Artesia Consulting

South Staffs Water

Non - household demand forecast for South Staffs Water WRMP19

Final report

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Author(s):	**Cristina Munilla Frances**
	Sarah Rogerson
	Rob Lawson

Any enquiries relating to this report should be referred to the authors at the following address:

Artesia Consulting Ltd, Unit 2 Badminton Court, Yate, Station Road, Bristol, BS37 5HZ.

Telephone: + 44 (0) 1454 320091

Website: www.artesia-consulting.co.uk

Executive Summary

The aim of this project is to develop a non-household demand forecast for the South Staffs Water region, to be included in the Water Resources Management Plan 2019 (WRMP19), which will provide annual estimates of the non-household demand for water up to 2044/45.

The forecasts presented in this report are either based on historic trends of actual consumption (either reported or measured), or use forecasts of explanatory variables such as population, unemployment and productivity to estimate future non-household consumption.

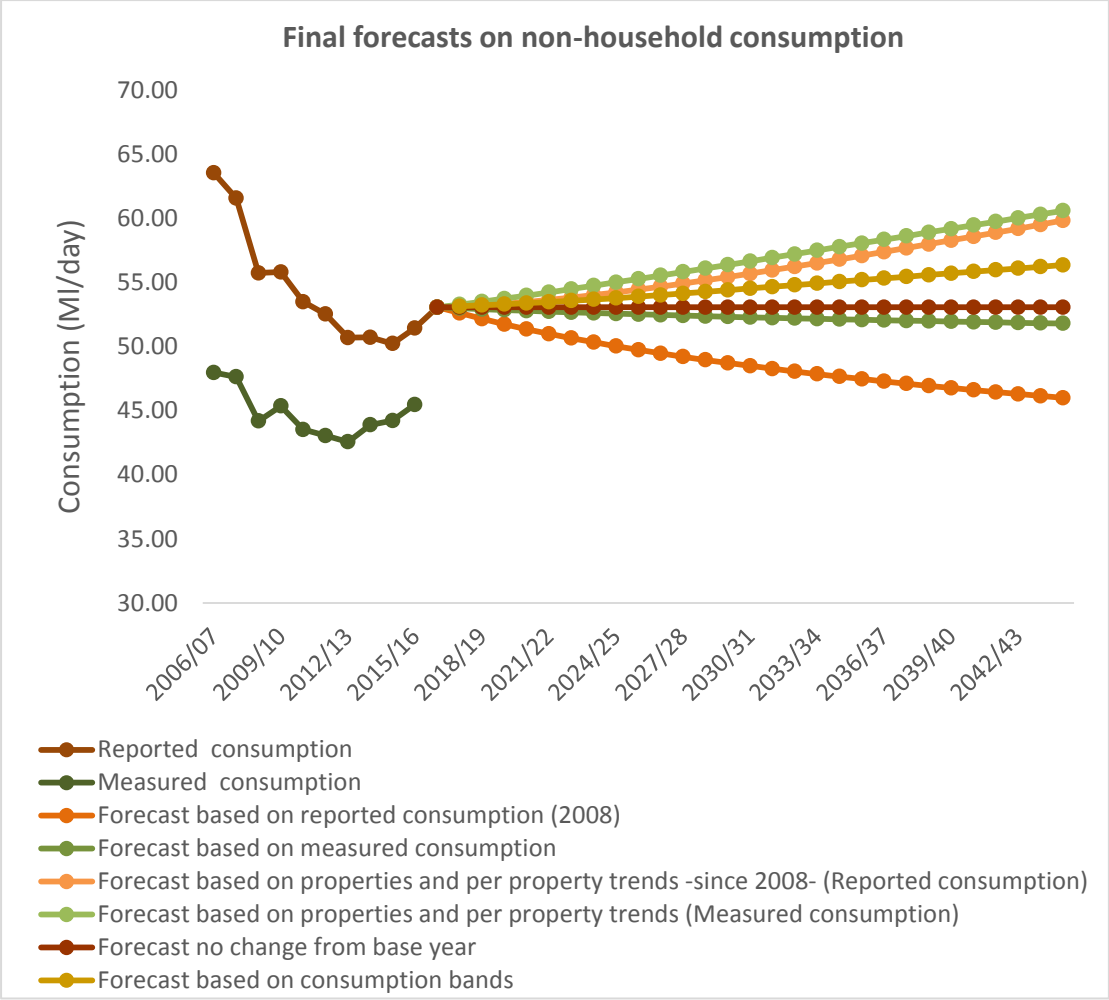
The analysis of total non-household consumption trends did not display strong relationships with economic factors. Likewise, results at lower levels (by industry and consumption band), showed few significant relationships and were mostly reverted to trends.

Analysis by rates of per property consumption did show a general expected increase in consumption, which is mainly driven by property numbers.

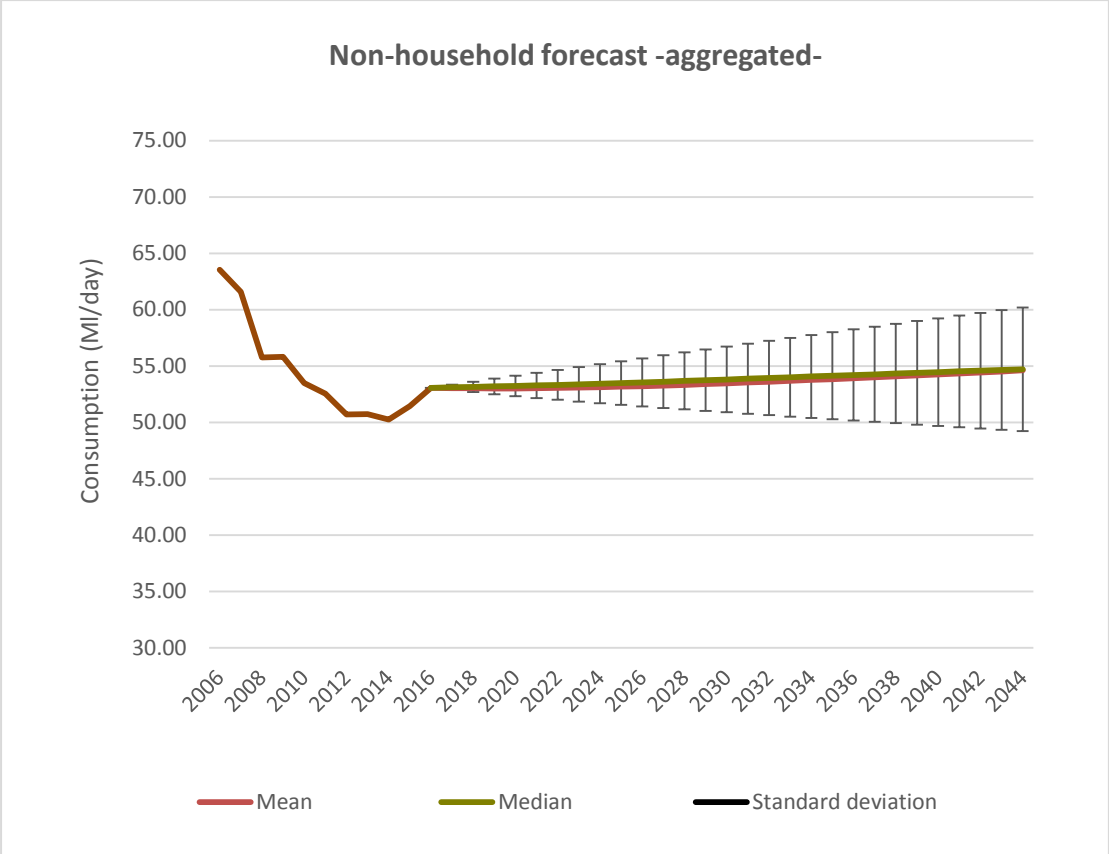
With regards to the consumption band analysis, there is a general expected increase in consumption, which is mainly driven by the numbers of properties that consume relatively small volumes of water. This trend for smaller non-households (in terms of water use) overcomes the trend for non-households which consume moderate to large volumes of water which are generally decreasing in number (with the exception of one specific band) and showing decreasing trends in overall consumption.

Analysis by industry type did not show a significant relationship with economic factors, and most industry forecasts were reverted to trends. In addition, analysis revealed uncertainties in the way the codes were assigned to individual properties and therefore this approach was not used in the forecast.

The figure below presents the forecasts that have been produced in this analysis.



These forecasts have been used to derive mean and median forecasts with an uncertainty range based on standard deviation of the range in forecasts, using simple statistical methods, as illustrated below.



These results are also presented in the table below.

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Mean	53.02	53.12	53.40	53.76	54.17	54.62
Median	53.19	53.43	54.74	54.07	54.40	54.72
Standard deviation	0.69	1.74	2.72	3.67	4.59	5.49

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1 Introduction

The aim of this project is to develop a non-household demand forecast for the South Staffs Water region, to be included in the Water Resources Management Plan 2019 (WRMP19), which will provide annual estimates of the non-household demand for water up to 2044/45.

The forecasts presented in this report are either trend-based, using historic consumption data or use forecasts of explanatory variables such as population, unemployment and productivity to estimate future non-household consumption. Other forecasting approaches may be possible for specific categories of non-households (e.g. using non-household population), however the methods used in this study are applicable to all property types and are considered appropriate for the proportion of non-household consumption in the South Staffs Water region.

These results are based on available regional data from South Staffs Water and national economic forecasts. As such the forecasts presented in this report do not include any judgements or assumptions on what may, or may not happen in the future, and do not include qualitative observations, for example related to future types of non-household growth or levels of water efficiency.

Section 2 describes the data used and methodology for forecasting. Section 3 presents the results of the forecasting based on several different approaches. Section 4 summarises the results of the analysis including an average and uncertainty range based on the forecasts derived in this study.

2 Methodology

2.1 Description of analysis

Two main types of trend analysis have been conducted in this project. The first set of analyses look at overall trends in historic data for total non-household consumption using two different sets of data. The first data set of reported annual figures for metered non-household consumption have been analysed, using data from 1992/93 to 2016/17. The second data set is measured non-household consumption, from actual metered consumption for the period 1992/93 to 2015/16.

The trend analysis of consumption in all non-household properties using these two data sets will be referred to as **reported trend** and **measured trend** respectively. The reported figures for non-household consumption will include adjustments for meter under registration (MUR) and supply-pipe losses (SPL)[1].

[1] Both these adjustments are made to the measured data using expert judgement in order to account for two key issues. 1) the fact that over time, meters measuring water supplied to properties tend to record less water flow than actually occurs. Current estimates of non-household MUR in Cambridge region is 4 percent. Total reported non-household consumption (at the company level) adds this percentage on to measured consumption to account for MUR. 2) Leakage in supply pipes. These pipes are usually located between a customer's meter and the property itself. Total reported non-

The second main type of analysis focuses on more in-depth analysis of measured data by analysing trends in groups of non-household properties that consume different amounts of water (consumption bands) and by examining trends in different types of non-household property (based on standard industry codes). Trends were produced and compared; and consumption data was tested against economic factors which included: population, unemployment rates, Gross Domestic Product (GDP) and growth.

The economic factors to complete the study are publicly available for the full forecasting period and have been obtained from the ONS website[2] and Knoema website[3].

Figure 1 summarises the analytical methods described above.

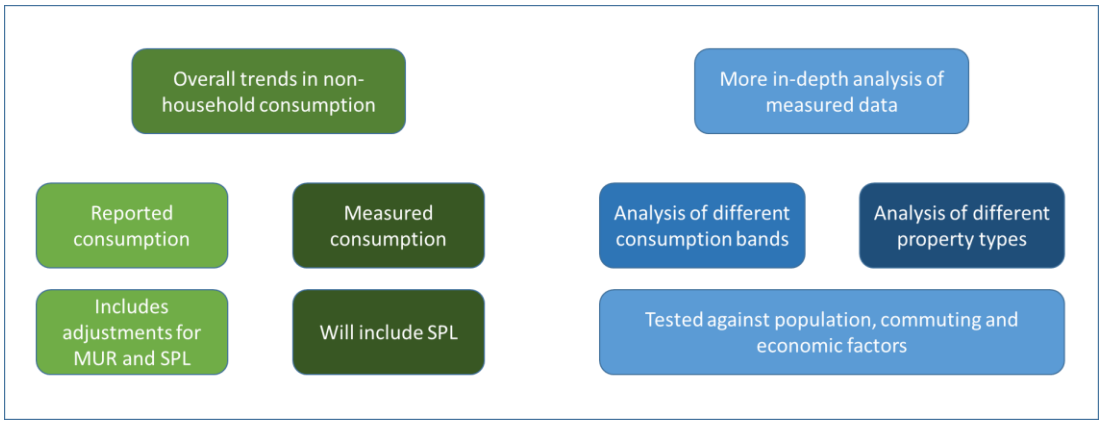

Figure 1 Summary of analyses conducted in this study

2.2 Data sources and data quality

For this analysis, two datasets have been used:

- A data set containing billed reported metered non-HH consumption covering the period: 1992/93 to 2016/17. This set has been used to produce a high level trend analysis which is further specified in section 3.1.

- A second set containing measured data for metered non-household consumption since 1992/93. Data prior to 2001/02 was removed from the analysis, as the processing time and computing cost of the whole data set proved to be exceptionally high. On the other hand, initial trials showed that the benefits of using the entire data set didn't translate into better performance.

- It is interesting to analyse consumption from a property numbers perspective. To that effect, the measured set was used to define properties by its address. It is worth noting that in some cases, properties with more than one meter, also presented different industry codes. In these cases, and in order to avoid giving

household consumption (at the company level) subtracts an estimate of total SPL from measured consumption to account for SPL. Therefore total measured non-household consumption will include supply pipe losses.

[2] https://www.ons.gov.uk/

[3] https://knoema.com/

greater weigh to a particular industry code, properties were defined by address and meter. For instance, “Address A”, would generally be defined as “Property A”. Nonetheless, where “Meter 1” was classified as Agricultural and “Meter 2” as Engineer, the property was split into two: “Property A1” and “Property A2”.

2.3 General comments

2.3.1 Retail competition

With the recent changes to the water market, which came in to effect on 1 April 2017, most businesses and organisations in England can now choose which company they want to supply their retail water services. Eligible businesses, charities and public sector customers are no longer restricted to buying retail water services from their regional water company. Instead, they are now free to choose their water retailer[4]. Cambridge Water has an increasing number of retailers who now deal directly with non-household customers.

There is an expectation (from regulators and government) that retail competition will lead to water efficiency in the non-household sector. In addition, the duty to promote the efficient use of water remains with the wholesale water company (i.e. Cambridge Water in this case) and the WRMP requires each water company to plan for water efficiency in its forecasts of non-household demand.

Each retailer has been asked for a policy statement describing its water efficiency strategy in an effort to incorporate third party initiatives within the consumption forecasts. However, there are no data to support this at present. In addition the analysis of historic trend will not capture any likely changes in consumption resulting from retail competition. Therefore the forecasts presented in this study do not take account of any future water efficiency but will reflect efficiencies achieved over the past 10-15 years.

Retail competition has required a careful review of the classification of properties as households / non-households. This split is considered to be accurate for the analysis presented here, particularly as the allocations have been reviewed recently by South Staffordshire Water.

2.3.2 Links with household consumption

Non-household forecasts are not explicitly related to household forecasts, however the more in-depth analysis will assess if there are any relationships between trends in consumption rates and population. This will be highlighted in the results section where relevant.

[4] http://www.open-water.org.uk/

3 Results

The following sections present:

- Analysis of the overall trends in total non-household consumption (section 3.1);
- Analysis of the trends in non-household consumption based on groups of non-household properties that consume different amounts of water – or consumption bands (section 3.2); and
- Analysis of the trends in non-household consumption by industry type (section 3.3).

Two high level trends in non-HH demand (section 3.1) were produced using reported and measured consumption. Analysis on consumption bands (section 3.2) and industry code (section 3.3) was based on a single dataset (measured consumption). Given the differences between both datasets (Figure 1 and Figure 2), measured consumption is adjusted to reported consumption by uplifting the raw data until the values in the base year are equal.

These results are summarised in section 4.

3.1 High level trend in non-household demand

Figure 2 shows the values for consumption and the reported number of properties since 1992/93. These values are influenced by the economic crisis. The steeper drop in consumption (blue line) and dip in number of properties between 2006/07 and 2010/11 (highlighted area) is attributed to the recession.

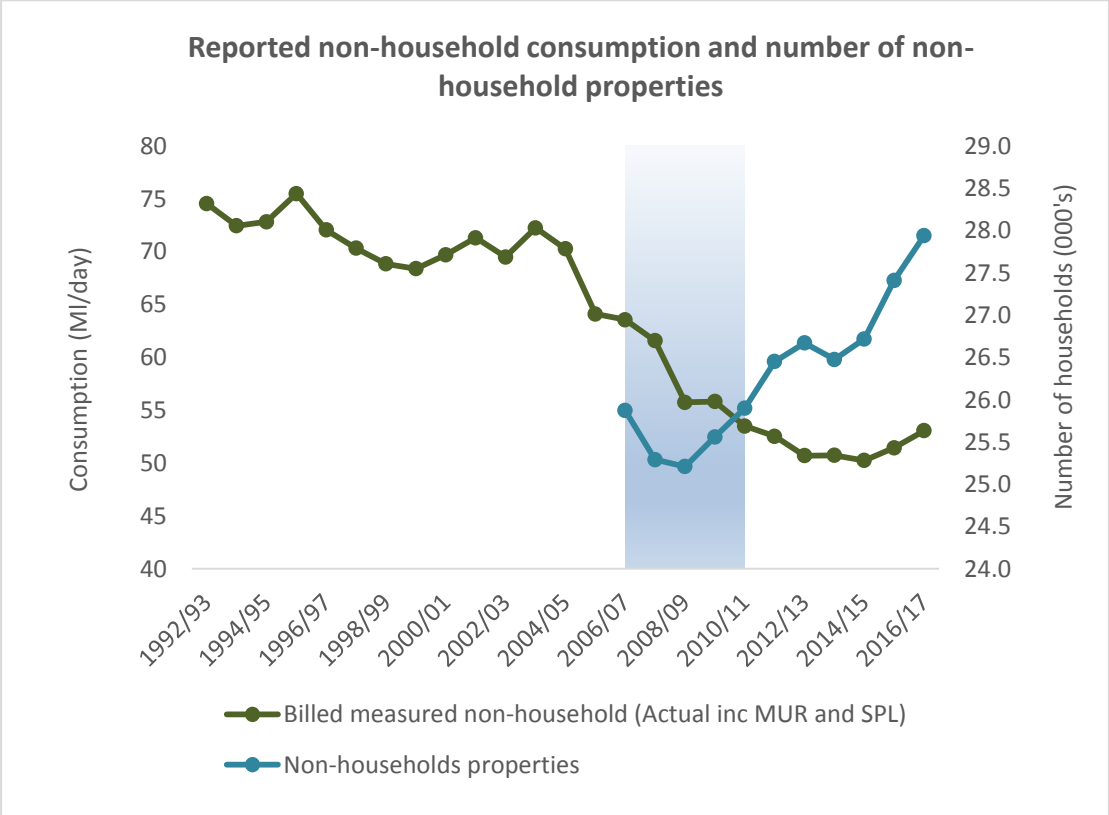

Figure 2 Reported non-household consumption and number of non-households

These data indicate that more recent consumption data would be more suitable for trend analysis, in order to remove the effects of the financial crisis on non-household water use. This was supported by further investigation of the trends created by using data from before the financial crisis, which resulted in extreme and unrealistically low forecasts. Figure 3 therefore shows a company-level forecast based on reported non-household consumption figures from 2008/09 to 2016/17. These data were used to develop a high-level company forecast: 'Forecast based on reported consumption'.

Measured data for metered non-HH consumption were used to create a second high-level forecast: 'Forecast based on measured consumption'. For this second high-level forecast, measured data covering the period 2008/09 to 2015/16 were used.

Outputs were calibrated to base year consumption data from reported metered non-HH consumption. Both forecasts are represented in Figure 3.

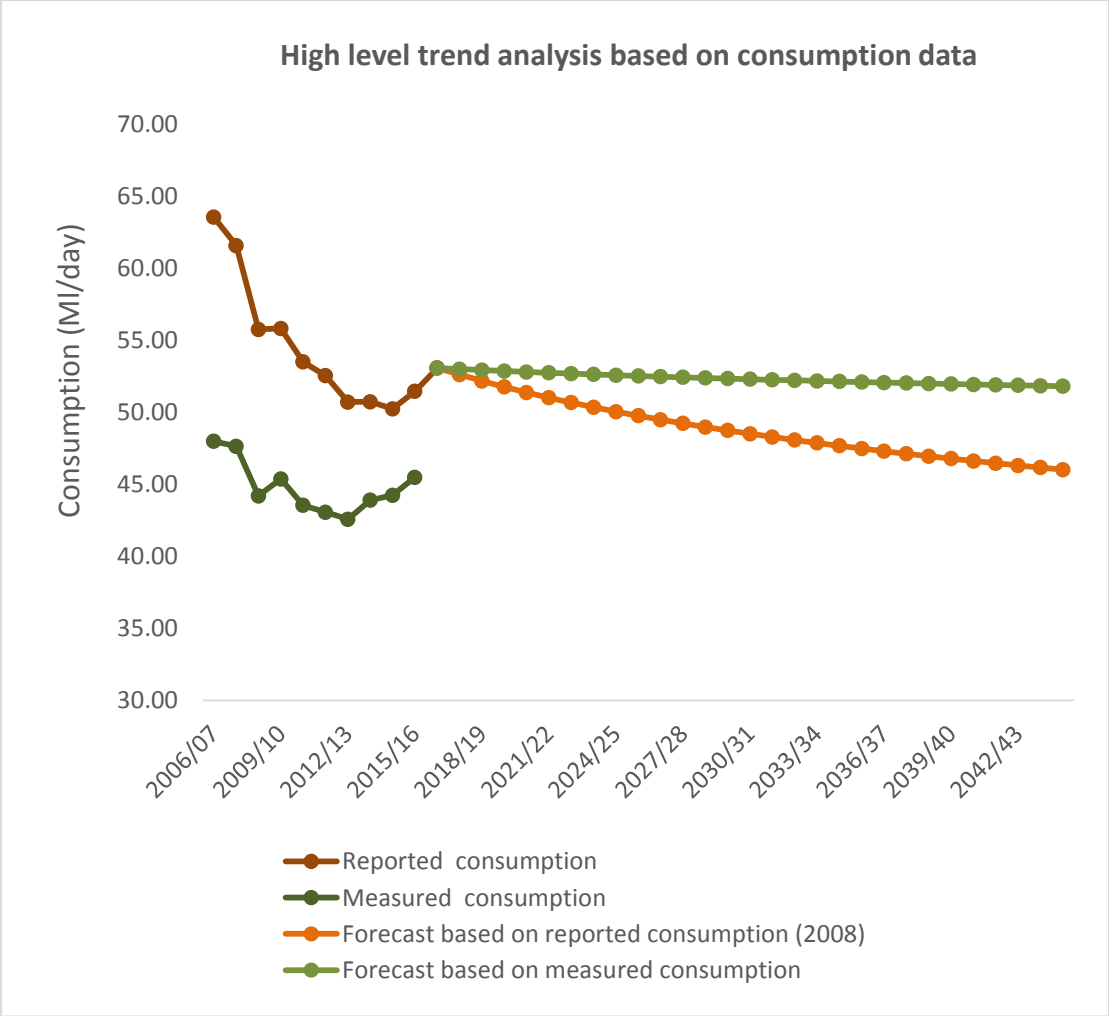

Figure 3 High level trend analysis based on consumption data

The forecast based on measured consumption results in a decrease in non-household demand of 1.26Ml/d over the planning period – a decrease of 2.4%. The forecast based on reported consumption results in a decrease in non-household demand of 7.06Ml/d – a reduction of 13.3%.

The relative pattern of the two historic trends also suggest changes in the adjustment to reported data for MUR and SPL, however this has not been investigated further. These trends have been given equal weighting as we believe each one has its own merit.

Trends were calculated for property numbers and consumption per property for both datasets. From these trends, consumption was calculated and added to Figure 4, resulting in higher forecasts than the first two high level forecasts.

Finally, a trend with no change from base year has been included.

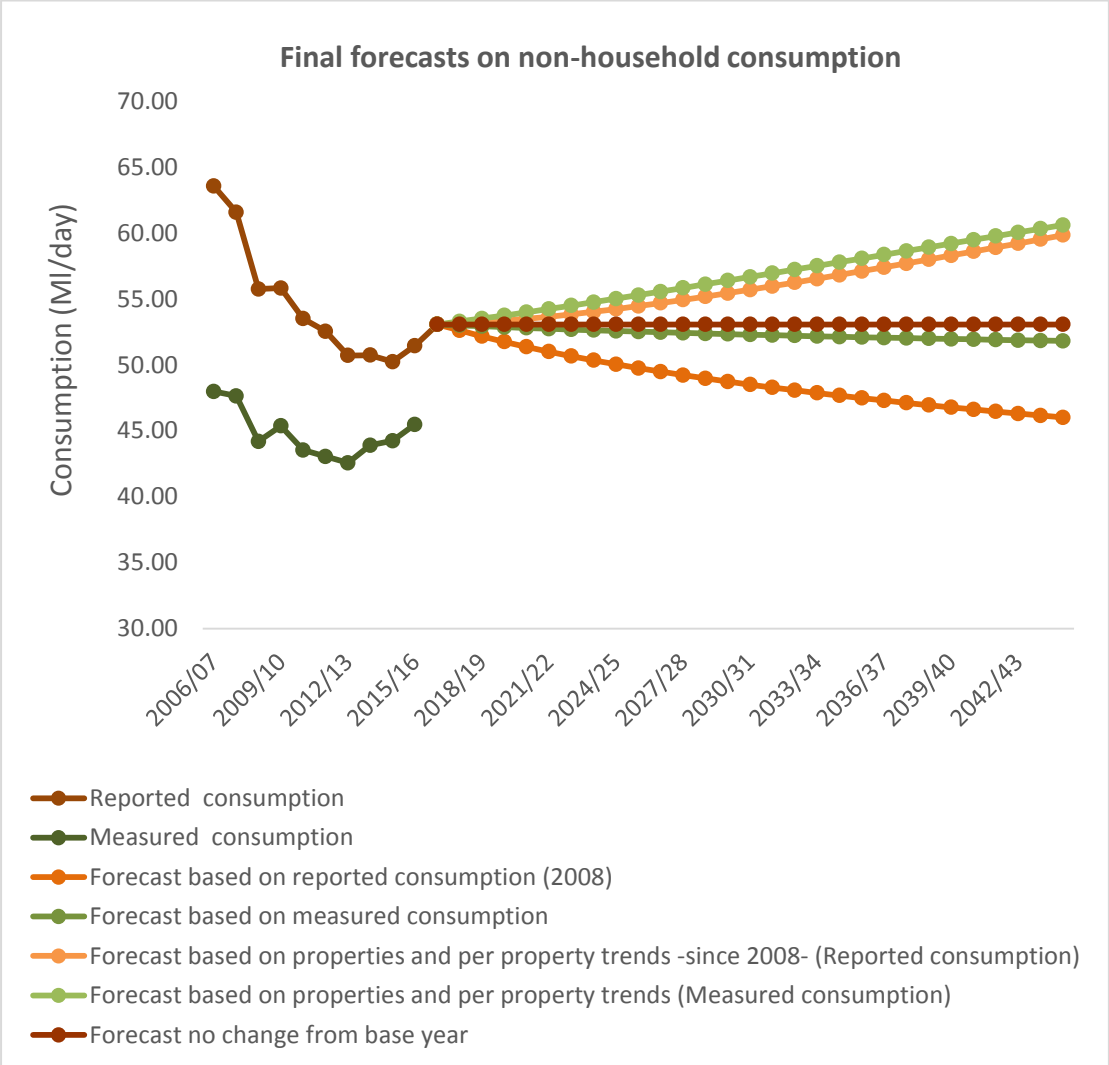

Figure 4 **High level trend analysis based on consumption and properties and consumption per property**

Initial trials have been carried out looking into the correlation and predictive power of some economic factors. The factors used included: total population, unemployment rate, growth, and GDP.

No significant relationships were found between high-level consumption data and these factors. However, analysis at lower levels – by consumption bands and industry codes – revealed some relationships that were masked in the high-level analysis. These results are discussed in the following section.

3.2 Analysis by consumption band

In this sections, the measured non-household consumption data has been used to further analyse and evaluate the non-household consumption. The available data has been categorised according to consumption bands and industrial activity defined by industry code (which is further analysed in section 3.3).

In a first instance, consumption bands were established and properties were assigned to one of the 9 groups presented in each year.

Table 1 Consumption bands

Band	Consumption (litres/day)	Property count (2015/16)	Group
Band A	0 – 250	11,383	Low
Band B	250 – 500	6,186	
Band C	500 – 1,000	2,821	
Band D	1,000 – 2,000	1,370	
Band E	2,000 – 5,000	741	Medium
Band F	5,000 – 10,000	420	
Band G	10,000 – 50,000	145	
Band H	50,000 – 1,000,000	39	High
Band I	Over 1,000,000	5	

Based on this, consumption per day in each consumption band is plotted by year below (Figure 5, Figure 6 and Figure 7). In order to ease the viewing, the bands have been grouped in three different graphs according to their total contribution to consumption per day.

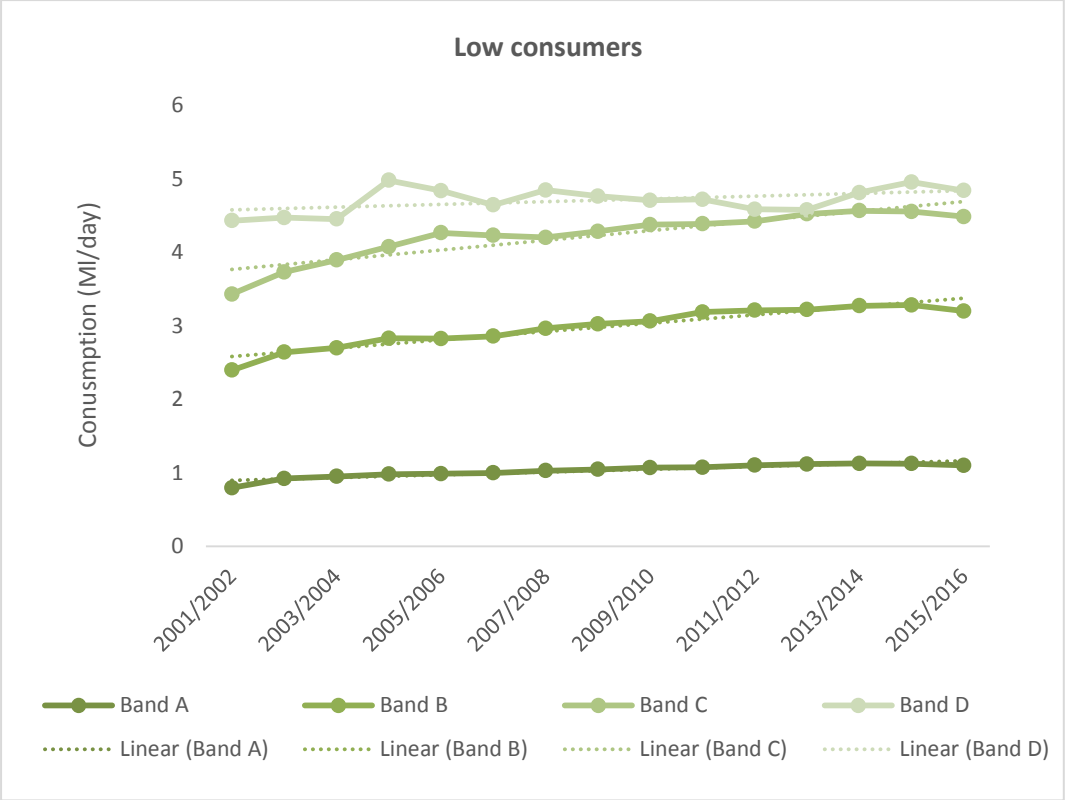

Figure 5 **Low consumers: Band A to Band F**

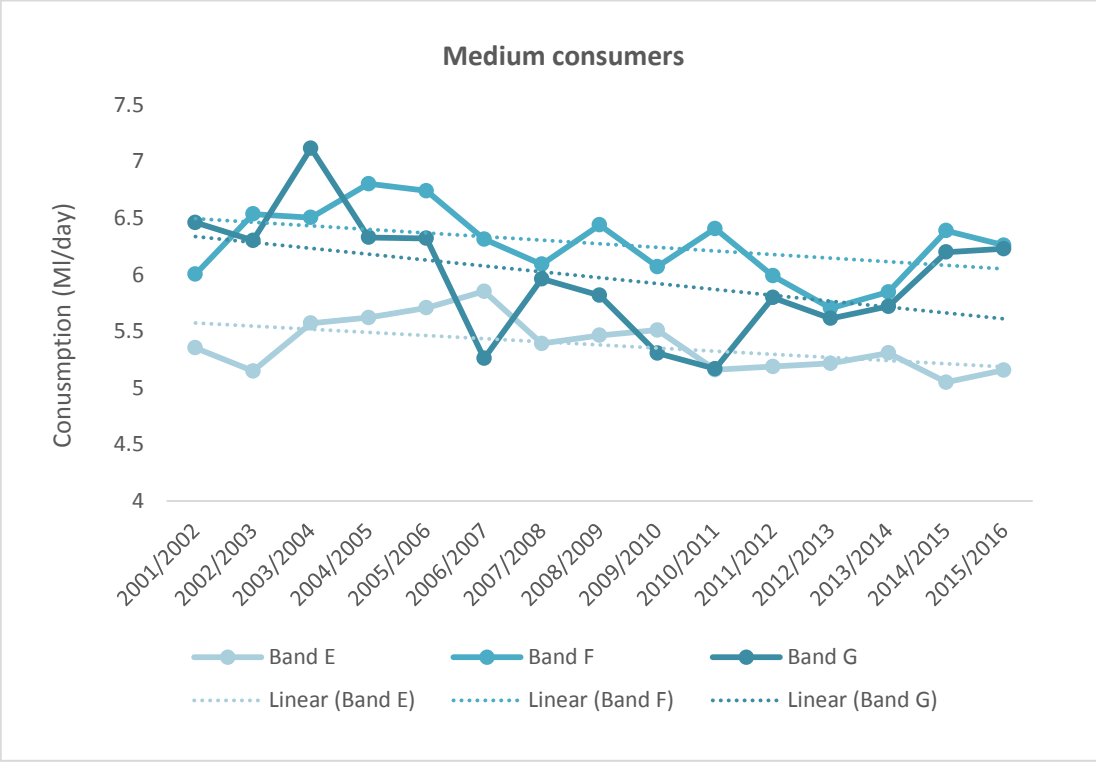

Figure 6 **Medium consumers: Band E, F and G**

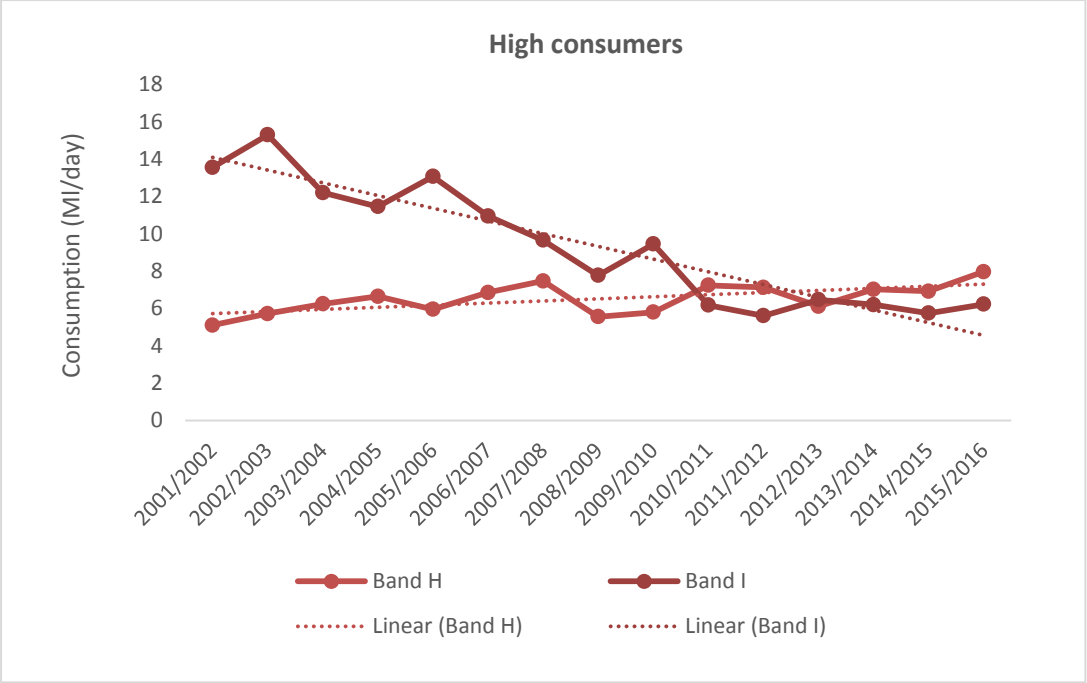

Figure 7 **High consumers: Band G and Band H (Primary vertical axis) and Band I (Secondary vertical axis)**

As shown in Figure 5, Figure 6 and Figure 7, the total contribution to consumption per day is higher in larger consumption bands. That is to say, consumption bands with higher consumption intervals, for instance, Band H and I, have a greater impact on annual contribution per day.

Figure 5 shows a gradual increasing trend in consumption in bands Band A to D, amongst which the trend for bands A and C are more pronounced. The increase in the number of properties for these three bands is also noticeable – and it is considered to be the main driver of this increased consumption.

It should be noted, however, that this total contribution per band is as well dependant on the number of properties on each band and, in this regard, the contribution of Band G (25,000-100,000 litres) towards consumption is actually lower than Band F (10,000 – 25,000 litres) (Figure 6).

The number of properties by consumption band a presented in Table 2.

Table 2 **Number of properties by band**

	Band A	Band B	Band C	Band D	Band E	Band F	Band G	Band H	Band I
2001/2002	7,548	4,645	2,145	1,251	767	400	153	26	11
2002/2003	9,052	5,130	2,342	1,258	748	431	139	29	9
2003/2004	9,706	5,190	2,445	1,256	803	427	162	30	8
2004/2005	10,265	5402	2,553	1,397	803	448	143	35	9

2005/2006	10,736	5,422	2,663	1,364	823	452	142	29	10
2006/2007	11,165	5,470	2,663	1,316	839	410	126	34	9
2007/2008	11,290	5,675	2,637	1,365	776	401	135	35	7
2008/2009	11,379	5,803	2,723	1,359	795	422	129	28	7
2009/2010	11,690	5,854	2,758	1,342	797	394	124	32	7
2010/2011	11,743	6,108	2,777	1,352	748	426	118	34	5
2011/2012	11,998	6,192	2,788	1,309	749	402	132	35	5
2012/2013	12,139	6,217	2,842	1,301	755	381	130	30	6
2013/2014	12,141	6,279	2,853	1,362	765	392	131	34	6
2014/2015	11,934	6,340	2,858	1,410	727	431	141	34	6
2015/2016	11,383	6,186	2,821	1,370	741	420	145	39	5
% (15/16)	49.26	26.77	12.21	5.93	3.21	1.82	0.63	0.17	0.02

Over a quarter of the consumption per day in 2015/2016 (31.22%) was attributable to properties within Bands H and I, in other words, approximately 0.2% of the total number of properties in 2015/16. And almost 60% of the total consumption per day was attributed to Bands F, G, H and I, as illustrated in Figure 8.

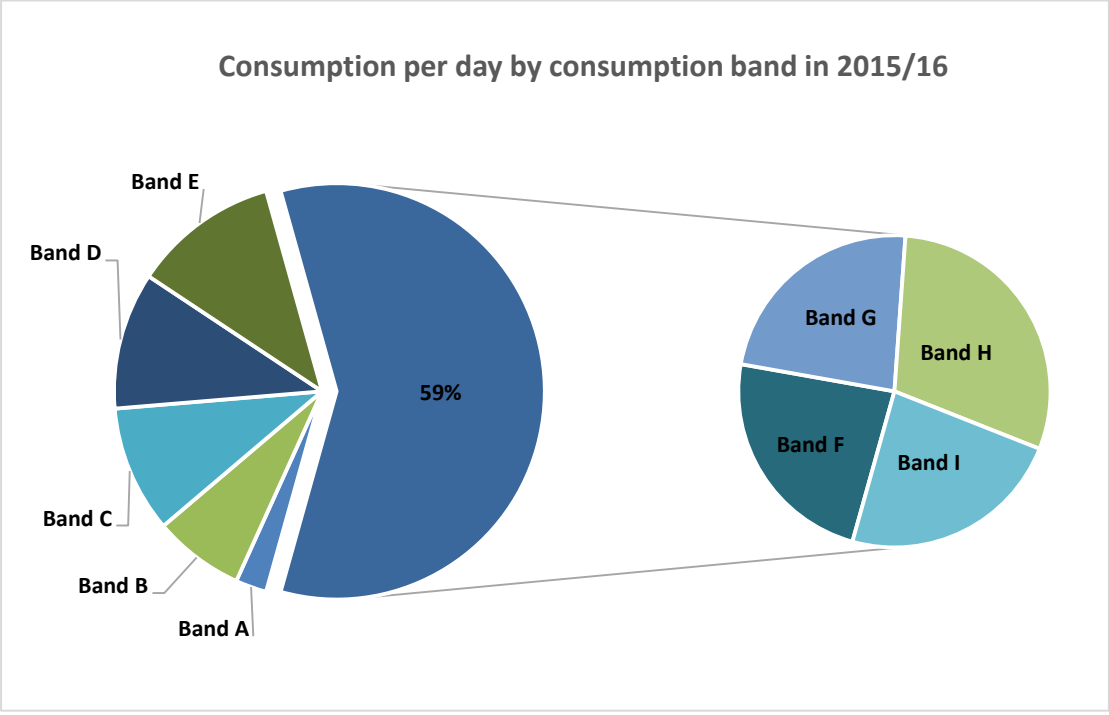

Figure 8 **Consumption per day by consumption band in 2015/16**

Figure 9 shows the percentage changes in the number of properties for each consumption band and for the period 2001/02 to 2015/16.

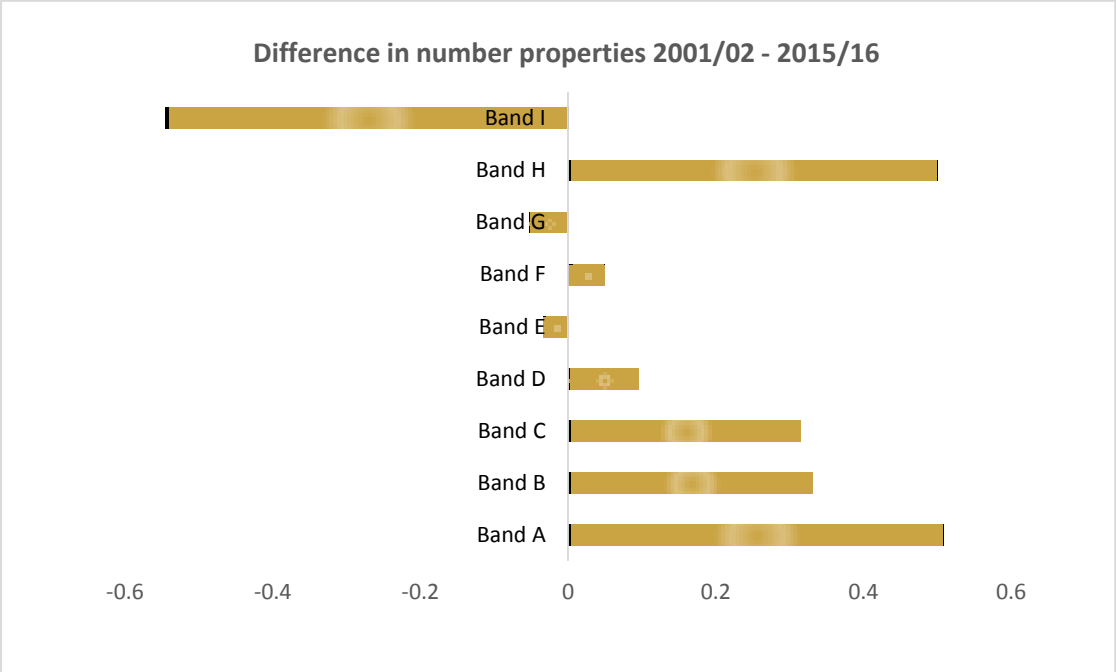

Figure 9 Difference in number of properties (2001/02 -2015/16)

Consumption in Band E and F (Figure 6) display a gradual decreasing trend. Bands G, H and I (Figure 7) show more irregular patterns which are in line with properties switching from one band to another. Nonetheless, combining these three Bands results in an overall negative trend (Figure 10).

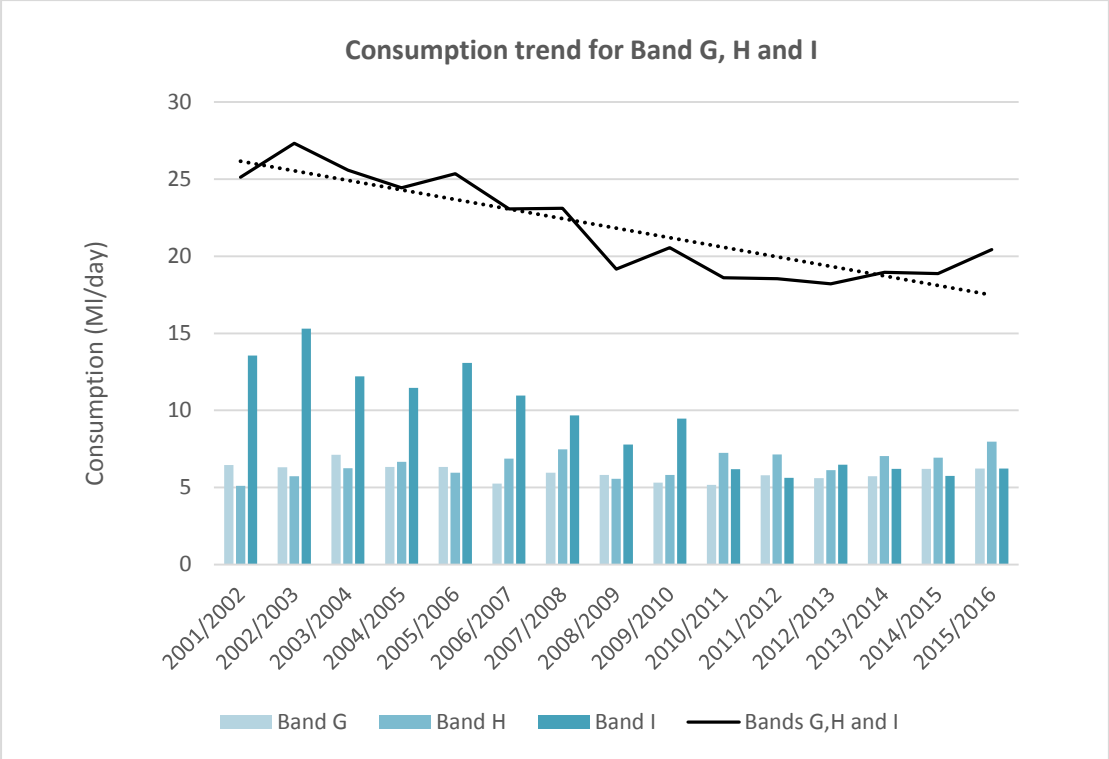

Figure 10 Consumption trend for Bands G, H and I

Band I (Figure 7 and Figure 10) consumption shows a distinct decreasing trend. This decrease may be attributed to consumers moderating their water consumption combined with sharp drops in consumption in some properties. Figure 11 shows trends for 12 individual properties that were classified at least one year as Band I.

Although most of the properties display negative trends, it is worth noting that three of them show a positive increase. In this way, the overall positive contribution to water consumption experienced by some larger consumers is masked. Because of their impact on total consumption, it is worth considering the individual evaluation of these large consumers.

Likewise, the drop in consumption in Band I (Figure 7) is accompanied by the increasing consumption in Band H. In this regard, it should be noted that the consumption band classification of a property is likely to change throughout the analysis period and for this reason, forecasts for each consumption have not been included in Figure 5, Figure 6 and Figure 7.

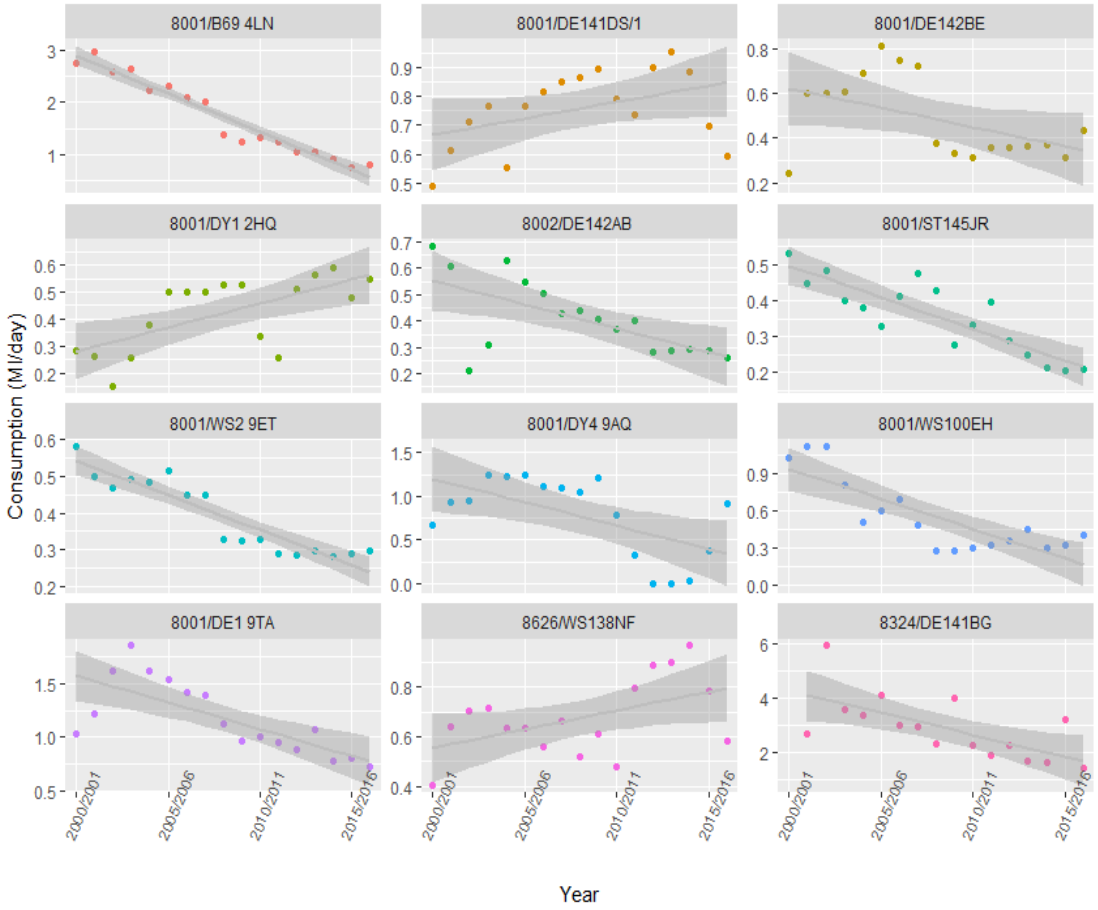

Figure 11 Property consumption (Band I)

An additional forecast based on consumption bands has been included in Figure 12.

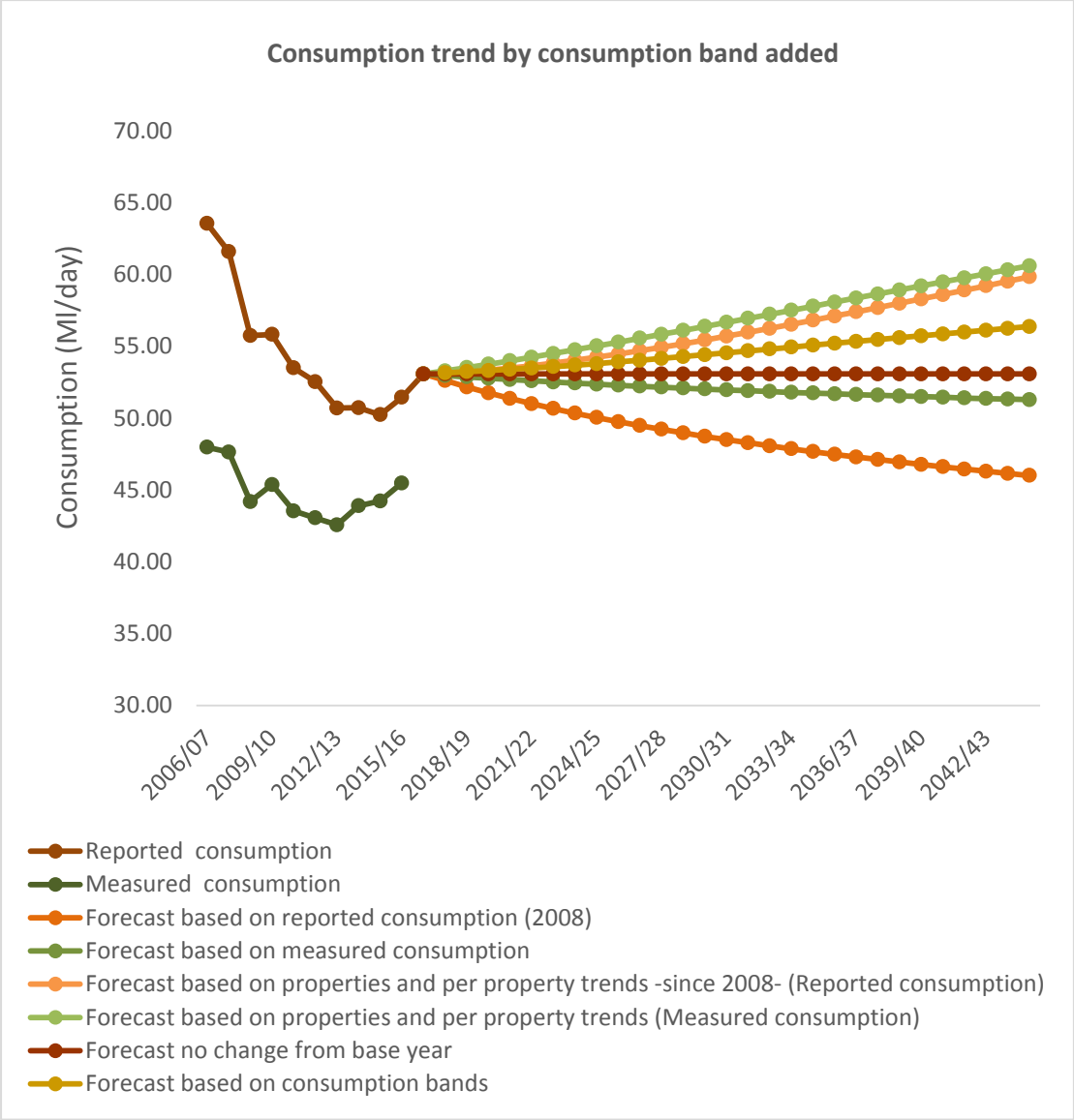

Figure 12 Consumption trend by consumption band added

3.3 Analysis by industry code

In order to further analyse consumption in different sectors, an analysis by industry code has been performed. In the same way as the consumption bands, each industry code was tested separately against a number of parameters such as population, unemployment, GDP and Growth. The results derived from this trend are presented in Figure 13. Although significant relationships affecting individual industry codes were found, further investigation showed that variables were flawed, and, as a consequence of this, results were not as robust as desired.

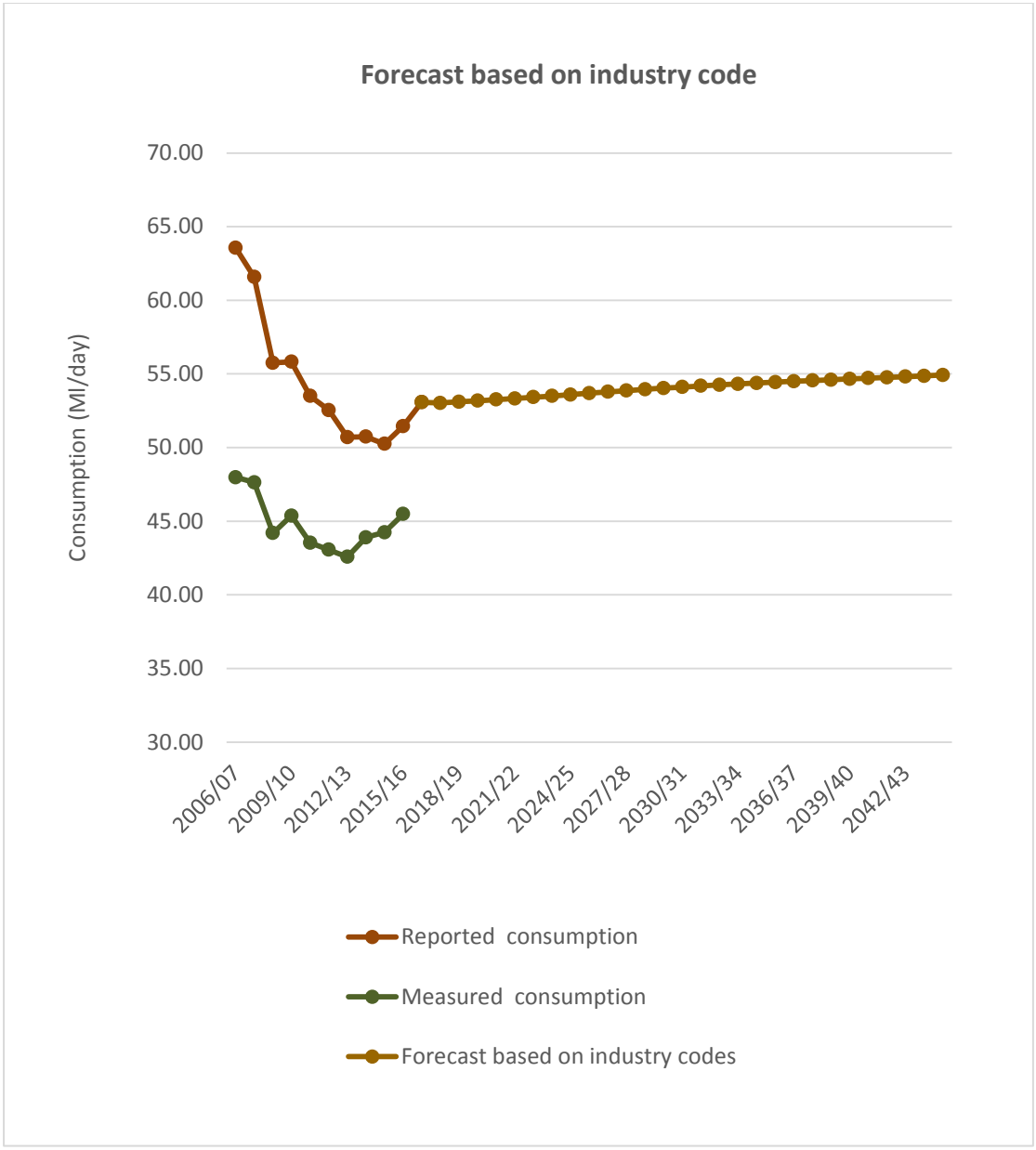

Figure 13 **Forecast based on industry code**

4 Summary

A set of non-household demand forecasts has been provided covering a 25-year period. High-level trend analysis presented in section 3.1 did not display strong relationships with economic factors. Likewise, results at lower levels (by industry and consumption band), showed few significant relationships and were mostly reverted to trends.

With regards to the consumption band analysis, there is a general expected increase in consumption, which is mainly driven by property numbers. While the number of properties in lower consumption bands (Bands A to D) show a continued growth, the number of properties in Band E, F and G remain relatively constant and the consumption in these bands display a decreasing trend due to a lower consumption per property. Finally, Band H displays a noticeable upward trend mainly driven by a higher number of properties. Inversely, Band I tend to reduce its consumption and this is accompanied by a reduced number of properties. This translates into larger consumers improving their consumption per property.

Analysis by industry type did not show a significant relationship with economic factors, and most industry forecasts were reverted to trends. However, analysis revealed uncertainties in the way the codes were assigned to individual properties and therefore this approach was not used in the forecast.

It is worth mentioning that the evaluation of individual larger consumers proved to be a useful investigation. As analysed in section 3.2.1, 30% of the consumption in 2015/2016 was attributed to 0.2% of the properties. This highlights the importance of larger consumers and its impact on final consumption figures.

Finally, Figure 14 illustrates the forecasts that have been produced for this analysis. Trends that represented unprovable or extreme scenarios were dropped from the final forecast.

Figure 14 Final forecasts for non-household consumption

Final forecasts include:

- Reported metered non-household consumption.
- Recorded metered non-household consumption.
- Forecast based on reported data since 2008/09.
- Forecast based on measured data since 2000/01.
- Trends for properties and consumption per property using the recorded dataset were calculated and used to generate a new forecast: "Forecast based on property

and per property trend (Measured consumption)". The same trend was produced using reported figures. "Forecast based on property and per property trend -since 2008- (Reported consumption"

- Forecast based on consumption bands, where consumption bands have been analysed separately and add up all together.
- Forecast no change from base year.

Values for each forecast every five years are displayed in Table 3. A summary graph is also provided in Figure 15. This graph illustrates the combination of the set of forecasts generated for the analysis and includes mean, median and bars on the graph represent the standard deviation.

Table 3 Forecasted values for non-household consumption

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Forecast based on reported consumption	51.76	50.04	48.73	47.67	46.78	46.01
Forecast on measured consumption	52.86	52.57	52.34	52.14	51.96	51.81
Forecast based on property and per property trend – reported consumption-	53.35	54.24	55.44	56.82	58.29	59.84
Forecast based on property and per property trend – measured consumption-	53.75	55.02	56.39	57.79	59.20	60.60
Forecast based on consumption bands	53.32	53.79	54.41	55.08	55.73	56.37

Finally, a summary graph is provided in Figure 15 and Table 4. This graph illustrates the combination of the set of forecasts provided for the analysis. Bars on the graph represent the standard deviation of the forecasts provided.

Two central tendency measures, mean and median, have been estimated for the set of trends. Given the similarity displayed by both parameters, we can accept a fairly normal distribution, justifying the use of parametric analysis.

We assume equal probabilities for each scenario and, based on the above consideration, we use the mean to get the central estimate and the standard deviation. Through this analysis we can understand the uncertainty around the mean forecast. The standard deviation can be used to define non-household forecast uncertainty in headroom, using a normal distribution around the mean forecast.

Table 4 Non-household forecast aggregated

	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Mean	53.02	53.12	53.40	53.76	54.17	54.62
Median	53.19	53.43	54.74	54.07	54.40	54.72
Standard deviation	0.69	1.74	2.72	3.67	4.59	5.49
Upper forecast[5]	53.71	54.86	56.12	57.43	58.76	60.11
Lower forecast[5]	52.33	51.38	50.68	50.09	49.58	49.13

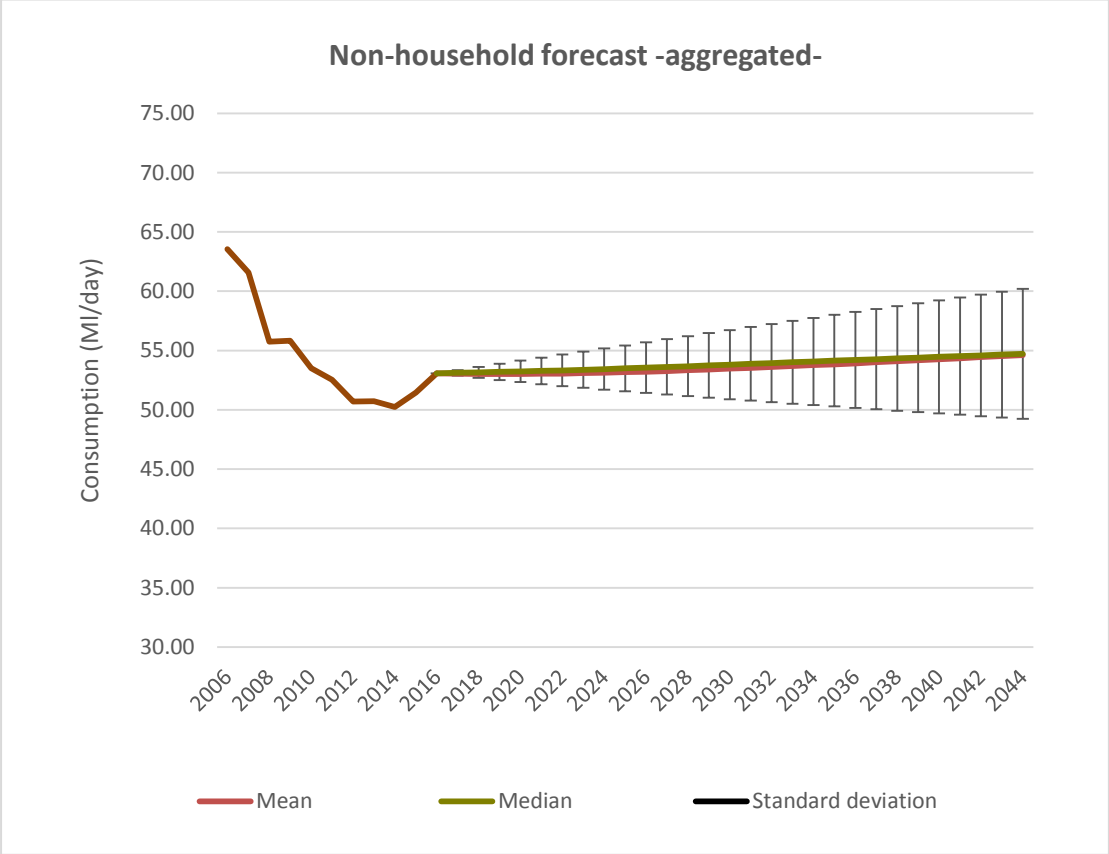

Figure 15 Non-household forecast aggregated

[5] For headroom