Ozark Plateau

2007 Field Analysis Summary

Subbasin Water Resource Management Program

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I. Introduction

The Ozark Plateau is a four-state region located primarily in southern Missouri and northern Arkansas, and including smaller areas in northwest Oklahoma and southeast Kansas (Figure 1). The Ozark Plateau consists of four physiographic regions: the Springfield Plateau, Salem Plateau, Saint Francois Mountains and Boston Mountains. Of these four regions only a small portion of the Springfield Plateau extends into the far southeastern corner of Kansas. Under this corner of Kansas lies the Ozark Plateau aquifer.

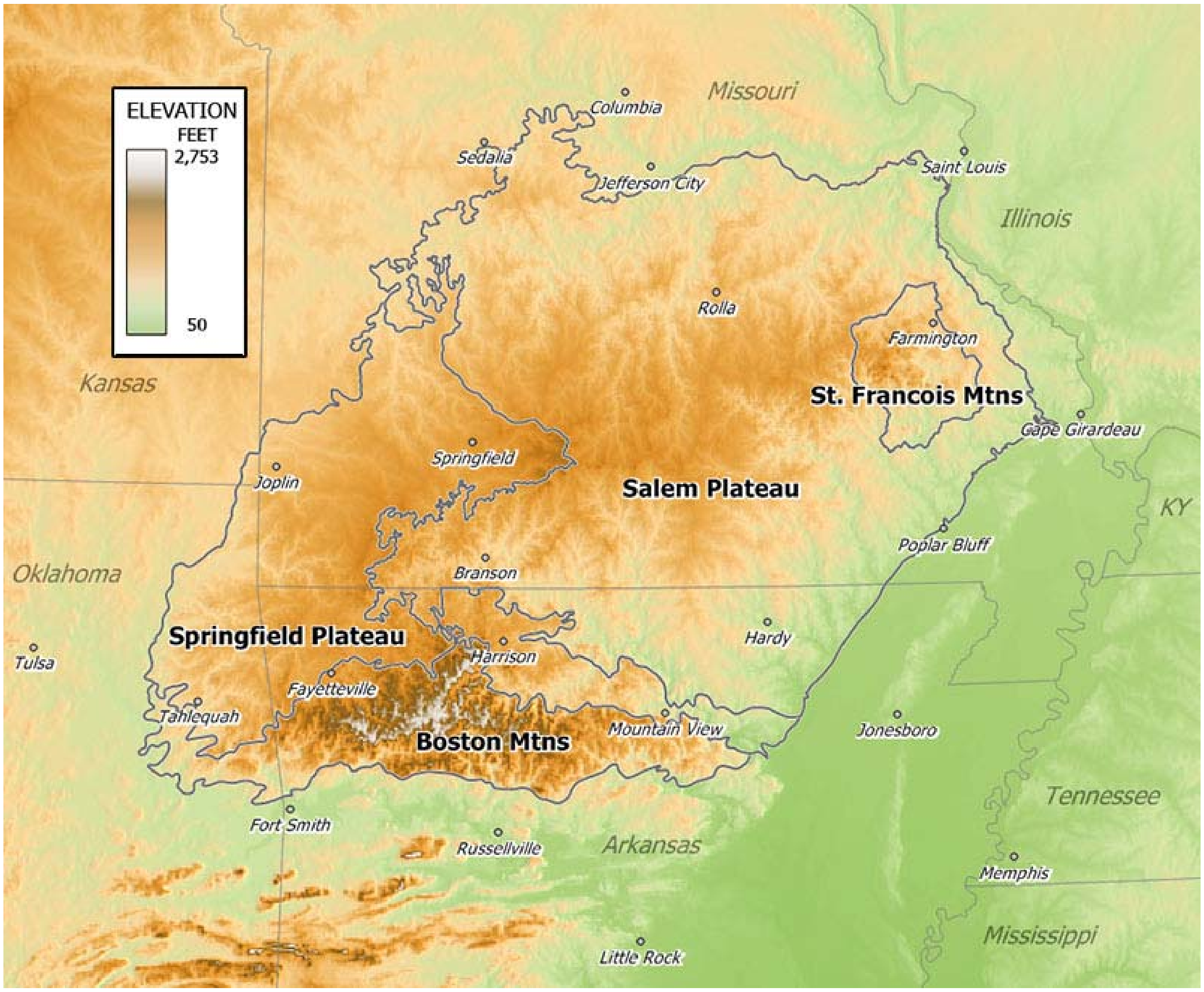

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Figure 1: Ozark Plateau

The Ozark Plateau aquifer is an important source of water for the quad-state region of southeast Kansas, southwest Missouri, northeastern Oklahoma and a small portion of northwest Arkansas. The Ozark Plateau aquifer consists of two aquifers, a deep aquifer and a shallower aquifer, both with discontinuous confining layers. The upper aquifer is the Springfield Plateau aquifer, the lower is the Ozark aquifer (Figure 2).

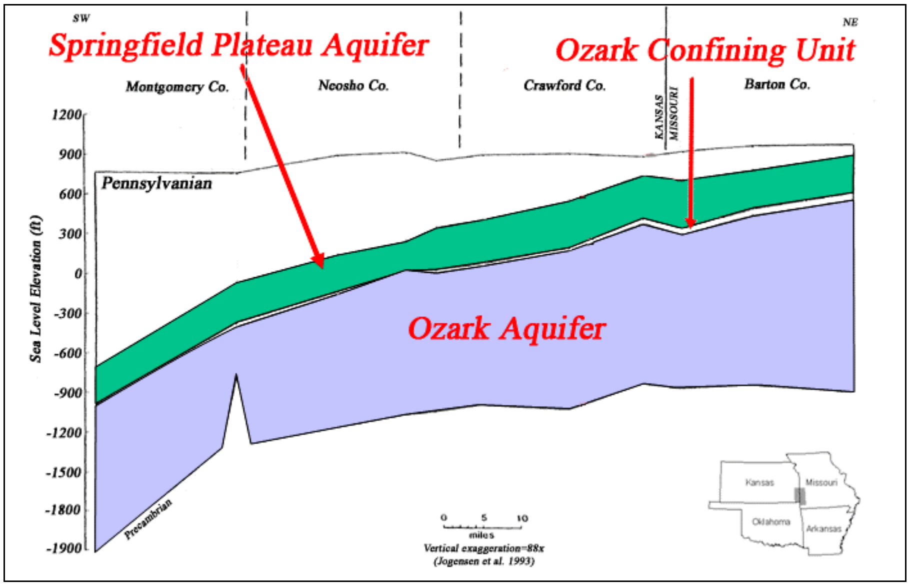

Figure 2: Ozark and Springfield Plateau Aquifers

Figure taken from Kansas Geological Survey Open File Report 2007-20 *The Southeast Kansas Ozark Aquifer Water Supply Program*.

The Springfield Plateau aquifer contains fresh water in southwest Missouri and northeast Oklahoma, where it is shallow and can produce water sufficient for domestic purposes. Water quality of the Springfield Plateau aquifer in Kansas is poor and may be unfit for domestic use due to extensive lead and ore mining in the area. Mining shafts have allowed contaminated water to move from the surface into the aquifer.

The Ozark aquifer contains usable water in southeast Kansas and is the source for most of the groundwater supplied to area municipalities and rural water districts. At the bottom of the Ozark aquifer is a brine layer (salt water) that is moving west to east across Kansas. There is concern that significant groundwater pumping in areas could potentially cause upwelling of brines within the aquifer and adversely impact water quality.

Due to uncertainty about the available water supply in the Ozark aquifer, as well as water quality concerns, in 2004 the Kansas Department of Agriculture's Division of Water Resources (KDA-DWR) established a moratorium on new appropriations from the aquifer in Kansas, except for some specified exceptions. The moratorium referenced a study of the Springfield Plateau aquifer and Ozark aquifer to be completed by December 31, 2010 (K.A.R. 5-3-29). The study by the U.S. Geological Survey (USGS), with state and local involvement, has been ongoing for several years and is anticipated to be completed in 2009. (http://ks.water.usgs.gov/Kansas/studies/OzarkAquifer/index.html).

In 2004, a groundwater well monitoring network was re-established for the Ozark aquifer moratorium area. The network consists of 24 wells that are screened within the Springfield Plateau aquifer, the Ozark aquifer, or both aquifers (referred to as the Ozark Plateau aquifer), and are measured on a quarterly basis. Also, in order to detect the potential eastward movement of salt water, a network consisting of 12 wells has been established from which water quality samples are taken quarterly. Lastly, three continuous monitoring wells have been drilled. Two of the monitoring wells are located in the Ozark aquifer at McCune and Pittsburg and one is located in the Springfield Plateau aquifer, also located at Pittsburg. All three wells have transducers installed and are equipped with satellite telemetry capabilities.

II. Precipitation

Precipitation in the Ozark Plateau area in Kansas averages 41 inches (in.) per year based on six precipitation stations. Figure 3 shows the annual variation in precipitation. This chart was derived from National Climatic Data Center (NCDC) stations located in Columbus (Cherokee County), Erie (Neosho County), Fort Scott (Bourbon County), Moran (Allen County), Parsons (Labette County) and Pittsburg (Crawford County). The data is downloaded then averaged to create the following chart. The highest precipitation total occurred in 1985 with 59 in. The lowest precipitation occurred in 1963 with 22 in. In 2006, the precipitation total was only 30 in., which is 73% of the average. Annual precipitation data for these NCDC stations is currently available through 2006.

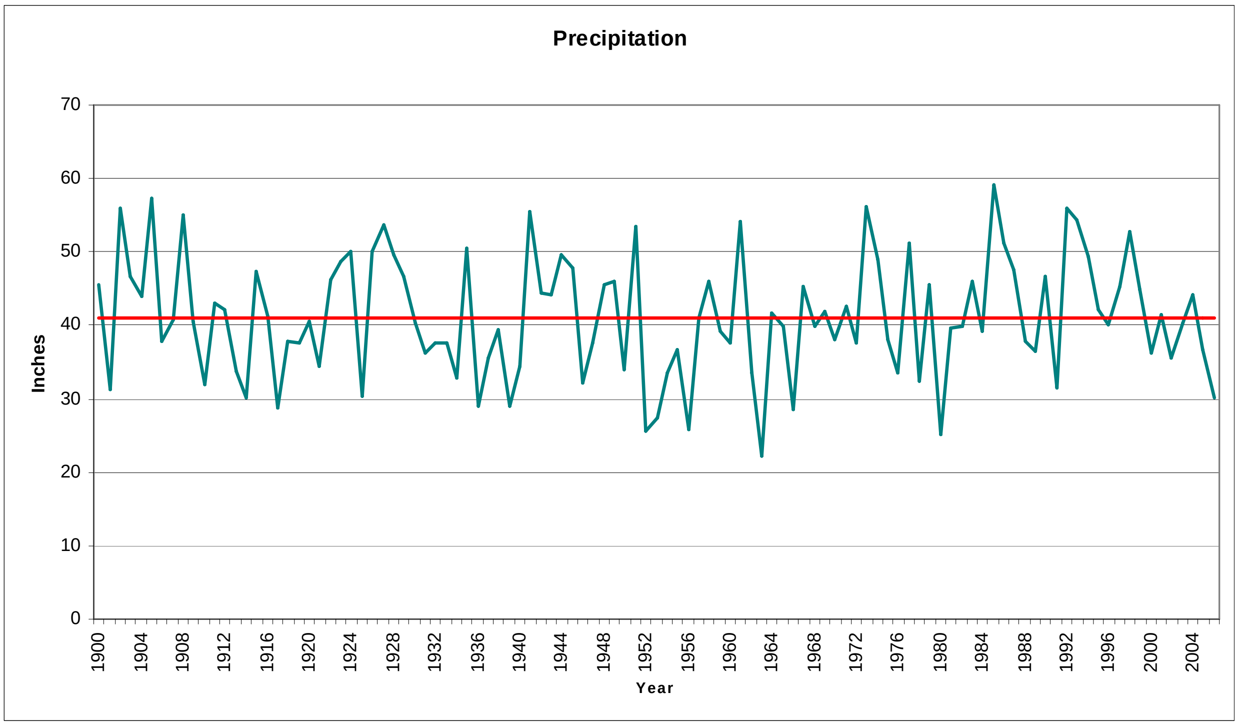

Figure 3: Average Ozark Precipitation 1900-2006

Figure 4 shows monthly precipitation for January 2007 to October 2007. November and December data are not currently available. With these measurements the subbasin experienced a total of 50.25 in. during the first 10 months in 2007. This is 9 in. above the annual average. June had the highest average with 15 in. while August had the lowest precipitation average with 1.7 in.

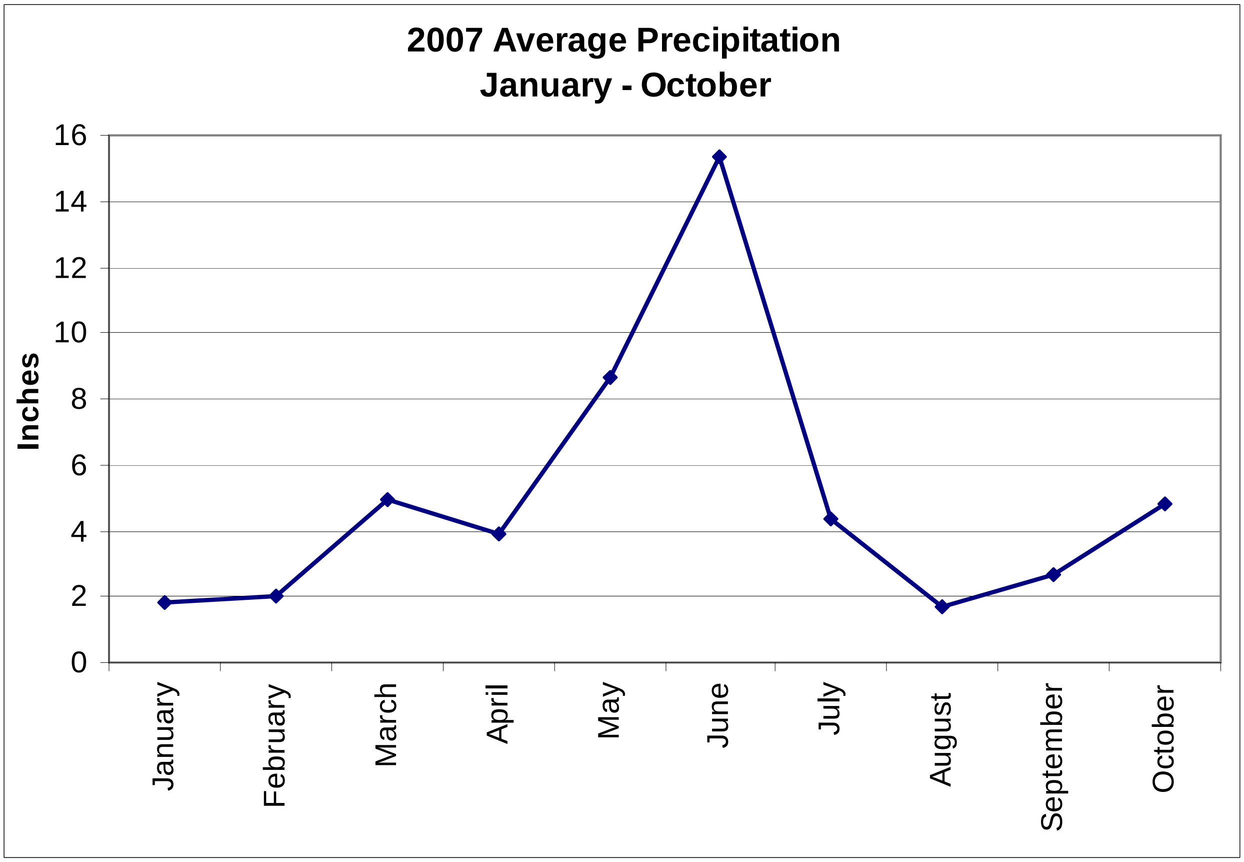

Figure 4: 2007 Monthly Average Precipitation (November and December data not available)

III. Surface Water

The Neosho River and the Spring River are the two major river systems that cut through the regulation area boundary of the Ozark Plateau aquifer (Figure 4). The lower Neosho River flows through Neosho and Labette counties, and briefly flows through the southwest corner of Cherokee County before flowing out of Kansas into Oklahoma. The Spring River enters Kansas on the eastern side of Cherokee County, flows through Cherokee County, and exits the state at the southern part of the county into Oklahoma. Both river systems are monitored by the USGS and have streamflow gages positioned near Parsons, Kansas on the lower Neosho River and near Quapaw, Oklahoma on the Spring River (Figure 5).

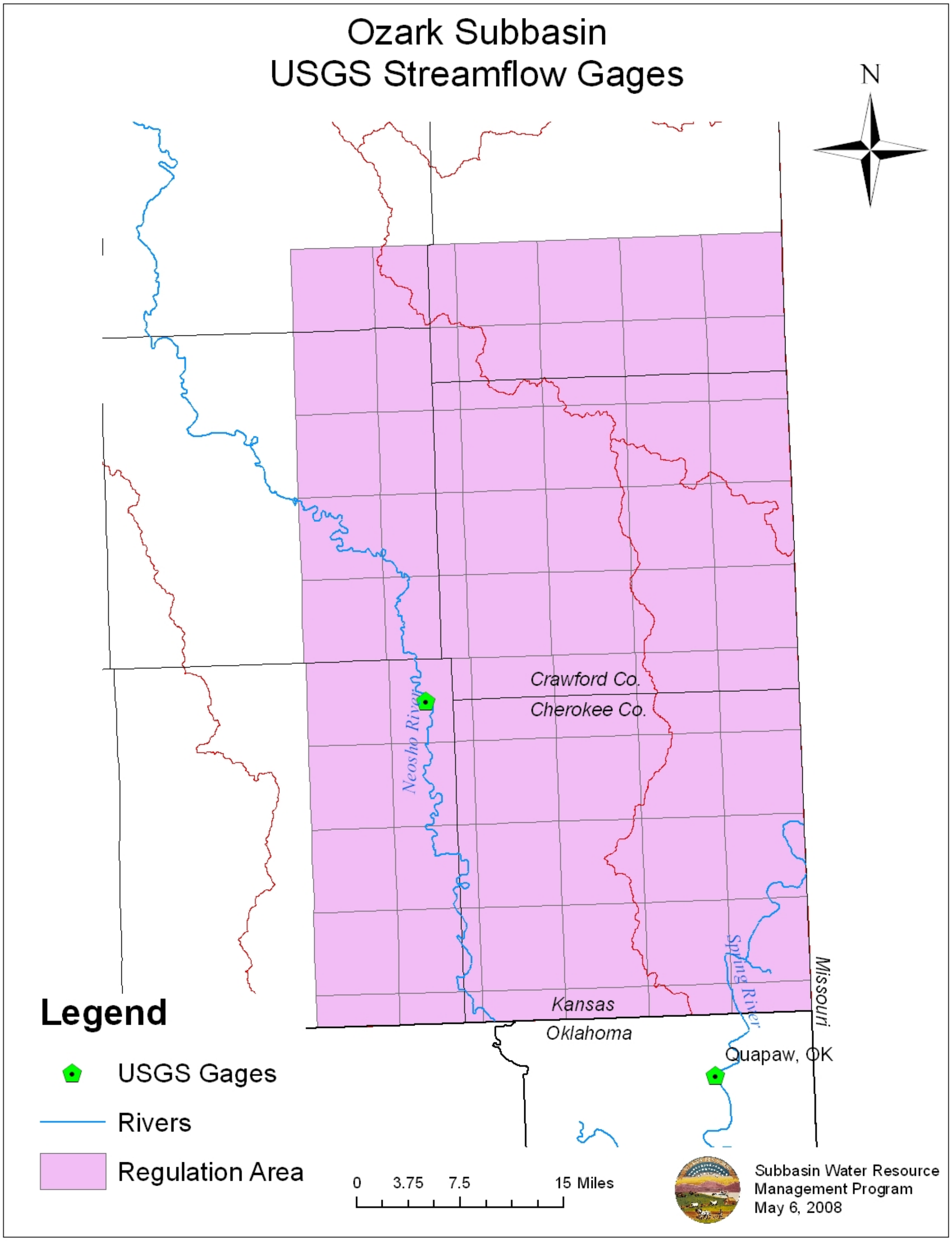

Figure 5: Neosho River and Spring River USGS streamflow gage.

Figure 6 was derived from the Parsons, Kansas and Quapaw, Oklahoma USGS gages and demonstrates how flow can vary each year. Following the 1951 flood the Neosho River reached periods of little to no flow during the subsequent drought.

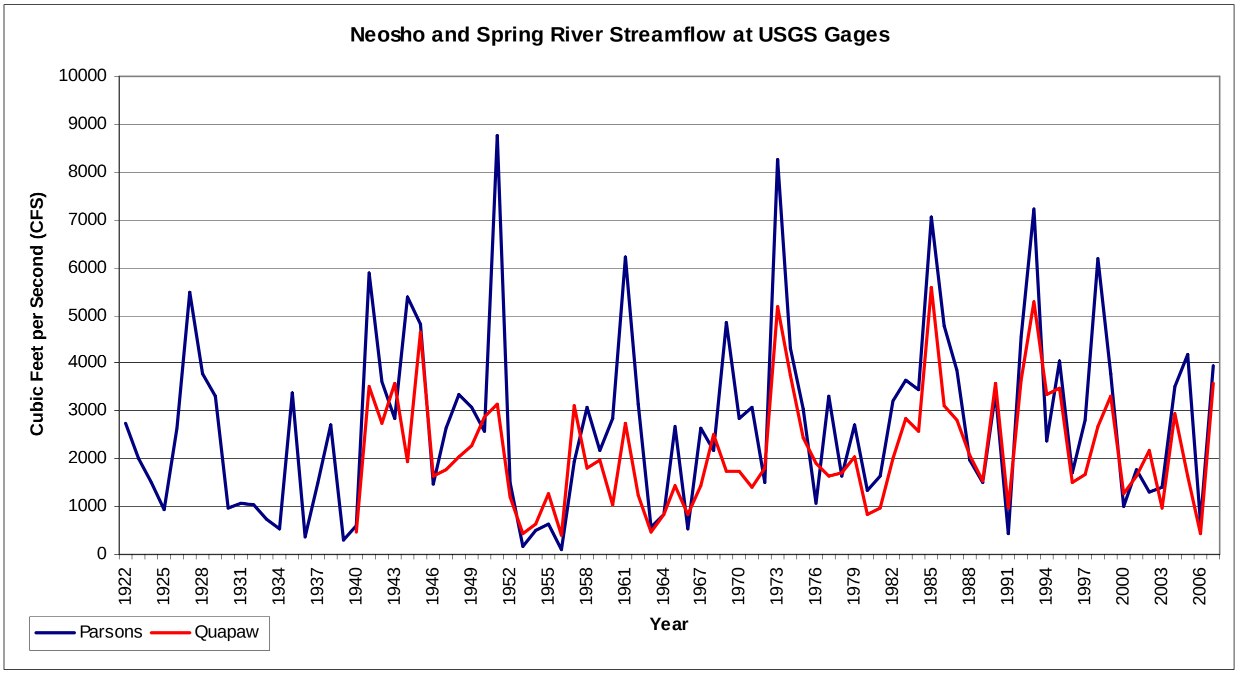

Figure 6: Streamflow at USGS Gages 1921-2007

In 1984, the Kansas legislature amended the Kansas Water Appropriation Act to establish Minimum Desirable Streamflows (MDS) on certain watercourses in Kansas. The statutory provision provided for the establishment of MDS flow criteria to be designated on a number of Kansas streams prior to a 1990 deadline. MDS flow criteria was established on the Neosho and Spring Rivers at specific USGS streamflow gages. Table 1 represents the MDS values for the lower Neosho River and the Spring River USGS streamflow gages. Figure 7 shows the streamflow measurements for 2007. The lower Neosho River gage is located near Parsons, Kansas and is used in administering MDS between the Iola, Kansas USGS gage and the Parsons, Kansas USGS gage. The Spring River gage near Quapaw, Oklahoma is used in administration of MDS at Baxter Springs, Kansas. The MDS values for the Neosho River near Parsons in parenthesis in Table 1 represent the spawning flows that are managed if the reservoir is in flood pool.

Table 1: Minimal Desirable Streamflow (MDS)

River	Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Neosho	**Parsons**	50	50	50	50 (100)	50 (300)	50 (300)	50	50	50	50	50	50
Spring	**Quapaw**	175	200	250	300	450	350	200	160	120	120	150	175

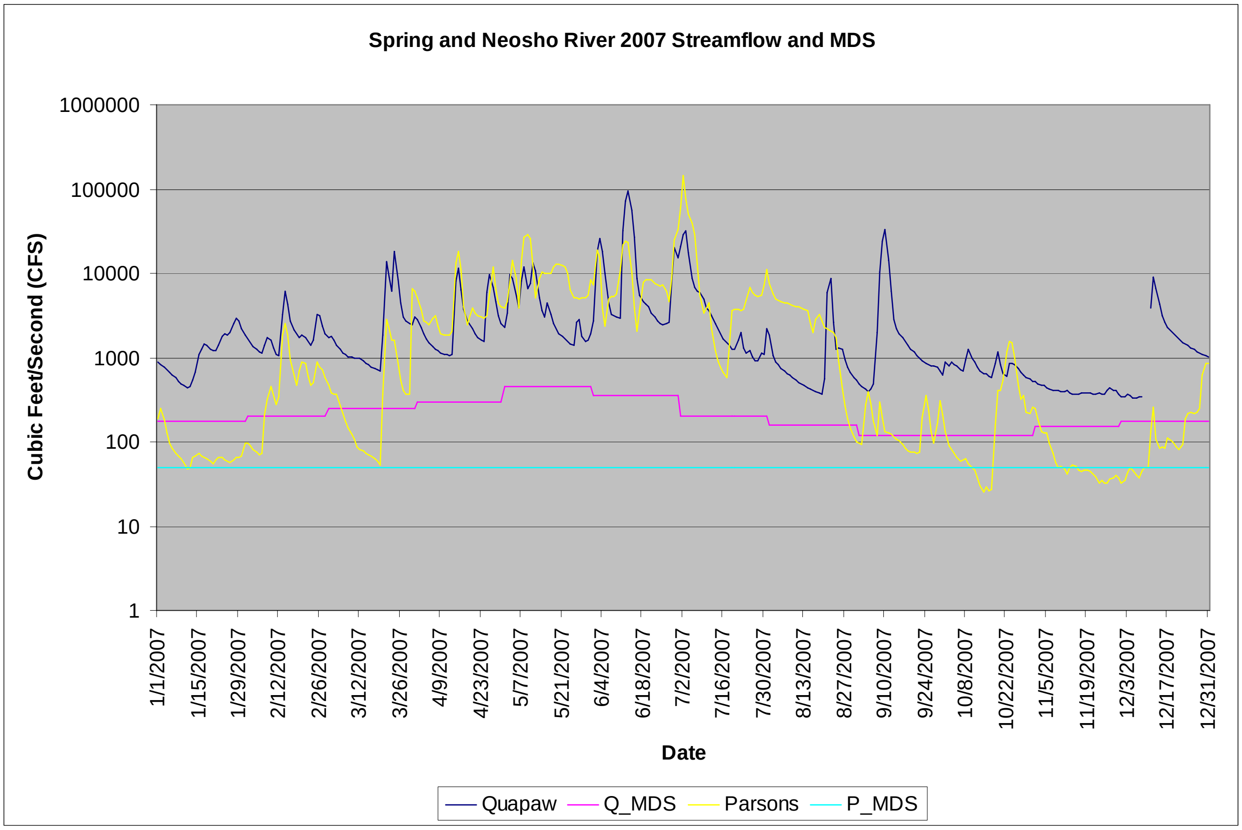

Figure 7: Daily Streamflow and MDS for 2007

Figure 8 charts the potential days in which MDS criteria are not met at the lower Neosho River gage and Spring River gage. Since MDS was established in 1984, the frequency of streamflow below the MDS criteria has been less at the Quapaw gage than at the Parsons gage. This is partly due to the fact that streamflows on the lower Neosho River are affected by operations of three federal reservoirs located within the basin (Marion, Council Grove, and John Redmond Reservoirs). The lower Neosho has a greater potential for flows below MDS criteria for consecutive years, resulting in the administration of MDS on the Neosho River in 2002, 2003, 2006, and 2007. MDS administration occurred for the first time on the Spring River in 2006.

The Parsons gage on the Neosho River has a longer record dating back to 1922, while recording on the Spring River at the Quapaw gage started in 1940. Over the periods of record, the average streamflow at the Parsons gage on the Neosho River was 2734.2 cfs and 2172.5 cfs at the Quapaw gage on the Spring River. During the 1990s, the Parsons gage had reduced flows and averaged 1994 cfs. On the other hand, the Quapaw gage averaged 2947.8 cfs during the 1990s. The Parsons gage is averaging higher streamflows at 2221.7 cfs than the Quapaw gage at 1835.1 cfs from 2000 to 2007.

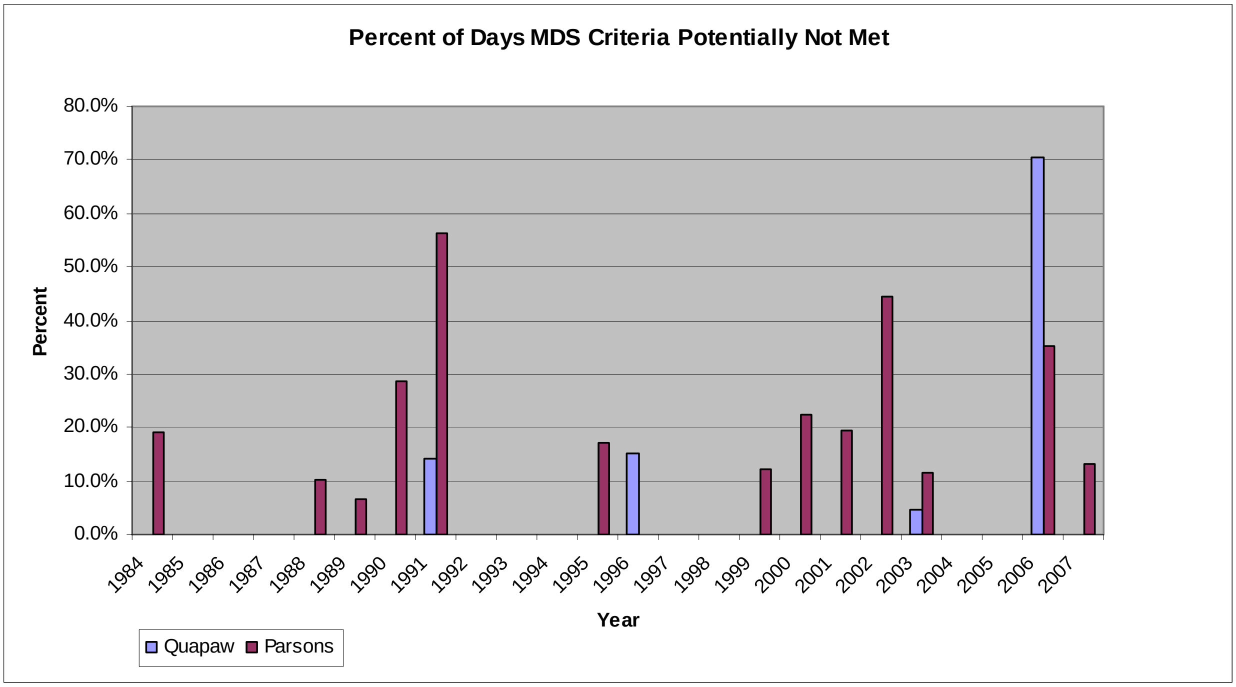

Figure 8: Percent of days potential MDS is not met at USGS gages

IV. Groundwater

In the Ozark Plateau region there are two aquifer sources in which groundwater level measurements are taken: the Ozark aquifer and the Springfield Plateau aquifer. The Springfield Plateau aquifer is of poor quality water and not used much for domestic purposes. Monitoring wells used in this report are located in the Ozark aquifer and what we refer to as the Ozark Plateau aquifer (wells believed to be screened in both the Ozark and the Springfield aquifers). There are no known monitoring wells solely screened in the Springfield Plateau aquifer besides the dedicated observation well at Pittsburg, Kansas. For this fieldwork summary, groundwater data was grouped by aquifer source. The monitoring well network is shown in Figure 9. Figure 10 and Figure 11 chart the groundwater in the Ozark and the Ozark Plateau aquifer. Well depths and water level trends vary between individual wells, which are partly due to majority of the well network consisting of active municipal wells.

There is little historical water level data to compare current water levels to; therefore, no five-year rolling averages were prepared. The KDA-DWR measures a total of 27 wells in the Ozark Plateau region. Generally, winter (December, January and February) measurements are used for the Subbasin Water Resource Management Program field analysis summary as this is a period in which irrigation wells are usually not pumping and recovery of the water table is occurring. Historically, in this area, spring, summer and fall were the common times to measure groundwater level data. Since the wells monitored are mostly municipal wells that pump year-round, capturing a period of recovery would be difficult. In reviewing the data, fall measurements (September, October, and November) seemed to be the most consistent time in which groundwater levels were taken, therefore, they were used for this analysis. Legal descriptions for monitoring wells are available in the appendix.

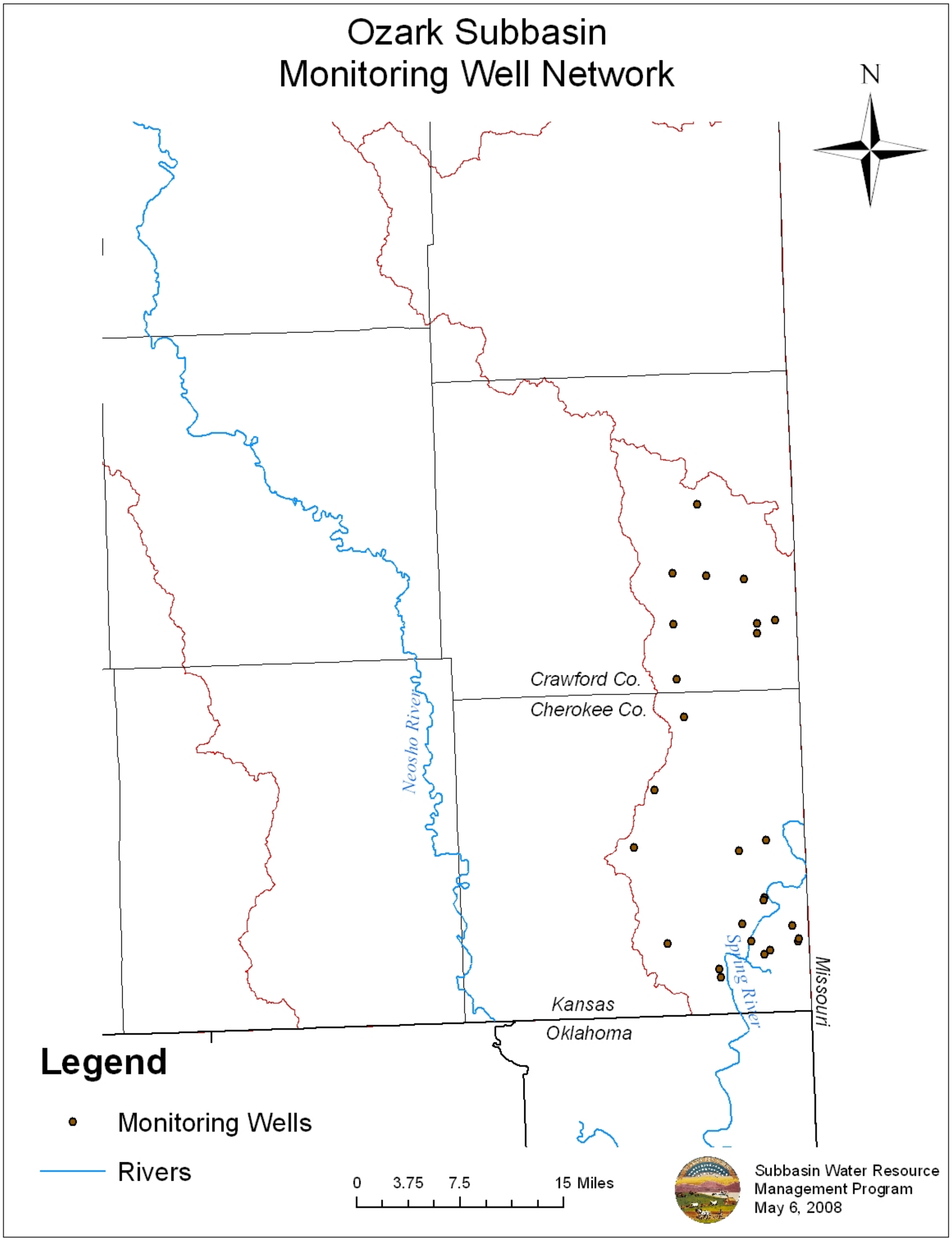

Figure 9: Ozark Monitoring Wells

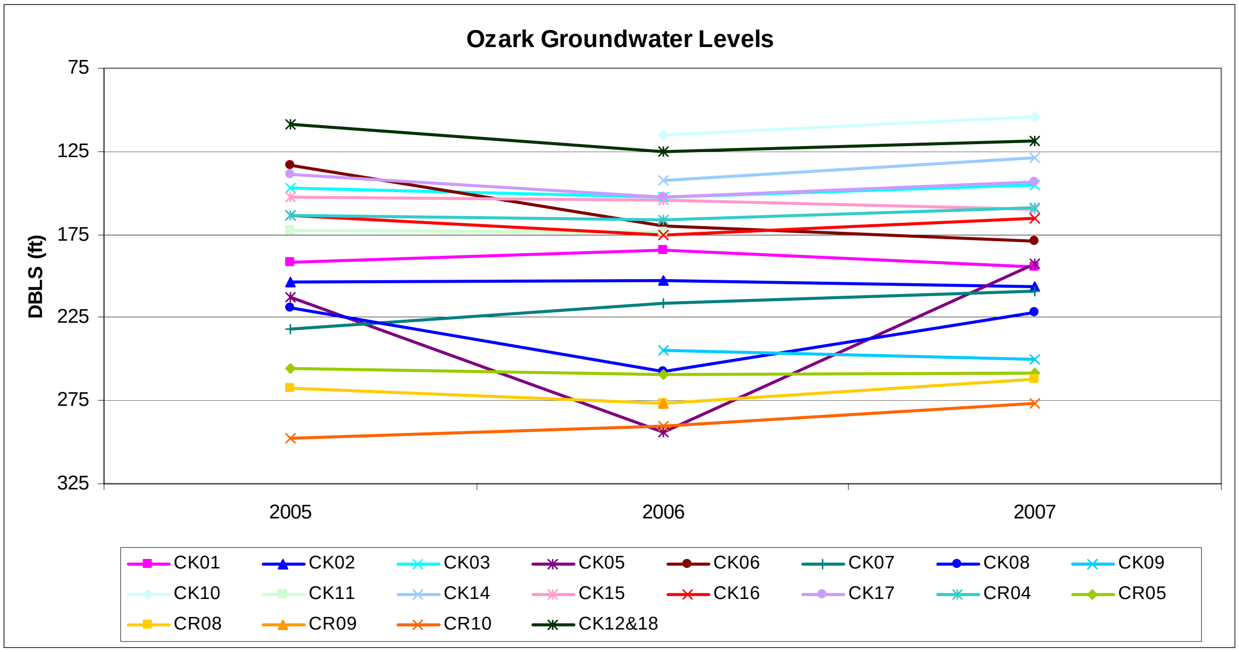

Figure 10: Groundwater levels for the Ozark aquifer

In the Ozark aquifer, there are 20 monitoring wells, which are identified by the Kansas Geological Survey well ID numbers (Figure 10). From 2005 to 2006 average water levels declined about 10 ft but increased about 14 ft from 2006 to 2007. CK05 declined approximately 66 ft from 1987 to 2007. CK12/CK18 has shown similar trends to CK05 and have declined about 41 ft from 1975-2007. Because these are pumping wells, some data is representative of pumping levels instead of static water levels.

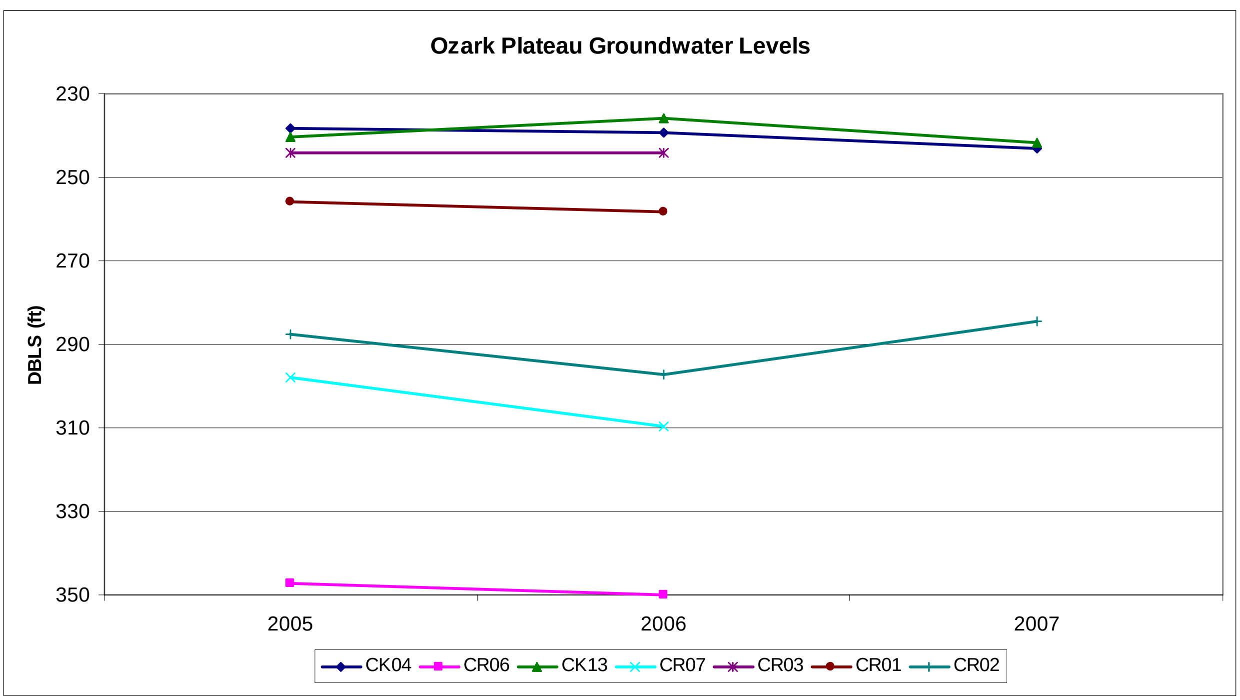

Figure 11: Groundwater levels for the Ozark Plateau aquifer

In the Ozark Plateau aquifer there are seven monitoring wells (Figure 11). Overall, from 2005 to 2006 water levels declined by about 3 ft but increased nearly 20 ft from 2006 to 2007.

V. Water Quality

Figures 12 to 15 chart salinity and conductivity values in the Ozark aquifer and Ozark Plateau aquifer from March 2007 to March 2008. Figures 12 and 13 show salinity levels have remained fairly consistent throughout the network. Figure 12 charts a range in salinity from 200 to 600 parts per million (ppm) in the Ozark aquifer, while the Ozark Plateau aquifer (Figure 13) has a range from 300 to 600 ppm. The U.S. Environmental Protection Agency's (EPA) secondary drinking water standard for chloride is 250 ppm.

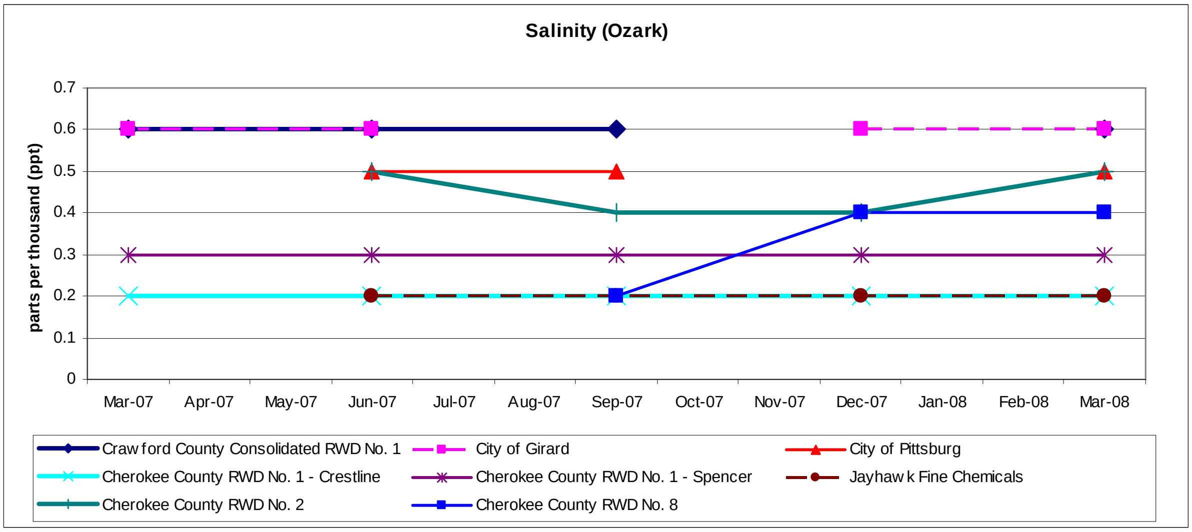

Figure 12: Ozark Aquifer Salinity

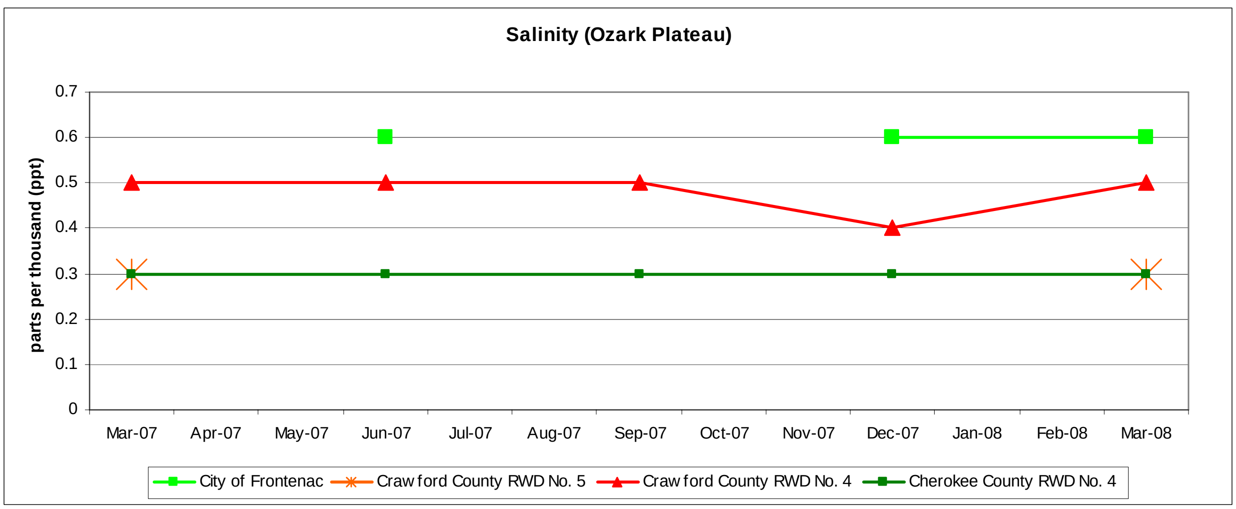

Figure 13: Ozark Plateau Aquifer Salinity

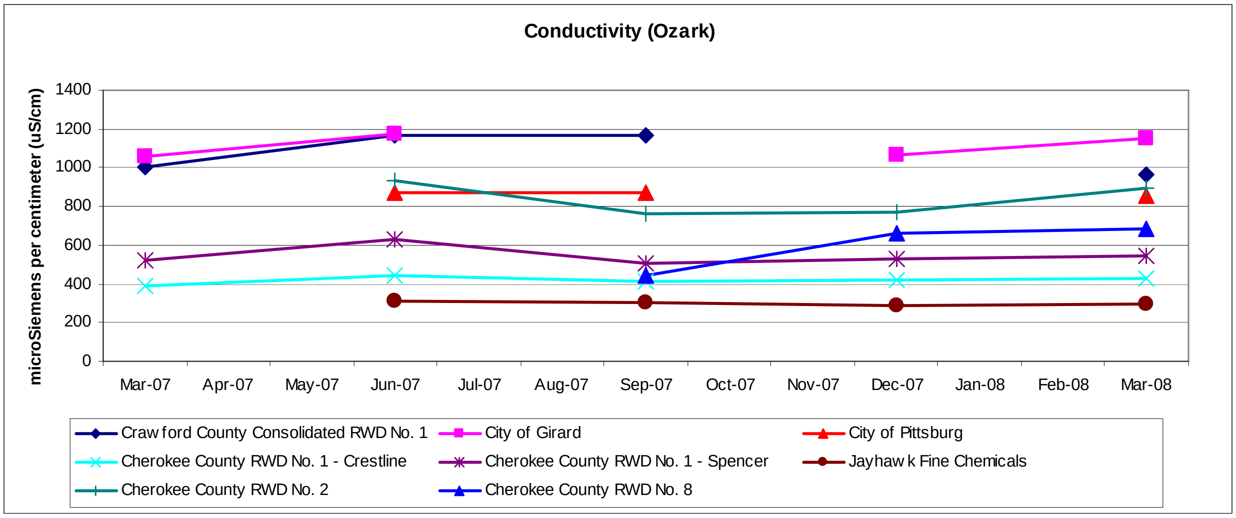

Figure 14: Ozark Aquifer Conductivity

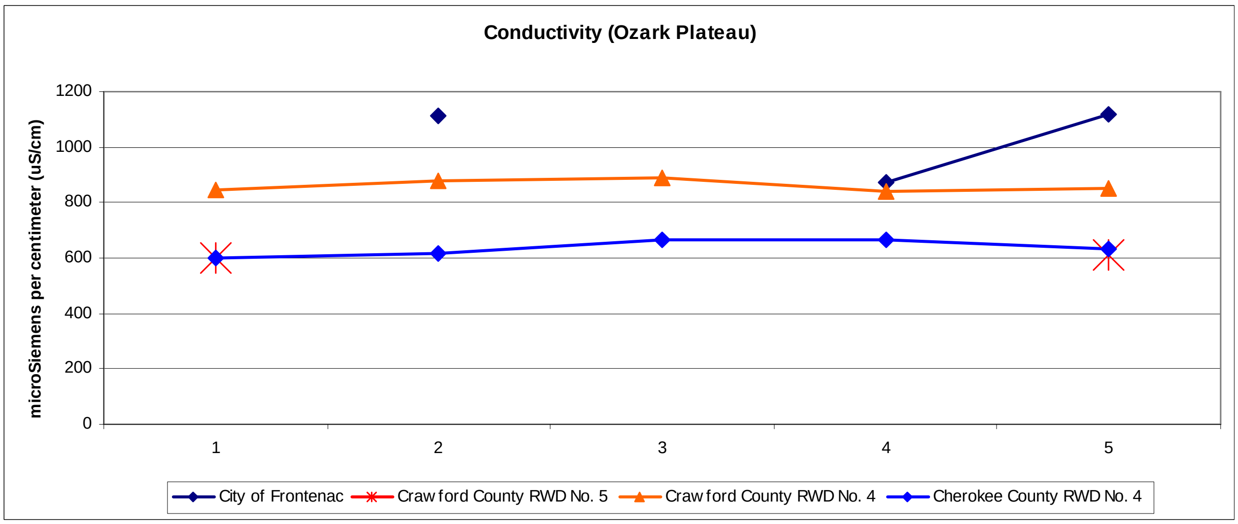

Figure 15: Ozark Plateau Aquifer Conductivity

Figure 14 and Figure 15 chart conductivity values for the Ozark aquifer and the Ozark Plateau aquifer. As with the salinity values, conductivity values remain fairly consistent with a range in the Ozark aquifer of 200 micosiemens/centimeter (µS/cm) to 1200 µS/cm (Figure 14) and a range in Ozark Plateau aquifer from 600 µS/cm to 1200 µS/cm (Figure 15). The electrical conductivity of water is directly related to the concentration of dissolved solids in the water. However, in order to determine the relationship laboratory tests are needed to correlate conductivity with total dissolved solids. The EPA secondary drinking water standard for total dissolved solids is 500 ppm; without knowing the correlation factor for these groundwater sources it is unknown at this time whether the range of conductivity measured in these aquifers is above or below the secondary drinking water standard.

VI. Water Use

The portion of the Neosho River basin within the Ozark Plateau region and the Spring River basin has a total of 328 water rights with an authorized quantity of 81,219 acre-feet. These water right numbers are for the following counties: Allen, Bourbon, Neosho, Crawford, Labette and Cherokee. The source of supply is groundwater for 101 water rights, or 31% of the total authorized (
Table 2). This analysis includes all water rights authorized for irrigation, municipal, recreation, industrial, domestic and stock water uses within the Ozark Plateau region.

Table 2: Water Rights in the Neosho and Spring River Subbasin

Type	Source	Number of Rights	Authorized Quantity
Vested	Surface Water	21	20,971 AF
Appropriated	Surface Water	206	47,404 AF
Vested	Groundwater	14	2,111 AF
Appropriated	Groundwater	87	10,733 AF
Total		328	81,219 AF

The water use ranges from 34,542 acre-feet in 1988 to 23,451 acre-feet in 2005. The average water use over the twenty-year span was 27,730 acre-feet (Figure 14). In the Neosho River basin, some municipal and industrial users obtain some of their water supply from federal reservoirs through Water Marketing contracts. Since Marketing Program contracts do not require water appropriation permits, diversions under contract are not reflected in Table 2. Additionally, all municipal and industrial users who divert surface water in the Neosho River basin are required to be members of the Cottonwood and Neosho River Basins Water Assurance District No. 3, which supports diversions of its members from a dedicated pool in Assurance reservoirs.

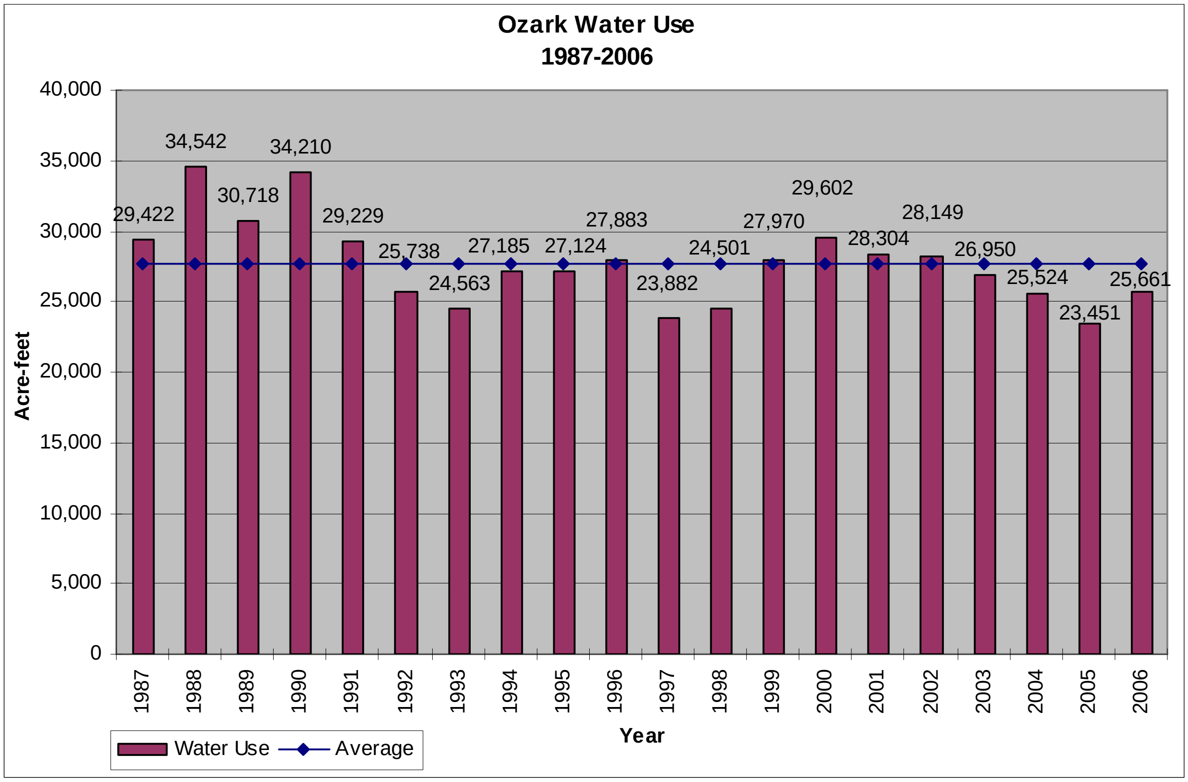

Figure 14: Ground and Surface water use 1987-2006

VII. Conclusions

In conclusion, precipitation in the regulated boundary area during 2006 averaged 30 in., which is below the normal average of 41 in. per year. With below average precipitation, water use for 2006 increased from the previous year, 23,451 AF to 25,661 acre-feet, which is below the average water use of 27,730 acre-feet. Also, during 2006, MDS administration occurred for the first time on the Spring River since MDS was established and MDS administration occurred on the Neosho River. Salinity and conductivity levels for both the Ozark aquifer and Ozark Springfield Plateau aquifer remained consistent from March 2007 to March 2008. The Ozark aquifer and Ozark Plateau aquifer water levels decreased from 2005 to 2006 but increased from 2006 to 2007. Continued monitoring of hydrologic conditions and their response to climate variations is important for evaluating the long-term effects of water usage on this subbasin and protection of property rights. It is important to understand recharge and the impacts of pumping and other factors on the hydrologic system.

VIII. Appendix

Name	Well ID	Aquifer	Legal Description	Latitude	Longitude
Cherokee Co. RWD 2	CK14	Ozark	34S25E08SWNWSW	37.093	-94.704
Cherokee Co. RWD 9	CK15	Ozark	34S25E20NWNENW	37.074	-94.693
Cherokee Co. RWD 8	CK16	Ozark	34S25E21NWNESE	37.064	-94.669
Cherokee Co. RWD 8	CK17	Ozark	34S25E28NWNWNW	37.06	-94.677
Galena	CK07	Ozark	34S25E23SENENE	37.072	-94.632
Galena	CK08	Ozark	34S25E13SWSWSW	37.075	-94.631
Galena	CK03	Ozark	34S25E14NWNWNE	37.089	-94.639

Baxter Springs	CK05	Ozark	34S24E36NENWNW	37.046	-94.737
Baxter Springs	CK06	Ozark	34S24E36NWNWSW	37.037	-94.735
Cherokee RWD 3	CK01	Ozark	34S24E17SWSWSE	37.075	-94.804
Jayhawk Fine Chemicals	CK09	Ozark	34S24E04NENWNE	37.119	-94.674
Jayhawk Fine Chemicals	CK10	Ozark	34S25E04NENWNE	37.117	-94.675
Cherokee RWD 1	CK11	Ozark	33S25E18NENESE	37.17	-94.705
Cherokee RWD 1	CK12&18	Ozark	33S25E09SENESE	37.18	-94.669
Columbus	CK02	Ozark	32S23E13NENENW	37.177	-94.843
Cherokee Co. RWD 4	CK13	Ozark Plateaus	32S24E29NWNWNW	37.237	-94.813
Weir	CK04	Ozark Plateaus	31S24E27NWSESW	37.313	-94.771
Arma	CR06	Ozark Plateaus	29S25E05SESESW	37.464	-94.779
Frontenac	CR07	Ozark Plateaus	20S25E04NESWSW	37.455	-94.684
Girard	CR05	Ozark	30S24E21NESENE	37.536	-94.742
Arcadia	CR04	Ozark	28S25E01NESWNE	37.398	-94.67
Crawford Co. RWD 1C	CR10	Ozark	30S24E02SESESE	37.46	-94.734
Pittsburg DWR	CR09	Ozark	30S25E28NENESE		
Pittsburg	CR08	Ozark	20S25E28SESESE	37.398	-94.67
Crawford Co. RWD 4	CR01	Ozark Plateaus	30S24E28NENENE	37.411	-94.78
Crawford Co. RWD 4	CR03	Ozark Plateaus	31S24E16NENENE	37.353	-94.778
Crawford Co. RWD 5	CR02	Ozark Plateaus	30S25E23SESWSW		