



# Lower Solomon River Subbasin

**2007 - Field Analysis Summary**

Subbasin Water Resource Management Program

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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 Lower Forks section. The Lower Forks include both a North and South stem of the river. The Lower Forks start right below Kirwin and Webster Reservoir flowing east towards Waconda (Glen Elder) Reservoir. The Lower North Fork begins in Phillips County and continues through Smith, Jewell and Mitchell counties. The Lower South Fork begins in Rooks County and continues through Osborne and Mitchell counties. The Lower North and Lower South Fork Solomon join together and flow into Waconda (Glen Elder) Reservoir in Mitchell County.

The Lower Forks sections have two irrigation districts operated out of Webster and Kirwin Reservoir. Water allocations from the reservoir storage are specified in contracts between the U.S. Department of Interior, Bureau of Reclamation and each irrigation district. Webster Irrigation District has not operated since 2004 in which 3,867 acre-feet was released. Kirwin Irrigation District operated in 2007, and released 2,809 acre-feet. Kirwin plans to operate in 2008 at 6 inches.

The Lower Forks flow through the middle range of the Smoky Hills. This area is known as “Post Rock Country” because it is capped by Greenhorn Limestone which was used by early settlers for fence posts. The alluvium consists mainly of gravel, sand, silt and clay that can be found in the channels and flood plains of all the major streams.

Figure 1 is a map of the entire Solomon basin.

# Solomon River Basin

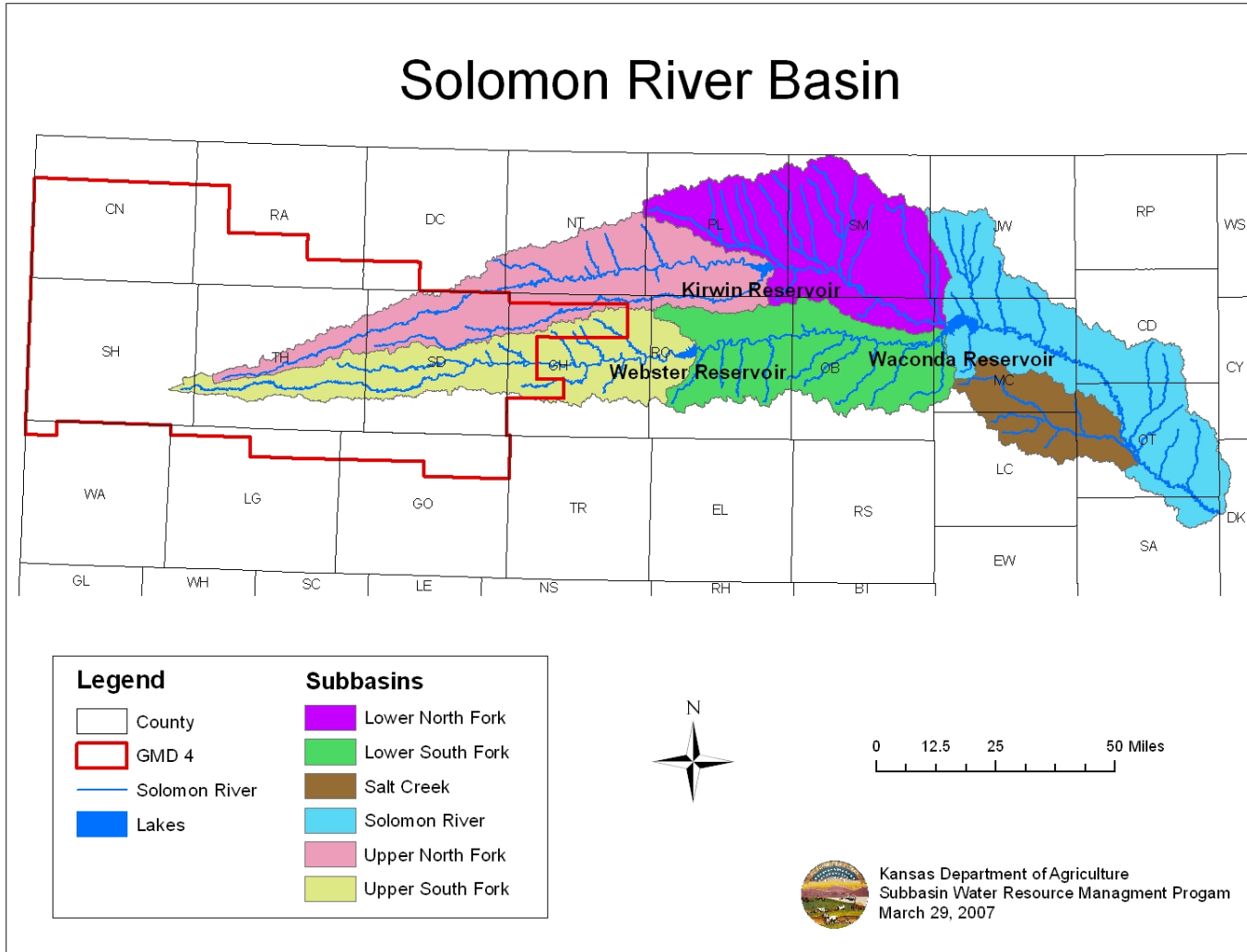
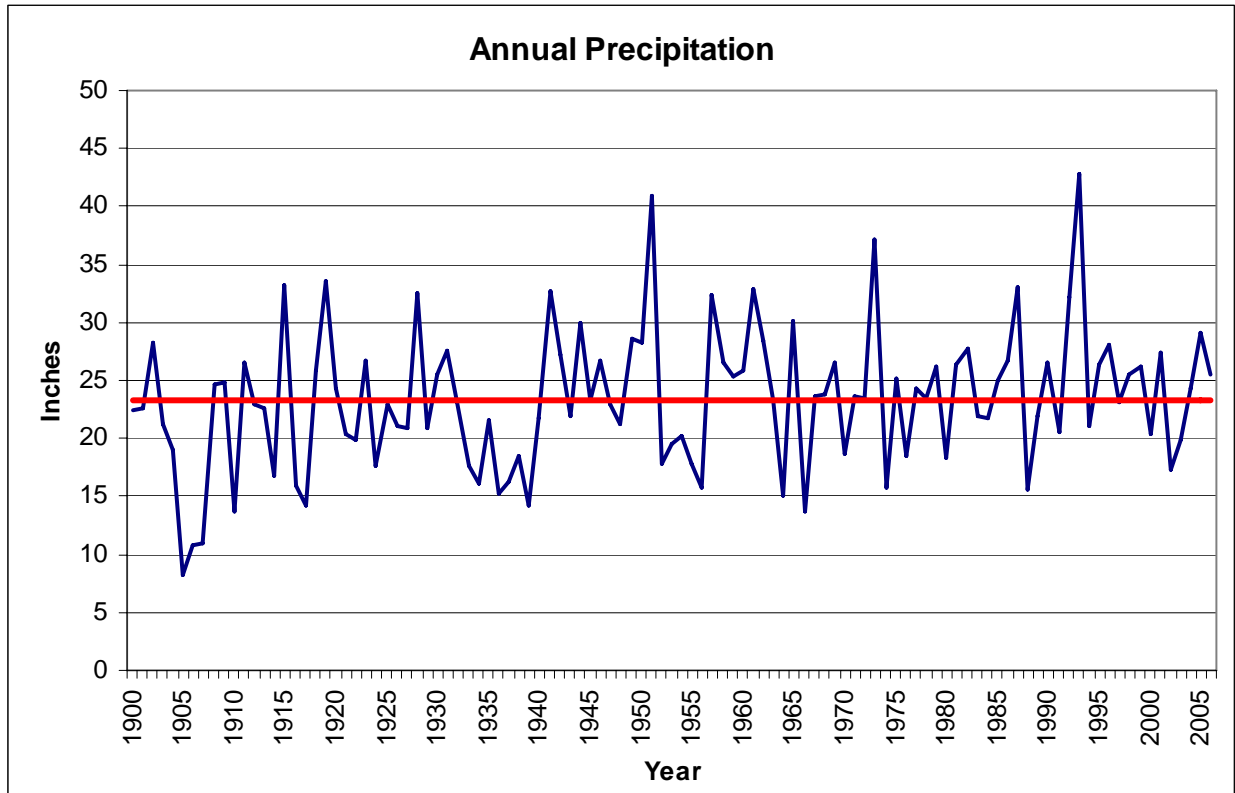


Figure 1: Solomon River Basin divided into subbasins

## II. Precipitation

Precipitation in the Lower Solomon subbasin averages 23.34 inches (in.) since 1900. Figure 2 shows the annual variation in precipitation. Both charts are derived from various National Climatic Data Center (NCDC) stations including Phillipsburg, Kirwin, Lebanon, Smith Center, Covert, Alton, Plainville and Webster. The data is downloaded then averaged to create the following charts. The highest precipitation totals occurred in 1993 with 42.87 in. and the lowest in 1905 with 8.22 in. Annual precipitation data available for these NCDC stations is currently available through 2006.



**Figure 2: Lower Solomon Subbasin precipitation 1900-2006**

Figure 3 shows precipitation for January 2007 to October 2007. November and December data are not currently available. With these measurements the subbasin experienced a total of 29.18 in. during the first 10 months in 2007. July had the most precipitation with 5.01 in. and February had the least with 0.61 in.

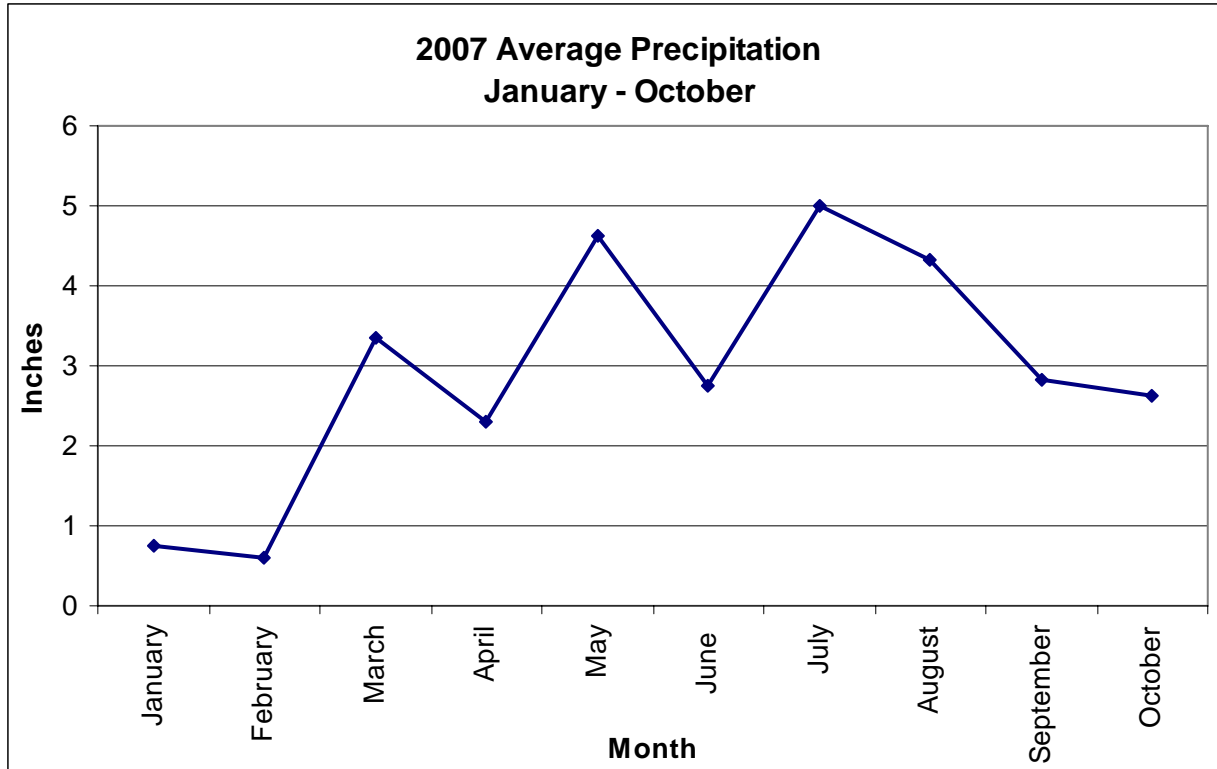


Figure 3: 2007 Monthly Average Precipitation (November and December data not available)

### III. Surface Water

Surface water in the Lower Fork sections is monitored by two USGS gages at Portis and Osborne. The Portis gage is on the Lower North Fork while the Osborne gage is on the Lower South Fork. Portis has a longer period of record dating back to 1945. Osborne gage began shortly after Portis in 1946 (Figure 4). Since both streamflow gages are downstream from reservoirs, the operations of Kirwin and Webster Reservoirs affect the streamflow.

The average flows over the period of record at these two gages were 115.3 cfs at Portis and 104.6 cfs at Osborne. During most of the 1990s, streamflow maintained higher levels at these gages averaging 175.3 cfs at Portis and 168.2 cfs at Osborne. Significantly reduced flows occurred in the 2000s averaging 33.3 cfs at Portis and 20.2 cfs at Osborne (Figure 5).

Overall Portis had more flow this past year compared to Osborne. The Lower South Fork nearly had no flow for several days in June. In 2007, both gages experienced their highest flows in late-July and early-August. Ice has likely affected the Portis and Osborne's gages during December 2007 (Figure 6).

# Lower Solomon Subbasin USGS Streamflow Gages

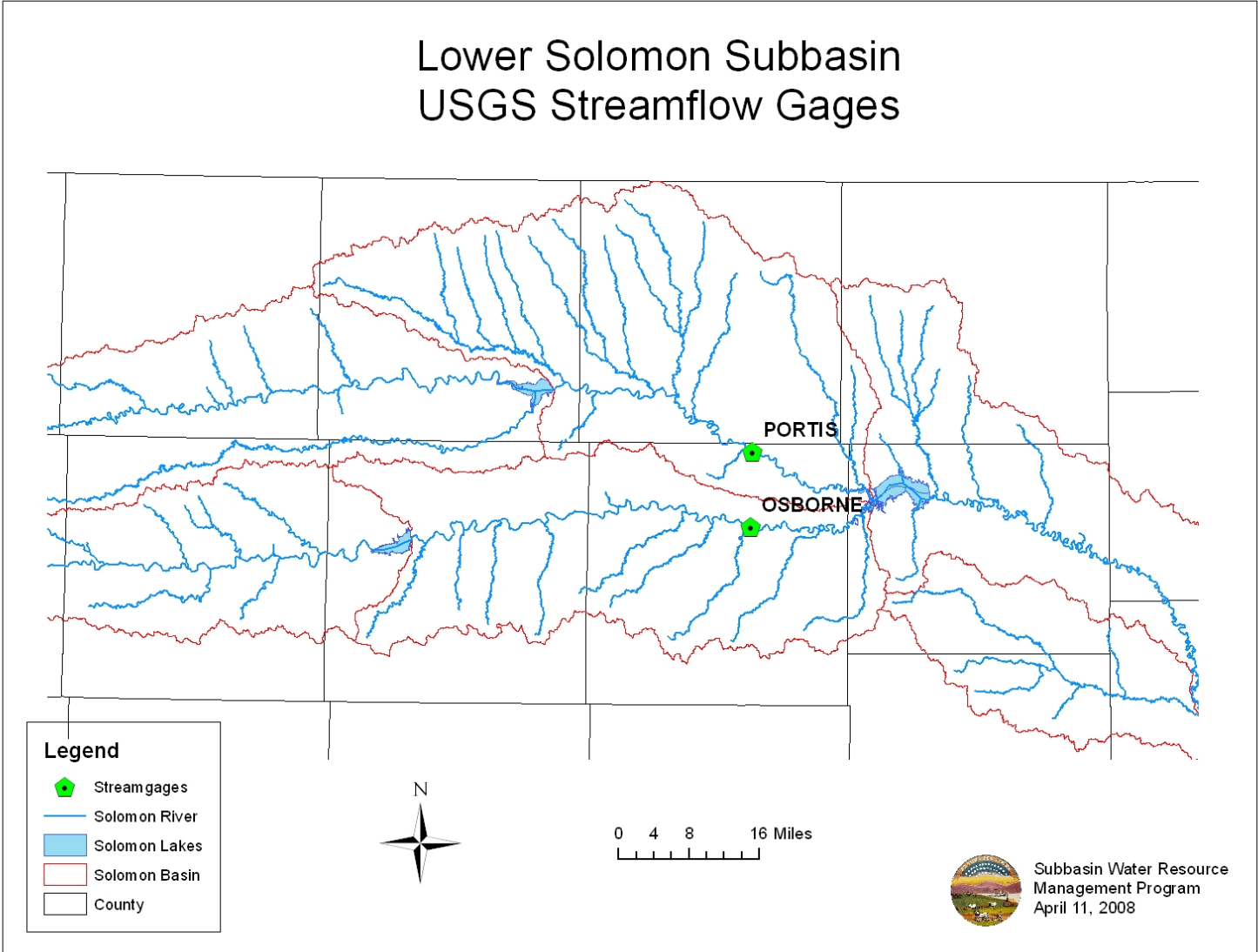


Figure 4: Lower Solomon River USGS Streamflow Gages

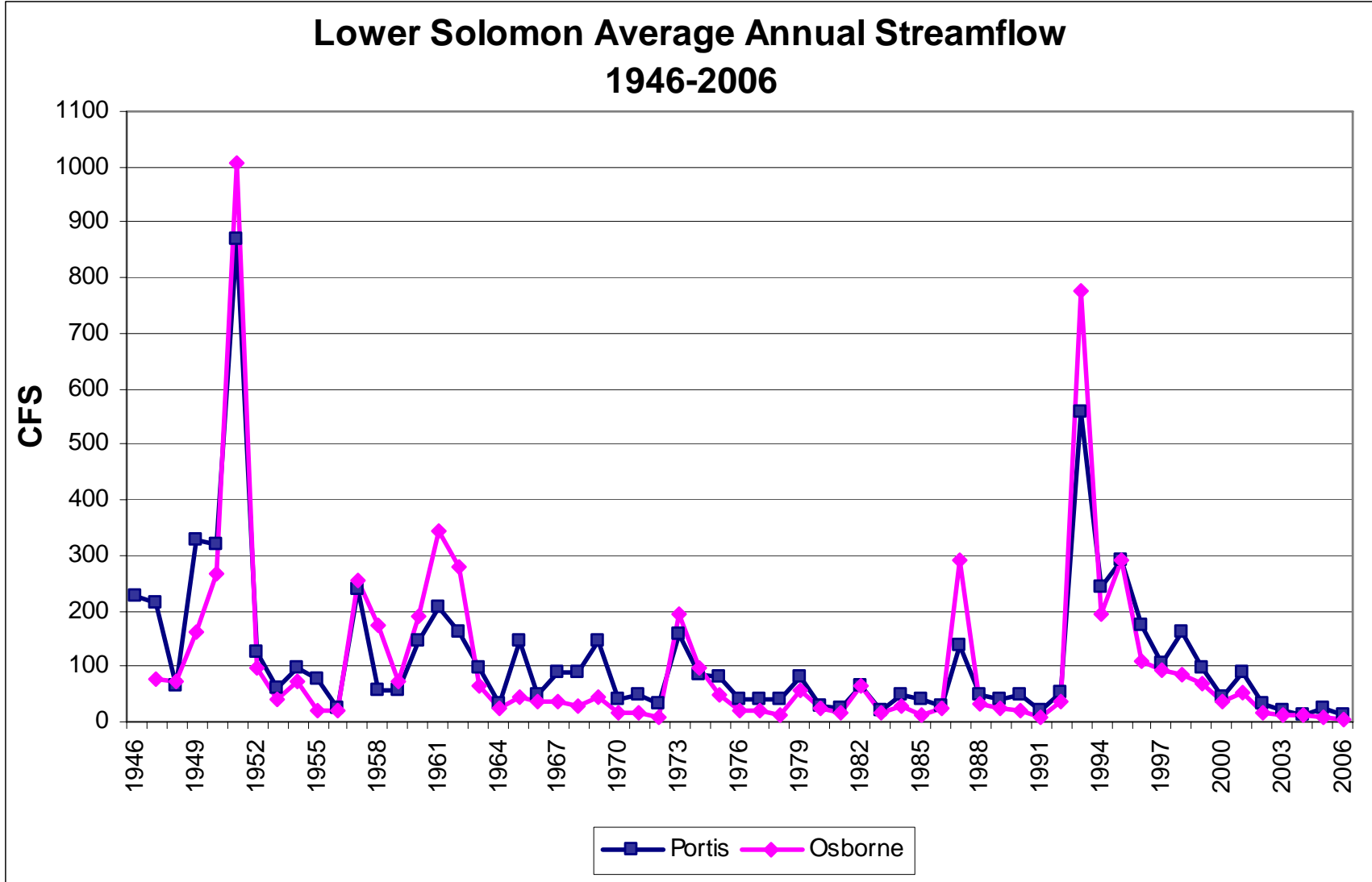


Figure 5: Streamflow at USGS Gages 1946-2006



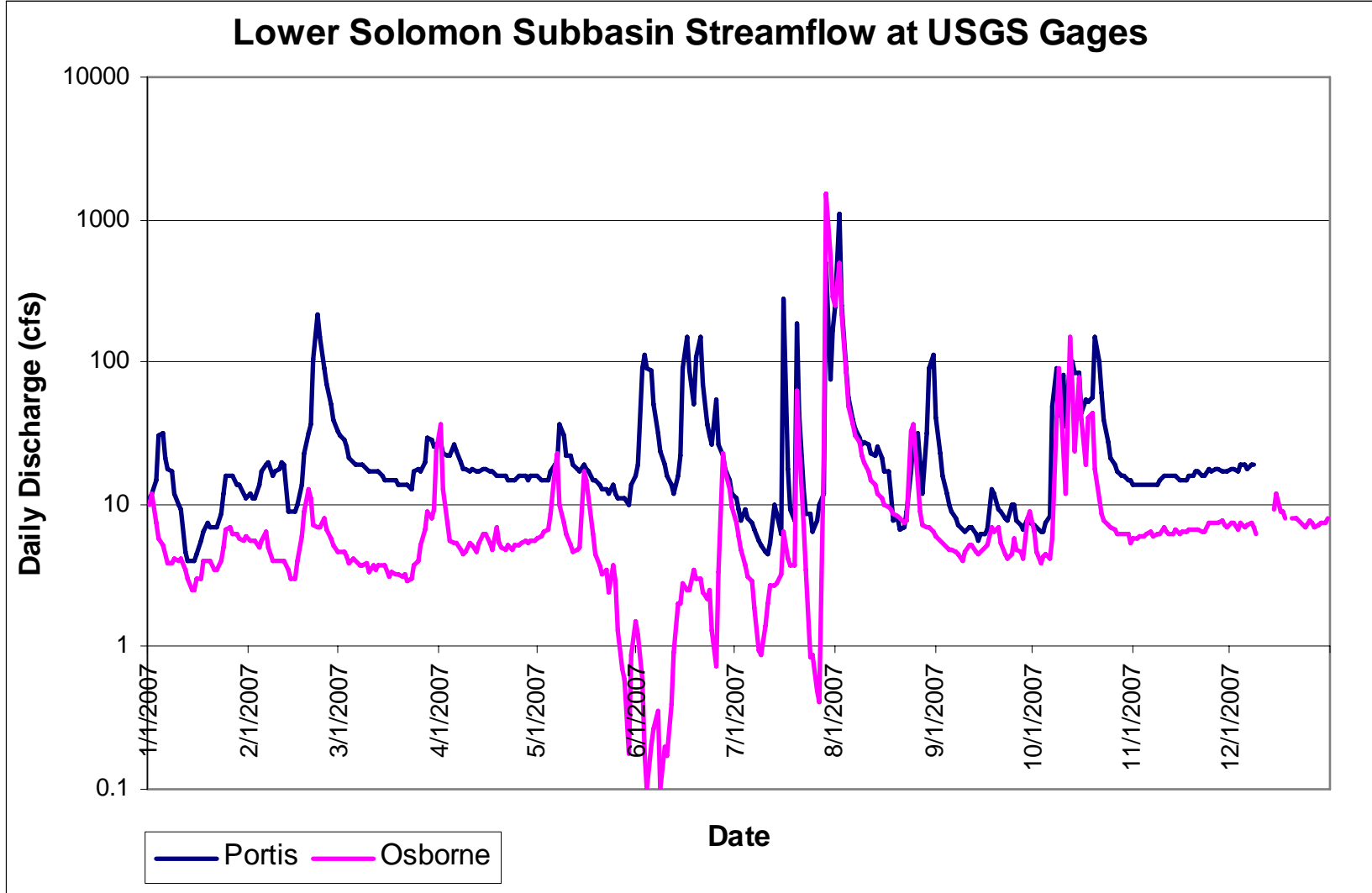


Figure 6: Daily Streamflow for 2007

## **IV. Groundwater**

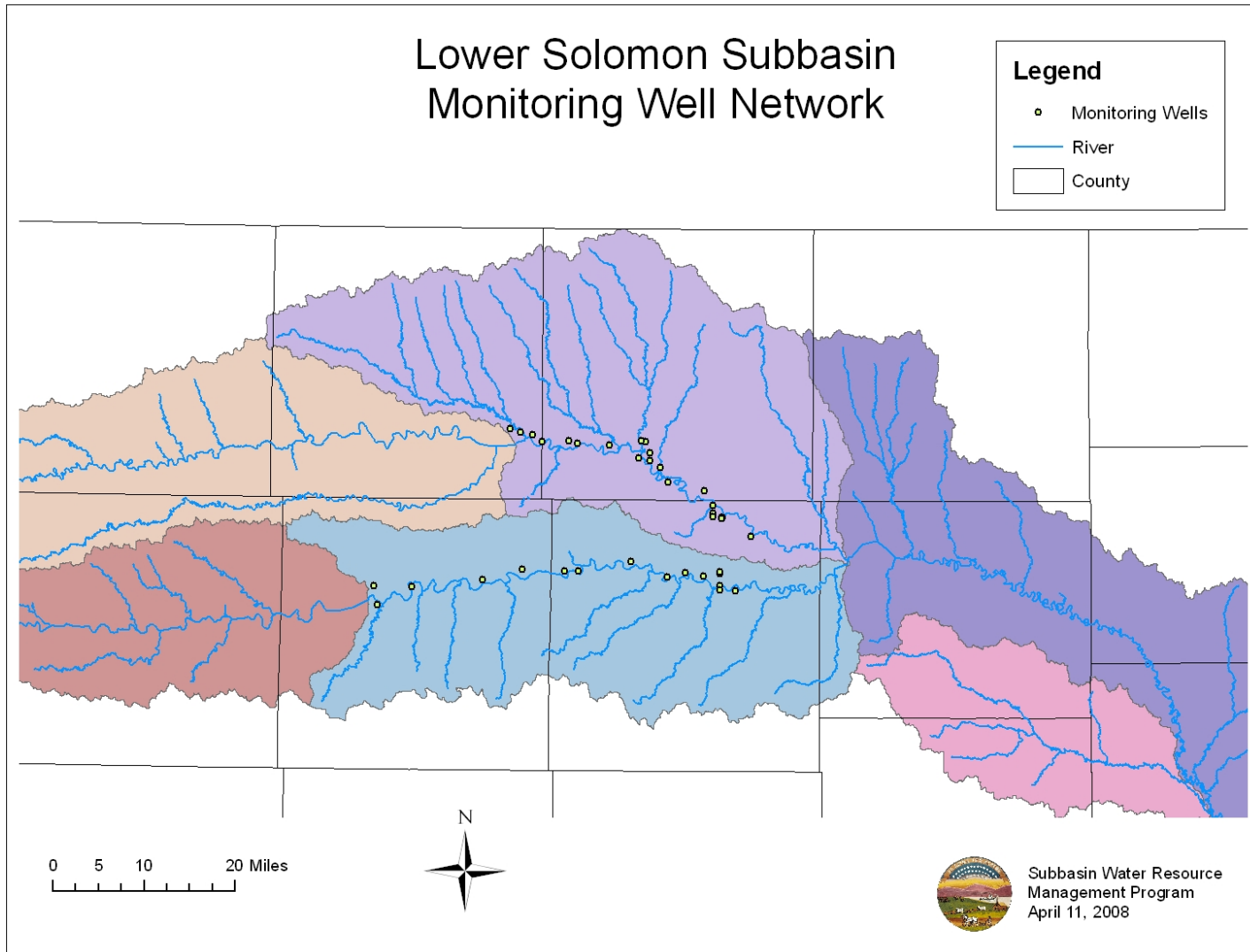
The Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) Subbasin Water Resources Management Program (SWRMP) measure groundwater levels in the Lower North and South Forks of the Solomon River subbasin. There are 37 monitoring wells used for these measurements. The monitoring wells were drilled in the alluvial aquifer system (Figure 7). 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 as they are considered to be the least affected by groundwater pumping.

Several of these monitoring wells have been measured since the early to mid 1960s. In the 1980s a number of wells were added to the monitoring network and in 2000 once the SWRMP started work in the subbasin additional monitoring wells were added.

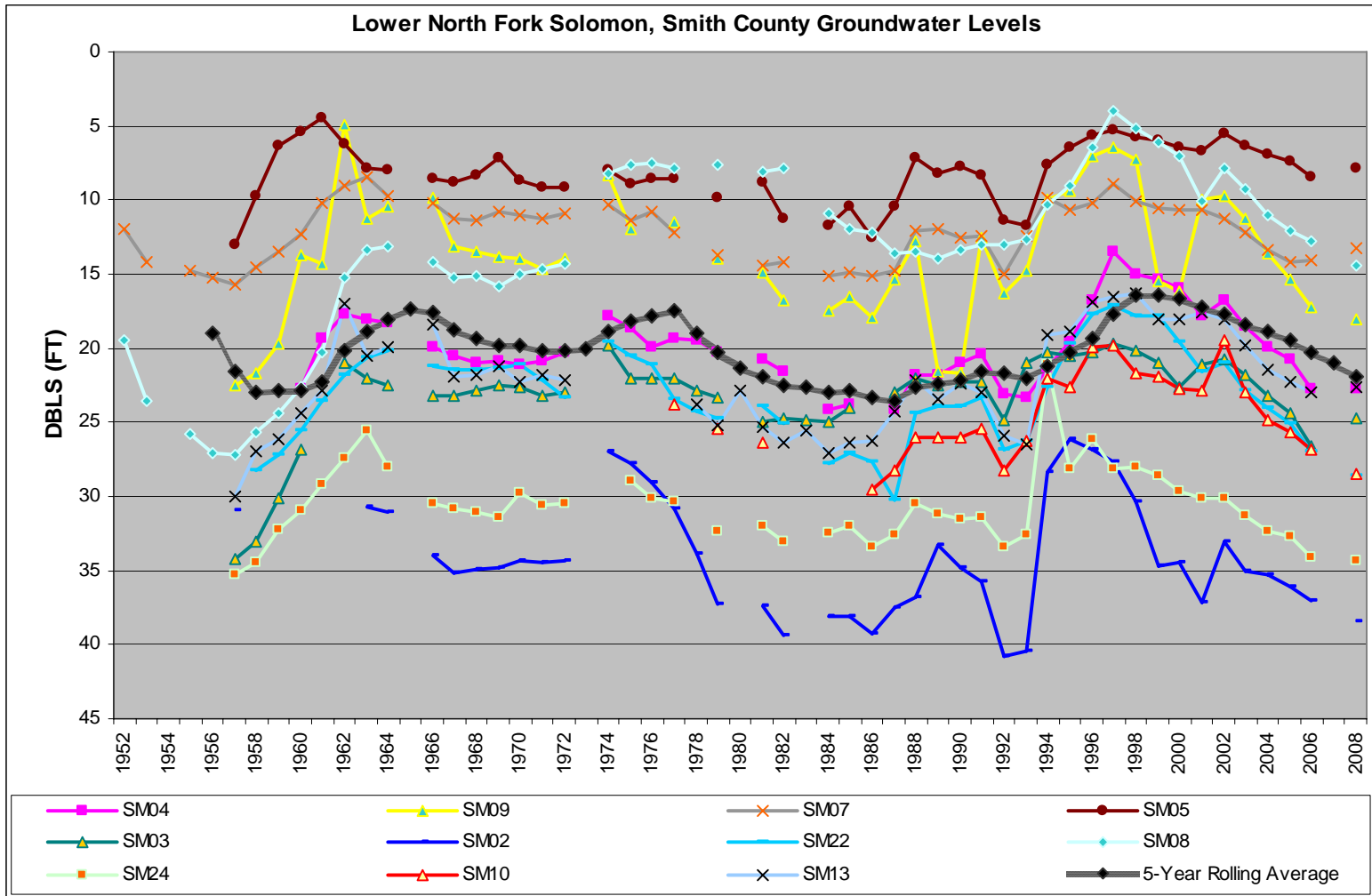
Ongoing observation of water levels is critical to understanding the fluctuations that may occur overtime. Historical records from observation wells can provide a hydrologic outlook on the long-term stability or decline of an area.

The water levels in the lower North and South Fork subbasin display pronounced seasonal fluctuations as there is additional influence by the operation of surface water delivery systems of the Kirwin and Webster Irrigation Districts. The canals used for delivery of the water act as artificial recharge systems as seepage of water occurs into the underlying alluvial aquifer. Monitoring wells adjacent to the canals show the increasing water levels during the course of the irrigation delivery season.

Groundwater measurements were not collected in 2007. Therefore, change in groundwater levels is a comparison of 2006 and 2008 water levels. The following figures chart groundwater levels in all the monitoring wells (legal descriptions are available in the appendix) and also the five-year rolling average of those wells. The y-axis is labeled depth below land surface (DBLS) and is measured in feet.

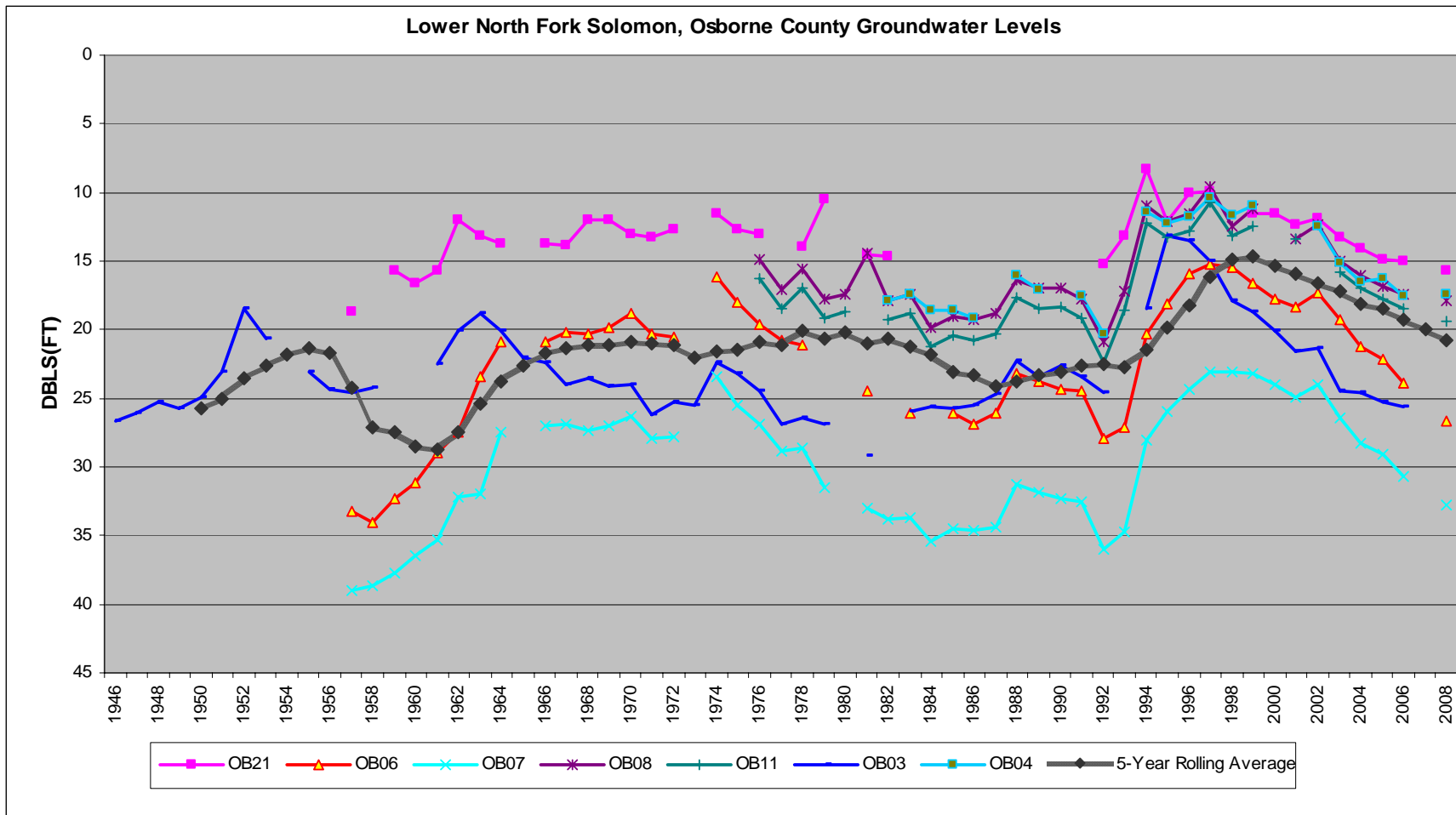


**Figure 7: Lower Forks Monitoring Wells**



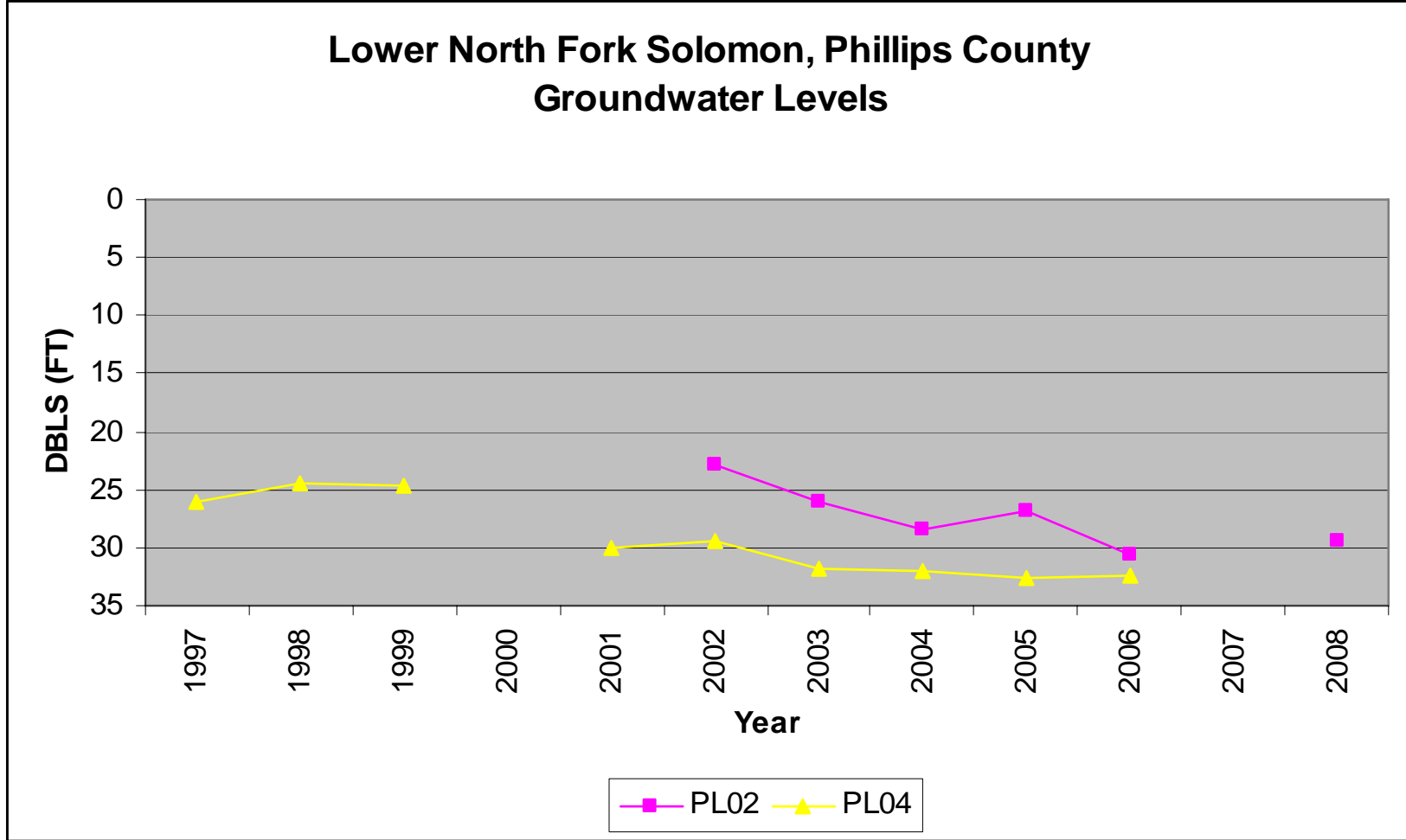
**Figure 8: Groundwater levels in Lower North Fork, Smith County**

The Lower North Fork, Smith County has 11 monitoring wells. In 2008, the average change in groundwater levels is an increase of 0.33 ft. The change in water levels ranged from a decline of 1.62 ft (SM10) to an increase of 0.82 ft (SM07). Groundwater measurements have been taken in the Smith County since 1942. Since 1942, SM03 has had a net increase of 9.58 ft and since 1957 SM02 has net declined 7.49 ft. The five-year rolling average shows a number of rises and falls in the water table over the years. There has been a downward trend since 1998 (Figure 8).



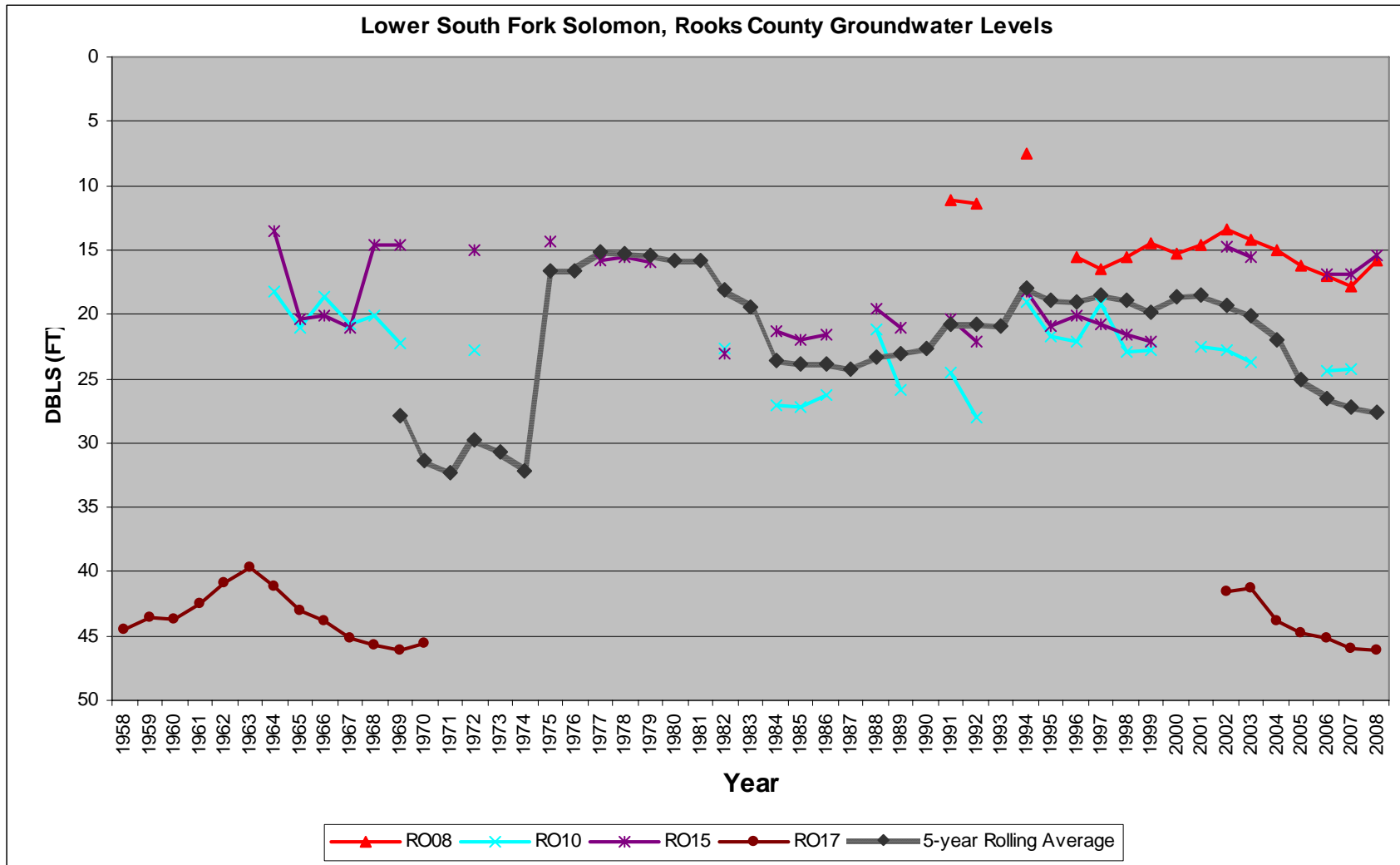
**Figure 9: Monitoring well levels in Lower North Fork, Osborne County**

The Lower North Fork, Osborne County has seven monitoring wells (Figure 9). The average change in water levels is a decline of 1.14 ft in 2008. Some wells have been monitored since 1946. Since 1957, OB21, OB06 and OB07 all show net increases in the water table of 2.99 ft, 6.55 ft, and 6.28 ft, respectively. The five-year rolling average shows rise and falls over time, with a distinct rise in the water table, in the early 1990s until around 1999, where the water levels begin to decline. Overall, the water levels appear to be higher than in the 1950s.



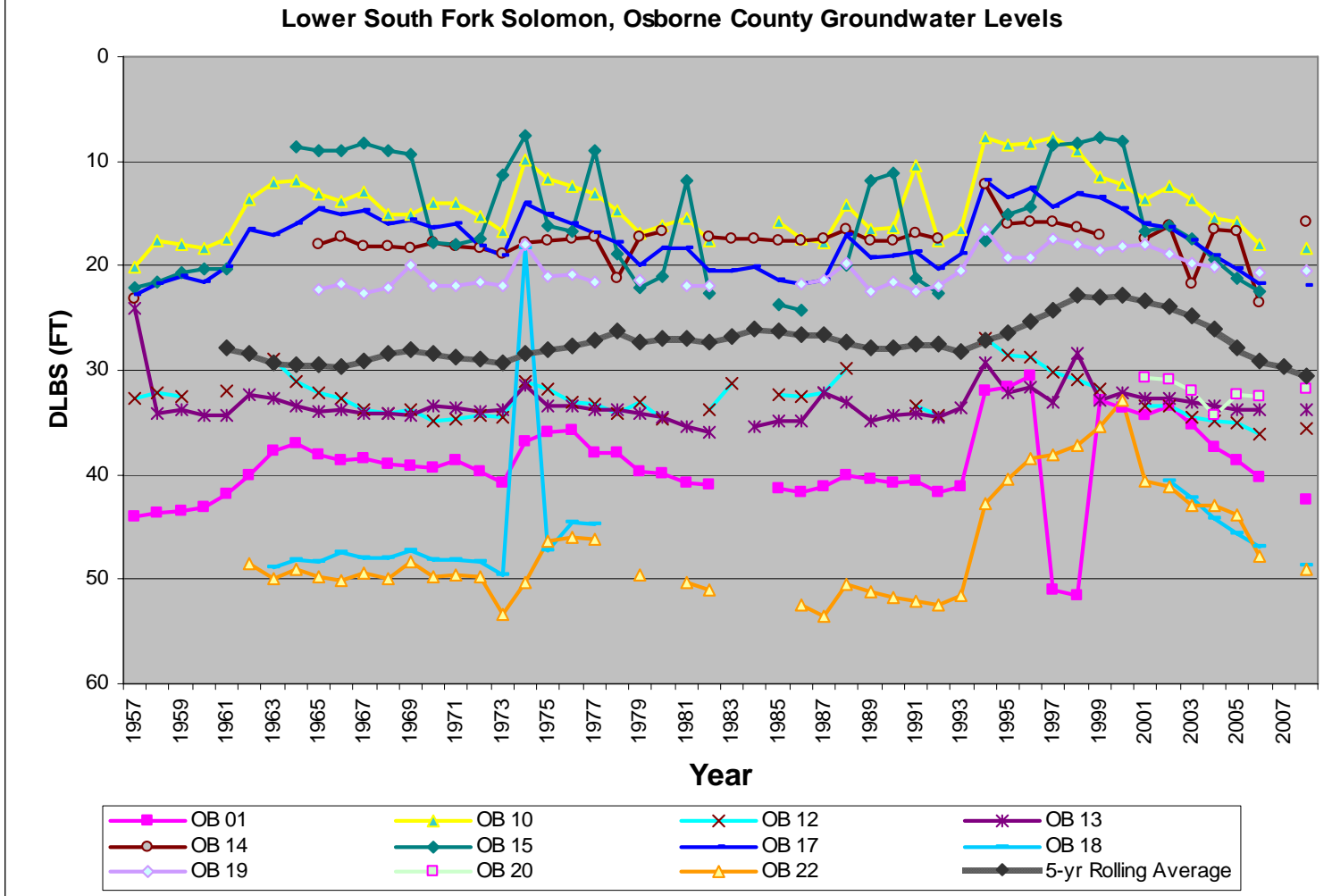
**Figure 10: Monitoring well levels in Lower North Fork, Phillips County**

The Lower North Fork, Phillips County has two monitoring wells (Figure 10). The average change in water level was not calculated since only PL02 was measured in 2008. PL02 was first measured in 2002 and PL04 in 1997. From 1997-2006 PL02 has net declined 6.35 ft, and from 2002-2008 PL02 has net declined 6.52 ft. No five-year rolling average was calculated due to the short period of time these two wells have been measured. Additional monitoring wells are being identified to add to the network in Phillips County.



**Figure 11: Monitoring well levels in Lower South Fork, Rooks County**

The Lower South Fork, Rooks County has four monitoring wells (Figure 11). The average change in water levels in Rooks County in 2008 is an increase of 0.57 ft. RO17 was first measured in 1958 where RO10 and RO15 were first measured in 1964. RO08 was added to the monitoring network in 1991. Since 1964 R010 has had a net decline of 6.13 ft and RO15 has net declined 3.34 ft. The five-year rolling average shows both rise and falls overtime with water levels currently on the decline.



**Figure 12: Monitoring well levels Lower South Fork, Osborne County**

The Lower South Fork, Osborne County has 11 monitoring wells (Figure 12). The average change in water levels in Osborne County is an increase of 0.35 ft in 2008. A number of wells in this area were first measured in 1957, with some wells added to the network in the 1960s. Since 1957, the changes in the water table have varied with net increases of 7.39 ft (OB14) to net declines of 9.70 ft (OB13). The five-year rolling average shows the rise in the water table in the mid to late-1990s and a declining trend since 1999.



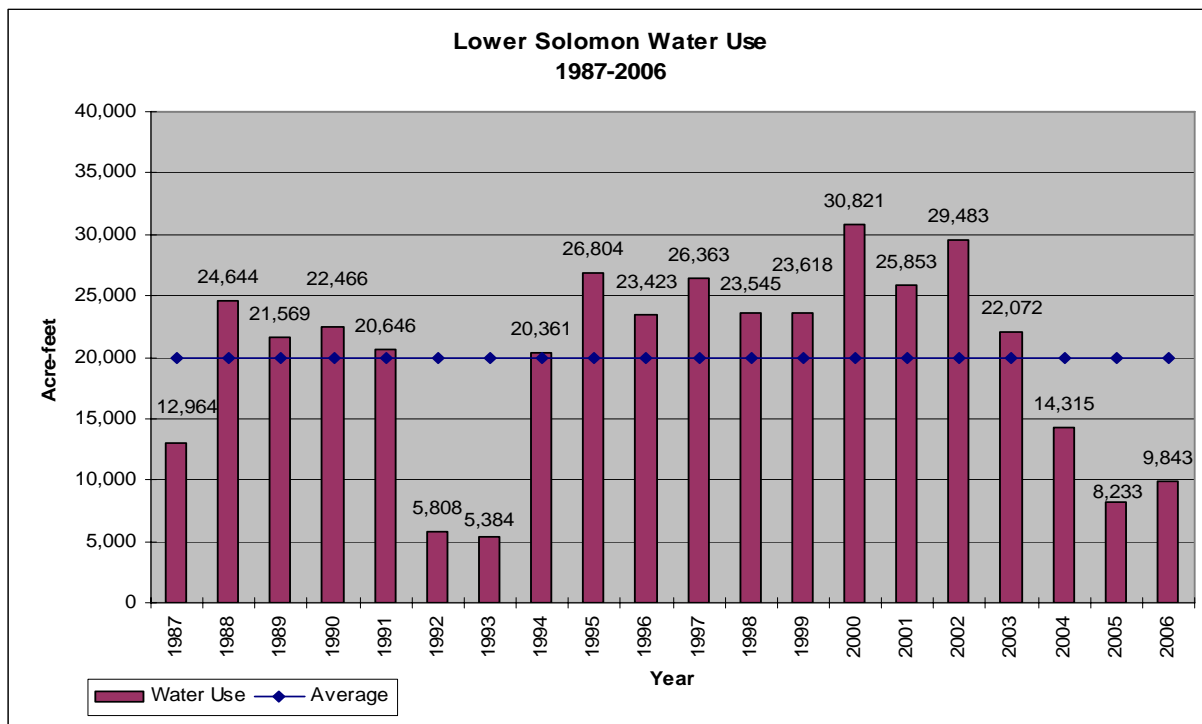
## V. Water Use

The Lower Solomon subbasin has a total of 472 water rights. The total authorized quantity for these water rights are 58,989.30 acre-feet. Most of the water rights and authorized quantities are appropriated surface and groundwater rights (Table 1). All irrigation, industrial, recreational, municipal, stock and domestic water rights were used in the analysis.

**Table 1: Water Rights in the Lower Solomon Subbasin**

Type	Source	Number of Rights	Authorized Quantity
Vested	Surface Water	17	1047.00
Appropriated	Surface Water	137	32,273.27
Vested	Groundwater	17	875.97
Appropriated	Groundwater	301	24,793.06

The water use ranges from 30,821 acre-feet in 2000 to 5,384 acre-feet in 1993. The average water use for the subbasin from 1987-2006 was 19,910.59 acre-feet. Water use in 2006 was 9,843 acre-feet. This was up from 2005 but still below the subbasin average (Figure 13).



**Figure 13: Ground and Surface Water use by year**

## VI. Conclusions

In conclusion, the Lower Solomon Forks did see some significant precipitation events during 2007 which at times allowed for high streamflow events. Groundwater levels are down throughout the subbasin. Water use increased from 2005, but is still way below the subbasin average.

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

<b>Monitoring Well ID</b>	<b>Legal Description</b>	<b>Subbasin</b>
OB03	06 12W 23 CDC	Lower North Fork
OB04	06 12W 08 CCC	Lower North Fork
OB05	06 12W 08 CCC, 2	Lower North Fork
OB06	06 12W 07 CBB	Lower North Fork
OB07	06 12W 07 CCB	Lower North Fork
OB08	06 12W 08 CCB	Lower North Fork
OB11	06 12W 17 BBB	Lower North Fork
OB21	06 12W 01 DA	Lower North Fork
PL02	04 16W 28 BAD	Lower North Fork
PL04	04 16W 27 DB	Lower North Fork
PL08	04 16W 26 DDD	Lower North Fork
SM02	05 13W 25 DDD	Lower North Fork
SM03	05 13W 17 BCC	Lower North Fork
SM04	04 14W 32 CDD	Lower North Fork
SM05	04 15W 35 CCB	Lower North Fork
SM06	04 15W 34 CBB	Lower North Fork
SM07	04 15W 31 CBC	Lower North Fork
SM08	05 14W 01 DAA	Lower North Fork
SM09	04 14W 36 CAD	Lower North Fork
SM10	05 14W 12 DAD	Lower North Fork
SM13	04 14W 36 CB	Lower North Fork
SM22	05 13W 28 BBB	Lower North Fork
SM24	05 14W 11 ADC	Lower North Fork
OB01	07 13W 13 BCC	Lower South Fork
OB10	07 13W 15 BBB	Lower South Fork
OB12	07 12W 28 ABA	Lower South Fork
OB13	07 13W 17 CBB	Lower South Fork
OB14	07 15W 10 CCC	Lower South Fork
OB15	07 14W 04 DDD	Lower South Fork
OB17	07 15W 08 DCC	Lower South Fork
OB18	07 12W 17 BC	Lower South Fork
OB19	07 12W 19 DAA	Lower South Fork
OB20	07 12W 19 DDA	Lower South Fork
OB22	07 12W 18 AAA	Lower South Fork
RO06	07 19W 23 CDB	Lower South Fork
RO08	07 17W 14CDD	Lower South Fork
RO10	07 18W 21 DCB	Lower South Fork
RO15	07 19W 35 DDC	Lower South Fork
RO17	07 16W 09 DDB	Lower South Fork