Appendix B: SESW Treatment Losses and Water Balance Technical Note – 8/11/16 (Atkins)

1. Scope

The aim of this study was to provide an auditable figure for WRMP tables and improved understanding of SESW's water balance. To achieve this we have:

- Reviewed the latest EA WRP and UKWIR guidance to identify any revisions in approach which might be required.
- Met with relevant SESW staff to gather information and further define work that would be required to deliver an improved assessment of raw water and treatment works losses.
- Reviewed historic data and provided recommendations of approach to update the previous analysis and ensure compliance.

2. Background

Atkins produced a detailed WTW losses report in 2006. Our understanding is that historically there were few records of raw water losses between the source works and the water treatment works. For the previous individual WTW losses and outage studies, Atkins civil/process engineers visited each WTW to talk to the plant managers and gather information on treatment process losses and outage incidents. The 2006 report assesses the losses at each site based on known process losses, and flow data over a short (approx. 2 week) time period.

We have updated the assessment of Water Treatment Works losses and water balance calculations based on flow data collected over the last 2 years.

3. Data Received

SESW provided indicative values at the start of the assessment based on monthly totals covering the period April 2015 – March 2016. This included a calculation of network water used in on-site processes (wash-water, chemical dosing etc.) and an assessment of raw water losses. The data are presented in Table 1. The assessment included a number of WTWs where water was 'created' rather than lost (indicated by negative figures). It is likely that this is a result of meter error and unaccounted for imports to the WTWs.

Table 1: Raw water and process losses assessment by SESW – April 2015 to March 2016

	Average Daily 2015/16 (Ml/d)		
WTW	**Output**	**Raw Water Losses**	**WTW Losses**
Kenley	17.95	0.08	2.56
Cheam	44.11	1.66	1.26
Elmer	36.62	-0.09	-4.45
Bough Beech	23.89	n/a	-0.18
Godstone	5.70	0.36	0.82
Woodmansterne	28.09	0.41	-1.15
Westwood	4.082	0.08	-0.07
Cliftons Lane	0	0.00	0.00
Total	**160.44**	**2.50**	**-1.22**

An initial start-up meeting was undertaken on 5th July 2016 between SESW and Atkins covering both SESW Treatment Losses and Water Balance. The principal points identified were:

- The initial review of WRMP19 guidance has highlighted that it remains largely unchanged with respect to raw and treatment works losses.
- The WRMP tables released in Nov 2015 are the most up to date version currently available and that new tables may be released soon.
- SESW are keen to improve their understanding of the Company's water balance and they have identified that there are examples of process water being drawn downstream from the distribution input flowmeter (e.g. Elmer WTW) and therefore importing unmetered water into the WTW. This will also result in an overestimation of per capita consumption. The aim of this study is to enhance this understanding.
- SESW took an action to prepare hand drawn sketches to allow a water balance of flows in the WTWs to be performed.
- The raw and treatment works losses data shown in Table 1 is comprehensive, but it would be useful to include additional supporting information to provide greater detail and an audit trail. SESW agreed to provide meter numbers and TAGs.

Initially a review of the site inflow/outflow diagrams produced by SESW was completed. These showed a number of metered and unmetered inflow/outflows from the sites. Data for the metered flows were requested and daily total data for the period 01/04/2014 to 31/03/2016 were received. We also requested estimates of the unmetered flows and these were provided by SESW's Production Manager.

We have based our analysis based on data and drawings made available by SESW. No flow data were received for Cliftons Lane WTW which is believed to be offline.

4. Water Balance

Using the data outlined in Section 3, a water balance analysis was carried out. The water balance is the volume of water that is unaccounted for by flow data and process water estimates, rather than what is lost/gained across the site. This was calculated as the sum of outflows, metered and unmetered losses minus the sum of the inflows. A negative balance indicates more water is being lost across the site than can be accounted for by metered and unmetered inputs. There are a number of positive balances implying that more was accounted for leaving the site than can be accounted for entering the site.

Table 2 shows the results of the water balance analysis. All sites apart from Cheam showed a water balance error greater than +/- 2%. There are number of potential sources for these errors.

All the sites use water from the network for chemical dosing and wash-water from unmetered connections. This will result in water gains across the site not accounted for by the meters. An estimation of the gain of water has been made by SESW. However, the calculation does not take in to account differences in plant throughput and may be a source of error. For example, the chemical dosing requirements are the same for both Westwood and Woodmansterne despite the average plant output being 4.05Ml/d and 26.33Ml/d respectively.

Other errors that could affect the water balance include:

- Flowmeter calibration errors.
- Leaking pipes or equipment.
- Leaking valves resulting in double counting of output.

Bough Beech is of particular note due to the analysis showing a gain of 4 Ml/d across the site. The major part of this gain (93%) is related to sludge supernatant which based on information from SESW. The site schematic indicated that the sludge supernatant it is returned the reservoir and lost from the site and therefore increases the difference between the inflow and the outflow.

Table 2 - Water Treatment Works Water Balance

Site	Average Plant Input (Ml/d)	Process Water Off Network (Ml/d)	Average Metered Water Losses (Ml/d)	Estimated Unmetered Losses (Ml/d)	Average Plant Output (Ml/d)	Balance (Ml/d)	Balance (%)
Bough Beech	23.51	0.12	3.79	0.02	23.89	4.07	17.2%
Cheam	44.06	0.51	0.46	0.00	44.01	-0.09	-0.2%
Cliftons Lane	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Elmer	39.41	1.20	0.11	0.02	37.50	-2.98	-7.3%
Godstone	6.33	0.06	n/a	0.05	5.61	-0.74	-11.6%
Kenley	19.38	0.10	n/a	0.02	18.36	-1.10	-5.7%
Westwood	3.87	0.10	n/a	0.00	4.05	0.08	2.1%
Woodmansterne	25.96	0.10	0.44	0.01	26.33	0.73	2.8%

4.1. Suggestions for Improving the Water Balance

The accuracy of the water balance at some locations is of concern as it may be due to errors in recording or due to real, unaccounted water losses. In order to improve the accuracy of the water balance and treatment losses estimate there are a number of recommendations that can be followed:

- The existing flowmeters should be re-calibrated.
- A review of flowmeter placement to ensure all inflows and outflows are accurately accounted for.
- Unmetered imports to the WTWs for chemical dosing and wash-water flows should either be metered or recalculated to take account of different dosing/wash-water requirements at each site.

5. Results

Table 3 summarises the treatment losses across the sites as recorded by flowmeters and accounting for network water used on site in the period April 2014 to March 2016. A negative figure for plant loss indicates more water was recorded entering distribution than can be accounted for entering the site. There are differences between the total loss figures reported in Table 1 and Table 3 which is in part due to different time frames being assessed. Additionally, the inflow data for Elmer and Kenley WTWs was found to differ between the two data sources leading to significant differences in calculated site losses.

Table 3 - Water Treatment Works Losses Based on 2014-2016 Flow Data

Site	Average Plant Input (Ml/d)	Process Water Off Network (Ml/d)	Average Plant Output (Ml/d)	Average plant loss (%)	Average plant loss (Ml/d)
Cheam	44.06	0.51	44.01	1.3%	0.56
Woodmansterne	25.96	0.10	26.33	-1.1%	-0.28
Bough Beech	23.51	0.12	23.89	-1.1%	-0.26
Cliftons Lane	n/a	n/a	n/a	n/a	n/a
Elmer	39.41	1.20	37.50	8.3%	3.11
Godstone	6.33	0.06	5.61	14.1%	0.79
Kenley	19.38	0.10	18.36	6.1%	1.12
Westwood	3.87	0.10	4.05	-2.0%	-0.08
Company Total	**162.52**	**2.18**	**159.75**	**3.1%**	**4.95**

Table 4 summarises the raw water losses between the source boreholes and the sites as recorded by flowmeters in the period April 2015 to March 2016. A negative figure for raw water loss indicates more water was recorded entering the site than was recorded being produced by the borehole.

There are no raw water losses reported for Bough Beech as this site is supplied by a storage reservoir and no data were available to assess how much water is lost between the reservoir and the treatment site. While the site inflow for this is noted in the table, it has not been included in the WRZ or company totals to avoid confusion.

Comparing the two datasets available shows that for Elmer and Kenley the site inflow data are different. It is also noted that the borehole flows for Kenley are estimated figures. It is recommended that the data for these two sites is investigated, and if necessary, the raw water losses should be updated.

Table 4 - Raw Water Losses Based on April 2015 to March 2016 Flow Data

Site	Average Borehole Abstraction (Ml/d)	Average Plant Input (Ml/d)	Average Raw Water Losses (Ml/d)
Cheam	46.39	44.73	1.66
Woodmansterne	27.18	26.77	0.41
Bough Beech	n/a	23.52 – not included in totals	n/a
Cliftons Lane	n/a	n/a	n/a
Elmer	30.79	30.88	-0.09
Godstone	6.79	6.43	0.36
Kenley	20.43	20.35	0.08
Westwood	3.99	3.90	0.08
Total	**135.57**	**133.07**	**2.50**