VEOLIA WATER PROJECTS LTD
DRAFT WATER RESOURCE MANAGEMENT PLAN 2024
ANNEX FIVE - LEAKAGE

Reducing leakage is an essential part of managing demand for water companies. OFWAT's new performance commitment requires water companies to reduce their leakage by 50% by 2050 (based on 2017/18) and by 16% by 2025.

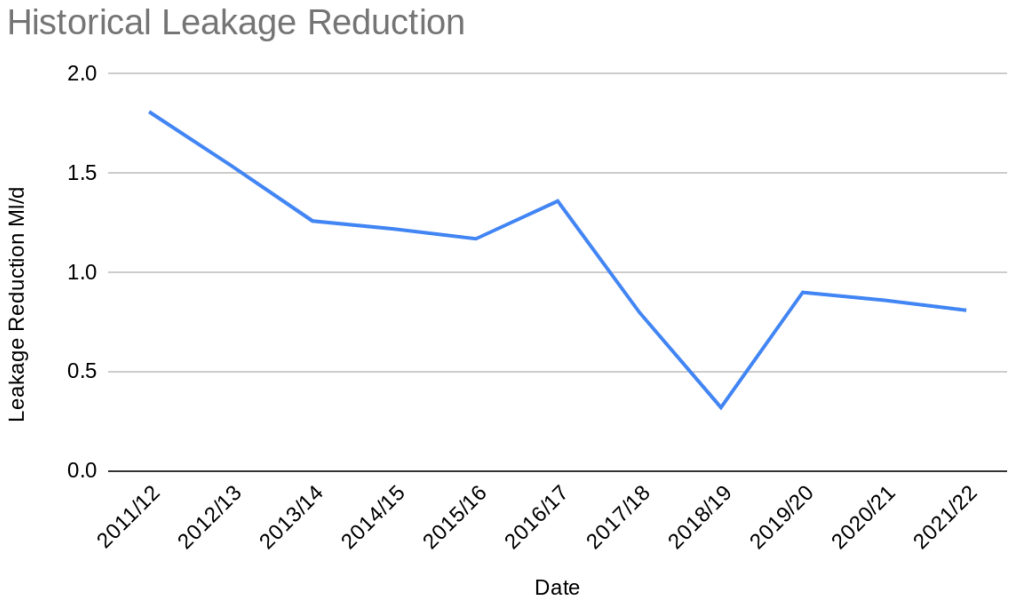
This appendix presents VWPL's long term leakage management plan for the Tidworth network to achieve the ambitious leakage targets.

1. Historical Leakage

Since commencing its operations, VWPL has continuously reduced the amount of water that leaks from the Tidworth network, as shown in Figure 1. From 2011/12 to 2021/22, VWPL reduced the overall leakage from 1.81 Ml/d to 0.81 Ml/d which represents a leakage reduction of 64%. This has been achieved through:

- An increase in metering coverage and the installation of AMR metering
- A review of the pressure management system
- Active leakage detection and leak repair campaigns

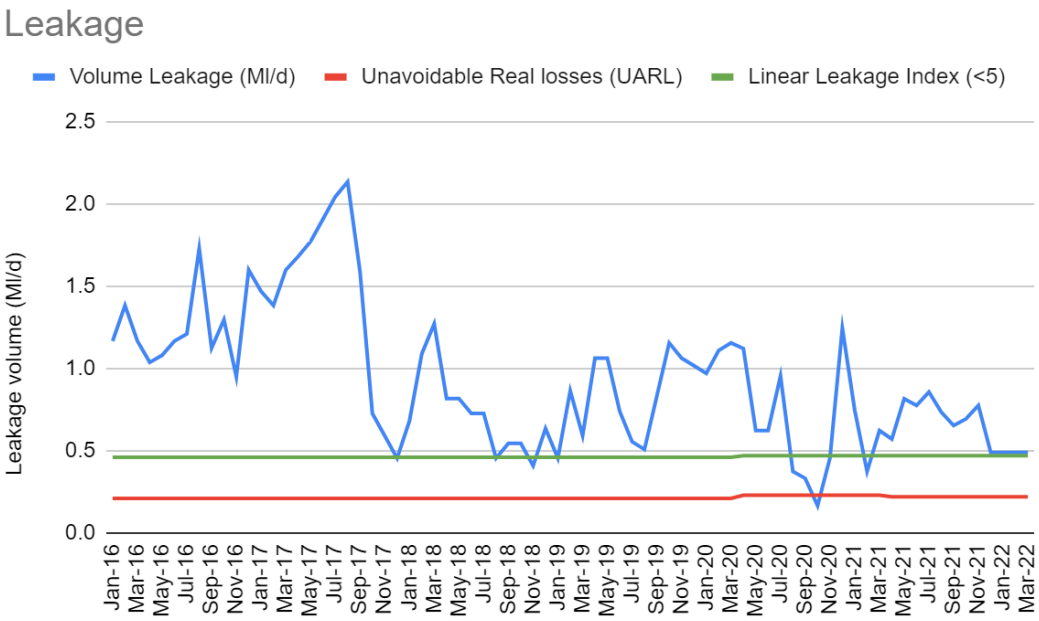
Figure 1 - Graph showing historical leakage*



Note: the values shown are annual regulatory returns

Figure 2 presents leakage volume from the Tidworth Network between Jan 2016 to March 2022.

Figure 2 - Graph showing leakage volume within the Tidworth Network from January 2016 to March 2022. *



*Note: ***Blue*** is actual leakage, ***Green*** is the Infrastructure Leakage Index (commonly used for VWPL international contracts) and ***Red*** is the Unavoidable Real Losses (the best that could theoretically be achieved by employing maximum resources). In addition, figures are taken from the annual regulatory returns.*

1.1. Network Metering

In accordance with the regulatory guidelines on reducing leakage within water supply networks, VWPL has continued increasing the metering coverage within its network during the WRMP19 cycle, in order to achieve more control over excessive water usage.

Following water industry best practice, the Tidworth distribution network has been divided into district metering areas (DMAs) to facilitate demand monitoring and efficient leakage management. There are currently 18 DMAs AMR metered in Tidworth and 5 AMR meters monitoring the bulk water supply to Leckford Bridge, the water supply into the Wessex Water enclaves and housing association properties.

Over the past 10 years, VWPL has installed more than 2,000 Automated Meter Reading (AMR) meters on the regulated network and more than 1,000 AMR meters on the MOD network operated under the Tidworth PFI. Approximately 84% of domestic households are metered in VWPL's Water Resource Zone (WRZ). All non-household properties (excluding the MoD) are also metered.

All AMR meters are managed through a meter management platform which highlights excessive or continuous water usage. This enables VWPL to respond quickly to potential leaks and liaise with customers with high or continuous water consumption.

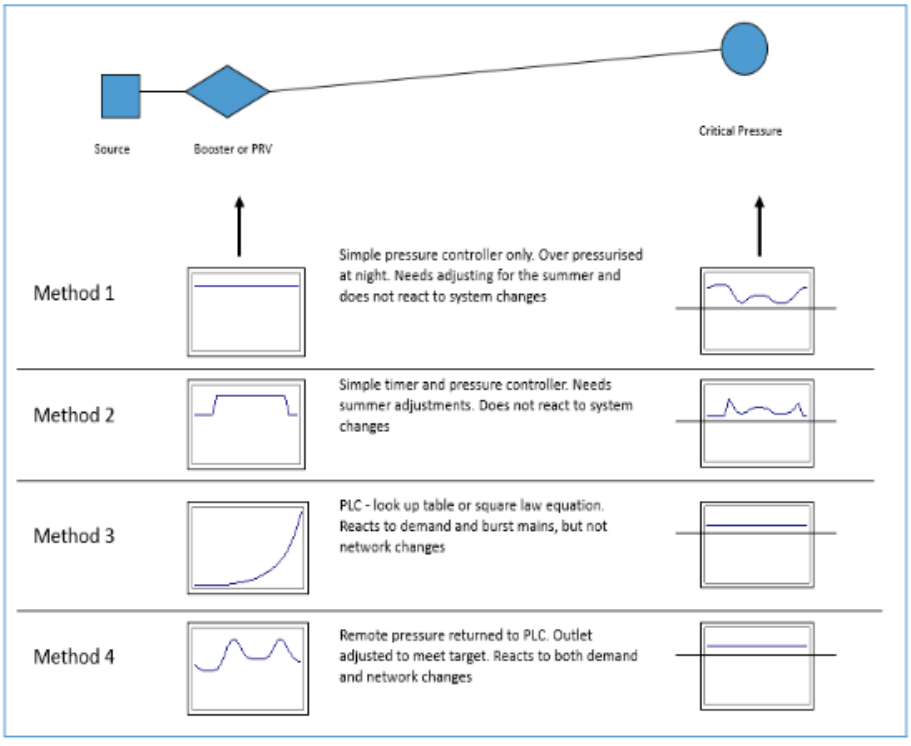
The metering infrastructure does not enable full monitoring of the water supply/consumption to/from the MOD garrisons. It provides only a limited picture of overall MOD consumption which is a challenge when trying to establish MOD usage. VWPL will install additional meters at the boundary of Perham Down and Tidworth Garrisons before the WRMP24 period starts (this is presented in more detail in section 6.3.3.3 of annex 1).

1.2. Pressure Management

The average pressure within the Tidworth network is approximately 49 metres head (m/h) and the pressure is maintained by three pressure management systems - Pressure Reducing Valves (PRVs). The PRVs operate on a fixed delivery pressure control, as shown in method 1 in Figure 3.

The installation of these PRVs has ensured that water pressure in the network is at an optimum level to ensure sufficient and efficient supply to customers, while reducing unnecessary excess pressure and pressure fluctuations which cause unnecessarily leakage (bursts and background leaks). VWPL believes that there is potentially an opportunity to further reduce pressure within the network; this will be investigated over the WRMP24 period.

Figure 3 - Diagram of the pressure management system within the Tidworth Network



2. Leakage Assessment

2.1. Leakage Reporting

VWPL leakage figures reported in VWPL Annual Returns are calculated using Netbase, Crowder & Co Ltd leakage management software.

Netbase collates meter readings and models water consumption and leakage across the potable water network operated and maintained by VWPL under its Inset appointment, to an industry standard degree of accuracy.

Meter readings are collected either manually by VWPL water technicians or automatically using Automated Meter Readings (AMR), and then reported into Netbase. The system calculates water use for PFI customers (MoD buildings, Service Families Accomodations and third party properties) and regulated customers using water industry standard methodologies.

Wherever meters and/or AMR meters are not available, domestic and non-domestic night water usage is estimated using a consumption model developed by Veolia Water and Crowder & Co Ltd, the leakage consultant.

2.2. Leakage Reporting Methodology

In its final reporting guidance for PR19, OFWAT has asked water companies to report leakage using a consistent methodology using “OFWAT Reporting guidance – Leakage”.

During the preparation of WRMP24, VWPL identified that the current version (23) of Netbase, Crowder & Co Ltd software used by VWPL was not fully compliant with the most recent OFWAT leakage reporting guidance which requires:

- Using a fixed Minimum Night Flow period (MNF) - *currently VWPL used the minimum night flow period between 00:00 and 06:00*
- Using a fixed MNF period for calculating night use allowances - *currently VWPL used the average night use between 00:00 and 06:00*
- Calculating Hour to Day factor (HDF) using pressure monitoring data - *currently VWPL has fixed the HDF at 22.84*
- Reporting DMA Availability - *currently VWPL reports only DMA operability*
- “Data infilling” when a DMA is not operable - *currently different estimation methodology used*

Therefore, VWPL commissioned Crowder & Co Ltd to assess the impact of updating the leakage reporting system to ensure compliance.

2.2.1. Netbase

The calculation performed within Netbase to report on the volume of supply lost within the Tidworth network is illustrated in Figure 4.

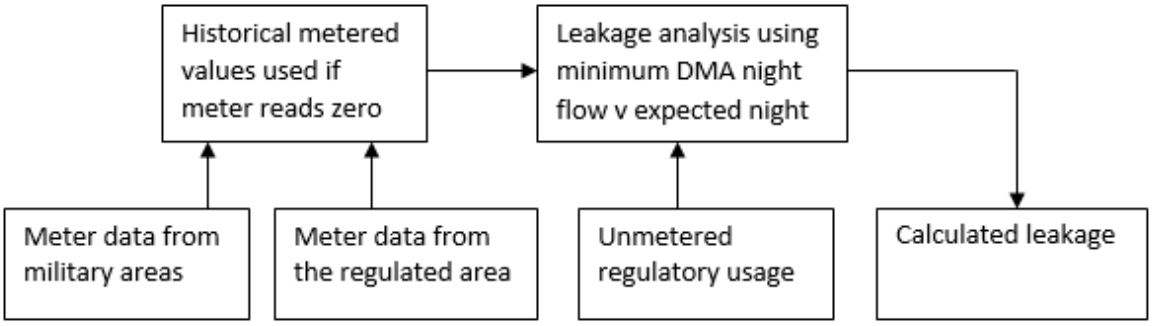
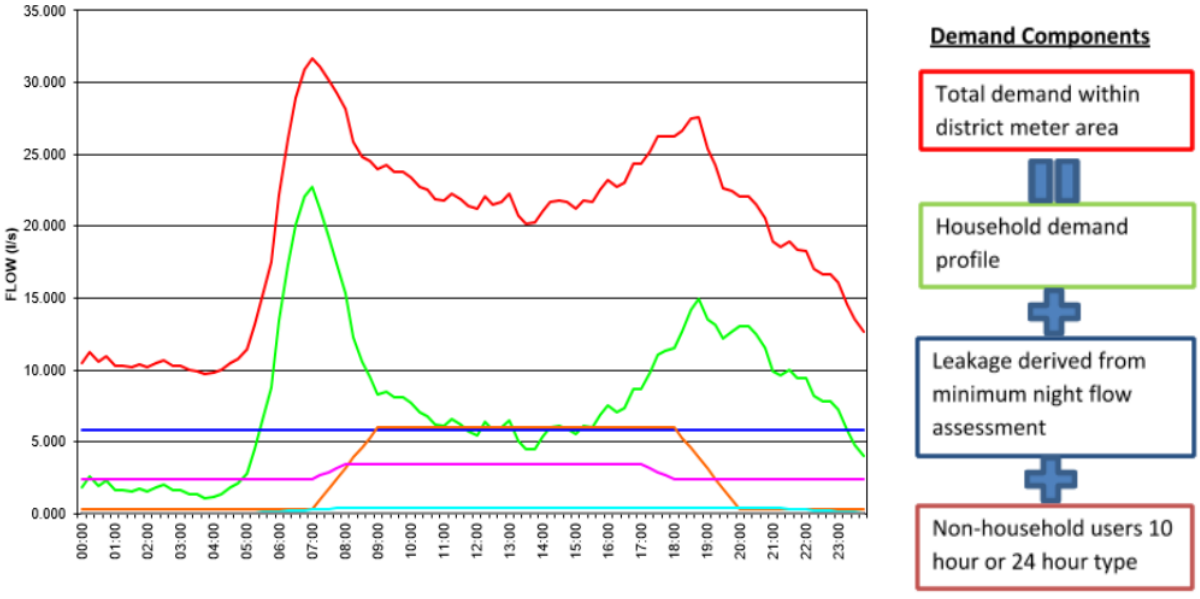


Figure 4 - Flow chart illustrating how VWPL recover leakage data from the network.

Although this is an approved method of establishing leakage, there are limitations on the calculation for PFI customers (MOD buildings, and Service Family Accommodation) usage within the Tidworth Network which is typically recovered from the district meters, and there are a number of uncertainties, including:

- Accuracy of metered flows into district meter areas (**red** line on Figure 5).
- Household demand and night usage (**green** line on Figure 5).
- Leakage calculated from minimum night flow (**blue** line on Figure 5).
- Non-household demand profile (**brown** line for the 10 hour profile and the **purple** line for the 24 hour profile).

Figure 5- Graphical representation of the assumptions/uncertainties associated with the leakage



Note: yhe **orange** and **light blue** lines are not relevant for the assessment and are therefore not considered further.

Then, leakage is further corrected using a Minimum Night Flow (MNF) and Hour Day Factor (HDF) adjustment multiplying factor as the night pressure is higher than the pressure encountered during the day.

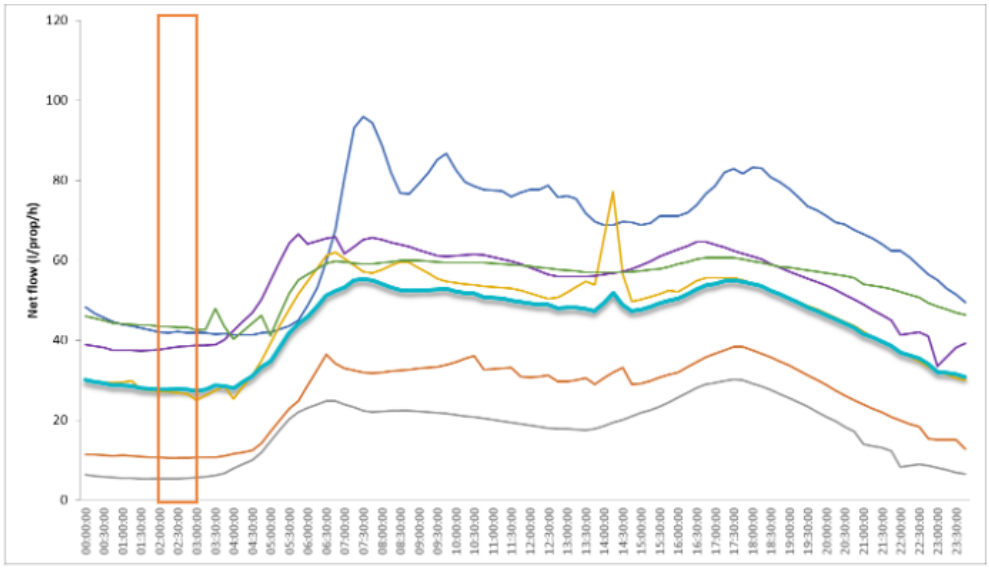
2.2.2. Non-compliance Impact Assessment

As mentioned above, the current methodology used by the version of Netbase used by VWPL is not fully compliant with the latest OFWAT guidance. VWPL requested Crowder & Co Ltd to assess the impact of updating the leakage reporting system to the latest reporting requirements.

Minimum Night Flow Period

First of all, VWPL needed to establish its fixed Minimum Night Flow (MNF) period instead of using the rolling lowest hour between 0.00 and 06.00 am MNF. This was established as the hour between 2 am and 3 am for the Tidworth network, as shown in Figure 6.

Figure 6 - Graph showing night usage*



Graph produced by Crowder & Co Ltd on behalf of VWPL. The **Blue line represents Tidworth Garrison, and other lines represent other Veolia operating areas not relevant to the VWPL Tidworth Inset.*

Given the extent of AMR metering in Tidworth, fixing the MNF period to the hour between 2 and 3 a.m. resulted in an increase of the MNF.

Household (HH) Night Usage

Crowder & Co Ltd subsequently assessed the change to the current Household Night use for the network in accordance with the agreed fixed MNF period and the AMR property data for the Tidworth network from April 2021 to March 2022 (Figure 7).

Figure 7 - VWPL AMR property data from the active Tidworth network*.

* It should be noted that some properties in the Tidworth network were excluded from the AMR data due to stopped meters, continuous flow (leak/plumbing losses), high intermittent usage, erroneous data points/data gaps.

	Count	Sample	%
Detached	528	93	18%
Semi-Detached	3375	1968	58%
Terraced	3108	683	22%
Flats	472	62	13%

The measured Household Night use between 2 and 3 a.m., was consistently lower than the previous average night use between 12 to 6 a.m., as shown on Figures 8 and 9.

Figure 8- Graph showing the night usage within the Garrison DMA.

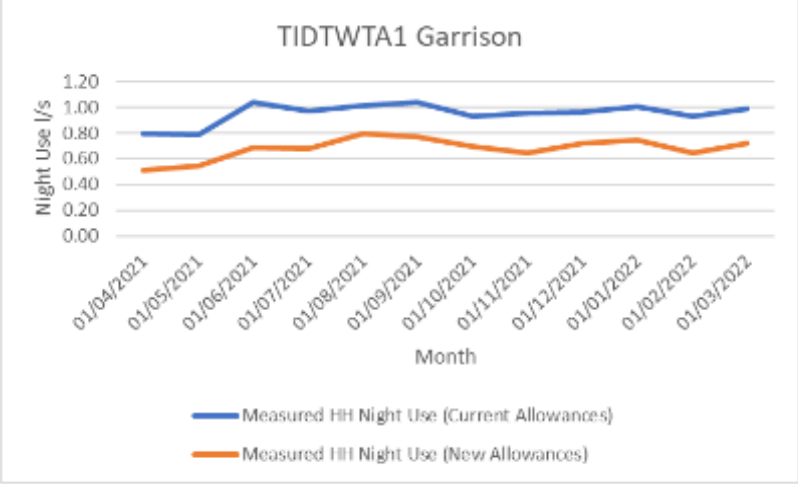
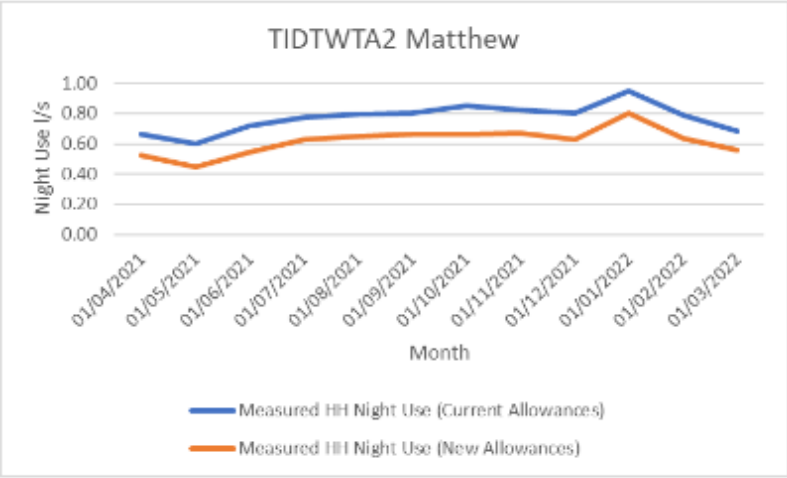


Figure 9 - Graph showing night usage within Mathew DMA.



Given the extent of AMR metering in Tidworth, the average HH night use was higher than the HH night use measured between 2.00 and 3.00 a.m.

Non-Household (NHH) Usage

Non-Household night use is more difficult to predict than household night use as most households have a similar pattern that can create a diurnal profile. Non-Household night use varies a lot between commercial types and within types, due to unknown factors such as occupancy and water usage patterns.

The introduction of the fixed Minimum Night Flow period from 2 am to 3 am was expected to have a negligible impact on Non-Household night usage.

Hour to Day Factor (HDF)

VWPL has used a HDF figure of 22.38 based on previous monitoring data. Given that the data has not been updated recently taking into account the actual pressure in the network, this HDF value was not considered to be compliant. So, VWPL carried out pressure monitoring of the network using pressure loggers and recorded the pressure for three weeks.

The data was shared with Crowder & Co Ltd and they established that there was minimal pressure variation in the Tidworth network between day and night (linked to the current pressure management system in place). The HDF for the network was updated from 22.35 to 23.5.

In summary, the compliance impact assessment for the Tidworth network equates to an overall increase in night leakage within the Tidworth network due to:

- A slight increase in HDF from 22.35 to 23.50.
- An increase in MNF due to the implementation of the fixed hour between 2 am to 3 am.
- A decrease in measured Household Night use due to implementation of the fixed hour between 2 am and 3 am.

- A negligible change in measured Non-Household Night use due to the implementation of the fixed hour between 2 am and 3 am.

When the updated findings of the leakage assessment were input into the existing project database, the following leakage figures for 2021/22 were generated, as shown on Figure 10.

Figure 10 - Comparison of the leakage figures calculated by Netbase 23 (current version) and Netbase 26 (compliant version)

Daily leakage (m3/day)				Ratio current/ proposed
Month	*Netbase V.23*	*Netbase V.256*	No. of days	
Jan 2022	412.28	669.19	30	0.6161
Feb 2022	665.78	1541.45	31	0.4319
Mar 2022	539.94	956.77	30	0.5643
Apr 2022	897.07	1126.78	31	0.7961
May 2022	829.70	1102.02	31	0.7529
Jun 2022	775.95	1005.42	30	0.7718
Jul 2022	685.81	1072.96	31	0.6392
Aug 2022	726.69	1105.05	30	0.6576
Sep 2022	545.43	1122.90	31	0.4857
Oct 2022	542.28	1253.23	31	0.4327
Nov 2022	527.35	1216.36	28	0.4335
Dec 2022	613.15	1226.52	31	0.4999
Average	**648.13**	**1117.73**	-	**0.5799**

2.2.3. Proposed revised 2017/18 Baseline

Based on the comparison figures presented above and following the Water UK Final Leakage methodology and the EA's supplementary WRMP24 guidance, VWPL has revised the 2017/18 baseline and WRMP24 leakage targets and submitted them to OFWAT for approval.

Applying the new guidance to the existing data set resulted in an increase in VWPL's estimate of leakage in the base year from 0.8 Ml/d to 1.35 Ml/d, as outlined in Figure 11. Those revised leakage figures and targets have been used for the WRMP24 baseline.

Figure 11 - Updated figures in accordance with OFWAT guidance.

	Leakage reported for 2017/18	Revised leakage for 2017/18	16% reduction by 2025	50% reduction by 2050
l/prop/d	249.09	429.57	360.84	214.78
Ml/d	0.8	1.38	1.16	0.69

The user supply pipe leakage (USPL) figures for the WRMP24 cycle have also been updated in accordance with the new OFWAT guidance and the data has been presented in both the planning tables.

3. Infrastructure Leakage Index

The Infrastructure Leakage Index (ILI) is a recognised method within the water industry for comparing leakage performance within supply networks. The ILI leakage performance method is considered to be appropriate for VWPL as it will take into account the uncertainties surrounding MoD influence within the network, i.e infrastructure and consumption.

This method involves calculating and applying the Unavoidable Annual Real Losses (UARL), which measures the lowest leakage rate that can economically be achieved within a water supply network. It takes into account the structure of the network modified by the average operational pressure across the network.

The application of UARL will be appropriate for VWPL as it takes into consideration the following factors:

- The structure of the VWPL operated network which is heavily influenced by the MoD and their activities.
- The operation of the network at a consistent average pressure of 49m/h which is due to the requirements of the Crown Fire Standards (requiring 20 l/s flow at 10 m).

The UARL figure for a selection of time slices within the statutory planning period is shown in Figure 12.

Figure 12 - The UARL and ILI figures for the Tidworth Network at varying time slices.

	Unit	2022/23	2023/24	2024/25	2025/26	2030/31	2034/35	2044/45	2049/50
Main	Km	93.76	93.8	93.82	93.86	94.058	94.058	94.058	94.058
Total Connections	no.	3813	4119	4168	4218	4231	4233	4237	4237
Service pipe*	m	0	0	0	0	0	0	0	0
Average Operating Pressure	m/h	49	49	49	49	49	49	49	49
UARL	L/d	232166	244196	246135	248130	248814	248893	249050	249050
UARL	Ml/d	0.23	0.24	0.25	0.25	0.25	0.25	0.25	0.25
ILI	Ml/d	3.70	3.52	3.49	3.47	3.46	3.46	3.45	3.45
* For the purpose of this assessment, VWPL has assumed that the meter is connected direct to the mains.									

The ILI for time slices within the statutory planning period is also shown in Figure 15 and ranges from 3.70 Ml/d within 2022/23 to 3.45 Ml/d in 2049/50. When these figures are compared with the industry performance metric standard (Figure 13), the network is classified as Category B. This represents a ‘Good’ standard and as such no urgent action is required, although the network should be monitored carefully in accordance with industry guidance.

Figure 13- The ILI metric standard.

Technical Performance Category		ILI	Litres/connection/day (when the system is pressurised) at an average pressure of:				
			10 m	20 m	30 m	40 m	50 m
Developed Countries	A	1 - 2		< 50	< 75	< 100	< 125
	B	2 - 4		50-100	75-150	100-200	125-250
	C	4 - 8		100-200	150-300	200-400	250-500
	D	> 8		> 200	> 300	> 400	> 500

4. Linear Leakage Index

The Linear Leakage Index (LLI) is used by Veolia to compare international contracts around the world, including contracts in mainland Europe.

VWPL typically calculates LLI using the following formula:

$$\text{LLI} = \frac{\text{Volume of leakage per day}}{\text{network (mains) length}}$$

The calculated LLI for the Tidworth network across varying time slices within the statutory planning period is shown in Figure 14.

Figure 14 - The LLI figures for the Tidworth Network at varying time slices.

	Unit	2022/23	2023/24	2024/25	2025/26	2030/31	2034/35	2044/45	2049/50
Leakage Volume	m3/d	1117	1100	1074	1029	845	770	545	420
Main	m	94	94	94	94	94	94	94	94
LLI		11.92	11.73	11.45	10.97	8.98	8.19	5.79	4.47

This calculated data can then be assessed in accordance with the following performance table (Figure 15). VWPL has considered the network to be classified as semi-urban due to the number of connections per km and the current network density.

Figure 15 - the LLI performance table.

Environment	Rural	Semi-Urban	Urban
Good	LLI < 1,5	LLI < 3	LLI < 7
Satisfactory	1,5 < LLI < 2,5	3 < LLI < 5	7 < LLI < 10
Border Line	2,5 < LLI < 4	5 < LLI < 8	10 < LLI < 15
Bad	4 < LLI	8 < LLI	15 < LLI

The predicted LLI value varies from 11.9 in 2022/23 to 4.46 in 2049/50. The 2022/23 LLI value has increased from the value of 7.95 that was recorded within the WRP19 due to the use of the revised leakage figure (compliant with latest OFWAT guidance) .

Using the information presented in Figure 16, the Tidworth network would be classified as bad in 2022/23 improving to satisfactory in 2049/50 when compared to other contracts using the LLI leakage performance method.

5. User Supply Pipe Leakage (USPL)

Another aspect of the leakage assessment for the Tidworth network is User Supply Pipe Leakage (USPL), which relates to leakage that occurs within a customer supply pipe after the meter but before the boundary on the customer property.

Any leakage that occurs after the meter within the customer property will not influence the calculation of Per Capita Consumption (PCC) or of the distribution losses but will directly impact the total leakage figure.

Assessing USPL on site through a detailed physical survey of the customer connections would be prohibitively expensive. Therefore, VWPL calculates a theoretical leakage figure per service connection (as shown in Figure 16), assuming that service pipes leak at the same rate as distribution mains.

Figure 16 - USPL figures for the Tidworth network at varying time slices.

	Unit	2022/23	2023/24	2024/25	2025/26	2030/31	2034/35	2044/45	2049/50
Total USPL	Ml/d	0.285	0.281	0.281	0.272	0.218	0.199	0.141	0.109
Metered NHH - USPL	Ml/d	0.008	0.028	0.028	0.027	0.022	0.020	0.014	0.011
Unmetered NHH - USPL	Ml/d	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Metered HH - USPL	Ml/d	0.131	0.218	0.219	0.213	0.179	0.163	0.115	0.089
Unmetered HH - USPL	Ml/d	0.026	0.034	0.034	0.032	0.018	0.016	0.011	0.009

6. Leakage Management Improvement Plan

VWPL has a programme of improvements in place to enable compliance with OFWAT leakage targets: 16% reduction by 2025 and by 50% by 2050. During the last WRMP cycle the following initiatives were rolled out:

- Effective pressure management system operated at 49m/h.

  VWPL has installed Pressure Reducing Valves in the distribution network. This has enabled VWPL to reduce unnecessary excess pressure and eliminate pressure fluctuations which cause unnecessary leakage (burst and background leaks).

- Replacement of old customers meters and installation of further AMR metering.

New housing developments are required to install meters compatible with VWPL's AMR system. The integration of the AMR data into VWPL's leakage management software enabled to improve the accuracy of the leakage figure.

- Validation of District Meter Areas (DMAs) and replacement of DMAs meters.

  In 2020/21, VWPL completed a validation of the consumption assumptions of its leakage management system - including property counts, validation of the metering information and integration of available AMR data, to improve the accuracy of leakage figures.

- Appointment of a Leakage Coordinator, responsible for leakage monitoring, targeting and leading leakage detection activities and the resolution of leakage issues.

- Implementation of a replacement programme of ageing ferrule valves (valves connecting the water main to the service connections).

  Over the past few years, failures of ageing ferrules valves resulted in leaks and bursts on the network. The proactive replacement programme will enable VWPL to prevent such events.

- High consumption notification.

  VWPL notifies customers with high consumption of the potential presence of a customer-side leak. VWPL can then offer technical assistance in leakage detection and repair.

In addition to the above, VWPL's clean water operations team holds regular meetings with VWPL asset management to discuss life cycles of water mains within the active network. The mains are categorised in accordance with the number of incidents that occur on one stretch of main pipework.

During the next WRMP cycle, VWPL will continue reducing leakage by implementing the following programme of works:

- Continue the ferrule valve replacement programme.
- Continue the installation of AMR customer meters and the integration of AMR data into the leakage management software.
- Enhance and support the reporting and resolution of customer side leaks by increasing the follow-up on high water consumption (including within Service Family Accommodation areas).
- Continue the replacement of DMA meters.
- Increase leakage monitoring and detection led by VWPL Leakage Coordinator
- Review the pressure management system.

  VWPL will investigate the opportunity to reduce the current operating pressure of 49m/h to 40m/h which could enable the reduction of background leakage and subsequently reduce the occurrence of bursts. This is subject to being able to maintain the Crown Fire Standard requirement of 20 l/s within hydrants.

Through the implementation of these initiatives, VWPL forecasts to achieve the OFWAT leakage targets with a predicted leakage figure of 1.08 MLd in 2025/26 (against a leakage target of 1.16 Ml/d) and 0.63 Mld in 2049/50 (against a leakage target of 0.69 Ml/d).