Memorandum – Water for Life – Hampshire: Carbon Estimates and Assessment Summary

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Subject:	W4L-H Water Carbon Estimates and Assessment		

1 Background and Purpose

The memo sets out how capital carbon, operational carbon and whole life cost carbon, have been estimated and how those estimates that then been used within the various assessments[1], before being included with in the Multiple-Criteria Decision Analysis (MCDA) and Consenting Evaluation to inform the identification of a Selected Option through the options appraisal process.

The RAPID Gate 2 template includes the following requirements for the Gate 2 submission:

Include main conclusions and issues arising including results of environmental work carried out to date and plan for future work:

- The carbon impact of the solution and initial outline of how the solution will take into account the carbon commitments.
- The carbon commitments referred to are the water industry's Public Interest Commitment of net zero by 2030 for operational emissions, and the UK government target to bring all greenhouse gas emissions to net zero by 2050

The RAPID Gate 2 template states that this could also include any additional commitments an individual company or region has made.

It further states "We expect companies to take full account of their greenhouse gas emissions in their decision making. Operational and embedded carbon emissions must be part of the 'best value' scheme assessment".

As part of the SW Options Appraisal Process, SW will apply its Strategic Objective on Carbon which states that:

"We will deliver solutions which ensure that we can continue to make progress towards meeting, and to support and contribute to, Water UK's commitment to become net zero carbon by 2030"

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[1] The assessments are: Carbon Capex, Opex and WLC, Emission Estimates, Carbon Assessment within Natural Capital

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Within Southern Water commitment and undertaking is to reach net zero operational carbon by 2030, and to implement the Southern Water's Net Zero Plan[2] ("SW Net Zero Plan"). In seeking to be part of delivering on this commitment we will be taking steps to drive down the operational carbon associated with our Selected Option for example by using 100% fully accredited renewable-backed power from our energy suppliers, and other measures set out in Section 5.1, below. In line with the net zero carbon hierarchy set out in the SW Net Zero Plan, we are committed to avoiding, reducing, replacing and removing carbon prior to offsetting any residual emissions, which should be a measure of last resort, see Section 5.

Southern Water is also committed to working with Ofwat to achieve an embedded carbon measurement by 2023.

2 Capital Carbon, Operational Carbon and Whole Life Carbon Emission Estimates

2.1 Capital carbon emissions estimates

Capital carbon covers greenhouse gas emissions arising from the creation, refurbishment, and end of life treatment of assets such as buildings and infrastructure.

The process undertaken to prepare the capital carbon emissions estimates for each of the options is based on PAS2080 and outlined as follows:

- The capital carbon assessment was based on scoping information from the Cost Intelligence Team, provided by Southern Water's Engineering and Technical Services.
- Analogous to cost models, the capital carbon models are based on curves created from data points, relating a driver defining the size of the asset to its carbon emissions. The carbon models are not based on the same underlying information as the cost models, and not all cost models have a directly corresponding carbon model. The size drivers also do not always match. Cost models were mapped to carbon models as closely as possible, with standardised assumptions made where drivers needed converting between units or different estimates of the asset size were required.
- Where costs were developed using a bottom-up approach or based on quotes from suppliers rather than cost models, a general approach to account for additional capital carbon was applied based on the relative proportion of the total cost. For example, if 90% of the total cost was based on cost models and 10% was bottom up, the total capital carbon was scaled up accordingly to account for the

[2] Our Net Zero Plan, Water For Life, Southern Water, https://www.southernwater.co.uk/media/4931/5585_net_zero_report_a4_v10.pdf

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additional assets. This approach was taken due to the wide range of assets which had been costed without reference to standard cost models and was a time-effective estimate of the carbon associated with these assets.

2.2 Operational Carbon emissions estimates

Operational carbon covers the greenhouse gas emissions associated with the operation and maintenance of assets during delivery of their function and services. This includes emissions associated with chemical use, power and transport. However, it did not take into account any operational impact, OPEX or operational carbon. Some of our sites do house renewable energy sources, and where a renewable energy supply could be affected by the bringing forward of an option it is assumed that this source would always be relocated or replaced, so would not be calculated as a loss.

The process undertaken to prepare the Operational carbon emissions estimates for the each of the options are as follows:

- Quantities for power use, chemical use and transport were taken from the operational cost estimates, with power and chemical use estimates provided by the Southern Water design team based on the design flows and process mass balance.

- Power
  - Emissions factors for grid electricity taken from BEIS Green Book projections and take into account projected grid de-carbonization from 2029 to 2100, with the emissions factor assumed to be constant after 2100[3]
  - BEIS Green Book values always appear to lag 2 years behind the Defra reported value in each year. Therefore, the values used for 2030 correspond to the 2028 value in the Green Book etc.

- Chemicals
  - Where available, emissions factors were taken from the Carbon Accounting Workbook (CAW). Chemical quantities were taken from the OPEX calculations, converted into the amount of pure chemical used.
  - Where not accessible from the CAW, an emissions factor for CO2e was found from an alternative comparable source as best estimate, for example no reasonable emissions factor could be located for anti-scalant, and therefore this was assumed to have the same emissions factor to orthophosphoric acid.

[3] Note this is different from using renewable power, as there is embedded carbon within all power production and transfer.

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- Transport
  - Emissions factors were taken from the CAW, which provides tCO2e/km travelled
  - Assumes operational journeys completed by van, large HGVs (>33t) used for sludge trucking and smaller HGVs (3.5-3.3t) for screening and grit transportation

- Operational maintenance
  - Carbon emissions associated with operational maintenance were assumed to be negligible and primarily associated with labour travel rather than significant additional materials use.

2.3 Whole Life Carbon estimates

The whole life carbon estimates include capital maintenance in addition to operational carbon over 108 years, and is calculated using the following:

- Capital carbon emissions;
- Annual Operational carbon emissions; and
- Capital Maintenance emissions.

The estimated annual carbon emissions profile was based on the whole life cost profile developed for the Net Present Value (NPV) and Average Incremental Cost (AIC) calculations[4].

- Years 1-4: Planning
  - Assumed no carbon emissions associated with planning phase

- Years 5-8: Construction
  - Assumes all Capital carbon emissions occur in years 4-8 in proportion to the following CAPEX breakdown:
    - Year 5: Proportional to 25% of planning costs and 20% remaining CAPEX costs
    - Year 6: Proportional to 25% of planning costs and 35% remaining CAPEX costs
    - Year 7: Proportional to 25% of planning costs and 35% remaining CAPEX costs
    - Year 8: Proportional to 25% of planning costs and 10% remaining CAPEX costs

- Years 9-100: Operation and Capital Maintenance
  - Capital maintenance emissions were assumed proportional to capital maintenance costs, e.g. if capital maintenance costs in year 13 are 1% total CAPEX, the capital maintenance carbon emissions in year 13 were estimated as 1% of total capital carbon emissions.

[4] See Level 3a Cost Modelling Report for Gate 2

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- Annual operational carbon emissions were included and calculated as above. As grid decarbonisation projections are included in the analysis, year 1 is assumed to be 2021 and the first operational year is assumed to be 2029. However, it is worth noting that this will not necessarily align with the current programme delivery date, which is subject to a degree of flexibility and may shift as it develops.

3 Monetised Whole Life Carbon

The monetised cost of carbon was calculated using the traded and non-traded carbon price forecasts from the *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*[5] (see comment and footnote).

The traded carbon price was applied to power-related emissions only, with the non-traded carbon price applied to all other emissions.

The current estimate of emissions provides a view of how much each of the options would add to Southern Water's existing emissions once commissioned.

Under Southern Water's commitment to net zero operational emissions by 2030, these operational emissions will need to be treated in accordance with our committed net zero carbon hierarchy (avoid and reduce, replace, remove and offset). The potential costs of offsets have not been included as this would be considered as part of Southern Water's overall net zero and offsetting strategy.

Table 1: Capital Carbon, Operational Carbon, Whole Life Carbon and the non-discounted monetised cost of carbon.

OPERATING REGIME	FLOW (MLD)	CAPITAL CARBON (tCO2e)	OPERATIONAL CARBON (tCO2e)	WHOLE LIFE CARBON (tCO2e)	MONETISED WHOLE LIFE CARBON (£M)
			A1		
MAX (DO)	75	165,000	26,800	2,115,000	558
MIN	15	165,000	5,200	733,000	177
AVERAGE	15.6	165,000	5,400	746,000	181

[5] *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*; Table 3, Carbon prices and sensitivities 2010-2100 for appraisal, 2018 £/tCO2, central price. *Prices correct as of August 2020.*

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A2					
MAX (DO)	**61**	**118,000**	**21,800**	**1,679,000**	**445**
MIN	**15**	**118,000**	**5,200**	**612,000**	**151**
AVERAGE	**15.46**	**118,000**	**5,300**	**623,000**	**154**
B2					
MAX (DO)	**61**	**68,000**	**11,200**	**872,000**	**230**
MIN	**15**	**68,000**	**3,400**	**357,000**	**87**
AVERAGE	**15.46**	**68,000**	**3,500**	**362,000**	**89**
B5					
MAX (DO)	**75**	**83,000**	**14,700**	**1,089,000**	**286**
MIN	**15**	**83,000**	**3,800**	**391,000**	**94**
AVERAGE	**15.6**	**83,000**	**3,900**	**398,000**	**96**
B4					
MAX (DO)	**75**	**71,000**	**4,600**	**363,000**	**86**
MIN	**6**	**71,000**	**1,100**	**193,000**	**41**
AVERAGE	**6.69**	**71,000**	**1,200**	**195,000**	**41**
D2					
MAX (DO)	**75**	**42,000**	**1,500**	**98,000**	**18**
MIN	**6**	**42,000**	**100**	**55,000**	**7**
AVERAGE	**6.69**	**42,000**	**100**	**55,000**	**7**
Ceramac[6]					
ALL REGIMES	**n/a**	**41,000**	**0**	**134,000**	**3**

Table 1 Capital, operational and whole life carbon estimates and monetised cost of carbon (2018 £/tCO2)

[6] Ceramac is applicable to all non-desalination options and should therefore be added to the carbon totals for each.

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4 Carbon Assessment within Natural Capital

Carbon from the perspective of natural capital is related to climate regulation Environmental and Social Safeguards (ESS). A key element of most safeguard systems is the use of a categorisation system for identifying environmental and social risk, applied at an early stage in a project cycle.

Assessing carbon in this context involves calculating the change in carbon sequestration as a result of land use change, and calculating its value, so that the risk associated with the project can be calculated. However, the assessment carried out to date has been very high level and therefore needs to be treated with caution.

4.1 Carbon Sequestration

Carbon sequestration is the capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

The carbon sequestration rates for natural capital stocks have been taken from the Environment Agency's *Water Resource Planning Guideline Supplementary Guidance: Environment and Society in Decision-Making.*[7] This provides a methodology for how to consider the value of the carbon associated with a change of land use, see Table 2 below.

Table 2: Carbon Sequestration of Land Use

Land use type	C seq rate (t/CO2e/ha/yr)
Woodland (deciduous)	4.97
Woodland (coniferous)	12.66
Arable land	0.10
Pastoral land	0.39
Peatland – Undamaged	4.11
Peatland – Overgrazed	-0.1
Peatland – Rotationally burnt	-3.66
Peatland – Extracted	-4.87

[7] Table 2 of the Environment Agency's Water Resource Planning Guideline Supplementary Guidance: Environment and Society in Decision-Making (2020).

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Land use type	C seq rate (t/CO2e/ha/yr)
Grassland	0.39
Heathland	0.7
Shrub	0.7
Saltmarsh	5.19
Urban	0
Green urban	0.40

Carbon sequestration rates of the relevant natural capital assets have been converted into monetary values using the Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values set out in the Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal[8].

To study habitat succession, the carbon sequestration value of the original habitat and the succeeded habitat were calculated. Then, the carbon sequestration value of the original habitat was subtracted from the value of the succeeded habitat. This then gives the carbon sequestration value of the succeeded habitat, while capturing the carbon sequestration value that was lost when succeeding the habitat.

Then the carbon sequestration rates of the relevant natural capital assets have been converted into monetary values using the Department for Business, Energy, and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values.

Non-traded carbon values have been applied to carbon sequestered as these emissions are not captured by the EU Emissions Trading Scheme. As the prices published by BEIS are in 2018, GDP deflators were used to adjust them to the 2019 base year of modelling.

5 Reducing Carbon in the Water Industry

5.1 Reducing Carbon: Towards Net Zero

[8] *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*; Table 3, Carbon prices and sensitivities 2010-2100 for appraisal, 2018 £/tCO2, central price

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The Water industry' has made a Public Interest Commitment to achieving **net zero** carbon by 2030 for operational carbon emissions.

Southern Water's Net Zero Plan sets out how we will reduce and prevent harmful greenhouse gases being released into the environment from our essential water and wastewater services.

Achieving net zero operational carbon by 2030 will be met by a combination of reductions, alternative approaches and carbon removals. This will mean that by 2030 any remaining greenhouse gases that we produce will be balanced by removals. These removals will include storing carbon on our own land (for example planting trees) or paying others to do it on our behalf.

SW's Net Zero Plan includes a number of pledges, to enable us to reach our net zero goals. These are that we will:

- Buy 100% fully accredited renewable-backed power from our energy suppliers from 1 April 2021
- Aim to generate 24% of our own renewable energy by 2025
- Transform our company vehicles by electrifying the fleet or introducing alternative low carbon fuels by 2030
- Aim for nature-based solutions and work in partnership with other organisations
- Report progress and our emissions annually in a transparent way
- Support collaborative research, development and innovation to make technological advances

As the design of our Selected Option progresses, a more detailed analysis will be carried out as to the specific operational carbon emission sources for the selected option, and ways that these can be reduced to enable Southern Water to reach its net zero goals.

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5.2 Decarbonisation

Approaches to decarbonisation in water sector route maps are generally based on good international practice, which involves prioritising all efforts to avoid and reduce emissions before any sequestration options are considered.

The SW approach to carbon net zero a s set out in the SW Net Zero plan can be described as:

- Prioritise all efforts to **avoid and reduce emissions** (e.g. managed water and wastewater demand/ capital carbon related to construction)

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- Identify opportunities for using alternative solutions that are lower carbon, for example **renewable approaches** (introducing new technologies)
- Establish opportunities to **remove and offset emissions** (e.g. nature-based solutions to increase carbon sequestration)

In addition to the above, capital carbon needs to be considered and decisions made regarding how this is assessed and how it is determined or netted out related to a scheme's boundary. It is these fundamentals that together support carbon net zero ambitions.

5.3 Identifying Key Opportunities for Avoiding and Reducing Emissions

A key part of delivering an efficient net zero strategy is to focus efforts where the largest and most efficient reductions can be made. As a starting point, developing an understanding of the major carbon contributors from a capital and operational perspective will help focus efforts on areas with the greatest reduction potential.

As the design of our Selected Option progresses, the baseline carbon account can be analysed in more detail to provide more understanding of specific carbon emission sources for the selected scheme.

Materials *specification*
Major sources of emissions are likely to be related to materials such as:

- Concrete
- Reinforced steel
- Plant fuel emissions associated with excavation and construction activities especially related to the pipelines
- Transport of materials to site and management of construction waste
- Power and chemical consumption (both construction and operational)

The products used in construction will significantly affect the overall carbon footprint of the schemes. In order to demonstrate capital carbon reductions, consideration will be given to performance specifications at the design stage.

Accounting for these specifications will allow for carbon metrics to be rerun at Gate 3 based on the specific standards that apply, rather the generic industry standards as is currently the case.

As part of this carbon metrics assessment, it may be appropriate to consider material made from recycling solutions for example. To achieve best outcomes and reduce scheme carbon intensity actions should include:

- Early supply chain engagement to identifying lower carbon alternative availability
- Review carbon specifications based on market materials and product availability

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- Add steps to the procurement process to account for material carbon specification

Reducing waste
Early management planning of disposal of waste can result in significant carbon emission and project cost-reductions during construction. Understanding for example, the type, quantity, and quality of waste at an early design stage is the most effective way to reduce carbon related to waste. For example, reduction or re-use of materials within the site boundary rather than transporting these off-site can result in robust and effective management including identification of potential users of any surplus evacuations as this can significantly support emission reduction.

Plant related to construction
There is likely to be a lot of spoil related to tunnelling of pipelines which will require transport either for re-use, treatment or other management of the spoil. Depending on the specific area of the pipeline (given the extent of the scheme) reduction in the carbon intensity related to the necessary removal of spoil may be feasible. Where road transport is necessary, the lowest carbon options should be considered related to heavy goods vehicles (e.g. the use of biomethane, hydrogen or electricity).

It is recognised that there are currently limited opportunities regarding low carbon HGV fleets nonetheless, technology is advancing rapidly and hence opportunities need to be revisited throughout the lifetime of the scheme (both construction and operation) and consider suppliers that are in the process of adopting decarbonised fleets.

5.4 Considering Renewable Approaches

The continued design development will review the power requirements of the process plant and pumping systems and will look to reduce this demand. Once there is a more detailed understand of the power requirements, then alternative renewable energy sources and other appropriate low carbon sources, will be considered. These could include, but not limited to:

- Solar panels on the large process plant structures,
- Connections from existing renewable energy sources or low carbon source e.g. [redacted] CHP system
- Energy recovery within the RO membrane installation
- Hydropower energy recovery within the transfer pipelines; and
- Corporate renewables power purchase agreement (PPA)

5.5 Removing and Offsetting Residual Emissions and Natural Sequestration

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Whilst construction can be done in such a way that carbon emissions are reduced, this is unlikely to result in carbon neutrality, especially where there is a reliance on other sectors to provide project input e.g. power and chemicals.

Therefore, developing offset opportunities should also be considered as part of the project, with investment in natural sequestration likely to be a key focus. This could include, for example, tree planting and other options to 'green' land known to support carbon sequestration. Based on published carbon figures potential carbon sequestration opportunities have been identified at a high level as part of the Natural Capital Assessment for each option.

As such the greatest benefits in terms of natural sequestration schemes are likely to come from large regional or national improvement schemes that have been planned and developed to maximise co-benefits and are at a sufficient scale to significant balance emissions, noting however, that opportunities for natural sequestration on SW's own landholdings will need be considered prior to purchasing offsets in the carbon markets.

5.6 Decarbonisation - Next Steps

In addition to optimising the use of renewables as stated in 5.4, the design team will consider the optimisation of the pipeline routes, pumping heads and the minimisation of excavation and fill in locating the recycling plant. We are also looking to bring additional carbon expertise into the team, to learn from wider industry experience and to benefit from this within the context of design work going forward to delivery.

The procurement team will ensure that low carbon requirements for construction and OPEX are contractually embedded into the Direct Procurement for Customers and all other contracts and that a low carbon philosophy is part of part of supply chain selection process.

6 'Best Value' scheme assessment

6.1 Carbon Assessment within MCDA

The MCDA is a best practice approach for economic appraisal defined by HMT Green Book and used widely in the water sector, including by WRSE (the alliance of the six water companies that cover the South East region of England).

It enables us to consider multiple criteria on a common basis and combine a broad range of information on an SRO's impacts into an overall assessment of Best Value, including the Net Social Impact (NSI) of the SROs (impacts to specific groups, such as customers, environment, society), and the deliverability and affordability (capital and operating costs) of the SROs.

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The MCDA incorporates capital carbon, operational carbon and whole life carbon (referred to in the MCDA as embodied carbon and operational carbon) as well as the carbon sequestration after impacts of construction and biodiversity net gain are considered (referred to in the MCDA as the climate regulation (NC)) as key 'Environmental' sub criteria that affect the overall NSI of the scheme. The MCDA also tests the rankings of the SROs under different assumed weightings to the NSI criteria.

Table 1 below presents the 'raw values' of the embodied carbon and operational carbon under both a BAU and drought scenario and the climate regulation (NC) values, adjusted to Present Value, 2021 prices to align with other monetised sub-criteria within the MCDA.

Table 1: Raw Value results for the Impact Assessment of the MCDA for carbon related sub-criteria

Raw Value					Options					
Criteria No.	**Scenario**	**Metric**	**Cluster**	**Unit**	**A.1**	**A.2**	**B.2**	**B.4**	**B.5**	**D.2**
E.03	**BAU and Drought**	**Climate regulation (NC)**	Environment	PV £, 2021	777,148	777,148	104,297	300,635	185,583	126,379
E.08	**BAU**	**Embodied and operational carbon**	Environment	PV £m, 2021	-42.5	-42.5	-24.6	-15.5	-26.7	-7.5
E.08	**Drought**	**Embodied and operational carbon**	Environment	PV £m, 2021	-43.2	-43.0	-24.9	-15.6	-27.0	-7.5

Source: Extract from Interim Update: Supporting Technical Report Option Appraisal 27 September 2021, Table 131 and 132
Note: values are presented in Net Social Impact welfare terms, meaning a positive value is beneficial (refers to a reduction in carbon emissions) and a negative value is a cost (refers to an increase in carbon emissions).

Table 2 shows these values converted to 'normalised scores' for use in the MCDA. This conversion is applied

MCDA Normalised Scores				Options					
Criteria No.	**Scenario**	**Metric**	**Cluster**	**A.1**	**A.2**	**B.2**	**B.4**	**B.5**	**D.2**
E.03	**BAU and Drought**	Climate regulation (NC)	Environment	100	100	0	29	12	3
E.08	**BAU**	Embodied and operational carbon	Environment	0	0	51	77	45	100
E.08	**Drought**	Embodied and operational carbon	Environment	0	0	51	77	45	100

to all the MCDA sub-criteria for all SROs using a 'localised' scoring approach, in line with best practice MCDA guidance from HM Treasury Green Book. This conversion is applied so that results can be consistently

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compared and combined at the sub-criteria level into an overall score across the MCDA framework, as not all sub criteria are in the same comparable units (they can be qualitative, quantitively or monetised units).

Table 2: Normalised Value results for the Impact Assessment of the MCDA for carbon related sub-criteria

MCDA Normalised Scores				Options					
Criteria No.	Scenario	Metric	Cluster	A.1	A.2	B.2	B.4	B.5	D.2
E.03	BAU and Drought	Climate regulation (NC)	Environment	100	100	0	29	12	3
E.08	BAU	Embodied and operational carbon	Environment	0	0	51	77	45	100
E.08	Drought	Embodied and operational carbon	Environment	0	0	51	77	45	100

Source: Extract from Interim Update: Supporting Technical Report Option Appraisal 27 September 2021, Table 133 and 134

6.2 Carbon Assessment within the Gate 2 Planning and Consenting Evaluation

The Consenting Evaluation has evaluated the performance of each SRO against a range of legislative and planning criteria that relevant factors in the future consenting process. The criteria cover a range of topics, consistent with those in the draft National Policy Statement for Water Resources Infrastructure, which includes carbon emissions. The Consenting Evaluation has therefore considered the whole life carbon results for each SRO.

The Consenting Evaluation considered the whole life carbon results for the average (BAU) and the maximum operating scenario presented in Table 1.

Table 4 sets out the level of consenting risk from a carbon perspective for the options and the definition of RAG criteria is set out in Table 5. The level of consenting risk relating to carbon is greatest for Options A.1 and A.2, although these are no longer under consideration.

Table 4 Consenting Evaluation RAG for Carbon

SRO	RAG
A1	(Red)
A2	(Red)
B2	(Amber)
B5	(Amber)
B4	(Amber)

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D2	

Table 5 - Definition of the 'RAG' Consenting Evaluation Criteria

Score	Definition
Substantial adverse	Potential for substantial consenting risks that are likely to be very challenging to overcome / mitigate. Impacts are likely to be unacceptable and will fail to meet required legal/policy tests based on current information.
Large adverse	Potential for major consenting risks. Impacts are likely to require significant mitigation but are potentially acceptable from legal / policy perspective. A case may need to be made e.g., balance of benefits against impacts but could be justified.
Moderate adverse	Potential for moderate consenting risks that will require the development of bespoke mitigation to address, but likely to be achievable and acceptable in policy terms i.e. policy compliance can be achieved.
Minor adverse	Potential for minor consenting risks that will require application of standard best practice.
Positive Impact	Potential for positive performance against policy.
No impact	Does not require appraisal and can be scoped out as not relevant to the Option e.g., no receptors within policy wording that could be affected.

Within the Consenting Evaluation with regard to Carbon under each option it was advised that for the operational carbon there is potential for offsetting through the use of a Power Purchase Agreement that would ensure the use of renewable energy sources. This has not been considered to date but should be progressed after Gate 2 to ensure that SW's wider commitments in its Net Zero Plan are met and any potential risks associated with an increasingly stringent future policy context in relation to carbon are also managed. Paragraph 4.4.7 of the dNPS states:

"The applicant should demonstrate that it has investigated feasible Options in terms of using energy efficient technology or processes, or using renewable energy sources, produced either on site or linked to any local renewable energy initiatives. The Secretary of State will consider the effectiveness of such mitigation measures in order to ensure that the carbon footprint is not unnecessarily high. The Secretary of State's view of the adequacy of the mitigation measures will be a material factor in the decision-making process".

Specifically, regarding Option A.1 and A.2, these Options were considered the most significant of all of those under consideration in relation to carbon.

The policy requirement to consider the effectiveness of mitigation suggests that effectiveness of offsetting of both the operational carbon, as well as the carbon effects of additional generation, will need to be considered. Without further detail at this stage, this remains a significant project risk for these Options.

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Regarding Options B.2 and B.5, the potential siting of the EBL would also result in the loss of existing solar panels and the associated renewable energy benefits that they provide. Therefore, there will be a need to ensure that this lost provision can be replaced to again reflect SW renewable energy targets and to meet wider net zero goals. This issue should be addressed in the event of a formal site selection exercise being undertaken for the Otterbourne EBL as noted in the HRA recommendations above.

Both the whole life carbon and the CAPEX and OPEX costs are slightly higher for Option B.5 compared to B.2 but are not sufficiently different to change any of the results and analysis reported for Option B.2.

Option D.2 was considered to be the least significant of all the Options under consideration with regard to carbon.

7 Comparison of Capital and Operational Carbon Estimates

Southern Water has calculated an estimate of the capital and operational carbon for each of the options, summarised in and Table 5 below:

Table 5: Capital and Operational Carbon Estimates

OPERATING REGIME	FLOW (MLD)	CAPITAL CARBON (tCO_2e)	OPERATIONAL CARBON (tCO_2e)
A1			
MAX (DO)	**75**	**165,000**	**26,800**
MIN	**15**		**5,200**
AVERAGE	**15.6**		**5,400**
A2			
MAX (DO)	**61**	**118,000**	**21,800**
MIN	**15**		**5,200**
AVERAGE	**15.46**		**5,300**
B2			
MAX (DO)	**61**	**68,000**	**11,200**
MIN	**15**		**3,400**

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AVERAGE	**15.46**		**3,500**
B5			
MAX (DO)	**75**		**14,700**
MIN	**15**	**83,000**	**3,800**
AVERAGE	**15.6**		**3,900**
B4			
MAX (Transfer)	**75**		**4,600**
MIN	**6**	**71,000**	**1,100**
AVERAGE	**6.69**		**1,200**
D2			
MAX (Transfer)	**75**		**1,500**
MIN	**6**	**42,000**	**100**
AVERAGE	**6.69**		**100**

The differences in the minimum and average operational carbon estimates are primarily driven by the sweetening flows of the desalination or water recycling plant options (A1, A2 B2, B5) operating at 15 Ml/d, or the Havant Thicket options (D2, B4) transferring at 5 ML/d, and the smaller WRP (B4) operating at 5 Ml/d.

As part of the SW Options Appraisal Process, SW will apply its Strategic Objective on Carbon which states that:

"We will deliver solutions which ensure that we can continue to make progress towards meeting, and to support and contribute to, Water UK's commitment to become net zero carbon by 2030".

Based on the minimum, average and maximum (drought) operational and embedded capital carbon estimates the ranked lowest carbon to highest and then the ranking multiplied to provide a combined figure. This is set out in Table 6 below.

Table 6: Lowest Estimated Capital and Operational Carbon

Option	Ranking of Capital Carbon	Ranking of Operational Carbon	Ranking of Multiplied Carbon
D2	1	1	1

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B4	**3**	**2**	**6**
B2	**2**	**3**	**6**
B5	**4**	**4**	**16**
A2	**5**	**5**	**25**
A1	**6**	**6**	**36**

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