

## UNMEASURED HOUSEHOLD PER CAPITA CONSUMPTION ANALYSIS

### Consumption Monitoring Areas (CMAs)

The Per Capita Consumption (PCC) for unmeasured household properties is estimated using data from the company's Consumption Monitoring Areas (CMAs). A total of 60 potential contributing CMAs have been set up within the Bristol Water network although due to reasons such as operational restrictions, equipment faults and meter under registration not all areas are used annually in the PCC estimation. For the reporting year 2007/08, 50 areas contributed towards the PCC estimation.

The CMA are small discreet areas established specifically to monitor unmeasured households and chosen because they have few (if any) non-household customers, a large proportion of unmeasured households and are of a similar Water Use Class.

CMAs are monitored closely and flow and pressure into each area recorded continuously at fifteen minute intervals using a data logger. The information is downloaded to a host computer every day via the PSTN or GSM system

A detailed leakage analysis based on logged flow and pressure data is carried out in the CAMMS software for each CMA. The software follows similar theories and concepts used for the higher-level leakage calculations. Where available an area specific value for household night use is also used where a specialised high frequency data analyser is deployed for household night use studies, making the leakage analysis highly accurate.

### Data Processing and Evaluation

The CAMMS (Consumption Areas Monitor and Management System) software is used to calculate the PCC for each of the CMAs, and allows the calculation of PCC on a financial year basis. The software requires 15 minute logged flow values to be imported for each of the CMAs. In order to calculate the PCC for each CMA correctly, the following elements need to be identified:

#### 1. Households

The number of households will be determined using information from the company's Data WareHouse (DWH) which contains the latest updates from the RAPID Billing system (property information) and Geographical Information System (GIS, CMA area configuration) and will be run for each area.

#### 2. Occupancy Rate

Populations in CMAs are determined from National Census 2001 data which is provided at ED level (Enumerator District level) by CACI Ltd. The population and occupancy data for each CMA is updated annually using forecast data provided by CACI Ltd. Where the CMA crosses a number of ED boundaries the weighted mean occupancy rate will be used.

$$CMAOccupancyRate = \frac{(Occ.RateED1 \times Properties.ED1) + (Occ.RateED2 \times Properties.ED2)}{TotalPropertiesinCMA}$$

To improve on the assessment of occupancy levels a number of occupancy surveys have been conducted by Bristol Water to measure the occupancy levels in 28 CMAs. The measured occupancy for these CMAs has been used in the estimation of the PCC.

3. **Non-household Consumption**

Although the key to the selection for the location of CMAs was domestic areas, it is however inevitable that some non-household users are apparent within some of the CMAs. Non-household users will be identified and levels of usage will be taken from the RAPID Billing System. Such usage will be deducted from the areas demand flow. Non-household properties are individually metered and have meter readings taken mostly every six months.

4. **Metered Households**

Since the CMAs are required to produce a PCC for unmeasured domestic usage, any metered household use will again be identified and subtracted from the areas demand flow. Metered households have meter readings taken six monthly and are stored within the RAPID Billing System.

CAMMS uses this data to calculate consumption, minimum night flow and night leakage for each CMA. Once a PCC is calculated for each Water Use class, a final company-wide figure can be calculated.

5. **Per Capita Consumption estimation**

Bristol Water use the statistical analysis methodology of Linear Regression to obtain unmeasured domestic PCC. To assess if a CMA is suitable to be used in the company PCC calculation for a given period, the overall suitability of the CMA is assessed by considering a number of suitability parameters, including % unmeasured household use of distribution input, % measured household use of distribution input, % non household use of distribution input, valid days contributing toward the reporting year and meter under registration status.

Per capita consumption at company level is determined by aggregation of the results obtained at CMA level. The basis of the aggregation is Water Use Class, which is a stratification of users by socio economic factors. The use of Water Use Class over other strata has been determined as most relevant by regression testing of CMA data. Statistical results for Water Use Class consistently show higher agreement than stratification by ACORN class, by house type, or by number of cars owned, for the data set at Bristol Water.

Work to improve the methodology of PCC assessment continues and the use of Water Classes for PCC stratification, as recommended by a consultant, is now being implemented. A comprehensive review of the PCC estimation within Bristol Water has been undertaken. The main elements of this review covered regression methodologies, CMA suitability parameters and improvements to the total number of contributing CMAs. For the base year 2007-08 the CMA level estimate of unmeasured household Per Capita Consumption is set out in the tables below.

**CAMMS PCC Results for FY 2007/2008**

Acorn Class	CMA Name	Use Class	Popn	Occy	PCC (l/person/day)
D27	1023 Sherston	3	539	2.29	203
B14	1133 Frampton Cotterell	2	495	2.38	145
B14	1138: Winterbourne	2	421	2.39	143
A04	1146: Frampton Cotterell	1	724	2.44	143
D30	2089 Bridgeyate	3	405	2.33	173
B11	2097: Longwell Green	3	423	1.92	161
B15	2131: Little Stoke	3	576	2.41	179
D26	2132: Patchway	1	1465	2.30	177
B10	2178 Thornbury	2	1624	2.52	146
D31	2246: Henbury	3	276	2.04	186
D31	2268: Ashley Down	3	390	1.96	224
E34	2275: Eastville	5	1091	2.47	168
E38	2277: St Werburghs	3	820	2.13	140
F42	2332: Hillfields	5	1589	2.40	162
E33	3019: Highridge	5	897	2.32	161
B14	3029: Whitchurch	2	1046	2.58	136
E33	3039: Whitchurch	5	1161	2.19	176
E33	3044: Stockwood PRV	5	2016	2.13	142
D28	3048: Stockwood	2	808	2.34	146
A03	3055 Keynsham	1	2159	2.36	174
F42	3101: Knowle	5	2072	2.65	152
E37	3102: Knowle	3	1636	2.35	116
E37	3112: Totterdown	3	1122	1.94	159
F48	3154 Bedminster	6	287	1.47	158
D31	3172: Bedminster	3	1868	2.06	142
A53	3294 Easton	6	665	2.13	120
C21	3306: Cotham	4	1131	2.33	139
E34	3399: Shirehampton	5	695	2.08	154
F43	3414: Shirehampton	6	1287	2.18	139
F43	3416: Lawrence Weston	6	1098	2.36	136
B10	4022: Portishead	2	411	2.82	133
A09	4036: Clevedon	4	625	2.19	175
A01	4045 Tickenham	1	289	2.39	219
D26	6076 Weston Super Mare	1	687	2.16	170
A03	7022 Bishop Sutton	1	411	2.08	227
B13	8304: Yatton	2	306	2.33	165
A04	8305: Longwell Green	1	855	2.52	166
B11	8310: Weston Super Mare	3	155	1.94	174
C21	8311: Hotwells	4	269	2.54	122
D28	8312: Hengrove	2	346	2.17	172
D27	8313: Clutton	3	241	2.51	140
D31	8314: Horfield	3	446	2.28	143
E34	8315: Frenchay	5	406	1.63	159
D30	8316: Downend	3	224	2.46	205
D31	8317: Bedminster	3	482	2.18	139
D31	8318: Shirehampton	3	597	2.09	137
E33	8319: Hartcliffe	5	281	2.58	158
E34	8321: Shirehampton	5	427	2.18	154
E37	8322: Bedminster	3	482	2.12	148
F40	8323: Shirehampton	6	793	1.88	186

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.5327
R Square	0.2838
Adjusted R Square	0.2533
Standard Error	53.693
Observations	50

ANOVA					
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>sig F</i>
Regression	2	53696	26848	9.31	0.00039
Residual	47	135501	2883		
Total	49	189197			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	120.06	69.665	1.7235	0.091	-20.080	260.21	-20.080	260.2
X Variable 1	101.99	30.949	3.2955	0.001	39.733	164.25	39.733	164.2
X Variable 2	66.440	28.564	2.3260	0.024	8.9772	123.90	8.9772	123.9

Occupancy of unmeasured Household of Whole Company Area	2.49
Proportion of Households in Water Use Class 1 in the Whole Company Area	0.220
Regression Calculation	388.65

95% confidence bands (random sampling error) = + or - 15.4 litres/hh/day

<b>Annual Company PCC l/p/day</b>	<b>156.09</b>
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95% confidence bands (random sampling error) = + or 6.2 litres/capita/day