Water Supply

Groundwater Sources and Supply

Kansas regulations broadly define groundwater as "water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers or the soil profile" (K.A.R. 28-16-28b(dd)). Groundwater in Kansas occurs in all of these features and is present across the state in various quantities, qualities and depths. Progressing west to east across the state, deep saturated aquifers change to shallower alluvial aquifers in most areas.

In western and south central Kansas, groundwater has historically been the most reliable source of large volumes of water for municipal, industrial and irrigation use. Quantities of available groundwater are declining in many areas, often due to overdevelopment. The Ogallala portion of the High Plains aquifer recharges at about one-half inch per year. Current irrigation practices pump water from the aquifer at a rate of two to four feet per year, and more.

In western Kansas, naturally limited surface water supplies, characteristic of a semi-arid climate, has been exacerbated by the decline of groundwater levels that historically provided baseflow to streams. In the past 50 years, many streams have gradually changed to intermittent or even ephemeral streams as the effects of lowering of the water table have manifested.

Scientists in local, state and federal agencies have been compiling information about groundwater resources for many years to recognize, understand and track trends and to inform decisions about management of the resource. In 2012, a Master Groundwater Well Inventory was established with support from the State Water Plan Fund (SWPF), and is maintained at the Kansas Geological Survey (KGS). This inventory provides an online central data repository for all the primary groundwater data sets in the state. Well completion logs, water rights information, annual water use and water well level data are accessible at the Kansas Master Ground-Water Well Inventory website.

Hydrologic models have been developed for many areas to further understand groundwater availability and use (Figure WS-01). Models help define the total water budget of a region and predict the response of the water system to changing conditions, such as droughts or floods, increased withdrawals or conservation measures.

In addition to the areas shown in Figure WS-01, a computer model is under development for the Western Kansas Groundwater Management District No. 1 (GMD) region which includes portions of Greeley, Wichita, Scott, Wallace and Lane counties. The Ogallala portion of the High Plains aquifer is the primary source of water in this region.

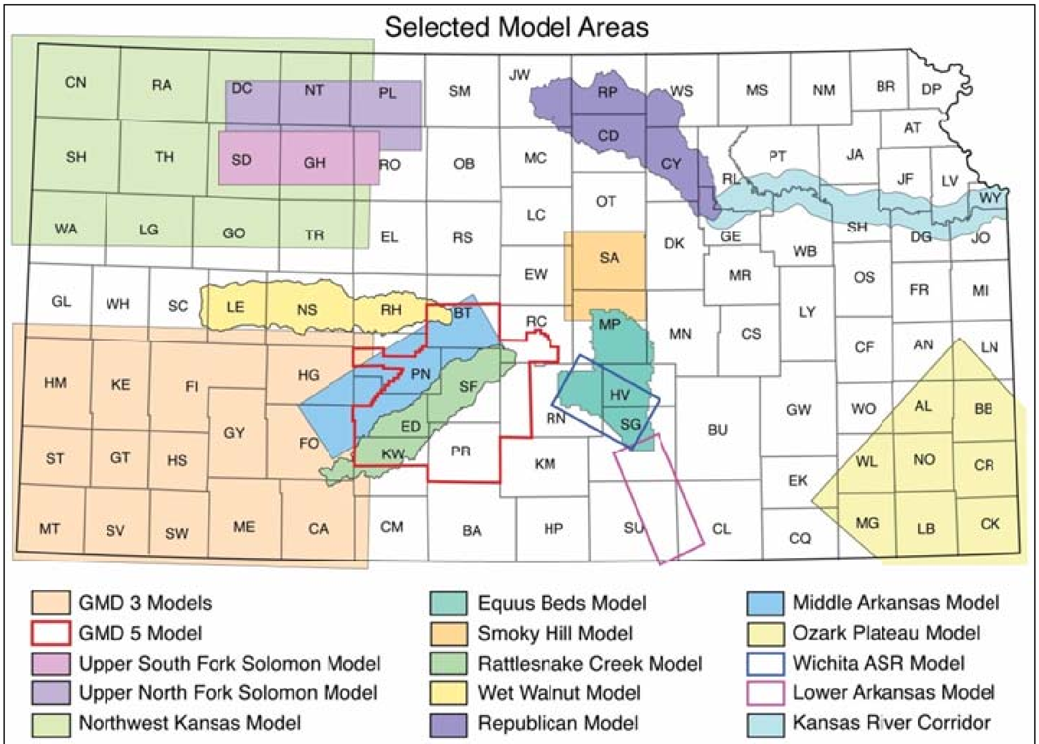

Figure WS-01. Locations of Hydrologic Models

Aquifers in Kansas

Alluvial Aquifers

Alluvial aquifers are associated with areas bordering streams and rivers. Alluvium is a general term for the unconsolidated sediments (sand, gravel, silt and clays) deposited by streams in river valleys. Alluvial deposits range in thickness from a few feet to as much as 300 feet. Depth to water is typically shallow and water stored in alluvial aquifers is usually directly connected to the stream. Where hydraulically connected, a distinction usually is not made between alluvial aquifer and the underlying High Plains aquifer.

Groundwater level declines in many stream valleys and associated alluvial aquifers have separated the interconnection with the stream and groundwater no longer provides baseflow into the stream. For example, in portions of the Pawnee, Walnut, Smoky Hill, Arkansas and Solomon rivers the groundwater no longer feeds the streams, and surface flows are intermittent, occurring only after large precipitation events or during releases from upstream reservoirs.

Groundwater recharge rate studies are useful in defining safe yield criteria for alluvial aquifers. An example is a study of the Lower Arkansas-Ninnescah River Alluvial aquifer from north of Wichita to Arkansas City and the Ninnescah River from Clearwater to its confluence with the Arkansas River.

High Plains Aquifer

In Kansas, the Ogallala, Great Bend Prairie and Equus beds are the primary aquifers that form the High Plains aquifer. Where interconnected, the alluvial aquifers are also considered part of the High Plains aquifer. Composed primarily of silt, sand, gravel and clay, from rock debris washed off the Rocky Mountains and other sources, the High Plains aquifer lies beneath eight states, covering approximately 174,000 square miles; in Kansas it includes 30,500 square miles.

In 2000, an estimated 21 million acre feet of water was pumped from the High Plains aquifer eight state region. In Kansas, an estimated 4.4 million acre feet of water was removed from the High Plains aquifer, 2.4 million acre feet from the Ogallala portion. In contrast, the average annual recharge to the Ogallala aquifer in Kansas is estimated at 0.72 million acre feet.

The Ogallala aquifer is the largest component covering the western third of the state. The eastern extension is formed by younger sediments deposited during the Ice Ages: the "Great Bend Prairie" aquifer in Stafford, Edwards, Pratt, Kiowa and parts of other counties, and the "Equus beds" aquifer in McPherson, Reno, Harvey and Sedgwick counties.

The High Plains aquifer is highly variable. The hydraulic conductivity, or how easily water moves through the aquifer, varies from less than 25 to over 200 feet/day. Depth to water varies from less than 25 to 50 feet in the Equus Beds, to over 350 feet in Haskell County, based on measurements from 2010 to 2012. Southwest Kansas has the greatest saturated thickness with over 300 feet still occurring in Seward and Stevens counties. West central Kansas averages less than 50 feet of saturated thickness.

Since 2007, the KGS, supported by the KWO, has hourly data in three index wells in the northwest, west central and southwest to gain a full understanding of the aquifer conditions, including recovery patterns when no irrigation is occurring.

Development of the Ogallala portion of High Plains aquifer is mature; most of the region is closed by order of Chief Engineer to new water right appropriations, or effectively closed through safe yield rules and regulations of Groundwater Management Districts.

The High Plains aquifer, particularly the Ogallala portion, has had long term declines in most regions due to widespread irrigation development and pumping.

A 2010 model of the Southwest Kansas GMD 3 region indicated groundwater pumping caused a nearly 30% decrease in aquifer storage from pre-development to 2007, for an average decline of roughly 70 feet. As groundwater levels declined, eventually there was a loss in the groundwater discharging to streams.

Droughts in southwest and south central Kansas in 2011 and throughout the State in 2012 led to increased irrigation pumping. Drought is persisting into early 2013. Until the drought conditions end, steep declines in the Ogallala aquifer are expected to continue. The water level declines in southwest Kansas from 2011 to 2012 averaged just over 4 feet; the five (2007 to 2012) year cumulative declines for the region average 13.24 feet. This region has had the largest declines. It is also the region that has the heaviest withdrawals, reflecting the greater aquifer storage.

Dakota Aquifer

The Dakota aquifer underlies most of the western two thirds of the state. Thirty six counties in the state have water rights permitted in the Dakota aquifer as a sole or partial component. The Dakota aquifer is developed as a water supply where fresh (<300 mg/L total dissolved solids) or only slightly saline, and other freshwater is not more easily available. In north central, central and parts of the southwest, the aquifer has substantial freshwater supplies.

In 2011, 2,237 wells reported active use of the Dakota aquifer. Use of the Dakota aquifer is highest in southwest Kansas (~86% of reported total use), primarily for irrigation. Most of these wells are where the Dakota underlies the High Plains aquifer. Estimated annual average withdrawals of 117,000 acre feet/year occurred between 2006 and 2010. Although the total amount of water withdrawn from the Dakota is a relatively small percentage, new construction of High Plains aquifer wells often is completed in both the High Plains and Dakota aquifers, so use of the aquifer is increasing. There are an estimated 11,000 domestic wells screened at least partially in the Dakota. Most of these are in north-central Kansas. Large areas of the Dakota aquifer are saline with concentrations that exceed 10,000 mg/L total dissolved solids. Other water quality concerns with the Dakota include fluoride, arsenic, nitrate, uranium, and radioactivity from radium isotopes and alpha particles.

Ozark Plateau Aquifer System

The Ozark aquifer system consists of the Ozark aquifer and the overlying Springfield Plateau aquifer, with a discontinuous confining unit separating the two aquifers. Originating in southern Missouri, it flows through southeast Kansas and into northeast Oklahoma and northern Arkansas. The groundwater flows in Kansas are almost entirely dependent on flows originating in Missouri.

Water quality in the aquifer is at risk from induced recharge from the overlying Springfield aquifer with its many contamination plumes related to mining and industry and the underlying and eastward migrating brine (salt) water. To the west, a 30 to 60 mile transition zone separates the Ozark aquifer from more saline water. The brine water can migrate east with further declines in the Ozark aquifer. A Kansas geological study projected the chloride concentration from eastward migration could exceed recommended drinking water limits in two of the City of Pittsburg wells by 2045 or 2060, if pumping rates and patterns continue.

Quantity concerns arose from significant declines in some Kansas wells, with increased use of the aquifer in Missouri. A computer model of the system by the USGS helped quantify Ozark aquifer supplies in Kansas. With this model, safe yield in Kansas was determined to be 36,000 acre feet annually, roughly three times the 2010 levels of authorized use.

Glacial Drift Aquifers

Glacial deposits cover the far northeast counties in Kansas. Complex interbedding of fine and course-grained material is characteristic of glacial deposits. Sand beds of 20 to 40 feet thick within these deposits are the most common water bearing sources. As with alluvial aquifers, no distinction is made between the glacial drift aquifer and the stream where there is a hydraulic interconnection.

Yields of wells completed in the glacial drift are highly variable both in yield and transmissivity. Sustainable yield is difficult to estimate as little is known of the aquifer hydrologic properties or its response to pumping. There continues to be development of the glacial drift aquifers, particularly in Jefferson and Atchison counties in northeast Kansas. Geologic mapping of this region (due 2014), will further define the hydrologic resources. Chemical quality is generally hard, but suitable for most uses. Elevated nitrate (>10 MCL) is a concern in some of these areas.

Minor Aquifers

The Wellington aquifer, part of the Sumner Group aquifer, occurs in eastern Sedgwick and western Butler Counties in extensively fractured shales of the Permian aged Wellington Formation. There is active development of the Sumner Group aquifer as part of the wider Wichita area. Portions of the Wellington aquifer have very high chloride levels (up to 180,000 mg/L), and in some areas along the Smoky Hill and Arkansas River valleys, discharge into the overlying fresh water alluvial aquifer.

Osage Cuestas aquifer

The Osage Cuestas aquifer system consists of fluvial sandstones that provide small quantities of water. The Osage Cuestas aquifer is an important source for many smaller communities, rural water districts and farms in Douglas, Franklin, Osage, Coffey, Montgomery and Elk counties.

Flint Hills Aquifer

The Flint Hills aquifer consists of limestone units that are water bearing strata for many springs and public water supplies in the Flint Hills region.

Equus Beds Aquifer

The Equus Beds aquifer is a part of the High Plains aquifer system, being comprised of silt, sand, gravel, clay, and rock of Quaternary age (younger than the Ogallala formation). Depth to water varies from 10 to 40 feet below ground surface (bgs) in the southern extent, to roughly 40 to 110 feet bgs in the northern McPherson area. Greatest saturated thickness is associated with ancestral bedrock channels. The 2011 to 2012 water level measurements indicated an average 3.12 foot decline, although over a five year period (2007 to 2011) declines averaged just 0.11 feet. The City of Wichita well field was developed in the Equus Beds aquifer beginning in 1940. Declines can be attributed to pumpage of the aquifer for both city and irrigation water. In 1965, Wichita increased its reliance on the newly built Cheney Reservoir for water supplies in order to decrease pressure on the aquifer from public water supply demands.

In 1993, the City of Wichita adopted a water supply plan which included development of an Aquifer Storage and Recharge (ASR) project. The ASR was developed, in part, to protect city water supplies from encroachment of saltwater from natural sources to the southwest and oilfield brine to the northwest by creating a hydraulic ridge. The ASR also serves to help meet the City's water supply needs. Water is diverted from the Little Arkansas River when flows exceed base flow, recharging the aquifer to levels required to meet the City's projected needs in 2020.

In 2006, Phase I of the Equus Beds ASR project was completed. The USGS has a groundwater flow model developed around the City of Wichita's Equus Beds ASR site. The model simulates chloride transport and groundwater flow in the Wichita well field area. Recharge to the site varies from four to 27%, depending on the soil types and as a percentage of precipitation. This model can be used to evaluate management and pumping scenarios.

Great Bend Prairie Aquifer

The Great Bend Prairie aquifer is also a part of the High Plains aquifer system. The average of recharge estimates is approximately two inches/year, with an average recharge range of 1.7-2.5 inches/year.