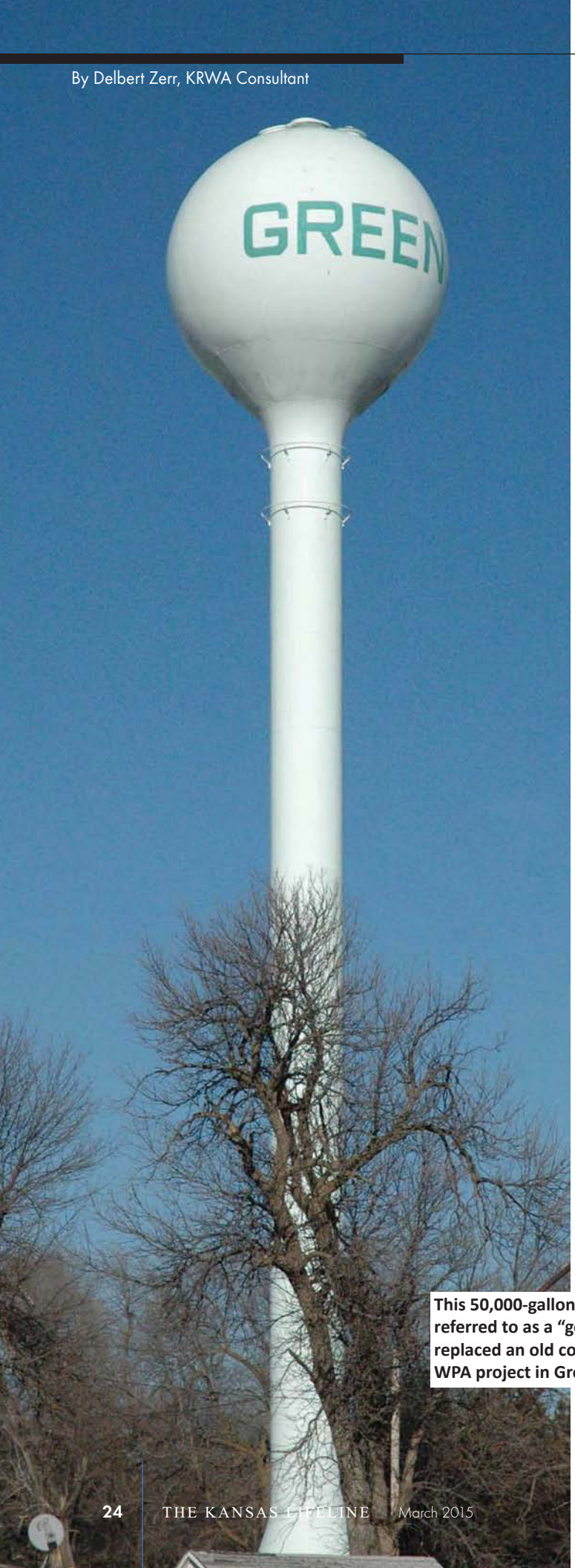
By Delbert Zerr, KRWA Consultant

Water System Improvements at Green Treat for Nitrate

The city of Green is located in the eastern part of Clay County about seven miles east and 3.5 miles north of Clay Center in north-central Kansas. Green was incorporated in 1908 and according to the 2010 census, has a population of 128. Green was named after the fourth governor of Kansas, Nehemiah Green, who offered and followed through with an offer to donate a church bell to the town in exchange for naming rights. The bell is still in use today. Like many small cities in Kansas whose water supply consisted of wells with treatment consisting of chlorination only, operating the system was relatively simple and operating costs were very minimal. After many years however, it became evident that major improvements were needed. The elevated storage tank with concrete pedestal which was built as a Works Projects Administration (WPA) project as a part of the New Deal of the 1930s and 40s had deteriorated and was in need of replacement. The city was nearly constantly repairing leaks in the distribution system. David Jermark, Mayor, stated that the cost of line repairs had reached a point where it was costing the city around $18,000 per year. Finally, three of the city's four wells produced water with borderline and at times excessive



This 50,000-gallon elevated tank, ò en referred to as a "golf ball on a tee" replaced an old concrete tank built as a WPA project in Green, Kansas.

nitrate in the range of 10 to 12 milligrams per liter (mg/L). Only one well produced water that met the 10 mg/L Maximum Contaminant Level (MCL) for nitrate: the city did not feel comfortable placing total reliance on one well.

The first improvement the city undertook was to replace the elevated storage tank. The new tank is a 50,000-gallon flared steel column (sphere) design and was constructed several years ago. The next question was how to deal with upgrading the distribution system and source.

One of the options for a new source was to look into a connection with another water system. The Clay Center Public Utilities Commission (PUC) had just constructed a reverse osmosis (RO) water treatment plant with adequate capacity to provide water to the surrounding area and communities.

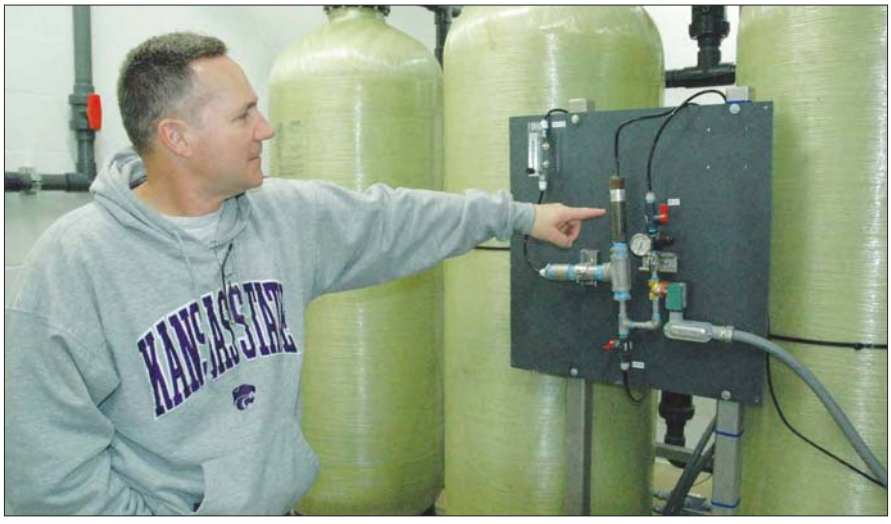
Ultimately the city chose to make improvements to the system in two phases.

The water system improvement project at Green included this water plant building that houses the nitrate removal units and chlorination equipment.

Several meetings were held to form a water district to the north and east of Clay Center that would include Green. Eventually though the city decided the cost was excessive and declined to be included in the project.

Ultimately the city chose to make improvements to the system in two phases. Phase I would consist of improvements to the distribution system and Phase II would deal with the source. The Phase I improvements consisted of replacement of 8,600 LF of polyvinyl chloride (PVC) pipe, 1,400 feet of high-density polyethylene (HDPE) pipe and replacement of 12 fire hydrants. About 700 feet of pipe was installed via directional bore and the remainder was open-cut construction.

Upon completion of Phase I, the city moved on to Phase II. The first step



Mayor David Jermark points to the Rosemount online nitrate analyzer used to control the regeneration cycle of the vessels.

Why is there a drinking water limit for nitrate?

Nitrates are very soluble and tend to move through soils, eventually ending up in groundwater. In water, nitrate has no color, no odor, no taste, and can only be detected by testing. Water containing high nitrate can cause methemoglobinemia, also known as infant cyanosis or blue baby poisoning in infants less than six months of age. This occurs because the conversion of nitrate to nitrite by bacteria in the stomach interferes with the oxygen-carrying capacity of the child's blood. Usually at around six months of age, the child's digestive system should be fully developed and should no longer suffer from the effects of nitrate poisoning. Consuming drinking water with nitrate levels near the drinking water standard does not normally increase the methemoglobin level of humans beyond infancy. In 1975 U.S. EPA set the MCL for nitrate in drinking water at 10 mg/L measured as nitrogen. Many Kansas public water systems have had nitrate in the range of 10 to 20 mg/l or higher for many years. There have been no known cases of methemoglobinemia as a result.

An electric modulation butterfly valve controls the flow from the wells, allowing for the desired blend of raw well water with treated water.

The display screen shows the status of operation. Operators can monitor operations remotely with mobile devices.

undertaken was to search for another source of water that would comply with the nitrate MCL of 10 mg/L. Several test wells were drilled with analysis results being unacceptable. With a connection to another public water supply system out of the question and a new well site not likely, the city felt the only option left was to construct a nitrate removal plant. BG Consultants, Inc., Manhattan was retained as the project design engineer. After securing bids from three suppliers, the city selected the lowest bid which was from AdEdge Water Technologies, LLC, Buford, Georgia to supply ion exchange equipment for nitrate removal.

Anion Exchange Treatment Plant from AdEdge Water Technologies

The nitrate removal treatment system consists of three pressured vessels with nitrate selective anion exchange resin. Normal operation will have two vessels in use with one on standby. A bypass line was installed to allow blending treated water with raw well water. The process utilizes sodium chloride to regenerate the resin. During the treatment process, there is an exchange of chloride for nitrate as the resin takes on the nitrate and gives-up or releases chloride into the treated water. The captured nitrate ions are eventually removed from the resin during the brine/rinse cycle and flows to waste to the city lagoon system. The initial startup of the plant was March 17, 2014.

The plant has a design flow rate of 40 gpm. The average daily usage is 12,000 gallons with peak usage at 40,000 gallons. Not all water needs to be treated however, and currently the finished water consists of about 50 percent treated water and 50 percent raw well water. The plan is to furnish water to customers with nitrate around 7.0 mg/L.

These three vessels used to remove nitrate. Each vessel measures six feet by two feet diameter and contains nitrate selective resin that allows an exchange of chloride for nitrate.

All water is disinfected at the end of the treatment process. Two peristaltic solution pumps were installed to inject sodium hypochlorite into the line prior to the distribution system.

J & N Elliot Construction, Morrowville, KS, was the contractor on Phase II and Banks Construction, Holton, KS, was the contractor for Phase I. Directional boring was done by Charlie's Construction, Frankfort, KS.

Overall, the city has upgraded the entire water system at a total cost of about $665,000. Of this amount, the city financed $201,000 utilizing general obligation bonds. The balance was paid with a Community Development Block Grant (CDBG) of $278,000 and a Rural Development (RD) grant of $186,000. Of course the improvements have resulted in an increase of rates to customers. The minimum rate which includes 1,000 gallons of water increased from $21.00 to $35.50 per month. The rate for each additional 1,000 gallons is $1.50.

Mayor Jermark stated that the city is pleased with the way the projects have been completed and wishes to acknowledge and thank the following organizations and agencies: North-central Regional Planning Commission, USDA Rural Development, Department of Commerce (CDBG), Kansas Department of Health and Environment (KDHE), and the Kansas Rural Water Association (KRWA).

Bert Zerr is currently a consultant with KRWA. He has been with KRWA since 2005. Prior to that, Bert was a District Engineer with the KDHE in the Salina District Office for 32 years.