CHAPTER THREE

WATER RESOURCES AND PRODUCTION CAPACITY

This section describes the water resources (water supplies) used by Tucson Water and the infrastructure used to deliver these water supplies to our customers. It also explains how drought may or may not impact either the water resource or the water system's ability to deliver water. General reliability comments are also included for water resources and system infrastructure.

Available Water Resources

Currently three water sources are both physically and legally available to Tucson Water for municipal supply:

- Groundwater,
- Colorado River water, and
- Effluent and Recycled Water

Having three sources of water gives the Utility a great deal of flexibility in how it responds to a drought, either on the Colorado River or locally.

Groundwater

Tucson Water pumps groundwater from a very large aquifer, well over 1,000 feet deep in many locations and hundreds of square miles in area. The estimated volume of groundwater physically available within Tucson Water's service area ranges from about 10 to 20 million acre-feet (City of Tucson Water Department, 2004). Net natural recharge in this area is estimated at 50,000 to 60,000 acre feet per year, or less than one percent of the total volume of groundwater in storage. As a result, most portions of this very large aquifer would respond very gradually to local drought conditions. Because of this, drought impacts to water supply from this aquifer may not become apparent unless local drought is sustained over decades. More shallow aquifers in some parts of this region, however, may be very responsive to a reduction in local precipitation and demonstrate impacts from relatively short-term drought.

Local drought may cause an increase in gallons per capita per day demand (GPCD). Unless additional renewable water supplies, such as Colorado River water, were available to meet that increased demand, or demand was reduced, additional groundwater would

have to be pumped. A *reduction* in the availability of Colorado River water to the City would also have to be made up with groundwater, unless demand was reduced. A combination of local drought *and* drought on the Colorado River could have a significant impact on our groundwater resources if demand was not reduced.

Finally, while the volume of physically available groundwater may be substantial, the City is limited in how much groundwater it can mine, or pump, under the Assured Water Supply (AWS) rules. Increased use of groundwater may be a viable response to drought, but could also have a detrimental impact on the City's ability to maintain its AWS designation in the future through overuse of groundwater. Minimizing the impacts of drought on our physical and legal access to groundwater is a principal focus of the Plan.

Colorado River Water

Tucson Water's current CAP allocation is just over 144,000 acre-feet per year[1]. Like any other surface water resource, the availability of Colorado River water depends on precipitation, especially snow-pack, in the Colorado River Watershed. Colorado River water, the only renewable surface water source available to Tucson, is imported to the Tucson area via the 336-mile long Central Arizona Project (CAP) canal (Figure 3.2).

Tucson Water is no longer the only water provider in the Tucson Active Management Area currently directly utilizing Colorado River water as a source of potable supply. Tucson Water has entered into Intergovernmental Agreements (IGAs) with the Pascua Yaqui Indian Nation and the Town of Oro Valley to take delivery of their CAP allocations (or a portion thereof) at one of the Clearwater Recharge and Recovery facilities and wheel the recovered water through the Tucson Water transmission system thereby increasing utilization of renewable water supplies within the Tucson Active Management Area. The Utility is in discussions with other local water providers for additional wheeling agreements as the region continues to move toward direct utilization of CAP.

As the Utility utilizes its CAP allocation to meet demand close monitoring of drought conditions on the Colorado River Watershed are needed because a severe drought on the Colorado could result in the Secretary of the Interior declaring a shortage on the river.

The Secretary annually (usually in October) determines the condition of the Colorado River for the coming "water year" as surplus, normal, or shortage. A declaration of shortage, meaning the river does not have sufficient capacity to fully meet all of the

[1] The current CAP allocation is 144,172 acre feet. This will increase by 19 AF once the Flowing Wells transfer is finalized.

allocations to states with contractual rights to the water, could impact delivery of Tucson's CAP water.

Figure 3.1: Central Arizona Project Canal

In surplus or normal water years, the Utility has reliable potable water supplies through the City of Tucson's Colorado River water allocation delivered through the Central Arizona Project, and its backup groundwater resources. However, if the Secretary declares a shortage on the Colorado River and CAP deliveries are reduced, Tucson Water's groundwater resources would likely have to be used for drought mitigation.

In anticipation of droughts on the Colorado River, the Arizona Water Banking Authority (AWBA) has been "firming" CAP allocations, or adding water supply reliability, for municipal users by storing (recharging) excess Colorado River water in underground facilities such as Tucson Water's Central Avra Valley Storage and Recovery Project (CAVSARP) and Southern Avra Valley Storage and Recovery Project (SAVSARP). If there were reductions in delivery of the City's CAP allocation due to drought on the Colorado River, this "firmed" water could be made available (pumped) to help meet demand.

Effluent and Recycled Water

Municipal wastewater effluent is a renewable water source that increases as the population increases. Effluent is generated by interior water usage such as toilets, showers, washing machines etc., and the volume generated is largely unaffected by drought, unlike groundwater and Colorado River water. In 2010, 64,500 acre-feet of effluent were produced from the metropolitan wastewater treatment plants in the Tucson area. The City of Tucson has an entitlement to about 31,536 acre-feet of this effluent. About 13,000 acre-feet of the City's current effluent entitlement was recycled in 2010 in the reclaimed water system, primarily providing irrigation water to customers with large turf facilities such as golf courses, parks, and athletic fields. An additional 500 acre feet of the City's secondary effluent was used on the Silver Bell Golf Course directly.

A prolonged drought, both locally and on the Colorado, or climate change could result in the implementation of potable water conservation measures that reduce interior demand and associated effluent volumes. However, given anticipated population growth and the amount of unused effluent, it is extremely unlikely that these conservation measures would result in an insufficient supply of effluent to satisfy the demands of the reclaimed system or other direct users of secondary effluent.

SYSTEM DELIVERY CAPACITY

This section provides an overview of how we produce our two potable water supplies, groundwater and Colorado River water, and how the City's wells are designed and constructed. Because drought affects each of these supplies differently each is discussed separately. Finally, the central distribution system and the isolated systems are discussed as these two are affected differentially by drought.

Potable Well Fields

To meet demand, Tucson Water relies on about 200 potable production wells spread over five well fields with a collective pumping capacity of about 200 million gallons per day (MGD). These wells either pump native groundwater or recover a blend of recharged Colorado River water and native groundwater. The combined production capacity of 200 MGD currently far exceeds the average daily demand of the peak 30-day period of about 140 MGD. (Figure 3.3)

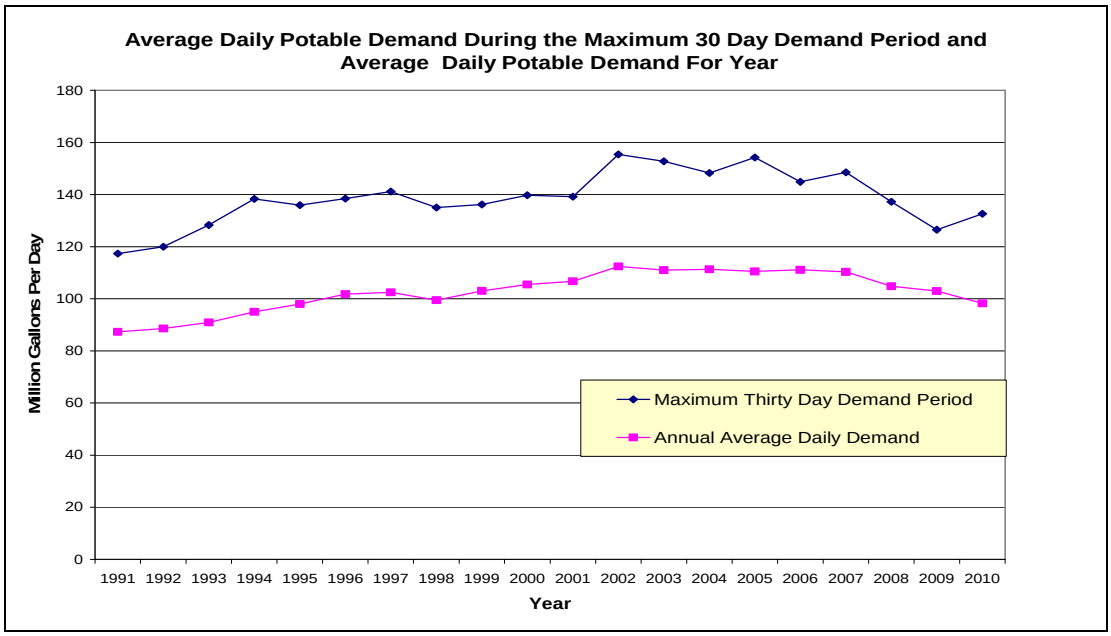

Figure 3.2: Average Daily Potable Demand and Maximum 30-Day Potable Demand

The Utility's wells are often drilled to depths which exceed 800 feet below land surface. For many of the City's wells, the perforated section begins below the water table and the perforated section is quite long. All these characteristics hold for the wells drilled at CAVSARP as well. At CAVSARP, the perforation design and depth was to capture both groundwater and "perched" recharged water to produce a mix of the two sources. In contrast, SAVSARP wells are screened somewhat higher in order to capture primarily recharged CAP water rather than groundwater. As a result, the overall production capacity of the Utility's well fields will note immediately impacted if the water table fell (Figure 3.4). For wells producing groundwater, under normal pumping conditions, it could take years of extreme local drought before the water table fell enough to negatively impact these wells. For wells located at recharge facilities it would take both a significant and sustained – six months to a year - reduction in the City's Colorado River water deliveries for these wells to begin to lose productive capacity. Given the design and deep penetration of Tucson Water's wells into the regional aquifers, they are generally not subject to sudden or dramatic

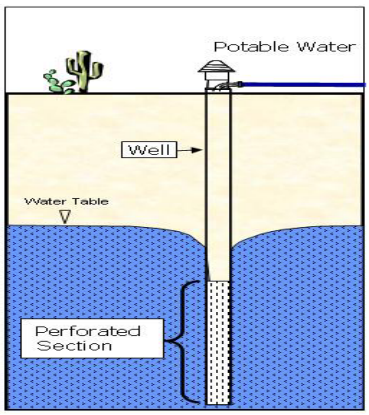

Figure 3.3: Well Diagram

declines in production if water tables fall as a result of either local or regional drought. However, aquifer-stewardship goals and subsidence issues preclude Tucson Water from solely relying on groundwater for drought preparedness.

Historically, Tucson Water relied on groundwater to supply potable demands. To that end four major well fields were developed. Since 2001, Tucson Water has been relying less on native groundwater to meet potable demands and more on renewable supply from imported Colorado River water. The Colorado River water is imported via the Central Arizona Project Canal to three recharge and recovery facilities:

- Central Avra Valley Storage and Recovery Project (CAVSARP) which went into operation in 2001;
- Pima Mine Road Recharge Project (PMRRP – jointly owned by the City of Tucson and the Central Arizona Water Conservation District) which went into full-scale operation in 2001;
- Southern Avra Valley Storage and Recovery Project (SAVSARP) which began operation in 2008.

The recharged Colorado River water is then recovered through new or existing well fields and delivered to customers. Two of the four well fields originally designed for producing groundwater are now producing a mixture of groundwater and recharged Colorado River water due to their proximity to the recharge projects. The Avra Valley Well Field which for years was used to pump groundwater, is now recovering Colorado River water recharged at SAVSARP. The Santa Cruz Well Field, located down gradient from PMRRP, now produces a blend of local groundwater and Colorado River water recharged at PMRRP.

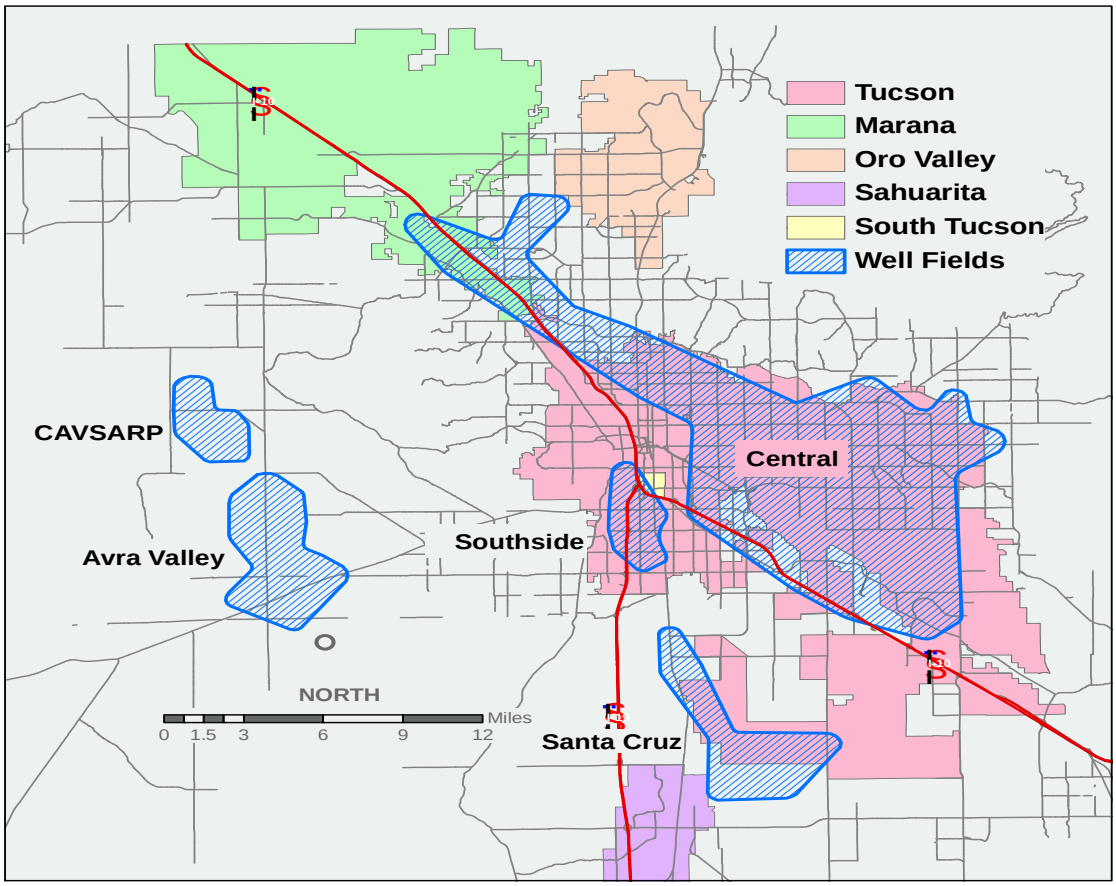

Figure 3.4: Tucson Water Well Fields

The mixture of groundwater and recharged Colorado River water recovered through the Avra Valley, CAVSARP and Santa Cruz Well Fields accounted for approximately 70% of Tucson Water's annual potable deliveries in 2010. In 2012, Tucson Water will purchase and recharge its full allocation of Colorado River water for the first time (144,172 acre-feet).

The combination of existing groundwater well fields, well fields which deliver a blend of groundwater and recharged Colorado River water, and the phased construction of the planned recovery well field at SAVSARP will result in production capacity increasing faster than potable demand. This should allow the Utility to comfortably satisfy the average daily demand of the peak 30-day period for at least the next 10 years, under normal climatic conditions within the Colorado River Watershed

The wells at CAVSARP and SAVSARP are designed to allow for continued operations for six months to a year, even in the event *no* Colorado River water was being recharged – for example, if the Central Arizona Project canal were to actually fail. Under drought conditions on the Colorado, it is possible, though very unlikely, that no Colorado River water would be delivered for recharge. The design of the recovery well system would allow these well fields to continue operating for some period of time at full capacity after a cut in CAP delivery was imposed. However, if the water table began to fall the production capacity of this well field could also fall, causing a shift in production back to the Central Well Field.

Central Distribution System and Isolated Systems

Tucson Water's potable systems are designed and operated so that the following operational and regulatory requirements are met:

- Maintain adequate system delivery pressures.
- Meet the daily peak demand.
- Meet potential fire-flow demands.
- Meet or exceed all primary drinking water standards.
- Maintain adequate system disinfection levels.
- Satisfy or exceed customer expectations.

About 99 percent of the water produced by Tucson Water's production wells enters the large, integrated central distribution system. Generally, the water produced from these wells can be moved anywhere in the central distribution system via pipelines, boosters, and reservoirs and may travel 40 to 50 miles to reach customers. Given the number of production wells and anticipated excess production capacity, the loss of a few wells to falling water tables will generally have little impact on the City's ability to meet demand.

In addition to the central distribution system, there are nine small, isolated potable systems supplied by dedicated production wells and associated supply infrastructure (Figure 3.6). These isolated systems rely entirely on native groundwater and supply infrastructure located in the immediate area. Isolated systems are more operationally

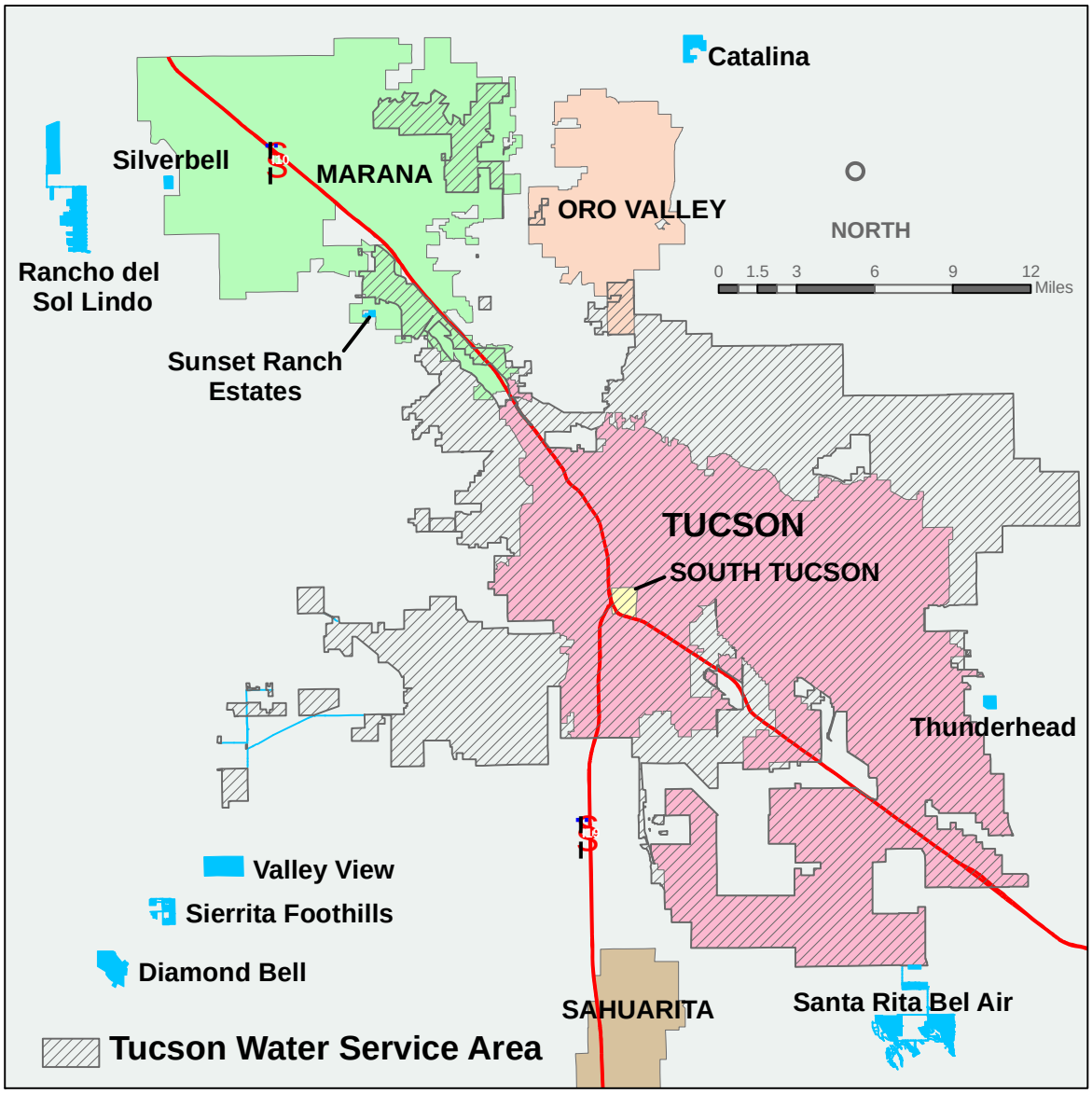

Figure 3.5: Tucson Water Isolated Systems

vulnerable, since they do not benefit from the system reliability available to the central distribution system, making them potentially more vulnerable to *local* drought impacts. Conversely, because such systems are not connected to the central distribution system, they cannot be impacted by drought conditions in the Colorado River Watershed and must be monitored separately.

Chapter Four utilizes the water supply and system information discussed above to identify specific drought indicators for the Utility and determine the factors that will trigger declaration of drought response stages for the Tucson Water service area and the response measures necessary to mitigate potential drought impacts.

Reclaimed Water System

The reclaimed system takes secondary effluent from Pima County's Roger Road Wastewater Treatment Plant and it is either filtered at the Tucson Reclaimed Water Treatment Plant for direct delivery or recharged and recovered for indirect delivery. Demand for reclaimed water is very responsive to increases in temperature and reduction in precipitation. The peak-demand period under drought could be extended, arriving earlier and lasting for a longer period of time. Though the availability of effluent will generally not be affected by drought, the demand from new and existing reclaimed customers could potentially outstrip the reclaimed system's capacity to meet demand. Under normal climatic conditions, the potable system has provided backup supply at critical times. Potable water will not provide backup supply to the reclaimed system during drought response stages 2, 3, and 4.