Long Term Delivery Strategy: Technical Annex

October 2023

Contents

Technical Annex to the LTDS

1. Introduction

This annex provides a detailed description of the adaptive planning approaches we have applied to develop our long-term delivery strategy (LTDS). This includes summarising our approaches to developing and applying testing methodologies for the Common Reference Scenarios (CRSs), how we developed and applied wider scenarios, and how we ensured the options we selected are best value.

2. Developing testing processes for the Common Reference Scenarios

2.1. Ofwat requirements

Many challenges faced by the water sector require long-term solutions. Making the right investment decisions is complicated by the fact that the future is inherently uncertain. The LTDS is intended to demonstrate how companies are managing future uncertainty in a way that delivers best whole life value for customers.

To demonstrate how our long-term plans manage future uncertainty Ofwat expects companies to use scenario planning to inform their LTDSs. The scenario planning tests companies' planned investments against variations in key assumptions. In turn, this will demonstrate that the core pathway and alternative pathways in the LTDS meet our long-term ambition under a range of plausible futures.

Ofwat has set out four Common Reference Scenarios (CRSs), each with two extremes, and expects all companies to use these scenarios to inform their strategy. The scenarios describe plausible 'benign' and 'adverse' extremes of future climate change, technology, demand, and abstraction reductions. Ofwat describes the CRSs as "plausible extremes, which offer a full spectrum of possible futures. Within this spectrum, the strategy should deliver its ambition for customers and the environment" (Ofwat 2022a, pg. 8).

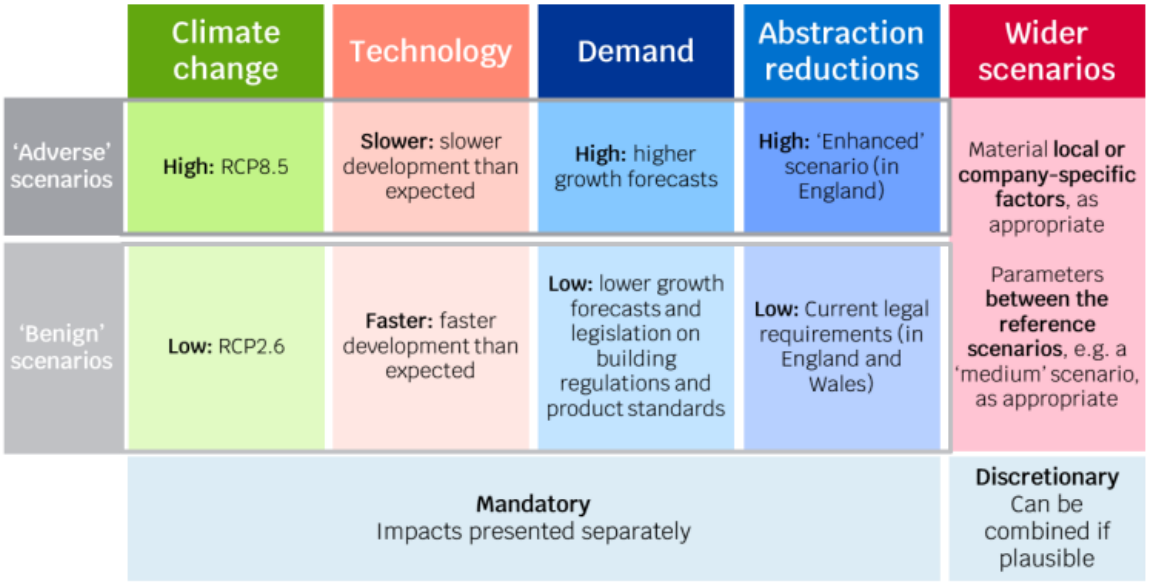


Figure 1: Common reference scenarios

2.2. Our approach

In order to ensure that our long-term strategy is robust to future uncertainty the LTDS guidance requires us to test all our enhancement investment as set out in data tables LS3 and LS4[1] against each of the CRSs. Where a planned enhancement investment is required across a majority of scenarios, the investment is considered to be 'low/no-regrets' and therefore appropriate for inclusion in our core pathway.

Where investment is only needed for a limited number of the future scenarios (particularly the more adverse extremes and/or further out into the future), this expenditure should not be included in the core pathway but be presented as an alternative pathway, with defined trigger and decision points for moving to the alternative pathway and a monitoring plan to track and respond to these.

The CRSs outlined by Ofwat in its LTDS guidance are existing uncertainties that we have already been considering within our strategic planning. For example, wider statutory planning documents such as the WRMP have already conducted extensive climate change uncertainty testing. As such, when developing the CRS testing approach, we have drawn upon existing processes, tools and methodologies wherever possible to ensure alignment and consistency with existing logic and efficiency of operations.

[1] Ofwat (2023) PR24 Final methodology submission tables and guidance. Available at

Figure 2 describes our approach to developing the CRS testing methodologies. The outcomes from the application of this process are reported in Appendix A: CRS Testing.

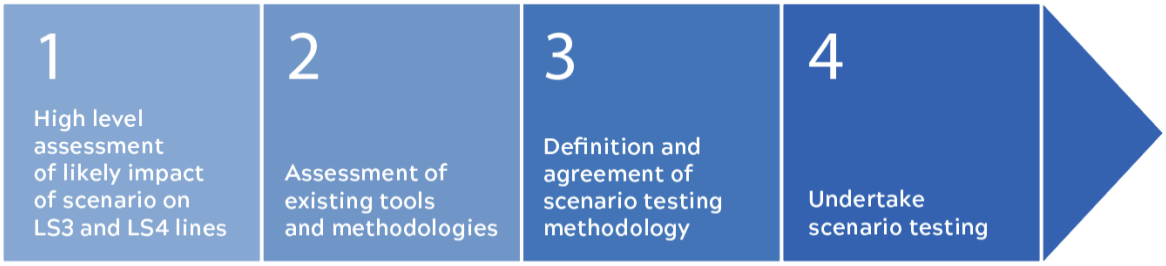


Figure 2: Our approach to developing CRS testing methodologies

Step 1: High-level assessment of likely impact of CRSs on LS3 and LS4

To undertake this activity, a template was developed listing all the enhancement investment lines for the LTDS from LS3 and LS4.

The template allowed space for colour coding of each line against each of the CRSs to indicate:

- If the expenditure was unlikely to be impacted by the scenario (grey).
- If the expenditure was likely to be impacted to a low degree by the scenario (turquoise). 'Low' was defined as the scenario may have an indirect or a low material impact on the enhancement investment line and therefore, taking a risk-based approach, should require monitoring and, potentially, testing in the future.
- If the expenditure was likely to be impacted to a high degree by the scenario (pink). 'High' was defined as the scenario was likely to have a direct, and material impact on the enhancement investment line and therefore that testing is required to substantiate the scale of this impact.

The template includes a column to substantiate the score assigned and to explain the required testing.

We engaged internal stakeholders with appropriate subject matter expertise to complete an initial assessment of the likely impacts of the CRSs against each enhancement line in data tables LS3 and LS4.

Step 2: Confirmation of assessment results

This assessment of impact developed in Step 1 was then tested with both our Scenario Lead subject matter experts (SMEs) and our Strategy Leads to endorse and/or refine the initial assessment. The results of this assessment are presented in Appendix A: CRS Testing. Table 1 shows the scale of testing required, as highlighted by the assessment.

Table 1: Summary of lines in LS3 and LS4 requiring testing against the CRSs

	Climate Change	Technology	Demand	Abstraction Reductions
Lines in LS3 requiring testing	10	30	5	12
Lines in LS3 not requiring testing	6	2	5	37
Lines in LS4 requiring testing	19	34	7	0
Lines in LS4 not requiring testing	3	3	0	0

Step 3 - Assessment of existing scenario testing tools and methodologies

Several different methods can be used to test expenditure in tables LS3 and LS4. These can be broadly grouped into models and judgement-based approaches:

- Models: such as network models. These may be existing or may need to be developed for the LTDS.
- Judgement of SMEs: in some cases, bringing together a group of appropriately qualified and experienced SMEs may be the most appropriate way to explore and test a scenario.

To develop our LTDS, a practical and pragmatic approach was adopted to establish how the CRS impact testing should be completed against each of the investment lines in data tables LS3 and LS4. This logic is presented in the decision tree below (Figure 3).

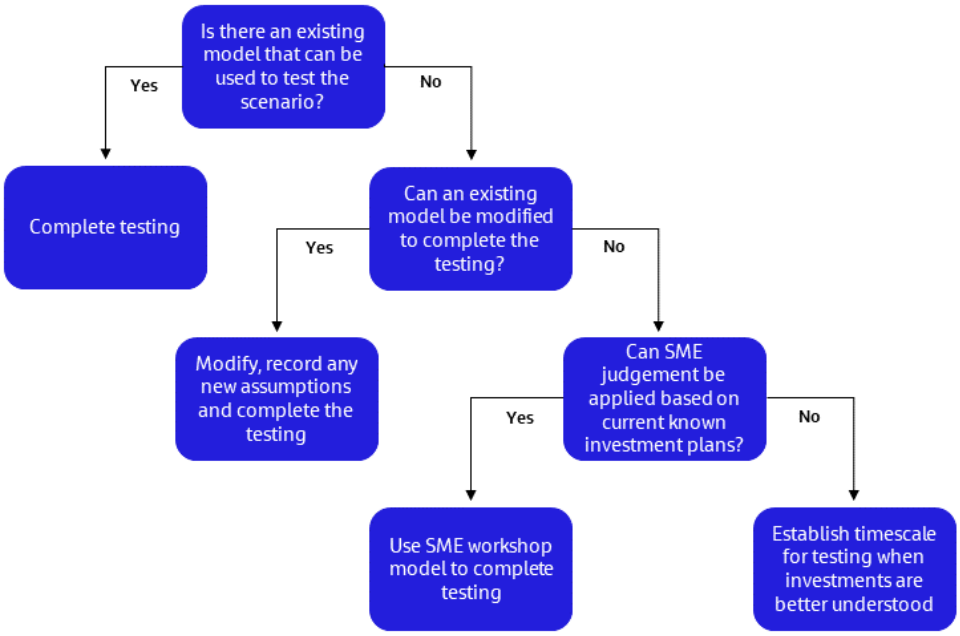


Figure 3: CRS testing decision tree

Using the outputs from Step 2, our SMEs were then consulted in line with the decision tree process to understand whether:

- Testing the investment line against the CRS specification had already been undertaken as a part of any statutory planning activities (such as WRMP or DWMP).
- There was an existing tool/method/approach (likely from statutory planning activities) that could be used to test the investment line against the CRS but testing in line with Ofwat's CRS specification had yet to be completed.
- There was no existing tool/method/approach that could be used to test the investment line against the CRS and a tool/method/approach needed to be (and could be) designed, agreed and implemented.
- There was no existing tool/method/approach that could be used, and SME judgement could not be used.

This activity allowed us to understand the scale of new tools and approaches that may need to be developed to ensure we could robustly test the full suite of CRSs.

Appendix A: CRS Testing presents a series of spreadsheets setting out the full detail of the CRS impact reviews.

Step 4 - Definition and agreement of scenario testing methodologies

Based on the outcomes from Steps 1 to 3, a scenario testing methodology was then outlined for each CRS. Each methodology follows the same structure, as follows:

- Summary of Ofwat expectation.
- List of enhancement expenditure lines from LS3 and LS4 that are likely to be impacted by that CRS.
- Testing already completed.
- Testing to be completed – known.
- Testing to be completed – options.
- Checklists for testing.

Appendix A: CRS Testing presents these methodologies.

2.3. Summary of testing approaches across all Common reference scenarios

Table 2 summarises the totality of common reference scenario (CRS) testing approaches applied across all enhancement lines in LS3 and LS4. The following sub-sections describe the testing required for each CRS in turn.

Table 2: Summary of required CRS testing

		Enhancement expenditure lines requiring testing	Enhancement expenditure lines not requiring testing	Testing Approach			
				Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
						SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
Abstraction Reductions	**LS3**	12	0	0	5	2	5
	LS4	0	0	0	0	0	0
Climate Change	**LS3**	10	6	6	0	6	4
	LS4	19	3	3	4	7	8
Demand	**LS3**	5	5	5	5	0	0
	LS4	7	0	0	7	0	0
Technology	**LS3**	30	2	0	0	30	0
	LS4	34	3	0	0	34	0

Abstraction reductions

Identifying relevant expenditure for testing

In England, the Environment Agency has published scenarios describing different levels of potential abstraction recovery required in the future[2]. The adverse and benign abstraction reductions CRSs cover two plausible extremes against which the core pathway should be tested:

- Adverse abstraction reductions (High): Associated with the Environment Agency's 'enhanced' abstraction reduction scenario. This involves greater environmental protection for Protected Areas and Sites of Special Scientific Interest rivers and wetlands, principal salmon and chalk rivers, achieved by applying the most sensitive flow constraints as appropriate to boost environmental protection.
- Benign abstraction reductions (Low): Under which only currently known legal requirements for abstraction reductions up to 2050 are planned for.

Table 3 summarises the high-level assessment of the likely impact of the abstraction reduction scenario on lines in LS3 and LS4 (i.e., Step 1 of the approach in Section 3.3), see Appendix A for a full breakdown.

Table 3: Impact of abstraction reduction CRS on LS3 and LS4 lines

Ofwat Data Table	Impact of scenario on expenditure lines in tables		
	High impact	Low impact	Lines not impacted
LS3 (Water enhancement expenditure)	12	5	15
LS4 (Wastewater enhancement expenditure)	0	11	26

Assessment of existing abstraction reduction CRS testing

Table 4 summarises the assessment of testing methodologies proposed for each high impact investment line in LS3. LS4 has not been included in this assessment as no lines were assessed to be highly impacted. A more detailed approach description for each line in the table below can be found in Appendix A: CRS Testing.

Table 4: Abstraction reduction CRS testing methodology for LS3

LS3 enhancement expenditure line		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
1	Biodiversity and conservation				✓
3	Eels/fish passes			✓	
4	Invasive Non-Native Species			✓	
5	Drinking Water Protected Areas				✓
10	Investigations				✓
11	Supply-side improvements	✓	✓*		

2 Environment Agency (2020) 'Water resources national framework, Appendix 4: Longer term environmental water needs', pp. 4-5. Available at https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

LS3 enhancement expenditure line		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
12	Demand-side improvements (excl leakage and metering)	✓	✓*		
13	Leakage improvements	✓	✓*		
14	Internal interconnectors	✓	✓*		
27	Addressing raw water quality deterioration (grey solutions)				✓
28	Addressing raw water quality deterioration (green solutions)				✓
29	Resilience	✓	✓*		

* Existing modelling does not fully cover necessary scope – further modelling required

How CRS testing was conducted

Our regional planning group, WRE, operates in a region that contains many important environmental and biodiversity sites, including Sites of Specific Scientific Interests (SSSIs), Ramsar Sites and the only water-based National Park, The Broads. The region's environmental destination defines a long-term vision for these special environments, that involves reducing the impact of abstraction. By doing this, waterbodies can be restored, protected, and enhanced. We have worked with other abstractors (public and non-public) in WRE to develop this strategy.

The bespoke environmental destination scenarios created by WRE are shown in Figure 4.

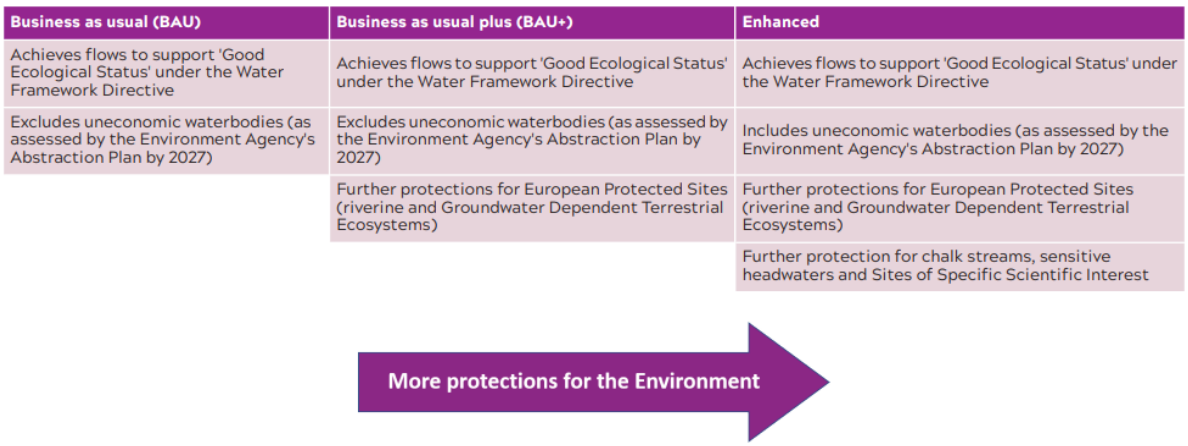


Figure 4: WRE environmental destination scenarios

WRE's Enhanced and BAU scenarios are consistent with the requirements of Ofwat's common reference scenarios for abstraction reductions.

We have applied WRE's Enhanced scenario to test the adverse (high) abstraction reductions scenario. This includes additional protection for ecologically sensitive sites from predicted climate change impacts by applying sensitive flow constraints and stretching environmental targets.

We have applied WRE's BAU scenario to test the benign (low) abstraction reductions scenario. This is based on currently known legal requirements and considers the implications of these on the environmental resilience of regional water sources.

For the water resources components of LS3, both extremes of this scenario were tested using the WRMP optimisation modelling process. This process selects preferred sequences of intervention which are assigned detailed, scheme-by-scheme, cost estimates.

For the WINEP and drinking water quality elements of LS3, both extremes of this scenario were tested in a series of SME workshops. This process considered how planned investment types would need to change to continue to deliver the relevant ambition in 2050 and, on this basis, inferred how the cost of the planned investment would need to change (for example, a percentage uplift on AMP8 estimates).

Climate change

Identifying relevant expenditure for testing

The climate change CRS is intended to test our planned investments against two plausible, extreme futures. The reference scenarios for climate change are set based on representative concentration pathways (RCPs). The RCPs specify different future concentrations of greenhouse gases to create a wide range of plausible future emissions scenarios. Ofwat has set the UKCP18 projections for RCP2.6 and RCP8.5 as the benign (low) (RCP 2.6) and adverse (high) (RCP 8.5) scenarios. Testing against these two extremes ensures that our LTDS has selected the best value options to meet its licence and statutory obligations and deliver its vision for its customers and the environment against an uncertain future.

For the specific instance of WRMP, supply impact is evaluated in sequence. Licence capping is the first consideration, due to the impact of water abstraction reductions, followed by statutory drought resilience requirements. Climate change is considered next, before finally, considerations of Environmental Destination. As laid out in our Forecast Report, the order of impact reflects the move to 1 in 200-year drought and licence capping to 'recent actual peak' evaluations.

Table 5 summarises the high-level impact assessment of the climate change CRS on LS3 and LS4. A full breakdown is provided in Appendix A.

Table 5: Impact of climate change CRS on LS3 and LS4 lines

Ofwat Data Table	Impact of scenario on expenditure lines in tables		
	High impact	Low impact	Lines not impacted
LS3 (Water enhancement expenditure)	14	7	11
LS4 (Wastewater enhancement expenditure)	22	4	11

Assessment of existing climate change CRS testing

Table 6 and Table 7 summarise the assessment of testing methodologies proposed for each high impacted investment line in LS3 and LS4. A more detailed approach description for each line in the table below can be found in Appendix A: CRS Testing.

Table 6: Climate Change CRS testing methodology for LS3

LS3 enhancement expenditure line	Enhancement	Enhancement	Testing has not been completed

		has already been tested part of strategic plan development	has not been tested but capability exists	and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
1	Biodiversity and conservation				✓
2	Eels/fish entrainment schemes				✓
3	Eels/fish passes				✓
4	Invasive Non-Native Species	✓			
5	Drinking Water Protected Areas			✓	
7	Wetland creation			✓	
9	25 year environment plan				✓
11	Supply-side improvements	✓			
12	Demand-side improvements (excl leakage and metering)	✓			
13	Leakage improvements	✓		✓	
23	Communication pipes replaced or relined	✓		✓	
27	Addressing raw water quality deterioration (grey solutions)			✓	
28	Addressing raw water quality deterioration (green solutions)			✓	
29	Resilience	✓			

Table 7: Climate Change CRS testing methodology for LS4

LS4 Enhancement expenditure line		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
1	Biodiversity and conservation			✓	
4	Increase flow to full treatment			✓	
5	Increase storm tank capacity – grey solution			✓	
6	Increase storm storage / reduce need for storm tanks on site – green solution		✓		
7	Storage schemes to reduce spill frequency at CSOs etc – grey solution		✓		
8	Storage to reduce spill frequency at CSOs etc – green solution		✓		
9	Surface water separation		✓		

LS4 Enhancement expenditure line		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
12	Nitrogen removal				✓
13	Nitrogen Technically Achievable Limit (TAL) monitoring, investigation or options appraisals				✓
14	Phosphorous removal – grey solution			✓	
15	Nutrient permit (N or P) tightening green solution			✓	
16	Tightening of sanitary parameters – grey solution			✓	
17	Tightening of sanitary parameters – green solution			✓	
18	Microbiological treatment – coastal waters				✓
19	Microbiological treatment – inland waters				✓
23	Sludge – disposal resilience and environmental impact				✓
24	25 Year Environment Plan				✓
27	Growth at sewage treatment works (excluding sludge treatment)				✓
28	Reducing flooding risk for properties	✓			
33	Resilience	✓			
36	Greenhouse gas reduction (net zero)	✓			
37	Enhanced activity to address harm from storm overflows				✓

How CRS testing was conducted

For the water resources components of LS3, both extremes of this scenario were tested using the WRMP optimisation modelling process. This process selects preferred sequences of intervention which are assigned detailed, scheme-by-scheme, cost estimates.

For the elements of LS3 and LS4 informed by our WINEP, bioresources elements of LS4 and drinking water quality elements of LS3, both extremes of this scenario were tested in a series of SME workshops. This process considered how planned investment types would need to change to

continue to deliver the relevant ambition in 2050 and, on this basis, inferred how the cost of the planned investment would need to change (for example, a percentage uplift on AMP8 estimates).

For the drainage and water recycling elements of LS4 both extremes of this scenario were considered in the modelling and best value options appraisal process. The best value plan put forward in the final DWMP was designed to address a level of climate change equivalent to that set out in the benign CRS, although the higher ambition set by the LTDS for sewer flooding, pollutions and overflows meant that additional capacity would be needed, the investment for which was extrapolated based on the original modelled option costs. Increased capacity was also identified as being needed under the adverse CRS, the investment for which was also extrapolated using subject matter expert judgement based on the DWMP modelling and option costs.

Demand

Identifying relevant expenditure for testing

The overarching requirement to test the core pathway against demand is to ensure additional capacity is not built in unnecessarily, but that the overall system has sufficient capacity to meet the needs of the residential population of the future.

Ofwat's adverse (high) and benign (low) demand scenarios make different assumptions about growth forecasts and building regulations and product standards.

Table 8 summarises the high-level impact assessment of the demand scenario on the enhancement expenditure lines in the LS3 and LS4 data tables. A full breakdown is provided in Appendix A.

Table 8: Impact of Demand CRS on LS3 and LS4 lines

Ofwat Data Table	Impact of scenario on expenditure lines in tables		
	High impact	Low impact	Lines not impacted
LS3 (Water enhancement expenditure)	10	4	18
LS4 (Wastewater enhancement expenditure)	7	12	18

Assessment of existing demand CRS testing

Table 9 and Table 10 summarise the assessment of testing methodologies proposed for each high impact investment line in LS3 and LS4. A more detailed description for each line is provided in Appendix B.

Table 9: Demand CRS testing methodology for LS3

LS3 enhancement expenditure line summary		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
5	Drinking Water Protected Areas	✓			
7	Wetland creation	✓			
10	Investigations [WINEP]	✓			
11	Supply-side improvements delivering	✓	✓*		

	benefits				
12	Demand-side improvements delivering benefits (excl leakage and metering)	✓	✓*		
13	Leakage improvements delivering benefits	✓	✓*		
14	Internal interconnectors delivering benefits	✓	✓*		
19	Smart metering infrastructure	✓	✓*		
27	Addressing raw water quality deterioration (grey solutions)	✓			
28	Addressing raw water quality deterioration (green solutions)	✓			

* Low growth scenario not currently tested but will be necessary for PR24 and the LTDS.

Table 10: Demand CRS testing methodology for LS4

LS4 enhancement expenditure line summary		Enhancement has already been tested part of strategic plan development	Enhancement has not been tested but capability exists	Testing has not been completed and no capability	
				SME judgement workshop to assess impacts	Impacts not known. Conduct investigations in AMP8
4	Increase flow to full treatment	✓	✓*		
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution		✓		
8	Storage to reduce spill frequency at CSOs etc - green solution	✓	✓*		
25	Investigations	✓	✓*		
27	Growth at sewage treatment works (excluding sludge treatment)		✓		
31	Sludge enhancement (growth)		✓		
37	Enhanced activity to address harm from storm overflows	✓	✓*		

* Model needs to be run for low growth scenario

How CRS testing was conducted

For the water resources components of LS3, both extremes of this scenario were tested using the WRMP optimisation modelling process. This process selects preferred sequences of intervention which are assigned detailed, scheme-by-scheme, cost estimates.

For the elements of LS3 informed by our WINEP, bioresources elements of LS4 and drinking water quality elements of LS3, both extremes of this scenario were tested in a series of SME workshops. This process considered how planned investment types would need to change to continue to deliver the relevant ambition in 2050 and, on this basis, inferred how the cost of the planned investment would need to change (for example, a percentage uplift on AMP8 estimates).

For the drainage and water recycling elements of LS4, the potential of options to provide capacity for differing levels of demand had been considered within the DWMP and the final DWMP best value plan was optimised to meet our most likely growth forecast, a trend-based forecast drawn

from company data, local authority plans and regional ONS projections (approach aligned with WRMP). Modelled DWMP option costs for schemes driven by growth were isolated and used to develop a unit cost rate which was used to assess the likely change in investment required under each of the two extremes for this CRS.

Technology

Where to apply the testing

Ofwat's technology CRS describes futures where full adoption and operationalisation of certain technologies become cost-beneficial by different dates. Ofwat expects companies to explore the potential impact of technological development on the relative costs and benefits of options and the likely optimal sequencing of activities.

Ofwat has specified an adverse (slower technological development) and benign (faster technological development) version of the technology CRS.

Table 11 summarises the perceived impact of the Technology CRS on the LS3 and LS4 data tables.

Table 11: Impact of technology CRS on LS3 and LS4 lines

Ofwat Data Table	Impact of scenario on expenditure lines in tables		
	High impact	Low impact	Lines not impacted
LS3 (Water enhancement expenditure)	18	12	2
LS4 (Wastewater enhancement expenditure)	33	1	3

The range and scope of technological advancements that may be available to us over the next 25 years is vast. We have already completed significant work in relation to establishing the range and likelihood of technological advances and has completed a recent project to understand some of the most likely advances that could influence its business.

This project identified a number of technological advances in addition to the CRS or that enhance the particular components of the technology CRS. We have therefore supplemented the technology CRS to create a broader technology scenario against which we have tested our planned expenditure.

3. Development of wider scenarios

3.1. Approach to developing wider scenarios

In addition to the CRSs, Ofwat set out the opportunity to create wider scenarios which include material local or company specific factors, or those between reference scenarios such as 'medium' impacts.

To identify the scenarios, we used a structured approach based on techniques from "The Futures Toolkit: Tools for Futures Thinking and Foresight across UK Government", a government guidance document that provides a set of tools and techniques to support long-term strategic thinking in policy making.

Our approach to identifying and defining company-specific, wider scenarios followed four broad steps, as shown in Figure 5 below.

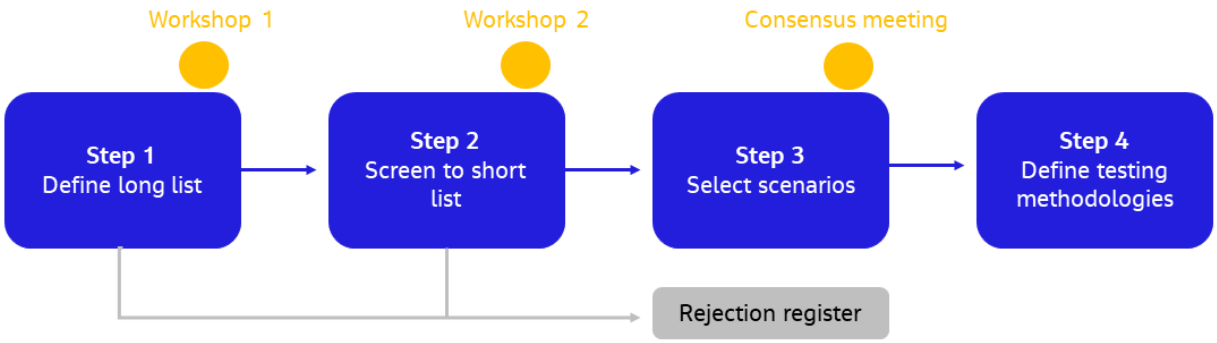


Figure 5 Our approach to developing the wider scenarios.

Step 1: Define long list of external factors

This step encouraged broad thinking to define a wide variety of factors that could impact our ability to deliver our services and ambition over the longer term.

We used a PESTLE framework to define a variety of political, economic, social, technological, legal and environmental factors. In doing this we used our understanding of our stakeholders and customers, as well as our collaboration with other water companies to understand how pressures on our sector, and other sectors that influence us, may change over time.

A workshop was then held with internal stakeholders to challenge this initial longlist and identify any other potentially material factors not yet captured. The output of this session was a refined longlist of almost 300 potential factors for further review.

To further explore the technological factors, we commissioned a standalone, comprehensive research project. The long-listed factors for technology were cross-referenced against the outputs from that research project. Development of our wider technology scenario is described separately at the end of this section.

Step 2: Screen to a short list

This step involved screening the longlist down to a more condensed shortlist for consideration as testing scenarios for the LTDS. We first reviewed all factors identified during Step 1 against the following criteria:

- **Is it a plausible and unique trend?** Ofwat requires scenarios to be plausible and we need scenarios to be sufficiently distinct from each other.
- **Is it addressed by an existing CRS?** We do not want to create overlap with the CRS, but we might want a wider scenario that goes beyond a CRS (a more extreme version of future climate, or a wider technology scenario for example).
- **Is it testable?** We need to be able to test strategies and enhancement expenditure lines against the scenario.

- **Is it within management control?** Scenarios should focus on exogenous factors.

Only factors identified as unique and plausible, not (fully) addressed by a CRS, testable, and outside of management control were taken forward. Justification for screening decisions was recorded and a rejection register established to inform future iterations of the LTDS.

A second workshop was then held with our internal stakeholder working group to consider the potential impact and uncertainty of each of the factors that passed the initial screening exercise. Each trend was assigned a 1-5 score for impact (against each of our strategic plans and for the business overall) and uncertainty.

Table 12: Impact and uncertainty scoring

Impact		Uncertainty	
1	Cost impact: <10% Programme impact: no delay Strategy impact: no impact on strategy.	1	There is relative certainty around the event or issue.
2	Cost impact: 10%-20% Programme impact: minor delays Strategy impact: strategy still effective with minor changes.	2	There is a good understanding of likelihood for this event or issue.
3	Cost impact: 20%-40% Programme impact: different year in same AMP Strategy impact: strategy still effective with significant changes.	3	There is reasonable uncertainty of likelihood in the near term with uncertainty increasing into the future.
4	Cost impact: 40%-75% Programme impact: pushed into next AMP Strategy impact: solution less effective even with significant changes.	4	There is very high uncertainty over this issue or event.
5	Cost impact: >75% Programme impact: delay by more than one AMP Strategy impact: solution no longer effective, alternative required.	5	There is very high uncertainty over this issue or event even in the relatively near future.

Following the workshop, the outputs were circulated for review by attendees, and other internal stakeholders who were unable to attend the session were also invited to comment.

Results and rationale were captured in a scoring spreadsheet, enabling the production of a Wilson Matrix for each PESTLE category. Figure 6 shows how the Wilson Matrix was used to identify factors scored as having the highest impact and uncertainty (i.e., those in the top right of the matrix) for further exploration as potential wider scenarios.

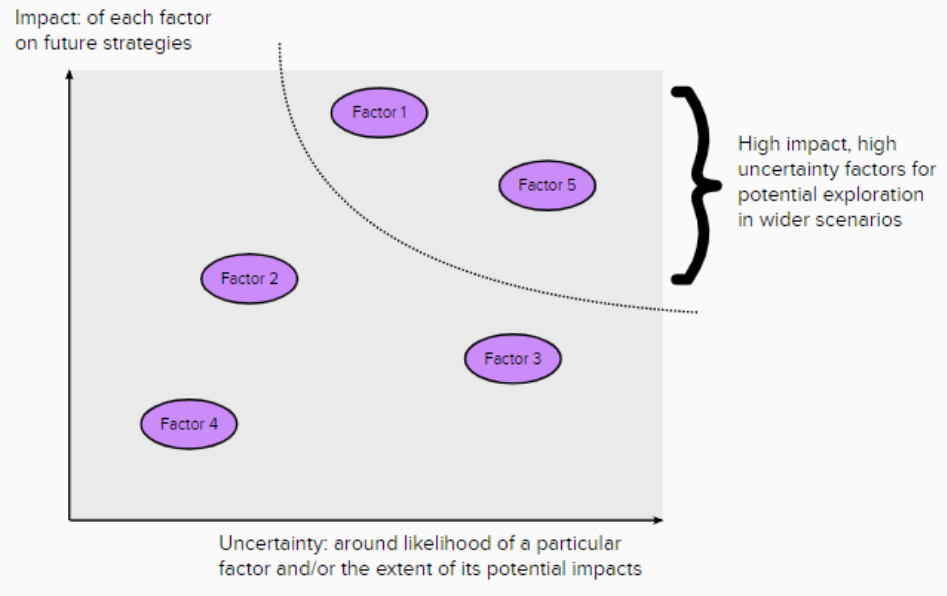


Figure 6: Wilson Matrix Example

The summary matrix presenting the impact and uncertainty score for each factor from this process is shown in Figure

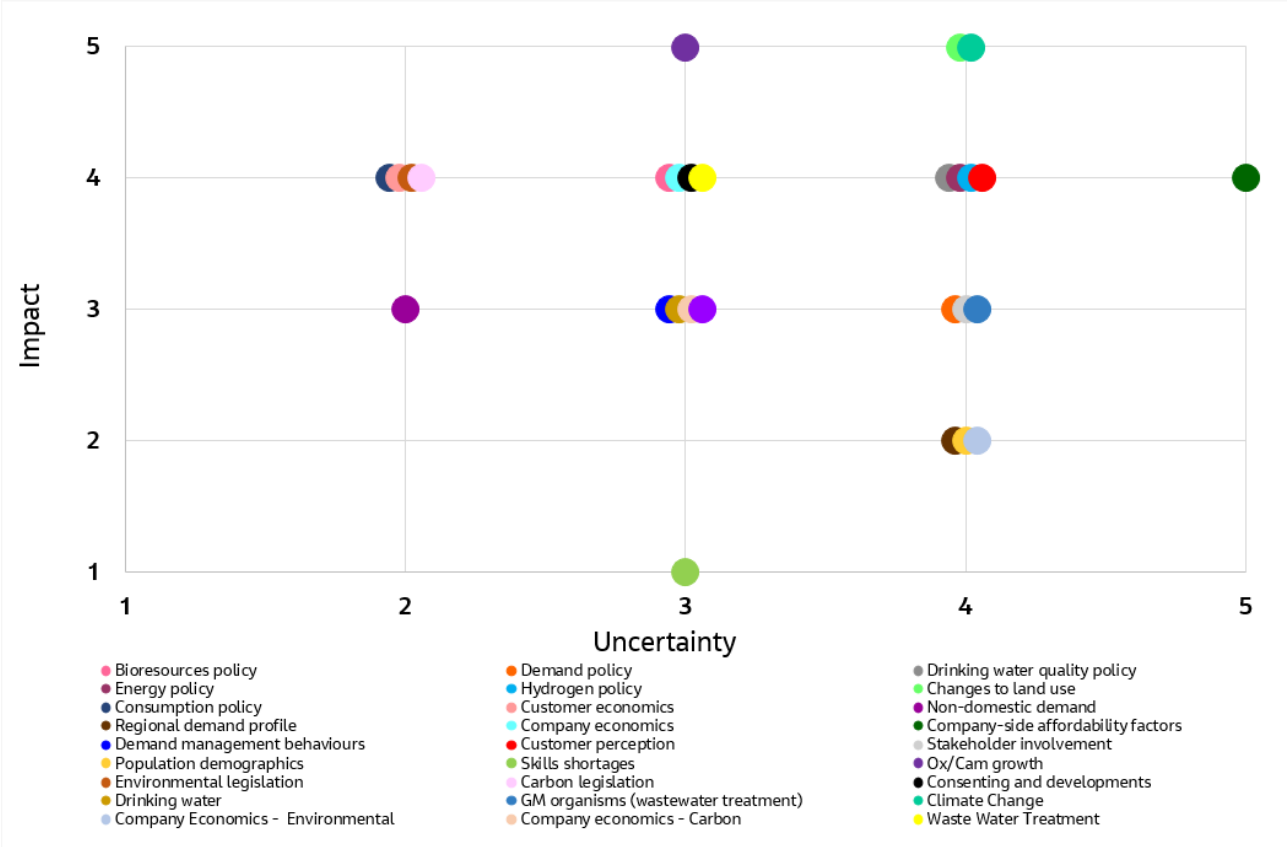


Figure 7: Wilson Matrix showing how all the factors were scored relative to each other

Step 3: Scenario selection

The 18 high impact and high uncertainty factors identified through the Wilson Matrix analysis were then tested for suitability as potential scenarios using the five key tests below.

- Material – is the scenario likely to have a material impact on key enhancement expenditure?

- Exogenous – is the scenario driven by factors external to the company and outside its control?
- Plausible – does the scenario reflect plausible events?
- Simple – can the scenario be clearly defined and tested?
- Regionally specific – does the scenario reflect an issue which is specific to the company or region?

Only five were found to be suitable for development into testable, plausible, clearly defined scenarios in accordance with the Ofwat guidance. These five potential scenarios were presented at a consensus workshop with our core working group, where potential impacts and scenario details were considered in greater depth, again using the above five tests as a guide. Table describes the draft scenarios and summarises the decisions reached.

Table 13: Summary of Consensus outcomes

Proposed wider scenario	Scenario description	Scoring and consensus decision
Environmental awareness and expectations	The recent public reaction over storm overflows has shown that public opinion, stoked by media attention, can have a major impact on regulatory requirements, leading to material impacts on water company costs. Changing societal expectations and increasing environmental awareness are already leading to increasing environmental pressure and a growing general discontent with the way in which water companies are licensed to operate. This could also drive policy change leading to increasing statutory requirements and/or increasing cost to meet these.	**Consensus:** Develop a more geographically specific wider scenario to test the impact of Landbank Availability on bioresources strategy. This was identified through discussions with the strategy leads as the issue with the highest level of plausibility and materiality.
Alternative growth (including OxCam)	We already have experienced very high growth as a region, as well as high point-source demands as a result of non-domestic growth. The location and timing of the OxCam growth arc is uncertain. If/when OxCam growth occurs it is likely to drive significant domestic/non-domestic demand increase as well as potentially impacting on wastewater treatment plans. There may also be potential change in agricultural demands due to UK food security	**Consensus:** **Not to be taken forward as a wider scenario.** Whilst population growth in the East of England will continue to be a key driver of enhancement spend, the common reference scenarios, which use ONS household and population projections and local plans, provide sufficient level of uncertainty testing. The main risk factor identified was the Ox/Cam growth arc, which will be addressed through an assumption. We will continue to monitor levels of growth to understand if there are material differences to growth in the region against these projections.
Regional hydrogen development	Region becomes a hub for hydrogen production leading to demand for effluent or desalination as a raw resource for hydrogen production. We are already receiving enquiries and expects these to increase. This has already been considered within the WRMP, but not within the DWMP or WINEP and there are significant implications for wastewater treatment and water quality.	**Consensus:** Reframe as 'Water for Energy' to encompass other forms of energy as well as carbon capture, utilisation and storage (CCUS).
Alternative climate change scenario	A mid-range climate scenario was considered as our region is one of the most vulnerable to climate change impacts in the UK.	**Consensus: NOT to be taken forward as a Wider Scenario** WRMP (and to a lesser extent DWMP) have already considered alternative climate change

Proposed wider scenario	Scenario description	Scoring and consensus decision
	Climate change impacts on water resources, sewer flooding, storm overflows and storage requirements; sea level rise could affect coastal infrastructure, wetland habitats, etc. Very high potential impact across WRMP, DWMP, Water Quality and WINEP.	scenarios to develop low/no regrets, best value plans. This option was not taken forward as the CRS definition was considered to provide a sufficient range of plausible futures to test the emerging core pathway and inform alternative pathways.
Level of stakeholder involvement	A future where collaborative delivery is the norm and solutions are routinely delivered with/through stakeholders, leading to a much higher focus on catchment solutions with multiple benefits. This could significantly affect the type and scale of end-of-pipe solutions required to be delivered by us in isolation. It is particularly relevant for WINEP and DWMP.	**Consensus: NOT to be taken forward as a Wider Scenario** Whilst increased partnership is a key element of our future ambition, the current understanding of how this will develop is not considered sufficiently mature to enable a fully informed scenario to be developed.

Our final wider scenarios selected through this process were therefore agreed as follows:

- Water for Energy (hydrogen and carbon, capture, utilisation and storage (CCUS))
- Landbank Availability (as this relates to bioresources strategy)

These were then developed into clearly defined scenarios with plausible extremes established for benign and adverse conditions.

Step 4: Define testing methodologies

To develop testing methodologies for the wider scenarios we followed the same approach used for the CRSs, which involved determining whether there is an existing model available to assess the impacts or whether a judgement-based assessment is possible. This approach is described in section 2.2 of this annex.

3.2. Final wider scenario definitions and testing methodologies

Water for Energy

Description

New energy (such as green hydrogen and nuclear) and the development of carbon, capture, utilisation and storage (CCUS), require large volumes of water for the production process. Water-based cooling technology may also be required.

The UK Hydrogen Strategy (HM Government, 2022)[3] sets the ambition to deliver 5 GW of low carbon hydrogen capacity by 2030, potentially rising to a demand of 7-20 GW by 2035 and 15 – 60 GW by 2060. Recently, the 5 GW ambition doubled to 10 GW, with at least half of this from electrolytic hydrogen. This increase in hydrogen production will have a significant impact on future water demand.

The East of England could become a major hub for any future hydrogen industry. We are already in discussions with several companies regarding supplying water to proposed hydrogen production facilities. Water Resources East (WRE) estimates future water need for energy could increase by approximately 140 Ml/d in the region by 2050, resulting in greater pressure on regional water sources.

Potential sources to meet energy water demand include treated wastewater effluent and desalinated water. Implications for wastewater treatment facilities and the receiving waterways will need to be considered. Desalination presents the opportunity for joint public water use and energy production. Our potable public water supply network is likely to be limited in its capacity to provide additional water for

[3] HM Government. (2022). *UK Hydrogen Strategy.* Available at: https://www.gov.uk/government/publications/uk-hydrogen-strategy

energy production, as the system is already under significant pressure from population growth, climate change, sustainability reductions and the need to increase supply resilience to severe drought.

The plausible scenarios for assessing the potential impact of future water demand for energy on our strategies are based on profiles for power sector projected annual consumption in the WRE Region, as outlined in the draft Regional Water Resources Plan in the Eastern Region. Three potential profiles of power sector projected annual water consumption are presented in the draft WRE Regional Plan. These reflect the Future Energy Scenario 2021 (FES21) produced by the National Grid Electricity System Operator, which represent credible pathways for the development of energy by 2050. The 'Adverse' and 'Benign' wider scenarios are the high and low energy sector growth, respectively.

Potential location of hydrogen production facilities

The government's Hydrogen Net Zero Investment Roadmap (HM Government, 2023)[4], published in April 2023, lists hydrogen projects that are (or have been) being considered under funding schemes. There are six projects identified within our operational area, and include sites near South Humber Bank, Sheffield, Great Yarmouth, Felixstowe, Dartmouth. These are shown in Figure 9 and listed below:

1 - Aldborough Hydrogen Pathfinder, SSE Thermal

11 - Green Hydrogen 3, RES and Octopus Green Hydrogen

12 - H2 Production Plant at High Marnham, JG Pears

23 - Hydrogen Lowestoft, Conrad Energy

26 - MCRU Integrated Hydrogen Delivery for a Fuel Cell Van Fleet, Centrica

36 - Port of Felixstowe Green Hydrogen Project, Scottish Power

The Centrica project, near the South Humber Bank, has been awarded funding as part of the Net Zero Hydrogen Fund strands 1 and 2. This project will use low carbon hydrogen generated from electrolysis to be distributed using mobile compressor refuelling units, MCRUs. These locations should be considered when testing the core pathway against the wider scenarios.

[4] HM Government (2023). *Hydrogen Net Zero Investment Roadmap.* Available at: Hydrogen net zero investment roadmap - GOV.UK (www.gov.uk)

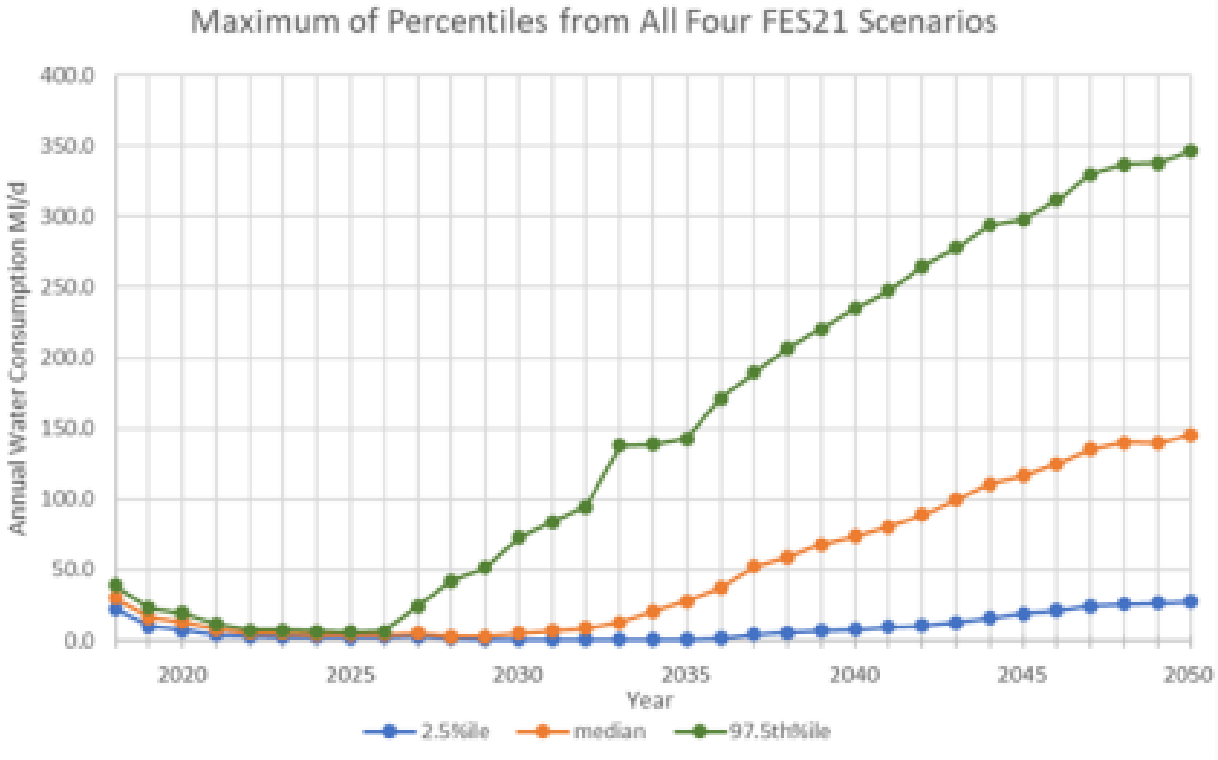


Figure 8: Power sector projected annual consumption in the WRE region[5]

[5] Water Resources East (WRE). (2022). *Draft Regional Water Resources Plan for Eastern England*. Available at: WRE-draft-Regional-Water-Resources-Plan-1.pdf

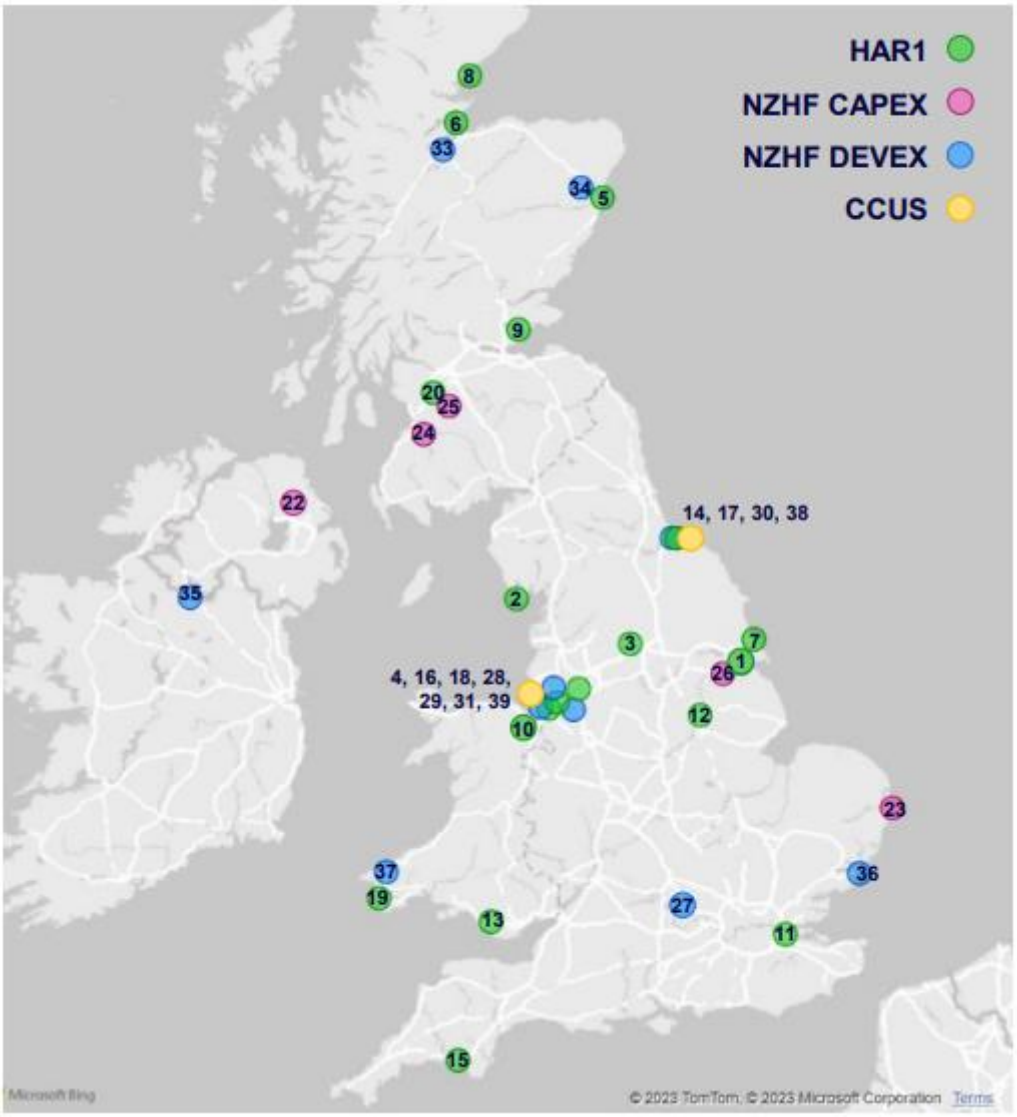


Figure 9: Location of potential Hydrogen Projects[4]

Adverse Scenario – High energy sector growth

Demand: Use WRE power sector projected annual water consumption 97.5th percentile probability level (2025 – 2050) – based on FES21.

Location: Assume hydrogen production facilities are developed at South Humber Bank and the tidal Trent, as well as other locations within our region identified as potential sites in the government's Hydrogen Net Zero Investment Roadmap.

Source: Demand met from desalinated water developed by Anglian Water and/or treated wastewater.

Benign Scenario – Low energy sector growth

Demand: Use Water Resources East (WRE) power sector projected annual water consumption 2.5th percentile probability level (2025 – 2050) – based on FES21.

Location: Assume hydrogen production facilities are developed at South Humber Bank and the tidal Trent only.

Source: Demand met from desalinated water developed by energy developer and/or treated wastewater.

Testing methodology

We used workshops with our key staff to identify and agree responses against the following questions:

- Are there plans for Water Recycling Centre (WRC) treatment improvements that could be rendered redundant by a demand for effluent? Should investment be cancelled, deferred, or replaced.
- How would a reduction in treated effluent flows in receiving water courses impact WINEP investment and environmental destination? What additional investment, is required if any?
- Are there potential benefits from construction of a desalination plant for joint Public Water Supply and hydrogen production? Should design be scaled up and/or brought forward?
- What are the implications for achieving Net-Zero GHG emissions? Is an increase in investment expenditure required?

Landbank Availability

Description

We dispose of treated biosolids via use on agricultural land as fertiliser. Autumn application to land typically takes 85% of our biosolids. The availability of land for this purpose is referred to as the landbank and the size of the landbank can vary based on a number of factors including government policy and farmer acceptance.

A landbank assessment has considered the remaining landbank available for applications of biosolids, aligned to different scenarios, reflecting alternative ways the Environment Agency may implement future legislation, including the Farming Rules for Water (FRfW) (Defra, 2022)[6] and Environment Agency Sludge Strategy, in addition to other external factors which may affect biosolids recycling.

FRfW require changes in the application of fertiliser and organic materials to land, to avoid a significant risk of agricultural diffuse pollution. It covers applying and storing these materials and the management of soil and livestock. It places restrictions on the timing and amount of nutrients farmers can apply to land. This will impact the management of bioresources. The Environment Agency enforces the FRfW in accordance with its published enforcement and sanctions policy and guidance.

A national landbank assessment (Grieve Strategic & ADAS, 2022)[7] has considered the remaining landbank available for applications and biosolids storage capacity required, aligned to different scenarios that reflect alternative ways the Environment Agency may implement FRfW. The landbank assessment modelled potential future changes to sludge management regulations / restrictions, external factors, emerging concerns and ongoing research, and the associated impacts.

The Adverse scenario for assessing the potential impact of landbank availability on our strategies is based on the assumption of a moderate decrease in available land and represents the 10-year most likely change (Scenario 4, presented in Figure 10). The Benign scenario assumes a minimal change in landbank availability compared to baseline (Scenario 3, presented in Figure 11Figure).

[6] Defra. (2022). *Applying the farming rules for water*. Available at: https://www.gov.uk/government/publications/applying-the-farming-rules-for-water/applying-the-farming-rules-for-water

[7] Grieve Strategic & ADAS. (2022). *National Landbank Study – Draft Phase II results.* PowerPoint slides (05/10/2022)

Adverse Scenario – Moderate decrease in available land

Land area available: Scenario 4 of the national landbank assessment - 10-year most likely change in landbank availability compared to baseline.

This represents a decrease in available land assuming a minimum 6-months storage to allow: logistics flexibility (longer haulage runs), over-winter storage (when farm access is limited), and inter-spreading season closed periods.

For this scenario there is insufficient available agricultural land to recycle all biosolids nationally.

Application rules: Biosolids application in autumn months is prohibited (except for a very small proportion, where crops have an immediate fertiliser requirement). Autumn application to land typically takes 85% of biosolids.

Benign Scenario – Slight decrease in available land

Land area available: Scenario 3 of the national landbank assessment - 10-year minimal change in landbank availability compared to baseline.

Application rules: No change

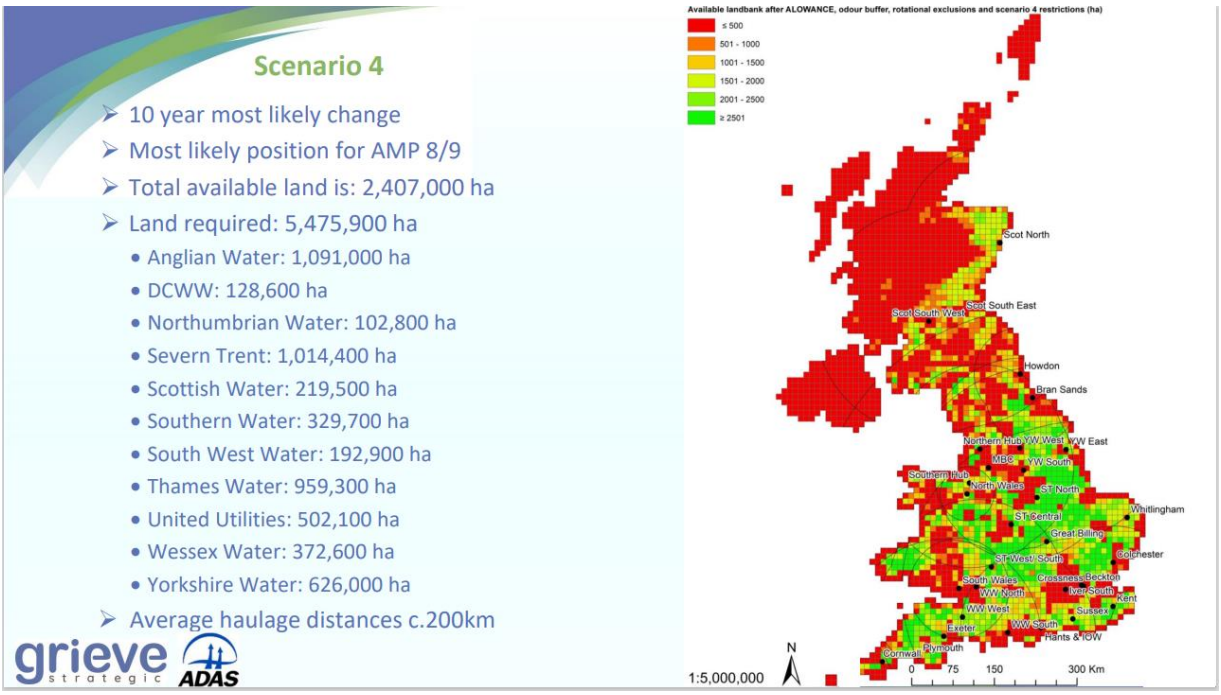


Figure 10: National Landbank Study – Scenario 4 (Adverse Scenario)

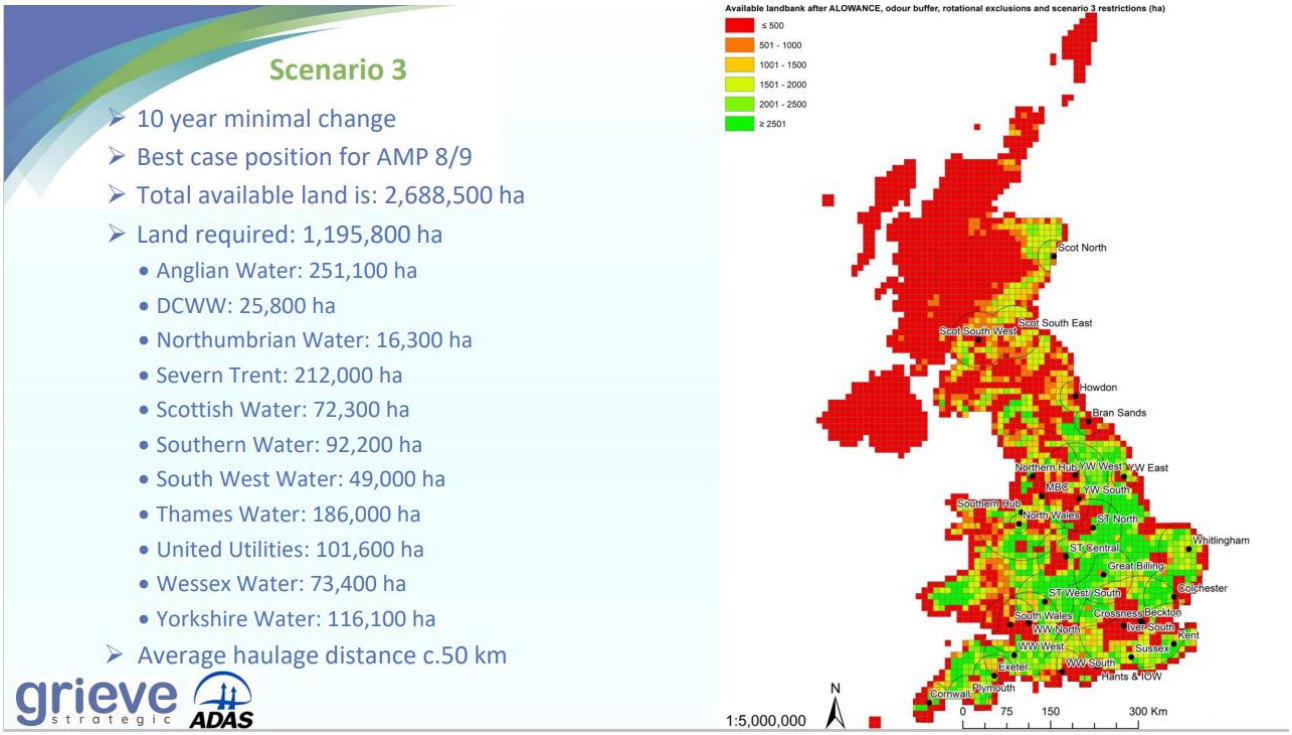


Figure 11: National Landbank Study – Scenario 3 (Benign Scenario)

Testing methodology

Our testing methodology for this wider scenario is as follows:

- Landbank modelling used to forecast available agricultural outlet (% production) and biosolids storage requirements into the future.
- Where landbank availability constraint is forecast, apply engineering judgement to determine other bioresources disposal routes and assess:
    - Whether the scenario would impact the planned investment in the core pathway? If yes, how would the enhancement expenditure need to change?
    - Would the sequencing of options need to change in response to the scenario? For example:
        - Should investment be cancelled, deferred, or replaced?
        - Should schemes be scaled up or down?

Extended technology scenario

Description

In addition to the two company-specific wider scenarios described above, we have also tested an extended technology scenario comprising the CRS technology conditions plus a wider range of new and emerging technologies. This was developed through a separate process as described below.

To develop our final technology scenario, we first commissioned Cambridge Consulting and Cap Gemini to help us to identify the range of technologies we should consider in the development of our strategy. This project identified the key technologies with the greatest potential to impact our business over the long-term. It first undertook a horizon scanning activity that identified a long list of over 90 technologies, which was then refined using analysis and workshops. The project then conducted an in-depth review of nine key technologies, and a high-level review of a further eleven technologies. More details can be found in the **AMP8 Long Term Delivery Strategy for Anglian Water – Final Integrated Technology Report.**

This report informed the list of technological developments we wanted to consider. To develop our final technology scenario we then had to describe the potential application of the technology, and consider when the full adoption and operationalisation would become cost beneficial in the fast and slow scenarios. We did this through a series of collaborative workshops with SMEs from across the business.

Our final technology scenario incorporates all the technological development identified in Ofwat's final guidance as well as the additional technologies identified through this process. The details of our final fast and slow scenarios are set out in the Figure 12 and Figure 13 below.

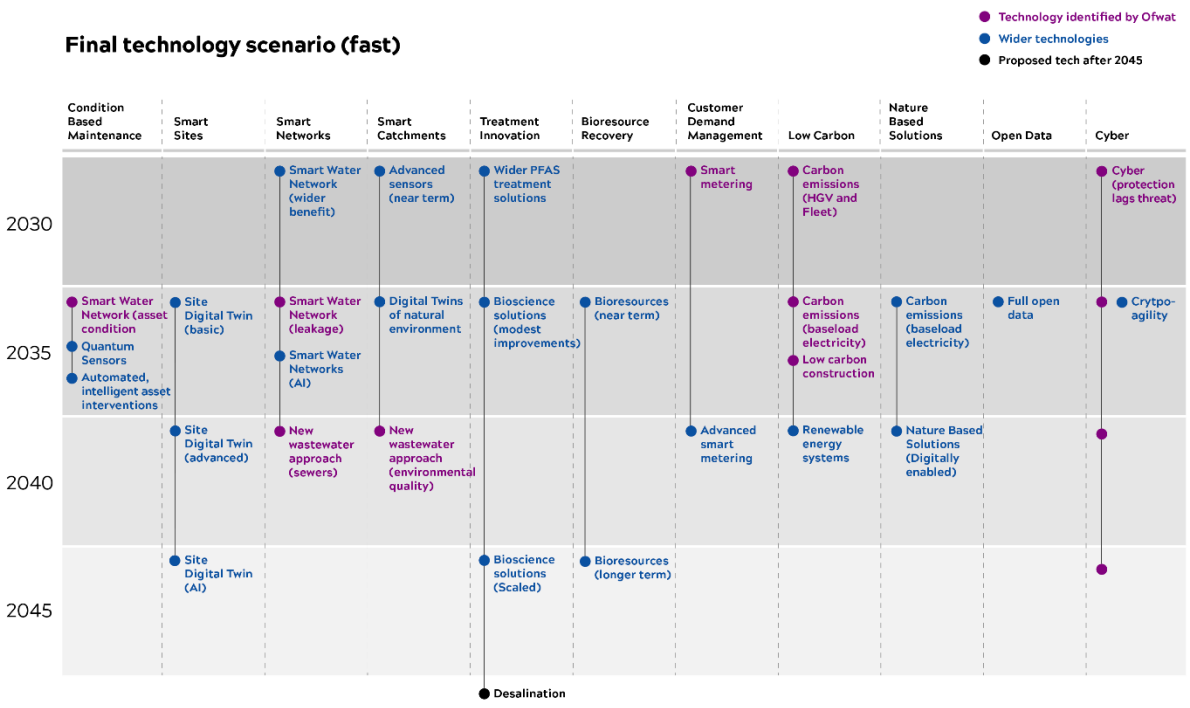


Figure 12: Final technology scenario (fast)

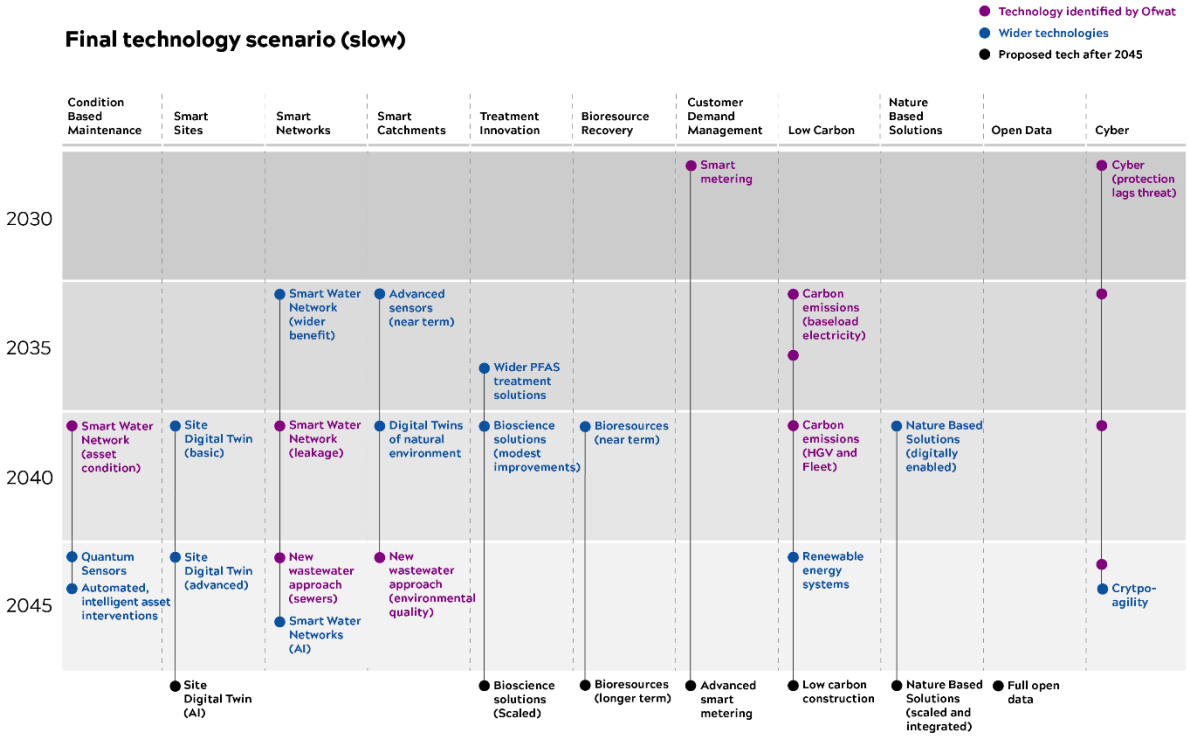


Figure 13: Final technology scenario (slow)

Note that, in Ofwat's final guidance full smart meter implementation and smart water networks are expected to be fully operational by 2035 in the fast scenario. We have, however, set them to 2030 in our final scenario. This reflects the date when we expect them to be fully operational in our strategy. It is also consistent with our revised draft WRMP.

Testing methodology

Due to the limited availability of evidence proving the precise impact of new and emerging technologies, testing of our technology scenario was undertaken using SME judgement through several targeted workshops with our core working group, cross-sector leads and representatives from our wider technology and innovation teams. These broadly followed the format set out below.

Technology scenario testing workshops:

Step 1 – Considering the core pathway schemes at sub-strategy level, discuss:

- What outcomes are required.
- What types of solutions are being deployed.
- Interdependencies with other sub-strategies.
- Known delivery risks.

Step 2 – consider the technology advances that may influence the types of solutions currently being proposed – this will be led by the technology SMEs and build on the information circulated/discussed in advance.

Step 3 – Consider if there are opportunities in the emerging technologies that would benefit the outcomes by:

- Reducing the delivery time.
- Improving the outcomes (wider capitals benefits).
- Improving productivity.
- Improving efficiency.

Step 4 – Consider any disbenefits, for example, increasing risk of cyber threats and any possible mitigations.

Step 5 – Where opportunities are established what are the qualitative benefits (e.g. faster delivery of outcome/more efficient delivery/greater wider benefits).

Step 6 – Consider whether/how the qualitative benefits can be quantified.

Step 7 – Consider likely timeline of availability of the technology and confidence in embedding it to enable the benefits to be realised.

Step 8 – following assessment of quantitative impact consider likely materiality and determine whether an alternative pathway may be justified.

Confirm actions required to finalise the assessment and address any items left in the "car park."

In some cases, it was not possible to disaggregate the collective benefit of a group of related technologies with sufficient confidence to assess the impact of slower implementation for specific sub-types. In these instances, we have represented the impact of the slower technology scenario on affected enhancement expenditure by assuming their absence.

3.3. Material factors to be addressed by assumptions

There were some shortlisted factors with high potential impact that were not selected as wider scenarios for this iteration of our LTDS, in particular those mentioned below. These have been addressed through assumptions in our LTDS, and their impact considered through sensitivity testing where appropriate. Additional wider scenarios may be required in future iterations of our LTDS to ensure that our long-term strategy remains robust to future uncertainties.

- **Levels of stakeholder collaboration** – we have assumed that water environment stakeholders gradually increase the extent of their collaboration, promoting catchment-based approaches to address issues. We need to work with these stakeholders to deliver our ambition and will not be able to achieve it if we work in isolation. Our core pathway assumes that through A-WINEP we will drive a step-change in partnership working that includes identifying innovative delivery models for environmental outcomes and funding sources available at catchment and landscape scale, such as our own investment proposals, agricultural grants, the use of environmental markets and wider corporate and philanthropic finance. In this way we will deliver our ambition without having to increase our existing levels of investment. We have tested the potential impact of not rolling out this approach more broadly in a sensitivity test documented in our LTDS.

- **Consenting and major developments** – major developments have a significant impact on water demand and our WRMP includes assumptions to address the growth anticipated within our region. The Oxford/Cambridge Growth Arc development in particular could have a significant impact on the location and scale of both economic and population growth in our region, but without greater certainty over the timing and specific nature and location of this development it is not possible to frame a plausible scenario for testing at this stage. The Demand CRS and Water for Energy Wider Scenario consider the impact of future demand changes using our best current view of plausible development within the region. For this iteration of our LTDS we assume there will be no other significant changes in the scale or location of demand. We will revisit this through further demand scenario testing at each iteration of our LTDS, and if new information becomes available mid-cycle.

- **Demand patterns** – Demand levels and patterns to be monitored and assumptions made for investment planning to be reviewed in future planning cycles if significant changes are observed (e.g. significant deviation from the WRMP assumption of a decreasing PCC).

- **Government policy and legislation** – Government policy and legislation have a significant impact on our services and the way we deliver them. No policy or legislative changes other than those covered by the CRSs or wider scenarios have been scenario tested at this time; however, we will continue to work closely with regulators to understand potential policy changes and consider how these could impact service delivery in advance of their adoption.

We will continue to monitor trends in our external environment through our regular horizon scanning exercises, to manage risks and identify opportunities as they arise.

4. Best Value assessment

A best value plan is one that considers factors alongside economic cost and seeks to achieve an outcome that increases the overall benefit to customers, the wider environment and overall society. In doing so, we will account for a wide range of public value benefits including wider resilience, environmental and societal factors.

A best value plan should also be efficient and affordable to deliver, legally compliant and account for the range of legislation that applies to it.

We believe developing a best value LTDS depends on three factors:

1) **Option Development:** solutions have been identified from a broad long list. This means ensuring we consider a full range of option types and are not constrained by existing ways of thinking.
2) **Option Sequencing:** solutions have been sequenced in the most effective and efficient way. This means we have considered multiple sequences of option deployment to arrive at the preferred option sequence.
3) **Option Selection:** solutions are selected through a cost benefit analysis that considers a broad range of value components. This means accounting for social and environmental costs and benefits as well as financial factors.

These three factors combine to ensure we select the right options at the right time and therefore produce a best value plan. Our best value framework for the LTDS addresses each of the three factors.

4.1. Our existing best value planning

We already apply long-term planning in several parts of our business. Our WRMP and DWMP both take a 25-year view to 2050. Both these strategic planning frameworks already address all three components of the best value framework for the LTDS. Table 14 below summarises what proportion of our planned expenditure has already been subject to best value analysis.

Table 14: Overview of existing best value planning for long-term expenditure

	Number of lines in LS3 (water expenditure)	Number of lines in LS4 (wastewater expenditure)
Expenditure that has already been subject to best value analysis	28	55
Expenditure that has not already been subject to best value analysis	13	6

Where planned expenditure is sourced from existing long-term plans that align to the best value framework for the LTDS, we have not re-visited any best value analysis, so long as this is contemporary and remains valid. We will conduct new best value analysis where expenditure from those existing long-term plans needs to be tested against new scenarios, or where expenditure has not previously been subject to long-term planning.

To supplement and support the existing best value analysis conducted through our WRMP, DWMP or WINEP frameworks, a qualitative assessment of best value has been conducted on all option types against the following best value components. Each of these components was scored relative to other options delivering the same function.

- Cost
- Carbon
- Social capital

- Natural capital
- Adaptability/flexibility
- Customer preference
- Certainty of outcome

The qualitative assessment was used (red, amber, green) (Table 15) and completed during a workshop with our Strategy Lead and other SMEs. Where existing best value analysis exists, this was used to inform the qualitative assessment and therefore provide a comparison and consistent overview with expenditure that has not previously been subject to best value analysis. Where customer preference information was not available to an appropriate level of granularity this has been inferred.

Table 15: Qualitative best value assessment

RAG Score	Definition
	No positive impacts. Negative impacts only.
	Balance of positive and negative impacts
	More positive than negative impacts
	N/A

Qualitative scores where then moderated by comparison across the full range of scores for each strategy. This best value analysis is summarised in the following sub-sections and was then used during the option selection and sequencing process.

4.3. Bioresources

Table 16 presents the qualitative best value analysis for the option types considered to deliver the bioresources ambition.

Table 16: Qualitative best value analysis for bioresources ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
Landfill								The costs and perception of landfill is no longer deemed acceptable or viable. Not aligned with industry drivers. Considered a last resort option.
Incineration								Provides guaranteed outlet but has high carbon impact. Residual product needs disposal. Expensive to deploy and sustain.
Use for industrial fuels								Unproven Production of a low-carbon fuel would be a minor contributor to the energy market. Requires development of infrastructure to use the fuel.
Thermal conversion to valuable products								Although a combustion process, carbon emissions are significantly lower than for incineration due to carbon sequestration in biochar or bio-oil. Produces range of products and therefore range of outlets. Requires research and development.
Use to support agriculture (non-food)								Production of biosolids for non-food agriculture unlikely to be a primary strategy. Runoff impacts require management.
Use to support agriculture (food)								Existing dominant outlet so proven and mature. Runoff impacts require management.
Use in restoration								Highly uncertain outlets and therefore security of disposal options.
Resource production								Production of targeted resources from biosolids requires clear markets. Specific products and markets uncertain.
Reduction in biosolids generation								Solutions are novel and require significant investment to be deployed at sufficient scale.

4.4. Drinking water quality

Table 17 presents the qualitative best value analysis for the option types considered to deliver the drinking water quality ambition.

Table 17: Qualitative best value analysis for drinking water quality ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
Taste and Odour – Filter wash water contact tank repurpose								This investment is to provide unchlorinated filter wash water to provide optimal conditions for the biological filters.
Taste and Odour – Filter wash water run to waste								This option is to install an automatic run to waste following a filter wash and pipework to a new terminal pumping station. This is not seen as a sustainable solution for the environment. It is also the most expensive option.
Taste and Odour – Filter wash water run to de-chlorination								This option is to install dechlorination facilities, to dechlorinate the wash water prior to filter washing. This is not seen as the preferred option due to the requirements for additional chemical usage.
Nitrate Treatment - Enhanced blending of treated water								Blending options are well known and effective. The application of blending in future nitrate treatment is affected by the impact of achieving the Environmental Destination on our current and future water sources.
Nitrate Treatment - Ion exchange plants								We have several years of experience of installing, operating and maintaining ion exchange plants across our region and the output from these treatment plants show that they are successful and effective at treating the raw water to ensure compliance of the final water for nitrate.
Nitrate treatment – Chlorine and Orthophosphoric acid dosing								This process can be applied alongside ion exchange treatment to enable nitrate standards to be met. Orthophosphoric acid dosing is also used at WTW to manage lead.
Treatment of lead presence with orthophosphoric acid dosing								We acknowledge dosing phosphate is not a sustainable long-term measure for lead compliance and we will continue to seek out alternatives to dosing.
Lead pipe replacement								Pipe replacement is an option that mitigate the risk of lead completely – if all lead is removed. We will balance the cost of replacement fairly across generation of bill payers and focus on high risk areas such as schools first.
Lead relining								Currently lead pipe relining is not accepted as a permanent solution. We will continue to

								consider new technologies and materials in the future.
Collaborative working, sampling and customer engagement regarding lead								enhanced sampling and customer comms work and literature to increase our understanding of lead in the network and raise customer awareness regarding private lead pipes.
GAC installation								Our primary control on most of our very high risk PFAS catchment sources is the GAC treatment process where installed, as we know this is effective at PFAS removal. Cranfield research support that newer GAC with higher iodine numbers as the best-case scenario to minimise the risk of PFAS breakthrough.
Virgin GAC replacement								Virgin GAC will have a significantly higher iodine number than the current regenerated media which will significantly reduce risk of PFAS breakthrough.

4.5. Water resources

Our WRMP has a well-defined process to ensure that best value options are selected within water company business plans. Table 18 presents the qualitative best value analysis for the option types considered to deliver the water resources ambition.

Table 18: Qualitative best value analysis for water resources ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
Fens reservoir								Possible supply-side options have been considered and modelled at both a regional and company level. Our analysis of the results shows that, at both regional and company level, the Fens and Lincolnshire reservoirs are selected as investments that perform well under a wide range of scenarios (for instance different climate change predictions). Reservoir construction is relatively cost and carbon intensive but provides guaranteed outcomes.
South Lincolnshire reservoir								
Water reuse								Water reuse is where used water from the sewer network is treated and cleaned to a high standard before redirecting it to a watercourse or reservoir where it is mixed with other waters.
Desalination								Desalination, as it is scalable and not reliant on freshwater sources, it also has a higher operational carbon and bill impact than reservoirs, and fulfils fewer best value objectives
Water transfers from other water company regions								We will utilise existing supply-side options by upgrading water treatment works so we can utilise existing licences. Transfers will be constructed, allowing us to move water from areas of surplus to areas of deficit.
Aquifer storage and recovery								After exploring DO benefit for WRMP24 and ascertaining the costs for drilling, it has been decided not to continue exploring the option.
Sea tankering								Sea tankering involves importing potable water from outside of the UK into UK ports by sea tanker. The option could be used to provide water resilience at times of high demand in water networks or during drought events
Backwash recovery								Backwash recovery involves cleaning filter backwash water and returning it to the head of a water treatment works to be treated again, rather than discharged to the environment or sewer. The amounts associated with such returns are generally small and can have impacts on water treatment processes.

Leakage reduction from mains replacement								As the frontier company for leakage the future contribution of leakage for the supply/demand balance has been considered against the likely costs. Mains replacement is typically more disruptive and more cost and carbon intensive than other options.
Leakage reduction (excluding mains replacement)								As the frontier company for leakage the future contribution of leakage for the supply/demand balance has been considered against the likely costs. Non-infrastructure leakage reduction measures such as pressure management are typically lower cost and carbon than mains replacement and less disruptive for customers.
Water efficiency measures								Tailored messaging will ensure we demonstrate to our customers why this water efficiency is important for their individual circumstances and local area.
Compulsory metering								Recent customer engagement has shown us that the majority of our customers believe, as do we, that it is fair to pay on the basis of the amount of water used. Our smart metering network will allow us to support customers in water efficiency measures
Tariffs								Potential tariffs could be used as a mechanism to reinforce seasonal messaging, promoting behavioural change and water efficiency during periods of peak summer demand.

4.6. Drainage and water recycling

Our DWMP has a well-defined process to ensure that best value options are selected within water company business plans. Table 19 presents the qualitative best value analysis for the option types considered to deliver the drainage and water recycling ambition.

Table 19: Qualitative best value analysis for drainage and water recycling ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
WRC growth								
WRC capacity – process optimisation on existing site								Process optimisation costs and carbon impact can vary significantly depending on the treatment types involved. Outcomes less predictable than new process provision.
WRC capacity – upgrade on existing site								Upgrading an existing large WRC site serving an urban area is typically more feasible and cost efficient for than building a new WRC due to economies of scale, and limited availability of appropriate alternative land in urban areas. Land availability and permit constraints can limit options for upgrading small, rural WRCs.
WRC capacity – NBS								Treatment wetlands offer higher social and environmental capital benefits than other WRC capacity options. Feasibility likely to be limited and costs high in urban areas due to availability of appropriate land.
WRC capacity – transfer flows to alternative WRC								Transferring flows to another WRC can be more cost effective than providing additional capacity at a constrained site.
WRC capacity – construct new WRC								A new WRC is typically a high cost and high carbon option compared to upgrading an existing site. Likely to be constrained by availability of land in urban areas. In rural areas however, a new local package plant may offer lower whole-life cost and carbon than pumping significant distances to a larger WRC with capacity for additional flows, whilst modular design and smaller size allows for scalability and greater local flexibility.
Smart consenting								Working with the Environment Agency to permit at a catchment level rather than individual WRCs can help maintain or improve water quality by maximising existing

								capacity and asset potential to avoid or minimise additional capacity requirements and costs.
Sewer flooding, pollutions and storm overflow reduction								
Increased conveyance and/or storage (grey)								Grey storage is relatively capital and carbon intensive, but typically straightforward to deliver and provides guaranteed outcomes.
Increased conveyance and/or storage (green)								Currently green solutions typically have higher up-front costs than equivalent grey solutions although they offer a wider range of benefits. Technological advancements expected to reduce costs and increase efficiency and reliability of green solutions over the period. Most cost-beneficial in catchments with existing natural transfer features.
Surface water removal (grey)								Constructing separate surface water pipe networks is relatively capital and carbon intensive, but provides guaranteed outcomes.
Surface water removal (green)								Currently green solutions typically have higher up-front costs than equivalent grey solutions although they offer a wider range of benefits. Technological advancements expected to reduce costs and increase efficiency and reliability of green solutions over the period.
Smart catchment management								Improved data and smart network operation can reduce the need for built solutions by maximising existing capacity, making it relatively low cost and carbon. Potential is limited by existing network capacity.
Behavioural change programmes								Targeted behavioural change programmes can have a significant impact on pollutions caused by blockages. They are relatively low cost and carbon, but need to be part of a wider strategy targeting pollutions due to other causes.

4.7. WINEP

WINEP has a well-defined process to ensure that best value options are selected within water company business plans. This is described within Environment Agency guidance documents and process methodology, and puts emphasis on least cost and best value options assessment through the use of Wider Environmental Outcomes (WEO) metrics, as defined by the regulator. All WINEP preferred options are submitted, assessed, and approved by environmental regulators as part of the standard WINEP development process. This will likely remain in place beyond PR24. This covers options within AMP8, and for a longer-term view consistent with other elements of the LTDS we assessed the WINEP options against the LTDS qualitative best value framework as shown in Table 20.

Table 20: Qualitative best value analysis for WINEP ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
WRC Process Improvement								Treatment enhancement is an essential part of the WINEP programme, providing best removal efficacies in order to achieve environmental outcomes. These are capital and carbon intensive solutions.
WRC Process Optimisation								Process optimisations is an efficient way of delivering less stringent environmental targets but provide no additional value.
WRC Storage Enhancement								Storage upgrades ensure environmental outcomes (WRCs spill to the environment less frequently) but are capital and carbon intensive.
WRC Green Solution (NBS)								Nature-first approach is limited by technical treatment ability, cost and deliverability.
Catchment Management								Catchment management is currently only available for very specific environmental needs, as the certainty of outcome doesn't compare to other solutions.
WRC Monitor Upgrade								Monitoring requirements can only be met through traditional solutions on our assets, offering limited wider value.
Network Storage Enhancement								Grey storage is capital and carbon intensive, but provides guaranteed outcomes.
Network Optimisation								Optimisation is more efficient that enhancement, but is limited by existing network capacity.
Network Green Solution (SuDs)								Nature-first approach is limited by solution certainty, cost and deliverability.
Anglian Water Land Management /Restoration								With direct land ownership, solutions can be delivered more efficiently and cheaply, although social benefits are limited through site access.
3rd Party Land Management /Restoration								Working on 3rd party land provides wider benefits for local communities but is reliant on acceptance of the landowner. This includes river restoration and habitat creation projects.

4.8. Resilience and security

Climate vulnerability

The programme of works includes condition and criticality investigations in AMP8, increased pressure monitoring of climate vulnerable mains, improvements to WISPA Climatic Mains tool to predict burst locations and a pipe renewal programme.

The AMP8 investigation outcomes will confirm the size and timeframe of the long-term programme. The programme will be adapted to take account of the outcomes.

- The size of the programme has been selected to balance the risk of service disruption with the customer bill impact.
- Our customer's highly rank reliable supplies. Investment to reduced service interruption aligns with customer preference – (include reference)
- Investigative work informs targeted mains renewal programmes. In this way, carbon impact is reduced by ensuring that only vulnerable pipes are renewed. Investigative works also increase the certainty of outcome.
- The programme is flexible in that it can be scaled up or down as new data on climate impacts on pipelines is gathered.

Flood protection

Working in partnership allows us to take an approach to managing flood risk that spreads the cost, risk and benefits across multiple partners. As such, it is important to embrace the opportunities to work in partnership when they become available. These opportunities are identified through engagement with other flood risk management partners such as Lead Local Flood Authorities. We scoped the alternative of working in isolation to address the flood risk at our assets to compare costs and benefits of this work, using the six capitals approach. This confirmed partnership schemes as the best value alternative.

We completed a detailed site assessment process to generate a short list of sites with a significant risk to service from flooding. This included a detailed desk-top analysis, asset owner verification and site visits to assess the probability and consequence of flooding.

We have a dedicated East Coast Flood Plan which draws on the learning we have gained from past flooding events in 2007, 2013 and 2017. An east coast tidal surge is the biggest single risk to our asset base, as the risk of flooding occurs over a 12-hour period, so it is essential that we focus on this to maintain service.

Investment to protect our assets from flooding is only proposed where it is necessary to supplement other measures that we already have in place to maintain service to our customers and protect the environment. We use the Cabinet Office's infrastructure resilience components to identify the best possible approach to managing risk. We considered alternative approaches to permanent installations, including the development of flood emergency response plans for our operatives to use when flood warnings are released by the Environment Agency.

Single point of failure and network resilience

The single point of failure investment is designed to reduce or eliminate the highest risks to protect the customers from loss of supply events or high-cost asset failures. For each high-risk site, we assessed the alternative options of refurbishment and replacement using our best value framework. We considered outage periods to minimise disruption to our customers and connectivity that provides supply resilience and enables reduced abstractions to support environmental outcomes.

We reviewed our strategy to reduce the number of properties on a single source of supply to ensure best value outcome. This determined that for some smaller demand areas, emergency contingency supplies are the best value option to minimise service disruption.

Securing critical sites

The securing of critical sites comes under the requirements of the SEMD (Security and Emergency Measures Directive)

The AMP8 investment programme is developed to respond to the actions raised by an external audit to ensure compliance with SEMD requirements.

As the investment is to meet regulatory standards, the solutions are specified and therefore alternative are not assessed.

Systems security

Investment is required to meet regulatory requirements outlined by the Network and Information Systems (NIS) Regulations 2018. We ensure compliance with targets set out in the Cyber Assessment Framework (CAF) Sector Specific Profile (SSP) and the recently published enhanced CAF.

Table 21 shows how different resilience and security options scored against the LTDS best value qualitative assessment.

Table 21: Qualitative best value analysis for resilience and security ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
Climate vulnerability								
Climate vulnerable mains and sewers – **Investigations, monitoring and renewals**								The option was selected as it supports the development of an adaptable and cost-efficient programme. The size of the programme was determined to balance the risk of bursts and impact on customer bills. The intervention is well established with a high certainty in reducing pipe bursts. The AMP8 and AMP9 renewals programme assumes mains replacement as this is less expensive and more effective than current relining techniques. Beyond AMP9 we have assumed the delivery and effectiveness of relining technologies is improved.
Overheating protection of vulnerable assets								Single alternative as protecting the vulnerable assets is the only viable way of reducing heat related failure. Proven, established techniques increasing the certainty of outcome. Size of the programme can be adapted to manage risk.
Flood Protection								
Working Partnership								We have a proven track record of delivering schemes in partnership with other authorities. These are always lower cost than if we delivered the same benefit in isolation, and generally deliver a greater range of benefits as we tend to deliver green solutions before grey solutions, thereby giving greater social and natural capital. Customers

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
								prefer this approach, but because programmes of delivery are controlled by a third party, there is often less adaptability/flexibility.
Working in isolation								Always more expensive to work in isolation. Whilst this gives us more flexibility, it is not the preference of customers and we tend to deliver grey solutions before green solutions, providing less benefits.
Delivering resistance and reliability								Provides a permanent solution to managing flood risk. Initial costs are higher (although still relatively low) but can result in cost savings over the long-term. In some cases, asset protection can be delivered in partnership with other agencies, e.g., the Environment Agency for assets at risk of coastal flooding. Our investment proposal is based on a detailed site assessment process to target high risk sites.
Using redundancy								Only applicable in certain circumstances, such as where water supplies can be re-zoned. We considered this for borehole sites, where raising the headworks was not possible due to site risks. Not applicable for water recycling assets.
Response and Recovery								This approach is generally acceptable for low consequence assets, but it is not appropriate for assets that have either a high likelihood or high consequence of failure.
Single point of failure and network resilience								
Alternative supply source								Where only a small number of properties will benefit from a connection, this option has a low Best Value outcome as cost and carbon impacts are higher than the risk reduction benefit.
Emergency contingency supply e.g., water tanker								This option is better value for small property clusters. An effective contingency plan with an alternative supply source provided by water tankers would minimise disruption to supply. Although, this is less preferable for the impacted customers, the overall reduced impact on cost bills is a benefit. The outcome is less certain than a permanent alternative supply option as it relies on the availability of tankers and third parties.
Critical supply resilience								The critical supply resilience programme identifies the assets where failure would have a high impact. For each high-risk failure site, alternative solutions have been considered using our best value framework. We compared the cost of

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
								the alternative and the value of the risk mitigated. We selected options that best balance against risk mitigation and customer bill impact. In each case we considered disruption to customers as well as the potential environmental impacts of the works. Some of these solutions involve mains replacement and dual mains installations which are cost. However, the outcome is more certain and the instance of a dual main, offers more flexibility. Where possible, the solutions have considered synergies with the WRMP investments and other existing programmes. For example, we have identified connections to the strategic main that will provide resilience benefits to properties at risk of supply failure.
SEMD								
Physical security measures to comply with SEMD requirements and external audit actions								The investment programme is responsive to SEMD compliance requirements. We ensure cost efficient delivery through our existing delivery contracts, benchmarking processes and technological horizon scanning.
Cyber Security								
Tools and NIS requirements								We investment programme is risk based, ensuring proportionate measures to secure out network and information systems. Our investment ensures targets under the enhanced Cyber Assessment Framework (eCAF) are met. We ensure cost efficient delivery through our existing delivery contracts, benchmarking processes and technological horizon scanning.

4.9. Net Zero

Table 22presents the qualitative best value analysis for the option types considered to deliver the net zero ambition.

Table 22: Qualitative best value analysis for net zero ambition

Option type	Cost	Carbon	Social capital	Natural capital	Adaptability / flexibility	Customer preference	Certainty of outcome	Comment
Chemical emission reduction schemes								Replacement of current chemicals with lower carbon alternatives although relatively expensive, the outcome and benefit are known.
Process emission reduction schemes								Process emission reductions can be undertaken through a range of site-specific solutions. However process emission science is still developing and therefore solution costs are maturing.
Replacement of HGV fleet with low emission alternatives								Clear and known carbon reduction outcome. Costs have become more viable over recent years. Solution option is necessary to both meet our own ambitions but to also comply with government ban on combustion engine vehicles
Biogas to grid schemes								Have already implemented a number of biogas to grid schemes so we have a good understanding of scheme costs and outcomes. It will also be possible to adapt solution should gas be required for incineration based alternative pathway
Residual risk liabilities								Doesn't directly mitigate our own carbon footprint but seeking to reduce this over time as we reduce our carbon footprint.

Appendix A: CRS Testing

High-level impact assessment of scenarios on investment lines

This section contains the high-level impact assessment of scenarios on investment lines undertaken with subject matters experts within Anglian Water.

Table A-1: LS3 – Abstraction reduction

Expenditure		Abstraction Reduction Impact and Comments			
		High (adverse)		Low (benign)	
1	Biodiversity and conservation	H	Cross over between abstraction reduction and non-abstraction measures	H	Cross over between abstraction reduction and non-abstraction measures
2	Eels/fish entrainment screens		Cross over between abstraction reduction and non-abstraction measures		Cross over between abstraction reduction and non-abstraction measures
3	Eels/fish passes	H	Cross over between abstraction reduction and non-abstraction measures	H	Cross over between abstraction reduction and non-abstraction measures
4	Invasive Non Native Species	H	Cross over between abstraction reduction and non-abstraction measures	H	Cross over between abstraction reduction and non-abstraction measures
5	Drinking Water Protected Areas	H	High - More sustainability reductions are likely to lead to more licences being reduced/eliminated and so leading to less DWPAs - more supply side options required (desalination + reuse) along with more stringent demand management targets.		No impact
6	Water Framework Directive		No impact		No impact
7	Wetland creation	L	Cross over between abstraction reduction and non-abstraction measures	L	Cross over between abstraction reduction and non-abstraction measures
8	Trade effluent discharge flow monitoring		No impact		No impact
9	25 year environment plan	L	Possible change in customer views leading to activity	L	Possible change in customer views leading to activity
10	Investigations	H	Would require more investigations due to increased sustainability reductions.	H	Assuming no further sustainability reductions the required investigation will be underway
11	Supply-side improvements	H	Additional abstraction reductions create pressure on supply/demand balance	H	Additional abstraction reductions create pressure on supply/demand balance
12	Demand-side improvements (excl leakage and metering)	H	Additional abstraction reductions create pressure on supply/demand balance /	H	Existing abstraction requirements - factor into plan
13	Leakage improvements	H	Additional abstraction reductions create pressure on supply/demand balance /	H	Existing abstraction requirements - factor into plan
14	Internal interconnectors	H	High - Further reduction in abstraction to be tested in the context of potentially bringing forward some aspects.	H	Existing abstraction requirements - factor into plan
15	New meters requested by existing customers (optants)		No impact		No impact

16	New meters introduced by companies for existing customers		No impact		No impact
17	New meters for existing customers - business		No impact		No impact
18	Replacement of existing basic meters with smart meters		No impact		No impact
19	Smart metering infrastructure		No impact		No impact
20	Improvements to taste, odour and colour (grey solutions)	L	Additional abstraction reductions could increase taste and odour issues.		No impact
21	Improvements to taste, odour and colour (green solutions)	L	Additional abstraction reductions could increase taste and odour issues.		No impact
22	Conditioning water to reduce plumbosolvency		No impact		No impact
23	Communication pipes replaced or relined		No impact		No impact
24	External lead supply pipes replaced or relined		No impact		No impact
25	Internal lead supply pipes replaced or relined		No impact		No impact
26	Other lead reduction related activity		No impact		No impact
27	Addressing raw water quality deterioration (grey solutions)	H	Additional abstraction reductions may place pressure on raw water quality /	L	Existing abstraction requirements - factor into plan
28	Addressing raw water quality deterioration (green solutions)	H	Additional abstraction reductions may place pressure on raw water quality	L	Existing abstraction requirements - factor into plan
29	Resilience	H	Reduced abstractions may reduce raw water resilience options		No impact
30	Security - SEMD		No impact		No impact
31	Security - Cyber		No impact		No impact
32	Greenhouse gas reduction (net zero)	L	High - could increase use of desalination technology		No impact

Table A-2: LS4 - Abstraction reduction

		Abstraction Reduction Impact and Comments			
Expenditure		High (adverse)		Low (benign)	
1	Biodiversity and conservation	L	Low impact	L	Low impact
2	Event Duration Monitoring at intermittent discharges		No impact		No impact
3	Flow Monitoring at sewage treatment works		No impact		No impact
4	Increase flow to full treatment		No impact		No impact
5	Increase storm tank capacity - grey solution		No impact		No impact

6	Increase storm storage / reduce need for storm tanks on site - green solution		No impact		No impact
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution		No impact		No impact
8	Storage to reduce spill frequency at CSOs etc - green solution		No impact		No impact
9	Surface water separation		No impact		No impact
10	Chemical Removal Schemes	L	Low impact	L	Low impact
11	Chemicals and emerging contaminants monitoring / investigations / options appraisals	L	Low impact	L	Low impact
12	Nitrogen removal	L	Low impact	L	Low impact
13	Nitrogen Technically Achievable Limit (TAL) monitoring, investigation or options appraisals	L	Low impact	L	Low impact
14	Phosphorous removal - grey solution	L	Low impact	L	Low impact
15	Nutrient permit (N or P) tightening green solution	L	Low impact	L	Low impact
16	Tightening of sanitary parameters - grey solution	L	Low impact	L	Low impact
17	Tightening of sanitary parameters - green solution	L	Low impact	L	Low impact
18	Microbiological treatment - coastal waters		No impact		No impact
19	Microbiological treatment - inland waters	L	Low impact	L	Low impact
20	Septic tank replacements - treatment solution		No impact		No impact
21	Septic tank replacements - flow diversion		No impact		No impact
22	Fish outfall screens		No impact		No impact
23	Sludge - disposal resilience and environmental impact		No impact		No impact
24	25 Year Environment Plan		No impact		No impact
25	Investigations	L	Low impact	L	Low impact
26	New or upgraded storm overflow screens		No impact		No impact
27	Growth at sewage treatment works (excluding sludge treatment)		No impact		No impact
28	Reducing flooding risk for properties		No impact		No impact
29	First time sewerage (S101a)		No impact		No impact
30	Sludge enhancement (quality)		No impact		No impact
31	Sludge enhancement (growth)		No impact		No impact
32	Odour and other nuisance		No impact		No impact
33	Resilience		No impact		No impact
34	Security - SEMD		No impact		No impact
35	Security - cyber		No impact		No impact
36	Greenhouse gas reduction (net zero)		No impact		No impact
37	Enhanced activity to address harm from storm overflows		No impact		No impact

Table A-3: LS3 – Climate Change

Expenditure		Climate change Impact and Comments			
		High (adverse)		Low (benign)	
1	Biodiversity and conservation	H	Changing weather patterns may impact on types of solutions that are effective /	L	Lower scenario will have mean less protective measures required to 'meet no detriment requirement' significantly reducing cost to achieve outcome or alternatively outperform targets
2	Eels/fish entrainment screens	H	Adverse - Changing weather patterns may impact on types of solutions that are effective		No impact
3	Eels/fish passes	H	Adverse - Changing weather patterns may impact on types of solutions that are effective		No impact
4	Invasive Non Native Species	H	Adverse - Changing weather patterns may increase spread of non native species. Will most likely require an increase in expenditure to deliver more natural capital solutions in addition to greater sustainability reductions (secondary impact on WINEP/WRMP /		No impact
5	Drinking Water Protected Areas	H	Unlikely to change requirements for existing sites - driven by specific legislation. However if high climate change drives more supply side schemes less expenditure maybe required on existing sites as some would not be remain viable (no licence available)	H	Changing weather patterns may lead to an increased need to protect drinking water sources
6	Water Framework Directive		No impact		No impact
7	Wetland creation	H	Changing weather patterns may impact on types of solutions that are effective e.g. may require further focus on wetland creation. Will most likely require an increase in expenditure to deliver more natural capital solutions in addition to greater sustainability reductions (secondary impact on WINEP/WRMP)	L	Less likely to be necessary
8	Trade effluent discharge flow monitoring		No impact		No impact
9	25 year environment plan	H	possible Climate Change affects customer views leading to activity	L	Benign - less likely, but still possible that relatively benign Climate Change affects customer views leading to activity being required
10	Investigations [WINEP]	L	Lead to more investigations as more potential detriment /	L	May lead to less investigations
11	Supply-side improvements	H	Supply Side Solutions likely to be larger (Ml/d) and higher in technological complexity		No impact
12	Demand-side improvements (excl leakage and metering)	H	Potentially leads to greater requirements for supply side and demand side solutions depending on the impact - e.g. whether its is a PDO or ADO impact. Achieving further smart meter penetration will help leverage customer behaviour change in reducing consumption and so	L	Increased peak period impact but not material for overall demand

			potential to reduce supply side interventions.		
13	Leakage improvements	H	Changing weather patterns may increase periods of breakout caused by prolonged drought. Most likely impact is an overall increase in mains failures and leakage due to higher variations in rainfall - in both summer and winter.		No impact
14	Internal interconnectors	L	As climate change impact increases, this is likely to create requirements for more Sustainable Reductions. / Benign - Changing weather patterns could still impact on types of solutions that are required		No impact
15	New meters requested by existing customers (optants)		N/A - existing optants		N/A - existing optants
16	New meters introduced by companies for existing customers		N/A - existing optants		N/A - existing optants
17	New meters for existing customers - business		N/A - existing customers		N/A - existing optants
18	Replacement of existing basic meters with smart meters	L	Changing weather causing increased water scarcity - leakage detection/consumer behaviour /	L	Factor into core pathway
19	Smart metering infrastructure	L	Changing weather causing increased water scarcity - leakage detection/changing consumer behaviour	L	Lower degrees of climate change may lead to options to slow down smart meter rollout.
20	Improvements to taste, odour and colour (grey solutions)	L	Adverse - Will changing weather patterns exacerbate - e.g. different water sources? /	L	Benign - Will eventually moderately changing weather patterns exacerbate - e.g. different water sources?
21	Improvements to taste, odour and colour (green solutions)	L	Adverse - Will changing weather patterns exacerbate - e.g. different water sources? /		Benign - Will even moderately changing weather patterns exacerbate - e.g. different water sources?
22	Conditioning water to reduce plumbosolvency		No impact		No impact
23	Communication pipes replaced or relined	H	No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns. As per notes in column S, likely adverse effects of climate change on pipe bursts but not related to lead specifically	H	No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns. As per notes in column S, likely adverse effects of climate change on pipe bursts but not related to lead specifically
24	External lead supply pipes replaced or relined		No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns		No direct impact but may alter lead renewal future policy if numbers of burst suppler and comm pipes increase due to changing weather patterns
25	Internal lead supply pipes replaced or relined		No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns		No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns
26	Other lead reduction related activity		No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns		No direct impact but may alter lead renewal future policy if numbers of burst supply and comm pipes increase due to changing weather patterns
27	Addressing raw water quality deterioration	H	Adverse - Changing weather patterns could lead to greater raw water	L	Lower impact, but still potential

	(grey solutions)		quality deterioration		
28	Addressing raw water quality deterioration (green solutions)	H	Adverse - Changing weather patterns could lead to greater raw water quality deterioration	L	Lower impact, but still potential
29	Resilience	H	Adverse - Changing weather patterns leads to more instances of weather that could exceed design parameters of infrastructure. /	L	Benign - Changing weather patterns will impact on resilience - lower impact than adverse
30	Security - SEMD		No impact		No impact
31	Security - Cyber		No impact		No impact
32	Greenhouse gas reduction (net zero)	L	Impacts both Adverse or Benign to greater or lesser degree. Factors may include - Changing weather patterns requires additional efforts to reduce GHG emissions. - Solutions identified to solve other aspects could lead to an increase in GHG emissions requiring additional activity in this area. - Targets may be changed over time - for example, Net Zero requirements may become more stringent, activity may be required to monitor and track, or dates may be changed.4	L	Impacts both Adverse or Benign to greater or lesser degree. Factors may include - Changing weather patterns requires additional efforts to reduce GHG emissions. - Solutions identified to solve other aspects could lead to an increase in GHG emissions requiring additional activity in this area. - Targets may be changed over time - for example, Net Zero requirements may become more stringent, activity may be required to monitor and track, or dates may be changed.

Table A-4: LS4 – Climate Change

Expenditure		Climate change Impact and Comments			
		High (Adverse)		Low (Benign)	
1	Biodiversity and conservation	H	Climate change e.g. faster rate of change may have a high impact on biodiversity and conservation		No impact
2	Event Duration Monitoring at intermittent discharges		No impact		No impact
3	Flow Monitoring at sewage treatment works		No impact		No impact
4	Increase flow to full treatment	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
5	Increase storm tank capacity - grey solution	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
6	Increase storm storage / reduce need for storm tanks on site - green solution	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
8	Storage to reduce spill frequency at CSOs etc - green solution	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
9	Surface water separation	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
10	Chemical Removal Schemes		No impact		No impact
11	Chemicals and emerging contaminants monitoring / investigations / options		No impact		No impact

	appraisals				
12	Nitrogen removal	H	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc		No impact
13	Nitrogen Technically Achievable Limit (TAL) monitoring, investigation or options appraisals	H	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc	L	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc
14	Phosphorous removal - grey solution	H	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc	L	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc
15	Nutrient permit (N or P) tightening green solution	H	Climate change may impact e.g. drier wetlands may not be as effective		No impact
16	Tightening of sanitary parameters - grey solution	H	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc	L	Climate change may cause changing weather patterns, changes in farming practises - i.e. higher concentrations and lower dilutions etc
17	Tightening of sanitary parameters - green solution	H	Climate change may impact e.g. rainfall increases or decreases / Benign - no impact		No impact
18	Microbiological treatment - coastal waters	H	Climate change may impact - e.g. increased sea temperature	H	Still impacted as sea temperature & level already rising
19	Microbiological treatment - inland waters	H	Climate change may impact - e.g. less water flow		No impact
20	Septic tank replacements - treatment solution		No impact		No impact
21	Septic tank replacements - flow diversion		No impact		No impact
22	Fish outfall screens	L	Low impact	L	Low Impact
23	Sludge - disposal resilience and environmental impact	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
24	25 Year Environment Plan	H	Climate Change effects affect customer views leading to activity	H	Customer views may still drive activity in a lower impact scenario
25	Investigations	L	Low impact	L	Low impact
26	New or upgraded storm overflow screens		No impact		No impact
27	Growth at sewage treatment works (excluding sludge treatment)	H	Climate change could lead to higher rainfall increasing likelihood		No impact
28	Reducing flooding risk for properties	H	Climate change leads to e.g. lower/higher rainfall		No impact
29	First time sewerage (S101a)		No impact		No impact
30	Sludge enhancement (quality)	L	Environmental targets may have an impact on e.g. biogas		No impact
31	Sludge enhancement (growth)	L	Environmental targets may have an impact on e.g. biogas		No impact
32	Odour and other nuisance		No impact		No impact
33	Resilience	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact
34	Security - SEMD		No impact		No impact
35	Security - cyber		No impact		No impact

36	Greenhouse gas reduction (net zero)	H	Impacts both Adverse or Benign to greater or lesser degree. Factors may include: - Changing weather patterns requires additional efforts to reduce GHG emissions. - Solutions identified to solve other aspects could lead to an increase in GHG emissions requiring additional activity in this area. - Targets may be changed over time - for example, Net Zero requirements may become more stringent, activity may be required to monitor and track, or dates may be changed.	H	Impacts both Adverse or Benign to greater or lesser degree. Factors may include: - Changing weather patterns requires additional efforts to reduce GHG emissions. - Solutions identified to solve other aspects could lead to an increase in GHG emissions requiring additional activity in this area. - Targets may be changed over time - for example, Net Zero requirements may become more stringent, activity may be required to monitor and track, or dates may be changed.
37	Enhanced activity to address harm from storm overflows	H	Climate change may cause changing weather patterns e.g. additional/reduced rainfall		No impact

Table A-5: LS3 – Demand

Expenditure		Growth Impact and Comments			
		High (adverse)		Low (benign)	
1	Biodiversity and conservation	L	High - growth could lead to more new developments - creating pressure on conservation spaces, an indirect impact / Low - no impact		No impact
2	Eels/fish entrainment screens		No impact		No impact
3	Eels/fish passes		No impact		No impact
4	Invasive Non Native Species		No impact		No impact
5	Drinking Water Protected Areas	H	Population growth will increase pressure on drinking water sources. In addition new developments are likely to encroach on DWPAs leading to more catchment monitoring requirements and greater likelihood of raw water deterioration.		No impact
6	Water Framework Directive		No Impact		No Impact
7	Wetland creation	H	High - Population growth may lead to greater encroachment onto existing/potential Wetland areas. Hence greater requirements		No impact
8	Trade effluent discharge flow monitoring		No impact		No impact
9	25 year environment plan		No impact		No impact
10	Investigations [WINEP]	H	Fast - Assuming encroachment - would lead to more investigations due to detriment	H	May lead to less investigations
11	Supply-side improvements delivering benefits	H	Leads to increased need for supply side solutions		No impact
12	Demand-side improvements delivering benefits (excl leakage and metering)	H	Growth leads to need for increased demand side solutions		No impact
13	Leakage improvements delivering benefits	H	Link to supply demand balance	L	Link to supply demand balance, reduced speed to leakage reduction required
14	Internal interconnectors	H	Growth could impact if the	L	Reduces need for connections to

	delivering benefits		additional demand is large enough for 2050 schemes to be accelerated.		new sources.
15	New meters requested by existing customers (optants)		N/A - existing optants		N/A – existing optants
16	New meters introduced by companies for existing customers		N/A - existing optants		N/A – existing optants
17	New meters for existing customers - business		N/A - existing customers		N/A – existing customers
18	Replacement of existing basic meters with smart meters		N/A - existing meters		N/A – existing meters
19	Smart metering infrastructure	H	Increased infrastructure is necessary	H	May lead to a slow down smart meter roll out.
20	Improvements to taste, odour and colour (grey solutions)	L	Higher growth = increase in numbers impacted?	L	factor into core pathway
21	Improvements to taste, odour and colour (green solutions)	L	Higher growth = increase in numbers impacted?	L	factor into core pathway
22	Conditioning water to reduce plumbosolvency		No impact		No impact
23	Communication pipes replaced or relined		No impact		No impact
24	External lead supply pipes replaced or relined		No impact		No impact
25	Internal lead supply pipes replaced or relined		No impact		No impact
26	Other lead reduction related activity		No impact		No impact
27	Addressing raw water quality deterioration (grey solutions)	H	Higher growth = greater demand	L	Factor into core pathway
28	Addressing raw water quality deterioration (green solutions)	H	High - Higher growth = greater demand	L	Factor into core pathway
29	Resilience	L	Higher growth = more reliance on existing assets	L	Factor into core pathway
30	Security - SEMD		No impact		No impact
31	Security - Cyber		No impact		No impact
32	Greenhouse gas reduction (net zero)		No impact		No impact

Table A-6: LS4 – Demand

Expenditure		Growth Impact and Comments			
		High (Adverse)		Low (benign)	
1	Biodiversity and conservation		No impact		No impact
2	Event Duration Monitoring at intermittent discharges	L	High growth might lead to additional activity being required		No impact
3	Flow Monitoring at sewage treatment works		No impact		No impact
4	Increase flow to full treatment	H	High growth might lead to additional activity being required		No impact
5	Increase storm tank capacity - grey solution	L	High growth might lead to additional activity being required		No impact
6	Increase storm storage / reduce need for storm	L	High growth might lead to additional activity being required		No impact

	tanks on site - green solution				
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution	H	High growth might lead to additional activity being required		No impact
8	Storage to reduce spill frequency at CSOs etc - green solution	H	High growth might lead to additional activity being required		No impact
9	Surface water separation	L	High growth might lead to additional activity being required		No impact
10	Chemical Removal Schemes	L	High growth might lead to additional activity being required		No impact
11	Chemicals and emerging contaminants monitoring / investigations / options appraisals		No impact		No impact
12	Nitrogen removal		No impact		No impact
13	Nitrogen Technically Achievable Limit (TAL) monitoring, investigation or options appraisals		No impact		No impact
14	Phosphorous removal - grey solution		No impact		No impact
15	Nutrient permit (N or P) tightening green solution		No impact		No impact
16	Tightening of sanitary parameters - grey solution		No impact		No impact
17	Tightening of sanitary parameters - green solution		No impact		No impact
18	Microbiological treatment - coastal waters		No impact		No impact
19	Microbiological treatment - inland waters		No impact		No impact
20	Septic tank replacements - treatment solution	L	High growth might lead to additional activity being required		No impact
21	Septic tank replacements - flow diversion	L	High growth might lead to additional activity being required		No impact
22	Fish outfall screens		No impact		No impact
23	Sludge - disposal resilience and environmental impact	L	High growth might lead to additional activity being required		No impact
24	25 Year Environment Plan		No impact		No impact
25	Investigations	H	Assuming encroachment - would lead to more investigations due to detriment		No impact
26	New or upgraded storm overflow screens		No impact		No impact
27	Growth at sewage treatment works (excluding sludge treatment)	H	High growth might lead to additional activity being required		No impact
28	Reducing flooding risk for properties	L	High growth might lead to additional activity being required		No impact
29	First time sewerage (S101a)	L	High growth might lead to additional activity being required		No impact
30	Sludge enhancement	L	High growth might lead to		No impact

	(quality)		additional activity being required		
31	Sludge enhancement (growth)	H	High growth might lead to additional activity being required		No impact
32	Odour and other nuisance		No impact		No impact
33	Resilience	L	High growth might lead to additional activity being required	L	Low growth might lead to some additional activity being required
34	Security - SEMD		No impact		No impact
35	Security - cyber		No impact		No impact
36	Greenhouse gas reduction (net zero)		No impact		No impact
37	Enhanced activity to address harm from storm overflows	H	High growth might lead to additional activity being required		No impact

Testing approaches for the CRSs

This section contains the detailed approach required for each of the enhancement investment lines for each of the common reference scenarios.

Table A-7: Assessment of abstraction scenario testing approach for each LS3 high impact investment line

LS3 Enhancement Line		Has enhancement already been tested?	If no testing to date, does capability exist?	If not tested and no existing capability, how will we test?
1	Biodiversity and conservation	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts WINEP has begun to look at the impact in context of flow changes from abstraction but investigations in AMP8 will quantify this link and the wider impacts of abstraction changes on biodiversity and conservation drivers. Next Steps: Since the impact of abstraction reduction on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with Biodiversity lead and Abstraction Reduction scenario lead and establish trigger points.
3	Eels/fish passes	No	No	Expert judgement Explore whether increased flows in chalk streams may cause demand for increased demand in eel/fish passes and how this might impact future planned expenditure. Testing will take place during a workshop with ecologist, abstraction scenario lead, WINEP lead.
4	Invasive Non-Native Species	No	No	Expert judgement Explore whether increased flows in chalk streams caused by the higher abstraction scenario may cause demand for increased numbers of invasive non-native species, particularly with transfer of raw water between catchments, and how this might impact future planned expenditure. Testing will take place during a workshop with ecologist, abstraction scenario lead, WINEP lead
5	Drinking Water Protected Areas	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts AMP8 investigations to cement quantification of relationship between scenario and impacts e.g. a rise in the water table results in an unknown retainment of chemicals. Next Steps: Since the impact of abstraction reduction on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with DrWPA driver lead and Abstraction Reduction scenario lead
10	Investigations	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts AMP8 investigations to cement quantification of relationship between scenario and impacts. Next Steps: Since the impact of abstraction reduction on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an

LS3 Enhancement Line		Has enhancement already been tested?	If no testing to date, does capability exist?	If not tested and no existing capability, how will we test?
				investigation/monitoring plan with Investigations lead and Abstraction Reduction scenario lead
11	Supply-side improvements	Yes The WRMP team has already completed testing against a high scenario and has created an adaptive pathway that manages the increased water supply capacity requirements identified in the adverse scenario (The Environment Agency's "enhanced scenario") (Ofwat 2022a). The conclusion of this testing is that significant additional water supplies would be required, for example via desalination, which requires significant additional investment. The WRMP requires that the EA's BAU + scenario is used to inform the most likely pathway. For LTDS the benign abstraction scenario is defined as "only currently known legal requirements" (Ofwat 2022a).	Yes Further testing is required to establish if the core pathway changes in response to the benign abstraction reduction scenario and establish if there is deviation between requirements for BAU+ (WRMP most likely pathway) and the benign CRS. Investigation in AMP are intended to provide insight into this with trigger point in 2029.	N/A
12	Demand-side improvements (excl leakage and metering)			N/A
13	Leakage improvements			N/A
14	Internal interconnectors			N/A
27	Addressing raw water quality deterioration (grey solutions)	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts It is not deemed possible to test this comprehensively and long-range with the current data set available. Impacts such as how much green water leaving in environment is unknown. Instead proposing an AMP-by-AMP monitoring plan with the potential for enhancement investment to be tested again in PR29 and beyond. Next Steps: Since the impact of abstraction reduction on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with Investigations lead and Abstraction Reduction scenario lead

LS3 Enhancement Line		Has enhancement already been tested?	If no testing to date, does capability exist?	If not tested and no existing capability, how will we test?
28	Addressing raw water quality deterioration (green solutions)	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts It is not deemed possible to test this comprehensively and long-range with the current data set available. Impacts such as how much green water leaving in environment is unknown. Instead proposing an AMP-by-AMP monitoring plan with the potential for enhancement investment to be tested again in PR29 and beyond. Next Steps: Since the impact of abstraction reduction on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with Investigations lead and Abstraction Reduction scenario lead
29	Resilience	Yes The WRMP team has already completed testing against a high scenario and has created an adaptive pathway that manages the increased water supply capacity requirements identified in the adverse scenario (The Environment Agency's "enhanced scenario") (Ofwat 2022a). The conclusion of this testing is that significant additional water supplies would be required, for example via desalination, which requires significant additional investment.	Yes The WRMP requires that the EA's BAU + scenario is used to inform the most likely pathway. For LTDS the benign abstraction scenario is defined as "only currently known legal requirements" (Ofwat 2022a). Further testing is required to establish if the core pathway changes in response to the benign abstraction reduction scenario and establish if there is deviation between requirements for BAU+ (WRMP most likely pathway) and the benign CRS. Investigation in AMP are intended to provide insight into this with trigger point in 2029.	N/A

Table A-8: Assessment of climate change scenario testing approach for each LS3 high impact investment line

LS3 enhancement line	Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
1	Biodiversity and conservation	No	No	Expert judgement No Biodiversity / Conservation schemes are planned beyond those included in AMP8 WINEP (as we are awaiting wider govt'/local gov't plans before aligning with them for longer term investments). For AMP8 WINEP climate change scenario assessed as Low Impact as unlikely that climate change will impact significantly over the next five year period - investments planned are low regrets. Could average historic spend and forecast out into the future and scenario model increased flows against this but no current models exist and would need to be built and with a likely change in government plans it would likely not produce results to high levels of confidence.
2	Eels/fish entrainment screens	No	No	Expert judgement No eels/fish entrainment screen schemes are planned beyond those included in AMP8 WINEP. For AMP8 WINEP climate change scenario assessed as Low Impact as unlikely that climate change will impact significantly over the next five year period - investments planned are low regrets. In light of uncertainty we're forecasting expenditure broadly in line with historical investment, but cannot model CRS impacts with any useful certainty due to the uncertainty of future scheme specifics
3	Eels/fish passes	No	No	Expert judgement No eels/fish entrainment pass schemes are planned beyond those included in AMP8 WINEP. For AMP8 WINEP climate change scenario assessed as Low Impact as unlikely that climate change will impact significantly over the next five year period - investments planned are low regrets. In light of uncertainty we're forecasting expenditure broadly in line with historical investment, but cannot model CRS impacts with any useful certainty due to the uncertainty of future scheme specifics
4	Invasive Non-Native Species	Yes We have already tested as part of WINEP based on UKWIR report demonstrating Anglian region likely to be significantly more vulnerable to Invasive Non Native Species in the future as result of climate change.		

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
5	Drinking Water Protected Areas	No		Expert judgement No testing has been undertaken to date and no certain investment profile has been accounted for beyond AMP8. Average historic spend required to be forecast into the future as expectation that programme will continue in a similar nature as risks emerge. Impacts on agriculture understood through existing studies commissioned but no model exists/has been used to attribute these impacts to DrWPA investments. Expert judgement required to attribute this impact. Suggested workshop with DrWPA driver owner (WINEP), climate change scenario lead and a risk modeller. Workshop to ascertain likely qualitative impacts of adverse and benign scenarios
7	Wetland creation			Expert judgement No testing has been undertaken to date and no certain investment profile has been accounted for beyond AMP8. Average historic spend required to be forecast into the future as expectation that programme will continue in a similar nature as risks emerge. Impacts on agriculture understood through existing studies commissioned but no model exists/has been used to attribute these impacts to DrWPA investments. Expert judgement required to attribute this impact. Suggested workshop with Wetland Creation driver owner, climate change scenario lead and risk modeller
9	25 year environment plan	No	No	AMP8 monitoring The only item in the 25 year Environment Plan is the AMP8 AWINEP. The only expenditure in the AWINEP is focused on improving governance structures for partnerships, there is no asset enhancement expenditure planned. Because we're looking at governance in AMP8, none of our AMP8 expenditure is impacted by any of the scenarios (growth, abstraction reduction, climate change, technology). Looking forwards beyond AMP8, whilst we have a good understanding of themes of investment under the 25 year environment plan, we do not have specific expenditure planned out. This is because we need our partnerships to push forwards their wants and we cannot yet predict what these will precisely be. The governance arrangements we are putting in place in AMP8 should help this Therefore, suggest for the LTDS the plan is to monitor this line of investment, work with partnerships to build a longer term strategy and when known test against the scenarios as set by Ofwat.

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
				Next steps: Since the impact of climate change on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with AWINEP lead
11	Supply-side improvements	Yes Both high and low scenarios already tested as part of WRMP	N/A	N/A
12	Demand-side improvements (excl leakage and metering)	Yes Both high and low scenarios already tested as part of WRMP	N/A	N/A
13	Leakage improvements	Yes (in part) Modelling has already been undertaken for the effect of climate change on summer pipe bursts (model tests RCP8.6 and 2.5 per Ofwat scenario) which will help inform effect on comms pipes replacement but modelling of summer bursts needs linking back to leakage improvements	N/A	Expert judgement Expert judgement should supplement the modelling to consider wider opportunities for climate change to impact leakage improvement enhancement expenditure. Suggest workshop to contain leakage expert, climate change lead, WRMP lead
23	Communication pipes replaced or relined	Yes (in part) Modelling has already been undertaken for the effect of climate change on summer pipe bursts (model tests RCP8.6 and 2.5 per Ofwat scenario) which will help inform effect on comms pipes replacement, but modelling of summer bursts needs linking back to comms pipes	N/A	Expert judgement Expert judgement should supplement the modelling to consider wider opportunities for climate change to impact comm pipe replacement/relining enhancement expenditure. Judgement workshop to contain leakage expert, climate change lead, WRMP lead
27	Addressing raw water quality deterioration (grey solutions)	No	No	Expert judgement We expect there to be impacts of climate change relating to water quality but these have not been fully assessed yet. We include some headroom to account for a known water quality risk in groundwater in the Suffolk West Cambs WRZ (see Planning Factors report, Table 1) under extreme drought. Elsewhere in groundwater, sources are likely to be licence constrained rather than yield constrained. For surface sources water quality does affect abstraction potential, but it is not clear that this has or will have a material impact on deployable output. A more direct concern is the impact of algae on reservoir water quality, an issue which already affects some reservoirs; we have conducted extensive research on this issue historically and currently have a PhD project looking at how this might change in future and the impact on deployable output. Next steps: Workshop including water quality, risk modeller and climate change lead to agree how to assess these impacts against these
28	Addressing raw water quality deterioration (green solutions)			

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
				investment lines
29	Resilience	Yes Scenarios already tested as part of Climate Change Adaption Report / Credo report	N/A	N/A

Table A-9: Assessment of Climate Change scenario testing approach for each LS4 high impact investment line

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
1	Biodiversity and conservation	No	N/A	Expert judgement No Biodiversity / Conservation schemes are planned beyond those included in AMP8 WINEP (as we are awaiting wider govt'/local gov't plans before aligning with them for longer term investments). For AMP8 WINEP climate change scenario assessed as Low Impact as unlikely that climate change will impact significantly over the next five year period - investments planned are low regrets. In addition, could average historic spend and forecast out into the future and scenario model increased flows against this but no current models exist and would need to be built and with a likely change in government plans it would likely not produce results to high levels of confidence. Suggest workshop to include Biodiversity lead and climate change scenario lead
4	Increase flow to full treatment	No	N/A	Expert judgement No schemes are planned for beyond AMP8 and likely not to see significant climate change impacts on FFT schemes within the next five years. In addition, could average historic spend and forecast out into the future and scenario model increased flows against this but no current models exist and would need to be built. Suggest workshop to include treatment lead and climate change scenario lead
5	Increase storm tank capacity - grey solution	No	N/A	Expert judgement No schemes are planned for beyond AMP8 and likely not to see significant climate change impacts on FFT schemes within the next five years. In addition, could average historic spend and forecast out into the future

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
				and scenario model increased flows against this but no current models exist and would need to be built. Suggest workshop to include treatment lead and climate change scenario lead
6	Increase storm storage / reduce need for storm tanks on site - green solution	No	Yes Only AMP8 schemes in WINEP – these have not had climate change testing undertaking against them but modelling of 2 and 4 degrees is possible and modelling will be done shortly.	N/A
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution	No	Yes For AMP8 schemes in WINEP – these have not had climate change testing undertaking against them but modelling of 2 and 4 degrees is possible and modelling will be done shortly For beyond AMP8, models exist but they are catchment by catchment and would need to be adjusted individually (very time-consuming c.4+ months). Our subject matter experts recommends instead taking a sample approach – i.e. study the impact of both benign and adverse scenarios on c.10 catchments and apply average impact across all catchments to ascertain overall impact. We have already successfully used this approach and undertaken sample of climate change modelling at RCP8.5 50th and 90th percentiles. To undertake this approach sample impact ascertainment may take c.1month and then would require time to add average uplift to other catchment models impact. Have already undertaken sample of climate change modelling (looking at flooding only rather than CSO spills) at RCP8.5 and 4.6 and 50th and 90th percentile. Would therefore need to undertake this approach for RCP2.6 - sample impact ascertainment may take c.1month and then would require time to add average uplift to other catchment models	N/A

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
8	Storage to reduce spill frequency at CSOs etc - green solution	No	Yes For AMP8 schemes in WINEP – these have not had climate change testing undertaking against them but modelling of 2 and 4 degrees is possible and modelling will be done shortly. For beyond AMP8, models exist but they are catchment by catchment and would need to be adjusted individually (very time-consuming 4+ months).). Our subject matter experts recommend taking a sample approach – i.e. study the impact of both benign and adverse scenarios on c.10 catchments and apply average impact across all catchments to ascertain overall impact. We have already successfully used this approach and undertaken sample of climate change modelling at RCP8.5 50th and 90th percentiles. To undertake this approach sample impact ascertainment may take c.1month and then would require time to add average uplift to other catchment models	N/A
9	Surface water separation	No	Yes For AMP8 schemes in WINEP – these have not had climate change testing undertaking against them but modelling of 2 and 4 degrees is possible and modelling will be done shortly. For beyond AMP8, models exist but they are catchment by catchment and would need to be adjusted individually (very time consuming 4+ months).). Our subject matter experts recommend taking a sample approach – i.e. study the impact of both benign and adverse scenarios on c.10 catchments and apply average impact across all catchments to ascertain overall impact. We have already successfully used this approach and undertaken sample of climate change modelling at RCP8.5 50th and 90th percentiles. To undertake this approach sample impact ascertainment may take c.1month and	N/A

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
			then would require time to add average uplift to other catchment models	
12	Nitrogen removal	No	No	AMP8 monitoring No current long-term nitrogen schemes planned however if changes in phosphorous limits are put in place (i.e. reduced limits) this may increase nitrogen concentrations and therefore this will need to be considered. Given the lack of investment forecast suggest monitoring this during coming AMPs and undertaking modelling if P removal limits are reduced Next steps: Since the impact of climate change on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with Nitrogen lead and climate change lead
13	Nitrogen Technically Achievable Limit (TAL) monitoring, investigation or options appraisals	No	No	
14	Phosphorous removal - grey solution	No	No	Model build required Potential flow changes due to climate change have been modelled already (aligned to Ofwat scenarios), but no wider climate change impacts have (including change in farming practises). Increased concentrations coupled with lower flows could cause significant impacts. Mathematical modelling required and should be built to assess the full impact Next steps: SME workshop - Treatment lead and climate change lead to identify quantifiable impacts of climate change on investment line. Treatment lead, climate change lead and modeller to design input parameters and required model outputs Modeller to design spreadsheet model of investments against quantified impacts
15	Nutrient permit (N or P) tightening green solution	No	No	
16	Tightening of sanitary parameters - grey solution	No	No	
17	Tightening of sanitary parameters - green solution	No	No	
18	Microbiological treatment - coastal waters	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
19	Microbiological treatment - inland waters	No	No	AMP8 investigations to cement quantification of relationship between scenario and impacts – likely to need more microbiological treatment with increased storm flows, but longer hot summer periods will increase natural UV treatment at beaches where samples are taken so potential for less Bathing Water Non-Deterioration notices. Impact of these climate change effects may balance each other out but unknown quantification of either effect. BWINV incidences (investigations) during AMP8 will help ascertain this. Next Steps: Since the impact of climate change on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with Microbiological treatment lead and climate change scenario lead and establish trigger points.
23	Sludge - disposal resilience and environmental impact	No	No	Expert judgement ADAS currently undertaking study to demonstrate impact of climate change (RCP 2.6 and 8.5) on sludge disposal - (increasing distance to landbanks) but will need to link outcome of this report back to enhancement investments proposed. Suggest workshop with ADAS, Bioresources lead and climate change scenario lead
24	25 Year Environment Plan	N/A	N/A	Monitor during AMP8 The only item in the 25 year Environment Plan is the AMP8 AWINEP. The only expenditure in the AWINEP is focused on improving governance structures for partnerships there is no asset enhancement expenditure planned. Because we're looking at governance in AMP8, none of our AMP8 expenditure is impacted by any of the scenarios (growth, abstraction reduction, climate change, technology). Looking forwards beyond AMP8, whilst we have a good understanding of themes of investment under the 25 year environment plan, we do not have specific expenditure planned out. This is because we need our partnerships to push forwards their wants and we cannot yet predict what these will precisely be. The governance arrangements we are putting in place in AMP8 should help this Therefore, suggest for the LTDS the plan is to monitor this line of investment, work with partnerships to build a longer term strategy and when known test against the scenarios as set by Ofwat. Next steps: Since the impact of climate change on this line item is not understood testing at this time against this line item is not possible.

LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
				Instead, propose next steps should be to design an investigation/monitoring plan design with AWINEP lead
27	Growth at sewage treatment works (excluding sludge treatment)	No	No	AMP8 Investigations required to determine precise link between scenario inputs and resultant impacts No comprehensive climate change impacts looked at as part of DWMP. Only looked at flow impacts. i.e. what goes to storm more often and therefore what's the impact on permit compliance. (even with excess flows this will go to storm tank which will just spill more often). Did not look at heat impact etc. Mathematical relationship between climate and growth at sewage treatment works unknown and therefore cannot model so suggest that during AMP8 this relationship is investigated and then modelled. Next Steps: Since the impact of climate change on this line item is not understood testing at this time against this line item is not possible. Instead, propose next steps should be to design an investigation/monitoring plan with treatment lead and climate change scenario lead and establish trigger points.
28	Reducing flooding risk for properties	Yes Scenarios already tested as part of Climate Change Adaption Report	N/A	N/A
33	Resilience	Yes Scenarios already tested as part of Climate Change Adaption Report / Credo report	N/A	N/A
36	Greenhouse gas reduction (net zero)	Yes NZ strategy contains comprehensive analysis of carbon reduction approaches	N/A	N/A
37	Enhanced activity to address harm from storm overflows	No	N/A	No schemes are currently planned and therefore no investment planned. Monitor during AMP8 No schemes are currently planned and therefore no investment planned. Next Steps: Agree with strategy lead approach to monitor need for schemes and therefore testing on an ongoing basis.

Table A-10: Assessment of scenario Demand testing approach for each LS3 high impact investment line

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
5	Drinking Water Protected Areas	Yes Testing against high population scenario already complete. Not tested low growth scenario as impact over 25 years deemed to be of low materiality	N/A	N/A
7	Wetland creation	Yes Testing against high population scenario already complete. Not tested low growth scenario as impact over 25 years deemed to be of low materiality	N/A	N/A
10	Investigations [WINEP]	Yes Testing against high population scenario already complete. Not tested low growth scenario as impact over 25 years deemed to be of low materiality	N/A	N/A
11	Supply-side improvements delivering benefits	Yes (partially) Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
12	Demand-side improvements delivering benefits (excl leakage and metering)	Yes (partially) Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
13	Leakage improvements delivering benefits	Yes (partially) Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
14	Internal interconnectors delivering benefits	Yes (partially) Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
19	Smart metering infrastructure	Yes (partially) Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
27	Addressing raw water quality deterioration (grey solutions)	Yes Testing against High growth scenario already complete. Low growth is not deemed to be the driver here - so testing high	N/A	N/A

LS3 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
		scenario only here is appropriate.		
28	Addressing raw water quality deterioration (green solutions)	Yes Testing against High growth scenario already complete. Low growth is not deemed to be the driver here - so testing high scenario only here is appropriate.	N/A	N/A

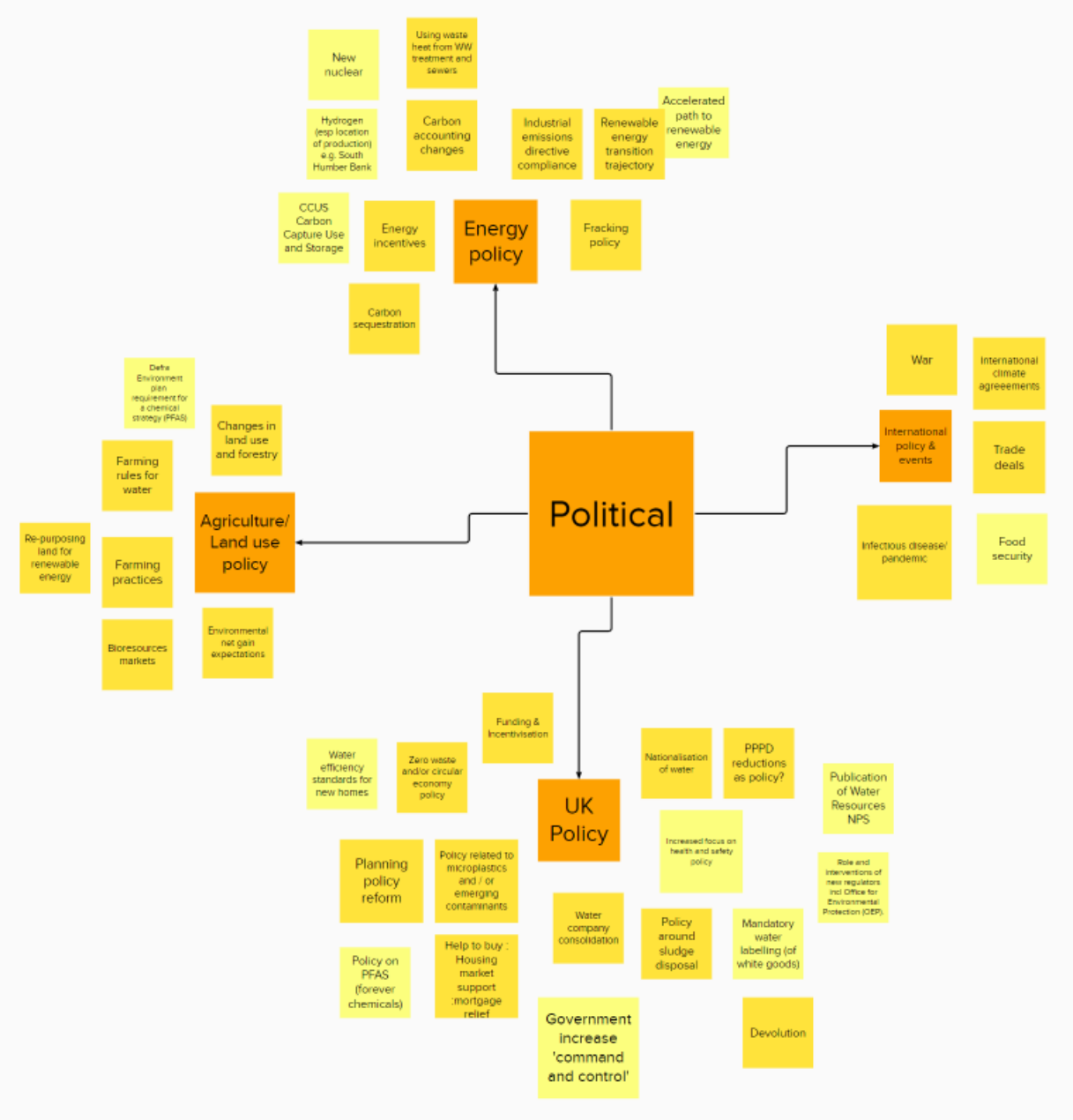
Table A-11: Assessment of Demand scenario testing approach for each LS4 high impact investment line

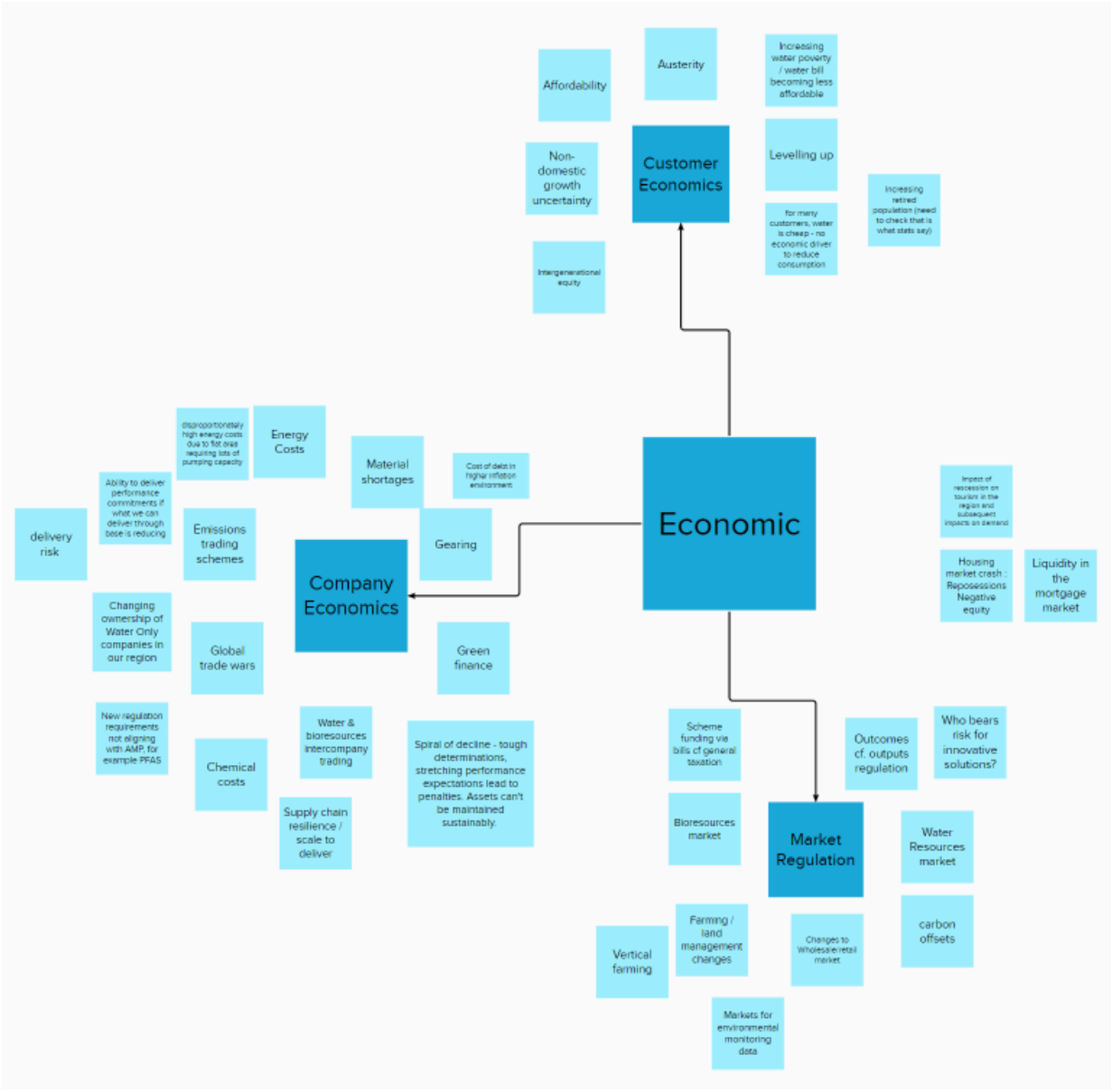
LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
4	Increase flow to full treatment	Yes (partially) Testing against High growth scenario has been completed. Low growth testing still required- have ONS data set and ability (models and capability)	Low growth scenario not tested & will require testing for LTDS and PR24	N/A
7	Storage schemes to reduce spill frequency at CSOs etc - grey solution	N/A	Yes (Catchment) Models exist that can be adjusted but would have to do one by one and would take months. Similar to climate change approach could do sample of modelling on handfuls of catchments then apply % uplift results to remainder of catchments	N/A
8	Storage to reduce spill frequency at CSOs etc - green solution	Yes (partially) Testing against High growth scenario has been completed. Low growth testing still required- have ONS data set and ability (models and capability)	Yes Need to run model with low scenario	N/A
25	Investigations	Yes (partially) Testing against High growth scenario has been completed. Low growth testing still required- have ONS data set and ability (models and capability)	Yes Need to run model with low scenario	N/A

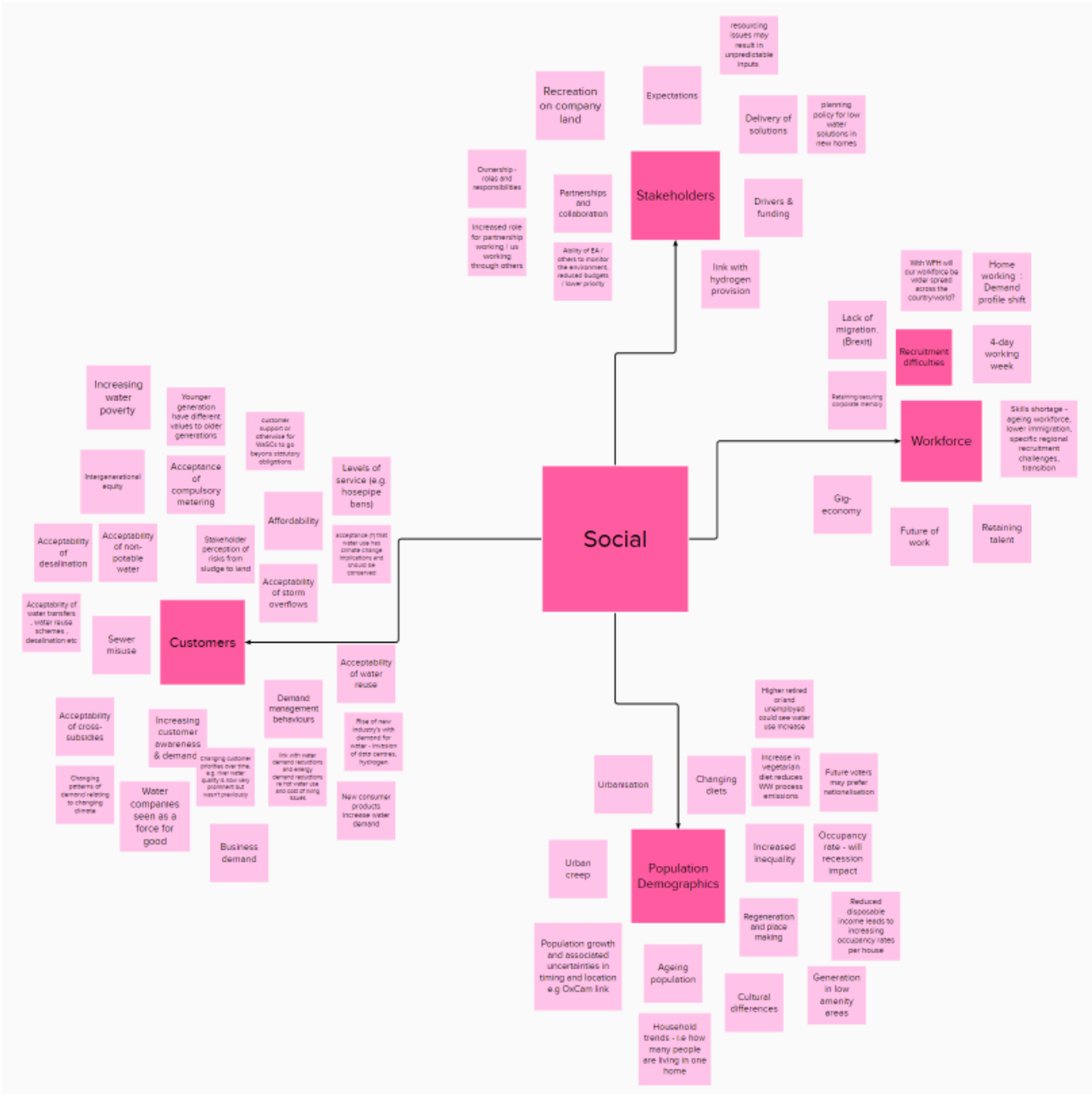
LS4 enhancement line		Has enhancement already been tested?	If no testing to date, does the capability exist?	If not tested and no capability - add to comments what possible options might be available
27	Growth at sewage treatment works (excluding sludge treatment)	No	Yes (Catchment) Models exist that can be adjusted but would have to do one by one and would take months. Similar to climate change approach could do sample of modelling on handfuls of catchments then apply % uplift results to remainder of catchments	N/A
31	Sludge enhancement (growth)	No	Yes BMA currently updating scenario testing model with additional functionality. Model has capability to test growth parameters aligned to Ofwat's Growth Scenario definition. Model will be fully available for usage March onwards and modelling likely to take c. <1 week to complete. Possibility to bring date forwards if use gowth scenario as part of the model testing/commissioning phase.	N/A
37	Enhanced activity to address harm from storm overflows	Yes (partially) Testing against High growth scenario has been completed. Low growth testing still required- have ONS data set and ability (models and capability)	Yes Need to run model with low scenario	N/A

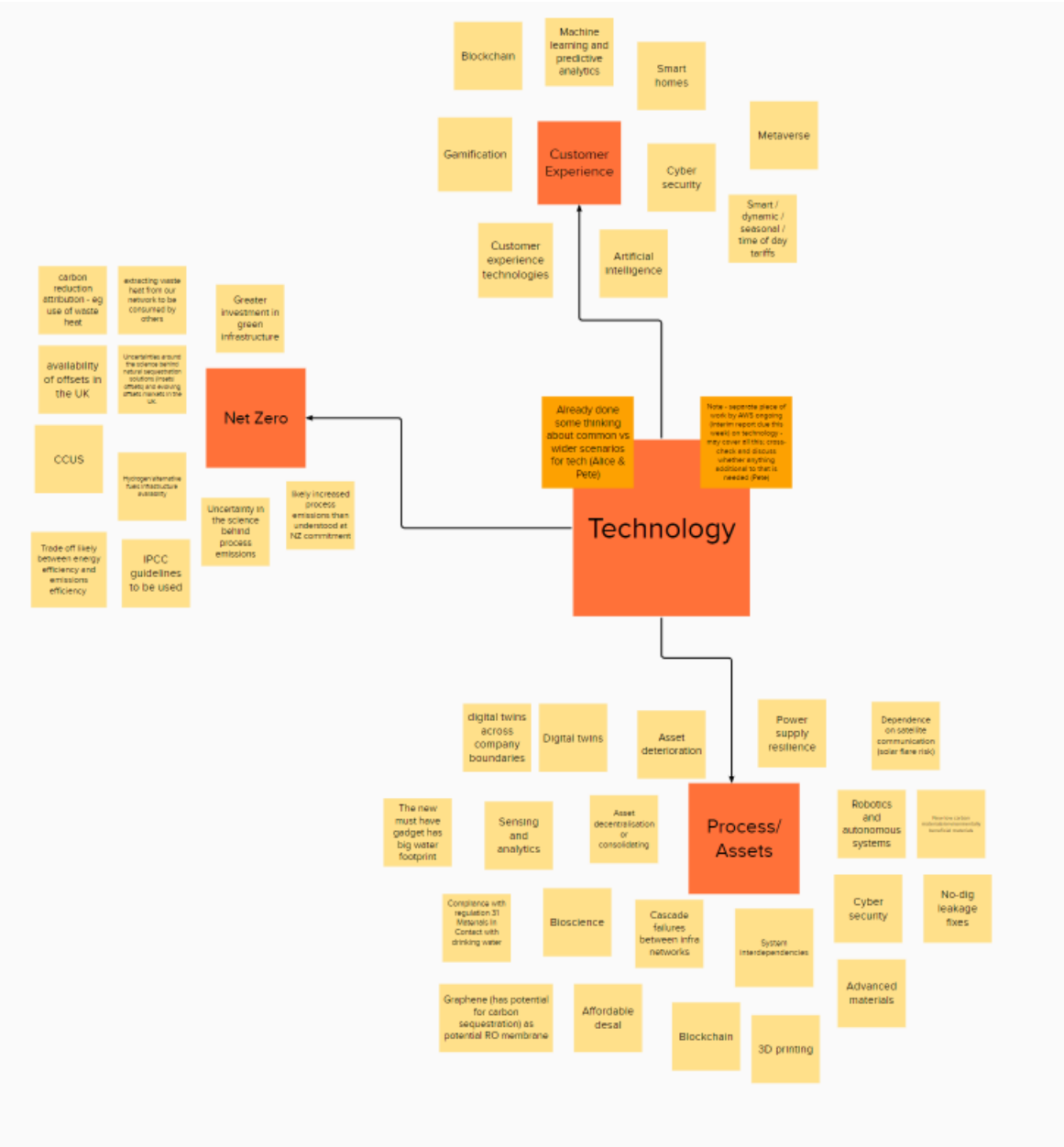
Appendix B: Wider scenario development

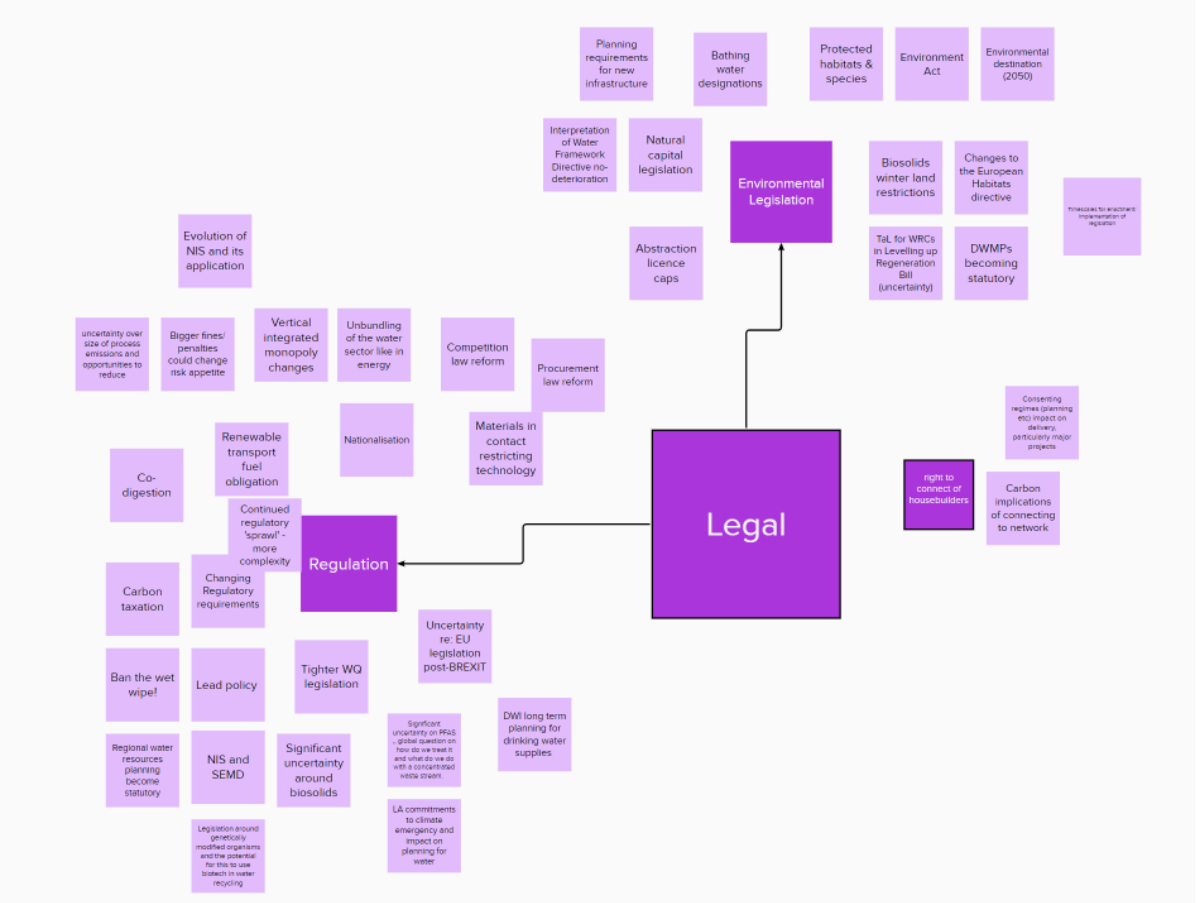
Outputs from the longlist development exercise

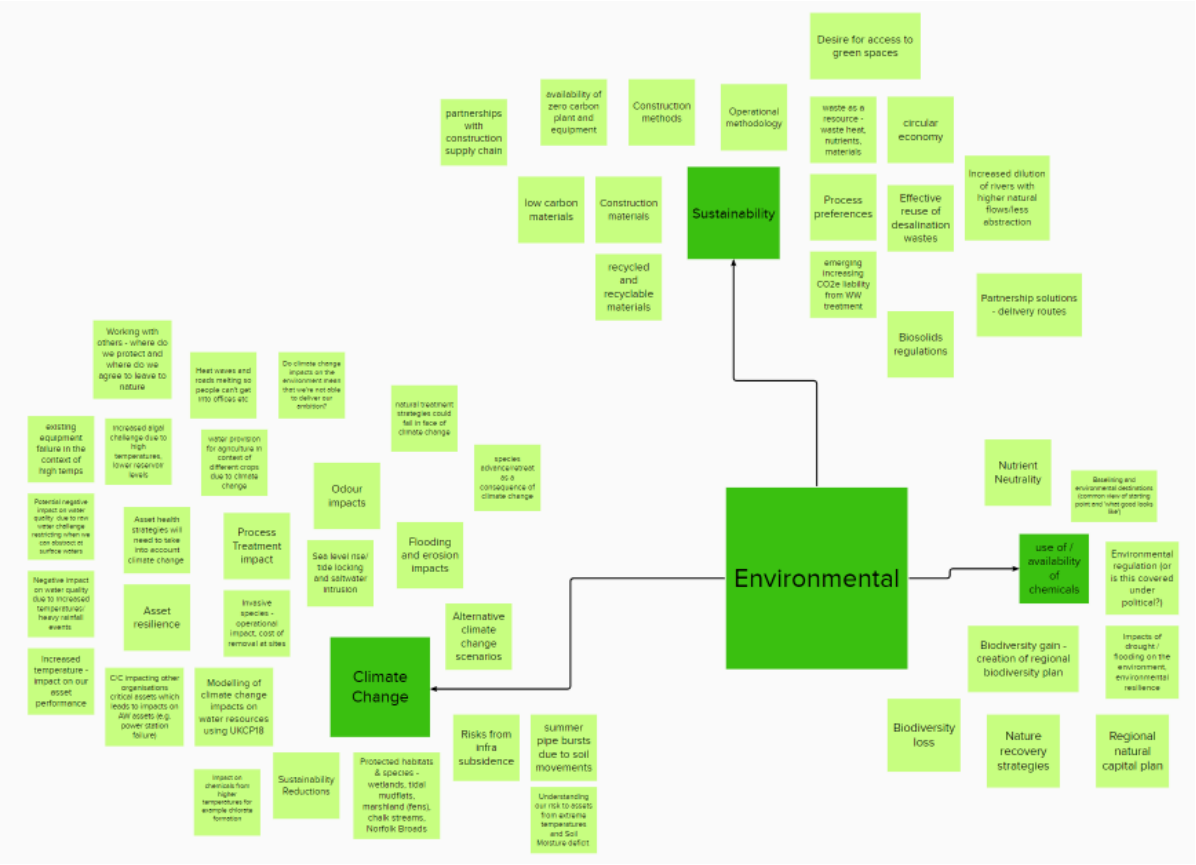



Economic
Customer Economics
Affordability
Austerity
Increasing water poverty / water bill becoming less affordable
Non-domestic growth uncertainty
Levelling up
for many customers, water is cheap - no economic driver to reduce consumption
Increasing retired population (need to check that is what stats say)
Intergenerational equity
Company Economics
Energy Costs
disproportionately high energy costs due to flat rate requiring lots of pumping capacity
Material shortages
Cost of debt in higher inflation environment
Gearing
Ability to deliver performance commitments if what we can deliver through base is reducing
delivery risk
Emissions trading schemes
Changing ownership of Water Only companies in our region
Global trade wars
Green finance
New regulation requirements not aligning with AMP, for example PFAS
Chemical costs
Water & bioresources intercompany trading
Supply chain resilience / scale to deliver
Spiral of decline - tough determinations, stretching performance expectations lead to penalties. Assets can't be maintained sustainably.
Impact of recession on tourism in the region and subsequent impacts on demand
Housing market crash : Repossessions Negative equity
Liquidity in the mortgage market
Market Regulation
Scheme funding via bills cf general taxation
Outcomes cf. outputs regulation
Who bears risk for innovative solutions?
Bioresources market
Water Resources market
carbon offsets
Vertical farming
Farming / land management changes
Changes to Wholesale retail market
Markets for environmental monitoring data


Social
Stakeholders
Recreation on company land
Expectations
resourcing issues may result in unpredictable inputs
Delivery of solutions
planning policy for low water solutions in new homes
Ownership - roles and responsibilities
Partnerships and collaboration
Drivers & funding
Increased role for partnership working / us working through others
Ability of EA / others to monitor the environment, reduced budgets / lower priority
link with hydrogen provision
Workforce
With WFH will our workforce be wider spread across the country/world?
Home working : Demand profile shift
Lack of migration. (Brexit)
Recruitment difficulties
4-day working week
Retaining/securing corporate memory
Skills shortage - ageing workforce, lower immigration, specific regional recruitment challenges, transition
Gig-economy
Future of work
Retaining talent
Customers
Increasing water poverty
Younger generation have different values to older generations
customer support or otherwise for WaSCs to go beyond statutory obligations
Intergenerational equity
Acceptance of compulsory metering
Levels of service (e.g. hosepipe bans)
Affordability
Acceptability of desalination
Acceptability of non-potable water
Stakeholder perception of risks from sludge to land
acceptance (?) that water use has climate change implications and should be conserved
Acceptability of storm overflows
Acceptability of water transfers , wtfair reuse schemes , desalination etc
Sewer misuse
Acceptability of water reuse
Demand menegement behaviours
Acceptability of cross-subsidies
Increasing customer awareness & demand
Rise of new industry's with demand for water - invasion of data centres, hydrogen
changing customer priorities over time, e.g. their water quality is now very prominent but wasn't previously
link with water demand reductions and energy demand reductions re not water use and cost of living issues
Changing patterns of demand relating to changing climate
Water companies seen as a force for good
New consumer products increase water demand
Business demand
Population Demographics
Higher retired or/and unemployed could see water use increase
Urbanisation
Changing diets
Increase in vegetarian diet reduces WW process emissions
Future voters may prefer nationalisation
Urban creep
Increased inequality
Occupancy rate - will recession impact
Regeneration and place making
Reduced disposable income leads to increasing occupancy rates per house
Population growth and associated uncertainties in timing and location e.g OxCam link
Ageing population
Cultural differences
Generation in low amenity areas
Household trends - i.e how many people are living in one home


Blockchain
Machine learning and predictive analytics
Smart homes
Metaverse
Gamification
Customer Experience
Cyber security
Smart / dynamic / seasonal / time of day tariffs
Customer experience technologies
Artificial intelligence
carbon reduction attribution - eg use of waste heat
extracting waste heat from our network to be consumed by others
Greater investment in green infrastructure
availability of offsets in the UK
Uncertainties around the science behind natural sequestration solutions (trees) offsets and evolving offsets markets in the UK
Net Zero
CCUS
Hydrogen/alternative fuels infrastructure availability
Already done some thinking about common vs wider scenarios for tech (Alice & Pete)
Note - separate piece of work by AWS ongoing (interim report due this week) on technology - they cover all this, cross-check and discuss whether anything additional to that is needed. (Pete)
Technology
Uncertainty in the science behind process emissions
likely increased process emissions than understood at NZ commitment
Trade off likely between energy efficiency and emissions efficiency
IPCC guidelines to be used
digital twins across company boundaries
Digital twins
Asset deterioration
Power supply resilience
Dependence on satellite communication (solar flare risk)
The new must have gadget has big water footprint
Sensing and analytics
Asset decentralisation or consolidating
Process/ Assets
Robotics and autonomous systems
Compliance with regulation 31 Materials in Contact with drinking water
Bioscience
Cascade failures between infra networks
System interdependencies
Cyber security
No-dig leakage fixes
Advanced materials
Graphene (has potential for carbon sequestration) as potential RO membrane
Affordable desal
Blockchain
3D printing


Legal
Environmental Legislation
Planning requirements for new infrastructure
Bathing water designations
Protected habitats & species
Environment Act
Environmental destination (2050)
Interpretation of Water Framework Directive no-deterioration
Natural capital legislation
Biosolids winter land restrictions
Changes to the European Habitats directive
Abstraction licence caps
ToL for WRCs in Levelling up Regeneration Bill (uncertainty)
DWMPs becoming statutory
Evolution of NIS and its application
uncertainty over size of process emissions and opportunities to reduce
Bigger fines/ penalties could change risk appetite
Vertical integrated monopoly changes
Unbundling of the water sector like in energy
Competition law reform
Procurement law reform
Nationalisation
Materials in contact restricting technology
Renewable transport fuel obligation
Co-digestion
Regulation
Continued regulatory 'sprawl' - more complexity
Changing Regulatory requirements
Carbon taxation
Ban the wet wipe!
Lead policy
Tighter WQ legislation
Uncertainty re: EU legislation post-BREXIT
DWI long term planning for drinking water supplies
Regional water resources planning become statutory
NIS and SEMD
Significant uncertainty around biosolids
Significant uncertainty on PFAS , global question on how do we treat it and what do we do with a concentrated waste stream.
LA commitments to climate emergency and impact on planning for water
Legislation around genetically modified organisms and the potential for this to use biotech in water recycling
right to connect of housebuilders
Carbon implications of connecting to network
Consenting regimes (planning etc) impact on delivery, particularly major projects

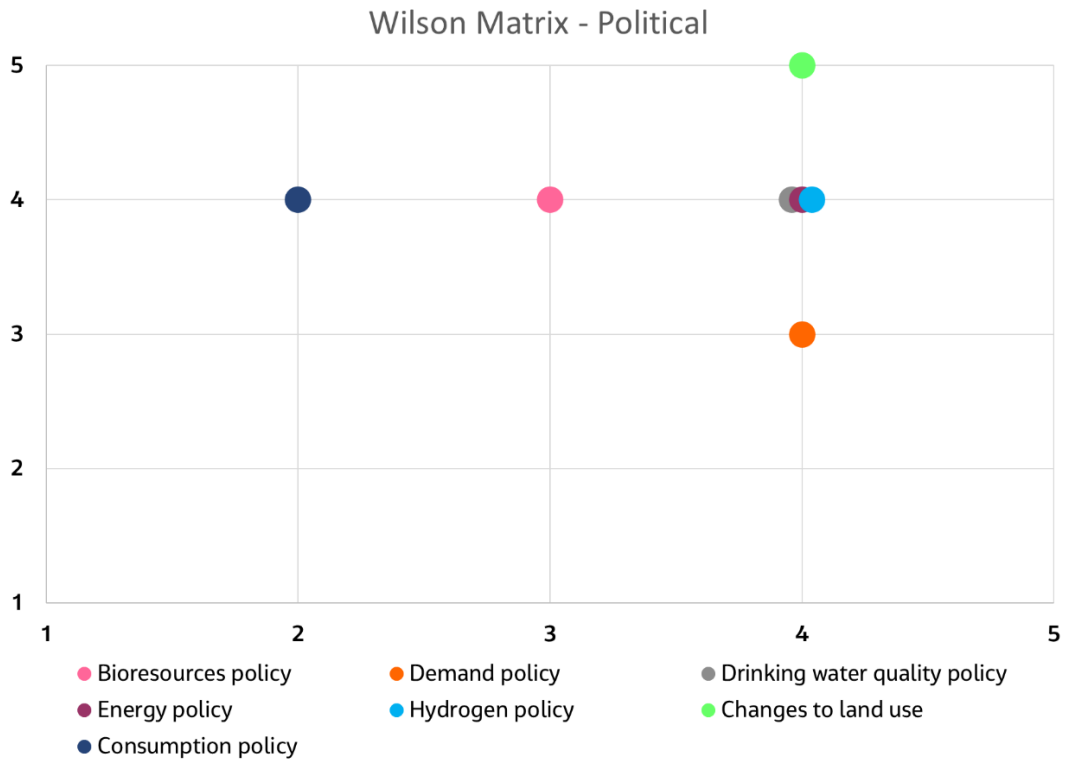

Environmental
Sustainability
Climate Change
Desire for access to green spaces
partnerships with construction supply chain
availability of zero carbon plant and equipment
Construction methods
Operational methodology
waste as a resource - waste heat, nutrients, materials
circular economy
low carbon materials
Construction materials
recycled and recyclable materials
Process preferences
Effective reuse of desalination wastes
Increased dilution of rivers with higher natural flows/less abstraction
emerging increasing CO2e liability from WW treatment
Partnership solutions - delivery routes
Biosolids regulations
Working with others - where do we protect and where do we agree to leave to nature
Heat waves and roads melting so people can't get into offices etc
Do climate change impacts on the environment mean that we're not able to deliver our emission?
natural treatment strategies could fail in face of climate change
existing equipment failure in the context of high temps
increased algal challenge due to high temperatures, lower reservoir levels
water provision for agriculture in context of different crops due to climate change
species advancement as a consequence of climate change
Nutrient Neutrality
Baselining and environmental destinations (common view of starting point and 'what good looks like')
Odour impacts
Potential negative impact on water quality due to new water challenge restricting when we can abstract at surface waters
Asset health strategies will need to take into account climate change
Process Treatment impact
Flooding and erosion impacts
Sea level rise/ tide locking and saltwater intrusion
use of / availability of chemicals
Environmental regulation (or is this covered under political?)
Negative impact on water quality due to increased temperatures/ heavy rainfall events
Asset resilience
Invasive species - operational impact, cost of removal at sites
Alternative climate change scenarios
Biodiversity gain - creation of regional biodiversity plan
Impacts of drought / flooding on the environment, environmental resilience
Increased temperature - impact on our asset performance
CIC impacting other organisations critical assets which leads to impacts on AW assets (e.g. power station failure)
Modelling of climate change impacts on water resources using UKCP18
Risks from infra subsidence
summer pipe bursts due to soil movements
Biodiversity loss
Nature recovery strategies
Regional natural capital plan
Impact on chemicals from higher temperatures for example chlorine formation
Sustainability Reductions
Protected habitats & species - wetlands, tidal mudflats, marshland (fens), chalk streams, Norfolk Broads
Understanding our risk to assets from extreme temperatures and Soil Moisture deficit

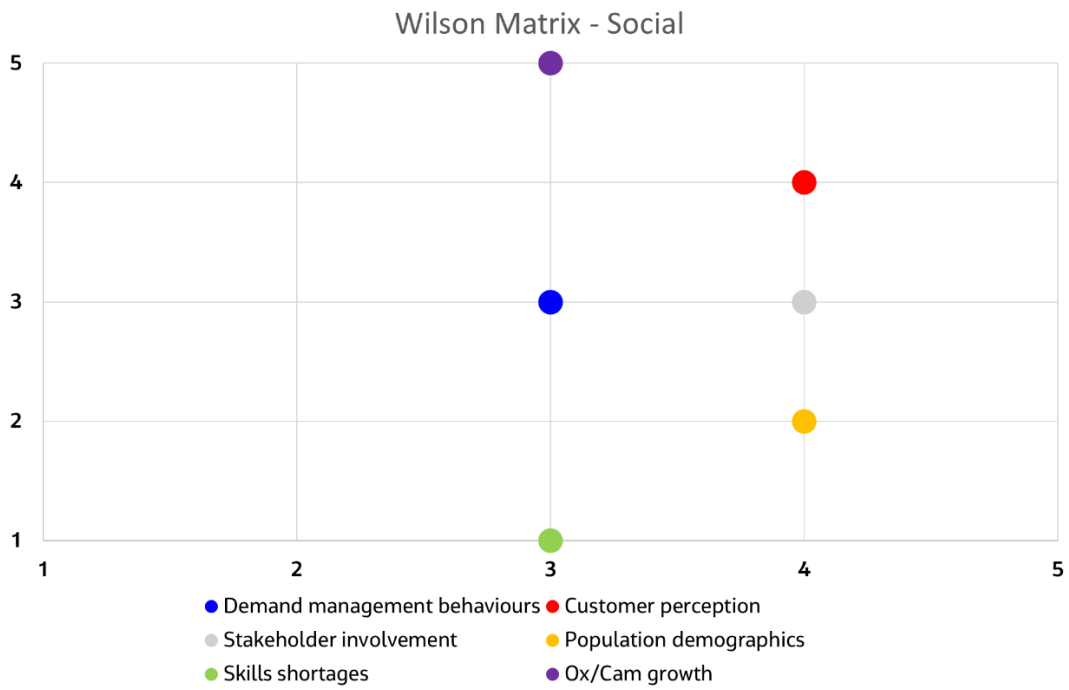
Outputs from impact vs uncertainty scoring exercise, used to generate the Wilson Matrices

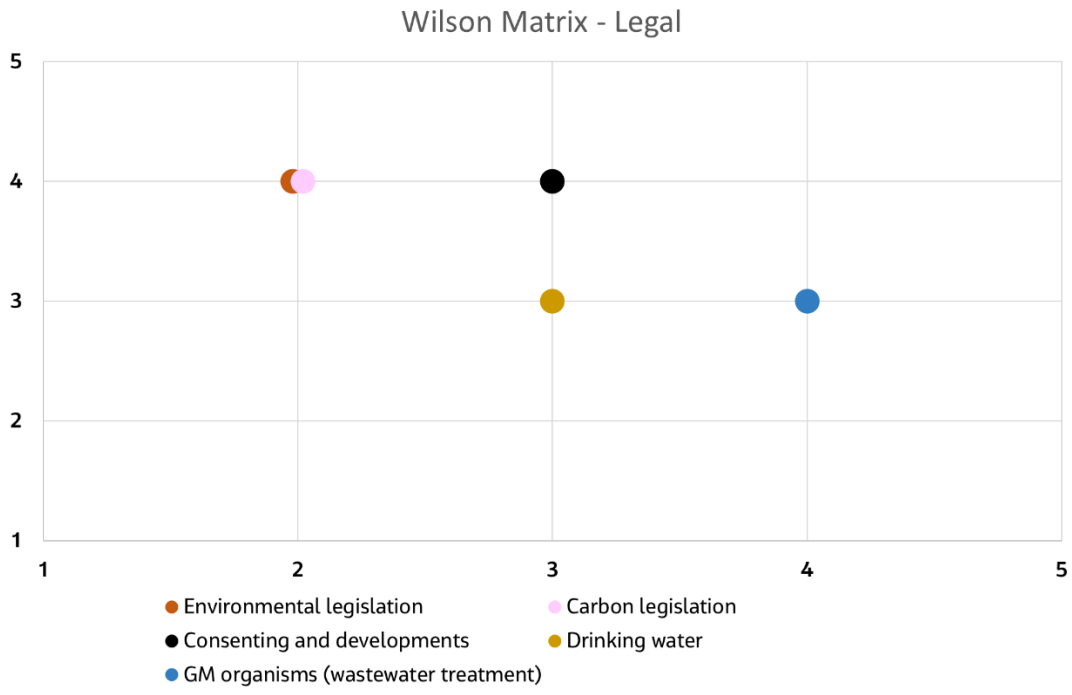
Impact vs. uncertainty scoring workshop information capture sheet

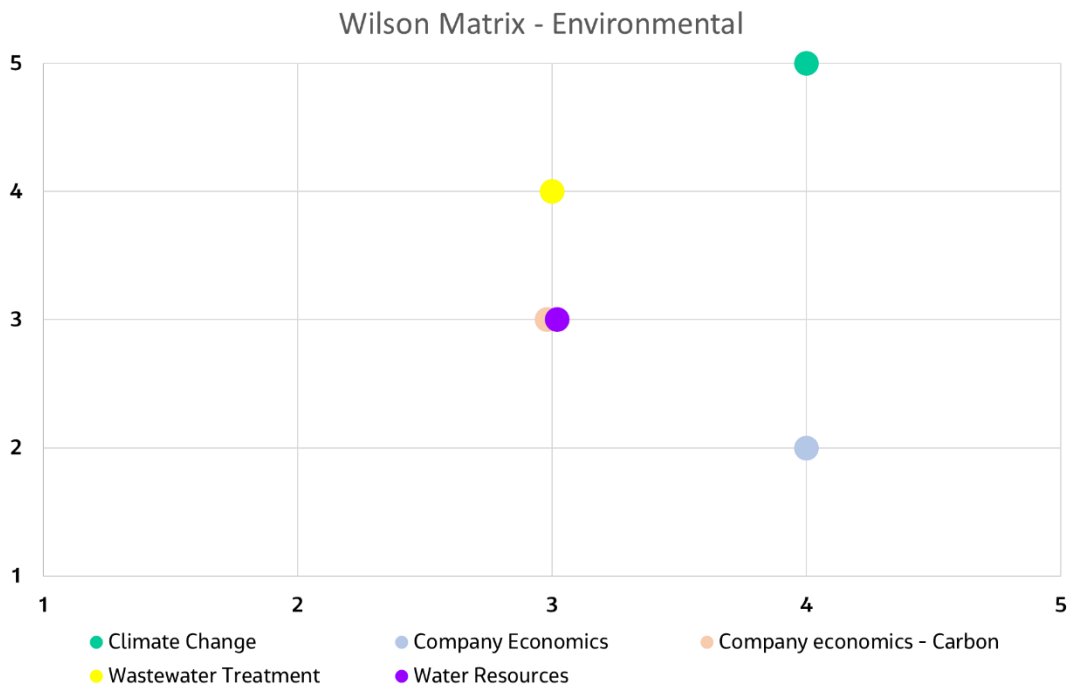
ID	PESTLE	Trend	Details	Overall Impact Score	Justification	Uncertainty Score	Justification
148	Political	Bioresources policy	Bioresources market, land restrictions, policy/regulation change. Farming rule for Water - Also release of nitrous oxide from bioresources (considerably higher than previous). Issues with biosolids in nutrient neutrality areas.	4	FRW could have a material impact on the business	3	FrfW timing is the main issue. But changes likely to happen. So its uncertainty over timing
222	Political	Demand policy	Local authorities developing their own targets for per capita consumption for new homes (Greater Cambridge considering an 85 l/p/p for example) - impact planning policy. Impacts new homes so a small proportion - effects timing of interventions not if they will happen.	3	Impacts new homes. Likely pushes out investments. 80 l/p/d means grey water reuse.	4	There are many local authorities and each could develop their own approach
156	Political	Drinking water quality policy	Policy related to PFAS, lead, microplastics.	4	High impact on water quality and knock on to net zero	4	We generally know the trend but the specifics around Govt policy have high uncertainty
200	Political	Energy policy	Energy policy related to renewables, fracking, nuclear. NOT hydrogen. Carbon tax.	4	Impact on Net Zero and bioresources (Gas to Grid). Cost impact on NZ (renewable energy cost from grid, + cost of offsets). Fracking could put at risk aquifers. Also significant impact on Base costs. WR a 3 for cooling water. DWMP - potentially extracting heat.	4	As for any Govt policy
213	Political	Hydrogen policy	Hydrogen policy (esp. location of production) e.g. South Humber Bank - non-domestic demand? Food security - non-domestic demand?	4	Growth of hydrogen production sector in region would significantly increase non-dom demand (not necessarily satisfied by AWS but there is no spare water in region). May have done this assessment as part of WRE (didn't see huge impact on demand). Maybe regionally insignificant but locally significant. Govt Policy trying to concentrate hydrogen production where there is water - also CCS opps. If hydrogen production colocated with water recycling centres - could improve water treatment quality. Hydrogen also affords NZ advantages. Bioresources strategy around ammonia, hydrogen, methane. Exporting hydrogen or fuel cells. Consider cross-over with Technology project	4	As for any Govt policy
NEW001	Political	Consumption policy	More Govt policy around climate mitigation and adaptation. Emphasis on reduced consumption and behaviour change - not just changed consumption.	4	Could be significant on WRMP, DWMP	2	Fairly certain it won't happen in the near term
184	Political	Changes to land use	Changes in land use related to implementation of nature recovery strategies, Biodiversity and Enviro Net Gain. Carbon offsetting (increase in regen farming), ELMS, farming practices.	5	Catchment impacts very significant If others reduce abstractions, could change WRMP. Would affect availability of offsets - change costs. With increased residual, cost of meeting liability increases. Overall: might impact ability to achieve ambition.	4	As for any Govt policy
22	Economic	Customer economics	Affordability, cost of living, inequality, water poverty, WTP	4	Could have significant impact on affordability of WRMP large reservoir schemes. Could delay implementation of WINEP & nett Zero schemes. Bioresources would be impacted by land use (cross cutting theme) - could drive change to incineration (expensive)	2	Current issue and v. likely to continue during 25 year period
106	Economic	Non-domestic demand	Significant regional uncertainty, large industrial clients, vertical farming, levelling up, new industry (e.g. Hydrogen, data centres), reduction in meat production	3	Hydrogen plant - could add significant non-dom demand. Impact on other strategies considered likely to be low.	2	Expect hydrogen plant, fairly certain. Other issues much less certain.
139	Economic	Regional demand profile	Housing market crash, increasing retired population, reduced tourism, reduced seasonal migration	2	Not considered likely to have a material impact. Used to dealing with large seasonal variation already so have flexibility built into system.	4	Hard to predict, likely to vary significantly between areas.
127	Economic	Company economics	Green finance, cost of debt, gearing	4	Company finance impacts on ability to deliver across the board.	3	Difficult times financially, high inflation, high cost of living, investor uncertainty.
128	Economic	Company-side affordability factors	Energy costs, chemical costs, construction materials costs	4	Costs are high already and forecasts are for rising costs for the foreseeable future. Impacts on CBA of options.	5	V. likely to see significant changes to costs (up & down) over 25 year period.
7	Social	Demand management behaviours	Demand management behaviours, cultural differences, impact of cost of living, new high-usage consumer products, white goods labelling	3	Potential for some impact on WRMP and DWMP in terms of demand, but WRMP already covers future PCC and impact on wastewater demand is not likely to be material, particularly compared to costs of other factors such as storm overflows and climate change.	3	Customer demand behaviours are unpredictable, but the company has a degree of influence through its public information/education outlets and there is some future visibility of policy trends affecting this (e.g white goods labelling, housing water efficiency standards, etc).
8	Social	Customer perception	Increasing customer awareness and demands, including perceived acceptability of (e.g.) storm overflows, water re-use, water quality, sludge-to-land, compulsory metering, WTP for environmental enhancements	4	The recent public reaction over storm overflows has shown that public opinion, often driven by media attention, can have a major impact on regulatory requirements, leading to material impacts on water company strategy.	4	This is highly influenced by events and by media, making it difficult to predict what the next big issue of the day might be.
13	Social	Stakeholder involvement	Contributions in kind, co-funding/delivery, delivering through partners, drivers and expectations, roles and responsibility	3	There is potential for working with/through stakeholders on catchment solutions to significantly affect the type and scale of end-of-pipe solutions required. This is particularly relevant for the WINEP and DWMP strategies, although probably less so for others.	4	Stakeholder input is notoriously difficult to confirm in the early stages of planning, in advance of specific schemes. We know the requirement to demonstrate concrete plans for co-delivery is typically challenging in both the DWMP and WINEP programme development.
23	Social	Population demographics	Changing patterns of demand due to ageing population, changing occupancy rates, climate change	2	Not considered likely to have a material impact on any of the strategies	4	No specific data or insights that the group were aware of - considered difficult to predict.
56	Social	Skills shortages	AWS and/or supply chain skills shortages and capacity issues due to reduced migration (Brexit), regional recruitment challenges, ageing workforce, future of working (4d wk, wfh)	1	Already worked through Brexit and Covid, impacts of skills shortages already experienced and being accommodated in BAU. Already deal with regional recruitment challenge. Largely within mgmt. control in terms of recruitment planning etc, so not considered a high impact issue. Scored a 2 on potential to impact on lead replacement programme.	3	Fairly certain to continue as things are, but not expecting any major new changes to the situation, hence medium.
40	Social	Ox/Cam growth	Potential regionally significant impacts on domestic and non-dom growth, may vary significantly from Growth CRS	5	Location and timing of the Ox/Cam growth arc is uncertain and the impact on AWS' 25yr plan would very significant across most strategies. Would mean "massive" growth if it were to occur.	3	Ox/Cam Arc is considered very likely to occur at some point within the strategy period (25yrs), although timing is less certain, hence medium.
141	Legal	Environmental legislation	Addressing: Protected habitats & species, Environment Act, habitats directive, biodiversity gain, zero waste, PFAS. NOT carbon.	4	Legislation only likely to become more stringent. 4 for WRMP as it pushes to EA enhanced abstraction reduction scenario. DWMP permits reduced. Bioresources - important for circularity.	2	Reasonable assumption that enviro and legal interpretation will get stricter. Mood music won't change for at least 5 years.
145	Legal	Carbon legislation	Renewable transport fuel obligation (% of renewables in fleet fuel), Industrial emissions directive compliance, emerging increasing CO2e liability from WW treatment. Incentives, certifications and observations.	4	Big impact on NZ through ops (our costs of meeting NZ). Impacts Bioresources investment decisions.	2	same as above.
154	Legal	Consenting and developments	Consenting regimes (planning etc) impact on delivery, particularly major projects. Development consents. Assuming impacts major water projects. Sizewell C. OxCam Arc.	4	Impact on major infra and demand drives WRMP and DWMP. Bio - allows for new options. Implications on NZ	3	Govt lead changes to planning policy don't really happen - battle between layers of planning.
156	Legal	Drinking water	Tighter WQ legislation such as materials (REG31), Lead, PFAS, microplastics	3	Significant WQ impact. Presence of pollutants.	3	Score reflects things we don't know about
181	Legal	GM organisms (wastewater treatment)	Legislation around genetically modified organisms and the potential for this to use biotech in water recycling	3	Could impact base more than strategies	4	not something we are clear on.
229	Environmental	Climate Change	Consideration of alternative scenarios to test specific regional concerns - higher/lower than CRS or point(s) in between	5	Affects issues such as water resources, sewer flooding, storm overflows and storage requirements; sea level rise could affect coastal infrastructure, fens, etc. Very high potential impact on WRMP and DWMP, also water quality and WINEP strategies could be significantly impacted.	4	Comprehensive research and modelling available to inform predictions, giving relative certainty although 'tipping point' implications not fullly understood and regional variations possible.
266	Environmental	Company Economics	Desire for green spaces, provision of access to AWS land, assets. Consideration in scheme design.	2	Not considered likely to have a material impact on strategies	4	Unpredictable, uncertain
169	Environmental	Company economics - Carbon	Carbon tax, accounting, capture, materials, etc.	3	Potentially material impact on net zero strategy if major improvements in carbon sequestration for example. Not considered likely to impact materially on other strategies.	3	Direction of carbon policy relatively well understood, but potential for new materials and processes hence medium overall
247	Environmental	Wastewater Treatment	Nutrient neutrality (offsetting nutrients - could require beyond BAT to balance)	4	High impact on wastewater strategies, very low on water - group selected 4 overall as where it would impact, the impact could be extremely significant.	3	Considered a foreseeable future regulatory requirement
269	Environmental	Water Resources	Impact on water quality due to raw water challenge restricting when we can abstract at surface waters.	3	Medium impact on water strategies, potential to impact on wastewater (e.g. WRC) is considered relatively low	3	Considered a foreseeable future regulatory requirement

Wilson impact/uncertainty matrices for individual PESTLE factors




Wilson Matrix - Social
5
4
3
2
1
1
2
3
4
5
Demand management behaviours
Customer perception
Stakeholder involvement
Population demographics
Skills shortages
Ox/Cam growth


Wilson Matrix - Legal
5
4
3
2
1
1
2
3
4
5
Environmental legislation
Carbon legislation
Consenting and developments
Drinking water
GM organisms (wastewater treatment)


Wilson Matrix - Environmental
5
4
3
2
1
1
2
3
4
5
Climate Change
Company Economics
Company economics - Carbon
Wastewater Treatment
Water Resources