Revised Draft Water Resources Management Plan 2024

Appendix 8A – Investment Programme Development and Assessment

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Title	Method Statement: Investment Programme Development and Assessment
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Executive Summary

Water Resources South East (WRSE) is developing a multi-sector, regional resilience plan to secure water supplies for the South East until 2100.

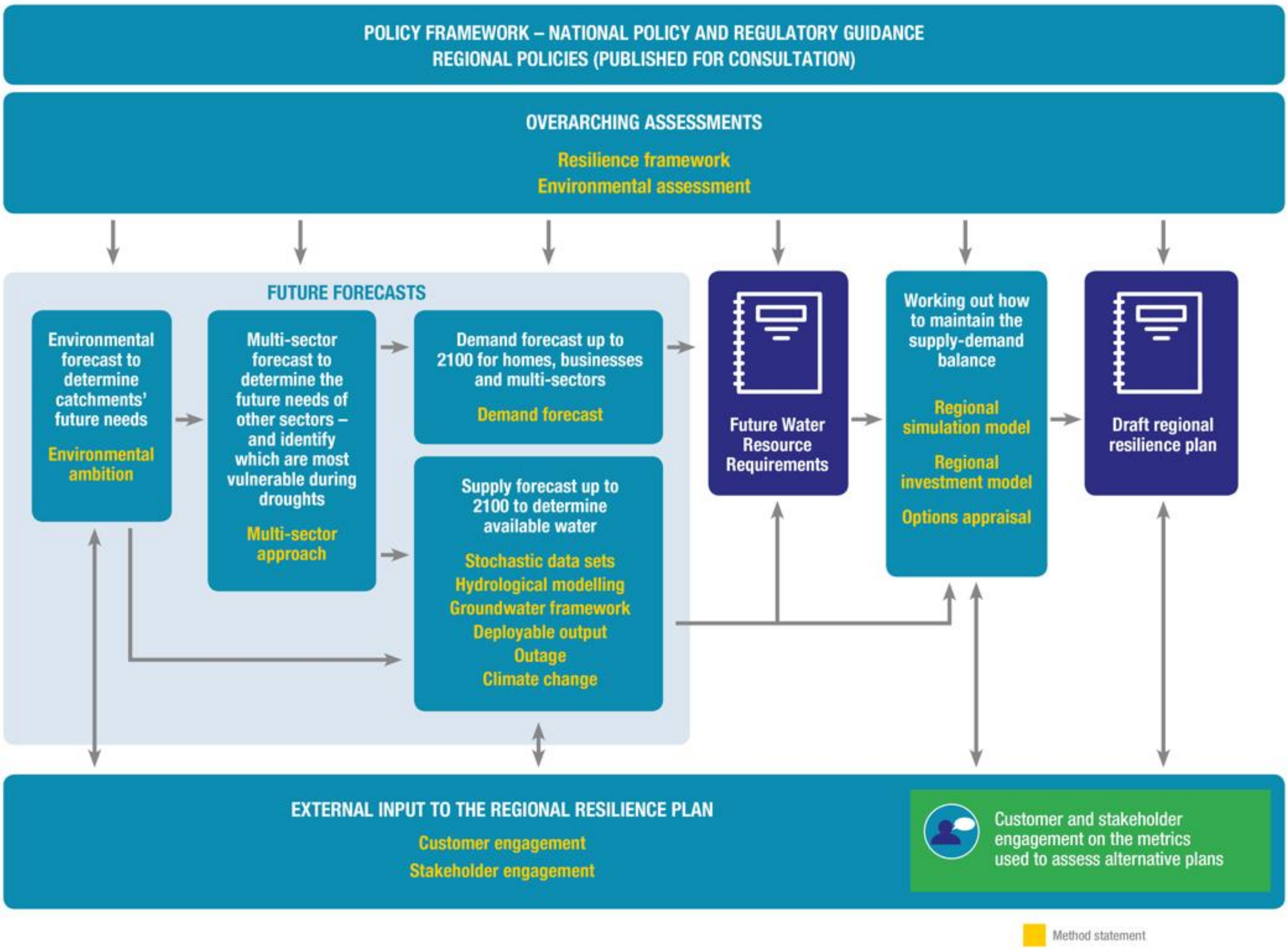
We have prepared method statements setting out the processes and procedures we will follow when preparing all the technical elements for our regional resilience plan. We are consulting on these early in the plan preparation process to ensure that our methods are transparent and, as far as possible, reflect the views and requirements of customers and stakeholders.

Figure ES1 illustrates how this investment programme development and assessment method statement will contribute to the preparation process for the regional resilience plan.

The scale and complexity of water resources planning for the South East of England requires advanced decision-making methods to ensure that a robust solution is reached. This method statement details the process and tools for developing a best value, adaptive regional plan as described by the WRSE resilience framework, with special focus on the regional investment model and its supporting infrastructure and models. A separate method statement details the Regional Simulation Model and its role in the decision-making.

Integrated risk modelling is used to explore and define problems to be solved for regional water planning to support public water supply, non-public water supply, the environment, and social amenity while allowing explicit exploration of different uncertainties or risks. Real options and adaptive planning methods are combined in the WRSE investment model which seeks good value solutions to the integrated risk problems to 2100, for a variety of different values including cost, resilience, environmental impact and customer preference.

Figure ES1: Overview of the method statements and their role in the development of the WRSE regional resilience plan



A visualisation tool supports understanding and comparison of the alternative investment programmes produced by the investment model, to allow shortlisting for specialised assessment and stress-testing, before a preferred solution is selected.

A data landing platform underpins all data flows across this process to support robust governance, quality assurance and reporting.

1 Introduction and timeline

1.1 By 2050, the South East of England is forecast to experience a shortfall in water resources needed to ensure a resilient water supply for the public, other users and the environment of between 1000[1] and 1750[2] Mld^{-1}.

1.2 The scale of the problem and controversial nature of some of the potential solutions means that an advanced decision-making method is advocated by the planning guidance. WRSE is developing both regional simulation and aggregated optimisation models to develop and test investment programmes and enable selection of a best value adaptive plan for the region.

1.3 The investment modelling method, together with the process for dealing with associated data flows, problem and risk definition, and solution appraisal, is detailed in this document.

1.4 The overall timeline and milestones for the decision-making process to support the regional planning is shown in Table 1.

Table 1: Milestones

Date of Delivery	Activity
July 2020	Method statements produced
Oct 2020	Policies and preferences agreed
Winter 2020/21	Initial resilience planning for the South East region
Spring 2021	Update Future Water Resource Requirements for South East England
Spring 2021	Confirm the policies and preferences that we will embed in our regional plan
Summer 2021	Reconciliation of draft regional plans to ensure alignment across England
January 2022	Publish WRSE draft Regional Plan for informal consultation

[1] March 2020, Future water resource requirements for South East England, WRSE.
[2] March 2020, *National Framework*, Environment Agency

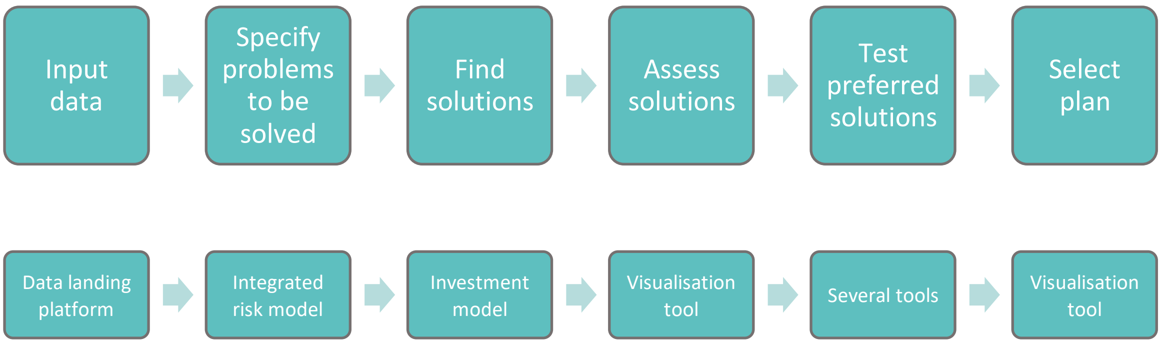
May 2022	Present the main issues raised in the consultation and how they will be addressed
August 2022	Publish our final draft Regional Plan
August 2022	WRSE water companies will submit their draft Water Resource Management Plans 2024 ahead of public consultation
March 2023	Water companies publish their revised draft Water Resources Management Plans
September 2023	WRSE will publish its final multi-sector, regional resilience plan

2 Process overview

2.1 The process for generating and testing the regional plan[3] can be summarised in the six main stages shown in 0 together with the tools necessary to assist the undertaking of each step; these stages are an amalgamation of the full 17-step process for *development of a plan* described in the WRSE Resilience Framework, to allow the mapping of each stage to the tool developed to support it.

2.2 The full 17-step process is broken down in Sections 3, 4 and 5 of this document, which details the methods and tools under development to work through this process, although detailed description of the methods for testing the preferred good-value solutions in terms of system resilience, environmental impact and customer impact are described in the separate method statements referenced in Section 6.

Figure 1: Steps to generate and test a regional plan



2.3 The first tool, the data landing platform (DLP, Section 2.34), will handle all data sharing and transformation between all steps in the process, and facilitate data quality control.

2.4 The integrated risk model (IRM, Section 3) is used to specify the supply-demand balances (SDBs) and SDB trees to be solved for each investment model run.

2.5 The investment model (IVM, Section 4) is used to search for the optimal combination of options across time to satisfy the problems defined by the IRM, subject to whichever decision parameters, constraints and objective functions are specified for that optimisation.

2.6 The visualisation tool (VTL, Section 5) is used to graph, map and tabulate the outputs from the IRM and IVM to assist with output quality control, decision-making, and selection of good value investment programmes by company and industry experts.

[3] June 2020, *Securing resilient water resources for South East England – consultation on our resilience framework*, WRSE.

2.7 Methods for testing a shortlist of good investment programmes are outlined in Section 6. Shortlisted solutions are sent via the DLP to the other workstreams for advanced testing, while the IVM is used with additional parameters such as option restrictions, alternative scenarios or changing constraints, to stress or sensitivity test those good value investment programmes that have been identified as preferred.

2.8 A final selection is made using the VTL, including the additional data from the stress, sensitivity, and additional testing, and the preferred adaptive regional resilience plan then exported via the DLP to a headroom assessment tool and the WRP tables, to support consultation and reporting (Section 7).

Input data

2.9 The methods for producing the input data required are detailed in the method statements for the workstreams which produce them. All data input to the DLP is signed-off by the input workstream and the version, authorisation and author automatically captured as part of the upload. This section lists the data required and expected provenance.

Planning scenarios and planning horizon.

2.10 The Water Resource Planning Guideline (WRPG) states that a Water Resource Management Plan (WRMP) must consider the worst-case dry year combination of supply and demand forecasts for each zone, together with the uncertainties incorporated in target headroom. Drought resilience must also be included, and the revision of the WRPG to be published this August is in line to advocate resilience to 1:500 drought by 2040.

2.11 To enable investment modelling for dry year and drought across WRSE, baseline supply and demand forecasts and uncertainty profiles are imported for each of five deterministic planning scenarios:

1. Normal year annual average (NYAA)
2. Dry year annual average (DYAA)
3. Dry year critical period (DYCP)
4. 1:200 drought (1:200)
5. 1:500 drought (1:500)

2.12 Deterministic DOs are also provided for supply options for each of the planning scenarios, and demand reduction profiles for each of the demand reduction strategies.

2.13 Where possible drought interventions are not included in supply or demand baselines; media campaign impacts, temporary use bans, non-essential use bans, and drought permits or orders are all included as options that have a deployable output (DO) or demand reduction available during the dry year or drought planning scenarios.

2.14 As explained in the Initial Resource Position for WRSE, the planning horizon for WRMP24 will be April 2025/26 to April 2099/2100.

Baseline supply forecasts

2.15 Baseline supply forecasts for the IRM and IVM define water available for use (WAFU) from each WRZ's own sources, plus or minus any external or commercial transfers to/ from the WRSE water companies, and inset appointments. These WAFU forecasts are generated by the Regional Simulation Model, based on regional weather and climate datasets, hydrological modelling, groundwater modelling and dynamic demand algorithms and methods.

2.16 Existing inter-zonal transfer pipelines and existing inter-zonal bulk transfer agreements within the region are included as options, to enable existing transfer agreement inclusion as either fixed volumes representing inter-company agreements, or options for optimisation of conjunctive use of regional WAFU, as desired for different IVM runs.

2.17 Drought intervention DO reduction or enhancement is not included in the baselines, but as options available for dry or drought year planning scenarios.

Baseline demand forecasts

2.18 Baseline demand forecasts for the IRM and IVM are generated by the demand modellers for each company, based on the regional population and properties forecasts generated by Edge Analytics (Population and Property Forecasts – Methodology and Outcomes). The modellers provide deterministic distribution input (DI) forecasts with DI per WRZ per year, for each planning scenario.

2.19 As there are several relevant population and properties forecasts, the demand forecasters are devising a method to select forecasts that are most applicable for regional adaptive planning, as detailed in the Demand Forecast method statement. It is feasible to include alternative demand forecasts either:

- as fixed baselines, for separate optimisations of a range of supply demand balances where the range covers supply uncertainties only; or
- as demand forecast uncertainty profiles in the integrated risk model, sampled to generate a range of supply demand balances for a single optimization

2.20 Testing and evaluation of the IRM and IVM with full data will enable determination of the preferred method, or combination, going forward.

2.21 Drought intervention DI reduction should not be included in the baselines, but as options available for dry or drought planning scenarios.

Situations and policies

2.22 Deterministic baseline forecasts require the forecaster to select a 'most likely' or 'best fit' forecast from among those feasible. Situations (i.e. circumstances beyond reasonable control of the water companies or regulators such as population growth, climate change etc.) and policies (either internal or governmental/

regulatory) are key factors that influence both system forecasts, and the uncertainty distributions around these influences are all captured as part of the supply and demand forecasting workstreams, to be input to the IRM via the DLP.

2.23 The guidance states that situation and policy uncertainties affecting public water supply forecasting should be sampled to provide a deterministic target headroom forecast to be included in problem development and ensure that water resources management planning can meet the risk that the future deviates from the most likely forecasts. The integrated risk model includes all the uncertainties used to create a target headroom buffer, but samples and solves for them separately and in combination to allow greater understanding of the relative impacts of key situations or policies on investment planning.

2.24 Situation and policy uncertainty profiles input to the IRM will include more than these key challenges to public water supply. Additional uncertainty profiles will also be input relating to environmental protection, non-public water supply, and wider South East systems, as defined in the WRSE Resilience Framework, so as to ensure that the problems to be solved are comprehensive enough to provide solutions resilient for all four systems.

Investment options

2.25 The Options Appraisal team provide all regional supply, demand and transfer options not included in the baselines, whether existing, under construction, or new. Options may be stand-alone or made up of:

- Option elements (resource, conveyance)
- Option phases (modular increases in resource DO)
- Option stages (planning, development, construction and operation)

2.26 For example, existing transfers are input with two elements:

- DO of the bulk transfer agreement under different planning scenarios (resource element)
- capacity of the transfer pipeline (conveyance element)

This enables the investment model to both run simulations of the system with the bulk transfer agreements fixed, or to run with optimisation of existing transfer pipeline utilisation.

2.27 Drought interventions are included as options to enable better understanding of the impact of temporary use bans, non-essential use bans, drought permits and drought orders, and better evaluate the investment cost of resilience to different levels of service.

2.28 Supply options due for completion before the 2025 start of the planning horizon will be included in the baseline forecasts. Options for which planning, development or construction is due to start before 2025 will be provided with a new completion date, remaining costs, and a revised DO estimate; the water company providing each of these options under development decides whether the decision to build is fixed or whether completion is still optional.

2.29 Demand reduction strategies per WRZ are developed in company from combinations of available demand options to meet different demand reduction targets. Three per zone are envisaged. Recirculation of WAFU through effluent discharge is a consequence of demand levels upstream and therefore, for each demand strategy in upstream zones, the associated effect on downstream WAFU is calculated by the simulation model for input via the DLP.

2.30 New supply options and transfers can include elements, phases and stages as listed above; the combination of the components by the investment model defines when or if an option is commissioned, the maximum DO available, and the combined operational expenditure, which the optimiser uses in comparison with the opex of all other options to minimise utilisation opex while satisfying demand across all four planning scenarios.

2.31 Whether new treatment is required in a zone depends on:

- baseline demand growth
- amount of demand reduction that frees up existing treatment capacity
- amount of DO reduction that frees up existing treatment capacity (e.g. sustainability reductions)

It is therefore feasible to pre-calculate the zonal treatment expansion required for each of the three demand reduction programmes per zone, for each situation. These treatment options and costs can be combined with the demand programme costs, for consideration of the two together in investment optimisation.

2.32 The multisector group and the Environmental group will also provide potential options which will be considered in the investment model, see Multi-sector Approach and Environmental Ambition method statements.

2.33 A full description of options development, appraisal, and option component mapping for modelling is included in the Options Appraisal method statement.

Data flow and quality control

2.34 Regional planning input data outlined in section 2.1 are being delivered by several workstreams listed above. The majority of these workstreams are being undertaken by different contractors, and each may include local data storage and visualisation elements to streamline and audit data. To control the data sharing, data management and quality assurance across the regional planning process a centralised Data Landing Platform (DLP) is being created.

- Stage 1 of DLP delivery enables all data storage, transfer and transformation to and from the integrated risk model, investment model and visualization tool.
- Stage 2 will extend the DLP to enable reporting the final problem, options and selection in the Water Resource Planning (WRP) tables for each zone in the region.

Data landing platform

2.35 The project data flows in Figure 2 outline the DLP stage 1 specification as the blue connections between workstreams, the codes for which are in Table 2. The key for the additional codes is in Appendix 1. Figure 3 shows the flow of information through the DLP.

Table 2: Integrated Risk and Investment Model Input Data

IRM/ IVM Input Data	Provided by	ID[4]
Baseline supply forecasts	Simulation model	M
Baseline demand forecasts	Demand forecasting models via simulation model	H→M
Forecast uncertainties	Simulation & demand forecasting models	F&J
Existing transfers	Options appraisal	N
New supply options and transfers	Options appraisal	N
Demand reduction strategies	Demand strategies via Options appraisal	C→N

[4] Data IDs relate to the Data Landing Platform flow chart,

Figure 2: Data flows through data landing platform

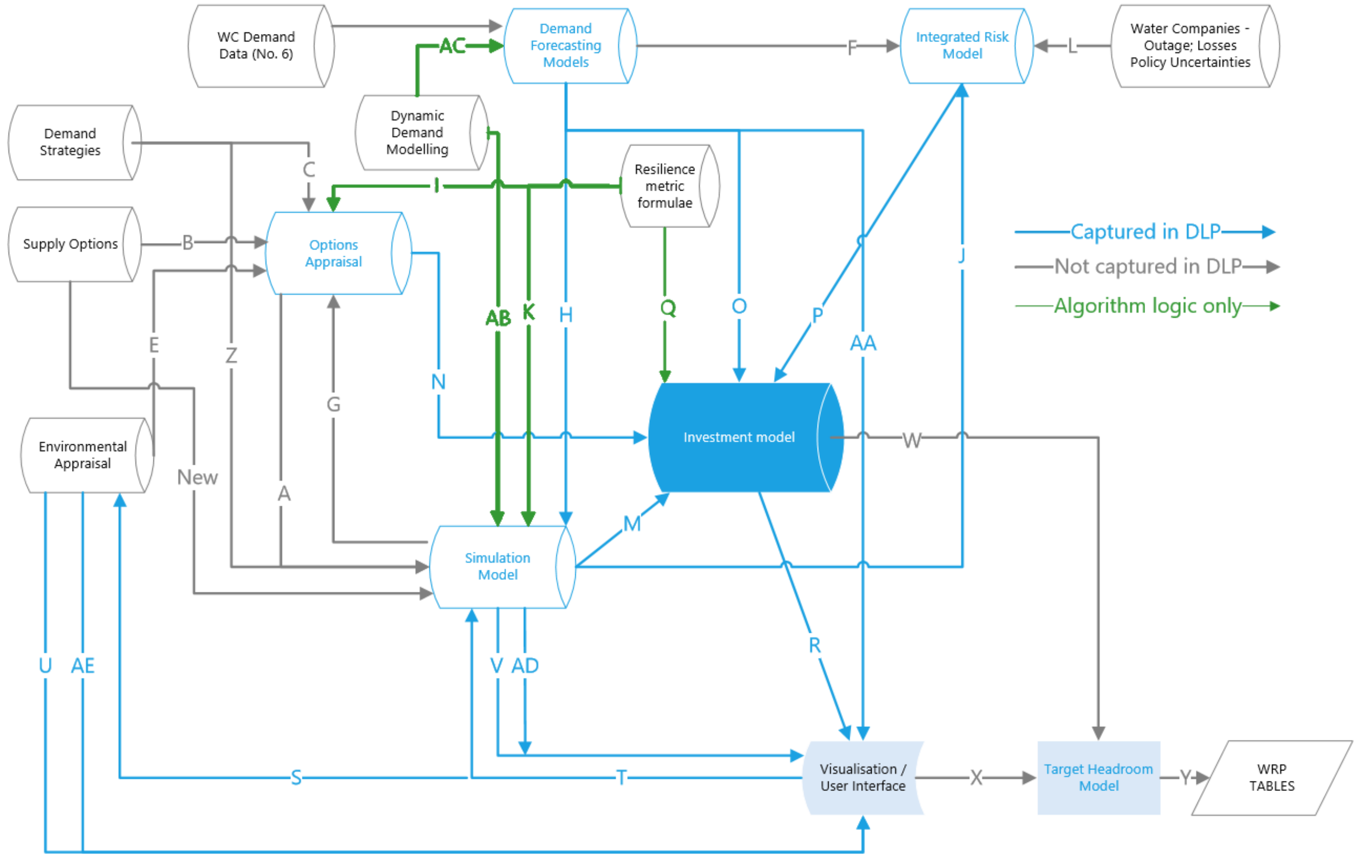
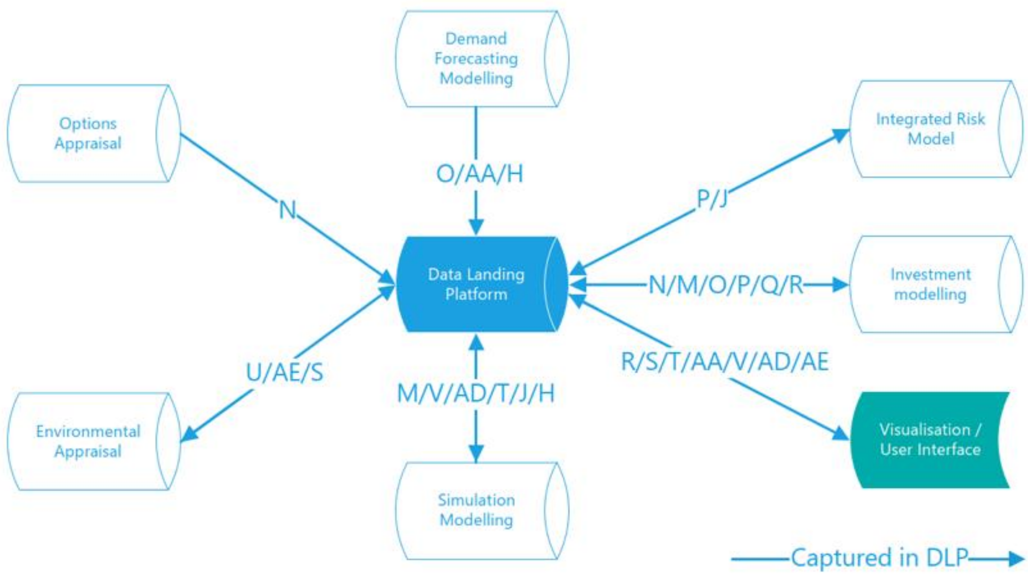


Figure 3: Flow of information through DLP



Data assurance

2.36 The DLP will support the quality assurance process, through either visual or automated verification or likely both. Metadata will be set up to ensure governance of inputs in terms of version control and input personnel, and to track any transformations carried out in the DLP.

2.37 The QA logic will be defined by WRSE and will include identifying gaps in data, outliers, values outside of set tolerances, and incorrect value types, using a combination of manual and automated verification to balance out the pros and cons of each (Table 3).

2.38 **Manual quality assurance**. Dashboards are developed with the defined logic, with WRSE visually reviewing the data for any anomalies.

2.39 **Automated verification and checking of datasets.** All defined logic will be automated and applied on data upload, with alerts sent to users if anomalies are detected.

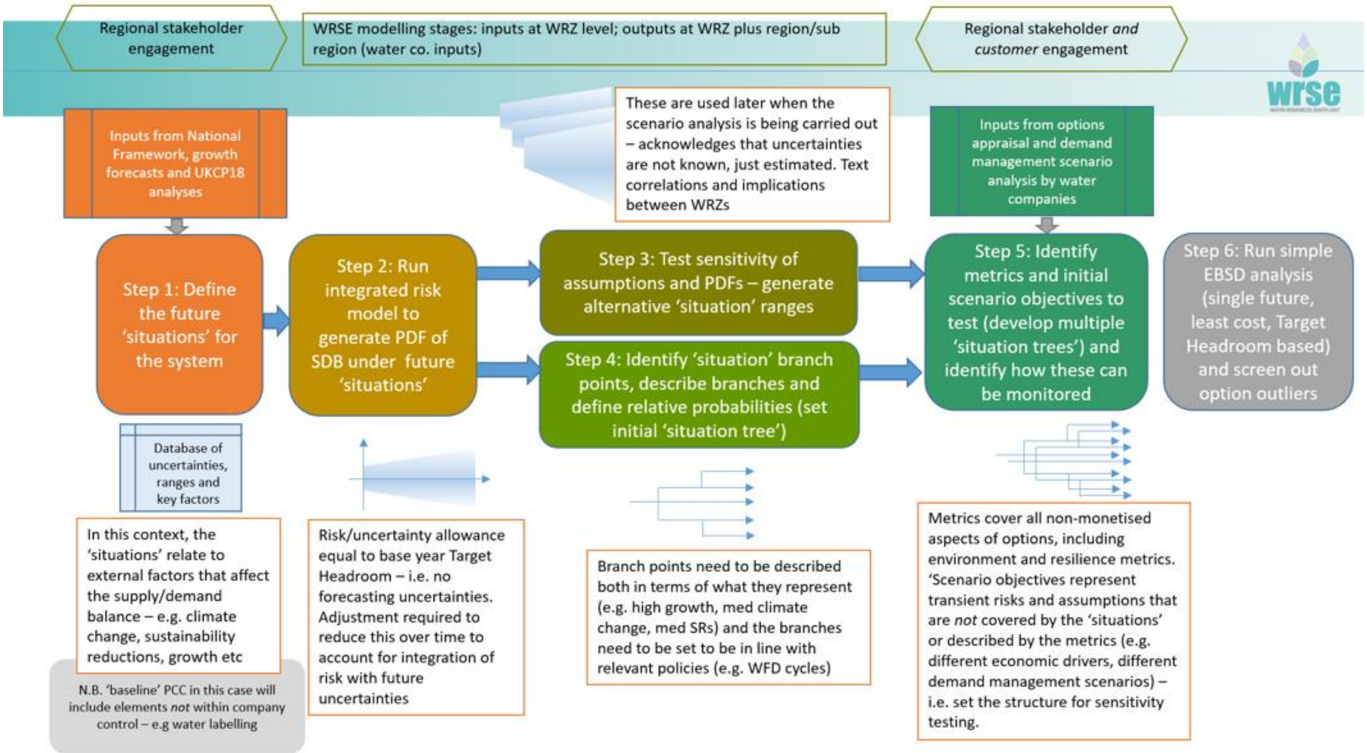
Table 3: Manual and automated QA comparison

QA method	Pros	Cons
Manual	Can pick up anomalies that are difficult to automate Can deliver contextual experience	Labour cost Time intensive Sometimes difficult to spot anomalies
Automated	Supports automated process and consistence Can reduce human error	Development cost Development time Can be relied on too heavily

3 Integrated risk modelling

3.1 The Integrated risk model derives the water resource planning problems to be investigated by the investment model; step 2 to step 5 of the *development of plan* process described in the Resilience Framework (Figure 4). Input data feeds into Step 1 and Step 5.

Figure 4: Integrated Risk Modelling as part of development of a plan



3.2 Before running the IRM to generate a PDF of situation uncertainties, the five supply and demand forecasts input via the DLP are first combined into four: NYAA, DYAA, DYCP and drought (EMDO[5]). The draft revised guidance states that 1:500 resilience should be attained in the 2030s; as such the EMDO baselines will represent 1:200 DO and DI until 2030, and 1:500 DO and DI from 2040, but the exact date of change from one level to the other may be varied in different SDB scenarios for optimisation in the investment model, or sensitivity testing of preferred regional plans.

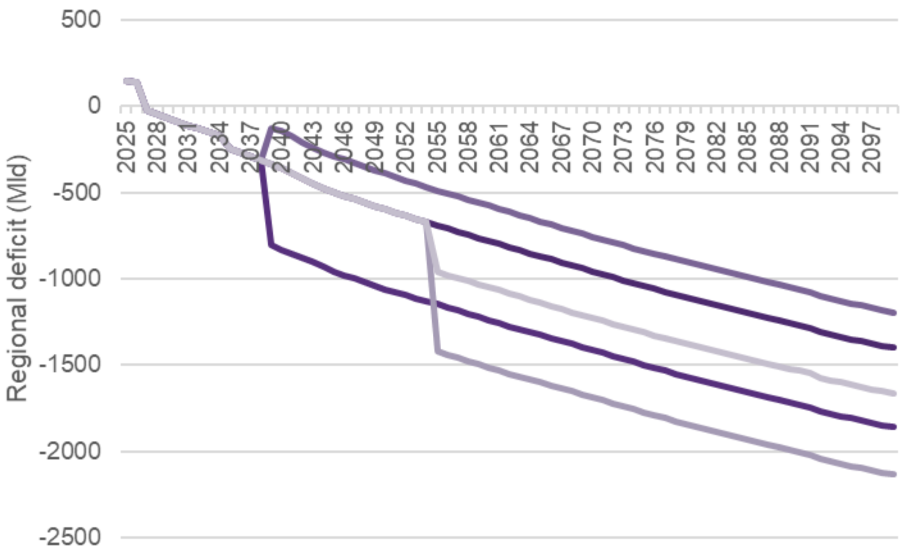
3.3 For the multisector we will use equivalent of the NYAA, DYAA, DYCP but there might not be significant differences in their values. We will work with the multisector stakeholder group to understand their typical seasonal demand pattern use.

[5] Emergency drought order return period

3.4 The situation and policy uncertainties are sampled sufficient times to create a probability density function (pdf) around the four baseline forecasts for each drought scenario (date by which 1:500 resilience should be available), to represent the uncertainty range of potential supply-demand balances (SBDs) across the planning horizon (Step 2).

3.5 Probability percentiles of the SDB pdfs can be selected for single-pathway runs (solved for in Step 6), or combined to create a branched adaptive future for optimisation (Figure 5), known as a SDB tree (Step 4).

Figure 5: Example supply-demand balance tree of one planning scenario



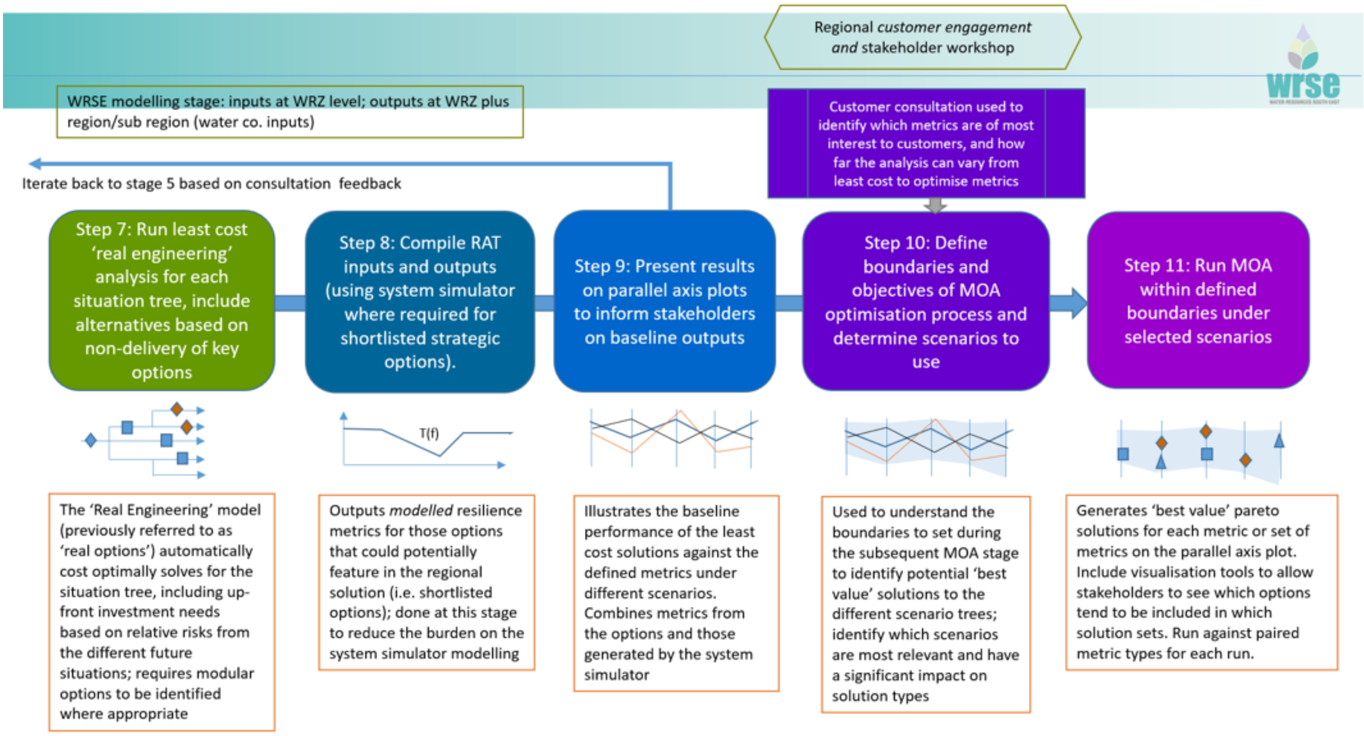
3.6 Alternative scenarios may be generated where a key situation or policy is used to perturb the baselines, and the remaining uncertainties combined in the pdf to generate SDBs and SDB trees (Step 5). Optimisation SDBs based on specific uncertainties will allow better understanding of the significance of individual drivers.

3.7 Assessment, assurance and sign-off of SDBs and SDB trees will be carried out using the visualisation tool (Section 5) before they are passed to the investment model for optimisation (Section 4).

4 Investment modelling

4.1 The investment model is used for option screening, clarification and refinement (Step 6), and optimisation to find the most adaptive programme of options for each SDB tree both for least cost (Step 7), and for a variety of alternative values of interest (Step 10 and Step 11)(Figure 6). Steps 8 and 9 utilise the visualisation tool described in the next section to assess outputs throughout the process.

Figure 6: Investment Modelling as part of development of a plan



4.2 The primary function of the investment model is to identify programmes of water resource and demand reduction investment which satisfy the SDBs or SDB trees for the four planning scenarios for each WRZ in the region across the planning horizon, while minimising cost (Step 7), an alternative objective function, or a combination of functions (Step 11).

4.3 Metrics for coarse programme appraisal are calculated for all programmes developed (Section 5), and optimisation can also be carried out to minimise or maximise the majority of the metrics (Section 5) and so seek to develop investment programmes which are better in terms of resilience, environmental impact or social value as defined by the stakeholders or practitioners (Step 10).

Conjunctive optimisation of planning scenarios

4.4 For a single SDB, the IVM seeks an optimal investment programme to ensure that the SDBs for each of the four planning scenarios is satisfied for each year in the planning horizon, in each zone, while minimising or maximising a single objective function, or multiple objective functions.

4.5 The IVM both ensures enough capacity is available in each year and prioritises utilisation of the assets selected to meet the objective function. For example, when minimising cost, new assets are selected by minimising fixed costs while prioritising utilisation of selected assets in ascending order of variable costs; the utilisation priority order will change as new assets with lower variable opex are commissioned throughout the planning horizon.

4.6 Proportionality weightings related to the likelihood of occurrence are applied to the planning scenarios to allow combination of utilisation from the different planning scenarios for objective function optimisation. Default values are in Table 4, although these can be adjusted per WRZ by the user.

Table 4: Weightings for planning scenario utilisation

Scenario	Calculation	Weighting
NYAA	40/52	0.7692
DYAA	8/52	0.1538
DYCP	1-(40/52+8/52+(15/200+60/500)/75)	0.0743
EMDO	(15/200+60/500)/75	0.0026

4.7 For an SDB tree, the IVM expands the optimisation to find the best solution that could meet the SDBs in all branches across the horizon.

4.8 These initial least-cost optimisations are used to assess the search space (number of options available) and refine those which are utilised, both identifying zones or areas where additional options, alternative option yields, or additional or alternative transfers would be beneficial, and identifying options which are never selected in any scenario (Step 6).

4.9 Step 6 also includes a conjunctive use analysis of the region, where existing formal bulk transfer agreements between WRSE zones are waived and the model optimises the transfer of water based on capacity of existing and potential transfer pipelines only, to identify the least cost sharing of resources and identify the minimum required resource development.

4.10 All assessments for Step 6 must be carried out for different risk scenarios, where the distribution on demand both in normal and dry year, and the impact of drought, is varied both spatially and temporally across the region, to assess for the full range of growth and weather scenarios.

Single or multi-objective optimisation

4.11 The IVM is designed to optimise against a single objective function, or a combination of two objective functions with boundaries to the primary objective function limiting the search range for the secondary, for example:

- maximise environmental net gain within a 20% cost increase from the least cost programme, or
- minimise cost within a greater than 20% increase in environmental net gain from the least cost programme.

4.12 The IVM can be set to run single or batch optimisations of SDBs or SDB trees and export the resulting programmes of investment to the visualisation tool for appraisal (Section 5).

4.13 Following the initial assessment of available options and regional conjunctive use in Step 6, the Investment model is run to develop least-cost programmes of investment that are robust across the SDB trees for each risk scenario developed within the IRM (Step 7). Alternative programmes of investment can be developed using the draft multi-objective analysis metrics (Step 11), to facilitate communication with and assessment by stakeholders (Step 10) following assessment and selection of reasonable alternative programmes to quality control solutions using the visualisation tool (Step 8 and Step 9).

Coarse metrics for programme appraisal

4.14 The cost, environment, resilience and customer metrics to be calculated in the investment model (Table 5) for each optimised programme will be fully defined through stakeholder engagement (Step 10), but placeholders have been designed in the investment model to allow for development, testing and refinement.

4.15 The investment programme metrics have been taken from a variety of sources: previous WRMPs, the resilience framework, environmental assessment framework, and discussion with customer engagement workstream leads. Both the calculation methods and the metric inclusion or combination will be subject to review as communication, utilisation and assessment progresses during plan development and engagement (Steps 7 to 11).

Table 5: Coarse programme metrics

Type of Function	Code	Name
Cost	COST	Least cost discounting
Cost/ Social	IGEQ	Intergenerational equity discounting
Environment	ENV+	Environmental benefit
Environment	ENV-	Environmental cost
Environment	BING	Biodiversity net gain
Environment	NATC	Natural capital
Resilience	COVA	Connectivity availability
Resilience	COVU	Connectivity use
Resilience	COTA	Contingency availability
Resilience	DELV	Benefit deliverability
Resilience	MITA	Mitigation availability
Resilience	MODA	Modularity availability
Resilience	DIVR	Diversity
Resilience	SURU	Surplus use
Social	CUPR	Customer preference for option type

Objective functions for programme development

4.16 The primary objective function of the model is least cost.

Least Cost Optimisation

4.17 Minimise the sum for all selected options for all zones, using the STPR6 for discounting, of:

- NPV Capex (annuitized)
- NPV Fixed Opex
- NPV Variable Opex (frequency weighted average of NYAA, DYAA, DYCP & EMDO)
- NPV Embedded carbon
- NPV Fixed Operational Carbon
- NPV Variable Operational Carbon

Subject to:

1. Supply must meet or exceed demand plus risk in each WRZ in each year of the planning period under all planning scenarios
2. The utilisation of each option in each year is strictly non-negative and does not exceed the maximum yield of that option

Alternative objective functions

4.18 Alternative objective functions are adaptations of the system metrics in Section 4.14. The value of each function is calculated for any solution programme; optimisation to find a solution focussed on one or more of the objective functions will be a user choice.

4.19 The objective functions available for investment modelling come from three sources: cost functions as defined and previously derived by the water companies; environmental assessment to enable coarse environmental evaluation and optimisation of investment programmes; and resilience assessment by metrics in the resilience framework screened as suitable for investment modelling:

Intergenerational Equity (IGEQ)

4.20 Minimise the sum of the same six cost categories as for least cost optimisation, for all selected options for all zones for all planning scenarios, using the IEDR for discounting.

4.21 As the standard STPR assumes that weighting the cost of investment toward future generations is preferable, an alternative, intergenerational equity discount rate, IEDR, has been defined[7] to allow more equitable sharing of the costs of long-term investments across generations.

Environmental benefit (ENV+)

4.22 Maximise, for all operation years, for all WRZs, the sum of the ENV+ scores for all new options

[6] HM Treasury Green Book *Social Time Preference Rate*.
[7] Appendix B: Intergenerational equity discount rate.

Environmental disbenefit (ENV-)

4.23 Maximise, for all construction and operation years, for all WRZs, the sum of the inverted ENV- scores for all new options

Biodiversity net gain (BING)

4.24 Maximise, for all years, for all WRZs, the biodiversity net gain values for all new options

Natural Capital (NATC)

4.25 Maximise, for all years, for all WRZs, the natural capital values for all new options

Connectivity availability (COVA)

4.26 Maximise, for all years, for all WRZs, for all planning scenarios, the capacity of inter-zonal transfers within the region

Connectivity use (COVU)

4.27 Maximise, for all years, for all WRZs, for all planning scenarios, the utilisation of inter-zonal transfers within the region

Contingency availability (COTA)

4.28 Maximise, for all years, for all WRZs, for all planning scenarios, the capacity of rapid deployment emergency capex schemes available

Benefit deliverability (DELV)

4.29 Maximise, for all years, for all WRZs, for all planning scenarios, the probability that actual yield sampled through uncertainties equals nominal yield

Mitigation availability (MITA)

4.30 Maximise, for all years, for all WRZs, for the drought scenario, the volume of DO in unused drought permits and orders

Modularity availability (MODA)

4.31 Maximise, for each branch point, for all WRZs, for all planning scenarios, the volume of remaining option phases for which the first phase has been commissioned

Diversity (DIVE)

4.32 Minimise, for all years, for all WRZs, for all planning scenarios, the standard deviation of the volume selected of each option type from the mean for all ten option types

Surplus use (SURU)

4.33 Minimise, for all years in which a new option is commissioned, for all WRZs, for all planning scenarios, the surplus available elsewhere in the region

Customer preference (CUPR)

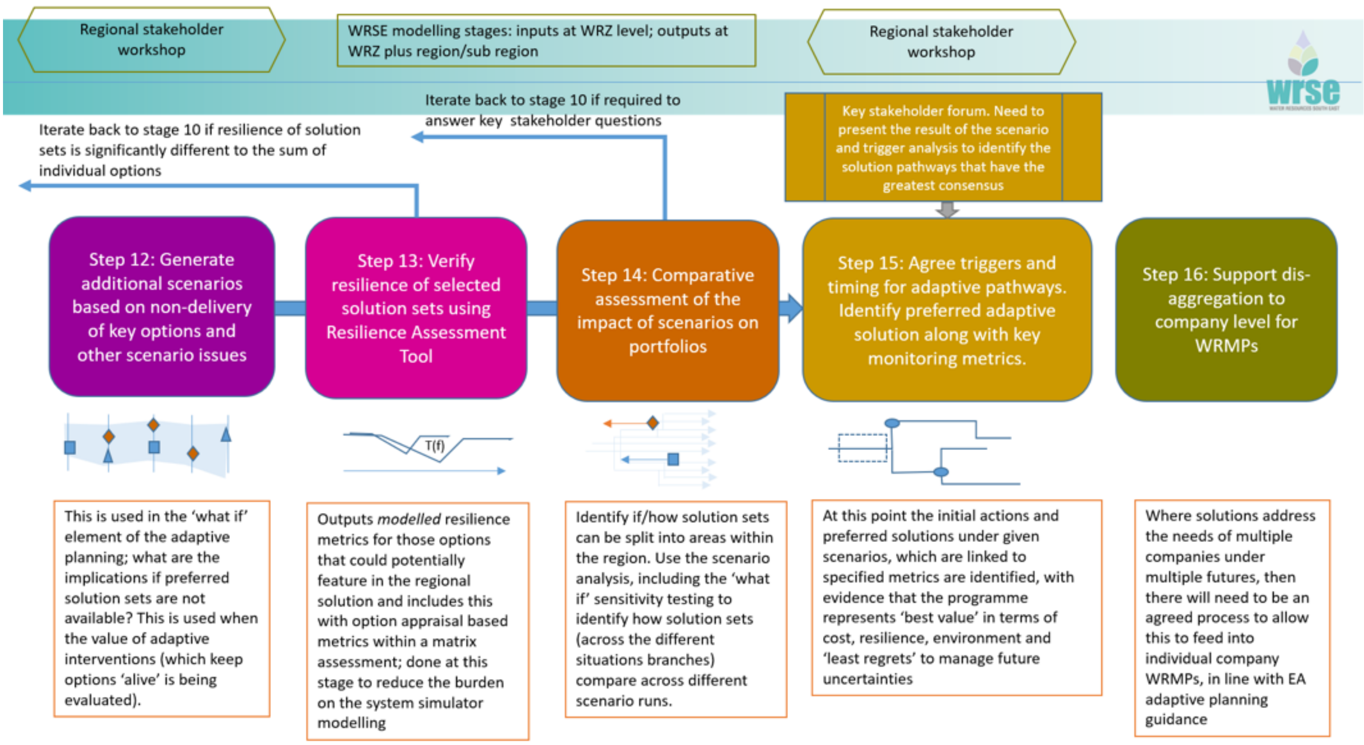
4.34 Maximise, for all years, for all WRZs, for all planning scenarios, the value based on customer preference for option types proportional to the volume supplied by each type.

4.35 Metric refinement or substitution will evolve with discussion, stakeholder engagement, visualisation and assessment, in line with consultation feedback on the resilience and environmental assessment frameworks, and refinement of the visualisation tools to enable analytic assessment using the additional metrics.

5 Programme visualisation and shortlisting

5.1 The visualisation tool is the primary decision support tool to allow quality assurance, appraisal, shortlisting, selection, communication and refinement of integrated risk SDB scenarios and trees and investment programme outputs and metrics throughout Steps 4 and 5, 8 and 9, and 13 to 15 of the development of a plan (Figure 7). As such the visualisation tool will be refined with all these audiences in mind, while considering the complexity of problem and option combinations that may be output from the IRM and IVM.

Figure 7: Visualisation to support the development of the plan



Problem visualisation: baseline forecasts & existing transfers

5.2 The VTL enables viewing of SDB scenarios on a map and chart, and exploration of the supply and demand balance change through time. This will be used to show how existing transfers are utilised through time to meet the demands in the receiving water resource zone (see Figures 8 and 9).

Figure 8: Visualisation of baseline forecasts

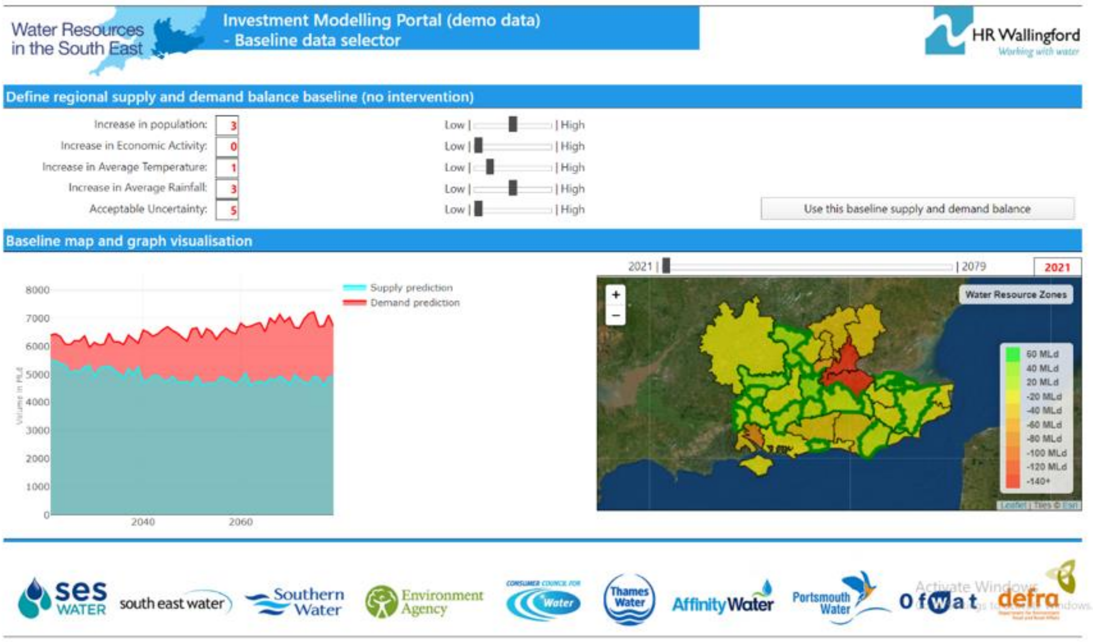
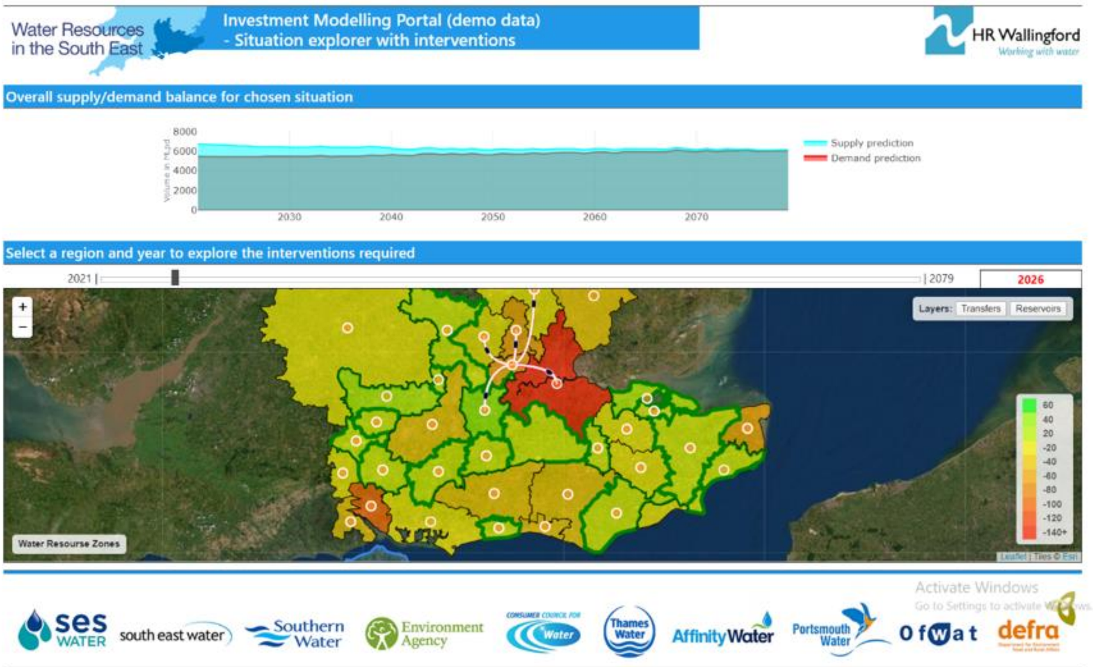


Figure 9: Visualisation of transfers



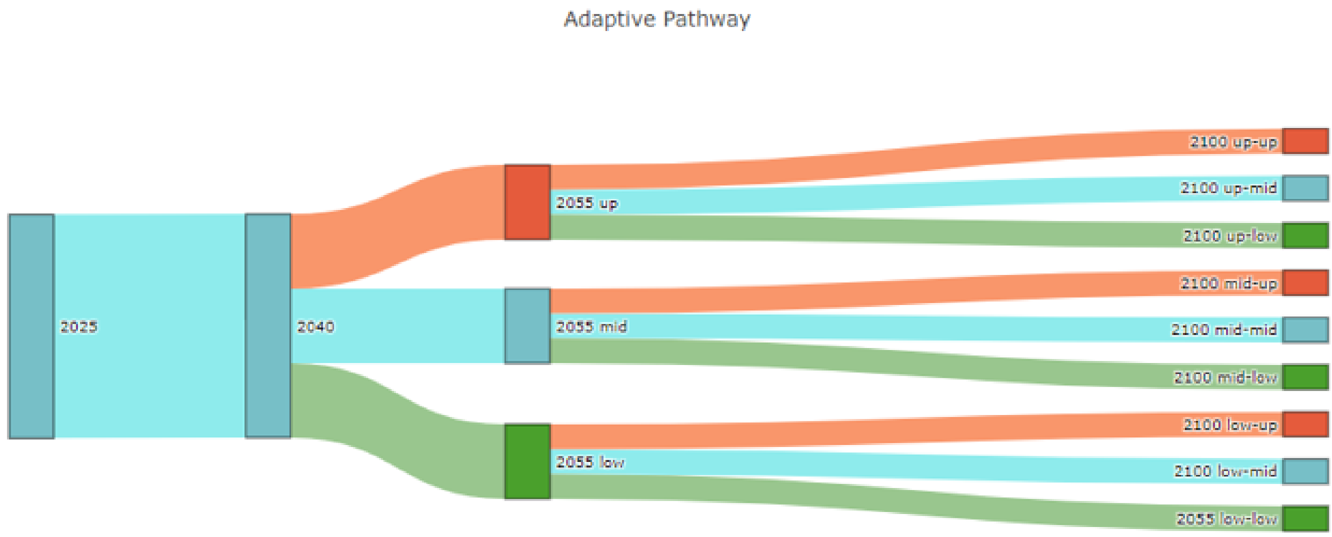
5.3 The purpose of these tools and various map layers is to gain a better understanding of where the requirements for water are being driven from and how the existing infrastructure can cope, or not, with these requirements. It is intended that the same set of tools are used to view the final preferred plan and its alternative plans.

Problem visualisation: SDB trees

5.4 The amount of water required through the planning period will change according to some key externals influences such as climate change, population growth, policies and the requirements of the environment in the future. We will use animated Sankey plots (see Figure 10) to visualise the SDB trees through time, for both problem and solution understanding.

5.5 For each of the branches we will provide examples of some of the factors that could drive the supply demand balances to those anticipated levels. This will provide regulators, stakeholders and customers with a better understanding of the characterisation of these branches. However, in many cases the anticipated supply demand deficits could be achieved by several different combinations of external factors. This is also the case at the more extreme areas of the supply demand balances, albeit that the potential number of combination factors that achieve similar supply demand balances would be limited.

Figure 10: Animated Sankey plots to visualise the SDB trees

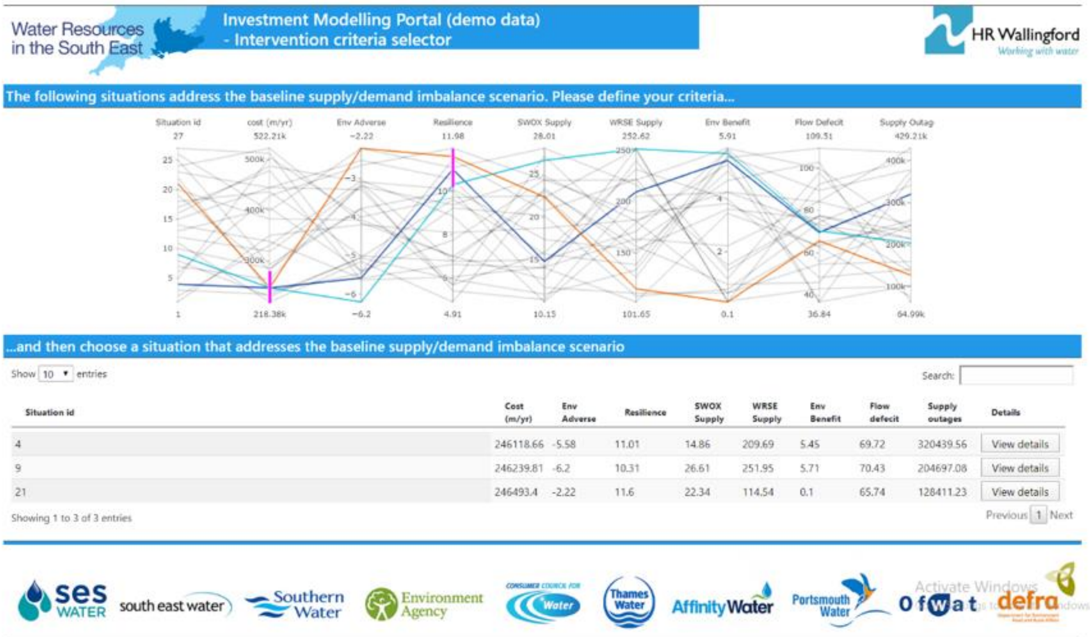


Programme appraisal: metrics

5.6 A core requirement of a decision support tool for programme appraisal is the ability to review and filter alternative investment programmes using a parallel axis plot. Each parallel axis will represent a key metric that has been identified as being important to the overall programme assessment. By plotting the performance of each metric for each individual programme we can understand which programmes perform better than others, but more importantly which programme are unacceptable. These forms of plots and visualisations are key to the development and understanding of the overall investment programmes and our discussion with customers and stakeholders to gain opinion on the various investment portfolios. An example parallel axis plot is shown in Figure 11.

5.7 The selection of the metrics used for programme appraisal will be the resilience and environmental assessment metrics and any other metrics agreed through the stakeholder and customer engagement.

Figure 11: Programme metrics on a parallel axis plot



Programme appraisal: options

5.8 In addition to the parallel axis plots we will also show which options are selected in a geographical context, see Figure 12 below. This will allow stakeholders, customers and regulators to review which schemes have been selected in the various water resource zones across the region and whether these options are company specific, catchment specific or multisector.

5.9 In addition to obtaining option information from the maps we will also show the overall volumetric or benefits information as well, as shown in the example in Figure 13. These overall tools and graphical displays will be able to provide programme information to regulators, stakeholders and customers. We are still developing these interfaces; we are trying to develop some other less technical summary of the schemes to help people navigate through the possible portfolio of options.

Figure 12: Mapping of programme options

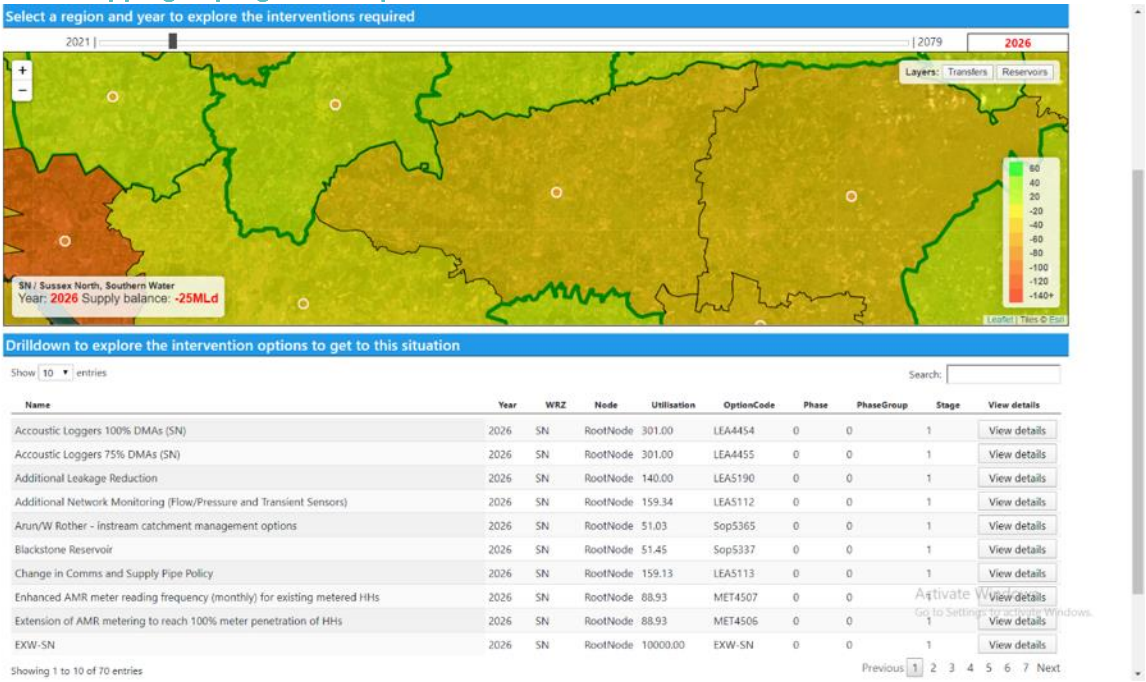
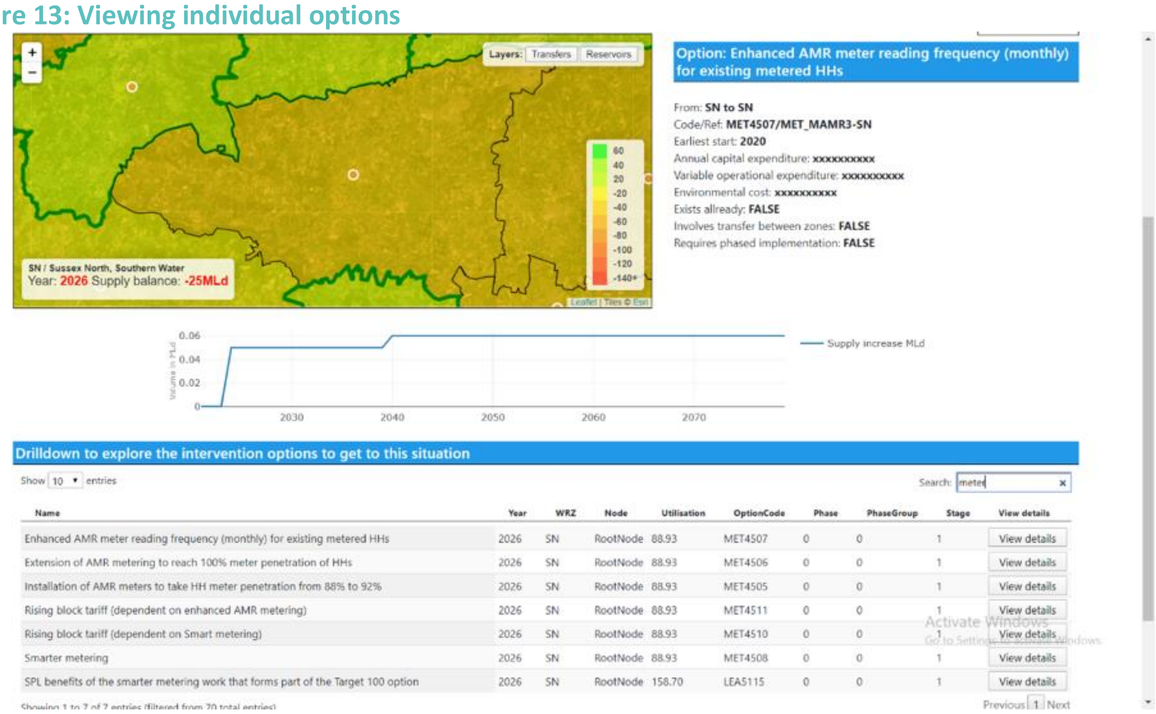


Figure 13: Viewing individual options



Programme shortlisting

5.10 All the components of the visualisation tool as set out above will aid programme appraisal for shortlisting of good value plans for more detailed assessment and appraisal (Steps 8 and 9).

5.11 Further development of the VTL is being scoped to support appraisal of regional plans for this more detailed understanding of resilience, environment, customer and stakeholder views, and better allow each group to understand the trade-offs between the different challenges.

6 Best value programme appraisal

6.1 Shortlisted good value investment programmes will be passed back via the DLP to:

- the simulation model for resilience assessment
- the environmental assessment teams
- the customer engagement team
- the integrated risk/ investment model for sensitivity analysis and stress testing

6.2 The results of the specialised assessments for each programme will be fed back into the visualisation tool for further comparative appraisal, and selection of a preferred adaptive regional plan, including seeking views from the various WRSE groups (advisory, environment, multi-sector), stakeholders, customers and regulators.

Resilience assessment

6.3 The resilience assessment of a regional plan is detailed in the WRSE Resilience Framework; the regional simulation model should be able to evaluate the effect of different stresses and hazards on a proposed investment programme in terms of impact on both the public water supply and non-public water supply, and also provide further information for the environmental assessment team directly related to water catchments.

Environmental assessment

6.4 Environmental assessment of options can give some understanding of the effect of combining them into a potential investment programme, but the type of regional-level environmental assessment proposed[8] will provide much greater understanding of their combined impact.

Customer assessment

6.5 Discussions with the customer engagement team have led to the proposal that customer focus groups could be trained and given access to the visualisation tool in order for the WRSE group to gain greater understanding of customer preference, and customers to better understand and demonstrate the trade-offs between resilience, environment, amenity and cost that they would prefer to make to support long-term water resources planning.

[8] March 2020, *Strategic Environmental Assessment (SEA) of the WRSE Regional Plan and environmental appraisal input to the WRMP24*, WRSE.

6.6 For this type of engagement, a form of bill impact calculation would be required to be integrated in the investment model and shown in the visualisation tool.

6.7 The scope for this method of customer engagement is under review; the initial proposal was for a separate tool to be used for engagement pre-investment modelling to feed customer preference data to the IVM.

Investment parameters sensitivity assessment

6.8 While the simulation model will evaluate the robustness of a potential investment programme to the majority of climate and weather challenges, further challenges such as uncertainties around option cost and DO, asset failure, alternative demand forecasts and failure to gain planning permission for key assets will be assessed in the investment model together with regional conjunctive use assessments, to better understand the adaptability and robustness of each shortlisted programme.

7 Selection of preferred plan, outputs and reconciliation

7.1 The additional data from the assessments in Section 6 will support appraisal of the shortlisted good value programmes and selection of a preferred resilient regional adaptive plan with the help of the visualisation tool (Figure 7, Steps 13-15).

7.2 The preferred plan will then be exported to the WRSE water companies to support their statutory WRMP submissions and consultations and communicated to the other water regions for national reconciliation.

Target headroom

7.3 The preferred resilience plan will be assessed for available headroom per zone per year in relation to the risk allowance around the baseline supply and demand forecasts from the robust adaptive plan selected, and compared with target headroom calculated using the method in the guidance in order to ensure compliance and populate the WRP tables.

WRP tables

7.4 An expansion of the DLP is proposed (Stage 2) to enable automated population of the WRP tables. The scope of this will follow the build of Stage 1 of the DLP.

7.5 It has not yet been determined how the WRP tables could best capture adaptive plans, or drought baseline forecasts – there may potentially be several additional tables addended to the core planning scenario tables.

Reconciliation of regional plans

7.6 A process for reconciliation of regional plans has been developed and will be implemented as necessary throughout the planning stages to ensure agreement on inter-regional transfers. The process of the reconciliation with the other regions is key to ensure that the various transfers align both in terms of volumes and dates.

8 The draft preferred plan

8.1 The selection of the preferred plan will have to accord with WRMP guidance and the UKWIR best value planning method. Currently both documents are in draft format and therefore we recognise that this method statement is still subject to change.

8.2 However, following the process that is outlined above we intend to derive a range of plans that can meet the key criteria that have been selected and discuss these with WRSE groups, stakeholders and customers. We hope that through this collaborative approach we will be able to understand what the consensus would be on the preferred plan and the reasons why it is preferred.

8.3 This preferred plan would be put forward to the WRSE board for their review and sign off. Following this governance review any changes would be relayed back to the groups and stakeholders. If there are no changes then this preferred plan and the alternatives would be put forward for consultation in January 2022.

8.4 We would then respond to the consultation submissions and adjust the plan accordingly, if required. The revised draft regional plan would then be used to inform: the WRMP's of the water companies, the multi-sector plans, national reconciliation of regional plans, and the catchment-based solutions to be delivered through the appropriate parties.

9 Next steps

9.1 We are consulting on this method statement from 1st August 2020 to 30th October 2020. Details of how you can make comments can be found here consultation website

9.2 We will take into account the comments we receive during this consultation process, in updating the Method Statement. Alongside this, the Environment Agency will shortly be publishing its Water Resource Planning Guidelines (WRPG) on the preparation of regional resilience plans. We may need to update parts of our method statements in response to the WRPG. We have included a checklist in Appendix 2 of this method statement which we will use to check that our proposed methods are in line with guidance where applicable.

9.3 If any other relevant guidance notes or policies are issued then we will review the relevant method statement(s) and see if they need to be updated.

9.4 When we have finalised our Method Statement, we will ensure that we explain any changes we have made and publish an updated Method Statement on our website.

Appendix 1: Codes for Data Landing Platform

Chart ID	Data OUTPUT	Data INPUT	Required for	Stage	Data fields required	OUTPUT Data format (.csv/.json)	INPUT Data format (.csv/.json)	Data volume and size (MB/GB)	Access requirements (e.g for API/SharePoint upload)	Security/ confidentiality	QA Process & Meta Data	Data Transformations
A	Options Appraisal	Simulation model	Calculate option DOs for different droughts used in adaptive futures	3	List of ~20 screened options	.xlsx or .csv	.xlsx or .csv	< 10MB	Simulation team download from published data tables on PowerBI	n/a	Tables to have meta dat tags of check/approval	n/a Simulation team to confirm format required to Options Appraisal team
B	Supply Options	Options Appraisal	To screen options for investment planning	3	Up to 700 options that pass into optionals appraisal, will have different benefits for each water company.	.xlsx	.xlsx	< 10MB	SharePoint upload - dedicated folders for each company to upload	Cost data held in Options Appraisal DB restricted to each WC and 'Admin'	Templates to include - Author/Check/Approval Meta data from SharePoint taken revision, date and 'uploaded by'	Yes - from Excel to .csv format for import into Azure DB
C	Demand Strategies	Options Appraisal	To consolidate options for investment planning	3	Up to 700 options that pass into optionals appraisal, will have different benefits and demands for each water company.	.xlsx	.xlsx	< 10MB	SharePoint upload - dedicated folders for each company to upload	Cost data held in Options Appraisal DB restricted to each WC and 'Admin'	Templates to include QA information Meta data from SP also taken fro Revision and 'uploaded' by	Yes - from Excel to .csv format for import into Azure DB
D	Demand Strategies	Simulation model	TBC - not essential	3	List of ~20 screened options	.xlsx	.xlsx or .csv	< 10MB	Supply WCs email excel to SM team	n/a	TBC - not essential	TBC - not essential
E	Environmental Appraisal	Options Appraisal	Options screening on environmental impact	3	3no. metrics for; Environmental benefit, adverse effect metrics, biodiversity (score system -10 - 0 - 10). 1 no. metric for natural capital fixed cost £/ML/yr or in 0-10 score 1 no. metric in land use tonnes of carbon (Tonne C02) 700 options, therefore 3500 data points	.csv	.csv	< 10MB	or SharePoint	Geospacial data with exact locations to be locally randomised or represented by zone	Meta data in data transfer to include QA information	Options team to confirm format/attributes required with Environmental team
F	Demand Forecasting Models	Integrated Risk Model	To consolidate all supply-demand balances in risk profile	3	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential
G	Simulation Model	Options Appraisal	To screen options for investment planning	3	Updated numbers for DO. & freefall numbers	.csv	.csv.	< 10MB	SharePoint upload or API	n/a	TBC - not essential	Options to confirm format/attributes required to Simulation team
H	Demand Forecasting Models	Simulation model	Simulation using different demand scenarios used in adaptive futures; Reforecasting of demand options' savings under different droughts	1	Split into components of household consumption, population, industrial consumption etc. to give a total demand value. 7 DO profiles over 75 year period to mirror the simulation model profile.	.xlsx	.xlsx or .csv	< 10MB	Assume it can be uploaded to a specified SharePoint or similar location.	None	No defined QA yet. Each water company completes its own checking internally using a different process and inputs into a master demand forecast model spreadsheet, which is checked.	Simulation modelling team to confirm transformations required from WRMP table 3 outputs
I	Resilience Metric Formulae	Options Appraisal	To assess resilience metrics of options	3	24 sub-metrics with scores e.g. yield, deliverability, modularity. Second Workshop - 16 metrics per option, 3 pt or 5 pt scale.	.xlsx	.xlsx	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential
J	Simulation Model	Integrated Risk Model	To consolidate all supply-demand balances in risk profile	1	Receives uncertainty profiles from the demand and simulation models.	.csv	.csv	< 10MB	Assume it can be uploaded to a specified location.	None	Metdata: date, timestamp, version of the model, include check / approve data, resource zone identifier.	n/a
K	Resilience Metric Formulae	Simulation model	To assess resilience of options DOs incl environmental impact; To assess resilience of preferred adaptive plan	3	resilience metrics	.csv	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential
L	Water companies (Outage etc.)	Integrated Risk Model	Including in integrated risk modelling SDBs	3	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential	TBC - not essential
M	Simulation Model	Investment model	Enable investment optimisation under adaptive futures	1	Central baseline DOs, and with climate scenarios, and drought. 37 resource zones, 5-7 DO scenarios, over 75 year period. For each zone it will output a single number - MLD of water available at each zone.	.csv	.csv	< 10MB	Assume it can be uploaded to a specified SharePoint or similar location.	None	Metdata: date, timestamp, version of the model, include check / approve data, resource zone identifier.	n/a
N	Options Appraisal	Investment model	Enable investment optimisation under adaptive futures	1	3 metrics from resilience metric. Costs, Carbon costs, yields. Options will be grouped with interdependencies & exclusivities.	.xlsx or .csv	.csv	< 10MB	Accessed through an API	Cost data access: 1. WRSE - all data; 2. PMB - single WC only.	Meta data in data transfer to include QA information	n/a Investment team to confirm to confirm transformations required from Options Appraisal team
O	Demand Forecasting Models	Investment model	Enable investment optimisation under adaptive futures	1	Split into components of household consumption, population, industrial consumption etc. to give a total demand value. 7 DO profiles over 75 year period to mirror the simulation model profile.	.xlsx	.csv	< 10MB	Accessed through an API	None	No defined QA yet. Each water company completes its own checking internally using a different process and inputs into a master demand forecast model spreadsheet, which is checked.	Investment modelling team to confirm transformations required from WRMP table 3 outputs

Appendix 2 Checklist of consistency with the Environment Agency WRMP24 Checklist

The Environment Agency published its WRPG on XXXXXX 2020, including the WRMP24 Checklist. The following table identifies the relevant parts of the checklist relating to this Method Statement, and provides WRSE's assessment of its consistency with the requirements in the Checklist.

No.	Action or approach	Method Statement ref:	WRSE assessment of consistency