86 mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39 ºC in summer** and reaching **20 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 2.7% to **96.8 (5-day accumulated) mm/day in summer** and a 11.8% percentage increase to **81.4 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.45 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-46: Duke's Cut to Farmoor - Climate Implications and Resilience Measures for Habitats

Habitat Type	**Climate Implications**	**Recommended Resilience Measures**
Onsite: Floodplain wetland mosaic, modified grassland, cereal crops, lowland meadows and ponds (priority habitat).	See the following tables: • Table 5.9: Neutral grassland potential future climate risks and resilience measures	

Habitat Type	Climate Implications	Recommended Resilience Measures
Off site: Floodplain Wetland Mosaic (CFGM) Other neutral grassland	• Table 5.12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures • Table 5.13: Floodplain wetland mosaic potential future climate risks and resilience measures • Table 5.14: Lowland meadow potential future climate risks and resilience measures	

5.3.8.2 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed.

Where off-site habitat is required, there are several Thames Water land holdings within the LPAs which could be further investigated for off-site BNG delivery including:

- Thames Water own land at Farmoor WTW and reservoir site, in the Vale of White Horse, which may provide opportunities for additional BNG delivery
- Yarnton STW, in West Oxfordshire - approx. 2ha of habitat area surrounding the STW comprising other neutral grassland, cereal crops and grassland tall herb and fen.
- The option is within the same LPA as one of the super BNG delivery sites: Land outside of Grimsbury Reservoir in Cherwell LPA which could provide opportunities for off-site delivery if required.

5.3.9 ASR Horton Kirby

5.3.9.1 BNG and Habitat Requirements

The ASR Horton Kirby option is within Sevenoaks LPA, which does not currently have any BNG % requirements in the Local Plan. Therefore, the default of a minimum of 10% BNG applies. It is noted that Kent County Council are currently considering the viability of a 20% BNG target in the future. The 10% BNG requirement was applied to this option. The on-site habitats that are likely present are cereal crops, modified grassland and lowland mixed deciduous woodland. No Very High distinctiveness habitat is likely to be present. Following the assumptions in section 4.2, Table 5.46 details the results from the BNG Metric 3.0 for the option. Off-site habitat units are likely to be needed to meet the BNG requirements. Table 5.47 provides the details of the estimated hectares of off-site habitat needed to achieve a 10% BNG and meet the trading standards.

Table 5-47: BNG Metric 3.0 Summary

On-site baseline	Habitat units	23.39
On-site post-intervention	Habitat units	5.54
Off-site baseline	Habitat units	38.00
Off-site post-intervention	Habitat units	59.08
Total net unit change	Habitat units	3.23
Total on-site net % change plus off-site surplus	Habitat units	13.80%

Table 5-48: Estimated hectares and habitat types of off-site habitat creation required to achieve BNG

Option ID	Off-site Habitat Types Required	Distinctiveness	Area (Ha)	Habitat Units
TWU_LON_HI-GRW_RE1_ALL_asrhortonkirby	Other neutral grassland	Medium	14	52.15
	Lowland mixed deciduous woodland	High	5	6.93
		Total:	19	59.08

Kent is currently producing its Local Recovery Network map and the old Kent Biodiversity Opportunity Areas no longer exist. Seven Oaks District planning map does however have Biodiversity Opportunities Layer[32], this was used to assess the strategic significance. The strategic significance for the baseline habitats was assigned as High as a precautionary approach, as parts of the site are within the Central North Downs BOA, although noted that High Strategic Significance should refer to the strategic significance of a location to specific habitat types. As a precautionary approach, the off-site habitat was assumed to not be within a BOA and the baseline was assigned Low strategic significance, as per the assumptions in section 4.2. The off-site creation of lowland mixed deciduous woodland was assigned Medium strategic significance, as listed as a priority habitat in the Kent. The offsite created neutral grassland was assigned Low strategic significance as is not a priority habitat in Kent. From the desk-based assessment, it was estimated that there are no hedgerow or river habitats present within the site.

This would result in a total on-site net % change plus off-site surplus of **13.80% habitat units.**

The option is approx. 500m from Farningham Wood SSSI. Any adverse impact on the SSSI and the site will not be able to achieve BNG. This is unlikely given the distance from the SSSI to the proposed works.

5.3.9.2 Climate Change Projections and Implications for BNG Delivery

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.48.

Table 5-49: ASR Horton Kirby Climate Projection Summary

ASR to Horton Kirby (Met Office Grid Square ID: 562500)	
Temperature	Air temperatures for the ASR to Horton Kirby option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.1 ºC to 19.3 ºC during summer** and **2.1 ºC to 6.6 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.8 ºC** and could potentially reach a maximum temperature of **9.5 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **14.1 ºC and 24.7 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 10.9% to 6.76 mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.2% to 3.80 mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **39.1 ºC in summer** and reaching **19.8 ºC in winter** compared to 1995 modelled baseline.

[32] Sevenoaks District Council, 2023. *Sevenoaks District Planning Map*. Available at: https://maps.sevenoaks.gov.uk/planning/.

ASR to Horton Kirby (Met Office Grid Square ID: 562500)	
	• Extreme 5-day total precipitation percentage increase of 0.8% to **79.1 (5-day accumulated) mm/day in summer** and a 10.6% percentage increase to **92.9 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.49 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-50: ASR Horton Kirby - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: Cereal crops, modified grassland and lowland mixed deciduous woodland	See the following tables: • Table 5.9: Neutral grassland potential future climate risks and resilience measures • Table 5.11: Lowland mixed deciduous woodland potential future climate risks and resilience measures	
Off site: Other neutral grassland Lowland mixed deciduous woodland		

5.3.9.3 BNG Delivery

In accordance the BNG mitigation hierarchy, on-site delivery of BNG will be prioritised. Currently the habitat reinstated on-site is assumed to be of poor condition and hence more hectares are required. However, if the habitat reinstated post-intervention above the pipeline can be classed as good then this will significantly reduce the amount of off-site habitat needed. Thames Water have land holdings at the north end of the option. These comprise approx. 5.8ha of habitat area which includes lowland mixed deciduous woodland, mixed scrub, other neutral and semi-improved grassland, other woodland broadleaved, and lowland dry acid grassland.

5.3.10 Strategic Resource Options

5.3.10.1 SESRO

SESRO (150 Mm^3) is within the Vale of White Horse District and on the border of South Oxfordshire LPA. Neither of these LPAs specify a BNG requirement within the Local Plans, so the minimum 10% BNG is required.

The BNG assessment for SESRO was undertaken as part of the RAPID Gate 2 process. The Gate 2 BNG assessment identified that the scheme is estimated to provide a net unit increase of 1,629.34 habitat units equating to a net gain of 33.09%. As much of the baseline habitats will be lost to the reservoir, this significant net gain in biodiversity indicates that the replacement habitats and future landscape surrounding the reservoir will be more beneficial to biodiversity than the current landscape. This is because the habitats to be created, such as the ponds and wetland habitat mosaic, will provide habitat for a range of species from invertebrates and amphibians to riparian mammals and breeding and wintering birds. The species rich grassland habitats will attract birds and invertebrates and the woodland habitats will develop into highly biodiverse areas. However, the trading rules for the loss of lowland mixed deciduous woodland have not been met within this

scheme. There would be a net loss of 939.57 habitat units of lowland mixed deciduous woodland and therefore this habitat type would need to be accounted for off-site.

SESRO will also result in a net unit loss of 96.45 hedgerow units (21.91% loss). Consequently, off-site compensation for the loss of these hedgerow units will be sought, and at a minimum, an additional 143 hedgerow units will need to be gained to achieve a ⩾10% net. This will be undertaken within a location where hedgerows will improve ecological connectivity in landscapes nearby to the scheme impact. The current metric does not take account for any potential advanced planting of hedgerow and tree lines which is likely to occur in order to maintain connectivity across the site during construction. Opportunities for advanced planting will be discussed during further iterations of Abingdon Reservoir masterplan. SESRO is also estimated to provide a net unit increase of 70.26 river units (16.41% net gain). The more naturalised planform and enhanced connectivity of the river channel to wetland floodplain habitats will significantly improve the quality and natural functioning of the river compared to the artificial conditions present currently.

The search of the Ancient Woodland Inventory identified no Ancient Woodland blocks located within the scheme boundary or directly adjacent. However, the search of the Ancient Tree Inventory highlighted the presence of one ancient tree within the scheme boundary and 14 veteran trees, one ancient tree and one notable tree along the River Ock to the north of the site. Under the current proposals for the Scheme, the trees along the River Ock will not be impacted and a suitable works exclusion zone will be installed around these trees to ensure their survival. The ancient tree located within the centre of the Scheme will be lost. The tree located within the centre of the indicative location for SESRO is an ancient crack willow (*Salix fragilis*) which has been pollarded. The tree is located within a tree belt adjacent to a public footpath. As the project will result in the loss of one ancient tree, which is categorised as irreplaceable habitat, the scheme cannot achieve BNG at the 'project level'. However, the project will generate meaningful gains for other biodiversity features such as neutral grassland, wet woodland and wetland areas.

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.50.

Table 5-51: SESRO Climate Projection Summary

SESRO 150 Mm3- 283 MLD (Lon Only)- Construction (Met Office Grid Square ID: 437500, 187500)	
Temperature	Air temperatures for the New Reservoir Abingdon option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19 ºC during summer** and **2 ºC to 6.2 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **3.4 ºC** and could potentially reach a maximum temperature of **9.1 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **13.5 ºC and 24.4 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.4% to 6.97mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 19.5% to 3.86mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **38.8 ºC in summer** and reaching **19.8 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 1.4% to **99.6 (5-day accumulated) mm/day in summer** and a 11% percentage increase to **87.1 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.51 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-52: SESRO - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: Floodplain wetland mosaic, cereal crop, modified grassland, lowland meadow, other woodland; broadleaved, other coniferous woodland and ponds (non-priority habitat)	See the following tables: ● Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures ● Table 5.9: Neutral grassland potential future climate risks and resilience measures ● Table 5.12: Ponds (non-priority and priority habitat) potential future climate risks and resilience measures ● Table 5.13: Floodplain wetland mosaic potential future climate risks and resilience measures ● Table 5.14: Lowland meadow potential future climate risks and resilience measures ● Table 5.15: River habitat potential future climate risks and resilience measures	
Off site: Floodplain Wetland Mosaic (CFGM) Woodland (broadleaved) Neutral Grassland		

5.3.10.2 Teddington Direct River Abstraction

The Teddington DRA SRO is within three different LPAs: Hounslow, Richmond upon Thames and Kingston upon Thames. For options requiring planning permission, schemes are required to satisfy the requirements of any applicable local planning policies in relation to BNG. Hounslow London Borough LPA has no known BNG % requirements within its Local Plan, therefore the default minimum of 10% BNG will apply from November 2023. Richmond upon Thames LPA requires a 20% BNG (within its Local Plan) and Kingston upon Thames LPA requires a 30% BNG within its emerging Local Plan[33]. However, consent for Teddington DRA may be pursued via a Development Consent Order (DCO) under the Planning Act 2008. The key planning policy applying to water resources infrastructure DCOs is the National Policy Statement for Water Resources Infrastructure, which contains guidance on assessing BNG. The legal requirement for a minimum of 10% for DCO projects is expected to become mandatory in 2025. The BNG assessment for Teddington DRA was undertaken as part of the RAPID Gate 2 process and assumed a 10% net gain was required; however, it should be noted that the BNG strategy for this scheme will meet the requirements set out by the planning route taken when this is defined.

The Gate 2 BNG assessment identified that 1.94 ha of habitat (2.35 habitat units) will be permanently lost due to construction of new above ground infrastructure. In order to achieve a 10% net gain an additional 0.235 units are required in additional to the units lost. A total of 2.67 habitat units from off-site mitigation would be required to achieve a 13.52% net gain for permanent habitat loss from the proposed works within Teddington. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this could require a total of 3.65 hectares of off-site habitat.

[33] Royal Borough of Kingston Upon Thames, 2023. Kingston's Local Plan. Available at: Kingston's Local Plan 2023-2041 (amazonaws.com)

The temporary habitat loss from the construction (e.g. site compounds) across the Teddington DRA scheme would result in the loss of 5.13 hectares of baseline habitats. This loss would be mitigated for in the first instance by reinstating baseline habitats. In order to achieve a 10% net gain an additional 7.56 units are required as 8.25 units were delivered through habitat reinstatement. A total of 8.17 habitat units of from off-site mitigation would be required to achieve a 14.27% net gain for temporary habitat loss from the proposed works within Teddington. To meet the BNG offsetting requirements and gain enhancements to the relevant habitats affected within the scheme footprint this could require a total of 13 hectares of off-site habitat.

A total of 16.65 ha of off-site habitat would be required to achieve a minimum of 10% net gain for both permanent and temporary terrestrial habitat loss within Teddington. A terrestrial habitat biodiversity opportunity areas mapping exercise was undertaken for the wider London Water Recycling SROs (which includes Teddington) within the London area. This identified a number of potential locations for off-site BNG delivery totalling 46.47ha.

The Teddington DRA scheme will create a loss of -0.12 river units through the creation of permanent structures, but has no temporary or operational disbenefits. In order to deliver a minimum of 10% net gain, a section of 1.8km of river assessed as 'poor condition', with major watercourse and riparian encroachment, and located outside the catchment would need to be enhanced to 'moderate condition' with a reduction to watercourse encroachment (from major to minor), to deliver a net gain, off-site of 0.13 river units (4.66 off-site baseline units and 4.79 off-site post-intervention units) and therefore an overall net change of 0.02 river unit (+15.74%), as per workbook calculations. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh survey will inform the enhancement measures required to enhance the river from 'poor to moderate condition. A minimal section of 0.05km within the waterbody directly impacted would be required to deliver a minimum of 10% net gain. Plans to deliver this gain will be further developed as part of the next stages of the RAPID gated process.

Climate projection data for the 25km grid square for the option was gathered from the UKCP18 datasets as described in section 4.1 (methodology) and is presented in Table 5.52.

Table 5-53: Teddington DRA Climate Projection Summary

Teddington DRA 75 MLD- Construction (Met Office Grid Square ID: 512500, 162500)	
Temperature	Air temperatures for the Kempton-100 option is projected to increase throughout the year under both emission scenarios in the 2060s. Under RCP8.5 mean temperatures are likely to increase by approximately **3.2 ºC to 19.9 ºC during summer** and **2 ºC to 6.9 ºC during winter** compared to a 1981-2001 modelled baseline**.** In winter, temperatures are unlikely to drop below **4.1 ºC** and could potentially reach a maximum temperature of **9.9 ºC** compared to a 1981-2001 modelled baseline**.** In summer temperatures are projected to be between **14.6 ºC and 25.2 ºC** compared to a 1981-2001 modelled baseline**.**
Precipitation	Precipitation for the Mortimer Disused Source option is projected to increase in winter and decrease in summer in the 2060s. Under RCP8.5 mean precipitation (mm/day) **increases by 12.3% to 6.51mm/day in** winter compared to a 1981-2001 modelled baseline**.** In summer, under RCP8.5, mean precipitation (mm/day) **decreases by 18.6% to 3.91mm/day** compared to a 1981-2001 modelled baseline**.**
Extreme Weather	Extreme projections with the 100-year return event under RCP8.5 project: • Extreme temperatures reaching **38.3 ºC in summer** and reaching **20.1 ºC in winter** compared to 1995 modelled baseline. • Extreme 5-day total precipitation percentage increase of 1.1% to **83.2 (5-day accumulated) mm/day in summer** and a 9.1% percentage increase to **105.6 5-day accumulated) mm/day in winter** compared to 1995 modelled baseline.

The option includes habitats that are anticipated to be significantly affected by changes to climate, based on the projections discussed in the table above and implications on habitat types presented in Section 5.2.4. In addition to existing habitats, future habitats created as part of mandatory net gain will also be vulnerable to changing climate conditions. Table 5.53 presents the habitat types required for the options to delivery BNG requirements, the climate risks and recommended resilience measures to be implemented as the option is taken through detailed design.

Table 5-54: Teddington DRA - Climate Implications and Resilience Measures for Habitats

Habitat Type	Climate Implications	Recommended Resilience Measures
Onsite: Modified grassland, other woodland (broadleaved), other neutral grassland, mixed scrub, lowland mixed deciduous woodland. River habitat	See the following tables: ● Table 5.8: Woodland (broadleaved and other) potential future climate risks and resilience measures ● Table 5.9: Neutral grassland potential future climate risks and resilience measures ● Table 5.10: Mixed Scrub potential future climate risks and resilience measures ● Table 5.11: Lowland mixed deciduous woodland potential future climate risks and resilience measures ● Table 5.15: River habitat potential future climate risks and resilience measures	
Offsite: Neutral grassland, other woodland (broadleaved), other neutral grassland		

5.4 Nutrient Neutrality

Nutrient neutrality is a means of ensuring that a development plan or project does not add to existing nutrient burdens within catchments, so there is no net increase in the nutrients as a result of the plan or project.

Nutrient pollution is a critical risk facing freshwater habitats and estuaries, which provides resources for wetland birds, fish and insects. Increased levels of nutrients like nitrogen and phosphorus can speed up the growth of certain plants, disrupting natural processes and damaging wildlife.

Due to excess levels of nutrients in certain English water catchments and as result of legislation and case law, Local Planning Authorities can only approve a plan or a project if they are certain it will have no negative effect on legally protected sites for nature. Natural England has issued advice for 31 habitats sites, spanning 27 catchments and a total of 74 local planning authorities (wholly or in part). Four of these LPAs contain rdWRMP24 options (see Table 5.54), however, they are not actually within a nutrient neutrality catchment. The T2ST Culham to Speen option is within 500m of the Lambourn SAC nutrient neutrality catchment.

Table 5-55: Options within LPAs subject to Natural England NN advice

Local Planning Authority subject to Natural England NN advice	Option
Lichfield	TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox
North Warwickshire	TWU_SWX_HI-IMP_SWX_CNO_oxc-dukes cutswox
Vale of White Horse	TWU_SWX_HI-TFR_STR_ALL_abing-farmoor pipe TWU_STR_HI-RSR_RE1_CNO_abingdon150(lon)
West Berkshire	TWU_KVZ_HI-GRW_ALL_ALL_mortimer recomm TWU_SWX_HI-GRW_ALL_ALL_moulsford gw TWU_KVZ_HI-TFR_T2S_ALL_t2st cul to speen

5.5 Natural Capital

Delivery of BNG requirements is also likely to have benefits for natural capital stocks and provision of ecosystem services. Once BNG delivery details have been refined and agreed these can be incorporated into a project level natural capital assessment for each option to qualify benefits. It should be noted that trade-offs may occur, for example planting woodland on agricultural land will provide ecosystem service benefits but will also cause loss of ecosystem services e.g. food production. Benefits may include:

- Planting of broadleaved or deciduous woodland – this can have ecosystem service benefits from carbon sequestration, natural hazard regulation from reduced run-off rates, potential recreational value if the area if open to the public, and air pollutant removal.
- Creation or enhancement of ponds and rivers – this can have ecosystem service benefits from natural hazard regulation slowing flows or creating water storage areas, water purification if reeds and other aquatic vegetation are included, and potential recreational value if the area is open to the public.

5.6 Next steps

Adopting a NbS approach

Adopting a NbS approach to the design and implementation of BNG is a significant opportunity. This requires and landscape and catchment-level approach to consider how habitat creation and enhancement can deliver the BNG requirement for these Options in ways that (for example) increase carbon sequestration, boost our resilience to climate change, mitigate flood risk, improve water quality and so on. These outcomes are measured by the Natural England BNG metric calculation in combination with NCA, and are best realised by adopting a NbS approach upfront.

Integrating climate resilience

Using climate projections from UKCP18 it is possible to identify future trends in climate which may negatively and in some cases positively impact upon habitats. For the WRMP24 options, this annex has shown that the sites where rdWRMP24 options are proposed (and impact BNG) are likely to be impacted by climate change. Potential resilience measures have also been explored for the various high value existing and proposed BNG habitats at each of the WRMP24 option sites.

As part of planning for BNG, it is vital to consider future climate conditions and the potential risks to reach and maintain at least 10% BNG to fulfil statutory requirements. For WRMP24 options requiring planning permission, it is anticipated that mandatory net gain will be required as a minimum. Traditional landscape designs and management plans may no longer be viable to achieve BNG given the risks discussed in Section 5.2. The climate data, climate analysis and suggested resilience measures should be used to support further assessments of the impacts of climate change on WRMP option habitats and how these habitats should be managed to achieve mandatory BNG. Each WRMP24 option should be assessed in greater detail and consider aspects of the baseline conditions of the site such as flood zones, soil type, topography and the existing water stress to aid in developing suitable and successful BNG strategies/ proposals for each of the sites.

General principles for incorporating climate resilience measures into BNG delivery of the rdWRMP24 options are presented below.

Table 5-56: General principles for incorporating climate resilience into BNG delivery

Resilience Measures	Description
Designing for diversity	Resilience measures for BNG should be designed with diversity in mind as this will increase resilience to a range of future climate conditions with no single resilience measure relied upon. This means if one resilience measure was to fail in providing adequate mitigation, there will be other measures in place to mitigate against climatic conditions. Designing for diversity may include: – Diversity in the use of both soft and hard engineering resilience measures. – Diversity of species mix used. – Diversity in terms of staggering planting arrangements and in staggering the actual planting. – Diversity in short-term and long-term management and monitoring regimes to ensure coverage of all types of habitats and ensure resilience measures are working.
Prepare and response plans	Ensuring processes are in place to both prepare and respond to extreme weather events is critical to minimise the impacts of these events on habitats when they occur. Plans may include: – Prepare ○ Regularly check local weather forecast to prepare for extreme weather events ○ Set up temporary solutions in the event of an upcoming extreme weather event. For example, use of temporary flood barriers to prepare for a severe precipitation event. – Respond ○ Following an extreme weather event, visit the BNG site and make an assessment of the condition to the BNG habitats. Identify remediation works necessary to maintain progress towards BNG targets. ○ Submit a plan and programme of remediation works with any necessary updates to the BNG Management and Monitoring Plan and BNG Metric calculation. ○ Undertake the remediation works and associated monitoring.
Vegetation management	Vegetation management will ensure newly planted species can successfully establish and be resilient to future climate conditions. Measures include: – Selecting species resilient to future climate with consideration of climate projections. For example, planting of drought tolerant species or species with a high temperature tolerance. – Consideration of planting non-local species that are suited to future climate conditions. – Identify locations for planting where individual species may be less vulnerable to future climate such as planting in more sheltered locations or areas with secure water supply. – Due to the increasingly longer growing season and vegetation growth, maintenance regimes (such as plant cutting) need to be altered to reflect this shift.
Water management	With potential for an increase in the severity of prolonged drought periods, as well as risk of summer flash flooding exacerbated by drought conditions and increase in winter flood risk, it is crucial that water is appropriately management. Measures to retain water during summer droughts and alleviate flooding during winter may include: – Design measures to reduce soils from drying out and retain water during summer droughts. – Establish and maintain water retaining features such as ponds. – Leaky barriers on run-off pathways. – Drainage pathways to reduce flood risk with consideration of climate change allowances. – Design measures to reduce soil compaction during winter.

Resilience Measures	Description
INNS and pest management plan	A dedicated disease and pest management plan will reduce disturbance, risk of vegetation failure and maintain good water quality of features such as ponds. The plan should include: – Regular monitoring of tree and plant species. – Actions to take when diseases or pests are discovered. – The plan should be kept updated and reviewed regularly for the emergence of new diseases or pests.
Establishing habitats	Maintaining existing or establishing new habitats provides a range of benefits depending on the type of habitat. Measures should also be taken to protect these habitats from human interference. For example: – Restrict public access and build designated footpaths to avoid damage to habitats and reduce risk of wildfire in the wider area.
Sustainable Drainage Systems (SuDS)	– SuDS aims to intercept and manage water run-off to reduce flood risk. SuDS can include a number of components which include but not limited to: – Wetlands: provide storm attenuation, sediment settlement and pollutant removal. – Trees: help surface water management through processes of transpiration, interception, increased filtration and phytoremediation. – Permeable pavements: allow infiltration or temporary water storage. – Bioretention: shallow, depressed landscaped areas which use engineered soils and enhanced vegetation to filter pollution and reduce runoff. – Retention: storm attenuation, sediment settlement and pollutant removal. – Rain gardens: vegetated shallow strips which accept runoff from overland flow. They provide vegetative filtering, settlement of pollutants and infiltration. – Infiltration trenches: shallow trenches filled with stone or rubble, located to receive lateral flow from an adjacent impermeable surface. They create temporary storage, filtration and infiltration.

Appendices

A.1 Climate Scoping Assessment Methodology

1. Identify current climate

An observed climate baseline was established by using climate data from the Met Office State of the UK climate report[34] and summary for South East England[35]. The baseline period is 1981-2000[36].

2. Identify projected climate

Climate variables

The UKCP18 probabilistic projections 25km grid cell containing each of the WRMP24 options was selected. Where options were in the same grid cell, this data was used for multiple options. Where an option spanned multiple 25km grid squares, grid squares were selected at regular intervals to get a spread of projected data for the length of the option and the range utilised to discuss changes in climate.

Data to describe projected change in average conditions as well as extreme weather events were obtained. Data was gathered from the following UKCP18 products:

- Probabilistic Projections:
  - Seasonal mean temperature (°C)
  - Seasonal maximum temperature (°C)
  - Seasonal minimum temperature (°C)
  - Seasonal mean precipitation (mm/day)

- Probabilistic Projections of Climate Extremes:
  - Extreme Temperatures (°C)
  - Extreme Precipitation (5 day accumulated) (mm/day)

Probabilistic Projections provide estimates of monthly, seasonal and annual mean changes and Probabilistic Projections of Climate Extremes provide an estimate of extreme daily values[37].

Probabilistic data shows the range of values for a climate variable, based on multiple runs on multiple climate models. The 50th percentile values are used in this assessment – the 50th percentile represents an 'as likely as not' outcome. For the probabilistic extremes, the inclusion of a range of return periods describes, in absolute values, extreme climate conditions that may occur. This can help inform relevant thresholds.

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[34] Met Office (2021) *State of the UK Climate 2021*. Available at: State of the UK Climate - Met Office

[35] Met Office *Southern England: Climate* [online]. Available at: southern-england_-climate---met-office.pdf (metoffice.gov.uk)

[36] The 1981-2000 baseline was chosen because this is the baseline used by the UK Met Office UKCP18 datasets and various UK climate change guidance documents such as Network Rail and IEMA guidance. Therefore, using this baseline will ensure consistency across UK climate projections.

[37] Met Office (2020) Probabilistic Projections of Climate Extremes [online]. Available at: ukcp18_factsheet_probabilistic_projections.pdf (metoffice.gov.uk)

Emissions scenarios

There is uncertainty over the trajectory of global greenhouse gas (GHG) emissions over the 21st century and the resulting change in climate. This uncertainty is represented in climate modelling by the use of multiple emissions scenarios. UKCP18 data is available for four emissions scenarios, reflecting different levels of GHG emissions over the 21st century, ranging from a low emissions scenario (RCP2.6) to a very high emissions scenario (RCP 8.5) and two medium emissions scenarios (RCP4.5 and RCP 6.0). The RCP6 (medium-high) and RCP8.5 (high)[38] scenarios were selected for this assessment. The choice of these scenarios is consistent with advice from the Committee of Climate Change to assess risks in a world that is 2 degrees warmer by the end of the century (RCP6.0) and a world that is 4 degrees warmer at the end of the century (RCP8.5).

Time horizon

Data on projected change in climate variables for the 2060s time horizon was collected from the UKCP18 probabilistic projections. A time horizon of 2065 was used to collect data from the UKCP18 probabilistic extremes data set. These time horizons align with the statutory requirement for BNG to secure habitats for at least 30 years.

Summary of climate projection data collected

The following climate projection data was collected for the WRMP option locations:

- **UKCP18 Probabilistic projections**: 25km grid cells, baseline period 1981-2000, time horizon 2060s (2050-2069), RCP6.0 and RCP8.5[39], 50th percentile values
  - Climate variables include seasonal (winter and summer) mean, maximum and minimum air temperature and precipitation rate. These variables describe change in average conditions.

- **UKCP18 Probabilistic extreme projections**: 25km grid cells, baseline year 1995, time horizon 2065, 50- and 100-year return periods.
  - Climate variables include maximum air temperature and 5-day total precipitation. These variables provide absolute extreme climate values.

- **UKCP18 Regional Projections (June 2023 update)**: 12km grid cells, baseline periods 1981-2000 and 2001-2020, annual, future warming levels above pre-industrial (1.5ºC, 2 ºC, 2.5 ºC, 3 ºC and 4 ºC).
  - Climate variables include:
    - Annual Count of Tropical Nights- Projections
    - Annual Count of Frost Days - Projections
    - Annual Count of Extreme Summer Days - Projections
    - Annual Count of Hot Summer Days - Projections
    - Growing Degree Days - Projections
    - Drought Severity Index 12-month accumulation (projections)

[38] Representative Concentration Pathways (RCP) are prescribed trajectories for GHG and aerosol concentrations and are used to project a range of climate scenarios. There are four main RCP scenarios with RCP8.5 describing a worst case scenario and RCP6.0 a high GHG emissions scenario.

[39] Representative Concentration Pathways (RCP) are prescribed trajectories for GHG and aerosol concentrations and are used to project a range of climate scenarios. There are four main RCP scenarios with RCP8.5 describing a worst case scenario and RCP6.0 a high GHG emissions scenario.

It should be noted that climate projections are not predictions or forecasts but simulations of potential scenarios of future climate under a range of hypothetical emissions scenarios and assumptions. The results, therefore, from the experiments performed by climate models cannot be treated as exact or factual, but projection options. The projections have been used to identify trends in future climate conditions of each of the WRMP options rather than predict the absolute values for the climate variable.


Thames
Water