Reporting guidance – Per Capita Consumption[1]

Objective

This guidance has been developed to enable all companies to report annual average per capita consumption for the defined year following a reasonable level of accuracy, applying consistent and reliable methods and common assumptions. This is to facilitate consistency of reporting by companies and comparisons of performance by customer representatives, regulators and other companies with reasonable confidence.

Key Principles

There are several key principles applied in the compilation of the guidance:

- Reporting of annual average per capita consumption forms part of each company's assurance process applied to all measures reported annually by companies;
- A company needs to have a written methodology or procedure in place for reporting average per capita consumption. This procedure is reviewed annually and updated as required. This will be consistent with the methodology for leakage reporting and may be included in that methodology;
- The reporting guidance for annual average per capita consumption reporting is set out as a consistent baseline for the industry which companies should achieve now or in the short and medium term;
- Where a company is not able to meet any part of the guidance then it is required to explain any shortfalls and its plans to address this;
- There are a number of areas which would benefit from future independent research to determine good practice. Proposals for further research in the future should be considered by the water industry. In the meantime, this guidance sets guiding principles and these may be refined and improved as further research is concluded.

Applying this methodology in conjunction with the leakage consistency methodology is likely to change reported PCC and comparisons of historic data may no longer be valid. There may

[1] This is the same guidance as included in the March 2018 report for Ofwat and Water UK: "Targeted review of common performance commitments".

also be a difference with the PCC figures in companies' Water Resources Management Plans (WRMPs).

Measure Definition

Annual average per capita consumption is defined as the sum of measured household consumption and unmeasured household consumption divided by the total household population. This is to be reported at the whole company level for this PC.

$$\frac{Measured\ household\ consumption + Unmeasured\ household\ consumption}{Total\ household\ population}$$

It is reported as the annual arithmetic mean per capita consumption expressed in litres per person per day (l/p/d).

The measure uses post MLE[2] (maximum likelihood estimation) data for measured household consumption and unmeasured household consumption.

Companies are required to report PCC to the Environment Agency in the Annual Review of Water Resources Management Plans and this is reported at water resource zone (WRZ) level. Companies should refer to Environment Agency reporting guidance for the Annual Review to ensure compliance with that when preparing their Annual Reviews.

In order to account for weather variations and how this impacts on PCC the PC will be based on a three-year average. PCC will be reported annually and a company's performance will be measured as a three-year average of the annual figures.

A company is required to report against this definition and:

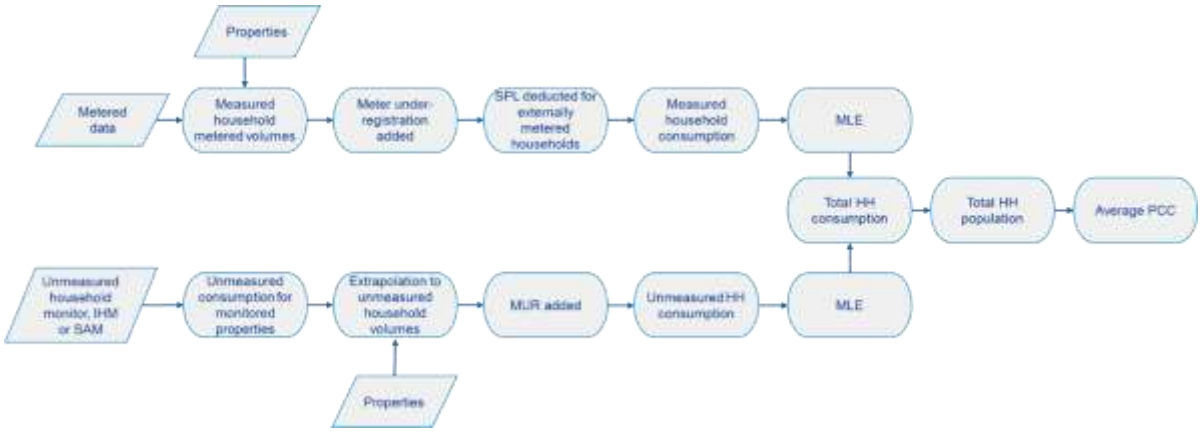
- Disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- Explain the reasons for any non-compliance;
- Set out its plans and programme to comply with the guidance; and
- Disclose any other factors which have an impact on the methodology for reporting per capita consumption.
- Set out any differences with the PCC figures reported in the WRMP.

[2] MLE is a technique used in the estimation of leakage and is described in the guidance for reporting the leakage performance commitment for PR19.

Reporting Process

The guidance is structured in the way that PCC is estimated and components of PCC are described in the following sections.

The process for deriving average PCC is shown in the following diagram.



Components of Per Capita Consumption Estimation

Properties

Measured household properties are needed to derive measured household metered volumes from a company billing system.

Unmeasured household properties are used in the unmeasured household consumption monitor calculations and for extrapolation to company area.

A company is expected to:

- Ensure the classification of properties as either household or non-household is consistent with the retail market definition of eligibility.
- Update property data at least annually.
- Exclude properties that are defined as void unless a company can evidence any use or losses from illegal occupation;
- Justify the number of void properties each year and how this is derived.

Population

Total household population is the denominator in the equation.

A company is expected to:

- Produce a total household population estimate every year based on the Water Resources Management Plan definition of household population as set out in the guidelines[3] and the UKWIR methodology for estimation of population.[4]
- Provide evidence to justify any adjustments made to population estimates for unaccounted for population (clandestine population such as migrant workers, tourists, holiday home owners)
- Demonstrate that the estimate is for household population only (non-household population is either estimated separately or deducted if the estimate obtained is total population for the area of supply). A company should set out its approach to excluding non-household population and demonstrate that this is consistent with the WRMP guidelines.

Occupancy

At this point in time it is not proposed that this average PCC measure should be derived from separate measured and unmeasured PCC estimates. It is therefore not necessary to disaggregate the total household population between measured and unmeasured households and there is no requirement for occupancy data for this measure.

Measured household consumption

The volume of measured household consumption should include water used by each measured household including meter under-registration but excluding supply pipe leakage.

Measured data shall be derived from the meter readings within the company's billing system including estimated reads and an adjustment for meter under-registration should be applied.

[3] Final Water Resources Management Plan Guidelines, EA/ Natural Resources Wales, May 2016
[4] UKWIR 15/WR/02/8, WRMP19 Methods – Population, Household Property and Occupancy Forecasting

For externally metered households an allowance for supply pipe leakage should be deducted from the metered volumes.

Companies must undertake a process of accruing consumption at year end to account for meter reading frequency cycles. A company should justify its approach to accruals and estimated reads.

New guidance on the estimation of unmeasured household consumption[5] proposes a measured household monitor to enable the nature of consumption patterns to be better understood. If a company uses a measured household consumption monitor it must set out its approach and justify its use in this methodology.

A company is expected to derive measured household consumption using the following criteria.

- Metered data taken from a company's own billing system, including actual reads and estimated reads;
- A deduction for supply pipe losses for externally metered properties consistent with the company's own current assessment of supply pipe losses;
- Adjustments to metered data for leakage allowances applied to individual customers can be included where a rebate has been applied to a customer's bill;
- Meter under-registration shall be applied consistent with a company's own estimates.

Unmeasured Household Consumption

The volume of unmeasured household consumption should include water used by each unmeasured household excluding supply pipe leakage. Dependent on the level of meter penetration a company has this can be a significant component of the water balance and therefore needs continual focus to maintain and improve the estimate. For the purposes of this PC unmeasured household consumption should be derived from PHC.

In general, companies are expected to use company specific data for unmeasured household consumption except for companies with high meter penetration where it may be impractical to establish and maintain a sufficiently robust sample of unmeasured properties. In this case sharing of unmeasured data with neighbouring companies or companies with similar demographics may be appropriate. Companies with high meter penetration must set out their approach to estimating unmeasured household consumption.

In most cases (except perhaps where a company's meter penetration is high) it is expected that unmeasured household consumption shall be estimated from a company's own consumption monitor following good practice as defined in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999'. Good practice has improved since this report with innovation and new technologies now available although the basic principles

[5] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

of the monitors is unchanged. Companies can use individual household monitors (IHMs) or Small Area Monitors (SAMs).

Further work is required to determine current good practice for sample size and stratification for IHMs and SAMs. Until this is concluded companies should continue to base their approach on a sample of at least 1000 for IHMs. Representation may be by demographic group, property type or other recognised statistical group. Companies must set out the evidence to demonstrate their sample is representative of their area.

Individual monitors should have a high resolution meter and associated logger to transmit data to a control centre. Data is expected to be collected at least at hourly intervals and regularly downloaded. The IHM needs continual monitoring to limit the level of any supply pipe losses or other continuous flows. Any other continuous flows are attributable to customer use or plumbing losses and should be included in estimates for consumption at household level.

While an allowance is made for meter under-registration it is expected that meters used for these consumption monitors will have an enhanced specification compared with normal domestic meters and as they are continually monitored meter failures and drift will be identified earlier than for normal domestic meters. Meters are expected to be selected and maintained to minimise meter under-registration. A phased meter replacement programme should be in place.

Until further guidance is developed companies should continue to base SAMs on a representative sample of areas of DMAs or smaller whole DMAs which are specifically designed with one meter and permanent data loggers. They should include minimal numbers of non-household properties and have minimal measured households (no more than 50% where practical).

Consumption for non-household properties within SAMs should be deducted from the area total consumption based on metered data or where unmeasured non-households are included using the unmeasured non-household consumption allowance. Companies should set out how they have deducted non-household consumption;

Consumption for measured households within SAMs should be deducted from the area total consumption based on metered data. Companies should set out how they have deducted household consumption;

The total sample size for SAMs is dependent on the acceptable uncertainty applied to consumption estimates and assumptions on SAM outage. There is currently no specification for number of properties included in SAMs for consumption estimates. This should be included in future guidance following further work. In the meantime, a company should set out its evidence to demonstrate the representativeness of its sample.

The IHM monitoring requirements for continual monitoring and meter under-registration shall be equally applied to SAMs.

A company is expected to derive unmeasured household consumption using the following criteria:

- Unmeasured household consumption (Ml/d) for the whole company shall be calculated from average unmeasured per household consumption (PHC expressed in l/household/day) multiplied by the number of unmeasured households.
- Average unmeasured household consumption shall be derived from a company's own IHM or SAM except where meter penetration is high and this makes this impractical.

- The PHC for the IHM or SAM sample shall be extrapolated to an average for the whole company based on stratification.
- The IHM or SAM shall follow the principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors' 1999 and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017;
- IHMs and SAM monitors shall be continually monitored and maintained;
- A company shall demonstrate that its IHM or SAM is representative of the company as a whole; disaggregation of the sample by demographic factors, property type or similar factors represents good practice. Valid data from the survey shall be from at least 80% of monitors as an annual average measure. A company may develop and use an alternative monitor as defined in the 2017 UKWIR Report but it must set out the approach taken and demonstrate why this is appropriate;
- In general, it is expected that where the proportion of metered properties in a SAM exceeds 50% of total properties then the area should not be included in the estimation of unmeasured consumption. Companies with high meter penetration may not be able to comply with this and this should be considered when deciding their approach to estimating unmeasured household consumption;
- Quantify the uncertainty allocated to unmeasured household consumption and provide evidence to justify the uncertainty value used;
- Meters shall be selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration should be less than the company's average meter stock;
- Estimates of supply pipe leakage shall be based on a company's own data which is updated annually; and
- Estimates of meter under-registration shall be based on a company's own data which is updated annually.

New guidance on the estimation of unmeasured household consumption[6] has been published. This provides further guidance on monitoring processes in particular the impact of adopting models to increasing meter penetration. The report sets out several potential options for estimating unmeasured households and a framework for selection of an alternative method. For companies with high meter penetration their approach to estimating unmeasured household consumption must be consistent with this guidance and they should set out their approach.

Data Infilling

Data will not always be available from IHMs or SAMs for a range of reasons. In these cases, data can be infilled using the following guiding principles; where a SAM or IHM property is inoperable data can be infilled using historic data from the same SAM or IHM property or

[6] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

average data from a SAM or IHM property with similar characteristics (from the same stratification).

Supply pipe leakage and plumbing losses

Supply pipe leakage should be excluded from consumption data. For measured households which are externally metered supply pipe leakage allowances should be deducted from the metered data. For unmeasured households externally metered as part of IHM surveys supply pipe leakage should also be excluded from the data. For SAMs estimates of supply pipe leakage must also be removed from the data.

A company should use its own estimates of supply pipe leakage and must set out its approach to deriving these estimates and how it excludes supply pipe leakage from metered household consumption and IHM or SAM data used in the PCC calculation. This is also linked to estimates of plumbing losses. A robust methodology to determining this is required. A recently started UKWIR study is looking at plumbing losses and may help with this.

A company is expected to:

- Take account of supply pipe leakage in the estimation of both measured household consumption and unmeasured household consumption;
- Use its own estimates of supply pipe leakage which are annually updated;
- Demonstrate how these estimates have been derived.

Meter under-registration (MUR)

Within the calculation of per capita consumption metered data is taken from:

- Customer meters;
- SAMs for unmeasured household consumption monitor meters; and
- Meters on IHM properties

Therefore, there is potential for MUR to impact on the estimates.

For meters where there is a bias for under registration then this should be accounted for in calculations.

A company should include estimates of meter under-registration for all meters where there is a bias for under registration. A company is expected to use its own data on under-registration and should justify the MUR figure used and how it has been derived. MUR should be reviewed annually.

Where a metering programme has recently been completed or ongoing, a company is expected to revise its assumptions. It is recognised that information on under-registration is limited and there is a need for further work to derive statistically representative values. It is expected that meter under-registration greater than 3% would need to be robustly evidenced.

While an allowance is made for meter under-registration for monitor meters (SAMs and IHMs) it is expected that these meters will have an enhanced specification compared with normal

domestic meters and as they are continually monitored meter failures and drift will be identified earlier than for normal domestic meters. Therefore, it is expected that MUR for monitor meters will be less than for all meters.

A company should set out its approach to estimating MUR for revenue meters and demonstrate annual updates.

A company should set out its approach to estimating MUR for monitor meters and demonstrate annual updates.

A company should set out its approach to stopped meters and demonstrate that there is no double counting between stopped meters in consumption from billing data and MUR.

Glossary

DMA	District Meter Area
IHM	Individual household monitor
Ml/d	Mega-litres per day
l/p/d	Litres per person per day
PCC	Per capita consumption (per person consumption)
l/h/d	Litres per household per day
PHC	Per household consumption
SAMs	Small area monitors
UKWIR	United Kingdom water industry research
MUR	Meter under-registration

The PCC PC should be broken down into its constituent elements for assessment of compliance for reporting purposes. The compliance checklist in Annex A identifies the elements in average per capita consumption to be considered. This should be consistent with some of the elements in the water delivered components of the water balance for leakage shadow reporting.

Annex A: Compliance Checklist

A company is required to complete this checklist for submission with its value of annual average per capita consumption.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on average per capita consumption reporting
A	Not compliant with the guidance and having no material impact on average per capita consumption reporting. For example, a material impact might be assessed as more than 1% of the reported value. A company should set out its approach to assessing whether an impact is material or not.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component / Element	**Component R/A/G**	**Element RAG**	**Reason for any non-compliant components**	**Confidence grade**
1	**Household population estimates**	R/A/G			

1a	Household population derived using WRMP methodology		R/A/G		
1b	Evidence for adjustments for clandestine population if any		R/A/G		
1c	Household population updated annually		R/A/G		
1d	Exclusion of non-household population in accordance with WRMP methods		R/A/G		
2	**Household property estimates**	R/A/G			
2a	Definition of household / non-household consistent with eligibility under market separation		R/A/G		
2b	Evidence of void properties updated annually		R/A/G		
2c	Property figures annually updated		R/A/G		
3	**Measured household consumption (Based on leakage PC RAG elements)**	R/A/G			
3a	Metered data is derived from own billing system		R/A/G		

3b	If leakage allowances are applied the process and evidence for this is clearly set out.		R/A/G		
3c	Average SPL deductions for externally metered households using company own data updated annually		R/A/G		
3d	Company own estimate of MUR for revenue meters which is updated annually.		R/A/G		
3e	Meter replacement consistent with own replacement programme				
4	**Unmeasured household consumption (Based on leakage PC RAG elements)**	R/A/G			
4a	Monitors follow principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999' and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017		R/A/G		

4b	Consumption is derived from own IHM or SAM or evidence to support other method appropriate for high meter penetration companies		R/A/G		
4c	Evidence that survey is representative (based on demography, property type or other factors) of the company as a whole; Valid data available from at least 80% of monitors as an annual average measure.		R/A/G		
4d	For companies using SAMs - SAM comprises a representative sample of customer' characteristics. The sample size is sufficient to provide a statistically representative sample after allowing for outages. Where the proportion of metered properties in an area exceeds 50% of total properties then further data validity tests are applied For companies using IHMs – IHM comprises representative sample of customer		R/A/G		

	characteristics. The sample is at least 1000 properties.				
4e	Uncertainty allocated to unmeasured household consumption is estimated and justified				
4f	There is continual monitoring and maintenance of IHMs and SAM monitors				
4g	Meters are selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration is less than the company's average meter stock				
4h	Estimate of plumbing losses is based on own data				
4i	Where unmeasured non-household reported volume is less than 2% of total non-household demand, data from a per property consumption study is refreshed every five years				

4j	Where unmeasured non-household reported volumes are greater than 2% of non-household demand, data from a property study is refreshed every two years				
4k	Company own estimate of MUR for monitor meters which is updated annually				
4l	Meter replacement consistent with own replacement programme				

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band				
	A	B	C	D
1	A1			

2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX