SOUTH WEST WATER

WRMP Support – Isles of Scilly Leakage Estimation

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1 INTRODUCTION

In support of South West Water's Water Resource Management Plan (WRMP) submission on leakage reduction scenarios, RPS were instructed to determine a leakage estimate for the Isles of Scilly (IoS). Due to limited timescales for analysis of network and consumption data for IoS, comparisons to the wider UK water industry were made to produce a scaled leakage prediction that aligns with that of areas with similar geography and location. RPS called upon available UK mainland and British Isles leakage data as well as extensive knowledge gained by performing leakage analysis for South West Water and many other UK water companies, including water companies with similar geography and network structure to that of the Isles of Scilly, over the last decade.

This document outlines RPS's approach to this task and details the data used in the analysis, the assumptions and methodologies employed to calculate leakage, and interpretation of the leakage prediction for the Isles of Scilly.

2 ISLES OF SCILLY DATA AND CHARACTERISTICS

SWW provided RPS with the data displayed below in Table 2.1 which contains the network characteristics at Island level for Isles of Scilly, as well as 6 monthly and seasonal distribution input (DI) averages. Please note that data supplied for St Marys covered a 4-month period though still included in the 6 monthly DI average. It should also be noted that distribution input data for St Marys was labelled as “total demand”. 4.31km of mains length couldn’t be assigned to an island using the DMA IDs provided so were categorised as “Unassigned”, but included in the IoS island total. Size is represented by the kJ metrics which provides an assessment of the number of joints in the system, this is explained in section 3.1.1.

Table 2.2 contains a breakdown of mains material by cohort and their corresponding length in kilometres. The material types BP (assumed to be Black Poly), AC, UPVC and U (assumed to be UPVC) are known to develop structural issues resulting in leakage breakouts. These materials form a significant proportion of the total network for IoS. However, it has been noted that the pipe diameters across the network may be categorised as small.

Weather data (Figure 2.1) has also been gathered by RPS to assist with the review of leakage and indicates that average temperatures for the islands do not drop below 6°C. This means that the network is unlikely to experience significant freeze thaw events which would result in leakage.

Table 2.1 Isles of Scilly Network Characteristics and Distribution Input

Island	Metering					Prop. Count	Mains Length (km)	Density (L/N) (m/prop)	Size (kJ)	6 Month Daily Avg. DI (Ml/d)	Summer Season Daily Avg. DI (Ml/d)
	AMI	AMR	Dumb	No Meter	Unable to Meter						
ST MARYS	723	117	10	118	223	1191	16.39	13.76	13.80	0.56	0.70
TRESCO	159	45	2	7	0	213	9.45	44.35	4.64	0.08	0.10
BRYHER	57	11	0	6	1	75	3.74	49.82	1.77	-	-
ST AGNES	5	26	0	0	0	31	2.64	85.25	1.10	0.01	0.01
ST MARTINS	26	4	0	0	0	30	1.79	59.75	0.81	0.01	0.02
Unassigned	-	-	-	-	-	-	4.31	-	-	-	-
Total	970	203	12	131	224	1540	38.32	24.88	23.55	0.67	0.83

Table 2.2 Isles of Scilly Mains Material Cohorts by Length

Cohort	Length (km)
AC	0.56
BP	12.47
CI	15.79
MDPE/PE80	8.37
MOPVC	0.01
U	0.03
UPVC	1.09
Total	**38.32**

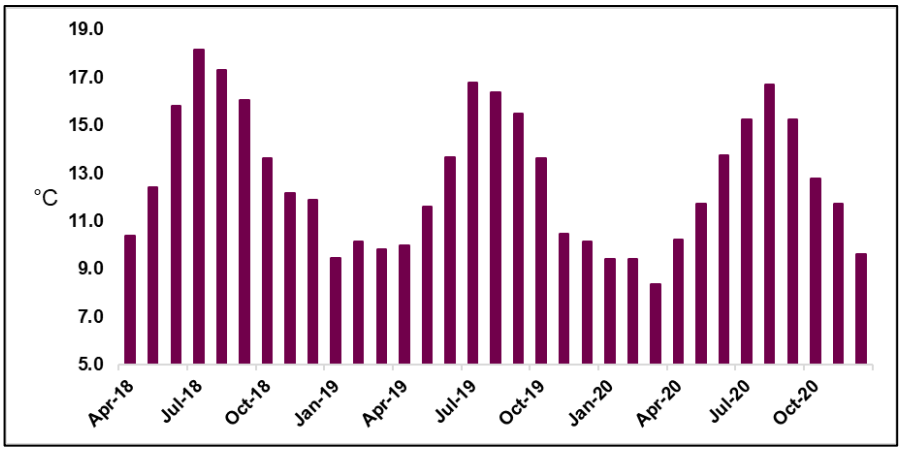

Figure 2.1 Isles of Scilly Monthly Average Temperatures - 2018/21

3 APPROACH

Due to a lack of available measured leakage and distribution network data for the Isles of Scilly (IoS) for this study, comparisons to the wider UK mainland and islands needed to be drawn to confidently estimate leakage. A range of mains characteristic and distribution network data from 19 UK and British Islands water companies was collated along with recent leakage performance levels and 2-3 year leakage performance averages, to portray a representative leakage picture of the UK water industry.

An assessment has been made using three approaches, namely Size (kj), property count and mains length as described below, a table summarising all of the industry information is provided in Table 3.1.

3.1.1 Size (kJ)

Using readily available IoS data provided by SWW, such as property counts and mains lengths, the 'size' (kJ) of each company could be calculated and allowed for Ml/kJ/d leakage values to be worked out. Some aspects of this analysis used size (kJ) to weight leakage averages so that scaling between IoS and the wider UK industry were fair. Using readily available IoS data provided by SWW it was possible to account for the variations in company network densities across the UK by normalising company data by the size (kJ) of the companies. Developed as part of the UKWIR Factors Affecting Background Leakage report[1], size (kJ) is a function that uses both the number of properties as well as the length of main, typically in a DMA, to calculate a sizing metric (see equation 1). This overcomes the need to normalise by property count or mains length, each of which have their inherent limitations due to network density factors.

$$\boldsymbol{Size\ (kJ) = (7\ .N + L\ /\ 3)\ /\ 1000} \qquad \boldsymbol{Equation\ 1}$$

Where: N = number of connections

L = length of the network in meters

Mainland UK size (kJ) values ranged from 1,592 to 51,231 contrasting with that of 139 to 1,010 on the British Isles. IoS size (kJ) was calculated to be 24 which is significantly less than the wider industry. The leakage ranged from 0.005 Ml/kJ/d to 0.02 Ml/kJ/d. Using the weighted average value to adjust UK leakage to IoS a result of 0.21 Ml/kJ/d was obtained.

3.1.2 Leakage per Property

Breaking leakage down to property level (l/p/d) is a useful metric when measuring leakage performance and is a suitable choice when comparing regions on a property count basis (see equation 2). Due to the nature of this project a l/p/d approach to predicting leakage is suitable for IoS. Describing leakage in this way allows for the data to be examined fairly despite potentially large differences in property counts between comparative areas.

$$\boldsymbol{Leakage\ per\ Property\ (l/p/d) = (\ L\ /\ N)\ /\ 10^6} \qquad \boldsymbol{Equation\ 2}$$

Where: L = leakage in Ml/d

N = number of connections

Property counts for UK companies range from 102,219 to 5,806,754 on the mainland and 7,826 to 33,867 on the Islands. Using properties as the descriptive factor results in a leakage range of 48.52 l/p/d to 138.92 l/p/d for UK mainland, and 90.84 l/p/d to 356.80 l/p/d for the Islands. The property count for IoS is 1540 and when weighted to a UK mainland and Islands weighted leakage average, results in a 0.15 Ml/d leakage prediction.

3.1.3 Leakage per Mains Length (km)

Calculating leakage per km of mains (see equation 3) helps to accommodate for possible undesirable differences in size or property counts between regions and companies, despite not accounting for mains

[1] Butler M., Grimshaw D., Factors Affecting Background Leakage, UKWIR 13/WM/08/49 (2012)

material type. Observing leakage at this level is a good measure of IoS leakage performance due to the assumed relationship between network lengths and leakage.

$$\boldsymbol{Leakage\ per\ Mains\ Length\ (m^3/km/d) = (L/N).1000} \qquad \boldsymbol{Equation\ 3}$$

Where: L = leakage in Ml/d

N = length of network in km

On the UK mainland, mains lengths range from 2629 km to 47354 km compared with 254 km to 2319 km on the Islands. The mains length on the IoS was calculated to be 38km with 43% located on St Marys alone. Using the IoS mains length with a UK mainland and Islands weighted leakage average resulted in a leakage prediction of 0.33 Ml/d.

Table 3.1 UK Mainland and Islands Water Company Leakage Performance

Company Ref.	Size (kJ)	Leakage (Ml/d/km)	Leakage (l/p/d)	Leakage (Ml/kJ/d)
A	34,084	4.93	63.21	0.0056
B	1,592	5.40	138.92	0.0089
C	22,946	7.66	99.17	0.0088
D	18,869	7.05	48.52	0.0052
E	45,674	8.76	97.10	0.0091
F	13,580	6.88	119.38	0.0093
G	51,231	20.02	109.46	0.0124
H	36,870	10.32	135.37	0.0119
I	19,982	6.12	110.91	0.0085
J	13,097	5.77	53.59	0.0053
K	27,040	9.50	130.08	0.0112
L	15,835	11.02	127.03	0.0117
M	6,036	5.49	71.04	0.0063
N	3,329	7.54	80.62	0.0076
O	3,220	7.07	85.20	0.0077
P	11,427	6.34	101.66	0.0082
Q	7,861			
R	340	6.46	90.84	0.0078
S-N	1,010	5.15	352.55	0.0118
S-E	826	2.40	195.86	0.0057
S-W	139	11.01	356.80	0.0200
Average	15,952	7.74	128.36	0.0092
W. Average		8.66	98.31	0.0091

4 RESULTS

In light of the anecdotally low leakage experienced on the Isles of Scilly and the low average DI it is recommended to use a value of 0.15 Ml/d as the draft average leakage value following the l/p/d approach. This equates to approximately 22.7% of DI, which is slightly lower than the UK national average.

A range of leakage predictions using the various methods described in section 3 are displayed in Table 4.1 and Table 4.2.

To more accurately predict leakage RPS advise that the leakage figures discussed are revised at a later date to take into consideration a more detailed review of the British Isles data, which may be more representative.

Table 4.1 Predicted Leakage for the Isles of Scilly derived from UK Mainland & Island Data

Approach	W.Avg. m3/km/d	W.Avg. l/p/d	W.Avg. Ml/kJ/d
Industry Data	8.66	98.31	0.0091
IOS Data	38.32 (Mains Length (km))	1540 (Properties (No.))	23.55 (Size (kJ))
Predicted Leakage (Ml/d)	**0.33**	**0.15**	**0.21**
% 6month Avg. DI	49.9%	22.7%	32.3%
% Summer DI	40.2%	18.3%	26.0%

Table 4.2 Predicted leakage for the Isles of Scilly derived from high level British Isles Island Data

Approach	W.Avg. m3/km/d	W.Avg. l/p/d	W.Avg. Ml/kJ/d
Industry Data	4.46	232.82	0.01
IOS Data	38.32 (Mains Length (km))	1540 (Properties (No.))	23.55 (Size (kJ))
Predicted Leakage (Ml/d)	**0.17**	**0.36**	**0.22**
% 6month Avg. DI	25.7%	53.9%	33.8%
% Summer DI	20.7%	43.4%	27.2%

5 DISCUSSION

By correlating the property count of the IoS to weighted average leakage values of UK mainland and British Isles, a scaled leakage estimate was obtained. The total leakage prediction for the IoS was calculated to be 0.15 Ml/d and was determined via a weighted average l/p/d assessment. This equates to 18.2% of DI during the summer months when demand is highest, and 22.6% of DI using a 6-month average. These %DI values are aligned with what would be expected on the UK mainland and instils a degree of confidence in the prediction.

Applying British Isles Islands data only is a valid approach when looking at the similarities they have to IoS in terms of customers and size, though it would result in a higher leakage figure, 0.36 Ml/d. It is thought that this result is unfairly influenced by some Islands which raises the importance of a more in-depth review of this data and potential revision of the IoS leakage value from this approach.

It is understood that average temperatures on IoS rarely drop below 6°C and although a large proportion of the mains materials in place are prone to leakage within the industry, the reduced possibility for freeze/thaw events combined with the small diameter nature of the network combine to indicate a low leakage level.

Although the approach taken here in calculating leakage is not typically recommended there is significant uncertainty in the leakage value provided given the nature of the data used. To more accurately predict leakage RPS advise that the leakage figures discussed are revised at a later date to take into consideration a more detailed review of the British Isles data, which may be more representative. However, the approach taken is robust given the timescales to undertake the assessment

A further recommendation is to undertake a detailed assessment of available DI data and consumption data from metering and smart metering to provide a flow balance assessment of leakage. Given the high meter penetration on the IoS it is likely that such a flow balance assessment will provide a considerably less uncertain leakage calculation and would be at the forefront of the UK water industry.