BLANKET SAND AND GRAVEL AQUIFERS— Continued

The High Plains aquifer is the most intensively pumped aquifer in the United States. During 1990, about 15 billion gallons per day, or about 17 million acre-feet per year, of water was withdrawn from the aquifer. An acre-foot is the volume of water that will cover one acre of land to a depth of one foot, or 43,560 cubic feet of water. Most of this water (almost 16 million acre-feet) was withdrawn for irrigation (**fig. 8**). Withdrawals during 1978 were much greater, with irrigation withdrawals amounting to almost 23 million acre-feet. Average annual withdrawals of water from the aquifer are much larger (2 to 35 times larger) than natural recharge to the aquifer. By 1980, withdrawals had resulted in water-level declines of more than 100 feet in parts of the aquifer in southwestern Kansas and the Texas panhandle (**fig. 9**). Declines were greatest in Texas, Kansas, and Oklahoma. Water levels rose locally in the aquifer, particularly in Nebraska, in response to increased recharge where surface water that was applied for irrigation infiltrated the aquifer.

The saturated thickness of the High Plains aquifer is the vertical distance between the water table and the base of the aquifer. In 1992, the saturated thickness of the aquifer ranged from 0 where the sediments that comprise the aquifer are unsaturated to about 1,000 feet in parts of Nebraska and averaged about 190 feet. Ground-water development has caused changes in the saturated thickness of the aquifer, because this thickness changes as aquifer water levels change. Between predevelopment conditions and 1980, the saturated thickness of the aquifer decreased in many places (**fig. 10**), but locally increased in Texas and Nebraska. The areas of increase are the result of increased recharge to the aquifer by one or more of the following factors: greater than normal precipitation; decreased withdrawals; or downward leakage of surface-water irrigation and water from unlined canals and reservoirs. Decreases in saturated thickness of 10 percent or more result in a decrease in well yields and an increase in pumping costs because the pumps must lift the water from greater depths.

Water in the High Plains aquifer generally is unconfined. Locally, clay beds confine the water, but regionally, water-table conditions prevail. The configuration of the 1980 water-table surface of the aquifer (**fig. 11**) generally conforms to the configuration of the land surface. Regional movement of water in the aquifer is from west to east; locally, the water moves toward major streams. The water-table contours bend upstream where they cross the North Platte, the Republican, and the Canadian Rivers (**fig. 11**), indicating that water moves from the aquifer to the rivers. By contrast, the contours are either straight or bend downstream where they cross the Arkansas River, indicating that the Arkansas is a losing stream and water from the river recharges the aquifer.

Significant parts of the High Plains aquifer in Kansas, Colorado, and New Mexico are unsaturated, as shown in **figure 11**. In these areas, the water table is discontinuous and only local supplies of water can be obtained from filled channels that have been eroded into bedrock.

Other blanket sand and gravel aquifers include the Seymour aquifer of Texas (fig. 4) which, like the High Plains aquifer, was deposited by braided, eastward flowing streams but has been dissected into separate pods by erosion; the Mississippi River Valley alluvial aquifer, which consists of sand and gravel deposited by the Mississippi River as it meandered over an extremely wide floodplain; and the Pecos River Basin alluvial aquifer, which is mostly stream-deposited sand and gravel, but locally contains dune sands.

GLACIAL-DEPOSIT AQUIFERS

Large areas of the north-central and northeastern United States are covered with sediments that were deposited during several advances and retreats of continental glaciers. The massive ice sheets planed off and incorporated soil and rock fragments during advances and redistributed these materials as ice-contact or meltwater deposits or both during retreats. Thick sequences of glacial materials were deposited in former river valleys cut into bedrock, whereas thinner sequences were deposited on the hills between the valleys. The glacial ice and meltwater derived from the ice laid down several types of deposits, which are collectively called glacial drift. Till, which consists of unsorted and unstratified material that ranges in size from boulders to clay, was deposited directly by the ice. Outwash, which is mostly stratified sand and gravel, and glacial-lake deposits consisting mostly of clay, silt, and fine sand, were deposited by meltwater. Ice-contact deposits consisting of local bodies of sand and gravel were deposited at the face of the ice sheet or in cracks in the ice. The glacial sand and gravel deposits form numerous local but highly productive aquifers in the area shown in **figure 4**. These glacial-deposit aquifers overlie bedrock aquifers in many places. Holocene alluvium that forms productive aquifers in many river valleys in the glaciated areas is derived from reworked glacial deposits and is not distinguished from the glacial deposits in the Atlas. Likewise, sand and gravel deposited by mountain, or alpine, glaciers in Alaska, the northern Rocky Mountains, and the Puget Sound area form local aquifers that are mapped together with alluvial sand and gravel with which they commonly are connected.

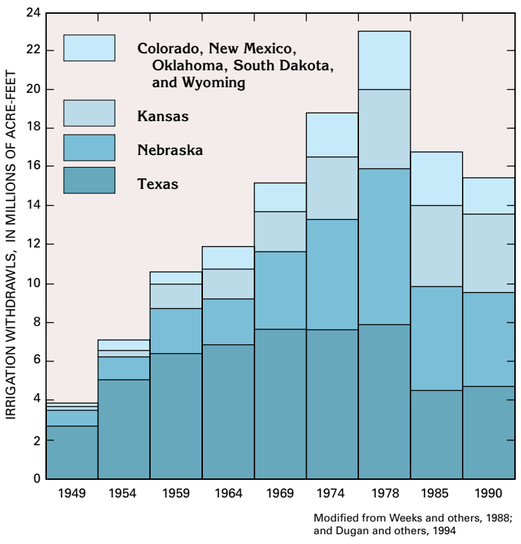

Figure 8. *Ground-water withdrawals from the High Plains aquifer for irrigation account for most of the discharge from the aquifer. Irrigation withdrawals have been largest in Texas and Nebraska.*

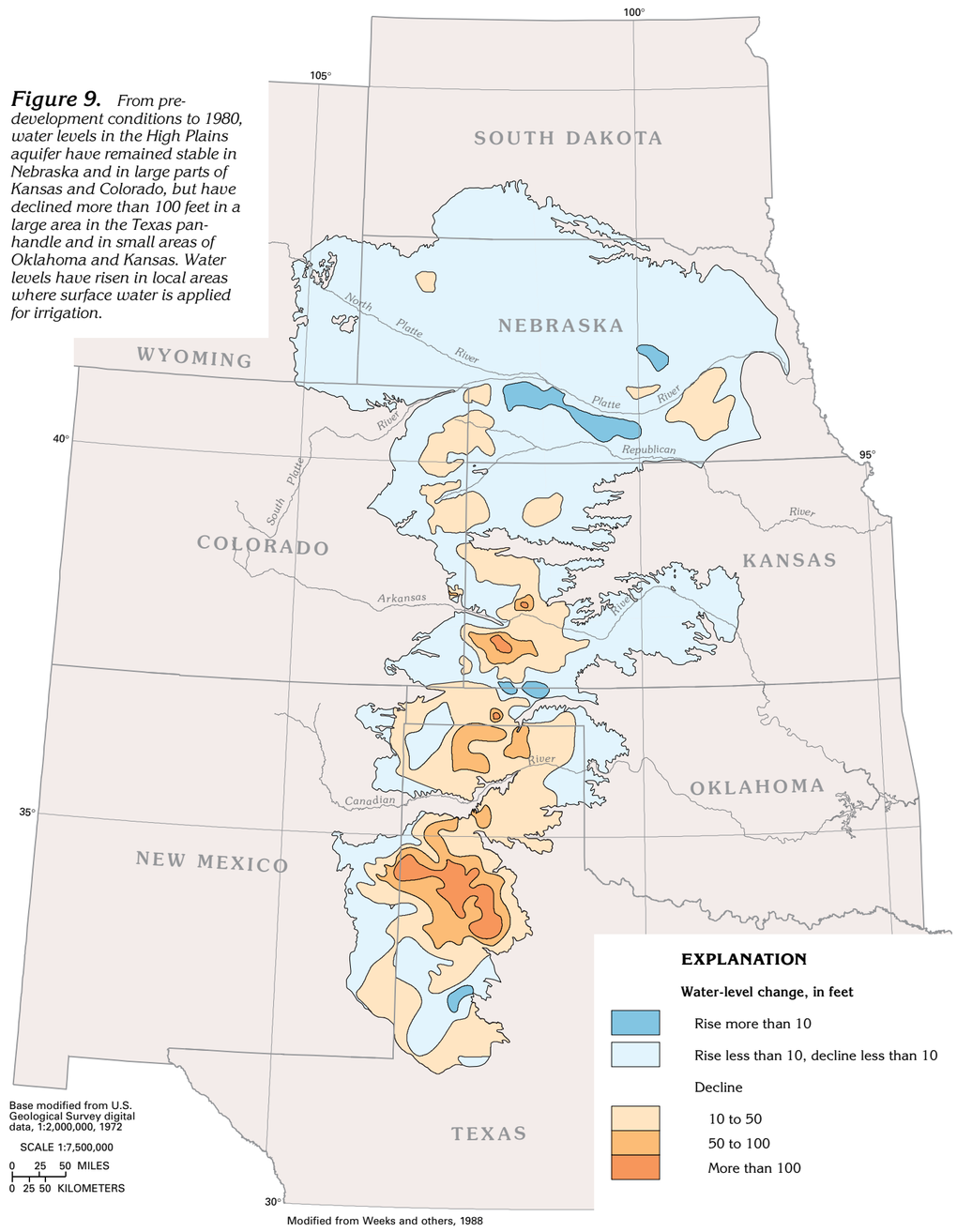

Figure 9. *From predevelopment conditions to 1980, water levels in the High Plains aquifer have remained stable in Nebraska and in large parts of Kansas and Colorado, but have declined more than 100 feet in a large area in the Texas panhandle and in small areas of Oklahoma and Kansas. Water levels have risen in local areas where surface water is applied for irrigation.*

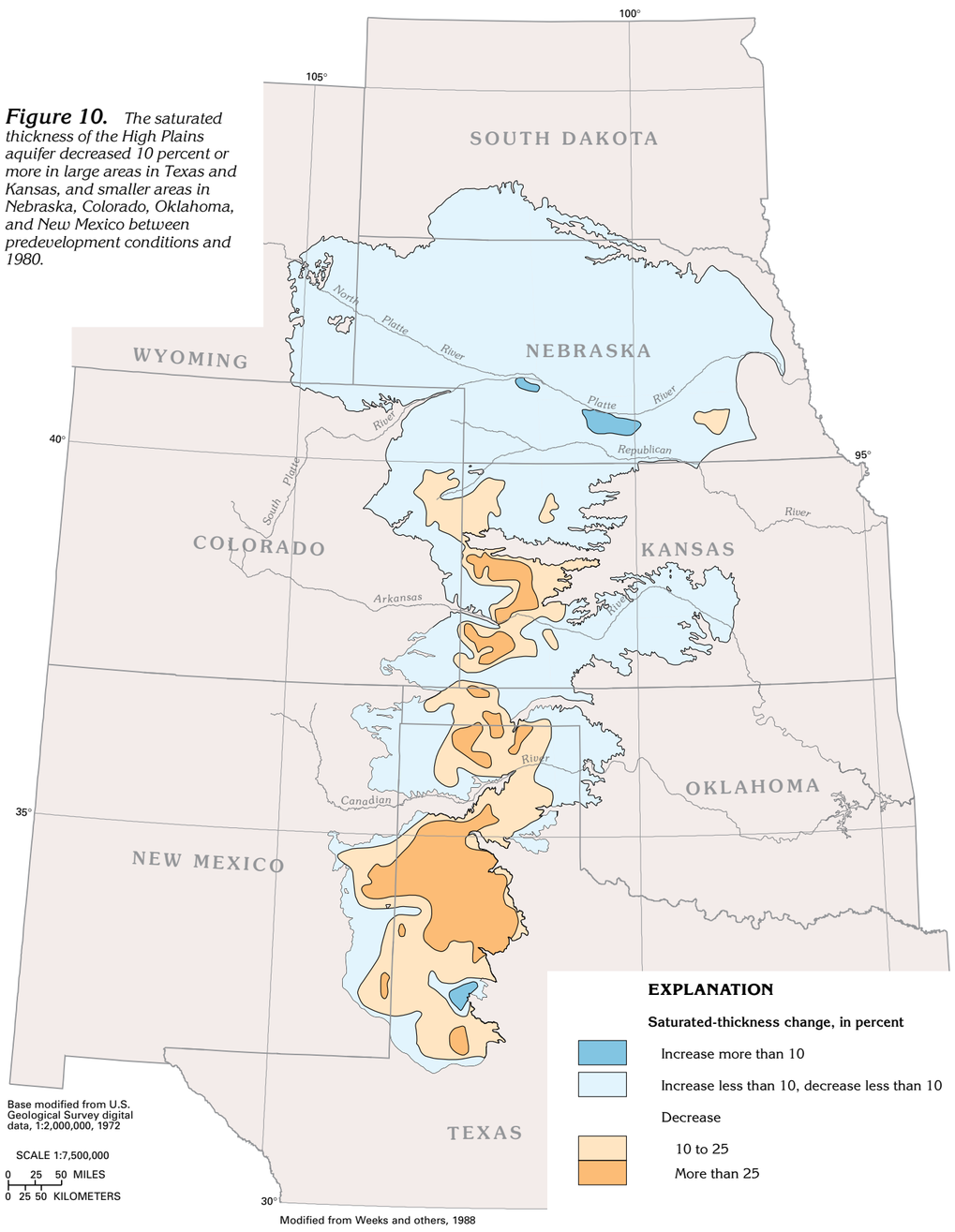

Figure 10. *The saturated thickness of the High Plains aquifer decreased 10 percent or more in large areas in Texas and Kansas, and smaller areas in Nebraska, Colorado, Oklahoma, and New Mexico between predevelopment conditions and 1980.*

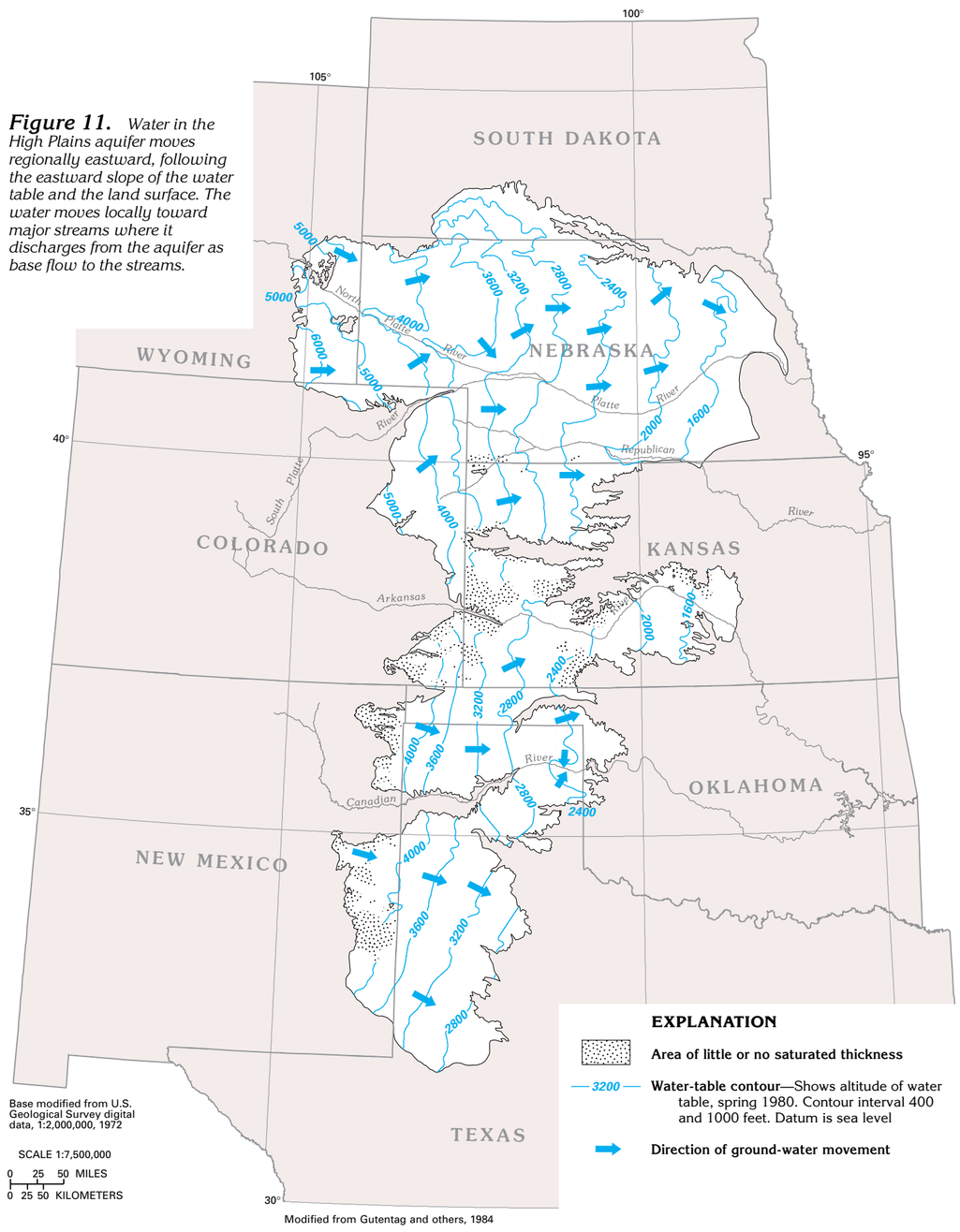

Figure 11. *Water in the High Plains aquifer moves regionally eastward, following the eastward slope of the water table and the land surface. The water moves locally toward major streams where it discharges from the aquifer as base flow to the streams.*