NWT-G02-003-001

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to United Utilities' statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, United Utilities will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

United Utilities

Water for the North West

North West Transfer SRO

UU Sources
Gate 2
Conceptual Design Report

14 November 2022

NWT-G02-003-001

United Utilities

Water for the North West

Contents

1. Executive Summary

1.1.1 The North West Transfer (NWT) Strategic Resource Option (SRO) is proposed to enable the redistribution of water from United Utilities' water supply network to support other regions of England and Wales in times of drought in those regions. The SRO entails a package of measures that would facilitate the transfer of supporting flows of up to 205 Ml/d via the rivers Vyrnwy and Severn, while maintaining levels of service to UU customers.

1.1.2 United Utilities has defined the following guiding principles for water transfers.

Table 1 - Principles

Principle	Criteria
Drinking Water Quality	UU customers will receive drinking water that is fully compliant with all regulatory standards.
Customer Acceptability	Customers must continue to have confidence in their water supply and acceptance in terms of taste, odour, appearance (discolouration) and pressure.
Resilience	The transfer must not have a net detrimental impact – and should ideally improve – the resilience of the water resource and assets used to provide services to customers.
Environment	The projects must not have a significant adverse effect on the environment, must be approved through regulatory oversight and must support, or at least not have a detrimental impact on the company's overall environmental performance.
Customer Bills	The scheme should provide demonstrable value for money for customers in the North West, as reflected in customer bills and customers in the region must receive a fair proportion of the national benefits, which arise from the scheme.

1.1.3 The scope of the proposed NWT SRO solution comprises two principal components:

Vyrnwy Aqueduct Enabling Works

1.1.4 Water to be transferred out of the region will be sourced from Lake Vyrnwy, During a transfer deployment, water originating from Lake Vyrnwy will be released into the river Vyrnwy and the river Severn. This will enable other water companies to abstract additional water from the River Severn, from points located downstream of the point of release into the river, for treatment and onward distribution within their networks.

1.1.5 Under transfer conditions, the water supply to customers that are currently served via Vyrnwy Aqueduct will be significantly reduced. Operational modifications to the existing Vyrnwy Aqueduct are proposed to enable the aqueduct to be recharged using treated water from an alternative source, temporarily, during water transfer periods. These operational modifications are termed the Vyrnwy Aqueduct Enabling Works and are detailed in a separate Conceptual Design Report.

UU Sources

1.1.6 New water resources will be required to make up the deficit in water supply to UU customers that would result from any given transfer out of area. The findings of water resource modelling indicate that 167 Ml/d of new treated water output would be required to enable the maximum proposed transfer of 205 Ml/d.

1.1.7 Gate 1, United Utilities identified 27 potential water resources for further assessment. This report presents the findings of the assessment process and the development of conceptual designs and associated cost estimates for each of the nine preferred sub-options that are included in the NWT SRO Full Solution. A further four water sources have been selected in reserve and may be called upon should any of the preferred sources be discounted following further investigations and assessment.

1.1.8 One of the water resources longlisted during Gate 1 related to Kielder Water. While the Kielder sub-option has not been discounted, it has not been considered and assessed as part of the NWT SRO Full Solution and, instead, is recommended for further consideration as a separate SRO.

1.1.9 The estimates of total expenditure, including provisions for risk and optimism bias, are presented in a separate Cost and Carbon Report.

Table 2 - NWT Full Solutions UU Sources Sub-Options.

WR Reference	Sub-Option Name	Option Type	Treated Water Output Capacity(Ml/d)	Solution
WR102b	GWE_WIDNES	GW enhancement	17	Full
WR107a2	GWE_AUGHTON PARK a2	GW enhancement	10	Full
WR107b	GWE_RANDLES BRIDGE	GW enhancement	11	Full
WR111	GWE_WOODFORD	GW enhancement	9	Full
WR113	GWE_TYTHERINGTON	GW enhancement	3	Full
WR149	ITC_WIGAN	WTW capacity increase, GW enhancement	13	Full
WR076	SWN_RIVER BOLLIN	SW new	25	Full
WR015	SWN_RIVER IRWELL	SW new	40 (WR015 and STT041b are mutually exclusive)	Full
WR049d	SWN_RIVER RIBBLE 49d	SW new	40	Full
WR105a1	GWE_LYMM a1	GW enhancement	4.5	Reserve
WR106b	GWE_WALTON_2	GW enhancement	8.45	Reserve
STT041b	SWN_RIVER IRWELL_ROCH	SW new	58 (WR015 and STT041b are mutually exclusive)	Reserve
WR144	SWN_RIVER TAME	SW new	5	Reserve

1.1.10 The conceptual designs are built upon the work completed in Gate 1 and WRMP19 and aligning to WRMP24, which ran in parallel with this study. Water resource modelling has been incorporated to

ensure the NWT SRO are designed to meet out of region transfer utilisation of 15% over the long-term average with a maximum continuous duration of 250 days.

1.1.11 The design process of each sub-option involved site visits, scoping engineering elements, generating process block diagrams, network modelling to assess customer acceptability, cost estimates, carbon calculations and constructability reviews. The conceptual design culminated in a series of technical reviews obtaining internal stakeholder buy-in within UU.

1.1.12 Drinking water quality, customer acceptability and sustainable abstraction are key focus for gate 3 with sampling, pilot plant trials and river and ground water modelling output. Drinking water quality, customer acceptability, resilience, environment and cost efficiency continue to be drivers for during gate 3 in line with the ACWG and RAPID guidelines. The UU sources Gate 3 submission, proposed quarter 4 2024. The selected sub-options will be progressed to Gate 3 for further consideration.

2. Introduction

2.1 Background

2.1.1 In 2016, Water UK published The Water Resources Long-term Planning Framework, which highlighted the "significant and growing risk of severe drought impacts arising from climate change, population growth and environmental drivers" in England. The report recommended that a portfolio of strategic supply side resources and transfers were required by 2065.

2.1.2 In 2018, the National Infrastructure Commission report entitled 'Preparing for a Drier Future, England's Water Infrastructure Needs' concluded that the water supply system in England was already operating under strain and that such pressure will only increase over the coming decades. The Commission predicted that, by 2050, an extra 4000 Ml/d of water supply and demand reduction will need to be delivered through a combination of leakage reduction, demand side initiatives and water transfers.

2.1.3 Ofwat initiated a Strategic Water Resources Options (SRO) programme, with the principal objective to provide at least 1500 Ml/d of water to areas of England facing water deficit. The North West Transfer (NWT) SRO is one of 17 schemes promoted by Ofwat in the PR19 Final Determination to identify new strategic water resources to meet deficits that are predicted to arise as a consequence of population growth and climate change. The Delivery of these solutions is subject to a formal gated process, where decisions are made on delivery penalties and solution funding progression. The Regulator's Alliance for Progressing Infrastructure Development (RAPID) oversees the development of the solutions that benefit from this funding.

2.1.4 The objective of the NWT SRO is to provide increased water supply both within the Water Resources West (WRW) region and to the Water Resources South East (WRSE) region, via the proposed Severn to Thames Transfer (STT) SRO. The NWT SRO has the potential to provide transfers of up to 205 Ml/d through the development of new water sources in the North West and enabling works to the Vyrnwy Aqueduct distribution system. This is subject to further assessment in future gates.

2.1.5 The NWT SRO was formed at Gate 1 by the merging of the previous UU Sources and Vyrnwy Aqueduct (VA Enabling Works) SROs to provide a holistic approach to delivering a transfer solution from the North West of England. The project scope and funding allocation was unchanged by this event.

2.1.6 At Gate 2, RAPID requires solutions to be developed to a standard suitable for submitting into final regional plans or final water resource management plans (WRMPs). This is the key stage at which sub-optimal solutions and options are eliminated and viable solutions and options are carried forward to the pre-planning stage (Gate 3). Section 3 of the NWT Gate 2 submission (Document Ref. NWT-G02-001-000) summarises the process employed by UU to select viable sub-options, and the development of concept designs for each element for assessment.

2.1.7 The UUS and VA options are designed to function independently of each other and the assessments of sub-options for each have been considered separately. This Conceptual Design Report (CDR) provides further detail on the process adopted in selecting a preferred portfolio of sub-options for the UU Sources element of the NWT SRO and describes the concept designs that were developed for each selected sub-option for assessment. A detailed assessment of sub-options for the VA Enabling Works is presented in a separate CDR (Document ref. NWT-G02-003-002).

2.2 The NWT Full Solution

2.2.1 The objective of this project is to investigate the potential for a solution that facilitates the transfer of water from the North West, without detriment to the levels of service to customers in the UU operating region or the environment. In support of this objective, UU established the following principles, which need to be achieved in order for UU to participate in trading.

Table 3 - UU Water Transfer Principles

Principle	Criteria
Drinking Water Quality	UU customers will receive drinking water that is fully compliant with all regulatory standards.
Customer Acceptability	Customers must continue to have confidence in their water supply and acceptance in terms of taste, odour, appearance (discolouration) and pressure.
Resilience	The transfer must not have a net detrimental impact – and should ideally improve – the resilience of the water resource and assets used to provide services to customers.
Environment	The projects must not have a significant adverse effect on the environment, must be approved through regulatory oversight and must support, or at least not have a detrimental impact on the company's overall environmental performance.
Customer Bills	The scheme should provide demonstrable value for money for customers in the North West, as reflected in customer bills and customers in the region must receive a fair proportion of the national benefits, which arise from the scheme.

2.2.2 The STT Interconnector is intended to transfer water from the river Severn to the river Thames to provide relief during periods of drought in south-eastern England (WRSE). The NWT Full Solution is required to provide supporting flow to WRSE via the STT, at times when the river Severn is running at or below hands-off flow level. The results of modelling undertaken by WRSE indicate that this will occur 15 % of the time over a long-term average.

2.2.3 UU has agreed, in principle, to provide supporting flow of up to 205 Ml/d of water from the Vyrnwy system for continuous transfer durations of up to 250 days in each deployment. These transfer requirements have been agreed with WRSE, which is the primary recipient of the proposed transfer.

2.2.4 The water supplied via NWT will be drawn from United Utilities' Vyrnwy supply system, which serves customers in and the conurbation normally. Supporting flows will be discharged into the River Vyrnwy and River Severn to enable surface water to be abstracted further downstream. The STT SRO would then abstract water from the River Severn for pre-treatment and onward transport via an interconnector to a point of discharge into the River Thames, as shown in Figure 1.

Figure 1 - NWT SRO and STT SRO links to River Thames

2.2.5 The proposed maximum transfer comprises up to 180 Ml/d sustainable yield from Lake Vyrnwy, via the rivers Vyrnwy and Severn, and 25 Ml/d of via an Shrewsbury. The transfer of treated water to Shrewsbury, known as the Shrewsbury Redeployment, will enable Severn Trent Water (STW) to reduce its abstraction from the River Severn by a corresponding amount, taking the combined transfer via the River Severn to 205 Ml/d.

2.2.6 Operation of the NWT Full Solution is reliant upon construction of new river Vyrnwy bypass pipeline and upgrading of the to Shrewsbury. These elements of work are being delivered as part of the Severn to Thames Transfer (STT) SRO and are discussed in more detail within the STT Gate 2 submission.

2.2.7 The NWT Full Solution comprises two main elements; modifications to the Vyrnwy system to enable raw water to be redirected to the River Vyrnwy or River Severn, and the commissioning and treatment of water from new sources to maintain capacity within United Utilities' integrated conjunctive supply network during periods of transfer.

2.2.8 Lake Vyrnwy is a resilient, high quality and cost-effective raw water supply that serves customers in and the conurbation normally, as part of UU's integrated conjunctive supply system. A key feature of UU's supply system is the ease with which water can be redistributed to meet changing operational needs. Accordingly, capacity within the system can be replenished using water sources that may be located remotely from the point of transfer. This has allowed UU to develop more cost effective, resilient options in less environmentally sensitive areas. It also means that if an option is discounted in the future, it can readily be substituted with another.

2.2.9 The UU Sources sub-options are spread across a wide geographical area, however each one provides benefits to the wider system. Allowing this indirect type of trading support helped us to reduce the cumulative capacity of options required for trading to well below the total trading amount (167 Ml/d versus 205 Ml/d). Accordingly, the portfolio of water source sub-options is required to meet or exceed the threshold value of 167 Ml/d.

2.2.10 The NWT Full Solution comprises nine water source sub-options (three surface water sources and six groundwater sources), which together provides a predicted output capacity of 168 Ml/d. The capacity of each sub-option has been estimated by preliminary hydrological and hydrogeological modelling and is subject to verification during the abstraction licence application process.

2.2.11 A lack of correlation between historical drought conditions in the North West and South East would indicate that trading is unlikely to be requested in support of STT during approximately half of droughts affecting the North West.

2.3 Previous Studies

2.3.1 The concept of using sources to support water transfer has been considered in the past as part of WRMP19, PR19 and most recently at Gate 1 under the UU Sources SRO.

Gate 1 – UUS SRO Conceptual Design Report

2.3.2 In Gate 1, the UU Sources SRO considered the suitability of numerous raw water source options to support the STT SRO. The UU Sources Conceptual Design Report for Gate 1 detailed the assessment of 27 selected source sub-options to support the transfer of water in up to five increments - 50 Ml/d, 75 Ml/d, 135 Ml/d, 150 Ml/d and 180 Ml/d.

2.3.3 The Gate 1 study appraised the options and promoted them through technical governance, supported by proxy water resource modelling, network modelling and water quality customer acceptability assessments to determine the selected shortlist. The overall engineering design was taken to a Level 1 engineering assessment (feasibility or concept level) with an overarching Class 4 (approximately -15 to +50%) under AACE Cost Estimate Classification System.

The key assumptions and risks are identified in the report included:

- The water transfer increments proposed at Gate 1 were subject to verification by WRSE, who we due to complete modelling exercises in Gate 2, however multiple portfolios of source options had been built up in line with potential water transfer scenarios.
- The UU Sources selected source options list was modelled with a water resources proxy-model.

2.3.4 The report recommended further water resource modelling at Gate 2 to demonstrate cost and benefit analysis of the source option in the system.

The UUS SRO Gate 1 CDR concluded that:

- A range of transfer volumes up to a maximum of 180 Ml/d in conjunction with the VA SRO were available for transfer.
- It was recommended that the selected 27 source options mentioned above be progressed to Gate 2 for further consideration. During Gate 2, source options were to be further assessed, modelled, and designed in more detail to reduce uncertainty, clarify assumptions and mitigate risks in the development of more robust scopes, costs and prices for water transfer.
- There are sufficient water sources in the North West to compensate for a transfer of up to 180 Ml/d, based on the utilisation figures provided by Thames Water as part of the WRMP19 process.
- The Gate 1 solution was scalable in its ability to transfer volumes of up to 180 Ml/d.

- An assessment of customer acceptability of changes in water further water quality assessments, around potential water source changes to facilitate transfers will need to be addressed as part of our Gate 2 investigations.
- The earliest delivery dates for the UU Sources ranged from 2028 (for transfers up to 50 Ml/d) to 2033 for the maximum transfer of 180 Ml/d, owing to the dependency on completion of the Vyrnwy Aqueduct SRO works.

RAPID Recommendations - Gate 1 Final Decision

2.3.5 RAPID's assessment of the Gate 1 submission concluded that further funding should be allowed for the UU Sources SRO to progress to Gate 2.

2.3.6 In the final decision for the UU Sources SRO Gate 1 submission, RAPID identified the following actions and recommendations to be addressed in the Solution Design section of the Gate 2 submission.

- Refine the list of source options down to a preferred suite early in the Gate 2 process, combining in portfolios as necessary for supply capacities. A manageable suite will allow for a full and detailed assessment to be completed during Gate 2. Progress and decisions on this action, including manageable numbers of preferred supply options, should be shared with regulators during checkpoint meetings.
- Ensure that further detailed utilisation calculations are undertaken early in Gate Two in order to feed into the environmental assessment.
- Ensure Welsh stakeholders and customers are included in solution specific engagement.
- Stakeholder engagement at gate two should further explore customer acceptability into change of supply source

2.4 Gate 2 Objectives and Study Scope

Objectives

2.4.1 The North West Transfer (NWT) project is aimed at identifying the additional new sources into UUs region required to allow the release of Lake Vyrnwy water to STT as well as establishing the required enabling works to facilitate the transfer of water from UUs system while maintaining a resilient supply of water to customers in the North West.

2.4.2 All SRO solutions must adhere to high level requirements set by RAPID for each Gate (1-5). The North West Transfer (NWT) solutions must also adhere to UU's Water Transfer Principles, as set by the UU Executive Board, and described in Table 3.

Gate 2 Conceptual Design Study Scope

2.4.3 The UU Sources element of the NWT Full Solution comprises a portfolio of individual source 'sub-options' to maintain appropriate additional WTW output capacity to facilitate the transfer of water out or area. At Gate 1, UU selected 27 sub-options to support the STT SRO in providing prospective water transfer options of 50, 75, 135, 150 and 180 Ml/d. These water source options were put forward for further assessment in Gate 2. From the 27 longlisted sub-options, 3 were out of region, namely Kielder and Cow Green Impounding Reservoirs, operated by Northumbrian Water, and Shropshire Union Canal (Llangollen Branch), operated by Canal and River Trust (CRT). One third-party in-region source option, Killington Impounding Reservoir, operated by CRT, was also longlisted.

2.4.4 Following Gate 1, UU considered a sixth water transfer increment, which would increase the total STT transfer volume to 205 Ml/d. This transfer option would entail the transfer of an additional 25 Ml/d of potable water to supply Severn Trent Water customers , known as the . The water source options longlist was checked and aligned with other major programme areas such as WRMP24, WINEP and UU Capital Delivery programmes

(Water and Wastewater) to ensure dependencies and opportunities were identified early and that only cost-effective solutions were promoted.

2.4.5 The Kielder Water option has been set aside and is recommended for development under a separate SRO in collaboration with Water Resources North (WReN).

2.4.6 Whilst all of the sub-options are required to support transfers, there are times when they can be used to support resilience in the North West. A lack of correlation between drought conditions in the North West and South East is particularly helpful, and means that transfers are unlikely to be requested in support of STT during approximately half of droughts affecting the North West.

2.4.7 In addition to supporting the STT SRO, United Utilities' WRMP24 and the draft Water Resources West Regional Plan recognise that the new water resources and infrastructure to be delivered via NWT also provide an opportunity to support a wider range of customers.

2.4.8 This Gate 2 Conceptual Design Report (CDR) presents the engineering study that has been undertaken in support of the Gate 2 assessment process for the NWT Full Solution.

2.5 Deliverables

2.5.1 To fulfil the study's scope, objectives and requirements highlighted above, the engineering work stream developed a set of deliverables that have been aligned to Gate 2 RAPID Requirements are listed below:

- Conceptual Design Report (CDR)
- Process Block Diagrams (PBDs)
- Scope documents
- Raw water quality data gap analysis
- Site visit Reports
- Cost estimates (Capex, Opex, Risk and Optimism Bias)
- Assessments of operational carbon and embodied carbon emissions
- Proposed site layouts
- Geotechnical / Geo-environmental risks and hazard identification
- Hydraulic modelling reports / surge analysis
- Network blending modelling reports
- UU sources engineering high level schedule
- Engineering Risk and Opportunities Registers
- Abstraction Licence Assessments and Costs
- Construction Hazard Assessment Reports
- Input information to Average Incremental Costs (AIC) model
- Input information to Gate 3 delivery programme

3. Technical Assessment and Sub-options Selection

3.1 Water Resource Benefit

3.1.1 The primary objective of the NWT SRO is to provide supporting flow to Water Resources South East region (WRSE) via the STT SRO. The benefits of the STT scheme and NWT SRO were calculated by transfer recipients. The model supported their assessments, but the benefits relate to their supply systems and supply-demand balances.

3.1.2 The current maximum transfer from the NWT SRO is 205 Ml/d, for use to support the STT SRO, or as direct transfers to other parties.

3.1.3 New water resources will be required to mitigate the deficit that would result from trading. UU has used an industry-leading system simulation approach to properly understand the water resource benefits of the sub-options, and to develop a best value solution. UU have worked closely with Water Resources West (WRW) to define best value and the approach was also aligned to UU's Water Transfer Principles.

3.1.4 The NWT SRO has a large degree of inherent flexibility. The water resources benefits can be scaled, phased, and readily incorporated into adaptive plans.

3.2 Water Resource Modelling

3.2.1 The NWT SRO is designed to meet a transfer utilisation of 15% over the long-term average with a maximum continuous transfer duration of 250 days. Utilisation is dictated by the flow conditions in the River Severn. The NWT SRO at this utilisation can be used to support deficits in both the West and Southeast regions.

3.2.2 There is a range of utilisation patterns possible for NWT SRO transferring water to the River Severn based on WRSE utilisation patterns available in the models.

3.2.3 Regional planning shows a need for the Northwest Transfer to be deployed from 2040 however it is part of the STT SRO which provides mitigation should other schemes not proceed.

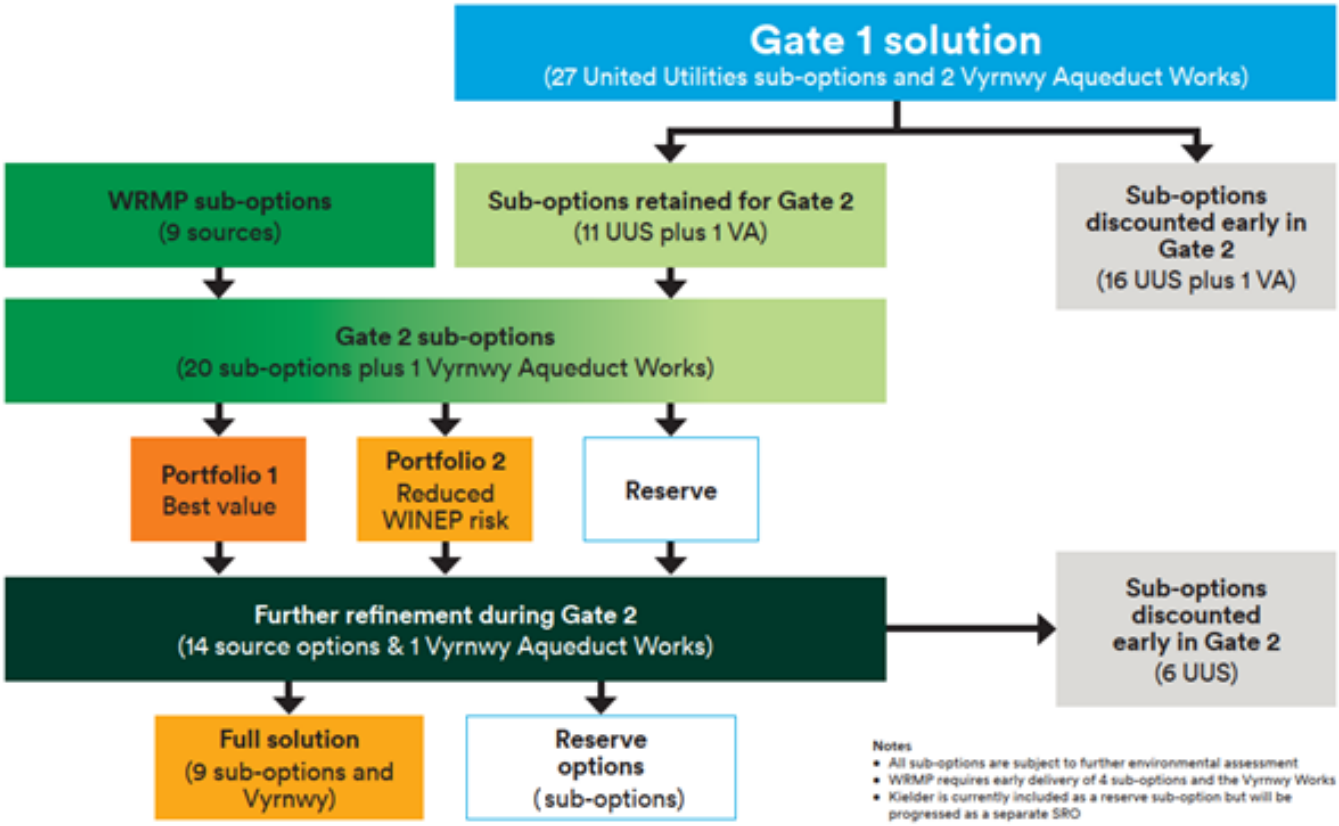
3.2.4 The UU Sources must be utilised when the trade is not in operation to ensure the UU is in a suitable state of readiness to support a transfer.

3.3 Short List Selection

3.3.1 The Water Resource Model has identified the preferred options and portfolios to be progressed through to Gate 3 and build upon the engineering work done to date. The model identified preferred options portfolio and reserve options portfolio.

3.3.2 At Gate 1, 27 sources were identified as feasible and were progressed to Gate 2. Following an updated water resource modelling exercise and a new strategic metric introduced at Gate 2, the list of sources has undergone a number of change controls. Figure 2 shows the process followed from Gate 1 to refining Gate 2 source options.

Figure 2 - NWT SRO source sub-options short list process



3.3.3 Key factors that influenced the discounted sub-options early include:

- New metric to increase treatment water capacity
- Low yield availability calculated in source options
- WINEP investigations concluding that no additional water is likely to be available at source

3.3.4 Table 4 describes in detail the reasons for not progressing options between Gate 1 and Gate 2.

3.3.5 Table 5 describes in detail the UUS from Gate 1 assessed at Gate 2.

Table 4 - Gate 1 to Gate 2 Options Progression

	Option Info		Gate 1 to Gate 2		
Group	**Sub-option ID**	**Sub-option Name**	**Included in UU Sources Gate 1?**	**Included in NWT Gate 2?**	**Comments**
Sub-options assessed in Gate 1	STT019	Transfer from Wirral to Liverpool via Mersey Tunnel	Yes	No	In Dry Weather conditions, there's no additional water to abstract from the due to the General Directions.
	STT029	River Lune	Yes	No	Not selected for Gate 2 because water resource modelling confirmed that this option provided minimal benefit to resilience or environmental metrics.
	STT034	Hollingworth Lake	Yes	No	Not selected for Gate 2 due to drinking water quality concerns, available yield, and conflicts with recreational use of reservoir.
	WR001	River Alt to Prescot	Yes	No	Not selected for Gate 2 due to drinking water quality concerns, and cost.
	WR010	River Greta / Wenning to Lancaster	Yes	No	Not selected for Gate 2 because the option does not increase production capacity.
	WR099b	Worsthorne	Yes	No	Not selected for Gate 2 because the option does not increase production capacity.
	WR101	Franklaw A, B & Z and Broughton	Yes	No	Not selected for Gate 2 because early results from the WINEP investigation on the Fylde Coast boreholes indicates there will be no additional water available for abstraction.
	WR102e	Bold Heath	Yes	No	Not selected for Gate 2 because the option does not increase production capacity.
	WR112	Bramhall	Yes	No	Not selected for Gate 2 due to high cost of water.
	WR123	Helsby and Foxhill	Yes	No	The scope of this option is included within the scope of option WR153. WR123 not include in Gate 2 as a standalone option.
	WR141	New river abstraction, River Irwell	Yes	No	Not selected for Gate 2 due to high cost of water.
	WR153	Simmonds Hill (Helsby, Foxhill, Mouldsworth, Manley Common, Manley Quarry, Five Crosses)	Yes	No	Results of Wirral and West Cheshire WINEP investigation show option is not suitable for trading.
	WR154	Sandiford (Organsdale, Delemere, Eddisbury, Cotebrook and Sandiford)	Yes	No	Results of Wirral and West Cheshire WINEP investigation show option is not suitable for trading.
	WR159	Individual Reservoirs Compensation Release Control	Yes	No	Not selected for Gate 2 because the option does not increase production capacity.
	WR810	Cow Green to Heltondale	Yes	No	Not selected for Gate 2 due to high cost of water, and potential environmental impacts due to length of pipeline and transfer of raw water between catchments.
	WR812	WIT_THIRD PARTY_22 (Kielder)	Yes	No (Separate SRO)	A variant of this option (WR812c) is proposed as a separate SRO.
	WR814a	Increased treatment capacity at Huntington	Yes	No	In Dry Weather conditions, there's no additional water to abstract from the due to the General Directions.
	WR815	Killington Reservoir to Thirlmere	Yes	No	Not selected for Gate 2 due to concerns over available yield from Killington Reservoir.
	WR821	Shropshire Union Canal	Yes	No	In Dry Weather conditions, there's no additional water to abstract from the due to the General Directions.

Table 5 - Gate 1 to Gate 2 Options Progression and Portfolio

	Option Info		Gate 1 to Gate 2			Gate 2 Portfolios	
Group	Sub-option ID	Sub-option Name	Included in UU Sources Gate 1?	Included in NWT Gate 2?	Comments	Full Solution	Reserve Sub-Options
Sub-options assessed in both Gate 1 and Gate 2	WR102b	GWE_WIDNES	Yes	Yes		Yes	
	WR107b	GWE_RANDLES BRIDGE	Yes	Yes		Yes	
	WR113	GWE_TYTHERINGTON	Yes	Yes		Yes	
	WR149	ITC_WIGAN	Yes	Yes		Yes	
	WR076	SWN_RIVER BOLLIN	Yes	Yes		Yes	
	WR049d	SWN_RIVER RIBBLE 49d	Yes	Yes (Variant)	Gate 1 option was WR049b, with lower capacity. WR049d no longer includes Anglezarke Reservoir.	Yes	
	WR105a	GWE_LYMM a1	Yes	Yes			Yes
	STT041b	SWN_RIVER IRWELL_ROCH	Yes	Yes (Variant)	Gate 1 option was STT041 (River Roch only). Now combined with WR015 to comprise abstractions from both River Roch and River Irwell. Sub-options STT014b and WR015 are mutually exclusive.		Yes
Sub-options added for assessment in Gate 2	WR107a2	GWE_AUGHTON PARK a2	No	Yes		Yes	
	WR111	GWE_WOODFORD	No	Yes		Yes	
	WR015	SWN_RIVER IRWELL	No	Yes	Sub-options WR0165 and STT041b are mutually exclusive.	Yes	
	WR106b	GWE_WALTON_2	No	Yes			Yes
	WR144	SWN_RIVER TAME	No	Yes			Yes
Sub-options added for assessment and	WR079d	Appleton	No	No	Hydrology calculations show the capacity of option is not sustainable		
	WR100	Thorncliffe Road	No	No	Results of Furness WINEP investigation show option is not suitable for trading.		
	WR120b	Cross Hill	No	No	Results of Wirral and West Cheshire WINEP investigation show option is not suitable for trading.		
	WR121a	Eaton	No	No	Results of Wirral and West Cheshire WINEP investigation show option is not suitable for trading.		

3.4 UU Sources Full Solution

3.4.1 The UUS full solution comprises nine preferred sub-options built around three surface water sources and six groundwater sources, which provide a predicted cumulative yield of 168 Ml/d (see Table 6 below). The full solution portfolio will be validated by further surveys and stakeholder engagement, to be undertaken in Gate 3.

3.4.2 Should any of the current preferred sub-options be discounted during this process, they will be replaced by one or more of four alternative sub-options (two surface water sources and two groundwater sources) that have been developed and held in reserve.

3.4.3 The designs incorporate new assets to abstract and transport raw water to the point of treatment, and either new water treatment works, or modifications to existing water treatment works to provide the required increase in treatment capacity. The new water sources will not provide the water required for transfer directly but will replenish supplies within UU's to facilitate transfers. The UU Sources, VA Enabling Works and STT SRO works would all be required to facilitate the transfer of supporting flows to WRSE.

3.4.4 Each transfer deployment will include a mobilisation phase before implementation of the transfer can occur. This is to enable time for sources to ramp up production, enable required network distribution modifications to be implemented and for planned outages to be completed or abandoned. At present a lead time of 25 days has been agreed for NWT to commence the supply of supporting flows to STT following acceptance of a request for transfer.

3.4.5 Consideration has been given to water softening treatments where the hardness of raw water is likely to be a concern. This potential requirement has been flagged as a risk, pending the findings of a raw water sampling and testing programme, which will be undertaken in Gate 3.

3.4.6 In addition to supporting the STT SRO, United Utilities WRMP24 and the draft Water Resources West Regional Plan recognise that the new water resources and infrastructure to be delivered via NWT would also provide opportunity to support a wider range of customers. Severn Trent Water has expressed an interest in receiving a transfer of 75 Ml/d from 2031.

3.4.7 A large proportion of the VA Enabling works, river Vyrnwy bypass pipeline and a number of new water resources would be required to enable a transfer of 75 Ml/d. UU has identified four water sources (River Irwell, Woodford , Tytherington and ITC Wigan) of to facilitate a transfer of 75 Ml/d from 2031. Validation and development of the design of these sub-options will be prioritised in Gate 3.

3.4.8 The selection of these sources was driven by water resource modelling.

Table 6 - UU Sources Sub-Options

WR Reference	Sub-Option Name	Sub-Option Description	Option Type	Treated Water Output Capacity (Ml/d)	Solution
WR102b	GWE_WIDNES	Increased abstraction from the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	17	Full
WR107a2	GWE_AUGHTON PARK a2	Increased abstraction from the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, treatment to	GW enhancement	10	Full

		potable standards and transfer to treated water storage in SRZ.			
WR107b	GWE_RANDLES BRIDGE	Increased abstraction from the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	11	Full
WR111	GWE_WOODFORD	Increased abstraction from the Manchester and East Cheshire Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	9	Full
WR113	GWE_TYTHERINGTON	Increased abstraction from the Manchester and East Cheshire Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	3	Full
WR149	ITC_WIGAN	Reinstate abstraction in the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, refurbish the existing treatment works, and transfer to treated water storage in SRZ.	WTW capacity increase, GW enhancement	13	Full
WR076	SWN_RIVER BOLLIN	New abstraction from the Bollin Dean Upper Mersey catchment, treatment to potable standards and transfer to treated water storage in SRZ.	SW new	25	Full
WR015	SWN_RIVER IRWELL	New abstraction from the Irwell catchment, treatment to potable standards and transfer to treated water storage in SRZ.	SW new	40 (WR015 and STT041b are mutually exclusive)	Full
WR049d	SWN_RIVER RIBBLE 49d	New abstraction from the Ribble catchment, treatment to potable standards and transfer to treated water storage in SRZ.	SW new	40	Full
WR105a1	GWE_LYMM a1	Increased abstraction from the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	4.5	Reserve
WR106b	GWE_WALTON_2	Increased abstraction from the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone aquifers, treatment to potable standards and transfer to treated water storage in SRZ.	GW enhancement	8.45	Reserve

STT041b	SWN_RIVER IRWELL_ROCH	New abstractions from the Irwell and Roch Irk Medlock catchments, treatment to potable standards and transfer to treated water storage in SRZ.	SW new	58 (WR015 and STT041b are mutually exclusive)	Reserve
WR144	SWN_RIVER TAME	New abstractions from the Goyt Etherow Tame catchment, treatment to potable standards and transfer to treated water storage in SRZ.	SW new	5	Reserve

3.4.9 Further detailed scope and design specifics of the above preferred sub-options can be found in Section 4.3.

5. Customer Acceptability Assessments

5.1.1 Water quality hardness assessments and impact to customer were carried out on the preferred source options. The assessment consisted of network modelling (blending ratios calculations) and water quality hardness reviews. These assessments were developed and assured by network modelling and process engineering disciplines.

5.1.2 On evaluating UUS options, each sub-option has a very different risk profile to bring it online. Some solutions under consideration require minimal mitigation for water quality risks, whereas others require a full new treatment process with a much more complex assessment. The latter of these will be undertaken and updated as more detailed engineering progresses. Consequently, the company has undertaken drinking water safety planning, and Regulation 15 new sources (where appropriate), approach to all options in the consolidated list of Gate 2 submission.

5.1.3 Network modelling including water quality blending risk assessments were carried out for each option to understand changes and any impacts on customers for both quality and pressures. Network modelling supported by process engineers carried out these assessments. The output of the modelling showed potential customers impacted and the scale of the impact (change in water quality).

5.1.4 This information was shared with the drinking water quality, stakeholder and customer acceptability work stream leads to develop customer communication and engagement plans.

5.2 Network modelling blending assessments

5.2.1 To mitigate customer acceptability concerns relating to changes in source water, network modelling was undertaken to identify options where significant water quality changes were anticipated.

5.2.2 For these 13 sub-options, blending ratios were identified based on hydraulically modelled results. The number of customers impacted were based on the notional solutions and the modelled results. The full list of modelled sources is shown in Table 25 below.

Table 25 - Water Quality Blend Sources Modelled

Option ID	Name	Capacity (Ml/d)
WR107b	Randles Bridge Knowsley Primrose Hill	12
WR015	River Irwell to new WTW at Heaton WTW	40
WR102b	Widnes BHs to Liverpool and Warrington	17
WR107a2	Aughton Park Moss End Boreholes No Ion Exchange	10
WR113	Tytherington Boreholes	3
WR149	ITC Wigan increased WTW capacity (SW) (Croft & Kenyon BHs in the scope document)	13
WR076	River Bollin	25
WR111	GWE_WOODFORD (8MLD)	9
WR049d	SWN_RIVER RIBBLE 49d - Rivington Increase capacity 40MLD	40
WR144	EFR_SADDLEWORTH	5
WR105a1	Lymm BHs to Sow Brook (no softening)	4.5
STT041b	River Roch and Irwell to new WTW at Heaton WTW	60

Option ID	Name	Capacity (Ml/d)
WR106b	GWE_WALTON_2	8.45

5.2.3 It is important to highlight that WR113 option was modelled in Gate 1. There was no need to re model this option as no changes to the blends, flows or volumes was envisioned in Gate 2.

5.2.4 These reports are not a comprehensive network hydraulic assessment and therefore future outputs in Gate 3 will focus more on the detail design and the options available to maintain levels of service in the network when sources are operating at the higher flows. More detailed modelling and reporting of risks and mitigation will be necessary.

5.3 Hardness assessments

5.3.1 Following from the blending studies described above, hardness calculations were completed of the proposed changes for the NWT SRO scheme. The assessments aim to inform the Stakeholder work stream in NWT SRO to assess customer acceptability by providing Twort (unit used to measure hardness of water) change figures to the total hardness of the water.

5.3.2 The blending ratios identified by the modelling studies, both for the current operating conditions and the proposed operating conditions under water transfer scenarios, were used as the basis of the process calculations. A flow weighted average of the sources is then calculated to determine the hardness of the blended water at each blend point for minimum, average and maximum water quality conditions. This calculation is completed for both the current operating conditions and the proposed operating conditions during water transfer periods.

5.3.3 The calculated hardness values for each blend were converted to a 'hardness' (Twort Limits) value, shown in Table 26, below. The impact of moving from the current conditions to transfer conditions was assessed to identify areas where the impact of blending has changed significantly in the Twort value. It has been assumed that a value of 2 or greater in the Twort Limits may lead to customer acceptability issues.

Table 26 - Categorisation of Water Hardness Values (Twort limits)

Hardness (mg CaCO3/l)		Twort Limits
Soft	0 - 50	1
Moderately Soft	50 - 100	2
Slightly Hard	100 - 150	3
Moderately Hard	150 - 200	4
Hard	200 - 300	5
Very Hard	>300	6

5.3.4 For existing sites or water supply zones, where treated water quality is known, historical data for hardness in the period 2010 to 2020 has been used. Where existing water quality data is not available, data has been used from a similar water type (e.g. river source, groundwater).

5.3.5 For sites where water softening has been considered in the treatment process, the calculations have been completed with and without softening. An assumption has been made for each site on the percentage reduction in water hardness that would be achieved by softening.

5.4 Assessment summary

5.4.1 A summary of the water hardness changes can be found in Table 27 below. Changes above 2 Twort levels are recommended to be further reviewed to ensure softening rigs or a robust stakeholder management plan is in place prior implementing the option.

Table 27 - Change in TWORT values summary

			Change in TWORT Value (Avg Condition)					
Number	Site		Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Softening recommended for Gate 3
STT041	River Roch to Heaton Park	18 Ml/d Option	1					No
STT041b	Rivers Irwell and Roch to Heaton Park	58 Ml/d Option	2	1				No
WR015	River Irwell to Heaton Park	40 Ml/d Option	1					No
WR049d/WR149	River Ribble to Rivington and Lightshaw BHS	Combined assessment	1	2	-1	4	3	No
WR076/WR105 (Option 1)	River Bollin and Lymm BHs - Option 1	Combined assessment - without softening	2	2	0			No
		Combined assessment - with softening	2	1	0			
WR076/WR105 (Option 2)	River Bollin and Lymm BHs - Option 2	Combined assessment - without softening	0	2	0			No
		Combined assessment - with softening	0	1	0			
WR076/WR105 (Option 3)	River Bollin and Lymm BHs - Option 3	Combined assessment - without softening	2	2	3			Yes
		Combined assessment - with softening	2	1	1			
WR102b	Widnes BHs		1	2				No
WR105a	Lymm BH							No
WR106	Walton and Daresbury	Without softening	5	5				Yes

			Change in TWORT Value (Avg Condition)					
		With Softening	2	2				
WR107a	Aughton Park	Without softening	2					No
		With Softening	-1					
WR107b	Randles Bridge	Without softening	2	3	3			Yes
		With Softening	-1	0	0			
WR111	Woodford BH		2	0	1	1	1	No
WR113	Tytherington BH		1					No
WR144	Saddleworth		0	0				No
WR149	ITC Wigan							No

5.4.2 It is important to note that network modelling is required to further assess the changes in hardness predictions. It is important to consider softening plants for WR106 and WR107b within Gate 3 to mitigate any customer acceptability risks.

5.4.3 Costs for softening rigs have not been included in Gate 2. It is expected that at Gate 3, these will be included following detailed network modelling of the sources. In addition, treated flow losses associated with the softening rig waste flows require further consideration at Gate 3 impacting the cost benefit of the solution.

6. Programme

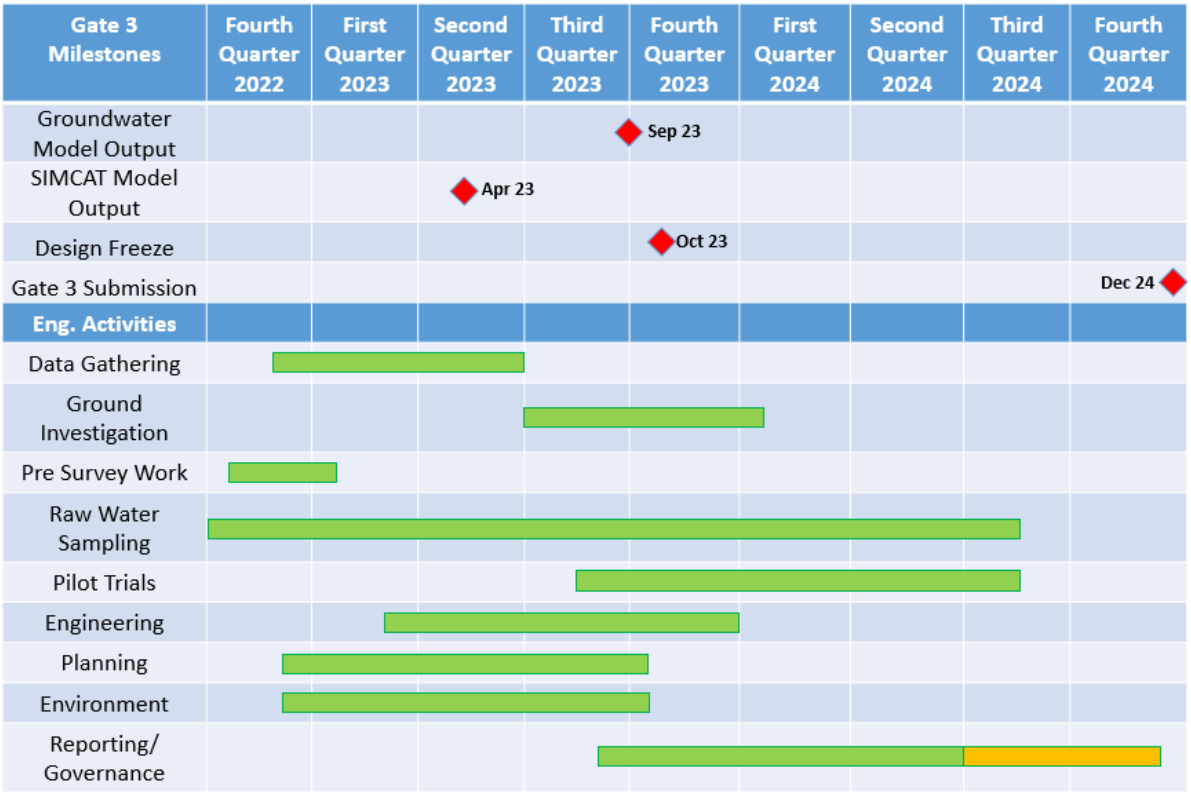
6.1.1 The UU Sources Gate 3 submission is scheduled for delivery winter 2024, after each of the source specific engineering, survey, planning and environmental activities have been completed. The Gate 3 submission date is dependent upon 3 key milestones;

- Completion of the EA groundwater modelling update and subsequent permission given to allow UU to abstract the specified flow rates from each of the groundwater sources. (Sep 23)
- Completion of the river water quality modelling update and subsequent permission given to allow UU to abstract the specified flows from each of the river sources. (Sep 23)
- Programme level agreement on the Gate 3 design freeze dates (Oct 23)

6.1.2 The Gate 3 submission end date is constrained by the expected minimum Gate 4 procurement timescales and the minimum construction timescales required to meet the latest UU sources completion dates. Figure 76 shows Gate 3 engineering key milestones and activities:

UU Sources Gate 3 Programme

Figure 76 - UU Sources Gate 3 Programme



6.1.3 It is anticipated that the construction for the Ground Water sources will take between 1.5 to 3 years under construction. The construction of the surface water sources will take between 1.5 to 5 years. The durations of construction period depend on the level of integration of existing assets, outages required for the delivery of the works and commissioning of the works with existing assets.

6.1.4 Construction delivery durations have been assessed using UU's historical knowledge summarised in the constructability reviews and commence once contracts are awarded and planning applications are in place. It is recommendation of the water quality monitoring and environmental survey screenings to commence early during Gate 3 to ensure planning applications can be submitted during December 2024.

6.1.5 It is important to highlight that the UUS are to be considered in conjunction with the Vyrnwy Aqueduct enabling works. Please refer to the Vyrnwy CDR for details on programme.

6.1.6 The above will enable trading to occur according to the current regional planning timescales.

Risks

6.1.7 Risks for the individual sub-options are summarised within the discussions of the individual sub-option designs. The risks in the UUS sub-options have not been costed. An assumption has been made in the SRO to account for costed risk as the Tender to Outturn costs derived from UUs internal estimating tool. Individual project risk registers have been compiled within each option and was managed at project levels in Gate 2. Details of assumptions and constraints can be found in the individual PBDs for each option.

6.1.8 It is important to highlight key overarching risks on both River Abstraction Projects and Ground Water Projects as listed below.

River Abstraction Project Risks (Threats)

(1) There is a threat that some or all of the final permitted abstraction rates from each of the five watercourse projects are significantly below their expected rate and are therefore unviable.

(2) There is a threat that climate change reduces the total amount of water available for abstraction in future years

(3) There is a threat that the quality of the water abstracted from each of the five watercourses is found to be unsuitable for treatment all year round

(4) There is a threat that the final treated water from the five abstraction watercourses do not blend well with the existing treated water stock, generating taste and odour complaints

(5) There is a threat that new contaminants are found within the watercourses that require new innovative processes to remove or make compliant

Ground Water Project Risks (Threats)

(1) There is a threat that some or all of the final permitted abstraction rates from each of the groundwater projects are significantly below their expected rate and are therefore unviable.

(2) There is a threat that climate change reduces the total amount of water available for abstraction in future years

(3) There is a threat that some or all of the groundwater sources are covered by existing or future conjunctive licences that further restrict what flows can be taken

(4) There is a threat that existing boreholes within the same conjunctive licence require a reduction in abstracting limits due to Environmental Destination or other regulatory environmental drivers prior to transfers.

(5) There is a threat that the quality of the water abstracted from each of the groundwater sources is found to be unsuitable for treatment all year round

(6) There is a threat that the final treated water from the groundwater sources do not blend well with the existing treated water stock, generating taste and odour complaints

(7) There is a threat that new contaminants are found within the groundwater sources that require new innovative processes to remove or make compliant

7. Conclusion

7.1.1 The NWT SRO in conjunction with VA Enabling Works, could enable a range of transfer volumes up to a maximum of 205 Ml/d that will support the current regulatory ambitions. It is therefore recommended that the preferred 13 UUS sub-options are progressed during the Gate 3 period. All sub-options are to be further assessed, modelled, surveyed and engineered to a greater level of detail, which will enable the Gate 2 assumptions and opportunities to be reviewed and revised and for the development of detailed risk mitigation plans. The outcomes of Gate 3 will result in more robust scopes, costs and prices for the water transfer programme and will focus efforts on achieving submissions for planning applications.

7.1.2 Water Resource modelling has proven that there are sufficient water sources throughout the North West to enable a transfer of up to 205 Ml/d based against the predicted utilisation figures whilst maintaining treatment production capacity and resilience within the regional network. A backfill of 168 Ml/d from the UU sources is recommended to progress with the 205Ml/d trade.

7.1.3 An initial comparison of the full solutions' costs and benefits were tested against the regional modelling and AIC. The regional network modelling will be progressed though Gate 3 to further assess the cost-benefit of the preferred UUS sub-options.

Next steps:

7.1.4 During Gate 3, the following activities will be undertaken to ensure the UUS can be progressed through the Gate:

- Assess results from the updated EA river and groundwater modelling as they become available in 2023.
- Assess the Regulators feedback with regards to water availability at the proposed UUS.
- Land referencing and section notices to facilitate intrusive survey work.
- Undertake additional engineering and site investigation desk stop studies and commission environmental survey work to enable the planning activities to progress during Gate 3.
- Further detailed network and MISER modelling to confirm network distribution scope requirements and future UUS operation, control and utilization.
- Continue with the water quality sampling programme, prepare detailed assessments, and undertake jar testing and pilot trials (design and implementation).
- Further modelling/testing/questionnaires to assess any groundwater customer acceptability concerns.
- Develop individual and overarching project schedules for each sub-option through to completion.
- Develop costed risk management plans.
- Develop stakeholder plans.
- Pre-planning application consultation work to ensure Planning Applications can be progressed during Gate 4.

8. Glossary

Abbreviation	Name
AACE	Association for the Advancement of Cost Engineering
ACWG	All Company Working Group
AIC	Average Incremental Costs
AMP	Asset Management Programme
ASVs	Auxiliary Supply Vehicle
BAU	Business As Usual
BH	Borehole
CAPEX	Capital Expenditure
CDR	Conceptual Design Report
CPO	Compulsory Purchase Order
CRT	Canal and River Trust
DMZ	Demand Management Zone
EA	Environment Agency
EIA	Environmental Impact Assessment
GAC	Granular Activated Carbon
GFH	Granular Ferric Hydroxide
GW	Groundwater
HA	Haweswater Aqueduct
HARP	Haweswater Aqueduct Resilience Project
HS2	High Speed Rail 2
INNS	Invasive Non-Native Species
kW	Kilowatt
MAHP	Major Accident Hazard Pipeline
MCC	Motor Control Centre
MI	Megalitres
Ml/d	Megalitres per day
MRM	Manchester Ring Main
NB	Nominal Bore
No.	Number
NRV	Non-Return Valve
NWT	North West Transfer
OPEX	Operational Expenditure
OPS	Operations (Operational Staff)
PAC	Powdered Activated Carbon
PBDs	Process Block Diagrams
PR19	Price Review 2019

Abbreviation	Name
PRoW	Public Right of Way
PS	Pumping Station
RW	Raw water
SACRED	Safety, Authorisation, Customer, Right First Time, Environment and Drinking Water
SBI	Site of Biological Interest
SIMCAT	Simulation Catchment modelling
SR	Service Reservoir
SRO	Strategic Resource Options
SSSI	Site of Specific Scientific Interest
STT	Severn to Thames Transfer
STW	Severn Trent Water
SUTW	Start Up To Waste
T&O	Taste and Odour
TOTEX	Total Expenditure
TPO	Tree Protection Order
TUB	Temporary Usage Ban
TWL	Top water level
UK	United Kingdom
UU	United Utilities
UUS	United Utilities Sources
UV	Ultraviolet
VA	Vyrnwy Aqueduct
WINEP	Water Industry National Environment Programme
WQ	Water quality
WR	Water Resource
WReN	Water Resources North
WRMP19	Water Resource Management Plan 2019
WRSE	Water Resources South East
WRW	Water Resources West
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

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