Mainstem Solomon River Subbasin

2008 - Field Analysis Summary

Subbasin Water Resource Management Program

Division of Water Resources
Kansas Department of Agriculture
109 SW Ninth Street – 2nd Floor
Topeka, KS 66612-1283
785-296-6087

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I. Introduction

The Solomon River Basin is divided into three sections: Upper Forks, Lower Forks and Mainstem. This field summary will cover the Mainstem section. The Mainstem subbasin starts below Waconda (Glen Elder) Reservoir flowing southeast towards Solomon, Kansas where it joins the Smoky Hill River. The Mainstem begins in Mitchell County and continues through Cloud, Ottawa, Saline and Dickinson County. It also includes the Salt Creek subbasin.

The Mainstem has one irrigation district operating out of Waconda (Glen Elder) Reservoir called the Glen Elder Irrigation District. Water allocations from the reservoir storage are specified in contracts between the U.S. Department of Interior, Bureau of Reclamation and the district. In 2007 the district released 13,529 acre-feet.

The largest town in the Solomon Basin lies in the Mainstem subbasin. Beloit has a population over 3,500 people. Its drinking water supply has some water quality issues due to the Dakota Aquifer springs that flow into the Solomon River. Timely releases from Waconda Lake help to dilute the chlorides and sulfates and make the water easier to meet drinking standards.

The Mainstem flows in the easternmost range of the Solomon River Basin and is capped by the Dakota Sandstone. The eastern boundary of the Smoky Hills is in Clay County where the Flint Hills Physiographic region begins. The average gradient for the Mainstem is 5 feet/mile. The elevation in the eastern part is 1,150 feet.

Figure 1 is a map of the entire Solomon basin.

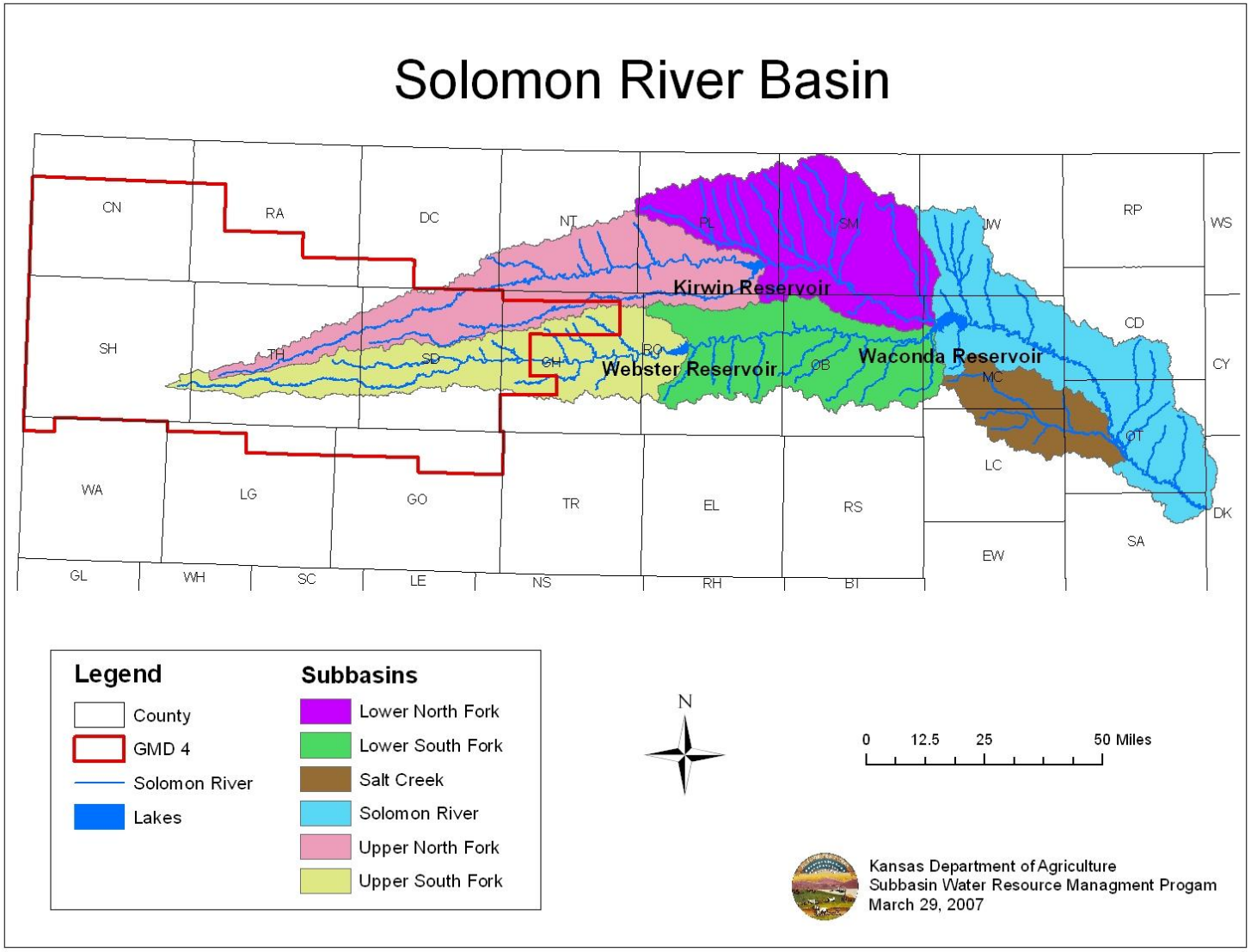

Figure 1: Solomon River Basin divided into subbasins

II. Precipitation

Precipitation in the Mainstem Solomon subbasin averages 26.72 inches (in.) since 1900. Figure 2 shows the annual variation in precipitation. Both precipitation charts are derived from various National Climatic Data Center (NCDC) stations located in the subbasin including Barnard, Beloit, Cawker City, Glen Elder, Ionia and Minneapolis. The data is downloaded then averaged to create the following charts. The highest precipitation totals occurred in 1993 with 48.96 in. and the lowest in 1956 with 12.12 in. Annual precipitation data for these NCDC stations is currently available through 2007.

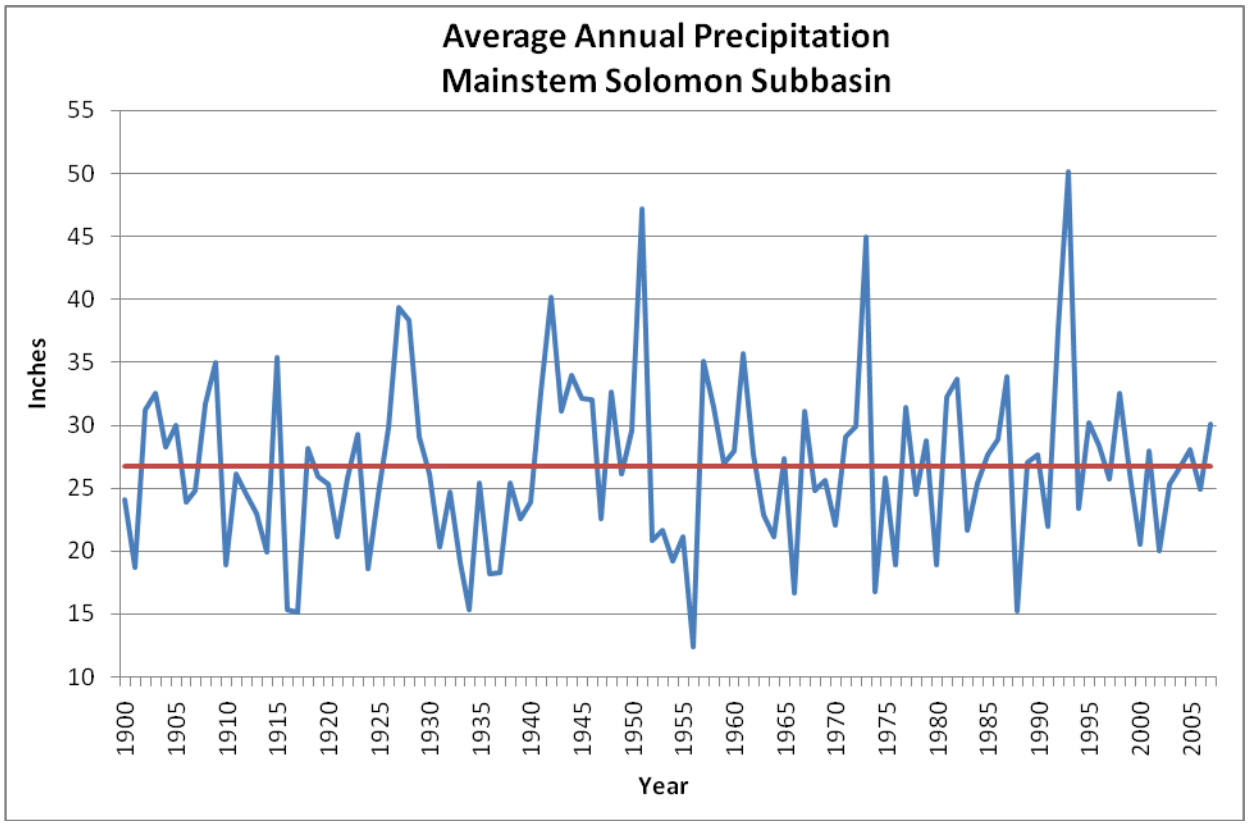

Figure 2: Mainstem Solomon Subbasin precipitation 1900-2007

Figure 3 shows monthly precipitation for January 2008 to December 2008. These measurements averaged a total of 33.36 in. for the subbasin. October had the most precipitation with 5.61 in. and December had the least with 0.45 in.

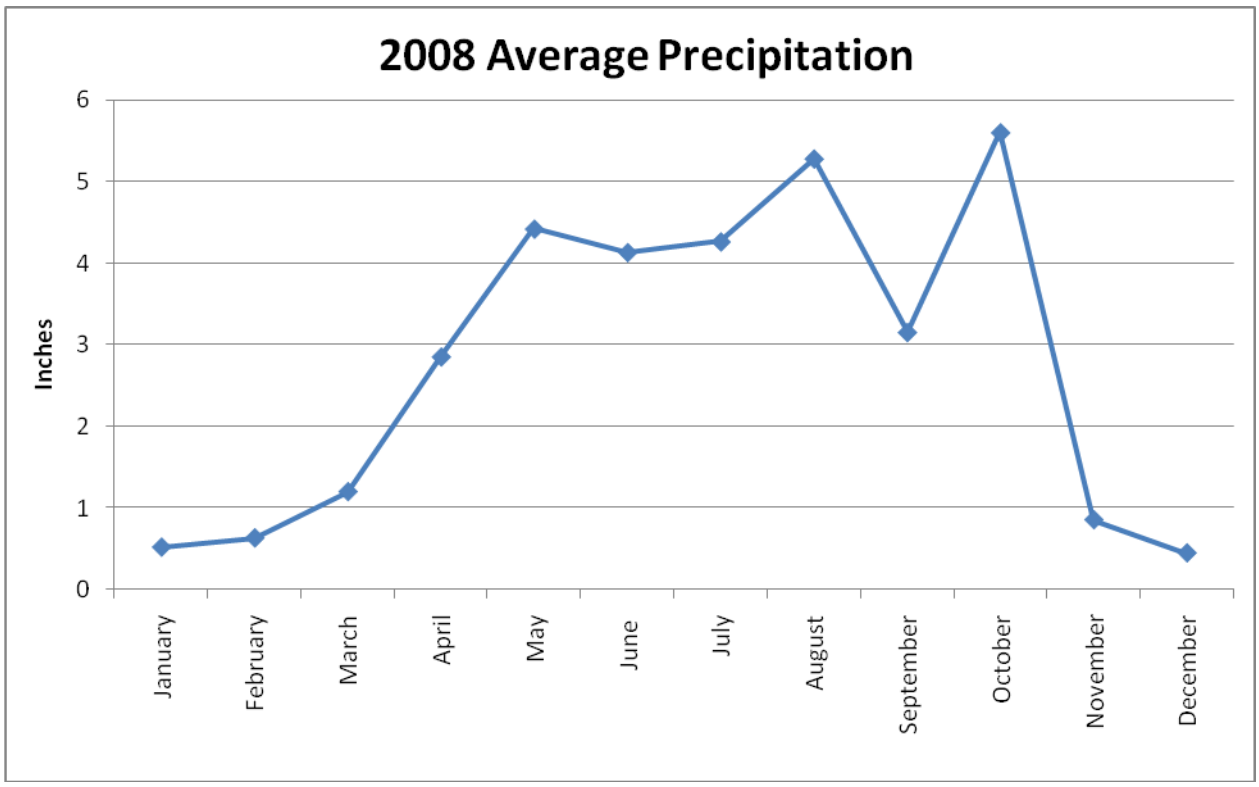

Figure 3: 2008 Monthly Average Precipitation (November and December data not available)

III. Surface Water

The mainstem subbasin has three streamflow gages monitored by the USGS. The first is below Glen Elder Reservoir, another downstream at Niles and the final gage is on the Salt Creek at Ada (Figure 4). The streamflow gage at Niles is the only gage with Minimum Desirable Streamflow (MDS) associated with it.

The Niles gage has an extensive record dating back to the late-1800s. Unfortunately, there is a gap in data from 1903 through 1917. The streamflow gage at Ada on Salt Creek began its record 1960. In 1965, a streamflow gage was installed at Glen Elder.

The average flows over the period of record at these three gages were 537.02 cfs at Niles, 63.58 cfs at Ada, Salt Creek and 214.35 cfs below Glen Elder. During most of the 1990s streamflow maintained higher levels at these gages, averaging 882.76 cfs at Niles, 107.53 cfs at Salt Creek and 467.55 cfs below Glen Elder. Significantly reduced flows occurred in the 2000s, averaging 177.23 cfs at Niles, 23.81 cfs at Salt Creek and 53.64 cfs below Glen Elder (Figure 5). Flows maintained for most of 2008 (Figure 6).
During the past year, streamflow at Niles stayed above MDS for most of the year. It did dip below MDS during the spring. Streamflow at the Glen Elder gage records more consistent flow due to reservoir releases. The Ada, Salt Creek streamflow gage shows more cyclical trends due to various precipitation events throughout the year. .

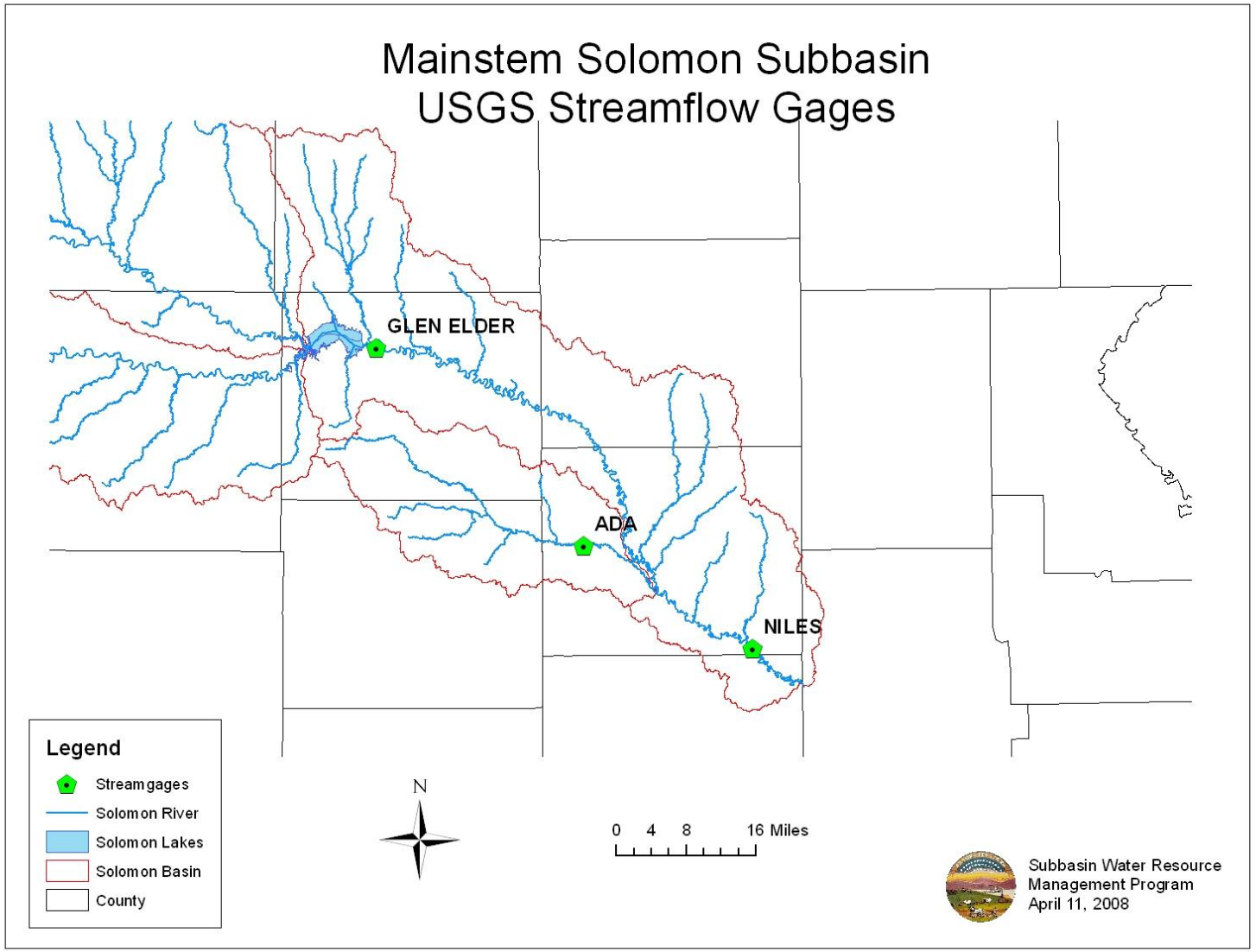

Figure 4: Solomon River USGS Streamflow Gages

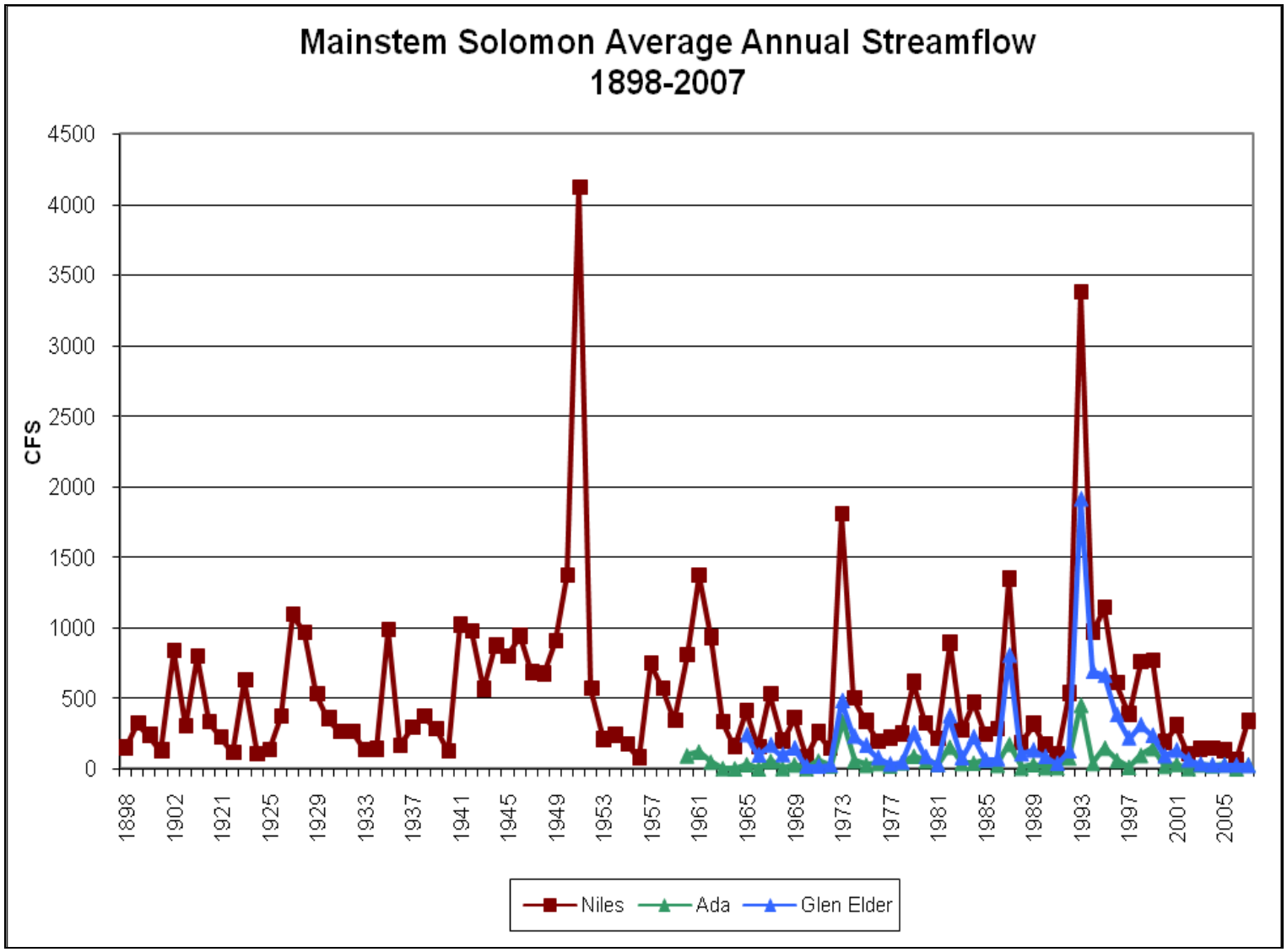

Figure 5: Average Annual Streamflow at USGS Gages 1898-2006

NOTE: There is no data for 1903-1917

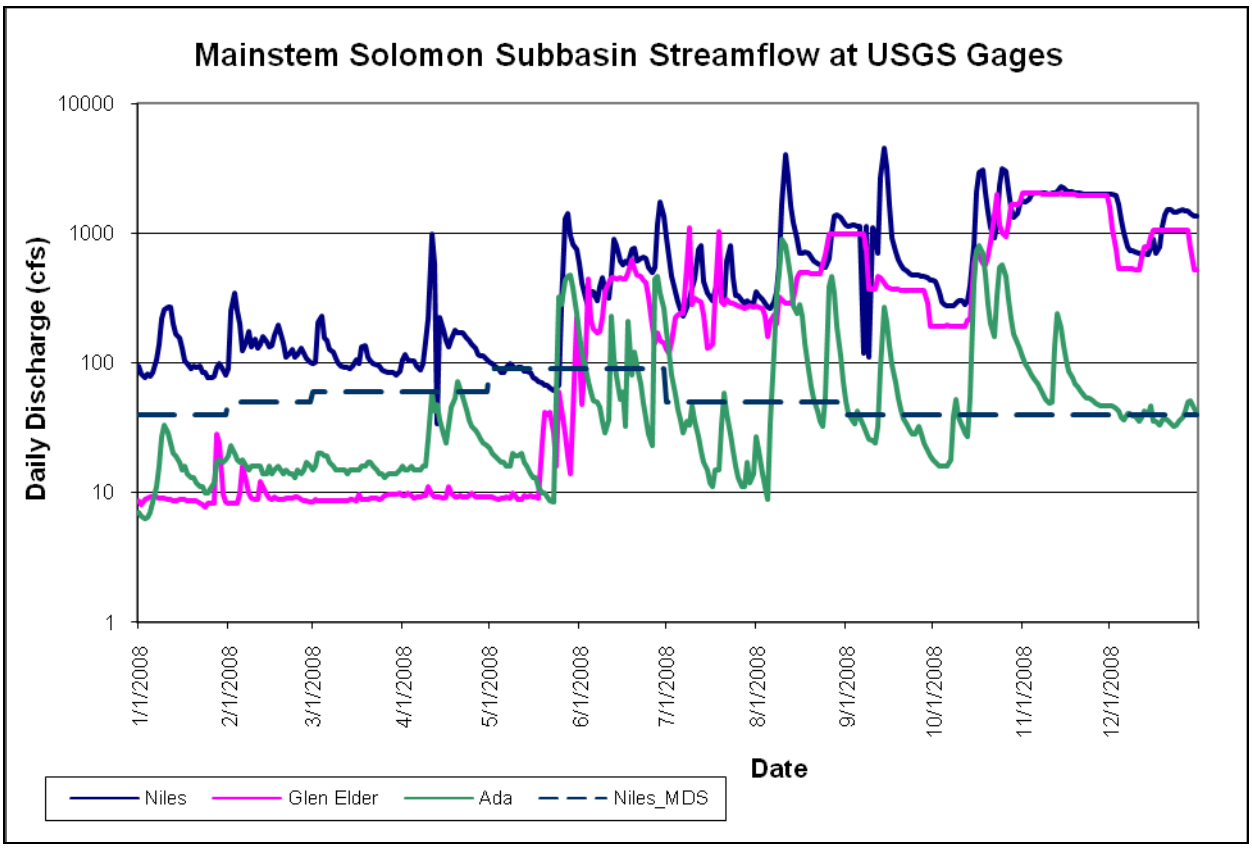

Figure 6: Daily Streamflow and MDS for Niles 2008

In 1984, the Kansas Legislature amended the Kansas Water Appropriation Act to establish Minimum Desirable Streamflow (MDS) for specific USGS streamflow gages. Administration of MDS begins after seven consecutive days of streamflow below the MDS mark and continues until the streamflow meets MDS for 14 consecutive days. Table 1 shows MDS by month for the Niles streamflow gage on the Solomon River.

Table 1: Minimum Desirable Streamflow (MDS)

Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Niles	40	50	60	60	90	90	50	50	40	40	40	40

For the first five years, streamflow was above the MDS criteria at Niles. From 1989 until 1992 criteria was met several times. During the 1990s when the subbasin saw higher levels of precipitation, the streamflow remained above MDS. Unfortunately in 2002, streamflow declined to meet MDS criteria. In 2007 and 2008, streamflow conditions improved due to above average precipitation amounts (Figure 7).

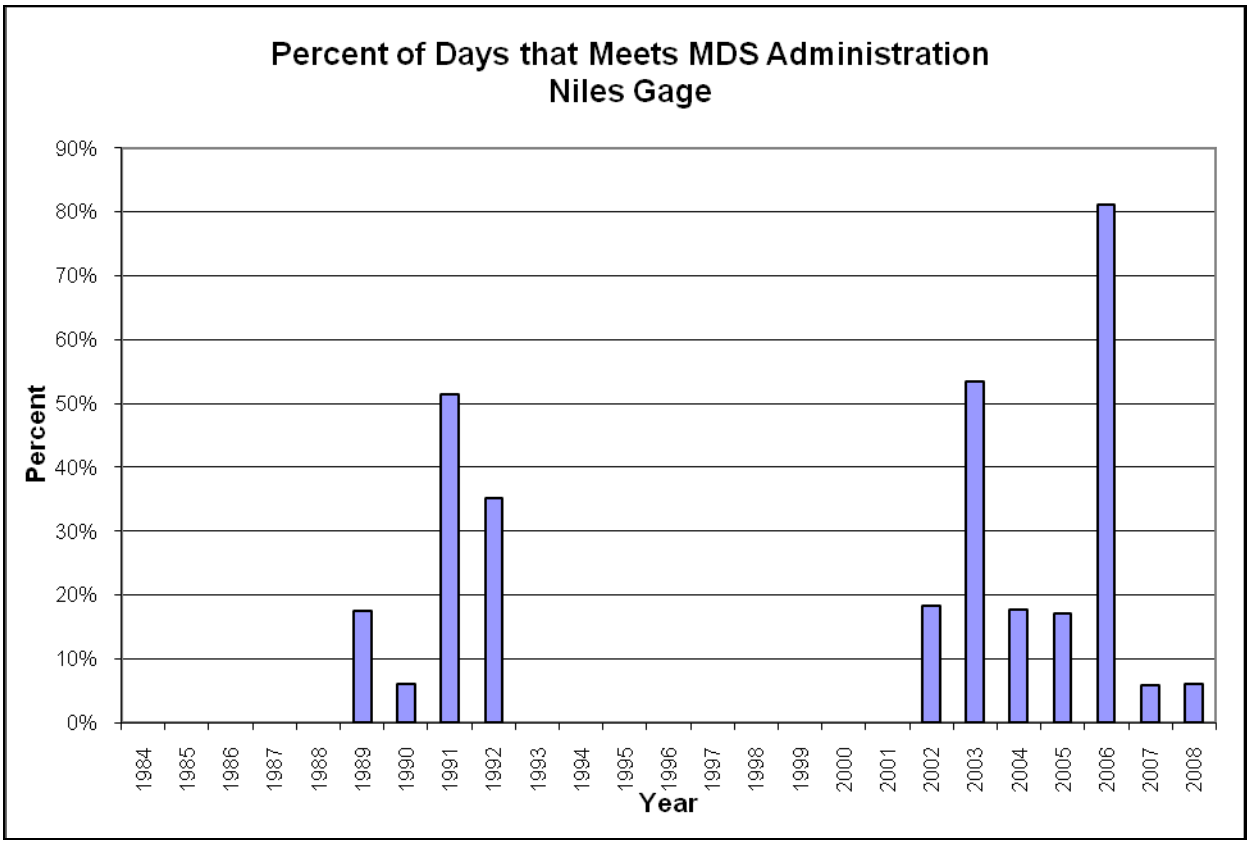

Figure 7: Percent of days MDS was not met at Niles USGS gage

IV. Groundwater

The Kansas Department of Agriculture, Division of Water Resources (KDA-DWR), Subbasin Water Resource Management Program (SWRMP) measures groundwater levels in the mainstem of the Solomon River subbasin. There are 11 monitoring wells used for these measurements all of which were drilled in the alluvial aquifer system (Figure 8). The wells are monitored on a tri-annual basis in winter, spring and fall. Only the winter measurements (December to February) are used for this analysis because those are considered to be the least affected by groundwater pumping. The following figures chart groundwater levels in all the monitoring wells (legal descriptions are available in the appendix) and also the five-year rolling averages of those wells. The y-axis is labeled DBLS (FT) which stands for depth below land surface.

A number of monitoring wells have been measured since the late 1950s to the early 1960's. In 2001 and 2003 a number of wells were added to the monitoring network. The wells display large seasonal fluctuations due to precipitation recharge and seepage from the river due to releases or spills from Waconda (Glen Elder Dam). Ongoing observation of water levels is critical to understanding the fluctuations that may occur over time. Historical records can provide a hydrologic outlook on the long-term sustainability or decline of an area.

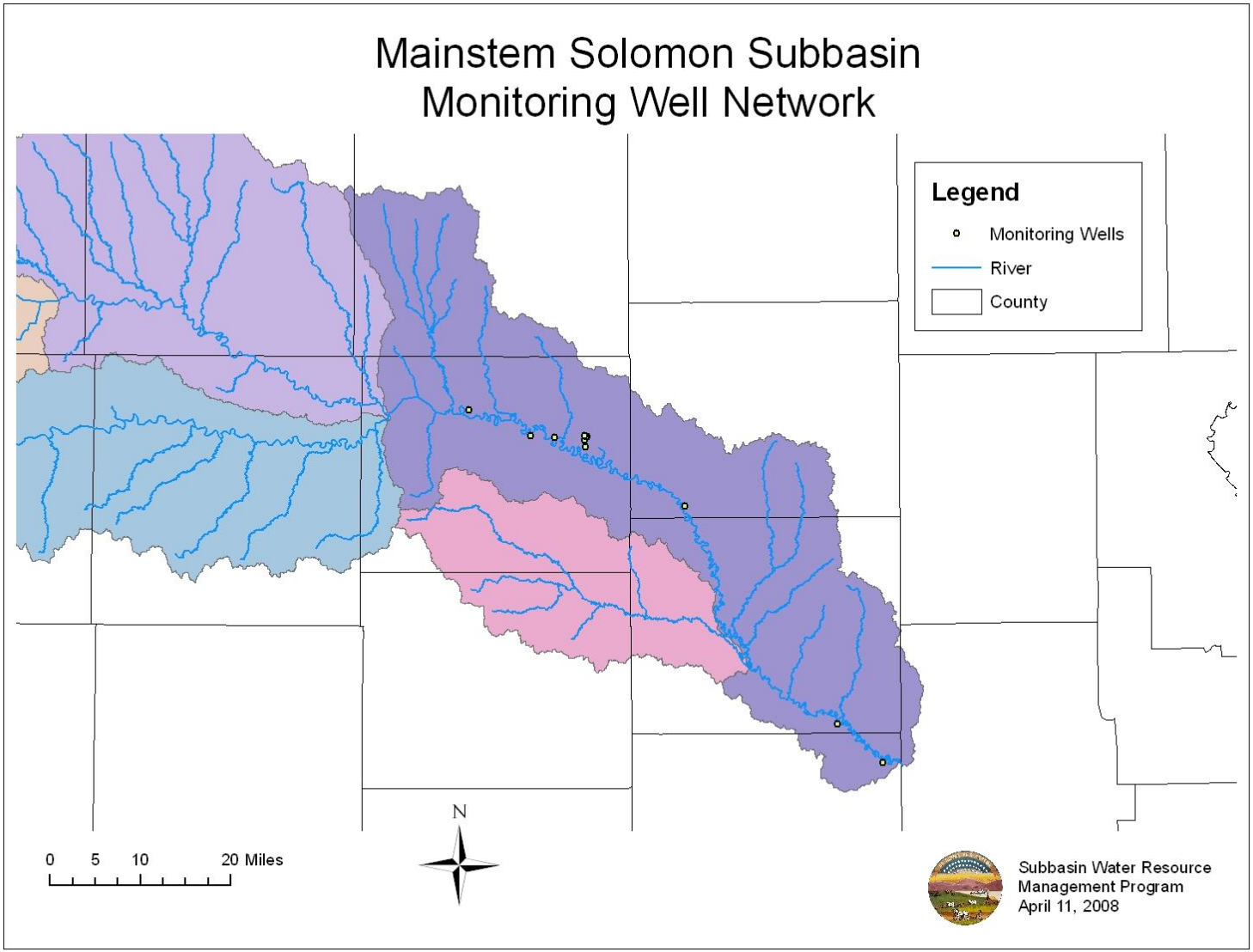

Figure 8: Mainstem Monitoring Wells

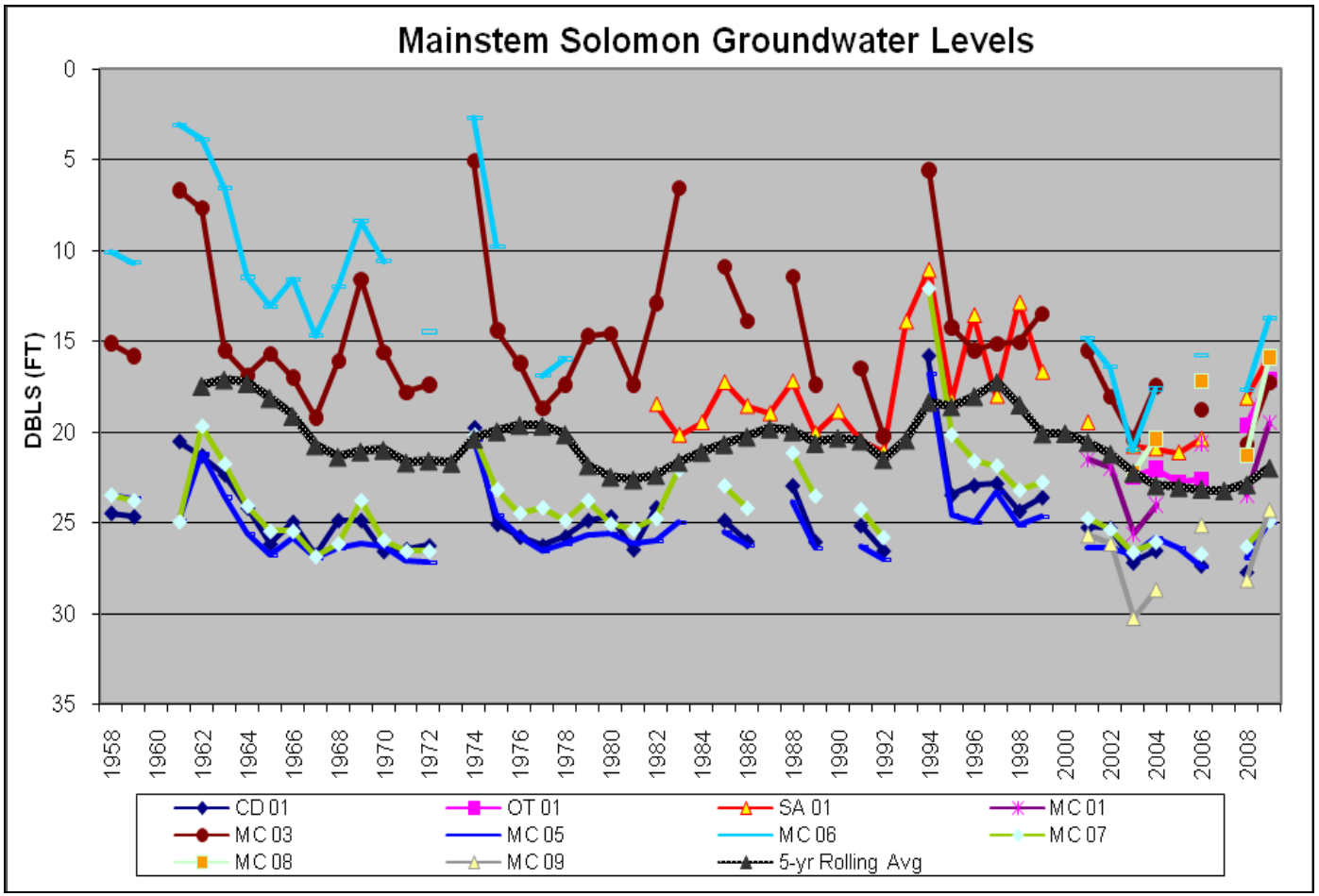

Figure 9: Monitoring wells located in the Mainstem Solomon Subbasin

There are 10 monitoring wells in the Mainstem Solomon subbasin. The mainstem has monitoring wells in four counties, Cloud, Saline, Mitchell and Ottawa counties. The average change in the water levels is an increase of 3.18 ft. All the monitoring wells had a positive change in water levels ranging from 1.41 ft (MC07) to 5.37 ft (MC08). The five-year rolling average does show a cyclical pattern with a declining trend since 1998 until 2007, but in both 2008 and 2009 it has rebounded (Figure 9).

V. Water Use

The Mainstem Solomon subbasin has a total of 296 water rights. The total authorized quantity for these water rights are 132,087.89 acre-feet. Most of the water rights and authorized quantities are for appropriated surface water rights (Table 2). The following map shows the points of diversion for the subbasin (Figure 10). Some water rights have more than one point of diversion associated with it.

Table 2: Water Rights in the Mainstem Solomon Subbasin

Type	Source	Number of Rights	Authorized Quantity
Vested	Surface Water	9	867.00
Appropriated	Surface Water	122	117,260.00
Vested	Groundwater	7	537.00
Appropriated	Groundwater	158	13,423.89

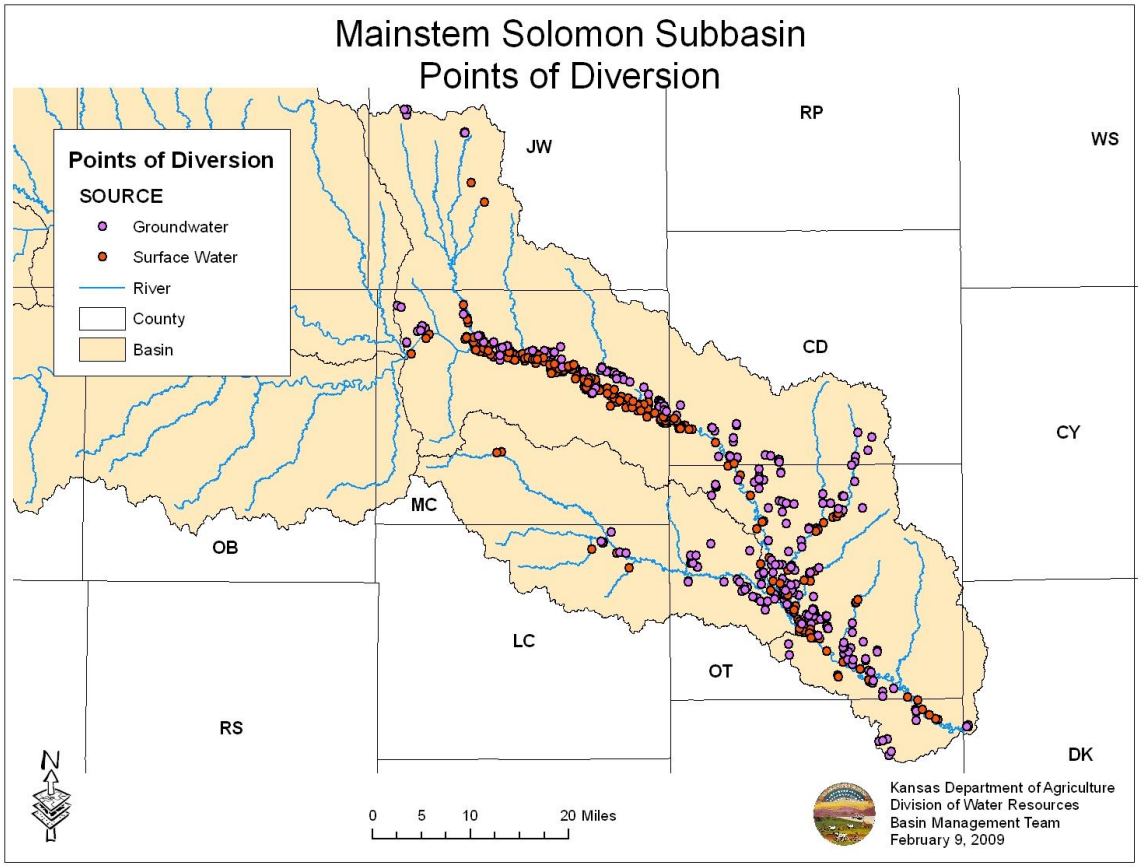

Figure 10: Mainstem Points of Diversion

The water use ranges from 30,326 acre-feet in 2002 to 2,990 acre-feet in 1993. The average water use for the subbasin from 1987-2007 is 14,916.82 acre-feet. Water use in 2007 was 23,204 acre-feet. This was down from 2006 but still well above the average for the subbasin (Figure 11). This analysis includes irrigation, industrial, recreation, domestic, stock and municipal.

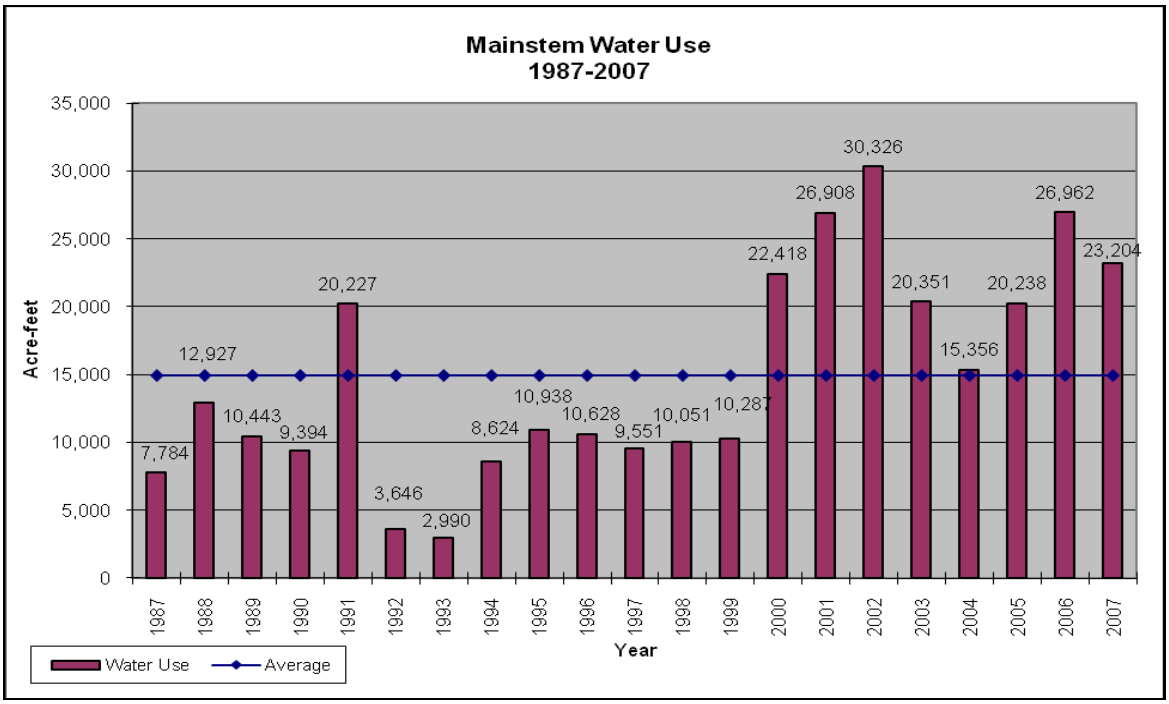

Figure 11: Ground and surface water use by year

VI. Conclusions

In 2008, the Mainstem Solomon subbasin received above average precipitation. The Niles streamflow gage also stayed above MDS criteria for most of the year. Both the five-year rolling average trend and annual water levels are up in 2009. Evaluating this change in hydrologic response to streamflow is an indication why it is so important to continue to study this basin at the current level to determine the long term effects of current water usage on this basin and existing property rights. It is equally important to understand how fast the system recovers after a recharge event as it is to understand the impacts of pumping and other factors on the hydrologic system.

VII. Appendix

Monitoring Well ID	Legal Description	Subbasin
CD01	08 04W 30 CBC	Mainstem
MC01	07 06W 17 CCD	Mainstem
MC03	07 06W 29 BBB	Mainstem
MC04	06 09W 36 DD	Mainstem
MC05	07 07W 18 DDA	Mainstem
MC06	07 06W 19 ADA	Mainstem
MC07	07 07W 22 ABB	Mainstem
MC08	07 06W 17 CCD,7	Mainstem
MC09	07 06W 17 CCB,2	Mainstem
OT01	12S 02W 26 DDC	Mainstem
SA01	13 01W 23 BCB,2	Mainstem