DWR EXHIBIT A
City of Wichita
Permit Application Transmittal Letter
July 3, 2003

CITY OF
WICHITA

Water & Sewer Department

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

July 2, 2003

RE: Permit Application for Equus Beds ASR Project

Dear Mr. Pope,

Enclosed are 10 applications for the first phase of 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 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. 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.

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

Office of the Director
City Hall • 8th Floor • 455 North Main • Wichita, Kansas 67202-1677
T 316.268.4504
www.wichitagov.org

southwest corner of Section 16, T25S, R2W; then south approximately ½ mile to the left bank 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 right bank 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 area, 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 ultimately 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 from the river 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.

Enclosed are applications for the first seven bank storage diversion wells that will be used to divert water from the Little Arkansas River. The extensive monitoring work completed as part of the City's Recharge Demonstration Project has proved that bank storage wells will capture bank storage water and will induce water from the Little Arkansas River. These wells will operate only during above base flow events in the Little Arkansas River. All of these wells are located upstream from the USGS gage located at U.S. Highway 50, and base flow has previously been established as 42 cfs from April to September, and as 20 cfs from October to March at that gage. The maximum annual quantity of water to be diverted from each well, in a very wet year, will be 1,500 acre-feet. The City will install a monitoring well(s) adjacent to each diversion well that will appropriately verify that the diversion wells are hydraulically connected to the river and that the wells will induce river water to replace the water pumped from the wells.

Need data

*

Also enclosed are applications for the first three (3) recharge and recovery wells. These three wells, in addition to three recharge basins, will receive the water from the bank storage wells and will recharge the aquifer. They will also have the ability to pump recharged water to the City for use as part of the City's water supply. The quantity of water available for recovery will be determined annually by using the accounting methodology described below. The maximum annual quantity of water that would be pumped from each of these wells is 1,000 acre-feet.

These applications are for the first phase of the ASR project, and other applications will be submitted as the City proceeds with future phases of the ASR project.

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 has many withdrawal wells, including those for municipal, irrigation, domestic, and other water users. The City will meter all water used to recharge the aquifer. However, measuring the movement of recharged water through this dynamic aquifer and determining the quantity of water available for recovery from a specific recovery well will be 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 this project.

The City has used this model to do three simulations that help predict how the aquifer will respond with, and without, the ASR project and to demonstrate the feasibility of the ASR project. The first simulation was used to confirm current conditions. It looked at the period from 1993 until 2002 to compare the model's projections with the actual water levels measured by the USGS. 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. The first modeling simulation closely replicates the water levels measured by the USGS.

The second simulation projected what water levels would have been if the City had not modified its water use in 1993, and continued to take a majority of its water supply from the Equus Beds. That simulation predicts that water levels would have continued to decline, and rather than an available storage volume of 200,000 acre-feet, that by 2002 a storage volume of 285,000 acre-feet would have been created. The third simulation projected what water levels would be like if the City had installed the first phase of the ASR project in 1993.

Enclosed is a graph generated by the model that depicts anticipated storage volume changes in the project area from January of 1993 to January of 2002. This graph shows that for the first simulation that the model predicted that the storage volume would have decreased by approximately 30,000 acre-feet by January of 1998, and by approximately 65,000 acre-feet by January of 2000. This is slightly lower than the storage volume calculated by the USGS using actual ground water level data, but the USGS used a specific yield of 0.20, and the City's model used a more conservative specific yield of 0.15.

The graph also shows the results of the simulation of what would have happened to the storage volume in the project area if the City had not altered its water use pattern in 1993. The model predicts that water levels would have continued to fall, and an additional 85,000 acre-feet of water would have been permanently removed from the aquifer.

These three simulations have demonstrated that the model can accurately predict the impact of the ASR project on the aquifer, and can be used on an ongoing basis to re-calibrate the storage capacities of the cells and to allocate recharge credits. A copy of the model is offered to your office if you do not currently have a copy.

Need copy of model

The model is based on the best available information, and it has proven its ability to predict the response of the aquifer to changing conditions. The model has predicted 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 (reduction in irrigation or municipal water usage). Without a fundamental change in water usage water levels will only exceed the 1993 levels because of the impacts of the ASR project. The City has constructed an Index Well network to monitor water levels and water quality in the project area, and the City recommends that the new Index Wells be used to supply additional data to the groundwater model to improve its accuracy over the life of the project.

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. The City is concerned about preserving the integrity of the aquifer, so it recommends that the 1993 level be established as the benchmark for the project rather than the projected deficit that would have been created by now if the City had not altered its water use pattern.

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 is recharged will be used by existing agricultural users. 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.

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. As documented by the USGS, and predicted by the model, this has increased the amount of water stored in the aquifer by approximately 70,000 acre-feet. The City feels that it is appropriate for it to receive recharge credits for this water, since that water would not be present if the City had not deliberately changed its water use patterns and utilized an alternate water source.

If the City cannot receive 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 an effective accounting strategy, the City believes that it would not represent good management of 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 wells located adjacent to the Little Arkansas River to capture water from the river. The project also demonstrated the viability of the various

Need report?

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. Previous modeling work done by the Bureau of Reclamation, "Arkansas River Water Management Improvement Study, Modeling of Chloride Transport in the Equus Beds Aquifer – 1993", has predicted that, unless there is a significant change in water use, that chloride levels will exceed the drinking water standard in much of the ASR project area. Water recharged through this project will form hydraulic barriers to those plumes and help protect the water quality in the ASR basin.

Water sampling by the USGS of the Index Wells has already found that at over 60% of the sites groundwater failed to meet drinking water standards for arsenic, nitrates or chlorides. The City will fully comply with all water quality standards established by KDHE and the USEPA for water used to recharge the aquifer, and all water used to recharge the aquifer will meet drinking water standards, even at sites that currently fail to meet drinking water standards.

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.

Enclosed is a check for $5,100 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, Dir. of Water and Sewer
Burns & MacDonnell

MICROFILMED

CITY OF WICHITA
City Treasurer's Office
455 N. Main, 12th Floor
Wichita, Kansas 67202
(316) 268-4651

Date: 06/13/2003
Vendor Number: 486029925
Check Number: 000184901
Vendor Name: STATE OF KANSAS DEPT OF AGRICULTURE

Voucher No.	PO Number	Invoice Number	Remittance Description	Invoice Amount	Discount Amoun
AV304908/001		20030609	Permit Fee Aquifer Stor Recover 633669	3,780.00	.00
AV304908/002		20030609	Permit r Aquifer Stor Recvy Proj 633669	1,320.00	.00

WATER RESOURCES
RECEIVED
JUL 03 2003
KS DEPT OF AGRICULTURE

TOTAL ******5,100.00

WARRANT CHECK

BY ORDER OF THE GOVERNING BODY
ISSUED, SIGNED, COUNTERSIGNED AND RECORDED
Intrust Bank, N.A.
WICHITA, KANSAS 67202

CHECK NUMBER 000184901

VOID AFTER 90 DAYS

THE CITY OF WICHITA
SEDGWICK COUNTY, KANSAS

CITY OF WICHITA
City Treasurer's Office
455 N. Main, 12th Floor
Wichita, Kansas 67202

40-2
1011

DATE
06/13/2003

CHECK AMOUNT
******5,100.00

PAY *Five Thousand One Hundred and NO/100 Dollars*

Chris Cherches, City Manager

TO THE ORDER OF
STATE OF KANSAS DEPT OF AGRICULTURE
109 SW 9TH 2ND FLOOR
DIVISION OF WATER RESOURCES
TOPEKA KS 66612-1283

Ray Trail, Director of Finance

Carla D. Palmer, City Treasurer

⑈000184901⑈ ⑆101100029⑆ 407684220⑈

MICROFILMED

COPIES OF THE APPLICATIONS ARE CONTAINED IN EXHIBITS B THROUGH L

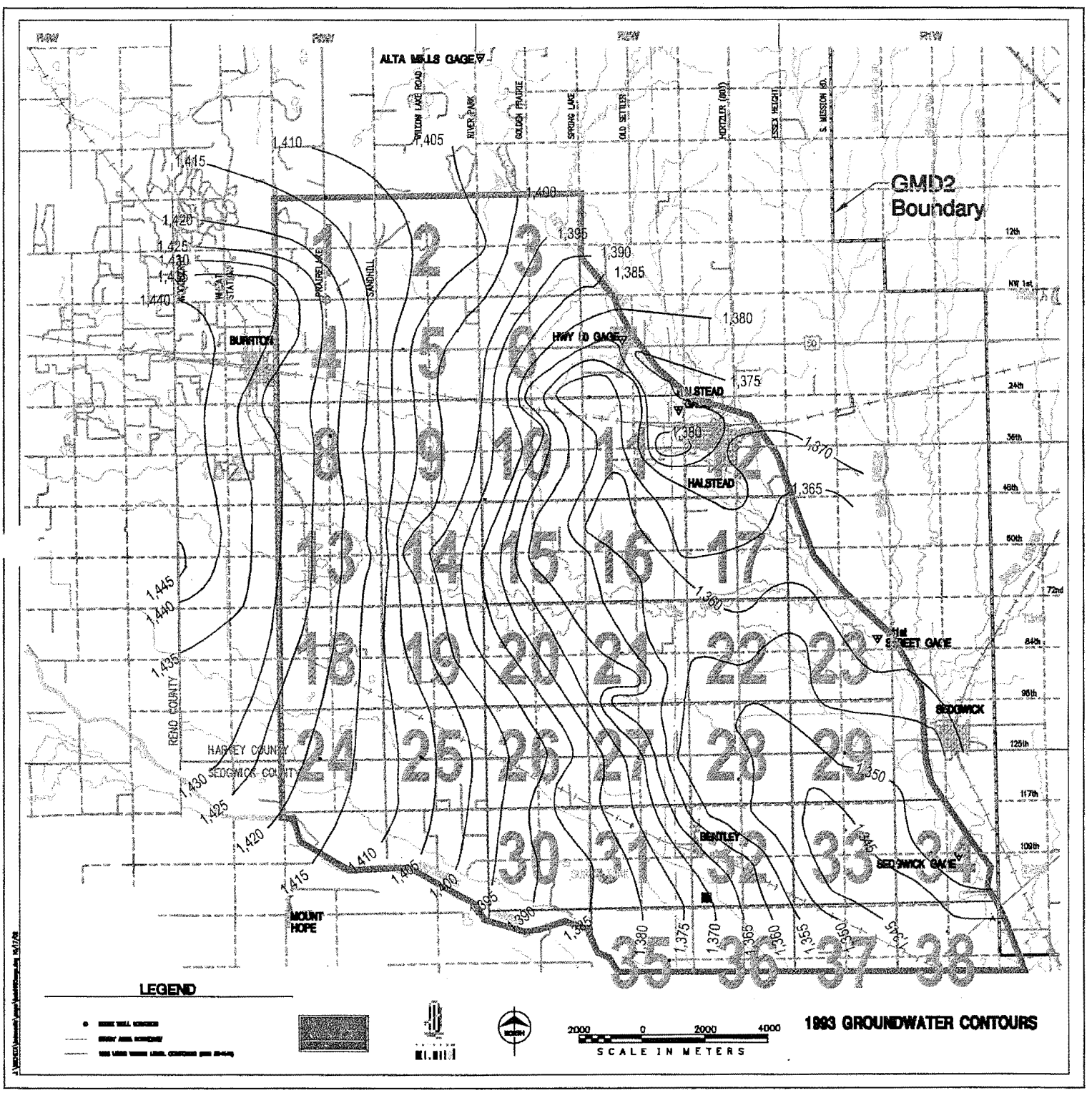
[DO NOT BATE-STAMP]

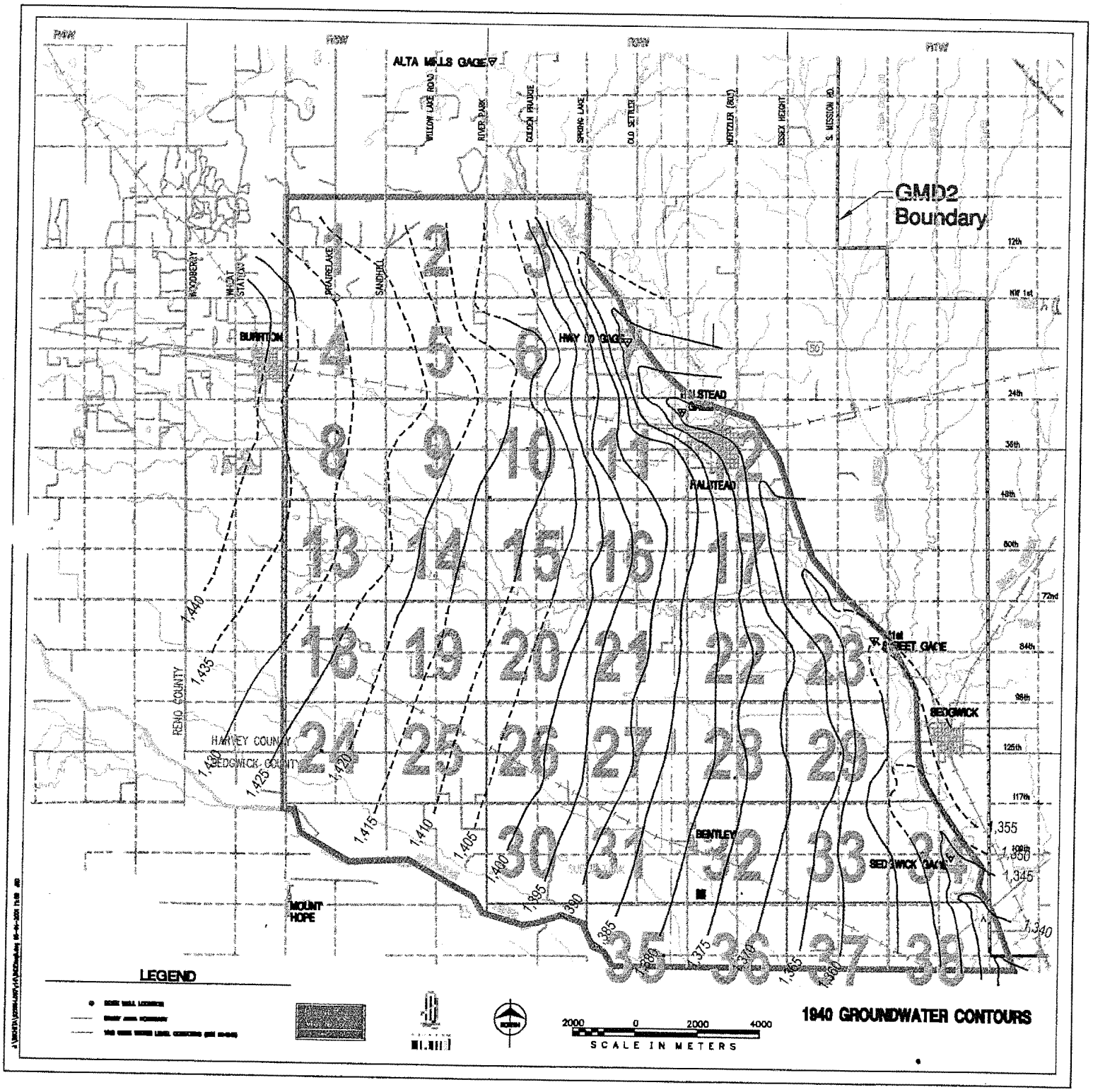
City of Wichita - Aquifer Storage and Recovery Project

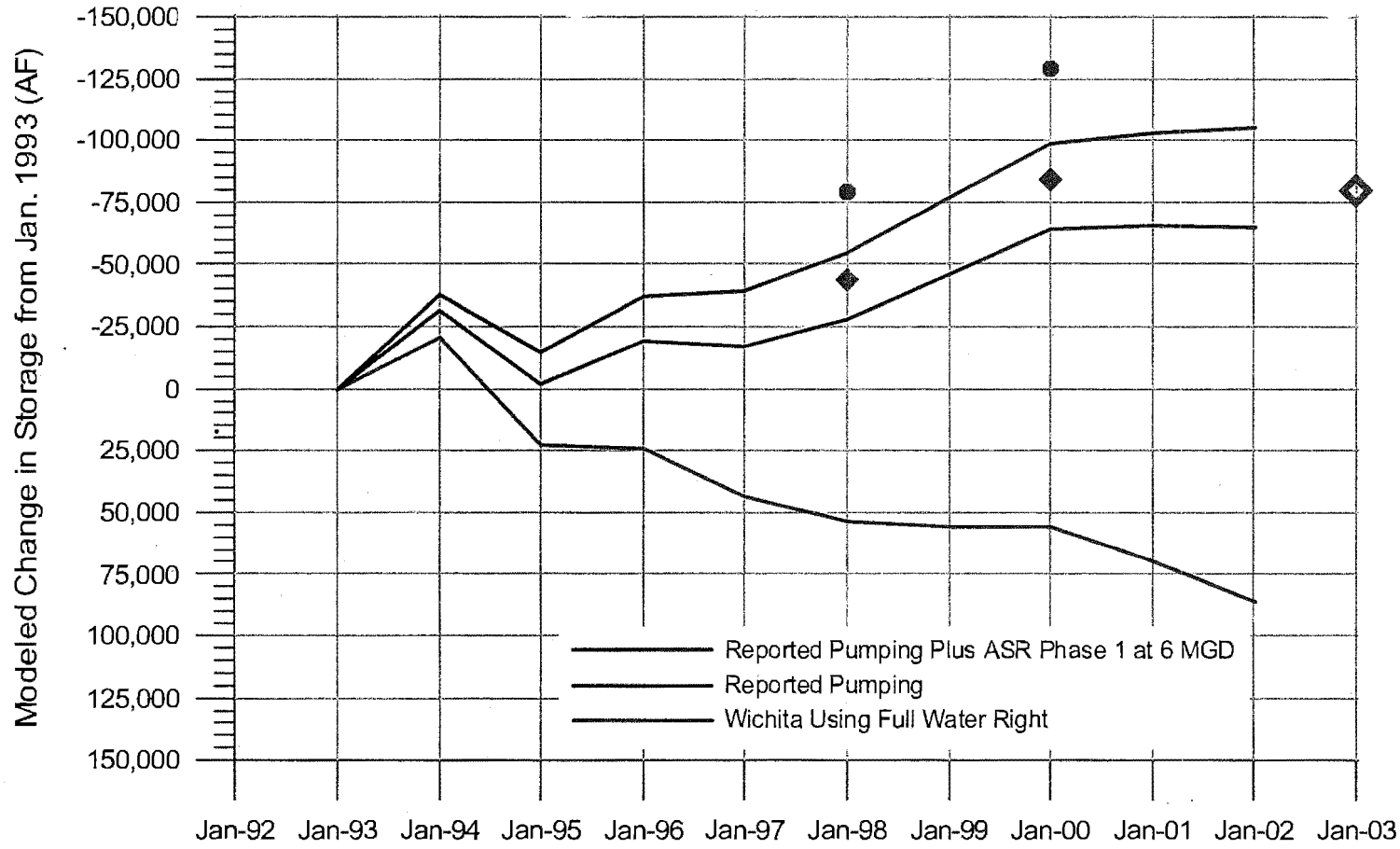
Water Levels and Storage Capacities

Cell Number	January 1940 Water Level Elevations	January 1993 Water Level Elevations	Water Level Difference 1940-1993 (ft)	Index Cell Storage Coeffcient	Index Cell Available Storage (Ac. Ft.)	Acre Feet per Foot of Water Level
1	1424.15	1413.48	-10.67	0.05	1,365	128
2	1416.8	1408.97	-7.83	0.05	1,002	128
3	1400	1396.62	-3.38	0.05	433	128
4	1431.35	1423.3	-8.05	0.25	5,152	640
5	1425.41	1407.27	-18.14	0.05	2,355	128
6	1412.13	1387.04	-25.09	0.09	5,760	228
7	1395.64	1363.97	-31.67	0.11	6,110	187
8	1430.97	1421.58	-9.39	0.10	2,425	256
9	1421.45	1402.49	-18.96	0.22	10,598	563
10	1412.43	1385	-27.43	0.18	12,947	460
11	1390	1365	-25.00	0.05	3,200	128
12	1370	1369.56	-0.44	0.25	217	494
13	1430	1422.04	-7.96	0.12	2,534	307
14	1417.5	1396.35	-21.15	0.25	13,760	640
15	1408.33	1366.74	-41.59	0.17	18,424	435
16	1398.33	1360	-38.33	0.18	17,706	460
17	1375.81	1365	-10.81	0.05	1,383	128
18	1425.68	1420.45	-5.23	0.20	2,717	512
19	1414.21	1401.85	-12.36	0.05	1,582	128
20	1404.48	1380	-24.48	0.18	11,325	460
21	1392.94	1367.02	-25.92	0.15	9,973	384
22	1374.75	1355	-19.75	0.24	12,256	614
23	1361.67	1358.78	-2.89	0.05	339	117
24	1421.94	1418.52	-3.42	0.25	2,188	640
25	1412.72	1407.04	-5.68	0.20	2,263	512
26	1401.19	1390	-11.19	0.16	4,504	410
27	1389.57	1371.19	-18.38	0.22	10,288	563
28	1376.69	1351.17	-25.52	0.19	12,736	486
29	1365.41	1351.13	-14.28	0.07	2,483	179
30	1396.86	1390	-6.86	0.25	4,390	640
31	1385	1377.5	-7.50	0.20	3,776	512
32	1374	1361.79	-12.21	0.18	5,658	460
33	1360	1344	-16.00	0.25	3,840	640
34	1349.26	1351	1.74			
35	1378.96	1376.77	-2.19	0.05	163	74
36	1370	1365	-5.00	0.25	2,016	403
37	1360	1351	-9.00	0.21	3,066	348
38	1350	1343	-7.00	0.05	596	85

TOTAL AVAILABLE STORAGE **201,530 Ac. Feet**







WATER BUDGET

Modeled Area = 140.8 mi2 (Specific Yield = 0.15)

USGS (Specific Yield = 0.20)
- ◆ Study Area = 165 mi2
- ● Well Field Area = 55 mi2

Index Well Measurements (Average Specific Yield = 0.153)
- ◇ Storage increase from Jan-1993 (interpolated) and Jan-2003 (measured) = 79,900 AF

storageplot.grf 4/22/03

As ■ ARSENIC REMOVAL

● DIVERSION WELL

RRW-1 ● RECHARGE RECOVERY WELL

RB-1 ■ RECHARGE BASIN

····· PROPOSED ELECTRICAL

— — PROPOSED WATER

WILLOW LAKE RD
RIVER PARK RD
GOLDEN PRAIRIE RD
NW 12TH ST
NW 1ST ST
L. Arkansas R.
U.S. HWY 50
24TH ST
36TH ST
48TH ST
SPUR CROSSING
PIPELINE CROSSING
WICHITA WELL NO. 41
PAXTON
HALSTEAD
RRW-1
RRW-2
RRW-3
RB-1
RB-2
RB-3
As

NORTH

4000 0 4000 8000
APPROXIMATE SCALE IN FEET

13

Burns & McDonnell SINCE 1898

Figure 1 – Rev. 6

ASR PHASE I
PROPOSED FACILITY
LOCATIONS