Chapter 2

2. Literature Review

The reduction and control of water loss is becoming even more vital in this age of increasing demand and changing weather patterns that bring droughts to a considerable number of locations in the world. Many water utilities have been developing new strategies to reduce losses to an economic and acceptable level in order to preserve valuable water resources. In an urban society, public or municipal water system supplies water, and this is usually the best assurance of an uninterrupted supply of economical and safe water to our people in cities.

The components of water demand are residential, commercial, industrial, institutional or public water uses, and unaccounted system losses and leakages. While all components generate revenue to the utility, the unaccounted system loss and leakages are not associated with total cost revenues, and are a source of wasted production costs. With today's high water production costs and rates, the expense of detecting and mitigating the unaccounted for water and leakages is an attractive option for minimizing operating expenditures. The water utility benefits by (a) saving the production costs of the water, (b) increasing revenues through sales of water saved, (c) deferring the system expansion and capital expenditures through the capture of lost water, and (d) reducing increases in utility rates, and thus maintaining better consumer relations. The annual volume of water loss is an important indicator of water distribution system efficiency, both individual years and as a trend over a period of years. High and increasing water losses are an indicator of ineffective planning and construction, and of low operational and maintenance activities. In Turkish cities, the average yearly water loss is as high as 51% of the water volume produced based on Turkish Statistical Institute (TSI) data of year of 2003 [11].

This study was aimed to propose an effective water loss management in Turkish cities. Thus, IWA water loss approach was advised for present study to manage water loss problem in Turkey. In the study, in addition to technical loss, some engineering proposals for the effective control of nontechnical loss and general water economy were suggested. Further, investigation of economical values of extra source obtained by reducing water loss was also evaluated. Finally, distributions of water consuming patterns of metropolitan cities in Turkey were as also presented.

2.1DIMENSIONS OF WATER LOSS IN DISTRIBUTION NETWORKS:

A safe, reliable and efficient water supply system is essential to any community In a water supply system including the water supply works, treatment plant, distribution network and storage facilities, the most expensive component is the water.

2.2 WATER DISTRIBUTION PATTERNS

A water distribution pattern for this study is divided into five groups. These consumers are (1) governmental institutions, (2) commerce and industry sectors, (3) residential buildings, (4) construction sectors and (5) parks, gardens, public fountain and etc. Water distribution rate among these consumers for the year of 2003 are seen in Figure 2.1. As seen in this figure, 65-72 % of distributed water was used at residential buildings. Institutional water consumption was very high for especially low populated cities (P < 100,000).

2.3 MAJOR FACTORS CONTRIBUTING TO HIGH LEVELS OF WATER LOSS IN TURKEY

There are several reasons for the high level of water loss in Turkey. These factors are given below, and some advisory solutions were briefly proposed in next sections.

2.3.1. Age of pipe network

It is estimated that nearly more than 50% of the pipe network was laid over 50 years ago. These include cast iron, asbestos cement, galvanized and carbon steel pipes. All these materials suffer from degradation over time due to operational measures, environmental conditions and general wear and tear and result in increased leakage in the network. It is therefore necessary to replace older mains so that less leakage occurs[12].

2.3.2. Poor maintenance of networks

In some cities including Istanbul, Ankara, Kayseri, etc., water authorities has performed a maintenance program for distribution system, and in recent years, an approximately more 50% of network system was replaced. For all cities, it is so difficult to find financial support to renew the water distribution system. Thus, the lack of finance to buy proper materials and poor construction resulted in increased leakage in the system.

2.3.3. Water scheduling

The problem of water scheduling caused by an intermittent supply results in leakage, with a cyclic pressure situation created due to having the supply turned on and off, increased levels of leakage are experienced due to stress being inflicted on the pipes causing them to rupture. There is clear irony in this situation as the problem of water scheduling is caused by water shortages. Due to high levels of water loss, a continuous supply is not available resulting in water schedules. The elimination of water schedules then, is a desired goal.

2.3.4. Customer side leakage

Because of the nature of the water storage systems in the country and the generally low rates paid by customers, there is little incentive to conserve water. Consequently, storage tanks and fittings remain unrepaired for long periods thereby contributing to significant loss. It is a significant component of water loss and a strain on the delivery of water.

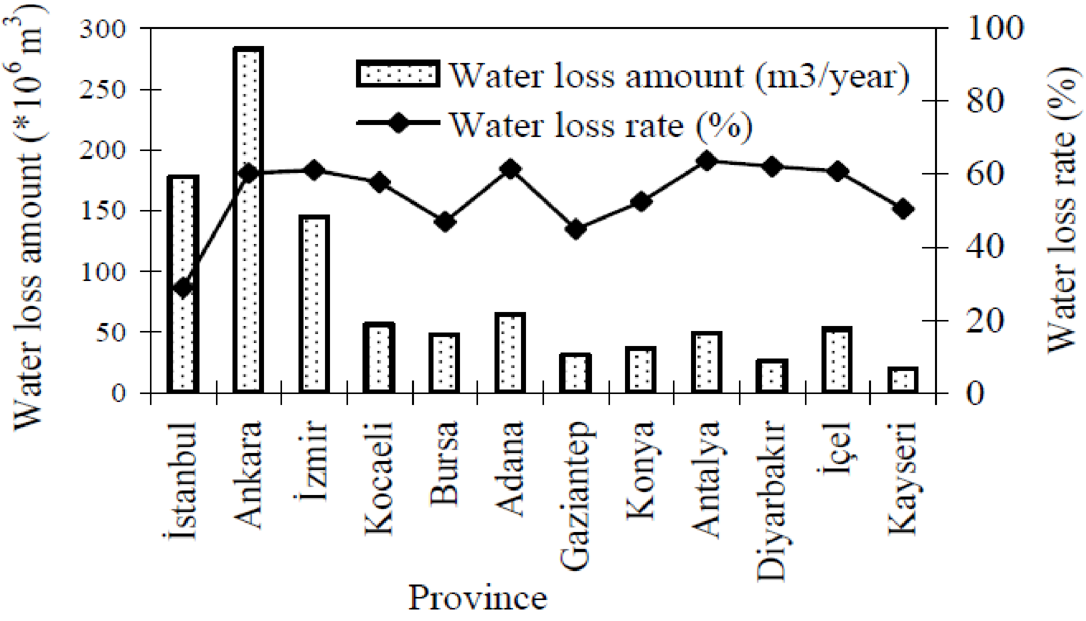

Figure 2.1 Water loss amount and rates of metropolitan city centers (p>5000,000)

2.3.5. Illegal connections:

There are a significant number of illegal users of water within distribution system in Turkish cities. The number of households who do not pay water rates but receive water from its distribution system is not known. As a consequence, they contribute significantly to apparent losses and revenue loss to the water authority.

These connections are often poorly laid just a few inches below the surface and will break easily resulting in real losses taking placed in the form of leakage. Illegal connections are therefore of significant concern of water utilities.

2.4 WATER LOSS MANAGEMENT

This work represents a major step to define the best practice approach for assessing and presenting basic elements of water loss management program in Turkish cities, and it will focus on international water loss approach to promote and facilitate the application of IWA recommended methodology of leakage monitoring and pressure management system[1].

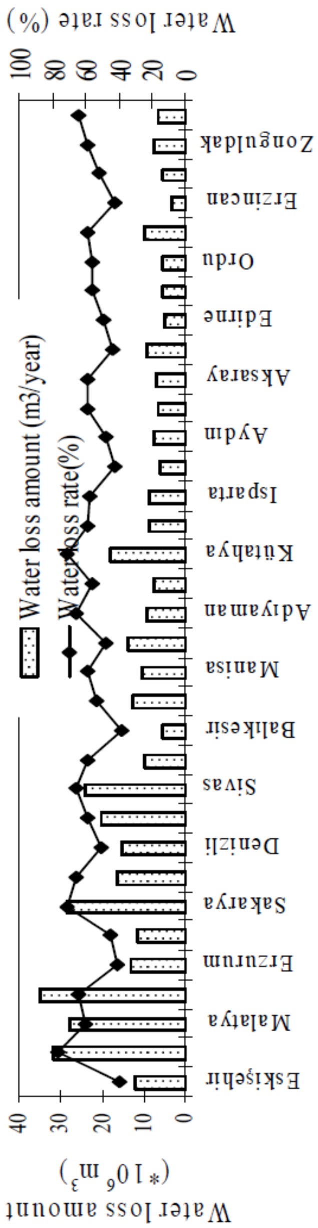

Figure 2.2 Water loss and province centers (100,000 p-500,000

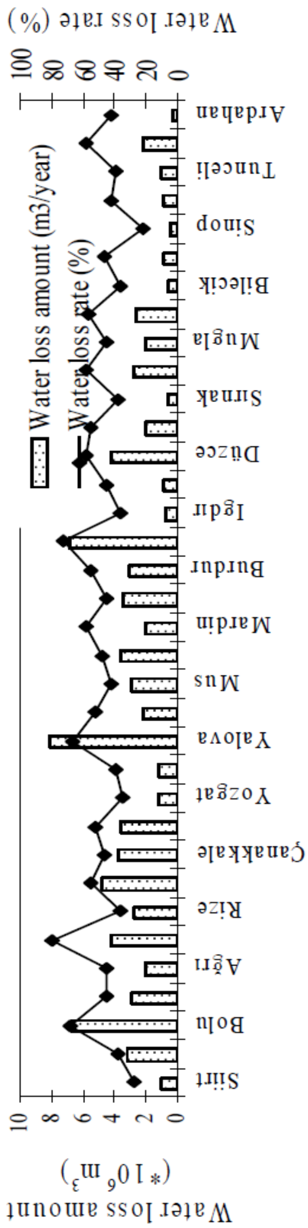

Figure 2.3 Water loss and province centers (100,000 p-500,000

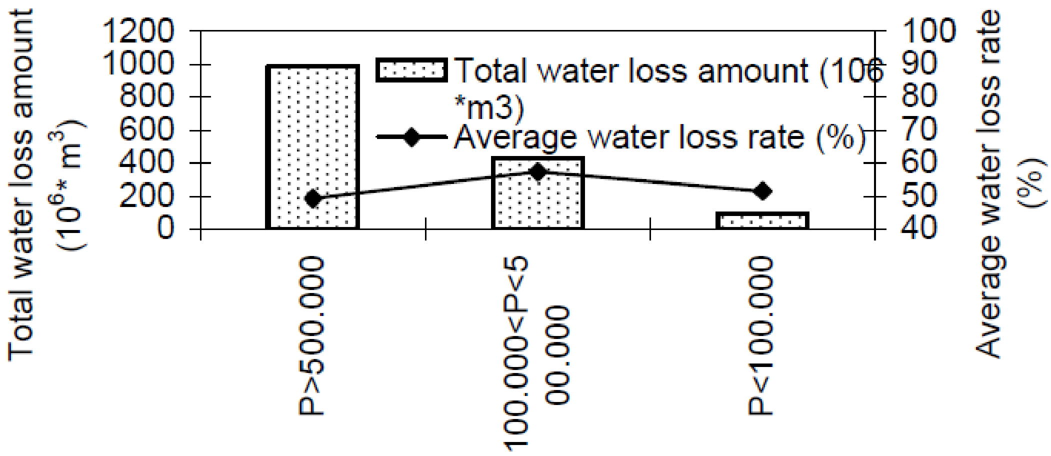

Figure2.4 Total water loss amount and average water loss rates of city

2.4.1 LEAKAGE MONITORING AND CONTROL

Leakage management can be classified into two groups including passive leakage and active leakage control. Passive control is reacting to reported bursts or a drop in pressure, usually reported by customers or noted by the company's own staff while carrying out duties other than leak detection. This method can be justified in areas with plentiful or low cost supplies. Often practiced in less developed supply system where the occurrence of underground leakage is less understood, it is the first step to improvement. Active leakage control (ALC) is when customers or other means deploy company staff to find leaks that have not been reported.

The main ALC methods are regular survey and leakage monitoring. Regular survey is a method of starting at one end of the distribution networks and proceeding

to the other using one of the following techniques:

♦ listening for leaks on pipe-work and fittings

♦ reading metered flows into temporarily-zoned areas to identify high-volume night flows

♦ using clusters of noise loggers (leak localizing)

Leakage monitoring is flow monitoring into zones to measure leakage and to prioritize leak detection activities. This has now become one of the most cost effective activities for leakage management programs.

The most appropriate leakage control policy will mainly be dictated by the characteristics of the network and local conditions, which may include financial constraints on equipment and other resources. Staffing resources are relevant, as a labor intensive methodology may be suitable if manpower is plentiful and cheap. If the geology of the area allows a high proportion of leaks to appear at the surface, a policy of regular survey followed by rapid repair may be adequate. If some leaks fail to appear at the surface, then, a more intensive policy of leakage monitoring is required.

The main factor governing choice, however, is the value of the water, which determines whether a particular methodology is economic for the savings achieved. A low activity method, such as repair of visible leaks only, may be cost-effective in supply areas where water is plentiful and cheap to produce. On the other hand, countries which have a high cost of production and supply, like the Golf States, can justify a much higher level of activity, like continual flow monitoring, or even telemetry systems, to warn of a burst or leakage occurring [11].

2.5 LEAKAGE MONITORING WITH DISTRICT METER AREA (DMA)

A flow measuring system in a water distribution system should include not only measurement of total flows from source or treatment plants, but also zone and district flows. This allows the engineer to understand and operate the distribution system in smaller areas, and allows more precise demand prediction, leakage management and control to take place. The measurement system must therefore be hierarchical at a number of levels, beginning at production measurement, via zone and district measurement and ending at the customer’s meter.

The technique of leakage monitoring is considered to be the major contributor to cost-effective and efficient leakage management. It is a methodology which can be applied to all distribution networks. Even in systems with supply deficiencies leakage monitoring zones can be introduced gradually. One zone at a time is created and leaks detected and repaired, before moving on to create the next zone. This systematic approach gradually improves the hydraulic characteristics of the network and improves supply.

Leakage monitoring requires the installation of flow meters at strategic points throughout the distribution system, each meter recording flows into a discrete district, which has a defined and permanent boundary. Such a district is called a district meter area and the concept of design and operation of DMA has been detailed in elsewhere [11]

The design of a leakage monitoring system has two aims:

1. To divide the distribution network into a number of zones or DMAs, each with a defined and permanent boundary, so that night flows into each district can be regularly monitored, enabling the presence of unreported bursts and leakage to be identified and located.

2. To manage pressure in each district or group of districts so that the network is operated at the optimum level of pressure.

It therefore follows that a leakage monitoring system will comprise a number of districts where flow is measured by permanently installed flow meters. In some cases, the flow meter installation will incorporate a pressure-reducing valve.

2.6 PRESSURE MANAGEMENT THROUGH DISTRIBUTION SYSTEM

Pressure management can be defined as the practice to manage system pressures to an optimum level of service ensuring sufficient and efficient supply to legal uses and consumers, while eliminating or reducing pressure transients and variations, faulty level controls and reducing unnecessary pressures, all of which cause the distribution system to leak and break unnecessarily. There are many different tools that can be used when implementing pressure management, including pump controls, altitude controls and sustaining valves [13].

It was reported that many water utilities introduced pressure management to their water distribution systems. In the most cases, large reductions in a new break frequency can be achieved over a wide range of pressures. In Australia, Canada, and Italy, ongoing monitoring shows that the reductions in break frequency have been sustained for over five years to date by implementing pressure management procedure [Lamber et al., 2006]. On the other hand, the rapid reduction in new break frequency following pressure management is immediately evident for Gracanica in Bosnia and Herzegovina.

Some of the pressure management benefits reported by many different utilities include:

♦ Reduction in annual repair costs

♦ Reduction of the repair backlog, shorter run times for bursts

♦ Fewer emergency repairs, more planned work

♦ Reduced inconvenience to customers

Calculations of the economic benefit of pressure management have been based on the predicted reduction in flow rates of existing leaks and the value of the water thus saved. If management of excess pressure can also regularly achieve reductions in numbers of breaks of between 28%

and 80% per year, the annual savings in repair costs will usually be far greater than the value of the water saved.

Replacement of mains and services, the most expensive aspect of water distribution system management, is normally initiated by break frequencies that are considered to be excessive. Most water utilities consider break frequency to be a factor outside their control, and something that can only be remedied by expensive replacement of mains and services. However, if pressure management can reduce break frequencies and extend the working life of parts of the distribution infrastructure by even a few years, the economic benefits would generally be even greater than the short term reduction in repair costs.

2.7 ECONOMICAL DIMENSION OF WATER LOSS

As shown in Figure 2.1, 2.2, and2.3, water loss rate was varied between 28 and 80%. If it is assumed that unit water production cost is half price of selling, total cost of water loss for all Turkish cities will be 563,906,549 YTL (304,800 EURO) for 2003 year provided that water loss rate is reduced to 20%. Average water selling price is obtained from TSI [TSI, 2003]. Figure 6 shows the relationships between the rate of reducing water loss and cost saving. Besides, in the case of reducing the rate of water loss to 20% through provincial centers in Turkey, water utilities will have a gain of 1,691,719,647 YTL (914,400 EURO) for the year of 2003 (Figure 2.5.[13].

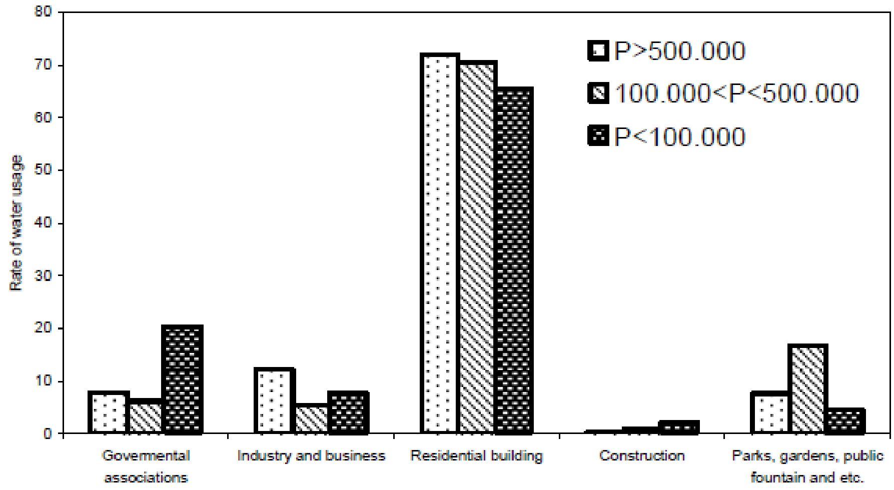

Figure 2.5 Water distributions patterns of provincial centers

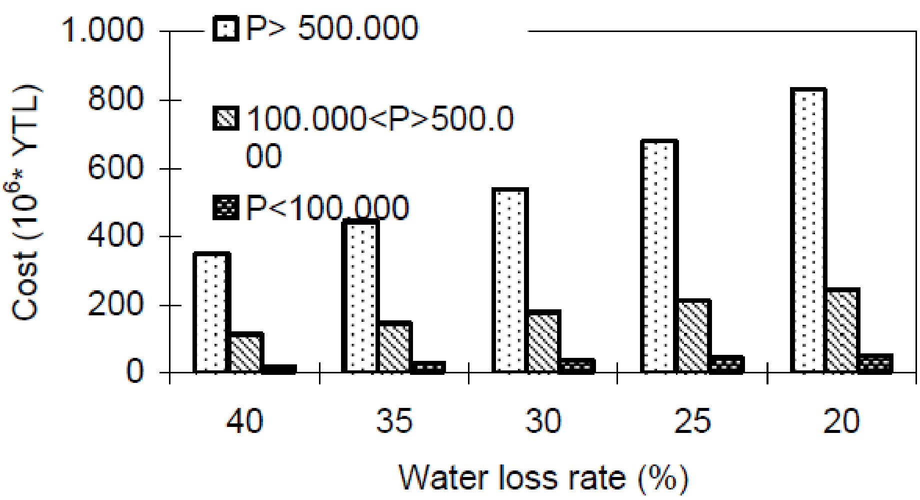

Figure 2.6 Economical dimensions of water loss