Willingness-to-pay research to support PR19

Technical Report

This report was prepared by

Impact Utilities

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Contents

Glossary

Abbreviation	Term
CEPA	Cambridge Economic Policy Associates
HH	Household
NHH	Non-household (commercial)
Ofwat	The economic regulator of the water sector in England and Wales
PR14	2014 price review
PR19	2019 price review
PSR	Priority services register
SME	Small or medium enterprise
SP	Stated preference
SSC	South Staffordshire Plc
WTP	Willingness-to-pay

Definitions of terms

Term	Definition
Business sector SIC code	The United Kingdom Standard Industrial Classification of Economic Activities (SIC) will be used to classify businesses by the type of economic activity in which they are engaged for analysis purposes.
Business size	For the purposes of this research, small and medium enterprise (SME) size has been defined in line with the European Commission (Enterprise and Industry) classification as follows: Micro – 1-10 employees (turnover of less than £2 million pa) Small – 11-50 employees (turnover of less than £10 million pa) Medium – 51-250 employees (turnover of less than £50 million pa).
Difficult to pay	Ofwat's Affordable for All report identifies domestic customers who are at risk of finding it difficult to pay their water and sewerage bills as those where 3% or more of the household income is spent on water and 5% or more on sewerage.
Geographical classification	The 2011 Rural-Urban Classification of Local Authority Districts and other higher level geographies will be used to classify survey participants into geographical categories as follows: • Mainly rural (rural population including hub towns ≥ 80%) • Largely rural (rural population including hub towns 50-79%) • Urban with significant rural (rural population including hub towns 26-49%) • Urban with city and town • Urban with minor conurbation • Urban with major conurbation. This geographical classification will be coded automatically from postcode information collected in the survey. These six categories can then be aggregated to rural versus urban.

Term	Definition
Vulnerable or 'hard to reach' customers	Ofwat's Vulnerability Focus Report defines a customer whose circumstances make them vulnerable, 'A customer who due to personal characteristics, their overall life situation or due to broader market and economic factors, is not having reasonable opportunity to access and receive an inclusive service which may have a detrimental impact on their health, wellbeing or finances.' The water sector has adopted a number of approaches to protect customers whose circumstances make them vulnerable, including those with transitional or temporary vulnerable classifications. These include: • Special assistance registers or priority services register • Financial assistance schemes to help with the cost of their bills • Special tariffs linked to social welfare payments (such as WaterSure) • Water efficiency measures to help customers manage their consumption • Direct debit schemes where customers receiving certain social benefits can arrange to have their bills directly debited on a weekly basis. Customers classed as vulnerable may or may not be included on a priority service register (PSR). Throughout this methodology statement, the term 'hard to reach' customers will be used to refer to vulnerable customers for consistency.

Executive summary

This report outlines the key findings from customer valuation research conducted for South Staffordshire Plc (referred to as SSC) to support its 2019 price review (PR19) for Ofwat. Extensive customer engagement identified customers' priorities for service investment to feed into SSC's business plan for the next regulatory period, due for submission to Ofwat in September 2018.

A seven-step process of customer engagement was conducted to inform PR19 decisions and assess customers' willingness and ability to pay for different service and investment levels for water services. This report focuses on the outputs from a large scale quantitative survey conducted with HH (household) and NHH (non-household) customers in South Staffordshire and Cambridge. The survey comprised primarily of a Stated Preference (SP) exercise, supported by Max Diff and Revealed Preference (RP) to assess customer priorities.

The main findings from the study are:

- Water Quality attributes are core hygiene factors: a key priority in both regions is 'water not safe to drink'
- However, customers are more willing to pay to improve lead pipe removal and softer water than other Water Quality attributes. This is likely driven by the perceived high levels of service offered in these other areas (water safe to drink, discolouration and taste/smell).
- Reliability of Supply is also a key hygiene factor – unexpected loss of supply is the core hygiene priority, followed by flooding of property by a burst pipe.
- Protecting the environment is a mid-ranked priority attribute in all insight to date, with Cambridge customers on average placing more importance on these areas. Renewable energy is also more of a priority among business customers in the Cambridge region.
- Leakage attracts a higher WTP value v other environmental attributes, but the issue is likely to relate to general perceptions of the standard of service than a specific need for improvement.
- Financially Vulnerable customers place higher value on Reliability of Supply attributes.

Background

Research objectives

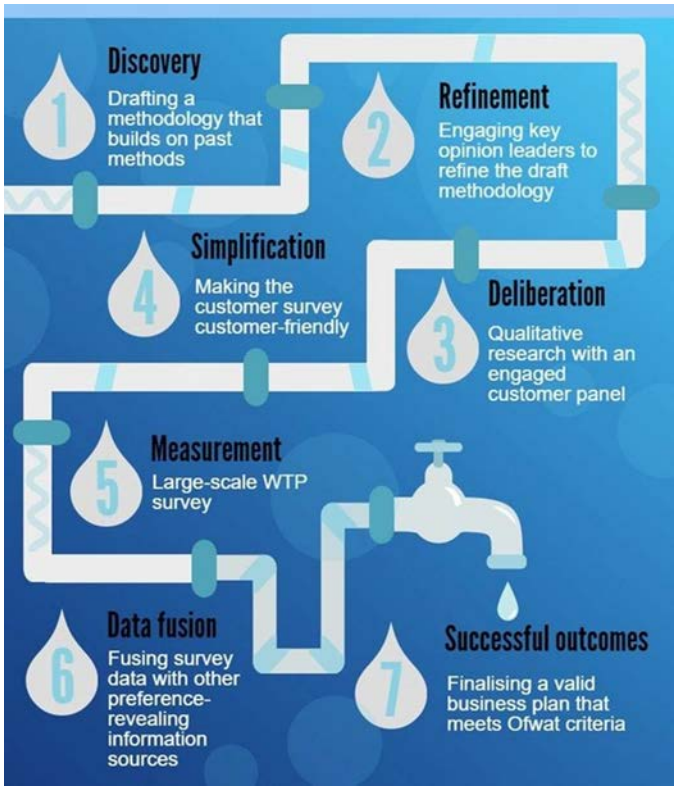
The primary objective of this research is to understand customer's willingness and ability to pay for different service and investment levels for water services for the five year period 2020-2025. By understanding customers' priorities for service investment and the value they place on these investments, SSC can reflect their preferences in its plans.

The research and analysis was conducted following best practice and in accordance with Ofwat's and CCWater's latest guidance. This notes the value of methods that were used in submissions for PR14 (most commonly, SP choice experiments) but encourages innovation to address the shortcomings identified with these. The most pertinent challenges raised are:

- How to ensure that customers fully understand the investment options being presented to them
- Limited engagement with some customer segments
- How to build confidence in the valuations through the use of appropriate triangulation with data sources from within and external to the research.

A seven step approach was devised, with a focus on repeated customer engagement across a wide range of customer segments to ensure robust survey materials that accurately and consistently represents customers' views.

7 step approach



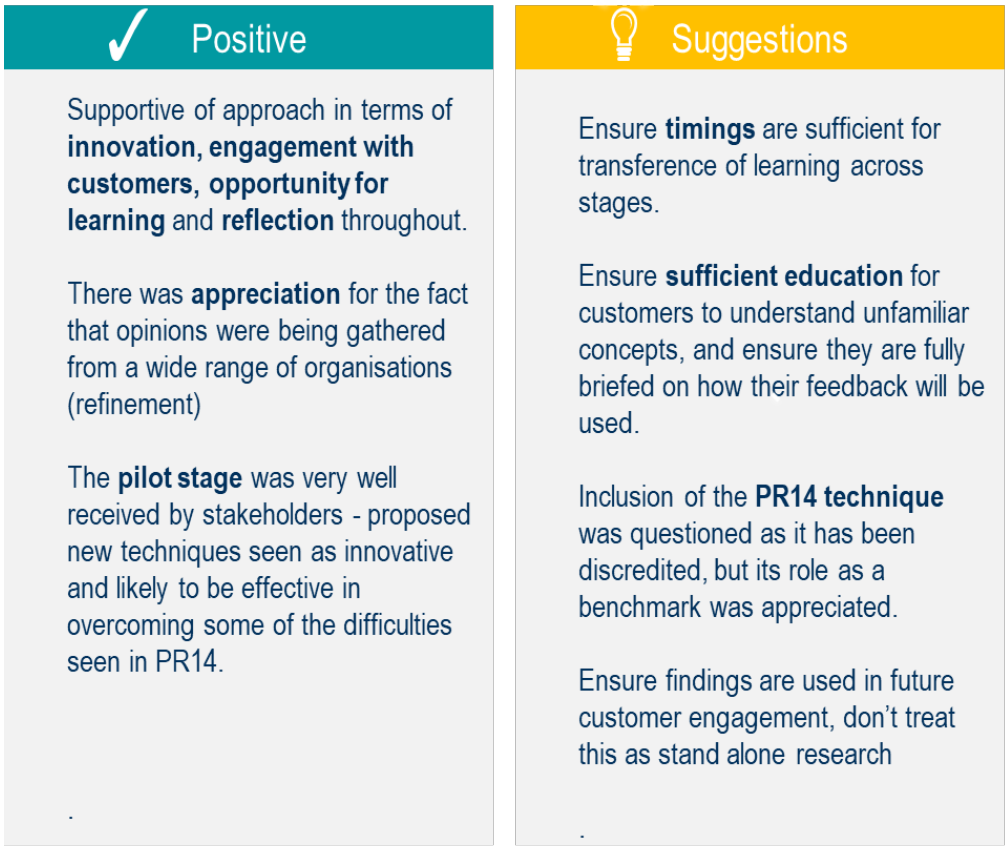
Summary of Refinement Stage

Impact Utilities produced a methodology statement outlining the proposed approach to conducting customer valuation research. The first draft was shared with key SSC colleagues and key industry stakeholders who were asked to give feedback on the approach. Stakeholders were asked to represent SSC customers and highlight any wider implications or considerations not included in the methodology.

Stakeholders from the following organisations participated in a depth interview and provided feedback:

- CCWater
- Citizens Advice
- Environment Agency
- Blueprint
- RSPB
- CEPA
- South Staffs Water Finance Director

Generally the feedback was positive, with useful suggestions provided, as summarised below.



The methodology was also independently peer reviewed by Dr Ariel Bergman, Lecturer in Energy Economics at the University of Dundee. This provided confirmation of the methodologies ability to provide accurate and robust results and achieve the requisite research objectives.

Summary of Deliberation Stage

The objective of this phase was to gather qualitative insights to inform the design of the survey instrument. A series of Engaged Customer Panels (ECPs) were conducted among HH and NHH customers in both South Staffordshire and Cambridge. Each customer recruited into the ECP took part in two 90 minute sessions.

Summary of approach per locations

Region	Group	ECP Group	Segment
Cambridge	1	Household	Millennial
	2	Household	ABC1
	3	SME/Commercial	
South Staffs	4	Household	C2DE
	5	SME/Commercial	
	6	Household	ABC1

In the first ECP meeting, participants were asked to group different topic areas into areas of priority, using a card sort exercise. They also provided feedback on the specific wording of the attributes, and desired performance levels.

During the second meeting of each ECP, particular attention was paid to the various approaches to the SP exercise. Each group were given the opportunity to review and appraise two of the three exercise as a respondent would and provided detailed feedback on areas that might be confusing, misleading or misunderstood.

In addition, a number of depth interviews were conducted with hard to reach customers to obtain their feedback to the survey content. This included interviews in both Cambridge and South Staffordshire, with two NHH interviews and eight hard to reach HH customers across the following classifications:

- 3 with physical disabilities
- 2 mentally impaired (1 x customer plus 1 x carer)
- 2 PTSD (I x customer plus 1 x carer)
- 1 long term debt (note that the ECP groups also contained a small number of finically vulnerable customers).

Separate reports are available which summarise the findings from this phase in detail. Broad themes identified are listed below:

- Avoid jargon (such as ‘bio diversity’)
- Provide sufficient context to allow an informed decision
- Be clear and succinct in the introduction to the stated preference exercise
- Images are useful to aid comprehension, especially for more complex attributes, however the images shown need to be clear and easy to understand
- Provide clear information around how the change to annual bills will be applied
- Ensure the stated preference exercise is presented in an easily digestible format.

Developing the quantitative survey

Stated Preference (SP) techniques enjoyed extensive use in the PR14 process, but there has been criticism of the unengaging, hypothetical and complex nature of the tasks employed, and indeed the high variation in the resulting willingness to pay values.

This project tested different presentations of the SP tasks, while still basing them on conventional and sound statistical principles. An extensive pilot assessed 4 alternative approaches, with the ‘Future Outcomes’ approach identified as the most favourable. This involves choices presented in terms of alternative futures (eg the next 10 years), in which events have either occurred or not occurred and prices vary. The length of time was also a variable (eg 20, 50, 80 years) so that the choices can include multiple occurrences of very infrequent events such as hosepipe bans.

The service levels tested were developed in collaboration with customers via engaged customer panels (ECP), depth interviews with hard to reach customers and industry stakeholders. They were also trialled in the quantitative pilot before an approach to ensure clarity and comprehension.

Methodology

Approach

A large scale quantitative survey with HH and NHH customers was conducted. The results of the pilot and the ECP engagement identified the optimal SP design. Approach 2 (Future Outcomes) was selected, with a max diff included as a step before the willingness to pay exercise.

Sample

The sampling approach ensured that the survey population is:

1. Statistically robust
2. Representative of the demographic and socio-economic profile of the region
3. Inclusive of the various geographical typologies (urban/rural) within the region
4. Reflective of the diversity within the population (inclusive of harder-to-reach customers).

1,573 interviews were conducted in the mainstage wave in October and November 2017. These interviews were combined with the surveys from the pilot survey that covered Approach 2 (Future Outcomes). This resulted in 1,999 interviews overall. 1,309 surveys were completed in South Staffs, and 690 in Cambridge. A total of 333 NHH interviews were completed across the two regions. Cambridge is a smaller and more rural area, meaning that the sample achieved was skewed towards South Staffs. However, we ensured that there was a robust sample in both regions to allow analysis to be completed for each subgroup. To determine the region that customers were from their postcode was taken at the beginning of the survey to match them to the correct region.

Analysis of the following subgroups was conducted:

Household

- Age
- Gender
- Households with children vs households without
- Social grade
- Hard to reach customers (including the elderly or disabled, those with a medical dependency or low income or on social tariffs or other customers who find themselves in vulnerable circumstances)
- Metered customers versus non-metered
- Urban, rural and suburban
- Region.

Quotas were set in line with the customer profile of SSC's regions to ensure a representative sample of customers (by age, gender and social grade for HH customers and by business size and sector for NHH customers) are interviewed. These quotas ensured that a statistically robust sample size was achieved in the key groups outlined above. To achieve the desired numbers in each region some quotas were loosened, and the data then weighted against the customer profile of each region, obtained from 2012 census data.

The majority of interviews were conducted online, however face to face, and recruit to online, methods were also used to be appropriate to the customers' situation. These techniques were specifically used for hard to reach and business customers.

The achieved figures of these key subgroups in each region are below, this includes the pilot interviews of those who completed approach 2 and the main wave interviews.

Quantitative HH interviews

	South Staffs Water			Cambridge Water Company		
Total	1096			560		
	Number	%	Pop %	Number	%	Pop %
Female	670	61	51	329	59	50
Male	426	39	49	229	41	50
18-29	149	14	22	86	15	25
30-44	289	26	26	129	23	23
45-59	338	31	24	175	31	27
60+	320	29	28	170	30	25
AB	225	21	20	137	24	40
C1	274	25	29	136	24	28
C2	168	15	22	69	12	16
DE	226	21	28	123	22	16
Rural	141	13	15	356	64	42
Urban	870	79	85	165	29	58

A robust number of hard-to-reach customers were also interviewed. A minimum number of 50 interviews are recommended for sub-group analysis, meaning that all except one group could be analysed separately.

	South Staffs Water	Cambridge Water Company
Hard to reach (any)	603	310
Physical disability	201	99
Limited accessibility of services	183	93
Financially vulnerable	125	80
Mental impairment	106	63
Carers	92	53
Transient vulnerability	50	40

Quantitative NHH interviews

A spread of company sizes and organisation types were recruited.

Total	213 South Staffs Water		130 Cambridge Water Company	
	Number	%	Number	%
Public	85	40	31	24
Private	123	58	91	70
Charity	4	2	6	5
Sole trader	13	6	12	9
2-9 employees	66	32	34	26
10-19 employees	23	11	12	9
20-49 employees	25	12	7	5
50-99 employees	23	11	8	6
100-249 employees	18	9	14	11
250+ employees	36	18	39	30

Survey methodology

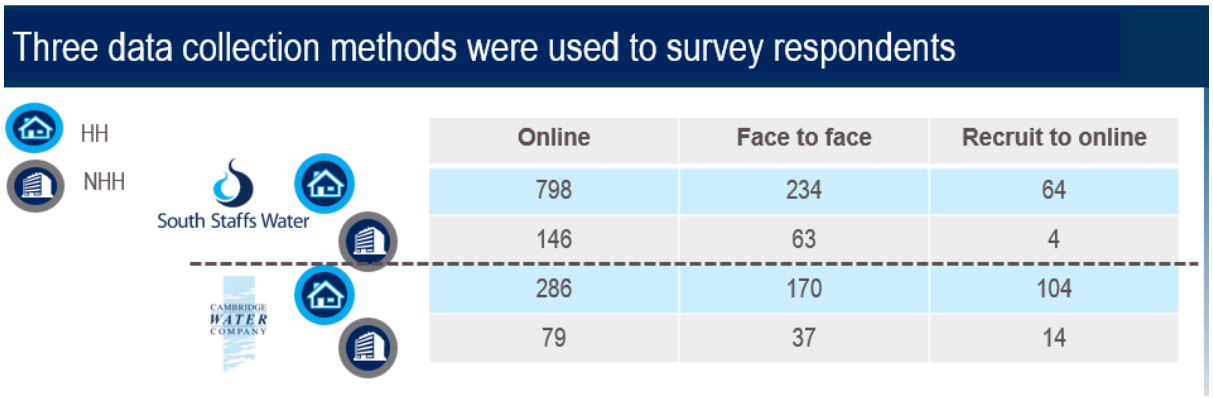
The primary method of data collection was online through online panels of respondents who are pre-registered and open to research of this kind. Panellists were targeted in the relevant SSC postcode areas and invited to complete the survey. This methodology means that the SP scenarios and associated educational materials were viewed on screen to inform the trade-off decisions; and the survey could be completed at a time and place convenient to the participant. Customers are also able to read the instructions and scenarios presented at their own pace, thereby increasing the likelihood of them fully understanding the scenarios presented.

It is acknowledged that certain customers are likely to be under-represented on an online-panel, therefore alternative techniques were used to recruit participants. Telephone interviews were not suitable as the necessary stimulus cannot be viewed. Therefore to ensure that the study engaged with the complete spectrum of customers, surveys were also completed face to face, with stimulus materials and the SP exercise shown on screen on a device carried by the interviewer. Between 20%-25% of interviews were completed face to face in each region. Participants were also recruited over the phone and then sent a link to complete the survey online, this was used predominantly in the Cambridge region due to less customers being part of panels and therefore made up 15% of Cambridge interviews.

HH customers completing the survey face-to-face or recruited by telephone to complete online were given an incentive of £10 per person (paid as a voucher or charitable donation) to help increase response rates and encourage survey completion. NHH customers were harder to recruit, and therefore were given an incentive of £20 per person (paid as a voucher or charitable donation).

The proportion of interviews conducted via each methodology (online panel, face to face, and telephone recruit to online) is documented below.

Data collection methods



	Online	Face to face	Recruit to online
HH	798	234	64
NHH	146	63	4
HH	286	170	104
NHH	79	37	14

To ensure the correct NHH customer completed the survey, a set of screening questions ascertained their working status, company size and their responsibility for (at least) inputting into financial decisions within their organisation. These screening questions were consistent across all three data collection methods

Survey instrument

The survey instrument took between 20 and 25 minutes to complete, with half of the time being spent on the SP exercise. Interviews conducted face to face were typically longer than those completed online. The rest of the questionnaire included demographic and household composition information such as bill affordability and meter type in the case of the household interviews. For the commercial interviews appropriate firmographic information such as water consumption, business size and industry sector was collected. Both survey instruments included a question requesting permission to re-contact respondents for further research related to this survey if necessary.

Exercises were tailored to the services provided within the respondent's SSC regions to remain as relevant as possible, including relevant figures of current performance.

Feedback to the survey was generally positive. Three quarters of respondents in South Staffordshire and two thirds in Cambridge rated the survey experience as very good or good, as shown in Figure A.3 and Figure A.4 below. Similar proportions felt that the survey was good/very good at offering them the ability to express their true opinions (70% Staffordshire and 61% Cambridge), with less than 10% rating this negatively in each region.

Respondents felt the survey was interesting and informative "*Gave me an insight into the complexity of the work South Staffs water have to do", "It was interesting considering the*

different priorities and the dilemma water companies face" and appreciated been asked their views *"Am pleased that South Staffs water are interested in my opinions"*

Customers generally found it easy to complete "*It is easy to understand and no technical issues", "Easy to understand and plenty of help from staff member conducting the survey".*

Survey length was rated slightly lower, and indeed a handful of negative comments related to the length of the survey "*Too many similar questions – 20 variants of the same"*.

Other negative comments related to customers not wanting to pay more "*I didn't want to pay any more".*

In addition, a full quality check was carried out on the data from the survey and any responses where it was clear that customers who had not taken sufficient consideration of their responses throughout the survey were removed from the final analysis set presented in this report. Examples of this include looking at the time taken to complete each screen to remove any 'speeders'.

Figure A.3 Survey feedback – South Staffordshire Water

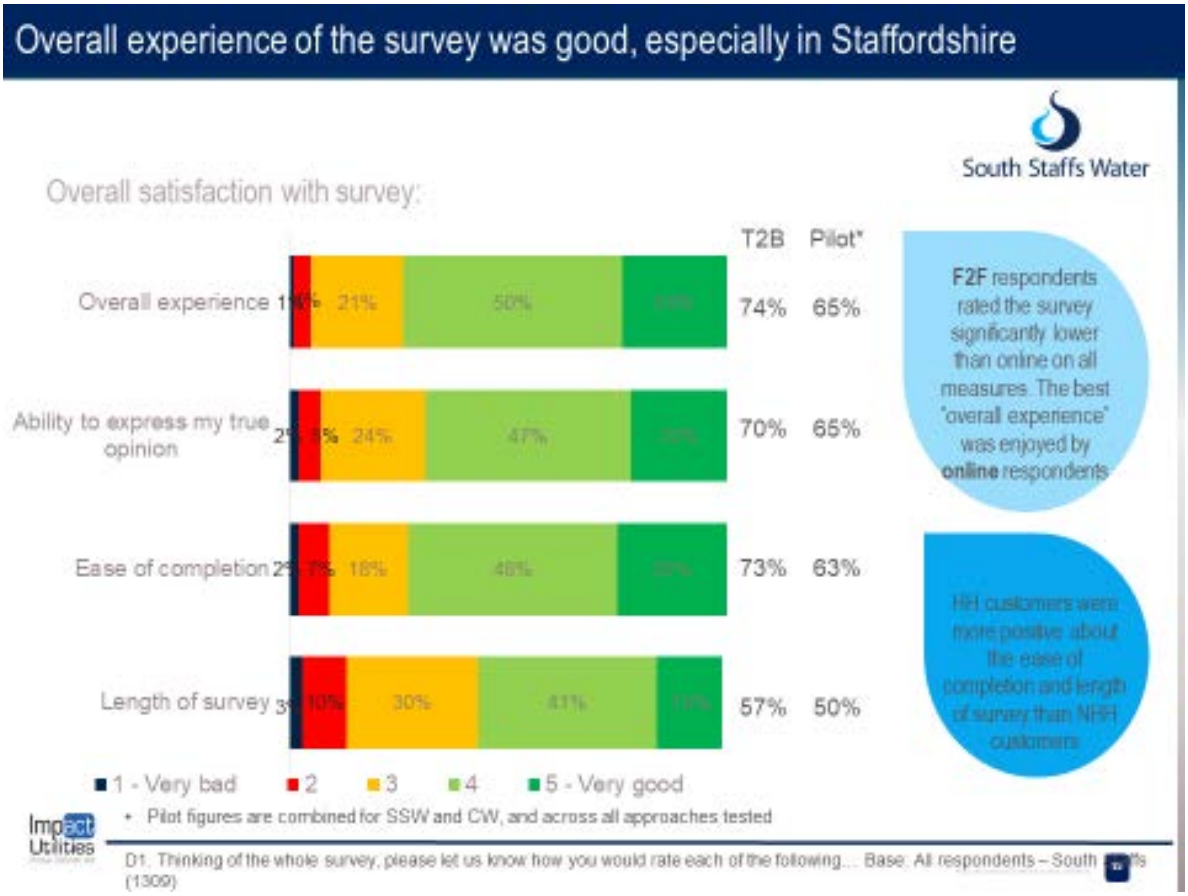
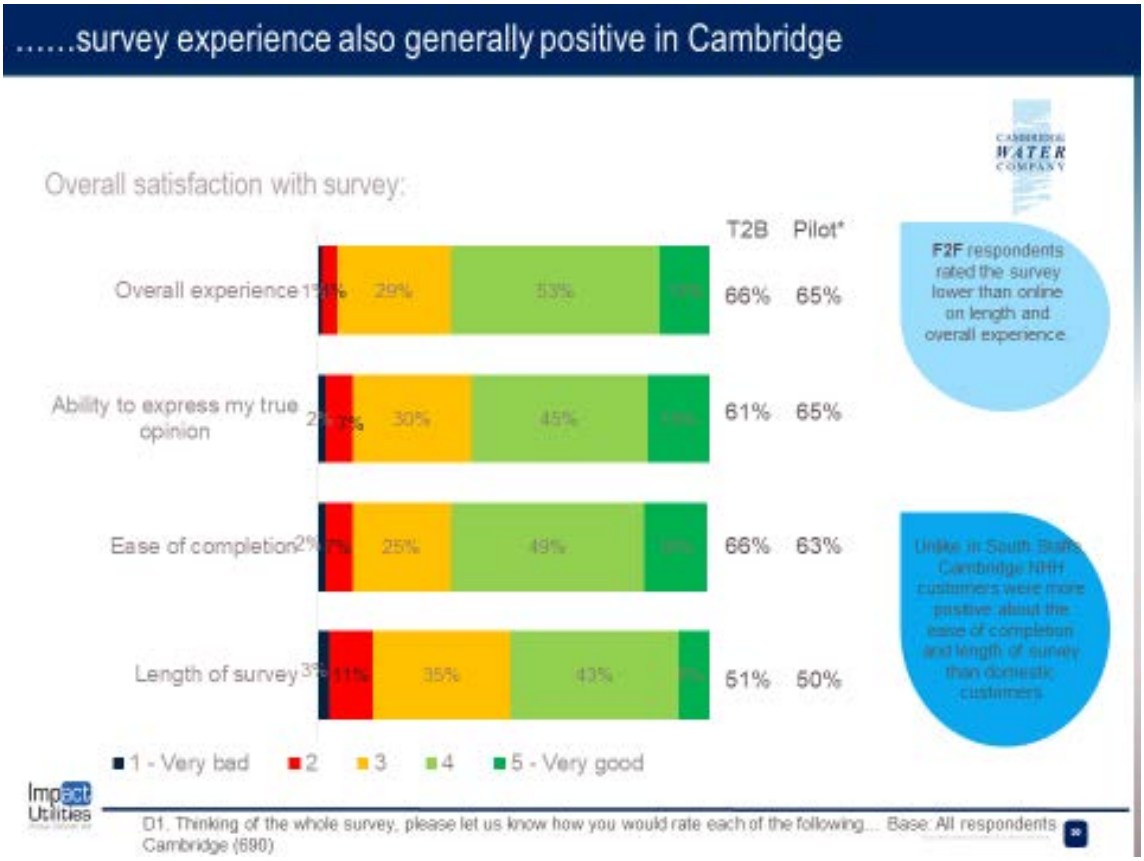


Figure A.4 Survey feedback – Cambridge Water

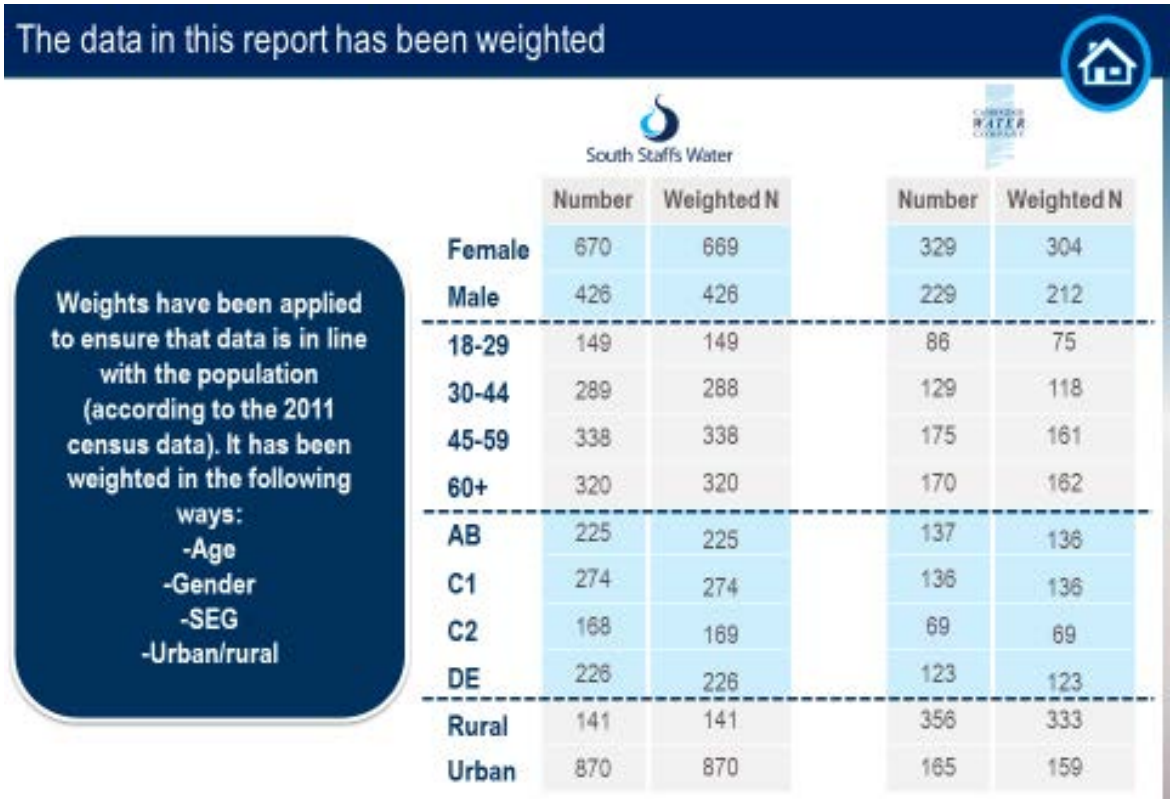


Weighting the data

The profile of the Households sample was very close to the known population proportions, due to the imposition of quotas. Nevertheless, a RIM weighting approach was used, using age, gender, SEG and urban/rural location. This resulted in individual respondent weights ranging from 0.74 to 1.76 and weighted numbers that matched closely for each profile measure.

Comparisons of the unweighted and weighted sample profiles are shown below.

Weights applied



Weighting for SMEs was not undertaken, because suitable region-specific target profile data was not available. However, we did take steps to ensure that we spoke to a sample that broadly reflected the total population: we aimed to achieve a mix of business sectors and company sizes that were broadly in-line with a random sample of NHH leads provided by SSC.

Table A.1 SME Company Size Profiles

Company size	SS	CAM
Sole trader (1)	6%	11%
Between 2 and 9	31%	28%
Between 10 and 19	11%	12%
Between 20 and 49	12%	9%
Between 50 and 99	11%	9%
Between 100 and 249	8%	13%
More than 250	17%	15%
I am not currently trading	1%	1%
Don't know	3%	2%

Key findings

In the absence of a competitive environment, water companies' are encouraged to actively engage with their customers in price setting. For PR19, OfWat requires a broad range of customer metrics to support investment decisions, including 'willingness to Pay' (WTP) measures. WTP is the measure of how much customers are willing to pay for improvements in service, expressed as the equivalent marginal increase in bills that they are willing to accept for improvements in service.

Aims and Objectives

This study sought to:

- Identify customer priorities and preferences for service charges and investments
- Provide input values to be used within the service measure framework for economic analysis (CBA) of investment, specifically the SSC Investment Optimiser tool
- Support the development of a revised set of outcome measures and performance commitments (ODIs) for the period 2020-2025
- Validate WTP results by triangulation with other customer engagement insights.

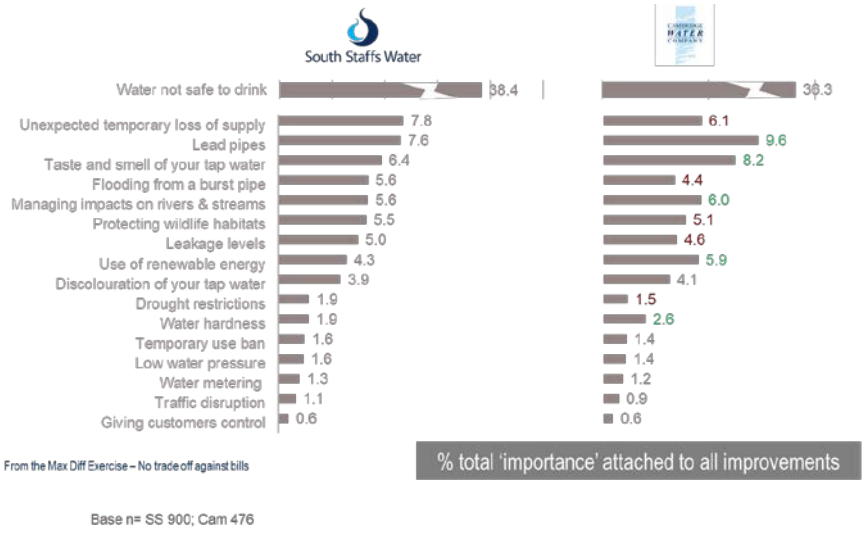
Initial Customer Priorities

Region and customer type

Customers who participated in the survey were first invited to indicate their priorities among different sets of potential service improvements, 5 at a time from a total of 17 different attributes (15 for NHH customers). This 'Max Diff' method simply required them to identify each time the item of highest priority and the item of lowest priority. In the analysis of the responses, a statistical model of the average impact of each attribute on these choices was estimated[1]. The results for Household (HH) customers are summarised in Figure 1 below.

[1] Sawtooth HB/CBC estimation of Max Diff responses, where the dependent variable is each attribute classified as the most important, least important and not chosen, for each set of attributes shown in each choice scenario

Figure 1: Customer Priorities - HH

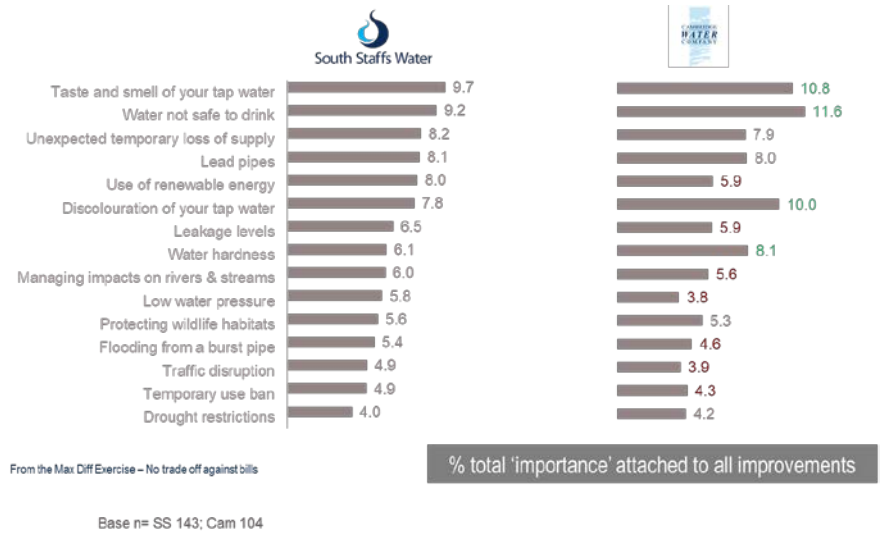


'Water not safe to drink' stood out in both regions, accounting for over a third of the total priority for improvement. This may illustrate the often observed outcome of a particularly severe event raising strong concerns for individuals, even though the likelihood of such an event is very low. Safe consumption of water will be a fundamental consideration for all customers and appears to have dominated here.

The figures here are represented as an index totalling to 100, summarising the relative impact of each attribute on the likelihood of it being chosen first. They are ranked in order of importance in Staffordshire. Significant differences between the regions are highlighted in green and red. For example, lead pipes gain more prominence in Cambridge, leakage levels less prominence.

NHH customers take a more balanced view, with water safety only one of a range of priorities. The figure below shows that 'Taste and smell', 'Loss of supply', 'Lead pipes', 'Use of renewable energy', 'discolouration' and 'Water hardness' have broadly similar levels of importance.

Figure 2: Customer Priorities – Non-Households



For each of these attributes respondents saw the three levels of service (current and 2 levels of improvement) that would later be tested in the WTP exercises, traded against Bill increases. When modelled as separate levels there was comparatively little variation in priority, suggesting that in this exercise customers were inclined to think in general terms rather than specific levels of improvement. However, evidence form the pilot suggested that the inclusion of specific levels encouraged respondents to give more considerate thought to each attribute.

As the next section will show, priorities changed somewhat when improvements were considered in the context of bill increases.

Priorities by Other Customer Groups

Analysis of different customer sub-groups identified the following main variations in priorities, based on significantly different results:

Households in the South Staffordshire area

- Older customers (45+) place even more weight on 'water not safe to drink' and 'lead pipes',
- Younger customers place more weight on 'unexpected temporary loss of water supply'.
- When customers have experienced specific problems, they don't show a greater importance attached to improving that particular problem, but they on the whole do place more importance on 'Water not safe to drink'. Those in rural areas also place more importance on this attribute.

Households in the Cambridge area

- It is younger customers who place more weight on 'lead pipes'
- When customers have experienced specific problems, they *do* show a greater importance attached to improving that problem, but like customers in South Staffordshire, they also place more importance on 'Water not safe to drink'.

Non-Household customers in the South Staffordshire area

- Smaller companies place less weight on 'Taste and smell of your tap water' and 'lead pipes'
- Public companies place more weight on 'Discolouration of your tap water' and 'lead pipes'.

Non-Household customers in the Cambridge area

- Smaller companies place *more* weight on 'Taste and smell of your tap water' and 'lead pipes'
- Public companies also place more weight on 'Discolouration of your tap water' but *less* on 'Water not safe to drink' and 'flooding form a burst pipe'.

Customer's Willingness to Pay for Service Improvements

Region and customer type

Figure 3 below summarises the average increases in annual bills that HH customers are willing to pay for significant service improvements across the 17 attributes tested in the research. Water quality issues dominate, but 'water not safe to drink', which stood out in the initial order of priorities, now appears among a number of other priorities such 'lead pipes' and 'water hardness'. This suggests that when improvements are presented in the context of what it might cost to implement them, HH customers adopt a more balanced approach to assessing priorities.

It should be noted that adding all these separate values together is useful as a way to compare the *relative* investment priorities, but the overall values (eg £60 and £63) for implementing all the improvements are likely to be an over-estimate of the *absolute* willingness to pay (WTP). This is because each customer will have some 'budget' limit operating behind their WTP. Survey respondents saw only four attributes at a time in any one trade-off scenario, and if confronted with all 17 attributes, may not have shown much higher willingness to pay overall[2].

Figure 4 summarises WTP for NHH customers, where results are expressed as percentage of annual bill, in recognition of the wide range of bill values. Priorities are broadly similar to HH.

[2] Research for SSW for the PR14 submission indicated a significant 'packaging effect' when all improvements were presented in one go to customers. This is an issue that can be explored in subsequent research planned by SSW in early 2018.

Figure 3: Maximum WTP Values for Household Customers

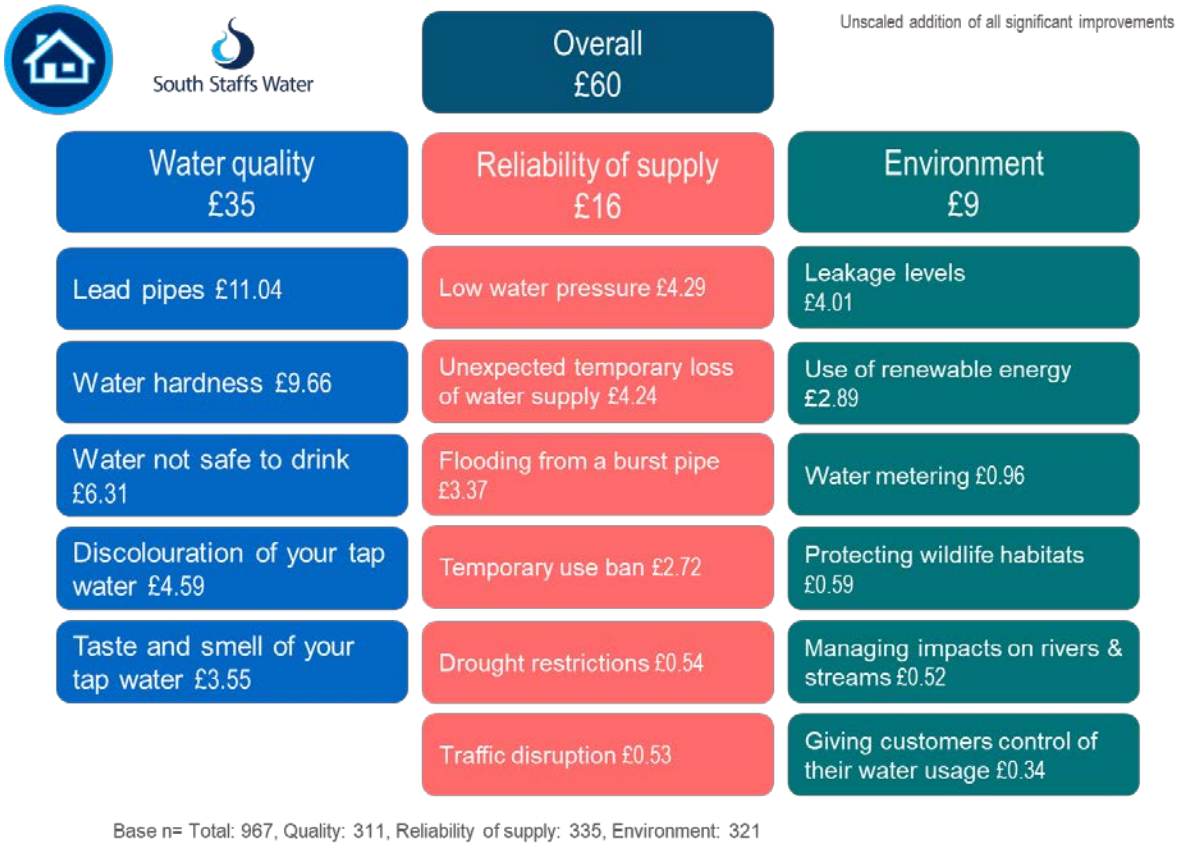
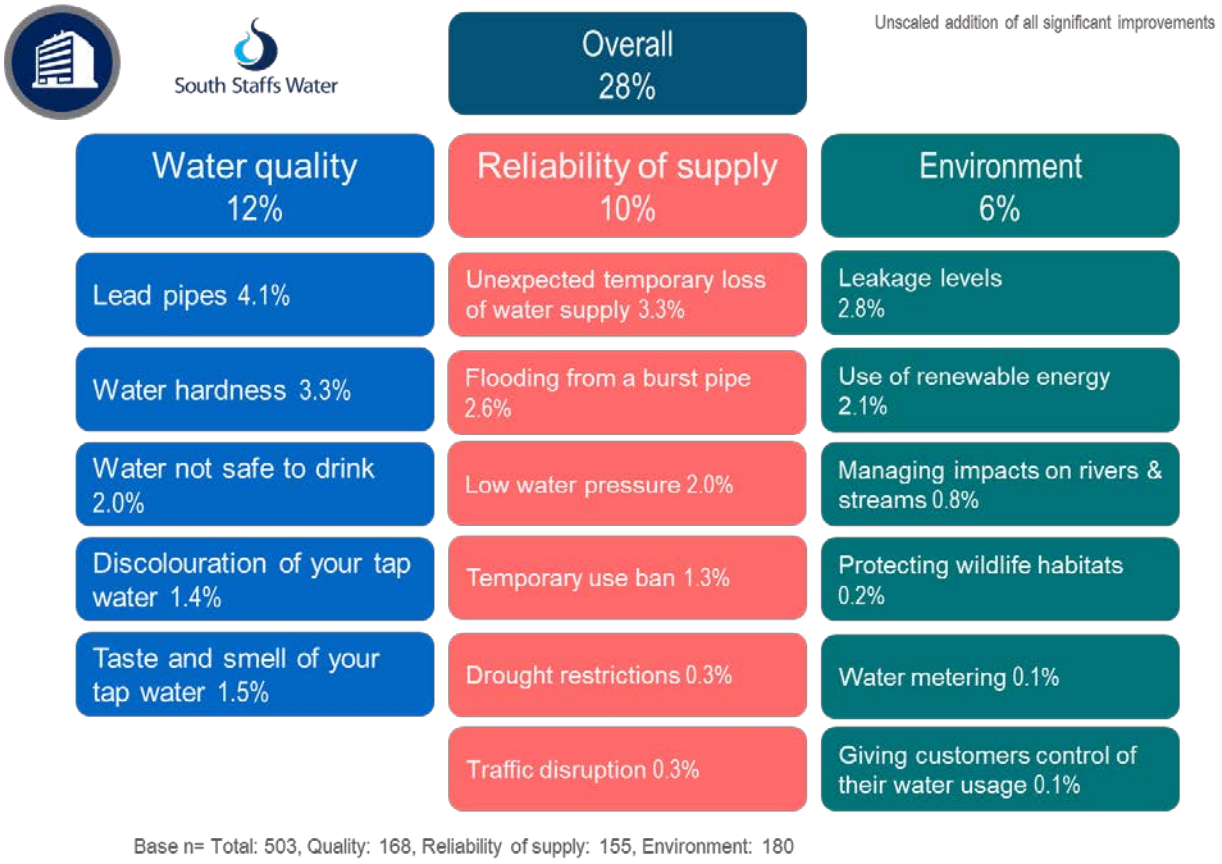
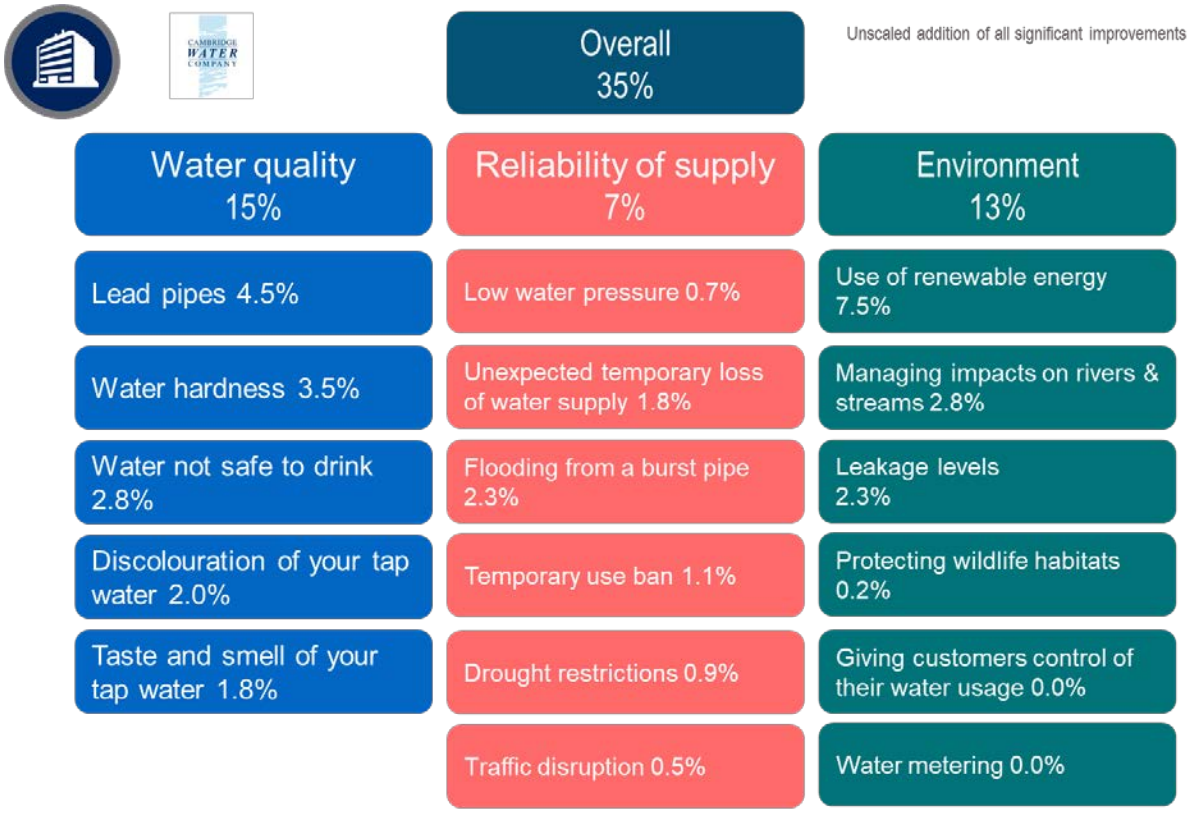


Figure 4: Maximum WTP Values for Non-Household Customers



Base n= Total: 503, Quality: 168, Reliability of supply: 155, Environment: 180



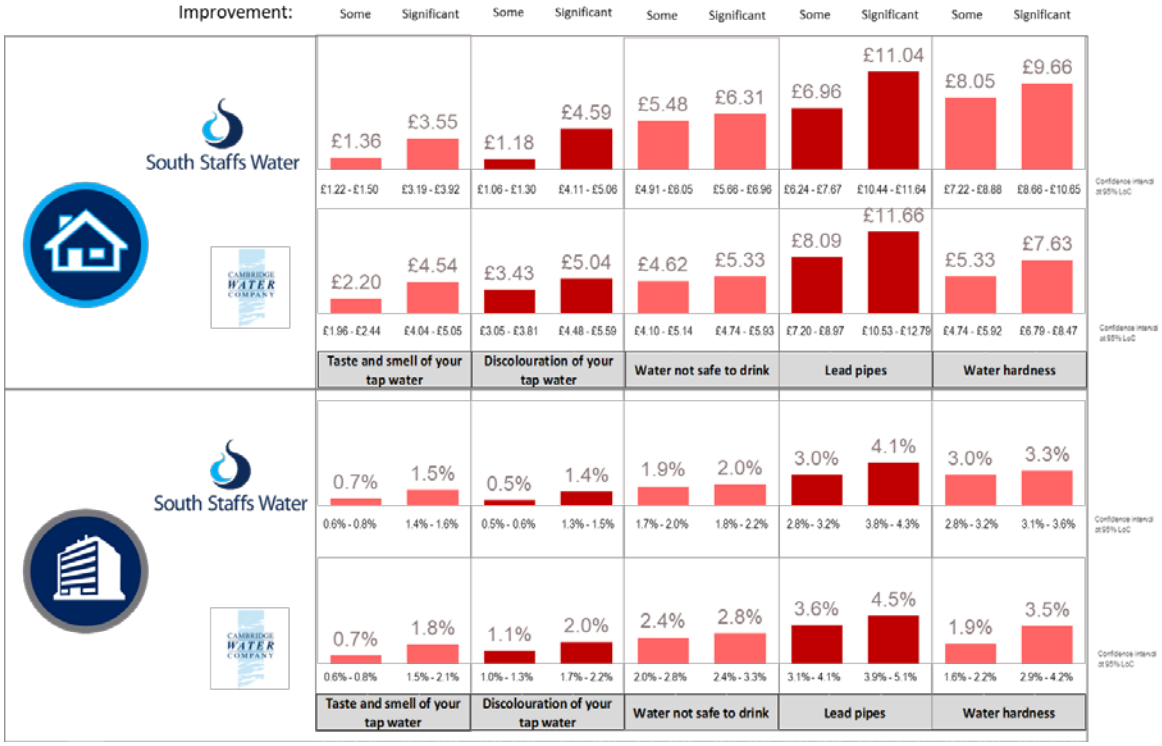
Base n= Total: 106, Quality: 33, Reliability of supply: 32, Environment: 41

Levels of Improvement

Each attribute tested in the WTP research was presented in terms of two possible levels of improvement from the current level: 'some improvement' and 'significant improvement'. Figures 5 to 7 summarise the value for each of these levels, together with the 'confidence intervals' around the average values reported[3].

In these results we see some variation in the way the values progress across the different levels of improvement. Some show that most of the value is achieved at the 'some improvement' level (eg 'Water not safe to drink' and 'Water hardness'), others show a step-change when moving to the 'significant improvement' level (eg 'Unexpected loss of water supply').

Figure 5: WTP values for each level of Water Quality Improvement



[3] The confidence interval represents the range in which the actual value for the population is likely to fall, given that our findings are based on a sample. It suggests that if the study was repeated 100 times, in 95 of those studies the result would fall in the range indicated.

Figure 6: WTP values for each level of Reliability of Supply Improvement

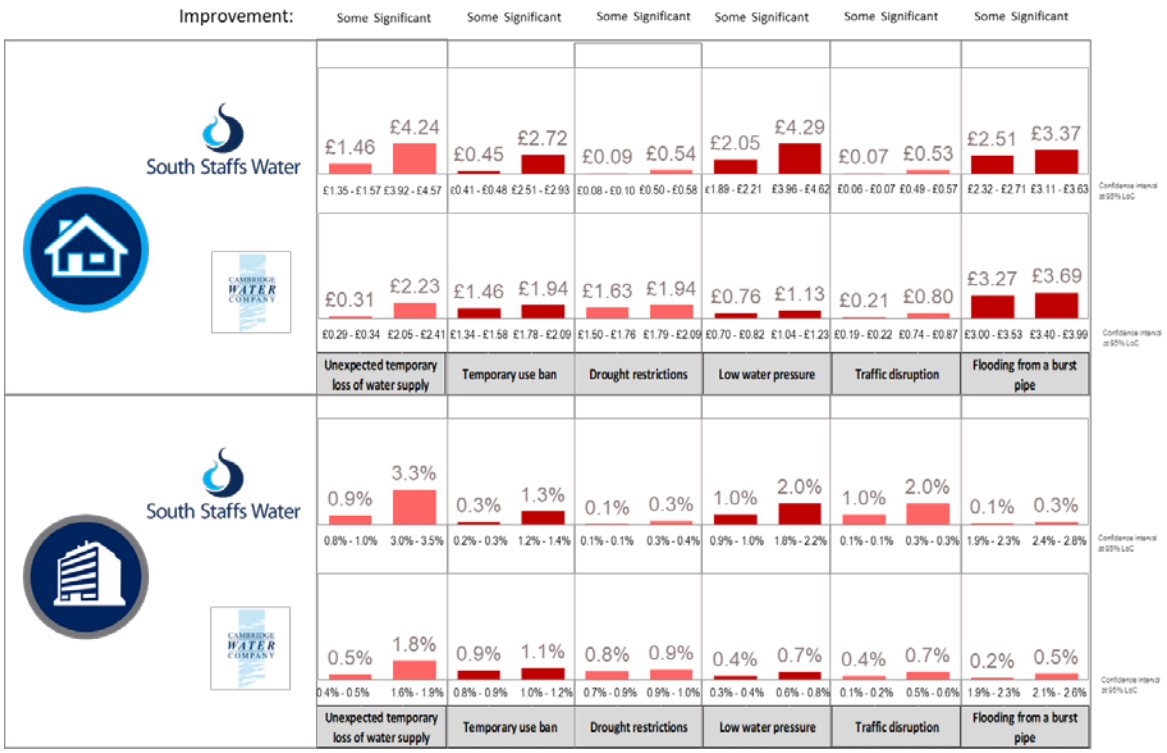
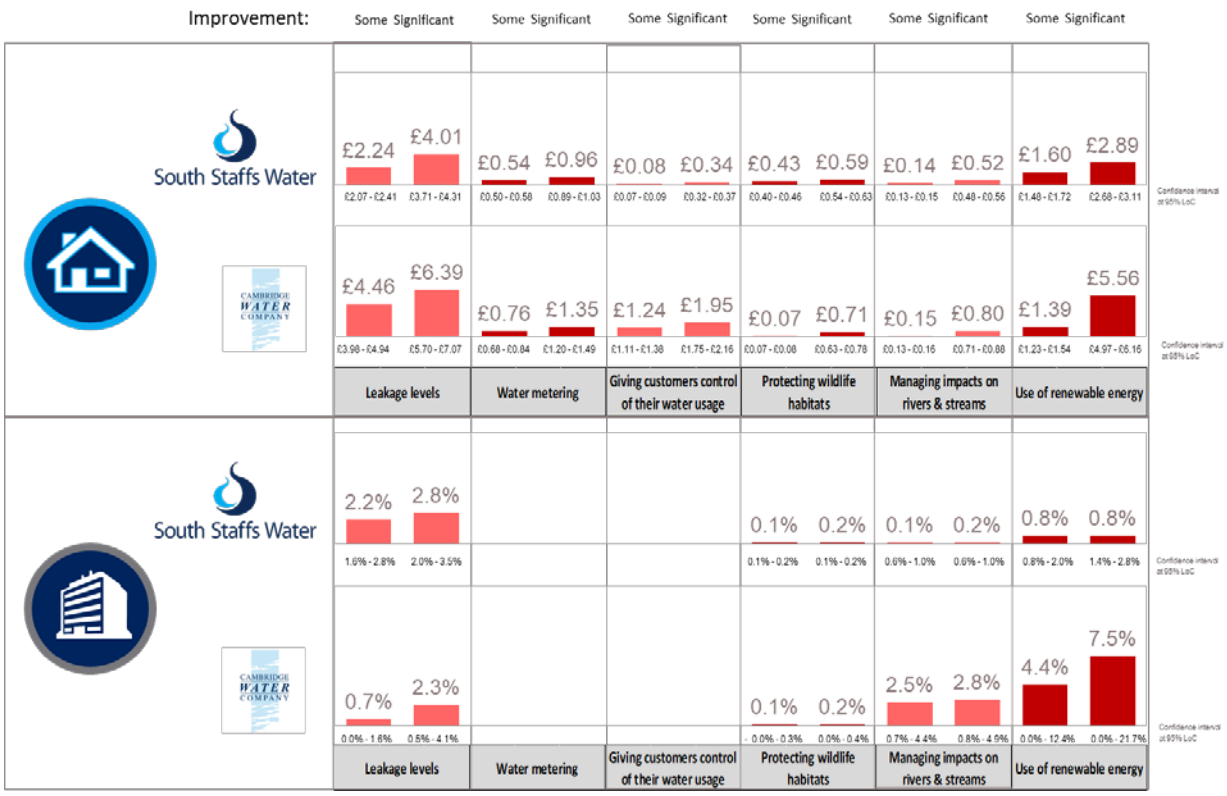


Figure 7: WTP values for each level of Environmental Improvement



Public and Private Valuations

When respondents were presented with alternative investment options in the WTP trade off exercise, half of them saw the choices expressed in terms of the impact on the region as a whole (eg 'number of households affected') and half saw them in terms of the impact it would have on them personally (eg 'you will experience this once over the next 20 years'). This gives a useful perspective when using the results for business planning, as customers who are directly affected by an event may have a greater willingness to pay for an improvement than those who are not.

All the values reported are an average of these two alternative ways of presenting the investment options. When the results were split by public/private, the following was observed:

- Water Quality attributes, with the exception of 'Taste and smell of your tap water' attract significantly higher WTP in both regions when asked in a private context compared to public.
- Low water pressure is the only Reliability of Supply attribute that attracts higher WTP figures in a public context in both regions.
- For environmental attributes, Cambridge customers clearly feel that investment is more highly valued at a public level than private. In SSW there are no strong differences for public/private.

Vulnerable Customers

When comparing the results for different social groups, financially vulnerable customer segments show a higher WTP than other customer groups when valuing Reliability of Supply, namely:

- Unexpected temporary loss of supply
- Low water pressure (SSW only)
- Traffic disruption
- Temporary use ban (only for significant improvement)
- Environmental: managing impacts on rivers and streams and renewable energy (less consistent).

Analysis also indicated that:

- Limited accessibility and transient vulnerability segments in SSW region show a higher WTP than the HH average across the majority of Reliability of Supply and Environment attributes

- Limited accessibility and transient vulnerability segments in Cambridge show a higher WTP than the HH average across the majority of Water Quality and Reliability of Supply attributes

- Customer with a physical disability resident in Cambridge show a higher WTP than the HH average across the majority of Reliability of Supply and Environment attributes

- In the SSW region Water Quality WTP values are consistently lower than the average in both regions among vulnerable customers – with the exception of those who are carers.

The observation that vulnerable customers attach higher WTP values for Reliability of Supply attributes is consistent with the insights from external SSW research highlighting how disruptions to supply can significantly impact on their lives.

Initial Priorities v WTP

Figure 8 compares the relative orders of priority observed in the initial measurement exercise without bills (Max Diff) and the subsequent WTP exercise with bills (Discrete Choice Exercises). Each item is standardised so that the most valued has a score of 1.0 and for the WTP values, the significant improvement level is used.

This suggests broad agreement between the initial priorities and the WTP values, with the notable exception of 'Water not safe to drink' among HH customers. For NHH customers, 'Use of renewable energy' takes on more importance for WTP (this is driven primarily by customers in the Cambridge area) while 'Taste and smell of your tap water', 'Discoloration' and 'Water not safe to drink' take on less importance.

Figure 8: Comparison of Max Diff and WTP Priorities

A Summary Customer Priorities

The following conclusions were taken from these results, drawing also on analysis of other customer priority and satisfaction work carried out by SSW:

- Water Quality attributes are core hygiene factors: a key priority in both regions is ‘water not safe to drink’ - valued slightly higher by SSW Household customers, but not significantly
- However, despite assigning a mid-ranked priority for lead pipe removal and softer water, customers are more willing to pay to improve these than other Water Quality attributes. This is likely driven by the perceived high levels of service offered in these areas (water safe to drink, discolouration and taste/smell) as indicated by external customer satisfaction and priorities research).
- Reliability of supply is also a key hygiene factor – unexpected loss of supply is the core hygiene priority, followed by flooding of property by a burst pipe.
- Protecting the environment is a mid-ranked priority attribute in all insight to date, with Cambridge customers on average placing more importance on these areas when assessing significant changes (‘some’ improvements are not significantly different). Renewable energy is more of a priority in the Cambridge region.
- Leakage is rated as mid-ranked priority, but becomes a higher priority for customers when they are educated about the level of water lost. It attracts a higher WTP value v other environmental attributes, but the issue is likely to relate to general perceptions of the standard of service than a specific need for improvement. External research for SSC’s WRMP engagement has highlighted a strong view that ‘morally’ the right thing to do and leakage levels need to be reduced.
- Temporary Use Bans: the majority of customers do not rank this as a priority (90% of customers from the WRMP research indicated the current level of service as acceptable). It attracts a medium level WTP value in relation to other wholesale attributes.
- Metering is not coming through as a customer priority in this study or in any other research to date. It attracts a relatively low WTP value in both regions, but in terms of the business plan it was often seen as an easy and cost effective demand side option to implement.

Data Triangulation

Objective

One of the challenges put forward by Ofwat during the review of the business plans in PR14 was that different companies had submitted very different estimates of their consumers' Willingness-To-Pay (WTP). Ofwat's concern was that they were not able to separate between cases where those differences were generated from genuine differences in preferences across the country (e.g. people in the water scarce Southeast could have a higher WTP to secure supply than people in the water abundant North of England) or, on the contrary, they were the result of the methodologies/questionnaire used by the companies.

To mitigate this effect, a robust approach to the estimation of the WTP in PR19 needed to consider, as far as practical, the consistency of the results with those obtained from other studies, as well as the consistency across different approaches to estimate WTP. This study has used a triangulation methodology conducted in partnership with Cambridge Economic Policy Associates (CEPA). This section presents this methodology and its findings.

Approach

The approach proposed to undertake this triangulation is based on the principles ICF developed for Customer Council of Water:[4]

- **Principle 1: Contributory evidence –** evidence should contribute to water companies' understanding of their customers' priorities, needs and values.
- **Principle 2: Methodology soundness** – evidence should have been generated using methods that have been soundly applied, with sufficient evidence to demonstrate that is the case.
- **Principle 3: Rigorous data gathering** – evidence should have been gathered in such a manner as to maximise the amount of information gained from the evidence, without introducing any bias into the evidence, with sufficient evidence to demonstrate that this is the case.
- **Principle 4: Credible interpretation** – conclusions drawn from the evidence must be credible, including sufficient exploration of alternative interpretations of the same evidence and comparison of the various sources of evidence explored for each alternative interpretation.

Principle 1: Contributory evidence

The main questionnaire included both 'Max Diff' and 'Discrete Choice' exercises. In the former, respondents expressed their priorities for investment without reference to trade-offs against bill payments. In the latter, they traded possible future levels of service representing different patterns and levels of investment, traded against bill payments and set in the

[4] ICF (2017), Defining and applying 'triangulation' in the water sector: How water companies can use different sources of customer evidence in business planning.

context of different lengths of time in the future. Therefore, the analysis evaluated the consistency of both the WTP but also the priority rankings.

For each one of these results, this methodology considers the following potential sources of inconsistencies:

- Internal inconsistency across the methodologies in the study;
- Other sources of engagement with SSC's customers (e.g. number of unwanted contacts);
- Temporal inconsistency between SSC studies; and
- Inconsistency with research undertaken by other parties (water companies or other third parties).

To ensure the analysis above produced a robust, balanced and proportionate evidence base for assertions on what matters to customers by testing the plausibility of the absolute WTP values. Impact Utilities and CEPA used a number of sources to identify alternative estimates of WTP. These sources could be grouped into:

- **Information to evaluate internal consistency of the results:** This considered the internal degree of consistency or otherwise between the results of the two techniques.
- **Information to evaluate timing consistency:** The current findings were compared against the results of the WTP analysis SSC submitted in PR14 to identify potential changes in the WTP estimates.
- **Information to evaluate consistency with other water companies:** When available, we used the information included in Business Plans or their supporting information as well as CCGs' reports and Water Resource Management Plants to identify alternative estimates of WTPs.
- **Information to evaluate consistency with other sources:** When undertaking the triangulation we also considered information published by other sources when it would reflect similar services. For example, information from the energy sector was used to consider potential WTP for the use of green energy or metering.

This 'web' of information will build confidence in those customer valuations that are most consistent across these different measures.

Principle 2 & 3: Robustness of alternative estimates

Once alternative sources of information were identified, the robustness and comparability of the findings was assessed, to identify those areas where there could be a need to undertake additional analysis that could trigger the introduction of adjustments/caveats to the initial estimates of WTP. The approach used in this report to evaluate the robustness of these alternative methodologies differs depending on the whether the piece of information being considered are (quantitative) WTP estimates or other sources of evaluation of consumers preferences. These methodologies are considered separately below.

Triangulation of alternative WTP estimates

When other studies include alternative WTP estimates for similar variables, Principles 2 and 3 will be articulated using the following steps:

1. **Evaluation of whether the estimate of WTP belongs to the range of potential WTP identified by other studies:** After collecting the estimates of WTP from other studies, we considered the comparability of the findings. Different studies use different metrics when presenting the WTP (e.g. WTP per customer, per surface area affected or per customer affected) and they can cover different kinds of customers (e.g. residential or businesses). Therefore, the first stage of this comparison was to identify those estimates that are likely to be comparable with the ones of this study. Those values that were found to be comparable were used to develop a range of potential estimates of WTP. With that acceptable range, it is possible that:
    a. **The alternative value falls outside of the 'acceptable' range of WTP in the study:** These cases will require a more detailed analysis to evaluate the reasons behind the differences in the WTP identified across the studies.
    b. **The alternative values fall inside of the 'acceptable' range:** In these cases no further analysis will be required as the average WTP in the study can be considered as a robust estimate of the WTP.
2. **Evaluation of the robustness of the alternative estimates:** For those cases where additional analysis is required (those falling under 1.a), it will be important to understand the reasons that could justify these differences. Impact Utilities and CEPA have worked together with SSC to identify reasons that could underpin these findings. To identify these potential differences, this study has considered, among others:
    * Consistency with previous SSC estimates. If the values are outside of the expected range but they are consistent with those SSC obtained in PR14, there appears to be a consistency that indicates that SSC's consumers have a particular preference for this attribute.
    * The alternative studies cover different activities / services which could justify that the range is different for SSC.
    * There are external factors that could have generated a distortion (e.g. regions facing water restrictions are more likely to be willing to pay to expand capacity).
3. **Identification of potential areas of adjustment/caveat:** When the alternative estimates are found to be robust, unbiased and consistently outside of the range obtained in our study, SSC could consider an adjustment to the WTP to account for that divergence.

However, before this is confirmed, we would advise more detailed evaluation of the potential roots of the difference is undertaken. When SSC considers the introduction of an adjustment we would recommend the introduction of a weighted average where the weights will be set depending on the degree of robustness of the data (e.g. size of the survey) and the targeting of the information to addressing the research question. As indicated by ICF in its report for CCWater "this study does not recommend prescriptive quality scoring, because this is unlikely to applicable to all scenarios in which water companies may seek to apply triangulation".

Following this process will provide robust analysis consistent with external sources.

Triangulation of other measures of customer preferences

The information coming from these sources is less likely to be triangulated with the results of the evaluation of the initial WTP as it would include a monetary value. However, this information will be crucial to ensure that the results obtained in terms of WTP are consistent and compliant with Principle 4 (i.e. they have a credible interpretation).

Before this data is used to evaluate the robustness of the results, the team will evaluate the robustness of the methodology using the same approach discussed above (point 2 in methodology for WTP measures).

Principle 4: Credible interpretation

The report will use the estimates obtained from the triangulation of the different WTP estimates and other measures of customer preferences to develop a credible interpretation of the overall results.

To ensure the robustness of the findings, the estimates of WTP was compared with other measures of customer preferences to ensure if the different results are internally consistent. For example, one could expect that customers will have higher WTP in those areas where they are either less satisfied or those higher in their ranking of challenges. If this is not the case, SSC should explore the reasons that underlie this difference and, when possible, provide an indication of what this would mean for the use of this data in Business Plans.

Verification and triangulation against external sources

After applying the methodology above, the main findings of the triangulation analysis are:

- 10 of the attributes being considered were in the range set by previous studies;
- 7 of the attributes had not been considered in other studies or the services were not comparable; and
- 2 of the attributes (protecting wildlife habitats and managing impact on rivers and streams) resulted in estimates that were significantly lower than the range from previous studies. Before considering triangulation, SSC should consider the possibility of reviewing in more detail the results of the current analysis.

The complete analysis is presented in the table below.

Figure 9: Summary findings for WTP

	Attribute	In range	In study[5]	Potential ranges (£ WTP)
WATER QUALITY	Taste and smell of your tap water		SSW: £1.36 CW: £2.20	**[0.75-1.83]** Values for the small improvement in the current study are, on average, in range.
	Discolouration of your tap water		SSW: £1.18 CW: £3.43	**[1.18-2.87]** Values for the small improvement in the current study are, on average, in range.
	Water not safe to drink		SSW: £5.48/6.31 CW: £4.62/5.33	Different studies use very different definitions of these services, so a meaningful range cannot be obtained.
	Lead pipes		SSW:£6.96/11.04 CW:£8.09/11.66	No other study was found on this issue.
	Water hardness		SSW: £8.05 CW: £5.33	**[1.10-8.53]** Values for the improvement in the current study are in the upper limit of the range. These findings are consistent with SSC's findings in PR14. Therefore, it appears that this is a particularly significant issue for SSC's consumers and they are prepared to put a higher value in this attribute than those in other areas.
SECURITY AND RELIABILITY OF SUPPLY	Unexpected temporary loss of water supply		SSW: £1.46 CW: £0.31	**[0-3.62]** Values for the improvement in the current study are mainly in range.
	Temporary use ban		SSW: £0.45 CW: £1.46	**[0.38 -3.08]** Values in this study are inside the range. Two values were excluded from this range as they were significantly higher than the rest of the observations. Given that those values were from Southern Water, this higher value could reflect the WTP of these customers is well above the values in the rest of the country as a result of the water scarcity in that region.
	Drought restrictions		SSW: £0.09/0.54 CW: £1.63/1.94	Different studies use very different definitions of these services, so a meaningful range cannot be obtained.
	Low water pressure		SSW: £2.05 CW: £0.76	**[0.20 - 2.21]** The value for small changes in the current study appear to be in the upper end of the range.
	Traffic disruption		SSW: £0.07/0.53 CW: £0.21/0.80	No other study was found on this issue.
	Flooding from a burst pipe		SSW: £2.51 CW: £3.27	**[1.41-2.76]** This range was based on the WTP for sewer flooding. This value can be

[5] This column reflects the values obtained for HH WTP. Where comparisons are possible, we have used the 'some improvement' levels, as these generally correspond most closely to the definitions used in other studies. All others show both 'some' and 'significant' levels. The values for NHH are more difficult to compare robustly as they are based on wide variations in bills amounts.

	Attribute	In range	In study[5]	Potential ranges (£ WTP)
				considered as a lower bound as, even if the damage done by sewers can be bigger, sewer flooding does not affect the whole ground floor, as assumed in this study.
PROTECTING THE ENVIRONMENT / LOWERING USAGE	Leakage levels (per customer)		SSW: £2.24 CW: £4.46	**[1.19-6.32]** Values in this study are in range.
	Water metering		SSW: £0.54 CW: £0.76	**[0.3-1.3]** The values in the analysis are consistent with those identified for household in other studies.
	Giving customers control of their water usage		SSW: £0.08/0.34 CW: £1.24/1.95	No study covering the value of the services of a smart meter has been identified.
ENVIRONMENT	Protecting wildlife habitats		SSW: £0.43/0.59 CW: £0.07/0.71	**[3.06 - 5.05]** Values in this study are significantly lower than in other analyses. It is important to understand whether there are reasons that justify this difference.
	Managing impacts on rivers & streams		SSW: £0.14/0.52 CW: £0.15/0.80	**[1.33 - 3.89]** Values in this study are significantly lower than in other analyses. It is important to understand whether there are reasons that justify this difference.
	Use of renewable energy		SSW: £1.60 CW: £1.39	**[1.71-2.3]** Even when the values of this WTP are obtained from other sectors, it appears the values are consistent.

Source: CEPA/Impact analysis

As part of the verification process, this report also considers the consistency over time of the WTP results for the company. The table below compares the WTP for household consumers for South Staffordshire Water[6].

[6] Comparisons for the Cambridge region were much more limited, with only a handful of attributes common to both studies.

Figure 10: Summary findings for WTP for households in SSW in PR14 and PR19

Attribute	Change	PR14	PR19
Taste and smell of your tap water	small improvement	£0.74	£1.36
	larger improvement	£1.47	£3.55
Discolouration of your tap water	small improvement	£1.44	£1.18
	larger improvement	£2.87	£4.59
Water not safe to drink	small improvement	£0.08	**£5.48**
	larger improvement	-	£6.31
Water hardness	small improvement	£3.51	£8.05
	larger improvement	£7.28	£9.66
Unexpected temporary loss of water supply	small improvement	£2.06	£1.46
	larger improvement	£3.62	£4.24
Temporary use ban	small improvement	£1.85	£0.45
	larger improvement	£3.08	£2.72
Flooding from a burst pipe	small improvement	£1.53	£2.51
	larger improvement	£2.76	£3.37
Leakage levels	small improvement	£2.35	£2.24
	larger improvement	£4.70	£4.01
Protecting wildlife habitats	small improvement	£3.03	**£0.43**
	larger improvement	£5.05	**£0.59**
Managing impacts on rivers & streams	small improvement	£1.33	**£0.14**
	larger improvement	£3.89	**£0.52**

Source: Impact analysis and SSW PR14 submission

Figure 10 shows that there have been significant variations in the WTP results between PR14 and PR19. In some cases, these results are larger than those one could expect as a result of inflation and potential WTP fluctuations over time. These differences, however, appear to reflect differences in the way the questions were put forward to consumers. For example, WTP for the "Water not safe to drink" is values at £0.08 in PR14 compared to £5.48 in this current study.

This change can be explained by a significant difference in the question presented to consumers. In PR14 consumers were asked to consider their WTP to reduce the number of properties affected every year for a boil water notice, while in the current PR19 survey the question focused on the WTP to reduce the frequency that they were unable to drink the water in their home for a period of 2 weeks. Both those two definitions cover situations where the water is not safe to drink but that is where the similarity ends. With the question in PR19 being much more direct to consumers and including a significant period of time of interruption of service which, as one could expect, increased the WTP significantly.

As with the analysis of results for other companies above, other areas where there have been significant changes in WTP are those related to the environment (i.e. "Protecting wildlife habitats" and "Managing impacts on rivers and streams"). Here, the changes in definitions have also been significant, making the comparison of the results very difficult.

For the “Protection wildlife habitats” attribute, in PR14 the focus was on the avoidance of minor pollution incidents while in PR19 the focus is on protecting and improving a number of additional hectares of wildlife habitats. In other words, the focus has moved from reducing the damage to increase the protection. A consistent result that can be observed in South Staffordshire Water WTP survey in PR14 is that consumers’ WTP is significantly higher to avoid reductions in their service than it is for improvements. Therefore it can be expected that consumers are willing to pay more to reduce the damage to the environment (and potentially to the value of their properties/land) caused by pollution incident than to improve the current state of the environment.

A similar difference applies to the “Managing the impact on rivers and streams” attribute. In PR14 this attribute asked consumers to consider their WTP for a reduction in the risk that the local rivers suffered low levels, while in PR19 the question focused on their WTP for improvements in the rivers and the land around them. As a result, it appears consistent with a reduction in the WTP between studies.

For non-household customers there is a broadly similar pattern of differences, with the largest variations affecting the same attributes. These results indicate that it will be appropriate to carry out further research to evaluate the effect on WTP values of changing the questions related to these attributes.

Figure 11: Summary findings for WTP for non-households in SSW in PR14 and PR19

Attribute	Change	PR14	PR19
Taste and smell of your tap water	small improvement	0.9%	0.7%
	larger improvement	1.9%	1.5%
Discolouration of your tap water	small improvement	1.7%	0.5%
	larger improvement	3.4%	1.4%
Water not safe to drink	small improvement	0.1%	**1.9%**
	larger improvement		2.0%
Water hardness	small improvement	3.2%	3.0%
	larger improvement	2.6%	3.3%
Unexpected temporary loss of water supply	small improvement	2.3%	0.9%
	larger improvement	4.0%	3.3%
Temporary use ban	small improvement	1.0%	0.3%
	larger improvement	3.1%	1.3%
Flooding from a burst pipe	small improvement	1.3%	2.1%
	larger improvement	2.4%	2.6%
Leakage levels	small improvement	2.8%	2.2%
	larger improvement	5.6%	2.8%
Protecting wildlife habitats	small improvement	3.4%	**0.1%**
	larger improvement	5.6%	**0.2%**
Managing impacts on rivers & streams	small improvement	1.4%	**0.8%**
	larger improvement	3.7%	**0.8%**

Source: Impact analysis and SSW PR14 submission

Grey Water Services

Who finds a 'grey water' system appealing?

There is a greater appeal of grey water systems in Cambridge when compared to South Staffordshire, with nearly half of Cambridge customers finding a grey water system appealing (37% in South Staffordshire and 47% in Cambridge[7]). There is a slight bias towards HH customers compared to NHH (37% SSW HH, 50% Cambridge HH, 34% NHH in both regions). Only 14%[8] of all customers found it unappealing.

There is a pattern related to age: those who are younger are more interested and those who are older are the greatest rejecters. There is also a pattern related to SEG: more affluent customers find grey water systems more appealing. There is no consistent pattern between rural and urban locations when comparing the two regions.

Figure 15: Appeal of a grey water system by Age, SEG, and Location[9]

		18-29	30-44	45-59	60+
SSW	T3B appealing	**38%**	**36%**	**37%**	**34%**
	B3B unappealing	13%	11%	12%	19%
Cambridge	T3B appealing	**54%**	**45%**	**55%**	**47%**
	B3B unappealing	7%	8%	11%	14%

		AB	C1	C2	DE
SSW	T3B appealing	**43%**	**37%**	**42%**	**29%**
	B3B unappealing	9%	13%	13%	18%
Cambridge	T3B appealing	**65%**	**51%**	**28%**	**34%**
	B3B unappealing	7%	10%	14%	16%

		Rural	Urban
SSW	T3B appealing	**40%**	**37%**
	B3B unappealing	9%	14%
Cambridge	T3B appealing	**46%**	**53%**
	B3B unappealing	13%	18%

HH customers who have a meter in South Staffordshire are significantly more likely to find grey water systems appealing, especially if they opted to have a meter themselves. There is however on a slight difference in Cambridge.

Figure 16: Appeal of a grey water system by whether customers have a meter

		Have meter – their choice	*Have a meter – installed in property*	NET have a meter	Don't have a meter
SSW	T3B appealing	**50%**	**49%**	**49%**	**30%**
	B3B unappealing	10%	10%	10%	16%
Cambridge	T3B appealing	**53%**	**53%**	**53%**	**48%**
	B3B unappealing	9%	11%	10%	15%

[7] Those scoring 8-10 on a 10 point scale where 1=very unappealing, 10 = very appealing.

[8] Those scoring 1-3 on the 10 point scale.

[9] Green = significantly higher when compared to the domestic total to a 95% confidence level Red= significantly lower when compared to the domestic total to a 95% confidence level

Willingness to pay for a grey water system

Because the grey water system was a new concept and not directly in the same category as general service improvements, customers' potential willingness to pay for such a system was tested using contingency valuation, separate from the service improvements tested in the main choice experiment. Here, survey respondents simply indicated their likelihood to take up a grey water system at a given price[10].

Figure 17 shows how take up varies with annual charge. Up to half of Household customers (40%-50%) would take up a grey water system at the lowest price tested (£1), falling to about one quarter at a price higher than £10. Non-household customers show a higher level of take up at £1 (50%-70%) but a similar rate of decline as price increases.

Figure 17: Grey water take up by annual charge

The 'Turnbull non-parametric method' was used to estimate WTP values. This gives a lower and upper bound to the mean and does not require the analyst to make a lot of restrictive assumptions about the respondents' preferences, other than that no respondents have a negative WTP or a WTP higher than 20%. The resulting value ranges are shown below.

[10] Respondents indicated likelihood to take up on a five point scale, where 1=very likely and 5 = very unlikely. The responses were adjusted to reflect typical over-claim for new products and services: a score of 1 was allocated a 80% likelihood to take up, a score of 2 allocated 20% and all other scores 0%.

WTP value ranges

	HH	NHH
South Staffordshire	£3.56 - £5.12	£5.01 - £7.17
Cambridge	£2.93 - £4.21	£3.79 - £5.41

If we take the upper value and apply it in the same way as for the main WTP results, we get the following estimates as IO inputs:

Figure 17: Grey water 'total pot' IO input values

	HH	NHH	ALL
SSW	£2,826,240	£263,440	£3,089,680
Cambridge	£551,550	£54,100	£605,610

Next steps

Further Analysis

The final values that can be used as IO inputs are sensitive to assumptions made about how the WTP results from the survey should be combined and simplified. HH and NHH results can be combined, but the result will be that the latter have a much higher contribution per customer due to their much higher annual bills. This is acceptable if the focus is on total value, but if the aim is to maximise the number of customers who benefit, an alternative approach would be to use % WTP values. However, for Cost Benefit Analysis, the aim is to maximise return on investment and the monetary values are key to this.

The IO input values presented in this report are based on total sample using 'public' definitions of attributes levels. In most cases, the levels for private and public were intended to represent the same level of improvement, but this can be open to interpretation. As a sensitivity test, these calculations can be repeated using private definitions. A step further would be to carry out a parallel analysis of private WTP values with private definitions v public WTP values with public WTP definitions. The final IO inputs from these analyses will indicate any important variations. Where these appear, these may be areas that need to be revisited in subsequent research (see below).

Further Research

There will be an opportunity to carry out further survey research to test issues raised in this analysis. The main topics to cover are:

- How sensitive are customers to the specific definitions of the attributes and attribute levels?
    - For example, leakage was presented with much larger variations than in the PR14 study, yet customers' WTP is broadly similar (see Figure 10). This may

be an example of customers being willing to pay for a general improvement but not being engaged with the specific levels of improvement. The effect is to give quite different IO input values (ie much lower per % improvement for PR19). In the follow-up research this attribute can be tested with similar levels to those of PR14 to see if WTP values change.

- In another example, it may be argued that the description of water hardness placed a lot of emphasis on the effect of scale on household appliances, giving an undue emphasis on its negative effects and therefore raising the WTP value. The same reasoning is true for lead pipes in terms of language and question framing.

- The environmental attributes 'rivers & stream' and 'habitats' could re-tested to assess if a loss of environment produces a stronger WTP figure.

- The relationship between private and public definitions of some attributes could also be reviewed.
  - The aim was for each to equate to the other, but in some instances such as traffic disruption the link is not straight forward (ie a public definition indicating the number of disruptions in the region on any one day v the private definition of how many disruptions an individual might actually experience per year).

- Is there a 'budgeting' effect?
  - Customers indicate a willingness to pay for an improvement, but it is likely that the amount they are willing to pay in total is subject to a budgetary limit. In the WTP trade-off exercises, respondents traded four attributes at a time. If all improvements were introduced across all 17 attributes tested (15 for NHH customers) a simple addition of all the WTP values as reported here is likely to over-state the absolute value (though not the relative value of each attribute). Further research would give the opportunity to test some specific examples of multiple improvements to see if there is some 'budgeting' effect that reduces the overall figure.

Application to Cost Benefit Analysis

The use of the WTP outputs from this research is reported in a separate technical document published by SSC.

Appendix

These appendices summarise the analysis of the stated preference (SP) element of the research. This exercise required respondents to make a choice between two scenarios composed of four attributes and price. The current levels and price was only an option in one choice set, all other choice sets consisted of two options that both represent a change from current levels. From this information discrete choice models were estimated, and the resulting coefficients used in calculating WTP.

Design of the Stated Preference Exercises

The Stated Preference Choice Exercise

This exercise presented respondents with paired choices between two alternative future outcomes with different future bill levels and then asked them to select their preferred option. The exercise was constructed using a randomised statistical design that presents 12 scenarios to each respondent. In addition to the 12 scenarios per respondent, we also included one additional 'fixed' scenarios that are the same for all respondents. The fixed task design was the only choice set where one of the options represents the current levels as one of the options, although in all scenarios respondents were reminded of these current levels, even though the option was not to experience them in the future. The fixed tasks were designed to give fixed points of comparison across respondents, independent of any statistical modelling of the choices.

Example scenarios are shown below.

Figure A.1: A 'Water Quality' ('Public' context) scenario offered to a Household Customer

Looking at the choice below which option would you prefer if these were the only options available?

Occurrences over the next 20 years	Option A	Option B
Households experience DISCOLOURED TAP WATER for a day *Currently this affects....34,600 out of 552,000 households per year (6.3%)*	This affects....1,400 out of 131,000 households per year (1.1%)	This affects....no properties (0%)
Due to contamination households are UNABLE TO DRINK THE WATER for a period of 2 weeks *Currently this happens...Once in 80 years (once in a lifetime)*	This happens...Never	This happens...Once in 80 years (once in a lifetime)
Households served by LEAD PIPES *Currently your water company...Maintains the current level (1 in 3 properties)*	Your water company...Removes lead from all properties containing people at highest risk eg hospitals, old peoples homes, schools and homes with children	Your water company...Maintains the current level (1 in 3 properties)
Households have HARD WATER *Currently your water company...Does not do anything*	Your water company...Does not do anything	Your water company...Supplies customers with free water softening devices if there is a genuine problem
The CHANGE IN YOUR **ANNUAL WATER BILL**	+£20 From £150 in 2019 To £170 in 2020	+£30 From £150 in 2019 To £180 in 2020
Select your preferred option:	○	○

Figure A.2: An 'Environment' scenario ('Private' context) for Non-Household Customer

Occurrences over the next 50 years	Option A	Option B
WATER LEAKAGE from yours, or your water company's water pipes *Currently the amount of water lost through leakage in any one year is....24%*	The amount of water lost through leakage in any one year is....5%	The amount of water lost through leakage in any one year is....10%
Protecting WILDLIFE HABITATS *Currently your water company should...Continue to protect and improve 99 hectares (which is 138 football pitches)*	Your water company should...Continue to protect and improve 99 hectares (which is 138 football pitches)	Your water company should...Protect and Improve an additional 6 hectares (8 football pitches) for wildlife and plants
Managing impacts on RIVERS & STREAMS *Currently your water company should...In all cases meet their duties to protect the rivers, streams and the land around them they affect*	Your water company should...Provide support for schemes covering an additional 50 hectares (or 69 football pitches) that restore the rivers and the land around them in your area	Your water company should...Provide support for schemes covering an additional 100 hectares (or 139 football pitches) that restore the rivers and the land around them in your area
Use of RENEWABLE ENERGY *Currently your water company should...Maintain their current level of 11% from renewable sources*	Your water company should...Ensure at least 30% comes from renewable sources	Your water company should...Ensure at least 50% comes from renewable sources
The CHANGE IN YOUR **ANNUAL** WATER BILL	35% From £150 in 2019 To £203 in 2020	20% From £150 in 2019 To £180 in 2020
Select your preferred option:	O	O

The Stated Preference Design

Using the Sawtooth CBC design software, 9 sets of 13 scenarios (12 random tasks and 1 fixed task) were constructed, to be randomly distributed across the respondents. The design was pre-tested to ensure low correlations between each contract elements and that each element appeared a similar number of times across the scenarios. Conditions were applied to limit the number of 'obvious' choices, minimising for example scenario options where improvements would be better than the alternative option but will a lower bill increase.

The main attribute descriptions and levels are shown in Figure A.3 below. To keep the amount of information manageable, each respondent was shown an exercise that consisted only of 'Water Quality', 'Security and Reliability of Supply' or 'Environment' attributes.

A 'partial' design was employed, in which the number of attributes shown in any one scenario was limited to four at a time. While this lowered the information content of each scenario, it also reduced the complexity of the choices and ensured an even number of attributes being shown across the three areas.

To reduce potential bias, the context for the scenarios was also varied in two ways:

- The presentation of attributes either entirely in terms of their 'Public' context (the general impact on households and businesses across the region), and their presentation in a 'Private' context (the impact on the customer personally). Figure A.4 highlights the different definitions for the latter. Respondents were randomly assigned to one or other context. Many of the levels were the same across 'Public' and 'Private' and in the case of four of the six environment attributes, exactly the same throughout. This is because they represented region-wide impacts that could not easily be expressed as personal impacts; nevertheless, the context for these was still 'their value personally to you' when presented as 'Private' attributes.

- The future 'horizon' in terms of a 20, 50 and 80 year viewpoint. This remained as one value for each respondent, but was randomly varied across the sample.

Figure A.3: Households attributes with '<u>Public</u>' Definitions (italics indicate Stafford / Cambridge differences)

	Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
WATER QUALITY	Taste and smell of your tap water	Your tap water tastes and smells different (e.g of chlorine) for a period of 3 days. (You do not know whether it is safe to drink or not until you contact your water company)	Households' water TASTES AND SMELLS DIFFERENT for a period of 3 days	*[8,400/1,900]* out of *[552,000/131,000]* households per year *([1.5%/1.4%])*	*[4,700/900]* out of *[552,000/131,000]* households per year *([0.8%/0.7%])*	No properties (0%)
	Discolouration of your tap water	The tap water at your property is discoloured for 24 hours. Running the tap for a few minutes will not remove this discolouration. (You do not know whether it is safe to drink or not until you contact your water company)	Households experience DISCOLOURED TAP WATER households' homes for a day	*[34,600/2,800]* out of *[552,000/131,000]* households per year *([6.3%/2.1%])*	*[17,300/1,400]* out of *[552,000/131,000]* households per year *([3.1%/1.1%])*	No properties (0%)
	Water not safe to drink	Due to contamination, you are unable to drink the water at your property for a period of 2 weeks.	Due to contamination Households are UNABLE TO DRINK THE WATER in your home for a period of 2 weeks	Once in 80 years (once in a lifetime)	Once every 120 years (Not in either mine or my children's lifetime)	Never
	Lead pipes	Approximately every 3rd property in the water company's area is served by a lead pipe, most of these are pipes are owned by the customer. (A harmless additive is added to the water supply to ensure the lead pipe poses no risk to health)	Households served by LEAD PIPES	Maintains the current level (1 in 3 properties)	Removes lead from all properties containing children	Removes lead from all properties
	Water hardness	Hard water causes appliances, taps, tiles, etc to scale which can reduce their usable life. Softening the water is an option but this can alter the taste of your water.	Households have HARD WATER	Does not do anything	Supplies customers with free water softening devices if there is a genuine problem	Softens the water supply so it does not cause unwanted damage to any part of your property or appliances

	Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
SECURITY AND RELIABILITY OF SUPPLY	Unexpected temporary loss of water supply	There is an unexpected problem with the network, such as a burst main, that means your property is without water for up to 24 hours.	Households are WITHOUT WATER for up to 24 hours	*[8,000/3,300]* out of *[552,000/131,000]* households per year *([1.4%/2.5%])*	*[4,000/1,600]* out of *[552,000/131,000]* households per year *([0.7%/1.3%])*	Never
	Temporary use ban	There is a hosepipe ban in your area for 5 months from May to September.	A TEMPORARY USE BAN for many households	Once in every [*40/80*] years (twice in a lifetime)	Once in every [*60/120*] years (once in a lifetime)	Never
	Drought restrictions	Because of a water drought, most of the region would have to get all their water from a standpipe located in your street for between 2 to 4 weeks.	A WATER DROUGHT in the area	Once in every 80 years (twice in a lifetime)	Once in every 120 years (once in a lifetime)	Never
	Low water pressure	The water at your property loses pressure a number of times throughout the day and night which reduces the water flow to a slow trickle.	LOW WATER PRESSURE at many households	*[56,100/12,200]* out of *[552,000/131,000]* households per year *([10.2%/9.3%])*	*[28,100/6,100]* out of *[552,000/131,000]* households per year *([5.1%/4.6%])*	*[14,000/3,000]* out of *[552,000/131,000]* households per year *([2.5%/2.3%])*
	Traffic disruption	Over time pipes need to be repaired or replaced, therefore you encounter road works on your journeys to and from your home This means you are delayed by 15 minutes each time you travel. Road works are typically in place for 3 days.	TRAFFIC DISRUPTION on many households' journeys	[*5/3*] active roadworks somewhere in region on an average day	[*3/2*] active roadworks somewhere in region on an average day	[*2/1*] active roadworks somewhere in region on an average day
	Flooding from a burst pipe	A pipe that supplies water to your property (either a water company owned mains or your own supply pipe) bursts and floods the ground floor of your property.	FLOODING FROM A BURST PIPE for a number of households	Once in every 80 years (twice in a lifetime)	Once in every 120 years (once in a lifetime)	Never

	Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
ENVIRONMENT	Leakage levels	Around *[24% / 20%]* of the water supplied by your water company is lost through leaking pipes. The majority of this is from the water company's pipe network and the rest from the supply pipe that serve customers' properties (which is the responsibility of the property owner). As new leaks are always appearing they can't be reduced to 0.	WATER LEAKAGE from households or the water company's water pipes	24% / 20%	12% / 10%	6% / 5%
	Water metering	The vast majority of business customers and *[33% / 70%]* household customers have a water meter fitted in this region which means they pay just for the water they use. The remaining properties pay a fixed amount per year depending on the rateable value of their property.	WATER METERS fitted in customers' homes	33% / 70%	65% / 80%	90% / 95%
	Giving customers control of their water usage	To help you understand and manage your water consumption your water company is able to give you a water meter reading via a device in your home.	WATER USAGE READINGS	Twice a year	Monthly	On demand
	Protecting wildlife habitats	All water companies have a duty to protect natural habitats and the variety of plant and animal life in them (ie biodiversity) in the areas where their operations may have an impact…….	Protecting WILDLIFE HABITATS	Continue to protect and improve 99 hectares (which is 138 football pitches)	Protect and Improve an additional *[19 hectares (26 football pitches) / 6 hectares (8 football pitches)]* for wildlife and plants	Protect and Improve an additional *[30 hectares (42 football pitches) / 10 hectares (14 football pitches)]* for wildlife and plants

Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
Managing impacts on rivers & streams	In order to supply customers your water company has to take water from the environment. Your water company works with other organisations (such as the Environment Agency) to ensure that the amount of water it takes does not negatively impact on river habitats	Managing impacts on RIVERS & STREAMS	In all cases meet their duties to protect the rivers, streams and the land around them they affect	Provide support for schemes covering an additional *[150 hectares (or 208 football pitches) / 50 hectares (or 69 football pitches)]* that restore the rivers and the land around them in your area	Provide support for schemes covering an additional *[200 hectares (or 278 football pitches) / additional 100 hectares (or 139 football pitches)]* that restore the rivers and the land around them in your area
Use of renewable energy	To pump water to customers' homes your water company uses a lot of electricity. Currently, 11% of the electricity used by your water company comes from renewable sources - eg solar panels, wind	Use of RENEWABLE ENERGY	Maintain their current level of 11% from renewable sources	Ensure at least 30% comes from renewable sources	Ensure at least 50% comes from renewable sources

Figure A.4: Households attributes with '<u>Private</u>' Definitions (italics indicate Stafford / Cambridge differences; bold indicates different from 'Public' descriptions; the final four attributes were the same as for 'Public' and are therefore not shown here)

	Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
WATER QUALITY	Taste and smell of your tap water	Your tap water tastes and smells different (e.g of chlorine) for a period of 3 days. (You do not know whether it is safe to drink or not until you contact your water company)	**Your water TASTES AND SMELLS DIFFERENT for a period of 3 days**	**Once in every *[60/70]* years (once in a lifetime)**	**Once in every *[90/100]* years (once in a lifetime)**	**Never**
	Discolouration of your tap water	The tap water at your property is discoloured for 24 hours. Running the tap for a few minutes will not remove this discolouration. (You do not know whether it is safe to drink or not until you contact your water company)	**You experience DISCOLOURED TAP WATER at your home for a day**	**Once in every [*15 years/45 years (twice in a lifetime)*]**	**Once in every [2*5 years (3 times in a lifetime)/65((once in a lifetime)*]**	**Never**
	Water not safe to drink	Due to contamination, you are unable to drink the water at your property for a period of 2 weeks.	**Due to contamination you are UNABLE TO DRINK THE WATER in your home for a period of 2 weeks**	Once in 80 years (once in a lifetime)	Once every 120 years (Not in either mine or my children's lifetime)	Never
	Lead pipes	Approximately every 3rd property in the water company's area is served by a lead pipe, most of these are pipes are owned by the customer. (A harmless additive is added to the water supply to ensure the lead pipe poses no risk to health)	**Your home is served by LEAD PIPES**	Maintains the current level (1 in 3 properties)	Removes lead from all properties containing children	Removes lead from all properties
	Water hardness	Hard water causes appliances, taps, tiles, etc to scale which can reduce their usable life. Softening the water is an option but this can alter the taste of your water.	**Your home has HARD WATER**	Does not do anything	Supplies customers with free water softening devices if there is a genuine problem	Softens the water supply so it does not cause unwanted damage to any part of your property or appliances

	Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
SECURITY AND RELIABILITY OF SUPPLY	Unexpected temporary loss of water supply	There is an unexpected problem with the network, such as a burst main, that means your property is without water for up to 24 hours.	**Your home is WITHOUT WATER for up to 24 hours**	**Once in every [*70 years (once in a lifetime) / 40 years (once in a lifetime)***	**Once in every [*105 years (once mine or my children's lifetime) / 60 years (once in a lifetime)***	**Never**
	Temporary use ban	There is a hosepipe ban in your area for 5 months from May to September.	**A TEMPORARY USE BAN at your home**	Once in every [*40/80*] years (twice in a lifetime)	Once in every [*60/120*] years (once in a lifetime)	Never
	Drought restrictions	Because of a water drought, most of the region would have to get all their water from a standpipe located in your street for between 2 to 4 weeks.	**A WATER DROUGHT in your area**	Once in every 80 years (twice in a lifetime)	Once in every 120 years (once in a lifetime)	Never
	Low water pressure	The water at your property loses pressure a number of times throughout the day and night which reduces the water flow to a slow trickle.	**LOW WATER PRESSURE at your home**	**Once every [10/11] years**	**Once every 15 years**	**Once every 20 years**
	Traffic disruption	Over time pipes need to be repaired or replaced, therefore you encounter road works on your journeys to and from your home This means you are delayed by 15 minutes each time you travel. Road works are typically in place for 3 days.	**TRAFFIC DISRUPTION on your journey to and from your home**	**Once per year**	**Once every 2 years**	**Once every 5 years**
	Flooding from a burst pipe	A pipe that supplies water to your property (either a water company owned mains or your own supply pipe) bursts and floods the ground floor of your property.	**FLOODING FROM A BURST PIPE at your home**	Once in every 80 years (twice in a lifetime)	Once in every 120 years (once in a lifetime)	Never
RON MEN	Leakage levels	Around *[24% / 20%]* of the water supplied by your water company is	**WATER LEAKAGE from yours, or your water company's water**	24% / 20%	12% / 5%	6% / 5%

Attribute	Full definition of attributes	Short Label	Current Position	Some improvement	Significant improvement
	lost through leaking pipes. The majority of this is from the water company's pipe network and the rest from the supply pipe that serve customers' properties (which is the responsibility of the property owner). As new leaks are always appearing they can't be reduced to 0.	**pipes**			
Water metering	The vast majority of business customers and *[33% / 70%]* household customers have a water meter fitted in this region which means they pay just for the water they use. The remaining properties pay a fixed amount per year depending on the rateable value of their property.	**WATER METERS fitted in customers' homes**	33% / 70%	65% / 80%	90% / 95%

Review of Responses

Before estimating the main discrete choice model, we reviewed the spread of responses. Figures A.5 below summarises the results of all respondents across the 13 choice sets, showing the percentage of times when an option was chosen that contained a particular attribute level. This gives an initial indication of the relative impact of each attribute.

Figure A.5: Percentage of cases where each attribute level is in the option chosen (base = all choice sets where the attribute level appears)**.**

	ENV HH			**Security**				**Quality**			
	Cam HH	SS HH	NHH Total	Cam	SS	HH	NHH	Cam	SS	HH	NHH
	167	301	81	189	353	461	81	188	344	447	85
Attribute 1	Leakage levels			Unexpected temporary loss of water supply				Taste and smell of your tap water			
Current	45%	47%	51%	50%	49%	50%	45%	50%	49%	49%	51%
small improvement	56%	57%	51%	55%	52%	53%	52%	54%	55%	54%	54%
larger improvement	48%	47%	49%	46%	49%	47%	52%	46%	46%	46%	45%
Attribute 2	Water metering			Temporary use ban				Discolouration of your tap water			
Current	49%	52%	n/a	49%	48%	48%	47%	49%	50%	49%	54%
small improvement	55%	54%		57%	53%	54%	56%	52%	51%	51%	53%
larger improvement	45%	44%		43%	49%	47%	47%	49%	49%	50%	43%
Attribute 3	Giving customers control of their water usage			Drought restrictions				Water not safe to drink			
Current	51%	54%	n/a	49%	50%	49%	52%	45%	46%	45%	46%
small improvement	53%	52%		55%	53%	53%	54%	57%	57%	57%	56%
larger improvement	46%	44%		46%	48%	48%	44%	48%	47%	47%	48%
Attribute 4	Protecting wildlife habitats			Low water pressure				Lead pipes			
Current	55%	55%	54%	52%	45%	47%	51%	42%	44%	43%	45%
small improvement	51%	54%	49%	56%	56%	57%	54%	54%	54%	54%	57%
larger improvement	45%	41%	47%	42%	49%	47%	45%	54%	52%	53%	48%
Attribute 5	Managing impacts on rivers & streams			Traffic disruption				Water hardness			
Current	49%	49%	45%	53%	50%	51%	52%	47%	45%	46%	47%
small improvement	59%	57%	54%	55%	57%	56%	55%	53%	55%	54%	53%
larger improvement	42%	43%	51%	42%	43%	42%	43%	50%	50%	50%	50%
Attribute 6	Use of renewable energy			Flooding from a burst pipe							
Current	44%	45%	49%	41%	43%	43%	40%				
small improvement	51%	52%	53%	57%	55%	55%	58%				
larger improvement	55%	53%	47%	51%	52%	52%	52%				
Price											
Current	70%	72%	58%	76%	68%	71%	69%	59%	60%	58%	66%
£10 / 5%	65%	65%	46%	66%	70%	69%	67%	63%	66%	66%	63%
£20 / 15%	58%	54%	48%	56%	55%	56%	54%	56%	53%	55%	48%
£30 / 20%	42%	43%	47%	41%	41%	41%	40%	48%	47%	48%	47%
£50 / 35%	19%	18%	52%	14%	19%	17%	22%	25%	26%	25%	28%

For example, in the table above, within the attribute ‘Price’, the level “1” is clearly much more attractive than level “4”, because it was part of the chosen option approx. 60-70% of the times it was shown, compared to only about 20% for level “4”.

This is a top-level analysis, so the comparison of levels is subject to a certain amount of ‘noise’, but already we would expect these more noticeable variations to appear as the strongest elements in the discrete choice model.

Because significant improvements often occur alongside higher prices this can make preference for this level of improvement appear lower than it really is.

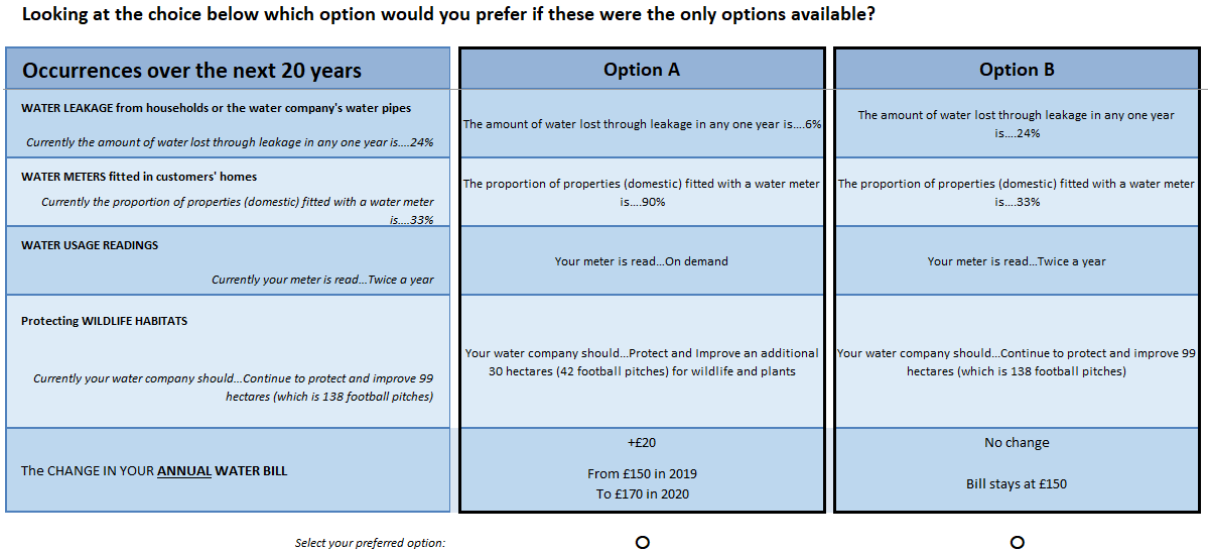
Further profiling of the price element within respondents’ choices, as well as the results of the fixed task are summarised in the table below

Figure A.6: Overview of respondents’ choice regarding price

		SS								
		Environment			Quality			Security		
		HH	NHH	Total	HH	NHH	Total	HH	NHH	Total
	Base	*301*	*45*	*346*	*288*	*56*	*344*	*311*	*42*	*353*
% of respondents who…	Pick “current” at fixed task	66%	69%	66%	43%	61%	46%	55%	62%	56%
	ALWAYS choose cheapest	34%	15%	32%	22%	16%	22%	28%	15%	27%
	ALWAYS choose most expensive	0%	0%	0%	0%	5%	1%	1%	0%	1%
% of choice sets where	cheapest option was chosen	75%	68%	74%	65%	68%	66%	75%	71%	74%

		Cambridge								
		Environment			Quality			Security		
		HH	NHH	Total	HH	NHH	Total	HH	NHH	Total
	Base	*167*	*36*	*203*	*159*	*29*	*188*	*150*	*39*	*189*
% of respondents who…	Pick “current” at fixed task	62%	81%	66%	41%	48%	42%	57%	64%	59%
	ALWAYS choose cheapest	32%	36%	33%	23%	29%	24%	45%	36%	43%
	ALWAYS choose most expensive	1%	0%	1%	1%	6%	2%	1%	0%	1%
% of choice sets where	cheapest option was chosen	75%	70%	74%	65%	66%	65%	79%	76%	78%

Figure A.7: Fixed Task



Looking at the choice below which option would you prefer if these were the only options available?

Occurrences over the next 20 years	Option A	Option B
WATER LEAKAGE from households or the water company's water pipes *Currently the amount of water lost through leakage in any one year is....24%*	The amount of water lost through leakage in any one year is....6%	The amount of water lost through leakage in any one year is....24%
WATER METERS fitted in customers' homes *Currently the proportion of properties (domestic) fitted with a water meter is....33%*	The proportion of properties (domestic) fitted with a water meter is....90%	The proportion of properties (domestic) fitted with a water meter is....33%
WATER USAGE READINGS *Currently your meter is read...Twice a year*	Your meter is read...On demand	Your meter is read...Twice a year
Protecting WILDLIFE HABITATS *Currently your water company should...Continue to protect and improve 99 hectares (which is 138 football pitches)*	Your water company should...Protect and Improve an additional 30 hectares (42 football pitches) for wildlife and plants	Your water company should...Continue to protect and improve 99 hectares (which is 138 football pitches)
The CHANGE IN YOUR **ANNUAL** WATER BILL	+£20 From £150 in 2019 To £170 in 2020	No change Bill stays at £150
Select your preferred option:	O	O

The fixed tasks indicate that for Environment and Security most respondents are not willing to pay extra for improvements in service (vs current levels). Quality however shows more willingness to pay (especially for HH) with less than half choosing the current option in the fixed task.

The cheapest option was also selected approx. 75% of the time within Environment and Security compared to approx. 65% within Quality.

The Modelling Approach

The basic functional form of the choice model suitable for discrete choice data is the multinomial logit (MNL) function, in which the ratio of the probability of choosing an option is a function of the exponential of the 'utility' of that option over the sum of the exponentials of all the utilities of all the options available. This is shown in the equation below.

Basic functional form of the choice model

$$P_i = \exp(U_i) / {}_1\sum^n \exp(U_n)$$

Where : P_i = Probability of choosing option i

U_i = utility of option I = $a_0 + b_1*X_1 + \ldots.. + b_n*X_n$

$a_0 + b_1 \ldots b_n$ are coefficients

$X_1 \ldots b_n*X_n$ are independent variables that describe the chosen option

The models can be used to calculate the willingness to pay for different levels of improvement to current service levels.

Conjoint analysis derives utilities ('part-worth' utilities in this case) to represent respondent preferences for product/service attributes. These utility scores are calculated using an Hierarchical Bayes algorithm which starts by estimating average utility scores for the sample

as a whole, and then determine how much each individual response differs from this average. Respondent level utilities are then adjusted to reflect each individual's choices.

Because information for the dataset as a whole is used when calculating utilities, we analysed the results for Cambridge and SS separately for Quality, Security and HH Environment. However due to low numbers we calculated NHH Environment for the two regions together. This meant we had 7 sets of data for analysis

When we have attribute levels that should logically have an order of preference e.g. price or quality there is an option to constrain the utility estimation to adhere to this order. We therefore ran the utility estimations twice for each data set once constrained and once unconstrained.

We constrained price to adhere to our assumption that lower prices should be preferred to higher prices, and attributes were constrained based on the assumption that, and utility should increase in line with level of improvement. Therefore, current is the best level for price, but the worst level for attributes.

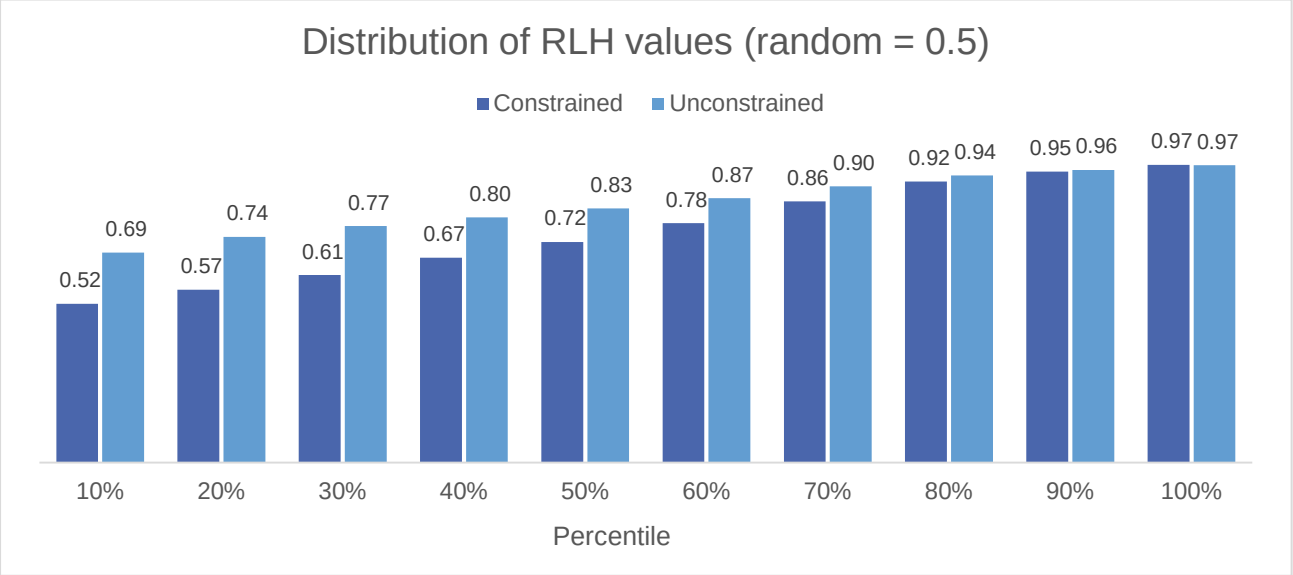
Goodness-of-Fit

The Sawtooth HB estimation software produces an RLH (**R**oot **L**ikeli**H**ood) figure for each respondent. The RLH is the nth root of the likelihood, where n is the total number of choices made by all respondents in all tasks. RLH is therefore the geometric mean of the predicted probabilities (1/k where k = number of choices).

In this SP exercise, there were two choices per scenario, so if the model was no better than random, the RLH would be 0.5; if it fitted the data perfectly, it would have a value of 1.

The chart below shows how the RLH for individual respondents is distributed for both the constrained and unconstrained models.

Figure A.8: Distribution of RLH



The final model developed for this study had an average RLH of 0.83 for the unconstrained estimations and 0.73 for the constrained estimations. Although constraining the estimates decreases the RLH by an average of 11%, the constrained model still fits the majority of respondents well.

Respondents whose RLH score sits below the lower confidence limit were excluded from the WTP calculations.

Summary of Model Utilities

The table below shows the average utility value and standard error of the estimates for each attribute level tested in the SP exercise.

Within each service attribute there are three levels (current, some and significant improvement) and five levels for price (current and increases of different £ or % amounts). We take the absolute value of the lowest level within an attribute (which will always be current for service attributes and the highest price increase for the constrained models) and add this value to all levels. This sets the lowest value to 0, and all other levels is the utility difference vs this point. Therefore the “current” level for service attributes has been excluded from the table.

Figure A.9: Utility Estimates

			Cambridge									
			HH					NHH				
			Utility	sd	se	Low	High	**Utility**	sd	se	Low	High
Quality	Taste and smell of your tap water	small improvement	**0.26**	0.43	0.03	0.00	0.66	**0.20**	0.22	0.04	0.00	0.60
		larger improvement	**0.54**	0.98	0.07	0.04	1.59	**0.50**	0.70	0.13	0.06	1.22
	Discolouration of your tap water	small improvement	**0.41**	0.74	0.06	0.02	0.90	**0.31**	0.35	0.06	0.03	0.78
		larger improvement	**0.60**	0.92	0.07	0.09	1.35	**0.54**	0.44	0.08	0.08	1.38
	Water not safe to drink	small improvement	**0.55**	1.25	0.10	0.01	2.07	**0.68**	1.03	0.19	0.01	2.67
		larger improvement	**0.64**	1.25	0.10	0.05	2.09	**0.79**	0.99	0.18	0.07	2.70
	Lead pipes	small improvement	**0.96**	1.37	0.10	0.04	2.85	**1.00**	1.16	0.21	0.08	3.13
		larger improvement	**1.37**	2.01	0.15	0.12	4.28	**1.26**	1.31	0.24	0.16	3.94
	Water hardness	small improvement	**0.63**	1.11	0.09	0.05	2.54	**0.51**	0.75	0.14	0.02	1.81
		larger improvement	**0.91**	1.49	0.11	0.11	3.12	**0.98**	1.84	0.34	0.04	2.35
	Price	No Change (current)	**5.69**	7.60	0.58	0.07	17.58	**6.23**	7.05	1.29	0.04	18.03
		£10 / 5%	**4.38**	5.35	0.41	0.06	12.01	**4.66**	4.91	0.90	0.04	12.58
		£20 / 15%	**3.23**	3.60	0.28	0.06	8.06	**3.30**	3.20	0.59	0.04	8.44
		£30 / 20%	**2.07**	2.15	0.17	0.04	4.80	**2.04**	1.86	0.34	0.03	4.89
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00
Security	Unexpected temporary loss of water supply	small improvement	**0.09**	0.25	0.02	0.00	0.48	**0.20**	0.52	0.08	0.00	0.67
		larger improvement	**0.65**	0.68	0.06	0.10	1.80	**0.76**	0.87	0.14	0.12	2.41
	Temporary use ban	small improvement	**0.42**	0.43	0.04	0.02	0.83	**0.37**	0.24	0.04	0.02	0.69
		larger improvement	**0.56**	0.53	0.04	0.05	1.15	**0.48**	0.30	0.05	0.03	1.02
	Drought Restrictions	small improvement	**0.48**	0.41	0.03	0.02	1.13	**0.34**	0.31	0.05	0.02	0.81
		larger improvement	**0.57**	0.46	0.04	0.04	1.36	**0.41**	0.34	0.06	0.04	0.95
	Low water pressure	small improvement	**0.21**	0.33	0.03	0.01	0.81	**0.16**	0.20	0.03	0.00	0.56
		larger improvement	**0.32**	0.45	0.04	0.04	1.15	**0.29**	0.41	0.07	0.04	1.00
	Traffic Disruption	small improvement	**0.06**	0.07	0.01	0.01	0.16	**0.07**	0.13	0.02	0.01	0.15
		larger improvement	**0.23**	0.32	0.03	0.03	1.13	**0.24**	0.31	0.05	0.04	0.90
	Flooding from a burst pipe	small improvement	**0.95**	1.30	0.11	0.07	4.17	**0.89**	1.03	0.17	0.07	3.35
		larger improvement	**1.08**	1.29	0.11	0.08	4.22	**1.00**	1.03	0.17	0.13	3.51
	Price	No Change (current)	**12.11**	11.04	0.93	0.33	23.32	**10.41**	8.71	1.41	0.19	23.46
		£10 / 5%	**9.12**	7.83	0.66	0.30	16.75	**8.04**	6.26	1.02	0.18	16.71
		£20 / 15%	**6.28**	4.90	0.41	0.28	10.68	**5.53**	3.83	0.62	0.18	10.66
		£30 / 20%	**3.69**	2.69	0.23	0.16	5.89	**3.30**	2.05	0.33	0.14	5.91
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00
Environment	Leakage Levels	small improvement	**0.71**	1.09	0.08	0.07	2.28	**0.02**	0.08	0.01	0.00	0.08
		larger improvement	**1.03**	1.54	0.12	0.09	3.09	**0.08**	0.13	0.02	0.00	0.20
	Water metering	small improvement	**0.12**	0.15	0.01	0.00	0.36	*n/a*				
		larger improvement	**0.22**	0.24	0.02	0.01	0.65					
	Giving customers control of their water usage	small improvement	**0.20**	0.25	0.02	0.00	0.59					
		larger improvement	**0.32**	0.35	0.03	0.01	0.93					
	Protecting wildlife habitats	small improvement	**0.01**	0.01	0.00	0.00	0.04	**0.00**	0.01	0.00	0.00	0.01
		larger improvement	**0.11**	0.16	0.01	0.01	0.30	**0.01**	0.02	0.00	0.00	0.01
	Managing impacts on rivers & streams	small improvement	**0.02**	0.03	0.00	0.00	0.07	**0.08**	0.12	0.02	0.01	0.32
		larger improvement	**0.13**	0.17	0.01	0.00	0.33	**0.09**	0.13	0.03	0.01	0.36
	Use of renewable energy	small improvement	**0.22**	0.55	0.04	0.00	1.28	**0.15**	0.70	0.13	0.00	0.14
		larger improvement	**0.89**	1.35	0.10	0.11	2.54	**0.25**	1.26	0.24	0.00	0.14
	Price Increase £(HH) / %(NHH)	No Change (current)	**8.60**	9.01	0.70	0.12	23.35	**0.21**	0.31	0.06	0.02	0.93
		£10 / 5%	**6.76**	6.62	0.51	0.12	16.86	**0.04**	0.23	0.04	0.00	0.00
		£20 / 15%	**4.91**	4.70	0.36	0.10	11.65	**0.04**	0.23	0.04	0.00	0.00
		£30 / 20%	**3.23**	3.04	0.24	0.07	7.17	**0.04**	0.22	0.04	0.00	0.00
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00

Figure A.9: Utility Estimates

			South Stafordshire									
			HH					NHH				
			Utility	sd	se	Low	High	**Utility**	sd	se	Low	High
Quality	Taste and smell of your tap water	small improvement	**0.13**	0.18	0.01	0.01	0.33	**0.15**	0.22	0.03	0.00	0.38
		larger improvement	**0.32**	0.33	0.02	0.05	0.98	**0.33**	0.38	0.05	0.04	0.96
	Discolouration of your tap water	small improvement	**0.11**	0.13	0.01	0.00	0.32	**0.11**	0.12	0.02	0.00	0.33
		larger improvement	**0.38**	0.54	0.03	0.02	1.36	**0.25**	0.27	0.04	0.01	0.70
	Water not safe to drink	small improvement	**0.51**	0.73	0.04	0.02	2.19	**0.39**	0.74	0.10	0.02	1.92
		larger improvement	**0.59**	0.81	0.05	0.03	2.63	**0.43**	0.78	0.11	0.03	2.06
	Lead pipes	small improvement	**0.65**	0.62	0.04	0.04	1.74	**0.64**	0.60	0.08	0.04	1.90
		larger improvement	**1.06**	0.91	0.06	0.08	2.65	**0.87**	0.75	0.10	0.07	2.41
	Water hardness	small improvement	**0.76**	0.81	0.05	0.01	2.38	**0.65**	0.59	0.08	0.01	1.68
		larger improvement	**0.89**	0.94	0.06	0.04	2.82	**0.72**	0.64	0.09	0.04	1.72
	Price	No Change (current)	**5.51**	6.27	0.38	0.07	15.47	**5.99**	5.37	0.74	0.05	15.03
		£10 / 5%	**4.66**	5.03	0.31	0.06	12.13	**4.91**	4.33	0.60	0.05	11.80
		£20 / 15%	**3.47**	3.51	0.22	0.05	8.40	**3.48**	2.93	0.41	0.04	8.19
		£30 / 20%	**2.11**	1.95	0.12	0.04	4.53	**2.14**	1.73	0.24	0.03	4.51
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00
Security	Unexpected temporary loss of water supply	small improvement	**0.21**	0.24	0.01	0.01	0.87	**0.13**	0.16	0.03	0.00	0.69
		larger improvement	**0.68**	0.63	0.04	0.10	1.82	**0.71**	0.69	0.11	0.10	2.39
	Temporary use ban	small improvement	**0.08**	0.25	0.01	0.00	0.29	**0.07**	0.16	0.03	0.00	0.32
		larger improvement	**0.48**	0.53	0.03	0.01	1.55	**0.34**	0.41	0.07	0.00	0.93
	Drought Restrictions	small improvement	**0.01**	0.02	0.00	0.00	0.05	**0.01**	0.01	0.00	0.00	0.07
		larger improvement	**0.08**	0.14	0.01	0.01	0.36	**0.08**	0.17	0.03	0.00	0.18
	Low water pressure	small improvement	**0.36**	0.42	0.02	0.00	1.25	**0.25**	0.28	0.04	0.00	0.66
		larger improvement	**0.73**	0.89	0.05	0.06	2.82	**0.47**	0.63	0.10	0.06	1.23
	Traffic Disruption	small improvement	**0.01**	0.01	0.00	0.00	0.04	**0.00**	0.00	0.00	0.00	0.05
		larger improvement	**0.08**	0.11	0.01	0.01	0.28	**0.05**	0.07	0.01	0.01	0.13
	Flooding from a burst pipe	small improvement	**0.39**	0.45	0.03	0.03	1.50	**0.55**	0.72	0.12	0.03	2.22
		larger improvement	**0.50**	0.46	0.03	0.10	1.63	**0.61**	0.72	0.11	0.07	2.26
	Price	No Change (current)	**9.46**	9.10	0.54	0.13	20.50	**6.77**	7.11	1.14	0.09	19.59
		£10 / 5%	**7.80**	7.12	0.42	0.13	15.84	**5.63**	5.66	0.91	0.09	15.26
		£20 / 15%	**5.95**	5.31	0.31	0.09	11.83	**4.08**	4.18	0.67	0.06	11.42
		£30 / 20%	**3.77**	3.26	0.19	0.06	7.21	**2.63**	2.60	0.42	0.04	6.97
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00
Environment	Leakage Levels	small improvement	**0.38**	0.55	0.03	0.05	1.91	**0.00**	0.00	0.00	0.00	1.04
		larger improvement	**0.72**	0.67	0.04	0.11	2.33	**0.04**	0.07	0.01	0.00	1.12
	Water metering	small improvement	**0.11**	0.12	0.01	0.00	0.26	*n/a*				
		larger improvement	**0.18**	0.28	0.02	0.01	0.54					
	Giving customers control of their water usage	small improvement	**0.02**	0.02	0.00	0.00	0.04					
		larger improvement	**0.05**	0.08	0.00	0.01	0.20					
	Protecting wildlife habitats	small improvement	**0.08**	0.10	0.01	0.00	0.22	**0.00**	0.00	0.00	0.00	0.03
		larger improvement	**0.11**	0.13	0.01	0.00	0.30	**0.00**	0.00	0.00	0.00	0.05
	Managing impacts on rivers & streams	small improvement	**0.03**	0.09	0.01	0.00	0.12	**0.06**	0.06	0.01	0.00	0.20
		larger improvement	**0.10**	0.29	0.02	0.00	0.43	**0.06**	0.06	0.01	0.00	0.20
	Use of renewable energy	small improvement	**0.30**	0.33	0.02	0.01	0.71	**0.01**	0.01	0.00	0.00	0.18
		larger improvement	**0.53**	0.47	0.03	0.07	1.53	**0.01**	0.01	0.00	0.00	0.65
	Price Increase £(HH) / %(NHH)	No Change (current)	**9.54**	9.91	0.58	0.09	20.63	**0.15**	0.15	0.02	0.03	11.12
		£10 / 5%	**7.61**	7.74	0.46	0.06	16.01	**0.00**	0.00	0.00	0.00	7.80
		£20 / 15%	**5.77**	5.71	0.34	0.05	11.86	**0.00**	0.00	0.00	0.00	7.53
		£30 / 20%	**3.65**	3.36	0.20	0.04	7.04	**0.00**	0.00	0.00	0.00	4.75
		£50 / 35%	**0.00**	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00

Confidence intervals were calculated for all utility estimates and then for the ratio of the estimates when WTP was calculated.

WTP Calculation

The WTP calculation uses the principle of utility equalization to estimate how much money a given feature is worth. For example, if we have two levels of service quality, current and improvement with a utility of 0 for current and 6 for improvement, and two price levels "no increase" and "£10 increase" with utilities of 8 and 0 respectively. In this example an improvement to service quality has a utility increase of **6**, while a £10 increase in cost decreases overall utility by **8**, therefore you can calculate the price equivalence for this improvement as **6**/**8**ths (0.75) of the distance between £0 and £10 increase, i.e. £7.50.

When there are more than two price levels the WTP calculation is applied across each of the levels tested, so the utility value for each £ price change is not constant between the minimum and maximum levels, instead it makes a step change at each level. For example, if we tested three price levels "no increase", "£5 increase" and "£10 increase" with utilities of 8, 3 and 0 respectively. If we used only the first and last price levels we would calculate the utility of a £7.50 increase as 6 (0.75*8). One the other hand, if we use the utilities of all the levels we would calculate the utility of a £7.50 increase as **5.5** which is the utility for a £5 increase (3) plus half the distance between £5 and £10 increase (0.5 * 5).

The WTP figures in this report have been calculated in this way.

Notes on confidence interval calculations used on utility estimates

Standard Deviation (sd) $\sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}}$ where x is the sample and n is the sample size.

Standard Error (se) $SE_{\bar{x}} = \frac{s}{\sqrt{n}}$ where S is the standard deviation of the mean and n is the sample size.

Confidence intervals around the WTP were calculated from the variance (Standard error ^ 2) of the model coefficients, using the following formula for the ratio of two coefficients:

V(y/x) = V(y)/x^2 + V(x)y^2/x^4

Where: V = variance
y and x are coefficients[11]

[11] Wolter, K, 1985, Introduction to Variance Estimation, Statistics for Social and Behavioral Sciences