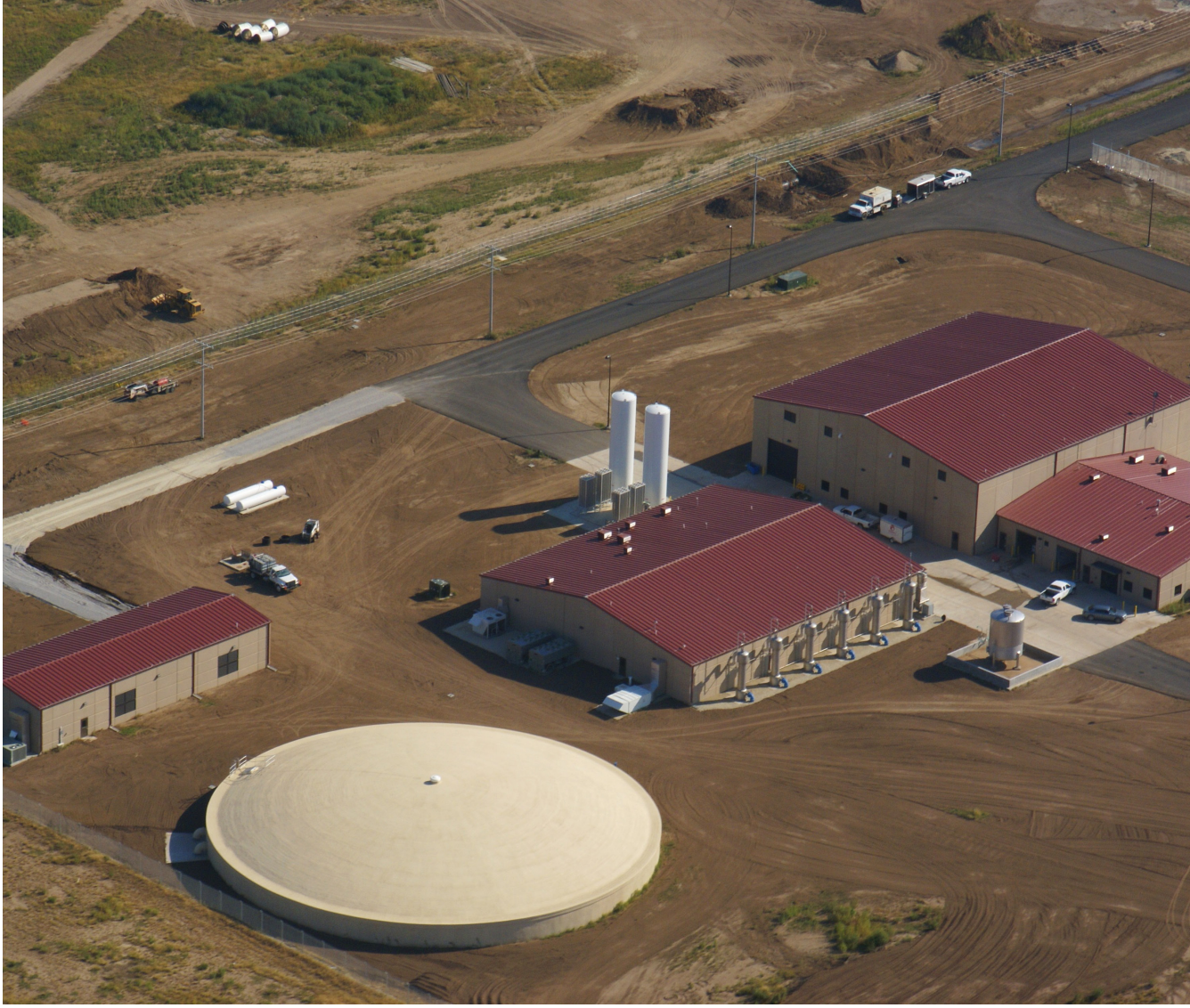

2015 Global Water Awards
Water/Wastewater Project of the Year

Wichita Equus Beds Aquifer Storage & Recovery (ASR) Project

Wichita, Kansas

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BURNS McDONNELL

Executive Summary

Executive Summary

Wichita's Equus Beds Aquifer Storage and Recovery (ASR) Project represents an integrated and innovative approach to obtaining a sustainable water supply, by protecting and sustaining an aquifer that provides water for both municipal and agricultural users.

Problem: The combined use of the Equus Beds aquifer by municipal and agricultural users has caused significant aquifer depletion, which has also increased the threat of chloride contamination from abandoned oilfield developments and natural sources of chlorides. The City depends on the 900,000-acre Equus Beds aquifer for much of its water supply. It is also the water source for a number of agricultural irrigators. Unfortunately, the water demands of the city, nearby municipalities, and agricultural users, far exceeded the aquifer's natural recharge rate. By 1993, water levels in the aquifer had dropped up to 40 feet from their predevelopment levels, a depletion of over 200,000 acre feet. The aquifer is also threatened by two sources of chloride contamination: one from oilfield brine improperly disposed of in the 1930s; and the natural chlorides associated with the Arkansas River. The falling water levels made the aquifer vulnerable to saltwater contamination that would have rendered the groundwater unfit for drinking or irrigation.

Solution: In 1993, Wichita adopted a multipronged Integrated Local Water Supply Plan that featured the Equus Beds Aquifer Storage & Recovery (ASR) project. By creating 60 recharge wells and three recharge basins, this injects up to 100 million gallons of water per day back into the Equus Beds aquifer, recharging the aquifer to levels required to meet the needs of the region and also provide a barrier to the movement of the chloride plumes. The intermittent water source is the Little Arkansas River (LAR). While it is considered an intermittent water supply, it is estimated that it would generally have enough water to supply the ASR project 120 days per year.

The City has also entered into cooperative partnerships with agricultural producers in the LAR watershed to establish a watershed protection program to enhance and protect the water quality in the river.

The first two phases of the project are complete, and the City can capture and recharge up to 35 million gallons per day, and as much as 15,000 acre feet per year into the aquifer. The varied users of the aquifer, the critical need of sustaining the water supply, and the scope of the project make this ASR project a model for recharge solutions.

Project Description

Wichita Equus Beds Aquifer Storage & Recovery (ASR) Project Wichita, Kan.

With a growing population and water levels in its aquifer dropping to unsustainable levels, the City of Wichita, Kan. embarked on a bold plan to ensure the region's future water needs. The Equus Beds Aquifer Storage and Recovery (ASR) Project will eventually have the capacity to divert and treat more than 100 million of gallons of water per day from the Little Arkansas River (LAR) and use that water to recharge the Equus Beds Aquifer.

The City depends on the 900,000-acre Equus Beds aquifer for a significant portion of its municipal water supply. It is also the source of water for a significant number or agricultural irrigators. The City began using the aquifer in 1940, but unfortunately the water demands of the city, nearby municipalities, and agricultural users, far exceeded the aquifer's natural recharge rate. By 1993, water levels in the aquifer had dropped up to 40 feet from their predevelopment levels, a depletion of over 200,000 acre feet . The aquifer is also threatened by two sources of chloride contamination: one from oilfield brine improperly disposed of in the 1930s; and the other from natural chlorides associated with the Arkansas River. The falling water levels made the aquifer vulnerable to saltwater contamination that would have rendered the groundwater unfit for drinking or irrigation.

Recognizing the need for action, in 1993 Wichita adopted a multipronged Integrated Local Water Supply Plan (ILWSP) that featured the Equus Beds Aquifer Storage & Recovery (ASR) project. By creating 60 recharge wells and three recharge basins, the ASR aims to eventually inject up to 100 million gallons of water per day back into the Equus Beds aquifer, recharging the aquifer to levels required to meet the needs of the region potentially through most of this century, and also provide a barrier to the movement of the chloride plumes. The intermittent water source for the ASR project is the Little Arkansas River (LAR). While it is considered an intermittent water supply, it is estimated that it can generally have enough water to supply the ASR project about 120 days per year.

A. Role of Entrant's firm

Burns and McDonnell has served the City throughout the development of the ASR project, beginning with a five-year demonstration project in 1995 to test the feasibility of diverting water from the LAR during wet weather into the aquifer. In Phase II of the project, Burns and McDonnell teamed with Alberici Constructors, Inc. and CAS Construction LLC to form an integrated design-build team to execute the design and construction of the river intake structure and water treatment facilities, with Wildcat Construction and Shelley Electric, both of Wichita, Kan. serving as major subcontractors to the joint venture. In addition, Burns and McDonnell served as the project engineer for the construction of all of the recharge wells and basins constructed in Phase II.

B. Role of other Consultants

Other consultants performed the design of the other facilities needed for Phase II, including the construction of two surge tanks, construction

of approximately 40 miles of high line electrical service and a new electrical substation, and approximately 19 miles of new raw water transmission pipelines and the development of a new SCADA system to help manage and operate the system.

C. Entrant's contribution to the project:

• Uniqueness and/or innovative application of new or existing techniques

Phase II of the project was designed to capture and recharge up to 30 MGD. In this phase the water is filtered using ultrafiltration membranes and then treated with Advanced Oxidation (AOP) to remove atrazine and viruses, and also mitigate bromate formation.

Membranes are used to treat drinking water around the world, but the Wichita ASR project represents the first time membranes have been combined with an AOP technology for aquifer recharge.

The Wichita installation was the largest AOP system installed to date — six times larger than the next biggest system.

To date, in spite of almost unprecedented drought periods, the ASR project has recharged almost 2 billion gallons back into the aquifer.
To address the challenging raw water quality and assure compliance with all finished water quality parameters, the following treatment process train was selected. This is the first and only application of this technology on this scale in the world. When the plant is in operation at high river levels, water is pumped from the river to the sedimentation basin which removes readily settable solids from the water. The settled water is then be pumped through the automatic strainers to remove any matter larger than 500 microns and then on to the plant site which is about 2.5 miles from the intake site. The water is treated by the submerged membrane system which removes any additional material from the water. The nominal pore size of the membranes is 0.04 microns, and any particulate matter in the water larger than this size will be removed. The water is then pumped through the AOP, where hydrogen peroxide and ozone are injected into the water for atrazine reduction and to achiev 4-log reduction in viruses, while preventing the formation of bromide. Finally, the water is stored in a 2.5-million-gallon ground-level clearwell before the high service pumps send the treated water out into the distribution system to be injected back into the aquifer or sent to the City. Major considerations for the process and equipment selection included the operation, control, and long term operation costs as well as the plant not being in continuous operation. It is estimated the plant will run 120 days per year based on the height and flow of the river at the intake site.

There are many unique aspects to the treatment facilities. Principal among them are:

- Clarification without chemical addition, which allows the return of all solids to the river.
- Use of a proprietary advanced oxidation process for atrazine destruction and to provide 4-log reduction of virus.
- Operation of the plant on an intermittent basis- on average the plant will run 120 days per year and will not be operated during winter months;
- Minimal redundant equipment required due to the facilities' noncritical nature.

- Membrane & AOP System Operation - The AOP system requires a constant flow rate of 15 or 30 MGD for proper water treatment. This was a unique operational parameter for the membrane system.

Membrane Cleaning - Initially one CIP tank was proposed for the membrane system that would mix chemical solutions for daily cleans, sodium hypochlorite recovery cleans, and citric acid recovery cleans. Modifications to the system saved over 100,000 gallons of water and over 60 hours of cleaning time

• ***Future value to the engineering profession and perception by the public***

The first two phases of the project have been completed, and the City is currently able to capture and recharge up to 35 million gallons per day, and as much as 15,000 acre feet per year into the aquifer. The varied users of the aquifer, the critical need of sustaining the water supply, and the scope of the project make this ASR project a model for recharge solutions. Water quality concerns represented one the biggest issues expressed by the public. The City of Wichita implemented an extensive and ongoing public information campaign when the ILWSP was adopted in 1993 to ease those concerns.

The city established a website, www.ks.water.usgs.gov/7-Equus-Beds-Recharge, that provides the public with information on the progress of the plan as well as data from the U.S. Geological Survey (USGS). By partnering with USGS to provide water quality data at near real-time speed, the City has gained public trust. Customers concerned about water quality can visit the website, where they can access the same data at the same time as city officials. This transparency has proven valuable in winning public confidence in the ASR project and the overall ILWSP.

• ***Social, economic, and sustainable development considerations***

Watershed Protection

As residents and producers in the project area became more aware of the City's desire to use the LAR as a water supply source for recharging the aquifer, and the water quality challenges of using the river, they established a watershed protection project, called a Watershed Restoration and Protection Strategy (WRAPS) project. The primary goal for the LAR WRAPS was to reduce atrazine in the river to 3 parts per billion (the drinking water standard) or less. The project has been very successful, with more than 350 producers participating and BMPs implemented on over 10,000 acres. This is a unique partnership between producers and a municipality to enhance and protect one water resource so it can be better utilized to protect and sustain another water resource.

• ***Complexity***

Much of the complexity of the project starts with the water source used for the ASR Project. There are no remaining "firm" water supplies available that are cost effective with the ASR Project. However, using the LAR as a water source for the recharge project presented many challenges. While projections based on historic flow conditions in the river indicate that it can provide enough water to meet the City's water supply needs, many of the times when the water is available are also the times when water quality in the river is the lowest. Because much of the watershed above the project is used for row crops, during runoff

events the river can have very high turbidities (up to 1,000 NTU) and also have atrazine levels above the drinking water standard of 3 ppb (as high as 40 ppb). In addition, because flows in the river are intermittent, any treatment techniques need to be able to set idle for long periods of time and then be able to quickly be brought into service. Additionally, since the project location is somewhat isolated, all this needs to occur with as small a staff as possible. All water recharged into the aquifer is required to meet all water quality standards established for drinking water, except for the residual disinfection requirement for drinking water. The recharge wells constructed as part of this project also demonstrated unique approaches to allowing water to be recharged. Instead of placing recharge water into the top of the recharge wells, the project used down tubes to place the water into the wells. Tubes were installed during construction that run from the top of the wells and are connected to the well casing above the first screen of the well and below the water table. This allows the water to flow into the well without creating any substantial head differential. Each tube (there are four at each well) is equipped with a different size PVC pipe so that flow into the well can be adjusted with the use of the different size pipes rather than just with the control valve at the wellhead. The well sites are also equipped with several groundwater monitoring wells that allow the City to monitor the depth of the groundwater during recharge activities at the well and also facility taking water quality samples if needed.

• ***Successful fulfillment of client/owner needs***

The development schedule for the initial design services was based upon a team selection and an executed agreement of April 1, 2009, and that the process design, scope of work, contract documents and GMP could be completed by September 1, 2009. This goal was accomplished.

During the initial services, a substantial completion date of August 31, 2011 was established. Final completion was to be by March 30, 2012. The targeted date for substantial completion was met, but unfortunately there was not enough water flowing in the river to do validation testing, which had to wait until adequate water was available in the river to run the intake facilities and the treatment plant.

• ***Original and Final Contact Value***

Phase II Treatment Plant
Original Contract Budget

The original contract budget for the river intake and treatment facilities was $105,000,000.

Completed Contract Cost

Grand Total/Contract Value - $73,338,950.00

Phase II Recharge Facilities
Contract Budget

The original contract budget for the recharge facilities $32,632,710.

Completed Contract Cost

Grand Total/Contract Value - $22,421,273.00

D. Summary:

The City of Wichita has embarked on a groundbreaking aquifer storage and recovery project to help meet its water supply needs. Phase II of that project can capture and recharge up to 30 million gallons per day from the Little Arkansas River into the Equus Bed Aquifer. Burns & McDonnell teamed with Alberici Constructors, Inc. and CAS Construction

to construct a design-build 30 MGD water treatment facility for Phase II of the City's ASR project, and Burns & McDonnell designed all of the recharge facilities for Phase II. Phase II of the project also has the ability to increase the capture of river water up to 60 MGD. A significant challenge to using water from the river was the very high turbidities and atrazine contamination in the river during the wet weather periods that the City is permitted to use river water. Phase II uses unique treatment technologies to address those contamination challenges. With the first two phases of the project completed, the City is now able to capture and recharge up to 35 million gallons per day, and recharge as much as 15,000 acre feet per year into the aquifer. The varied users of the aquifer, the critical need of sustaining the water supply, and the scope of the project make this ASR project a model for recharge solutions and water resource development and sustainability.

With The first two phases of the project completed, and the City is now able to capture and recharge up to 35 million gallons per day, and as much as 15,000 acre feet per year into the aquifer. The varied users of the aquifer, the critical need of sustaining the water supply, and the scope of the project make this ASR project a model for recharge solutions to protect and sustain a valuable water supply.

This project includes the design and construction of a river water intake on the Little Arkansas River, an advanced water treatment plant featuring membrane filtration and advanced oxidation, and a high service pump station to deliver treated water to the aquifer or City as required. The facility is sized for an initial capacity of 30 MGD, expandable to 60 MGD in the future. The recharge facilities include 21 recharge wells and one recharge basin. The treatment process includes a pre-sedimentation basin to remove large solids, the use of submerged membranes to filter the water, and the use of advances oxidation to remove atrazine and provide the disinfection of surface water microbes and viruses. The advance oxidation treatment involves adding hydrogen peroxide to the water at the same time as ozone is added. The combination of those two strong oxidants forms a very strong oxidant that is capable to destroying both the pesticides and viruses that might be in the water. This project represented the first time those technologies were used together at this scale of a project. The City is also participating with producers in the watershed above the project to implement practices to reduce pesticide usage that can impact water quality in the river.

Key Participants

In Phase II of the project, Burns and McDonnell teamed with Alberici Constructors, Inc. and CAS Construction LLC to form an integrated design-build team to execute the design and construction of the river intake structure and water treatment facilities.

ABC Partners
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Kansas City, MO
816-822-9300
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Photos

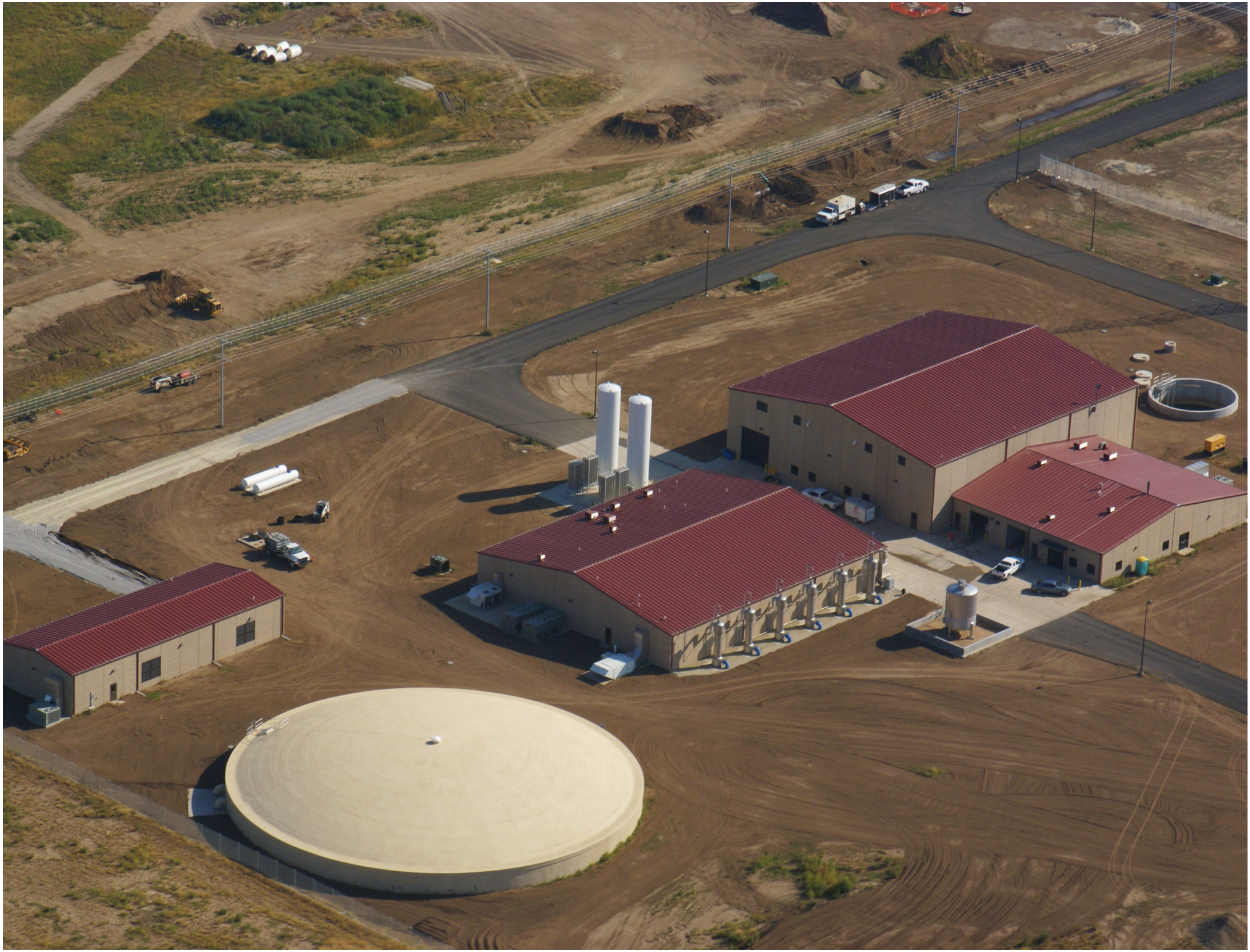

Photo 1: Aerial of project facilities

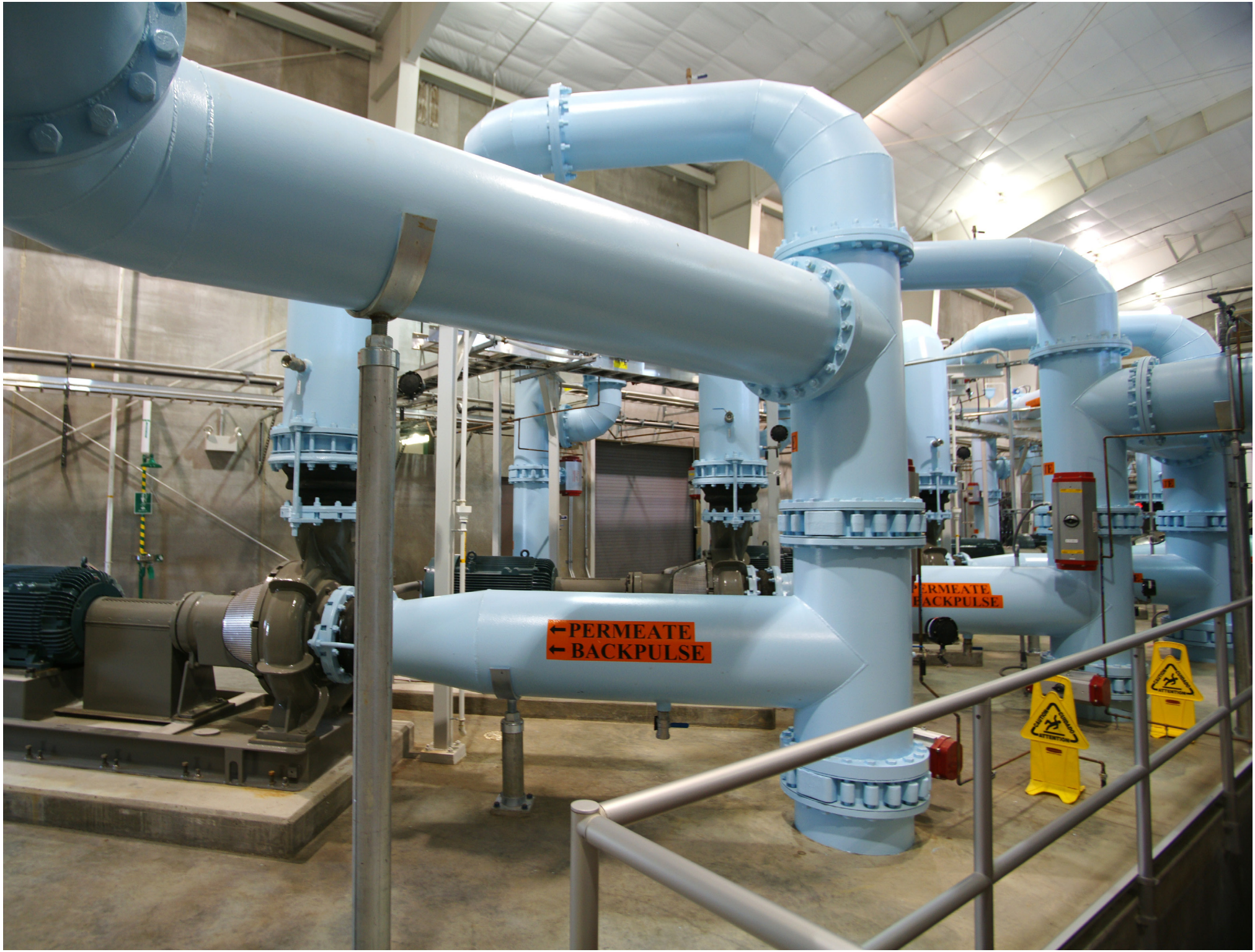
←PERMEATE
←BACKPULSE

Photo 2: Permeate Pumps

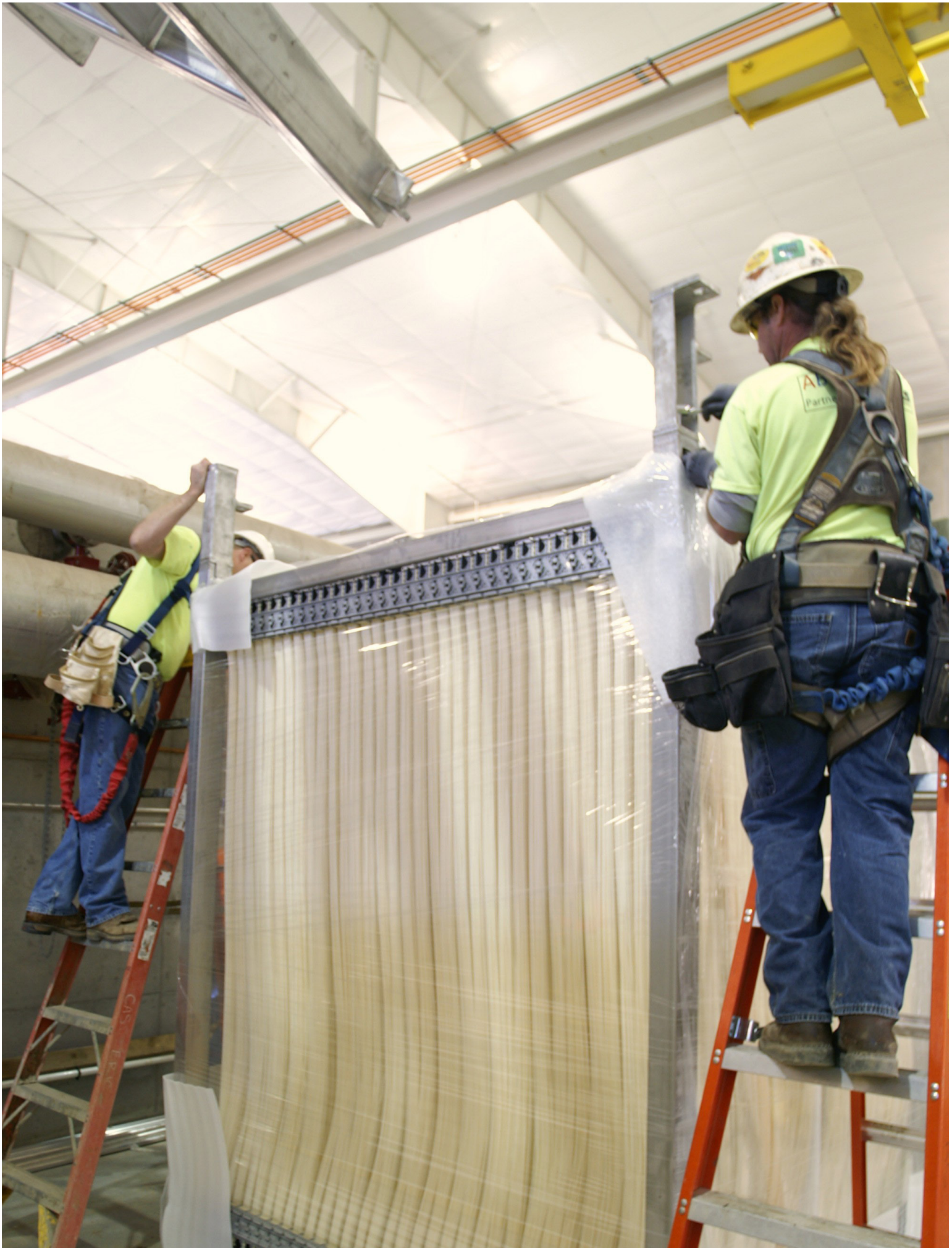

Photo 3: Membrane installation


CIP SUPPLY

Photo 4: Membrane piping and control

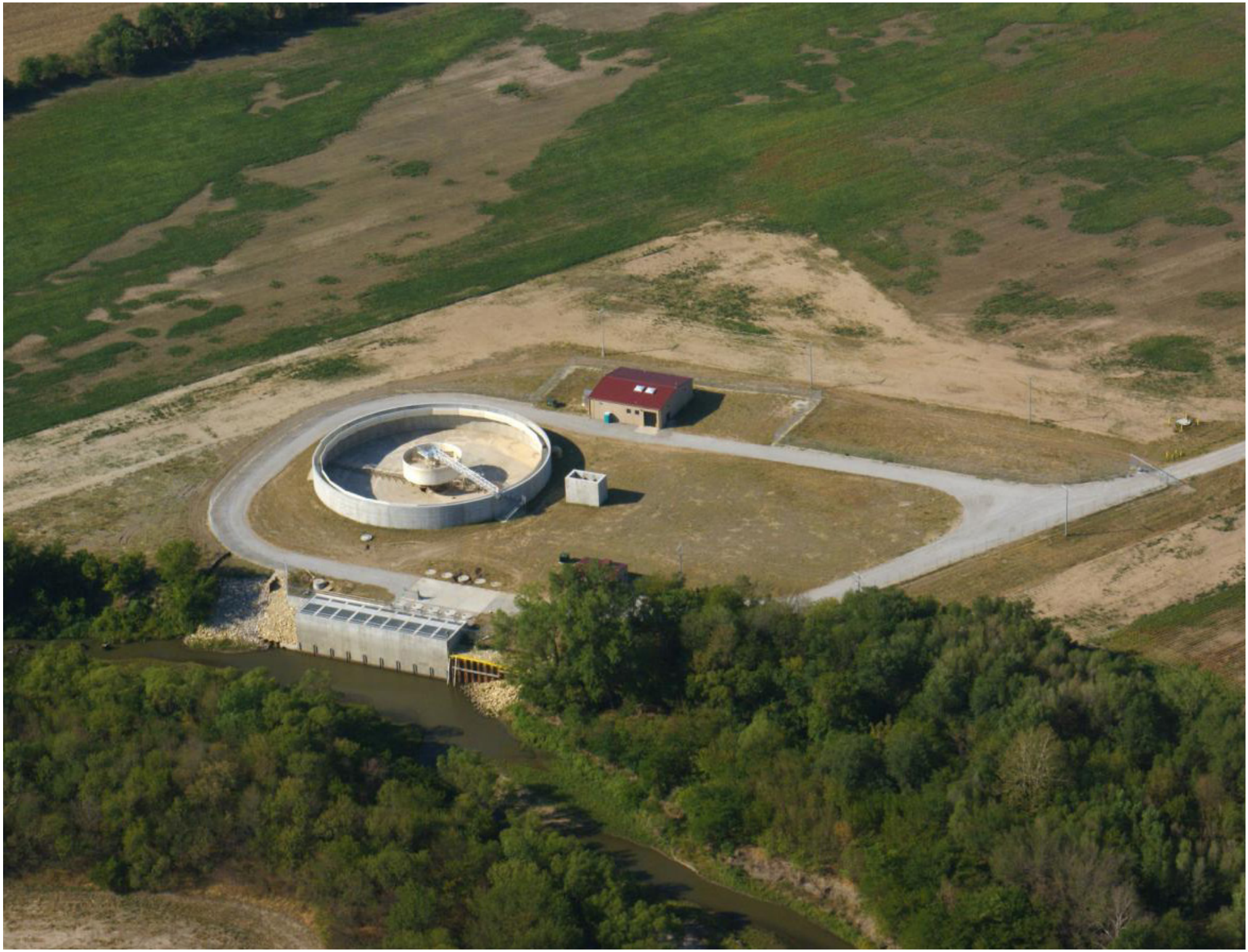

Photo 5: Aerial of intake buildings

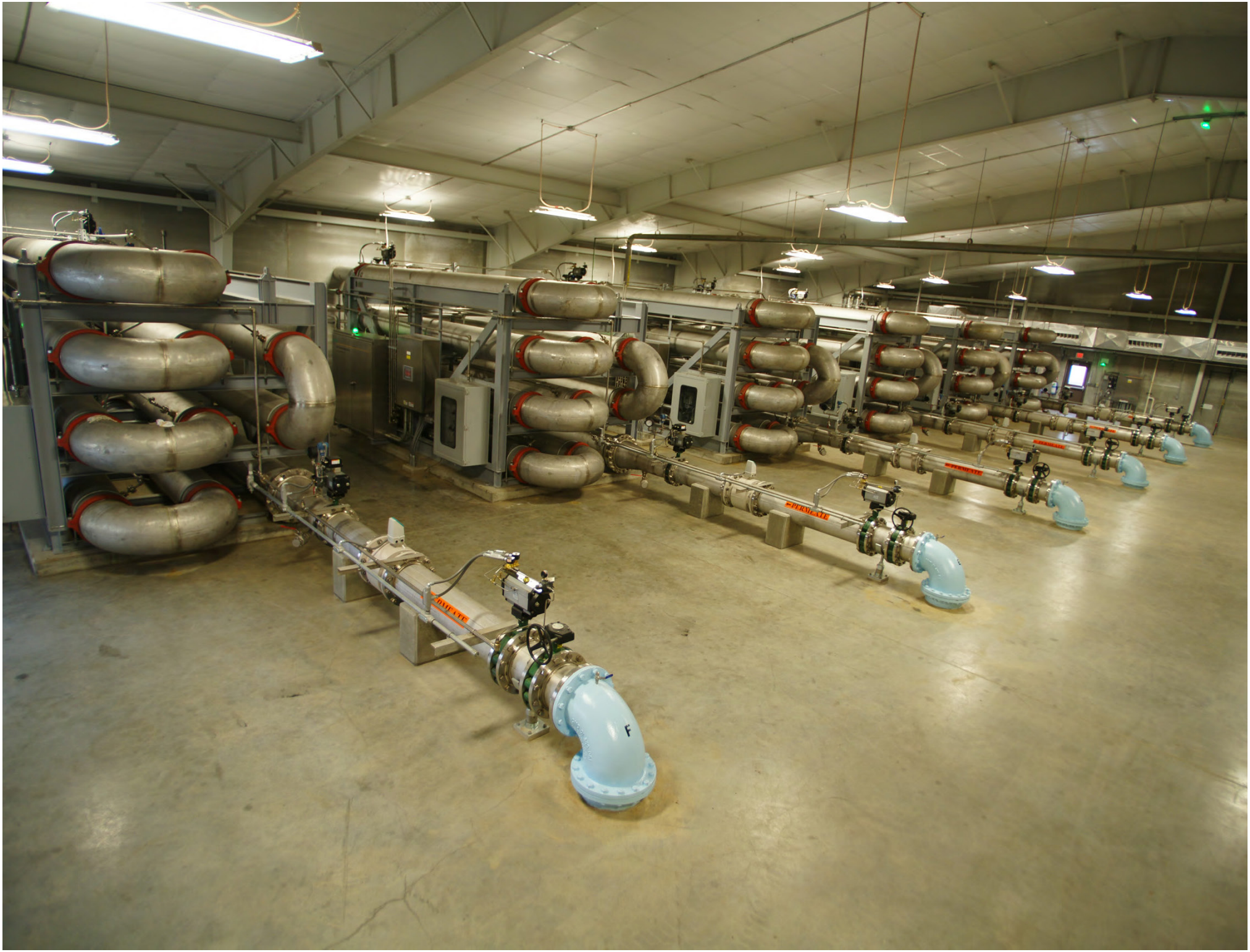

Photo 6: Hydrogen peroxide/ozone reactors

Press Release

News Release

FOR IMMEDIATE RELEASE
December 15, 2014

For more information, contact:
Brian Meier: 316-616-0520

Burns & McDonnell project is assuring recovery of Equus Beds Aquifer, a major water resource for City of Wichita

WICHITA, KS --- Since the 1940s, the City of Wichita has depended on the 900,000-acre Equus Beds aquifer as a source of drinking water and for agricultural irrigation. By the early 1990s, however, it had become clear to city engineers that demands of the city, agricultural users and other nearby municipalities had exceeded the aquifer's natural recharge rate. Water levels had dropped up to 40 feet from predevelopment levels, leaving it vulnerable to two sources of chloride contamination: one from oilfield brine improperly disposed in the 1930s and the other from natural chlorides contained within the nearby Arkansas River that threatened to leach into the aquifer. Against these conditions, population was growing in Wichita and in nearby communities, creating accelerating demand on water resources.

The crisis prompted a bold action plan by the city: development of a multipronged Integrated Local Water Supply Plan and its centerpiece, the Equus Beds Aquifer Storage and Recovery (ASR) project. Today, 20 years later, the project is well on its way to delivering enough water to recharge the aquifer and stabilize it for future generations.

The project has been entered into the American Council of Engineering Companies (ACEC) Engineering Excellence Awards competition for 2015.

The ASR concept was first introduced in 1995 when a demonstration project was developed to test the feasibility of diverting water from the Little Arkansas River, treating it to potable standards and then reinjecting it back into the aquifer. During the demonstration project, more than 1 billion gallons of water were taken from the river and safely added to the aquifer, providing convincing evidence that it could meet the city's aquifer recharge goals.

In a second phase of the project, Burns & McDonnell teamed with Alberici Constructors and CAS Construction on a design-build project to complete a river intake structure and water treatment facilities.

The project team also included Wildcat Construction and Shelley Electric, both of Wichita, Kan., who served as major subcontractors to the joint venture. In addition, Burns & McDonnell served as the project engineer for the construction of all of the recharge wells and basins constructed in Phase II. The ASR project eventually will have the capacity to divert and treat more than 100 million gallons of water per day from the Little Arkansas River during high-flow periods, which are estimated to be approximately 120 days per year. Water diverted into the treatment facility is filtered using ultrafiltration membranes and then treated with advanced oxidation, using a combination of ozone and hydrogen to destroy organics such as atrazine. Though membranes are commonly used at treatment facilities around the world, the Wichita ASR project is the first time they have been used in combination with advanced oxidation technology for aquifer recharge. The Wichita project also is the largest advanced oxidation system installed to date – six times larger than the next biggest system.

Following treatment, the clean water flows through an extensive network of water transmission lines to 60 recharge wells and three recharge basins. To date, during a period of almost unprecedented drought, the ASR project has recharged nearly 2 billion gallons of water back into the aquifer. The project eventually will have the capacity to divert and treat more than 100 million gallons of water per day, where it will serve as a barrier against continued movement of chloride plumes and assuring the Equus Beds Aquifer will remain a vital source of clean water for many decades to come.

About Burns & McDonnell

Founded in 1898, Burns & McDonnell is a 100-percent employee-owned firm providing engineering, architecture, construction, environmental and consulting services. With 5,000 professionals working in more than 30 regional, national and international offices, Burns & McDonnell is able to offer clients one source for permitting, design, construction and commissioning services. For more information about Burns & McDonnell, visit www.burnsmcd.com.

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