Population, Climate, and Total Water Management: Implications for Water Managers

Edward G. Means III[1], Nicole West[1], and Roger Patrick[2]

[1]McGuire/Malcolm Pirnie Environmental Consultants

[2] Competitive Advantage Consulting Ltd.

Introduction

This article is part of a series of publications which present the findings of the Awwa Research Foundation project "Update of the Strategic Assessment of the Future of Water Utilities." This study revisits the 2000 study of water utility trends. The update was initiated with project team interviews of key industry leaders to frame the preparation of a detailed issue paper on trends. The issue paper was provided to workshop participants in advance of a 2 day workshop of industry leaders that was convened on November 30 in Huntington Beach, CA. The purpose of the workshop was to:

1. assess the significance of the trends,
2. develop strategies to help prepare for the future, and
3. test those strategies against several future scenarios.

This paper is one of a series of six papers examining the trends identified during the workshop that are relevant to drinking water utilities and professionals. This paper summarizes the project's findings on population trends, demographic, and climate change and their impact on the future of water resources and the shift to total water management.

Population and Demographics

Population Growth Will Continue. The changing population and demographics of the United States was identified as one of the major trends that will affect how the water industry operates in the next 20 years. The number of people, where they live, how old they are, their education, and income levels are important factors that water industry leaders need to consider when planning for the future. In addition, water utilities need to begin planning for the increase in water demand that this population growth will drive.

As the U.S. population grows, so will the water utilities' customer bases. The population is expected to increase by 50% by the year 2050; reaching 309 million by 2010, 336 million by 2020, and 419 million by 2050 (Figure 1).

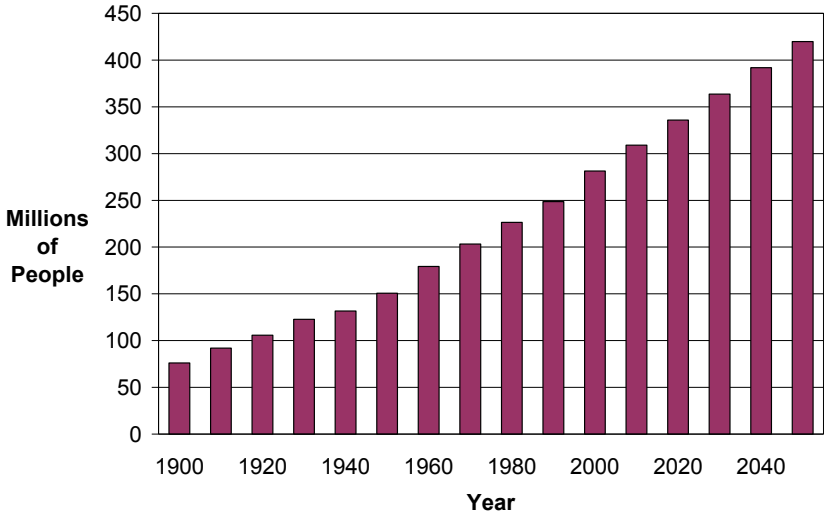

Figure 1 Past and Predicted U.S. Population 1900-2050

(Source: Hobbs and Stoops, 2002 and U.S. Census Bureau)

Most of this growth will continue to occur in the West and South and in urban areas. As a result, absent demand management, water demand will increase the most rapidly in these two regions (Figure 2). It is predicted that by 2025 the South and West will be home to close to two-thirds of the country's population.

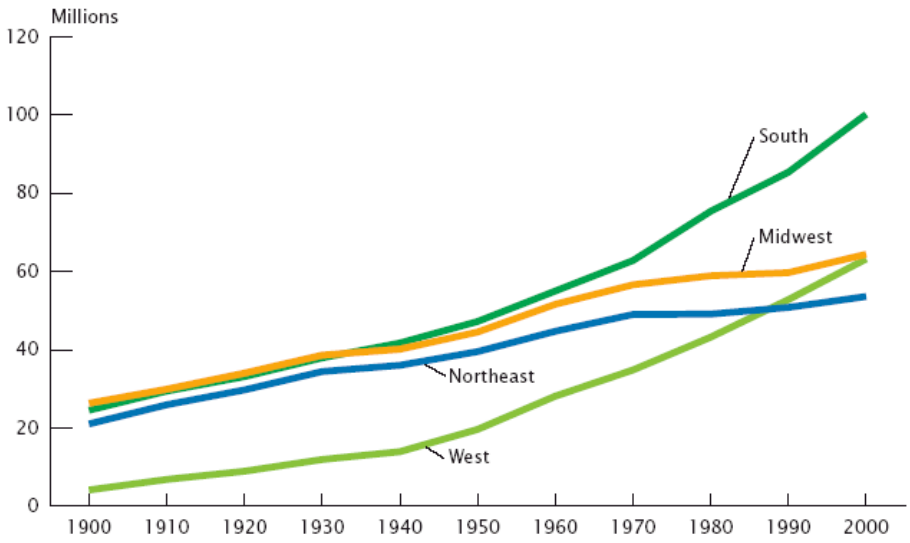

Figure 2 Total Population by Region 1900-2000

(Source: Hobbs and Stoops, 2002)

Expansion of customer bases provides the ability for growing communities to spread rates across a broader base. However, the capital programs necessary to provide facilities to accommodate that growth will raise water rates significantly in many communities. Also, the population growth appears to be targeted at areas that currently have water supply constraints. To this end, the Bureau of Reclamation has identified 25 western "hot spots" where water conflicts are expected over the next 25 years (2003). This report sited four primary tools to address this issue:

1. Conservation, Efficiency, and Markets,
2. Collaboration,

3. Improved Technology, and

4. Remove Institutional Barriers and Increase Interagency Coordination

On the other hand, shrinking populations in some communities will further stress the financial capability to provide adequate replacement of infrastructure.

Accommodating population growth will require adequate housing and transportation systems. This growth will occur in the watersheds of many water systems. The management of contamination from additional human activity will be increasingly important. Development of agricultural land to accommodate housing may free up water for urban use and facilitate water transfers from willing seller to buyer.

Customers Will Continue To Grow Older. Life expectancy has steadily increased over the past 50 years (Figure 3).

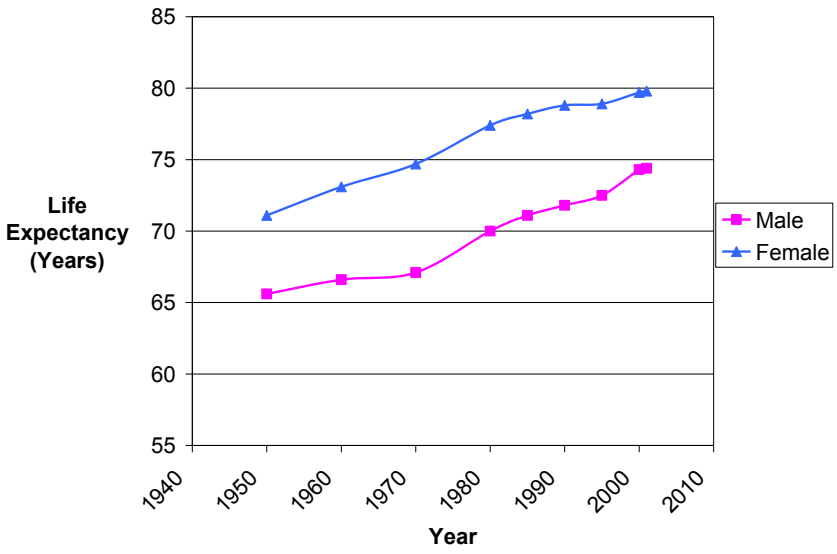

Figure 3 Life Expectancy at Birth 1950-2001

(Source: Centers for Disease Control)

This trend of increasing life expectancy is expected to continue into the next century and, as a result, a larger portion of the population will be older. The number of people 65 and over will begin to increase rapidly in 2011 when the first of the baby boomer generation reaches age 65 (Figure 4).

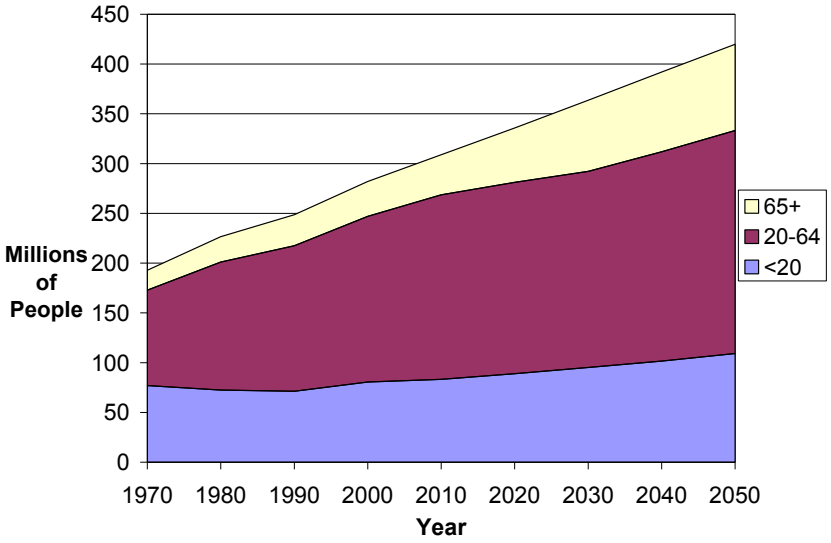

Figure 4 Projected Age Structure 1970-2050

(Source: U.S. Census Bureau)

By 2030, the number of older Americans will have more than doubled to 70 million, or one in every five Americans. In contrast, the number of people under 20 is expected to increase only slightly, although the overall number of people age 18 to 64 will continue to increase. This trend is important to the water industry as older people could be more sensitive to contaminants in their water and could be on a fixed income and therefore more resistant to rate changes. Additionally, seniors tend to vote and be more active politically than younger generations.

The Ethnic Makeup of the U.S. Will Continue to Shift. The ethnicity of the water utility customer base could affect how drinking water information (such as Consumer Confidence Reports or CCRs) is disseminated and what type of information is conveyed. Between 1980 and 2000 the Hispanic population in the U.S more than doubled. This trend is projected to continue with most of the population growth over the next 25 years occurring in the Hispanic population, which is predicted to increase by 37 million people, as opposed to an increase of just over 13 million people in the White, non-Hispanic population, 15 million in the Black population, and 12 million in the Asian population.

Income Gaps Continue to Grow. The level of water customer's personal income may affect what types of houses and appliances are purchased and possibly the type of landscaping installed. Along with the cost of water, income will affect how much water people buy. Recent trends indicate that the gap between the rich and poor is growing. Over the past two decades, incomes of Americans with the highest incomes have grown faster than those with the lowest. The average income of the top 5% of households has grown from $66,617 to $260,464 from 1980 to 2001 (adjusted for inflation). Conversely, household income of the bottom 20% of households increased by only $5,653 from 1980 to 2001. As a result, there may be an increasing gap between people who are willing to pay more for water and those who will resist rate increases.

The Population Will Become More Educated. Recent trends indicate that education levels are rising and as the U.S. population becomes more educated, customers are likely to demand more and better information from their water utilities. The percentage of the population with college

degrees or with some college education has increased in the past two decades. College graduates and people with some college education grew from 32% to 52% between 1980 and 2002. During the same period, the portion of the population with less than a high school degree shrank from 31.4% of the population in 16%.

Strategies for Population/Demographic Changes. To help prepare for the coming population changes, water utilities need to understand how the current population uses water and how population growth will affect water use. In order to understand what factors drive water consumption, water utilities need to collect water consumption data to account for water usage. One important strategy to deal with future increases in water use is for utilities to look at how they can decrease water consumption by recycling or conservation before looking for new supplies. It is likely that greater attention to reducing unaccounted for water volumes is likely, especially in communities with deteriorating infrastructure.

Communication with consumers will be key. State of the art communication tools can be used to convey the water situation to consumers and receive feedback on community values, needs for water, and willingness to pay information. Focus groups and surveys can help utilities understand the consumers, while education programs can help consumers understand the water supply and quality challenges. Education programs should focus on educating not only homeowners but also planners, environmental groups, government officials, and children. Water utilities should also strive to understand the differences between customers (bill payers) and consumers (drinkers).

Climate Change

Climate change has the possibility to exacerbate the pressures that population growth will cause on water supplies. Different climatological models yield fairly consistent ranges of warming scenarios for all regions in the United States, and they all agree that major changes will begin to occur within the next 20 years (Figure 5).

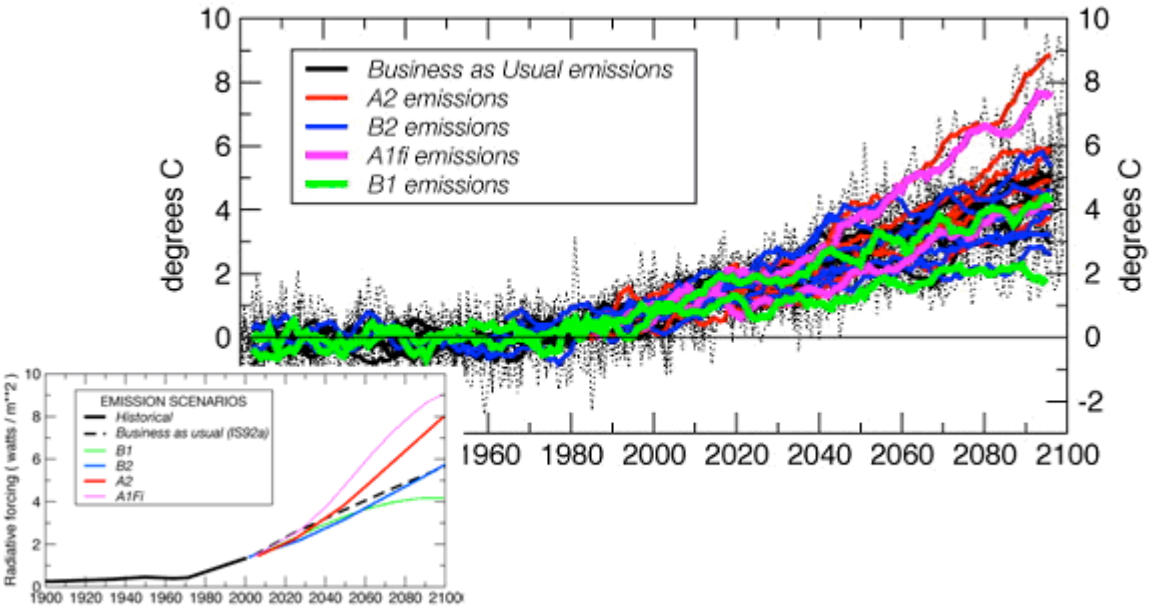

Figure 5 Projected Changes in Annual Temperature Changes in Northern California (Source: Dettinger, et al. 2004)

The potential impacts of global warming to the United States are uncertain and vary by region. For example, there is no consensus on the impacts to average annual precipitation. However, the variability in annual precipitation is projected to increase, meaning the wet years will get wetter and drought years will become more severe. Storm events may be more infrequent but more intense, and may come during different times of the year then is typical. As a result, water

infrastructure, such as dam spillways, may be under designed to deal with future climate variability.

The warming trend will also result in less snowfall that melts earlier, which will cause streamflows to occur earlier and not last as long. This will most greatly impact water utilities that rely on spring snowmelt to fill their reservoirs with a water supply for the summer months. If current reservoir management practices continue, the water that melts earlier in the year will be released for flood control. With less snow melting in the spring there will be less water available to capture for drinking. As a result, water utilities may need to change water resources and consider contingency plans to deal with the loss of current water resources.

Many climate change models predict higher sea levels as a result of melting polar ice caps and potentially increased runoff volumes. The rising sea levels will lead to salt water intrusion into coastal groundwater. In addition, sea level rises could render estuary water intakes inoperable. Regulatory compliance could become more of a problem due to the increases in bromide and iodide due to seawater intrusion and the increase in contaminant concentrations due to low summertime streamflow. Changing flow patterns could also cause turbidity spikes at drinking water treatment plant intakes, causing further compliance issues.

Strategies For Dealing With Climate Change. The strategies are similar to those for dealing with population growth. There are two primary strategies to address the uncertainties of climate change. The first is to understand the water supply vulnerabilities of the utility to changes in volume, duration or timing of precipitation. This requires careful assessment and or modeling of

watersheds considering climate models. This is especially important given the variations in precipitation that local geologic features can cause. Understanding the impact of less or more precipitation on storage needs is especially important. Given an understanding of the uncertainties, water utilities need to manage future water demands/supplies to limit the impact of climate change. Several strategies include diversifying the water supply, securing firm water supplies before cities issue building permits, and having builders pay for new infrastructure/supply as well as additional impact fees. Water utilities should consider developing integrated resource plans and examine how water resources can be reallocated to areas with the greatest growth in demand (e.g. agriculture to urban transfers). One opportunity that water utilities have not considered is the selling of CO_2 reduction credits to participating nations under the Kyoto Accord.

Total Water Management

Public water suppliers are being forced to meet increasing water demands as the population increases and more people connect to public water supply systems. Figure 6 shows that public water supply withdrawals have been increasing since 1950. In fact, public water supply withdrawals more than tripled between 1950 and 2000 while the U.S. population did not even double. Withdrawals for public water supply are expected to continue to increase over the next two decades as the population continues to grow. As a result of these increasing water supply challenges, utilities are starting to adopt a more holistic approach to water management to plan for long-term water sustainability.

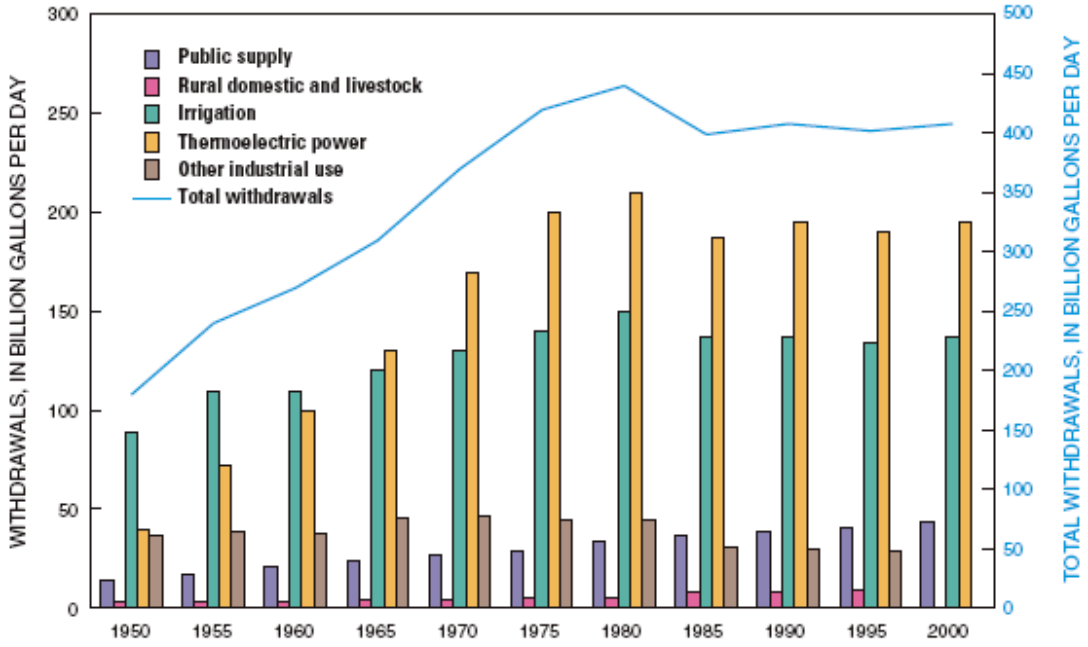

Figure 6 Trends in Total Water Withdrawals by Water-Use Category (1950 – 2000)

(Source: USGS, 2004)

There are also climatological influences that have greatly impacted water utilities in recent years. For example, nearly half of the continental U.S. has experienced drought conditions during the past few years (Mehan, 2003), which has resulted in regionalized depletion of short- and long-term drinking water supplies. Some researchers believe that much of the recent western regional growth occurred during a wetter than average time period. Continuing research into drought cycles over the past 800 years suggest that the 20th century provided the West with more water than is "normal" (Johnson and Murphy, 2004). Thus, the amount of actual drinking water resources available to water utilities in the future may be significantly less than expected.

Historically, water utilities have tended to manage these water-related issues with little or no regional perspective, and only limited interaction with other municipal departments. Recently,

the concept of "total water management" has been applied by water systems to more efficiently develop holistic water management goals and plans. AWWA has embraced the total water management concept and has defined it as the effort of the "water supply industry to assure that water resources are managed for the greatest good of the people and the environment and that all segments of society have a voice in the process" (AWWA, 1994). The goal of total water management is to address the interrelationships between all aspects of the "environment and society on a regional basis rather than dealing with each issue discretely and within limited parameters" (AWWA, 1994). Further, the philosophy of total water management recognizes the shift from considering water as an unlimited resource to a limited resource that has variability in quantity and quality.

Some utilities are conducting a variety of activities to bring a more holistic approach to water usage. These activities include performing integrated water resources planning, obtaining additional water supplies to meet long-term water demands, implementing water conservation programs, reusing wastewater, managing stormwater systems to maximize water yields, and developing source water protection programs. As a result of the adoption of the total water management concept, planning on a watershed wide basis is becoming more important for utilities to manage their resources. For example, a carefully developed and implemented source water protection program is important for the total water management approach because it ensures that existing water supplies do not become damaged and unusable as potable water supplies.

Historically, water utilities have focused water planning efforts on obtaining additional surface water or groundwater sources to meet increasing demands associated with population growth and economic development (AWWA, 1995). Typically, this involved purchasing new surface water resources or adding groundwater resources, which is becoming less effective because most surface water supplies have already been secured, many natural groundwater resources have already been overextended and cannot serve as long-term, sustainable water supplies, and new water agreements tend to have restrictions and not always provide water utilities with adequate water supplies during emergency scenarios.

Although more traditional methods of obtaining new water sources may not be feasible, utilities have demonstrated that they can successfully obtain adequate water sources by implementing a total water management plan. Regionalization can help utilities optimize drinking water supplies to meet increasing customer water demands by reallocating unevenly distributed regional water resources, protecting and managing regional drinking water supplies and identifying and securing new water supplies.

Numerous utilities have conducted integrated resource planning processes since the early 1990s, and some of the common elements of those plans have included conservation programs, wastewater reclamation, and development of new surface water supplies (Maddaus and Maddaus, 2001). These total water management approaches can be significantly lower in cost than purchasing new water sources. For example, the cost of desalination has decreased in recent years due to advances in treatment technology (Figure 7).

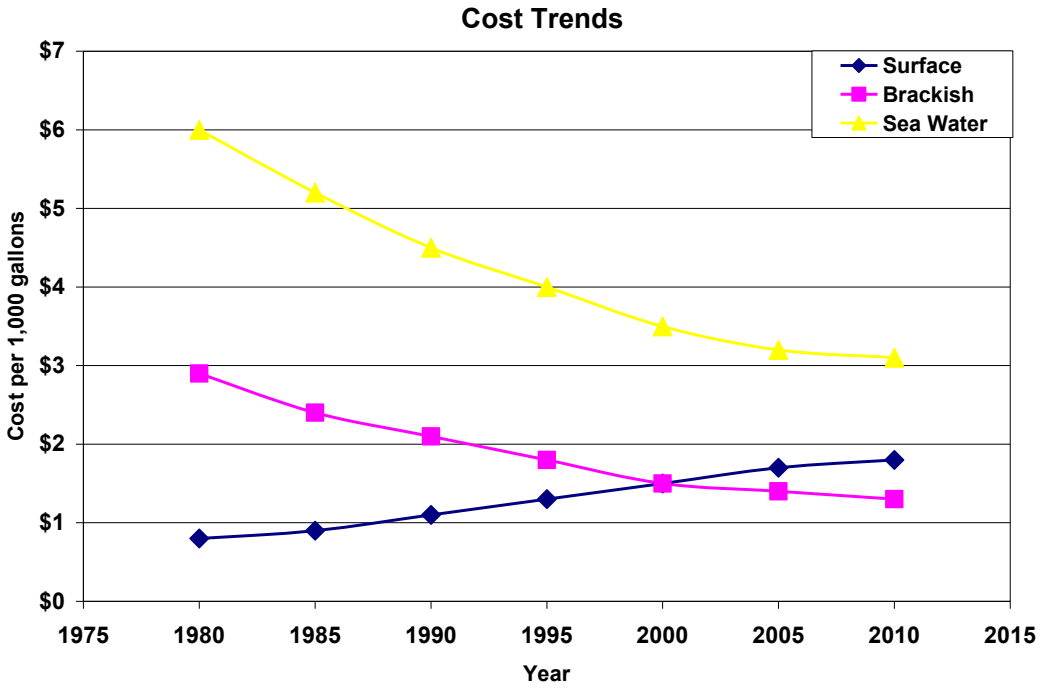

Figure 7 The Cost of Desalination Compared to the Cost of Importing Surface Water Includes Debt Service and Operations (Source: Chaudry, 2003)

Water conservation is one of the first activities that water utilities typically implement to address current or future water shortages (AWWA, 1995). A carefully developed and implemented water conservation program can lead to a 10 to 30% reduction of per capita water consumption within 10 to 20 years (Maddaus and Maddaus, 2001; AWWA, 2004). AWWA estimates that a 30% decrease in water consumption across the entire U.S. would result in a savings of over 5 billion gallons of water per day, equating to roughly $11 million saved daily (AWWA, 2004).

As water shortages and drought become more prevalent across the U.S., wastewater reuse alternatives are becoming a more feasible and necessary alternative for the total water management approach. Many wastewater utilities have already implemented wastewater

recycling programs to offset potable water usage. Some programs involve watering golf courses, parks, and other open spaces with treated wastewater.

Conclusion

Water utility customers are expected to change and water demand is expected to increase in the next 20 to 25 years. In positioning their utilities for success in the future, utility managers should consider how their businesses might be affected by these changes. Water utilities will have to take a broad look at the effects of population growth and climate change when developing their strategic and resource plans. As a result, water utilities may have to start considering adopting a total water management approach to plan for long-term water sustainability.

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