Managing leakage by District Metered Areas: a practical approach

● This article, by **JOHN MORRISON**, is the fifth in a special series of articles for *Water21* by the IWA Water Loss Task Force. It highlights the work being undertaken by the DMA Manual team to produce an international manual to assist leakage practitioners implementing leakage control by district metered areas (DMAs) or 'sectorization'.

The scope of this series of articles, 'A Practical Approach to Water Loss Reduction', was recently outlined in *Water21* by Ken Brothers[1], Chair of the IWA Water Loss Task Force. This article outlines the role of district metered area management as an effective leakage control methodology and the aims and objectives of the IWA Water Loss Task Force in producing an international DMA manual.

In Richard Pilcher's recent article (*Water21*, December 2003) on leak detection practices and techniques he referred to Sextus Julius Frontinus, Water Commissioner to Rome in 90 AD, who used a crude measuring device to determine leakage in the system. Many advances have been made since Roman times, but leakage occurs even in the newest distribution system and leakage engineers require a range of equipment and techniques to measure, control and reduce leakage in today's networks.

One of the options, which has proved highly successful in particular in the UK - where it was originally promoted - is

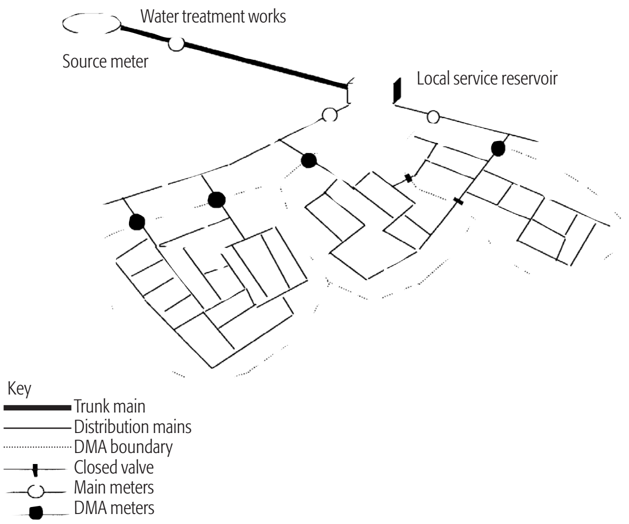

Figure 1. Division of Distribution Network into DMAs

leakage control using what are termed district metered areas (DMAs). The concept of DMA management was first introduced to the UK water industry in the early 1980s, in UK Report 26[(2)], where a district is an area of a distribution system which is specifically defined, e.g. by the closure of valves, and in which the quantities of water entering and leaving the district are metered as shown in Figure 1. The subsequent analysis of flow, particularly of the night flow, calculates the level of leakage within the district. This is to determine not only whether work should be undertaken to reduce leakage, but also to compare levels of leakage in the different districts to assess where it is most beneficial to undertake leak location activities.

Since Report 26 was first published, the UK water industry has done considerable work to improve the understanding of leakage by DMA management. The industry's research group UKWIR has produced the following collaborative documents dealing with key issues affecting DMA leakage management within the UK water industry:

- UK Water Industry Managing Leakage - Interpreting Measured Night Flows (1994)
- UK Water Industry Managing Leakage - Using Night Flow Data (1994)
- Manual of DMA Practice 1999
- Leakage Estimation from Night Flow Analysis 1999
- The Natural Rate of Rise of Leakage 1999
- Estimating Legitimate Non-Household Night Use Allowances 1999
- Household Night Consumption 2002
- Background Leakage 2003
- Service Pipe Leakage 2003

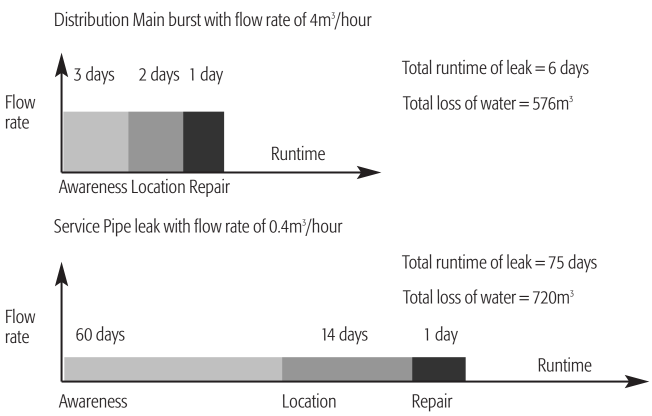

Figure 2 Effect of burst duration on total leakage

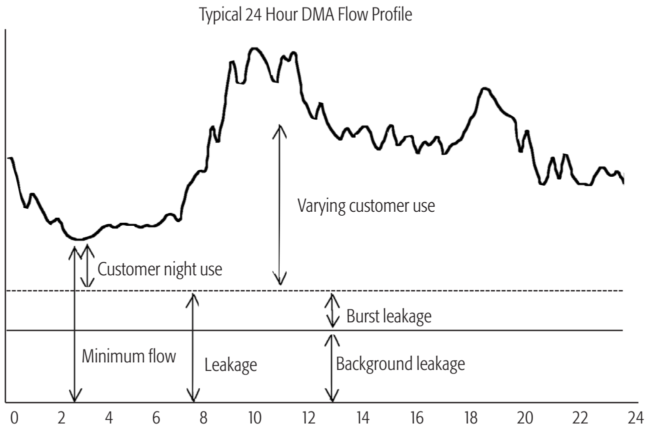

Figure 3. A typical 24 hour flow profile of the components of leakage and customer use

Aim of the IWA Manual

The IWA manual is aimed at staff that have little or no experience of leakage control using DMAs. It will draw on the experience of international leakage practitioners to pull together the key essentials of best practice and outline the

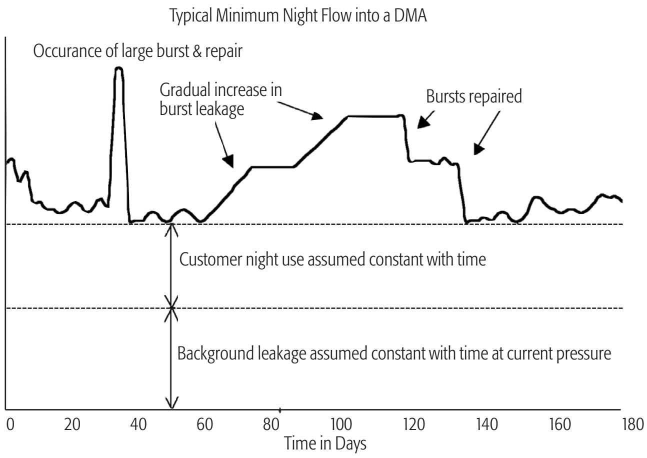

Figure 3. 4. UK Water Industry Managing Leakage (1994), Engineering & Operations Committee Reports A- J

technical understanding behind DMA management. The manual should be seen as a starting point, and the influence of local variations must always be considered.

Whilst the manual will outline best practice, we should remember that DMA methodologies and flow data analysis techniques have been highly developed by many water utilities over many years. For example, systems such as geographical mapping systems have been customised to provide data to support DMA design and management. The manual is therefore intended to provide guidance to a staged approach to best practice, which will provide an appropriate route to the key actions required to start implementing leakage control by DMA management.

The role of DMA management

The key to effective management of leakage using DMAs is to have a clear understanding of the theory of leakage. Leakage is split into two main components - background leakage and annually occurring bursts (sometimes referred to as breaks). [(3)(4)]

Background Leakage is the aggregation of sources of loss from all fittings on the network that are individually too small to be detected.

Burst Leakage is the loss of water resulting from annually occurring holes/fractures in the network pipework, including customer service connections, which can be located using a range of specialised equipment.

The role of DMA management is to divide the distribution network into manageable areas or sectors into which the flow can be measured to determine whether bursts are present. The duration of water being lost is kept to a minimum by analysing the flow data so that the leakage practitioner is aware as early as possible that bursts have occurred. The total volume of water lost is:

Burst leakage =(the rate of flow) x (the length of time over which the break/burst has occurred)

The detailed analysis of the flow in the DMA enables the leakage practitioner to identify when the incidence of a burst has occurred and to plan work to locate and repair the failure. It is the frequency of this analysis followed by location and repair work that will limit the loss of water. It should be noted that depending on the nature of the network a large percentage of bursts will be reported to the utility as water seeps or gushes to the surface or causes reduction of network pressure. Often this apparent activity, dealing with a large number of reported bursts, leads a water utility to wrongly consider that it is dealing effectively with leakage.

Figure 2 shows the importance of dealing with bursts other than those reported by the public. The total runtime of larger (reported) burst tends to be much less than that of the smaller bursts. The much longer awareness and location time of these smaller bursts can in a lot of cases lead to higher overall losses.

Introduction of DMAs

DMAs are often used as a tool to control and drive down leakage in networks that have received little or no leak location work other than dealing with reported occurrences. Initially the DMAs will be used as a tool to determine which parts of the network are experiencing the highest level of leakage and to discount areas where there is limited leakage, so that resources can be targeted to the greatest effect. As work progresses and bursts are located and repaired, the success of this work can be measured at a local level, as initially the impact of the work is unlikely to be perceived within the larger network.

The manual aims to provide broad guidance on how DMAs should be designed and the key parameters that should be taken into account. One area that is not always fully linked to DMA management is that of pressure management. Julian Thornton's article Managing Leakage by Managing Pressure (*Water21*, October 2003) clearly identified the relationship between leakage and pressure and the potential leakage savings to be made. What is common to the introduction of pressure management and DMA management is the requirement to define the area of the network, to close the boundaries and to measure the inflows and outflows - whether for DMA analysis or to control inlet pressures. Clearly where the topography dictates, the planning of Pressure Management Areas (PMAs) and DMAs should be undertaken as one overall concept, although implementation of one stage may come before the other.

As work progresses and leakage is reduced in the established DMAs, the purpose of the analysis switches to a monitoring role, where the flow into the DMA is monitored to ensure early identification of new bursts, which will trigger the need for new leak location work. In many instances where the ongoing requirement of DMA management has not been implemented, the early leakage savings have been lost due to the occurrence of these new ongoing bursts not being dealt with.

Many water utilities have integrated DMA data capture into their SCADA (supervisory control and data acquisition) systems. This provides ease of data capture and availability of additional flow data to assist in the resolution of network problems. This approach has proved particularly effective when it is implemented together with a sophisticated analysis package that provides the leakage practitioner with guidance to which DMAs require leak location work.

Estimating leakage

Best practice analysis of DMA flows, requires the estimation of leakage when the flow into the DMA is at its minimum. This typically occurs at night when customer demand is at its minimum and therefore the leakage component is at its largest percentage of the flow.

Techniques are now available to analyse the minimum night flow to estimate the level of leakage and additionally to split this estimate into background and burst volumes as shown in Figure 3.

The analysis of leakage is based on the minimum night flow, which can be recorded and analysed continuously night after night with the use of data loggers and appropriate software. This analysis enables the leakage practitioner to monitor the DMA or groups of DMAs for the occurrence of new bursts and their subsequent repair, as shown in Figure 4.

Based on this analysis, summary reports of estimated leakage from bursts in individual DMAs can be developed to provide the leakage practitioner with a schedule of leakage that can be reduced. This reduction can be represented as a volume of water, a potential number of bursts that can be found, an estimate of the cost of leakage that is being lost, or a ranking system developed to suit local conditions. When fully developed this analysis will enable a leakage practitioner to monitor a large number of DMAs effectively and focus work in key DMAs, which will generate most benefit from leak location.

The level of leakage can be further confirmed by a 'top down' assessment of leakage. This analysis requires an assessment of customer use, which is subtracted from the total flow into the area to estimate leakage. In most instances this leakage volume, measured over a period of 6 to 12 months, will be compared with the aggregate of leakage from DMAs in the same area.

Whilst the above analysis of night flow represents best practice guidance, the manual will outline possible interim approaches, so that analysis can be carried out in the interim to enable leak location targeting to progress whilst additional data is gathered. This may take several years.

Assistance

The small team currently working on the manual would welcome additional participation from leakage practitioners. In particular we are looking for examples of DMA management and details of any work undertaken on assessing customer night use on networks outside the UK.

Please contact Ken Brothers, Chair of the WLTF at: Kenb@hrwc.ns.ca if you feel you can offer such information. ●

References

1. Brothers, K.J. A practical approach to Water Loss Reduction. Water 21, 2003 54-55

2. Report 26 Leakage Control Policy & Practice (1980), UK Water Authorities Association

3. Lambert A.O. and Morrison J.A.E. (1996) Recent Developments in Application of Bursts and Background Estimates Concepts for Leakage Management. Water & Environmental Management Journal volume 10 No2 April 1996

4. UK Water Industry Managing Leakage (1994), Engineering & Operations Committee Reports A- J