

# Belpre constructs new ion-exchange nitrate removal plant

**B**elpre, Kan., located in the south-central part of the state on U.S. Highway 50 about 15 miles south of Larned, has the distinction of being the first city in the state to plant a Balsam Fir tree in 1888. At the time, there were very few trees in Edwards County, other than Cottonwood trees along the Arkansas River. This tree however, succumbed to a common weather condition in Kansas and was destroyed by high winds in 1996. Edwards County is in the heart of prairie country. Much of the county is covered with a sandy soil used to produce alfalfa. Small hills that look like grass covered sand dunes are also common.

Belpre has utilized groundwater as their source of water for years. Within the last several years however, the well water tested high in nitrate. The city governing body was then faced with a decision upon receiving a Kansas Department of Health and Environment (KDHE) order to achieve compliance with the maximum contaminate level (MCL) of 10 milligrams per liter (mg/l) nitrate as N.

## What are nitrates?

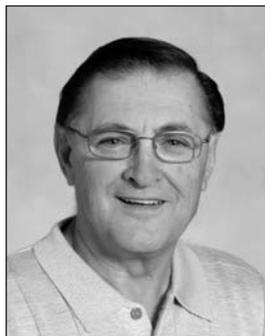
Nitrates occur naturally in the environment and are needed for plant growth. Nitrates (NO<sub>3</sub>) and nitrites (NO<sub>2</sub>) are nitrogen-oxygen chemical units that combine with various organic and inorganic

compounds. Sources of nitrate in ground water include, but are not limited to the following: runoff from chemical fertilizers; runoff from lawns and gardens; runoff from livestock facilities; and individual septic systems. The

greatest use of nitrates is as fertilizer. Since nitrates are very soluble and do not bind to soils, they have a high potential to migrate to groundwater. Because they do not evaporate, nitrates/nitrites are likely to remain in



The photo at left shows construction during the first week of March 2008 on the water treatment plant building at the well site located in Belpre. The contractor on the project was Cook Construction, Holcomb, Kansas.



Bert Zerr  
Consultant



Pictured above are the two ion exchange tanks with related piping system. The tanks contain nitrate selective resin provided by Krudico, Inc., and the piping system within the tanks was supplied by Pentair Water Treatment. In the background are two brine tanks and one of the city's well pumps. **Inset:** Pictured is an enlarged view of one of the automatic control valves located on top of the ion exchange tanks. Automatic operation is based on flow through the plant.

water until consumed by plants or other organisms. In water, nitrate has no taste or odor and can only be detected by testing. Nitrates, when taken into the body, are converted into nitrites.

to comply with the requirements.” The city basically looked at two options: 1) drill a new well in a location with water lower in nitrate; or, 2) construct a nitrate removal plant. After serious

another well around here that wouldn't have the same problem in five or ten years?” Don also noted, “Unlike other treatment techniques such as reverse osmosis, ion-exchange



**Far left:** Don Hellar, Project Engineer, removes the cover from one of the brine tanks to display the salt brine solution used to regenerate the resin in the ion exchange tanks. **Left:** Don Hellar points out the approximate level of the resin in the ion exchange tank.

### What are the health effects?

A U.S. EPA Consumer Factsheet provides this information on health effects: *For the short-term, excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin.* The presence of nitrite in the digestive tract of infants can lead to a disease called methemoglobinemia or infant cyanosis. This condition is also known as “blue baby syndrome” because of the bluish coloring of mucous membranes in infants.

### Belpre considers options

Belpre's source of water consists of two wells. One has a capacity of 250 gpm and the other produces 100 gpm. The nitrate levels range 8 to 20 mg/l nitrate as (N). Because nitrate was at these levels, Mayor Roy Freeman said, “The city had no choice but

consideration, the city chose the treatment plant, considering this option as more long term. According to project consultant Don Hellar with the engineering firm of Evans-Bierly-Hutchison (EBH) & Associates, the city was faced with the following question: “Where are you going to locate

is a relatively simple process that is easy to operate and affordable for small systems where there is no full time operator.”

### Nitrate removal by ion-exchange

Removal of nitrate by ion-exchange is very similar to water softeners that are commonly used

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Shown here is the double lined lagoon used to contain the concentrated nitrate and brine waste water. Note the attraction to wildlife, the hawk, located in the small circle and seen close-up in the inset and the rather significant security fence. Don Hellar noted that deer are the most serious hazard to the synthetic liners, as their hooves will damage the liner causing it to leak.



Seen above is the manhole where water that seeps through the first liner collects. Current seepage rate is about two gallons per month, well within KDHE specifications according to Don Hellar. Don stated that a pump will be obtained to return the seepage water to the lagoon.

in many homes. Instead of a cation resin used in softening however, an anion exchange resin is used to remove nitrate. Sodium chloride (salt brine) is used to regenerate the resin in both softening and nitrate removal systems.

The Belpre plant contains two polyethylene ion-exchange tanks that contain a nitrate selective anion resin. Nitrate selective resins prefer nitrate over other competing contaminants such as sulfate. The tanks are rated at 200

gpm each and are currently manually set to treat 105,000 gallons before switching automatically to the next tank. Both wells are set up to treat or bypass part of the flow, depending on the nitrate level of the incoming water. At the completion of the treatment cycle, the media is regenerated with a salt brine solution. A total of 1,500 gallons of water is used in the backwash/regeneration process. Waste water from this process consisting of concentrated nitrate and waste salt water brine flows to a double high-density polyethylene (HDPE) lined lagoon.

#### Why double-lined lagoon?

KDHE considers the waste water from the plant as industrial waste. The KDHE requirements pertaining to lagoons containing industrial wastewater state that the lagoon must be double lined. A summary of just a few of the requirements are as follows: Primary and secondary impermeable synthetic membrane liners with leak detection must be

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The photo above shows workers on the lagoon project sealing the HDPE liner joints.



Seen above is the pressure gauge that was used to confirm that the HDPE liner joints on the lagoon liner were adequately sealed.

provided; both liners must be at least 30 mils (0.030 inch) thick (membrane mil thickness used in the lagoon at Belpre is 60 mils); a conduit to allow movement of the fluid must be provided between the two liners (geonet-type material was used as the conduit at Belpre); both liners must be anchored at the top of the lagoon dike; maximum seepage rate allowed is 1/64-inch-per-day; and, a reliable seam testing method must be used to verify the adequacy of the seaming process. Additional information pertaining to double-lined lagoons can be viewed on the KDHE Web site.

### Summary

The cost of the project was \$450,000, an unmanageable amount for a city with a population of 104 citizens to pay. Without financial assistance the project would have been impossible for Belpre. The city was fortunate to obtain that assistance in the sum of \$350,000 from a combination of Rural Development grant and loan and Community Development Block Grant. The city taxpayers were therefore left with a balance of \$100,000 as their responsibility. Water rates prior to the project

were \$17 for 1,000 gallons plus \$1.50 for each 1,000 gallons above the minimum. As a result of this project, water rates increased to \$30 for the first 5,000 gallons plus \$1.50 per 1,000 gallons thereafter. When asked whether local residents had any comments about the project Mayor Freeman

said, "People had two to three years to get familiar with the need to address the problem. Doris Freeman, a Belpre council member added, "Overall, people here just want good drinking water."



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