# Solomon Basin High Priority Issue
# Ogallala-High Plains Aquifer Declines
# January 2009

**Issue**

Long-term management of the Ogallala-High Plains and alluvial aquifers to extend and conserve the life of the aquifer, while meeting area needs.

**Vision**

Sufficient water resources in western Kansas to support healthy, economically strong communities and rural life-styles, today and for future generations.

**Goal**

Extend and conserve the life of the Ogallala–High Plains aquifer.

**Description**

The Ogallala portion of the High Plains aquifer (Ogallala-High Plains aquifer) underlies western portions of the Solomon River basin. Within the basin, the Ogallala underlies Thomas, Sheridan and Graham counties, along with parts of Norton, Phillips and Rooks counties, and southern Smith County. Thomas and Sheridan counties and part of Graham County are in Northwest Kansas Groundwater Management District No. 4 (GMD4). The aquifer fringe outside GMD4 is managed by Kansas Department of Agriculture-Division of Water Resources (DWR).

Ground water supplies significant appropriations (95% in 2006) of municipal, irrigation, industrial and domestic water in the basin from the alluvial and Ogallala-High Plains aquifers. The Ogallala-High Plains aquifer has been developed so extensively that the amount of water withdrawn annually is significantly more than the recharge, resulting in ground water declines. Some areas are already experiencing shortages in meeting demand. As ground water levels decline, the aquifer loses hydraulic connection with the overlying alluvial aquifers and rivers and no longer contributes much, if any, base stream flow. Since the 1950s (predevelopment), Ogallala water levels have declined as much as 45 percent in Thomas, Sheridan and Graham Counties. Water levels have been reduced up to 50 feet in the majority of those portions of Thomas and Sheridan counties located in the basin.

More recently, water levels have declined up to 30 feet over the ten-year period from 1996-2006. The greatest decline is centered south of Hoxie in Sheridan County. Generally, Thomas and Sheridan county areas in the basin have declined by 5-20 feet in the ten-year period. The overall decline has contributed to a progressive reduction in flow during the past several decades in the upper North Fork and upper South Fork of the Solomon River.(1)

Water users in parts of Thomas, Sheridan and Graham counties are already experiencing shortages in meeting demand. To extend and conserve the life of the Ogallala –High Plains aquifer, GMD4 and DWR are defining priority areas to reduce aquifer declines. Federal and State voluntary incentive programs to reduce water use have been developed and targeted to priority areas.

A 2006 Kansas Water Office (KWO) analysis of water level data from 1981-2005 indicated that the aquifer decline rate had not been reduced by a statistically significant amount between two time periods: pre-1993, and 1993-2005.(4)

Ground Water Appropriations

Total appropriations in the basin from the Ogallala-High Plains aquifer and overlying alluvium are approximately 249,860 acre feet for all beneficial uses in the Solomon basin. This represents 1,100 active water rights from 1,211 wells.(6)

The majority of the producing wells in the Ogallala-High Plains aquifer and associated alluvium, about 1,044 wells, are within the GMD4. These appropriations total 243,827 acre feet, or nearly 98% of the Ogallala appropriations in the basin.

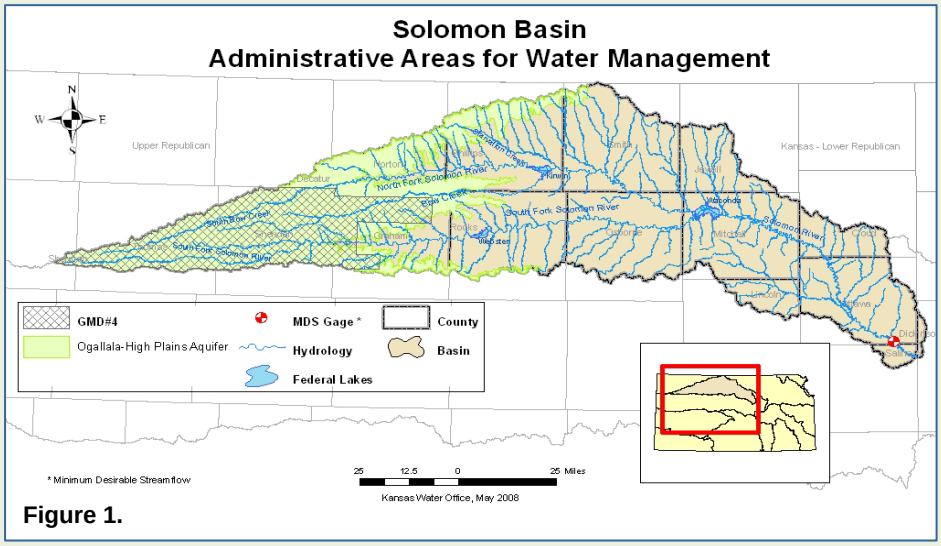


**Figure 1.**

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## Water Use

The 2006 reported ground water use from the Ogallala-High Plains aquifer area was 132,778 acre feet. Reported water use for 2006 within GMD4 was 129,635 acre feet from 1,010 wells. Irrigation use is 98% of the Ogallala-High Plains reported use in the basin.(7)

Annual irrigation water use reported and quantified by township for 2002-2006 is provided in Table 1 below, based on data analysis by DWR.(6) (Note some townships have water use in more than one area, such as a GMD and the fringe, therefore the sum of the number of townships analyzed for each area is not the same as those included in "ALL" in the table.) The majority of a township may be in another basin or have no access to the Ogallala–High Plains aquifer.

There has been widespread adoption of more efficient irrigation systems in the Kansas High Plains, shifting from flood and center pivot irrigation to center pivot with drop nozzles.(8) A study by Kansas State University in 2006 found that the number of acres irrigated is a more important determinant of changes in water use than the adoption of more efficient irrigation systems.(2) The authors concluded that if the irrigated acres are held steady after conversion to a more efficient irrigation system, net water use would, on average, change little; it is with a decrease in irrigated acres that a reduction in water use is assured.

## Aquifer Declines

Average water levels in the aquifer within the groundwater management districts have continued to decline over the past ten years.

The overall average water table (top of ground water) decline in the High Plains region over the 2005 calendar year was 0.57 feet, which was somewhat more than the average decline during 2004 (0.15 feet) but less than the average annual decline rate over the five years since the 2001 measurements (approximately 0.98 feet/year).

Figure 2 is an estimated projection of the years until the High Plains aquifer reaches a point where wells will only be able to produce 400 gallons per minute (gpm) if ground water level trends from 1996 to 2006 repeat continuously and unchanged into the future.(10) This methodology is best suited to the Ogallala portion of the Ogallala-High Plains aquifer because of the relatively extensive data sets for the Ogallala. The variability of the system is the biggest drawback.

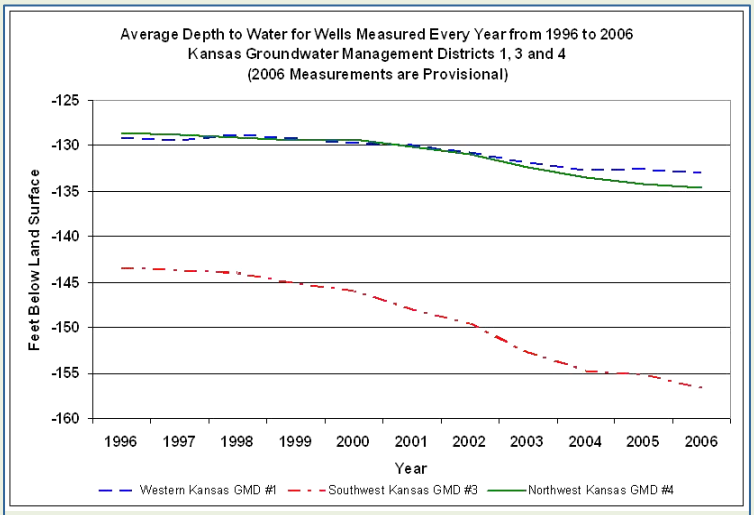


**Figure 2.**

## Activities and Progress

Various programs and activities have been initiated to reduce the decline rate of the Ogallala-High Plains aquifer and to extend and conserve the aquifer. Tools such as ground water and surface water models and more detailed aquifer characterization have been developed. In the Solomon basin, the determination of Ogallala subunit priority areas, setting subunit goals and developing management plans to reach these goals has been the responsibility of GMD4 along with DWR for areas outside the district.

Good data is essential to the determination of decline rates. Data development includes calibration of the ground water model or models to better understand the aquifer and subunits. Water flowmeters, now required on

**Table 1. Water Use for Ogallala Area in Solomon Basin**

| Area | Number Townships Quantified | Number Points of Diversion | 2006 Water Use (AF) | Acre-feet/ acre 2002 | Acre-feet/ acre 2003 | Acre-feet/ acre 2004 | Acre-feet/ acre 2005 | Acre-feet/ acre 2006 |
|---|---|---|---|---|---|---|---|---|
| **GMD4** | 32 | 1,242 | 150,104 | 1.32 | 1.21 | 1.19 | 1.01 | 1.05 |
| **Fringe** | 7 | 123 | 4,501 | 0.86 | 0.80 | 0.67 | 0.56 | 0.59 |
| **All** | NA | 1,386 | 143,216 | 1.21 | 1.06 | 0.97 | 0.80 | 0.91 |

# Solomon Basin High Priority Issue
# Ogallala-High Plains Aquifer Declines
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almost all wells, provide improved information on withdrawals. All wells in GMD4 should be metered by December 31, 2009. Annual water level measurements from "index" wells as well as weather station data to quantify precipitation provide information contributing to more accurate models.

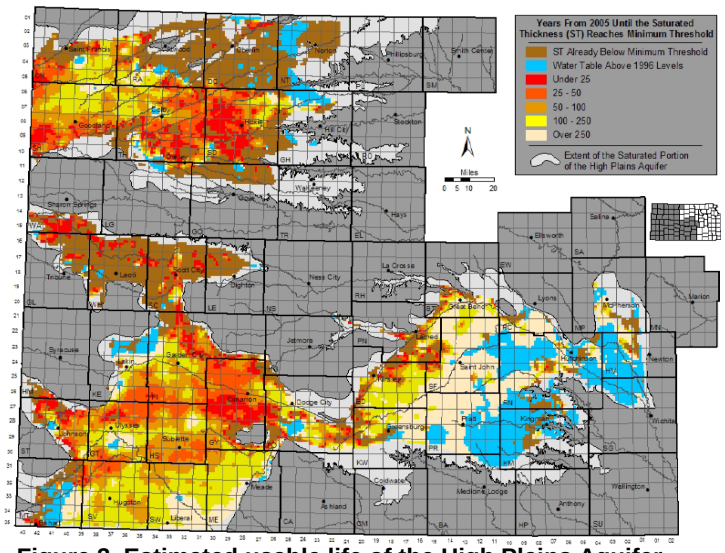


**Figure 3. Estimated usable life of the High Plains Aquifer**

GMD4 has identified six high priority subunits within their area, portions of which are in the Solomon basin. The GMD4 board is in the process of establishing preliminary water use goals and enhanced management actions for the high priority aquifer sub-units.(5)

The state and GMD4 have modeled management scenarios for six high priority subunits shown in Figure 4. Based on hydrologic conditions, corresponding economic estimates were produced for the cropping changes anticipated to occur as ground water levels change, based on historical farm decision triggers determined by K-State. The study considered a variety of water conservation policies aimed at achieving a 30% reduction in current ground water consumption levels. The economic effects of various water conservation policies on producer gross profits and regional economy were estimated.(3)

Voluntary programs have been targeted to areas determined by GMD4 within district boundaries and by DWR in the fringe areas. Federal Ground and Surface Water Programs of the Environmental Quality Incentive Program (EQIP) were focused for two years on these areas with projects selected annually. GMD4 utilized all resources allocated for their areas for incentive payments of $100 per acre annually for three years on eligible acres that convert irrigated land to non-irrigated land.

State programs have offered incentives to retire water rights in some areas, however that opportunity has not been provided to the Solomon basin through 2008. GMD4 high priority subunits may be eligible in the future. Regulatory programs have included special assistance by DWR to irrigators that have pumped in excess of their water rights and the area average.

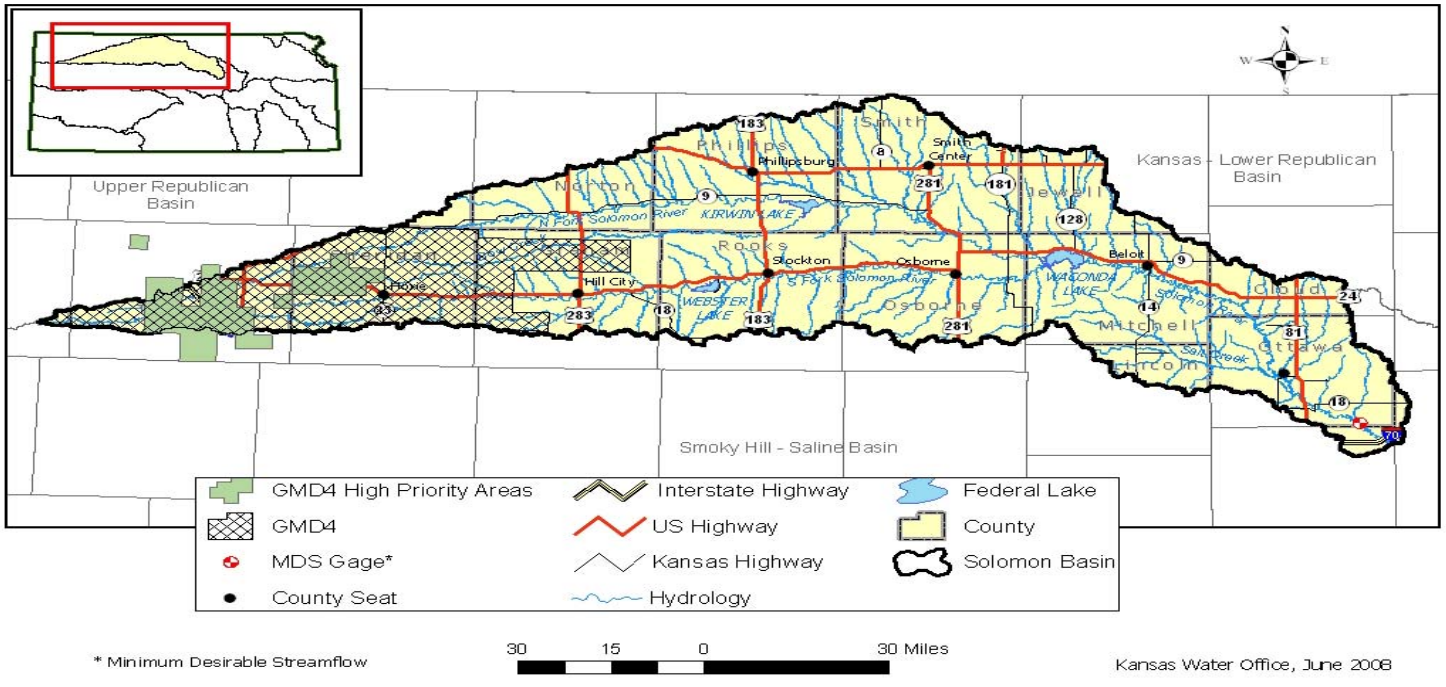


**Figure 4. Northwest Kansas GMD No. 4 High Priority Areas**

# Solomon Basin High Priority Issue
# Ogallala-High Plains Aquifer Declines
# January 2009

Progress toward reducing the aquifer decline rate was evaluated by the Kansas Water Office in 2006 using water level data from 1981 to 2005. The median annual water level changes were calculated for each region and standardized or indexed to antecedent moisture conditions using the Palmer Drought Severity Index (PDSI) for the appropriate region. The comparison of pre-1993 and 1993-2005 periods concluded that there was no discernable change in the rate of water level declines in the Ogallala–High Plains region. It also concluded that in the northwest Ogallala aquifer area (GMD4 and DWR fringe areas), as of 2005, there has been no statistically significant change (at a five percent error level) in the rate of decline.[4]

It should be noted that the percentage of total water use that has been reduced through voluntary and regulatory programs is small. A reduction of decline rates will likely take many years or decades to be recognizable unless participation and reductions are greater.

Priority Aquifer Subunits: Priority aquifer subunit maps are used to guide state and federal efforts on water conservation. The priority aquifer subunit areas are being further defined by the groundwater management districts inside each district, and the Division of Water Resources for areas of the Ogallala-High Plains aquifer outside of the district, with input from the public. Currently, Figure 5 illustrates priorities. This will be used until new priority aquifer subunit maps are defined and approved. Specific target areas are defined for areas eligible for enrollment in EQIP quick response areas and the Water Transition Assistance Program (WTAP).

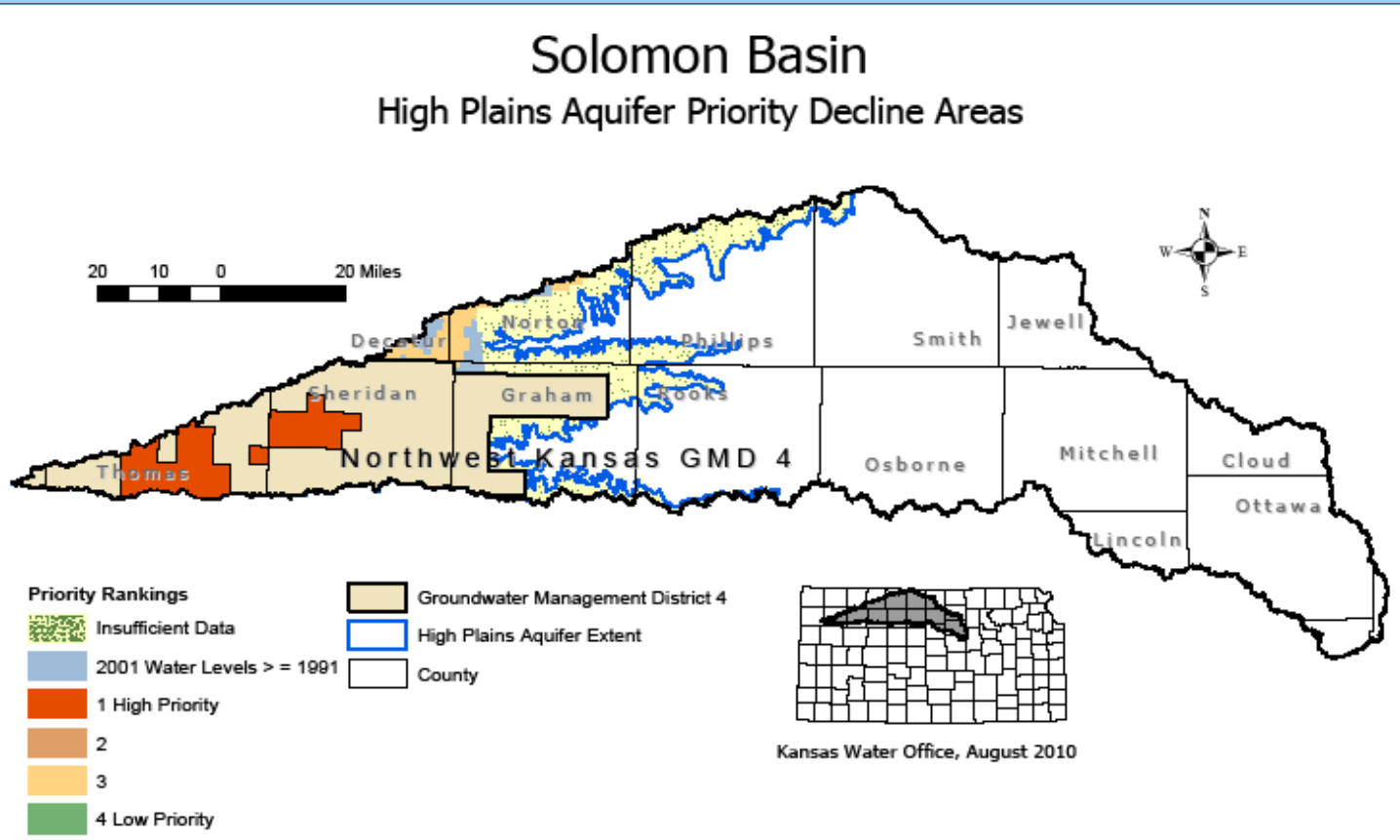


**Figure 5.**

The priority rank shown on this map outside GMD4 is based on an area's total score from two databases: estimated usable lifetime and density of ground water use. Useable lifetime is defined as the ability to support a 400 gpm well yield, on every quarter section, pumping for 90 days. Rank 1 indicates areas with a short estimated usable lifetime and a history of higher ground water usage. Rank 4, the lowest concern areas, have a relatively long useable lifetime and low total water use.

# *Solomon Basin High Priority Issue*
# *Ogallala-High Plains Aquifer Declines*
# *January 2009*

**Recommended Actions**

1. DWR should identify priority subunits. In their areas of responsibility, GMD4 and DWR should identify priority aquifer subunits or areas and develop specific goals and management strategies to extend and conserve the life of the aquifer.

2. GMD4 and DWR should manage aquifer subunits to maintain economic health while ensuring sufficient water resources for future generations of western Kansas communities and rural populations and chosen lifestyles.

3. Provide opportunities to permanently or temporarily reduce water use through voluntary programs (state, federal, and local).

4. Educate water users, decision makers and the general public on the condition of the aquifer and methods and opportunities to reduce water use.

5. Support research for high value, low water use crops.

6. Seek crop insurance option for limited irrigation crops from USDA Risk Management Agency.

In order to implement the actions stated above, the following specific activities are recommended:

- Provide technical support, including hydrologic modeling, if appropriate, to project current and future aquifer conditions. Identify and implement activities to promote local conservation to extend the life of the aquifer that accrues to the aquifer subunit or region where water savings has occurred.
- Recognize the benefit of aquifer subunit planning. Management of the aquifer by subunit can benefit the local community's economic well-being and social connectedness, reduce over pumping and well shut offs from impairments.
    - Encourage ownership in one's aquifer subunit; promote local leadership.
    - Form subunit teams for local leadership of aquifer subunits or other methods of managing local areas/subunits for reduced consumptive water use.
    - Target incentive based programs to aquifer subunits that have a long-term vision and plan.
    - Implement aquifer subunit plans that assure water into the future to help attract industry, thus contributing to the economic health of the subunit and area.
- Consider the long term impact of climatic change on the water demands for the region.
- Consider interstate discussions on water conservation and planning where aquifer subunits cross state boundaries, and are not directly impacting an existing surface water compact.

# Solomon Basin High Priority Issue
# Ogallala-High Plains Aquifer Declines
# January 2009

**Resources**


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3. Golden, Bill, Petersen, Jeff, and O'Brien, Dan. 2008. *Potential Economic Impact of Water Use Changes in Northwest Kansas*.

4. Kansas Water Office. 2006. *Ogallala Aquifer Water Level Decline Rate, Status Report*.

5. Northwest Kansas Groundwater Management District No 4. 2008. Water Resources Web Page. http://www.gmd4.org/newstuff.html. September 8, 2008.

6. Kansas Dept of Agriculture. 2007. *Kansas Irrigation Water Use Report 2006*.

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8. Perry, Charles. 2006. *Effects of Irrigation Practices on Water Use in the Groundwater Management Districts Within the Kansas High Plains, 1991-2003*. Scientific Report 2006-5069. United States Geological Survey.

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11. Young, David P, Whittemore, Donald O., and Wilson, Blake B. 2007. *Bedrock Surface and Aquifer Properties of the Alluvial Valleys of the Upper North and South Forks of the Solomon River Basin, Kansas.* Kansas Geological Survey Open-file Report 2007-4.


**Ogallala Outcrop. Photo courtesy Kansas Geological Survey**