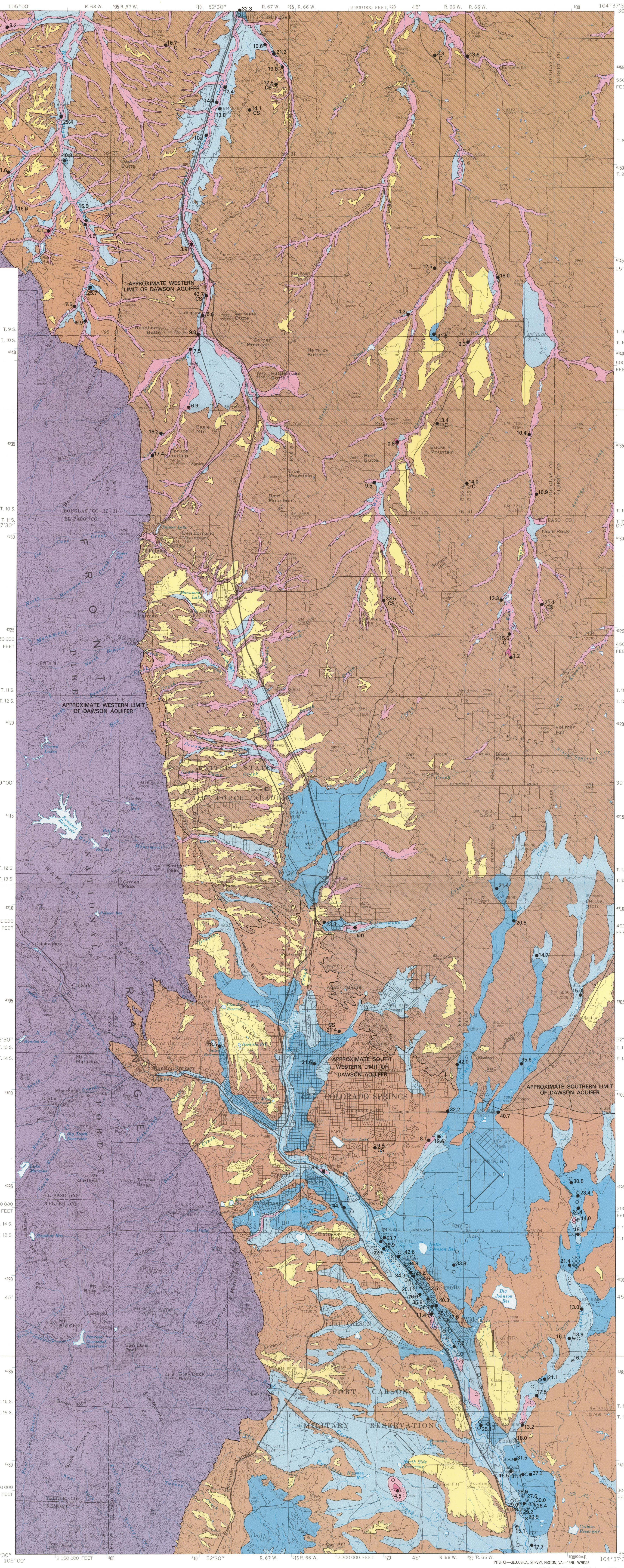
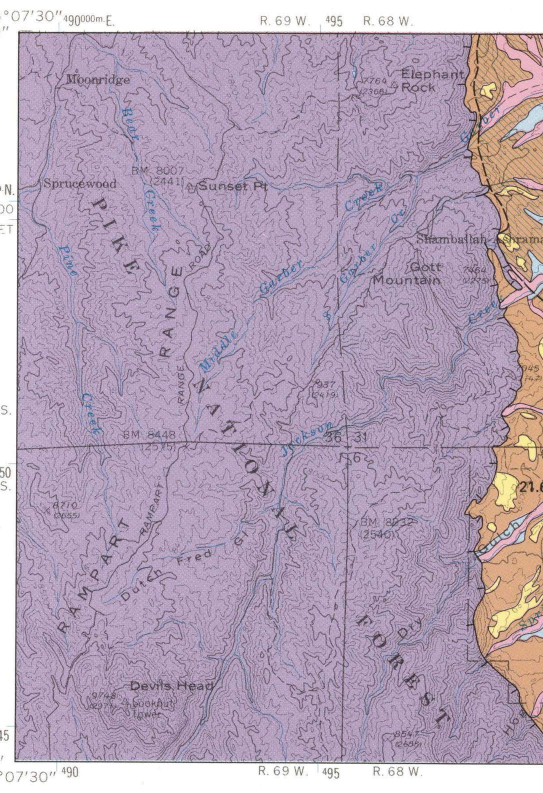



EXPLANATION

DEPTH TO WATER TABLE IN UNCONSOLIDATED ALLUVIAL DEPOSITS[1], IN FEET BELOW LAND SURFACE

- Less than 5
- 5 to 10
- 10 to 20
- Greater than 20

AREAS WHERE UNCONSOLIDATED ALLUVIAL DEPOSITS ARE NOT PERENNIALLY SATURATED; DEPTH TO SEASONAL WATER TABLE GENERALLY RANGES FROM 5 TO 20 FEET—Where areas are not irrigated, the deposits usually are drained by midsummer. Where areas are irrigated, seasonal water table may remain through the growing season with drainage of deposits occurring during the autumn

AREA OF DAWSON AQUIFER; DEPTH TO WATER-TABLE GENERALLY MORE THAN 20 FEET AND COMMONLY MORE THAN 100 FEET—Shallowest depths to water table generally occur along stream valleys and in colluvial deposits

AREAS WHERE LOCALIZED WATER-TABLE AQUIFERS OCCUR IN COLLUVIAL, LANDSLIDE, AND WINDBLOWN DEPOSITS, AND IN CONSOLIDATED SEDIMENTARY ROCKS WHERE ROCKS NEAR LAND SURFACE ARE FRACTURED AND WEATHERED—Aquifer materials may not be perenially saturated; depth to water table generally ranges from 5 to 20 feet; depth to seasonal water table generally less than 10 feet

AREA WHERE LOCALIZED WATER-TABLE AQUIFERS OCCUR IN FRACTURED CRYSTALLINE ROCKS—Fractures may not be perenially saturated; depth to water table may be more than 100 feet

CONTACT BETWEEN UNCONSOLIDATED ALLUVIAL DEPOSITS AND OTHER DEPOSITS AND ROCKS—Dashed where approximately located

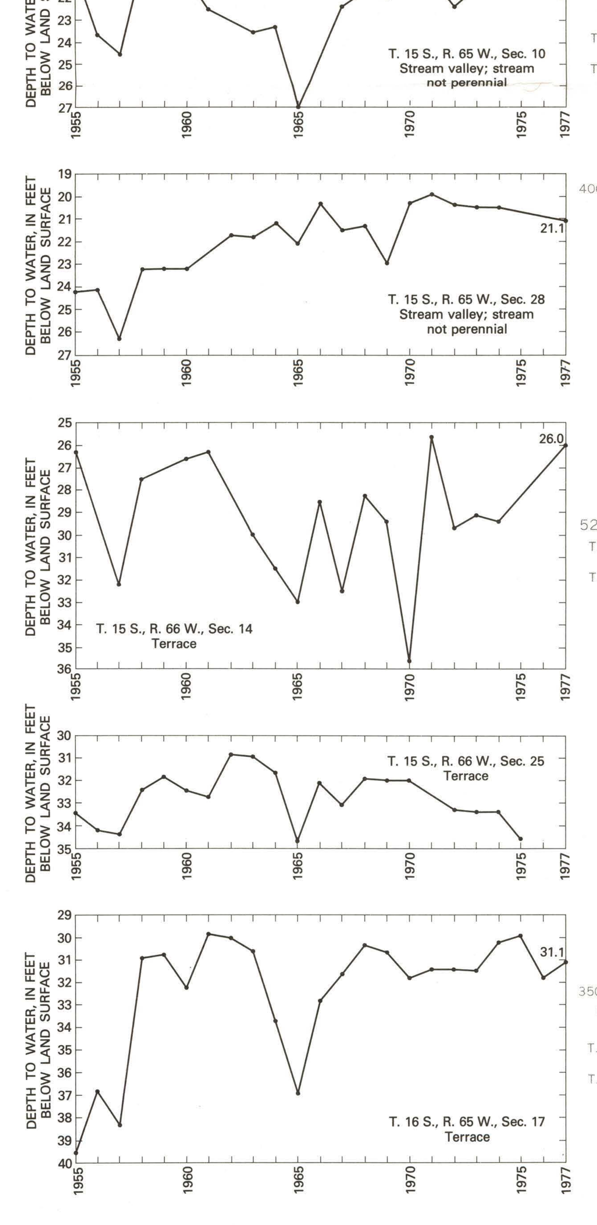
EASTERN OUTCROP LIMIT OF FRACTURED CRYSTALLINE ROCKS

9.8 CS — WELL WHERE DEPTH TO WATER TABLE WAS MEASURED IN 1976 OR 1977—Number is depth to water table, in feet below land surface
C, Well completed in colluvial deposits
CS, Well completed in consolidated sedimentary rocks
All other wells completed in unconsolidated alluvial deposits

16.1 — WELL COMPLETED IN UNCONSOLIDATED ALLUVIAL DEPOSITS WHERE DEPTH TO THE WATER TABLE WAS MEASURED FOR AT LEAST 3 YEARS DURING 1972–75—Number is average depth to the water table for the period, in feet below land surface (data from Major, Kerbs, and Penley, 1975)

WELL COMPLETED IN UNCONSOLIDATED ALLUVIAL DEPOSITS WHERE DEPTH TO THE WATER TABLE WAS MEASURED BETWEEN 1954 AND 1976

[1]Depth to water table generally less than 20 feet in localized areas of unconsolidated alluvial deposits (not shown on map) occurring in stream valleys traversing fractured crystalline rocks



METRIC CONVERSIONS

MULTIPLY	BY	TO OBTAIN
Foot	0.3048	Meter
Mile	1.609	Kilometer
Acre	0.4047	Hectare

Base compiled by U.S. Geological Survey in 1972 from 1:24,000 quadrangles dated 1954–1966
Limited revision from aerial photographs taken 1969
50,000-foot grid based on Colorado coordinate system, north zone
5000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue
Metric elevations are shown in parentheses

APPROXIMATE MEAN DECLINATION, 1980

SCALE 1:100 000

CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT 50-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1980—W79325

Geology modified from Trimble and Machette, 1979

INTRODUCTION

The depth to the water table is a hydrologic factor that can be used by State and local officials to assist them in making decisions regarding land-use conversion in the rapidly urbanizing Colorado Springs—Castle Rock area (index map). This report presents the results of a 2-year investigation to determine the depth to the water table, water-table fluctuations and trends, and to relate the results of the investigation to urban planning. The report is one of a series of geologic and hydrologic reports prepared by the U.S. Geological Survey to demonstrate the usefulness of earth-science information in urban planning.

In the Colorado Springs—Castle Rock area, the principal water-table aquifers consist of unconsolidated alluvial deposits that are perennially saturated and of consolidated sedimentary rocks comprising the Dawson aquifer. The unconsolidated alluvial deposits, which have a maximum thickness of about 100 feet, occur in stream valleys and in terraces both along the stream valleys and on slopes of the foothills east of the Front Range (diagrammatic section). Ranges in depth to the water table shown on the map were delineated only for the unconsolidated alluvial deposits because the depth to the water table in the Dawson aquifer is generally more than 20 feet and usually will not be a factor affecting urban planning.

Underlying the unconsolidated alluvial deposits and exposed at the land surface in most of the study area north of Colorado Springs and east of the Front Range is the Dawson aquifer. The Dawson is a consolidated sedimentary-rock aquifer consisting of an upper and lower unit (Livingston and others, 1975, 1976). The upper arkosic unit contains coarse sand, ironstone layers, and some sandstone beds. The lower unit contains beds of sandstone, claystone, and siltstone. The maximum thickness of both units is about 2,500 feet. Although water in the aquifer locally occurs under artesian conditions, water-table conditions are more common. Hydraulic connection between the unconsolidated alluvial deposits and the Dawson aquifer is greatest where stream valleys have been eroded into the Dawson.

The water-supply potential of the Dawson aquifer in the study area is being investigated. Results of completed investigations in El Paso County indicate that the aquifer may be a major source of water supplies for urban development (Livingston and others, 1975, 1976).

The depth to the water table in the Dawson aquifer is generally more than 20 feet and commonly it is more than 100 feet. The shallowest depths to the water table generally occur along stream valleys and in colluvial deposits derived from the Dawson aquifer.

Locally, water-table aquifers also occur in the upper weathered and fractured zone of other consolidated sedimentary rocks that form the foothills east of the Front Range and that crop out in the southern part of the area; in colluvial and landslide deposits that occur on the slopes of the consolidated sedimentary rocks; and in windblown deposits that occur in the vicinity of Colorado Springs. In the crystalline rocks that form the Front Range in the western part of the area, water occurs locally in fractures. The fractures generally will contain water only to a depth of about 300 feet below land surface. Because of the localized occurrence of these water-table aquifers and because some of the aquifer material and fractures are drained for part of the year, these aquifers were not studied in detail during this investigation. Where water levels were measured in wells completed in these localized aquifers, only the locations of the wells and the measured depths to water are shown on the depth-to-water map. Artesian aquifers, which occur in the consolidated sedimentary rocks in the eastern part of the area, were not studied during this investigation.

Water levels were measured once in 99 wells during 1976 or 1977 to determine the depth to the water table. Additional information about these wells is included in a report by Hutchinson and Hillier (1978). A comparison between water levels measured during 1976–77 and water levels measured by the U.S. Geological Survey since the middle 1950's in areas where ground-water pumpage is greatest indicated that no significant upward or downward trend in the water table has developed in the area during the past 20 years. Water levels in 1976–77 were about the same as in the middle 1950's. Therefore, water levels reported by Major, Kerbs, and Penley (1975), McConaghy and others (1964), and Jenkins (1961) and water levels reported by well drillers were used to supplement the 1976–77 data in the compilation of the depth-to-water map. The data reported by drillers were obtained from the files of the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer.

Physiography and geology (Trimble and Machette, 1979) also were used in the compilation. For example, along Fountain Creek and its principal tributaries and along the streams in the northern part of the area, the scarps of the terraces were used to map the boundary between the shallow water table in the flood plains and the deeper water table in the terraces.

Appreciation is extended to the many well owners in the Colorado Springs—Castle Rock area for permitting access to their wells for the purpose of collecting the data used in this report.

RELEVANCE TO URBAN PLANNING

The depth to the water table is a relevant factor in planning for urban development, as indicated by the following example:

A. Depth to the water table is less than 5 feet either seasonally or annually:

1. The effectiveness of individual domestic waste-disposal systems could be reduced and untreated wastes could enter the ground-water system. Some of the biochemical reactions associated with individual waste-disposal systems occur in the unsaturated zone below or adjacent to the system. Because the reactions do not occur in water, the greater the depth to the water table, the greater the possibility that these reactions will complete the conversion of wastes to an effluent that is not a health hazard.
2. Road and highway stability could be affected. Access to lands might be limited where marshy ground exists.
3. Soil-salinity problems could develop. The types of vegetation that could be grown in these areas would be dependent on the degree of the salinity, but, even without any salinity problems, many types of vegetation could not grow in these areas.
4. Unstable soil structure, which often limits the use of the land, could exist.
5. Construction of structural or building foundations could be hampered by the flow of ground water into the construction excavations.
6. Basements could be subject to collapse resulting from water pressure and flooding.

The situations described in items 4, 5, and 6 also could occur in areas where the depth to the water table is not more than 10 feet either seasonally or annually.

B. Depth to the water table related to depth of installation:

1. Liquid wastes or leachates from solid wastes could be introduced directly into the ground-water system by water moving through landfills and related types of facilities, resulting in degradation or pollution of the ground water. The possibility of degradation or pollution would be dependent on the type of wastes, the depth of burial of the wastes, and the seasonal or annual depth to the water table in the area of the landfill or related type of facility.
2. Ground water could enter leaky sanitary sewers, resulting in a significant increase in the volume of wastes to be processed by waste-treatment facilities. The volume of water entering a leaky sanitary sewer would be dependent on the depth of burial of the sewer and the seasonal or annual depth to the water table.
3. The placement of electric and telephone utility lines below ground and the type of insulation and conduits required for below-ground installation would be, in part, dependent on the depth to the water table.

DEPTH TO THE WATER TABLE

Measured depths to the water table during 1976–77 in the unconsolidated alluvial deposits ranged from 0.8 to 63.7 feet. Generally the depth to the water table in the flood plains of perennial streams in the northern two-thirds of the area was less than 10 feet and locally was less than 5 feet. In the southern one-third of the area, the depth to the water table in the flood plains of perennial streams generally was less than 20 feet and locally was between 5 and 10 feet. No depth-to-water measurements made during 1976–77 were less than 5 feet in wells in the flood plains of perennial streams in the southern one-third of the area. However, water-level measurements made prior to this investigation indicate that the depth to the water table probably is less than 5 feet, at least for part of the year, in localized areas. In the flood plains of the principal nonperennial streams, Sand and Jimmy Camp Creeks, located east and southeast of Colorado Springs, the depth to the water table generally was greater than 10 feet.

The depth to the water table in the terraces generally was greater than 10 feet in the northern two-thirds of the area and greater than 20 feet in the southern one-third of the area. Water levels in wells completed in colluvial deposits and consolidated sedimentary rocks ranged from 3.3 to 43.7 feet.

WATER-TABLE FLUCTUATIONS AND TRENDS

Annual fluctuations of the water table in all the aquifers except the fractured crystalline rocks generally are less than 10 feet although the maximum fluctuation is not known. Both seasonal and annual fluctuations of the water table are smaller in the aquifers underlying the flood plains of perennial streams because of the hydraulic connection between the streams and the aquifers. Because of the limited storage capacity in the fractures, seasonal and annual fluctuations of the water table in the fractured crystalline rocks may be greater than 10 feet.

In areas that are not extensively irrigated, the depth to the water table generally is shallowest during the spring and early summer when the aquifers are being recharged by snowmelt and rain. The greatest depth to the water table generally occurs in the late autumn when recharge is minimal and water in the aquifers has been partly depleted by pumpage from wells, evapotranspiration, and by natural discharge to lakes, ponds, springs, streams, and swamps. In areas that are extensively irrigated, the depth to the water table may remain within a few feet of the land surface throughout the growing season because part of the applied water percolates through the soil and recharges the aquifer.

Water-table trends are shown both by the hydrographs and the data in the table. The hydrographs present water-level measurements made at approximately the same time each year to eliminate the effects of seasonal fluctuations of the water table. The hydrographs indicate that no significant upward or downward trend in the water table has developed since the middle 1950's.

The data in the table also indicate that the water level in the area was about the same in the middle 1950's as in 1976–77. Of the 16 wells listed in the table, no water levels have declined more than 5 feet; the maximum decline was 3.5 feet. Water levels in three wells have risen more than 5.0 feet; the maximum rise was 6.8 feet.

A continual downward trend of water levels, which may indicate that water is being pumped or mined from the aquifer(s) at a rate that is greater than the rate of recharge to the aquifer(s), is not apparent on any hydrograph or from the data in the table. However, mining of ground water may be occurring in those parts of the area where continual long-term water-level data are not available.

As urban development increases in the area, the possibility of ground-water mining also will increase if water-table aquifers are used as sources of water for the development. While ground-water mining could decrease or eliminate some of the adverse effects caused by a shallow water table, ground-water mining also would decrease the amount of water available for use.

If ground-water mining occurs, continued pumping of existing wells at the same or increased rates will result in the following sequence of events:

1. Water levels decline, well yields decrease, and pump intakes have to be lowered in the wells.
2. Wells have to be deepened, in some localities to the base of the aquifer, and pump intakes lowered to as near the bottom of the wells as possible, if this has not been done previously.
3. Aquifers are dewatered. Water levels of surface-water features may decline if there is hydraulic connection between them and the aquifers. Pumping wells could deplete streamflow and significantly lower water levels in lakes, ponds, and swamps.

Installing additional wells in areas where water is being mined only accelerates the sequence of events listed above. The existence of or the potential for ground-water mining are factors that need to be evaluated in planning for urban development.

LIMITATIONS OF THE INVESTIGATION

The users of this report need to be aware that the water-table data represent a compilation of water levels measured throughout 1976 and 1977. Because of seasonal or annual variations in ground-water recharge or discharge, the data do not necessarily represent either the shallowest or the greatest depth to the water table that could occur or has occurred. Water-level measurements would have to be made at least during the spring and late fall, and perhaps throughout the year, at a specific site intended for a specific use, to determine the potential effects of water levels on the use of the site. The scale of the map in this report precludes its use for specific site selection; larger scale maps need to be used for this purpose. Also, areas of shallower depths to the water table than those shown on the map occur locally especially around the edges of lakes, ponds, and reservoirs, along irrigation canals where leakage occurs, and in the valleys of perennial streams.

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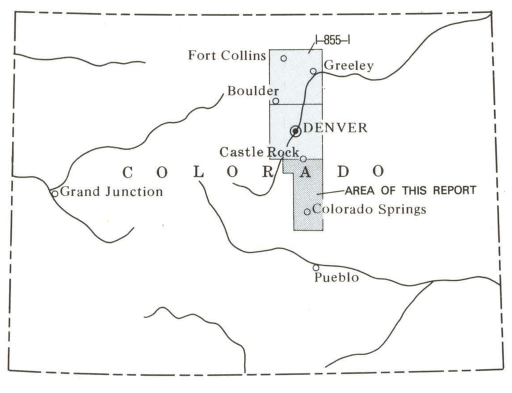
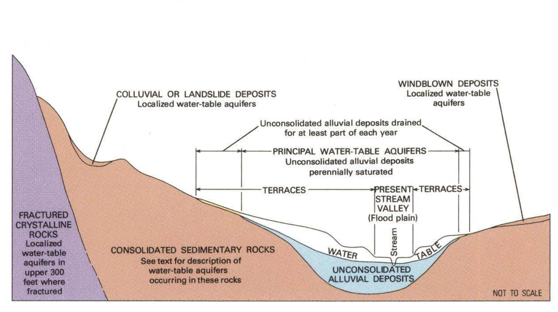


MAP SHOWING AREA OF FRONT RANGE URBAN CORRIDOR



DIAGRAMMATIC SECTION SHOWING OCCURRENCE OF WATER-TABLE AQUIFERS

COMPARISON BETWEEN WATER LEVELS MEASURED IN THE MIDDLE 1950'S AND WATER LEVELS MEASURED DURING 1977 IN THE SAME WELLS

Location of 10-acre area: Section	Township, south	Range, west	Date	Depth to water (feet below land surface)	Date	Depth to water (feet below land surface)	Rise (+) or decline (−) in water level (feet)
UNCONSOLIDATED ALLUVIAL DEPOSITS							
27	14	65	3-18-55	25.2	7-6-77	23.4	+1.8
34	14	65	3-17-55	24.6	2-27-77	24.4	+.2
3	15	65	12-17-54	22.1	2-27-77	18.1	+4.0
15	15	65	4-15-55	19.4	2-27-77	13.0	+6.4
22	15	65	3-22-55	19.5	2-27-77	16.1	+3.4
11	15	66	4-22-57	33.4	2-23-77	34.3	−.9
11	15	66	3-30-55	43.6	3-1-77	40.4	+3.2
13	15	66	4-22-57	47.1	2-23-77	40.3	+6.8
14	15	66	7-21-54	35.7	2-23-77	35.8	−.1
14	15	66	7-17-54	33.8	2-23-77	36.7	−2.9
24	15	66	6-23-54	14.1	7-15-77	17.6	−3.5
6	16	65	8-21-54	26.7	7-8-77	25.7	+1.0
8	16	65	9-7-54	36.4	7-12-77	37.2	−.8
8	16	65	9-7-54	20.0	2-22-77	16.5	+3.5
16	16	65	8-25-54	43.4	7-12-77	37.2	+6.2
28	16	65	9-13-54	19.2	7-13-77	17.7	+1.5

DEPTH TO THE WATER TABLE (1976–77) IN THE COLORADO SPRINGS—CASTLE ROCK AREA, FRONT RANGE URBAN CORRIDOR, COLORADO

By
Donald E. Hillier and E. Carter Hutchinson
1980

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