Gate 1 queries process

Strategic solution(s)	Thames to Affinity Transfer
Query number	TAT002
Date sent to company	19/07/2021
Response due by	21/07/2021 [extended to 23/07/21]

Query

1) Please explain why the option(s) are being developed at their stated volumes

2) For utilisation:
    a. Please explain what assumptions have been made regarding scheme utilisation to inform the Opex costs. Please explain the reasoning behind the utilisation value(s) used

    b. Why is utilisation assumed within cost calculation only for 100 ml/d options and not for 50Ml/d options

3) For water resources benefit:
    a. Please can the method for calculating 1 in 500 DO be provided

    b. Please can an explanation be given for why only an average and not a peak DO is required

    c. Please can an explanation be provided for how non-public water supply future demand has been considered

4) Please can detail be provided on how the wider resilience benefits are being assessed.

5) Please can the methodology, and associated relevant frameworks, used to calculate operational and embodied carbon and to guide the carbon assessment be provided

Solution owner response

1) The 50 and 100 Ml/d volumes provide consistency with the transfer volumes used for WRMP19, aligned to the need and requirements of Affinity Water. There are three reasons why this range was selected:

    a. Work undertaken during the Gate 1 process by Affinity water has confirmed that the lowest environmental destination scenario required by the Environment Agency is likely to drive the need for a single 100 Ml/d capacity SRO. The more enhanced destination scenarios increases this demand to closer to 200 Ml/d. However, network constraints within Affinity water's distribution system mean that a single 200 Ml/d transfer would require fundamental network reinforcement and reconfiguration and hence a series of 100 Ml/d options makes more strategic sense and a single 200 Ml/d option at a single 'hub' is harder to justify and integrate into the existing network.

    b. The 50 and 100 Ml/d options fit better with an adaptive planning approach as outlined in WRMP19, to manage future uncertainty, and better enable Affinity Water to manage a sequence of additional resource options over time.

    c. During discussions ahead of Gate 1, the DWI have made representations to Affinity Water that they are concerned about the resilience for Affinity Water of over-reliance on the River Thames as it's single source of water, given their lack of raw water storage, and the fact that all of their surface water already comes from the River Thames. The primary risk comes from pollution incidents or rapidly fluctuating water quality leading to prolonged treatment works shutdown. Hence, additional options from the system must be managed carefully. T2AT options greater than the proposed 50 or 100 Ml/d were considered to skew this River Thames reliance too far.

2) For utilisation:

    a. The two assessments of opex are based upon a 100% and a 25% utilisation of the schemes. This is to ensure we can assess scheme cost on a theoretical maximum basis (100%) and on the basis of the expected utilisation (25%). Based upon the modelling work we have completed for Gate 1, 25% is a represenattive value for the expected utilisation of the transfer scheme for Affinity water during dry year annual average conditions. Also, 25% - 30% represents a reasonable through-flow to maintain a water treatment works in operational state during periods of low utilisation, so that it can be 'ramped' up to full use when required.

    b. The same utilisation (100% and 25%) is assumed for all options, consistent with a number of the other SROs. This is the same for both the 100 Ml/d and the 50 Ml/d values. In section 10 of the Gate 1 submission, we presented only the values for the 100 Ml/d option, due to page limit constraints and as these provided a representative appraisal of the options. The equivalent table for the 50 Ml/d options is presented below, for information.

NPV and AIC for each of the 50 Ml/d capacity options

Option name	Units	Sunnymeads 1	Sunnymeads 2a	Maidenhead	Walton 2b
Option benefit – additional resources or demand saved	Ml/d	50	50	50	50
Total planning period option benefit (NPV)	Ml	348,935	348,935	348,935	348,935
Total planning period indicative capital cost of option (CAP. NPV)	£000	158,979	161,846	150,900	204,084
Total planning period indicative operating cost of option (OP. NPV)	£000	48,877	52,880	48,091	59,770
Total planning period indicative option cost (NPV)	£000	207,856	214,726	198,991	263,854
Average Incremental Cost (AIC) (max. utilisation)	p/m³	60	62	57	76
Average Incremental Cost (AIC) (25% utilisation)	p/m³	52	54	49	66
Option name	**Units**	**ETR**	**Teddington DRA**	**Mogden Reuse**	**Beckton Reuse**
Option benefit – additional resources or demand saved	Ml/d	50	50	50	50
Total planning period option benefit (NPV)	Ml	348,935	348,935	348,935	348,935
Total planning period indicative capital cost of option (CAP. NPV)	£000	135,009	194,723	204,084	159,039
Total planning period indicative operating cost of option (OP. NPV)	£000	49,195	53,324	59,770	46,040
Total planning period indicative option cost (NPV)	£000	184,205	248,047	263,854	205,079
Average Incremental Cost (AIC) (max. utilisation)	p/m³	53	71	76	59
Average Incremental Cost (AIC) (25% utilisation)	p/m³	45	62	66	51

Note: maximum utilisation is assumed for these calculations: 1 in 500 year deployable output for 365 days / year, to enable comparison between options.

As stated in the Gate 1 report, it should be noted that these costs do enable comparison between options, but do not take account of the holistic costs of the scheme, as they exclude the required raw water source hence should not be used for decision making in isolation.

3) For water resources benefit:

a. Overview of Deployable Output analysis

Deployable Output (DO) is defined as the supply capability for a water resources system under specified conditions, as constrained by: hydrological yield; licensed quantities; the environment (via licence constraints); abstraction assets; raw water assets; transfer and/or output assets; treatment capability; water quality; and levels of service, as defined by the WRPG. A recent development in water resource planning is the requirement that companies must plan to be resilient during a '1 in 500-year' drought, and as such DO should be calculated subject to the consideration of '1 in 500-year' drought events.

The T2AT option is of sufficient size, and the nature of London's and Affinity Water's water resource systems are sufficiently different, that there is

potentially a material conjunctive use benefit that may arise from a raw water transfer between Thames Water's London WRZ and Affinity Water's WRZs. That is to say that the DO benefit of the scheme to Affinity Water may be larger than the DO disbenefit of the scheme to London. This would be driven by differing vulnerabilities of the different water resource systems, i.e. a 1 in 500-year drought for London may well be an event which does not impact Affinity Water as severely, and vice-versa. As such, an assessment has been made of the DO benefit and disbenefit associated with this transfer, rather than assuming a direct transfer of DO.

A summary description of salient features of the methodology followed for the calculation of DO is given here. However, the methods followed and models used have been developed by WRSE, and as such readers are directed towards relevant WRSE method statements for a more detailed description, in particular method statements on 'Calculation of Deployable Output', 'Regional System Simulation (RSS) Model', and 'Stochastic Climate Datasets'. These may be found on WRSE's website (https://wrse.uk.engagementhq.com/method-statements). The DO benefit and disbenefit associated with T2AT options have been calculated using the 'Tier 1' approach outlined in the 'Calculation of Deployable Output' method statement.

Current water resource guidelines and practices focus on the calculation of DO at a 'system' level, as opposed to individual source level, recognising that sources may act in a conjunctive way. In particular, the EA's WRPG supplementary note on '1 in 500' states that '1 in 500' DO should be defined using 'system response'. The DO assessment for T2AT options follows this principle, and as such the DO of T2AT options is assessed as part of wider water resource systems. DO benefits and disbenefits for T2AT options are being modelled using the WRSE regional simulation model, built using the Pywr10 modelling platform.

The DO benefit and disbenefit for T2AT options are found by finding the difference between WRZ DO with and without a T2AT option in place. For both 'with' and 'without' cases, the relevant DO is found by determining the highest level of demand that can be placed on a zone before emergency restrictions would be implemented more often than once every five hundred years. The '1 in 500' DO is found using long, stochastically generated weather datasets; these datasets represent different versions of what 'could' have happened during the second half of the 20th Century. These datasets are run through hydrological and hydrogeological models to give 19,200 years-worth (400 x 48 years) of flow and groundwater timeseries data.

This flow and groundwater data is then fed into the Pywr water resources model, which is a 'behavioural water resources model' in which the water resource system, including both demand for water and supply sources are represented. In behavioural water resources models, DO is found by applying different levels of demand and observing system (Level of Service) outcomes, iterating demand upwards until outcomes defined as 'failure' are seen. In this case, DO is found using the input flow and groundwater yield datasets by finding the level of demand at which there is a transition from 38 to 39 (19,200/500 = 38.4) 'Level 4' failures across the 19,200-year input timeseries. A key point of this approach is that the DO benefit/disbenefit of T2AT schemes is not being determined for individual drought events, it is instead being found across a whole timeseries. The introduction of a large conjunctive scheme has the potential to change the events to which

the Thames Water and Affinity Water resource systems are vulnerable and using a DO modelling approach which considers the whole stochastic timeseries accounts for this implicitly, such that the DO benefit/disbenefit value found is the increase/decrease in Affinity Water/London DO that would be generated were a T2AT in place.

For Affinity Water, initially the baseline Affinity Water central region DO is found on a zone-by-zone basis without the transfer in place (baseline DO), using the whole stochastic sequence. Runs using the whole stochastic sequence at single levels of demand of DO plus 50, 100, and 150Ml/d (with additional demand placed proportionally across all Affinity Water zones) with the T2AT available as a 'bulk supply' into 'hubs' in the Pywr model for Affinity Water WRZ3 and WRZ4 are then conducted with and without current inter-zonal network constraints in place, in order to verify that the DO benefit of T2AT schemes is equal to scheme capacity, and to identify inter-zonal constraints that may need to be overcome to make use of a scheme. The time series of transfers made for each scheme size will be captured in a model run for use in the Thames Water DO disbenefit calculation. The T2AT scheme will be prioritised in the Pywr model such that Affinity Water makes use of existing resources up to 'Average DO' first, with T2AT utilised before Affinity Water use the 'Peak DO' of their existing sources.

To assess the disbenefit of a scheme to Thames Water, London's baseline DO is initially found (i.e. without a T2AT scheme in place) using all stochastic timeseries. Then, rather than explicitly represent the T2AT as it would exist in reality, the time series of T2AT transfers found in one of the runs detailed above for Affinity Water (for a given transfer capacity, with network constraints removed) is taken away from flows in the River Thames (i.e. to represent what flows would be like in the River Thames with a T2AT providing DO benefit to Affinity Water). London's DO is then found with this 'timeseries of transfers' removed from the river, and the DO disbenefit of the scheme is London's baseline DO minus the DO found with the transfer timeseries in place. This is necessary because the WRSE DO methodology is centred around finding the DO of a single zone with other demands around the catchment held at WRMP Year 5 Final Plan Distribution Input, rather than finding a 'regional DO'. This approach allows for the calculation of the DO disbenefit of the scheme to London while properly accounting for potential conjunctive use benefits.

In investment modelling, a T2AT scheme is then ascribed a resource, and when a T2AT scheme is chosen, a transfer from Thames Water to Affinity Water is made, and a resource benefit to Thames Water is applied.
It has previously been mooted that increased river flows from effluent returns associated with a T2AT transfer should be accounted for in DO modelling, which would not be captured by the approach above. However, river flow benefits are not created by the presence of a transfer; rather, they are created by increases in demand and returns from effluent, or reduction in abstraction. As such, DO benefit to London of upstream changes is not considered to be associated with the T2AT, but rather with, for example, sustainability reductions.

Regarding the DO benefit to London of sustainability reductions upstream, work has been carried out to dynamically consider the flow benefits that may be brought about by potential future sustainability reductions, recognising that the interaction between groundwater sources and river flows is complex and time-variant, particularly in catchments where rivers are partly ephemeral, as

interactions between groundwater and surface water are inhibited when rivers are perched. Algorithms have been developed which allow for the calculation of time-variant flow benefits to the River Thames associated with upstream abstraction reductions. These have been run for the full stochastic time series, such that the DO benefit associated with upstream reductions can be found for London consistent with 1 in 500-year drought conditions. Sustainability reductions are then represented in investment modelling as having a DO disbenefit for those zones in which a reduction is made, and a DO benefit for London, as the nature of the Lower Thames Operating Agreement means that additional water in the River Thames can be abstracted in the Lower Thames, although, as outlined above, the complex and time-variant interaction between groundwater and surface water sources needs to be taken into account.

b. Explanation of average DO and not peak.

DO has only been described according to ADO for two key reasons. The first, and simplest, reason is that the peak DO is effectively the same as the scheme capacity, so modelling evaluation is not required.

The second reason is that the nature of Affinity Water's resource system and demand profile mean that ADO is the primary indicator of resource stress and hence the focus of the supply/demand balance. 'ADO' is calculated using Affinity Water's behavioural model, in accordance with the UKWIR 'Manual of Source Yields'. Because of the lack of storage, drought supply/demand risk is driven by the capability of our drought vulnerable groundwater sources to output at required rates over periods of higher demand and low groundwater levels. This is measured according to 'MDO', the capability of sources to output over a rolling 30 day period, and 'PDO', the capability of sources to output over a rolling 7 day period. Both of these parameters are evaluated on a daily basis for long time series stochastic data sets, and form one of the three key inputs to the behavioural model. The 'ADO' is then calculated as the level of annual average demand that can be managed given Affinity's demand profile (the second key input) and profile of demand restriction savings associated with TUBs and NEUBs (the third key input). The ADO therefore effectively incoporates all of the relevant water resource inputs, including the PDO of our sources, which is why Affinity uses it as the primary indicator of resource system stress.

c. Consideration of non-public water supply future demand

The T2AT is, first and foremost, a transfer from Thames Water to Affinity Water only, to meet AFW's needs. This is the basic premise of the scheme as outlined in WRMP19. The T2AT has not been conceptualised to supply water for other sectors.

However, as part of their preparations for WRMP24, Affinity Water has reviewed the potential future demand for water for non-public water supply within their WRZs using WRSE consistent data sets. The data demonstrated that for the most part, non-public water consumption in Affinity Water's Central region is highly distributed and relatively small in scale. Local other sector demand is generally therefore not a significant component of either the regional or national demand within the Affinity Water supply area nor is it at local scale. The potential to develop such opportunities is therefore limited in scope for a strategic scale transfer option such as the T2AT, which is essentially a conveyance route to transfer water from a strategic source

option (to meet Affinity Water customer demand). Affinity Water is working on non-SRO scale non-public water supply side concepts at local scale separately under the WRMP options programme; that work is focused on locally distributed non-public water supply demands and the availability of water within the supply area, which will be reported in due course alongside the draft WRMP.

4) We have attached supporting data produced by WRSE to provide insight into the resilience framework and assessment undertaken for the South East regional plan. This is the resilience analysis that has been used by the T2AT SRO.

5) The methodologies for carbon footprint analysis are documented in Section 7 of the Environmental Assessment Report supporting technical document. This was provided to RAPID under response to query TAT001.

Date of response to RAPID	23/07/21
Strategic solution contact / responsible person	***[redacted text, personal information]*** SRO Programme Manager ***[redacted text, personal information]*** ***[redacted text, personal information]***