Cape Coral's Approach to Water Resource Management

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Problems associated with resource allocation (especially freshwater supplies) began to intensify in Florida after World War II as growth of the state's population began to occur in a great, unchecked surge (Carter, 1974). In 1950, Florida had 2.7 million people and ranked only 20th among the 48 states in population, but by 1970 it had grown to 6.7 million people and ranked ninth. It had become the fastest-growing state in the nation. Rapid population growth continued, and today Florida is the fourth most populous state in the nation with more than 18 million people.

While the population continues to increase, it is currently expanding at a much lower rate. Reflecting the recent economic downturn and problems with home foreclosures, Florida's population increase was only 0.7 percent in 2008.

During the 1950s and 1960s, land development companies, taking advantage of rapid population growth and the desire among millions of people to invest in Florida real estate, subdivided more than 1.6 million acres into over 2.1 million lots in the state. In 1958, Gulf American Corporation (originally Guaranty Land and Title Company) began to develop Cape Coral, one of the nation's largest pre-platted subdivisions.

Located along Florida's southwestern Gulf Coast, Cape Coral encompasses 65,000 acres, or approximately one-eighth the total land area of Lee County, on a large peninsula situated between the Matlacha Pass and the Caloosahatchee River near the Gulf of Mexico (Figure 1). It is not surprising that severe water resource degradation has taken place, since wetlands and groundwater recharge areas are intolerant of even sparse development, not to mention the intensive development associated with the creation of over 135,000 home sites and the provision of the infrastructural needs of a large community (Stroud, 1995).

As with many lot sales subdivisions, water resource problems began at Cape Coral long before the first lots were sold—the result of poor site selection decisions made by the developers.

Prior to development, the entire peninsula that is now Cape Coral consisted of coastal wetlands and interior forests that were vital groundwater recharge areas. Pine forests and palmetto covered much of Cape Coral's higher elevations, while extensive mangrove swamps and tidal marshes were found near the shoreline. These ecologically valuable environments stored and purified large volumes of water that drained into them from higher elevations. The peninsula was also the location of vital fish nurseries and wildlife habitat (Allan, et al, 1977).

It is ironic that Cape Coral's water resource problems began because of a need to provide dry land for residential use. The extensive drainage and fill work engineered to create an elaborate system of coastal and upland canals caused many problems, including severe damage to a shallow freshwater aquifer. The developers also removed 90 percent of the

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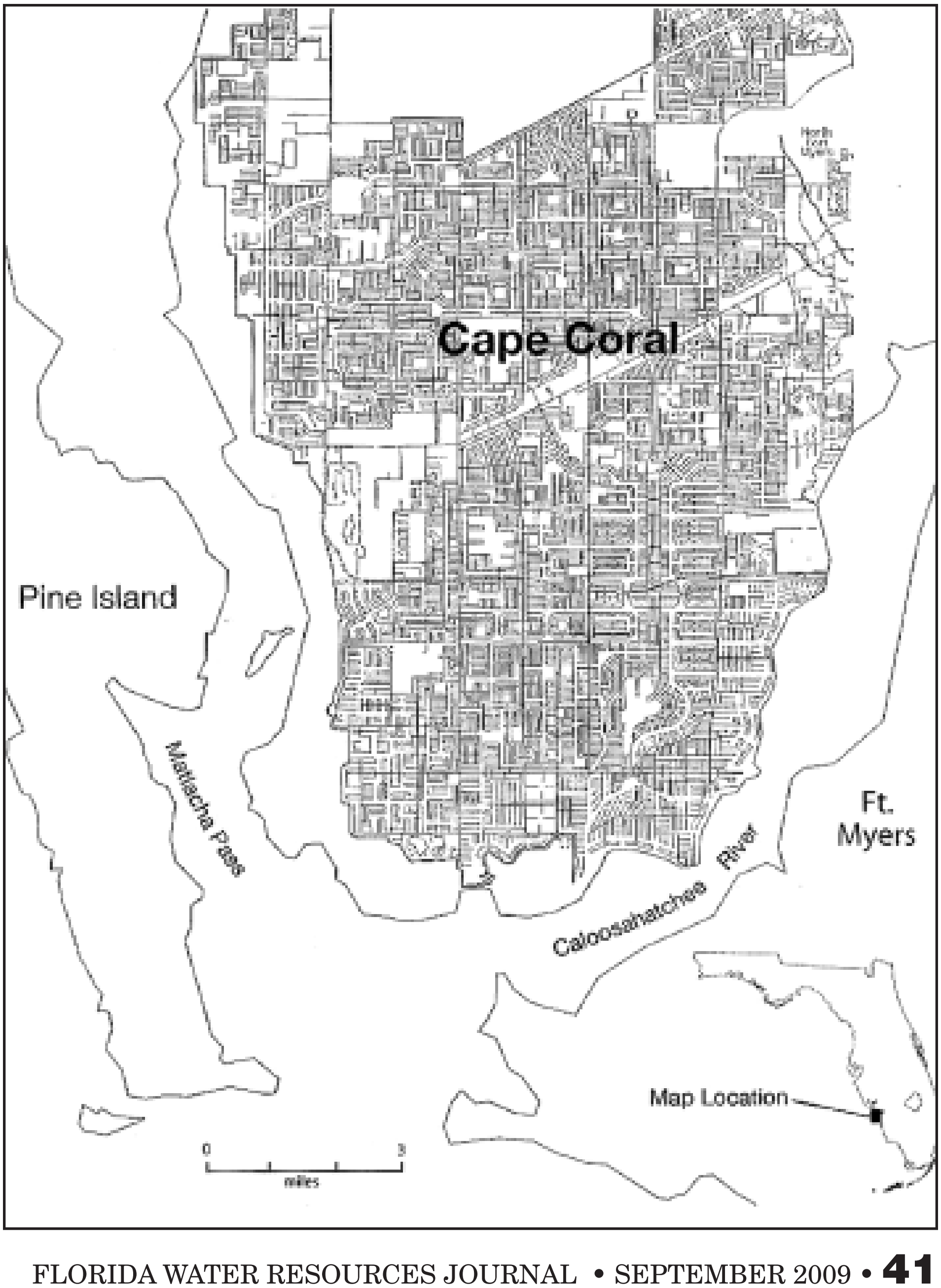

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tree canopy and damaged fish nurseries and wildlife habitat (Stroud, 1991).

For years water use was minimal, and the need for a sophisticated water supply system was non-existent. Individual lot owners simply dug wells, most of which were relatively shallow, into the water table (surficial aquifer) and Mid-Hawthorn formations to obtain an adequate water supply. The wells were few in number and did not overtax potable water supplies.

This trouble-free situation with water supply began to change during the 1970s, coinciding with a dramatic increase in water use across southwest Florida. As Cape Coral grew in population, some lot owners continued to dig wells while others were connected to the city's central water system. Both individual wells and city-controlled central systems were tapping the same relatively shallow Mid-Hawthorn aquifer. This aquifer, with a moderate-to-slow recharge rate, also served as a source of supply for commercial and industrial uses at Cape Coral and as a major source of water for the city of Fort Myers (Stroud, 1991).

By the early 1970s that it became apparent to city officials that water resource problems could not continue unresolved. Cape Coral's population had grown to 11,470 by 1970 and the city was using approximately 1.7 million gallons of water per day (MGD). The limits of the Mid-Hawthorn aquifer were becoming apparent, as its water level was beginning to drop at an alarming rate—a clear warning that the aquifer's capacity was being exceeded (Stroud, 1991).

Demands for residential use more than doubled to over 4.8 MGD in 1980 and exceeded 13 MGD by 1990. By the year 2000, the population exceeded 102,000, and by 2007 it had climbed to more than 160,000, making Cape Coral the largest city between Tampa and Miami.

Despite a recent slowdown in growth because of the economic downturn, there remains a tremendous demand for water, but fortunately, potable water use at Cape Coral has actually dropped 2 MGD from its peak in 1990. How did the city manage to dramatically lower the amount of potable water use while continuing to grow? The answer is tied to several important steps that Cape Coral took under its water management plan.

The city decided to implement a dual water system and incorporate water reuse into its plan to conserve potable water. The dual system provides both treated (potable) water and reclaimed water for irrigation to each residence served by central water and sewer. The city also imposed restrictions on the irrigation of lawns and increased the price of water.

In spite of a reduction in the use of potable supplies, the growth potential at Cape Coral, with approximately 70,000 vacant lots, remains high. Although current water supplies appear to be adequate, the city must continue its efforts to curb demand (Fenske, 2008 and Smith, 2007).

Cape Coral has made significant progress from the developer's original idea of simply allowing individual owners to provide their own water supply by using wells. The city began to assist property owners when it installed a central system during the mid to late 1960s that supplied water to a small, developed core in the southeastern portion of the city. The wells that supplied water for the central system tapped the heavily used Mid-Hawthorn aquifer.

Since those early days, Cape Coral has established an impressive utilities expansion plan that will provide water and sewer services for the entire city by 2018 (Reilly, 2008). Central water and sewer service has been extended from the original southeastern sector to include most of the land area in the southern part of the city. Also, realizing that additional sources of water must be found, Cape Coral began looking for other supply sources during the mid to late 1970s.

The most attractive option seemed to be the continued use of groundwater, but from a deeper aquifer. The city dug several new wells that extended into the Lower Hawthorn, an aquifer with a large volume of water.

The advantages of using the Lower Hawthorn formation are numerous. It is a proven productive source with relatively consistent water quality that is cost-efficient to treat. The resource can be developed within the city limits of Cape Coral, so agreements with other municipal entities are not required, and few problems exist with conveying the water to where it is needed via rights-of-way access.

A major disadvantage of the Lower Hawthorn is its relatively high salt content. As a means to alleviate the high level of chloride, the city decided to invest in an innovative reverse-osmosis (RO) water treatment plant. Construction of the RO facility was completed in 1976. Initially its total capacity was only 3 MGD, but expansions increased the capacity to 15 MGD during the 1980s and to 18 MGD in 2007 (Kopko, et al, 2007). The facility became the only source of potable water supply for city residents, except for individuals using private wells (city of Cape Coral, 2008).

Reverse osmosis is a process designed to remove and substantially reduce chlorides (salts) in the water. The 23 wells that supply water to the RO plant tap the Lower Hawthorn Aquifer at depths ranging from 650 to 900 feet and have chloride levels between 50 and 1,100 parts per million (ppm). Since normal drinking water should contain no more than 250 ppm as mandated by the Florida Department of Environmental Protection, it is necessary to reduce those chlorides as well as other impurities before the water goes out to the consumer. Fortunately, low-pressure RO membranes reduce chlorides and remove approximately 97 percent of all the impurities in the water (city of Cape Coral, 2008).

Although the RO plant at Cape Coral is one of the largest in the world, its water supply is inadequate to meet the demand for potable water from a build-out population that may exceed 350,000. For this reason, the city has a new RO plant under construction that will increase water supply capacity to 30 MGD, sufficient to meet its needs for years to come.

Subsequent expansion phases at the new RO plant in North Cape Coral will provide a maximum capacity of 36 MGD. Coupled with 18 MGD from the original RO plant, this will provide a capacity of 54 MGD, which is estimated to be adequate for future needs (Reilly, 2008).

Irrigation water is provided by advanced wastewater treatment and freshwater canals. Cape Coral's Water Reclamation Division has two advanced wastewater treatment plants, a collection system made up of several lift stations, and a modern laboratory. The collection system is monitored continuously by a supervisory control and data acquisition (SCADA) system. The certified laboratory performs sample analyses for the city's water production and water reclamation facilities.

The Everest Parkway Water Reclamation Plant is an 8.5-MGD modified Bardenpho Advanced Treatment Facility. The Bardenpho method is a five-stage biological treatment process that provides for the removal of BOD, TSS, nitrogen, and phosphorus removal. A biological process is used to remove nitrogen with no chemical additives except for aluminum sulfate, which is used to supplement the biological process in the removal of phosphorus.

The expansion and modification at the Everest Facility from an activated sludge process to the modified Bardenpho process began in 1990, and the reclamation system was put into service in 1992. Water quality at this plant meets or exceeds the requirements for river discharge.

While the Everest Plant discharges into the Caloosahatchee River occasionally, a water reclamation goal is to eliminate all surface discharge. The plan is to use deep-well injection, rather than stream discharge in the future

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(Fenske, 2009).

The Southwest Water Reclamation Plant was added to the system in 1994. Unlike the Everest Plant, this 6.6-MGD facility normally runs in the conventional treatment mode. Since none of the water from this plant will be discharged into streams, and since all the reuse water is designated for spray irrigation, there is no need to reduce phosphorus and nitrogen levels. (Fenske, 2009).

Five canal pumping stations placed in various locations along the city's vast freshwater canal system are used to supplement the reuse system. Canal water is used when the demand for irrigation water is more than both water reclamation facilities can supply. When water is pumped from the canals, it first passes through a coarse screen, followed by a fine screen, and is chlorinated before it enters the reuse system. The SCADA system located at the Everest Facility monitors the reclaimed water on a consistent basis.

Since the inception of the reclaimed water system, over 1.9 billion gallons of potable water have been saved by using reuse water rather than potable water for irrigation. Prior to its installation, potable water use peaked at 13 MGD in 1990 when the population was only 74,000—and a substantial portion was used for irrigation. With a current population of over 160,000—more than double the 1990 figure—potable water use is approximately 11 MGD.

The dual system now serves approximately 50 percent of the properties in Cape Coral and will be extended to other areas in conjunction with the phased utilities expansion plan currently underway.

This does not mean that there will be no water resource problems in the future. One of the most significant concerns is the increased use of the Lower Hawthorn Aquifer by surrounding communities. Based in part on the successful use of RO water at Cape Coral, several surrounding communities are either now using or are planning to dig wells into the Lower Hawthorn and use RO treatment to produce a potable water supply. This expanded use could overtax the yield capacity of the aquifer, making it more difficult, if not impossible, for Cape Coral to receive permits for additional pumping from the Lower Hawthorn in the future.

City officials are already making plans to tap deeper aquifers in the future. These include the Suwannee, Ocala, and Avon Park aquifers ranging from approximately 1,000 feet to 1,700 feet below the surface. Unfortunately, these deeper aquifers require even more treatment because of their higher salinity and the maximum conversion during the RO process decline with depth to 70 percent or less. Other disadvantages include higher reverse-osmosis pressure, the requirement for effluent concentrate disposal by deep-well injection, and higher pumping cost (Stroud, 1991).

Other ideas for obtaining fresh water include constructing a pipeline that would bring water to Cape Coral from west-central and central Florida, the use of the Caloosahatchee River, aquifer storage and recovery, the use of saline surface water and desalination, the creation of a North Cape Coral reservoir, and the use of a bulk water purchase arrangement. While these options are being considered, they are in the early planning stages and their feasibility has not been explored fully.

One fact remains clear: The city must continue to provide an adequate water supply for what has been to date a rapidly expanding population. Although only half the properties within Cape Coral have been developed, current water usage is high. It is also clear that the city made a forward-looking decision when it opted to install a dual water system. It has been a highly successful system that dramatically reduced the use of potable water and reduced the pressure on the original RO plant.

Cape Coral has made tremendous strides in expanding its water supply capacity, and in reducing the use of potable water during the last two decades. Energetic efforts by the Cape Coral Public Works Department have paid dividends and have avoided many of the water resource problems that were looming years ago. It appears that adequate supplies of potable water will be available for a potential build-out population of between 350,000 and 400,000 if the planned expansions in RO capacity take place and if there are no unforeseen difficulties in obtaining and purifying deep groundwater supplies.

Conclusions

Even communities with a poor layout and design and a history of inefficiency are now beginning to realize the importance of conservation and the need to preserve natural resources, especially fresh water. This article illustrates the importance of making provisions for water supply within pre-platted communities where water needs may be minimal during the early stages of development. Obviously, demands will increase dramatically if the community "succeeds" and experiences rapid population growth.

Unfortunately, water resource problems are not limited to dry environments. Cape Coral, for example, located in water-rich Florida, has experienced significant water resource problems during the last two decades. Potential problems for the future include competing demands on already limited supplies, the degradation of existing sources of supply from unexpected pollution sources, or an abnormal rise in the demand for water from rapid population growth. These and other potential problems highlight the importance of water resources planning and management that includes protection of existing sources and an ongoing search for new sources of supply and innovative conservation techniques. Although Cape Coral has undertaken innovative initiatives to meet existing water needs, long-term success will require a regional commitment and cooperation among all users of what is likely to be limited supplies of potable water.

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