GROUND-WATER RESOURCES PROGRAM

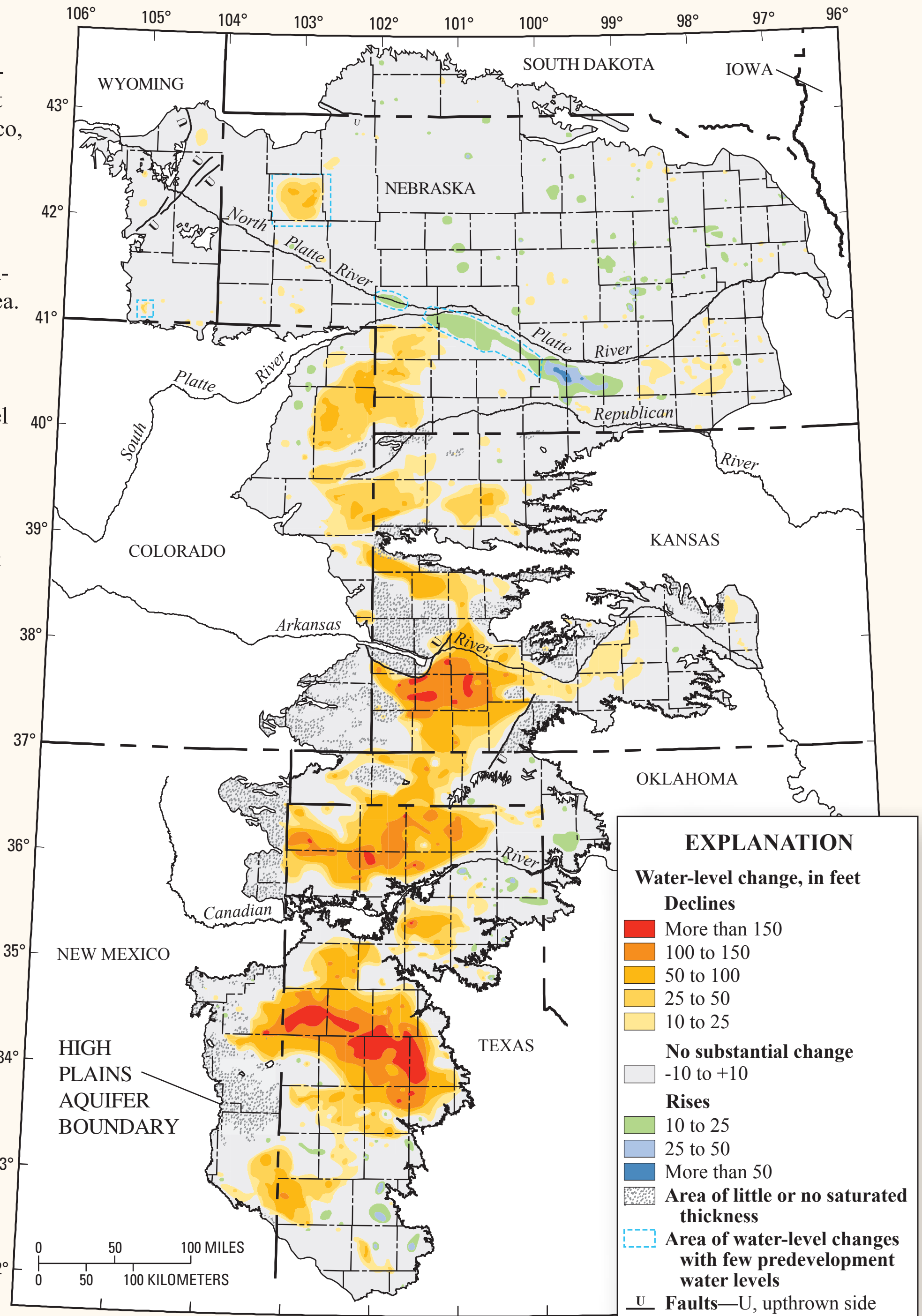
Changes in Water Levels and Storage in the High Plains Aquifer, Predevelopment to 2007

—By V.L. McGuire

The High Plains aquifer underlies 111.6 million acres (174,000 square miles) in parts of eight States—Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. The area overlying the High Plains aquifer is one of the primary agricultural regions in the Nation. Water-level declines began in parts of the High Plains aquifer soon after the beginning of substantial irrigation with ground water in the aquifer area. By 1980, water levels in the High Plains aquifer in parts of Texas, Oklahoma, and southwestern Kansas had declined more than 100 feet (Luckey and others, 1981). In response to these water-level declines, the U.S. Geological Survey (USGS), in collaboration with numerous Federal, State, and local water-resources agencies, began monitoring more than 7,000 wells in 1988 to assess annual water-level changes in the aquifer. This fact sheet summarizes changes in water levels and drainable water in storage in the High Plains aquifer from predevelopment (before about 1950) to 2007 and serves as a companion product to a USGS report that presents more detailed and technical information about water-level and storage changes in the High Plains aquifer during this period (McGuire, 2009).

The areas of water-level changes in the High Plains aquifer from the time before substantial ground-water irrigation development (predevelopment) to 2007 are shown in figure 1. Drainable water in storage is the fraction of water in the aquifer that will drain by gravity and can be withdrawn by wells. The remaining water in the aquifer is held in the aquifer material by capillary forces, and generally cannot be withdrawn by wells. Drainable water in storage is termed "water in storage" in this fact sheet (McGuire, 2009).

In parts of the area that overlie the High Plains aquifer, farmers and ranchers began using ground water for irrigation extensively in the 1930s and 1940s. Estimated irrigated acreage in the area overlying the High Plains aquifer increased from 1940 to 1980 and changed slightly from 1980 to 2005: 1949—2.1 million acres, 1980—13.7 million acres, 1997—13.9 million acres, 2002—12.7 million acres, 2005—15.5 million acres. In 2005, irrigated acres overlaid 14 percent of



Base from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area conic projection
Standard parallels 29°30' and 45°30', central meridian -101°

Figure 1. Water-level changes in the High Plains aquifer, predevelopment to 2007 (modified from Gutentag and others, 1984; Lowry and others, 1967; Luckey and others, 1981; and Burbach, 2007).

the aquifer area, not including the areas with little or no saturated thickness (McGuire, 2009).

About every 5 years, ground-water withdrawals for irrigation and other uses are compiled from water-use data and reported by the USGS and agencies in each State. Ground-water withdrawals from the High Plains aquifer for irrigation increased from 4 to 19 million acre-feet from 1949 to 1974. Ground-water withdrawals for irrigation in 1980, 1985, 1990, and 1995 were 4 to 18 percent less than withdrawals for irrigation in 1974. Ground-water withdrawals for irrigation were 21 million acre-feet in 2000 and 19 million acre-feet in 2005 (McGuire, 2009).

Water-level changes in the aquifer result from an imbalance between discharge and recharge. Discharge is primarily ground-water withdrawals for irrigation. Discharge also can include evapotranspiration where the water table is near the land surface, and seepage to streams, springs, and other surface-water bodies where the water table intersects the land surface. Recharge is primarily from precipitation. Other sources of recharge can be seepage from streams, canals, and reservoirs, and irrigation return flows.

Water-level declines may result in increased costs for ground-water withdrawals because of increased pumping lift and decreased well yields (Taylor and Alley, 2001). Water-level declines also can affect ground-water availability, surface-water flow, and near-stream (riparian) habitat areas (Alley and others, 1999).

Water-Level Changes, Predevelopment to 2007

The map of water-level changes in the High Plains aquifer from predevelopment to 2007 (fig. 1) was generated using methods described by McGuire (2009). The map is based on water levels from 3,643 wells, which were measured in both predevelopment and in 2007, and other previously published data in areas in Nebraska and Wyoming with few predevelopment water levels (Lowry and others, 1967; Luckey and others, 1981; Burbach, 2007; fig. 1).

The water-level changes from predevelopment to 2007 ranged from a rise of 84 feet in Nebraska to a decline of 234 feet in Texas. The area-weighted, average water-level change from predevelopment to 2007 was a decline of 14.0 feet. From predevelopment to 2007, water levels declined more than 10 feet in approximately 26 percent of the aquifer area, more than 25 feet in about 18 percent of the aquifer area, and more than 50 feet in about 11 percent of the aquifer area. In approximately 72 percent of the aquifer area, water-level changes ranged from a decline of 10 ft to a rise of 10 ft. In approximately 2 percent of the aquifer area, water levels rose more than 10 ft from predevelopment to 2007 (McGuire, 2009).

Change in Water in Storage, Predevelopment to 2007

Total water in storage in 2007 was about 2.9 billion acre-feet, which was a decline of about 270 million acre-feet since predevelopment. Water in storage for predevelopment was estimated from water in storage in 2000 and water-level changes from predevelopment to 2000. Changes in water in storage before predevelopment were not estimated (McGuire, 2009).

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For More Information

Director, USGS Nebraska Water Science Center
5231 South 19th Street
Lincoln, NE 68512
(402) 328–4100

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