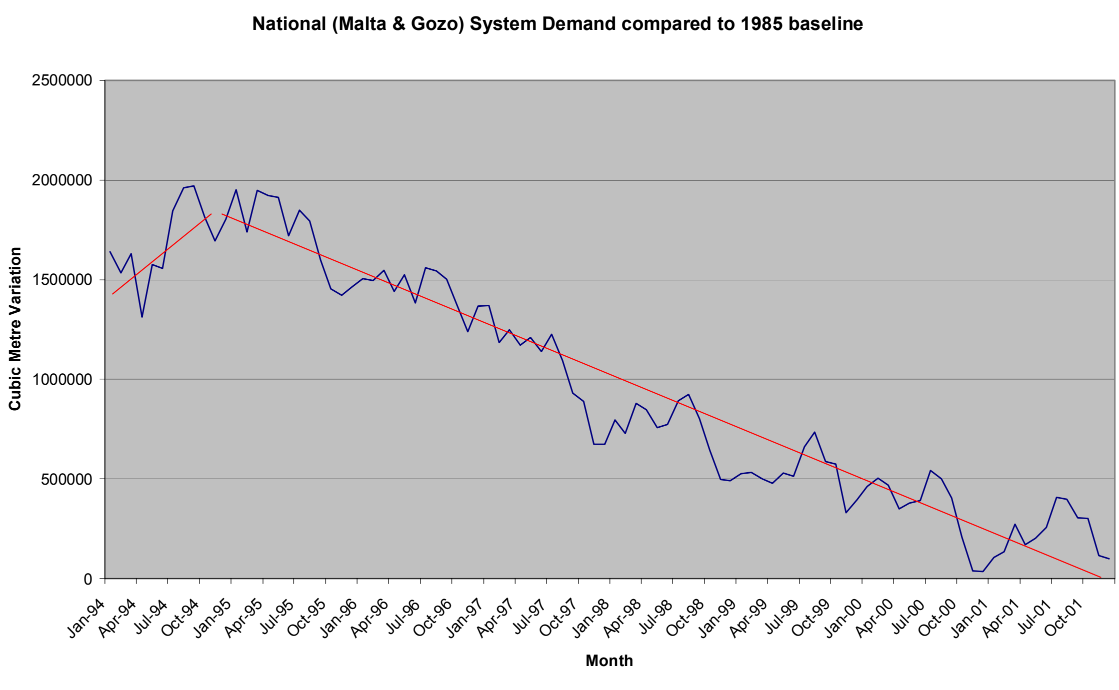
Strategic Management of Water Leakage in the Maltese Islands

Ing. Alex Rizzo B.Elec.Eng.(Hons.) MBA C.Eng MIEE
(Email: arizzo@wsc.com.mt)

INTRODUCTION

Today, leakage has taken on a prime strategic role within the operating framework of the Malta Water Services Corporation (WSC). Leakage may be defined as a water resource. It is viewed as an excellent indicator of the overall performance of a water corporation and is a versatile means of achieving an often-delicate balance between water supply and water demand. Reducing leakage will often defer major capital expenditure by reducing the need to build new water production plant. It will result in substantial savings for every cubic meter of water that is not lost, at a value of the marginal cost of water produced. It will significantly impact upon the environment through reduced energy consumption, resulting in less burning of fossil fuels. It will allow for better pressure management, leading to an enhanced level of service for the consumer. Finally, a well-managed leakage control initiative will result in less futile excavations for suspected leakages and less disruptions in the repair of existing leakages.

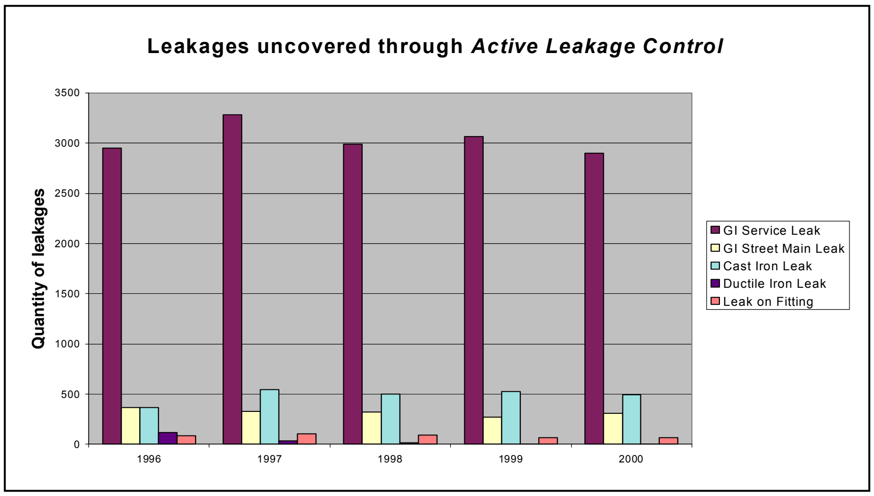
Figure 1. Reduction in water produced and consumed in the Maltese Islands



The above graph summarizes the effect of an aggressive national leakage control campaign. The graph depicts water produced and consumed, compared to a base year (1985) in order to eliminate seasonal fluctuations. Since water consumed consists of two components, legitimate consumer usage and leakage, a steady reduction in leakage has dropped production figures to practically pre-1985 values.

Looking at leakage volume-wise, water leakage within the local distribution network has been more than halved from an all-time high of around 2,800 m^3/Hour in 1995 to below 1,200 m^3/Hour in 2001. The actual volume of water consumed daily in the Maltese Islands (as a combination of both legitimate consumption and leakage losses) has been correspondingly reduced from 5,895 m^3/Hour in 1995 to below 4,000 m^3/Hour in 2001. This is seen as a healthy start by the WSC but, as shall be shown further on, much more has to be done to reach a final leakage target of 300 m^3/Hour. One of the biggest hurdles that the WSC faces is in the large quantity of galvanized house service pipes that exist, these being highly leakage prone. Figure 2 shows that galvanized pipe leakages make up more than double the combined leakages from all other pipe materials utilized locally.

Figure 2. Spectrum of leakages uncovered over the years

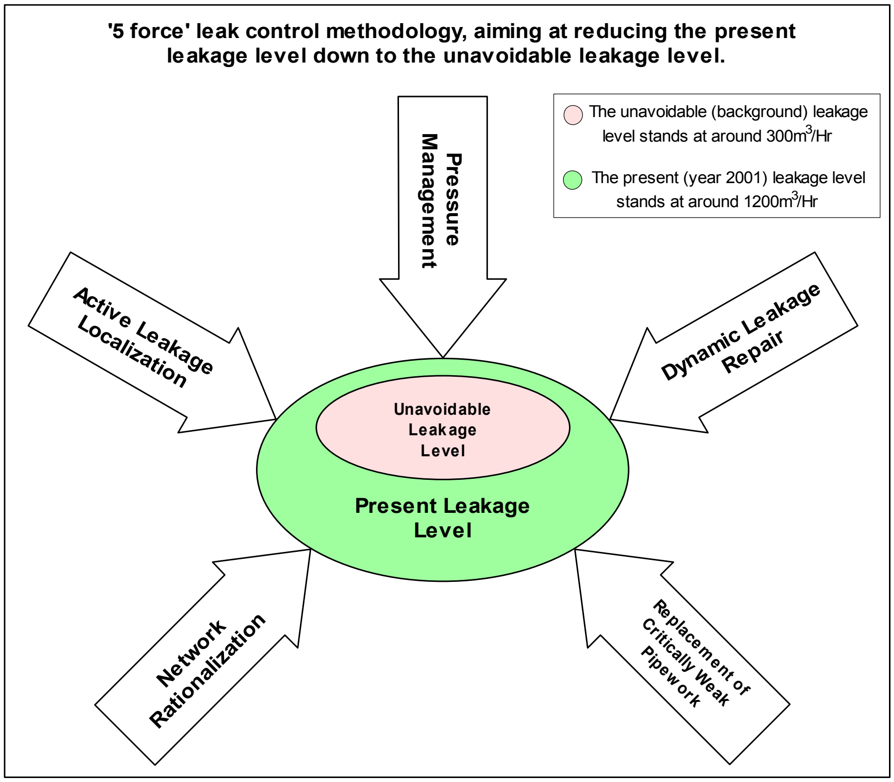


THE NATIONAL LEAKAGE CONTROL METHODOLOGY

Leakage control is more than just locating and repairing leaking pipes. On a low management level it can be seen as the tactical implementation of a choice leakage control methodology, whilst on a high level it is the management of a corporate strategy. The methodology adopted by the WSC was not one of chance, but one that was researched, trialed and tested intensively prior to its adoption. The Island of Gozo was utilized by the WSC as a trial site, mainly due to the fact that it boasted a naturally encapsulated network. In order to implement this methodology, depicted graphically in figure 3, a fundamental reengineering of the existing work structures and practices was required. Most important was the launching of a scheme of 10 self-directed work teams where each team of three to four leak detectors is led by a leakage technician, with well defined boundaries of operation and levels of accountability. A continuous professional development programme was initiated at the WSC's Institute of Water Technology, allowing for regular training in the latest leakage control techniques and technologies.

The methodology depicted graphically in figure 3 was adopted by the Corporation and refined over the years.

Figure 3. The National Leakage Control Methodology.



The figure above shows two ellipses, one within the other. The reader is asked to picture the outer ellipse (coloured in green) as a representation of the value of national water leakage, at 1,200 m^3/Hour. The inner ellipse (coloured in pink) represents the lowest technically achievable leakage level, computed at 300 m^3/Hour. All efforts are to be directed at reducing the size of the outer ellipse to that of the inner ellipse, and to sustain the new size once achieved. In order to do this, the WSC applies 5 interrelated and coordinated activities that act as 'forces' attempting to compress the outer ellipse inwards. If any of these 5 forces is found to be weak then the ellipse will not compress, but will solely shift towards the weaker force.

In brief, these five activities are described as follows:

Active leakage localization: This activity is a combination of the use of advanced leakage localization technology and the use of well-trained leak control work teams. The concept applied here is one of steadily converging onto a single, hidden leakage within many kilometers of water distribution network. Zoning and electronic data logging of water supplying the zones are utilized to pinpoint zones of high leakage. Step-testing is carried out to pinpoint individual segments within a zone that contain leaking pipework. In order to locate the precise leakage, a range of equipment is available to choose from, such as acoustic detection sets, correlators and digital leak noise data loggers. This '*active*' leakage localization is distinguished from '*passive'* leakage control, where water appears at the surface and is usually easy to locate and repair. The local terrain is unfortunately unfavorable to passive leakage control, as the vast quantity of water leakages never appear as water running out on the surface of the street.

Pressure management: The relationship between water leakage and water pressure is an almost linear one. This means that an increase in system pressure from, say, 1 to 2 bar (1 bar = 10 metres head) will double the amount of water leaking out of existing bursts in the network. The WSC utilizes two alternative schemes for controlling water pressure within the network. The first scheme consists of variable speed pump control, where water pumped directly into the network is sustained at a stable water pressure at the downstream of the pump. This is carried out by means of a controller that adjusts the frequency of the electricity supplied to the pump in accordance to changes that take place to the downstream pressure of the pump. The second scheme consists of maintaining a stable but reduced water pressure at the lower parts of the water network, be these fed by gravity (via reservoir) or direct pumping. A system is used whereby a mechanical pressure reducing valve is electronically controlled to supply the desired downstream water pressure.

Dynamic leak repair: This activity complements the one opposite it in the 5-force methodology; that of active leakage localization. Speed and quality of leakage repair are essential here and the WSC often outsources an excessive repair workload to trained local contractors.

Replacement of critically weak pipework: Active leakage control provides extremely valuable information on the condition of the water distribution network. Each leakage that is repaired provides a window that opens up an understanding into the condition of that particular segment of water main. The WSC utilizes a geographical information system (GIS) to map out water leakages as a layer, superimposed onto other data layers such as the hydraulic distribution network. This allows for the targeting of critically weak pipe segments for replacement. Leaking galvanized house services are replaced with new polyethylene pipework as a matter of priority.

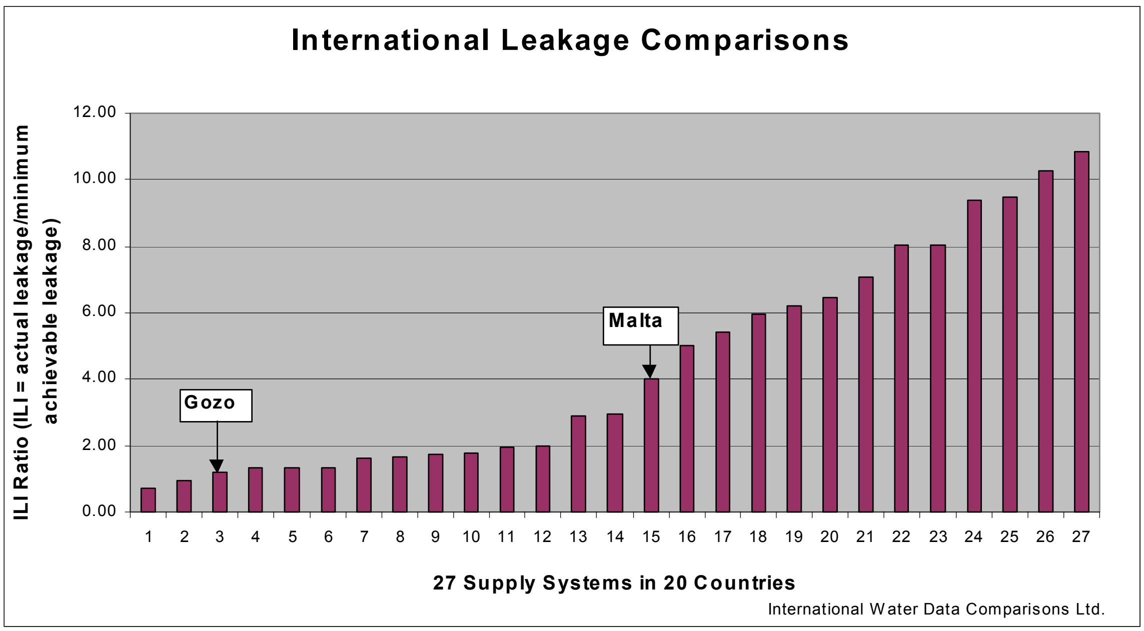
Network Rationalization: This activity consists of a combination of office work and on-site implementation. Many parts of the water distribution network were, in the past, commissioned with the objective of getting water to the customer , but without the requisites of a well-designed and properly documented network. Network rationalization consists of two major activities: 1) simplifying parts of the network that are unnecessarily complex, often by eliminating unwanted water mains, and 2) redesigning parts of the network in accordance to present zoning criteria.

USE OF A HIGH LEVEL PERFORMANCE INDICATOR FOR STRATEGIC TARGET SETTING

The WSC has joined up with a growing number of water utilities world wide that are adopting the use of the Infrastructure Leakage Index (ILI) as a means of measuring and benchmarking water leakage. The ILI is a high-level performance indicator advocated by the *International Water Association* (IWA) and already adopted by various countries around the globe. The ILI is computed as the ratio of the total national leakage (Current Annual Real Losses, or '**CARL**') to the minimum technically achievable leakage value (Unavoidable Annual Real Losses, or '**UARL**'). Hence an ILI of 1 implies that the national value of leakage will have been reduced to its minimum technically achievable value (for a given pressure regime), a feat that can only be achieved by an organization that is highly competent and that boasts a water network that is in good infrastructural condition.

Looking back at the methodology depicted in figure 3, the ILI would be calculated by dividing the area of the outer ellipse by the area of the inner ellipse. As stated previously, the CARL for the Maltese Islands for year 2001 stands at 1,200 m^3/Hour, whilst the UARL is computed at approximately 300 m^3/Hour. This gives a national ILI of 4. A ten-year long-range target has been set by the WSC to achieve an ILI of 1 by 2010. A mid-range three-year goal has been set to achieve an ILI of 2 by 2005. Both goals depend upon the successful implementation of the methodology shown in figure 3 to achieve these ambitious targets. By utilizing the Island of Gozo as a trial, or pilot, site the WSC has already achieved a level of internationally acclaimed success in reaching very low levels of leakage. In an international study by the independent company *International Water Data Comparisons Ltd*. (UK), Gozo was indicated as having one of the lowest ILI values for 27 utilities, at approximately 1.5.

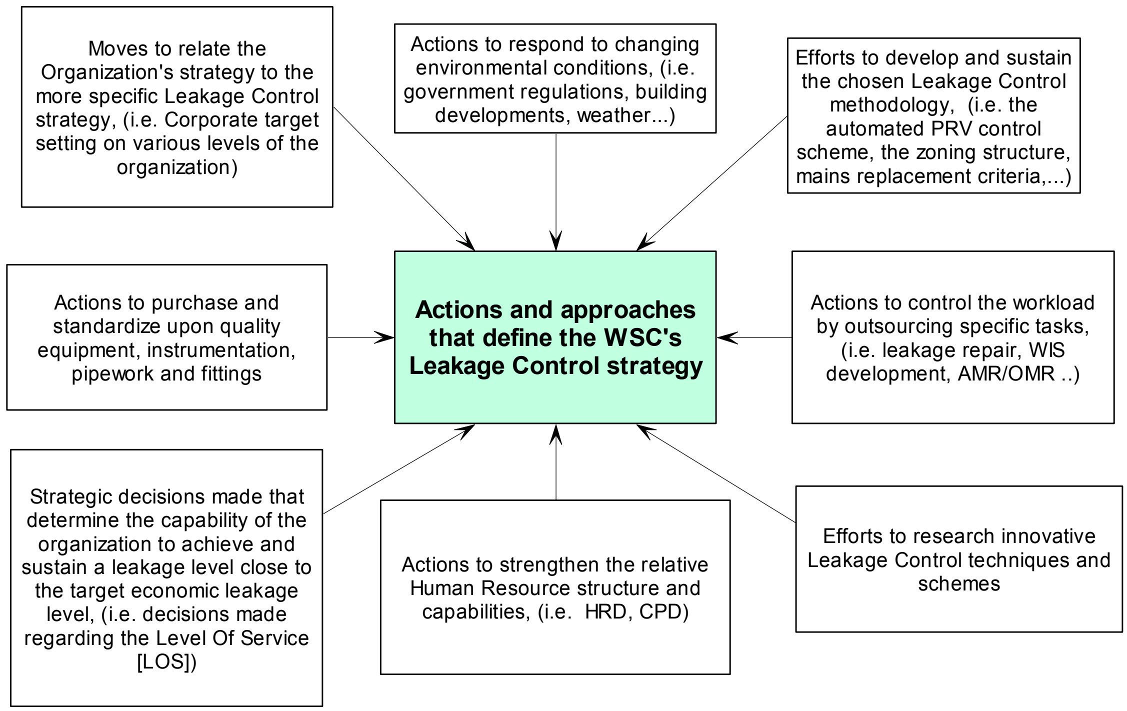
Figure 4. An international comparison of ILI values for 20 countries



Leakage control can only be sustained through the implementation of a long-term leakage control policy that depends both upon a) the short-term tactical implementation of the established leak control methodology and, at a higher integrative level, upon b) the attitude, policies, targets and perspective of the water authority concerned. This leads to leakage management as a corporate strategy, as depicted in figure 5.

The actions and approaches shown in figure 5 all have to be consistently implemented for success to be achieved in the sustaining of the 5 – force methodology depicted in figure 3. For example, the efforts made to research into innovative leak control techniques can result in the standardization upon a technique that may strengthen the force titled "*Active Leakage Localization*". The decisions made regarding an established Level Of Service (LOS), say at 15 metres head, may strengthen the force titled " *Pressure Management*". Policies regarding the outsourcing of work to leakage repair contractors may impact upon the force titled "*Dynamic Leakage Repair*". Work towards building and maintaining a trained and motivated workforce would possibly strengthen all five forces.

Figure 5. The WSC leakage control strategy



One of the more critical actions that have been launched by the WSC as part of its leakage control strategy concerns its efforts to research innovative leakage control techniques and schemes. A partnership has been set up with the Department of Power and Control, Faculty of Engineering, University of Malta with the objective of joint research into network control and leakage detection techniques. The fields of research that have been completed so far include; telemetering within the water distribution network, electronic control of pressure reducing valves, variable speed pump control as a means of sustaining a stable water pressure, and the spectral analysis of leak noise. The next field of research to be targeted shall focus more on ‘apparent’ water losses, mainly those losses that occur when a consumer metering scheme is not properly designed for the water consumption patterns that are predominant.

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The Author
Alex Rizzo has managed the national leakage control initiative from 1994 to 2001 and presently acts as manager for the Water Services Corporation Gozo Unit. He is actively involved within the *International Water Association* Performance Indicator group on leakage control, and has presented various papers on the subject of leakage control.

Organization: Water Services Corporation
Qormi Road
Luqa LQA05
Malta

Telephone: +356 7941 7176
Fax: +356 2155 7959
Email: arizzo@wsc.com.mt

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