Appendix 5e:
Understanding Customer Values_ Stated Preference Report

YorkshireWater

PR19 Understanding Customer Values: Work Package 1 – First Round Stated Preference

Prepared for Yorkshire Water

Acknowledgements

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Quality information

Document name	Prepared for	Prepared by	Date	Approved by
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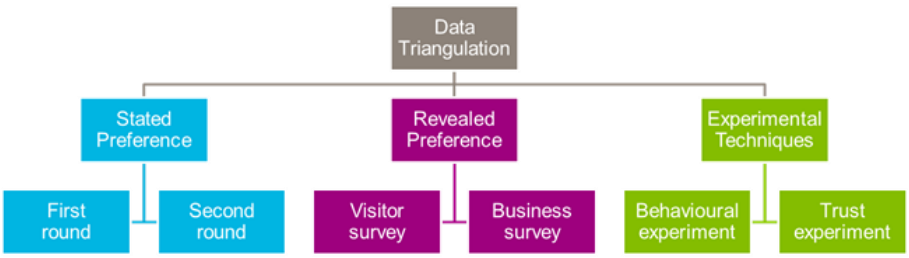
Work Package 1 – First Round

Context

The aim of this project is to undertake primary research to ascertain the values that Yorkshire Water (YWS) customers place on changes in service measures such as interruptions to supply or drinking water failures. These values will then be used to populate the Decision Making Framework (DMF) in order to inform the investment planning process and support the wider Outcome Delivery Incentives (ODI) work stream.

In light of Ofwat's recommendations for improving the approach to understanding customer's values in PR19, the project includes six work packages (see Figure 1) which draw on a range of data to allow methodological triangulation; whereby data of different types are used to cumulatively refine and validate research outputs.

Figure 1**. Overview of the six work packages**



Aims

The aim of this work package is to try to estimate the values YWS' customers and business consumers place on changes in service measures using a stated preference survey. Values are derived for the attributes included in the survey with the view that these will be compared to costs to help determine potential areas for investment at PR19. The specific questions which this work package aims to answer are as follows:

- What is the willingness-to-pay (WTP) amongst YWS customers for changes in service measures?
- How does WTP differ across socio-economic group, age, lifestage, vulnerable customers, low income customers, location in the region, and those who have experienced a service measure failure?
- How do use and non-use values compare for environment related service measures (i.e. bathing water quality, river water quality, pollution incidents, and land conservation)?

Method

This work package involved undertaking two surveys with YWS customers; both of which were quantitative surveys conducted via a combination of Computer Aided Personal Interviewing (CAPI) and online panel. A total of 1,020 household and 542 business surveys are included in the analysis for this work package. The make-up of household surveys was based on a pre-agreed sample structure in order to provide a

representative sample of bill paying household customers in the YWS region by age, socio-economic group, gender, region, and metered status. Business interview quotas were based on region, sector, and the number of employees in the business.

This work package used stated preference methods to undertake quantitative customer research. Stated preference methods attempt to directly elicit customer preferences for service priorities and improvements by asking choice or direct valuation questions through survey questionnaires and interviews. A choice experiment (CE) approach of stated preference was adopted in this work package.

The stated preference survey design implemented in this work package was composed of the specification of four fundamental components:

- Water quality, water supply, sewerage services, the environment and their levels for the CE questions
- The experimental design for the CE exercise
- The strategy for sampling and implementing the survey

In addition, the inclusion of attitudinal questions acting as covariates for the modelling (used to estimate the contribution of use and non-use values to customer's WTP) aimed to reduce issues of double counting of values within the DMF.

To assist in customer understanding of the concepts being presented to them a visually engaging set of show cards and choice cards were developed. Examples of the design are shown in Figures 1 and 2 below.

Figure 1: Show card example

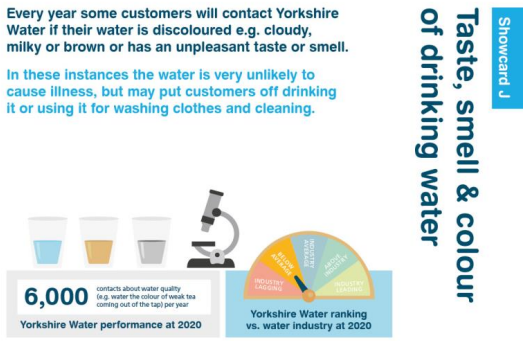
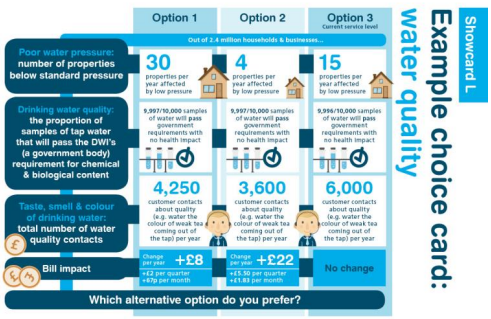


Figure 2: Choice card example



Customer understanding of the show cards and choice cards was tested in the cognitive phase, and customer understanding of the concepts was high.

Results

Household

Table 1 below summarises the choice behaviour observed with the household customer samples across the four service area blocks. For each choice experiment, household customers were shown four sets of three choices, the status quo and two alternative options with different bill impacts associated with each. The alternative options were chosen, at random, from 96 alternatives per service block area.

Table 1. Choice frequencies for household samples

Service area	Status quo	Alternative 1	Alternative 2
Water quality	66%	17%	17%
Supply of water	57%	21%	22%
Sewerage services	54%	23%	23%
Environment	51%	24%	25%

Table 2. Proportion of serial status quo choices and bill reduction option choices

Service area	Always choose status quo	Always choose bill increases	Always choose bill reductions
Water quality	39%	15%	6%
Supply of water	33%	13%	9%
Sewerage services	34%	16%	8%
Environment	32%	24%	6%

Table 1 reveals a very high level of choice of the status quo option within each of the service area blocks having a higher level of choice for the status quo option than alternatives combined. There is some level of trading with the alternative hypothetical options noted, particularly in the environmental water service option.

Table 2 meanwhile, shows around a third of respondents consistently choose the status quo when given multiple choices.

The final WTP and willingness-to-accept (WTA) estimates for household customers, based on a non-linear model, are summarised in

Table 3. In almost all of the areas considered, the level of WTA is greater than the level of WTP for the greatest service decrease or increase.

Table 3. Household willingness-to-pay and willingness-to-accept estimates

Service area	Service level attribute	WTP / WTA			
		-1	+1	+2	+3
Water quality	Poor water pressure: number of properties below standard pressure	-£1.37	£0.48	£0.82	£1.05
	Drinking water quality: proportion of samples of tap water that will pass the DWI's requirement for chemical & biological content	-£1.11	£0.49	£1.66	£2.15
	Taste, smell & colour of drinking water: total number of water quality contacts	-£1.49	£2.09	£3.74	£4.40
Supply of water	Unexpected supply interruption of 3–6 hours: total properties affected	-£0.82	£0.20	£0.61	£0.77
	Leakage	-£1.09	£0.44	£0.72	£0.83
	Water use restrictions e.g. hose pipe ban	-£0.50	£0.26	£0.26	£0.29
Sewerage services	Sewer flooding inside properties: number of incidents per year	-£1.13	£0.57	£1.19	£1.43
	Sewer flooding outside properties: number of incidents per year	-£0.82	£0.28	£0.46	£0.64
	Properties subjected to chronic (seasonal) unbearable smells from sewers and treatment works: complaints to YWS per year	-£0.21	£0.40	£0.60	£0.66
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard	-£0.91	£0.32	£0.48	£0.49
	Length of rivers in Yorkshire improved (%)	-£0.82	£0.83	£1.14	£1.35
	Category 3 pollution incidents: number of minor incidents that have a minimal impact on the quality of water in the area	-£0.43	£0.33	£0.60	£0.82
	Area of land conserved or improved by Yorkshire Water: hectares	-£0.56	£0.39	£0.53	£0.58

Business

Table 4 and

Table 5 summarise the choice behaviour observed with the business customer samples across the four service area blocks. For each choice experiment business customers were shown four sets of three choices, the status quo and two alternative options with different bill impacts associated with each. The alternative options were chosen, at random, from 96 alternatives per service block area.

Table 4. Choice frequencies for business samples

Service area	Status quo	Alternative 1	Alternative 2
Water quality	62%	18%	20%
Supply of Water	49%	25%	26%
Sewerage services	50%	26%	24%
Environment	46%	27%	27%

Table 5. Proportion of serial status quo choices and bill reduction option choices

Service area	Always choose status quo	Always choose bill increases	Always choose bill reductions
Water quality	34%	19%	9%
Supply of Water	31%	17%	7%
Sewerage services	29%	15%	8%
Environment	29%	28%	5%

Table 4 reveals a very high level of choice of the status quo option with two service area blocks having a higher level of choice for the status quo option than the alternatives combined. Environmental services have the largest deviation from the status quo.

Table 5 shows about a third of business respondents consistently choose the status quo when given multiple choices. The remainder of respondents in

Table 5 select different options across the CE sets within the blocks.

The final WTP and WTA estimates for business customers, based on the non-linear model are summarised in **Table 6**. In almost all of the areas considered, the level of WTA is greater than the level of WTP for the greatest service decrease or increase.

Table 6. Business willingness-to-pay and willingness-to-accept estimates

Service area	Service level attribute	WTP / WTA			
		-1	+1	+2	+3
Water quality	Poor water pressure: number of properties below standard pressure	-0.20%	0.20%	0.27%	0.29%
	Drinking water quality: proportion of samples of tap water that will pass the DWI's requirement for chemical & biological content	-0.38%	0.26%	0.37%	0.40%
	Taste, smell & colour of drinking water: total number of water quality contacts	-0.43%	0.57%	1.21%	1.41%
Supply of water	Unexpected supply interruption of 3–6 hours: total properties affected	-0.23%	0.11%	0.26%	0.28%
	Leakage	-0.37%	0.13%	0.24%	0.26%
	Water use restrictions e.g. hose pipe ban	-0.05%	0.08%	0.15%	0.21%
Sewerage services	Sewer flooding inside properties: number of incidents per year	-0.28%	0.12%	0.26%	0.34%
	Sewer flooding outside properties: number of incidents per year	-0.12%	0.12%	0.20%	0.21%
	Properties subjected to chronic (seasonal) unbearable smells from sewers and treatment works: complaints to YWS per year	-0.08%	0.12%	0.25%	0.29%
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard	-0.17%	0.13%	0.16%	0.21%
	Length of rivers in Yorkshire improved (%)	-0.35%	0.40%	0.73%	0.74%
	Category 3 pollution incidents: number of minor incidents that have a minimal impact on the quality of water in the area	-0.23%	0.17%	0.33%	0.45%
	Area of land conserved or improved by Yorkshire Water: hectares	-0.20%	0.20%	0.27%	0.11%

Implications

For both the household and business surveys, in terms of statistical validity, the models provide a good fit to the data. The reliability of the analysis is supported by the validity assessments. There is a high tendency to stay with the status quo, especially for Water Quality, amongst household and business customers. This trend is more marked than in PR14 with approximately a third of customers sticking with the status quo throughout the PR19 survey; perhaps indicating either a fear of change in uncertain economic times or a satisfaction with the existing levels of service.

Across all attributes except for Taste, Colour, and Smell of Drinking Water, the Willingness to Accept amongst household customers is greater than the Willingness to Pay. The picture is similar amongst businesses for the Willingness to Pay greater for Taste, Colour and Smell of Drinking Water. For Sewer Flooding outside properties and Length of Rivers in Yorkshire Improved there is no difference between Willingness to Accept and Willingness to Pay.

Analysis of WTP estimates and data by sub-groups including demographics, socio-economic groups, vulnerable definitions, and prior service experiences, shows the WTP ranking per service measure remaining largely consistent across analysis groups, with Taste, Colour, and Smell of Drinking Water consistently having the highest WTP estimate value, regardless of group. There are, however, a number of significant WTP differences when service measure outcomes are compared (see Appendix 2: Results).

Levels of Willingness to Pay are lower than in previous years; with 42% of household customers falling into the Financially Vulnerable category and high preferences for the status quo, this study is reflective of the current economic climate and such constraints on WTP should be taken into account when investment planning.

For PR19, further analysis has been conducted to express the Total Economic Value in terms of 'use' and 'non-use' values. Non-use WTP estimates are higher for the environmental service areas than the other service areas. Conversely, the Use WTP estimates tend to be lower for the environmental service areas compared to the other service areas.

When looking at vulnerable customer definitions it becomes apparent that WTP differences are largely isolated to issues of water quality and supply of water, while sewerage services and environmental service measures throw up fewer differences. For all of these differences, customers not classed as vulnerable have higher WTP estimates than customers who might be considered vulnerable. The suggestion here is that while WTP preferences might be broadly in line, the additional amount that customers in vulnerable circumstances are willing to pay on top of the expected bill amount is lower than those not in vulnerable circumstances. This applies whether they are financially vulnerable or whether their vulnerability is health-related. This is likely to be because there is so much correlation between the two vulnerabilities with financial circumstances thus driving WTP. Similarly, customers in lower SEG groups have lower WTP estimate amounts across a number of service measures than higher SEG customers.

When looking at WTP differences by service experience, it is interesting to note that the type of experience appears to dictate the extent to which significant differences occur. For example, when comparing customers who have experienced low water pressure with those who haven't, only one significant difference occurs across the 13 service measures. However, by contrast, when looking at sewer flooding inside the property on an experienced vs. not experienced basis, 11 significant differences occur. Customers experiencing the following service failures have a higher WTP for this service measure, than those who haven't:

- Sewer flooding inside properties
- A leaking water supply pipe close to your property
- Restriction on how you can use water e.g. a hosepipe ban

YorkshireWater

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djs research

PR19 Understanding Customer Values: Willingness to Pay, Work Package 1 Report

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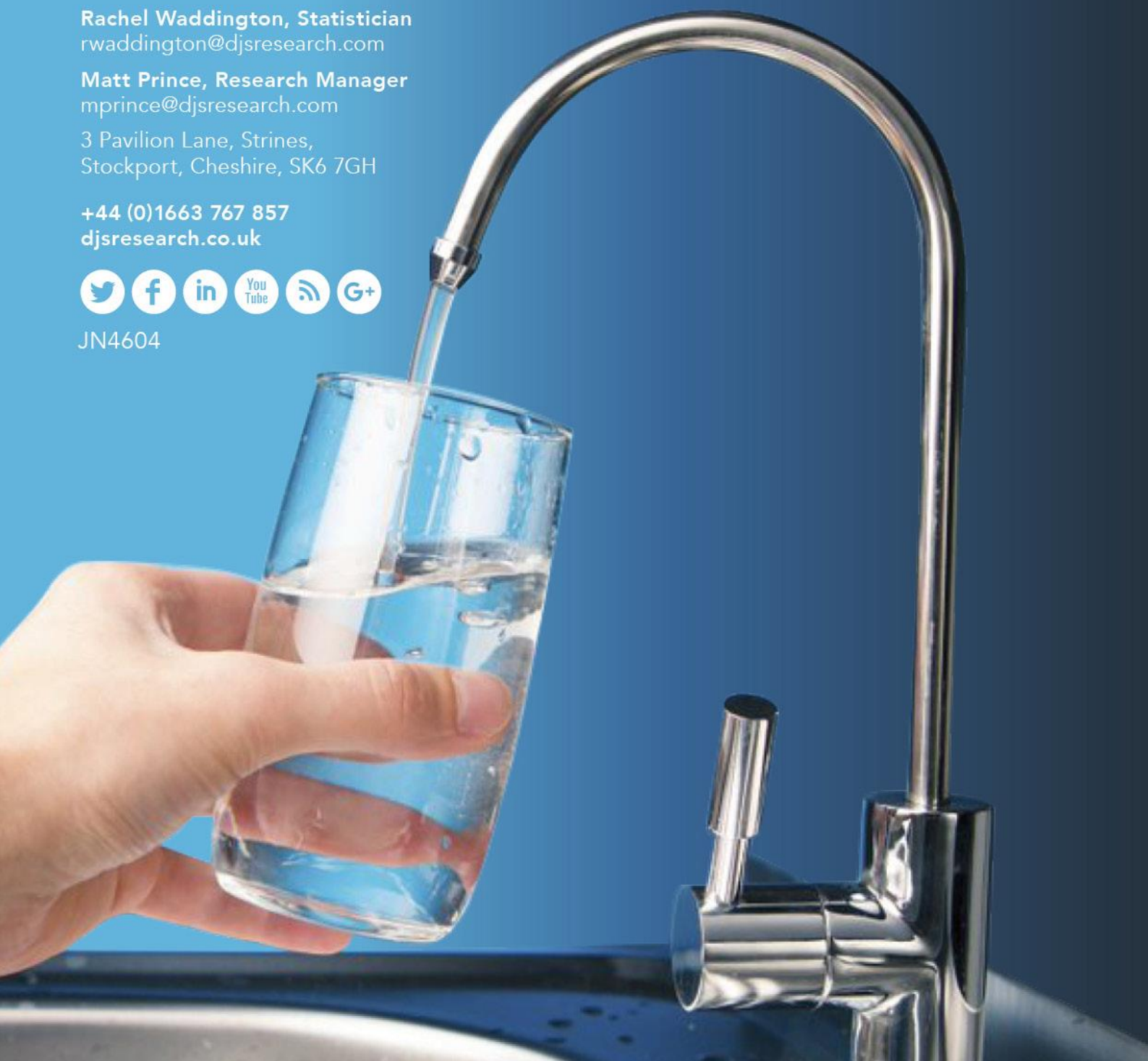

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Contents

This document has been prepared by DJS Research Ltd (DJS), consisting of the following project team:

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A table of contents is provided below:

Appendix 1 - approach

Design and interviewing summary

Surveys were designed by DJS Research, Yorkshire Water and Aecom, with input from London Economics and the Yorkshire Water Customer Forum Group. A detailed outline of the conceptual approach to the survey design is provided in the *Conceptual summary* (p.13) section.

Prior to conducting the main fieldwork, a pilot phase testing both the household and business customer surveys was conducted in August 2017.

The pilot phase of the fieldwork consisted of 10 CAPI interviews and 50 online interviews with household customers and 5 CAPI interviews with business customers.

The purpose of the pilot phase was to validate the survey structure and design, with the aim of refining the approach and questions ahead of the main fieldwork period.

CAPI interviews in the pilot phase were conducted by experienced interviewers who were accompanied by a member of the DJS Research team, who were present to observe the interviews.

The findings of the pilot phase suggested the surveys were well understood by customers (both household and business), but that some refinement of approach was required to optimise the survey design and validity.

Main stage surveys

Across both surveys pictorial show cards and choice experiment grids were created to aid respondent understanding of the concepts displayed (examples of the show cards are shown from p.21). In addition, show cards were created to deliver information to respondents about Yorkshire Water's responsibilities. CAPI respondents were provided with bound, laminated booklets of the show cards and example grids, while online respondents were shown 'dynamic' on-screen images which re-sized according to the device used.

Household survey

The technical aspects of the survey concept are discussed later in this report from p.12 This section outlines the final survey design mechanics. The final household survey consisted of six main question sections:

- **Screening questions** to establish respondent suitability for the survey:
    - The respondent does not work in any conflict professions (Journalism, advertising, market research, PR, the water industry or the Environment Agency)
    - The respondent has their water and sewerage services provided by Yorkshire Water;
    - And, has sole or joint responsibility for paying the water bill

- **Attitudinal and experience questions** to improve the stated preference field and to provide use and non-use values.
- **Choice experiment blocks** to establish stated preference across four service areas
    - Respondents were provided with show cards for each of the service level attributes (discussed and shown in detail from p.21), before being asked to make their choices;
    - Respondents were shown 3 choice cards per service area (12 choices in total). Prior to making their choices, respondents were provided with an example choice card and an explanation of the questions they would be asked. Each respondent was provided with 3 options per choice – two price changing options (stated in monetary value) and one 'no change' option.
- **A whole package choice experiment** where respondents were provided with 2 choices – top level service provision for each service level attribute and a randomly assigned additional bill value, and Yorkshire Water's stated performance for 2020 for each service level attribute – 'no change'
- **Choice experiment validation questions** to establish the extent to which the respondent had understood the concepts and questions they were faced with, and to understand the rationale behind the respondent's decision making
- **Classification and demographic questions** to provide the basis for sub-group analysis

Business survey

The business survey followed the same approach in respect of the **choice experiment blocks**, and the **whole package choice experiment –** although here the stated change was expressed in terms of a percentage bill change as opposed to the monetary changes shown for household customers.

Other elements of the survey were tailored accordingly for a business audience

- **Screening questions** to establish;
    - that the respondent has responsibility for the water bill within the business
    - the business is supplied by Yorkshire Water (even if not billed by, following commercial water reform in April 2017)
- **Classification questions** to establish the business sector and the business size (in respect of employee numbers)
- **Importance of water questions** to establish the importance of water to the day to day running and operation of the business

Interviewing

Interviews across both the household and business surveys were conducted using the following approaches:

- **Computer Aided Personal Interviewing (CAPI):** surveys were conducted in the customer's home/business on a tablet device and were interviewer led. Interviewers were provided with quotas, and sampling points by region were designed to provide a robust representation of customers across Yorkshire.
- **Online panel interviews:** surveys were completed by the respondent online. Quotas on participation were set to ensure a representative sample of customers and respondents were sourced through panel providers.

The use of a CAPI approach, in conjunction with online panel, was used in order to reach customers and communities that may be underrepresented online.

Interviews were conducted from 31st August to 9th October 2017.

Sample

Household

The following split of interviews across household quota groups was achieved:

Table 7: Household interviews

	WP1 – Household CAPI	WP1 – Household online	WP1 – Household total
Male	46	440	486
Female	68	461	529
Prefer not to say / Transgender / Non-binary	0	5	5
18-34	16	151	167
35-44	11	149	160
45-54	26	180	206
55-64	22	183	205
65+	39	243	282
North Yorkshire	23	144	167
East Yorkshire	10	107	117
South Yorkshire	34	230	264
West Yorkshire	47	425	472

ABC1	23	479	502
C2DE	91	427	518
Metered	41	511	552
Unmetered	73	395	468
Total	**114**	**906**	**1020**

Final sample splits on gender, region, SEG and metered status all fell within 5% of original sample quota targets. The final numbers on age show a slight over-representation of 55-64s, and a slight underrepresentation of under 35s – however, given the overall profile of the sample make-up it was decided that no weighting of data was necessary.

Business

Table 8: Business interviews

	WP1 – Business CAPI	WP1 Business online	WP1 – Business total
North Yorkshire	34	41	75
East Yorkshire	30	20	50
South Yorkshire	101	49	150
West Yorkshire	129	100	229
Micro (0-9 employees)	228	72	300
Small (10-49 employees)	65	40	105
Medium (50-249 employees)	3	60	63
Large (250+ employees)	-	74	74
Industrial	68	85	153
Commercial	140	56	196
Public sector	57	42	99
Other (3rd sector, arts & entertainment etc.)	31	63	94

Total	**296**	**246**	**542**

Region wasn't recorded for all businesses, due to complications of multi-site organisations, operating across multiple regions of Yorkshire and the rest of the UK.

In order to gain access to smaller businesses, that might not be well represented in online panels, the focus of the CAPI interviews was on micro and small businesses.

Yorkshire Water online community

In addition to the main stage interviews, the online questionnaire was opened to members of Yorkshire Water's online community. Members were invited to take part in the survey via a survey link. Overall, 175 interviews were completed via this method. The results of these interviews are used for comparison with the willingness to pay results of the total sample of the main stage surveys in Appendix 2 of this report.

Conceptual summary

This section provides an overview of the concepts and theories that underlie the stated preference methods. The section is written as a non-technical piece for a wide audience, however, some technical complexity is both inevitable and useful.

Estimating customer willingness to pay and accept

Quantitative research as undertaken in this study involves designing a survey that elicits the preferences of two separate samples representative of YW household and business customers. During the survey, respondents are asked to trade off maintained or improved quality of water and wastewater services against increases in the water bill. This trade off results in what economic literature calls Willingness to Pay (WTP). If individuals are willing to pay to avoid a decline (maintenance) and to secure an improvement, the survey results in positive and significant WTP estimates.

Respondents are also asked to trade off the declining quality of water and waste water services against a decline in the water bill – if maintenance and improvement investment is not necessary, bills will not need to increase to pay for them. This trade-off results in what economic literature calls Willingness to Accept Compensation (WTA). If individuals are willing to accept bill declines as compensation to tolerate service declines and to forgo service improvements, the survey results in positive and significant WTA estimates.

The bill impacts that respondents are shown are based on the expected costs to consumers associated with the investments necessary to improve the service. Varying levels of bill impacts are presented to respondents. The advantage of using water bills to express the trade-offs is that it is familiar to respondents and the actual vehicle through which service changes will come about. It also allows for WTP and WTA to be expressed in monetary terms. This allows for the benefits (or costs) of service changes to the customers to be compared directly to the cost of providing

service changes (or avoided costs for service decline) to the company. In other words, WTP and WTA are estimated to make Cost Benefit Analysis (CBA) possible.

The main purpose of this research is to estimate the Total Economic Value (TEV) for each water service. Further analysis then aims to express this TEV in terms of 'use' and 'non-use' values. 'Use value' relates to how customers use water as a private good and are therefore likely to be concerned about the quality and security of the Supply of Water and wastewater management. Customers may also benefit from services that affect the quality of the environment either because they directly use the environment (e.g. for recreation) or because good environmental quality affects their quality of life. This measure is called 'indirect use value'. Finally, customers may value YW's services for the benefit of others (altruism value), for future generations (bequest value) and, especially for environment-related services, for the benefit of the environment (existence value). Together, these motivations are labelled as 'non-use values'.

All these use and non-use value components make up the Total Economic Value (TEV) that valuation methods aim to estimate. There are two primary methods for estimating customers' WTP and WTA: revealed preference and stated preference. This research uses stated preference methods. Stated preference studies are a survey based approach that can be undertaken in two ways. Contingent valuation (CV) directly asks respondents for their WTP or WTA for a change in the provision of a good or service, while choice experiments (CE) ask respondents to state their most preferred option from a range of choices and consequently infers their WTP or WTA from these choices. In the context of this study, the choices are made between individual services (or attributes) in different combinations with a price tag (water bill amount) associated with each choice. This study uses a choice experiment methodology due to the complex nature and number of water Service Measures and varying levels that are investigated. Revealed preference has been used in Work Package 3.

Stated preference choice experiments - summary

Choice modelling is underpinned by consumer demand theory, particularly the theory of consumer behaviour following Lancaster (1966) and Rosen (1974). Consumer demand theory assumes that the utility that customers receive from their water and sewerage services derives from the characteristics of this good (e.g. the provision they receive, the quality and safety of their water supply, and the disposal of waste water).

CEs are used by economists to reveal individuals' preferences and their willingness to pay for particular attributes of goods and services. In a choice experiment, individuals participating in a questionnaire survey are typically shown a choice card depicting two or three alternative packages of service options. They are then asked to identify the alternative that they prefer. Each alternative is based on a number of service attributes (with associated bill impacts) that vary across the alternatives.

Information on Willingness to Pay and preferences across different service measures are determined by observing the trade-offs that people make across repeated choices based on different choice cards. The attributes of interest in this study are the service measures that Yorkshire Water and its customers consider important, plus bill impact. The varying levels involve potential increases or decreases to the current standard of service provision for each service measure and the associated change to water bills. Five levels were used in the experiment – two increases in standards for a service measure and two decreases, in addition to the status quo where all service measures remain at 2020 levels. The current situation was included because consumers usually make choices in relation to what they currently have; rather than making choices just between hypothetical alternatives. It is usual practice in choice experiments to include the status quo, if the status quo is an option that the consumer could choose.

In the CEs conducted in this survey, various combinations of service measure are traded-off against each other and against changes to customers' water bills. The first four CEs (CE1-CE4) are each based on a 'block' of service measures (i.e. CE1 is based on Water Quality; CE2 is based on Supply of Water; CE3 is based on Sewerage Services; and CE4 is based on Environmental Factors. This is followed by a full-package CE where the respondent is shown all 13 water services at the highest level of improvements alongside the status quo with associated bill impact shown at various levels. Each of CE1 to CE4 consisted of three separate choice exercises each based around a set of three alternative combinations of attributes based on various levels of service measure and a bill change. In each case respondents were asked to choose their most preferred combination of service measure levels from those offered. Repeated choices by customers (three for each of CE1-CE4) reveal the trade-offs they are willing to make between service measures, their levels and their water bills. Each set of choices contained the status quo option.

The inclusion of the status quo was important for customers to make an informed choice. If they think about moving away from the status quo, then they consider the alternatives and decide whether or not they offer an improvement in utility. Thus, in the context of this study, customers might be assumed to consider whether or not they are satisfied with the current water quality, water supply sewerage and environmental service standards provided by YW and, if not, then to consider what service measures they wished to see changed and how much they were willing to pay for service improvements (or how much financial compensation they require for a lower level of service).

In a CE it is assumed that individuals know their own preferences and are able to choose which alternative scenario offers them the highest utility (a nested approach). Thus, if an individual is assumed to choose alternative j over alternative k, if the utility derived from attribute bundle j is greater than the utility derived from attribute bundle k; i.e. if $U_{ij} > U_{ik}$, where U_{ij} is the total utility associated with alternative j

and Uik is the total utility associated with alternative k. The utility function for respondent i related to alternative j is specified as:

Uij = Vij + εij

where Vij is the 'measurable' systematic utility function observed by the analyst because it is linkable to the attribute levels of each alternative (e.g. linked to the levels of service they are shown) and εij is a random component, which is known to the individual, but remains unobserved to the analyst. This random component (εij) arises either because of randomness in the preferences of the individual or the fact that we do not have the complete set of information available to the individual.

Figure 1 presents the different types of econometric models that are used to analyse the respondents' choices. These increase in their level of complexity and explanatory power from Conditional Logit (CL) to Generalized Mixed Logit (GMXL) models.

Figure 1: Types of econometric modelling used

Model	Description
Conditional Logit (CL) model	This model explains the likelihood of an option being chosen by a respondent, explained by the attributes of the Water Service alone and does not include the characteristics of the respondent.
Multinomial logit (MNL) model	This model explains the likelihood of an option being chosen by a respondent by the attributes of the Water Service and the characteristics of the respondent.
Nested logit (NL) model	This is an extension of the above MNL model. It treats decisions as a 'hierarchical' choice, for example choosing whether or not they reject the status quo and then choosing between alternative improvement options.
Error corrected (EC) model	This model relaxes the MNL assumptions on the error term in relation to how a decrease in the likelihood of choosing an option is correlated to the chance of selecting an alternative option.
RPL Mixed logit (MXL) models	These improve upon the MNL models, addressing their limitations via a set of alternative models: • Random Parameter Logit (RPL) model: the MNL model assumes that respondents' choices are influenced by the same variables in the same way. In other words, the coefficients of the variables are the same over all respondents (i.e. homogeneity in preferences). The Random Parameter Logit(RPL) model allows for the assumption that different variables influence individual respondents in different ways. In other words, the coefficients vary between individuals (i.e. heterogeneous preferences).
Generalized Mixed Logit(GMXL)	The generalized mixed logit model developed by Fiebig et al (2010) is an extension of the Random Parameter Logit model which allows for heterogeneity in both preference and scale which often coexist but observations have revealed that their importance varies in different choice contexts.

Linear or Non-linear WTP and WTA estimates

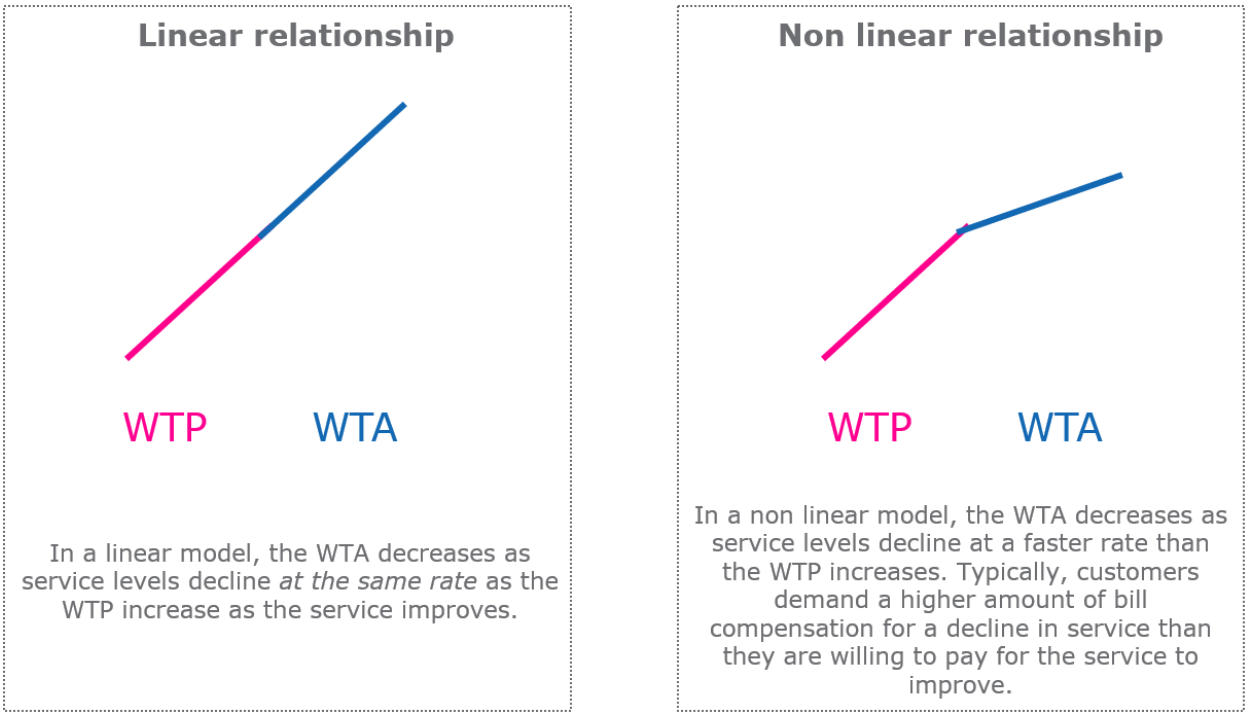
Our study design includes both service improvements and deteriorations for all attributes and associated bill increases and reductions, respectively. This means we are able to estimate both WTP for service improvements and WTA (compensation) to tolerate service level decreases.

It is unlikely that there will be perfect symmetry in WTA and WTP estimates – where symmetry means WTP for a +1 service level increase equals WTA for a -1 level of service decrease. Specifically, it is typically observed that a loss or deterioration of a unit of service is valued more highly than an equivalent gain in service level

This discrepancy between WTA and WTP can be examined by considering both linear and nonlinear functions. A linear function would be consistent with symmetry, whereas piecewise linearity – specifically a spline at the threshold between deteriorations and improvements would provide evidence of asymmetry.

Willingness to pay (WTP) vs. Willingness to Accept (WTA)

Figure 2: WTP vs. WTA



Each of the models described in Fig 1 are linear models, in the sense that the same coefficient estimate applies over the whole range of service levels from Level -2 to Level +2). When considering non-linear models, we use a utility specification where different service levels may have utility effects each represented by specific dummy variable coefficients. In such models separate coefficients are estimated for each level of service (-1, 0, 1, 2 and 3).

Comparing the 'fit' for each model

There is no single criterion by which a model can be identified as the 'correct' or 'best' model. Models are assessed on a wide range of criteria including:

- **Econometric assumptions**: criteria such as any perceived difference between the status quo and alternatives by customers; how error components are accounted for in the model; or allowed to vary across customers; linear or non-linear functional relationships; etc.;
- **Goodness-of-fit of the model**: across various goodness-of-fit criteria, including log-likelihood; AIC; BIC; HQIC; McFadden pseudo R^2, AdjR^2; etc.;
- **Positive or negative coefficients**: do the signs conform to a priori expectations: that is, as service levels improve does utility increase, and conversely as service levels fall does utility decrease?
- **Statistical significance of the coefficients**: are the coefficients statistically significant?

A pseudo-R^2 is a measure of goodness of fit: the higher the pseudo-R^2 value, the greater the ability of the model to explain the choice data. A pseudo-R^2 value of 0.12 is considered good for CL models employing cross-sectional data (Breffle and Rowe, 2002).

Checking the validation of the estimates

An important component of the analysis of stated preference data is to assess validity. Evidence in support of the validity of the results can be found in a variety of ways. There are generally two types of validity tests that researchers employ in stated preference exercises: content validity and construct validity.

Content validity

Content validity refers to whether the survey questionnaire succeeded in achieving meaningful and accurate measures of the respondents' WTP (or WTA) for the water service being valued. Content validity can be affected by the information provided to respondents on the good or service, the structure of the choice experiment, and the change to customers' annual water bills. The WTP and WTA values provided in this analysis will always be estimates but, we can use some data from other questions in the survey to determine if problems with content validity are evident.

It is important to identify if there are any systematic biases in responses (i.e. a respondent always choosing the same option in a CE) or evidence of protest responses). Other assessments of content validity include examining responses to questions that assessed the level of the respondents' understanding of the choice experiments. In addition, for CAPI (Computer Aided Personal Interview) surveys interviewers report on respondents' understanding and ability to pick between the options presented in the CE exercise and provide additional feedback about how individual respondents have engaged with the task.

Construct validity

In addition to content validity, stated preference studies are often subjected to tests of construct validity, which examine whether or not the results are consistent with external evidence and expectation. Construct validity is generally broken down into two categories: convergent validity and theoretical validity.

Convergent validity

Convergent validity refers to the comparison of WTP (or WTA) results for the same goods or services derived by different methods. Our study uses the CE method to estimate WTP and no other directly comparable stated preference method.

Theoretical validity

Theoretical validity involves testing the study results against the expectations established by economic theory. One common application is to examine WTP responses based on socio-economic and demographic factors that should influence customers' values. If the results show that WTP (or WTA) is dependent on these variables, this provides further evidence that the results conform to expectations and are theoretically valid.

For example, we expect to see that customers who are identified as 'financially vulnerable' will be have lower WTP compared to respondent who are not financially vulnerable.

Choice experiment blocks

The choice experiment blocks and service level attributes to be tested within the survey were created and refined over a period of weeks by Yorkshire Water, Aecom and DJS Research. Four choice experiment blocks were tested: water quality; water supply; sewerage services, and environment.

Bill impacts for household customers were expressed as an actual amount, and for business customers as a percentage change in their annual bill. The bill impacts in the experimental design were derived from actual expected service development costs.

The number of service measures was too great to include in one single CE: customers would be unable to trade-off all simultaneously. Hence the service measures were divided into four blocks based on how they impacted on services. These four blocks of service measures formed the basis of CE1 to CE4 respectively. An experimental design was produced for each of these blocks.

Designs that are both orthogonal (when the services that are being valued are uncorrelated) and balanced (when each level occurs equally often) are often used in choice experiments. However, it is more important in this exercise to maximize the amount of information obtained. Thus, the selected scenarios, need to be the combination which produces the most information for the model, given certain prior information.

A full factorial design is not necessary in this exercise. A fractional factorial design was used, which allow for the main effect of each service measure to be estimated; and in some cases, second order interactions, where such interactions exist between individual service measures.

For the 'Water Quality' block which had three service measures (Poor Water Pressure, Drinking Water Quality and Taste, Smell and Colour of Drinking Water), plus bill impact, a full factorial would have resulted in 5^4= 625 profiles or different combinations of service measure and bill effect. Water Supply and Sewerage Services would also have 625 profiles in the full factorial design.

For the Environmental block which had four service measures, plus BILL, a full factorial would have resulted in 3,125 profiles.

An efficient design was produced for each block. For the Water Quality, Water Supply and Sewerage Services blocks the efficient design resulted in 80 choice cards, each consisting of two hypothetical alternatives, plus the status quo.

The two hypothetical alternatives were presented to the respondent in random order (as option 1 or option 2) to avoid any positioning bias. The status quo measure was always presented as option 3. This allowed of a quicker digestion of the information presented to respondents.

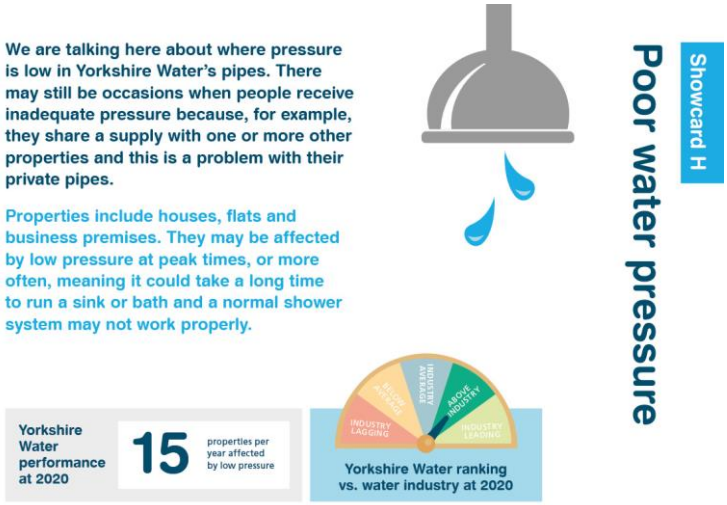
The same set of choice cards were used with both domestic and business customers with the slight difference in the way that bill impacts were presented.

The theoretical expectations, a priori of the results, would be that Utility values increase in line with an increase in level for each Water Service, that is, all things being equal, customers prefer services to be improved. At the same time, we also expect that Utility values will decrease as water bill increases.

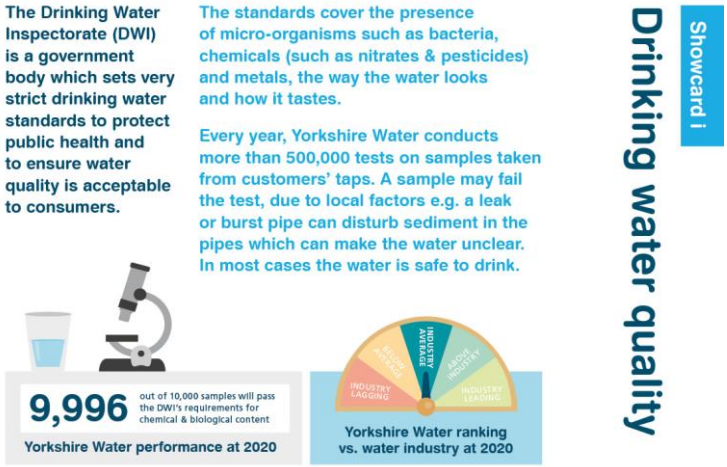
Water quality

Three types of water quality issue were covered in the study. For each of the service level attributes a visual show card was designed to aid respondents' understanding of each of the attributes. In addition, details of Yorkshire Water's forecasted performance (relative to the rest of the industry) at 2020, and the number(s) of incidents this level of performance this would result in across the Yorkshire Water network were shown, prior to respondents being asked to state their preference. The show cards presented are shown overleaf.

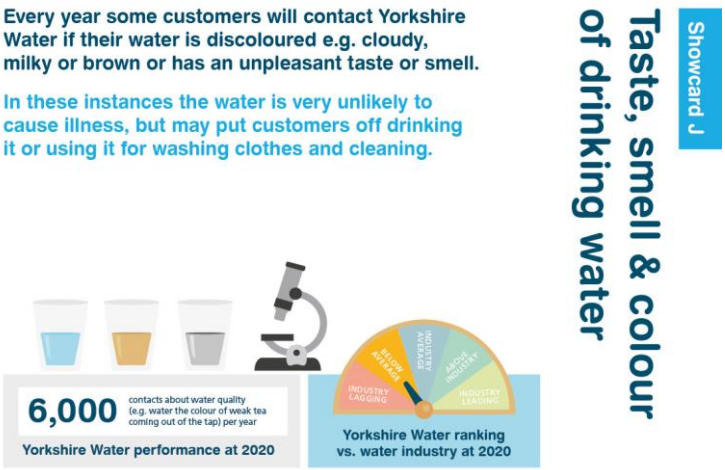
Poor water pressure:



Drinking water quality:



Taste, smell & colour of drinking water:

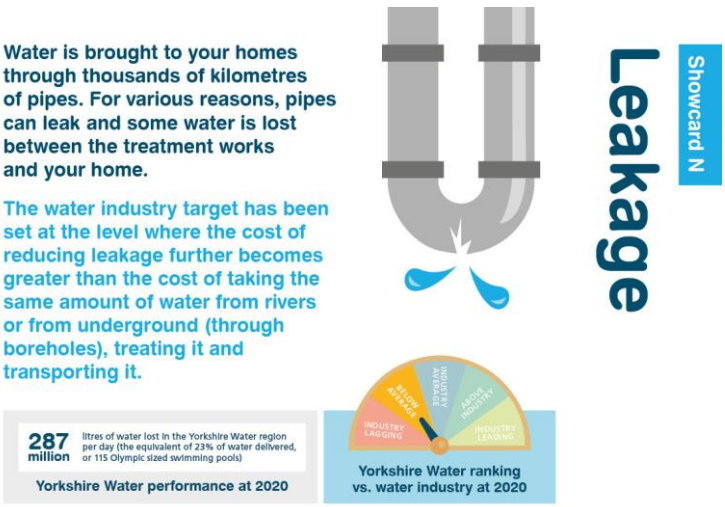


Water supply

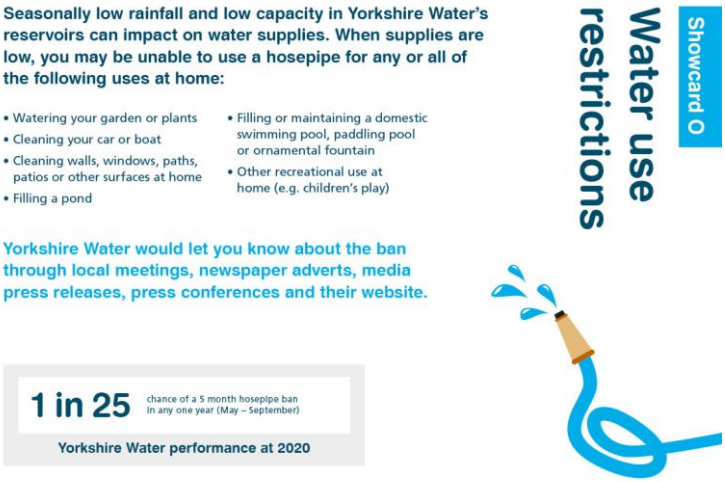
Three types of water supply issue were covered in the study. The show cards presented are shown below.

Unexpected supply interruption of 3–6 hours

Leakage



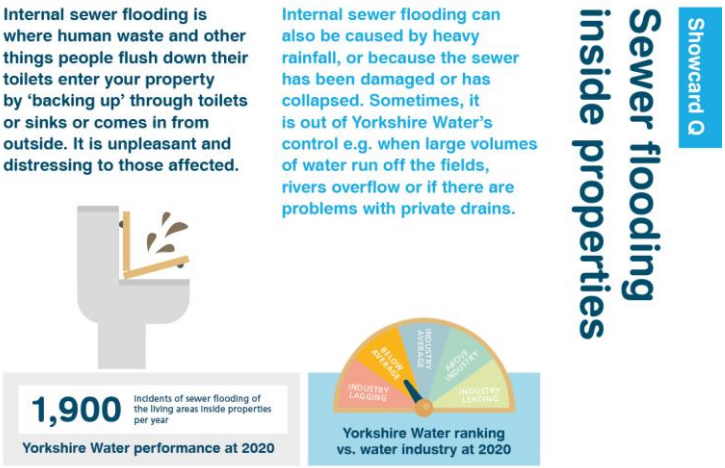
Water use restrictions



Sewerage services

Three types of sewerage service issue were covered in the study. The show cards presented are shown below.

Sewer flooding inside properties



Sewer flooding outside properties

Showcard R

Sewer flooding outside properties

These are incidents of sewer flooding affecting external areas such as roads, car parks, footpaths, public open spaces, fields, agricultural land and woodland.

They happen if the sewer system backs up, either because the rainfall is so heavy it has filled the sewer system, or because the sewer has become blocked or damaged.

10,500 Incidents of sewage flooding outside customers' homes but on their land, blocking access to their property per year

Yorkshire Water performance at 2020

Smell from sewers & treatment works

Showcard S

Smell from sewers & treatment works

Unpleasant smells from sewers & treatment works can affect properties including houses, flats and business premises.

They may experience such smells on certain days or at certain times of the year e.g. when it is warm or windy. The sale value of their home may be affected by being in an area which is affected by the odour.

6,000 complaints to Yorkshire Water per year because they are affected by smells from sewers & treatment works

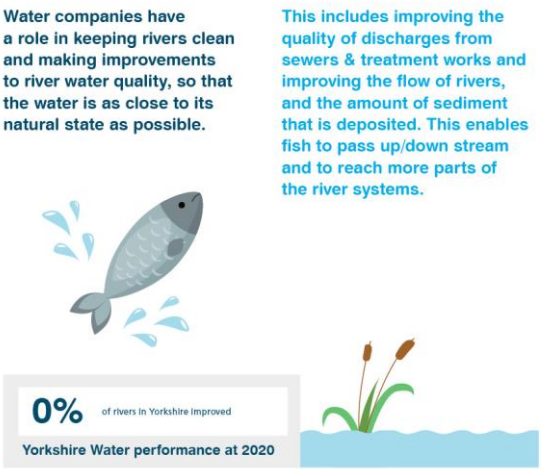
Yorkshire Water performance at 2020

Environmental

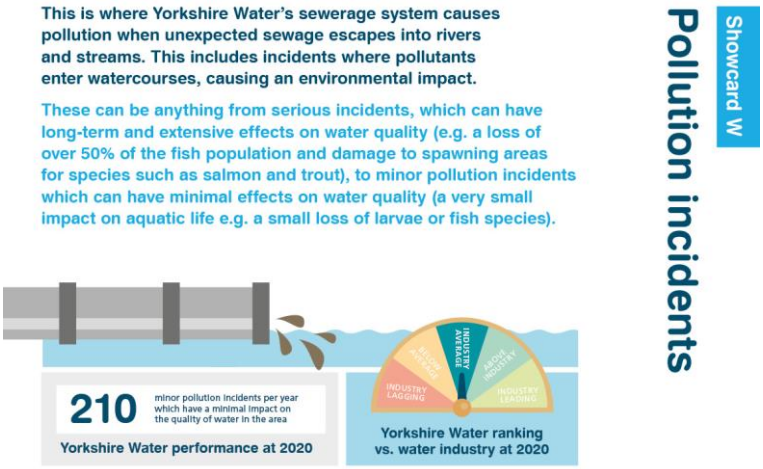
Four types of environmental issue were covered in the study. The show cards presented are shown below.

Bathing water quality

River water quality



Pollution incidents

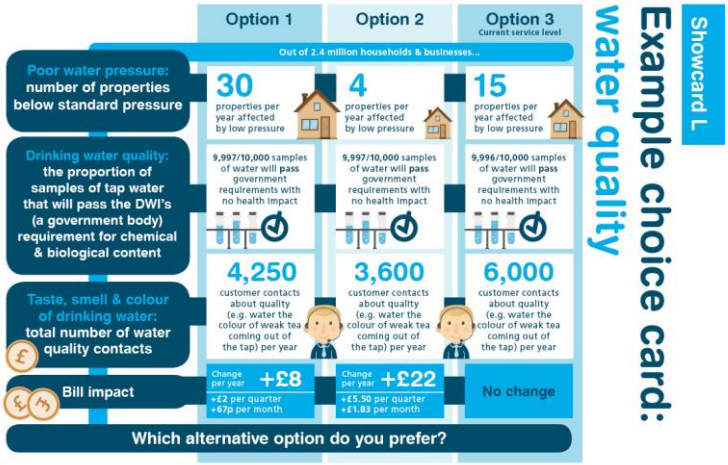


Land conserved or improved by Yorkshire Water

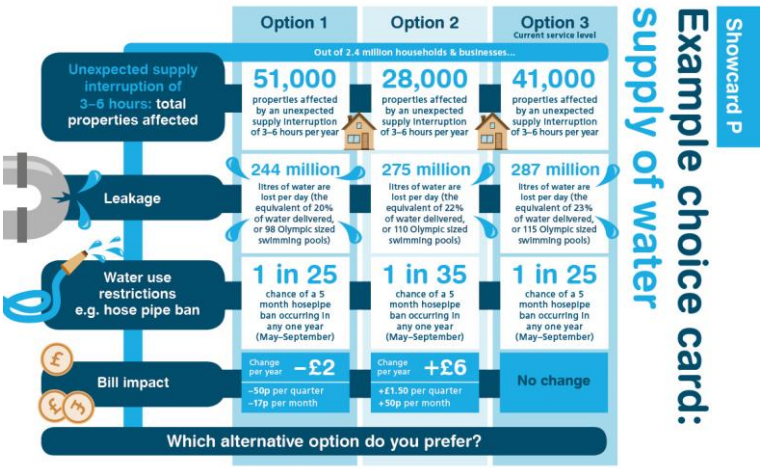
Choice experiment examples

Examples of the choice experiment grids presented to respondents to make their stated preference choices against each of the service level areas, are shown below. The only difference in the choice experiment examples shown to household and business respondents was the option 1 and 2 values – where household customers were shown a monetary value, business customers were shown a percentage change figure.

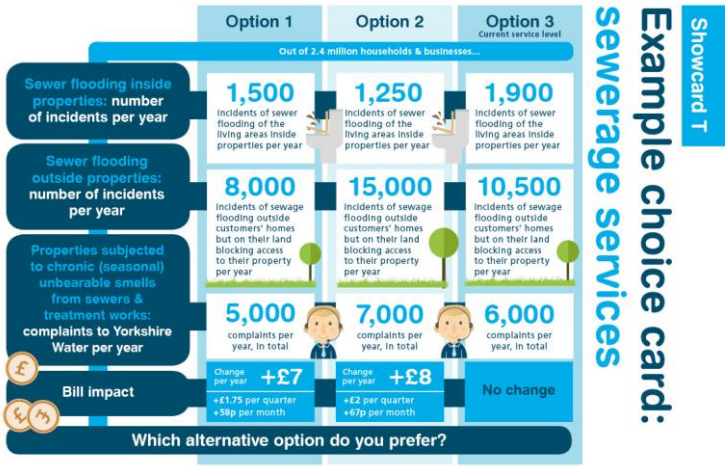
Water quality



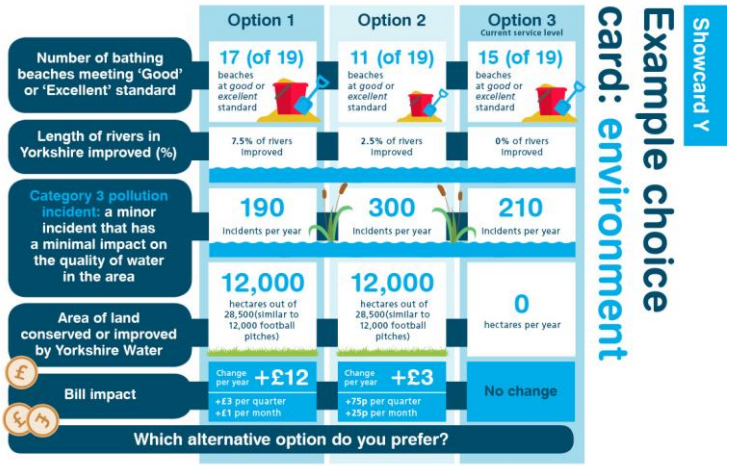
Supply of Water



Sewerage services

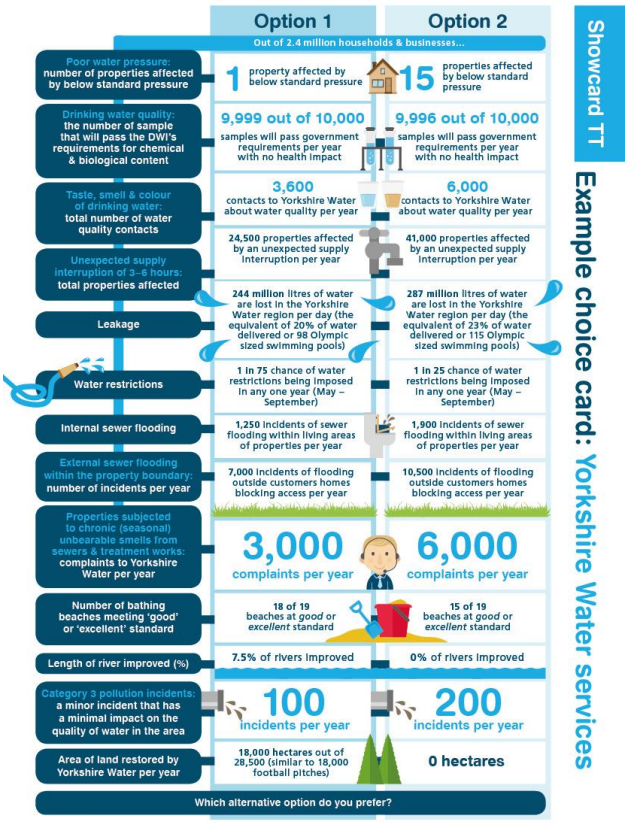


Environment



Whole package choice experiment

Respondents were also provided with a whole package choice experiment, with two choices – either the top level of service per service level attribute, for a randomly selected bill impact, or a no change option comprising of Yorkshire Water's committed service levels from 2020:



Appendix 2 – results and findings, household

Introduction

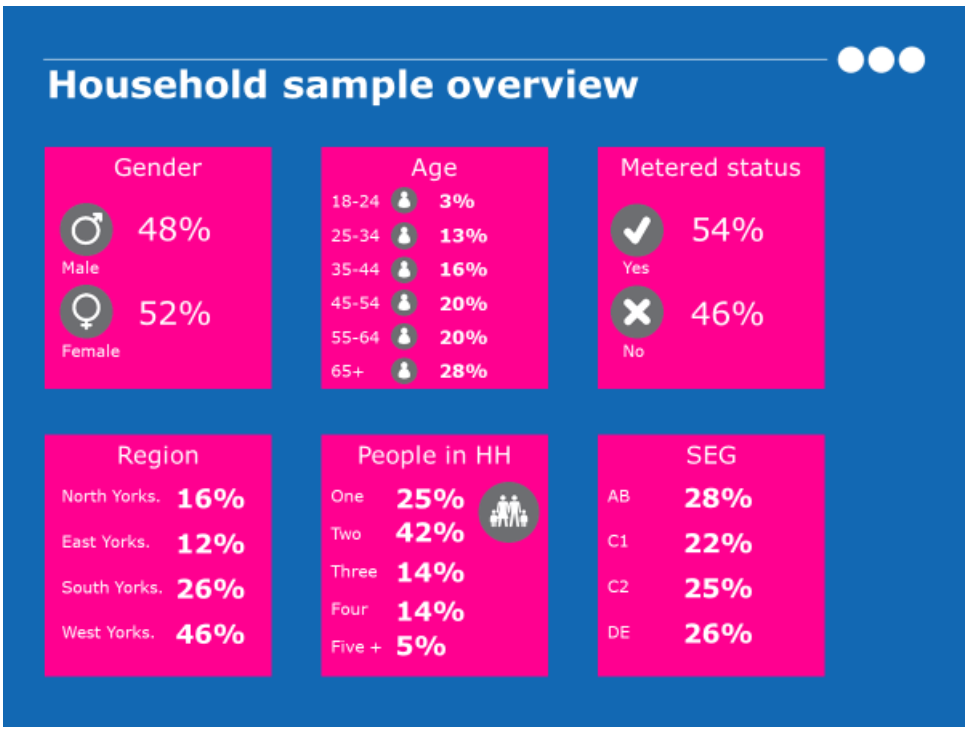
This section of the report presents the main findings from the Work Package 1 household survey. Target quotas were applied to gender, region, age, metered status and SEG, to ensure a representative sample of bill paying customers were consulted.

A total of 1,020 interviews were conducted with household customers, with a split of 906 online interviews and 114 CAPI interviews.

Household respondent profile

The images below show a demographic sample overview

Figure 3: Household sample



Sub-group analysis

The analysis section of this report includes data and analysis of various customer groups. Firstly, demographic groups, as outlined above are analysed, and any differences in attitude or outcome are either presented in chart form, or discussed in the report commentary. In addition, two further sets of customer groups are analysed:

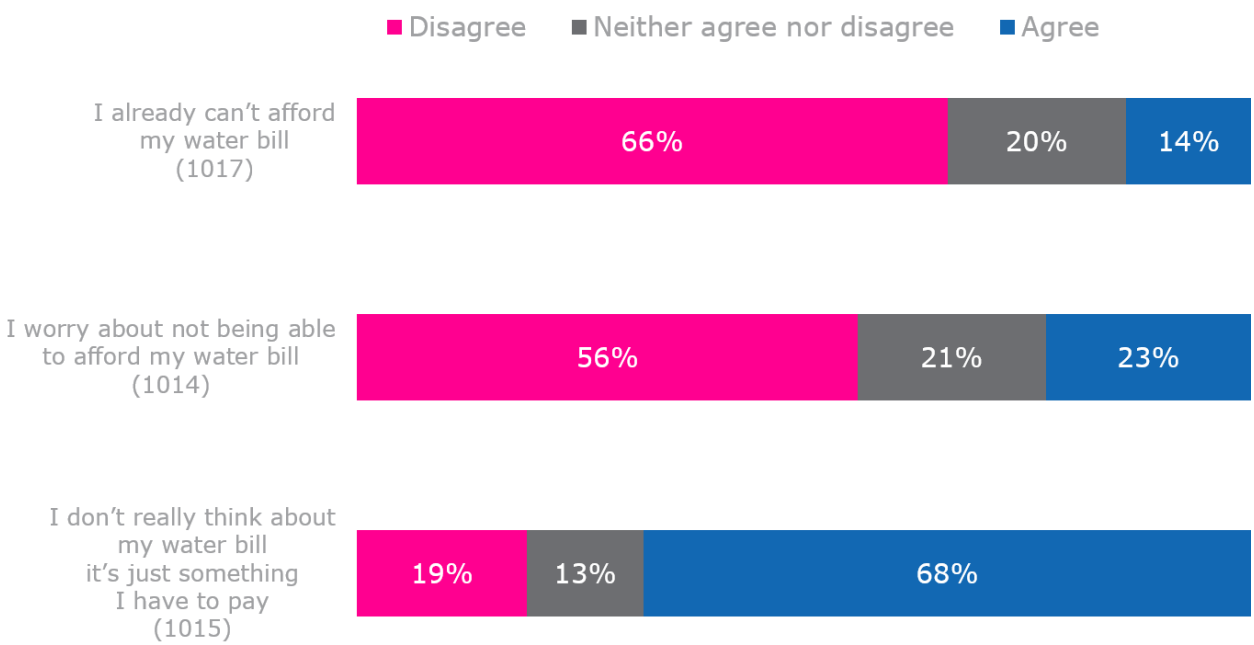
- Customers in vulnerable circumstances vs. customers not in vulnerable circumstances
- Customers who have had service experiences/outages in the past three years vs. customers who haven't experienced service experiences/outages in the past three years

The next two sections discuss the make-up of the variables outlined above.

Customers in vulnerable circumstances

In order to identify customers who might find themselves in vulnerable circumstances a number of questions were asked to respondents. Firstly, customers were asked to rate the extent to which they agreed with three statements relating to the affordability of water bills. Two statements dealt with concerns about paying water bills ("I worry about not being able to afford my water bill" and, "I already can't afford my water bill"), and one statement concerned not thinking too much about water bills ("I don't really think about my water bill it's just something I have to pay")

Figure 4: Water bill affordability – household



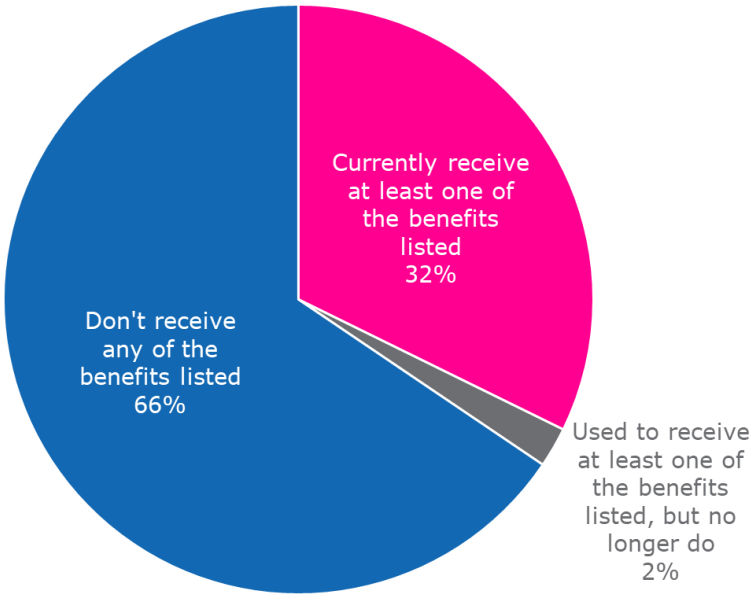
Base: all household respondents, excluding don't knows (as shown)

In the first iteration of the *customers in vulnerable circumstances* variable, customers who strongly or slightly agreed with either of the top two sentiments were classed as 'bill vulnerable'. However, as the analysis progressed, it became clear that the definitions of vulnerability were too broad as to be useful, so a secondary analysis of customers who agreed strongly with either of the top two sentiments was undertaken.

Towards the end of the survey respondents were asked whether they are in receipt of any of the following benefits (please note: fieldwork was carried out during the period of Universal Credit roll out. Benefit brackets were used from the pre-Universal Credit list):

- Housing benefit
- Jobseekers allowance
- Working tax credits
- Child tax credits
- Employment and Support Allowance
- Pension Credit
- Universal Credit
- Disability Living Allowance

Figure 5: Customers in receipt of benefits

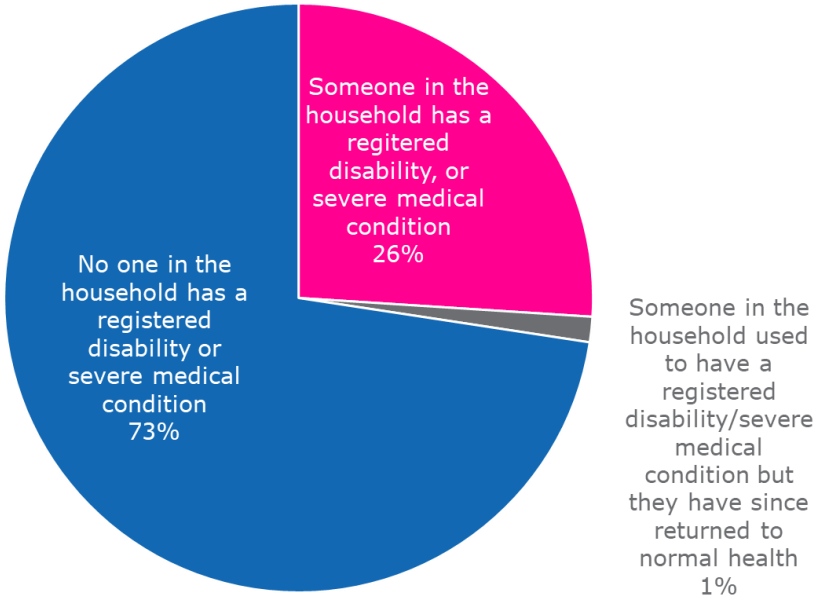


Base: all household respondents, excluding 'prefer not to say' (1,003)

Additionally, respondents were also asked how many people there are in their household, and their household income. Households of fewer than four people with an annual income of <£10,000, or with four or more residents and a household income of <£20,000 are also included in definitions of customers in vulnerable circumstances.

Additionally, questions were also asked in order to establish the number of respondents who might be considered vulnerable due to them (or someone in the household) having a physical or mental disability, and/or or a learning difficulty.

Figure 6: Households with someone registered disabled, or suffering from a severe medical condition



Base: all household respondents, excluding 'prefer not to say' (1,014)

Of the 27% of customers who report someone in their household having a current or historic disability or severe medical condition, 25.3% report the disability affecting the way in which water is used/consumed (6.8% of the total).

A separate question asked of respondents in an effort to be able to classify vulnerability was whether English is spoken as a first language, or not. Overall, only 21 (2%) interviews with respondents where English is not their 1st language were recorded – meaning there isn't a sufficient base of responses to include as a separate (robust) definition of vulnerability due to language.

Based on the possible indicators of vulnerability discussed, four definitions have been created, and are used for additional analysis later in the report:

- **Possible vulnerability:**
  - respondents who agree, strongly or slightly, with either of the two bill struggle statements, and/or;
  - report being in receipt of benefits, and/or;
  - report someone in the household having a disability and/or a learning difficulty, and/or;
  - live in a household of <4 people and have an annual household income of <£10,000, or live in a household of 4+ people and have an annual household income of <£20,000

This definition of potential vulnerability resulted in 54.8% of the sample being flagged. Based on this large proportion, it was felt that a 'stricter' definition of vulnerability was required in order to truly understand whether any differences in attitude or WTP exist between customers in different circumstances. Therefore, a second definition of vulnerability was created:

- **Focussed vulnerability:**
  - respondents who agree strongly with either of the two bill struggle statements, and or;
  - respondents who receive help to pay their water bill, and/or;
  - report someone in the household having a disability that impacts on the way water is used/consumed

This more focussed definition resulted in 24.5% of the sample being flagged as vulnerable.

In addition to these two definitions of vulnerability, 2 further definitions were created and analysed in order to provide data comparability across Work Packages:

- **Financially vulnerable:**
  - respondents who agree, strongly or slightly, with either of the two bill struggle statements; and/or;
  - Receive(d) help to pay a bill, and/or;
  - Receive(d) benefits, and/or;
  - live in a household of <4 people and have an annual household income of <£10,000, or live in a household of 4+ people and have an annual household income of <£20,000

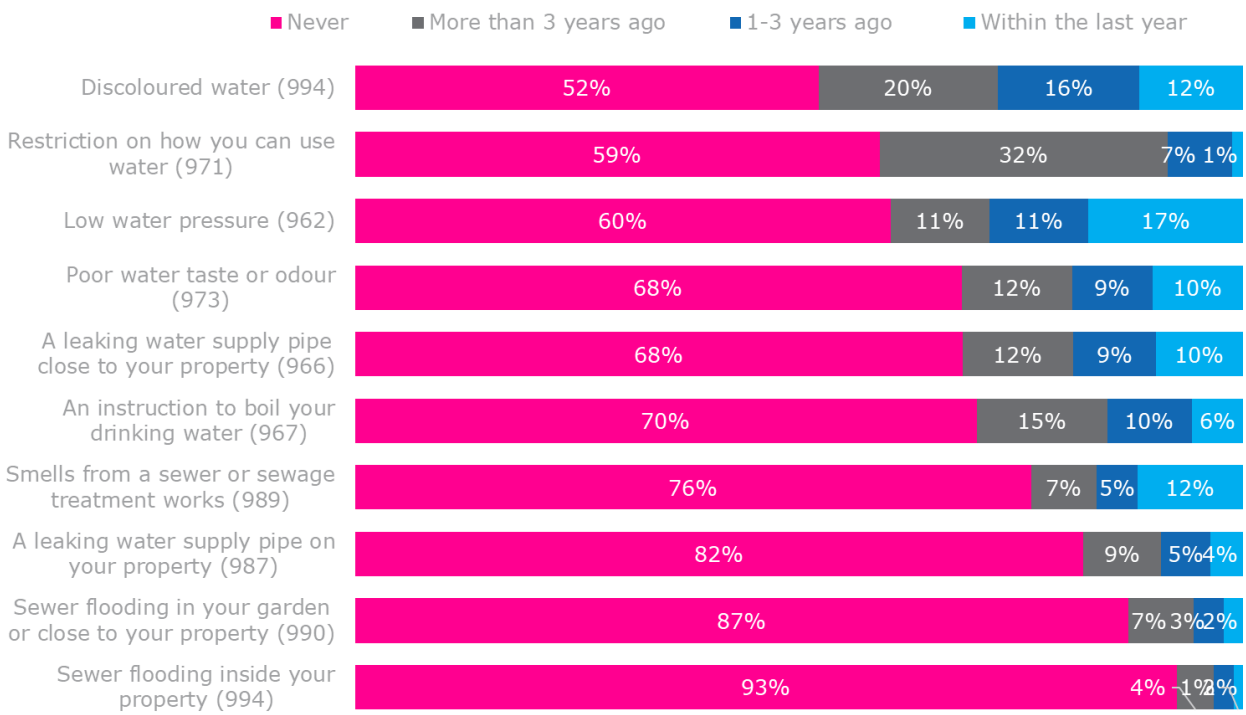
- **Health vulnerable:**
  - respondents aged 75+, and/or;
  - respondents who report someone in the household having a disability
    - Note: within the sample, there are no incidences of customers age 75+ who don't also report a disability

The financially vulnerable definition covers 41.7% of the sample, and the health vulnerable definition covers 26.9% of the definition.

Service experiences

In order to include an additional layer of understanding to respondent reactions in the stated preference exercises, respondents were asked whether they had ever experienced any of the following water related service experiences whilst living in Yorkshire. The chart overleaf shows the proportion of respondents reporting having experienced each issue.

Figure 7: Service experiences - household



Base: all household respondents excluding don't know per issue (as shown)

The 17% of respondents who said they had experienced smells from sewers or sewage treatment works in the past three years were asked a follow up question about where they experience the issue. Of those respondents, 46 (28%) said they'd experienced the smells only at their property, and 26 (16%) said they'd experienced smells caused by sewers/sewage treatment works both at their property and when out. The remainder (56%) either couldn't remember where they'd experienced the smells, or had only experienced them when passing near a sewer/sewage treatment works.

Overall, 209 (21%) have never experienced any of the incidents listed, and 369 (36%) have not experienced any of the incidents listed in the past 3 years. In the past 12 months, 394 (39%) have experienced at least one of the incidents listed.

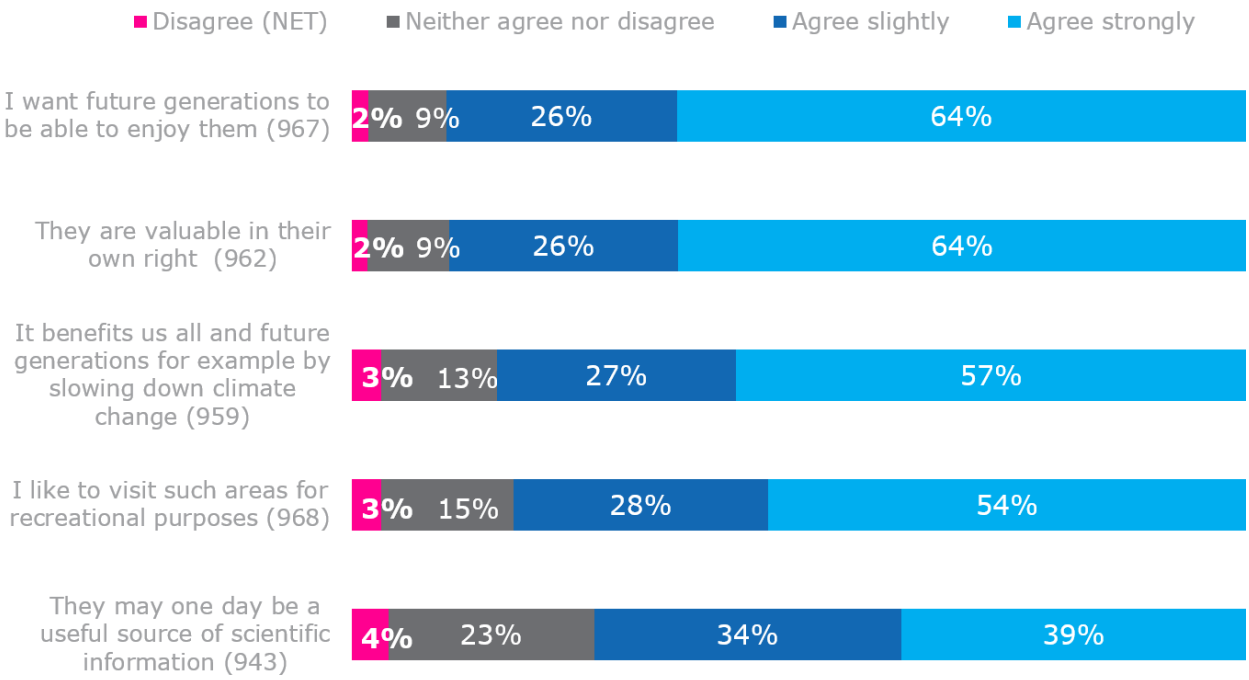
Attitudinal statements

The household surveys included a set of five attitudinal statements for use in evaluating the impact of attitudes on water service values. The attitudinal statements are controlled for as covariates within the modelling – used to estimate the contribution of non-use values to a customer's WTP.

This section outlines the overall response to these attitudinal statements at a total level:

Figure 8: Attitudinal statements

Protecting Yorkshire's land and water environments such as lakes, rivers, bathing waters, woodlands, and grasslands is really important to me, because…



Base: all household respondents, excluding don't know responses (as shown)

Due to high levels of agreement across all statements, further analysis using these statements is based on a 'strongly agree' vs. the rest basis.

Analysis and results

This section of the report contains analysis of the household Willingness to Pay (WTP), with a broad structure of the findings outlined as follows:

- Examination of the preference for the status quo
- Economic modelling results
- The final/preferred WTP table for each of the 4 CE blocks
- Results of the full-package CE
- Analysis of sub-group results
- Use and Non-Use values
- The validity of the outcomes

Preference for the status quo

The tables below summarise the choice behaviour observed within the household customer samples across the four service area blocks:

Table 9: Choice frequencies for household samples

	Status quo	Alternative 1	Alternative 2
Water quality	66%	17%	17%
Supply of Water	57%	21%	22%
Sewerage services	54%	23%	23%
Environment	51%	24%	25%

Table 10: Proportion of serial status quo choices and bill reduction option choices

	Always choose status quo	Always choose bill increases	Always choose bill reductions
Water quality	39%	15%	6%
Supply of Water	33%	13%	9%
Sewerage services	34%	16%	8%
Environment	32%	24%	6%

Table 9 shows that the status quo is selected at least half of the time across the four service areas - revealing a very high level of choice of the status quo option within each of the service area blocks. There is some level of trading with the alternative hypothetical options noted, particularly in the environmental service block.

Table 10, meanwhile, shows the percentage of respondents who always select the status quo (or increases or decreases) – showing that around a third of respondents consistently choose the status quo when given multiple choices. The remainder of respondents in Table 10 select different options across the CE sets within the blocks.

Economic modelling results

Block 1 - Water Quality

After extensive analysis of the data, three models were considered to describe the choice data obtained from the domestic customers. The first was a simple Conditional Logit model, while the other two were the Random Parameter Logit model and the Generalised Mixed Logit model.

For the Water Quality choice set based on CE1, the Random Parameter Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2, = 0.20 (compared with 0.16 for the Generalised Mixed Logit model, and 0.17 for the Conditional Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures (poor water pressure, drinking water quality and taste, smell and colour of drinking water); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 11 below reports the results of all three models. The positive signs on the coefficients of the Water Quality in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were highly statistically significant at the 99% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choices (as noted earlier, a high level of preference for the status quo option exists).

Table 11: Models of Water Quality choice data

	Conditional Logit		**Random Parameter Logit**		**Generalised Mixed Logit**	
	Pseudo R^2	**0.17**	Pseudo R^2	**0.20**	Pseudo R^2	**0.16**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Poor water pressure: number of properties below standard pressure	0.19063	0.0000	0.13645	0.0000	0.177546	0.0000
Drinking water quality: the proportion of samples of tap water that will pass the DWI's (a government body) requirement for chemical	0.16774	0.0000	0.185962	0.0000	0.196532	0.0000

& biological content						
Taste, smell & colour of drinking water: total number of water quality contacts	0.55537	0.0000	0.44492	0.0000	0.4866	0.0000
Bill impact	-0.13444	0.0000	-0.11507	0.0418	-0.15422	0.0000
Status quo	0.60757	0.0000	0.752369	0.0000	0.58756	0.0000

The marginal WTP for a service level change in each service measure are presented in Table 12. Based on the Conditional Logit model, domestic customers were prepared to pay on average £0.66 more on their bill for each increase in drinking water quality service level. Table 12 also reports the 95% confidence intervals associated with marginal WTP for all three models.

The Random Parameter Logit model, which is linear, suggests that the average domestic customer is willing to pay an additional £2.07 for a level increase in taste, smell and colour of drinking water.

Table 12: WTP results for Water Quality choice data

	Conditional Logit			**Random Parameter Logit**			**Generalised Mixed Logit**		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Poor water pressure	£0.75	£0.56	£0.93	£0.64	£0.48	£0.79	£0.74	£0.55	£0.92
Drinking water quality	£0.66	£0.47	£0.84	£0.87	£0.72	£1.02	£0.82	£0.60	£1.03
Taste, smell and colour of drinking water	£2.17	£1.97	£2.37	£2.07	£1.74	£2.41	£2.02	£1.89	£2.14

All three of the models reported above assume a linear relationship between WTP and the level of service they receive. However as previously suggested, WTP and WTA tend not to be symmetrical. Such a non-linear utility function can be modelled with a non-linear function; but an alternative is to model the non-linear relationship through a piecewise regression model (i.e. fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model, or fixed effects model, was estimated using each of the three models used above. While the Generalised Mixed Logit and Random

Parameter Logit models provide a better fit with the data they do not provide statistically significant coefficient values for a number of the service measure effects. Given that the purpose of this exercise is to estimate customer WTP for improvements in service measure levels it was decided to base the following discussion on the Conditional Logit Model (table 13), where most coefficient values are significant and capable of meaningful interpretation.

In this model most coefficients change monotonically: for example, drinking water quality(L-1) < drinking water quality(L+1) < drinking water quality(L+2) < drinking water quality(L+3).

Table 13: Non-Linear Conditional Logit model for water quality

	Pseudo R^2	**0.16**			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Poor water pressure (L-2)	-0.62899	0.000	-£2.25	-£2.70	-£1.79
Poor water pressure (L-1)	-0.38497	0.000	-£1.37	-£1.52	-£1.23
Poor water pressure (L+1)	0.13327	0.007	£0.48	£0.32	£0.63
Poor water pressure (L+2)	0.22959	0.007	£0.82	£0.50	£1.14
Poor water pressure (L+3)	0.29565	0.016	£1.05	£0.76	£1.81
Drinking water quality (L-2)	-0.52912	0.000	-£1.89	-£2.82	-£0.96
Drinking water quality (L-1)	-0.31188	0.000	-£1.11	-£1.42	-£0.80
Drinking water quality (L+1)	0.13701	0.000	£0.49	£0.34	£0.64
Drinking water quality (L+2)	0.4654	0.001	£1.66	£1.37	£1.95
Drinking water quality (L+3)	0.5986	0.005	£2.15	£1.74	£2.75
Taste, smell and colour of drinking water (L-2)	-0.94947	0.000	-£3.39	-£4.05	-£2.74
Taste, smell and colour of drinking water (L-1)	-0.41606	0.000	-£1.49	-£1.78	-£1.19
Taste, smell and colour of drinking water (L+1)	0.58444	0.000	£2.09	£1.42	£2.75

Taste, smell and colour of drinking water (L+2)	1.04639	0.000	£3.74	£2.79	£4.68
Taste, smell and colour of drinking water (L+3)	1.2236	0.000	£4.40	£3.54	£5.27
Bill impact	-0.09603	0.000			

The results of the fixed effects model indicate that the average domestic customer would be prepared to pay a +£1.66 increase on their water bill to increase drinking water quality level from the status quo to level +2. The average customer would be willing to accept a decrease in taste, smell and colour of drinking water to level -1 for a bill reduction of -£1.49 per year.

Overall, the fixed effect model for water quality indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP and WTA. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 2 – Supply of Water

Again, the 3 models were applied to the data relating to CE2, Supply of Water.

For the Supply of Water choice set based on CE2, the Random Parameter Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2, = 0.27 (compared with 0.22 for the Generalised Mixed Logit model, and 0.25 for the Conditional Logit Model). In the Random Parameter Logit Model, tastes were assumed to be normally distributed with respect to the service measures (unexpected supply interruption, leakage and water use restrictions); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 14 reports the results of all three models. The positive signs on the coefficients of the Supply of Water in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choices (as noted earlier, a high level of preference for the status quo option exists).

Table 14: Models of Supply of Water choice data

	Conditional Logit		**Random Parameter Logit**		**Generalised Mixed Logit**	
	Pseudo R^2	**0.25**	Pseudo R^2	**0.27**	Pseudo R^2	**0.22**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**

Unexpected supply interruption of 3–6 hours: total properties affected	0.42834	0.0000	0.39569	0.0000	0.456554	0.0000
Leakage	0.40739	0.0000	0.454667	0.0000	0.485652	0.0000
Water use restrictions e.g. hose pipe ban	0.14506	0.0000	0.17344	0.0338	0.123357	0.0000
Bill impact	-0.26257	0.0000	-0.25292	0.02825	-0.26684	0.0000
Status quo	0.28764	0.0155	0.25963	0.0006	0.33237	0.00012

The marginal WTP for a service level change in each service measure is presented in Table 15. Based on the Conditional Logit model, domestic customers were prepared to pay on average +£0.81 more on their bill for each increase in unexpected supply interruption service level. Table 15 also reports the 95% confidence intervals associated with marginal WTP for all three models.

The Random Parameter Logit model suggests that the average domestic customer is willing to pay an additional +£0.35 for a level increase in water use restrictions.

Table 15: WTP results for Supply of Water choice data

	Conditional Logit			**Random Parameter Logit**			**Generalised Mixed Logit**		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Unexpected supply interruption	£0.81	£0.73	£0.90	£0.72	£0.64	£0.80	£0.80	£0.70	£0.90
Leakage	£0.77	£0.69	£0.86	£0.83	£0.74	£0.91	£0.85	£0.78	£0.92
Water use restrictions	£0.31	£0.21	£0.40	£0.35	£0.20	£0.50	£0.24	£0.18	£0.29

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However, the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit model (see Table 16), where most coefficient values are significant and capable of meaningful interpretation.

Table 16: Non-Linear Conditional Logit model for Supply of Water

	Pseudo R^2	0.16			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Unexpected supply interruption (L-2)	-0.79613	0.000	-£1.48	-£1.81	-£1.16
Unexpected supply interruption (L-1)	-0.44171	0.000	-£0.82	-£1.12	-£0.53
Unexpected supply interruption (L+1)	0.1055	0.020	£0.20	£0.12	£0.27
Unexpected supply interruption (L+2)	0.32734	0.000	£0.61	£0.53	£0.69
Unexpected supply interruption (L+3)	0.41326	0.000	£0.77	£0.65	£0.89
Leakage (L-2)	-0.86924	0.000	-£1.62	-£1.99	-£1.25
Leakage (L-1)	-0.5833	0.000	-£1.09	-£1.41	-£0.76
Leakage (L+1)	0.23618	0.063	£0.44	£0.21	£0.67
Leakage (L+2)	0.38712	0.056	£0.72	£0.12	£1.32
Leakage (L+3)	0.4452	0.065	£0.83	£0.24	£1.42
Water use restrictions (L-2)	-0.27771	0.002	-£0.52	-£0.85	-£0.19
Water use restrictions (L-1)	-0.26775	0.001	-£0.50	-£0.80	-£0.19
Water use restrictions (L+1)	0.1389	0.009	£0.26	£0.15	£0.37
Water use restrictions (L+2)	0.14071	0.035	£0.26	£0.18	£0.35
Water use restrictions (L+3)	0.1536	0.042	£0.29	£0.20	£0.38
Bill impact	-0.12805	0.000			

The results of the fixed effects model indicate that the average domestic customer would be prepared to pay a +£0.72 increase on their water bill to increase leakage level from the status quo to level +2. The average customer would be willing to accept a decrease in leakage to level -1 for a bill reduction of -£1.09 per year.

Overall, the fixed effect model for Supply of Water indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 3 – Sewerage Services

Again, the 3 models were applied to the data relating to CE3, sewerage services.

For the sewerage services choice set based on CE3, the Random Parameter Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2, = 0.19 (compared with 0.17 for the Generalised Mixed Logit model, and 0.17for the Conditional Logit model). In the RPL model, tastes were assumed to be normally distributed with respect to the service measures s (sewer flooding inside properties, sewer flooding outside properties and Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 17 reports the results of all three models. The positive signs on the coefficients of the sewerage services in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choice.

Table 17: Models of Sewerage Services choice data

	Conditional Logit		Random Parameter Logit		Generalised Mixed Logit	
	Pseudo R^2	0.17	Pseudo R^2	0.19	Pseudo R^2	0.17
	Coefficient	Prob.|z|>Z	Coefficient	Prob.|z|>Z	Coefficient	Prob.|z|>Z
Sewer flooding inside properties: number of incidents per year	0.47757	0.0000	0.53403	0.0062	0.512367	0.0000
Sewer flooding outside properties: number of incidents per year	0.29141	0.0000	0.29457	0.0241	0.266534	0.0000
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	0.299857	0.0000	0.27929	0.0219	0.313222	0.0000
Bill impact	-0.24351	0.0000	-0.28759	0.0003	-0.26598	0.0000
Status quo	0.28895	0.014	0.20028	0.06025	0.299896	0.009506

The marginal WTP for a service level change in each service measure are presented in Table 18. Based on the Conditional Logit model, domestic customers were prepared to pay on average +£0.92 more on their bill for each increase in sewer flooding inside properties: number of incidents per year service level. Table 18 also reports the 95% confidence intervals associated with marginal WTP for all three models.

The Random Parameter Logit model suggests that the average domestic customer is willing to pay an additional +£0.52 for a level increase in properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works.

Table 18: WTP results for Sewerage Services choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Sewer flooding inside properties: number of incidents per year	£0.92	£0.83	£1.01	£0.99	£0.71	£1.28	£0.97	£0.89	£1.05
Sewer flooding outside properties: number of incidents per year	£0.56	£0.48	£0.65	£0.55	£0.43	£0.66	£0.50	£4.39	-£3.38
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	£0.58	£0.46	£0.69	£0.52	£0.46	£0.58	£0.59	£0.52	£0.66

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However, the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit Conditional Logit model (see Table 19), where most coefficient values are significant and capable of meaningful interpretation.

Table 19: Non-Linear Conditional Logit model for sewerage services

	Pseudo R^2	0.16			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Sewer flooding inside properties: number of incidents per year (L-2)	-0.9705	0.000	-£2.00	-£2.37	-£1.63
Sewer flooding inside properties: number of incidents per year (L-1)	-0.54994	0.000	-£1.13	-£1.50	-£0.77
Sewer flooding inside properties: number of incidents per year (L+1)	0.27438	0.043	£0.57	£0.40	£0.73
Sewer flooding inside properties: number of incidents per year (L+2)	0.57874	0.016	£1.19	£1.03	£1.36
Sewer flooding inside properties: number of incidents per year (L+3)	0.6956	0.019	£1.43	£1.24	£1.62
Sewer flooding outside properties: number of incidents per year (L-2)	-0.60341	0.000	-£1.24	-£1.85	-£0.64
Sewer flooding outside properties: number of incidents per year (L-1)	-0.39762	0.000	-£0.82	-£1.41	-£0.23
Sewer flooding outside properties: number of incidents per year (L+1)	0.13393	0.016	£0.28	£0.10	£0.45
Sewer flooding outside properties: number of incidents per year (L+2)	0.22077	0.019	£0.46	£0.25	£0.66
Sewer flooding outside	0.3121	0.09	£0.64	£0.43	£0.85

properties: number of incidents per year (L+3)					
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L-2)	-0.43751	0.000	-£0.90	-£1.29	-£0.51
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L-1)	-0.10082	0.028	-£0.21	-£0.40	-£0.01
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+1)	0.19354	0.022	£0.40	£0.27	£0.52
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+2)	0.29183	0.003	£0.60	£0.34	£0.86
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+3)	0.3220	0.006	£0.66	£0.45	£0.87

Bill impact	-0.1506	0.000			

The results of the fixed effects model indicate that the average domestic customer would be prepared to pay a +£1.19 increase on their water bill to increase sewer flooding inside properties level from the status quo to level +2. The average customer would be willing to accept a decrease in properties subject to chronic smells to level -1 for a bill reduction of -£0.21 per year.

Overall, the fixed effect model for sewerage services indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 4 – Environment

For the environment choice set based on CE4, the Conditional Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2 = 0.25 (compared with 0.22 for the Generalised Mixed Logit model, and 0.19 for the Random Parameter Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures s (number of bathing beaches meeting 'Good' or 'Excellent' standard, length of rivers in Yorkshire improved, category 3 pollution incident, and area of land conserved or improved by Yorkshire Water); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 20 reports the results of all three models. The positive signs on the coefficients of the environment in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choice.

Table 20: Models of Environment choice data

	Conditional Logit		Random Parameter Logit		Generalised Mixed Logit	
	Pseudo R^2	**0.24**	Pseudo R^2	**0.19**	Pseudo R^2	**0.23**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Number of bathing beaches meeting 'Good' or 'Excellent' standard	0.14935	0.0000	0.131222	0.0000	0.152236	0.0000
Length of rivers in Yorkshire improved (%)	0.40956	0.0000	0.44395	0.0013	0.412356	0.0000
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	0.20553	0.0000	0.21825	0.0000	0.239562	0.0000
Area of land conserved or improved by Yorkshire Water	0.20544	0.0000	0.20951	0.0365	0.198956	0.0000
Bill impact	-0.19872	0.0000	-0.30226	0.0018	-0.24224	0.0000
Status quo	0.13399	0.0000	0.1702	0.00512	0.165459	0.0000

The marginal WTP for a service level change in each service measure are presented in Table 21. Based on the Conditional Logit model, domestic customers were prepared to pay on average +£1.11 more on their bill for each increase in the length of rivers in Yorkshire improved service level. Table 21 also reports the 95% confidence intervals associated with marginal WTP for all three models.

Table 21: WTP results for environment choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Number of bathing beaches meeting 'Good' or 'Excellent' standard	£0.40	£0.29	£0.34	£0.26	£0.43	£0.40	£0.29	£0.51	£0.40
Length of rivers in Yorkshire improved (%)	£1.11	£0.98	£1.16	£1.02	£1.31	£1.08	£0.98	£1.18	£1.08
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	£0.56	£0.44	£0.57	£0.46	£0.68	£0.63	£0.49	£0.76	£0.63
Area of land conserved or improved by Yorkshire Water	£0.56	£0.45	£0.55	£0.40	£0.70	£0.52	£0.44	£0.61	£0.52

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However, the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit model (see Table 22), where most coefficient values are significant and capable of meaningful interpretation.

Table 22: Non-Linear Conditional Logit model for environment

	Pseudo R^2	0.16			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L-2)	-0.62446	0.000	-£1.64	-£2.13	-£1.15
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L-1)	-0.34585	0.001	-£0.91	-£1.35	-£0.47
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+1)	0.12209	0.009	£0.32	£0.20	£0.45
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+2)	0.1816	0.030	£0.48	£0.26	£0.69
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+3)	0.1865	0.029	£0.49	£0.25	£0.70
Length of rivers in Yorkshire improved (%) (L-2)	-0.55843	0.000	-£1.47	-£2.08	-£0.86
Length of rivers in Yorkshire improved (%) (L-1)	-0.3128	0.000	-£0.82	-£1.05	-£0.59
Length of rivers in Yorkshire improved (%) (L+1)	0.31487	0.044	£0.83	£0.64	£1.01
Length of rivers in Yorkshire improved (%) (L+2)	0.4339	0.040	£1.14	£0.96	£1.32
Length of rivers in Yorkshire improved (%) (L+3)	0.5132	0.026	£1.35	£1.17	£1.53
Category 3 pollution incident: a minor incident that has a minimal impact	-0.59701	0.000	-£1.57	-£1.99	-£1.15

on the quality of water in the area (L-2)					
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L-1)	-0.16218	0.052	-£0.43	-£0.70	-£0.15
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+1)	0.12715	0.078	£0.33	£0.12	£0.55
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+2)	0.22881	0.013	£0.60	£0.44	£0.77
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+3)	0.3123	0.023	£0.82	£0.64	£1.00
Area of land conserved or improved by Yorkshire Water (L-2)	-0.54773	0.000	-£1.44	-£1.90	-£0.98
Area of land conserved or improved by Yorkshire Water (L-1)	-0.21405	0.000	-£0.56	-£0.85	-£0.28
Area of land conserved or improved by Yorkshire Water (L+1)	0.14724	0.060	£0.39	£0.09	£0.68
Area of land conserved or improved by Yorkshire Water (L+2)	0.20249	0.026	£0.53	£0.38	£0.68
Area of land conserved or improved by	0.2220	0.033	£0.58	£0.42	£0.74

Yorkshire Water (L+3)					
Bill impact	-0.10394	0.000			

The results of the fixed effects model indicate that the average domestic customer would be prepared to pay a +£1.14 increase on their water bill to increase Length of rivers in Yorkshire improved (%) level from the status quo to level +2. The average customer would be willing to accept a decrease in area of land conserved or improved by Yorkshire Water to level -1 for a bill reduction of -£0.56 per year.

Overall, the fixed effect model for environment indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Willingness to Pay estimates

The final WTP and WTA based on the non-linear model estimates are summarised in Table 23. In almost all of the service level areas considered, the level of WTA is greater than the level of WTP for the greatest service decrease or increase.

Table 23: WTP and WTA estimates – all service levels

Service area	Service level attribute	Willingness to Pay			
		Reduction in service	Improvement in service		
		-1	+1	+2	+3
Water quality	Poor water pressure: number of properties below standard pressure	-£1.37	£0.48	£0.82	£1.05
	Drinking water quality: the proportion of samples of tap water that will pass the DWI's (a government body) requirement for chemical & biological content	-£1.11	£0.49	£1.66	£2.15
	Taste, smell & colour of drinking water: total number of water quality contacts	-£1.49	£2.09	£3.74	£4.40
Supply of Water	Unexpected supply interruption of 3–6 hours: total properties affected	-£0.82	£0.20	£0.61	£0.77
	Leakage	-£1.09	£0.44	£0.72	£0.83
	Water use restrictions e.g. hose pipe ban	-£0.50	£0.26	£0.26	£0.29
Sewerage services	Sewer flooding inside properties: number of incidents per year	-£1.13	£0.57	£1.19	£1.43
	Sewer flooding outside properties: number of incidents per year	-£0.82	£0.28	£0.46	£0.64
	Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	-£0.21	£0.40	£0.60	£0.66
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard	-£0.91	£0.32	£0.48	£0.49
	Length of rivers in Yorkshire improved (%)	-£0.82	£0.83	£1.14	£1.35
	Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	-£0.43	£0.33	£0.60	£0.82
	Area of land conserved or improved by Yorkshire Water	-£0.56	£0.39	£0.53	£0.58

Table 24: WTP and WTA estimates – online community panel

Service area	Service level attribute	Willingness to Pay			
		Reduction in service	Improvement in service		
		-1	+1	+2	+3
Water quality	Poor water pressure: number of properties below standard pressure	-£1.37 (-£1.19)	£0.48 (£0.80)	£0.82 (£1.02)	£1.05 (£1.67)
	Drinking water quality: the proportion of samples of tap water that will pass the DWI's (a government body) requirement for chemical & biological content	-£1.11 (-£0.96)	£0.49 (£0.67)	£1.66 (£1.22)	£2.15 (£2.70)
	Taste, smell & colour of drinking water: total number of water quality contacts	-£1.49 (-£1.35)	£2.09 (£1.89)	£3.74 (£3.51)	£4.40 (£4.62)
Supply of water	Unexpected supply interruption of 3–6 hours: total properties affected	-£0.82 (-£0.50)	£0.20 (£0.48)	£0.61 (£0.91)	£0.77 (£1.03)
	Leakage	-£1.09 (-£0.80)	£0.44 (£0.39)	£0.72 (£0.86)	£0.83 (£1.12)
	Water use restrictions e.g. hose pipe ban	-£0.50 (-£0.27)	£0.26 (£0.32)	£0.26 (£0.39)	£0.29 (£0.48)
Sewerage services	Sewer flooding inside properties: number of incidents per year	-£1.13 (-£0.83)	£0.57 (£0.69)	£1.19 (£1.18)	£1.43 (£1.73)
	Sewer flooding outside properties: number of incidents per year	-£0.82 (-£0.68)	£0.28 (£0.32)	£0.46 (£0.66)	£0.64 (£0.87)
	Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	-£0.21 (-£0.31)	£0.40 (£0.45)	£0.60 (£0.63)	£0.68 (£0.81)
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard	-£0.91 (-£1.22)	£0.32 (£0.68)	£0.48 (£1.37)	£0.49 (£1.66)

	Length of rivers in Yorkshire improved (%)	-£0.82 (-£0.63)	£0.83 (£0.71)	£1.14 (£1.28)	£1.35 (£1.82)
	Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	-£0.43 (-£0.99)	£0.33 (£0.65)	£0.60 (£0.98)	£0.82 (£1.43)
	Area of land conserved or improved by Yorkshire Water	-£0.56 (-£1.13)	£0.39 (£0.42)	£0.53 (£0.91)	£0.58 (£1.31)

In general, the values from the online community WTP analysis are well matched between the online community sample and the main stage survey sample; although some individual levels have some large differences (for example – over £1 between the acceptance for a decline L-2 in water taste & smell); most levels show little change and are directionally comparable. The online community sample is skewed slightly towards older age groups, and there is a higher proportion of females in the sample than in the nat. rep main stage sample.

Full package CE

In the final choice experiment, CE5, respondents were presented with the full package of 13 service levels shown at highest levels of service (L+3) at a range of bill impacts for the total package (£30, £50, £65, £80, £100, £120).

The level of acceptance declines at each increased water bill impact. In each case, the status quo is preferred to the alternative scenario.

Table 25: CE5 choice by scenario at each bill impact

	Alternative scenario (L+3)	Status quo – no bill impact
£30	40.9%	59.1%
£50	34.8%	65.2%
£65	34.0%	66.0%
£80	32.5%	67.5%
£100	31.4%	68.6%
£120	27.0%	73.0%

Variation in estimated WTP by socio-economic, and demographic characteristics

The choice models investigated provide the ability to estimate WTP for individual attributes at the level of individual respondents. This allows us to investigate how respondent WTP varies across the household samples according to a range of characteristics.

We have explored the variation in household WTP against the following classifications of factors:

- Age: Under 45 vs. 45+
- Gender: Male vs. Female
- Household size: Number of people in the household
- Metered status: Metered vs. Unmetered
- SEG: ABC1 vs. C2DE
- Region
- Vulnerability: Not vulnerable vs. Possible vulnerability
- Vulnerability: Not focussed vulnerability vs. Focussed vulnerability
- Vulnerability: Not financially vulnerable vs. Financially vulnerable
- Vulnerability: Not health vulnerable vs. Health vulnerable
- Method of interview: Online vs. CAPI
- Service experiences

The following tables show only significant differences. Measures that show no data show no significant difference in WTP values between comparative groups.

Table 26: Variation in estimated WTP by age

Service area	Service level attribute	<45	+45
Water quality	Poor water pressure	£0.93	£0.60
	Drinking water quality		
	Taste smell and colour of drinking water	£2.16	£3.40
Supply of water	Unexpected supply interruption		
	Leakage	£0.65	£1.00
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties	£0.37	£0.91
	Smell from sewers and treatment works	£0.71	£0.50
Environment	Bathing water quality	£0.32	£0.53
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water	£0.45	£0.69

WTP estimates by age show that younger customers (under 45) place a significantly higher value on reducing the number of properties affected by poor water pressure, and combating smells from sewers and sewage treatment works than customers who are aged 45 and over. Older customers meanwhile place a significantly higher WTP value on the taste, smell and colour of drinking water, reducing the incidence of leakage, sewer flooding outside properties, river water quality and land conserved or improved by Yorkshire Water. Overall, older customers are willing to pay more, across a wider variety of service measures than younger customers.

Table 27: Variation in estimated WTP by Gender

Service area	Service level attribute	Female	Male
Water quality	Poor water pressure		
	Drinking water quality		
	Taste smell and colour of drinking water		
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents	£0.61	£0.51
	Land conserved or improved by Yorkshire Water		

The only gender difference in WTP concerns pollution incidents, where females have a higher WTP value than their male counterparts. Otherwise, no significant differences are observed.

Table 28: Variation in estimated WTP by number of people in the home

Service area	Service level attribute	1	2	3	4+
Water quality	Poor water pressure	£0.58	£0.78	£0.67	£0.94
	Drinking water quality	£0.55	£0.68	£0.71	£0.72
	Taste smell and colour of drinking water				
Supply of water	Unexpected supply interruption				
	Leakage	£0.72	£0.83	£0.85	£0.65
	Water use restrictions				
Sewerage services	Sewer flooding inside properties	£0.78	£1.05	£0.91	£0.85
	Sewer flooding outside properties				
	Smell from sewers and treatment works	£0.49	£0.61	£0.66	£0.57
Environment	Bathing water quality				
	River water quality				
	Pollution incidents	£0.98	£1.21	£1.08	£1.10
	Land conserved or improved by Yorkshire Water				

Significant differences by size of household are noted for 6 service measures. The most marked WTP differences are between the one person households and multiple occupancy homes with the one person households having a consistently lower WTP estimate across the six significantly different service measures.

Table 29: Variation in estimated WTP by metered status

Service area	Service level attribute	Metered	Unmetered
Water quality	Poor water pressure		
	Drinking water quality		
	Taste smell and colour of drinking water	£2.43	£3.08
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties	£0.80	£1.02
	Sewer flooding outside properties	£0.65	£0.50
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

Significant differences in WTP estimates only occur across three of the 13 service measures. Metered customers place a higher WTP value on sewer flooding outside properties, while unmetered customers would be willing to pay more for the taste smell and colour of drinking water (although WTP estimates across both groups are high) and sewer flooding inside properties.

Table 30: Variation in estimated WTP by SEG

Service area	Service level attribute	ABC1	C2DE
Water quality	Poor water pressure		
	Drinking water quality	£0.81	£0.59
	Taste smell and colour of drinking water		
Supply of water	Unexpected supply interruption	£0.97	£0.74
	Leakage	£0.87	£0.70
	Water use restrictions		
Sewerage services	Sewer flooding inside properties	£1.16	£0.81
	Sewer flooding outside properties	£0.69	£0.49
	Smell from sewers and treatment works	£0.66	£0.53
Environment	Bathing water quality	£0.47	£0.36
	River water quality	£1.29	£1.00
	Pollution incidents		
	Land conserved or improved by Yorkshire Water	£0.66	£0.50

Unsurprisingly, higher SEG customers display a higher WTP propensity than lower SEG customers. In particular, higher SEG customers' WTP estimates are higher across all three sewerage service measures. Interestingly, there is no difference in WTP for the highest valued service measure; taste, smell and colour of drinking water – suggesting that customers across both categories are equally unlikely to want to compromise on this service area.

Table 31: Variation in estimated WTP by Region

Service area	Service level attribute	East Yorks.	North Yorks.	South Yorks.	West Yorks.
Water quality	Poor water pressure	£0.75	£0.81	£0.67	£0.78
	Drinking water quality				
	Taste smell and colour of drinking water				
Supply of water	Unexpected supply interruption	£0.67	£0.90	£0.75	£0.85
	Leakage				
	Water use restrictions				
Sewerage services	Sewer flooding inside properties	£1.06	£0.95	£0.84	£0.92
	Sewer flooding outside properties				
	Smell from sewers and treatment works				
Environment	Bathing water quality				
	River water quality	£1.24	£1.08	£1.13	£1.07
	Pollution incidents				
	Land conserved or improved by Yorkshire Water				

Customers in South Yorkshire show the lowest WTP levels for poor water pressure and sewer flooding inside properties. Meanwhile, customers in East Yorkshire have the lowest WTP estimate for unexpected supply interruptions, but the highest for river water quality and for inside sewer flooding.

Table 32: Variation in estimated WTP by possible vulnerability

Service area	Service level attribute	Not possible vulnerability	Possible vulnerability
Water quality	Poor water pressure	£0.83	£0.73
	Drinking water quality		
	Taste smell and colour of drinking water	£2.37	£2.10
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

When looking at the broadest of the four vulnerable customer definitions few significant differences emerge – with no differences apparent across the supply of water, sewerage services or environment blocks. Where differences do appear, in the water quality measures, non-vulnerable customers (by this definition) display a higher WTP to reduce the chances of poor water pressure, and being affected by water quality issues relating to the taste, smell and colour of drinking water.

Table 33: Variation in estimated WTP by focussed vulnerability

Service area	Service level attribute	Not focussed vulnerability	Focussed vulnerability
Water quality	Poor water pressure	£0.83	£0.64
	Drinking water quality	£0.71	£0.58
	Taste smell and colour of drinking water	£2.29	£2.03
Supply of water	Unexpected supply interruption		
	Leakage	£0.81	£0.70
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

When a more focussed definition of vulnerability is applied, a wider set of differences in WTP estimates emerges, although it is noticeable that there are no significant differences across any of the seven sewerage services and environment service measures. Where differences do exist, customers who aren't included in the focussed vulnerability definition are willing to pay more for improvements to poor water pressure, drinking water quality, the taste smell and colour of drinking water and leakage.

Table 34: Variation in estimated WTP by financial vulnerability

Service area	Service level attribute	Not financially vulnerable	Financially vulnerable
Water quality	Poor water pressure	£0.81	£0.73
	Drinking water quality	£0.72	£0.62
	Taste smell and colour of drinking water	£2.39	£2.05
Supply of water	Unexpected supply interruption		
	Leakage	£0.86	£0.71
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

When the parameters of possible vulnerability are changed to look specifically at financial vulnerability, the outcomes are broadly in-line with the focussed vulnerability definition. Where significant differences exist, WTP is higher for non-financially vulnerable customers (by our definition) – but across the sewerage service and environment blocks, no significant differences occur.

Table 35: Variation in estimated WTP by health vulnerability

Service area	Service level attribute	Not health vulnerable	Health vulnerable
Water quality	Poor water pressure	£0.81	£0.68
	Drinking water quality		
	Taste smell and colour of drinking water	£2.34	£1.91
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

When customers who are classed as health vulnerable are compared to non-health vulnerable customers, few significant differences occur. Non-health vulnerable customers have a higher WTP value estimate for poor water pressure and taste, smell and colour of drinking water, but otherwise no significant differences emerge. Although the difference between taste, smell and colour of drinking water values show a big difference (£0.43), it remains the highest WTP value measure across both groups.

Table 36: Variation in estimated WTP by mode of interview

Service area	Service level attribute	CAPI	Online
Water quality	Poor water pressure	£0.45	£0.79
	Drinking water quality	£0.31	£0.71
	Taste smell and colour of drinking water	£1.03	£2.31
Supply of water	Unexpected supply interruption	£0.40	£0.86
	Leakage	£0.43	£0.81
	Water use restrictions	£0.14	£0.33
Sewerage services	Sewer flooding inside properties	£0.36	£1.00
	Sewer flooding outside properties	£0.22	£0.60
	Smell from sewers and treatment works	£0.30	£0.62
Environment	Bathing water quality		
	River water quality	£0.64	£1.17
	Pollution incidents		
	Land conserved or improved by Yorkshire Water	£0.33	£0.59

Significant differences between the mode of contact show that those interviewed using CAPI reported lower WTP estimates compared to the online sample in all but two of the service measures. When considering these differences, we must acknowledge that the CAPI interviews were conducted with the hard to reach or vulnerable customers who were underrepresented in the online sample. People with disabilities, older respondents or people in financial difficulties were over represented in the CAPI interviews.

Table 37: Variation in estimated WTP by service experience: poor water taste or odour

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure		
	Drinking water quality		
	Taste smell and colour of drinking water		
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions	£0.30	£0.36
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents	£0.55	£0.62
	Land conserved or improved by Yorkshire Water		

Whether customers experience poor water taste or odour has little overall difference on WTP value estimates, including the taste, smell and colour of drinking water. Only water use restrictions and pollution incidents service measures show a significant difference in WTP values – with both revealing a higher WTP amount among customers who have encountered the service experience.

Table 38: Variation in estimated WTP by service experience: sewer flooding inside your property

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.73	£1.17
	Drinking water quality	£0.66	£0.79
	Taste smell and colour of drinking water	£2.14	£3.02
Supply of water	Unexpected supply interruption		
	Leakage	£0.76	£0.96
	Water use restrictions	£0.30	£0.57
Sewerage services	Sewer flooding inside properties	£0.90	£1.44
	Sewer flooding outside properties		
	Smell from sewers and treatment works	£0.58	£0.68
Environment	Bathing water quality		
	River water quality	£1.10	£1.39
	Pollution incidents	£0.55	£0.81
	Land conserved or improved by Yorkshire Water	£0.55	£0.90

When comparing customers who have experienced sewer flooding inside their property with those who haven't, significant differences across 11 of the 13 service measures occur. In each of the 11 service areas with significant differences, those who have experienced sewer flooding inside their property have a higher WTP value than those who haven't had the experience – suggesting that having a service experience with potentially severe outcomes can result in higher levels of WTP for services across a variety of measures.

Table 39: Variation in estimated WTP by service experience: Sewer flooding in your garden or close to your property

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.74	£0.96
	Drinking water quality		
	Taste smell and colour of drinking water	£2.13	£2.82
Supply of water	Unexpected supply interruption	£0.80	£1.04
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties	£0.90	£1.25
	Sewer flooding outside properties		
	Smell from sewers and treatment works	£0.57	£0.70
Environment	Bathing water quality		
	River water quality	£1.10	£1.30
	Pollution incidents	£0.55	£0.74
	Land conserved or improved by Yorkshire Water	£0.55	£0.71

Although not as marked as the comparative outcomes for sewer flooding inside a property, customers who have experienced sewer flooding outside also show a higher WTP propensity – this time across 8 of the 13 service measures. Interestingly, the WTP value for sewer flooding outside of properties across the two groups is not significantly different, suggesting that in some scenarios the experience has an impact on the individual's wider attitude (or WTP) towards water service, but not on the actual measure by which they were affected.

Table 40: Variation in estimated WTP by service experience: Smells from a sewer or sewage treatment works

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.73	£0.87
	Drinking water quality	£0.64	£0.77
	Taste smell and colour of drinking water	£2.09	£2.58
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties	£0.90	£1.01
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents	£0.54	£0.65
	Land conserved or improved by Yorkshire Water		

Respondents who have experienced smells from sewers or sewage treatment works have higher WTP values for all three water quality service measures, sewer flooding inside the property, and pollution incidents, but interestingly not for smells from sewers and treatment works.

Table 41: Variation in estimated WTP by service experience: A leaking water supply pipe on your property

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.71	£1.11
	Drinking water quality	£0.63	£0.94
	Taste smell and colour of drinking water	£2.11	£2.79
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions	£0.30	£0.39
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents	£0.55	£0.65
	Land conserved or improved by Yorkshire Water	£0.55	£0.71

Customers who have experienced a leaking supply pipe in the past have a higher estimated WTP across all three water quality service measures than those who haven't experienced a leaking supply pipe in the past. As with some other experiences, despite the issue in question having a significant impact on the WTP estimates of a number of service measures, it doesn't appear to have any impact on the WTP value of the experience in question (Leakage); this could be because the leak was on their own pipes and not those external to their properties.

Table 42: Variation in estimated WTP by service experience: A leaking water supply pipe close to your property

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.72	£0.88
	Drinking water quality		
	Taste smell and colour of drinking water	£2.05	£2.69
Supply of water	Unexpected supply interruption		
	Leakage	£0.72	£0.97
	Water use restrictions	£0.29	£0.40
Sewerage services	Sewer flooding inside properties	£0.89	£1.05
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality	£0.37	£0.52
	River water quality	£1.06	£1.35
	Pollution incidents	£0.53	£0.71
	Land conserved or improved by Yorkshire Water	£0.53	£0.71

Experience of a leaking supply pipe close to the property has an interesting impact on WTP estimates across the four environment service measures. In each case those with prior experience of the external leaking supply pipe close to their property have a higher WTP estimate than those who haven't had the experience.

Table 43: Variation in estimated WTP by service experience: Low water pressure

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure		
	Drinking water quality		
	Taste smell and colour of drinking water	£2.06	£2.44
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions		
Sewerage services	Sewer flooding inside properties		
	Sewer flooding outside properties		
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

Despite low water pressure being a service measure with a high proportion of significant differences by sub-group analysis, when those who have and haven't experienced it in the past are compared, only one significant difference emerges – the taste, smell and colour of drinking water, which is the service measure with the highest level of WTP estimate overall. This suggests that although perceptions (and there for WTP) are different across a number of groups, the actual impact of experiencing it doesn't unduly affect wider attitudes towards water supply and service.

Table 44: Variation in estimated WTP by service experience: Restriction on how you can use water (e.g. a hosepipe ban)

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.73	£1.02
	Drinking water quality	£0.64	£0.88
	Taste smell and colour of drinking water	£2.12	£2.78
Supply of water	Unexpected supply interruption		
	Leakage		
	Water use restrictions	£0.30	£0.43
Sewerage services	Sewer flooding inside properties	£0.91	£1.04
	Sewer flooding outside properties		
	Smell from sewers and treatment works	£0.57	£0.70
Environment	Bathing water quality		
	River water quality		
	Pollution incidents		
	Land conserved or improved by Yorkshire Water		

Experience of water use restrictions in the past has a significant impact on the WTP estimates for this service measure as well as three water quality service measures, sewer flooding inside properties, smells from sewers and sewage treatment works. In each case the WTP estimate is higher for those that have had the experience than those who haven't.

Table 45: Variation in estimated WTP by service experience: An instruction to boil your drinking water

Service area	Service level attribute	Not experienced	Experienced
Water quality	Poor water pressure	£0.73	£0.89
	Drinking water quality	£0.64	£0.78
	Taste smell and colour of drinking water	£2.10	£2.59
Supply of water	Unexpected supply interruption		
	Leakage	£0.75	£0.91
	Water use restrictions	£0.29	£0.43
Sewerage services	Sewer flooding inside properties	£0.89	£1.08
	Sewer flooding outside properties	£0.55	£0.64
	Smell from sewers and treatment works		
Environment	Bathing water quality		
	River water quality	£1.08	£1.28
	Pollution incidents	£0.54	£0.67
	Land conserved or improved by Yorkshire Water		

When customers who have experienced drinking water boil notices are compared against those who haven't had the experience, significant differences in WTP estimates occur across 9 of the 13 service measures – including across all three water quality service measures.

Use and non-use valuations

The WTP and WTA estimates provided in this report have been total economic valuations, meaning they contain both the 'use' values (the value the respondent places on the services they receive and use) and the 'non-use' values (the indirect value that the respondent places on the water service for altruistic reasons). To measure the amount of use and non-use value each respondent places on Water Services, the survey questionnaire included a raft of attitudinal questions. Respondents attitudes to protecting Yorkshire Water's land and water environments such as lakes, rivers, bathing waters, woodlands, and grasslands were evaluated via a series of questions including 'it is important to me because I like to visit for recreational purpose' (a 'use' value) and 'it is important to me because I want future generations to be able to enjoy them' (a non-use value). A composite score based on the combined responses to the 'use' statements was created as was a composite score of 'non-use' statements.

To test the extent to which these use and non-use composite scores impact on WTP estimate for each service level, the use and non-use variables were included as choice invariant variables within the Conditional Logit model.

Table 46: Conditional Logit model use and non-use choice invariant variables coefficients

	Non-use	Use
Water quality	0.118 (p=0.023)	0.394 (p=0.000)
Supply of Water	0.061(p=0.039)	0.551(p=0.020)
Sewerage services	0.070(p=0.036)	0.530(p=0.021)
Environment	0.170(p=0.000)	0.375(p=0.000)

Table 47: Conditional Logit model margin WTP divided into Use and non-use Values

Per +1 level increase based on Conditional Logit model	Marginal WTP	Use	Non–use
Poor water pressure	£0.75	£0.57	£0.17
Drinking water quality	£0.66	£0.50	£0.15
Taste, smell and colour of drinking water	£2.17	£1.67	£0.50
Unexpected supply interruption	£0.81	£0.73	£0.08
Leakage	£0.77	£0.70	£0.08
Water use restrictions	£0.31	£0.27	£0.03
Sewer flooding inside properties: number of incidents per year	£0.92	£0.81	£0.11
Sewer flooding outside properties: number of incidents per year	£0.56	£0.50	£0.07
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	£0.58	£0.51	£0.07
Number of bathing beaches meeting 'Good' or 'Excellent' standard	£0.40	£0.28	£0.13
Length of rivers in Yorkshire improved (%)	£1.11	£0.76	£0.35
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	£0.56	£0.38	£0.17
Area of land conserved or improved by Yorkshire Water	£0.56	£0.38	£0.17

'Non-use' WTP estimates are higher for the environment service areas than they are for the other water and sewerage services. Conversely, 'use' estimates are higher for the water and sewerage services.

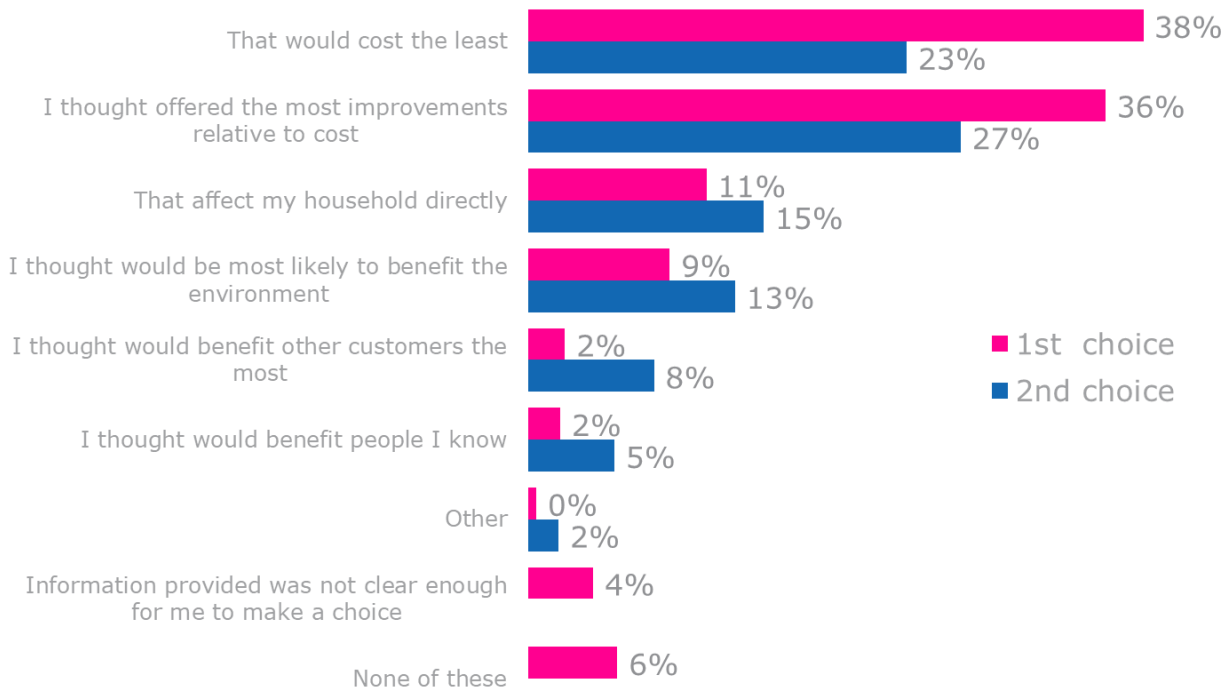
Validity of survey results

We conclude our analysis of the household survey with evidence on our validity checking.

After the choice experiment blocks, respondents were asked to select from a pre-coded list, which two statements (a first choice and a second choice) came closest to describing the rationale behind their choices. The chart below shows the overall decision-making choices of the household sample.

Figure 9: decision-making rationale

I chose the options…

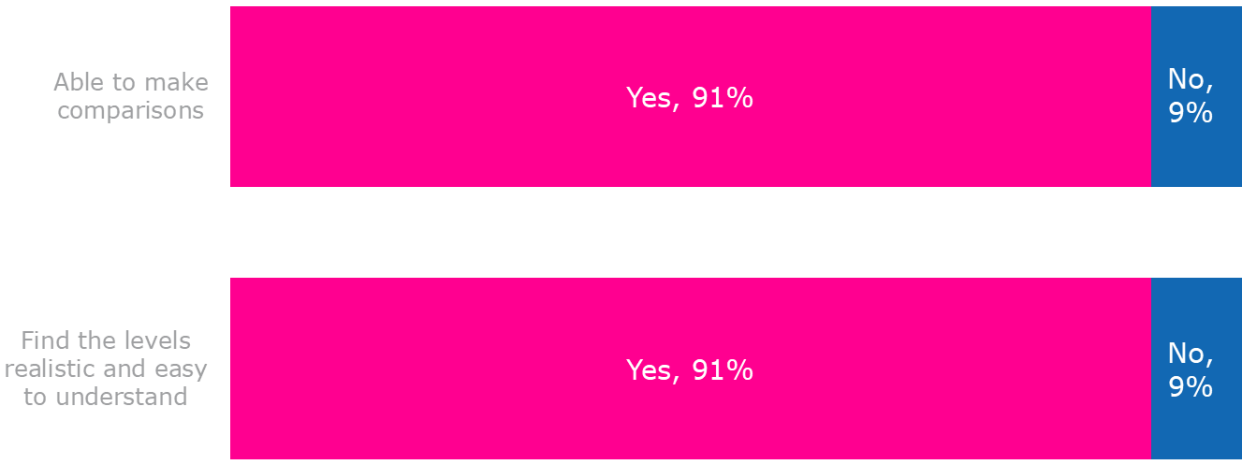


Base: all household respondents

Making choices based on realistic and easy to understand levels of service

To understand the extent to which respondents understood the choice experiments, and the extent to which they felt the levels of service (and associated costs) realistic, two questions were asked. Firstly, *'did you feel able to make comparisons between the choices I presented to you?'* and secondly, *'In the choices did you find each of the levels of service we described, realistic and easy to understand?'*.

Figure 10: ability to make comparisons, and the ease of understanding service levels



For both questions, just over 9 in 10 said they were able to make comparisons, and that the service levels were realistic and easy to understand.

The one in ten who said 'no' to each question were asked for the reason why. Answers were similar for both and centred around customers finding the information too much or too complicated:

> *"It was complicated to differentiate between all the choices and you just tend to not want prices to rise"*

> *"It was quite difficult to compare all the choices and decide the best option"*

> *"There were so many comparisons and so much information it started to cloud my mind"*

> *"I couldn't care less about the options and there was far too much information about things, I don't care about, homes affected by something or other"*

Ease of understanding is significantly higher than the levels of understanding reported in the PR14 exercise where 73.7% of respondents found the choice experiment tasks understandable.

Construct validity

In order to assess the construct validity, we interrogate the results in terms of how well they conform with our a priori expectations and uphold statistical theory.

The direction of signs of all of the coefficients observed in this study are consistent with our expectations. For example, Utility increases as water service levels increase and Utility decreases as bill impacts increase.

In terms of statistical validity, the models provide a good fit to the data. A pseudo-R^2 value of 0.12 is considered good for Conditional Logit models employing cross-sectional data (Breffle and Rowe, 2002), and many studies have reported lower pseudo-R^2 values. All the models presented display good model fit.

In addition, the results also conform to economic theory in terms of variables explaining choices.

Appendix 2 – results and findings, business

Introduction

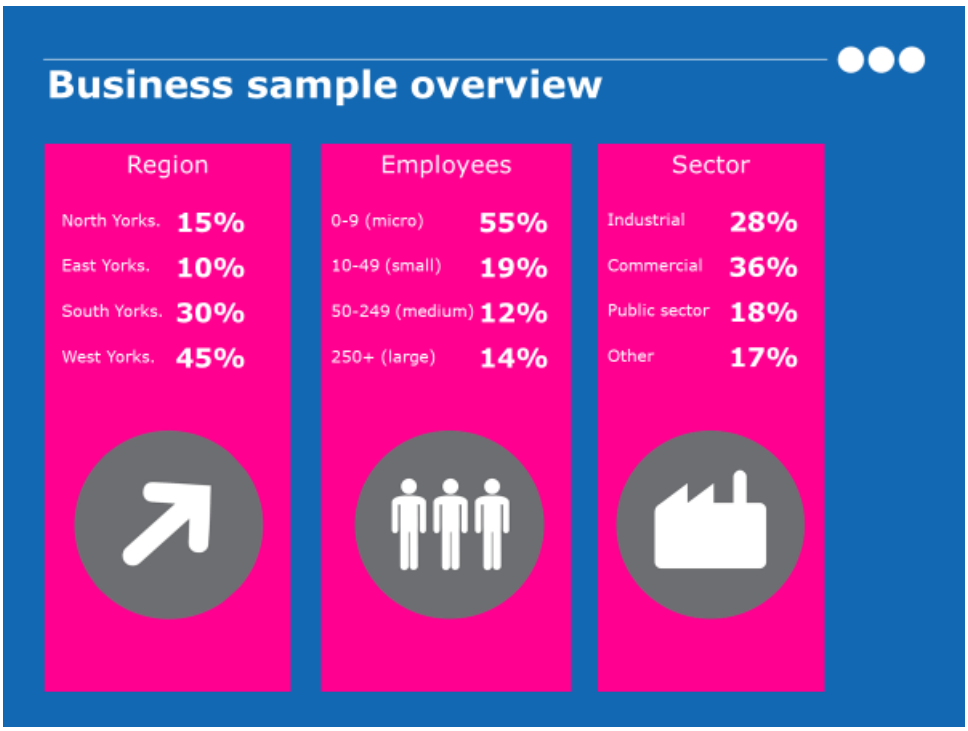
This section of the report presents the main findings from the Work Package 1 business survey. Target quotas were applied to region, sector and the number of employees to ensure a diverse sample of businesses were consulted.

A total of 542 interviews were conducted with business customers, with a split of 246 online interviews and 296 CAPI interviews.

Business respondent profile

The images below show a demographic sample overview of the businesses consulted during fieldwork.

Figure 11: Business sample



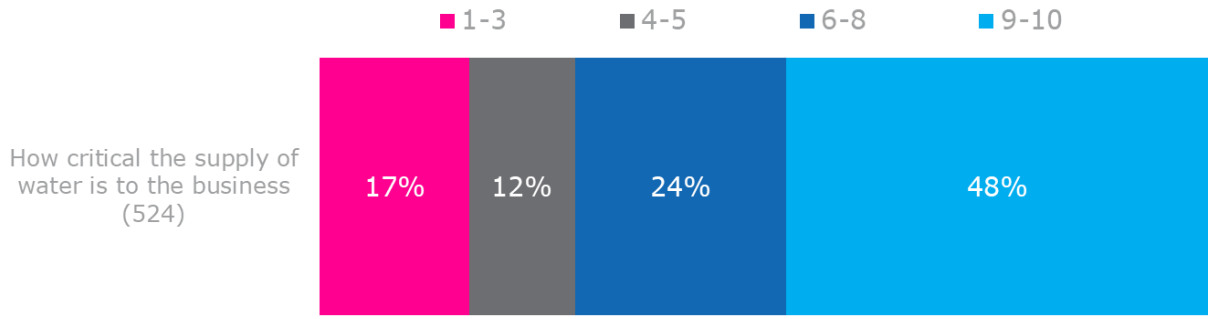
Sub-group analysis

The analysis section of this report includes data and analysis of various business customer groups. Firstly, sample groups as outlined above are analysed, and any differences in attitude or outcome are either presented in chart form, or discussed in the report commentary. In addition, a further set of business customers are analysed:

- Water critical nature of the business

All respondents were asked how critical the Supply of Water is to their business being able to operate. The chart below shows the breakdown of responses to this question:

Figure 12: criticalness of water supply to the business

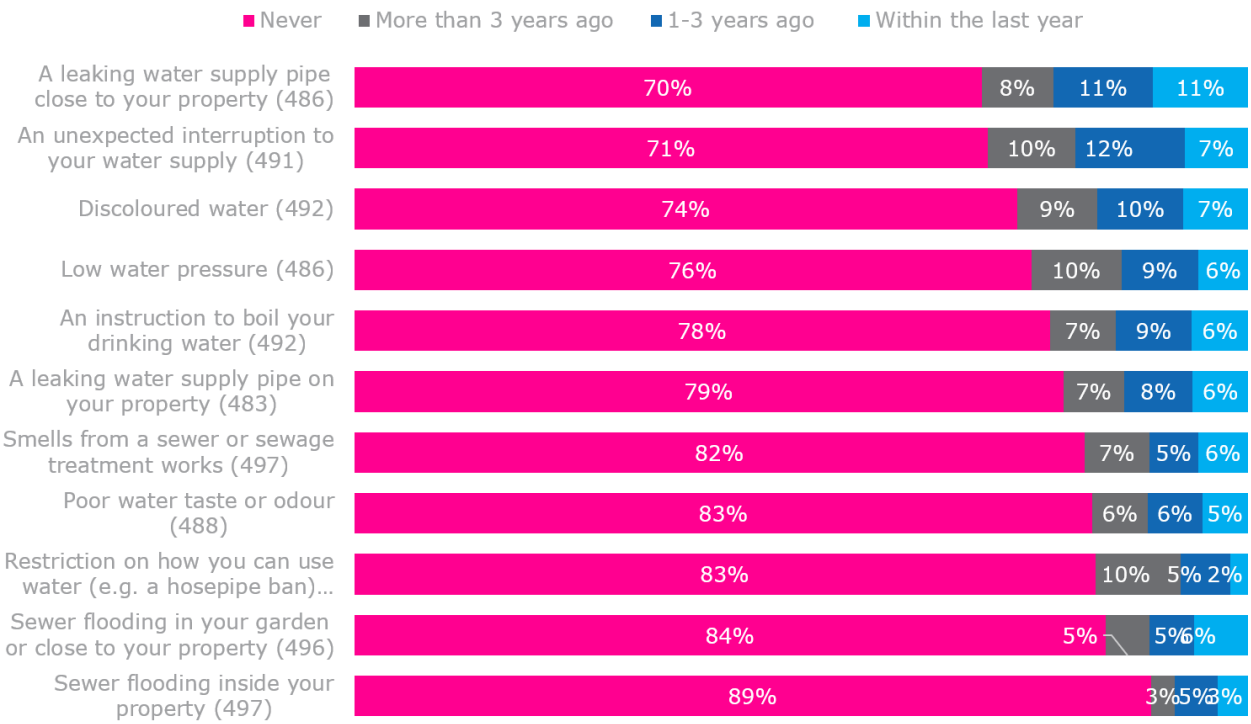


Base: all business customers, excluding don't know responses (as shown)

Service experiences

In order to include an additional layer of understanding to reactions in the stated preference exercises, respondents were asked whether their business had ever experienced any of the following service experiences in Yorkshire. The table below shows the proportion of respondents reporting having experienced each issue.

Figure 13: Service experiences



Base: all business respondents excluding don't know per issue (as shown)

Analysis and results

This section of the report contains analysis of the business Willingness to Pay (WTP), with a broad structure of the findings outlined as follows:

- Examination of the preference for the status quo
- Results from each model
- The final/preferred WTP table for each of the 4 CE blocks
- Results of the full-package CE
- The validity of the outcomes

The tables below summarise the choice behaviour observed with the business customer sample.

Table 48: Choice frequencies for business samples

	Status quo	Alternative 1	Alternative 2
Water quality	62%	18%	20%
Supply of Water	49%	25%	26%
Sewerage services	50%	26%	24%
Environment	46%	27%	27%

Table 49: Proportion of serial status quo choices and bill reduction option choices

	Always choose status quo	Always choose bill increases	Always choose bill reductions
Water quality	34%	19%	9%
Supply of Water	31%	17%	7%
Sewerage services	29%	15%	8%
Environment	29%	28%	5%

Table 48 shows that the status quo is selected at least half of the time for Water Quality and Sewerage services, and just under half of the time for Supply of Water and Environment - revealing a very high level of choice of the status quo option with two service area blocks. Environmental services have the largest deviation from the status quo.

Table 49, meanwhile, shows the percentage of respondents who always select the status quo (or increases or decreases) – showing that around a third of business

respondents consistently choose the status quo when given multiple choices. The remainder of respondents select different options across the CE sets within the blocks.

Block 1 - Water Quality

After extensive analysis of the data, three models were considered to describe the choice data obtained from the business customers. The first was a simple Conditional Logit model, while the other two were the Random Parameter Logit model and the Generalised Mixed Logit.

For the water quality choice set based on CE1, the Generalised Mixed Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2 = 0.16 (compared with 0.16 for the Random Parameter Logit model, and 0.14 for the Conditional Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures s (poor water pressure, drinking water quality and taste, smell and colour of drinking water); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 50 reports the results of all three models. The positive signs on the coefficients of the water quality in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were highly statistically significant at the 1% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choices (as noted earlier, a high level of preference for the status quo option exists).

Table 50: Models of Water Quality choice data

	Conditional Logit		Random Parameter Logit		Generalised Mixed Logit	
	Pseudo R^2	**0.14**	Pseudo R^2	**0.16**	Pseudo R^2	**0.16**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Poor water pressure: number of properties below standard pressure	0.15184	0.0000	0.1186	0.0000	0.178656	0.0000
Drinking water quality: the proportion of samples of tap water that will pass the DWI's (a government body) requirement for chemical & biological content	0.17285	0.0000	0.2283	0.0000	0.19979	0.0000
Taste, smell & colour of drinking water: total number of water quality contacts	0.55123	0.0000	0.532213	0.0000	0.511231	0.0000
Bill impact	-0.496582	0.0000	-0.31135	0.0000	-0.51123	0.0000
Status quo	0.50755	0.0000	0.58539	0.0000	0.586236	0.0000

The marginal WTP for a service level change in each service measure are presented in Table 51. Based on the Conditional Logit model, business customers were prepared to pay on average 0.2% more on their bill for each increase in drinking water quality service level. Table 51 also reports the 95% confidence intervals associated with marginal WTP for all three models.

The RPL model, which is linear, suggests that the average business customer is willing to pay an additional 0.72% for a single level increase in taste, smell and colour of drinking water.

Table 51: WTP results for water quality choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Poor water pressure	0.18%	0.10%	0.25%	0.14%	0.10%	0.17%	0.20%	0.13%	0.28%
Drinking water quality	0.20%	0.13%	0.27%	0.26%	0.19%	0.34%	0.23%	0.16%	0.30%
Taste, smell and colour of drinking water	0.64%	0.56%	0.72%	0.61%	0.55%	0.67%	0.58%	0.53%	0.63%

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However as previously suggested, utility increases at a decreasing rate as the service measure level improves. Such a non-linear utility function can be modelled with a non-linear function; but an alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model, or fixed effects model, was estimated using each of the three models used above. While the Generalised Mixed Logit and Random Parameter Logit models provide a better fit with the data they do not provide statistically significant coefficient values for a number of the service measure effects. Given that the purpose of this exercise is to estimate customer WTP for improvements in service measure levels it was decided to base the following discussion on the Conditional Logit model (see Table 52), where most coefficient values are significant and capable of meaningful interpretation.

In this model most coefficients change monotonically: for example, drinking water quality(L-2) < drinking water quality(L-1) < drinking water quality(L+1) < drinking water quality(L+2).

Table 52: Non-Linear Conditional Logit model for Water Quality

	Pseudo R^2	0.15			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Poor water pressure (L-2)	-0.51304	0.000	-0.52%	-0.71%	-0.33%
Poor water pressure (L-1)	-0.19924	0.115	-0.20%	-0.45%	0.05%
Poor water pressure (L+1)	0.198653	0.000	0.20%	0.12%	0.28%
Poor water pressure (L+2)	0.265986	0.000	0.27%	0.21%	0.32%
Poor water pressure (L+3)	0.28465	0.000	0.29%	0.23%	0.35%
Drinking water quality (L-2)	-0.68317	0.000	-0.69%	-0.96%	-0.42%
Drinking water quality (L-1)	-0.37391	0.006	-0.38%	-0.61%	-0.15%
Drinking water quality (L+1)	0.25903	0.051	0.26%	0.16%	0.37%
Drinking water quality (L+2)	0.3665	0.000	0.37%	0.28%	0.46%
Drinking water quality (L+3)	0.3907	0.001	0.40%	0.29%	0.51%
Taste, smell and colour of drinking water (L-2)	-0.90374	0.001	-0.92%	-1.07%	-0.76%
Taste, smell and colour of drinking water (L-1)	-0.42005	0.000	-0.43%	-0.52%	-0.33%
Taste, smell and colour of drinking water (L+1)	0.56083	0.0009	0.57%	0.47%	0.67%
Taste, smell and colour of drinking water (L+2)	1.19731	0.0000	1.21%	0.96%	1.47%
Taste, smell and colour of drinking water (L+3)	1.3929	0.0000	1.41%	1.23%	1.59%
Bill impact	-0.32155	0.0000			

The results of the fixed effects model indicate that the average business customer would be prepared to pay a +0.37% increase on their water bill to increase drinking water quality level from the status quo to level +2. The average customer would be willing to accept a decrease in taste, smell and colour of drinking water to level -1 for a bill reduction of -0.43% per year.

Overall, the fixed effect model for Water Quality indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 2 – Supply of Water

Again, the 3 models were applied to the data relating to CE2, Supply of Water.

For the Supply of Water choice set based on CE2, the Random Parameter Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2 = 0.25 (compared with 0.21 for the Generalised Mixed Logit model, and 0.22 for the Conditional Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures s (unexpected supply interruption, leakage and water use restrictions); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 53 reports the results of all three models. The positive signs on the coefficients of the Supply of Water in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choices (as noted earlier, a high level of preference for the status quo option exists).

Table 53: Models of Supply of Water choice data

	Conditional Logit		**Random Parameter Logit**		**Generalised Mixed Logit**	
	Pseudo R^2	**0.22**	Pseudo R^2	**0.25**	Pseudo R^2	**0.21**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Unexpected supply interruption of 3–6 hours: total properties affected	0.42834	0.0000	0.39569	0.0000	0.456554	0.0000
Leakage	0.40739	0.0000	0.454667	0.0000	0.485652	0.0000
Water use restrictions e.g. hose pipe ban	0.14506	0.0000	0.17344	0.0338	0.123357	0.0000
Bill impact	-0.26257	0.0000	-0.25292	0.02825	-0.26684	0.0000
Status quo	0.28764	0.0155	0.25963	0.0006	0.33237	0.00012

The marginal WTP for a service level change in each service measure are presented in Table 54. Based on the Conditional Logit model, business customers were prepared to pay on average +0.24% more on their bill for each increase in the unexpected service interruption level. Table 54 also reports the 95% confidence intervals associated with marginal WTP for all three models.

Table 54: WTP results for Supply of Water choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Unexpected supply interruption of 3–6 hours: total properties affected	0.24%	0.21%	0.28%	0.21%	0.18%	0.24%	0.22%	0.20%	0.24%
Leakage	0.20%	0.17%	0.24%	0.25%	0.19%	0.30%	0.21%	0.18%	0.25%
Water use restrictions e.g. hose pipe ban	0.08%	0.04%	0.11%	0.06%	0.04%	0.09%	0.09%	0.05%	0.12%

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit model (see Table 55), where most coefficient values are significant and capable of meaningful interpretation.

Table 55: Non-Linear Conditional Logit model for Supply of Water

	Pseudo R^2	0.24			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Unexpected supply interruption of 3–6 hours: total properties affected (L-2)	-0.71762	0.000	-0.37%	-0.49%	-0.25%
Unexpected supply interruption of 3–6 hours: total properties affected (L-1)	-0.45257	0.000	-0.23%	-0.35%	-0.11%
Unexpected supply interruption of 3–6 hours: total properties affected (L+1)	0.21534	0.040	0.11%	0.05%	0.17%
Unexpected supply interruption of 3–6 hours: total properties affected (L+2)	0.49483	0.000	0.26%	0.17%	0.34%
Unexpected supply interruption of 3–6 hours: total properties affected (L+3)	0.5411	0.000	0.28%	0.18%	0.38%
Leakage (L-2)	-0.81375	0.000	-0.42%	-0.56%	-0.28%
Leakage (L-1)	-0.71435	0.000	-0.37%	-0.49%	-0.25%
Leakage (L+1)	0.25838	0.017	0.13%	0.06%	0.20%
Leakage (L+2)	0.4681	0.018	0.24%	0.19%	0.30%
Leakage (L+3)	0.4953	0.021	0.26%	0.20%	0.32%
Water use restrictions e.g. hose pipe ban (L-2)	-0.34481	0.002	-0.18%	-0.29%	-0.07%
Water use restrictions e.g. hose pipe ban (L-1)	-0.10585	0.018	-0.05%	-0.10%	-0.01%

Water use restrictions e.g. hose pipe ban (L+1)	0.16195	0.022	0.08%	0.05%	0.12%
Water use restrictions e.g. hose pipe ban (L+2)	0.2873	0.015	0.15%	0.09%	0.21%
Water use restrictions e.g. hose pipe ban (L+3)	0.4012	0.013	0.21%	0.14%	0.28%
Bill impact	-0.36591	0.000			

The results of the fixed effects model indicate that the average business customer would be prepared to pay a +0.24% increase on their water bill to increase leakage level from the status quo to level +2. The average customer would be willing to accept a decrease in leakage to level -1 for a bill reduction of -0.37% per year.

Overall, the fixed effect model for Supply of Water indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 3 – Sewerage Services

Again, the 3 models were applied to the data relating to CE3, sewerage services.

For the sewerage services choice set based on CE3, the Conditional Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2 = 0.23 (compared with 0.21 for the Generalised Mixed Logit model, and 0.21 for the Random Parameter Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures (sewer flooding inside properties; number of incidents per year, sewer flooding outside properties; number of incidents per year and properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 56 reports the results of all three models. The positive signs on the coefficients of the sewerage services in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choice.

Table 56: Models of Sewerage Services choice data

	Conditional Logit		Random Parameter Logit		Generalised Mixed Logit	
	Pseudo R^2	**0.23**	Pseudo R^2	**0.21**	Pseudo R^2	**0.21**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Sewer flooding inside properties: number of incidents per year	0.44571	0.0000	0.39687	0.0000	0.468798	0.0000
Sewer flooding outside properties: number of incidents per year	0.19914	0.0000	0.14827	0.0000	0.213569	0.0000
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	0.21424	0.0000	0.20819	0.0000	0.221312	0.0000
Bill impact	-0.85406	0.0000	-0.72337	0.0000	-0.80002	0.0000
Status quo	0.23	0.0000	0.22044	0.0000	0.24569	0.0000

The marginal WTP for a service level change in each service measure are presented in Table 57. Based on the Conditional Logit model, business customers were prepared to pay on average +0.29% more on their bill for each increase in sewer flooding inside properties; number of incidents per year service level. Table 57 also reports the 95% confidence intervals associated with marginal WTP for all three models.

The Random Parameter Logit model suggests that the average business customer is willing to pay an additional +£0.52 for a level increase in properties subjected to

chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year.

Table 57: WTP results for sewerage services choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Sewer flooding inside properties; number of incidents per year	0.29%	0.27%	0.31%	0.30%	0.26%	0.33%	0.29%	0.25%	0.33%
Sewer flooding outside properties; number of incidents per year	0.13%	0.10%	0.16%	0.11%	0.07%	0.15%	0.13%	0.11%	0.16%
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	0.14%	0.11%	0.17%	0.15%	0.12%	0.19%	0.14%	0.11%	0.16%

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However, the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit model (see Table 58), where most coefficient values are significant and capable of meaningful interpretation.

Table 58: Non-Linear Conditional Logit model for sewerage services

	Pseudo R^2	0.15			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Sewer flooding inside properties; number of incidents per year (L-2)	-0.79644	0.000	-0.45%	-0.58%	-0.32%
Sewer flooding inside properties; number of incidents per year (L-1)	-0.50168	0.000	-0.28%	-0.41%	-0.15%
Sewer flooding inside properties; number of incidents per year (L+1)	0.21766	0.000	0.12%	0.07%	0.17%
Sewer flooding inside properties; number of incidents per year (L+2)	0.46589	0.000	0.26%	0.18%	0.34%
Sewer flooding inside properties; number of incidents per year (L+3)	0.6012	0.000	0.34%	0.25%	0.43%
Sewer flooding outside properties; number of incidents per year (L-2)	-0.35074	0.005	-0.20%	-0.33%	-0.06%
Sewer flooding outside properties; number of incidents per year (L-1)	-0.21781	0.059	-0.12%	-0.25%	0.00%
Sewer flooding outside properties; number of incidents per year (L+1)	0.205264	0.000	0.12%	0.10%	0.13%

Sewer flooding outside properties; number of incidents per year (L+2)	0.35074	0.000	0.20%	0.17%	0.23%
Sewer flooding outside properties; number of incidents per year (L+3)	0.3798	0.000	0.21%	0.17%	0.25%
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L-2)	-0.39677	0.003	-0.22%	-0.34%	-0.11%
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L-1)	-0.15008	0.027	-0.08%	-0.08%	-0.09%
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+1)	0.20546	0.036	0.12%	0.07%	0.16%
Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+2)	0.44463	0.000	0.25%	0.12%	0.38%
Properties subjected to chronic (seasonal)	0.5146	0.000	0.29%	0.20%	0.38%

unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year (L+3)					
Bill impact	-0.41017	0.000			

The results of the fixed effects model indicate that the average business customer would be prepared to pay a +0.26% increase on their water bill to increase sewer flooding inside properties; number of incidents per year level from the status quo to level +2. The average customer would be willing to accept a decrease in properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works to level -1 for a bill reduction of -0.08% per year.

Overall, the fixed effect model for sewerage services indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Block 4 – Environment

For the environment choice set based on CE4, the Conditional Logit model performed best in terms of goodness-of-fit to the data with a Pseudo R^2 = 0.21 (compared with 0.19 for the Generalised Mixed Logit model, and 0.20 for the Random Parameter Logit model). In the Random Parameter Logit model, tastes were assumed to be normally distributed with respect to the service measures s (number of bathing beaches meeting 'Good' or 'Excellent' standard, length of rivers in Yorkshire improved (%), category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area, and area of land conserved or improved by Yorkshire Water); but the bill coefficient was assumed to be fixed, as was the status quo coefficient.

Table 59 reports the results of all three models. The positive signs on the coefficients of the environment in the models conformed to prior expectations, i.e. as the service level increases, so the probability of choice increases. All of the coefficients were statistically significant at the 5% level. The coefficient for the status quo choice is positive and statistically significant suggesting that the presence of the status quo option was a significant factor in respondent choice.

Table 59: Models of Environment choice data

	Conditional Logit		Random Parameter Logit		Generalised Mixed Logit	
	Pseudo R^2	**0.21**	Pseudo R^2	**0.20**	Pseudo R^2	**0.19**
	Coefficient	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**	**Coefficient**	**Prob.|z|>Z**
Number of bathing beaches meeting 'Good' or 'Excellent' standard	0.16619	0.0000	0.131222	0.0000	0.189756	0.0000
Length of rivers in Yorkshire improved (%)	0.45885	0.0000	0.44395	0.0013	0.42316	0.0000
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	0.22186	0.0000	0.21825	0.0000	0.213569	0.0000
Area of land conserved or improved by Yorkshire Water	0.12092	0.0000	0.20951	0.0365	0.132695	0.0000
Bill impact	-0.17756	0.0000	-0.30226	0.0018	-0.18988	0.0000
Status quo	0.1787	0.0029	0.1702	0.00512	0.199898	0.0000

The marginal WTP for a service level change in each service measure are presented in Table 60 Based on the Conditional Logit model, business customers were prepared to pay on average +0.39% more on their bill for each increase in length of rivers in Yorkshire improved (%) service level. Table 60 also reports the 95% confidence intervals associated with marginal WTP for all three models.

Table 60: WTP results for environment choice data

	Conditional Logit			Random Parameter Logit			Generalised Mixed Logit		
	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL	Marginal WTP	95% LL	95%UL
Number of bathing beaches meeting 'Good' or 'Excellent' standard	0.14%	0.09%	0.19%	0.15%	0.10%	0.20%	0.16%	0.10%	0.22%
Length of rivers in Yorkshire improved (%)	0.39%	0.33%	0.44%	0.35%	0.29%	0.41%	0.36%	0.32%	0.40%
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	0.19%	0.14%	0.24%	0.21%	0.14%	0.27%	0.18%	0.14%	0.22%
Area of land conserved or improved by Yorkshire Water	0.10%	0.06%	0.15%	0.11%	0.07%	0.14%	0.11%	0.06%	0.16%

All three of the models reported above imply that there is a linear relationship between WTP and the level of service they receive. However, the alternative is to model the non-linear relationship through a piecewise regression model (i.e. a fixed effects model). A non-linear utility change model or fixed effects model is therefore used to assess whether a non-linear relationship holds for service improvements and service reductions.

The non-linear utility change model is again based on the Conditional Logit model (see Table 61), where most coefficient values are significant and capable of meaningful interpretation.

Table 61: Non-Linear Conditional Logit model for environment

	Pseudo R^2	0.23			
Observations = 9180	**Coefficient**	**Prob.|z|>Z**	**Marginal WTP**	**95% LL**	**95%UL**
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L-2)	-0.4475	0.000	-0.36%	-0.54%	-0.19%
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L-1)	-0.2112	0.000	-0.17%	-0.32%	-0.03%
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+1)	0.1632	0.022	0.13%	0.08%	0.19%
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+2)	0.19526	0.000	0.16%	0.10%	0.22%
Number of bathing beaches meeting 'Good' or 'Excellent' standard (L+3)	0.2612	0.000	0.21%	0.14%	0.28%
Length of rivers in Yorkshire improved (%) (L-2)	-0.88092	0.000	-0.72%	-0.60%	-0.83%
Length of rivers in Yorkshire improved (%) (L-1)	-0.42666	0.001	-0.35%	-0.54%	-0.15%
Length of rivers in Yorkshire improved (%) (L+1)	0.49391	0.017	0.40%	0.27%	0.53%
Length of rivers in Yorkshire improved (%) (L+2)	0.89268	0.011	0.73%	0.57%	0.88%
Length of rivers in Yorkshire improved (%) (L+3)	0.9031	0.000	0.74%	0.58%	0.90%
Category 3 pollution incident: a minor incident that has a minimal impact	-0.50342	0.000	-0.41%	-0.63%	-0.19%

on the quality of water in the area (L-2)					
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L-1)	-0.2775	0.032	-0.23%	-0.26%	-0.19%
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+1)	0.2042	0.008	0.17%	0.11%	0.22%
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+2)	0.4053	0.002	0.33%	0.22%	0.44%
Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area (L+3)	0.5542	0.000	0.45%	0.36%	0.54%
Area of land conserved or improved by Yorkshire Water (L-2)	-0.35701	0.003	-0.29%	-0.48%	-0.10%
Area of land conserved or improved by Yorkshire Water (L-1)	-0.28461	0.002	-0.23%	-0.29%	-0.17%
Area of land conserved or improved by Yorkshire Water (L+1)	0.0836	0.050	0.07%	0.00%	0.13%
Area of land conserved or improved by Yorkshire Water (L+2)	0.12791	0.030	0.10%	0.05%	0.15%
Area of land conserved or improved by	0.1295	0.045	0.11%	0.05%	0.17%

Yorkshire Water (L+3)					
Bill impact	-0.27049	0.000		-	

The results of the fixed effects model indicate that the average business customer would be prepared to pay a +0.73% increase on their water bill to increase length of rivers in Yorkshire improved (%) level from the status quo to level +2. The average customer would be willing to accept a decrease in area of land conserved or improved by Yorkshire Water to level -1 for a bill reduction of 0.23% per year.

Overall, the fixed effect model for environment indicates that there is diminishing marginal utility for improvements in some service measure levels; and also, asymmetry between WTP for improvements in service levels and WTA (compensation or bill reductions) for a lower level of service. This suggests the non-linear approach is superior to the linear assumptions of the previous models.

Willingness to Pay estimates

The final WTP and WTA based on the non-linear model estimates for business customers are summarised in table 62. In almost all of the service level areas considered, the level of WTA is greater than the level of WTP for the greatest service decrease or increase.

Table 62: WTP and WTA estimates – all levels Business Customers

Service area	Service level attribute	Willingness to Pay			
		Reduction in service	Improvement in service		
		-1	+1	+2	+3
Water quality	Poor water pressure: number of properties below standard pressure	-0.20%	0.20%	0.27%	0.29%
	Drinking water quality: the proportion of samples of tap water that will pass the DWI's (a government body) requirement for chemical & biological content	-0.38%	0.26%	0.37%	0.40%
	Taste, smell & colour of drinking water: total number of water quality contacts	-0.43%	0.57%	1.21%	1.41%
Supply of Water	Unexpected supply interruption of 3–6 hours: total properties affected	-0.23%	0.11%	0.26%	0.28%
	Leakage	-0.37%	0.13%	0.24%	0.26%
	Water use restrictions e.g. hose pipe ban	-0.05%	0.08%	0.15%	0.21%
Sewerage services	Sewer flooding inside properties: number of incidents per year	-0.28%	0.12%	0.26%	0.34%
	Sewer flooding outside properties: number of incidents per year	-0.12%	0.12%	0.20%	0.21%
	Properties subjected to chronic (seasonal) unbearable smells from sewers & treatment works: complaints to Yorkshire Water per year	-0.08%	0.12%	0.25%	0.29%
Environment	Number of bathing beaches meeting 'Good' or 'Excellent' standard	-0.17%	0.13%	0.16%	0.21%
	Length of rivers in Yorkshire improved (%)	-0.35%	0.40%	0.73%	0.74%

	Category 3 pollution incident: a minor incident that has a minimal impact on the quality of water in the area	-0.23%	0.17%	0.33%	0.45%
	Area of land conserved or improved by Yorkshire Water	-0.23%	0.07%	0.10%	0.11%

Full package CE

In the final choice experiment, CE5, respondents were presented with the full package of 13 service levels shown at highest levels of service (L+2) at a range of bill impacts for the total package (7%, 12%, 16%, 20%, 25%, 30%).

The level of acceptance declines at each increased water bill impact. In each case, the status quo is preferred to the alternative scenario.

Table 63: CE5 choice by scenario at each bill impact - Business

	Alternative scenario (L+2)	Status quo – no bill impact
7%	43.8%	56.3%
12%	33.0%	67.0%
16%	34.7%	65.3%
20%	27.6%	72.4%
25%	24.1%	75.9%
30%	24.2%	75.8%

Content validity

Following the series of choice experiments, respondents were asked to offer reasons for the way they had made their selections. The most frequently mentioned reasons for choice was 'least cost to business' which was mentioned by 53% of respondents. This was closely followed by 'offers the most improvements relative to cost' with 46% of respondents reporting this was a reason behind their choice.

15% of business respondents mentioned their choices were altruistic and would benefit other customers. Only 24 respondents (4% of the sample) mentioned that they felt the information presented to them was not clear enough to make their choice.

Table 64: Motivations for choice in the CEs

Reasons for choice	%
I chose the options that would cost the least to the business	53%
I chose the options which I thought offered the most improvements relative to cost	46%
I chose improvements that I thought would be most likely to benefit the environment	25%
I chose the options that affect or are most likely to affect my business directly	25%
I chose the options that I thought would benefit people and businesses I know	21%
I chose the options that I thought would benefit others the most	15%
The information provided was not clear enough for me to make a choice	4%

In addition, two further questions relating to how well they felt they could make choices in the experiment and how realistic they found the scenarios presented to them. The levels of ease of understanding amongst business customers is higher than the levels reported in PR14 where 70.8% of business customers reported that the choice experiment task was easy to understand.

Did you feel able to make comparisons between the choices I presented to you?

Reasons for choice	%
Yes	91%
No	9%

In the choices, did you find each of the levels of service we described, realistic and easy to understand?

Levels were realistic and easy to understand	%
Yes	90%
No	10%

The one in ten who said 'no' to each question were asked for the reason why. Answers were similar for both and centred around business customers finding the information too complicated or too little variation between the options:

"I didn't feel there were much between the options to justify the increases"

"Of necessity in a survey like this, the level of detail is quite low

"It wasn't very clear what the differences actually were."

"Quite a few ... I had to really concentrate"

Construct validity

In order to assess the construct validity, we interrogate the results in terms of how well they conform with our a priori expectations and uphold statistical theory.

The direction of signs of all of the coefficients observed in this study are consistent with our expectations. For example, Utility increases as water service levels increase and Utility decreases as bill impacts increase.

In terms of statistical validity, the models provide a good fit to the data. A pseudo-R^2 value of 0.12 is considered good for Conditional Logit models employing cross-sectional data (Breffle and Rowe, 2002), and many studies have reported lower pseudo-R^2 values. All the models presented display good model fit.

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