Upper Arkansas River

2008 Field Analysis Summary

Subbasin Water Resource Management Program

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I. Introduction

In 1998, the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) formed a group with local stakeholders in the Upper Arkansas River subbasin through the Subbasin Water Resource Management Program (SWRMP). The primary areas of focus for this subbasin program were the ditch service areas located in northeastern Kearny and northwestern Finney Counties and the stretch of the alluvial corridor from the Kansas/Colorado Stateline ("Stateline") east to the Ford/Edwards County line. Program activities include collection of streamflow and groundwater level measurements, thus allowing a better understanding of the stream-aquifer interaction between the groundwater system and the Arkansas River.

The Upper Arkansas subbasin has an area of approximately 2,503,000 acres, including all or parts of eleven (11) counties including Greeley, Hamilton, Wichita, Kearny, Grant, Scott, Finney, Haskell, Gray, Hodgeman and Ford (Figure 1). The Upper Arkansas River subbasin extends from the Stateline near Coolidge, Kansas east to the eastern Ford County line. The Middle Arkansas subbasin neighbors the Upper Arkansas subbasin to the east.

Most of the Upper Arkansas subbasin falls under the local jurisdiction of the Southwest Kansas Groundwater Management District No. 3 (GMD No. 3), while a small portion is within the Western Kansas Groundwater Management District No.1 (GMD No. 1) and areas outside of a Groundwater Management District are under the jurisdiction of the KDA-DWR.

The climate is semiarid with long-term[1] average annual precipitation ranging from 16.33 inches at Syracuse, Kansas to 20.90 inches at Dodge City, representing a 5-inch precipitation variation from one side of the basin to the other. The range of annual precipitation in this subbasin over the period of record varies from 8 inches to 30 inches. Most of the precipitation occurs from May through August as the result of thunderstorms. The primary source of surface water is generated in Colorado and subject to the climatic variations of snowfall and precipitation in that portion of the Arkansas River Basin.

Most irrigation is from the Ogallala-High Plains and alluvial aquifers, but there are also six irrigation ditches that divert surface water from the Arkansas River from the Stateline east to Garden City. The surface water used by these irrigation ditches is monitored by a compact between Colorado and Kansas. There are additional surface water rights between Garden City and the eastern boundary of the subbasin.

An Intensive Groundwater Use Control Area (IGUCA) has been in place along the entire alluvial corridor since 1986 (Figure 1). The IGUCA was the result of request by GMD No. 3 to review information suggesting that the rate of withdrawal of groundwater equaled or exceeded the rate of recharge causing excessive groundwater declines and that conditions existed that required regulation in the public interest. Provisions of the IGUCA restrict both new and change

[1] Based on qualified precipitation data from the High Plains Regional Climate Center (http://www.hprcc.unl.edu/index.php). The average annual precipitation for period of 1948 to 2006 was determined for Syracuse (54 years used) and Dodge City (56 years used).

applications, set well construction requirements to prevent leakage between the alluvial and Ogallala-High Plains aquifers, require flow meter installation, etc.[2]

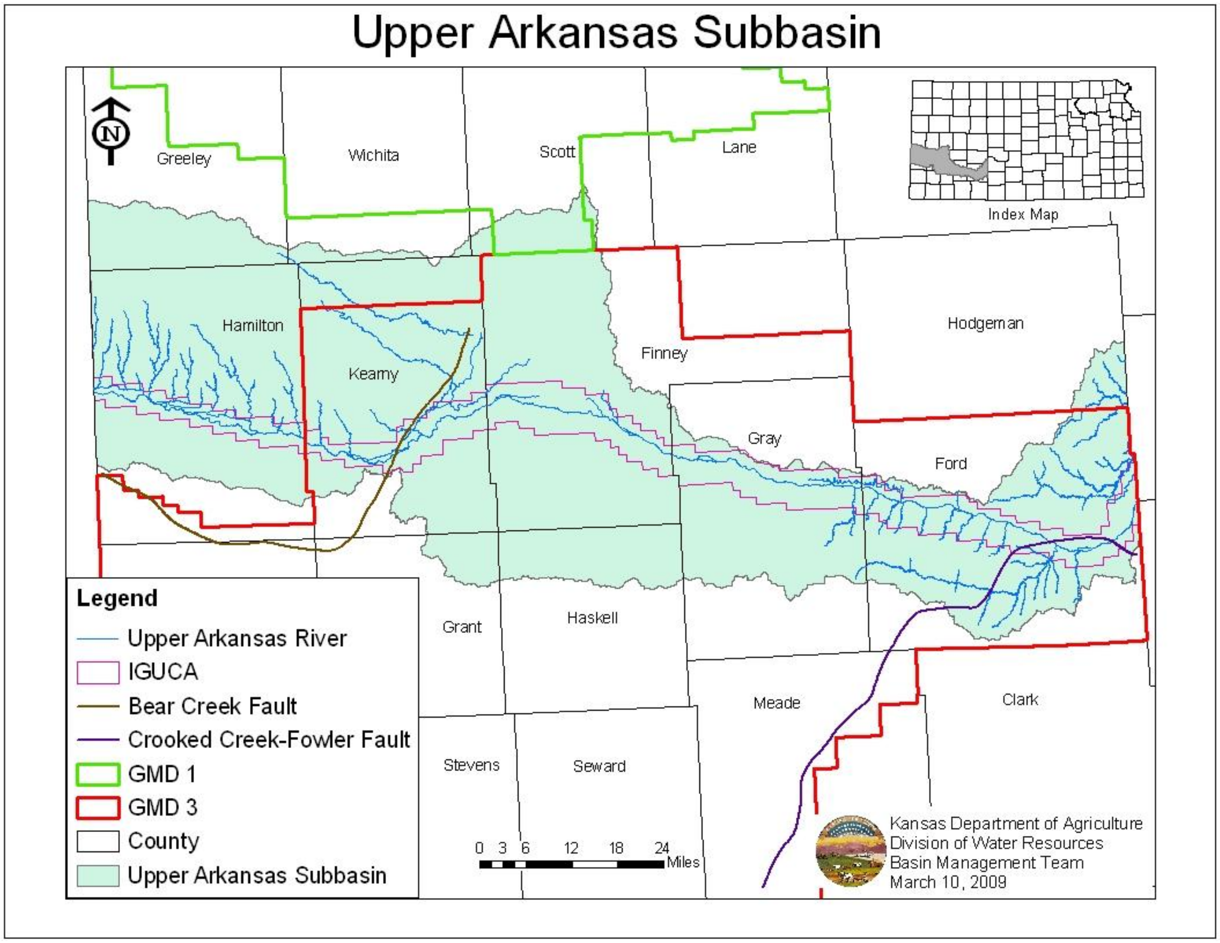

Figure 1: Upper Arkansas River Subbasin

The subbasin lies in the High Plains physiographic region and the dominant economies are agriculture and oil and natural gas production (US Dept of Agriculture, 1973). Alluvial groundwater depletion related to diversion for pumping, phreatophytes[3] and water quality degradation of alluvial groundwater from surface water flows of the Arkansas River are currently the major water issues facing the subbasin (Whittemore, 2000). To help understand these issues, the Kansas Geological Survey is constructing a steady state model for Southwest Kansas Groundwater Management District No. 3. The focus of the model is to learn more about aquifer storage and change through time within the Upper Arkansas subbasin. The projected completion date for the model is in 2010.

This report will provide information related to precipitation, surface water flows, groundwater levels and water use for the most recent period where there is complete data and provides a comparison of the recent data to historical data.

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[2] More information about the Arkansas River IGUCA is available at http://www.ksda.gov/appropriation/content/291.

[3] Phreatophytes are deep-rooted plants (typically trees) that obtain water from the water table.

II. Precipitation

Precipitation in the Upper Arkansas River subbasin averages 19.66 inches (in.) per year based on five precipitation stations. Figure 2 shows the annual variation in precipitation. This chart was derived from National Climatic Data Center (NCDC) stations located at: Syracuse in Hamilton County, two stations in Garden City in Finney County, Cimarron in Gray County and Bellefont in Ford County. The data was downloaded then averaged to create the following chart. The highest precipitation occurred in 1951 with 30.05 in. and the lowest precipitation occurred in 1956 with 8.32 in. The wide variability in precipitation is typical of a continental climate. Precipitation was above average in 2005 and 2006, but was just below average in 2007 at 19.51 in. Annual precipitation data for these NCDC is currently available through 2007. Figure 3 charts the preliminary average monthly precipitation for 2008. The highest precipitation was seen in October with 5.35 in. and the lowest precipitation was in March with 0.18 in. of precipitation. The overall average rainfall in 2008 for the Upper Ark subbasin was just above average at 19.73 in.

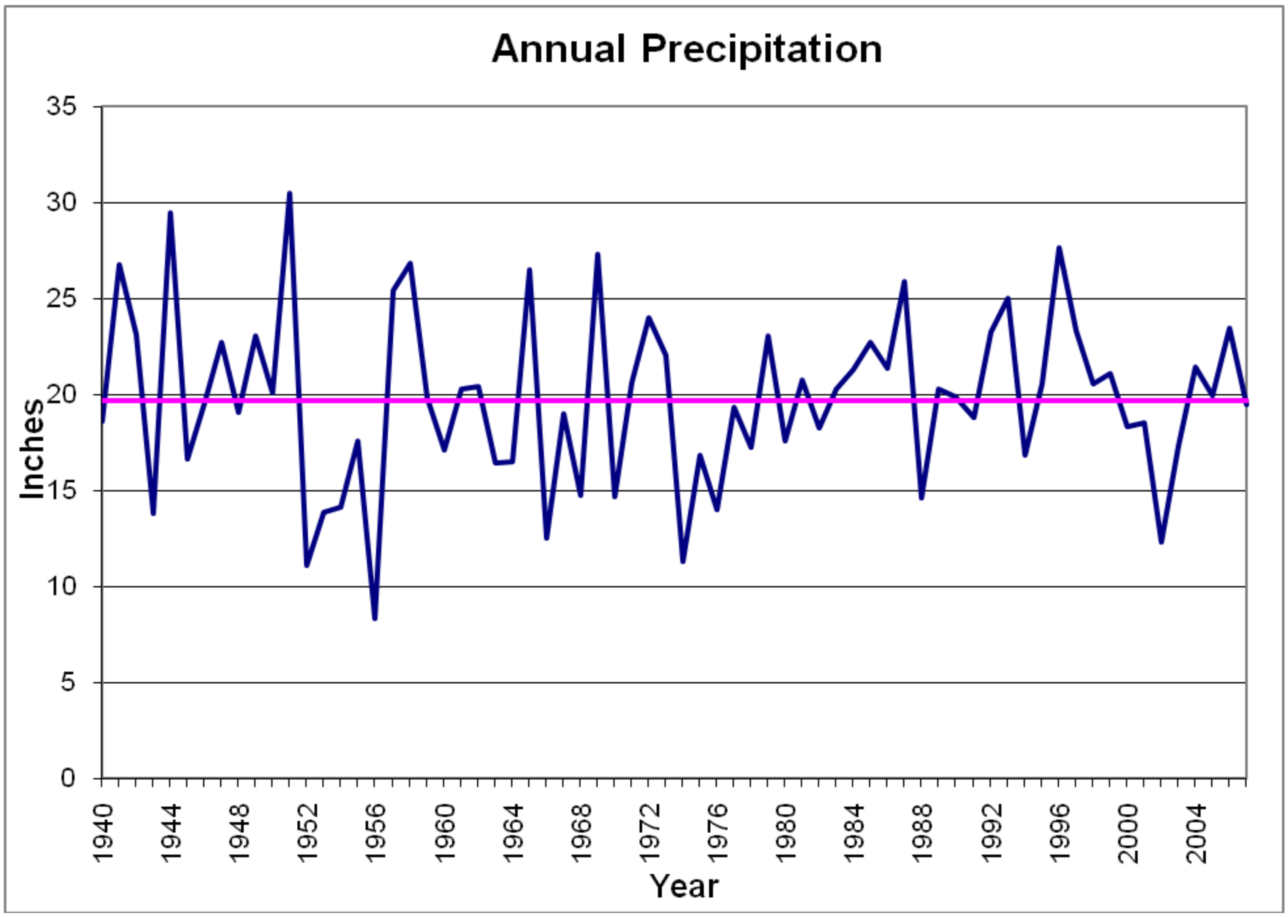

Figure 2: NCDC Annual Average Precipitation in Upper Arkansas Subbasin 1939-2007

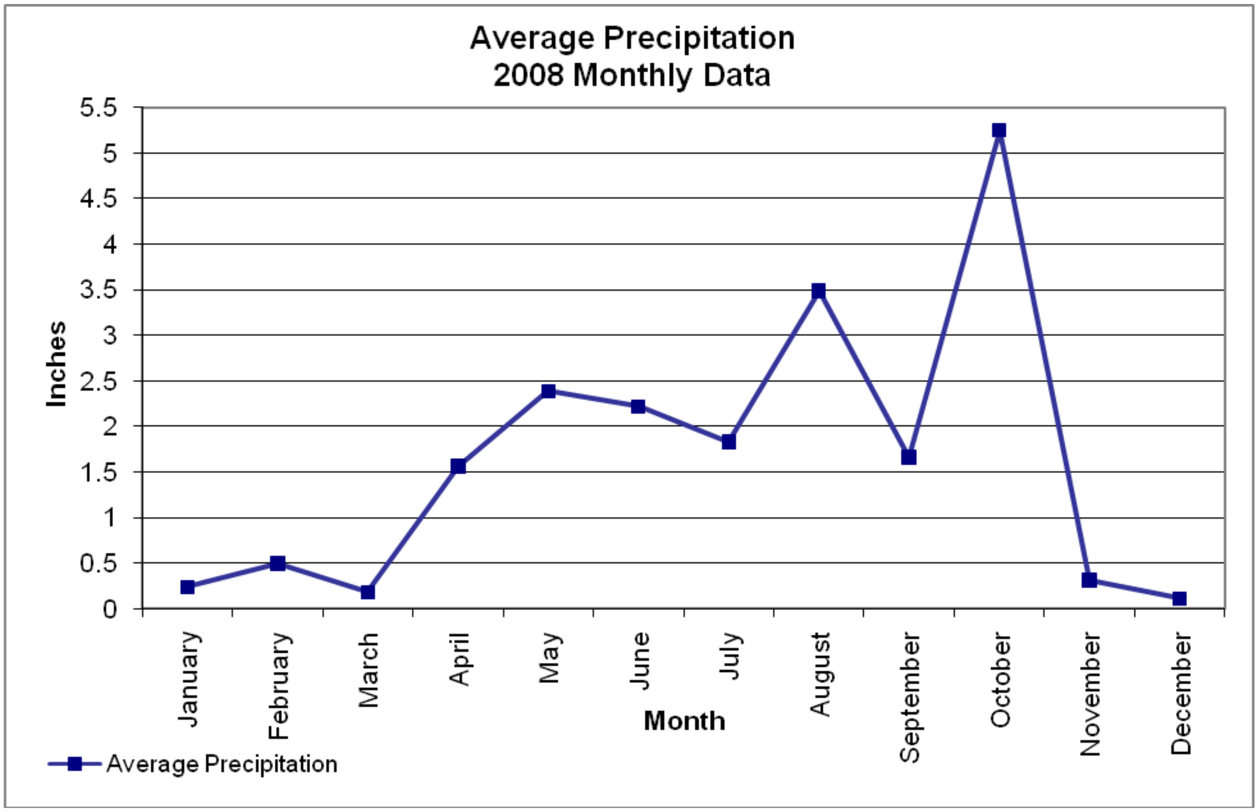

Figure 3: Monthly Average Precipitation in Upper Arkansas Subbasin for 2008

III. Surface Water

The flow in the Upper Arkansas River is influenced by the operations of an interstate compact between Colorado and Kansas ("compact"). Under the compact, some surface water inflows are stored in John Martin Reservoir, located approximately 90 miles west of the Stateline, near Lamar, Colorado for use in Kansas. Water releases are coordinated with KDA-DWR and the Associated Ditches.

In Colorado, there are tributaries below John Martin Reservoir that contribute to surface water flows, along with irrigation return flows. In Kansas, there is only one tributary, Mulberry Creek which enters the Arkansas River near Dodge City in Ford County.

Streamflow decreases in the Upper Arkansas River from west to east. The stream segment from the Stateline to Garden City is a losing stretch due to seepage to the alluvial aquifer system, evapotranspiration, groundwater pumping and surface water diversions. From Garden City to the eastern boundary of the Upper Arkansas subbasin, this is also a losing reach due to a lack of streamflows from above Garden City, very limited local inflows, and groundwater pumping. River water is a primary source of recharge to the alluvial aquifer system.
The USGS gages at Garden City and Dodge City show long periods of no flow. Generally only high flows resulting from flood conditions pass Garden City but these events are relatively rare. Minimal Desirable Streamflow (MDS) is not established at any of the gages in the Upper Arkansas River subbasin.

There are six USGS streamflow gage sites along the Upper Arkansas River, as well as four USGS measuring stations on the six irrigation ditches. The streamflow measurement sites begin at the Stateline and continue downstream to Dodge City, Kansas (Figure 4). In addition to the six river gages currently in use along the Upper Arkansas River, there have been other river gages used in the past (Table 1). On occasion, staff from KDA-DWR makes streamflow measurements at various locations in the subbasin.

Table 1: List of gages past and present in the Upper Arkansas River valley

Gage location	Dates measured
Arkansas River near Coolidge	May 1903 to October 1903
	March 1921 to May 1921
	October 1950 to present
Arkansas River at Syracuse	August 1902 to September 1906
	October 1920 to present
Arkansas River at Kendall	April 1979 to September 1982
	1987 – May 2000
	June 2000 to present
Arkansas River below Amazon diversion	April 1977 to September 1982
Arkansas River at Lakin	April 1978 to September 1982
Arkansas River at Deerfield	1987 – September 1998
	October 1998 to present
Arkansas River at Garden City	June 1922 to June 1970
	1980 – 1986
	October 1986 to present
Arkansas River at Dodge City	October 1902 to September 1906
	September 1944 to present
Mulberry Creek near Dodge City	March 1968 to September 1990

In analyzing streamflow from 1903 to present, only the streamflow at Coolidge, Syracuse, Deerfield, Kendall, Garden City and Dodge City is included (Figure 4). Figure 5 charts the annual streamflow at each of the six USGS stream gages. Over the period of record, the average annual streamflow at Syracuse (1903-2007) was 286.65 cfs, Coolidge (1951-2007) was 215.09 cfs, Deerfield (1999-2007) was 123.52 cfs, Kendall (1980-1982; 2001-2007) was 104.2 cfs, Garden City (1923-1969; 1987-2007) 174.29 cfs, and Dodge City (1903-1906; 1945-2006) was 126.73 cfs.

During the 1990s average annual streamflow at Syracuse was 302.67 cfs, Coolidge was 337.91 cfs, Garden City was 174.80 cfs and Dodge City was recording 97.96 cfs. The Kendall and Deerfield gages were not in operation in the 1990s. From 2000 to 2007, in general gages recorded streamflows lower than the period of record, with the exception of Kendall which was slightly above the period of record. Syracuse recorded an annual average from 200-2007 of 138.16 cfs, Coolidge was 149.38 cfs, Deerfield was 58.10 cfs, Kendall (no record in 2000) was 105.6 cfs, Garden City was 32.57 cfs and Dodge City was 0.22 cfs. As previously noted, there were long periods of time when the flow at the Garden City and Dodge City gages was zero, but the annual averages above zero reflect the effects of short-duration flows associated with high magnitude precipitation events.

Figure 6 represents the preliminary streamflow in 2008. Dodge City did not have any recorded flow in 2007 and no data was currently available for 2008. Garden City had some occurrences of minimal flows during 2008, due to localized runoff events. Flows at Coolidge, Syracuse and Kendall are similar due in large part to the operation of the irrigation ditches. Deerfield is further downstream and had a more variable flow, with periods of no flow in parts of March, April, June and July. Syracuse, Deerfield, and Kendall flows were all affected by ice in all or part of December 2008. For 2008, there were a total of 100,293 acre-feet of flow recorded at the Stateline. This compares to a Stateline flow of 133,437 acre feet in 2007. In 2008, approximately 55,500 acre-feet were released from storage accounts in John Martin Reservoir for delivery to Kansas. The six irrigation ditches diverted approximately 45,823 acre-feet in 2008.

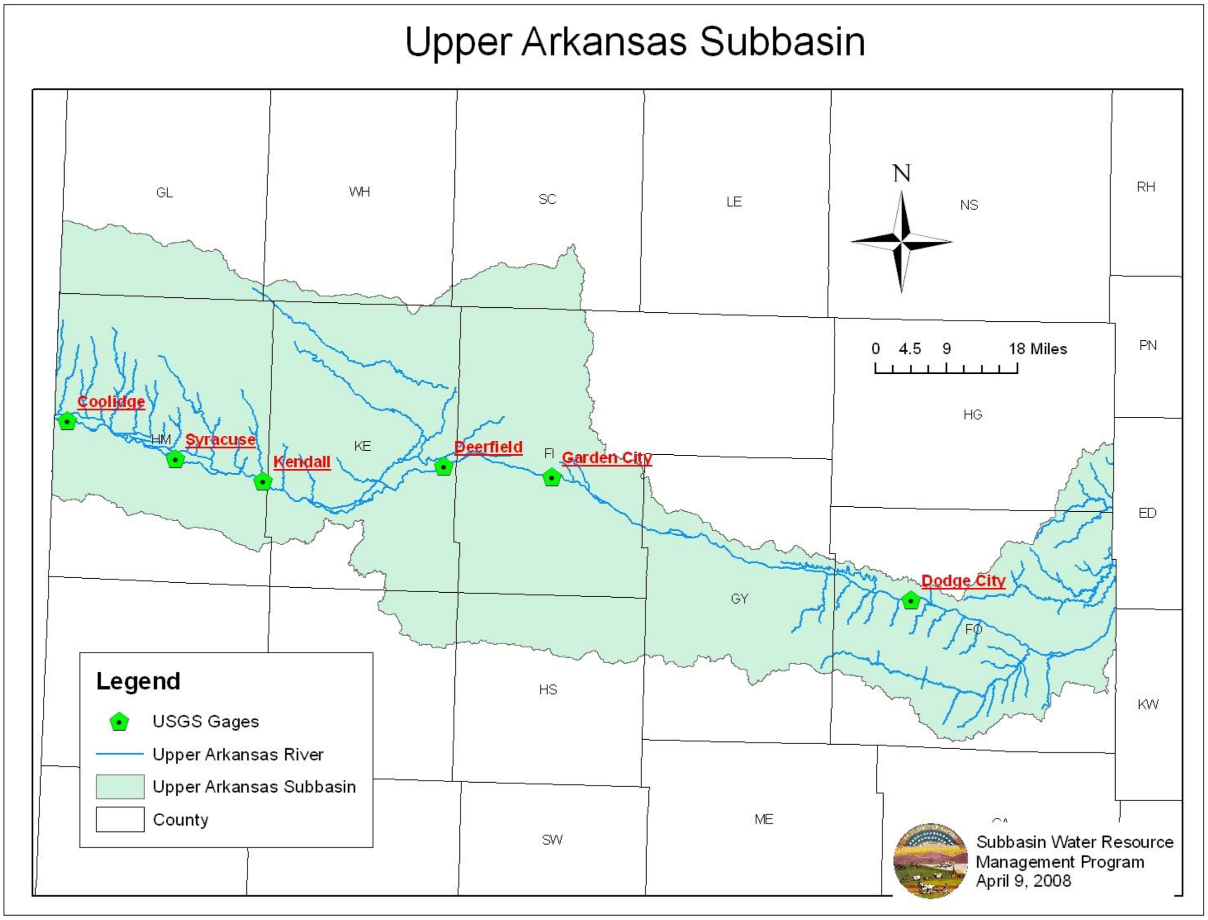

Figure 4: USGS Stream gage sites along the Upper Arkansas River valley

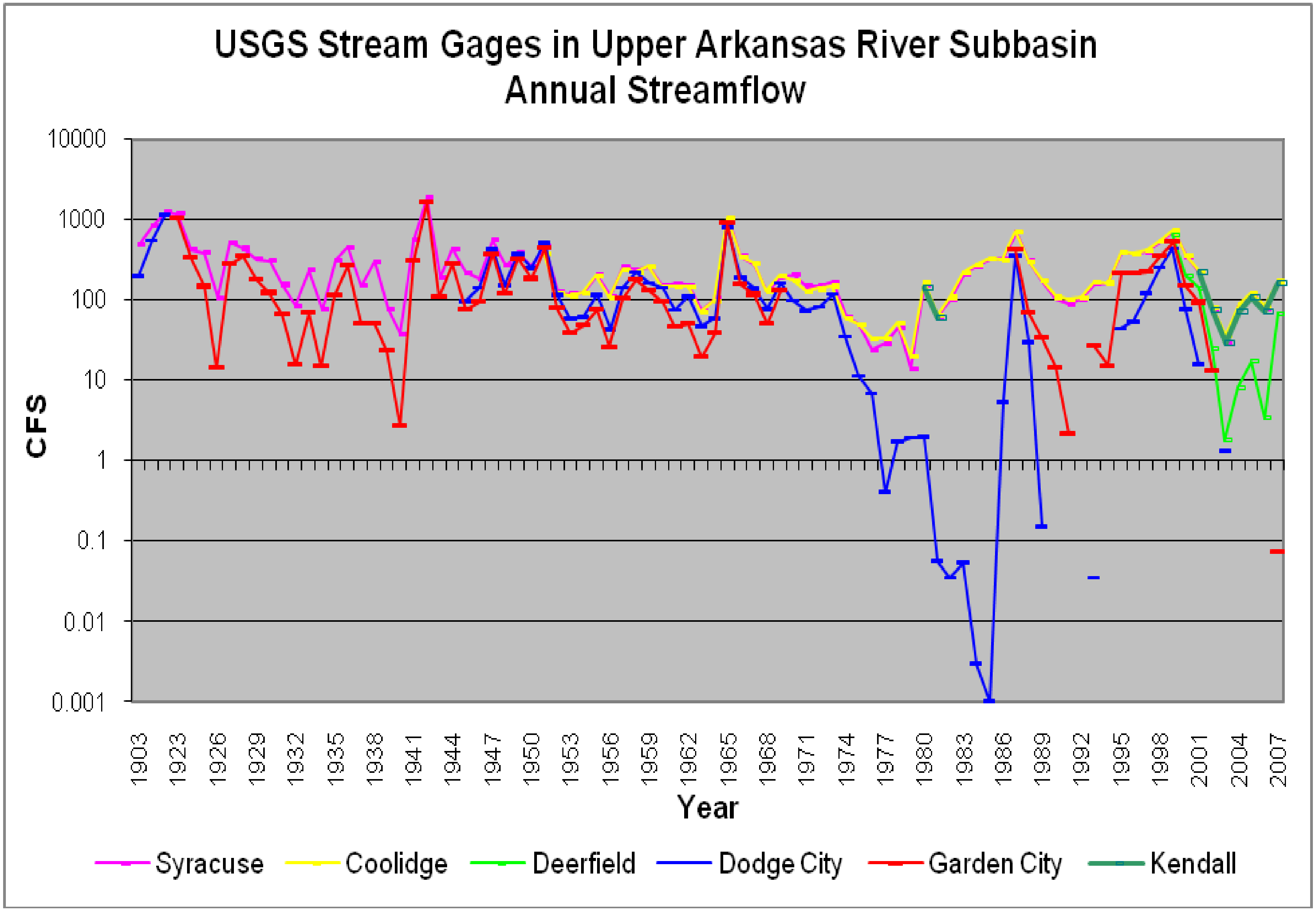

Figure 5: Streamflow at the Upper Arkansas USGS Gage stations 1903-2007

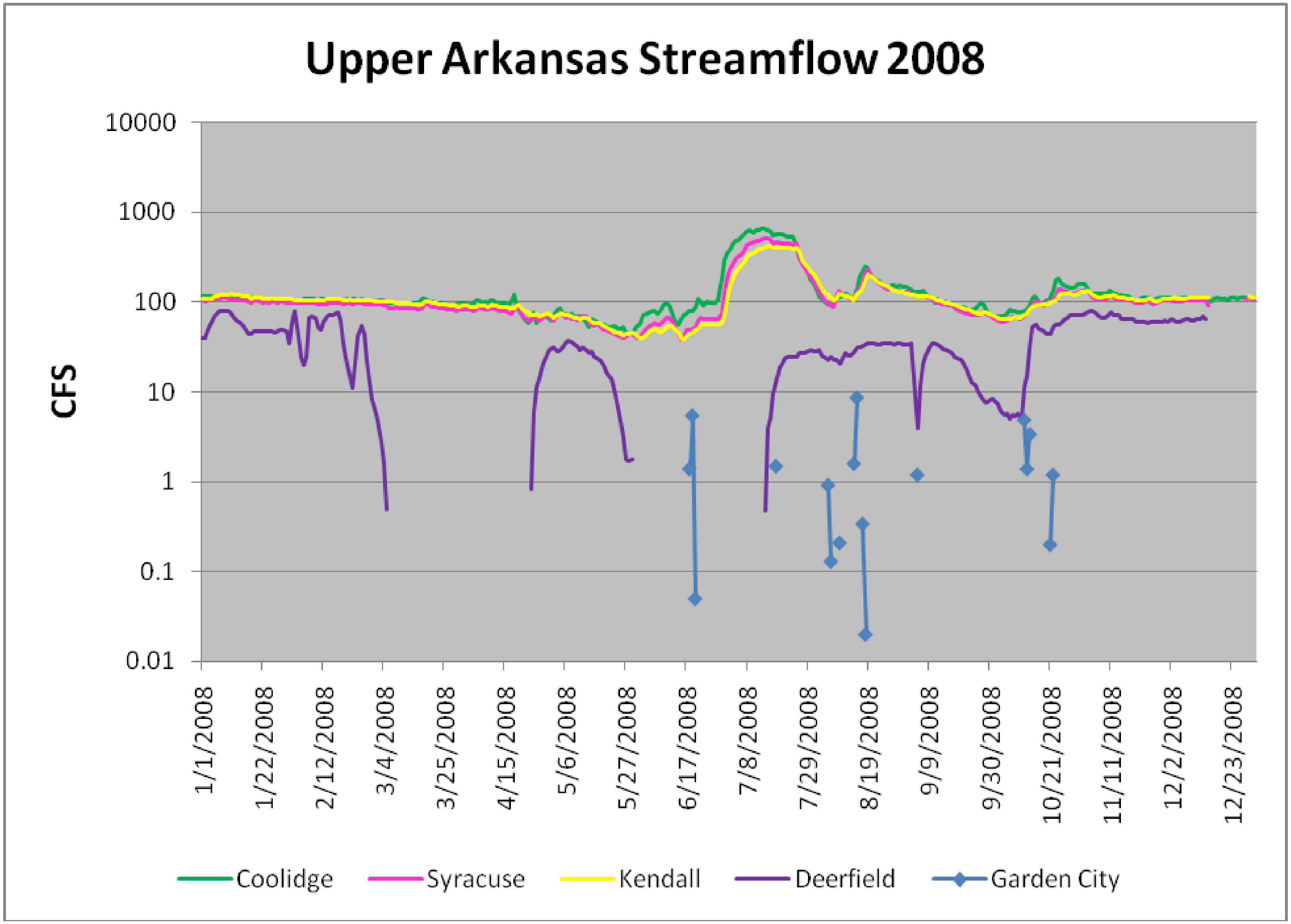

Figure 6: Streamflow along the Upper Arkansas, 2008

IV. Groundwater

The Kansas Geological Survey (KGS) and the KDA-DWR cooperatively measure groundwater levels in the Upper Arkansas Subbasin. There are a total of 100 groundwater wells in the alluvial, the Ogallala-High Plains and Dakota aquifers used for this analysis (Figure 7). The Subbasin Water Resource Management Program measures wells in the winter, spring and fall.

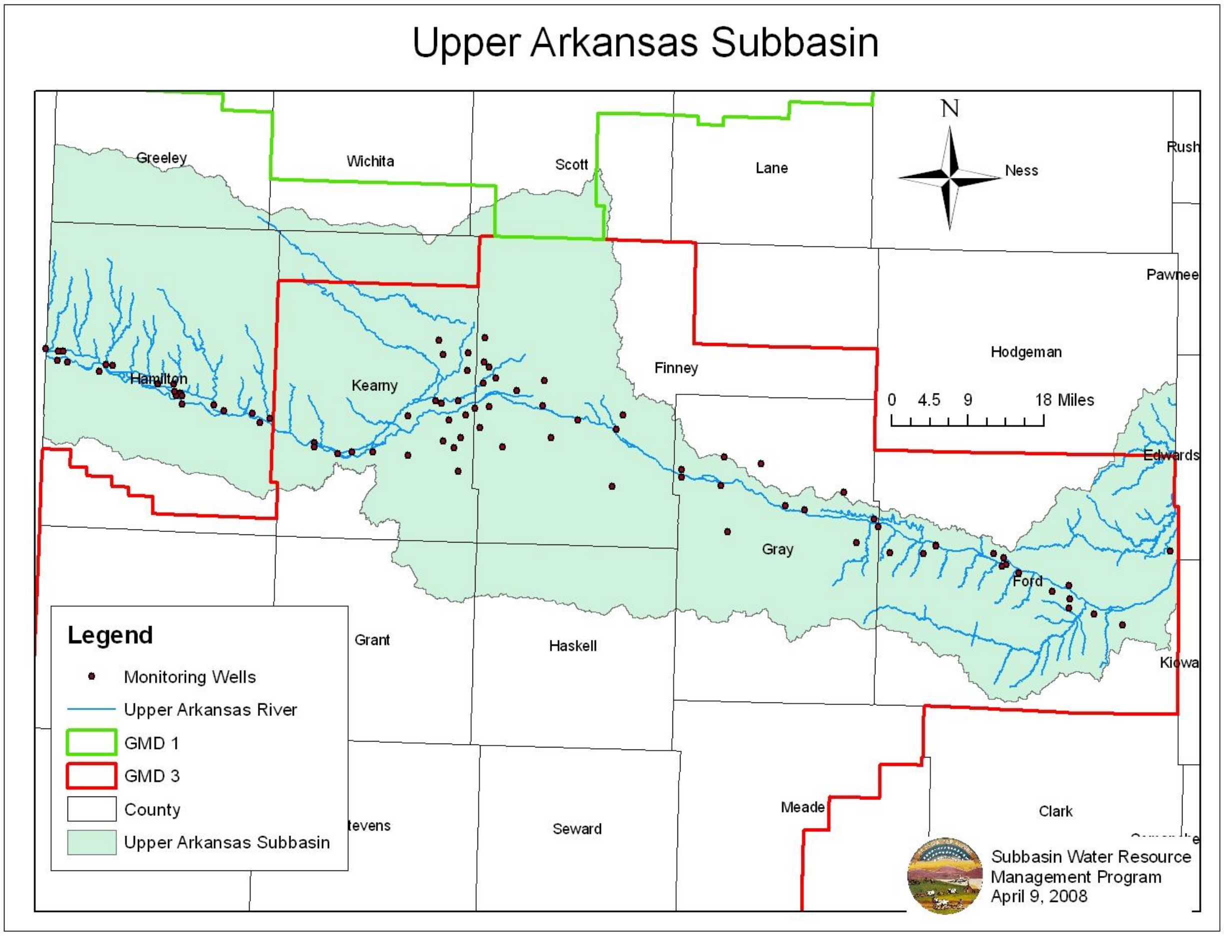

Figure 7: Upper Arkansas River Subbasin Monitoring Wells

Ongoing observation of water levels is critical to understanding fluctuations that may occur over time. Historical records from observation wells can provide a hydrologic outlook on the long-term stability or decline in an area. Pumping from the Ogallala-High Plains aquifer creates a strongly downward hydraulic gradient in the aquifer, but the leaky aquitard[4] above limits affects on the alluvial aquifer.

[4] An *aquitard* is a layer of low permeability material that restricts the flow of groundwater from one aquifer to another.

Wells located within the Ogallala-High Plains aquifer typically are drilled deeper than alluvial wells and in some areas of the subbasin are hydraulically connected to the alluvial aquifer system. In other areas, especially Gray County, the Ogallala-High Plains and the alluvial aquifer systems are no longer hydraulically connected.

Figure 8 through Figure 16 display current and historic water level trends of the 100 monitoring wells used for this analysis. Only winter (December, January and February) measurements were used in the water level hydrographs since those groundwater levels are considered to be least affected by pumping for irrigation. Legal descriptions of the monitoring wells can be found in the appendix. Wells were divided by aquifer system to better demonstrate the responses in the groundwater levels in response to surface water flows. The y-axis is labeled as depth below land surface (DBLS) and measured in feet.

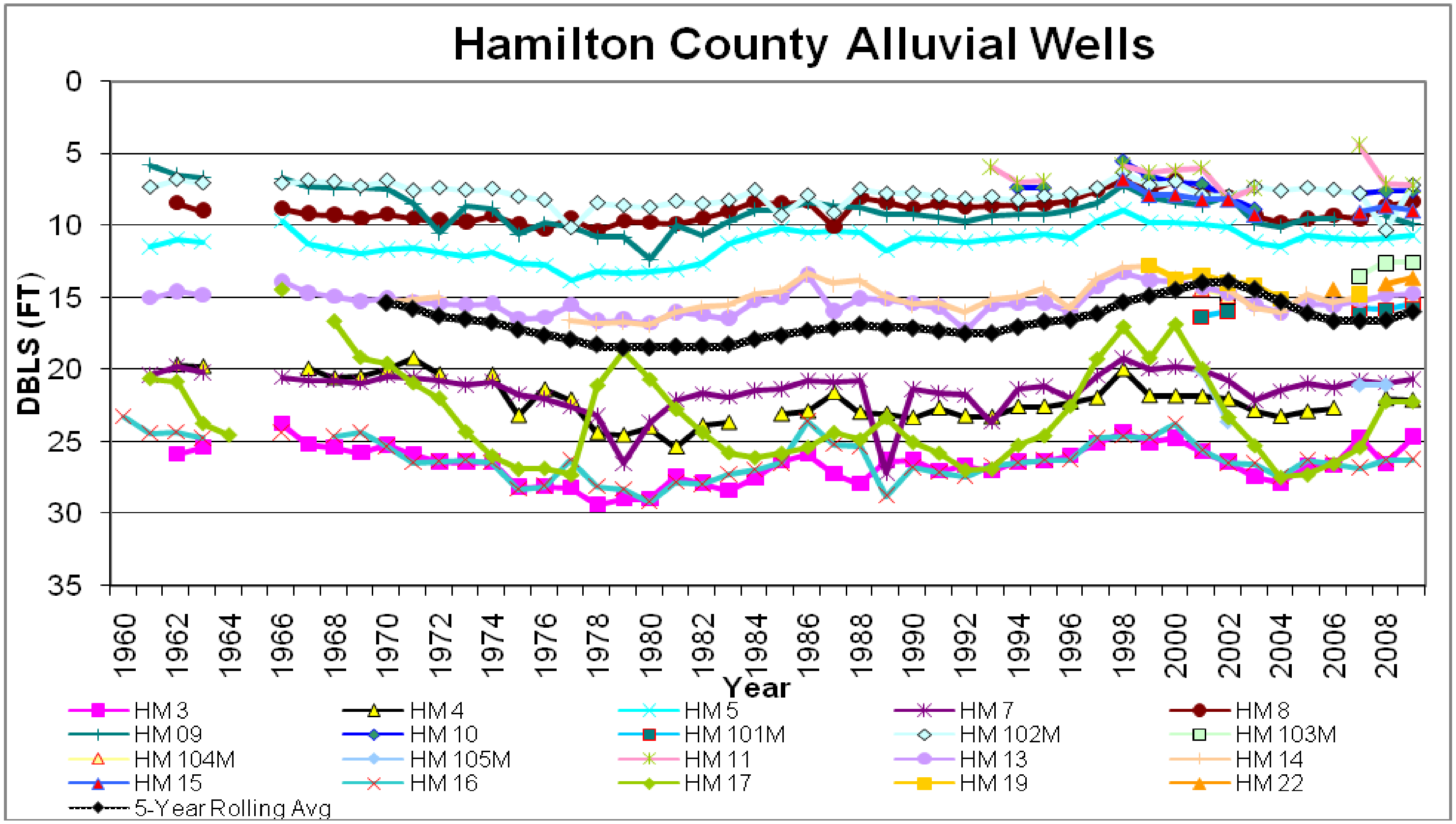

Figure 8: Hamilton County Observation wells 1960-2009

Observation wells in Hamilton County are only in the alluvial aquifer as the Ogallala-High Plains aquifer is absent west of the Bear Creek dissolution zone. There are 20 observation wells monitored in Hamilton County. Water levels in Hamilton County appear to remain very stable with fluctuations in the order of approximately 5 ft (Figure 8). On average the water levels were stable from 2008 to 2009, with a slight average increase of 0.35 ft. In individual wells, changes in water levels varied: decreasing as much as 0.49 ft (HM09) and increasing as much as 3.15 ft (HM102M). There are a number of wells with long-term water level records. Since 1962, HM04 has experienced a net decline of 2.48 ft. Since 1961, HM07 and HM09 have had net declines of 0.3 ft and 4.04 ft, respectively, while HM05 has increased by a net 0.77 ft. The five-year rolling average shows that the water levels have remained fairly stable.

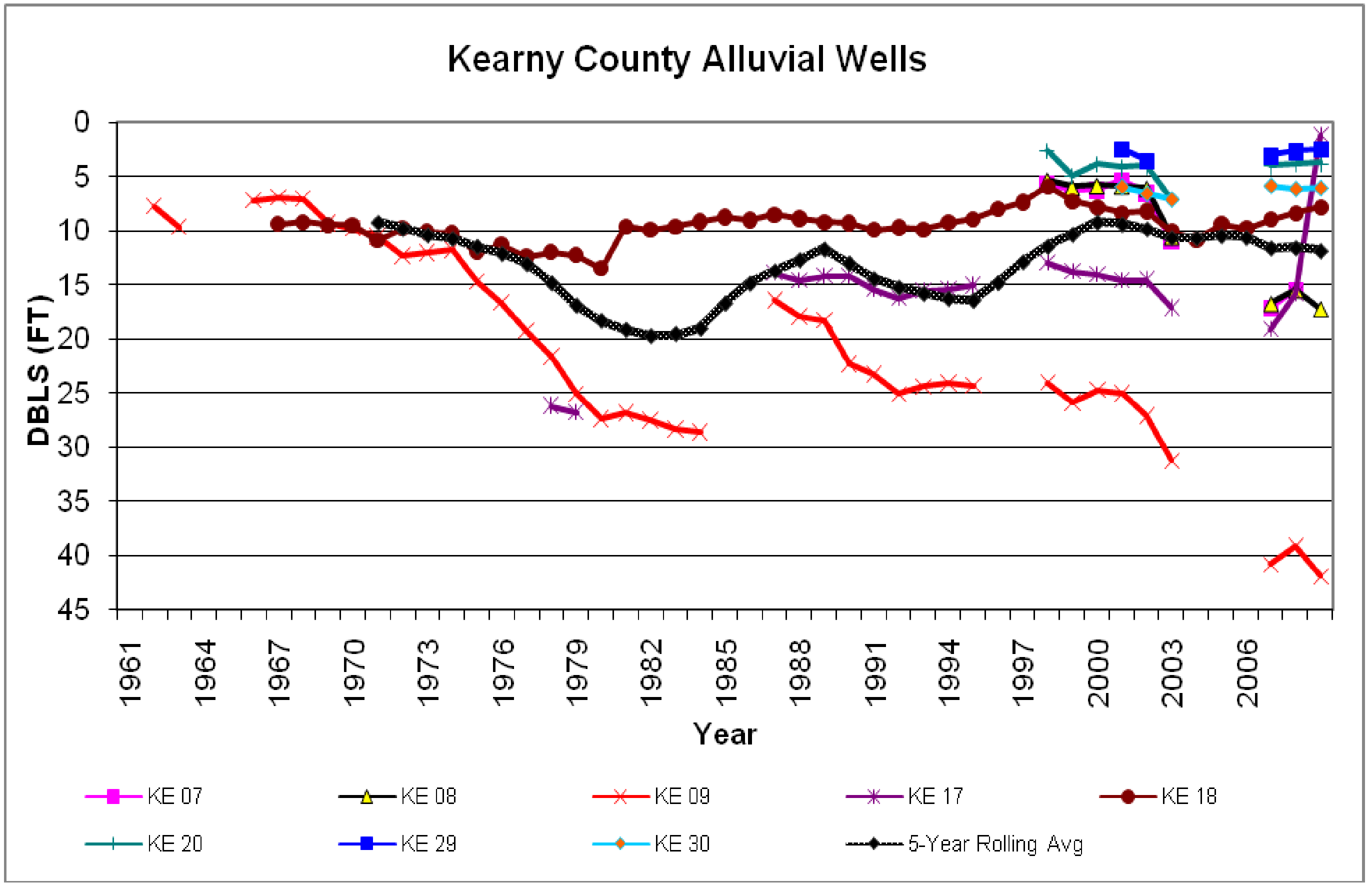

Figure 9: Alluvial groundwater levels in Kearny County 1961-2009

Observation wells in Kearny County are located in both the alluvial and Ogallala-High Plains aquifer. Figure 9 shows the eight alluvial observation wells in Kearny County. KE09, KE17 and KE18 have the longest record. KE09 water level measurements indicate that since 1962 the water table has experienced a net decrease of more than 30 ft in this well. Water level changes during 2008 to 2009 ranged from an increase of 14.64 ft (KE17) to a decrease of 2.74 ft (KE09). The sharp increase in water level for KE17 is likely attributed to the infiltration into the aquifer from use of the South Side Ditch for water transport downstream. The well is within ¼ mile from the ditch. The five-year rolling average shows fluctuations over time, but currently water levels over the past decade are up and remaining relatively stable in the alluvial valley.

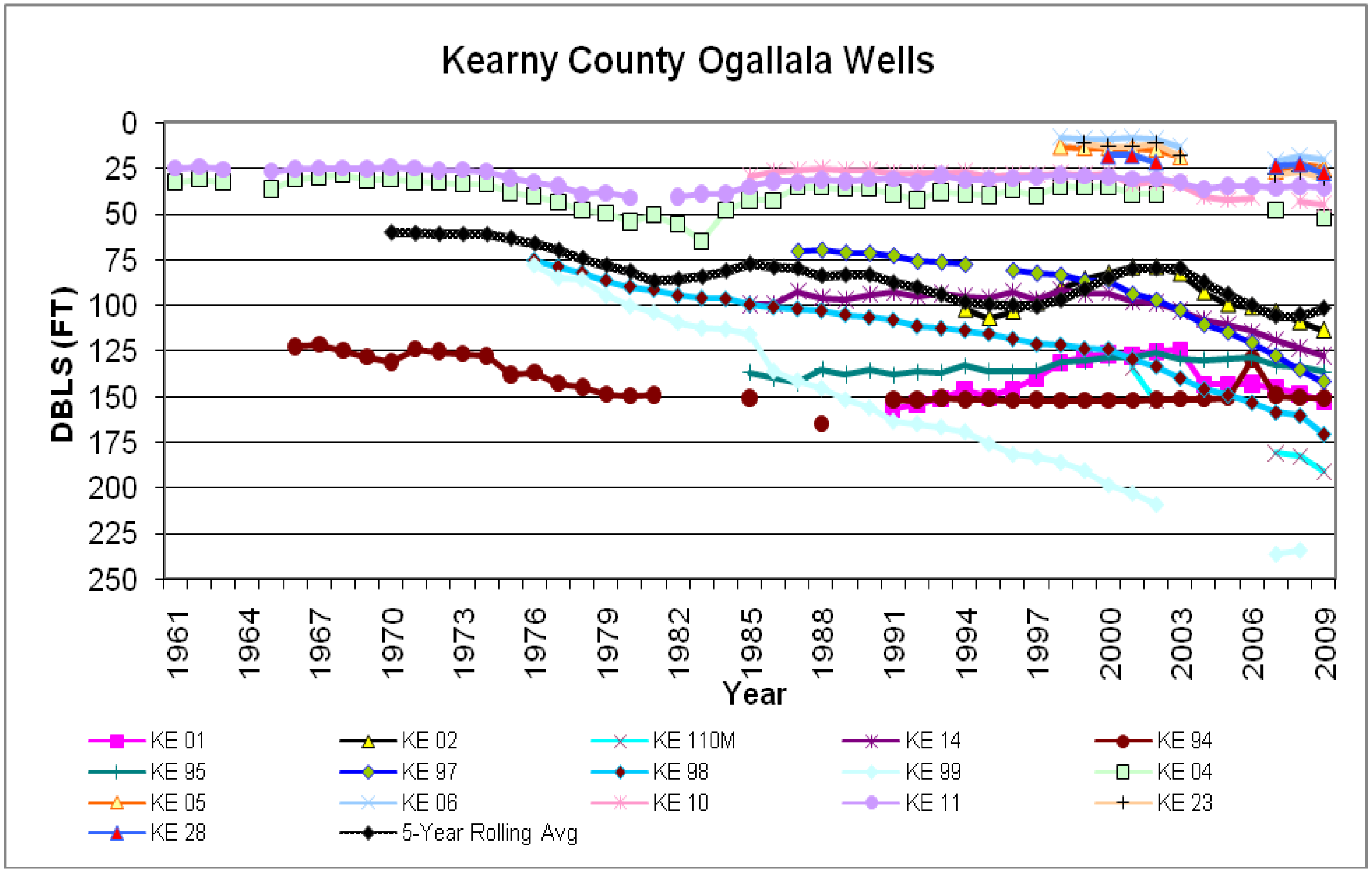

Figure 10: Ogallala-High Plains groundwater levels in Kearny County

Figure 10 shows the 16 Ogallala-High Plains wells monitored in Kearny County. The water levels over the last year in the Ogallala-High Plains exhibited an average decline of 4.08 ft. All water level changes from 2008-2009 showed a decrease. The water level decreases ranged as much as 10.11 ft (KE98) to 0.47 ft (KE94). There are a number of wells with long-term historical records. KE99, since 1976 has declined a net 156.5 ft, whereas KE11 since 1961 has seen a net decline of 10.52 ft. The five-year rolling average shows the water levels generally declining over time with some increases in the 1980s and late1990s into the early 2000s.

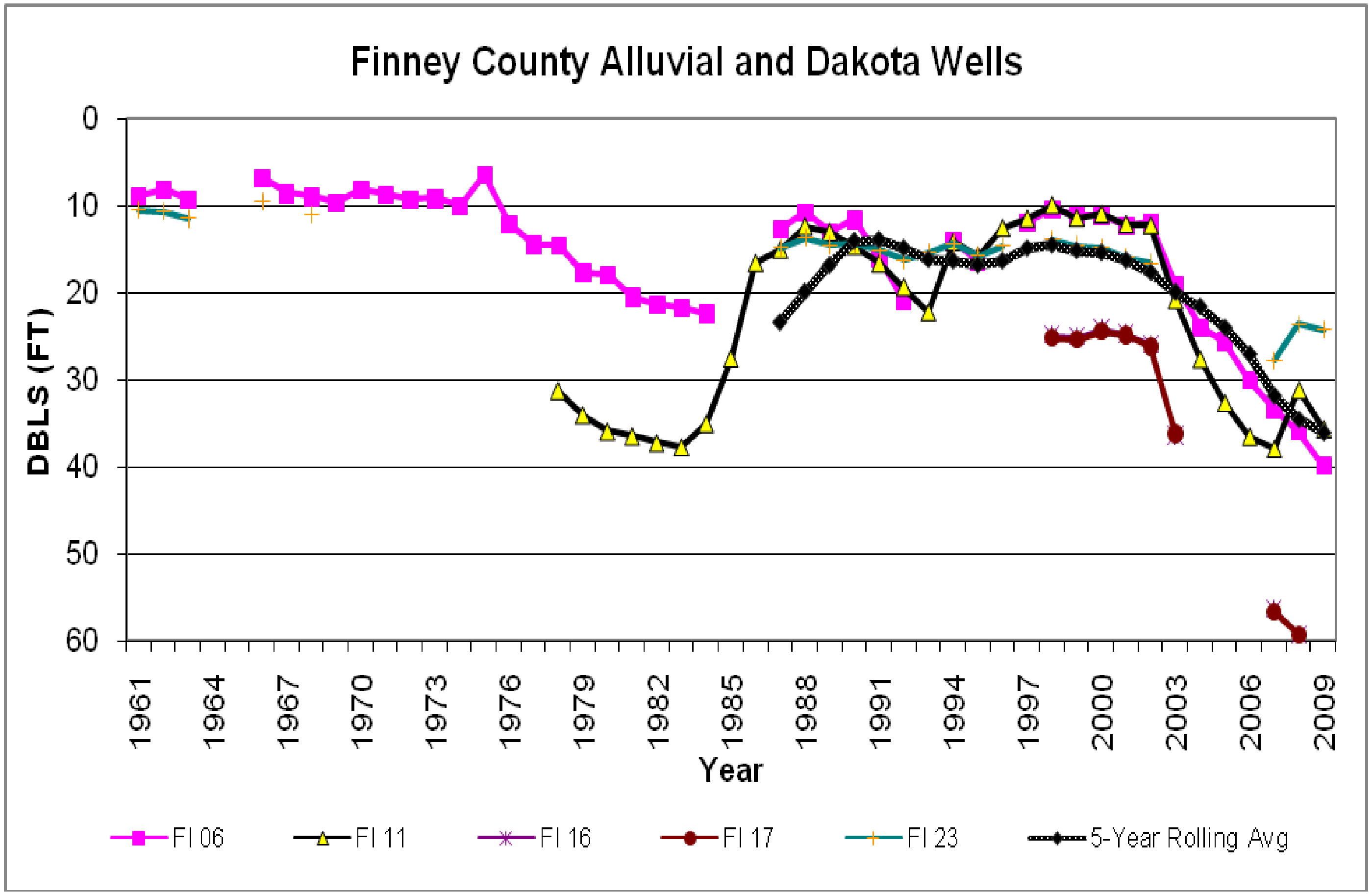

Figure 11: Alluvial groundwater wells in Finney County

Observation wells in Finney County are located in the alluvial and Ogallala-High Plains aquifers and one well in the Dakota Aquifer (FI12). Figure 11 represents the five alluvial observation wells monitored in Finney County. The alluvial water levels in Finney County experienced an average decrease of 3 ft from 2008 to 2009 and ranged from decreases of 4.51 ft (FI11) to 0.59 ft (FI23). The five-year rolling average for the alluvial wells shows an overall declining trend since the late 1990s. Measurements were not available in 2009 for F16 and well F17 was dry.

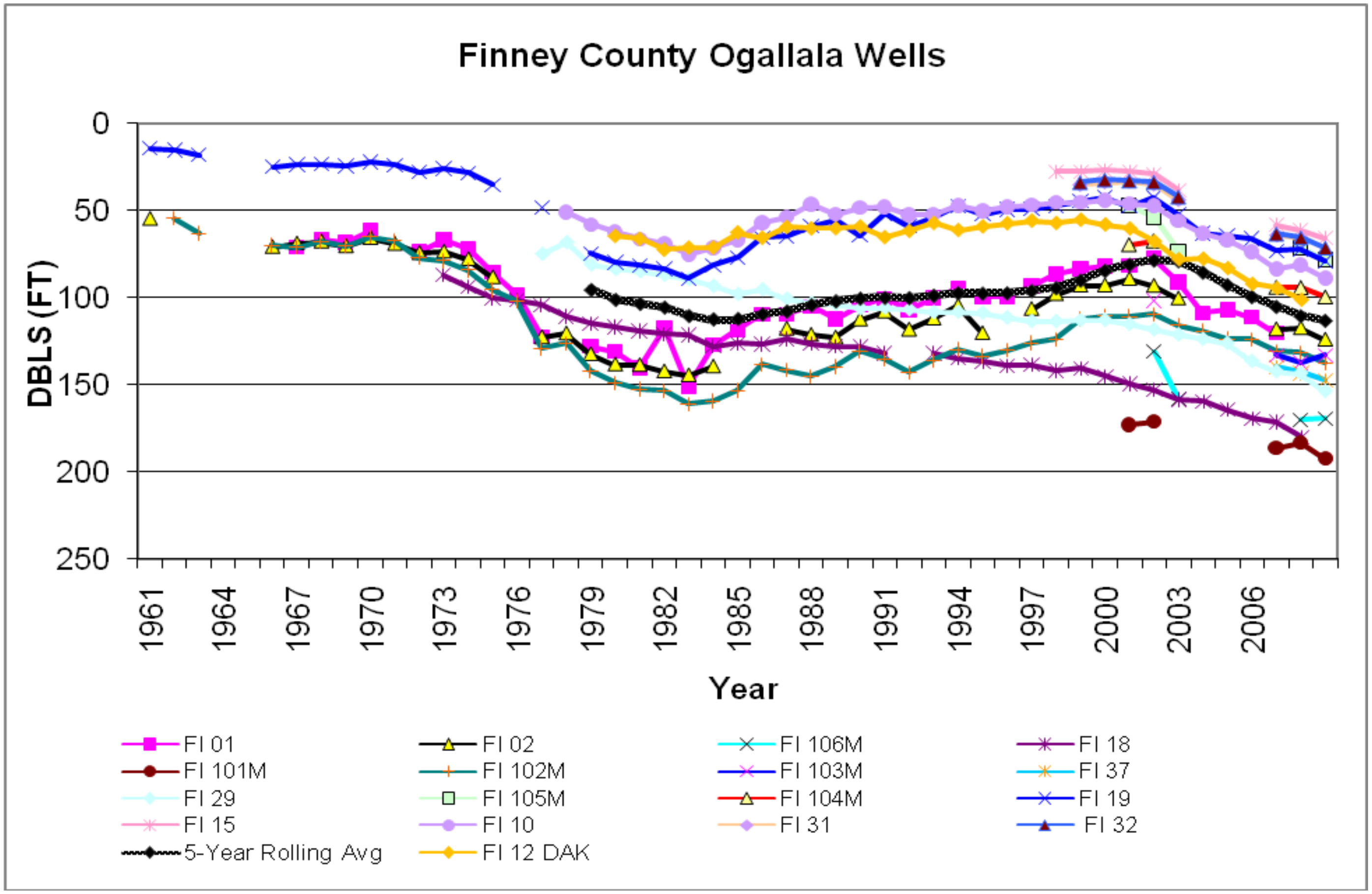

Figure 12: Ogallala-High Plains groundwater wells in Finney County

Observation wells for the Ogallala-High Plains are represented in Figure 12. There are 16 Ogallala-High Plains aquifer monitoring wells which have shown an average decline of about 5.5 ft from 2008 to 2009. The 2008 to 2009 changes in water levels varied from a decline of 10.2 ft (FI 29) to an increase of 4.32 ft (FI103M). A number of these wells have long-term water level records. Despite some increases in the early to mid 80's, FI19, FI02 and FI102M have exhibited net declines of 64.35 ft, 69.25 ft and 82.57 ft, respectively over the period of record. Also in Figure 11, the one Dakota well (FI12) monitored in Finney County showed a decline of 6.65 ft from 2008 to 2009 and a net decline of nearly 30 ft since 1981. The five-year rolling average shows an increase in water levels occurring in the late 1990s to early 2000s and the water levels are now on a declining trend.

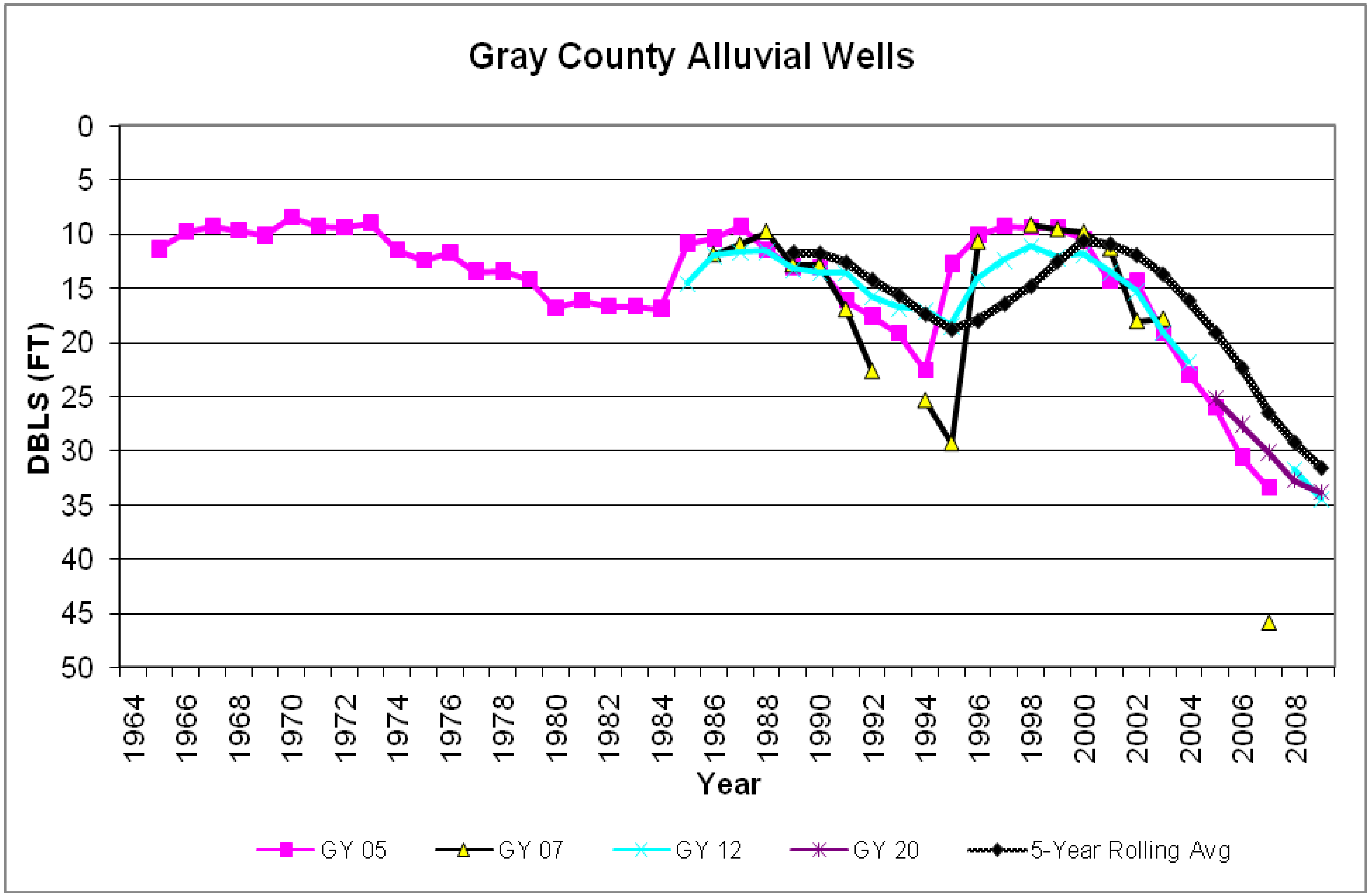

Figure 13: Alluvial groundwater levels in Gray County

Observation wells located in Gray County are monitored in both the alluvial and Ogallala-High Plains aquifers. There are four alluvial wells monitored in Gray County (Figure 13). The water levels exhibited an average decline of 2 ft from 2008 to 2009. GY05 has the longest water level record in this group, and it shows that from 1965-2007 the water table has had periods of rises and falls but has declined 24 ft since 1999. In 2009 GY05 was dry and GY07 was obstructed. The five-year rolling average shows a sharp decline of nearly 20 ft since 2000.

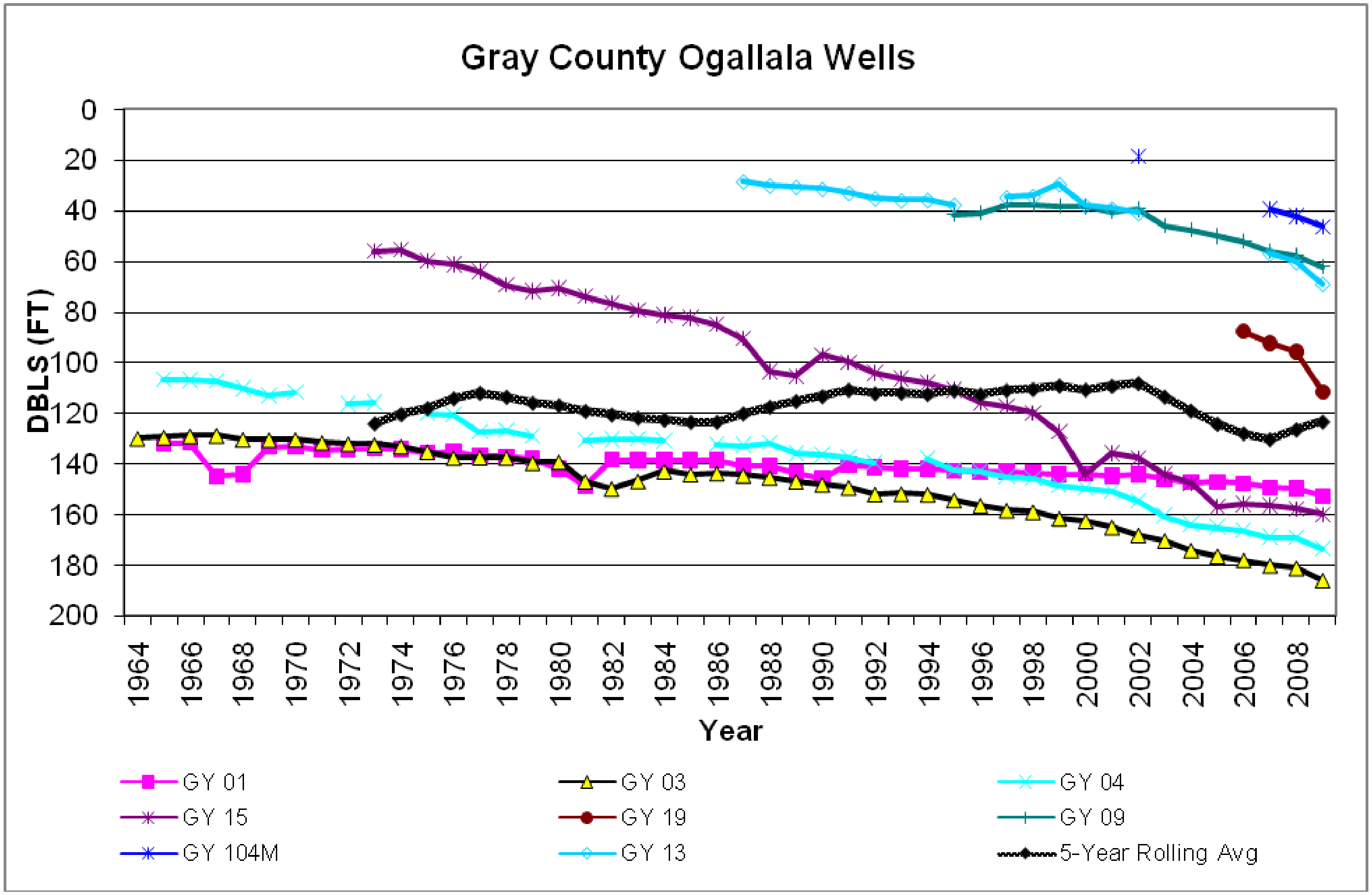

Figure 14: Ogallala-High Plains groundwater levels in Gray County

There are eight observation wells monitored in the Ogallala-High Plains aquifer in Gray County (Figure 14). All observation wells showed a decline in water levels from 2008 to 2009. The 2008 to 2009 declines ranged from 2.1 ft to 15.75 ft with an average decline of 5.85 ft. There are a number of wells with long-term records. Since 1964, GY03 has experienced a net decline of 56.26 ft and since 1965 GY01 and GY04 have exhibited net declines of 20.69 ft and 66.64 ft, respectively. The five-year rolling average shows water levels fluctuating, but remaining relatively stable over the period of record.

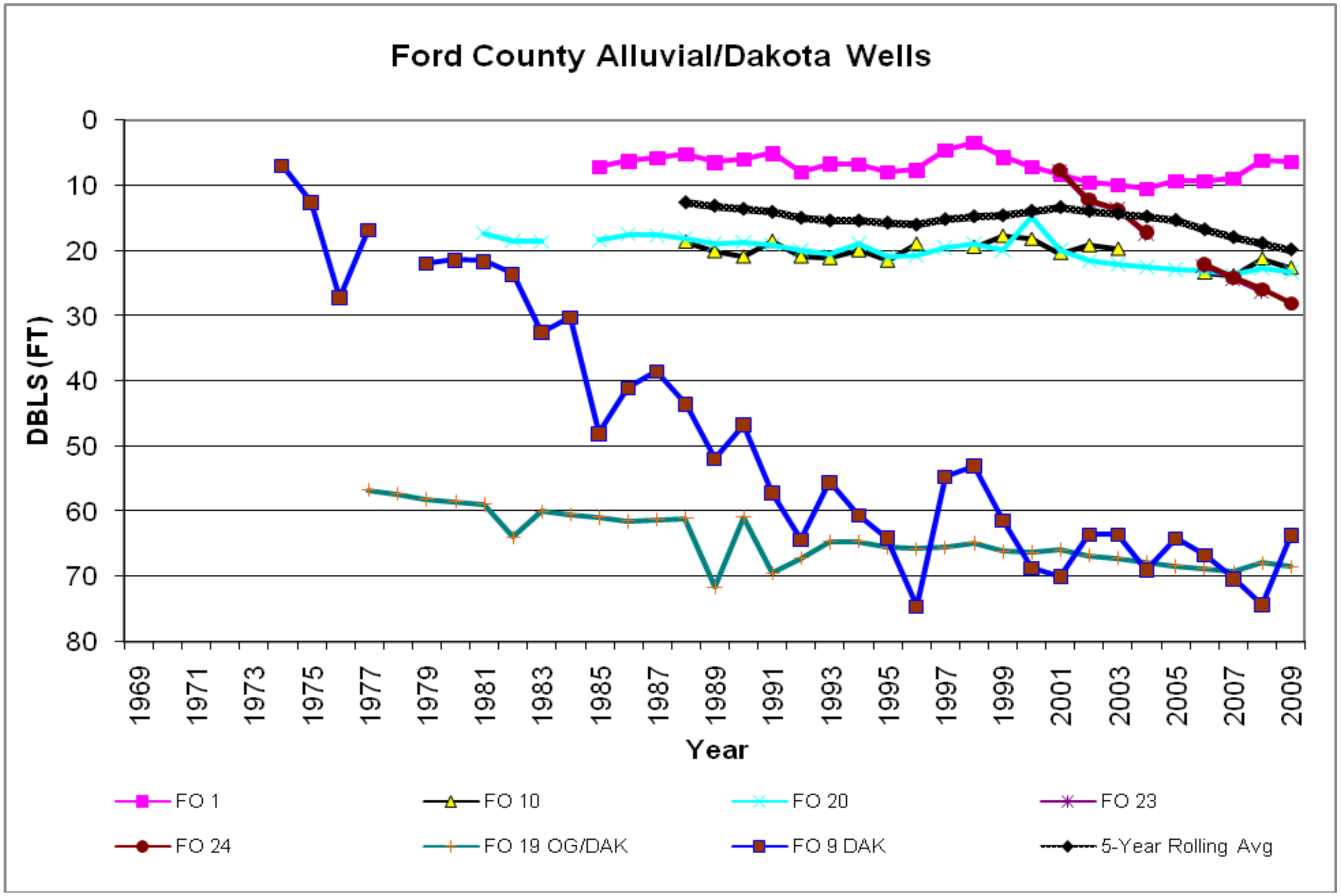

Figure 15: Alluvial, Ogallala-Dakota and Dakota groundwater levels in Ford County

Observation wells in Ford County are drilled in the alluvial, Ogallala-High Plains and Dakota aquifers. There are five alluvial aquifer observation wells that have shown an average decrease of 1.27 ft from 2008 to 2009 (Figure 15). The 2008 to 2009 change in water levels ranged from a 0.18 ft decrease in FO01 to a 2.09 ft decrease in FO23 and FO24. The five-year rolling average for the alluvial wells shows water levels remaining stable but had a slight decline in the last five years. One well (FO19) is drilled in both the Ogallala-High Plains and Dakota aquifers, according to records and has declined 11.82 ft since 1977. FO09, drilled in the Dakota aquifer showed an increase of 10.65 ft this last year and a net decline of 56.75 ft since 1974.

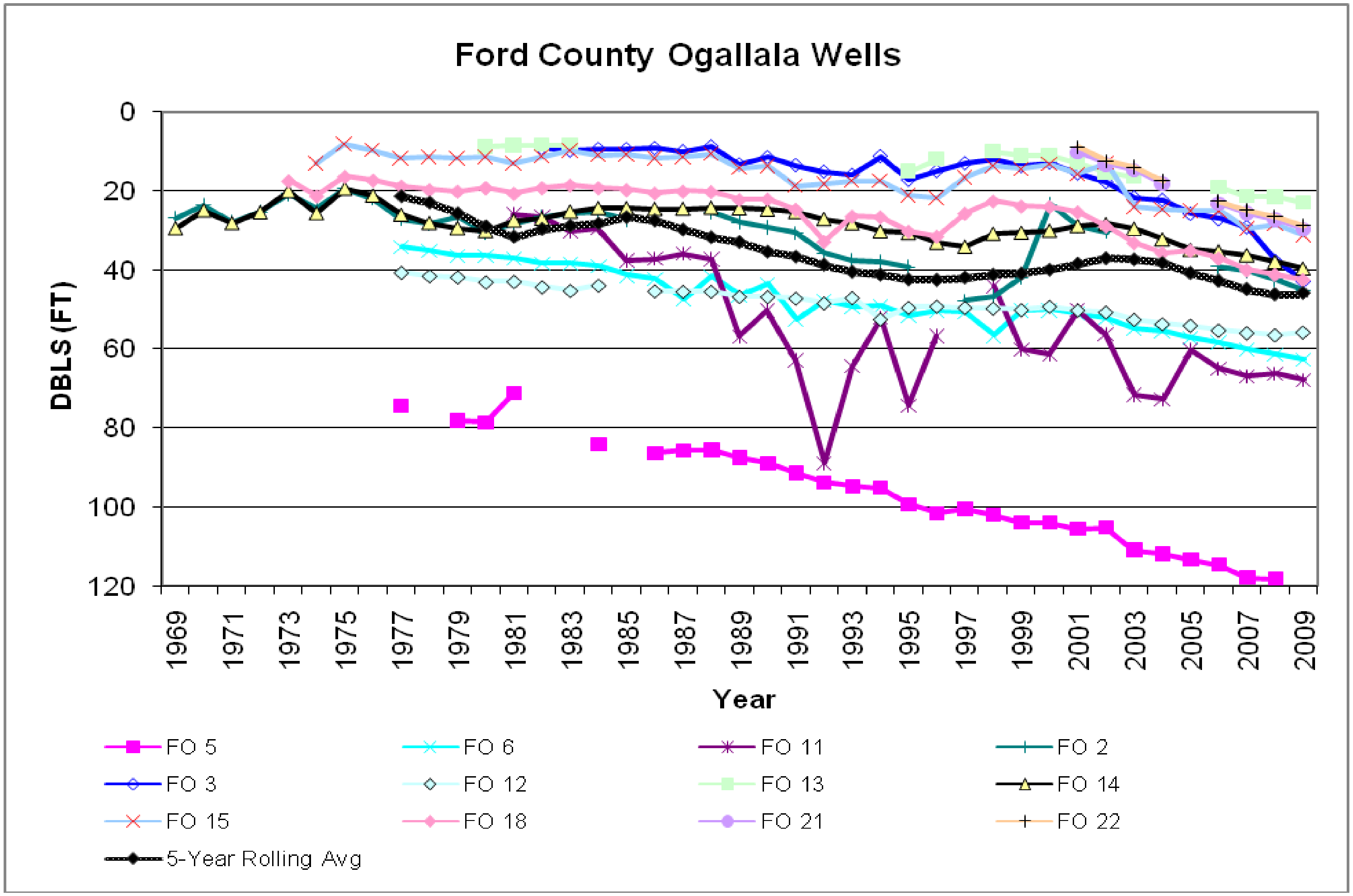

Figure 16: Ogallala-High Plains groundwater levels in Ford County

There are 15 observation wells monitored in Ford County for the Ogallala-High Plains aquifer (Figure 16). The water levels exhibited an average decline in Ford County of 1.97 ft from 2008 to 2009, ranging from an increase of 0.69 ft (FO12) to a decline of 5.19 ft (FO03). FO02 and FO14 have been monitored since 1964 and have shown net declines of 18.18 ft and 10.23 ft, respectively. In 2009 well FO05 was dry. The five-year rolling average shows a net decline of nearly 25 ft in water levels for the Ogallala-High Plains in Ford County over the period of record.

V. Water Use

The Upper Arkansas River subbasin has a total of 4,262 water rights with an authorized quantity of 1,565,497.40 acre-feet. The subbasin has very few vested water rights compared to appropriated water rights. Water appropriated from groundwater sources is greater than 1.3 million acre-feet per year (Table 2). The points of diversion for these water rights are shown in Figure 17. More than one point of diversion may be associated with each water right.

Table 2: Water Rights and Authorized Quantities in the Upper Arkansas Subbasin

Source	Type	No. of Rights	Authorized Quantity
Surface	Vested	20	150,249.00
Ground	Vested	344	104,430.40
Surface	Appropriated	39	8,773.00
Ground	Appropriated	3,859	1,302,045.00

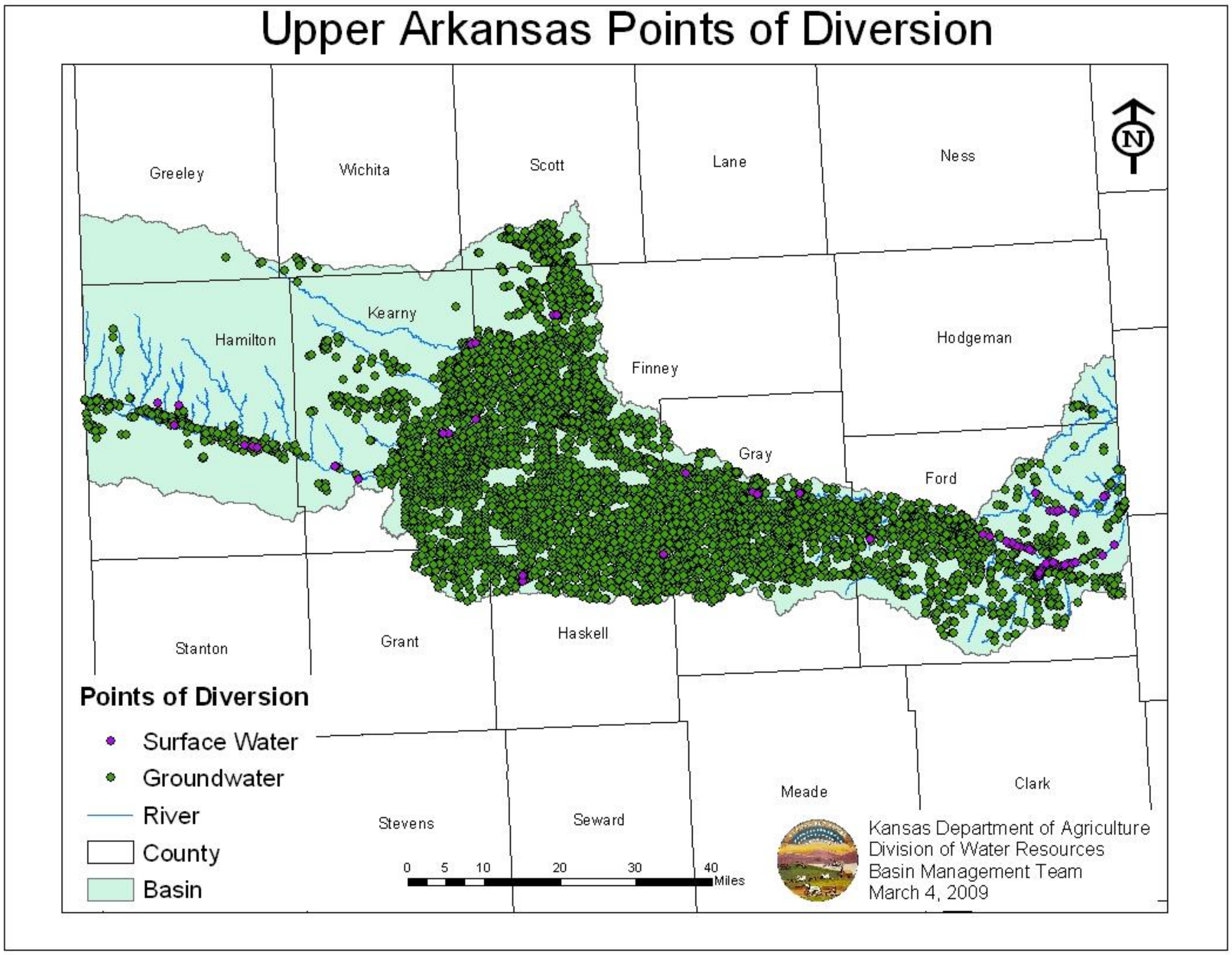

Figure 17: Upper Arkansas Subbasin Points of Diversion

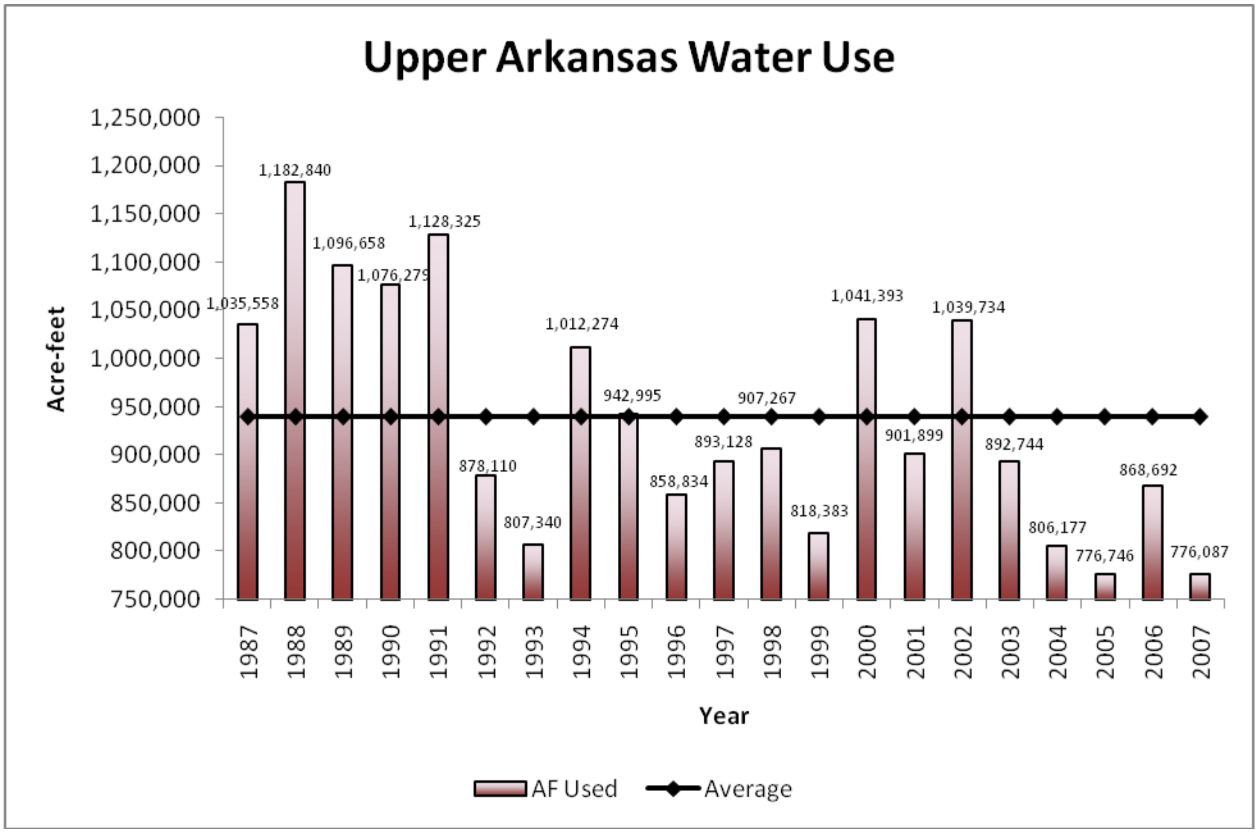

Figure 18: Upper Arkansas Subbasin Water Use 1987-2007

The water use in the Upper Arkansas subbasin ranges from 776, 087 acre feet in 2007 to 1.2 million acre-feet in 1988. The average water use over this twenty-year span was 940,070 acre-feet (Figure 18). Water use in 2007 (the most recent year for which complete records are available) was the lowest of the twenty year period. Of this total, groundwater use in 2007 was 741,347 acre-feet, or 53% of authorized quantities. In addition, surface water use in 2007 was 34,740 acre-feet, or 22% of authorized quantities. This analysis used all irrigation, industrial, recreation, municipal, domestic and stock water rights.

VI. Conclusions

The year 2008 appears to have been a slightly above average year for precipitation with 19.73 in. After two years of above average or near average precipitation, streamflows were improved for 2008. Water levels in the alluvial aquifer have remained relatively stable in Hamilton County, increased in Kearny County, but declined in Finney, Ford and Gray counties. Water levels in the Ogallala-High Plains aquifer continued to decline as well as the Dakota well in Finney County and FO19 in Ford County. However, the Ford County Dakota well FO09 experienced a 10.65 ft increase from 2008 to 2009. The five-year rolling averages for the subbasin show a net decline. Reported water use in 2007 was below average and was the lowest reported usage for the twenty year period. 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 equally important to understand how fast the system recovers after recharge events as it is to understand the impacts of pumping and other factors on the hydrologic system.

VII. Appendix

Well Id	Legal	Latitude	Longitude
FI01	23S 33W 28 SWSESW	38.01825	-100.95140
FI02	23S 34W 28 SWSENE 01	38.02057	-101.05790
FI06	24S 32W 25 SWNWNW 02	37.93769	-100.79160
FI10	24S 33W 09 SWSWSE 01	37.97449	-100.95380
FI101M	23S 34W 06 NENESE	38.08995	-101.08450
FI102M	23S 34W 17 SWSWSW	38.04692	-101.08390
FI103M	23S 34W 20 NENWSW	38.03926	-101.07410
FI104M	23S 34W 32 NWSWSW	38.01099	-101.08430
FI105M	24S 34W 17 NE	37.97049	-101.07080
FI106M	24S 34W 30 SE	37.93415	-101.08900
FI107M	24S 32W 13 SESENW	37.96288	-100.77720
FI11	24S 33W 09 SWSWSE 02	37.97449	-100.95380
FI12	24S 33W 09 SWSWSE 03	37.97449	-100.95380
FI15	24S 32W 19 3	37.95171	-100.87660
FI16	24S 32W 19 4	37.95173	-100.87660
FI17	24S 32W 19 5	37.95172	-100.87650
FI18	24S 33W 34 SWNESW	37.92037	-100.93320
FI19	24S 34W 01 NWSWNW	37.99982	-101.01100
FI23	24S 34W 18 NWSWSW	37.96676	-101.10240
FI29	25S 34W 10 NENWNW	37.90164	-101.03790
FI31	24S 32W 19 1	37.95168	-100.87650
FI32	24S 32W 19 2	37.95166	-100.87660
FI37	25S 32W 35 NESWNE	37.84003	-100.79690
FO01	26S 21W 25 SWSWSW	37.74897	-99.57739
FO02	26S 24W 32 SESENE	37.73892	-99.96124
FO03	26S 26W 18 SWSWNW	37.78231	-100.21430
FO05	26S 26W 32 SESWSW	37.73704	-100.18770
FO06	26S 26W 36 SESWSW	37.73745	-100.11450
FO09	27S 23W 24 NWSWNW	37.6869	-99.79632
FO10	27S 23W 25 SWSWSW	37.66413	-99.79525
FO11	27S 23W 28 NENENE	37.67646	-99.83376
FO12	27S 23W 36 SWSWSW	37.64699	-99.79607
FO13	27S 24W 12 SWSWSW	37.70692	-99.90565
FO14	27S 24W 03 NWNWSE	37.73284	-99.93990
FO15	27S 24W 03 SWSESE	37.72116	-99.93452
FO18	27S 24W 09 NENESE	37.71824	-99.94289
FO19	28S 22W 12 SWNESW	37.6206	-99.67934
FO20	28S 22W 05 NESESE	37.63871	-99.74091
FO21	26S 25W 32 1	37.7512	-100.08740
FO22	26S 25W 32 2	37.75116	-100.08740
FO23	26S 25W 32 3	37.75111	-100.08740
FO24	26S 25W 32 4	37.75107	-100.08740
GY01	25S 27W 33 NENWNW	37.83923	-100.29120

GY03	25S 29W 07 NWSWNW	37.89606	-100.55460
GY04	25S 29W 14 NENWNW	37.88533	-100.47350
GY05	25S 30W 20 NWSWNW	37.87188	-100.64620
GY07	25S 30W 25 SESWNE	37.8463	-100.56000
GY09	26S 27W 12 SWSESE	37.79499	-100.22480
GY104M	25S 30W 19 SESESE	37.85872	-100.64660
GY12	26S 28W 06 SESENW	37.81394	-100.41870
GY13	26S 28W 10 NWNWSW	37.80766	-100.37640
GY15	26S 30W 24 SESESE	37.76631	-100.54240
GY19	26S 27W 27 SESWSW	37.7538	-100.26050
GY20	26S 28W 06 SESENW 02	37.81398	-100.41900
HM03	23S 42W 26 SESWNE	38.01848	-101.89600
HM04	23S 42W 27 SESENW	38.01925	-101.91040
HM05	23S 42W 34 SWNWNW	38.00809	-101.92600
HM07	23S 43W 23 NWSWNW	38.03961	-102.01660
HM08	23S 43W 25 SWNWSE	38.02057	-101.99540
HM09	24S 39W 19 SWNWSW	37.94723	-101.64880
HM10	24S 39W 22 SWSENE	37.94547	-101.58750
HM101M	23S 43W 23 NESW	38.03992	-102.00630
HM102M	23S 43W 26 NWSWSW	38.02289	-102.01750
HM103M	24S 40W 07 SE	37.97568	-101.74700
HM104M	24S 40W 18 NWNENW	37.971	-101.75590
HM105M	24S 39W 25 NESWSE	37.93767	-101.54790
HM11	24S 39W 26 SWSESE	37.9294	-101.56970
HM13	24S 40W 07 SWNWNW	37.97775	-101.75990
HM14	24S 40W 17 NWNWNW	37.97129	-101.74230
HM15	24S 40W 20 NWNWNW	37.95697	-101.74220
HM16	24S 40W 23 NENENW	37.95752	-101.67250
HM17	24S 41W 01 SENESE	37.99117	-101.76160
HM19	24S 41W 02 SWNWSE	37.99032	-101.79590
HM22	23S 43W 21 NENWNE 03	38.04335	-102.04390
KE01	23S 35W 12 SWSWSW	38.06175	-101.12070
KE02	23S 35W 25 NWNWNW	38.03148	-101.12060
KE04	24S 35W 09 SWSWSW	37.97382	-101.17480
KE05	24S 35W 11 SWNWSW 02	37.97984	-101.13850
KE06	24S 35W 11 SWNWSW 03	37.97986	-101.13840
KE07	24S 35W 11 SWNWSW 04	37.97988	-101.13840
KE08	24S 35W 11 SWNWSW 05	37.97989	-101.13830
KE09	24S 35W 22 SWSWSW 02	37.94499	-101.15710
KE10	24S 35W 24 NWSWNW	37.95573	-101.12060
KE11	24S 36W 23 SWNWNW 02	37.95005	-101.24800
KE110M	25S 35W 10 NESWNE	37.89774	-101.14440
KE14	25S 36W 14 NW	37.88261	-101.24430
KE17	25S 37W 12 SESESE	37.8862	-101.32230
KE18	25S 37W 15 NENWNE 02	37.8845	-101.36620
KE20	25S 37W 17 NESESW	37.88162	-101.39830

KE23	24S 35W 11 SWNWSW 01	37.97984	-101.13850
KE28	24S 35W 08 NESWSW	37.97832	-101.18880
KE29	25S 38W 11 SENENE	37.89793	-101.45000
KE30	25S 38W 11 SESENE	37.89161	-101.45000
KE94	23S 35W 05 NESWSW	38.083	-101.18460
KE95	23S 35W 16 NWNWSW	38.05813	-101.17550
KE97	25S 35W 04 NWSESE	37.90873	-101.16830
KE98	25S 35W 02 NWNENE	37.9157	-101.13020
KE99	25S 35W 26 NWNENW	37.85778	-101.13400