PREPARED IN COOPERATION WITH THE
COLORADO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RESOURCES,
OFFICE OF THE STATE ENGINEER; THE DENVER BOARD OF WATER COMMISSIONERS;
AND ADAMS, ARAPAHOE, DOUGLAS, ELBERT, AND EL PASO COUNTIES

HYDROLOGIC CONDITIONS

Most precipitation that falls on the land surface runs off in streams and creeks, is evaporated from the soil surface, or is consumed by vegetation. In addition, a small part of the precipitation usually percolates to depth and recharges the ground-water supply. The diagram of ground-water movement (fig. 7) illustrates the principal methods of recharge to the Denver aquifer. In the outcrop area, recharge occurs as deep infiltration of precipitation in the highland areas between stream channels or as infiltration of water from alluvial aquifers located above the water level in the bedrock aquifer. In the central part of the basin, downward movement of water from the overlying Dawson aquifer is probably the principal source of recharge in this 1,200-square-mile area. Most water moves laterally through the sandstone and siltstone beds from areas of recharge toward areas of discharge. This can occur on both a local and regional scale. On a local scale, water moves from the highland recharge areas in the outcrop through the upper part of the aquifer to the discharge areas in nearby stream valleys. On a regional scale, water moves from outcrop recharge areas, or from the central part of the study area, into deeper parts of the aquifer and discharges in more remote stream valleys. In the stream valleys, water from the Denver aquifer discharges into streams, into the alluvial aquifers along the stream channels, or is consumed by vegetation growing in the valleys. Although most of the water in the Denver aquifer flows laterally through the aquifer, some water discharges by moving downward from the Denver aquifer into the underlying Arapahoe aquifer. In addition to these long-standing processes of natural discharge, relatively recent discharge is occurring from pumping wells. In areas where pumping has caused significant water-level declines, natural discharge no longer may occur and pumpage may be the only ground-water discharge.

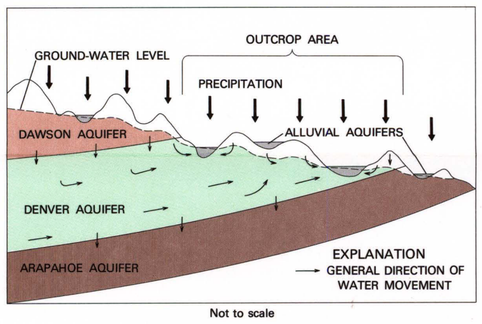

FIGURE 7.—DIAGRAM OF GROUND-WATER MOVEMENT

Perennial streams that are cut into the Denver Formation may be supplemented either directly or indirectly by ground-water discharge from the Denver aquifer. Streamflow is directly supplemented by springs and seeps that occur as a result of natural discharge of water from the Denver aquifer at the land surface. Streamflow is indirectly supplemented where water from the Denver aquifer first discharges into alluvial aquifers and the water in the alluvial aquifer in turn discharges into the stream.

The 1978 potentiometric surface map (fig. 8) shows the elevation of the standing-water level during 1978 in wells completed in the Denver aquifer. The elevation of the potentiometric surface was highest in the southern part of the aquifer and lowest near Commerce City. Water in the aquifer moves from points of higher water-level elevation to points of lower water-level elevation along paths that are perpendicular to the potentiometric contours shown on the map. The arrows on the map indicate the general direction of this water movement. In the northern, eastern, and southern parts of the aquifer, water generally is moving from the south-central part of the area toward the margins of the aquifer. The relatively sharp bends in the potentiometric contours near some small streams are the result of water moving from the aquifer into the stream valleys. Near the western edge of the aquifer, water is moving either approximately parallel to the aquifer limit or is moving east from the aquifer limit toward the South Platte River. Ground water flows from the west, east, and southeast into a major trough in the potentiometric surface extending along Plum Creek and the South Platte River to the area northeast of Commerce City. The trough was originally shallower, being formed by the natural discharge of ground water into the South Platte River and its tributaries, but it has been deepened during the past 100 years by pumpage in the Denver metropolitan area.

The 1978 potentiometric surface in the Denver aquifer generally was 0 to 100 feet above the water level in the alluvial aquifers along Clear, Plum, and Cherry Creeks. This difference in water level would have allowed water to move from the Denver aquifer into these alluvial aquifers. Along the South Platte River and Coal and First Creeks the potentiometric surface in the aquifer generally was 0 to 300 feet below the water level in the alluvial aquifers. This would have allowed water to move from these alluvial aquifers into the Denver aquifer. Near Commerce City the potentiometric surface in the Denver aquifer is generally 100 to 300 feet higher than the potentiometric surface in the underlying Arapahoe aquifer. This would allow the downward movement of water from the Denver aquifer into the underlying Arapahoe aquifer.

In the central part of the aquifer, water-level data for the Denver aquifer are unavailable and the potentiometric surface cannot be accurately defined. However, in rural areas, water levels in the Denver aquifer appear to be similar to, or a few tens of feet lower than those in the Dawson aquifer. In areas where ground-water pumpage is large, such as the suburban area southeast of Denver, the water levels in the Denver aquifer are 100 to 200 feet below water levels in the Dawson aquifer. If, as these data indicate, the shape of the potentiometric surface is generally similar in the two aquifers, then the general direction of water movement in the Dawson aquifer also will indicate the general direction of water movement in the central part of the Denver aquifer. It thus seems likely that a ground-water divide occurs in the Denver aquifer near a line from Monument to Calhan. Ground water north of the divide moves in a northerly direction while ground water south of the divide moves in a southerly direction.

Water-level measurements made between 1956 and 1960 in wells completed in the Denver aquifer were used to estimate the 1958 potentiometric surface. These data were adequate to define this surface only in the northwestern part of the area, as shown on figure 9. The direction of ground-water movement in 1958 was similar to the direction of movement during 1978.

The difference in potentiometric-surface elevations between 1958 and 1978 is the change in water level that has occurred in the aquifer during the 20-year period. Water-level declines have exceeded 200 feet in a 40-square-mile area east of Denver, and declines exceeding 50 feet have occurred in large areas along the eastern and southern edges of the metropolitan area (fig. 10). These water-level declines are the result of two factors. First, the rate of ground-water pumpage has increased in these areas as suburban development has spread from the Denver metropolitan area. Second, significant water-level declines which occurred in the central part of the metropolitan area prior to 1958 have gradually spread into the suburban areas and further contributed to the water-level declines in these areas. Water-level rises of as much as 100 feet in the central part of the metropolitan area are due to a decrease in pumping in this area since 1958 in response to the increased availability of municipal water supplied from surface-water sources. Near Cherry Creek Reservoir the water level in the Denver aquifer rose more than 50 feet probably as a result of recharge from the reservoir. The 1958 to 1978 water-level change data from wells at a few scattered locations in other parts of the Denver aquifer generally show water-level rises or declines of less than 50 feet with no consistent pattern in these areas.

During 1883 and 1885, water-level measurements were made in a few wells completed in the Denver aquifer near the South Platte River in the central metropolitan area (Emmons and others, 1896). Water levels measured in those years were generally 30 to 80 feet above land surface and it was common for water to flow from uncapped wells in this area. By 1958, water levels in this area had declined 120 to 160 feet below the 1885 levels. By 1978, water levels in this area had risen slightly but remained about 100 to 130 feet below the 1885 levels.

Wells completed in the Denver aquifer generally yield from 0.05 to 1.0 gallon per minute per foot of drawdown. Therefore, if the water level in a well declines 100 feet while the pump is operating, the well probably would yield between 5 and 100 gallons per minute. Three factors that affect the yield of a well are: (1) The thickness of water-yielding material penetrated by the well, (2) the permeability of the material, and (3) the distance the water level in the well can be drawn down while the pump is operating. Thus, a well completed in a large thickness of permeable sandstone at sufficient depth to allow a significant water-level drawdown while pumping would yield more water than a well completed in a thin, less permeable sandstone that has a water level near the base of the sandstone.

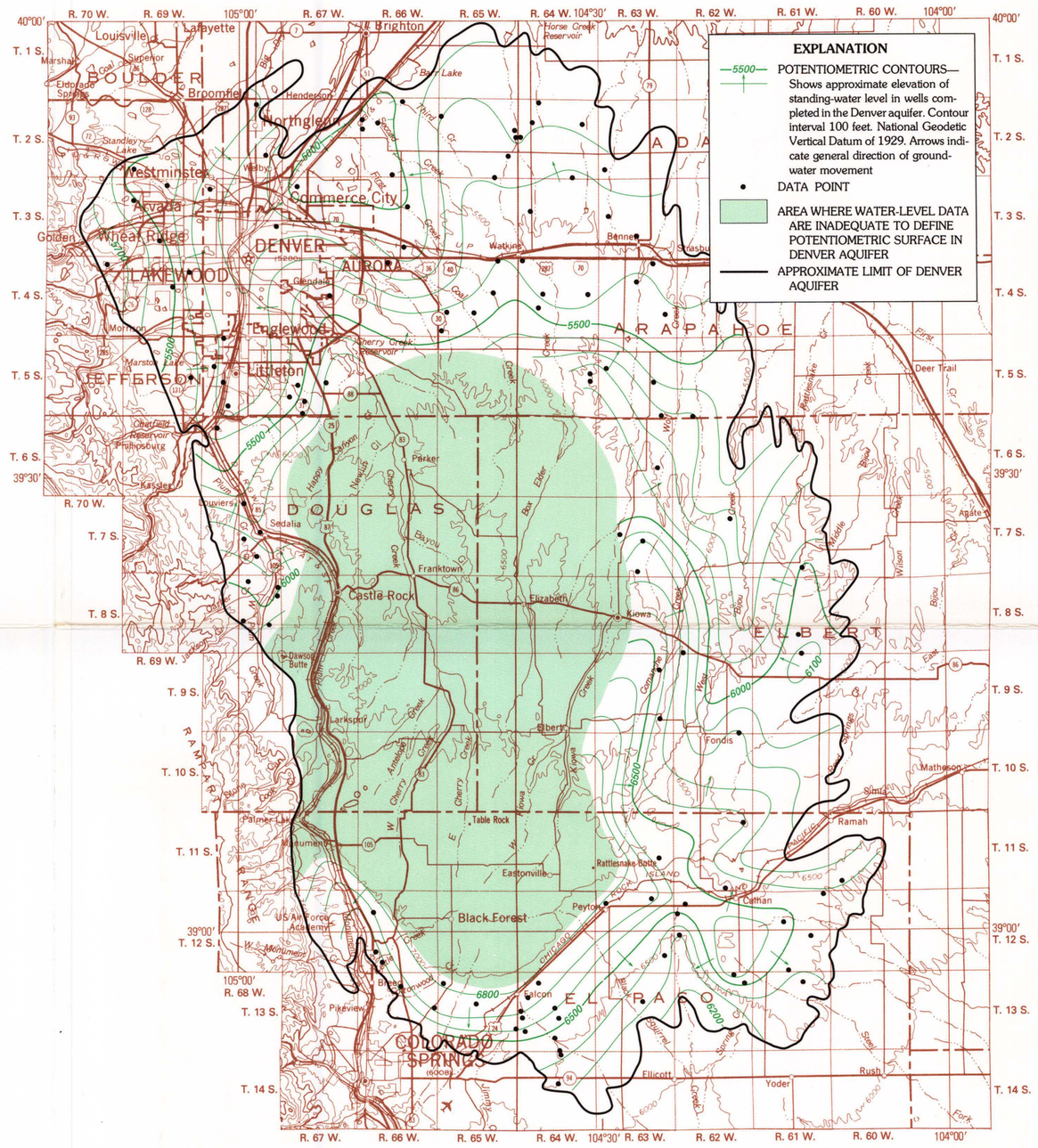

FIGURE 8.—MAP SHOWING ELEVATION OF POTENTIOMETRIC SURFACE IN THE AQUIFER, 1978

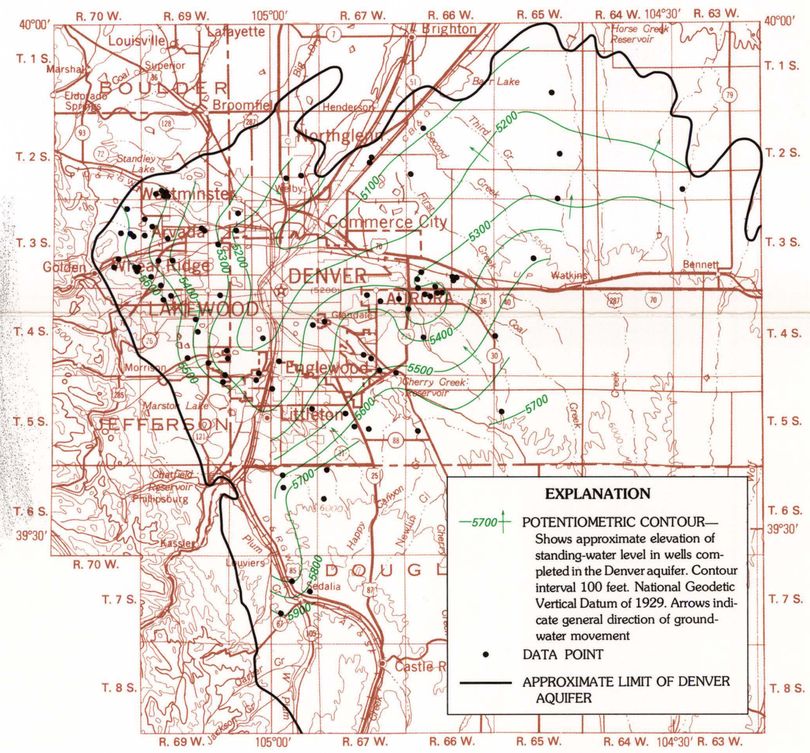

FIGURE 9.—MAP SHOWING ELEVATION OF POTENTIOMETRIC SURFACE IN THE AQUIFER, 1958

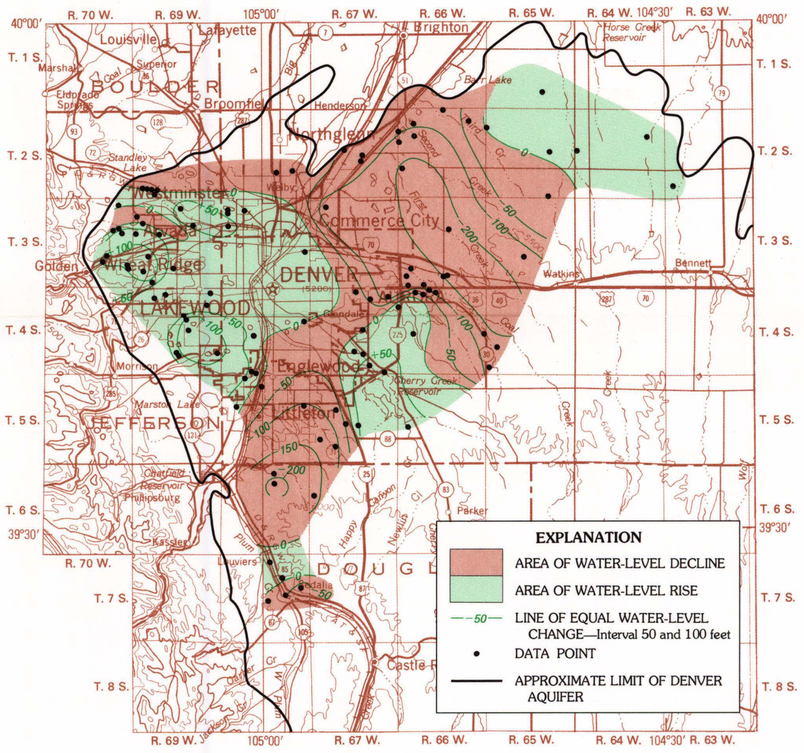

FIGURE 10.—MAP SHOWING WATER-LEVEL CHANGES IN THE AQUIFER BETWEEN 1958 AND 1978

Base from U.S. Geological Survey
State base map, 1969

SCALE 1:500 000

10 0 10 20 30 40 50 MILES

10 0 10 20 30 40 50 KILOMETERS

CONTOUR INTERVAL 500 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1981—W80585

GEOLOGIC STRUCTURE, HYDROLOGY, AND WATER QUALITY OF THE DENVER AQUIFER IN THE DENVER BASIN, COLORADO

By
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John C. Romero, Colorado Division of Water Resources

1981