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ASR Permit application

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January 30, 2003

Mr. David Pope, P.E., Chief Engineer
Division of Water Resources
Kansas Board of Agriculture
901 S. Kansas Ave., Second Floor
Topeka, KS 66612-1283

RE: Permit Application for Equus Beds ASR Project

Dear Mr. Pope,

Enclosed is an application for the City of Wichita's Aquifer Storage and Recovery (ASR) project in the Equus Beds Aquifer.

The City of Wichita has developed an Integrated Local Water Supply Plan to meet its projected water supply demands through the year 2050. The Plan includes a number of components that must be coordinated in order to be successful, and the proposed ASR project is a critical component of the Plan. The proposed ASR project is in the area of the Equus Beds Aquifer that includes the City's existing water supply wellfield

As shown in the USGS Water-Resources Investigations Report 00-4267, "Status of Ground-Water Levels and Storage Volume in the Wichita Well Field Area, South-Central Kansas, 1998-2000", water levels declined in the wellfield area from 1940, when the City first began to use water supply wells in the aquifer, until about 1957, which was the end of the 1950's drought. Water levels rose after the drought and remained fairly stable in the area until about 1977, when irrigation water use in the area increased dramatically. That additional water usage resulted in significant water level declines, which continued until 1993, when the City adopted its Water Supply Plan. The proposed ASR project intends to use water from the Little Arkansas River to recharge the portion of the aquifer that was dewatered until 1993.

The substantial, and consistent, decline in water levels from the 1970's until 1993 demonstrates that water use by municipal and agricultural water users exceeded the safe yield of this portion of the Equus Beds.

Prior to 1993 the City obtained about 60% of its water supply from the Equus Beds Wellfield and about 35% of its water from Cheney Reservoir. However, to protect the aquifer the City has increased the use of Cheney Reservoir and correspondingly dramatically reduced the water used from the Equus Beds aquifer. Cheney Reservoir now provides over 65% of the City's water supply, and the Equus Beds Wellfield provides only about 30% of the City's water supply. This reduction in groundwater use has allowed water levels to rise by as much as 20 feet in the area. This is an unprecedented increase, and can only be attributed to the decrease in groundwater usage by the City. However, increases in water demands caused by the growth in the City's water customer base will not allow this trend to continue indefinitely. In fact, it is projected

Mr. David Pope, PE.
RE: City of Wichita ASR Permit for Equus Beds
January 30, 2003
Page 2

that water demands will exceed the City's existing water supplies sometime between 2015 and 2020.

ASR Basin Storage Area - The City has evaluated the area around the existing water supply wellfield and has established an area for the ASR project. The enclosed map (Figure 1) shows the project area. A general description of the area would be to start at the NW corner of Section 9, T23S, R3W; then south approximately 12 miles to the southwest corner of Section 4, T25S, R3W; then east 4 miles to the southeast corner of Section 1, T25S, R3W; then south 2 miles to the southwest corner of Section 18, T25S, R2W; then east approximately 2 miles to the southwest corner of Section 16, T25S, R2W; then south approximately ½ mile to the banks of the Arkansas River, then southeasterly along the Arkansas River to approximately 600 feet south of the north line of Section 28, T25S, R2W; then east approximately 8 miles to the banks of the Little Arkansas River in Section 26, T25S, R1W; then northwesterly along the Little Arkansas River for approximately 15 miles to the north line of Section 21, T23S, R2W; then west approximately ½ mile to the southeast corner of Section 17, T23S, R2W; then north approximately 2 miles to the northeast corner of Section 8, T23S, R2W; then west approximately 6 miles to the point of beginning.

The project area encompasses approximately 134 square miles. To improve the ability to manage this large project area, the City recommends that the project be divided into smaller areas, called cells. Figure 1 depicts the project area divided into 38 cells, with most cells encompassing approximately 4 square miles.

Water levels in the project area have been measured and mapped by the USGS since 1940. This data, plus tests performed by the City of Wichita, have helped to identify the storage capacity of the ASR, which is the portion of the aquifer that was de-watered between 1940 and 1993. The City has also installed new "Index Wells" in each cell that can be used to monitor changes in water levels and water quality. Enclosed is a table that identifies the changes in water levels in each cell from January 1940 to January 1993. Water levels in January 1993 were selected as the bottom of the ASR storage basin because they are the lowest levels of record, and the January 1940 water levels were selected as the top of the ASR storage basin because they represent predevelopment water levels. The table also shows a storage coefficient for each cell, the estimated available storage capacity for each cell, and the estimated change in water storage per foot of change in each cell. The City estimates that there is a **total storage capacity of 201,530 acre-feet** available in the ASR basin. Also enclosed are maps that show the water level contours for the 1940 and 1993 water level measurements, a map depicting the available storage volume by section for the ASR area (Figure VII-25) and a map depicting the 1993 dewatered zone effective porosity (Figure VII-24)

Recharge Facilities - The City of Wichita intends to use excess flows from the Little Arkansas River as the source water for the ASR project. The maximum rate of diversion for the project is proposed to be 100 million gallons per day (MGD) of water from the river during above base-flow events. The City's current plan is to divert up to 75 MGD using water wells located adjacent to the river that can capture bank storage water and induce river water into the wells. The City's conceptual design is to utilize 53 of these wells, with an average capacity of 1,000 gpm per well. The City also plans to withdraw up to 25 MGD directly from the river during those same flow conditions. However changes in water treatment technology or drinking water regulations may change the proportion of river water captured using these two methodologies. The current plan is to utilize 42 wells and 11 recharge basins to recharge the aquifer. Figure 1 depicts a general concept of the location and number of facilities needed for the ASR project. The maximum annual diversion from the river, as well as the minimum annual amount, will be dependent on rainfall events and could vary substantially from one year to another. Based on the flow history in the Little Arkansas River, the City estimates that the system will be able to recharge an average of 20,700 acre-feet per year, and that the maximum annual quantity that could be recharged into the aquifer during an extremely wet year will be approximately 80,000 acre-feet. This system will become a critical component of the City's water supply through the year 2050. The system enhancements that will be constructed through that time period will allow the production of up to 146 MGD from the wellfield in a worse case drought condition in 2050. This is about double the City's current ability, which is up to 72 MGD.

Accounting Methodology – The Equus Beds Aquifer is a dynamic aquifer, which offers some unique challenges in developing methodologies to account for water that is recharged into the aquifer, and later recovered from it. Water is not only moving into the proposed ASR basin, but it also migrates out of the basin, as well as discharging into area streams and rivers, such as the Little Arkansas River. This is in addition to the natural recharge that the aquifer receives from precipitation. The aquifer in the project area is also multiple withdrawal wells, with municipal, irrigation, domestic, and other water users. The City will meter all water used to recharge the aquifer. Metering will occur either at an individual recharge location, or at a header pipe that might serve several locations. However measuring the movement of recharged water through the aquifer, and determining the quantity available for recovery from a specific recovery well is more difficult.

To assist in this complicated task the City recommends the use of the groundwater model initially developed by the Bureau of Reclamation and the USGS. This model has been refined to improve its accuracy as part of the City's research for the project.

The City has used this model to do two simulations that have demonstrated the feasibility of the ASR project, and predict how the aquifer will respond with, and without, the ASR project. The first simulation was for the 100 MGD ASR project. This simulation used a water budget to account for water that was directly recharged, water that enters into the recharge area, water that is discharged into the Little Arkansas River and other streams as groundwater levels increase and other losses and withdrawals from the aquifer. The second simulation was used to evaluate the

impact on the aquifer after the City altered its water use patterns and increased its use of water from Cheney Reservoir. This simulation accurately predicted those impacts as they were actually measured by the USGS. The City believes that the model is an effective tool to validate the concepts of the ASR project, and can be used on an ongoing basis to re-calibrate the storage capacities of the cells. It also accurately simulates the various conditions previously described. I have enclosed a copy of the chapter from the City's Concept Design Plan that provides a more detailed explanation of the features of the water model. A copy of the model is offered to your office if you do not currently have a copy. In addition to the groundwater model, the City has also constructed the new Index Well network to monitor water levels and water quality.

The model is based on the best available information, and it does a good job of predicting the response of the aquifer to changing conditions. The model has determined that as Wichita's water demands grow, and the City again uses its full water rights from the Equus Beds, that groundwater levels in the ASR project area will return to the 1993 levels, and will then continue to decline, unless there is either an ASR project or a fundamental change in water usage. Water levels will only exceed the 1993 levels only because of the impacts of the ASR project, therefore the City recommends that groundwater levels become the primary basis for administering the ASR project. This methodology will assure that the aquifer not be jeopardized by the operation of the ASR project, and that water levels are not allowed to decline below the levels that existed in January of 1993. The City recommends that the new Index Wells be used as the primary basis for determining where, and how much, water is available for recovery.

The City's proposed accounting methodology would measure water levels in the Index Wells in January of each year, and the volume of water available for recovery in each cell would be determined by calculating the water level difference between the annual measurement and the 1993 level. That difference would then be multiplied by the storage coefficient for each cell. The additional water in each cell would be distributed equally to each of the City's recovery wells located in that cell. The enclosed table indicates the quantity of water available per foot of change in each cell. The model, and any other new information about the hydrogeology of the aquifer, can be used to modify those quantities as time goes on, thus assuring the protection of the aquifer.

Because of the over-appropriation of water rights in the ASR area above the safe-yield quantity, the City acknowledges the model's predictions that a portion of the water that it will be recharging into the area will be used by existing agricultural users. Because of those agricultural withdrawals and other losses, the model predicts that the City will be able to recover only about ??? % to the water that is directly recharged into the project area. However, even with those additional withdrawals, the City believes that it can recharge enough water to allow groundwater levels to exceed the levels that existed in January of 1993, and that the ASR project can provide a crucial component of the City's water supply needs.

Water levels in the ASR area will not exceed the January 1993 levels without the direct intervention of the City of Wichita, either through a planned water use strategy or through the

ASR project. Therefore the City believes that it is appropriate to receive credit for all water that is in the ASR area above that baseline level.

Passive Recharge Credits - As previously mentioned, water levels in the ASR basin have already increased substantially since 1993. This unprecedented increase is directly related to changes that the City of Wichita has made in using its water sources. A direct result of those choices is the reduction of the City's withdrawals from the Equus Beds to quantities withdrawn in the 1940's. As documented by the USGS, this has increased the amount of water stored in the aquifer by approximately 150,000 acre-feet. The City feels that it is appropriate for it to receive recharge credits for at least some portion of this water, since that water would not be there if the City had not deliberately changed its water use patterns.

If the City is unable to get any recharge credits for this water, it would be in the City's best interest to accelerate its water use from the aquifer and remove all of the passive recharged water so that the available storage volume can be increased. While this might be a good idea from an accounting perspective, we believe that it would not represent good management for the aquifer, and it would increase the risks of salt-water contamination of the aquifer. The City therefore urges your consideration of granting recharge credits for the passive recharge that has occurred since 1993.

Demonstration Project - The City has completed a Recharge Demonstration Project to validate the major issues associated with this ASR project. The Demonstration Project successfully confirmed the existence of Bank Storage and the ability of a well located adjacent to the Little Arkansas River to capture water from the River. It also demonstrated the viability of the various recharge techniques that will be used in this project, including recharge wells, recharge trenches, recharge pits, and gravity flow recharge wells.

Water Quality - Protecting the water quality in the aquifer is a vital component of the ASR project. The ASR basin is currently threatened by two significant salt-water sources: 1) the salt-water plumes created as a result of improper disposal of oil field brine in the Burton area, and 2) salt-water coming from the Arkansas River. As the aquifer is recharged it will form hydraulic barriers to these plumes and help protect the water quality in the ASR basin. The City will also comply fully with all water quality standards established by KDHE and the USEPA for water used to recharge the aquifer.

As previously noted, the water level declines that occurred in the ASR area prior to 1993 were caused by the over appropriation of water rights to agricultural water users that occurred after the City obtained its municipal water rights. Those declines, if not addressed, represent a significant impairment of the City's senior water rights in the Equus Beds. The City believes that this ASR project not only helps meet the City's future water supply needs, but it also appears to be the only alternative to averting a claim of impairment from junior agricultural water users.

The City appreciates your consideration of our application and recognizes that this is the first ASR application submitted to your office. The City is willing to provide any information you might find helpful.

This application is only for the ASR project, and additional applications will be submitted for each well and structure used to divert water from the Little Arkansas River and for each well used to recover stored water.

Enclosed is a check for \$16,320 to cover the application fees. If you have any questions, or need additional information, please contact me (316-268-4578).

Sincerely,

CITY OF WICHITA

Gerald T. Blain, P.E.
Water Supply Projects Administrator

xc: David Warren