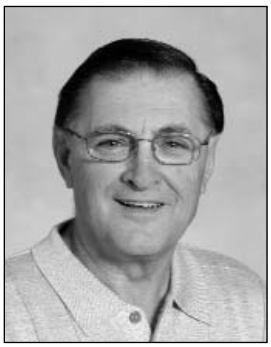
by Bert Zerr

Abilene's reverse osmosis water plant seven years later

The history of Abilene, Kan. dates from the colorful pioneer cattle days when great herds of longhorns were driven overland via the Chisholm Trail from Texas to Abilene, the western terminus of the first railroad through Kansas. Abilene's reputation as the "wickedest and wildest town in the west" was developed during this time. It was during those years that Wild Bill Hickok became famous as a lawman. Many years later, another individual from Abilene, General Dwight D. Eisenhower, became famous serving as the Supreme Commander of the Allied Expeditionary Force during World War II followed by two terms as the President of the United States. In keeping with President Eisenhower's People to People program, Abilene has Omitama, Japan as its Sister City. Since 1984 a variety of exchange programs have been conducted between the two cities.



Bert Zerr
Consultant

Public water supply issues

Abilene had for many years operated with a plentiful supply of water from wells located west of town in what is known as the Sand Springs area. They include two large producing wells located within the city, and several other wells located just west of town. Problems were detected in 1985 when the water from the two wells within the city was found to contain high levels of Volatile Organic Chemicals (VOCs), requiring the wells to be taken off line. Later the water from the wells west of town, including the Sand Springs wells, was found to contain excessive nitrate. In addition, the Sand Springs wells, which are limestone cavity wells, were identified as "Groundwater under the Direct Influence of Surface Water." The water from these wells becomes turbid when the water level in the Smoky Hill River would rise. Since the Sand Springs wells had been a very good source of water for a number of years, with an early water right, the city was not willing to give them up.

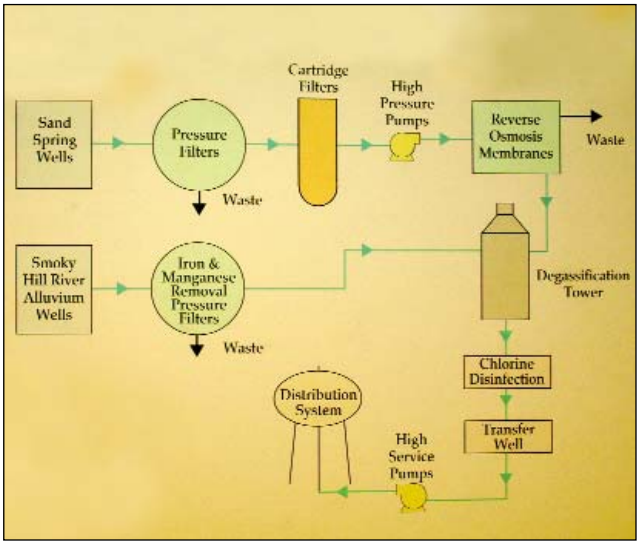
> Since the Sand Springs wells had been a very good source of water for a number of years, with an early water right, the city was not willing to give them up.

Need for water treatment

It was evident then that a water treatment plant was needed to treat water from the Sand Springs wells. The engineering firm of Professional Engineering Consultants, P.A. (PEC) was retained to evaluate treatment options. Eventually, after reviewing the options which included installing a reverse osmosis (RO) pilot plant, the city elected to proceed with the RO option for nitrate removal. Actually a combination of treatment technologies was utilized. The technologies selected include: greensand/anthracite/sand pressure filters for pre-filtering followed by five micron cartridge filters to comply with surface water treatment rule requirements, followed by RO membranes for nitrate removal. Also, a second source of water consisting of new wells developed in the river alluvium south of town was added to the system. These wells were

Cliff Gibbs, Abilene Public Works Director, stands next to the reverse osmosis water treatment plant site signage. The facility was the first and only RO plant of its size to be built in the state of Kansas to date. Gibbs oversaw the building of the water plant and will soon be busy with a new wastewater plant project for the city.

low in nitrate but contained some iron and manganese. Alluvium well water is pumped to the treatment plant where treatment of the water consists of oxidation of the iron and manganese by injecting potassium permanganate and chlorine into the line prior to pressure filtration.



The plant schematic shows the progression of both streams of water, the Smokey Hill River Alluvium and the Sand Springs, through filtering, reverse osmosis, treatment and distribution processes.

Other factors for "RO"

In addition to producing a very good quality water, other factors that were considered in the selection of RO as the preferred treatment process include: (1) The modular design of the facilities provides easy installation, in a short time frame, as demands change; (2) The cost of RO membranes has decreased while membrane technology has increased; and (3) Anticipated compliance is expected with all predictable future regulations which might be imposed on public water supply systems.

Reverse osmosis process

A semi-permeable membrane is used to remove nitrates and other minerals from the water. The membrane is designed to allow only water to pass through. As such, when pressure is applied, water will pass through but the inorganic ions will not. Inorganic ions that were in the well water will be removed and carried away in the waste stream.

Plant operation

The city began operation of the $6.5 million, 4.0 MGD, plant in October 1998. The RO portion of the plant consists of four skids, each with 15 tubes (or houses) for a total of 60 tubes. Each tube contains seven membranes; each skid with 15 tubes contains 105 membranes. The total number of membranes for the four skids is 420. The projected life of the membranes at the time of construction was five to six years. Thus far, the city has replaced all membranes in three of the four skids at a cost of $600 per membrane. The membranes in one skid were replaced three years ago, just meeting the projected life, and in the other two skids replacement of the membranes occurred last year, exceeding the projected life. The last skid is original and still operating. The new membranes are more efficient requiring a lower pressure to operate (114 psi compared to 130 psi), have a higher cleaner capacity and a better rejection rate.

At the present time, the finished water blend consists of 60% Sand Springs water (five wells) and 40% alluvium (three wells). With a raw well water flow rate of 522 gpm, the plant produces finished water at the rate of 417 gpm with a waste stream of 105 gpm. Typical daily production at this plant which serves, not only city of Abilene customers, but also Dickinson County Rural Water District 2 customers, is about 1.0 MG during colder months and about 1.75 MG during warmer months. From a quality standpoint, the final blend of water from the two sources is very good (See chart below).

ABILENE KANSAS
SAND SPRINGS AQUIFER WATER

Reverse Osmosis Plant Performance

Sand Springs Influent		Reverse Osmosis Effluent	
Hardness	±270	Hardness	±3
Nitrate	±10.5	Nitrate	±0.7
Iron	±0.07	Iron	Not Detectible
Manganese	NA	Manganese	NA

River Alluvium Influent		Pressure Filter Effluent	
Hardness	±380	Hardness	±380
Nitrate	±3.2	Nitrate	±3.2
Iron	±1.18	Iron	±0.06
Manganese	±0.10	Manganese	±0.01

Blended Characteristics			
Hardness	±150	Iron	±0.02
Nitrate	±1.7	Manganese	Not Detectible

Cliff Gibbs describes the workings of the plant's RO tube units with the cutaway model on the table. The off-white semi-permeable membrane is seen at the left end of the model.

Norm Holt, water plant operator, and Jay Leusman, lead water plant operator, lean on a replacement RO membrane, 420 of which fit in the 60 tubes arrayed in the four skids behind them.

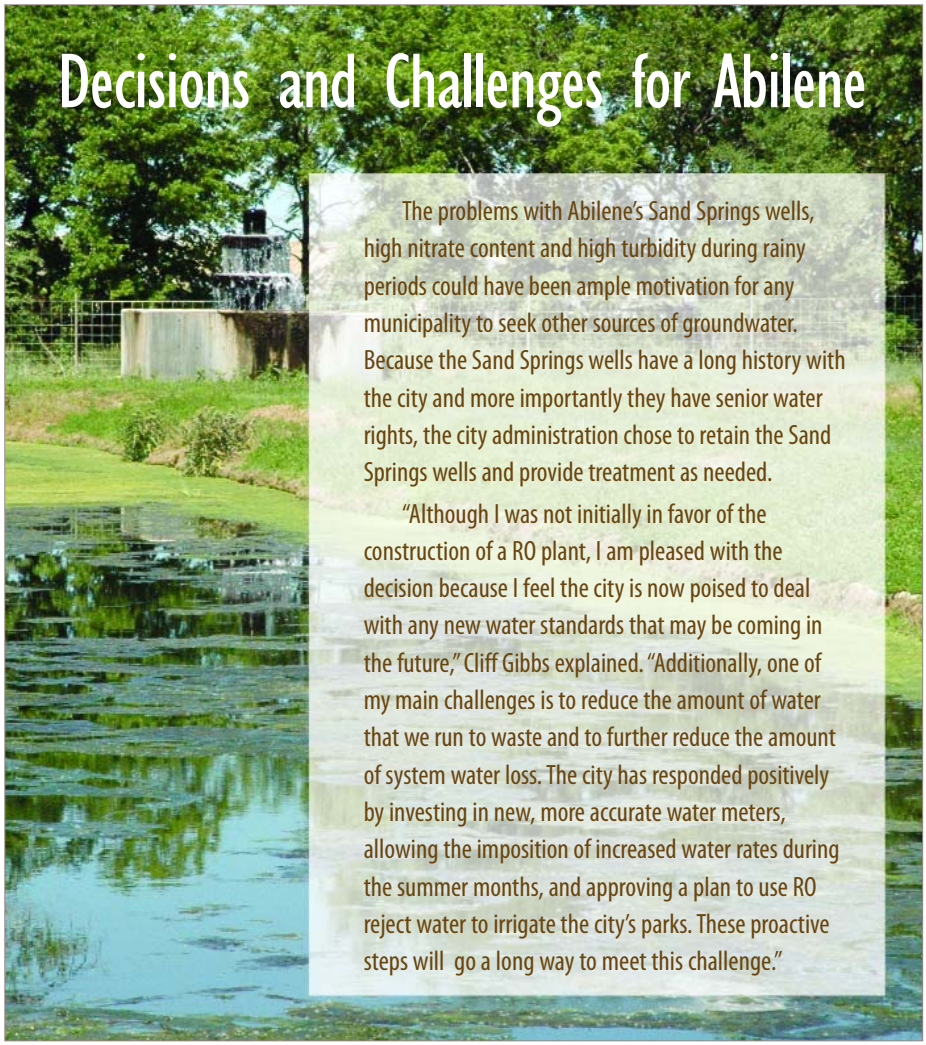
Current status

Overall, the city is happy with the quality of water being produced and operational staff members are comfortable with plant operations. Lead water plant operator, Jay Leusman, noted, "Plant operations are made easy and efficient by computer controls." Cliff Gibbs, Abilene Public Works Director, indicated however, "We continue to work toward reducing the amount of water lost because water lost in the plant waste stream coupled with the recent drought conditions has been an issue of concern." As a result, the city has taken steps to reduce the amount of water loss. These steps include: (1) Doubling the water rates to customers during the summer months to reduce wasting. This appears to have been successful in reducing water usage as daily water production prior to implementing

Above: *Filter cartridges in the process are being replaced in the pressure cannister before water is pumped to the RO tubes.*

Right: *Jay Leusman explains the set-up for the plant master computer control panel. The computerized control process makes the plant more efficient and easier to operate.*

this measure was 2.0 to 2.5 MGD, up from the current production of 1.75 MGD, (2) replacing service meters with new meters. Equipment includes a receiver transmitter with radio-read and data logging capabilities which stores data for 64 days. The meter is capable of measuring flow in a ¾ inch meter at 21 oz. per min.; (3) matching meter size to customer needs. "We recently replaced a 2-inch meter with a 1-inch meter at a local fast food establishment because the larger meter was unable to measure the low flows servicing the soft drink machines. The 2-inch meter had been specified by the architect. A significant increase in water usage has been documented since the change," noted Gibbs. And finally; (4) the city is currently considering using water in the waste stream to irrigate city grounds such as parks and ball fields. Waste stream (reject) water is currently being discharged into Mud Creek as permitted by the KDHE. Reuse of this water would reduce the demand on the wells, thereby helping to maintain a reasonable water table in the Sand Springs well field.



Decisions and Challenges for Abilene

The problems with Abilene's Sand Springs wells, high nitrate content and high turbidity during rainy periods could have been ample motivation for any municipality to seek other sources of groundwater. Because the Sand Springs wells have a long history with the city and more importantly they have senior water rights, the city administration chose to retain the Sand Springs wells and provide treatment as needed.

"Although I was not initially in favor of the construction of a RO plant, I am pleased with the decision because I feel the city is now poised to deal with any new water standards that may be coming in the future," Cliff Gibbs explained. "Additionally, one of my main challenges is to reduce the amount of water that we run to waste and to further reduce the amount of system water loss. The city has responded positively by investing in new, more accurate water meters, allowing the imposition of increased water rates during the summer months, and approving a plan to use RO reject water to irrigate the city's parks. These proactive steps will go a long way to meet this challenge."