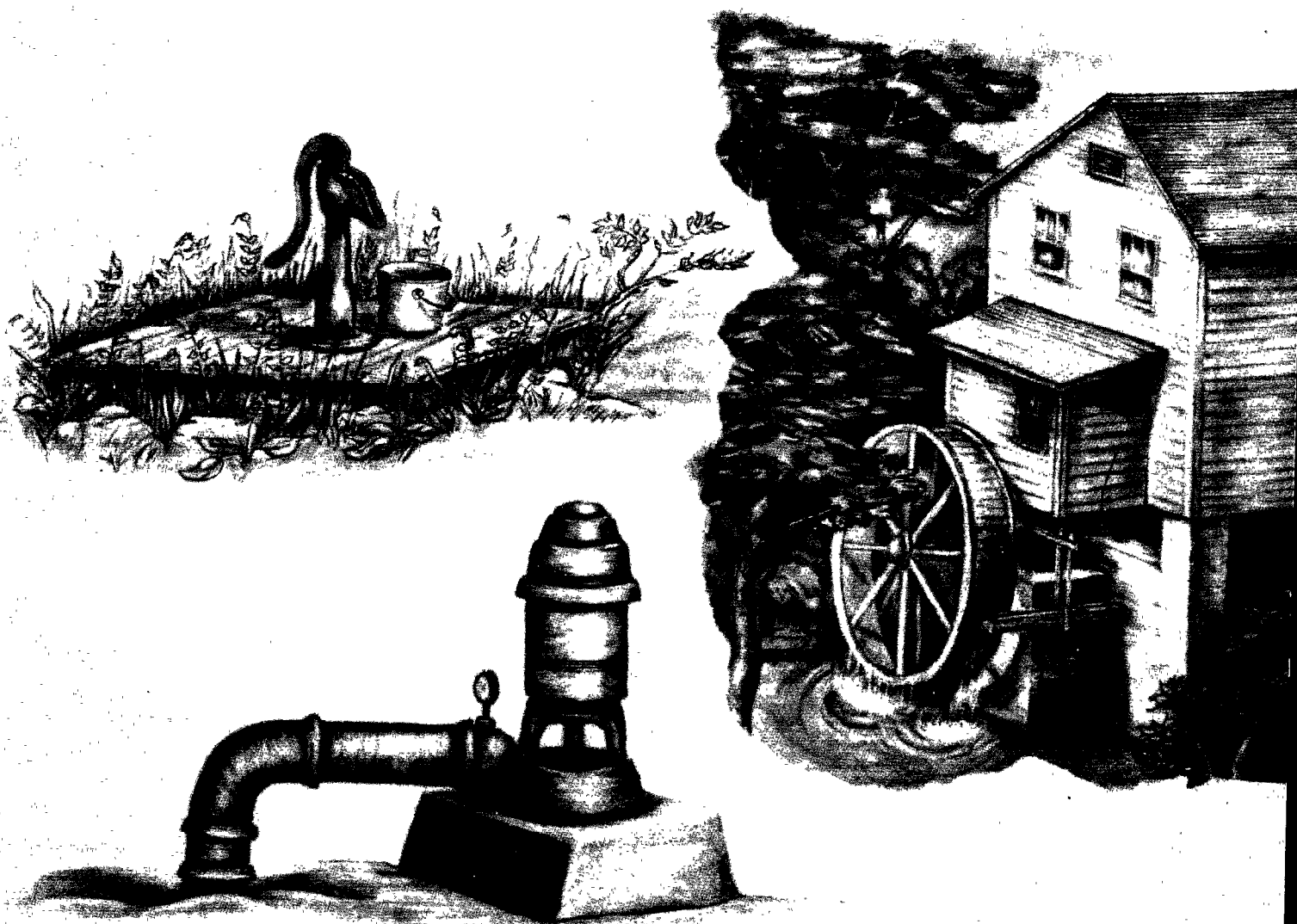


PRELIMINARY
DELINEATION AND DESCRIPTION OF THE REGIONAL AQUIFERS
OF TENNESSEE--
THE CENTRAL BASIN AQUIFER SYSTEM



Prepared by
U.S. GEOLOGICAL SURVEY
in cooperation with the
U.S. ENVIRONMENTAL PROTECTION
AGENCY

PRELIMINARY DELINEATION AND DESCRIPTION OF THE REGIONAL AQUIFERS
OF TENNESSEE--THE CENTRAL BASIN AQUIFER SYSTEM

J.V. Brahana and Michael W. Bradley

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 82-4002

Prepared in cooperation with the
U.S. ENVIRONMENTAL PROTECTION AGENCY



Nashville, Tennessee
1986

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, Tennessee 37203

Copies of this report can be
purchased from:

Open-File Services Section
U.S. Geological Survey
Box 25425, Federal Center
Lakewood, CO 80225

CONTENTS

Abstract	1
Introduction	1
Geology	2
Hydrology	3
Water quality	4
Drinking-water supplies	5
Contamination	5
Hydrocarbon, mineral, and geothermal resource use	5
Summary	6
Selected references	34

ILLUSTRATIONS

Figure 1-3. Maps showing:

1. Areal extent of the Central Basin aquifer system and physiographic provinces in Tennessee 7
2. Structure contours on the base of the Chattanooga Shale, the top of the Central Basin aquifer system 8
3. Structure contours on the top of the Knox Group, the base of the Central Basin aquifer system 10
- 4-10. Geohydrologic sections showing water quality in the Central Basin aquifer system:
 4. Along line A-A' 12
 5. Along line B-B' 12
 6. Along line C-C' 14
 7. Along line E-E' 14
 8. Along line F-F' 15
 9. Along line G-G' 16
 10. Along line H-H' 16
11. Sketch showing conceptual model of ground-water occurrence in the Central Basin aquifer system 17
- 12-15. Maps showing:
 12. Concentrations of dissolved solids in the Central Basin aquifer system 26
 13. Areas of use and potential use of the Central Basin aquifer system as a source of drinking water 28
 14. Contamination sites in the Central Basin aquifer system 30
 15. Location of potential mineral and hydrocarbon resources in the Central Basin aquifer system 32

TABLES

Table 1. Geohydrology of the formations comprising the Central Basin aquifer system, and confining units	18
2. Dissolved-solids concentrations in water from selected wells in the Central Basin aquifer system	22
3. Summary of public drinking-water supplies derived from the Central Basin aquifer system	25
4. Description of contamination sites in the Central Basin aquifer system	31

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For the convenience of readers who may want to use the International System of Units (SI), the data may be converted by using the following factors:

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
inch (in.)	25.4	millimeters (mm)
feet (ft)	0.3048	meters (m)
feet per mile (ft/mi)	0.1894	meters per kilometer (m/km)
mile (mi)	1.609	kilometers (km)
square miles (mi ²)	2.590	square kilometers (km ²)
gallons per minute (gal/min)	0.06309	liters per second (L/s)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

PRELIMINARY DELINEATION AND DESCRIPTION OF THE REGIONAL AQUIFERS OF TENNESSEE--THE CENTRAL BASIN AQUIFER SYSTEM

By J.V. Brahana and Michael W. Bradley

ABSTRACT

The Central Basin aquifer system is composed of Devonian and Ordovician carbonate and shale rocks. This aquifer occurs west of the Valley and Ridge province and crops out in the Central Basin and the Sequatchie Valley of Tennessee. Ground water in the Central Basin aquifer occurs primarily in solution openings and fractures, and the flow system is generally limited to 300 feet or less below land surface. However, some fracture and minor faults may allow vertical recharge to the underlying Knox Group, which marks the lower boundary of the Central Basin aquifer system. Away from the Central Basin, the upper limit of the Central Basin aquifer system is the Chattanooga Shale, an effective confining unit.

The Central Basin aquifer system, an important source of drinking water, supplies most of the rural domestic and many public supplies of drinking water in the Central Basin and the Sequatchie Valley. Dissolved-solids concentrations often are less than 500 milligrams per liter where the aquifer is part of a dynamic flow system. Dissolved-solids concentrations may reach thousands or tens of thousands of milligrams per liter below the zone of dynamic flow.

INTRODUCTION

The Safe Drinking Water Act (Public Law 93-523) includes provisions for the protection of underground sources of drinking water. Specifically, Part C of the Act authorizes the U.S. Environmental Protection Agency (EPA) to establish regulations to assure that underground injection of contaminants will not endanger existing or potential sources of drinking water. As developed by EPA, the regulations require that all underground sources of ground water with less than 10,000 milligrams per liter (mg/L) dissolved solids that do not contain hydrocarbon, mineral, or geothermal resources, be designated for protection whether or not they are currently being used as a source of drinking water.

Within a format of hydrogeologic atlases, the geologic formations of Tennessee (Miller, 1974) have been combined into eight major regional aquifer systems having a broad areal extent. Each aquifer is characterized by a unique set of hydrologic conditions and water quality.

The purpose of this report is to describe the formations that comprise the Central Basin aquifer system and to delineate zones within this aquifer that are actual or potential drinking water sources. This report on the Central Basin aquifer system provides generalized information on (1) the areal and stratigraphic occurrence, (2) dissolved-solids concentration of the ground water, (3) area of use and potential use based on best available data, (4) the hydraulic character, (5) the areas of known ground-water contamination, and (6) the known locations of current and potential hydrocarbon, mineral, and geothermal resources in the sequence of geologic formations that occur in the stratigraphic interval between the bottom of the Chattanooga Shale of Devonian age and the top of the Knox Group of Ordovician and Cambrian age.

GEOLOGY

The geology of the Central Basin aquifer system is relatively well defined on a regional scale. The rocks, which range in age from Devonian to Ordovician, are almost all carbonates, primarily limestones. Some shaly zones exist in the section, as well as phosphatic-rich layers and several thin bentonite beds, which strongly influence the hydrology. Chert is generally restricted to Devonian formations. Rocks comprising this aquifer system are summarized in table 1. The generalized area of occurrence of the Central Basin aquifer system is shown in figure 1.

The Devonian to Ordovician formations are overlain by Mississippian rocks in the area of the Highland Rim and Cumberland Plateau. Devonian to Ordovician rocks of the Central Basin aquifer system are exposed on the east side of the Sequatchie Valley. The central and western side of the valley are underlain by the Knox Group and the Mississippian formations, respectively. West of the western limit of occurrence of Mississippian rocks, where these rocks have been eroded away, the formations of the Central Basin aquifer system are overlain by Cretaceous formations.

The base of the Chattanooga Shale is defined as the top of the Central Basin aquifer system. The generalized configuration of this surface is shown in figure 2. The base of the Central Basin aquifer system is shown as the top of the Knox Group of Ordovician and Cambrian age. The altitude of this surface is shown in figure 3.

Structurally, the rocks of the Central Basin aquifer system are relatively undeformed with the exception of the nearly vertically dipping rocks on the flanks of the anticline in which the Sequatchie Valley is eroded. Dips are gentle throughout most of the area, averaging less than one degree, although locally, dips of more than three degrees may be observed. The Nashville Dome is the dominant structural feature; it is a low dome whose crest is in southern Rutherford County (fig. 2). The Central Basin was formed by the erosion of this dome. During the upwarping and doming of the Nashville Dome, the rocks at the crest were stretched, resulting in the formation of the systematic joints, parallel sets of almost vertical fractures along which relatively little displacement has occurred.

The location where lines of cross section have been constructed for this report are shown in figures 2 and 3. The cross sections are shown in figures 4 through 10. These figures include the generalized structural and stratigraphic configuration of the formations that make up this aquifer system and the dissolved-solids concentrations of the water within the formations. Minor folding of the rocks is not unusual throughout the area, but it is commonly attributed to dissolution of the carbonate rocks, and is generally only local.

The detailed geology of the component formations have been described in a number of published reports. The following were used to compile this atlas: Bassler (1932); Piper (1932); Theis (1936); Wilson (1948); Wilson (1949); Freeman (1953); Hass (1956); Newcome (1958); Conant and Swanson (1961); Hardeman (1966); Milici (1969); Miller (1974); and Wiethe and Sitterly (1978).

HYDROLOGY

Nearly all the ground water in the outcrop area of the Central Basin aquifer system is contained in a shallow flow system of solution channels. These channels are highly irregular in their distribution throughout the solid rock mass and generally occur within 300 feet of the land surface. The solution channels are openings along joints and bedding planes that have been enlarged by solution of the limestones. These channels represent zones of secondary porosity and permeability in an otherwise nonporous, impermeable rock mass. Bedding planes are thought to be the major control in the formation of solution cavities. Zurawski (1978) reported that most of these cavities are elongated as horizontal sheetlike openings. A conceptual model of ground-water occurrence in the Central Basin is shown in figure 11.

The bentonite zones in the upper part of the Carters Limestone (table 1) also play a significant role in the hydrology of the Central Basin aquifer system. In areas where the bentonite layers are unbreached, the downward movement of ground water is restricted (Burchett, 1977). This isolates the ground water below the bentonite from the shallow, dynamic flow system within the Central Basin aquifer system. Where the bentonite zones are breached by open joints or stream valleys, solution openings can form in the underlying limestone. Ground water in these openings can receive recharge from precipitation and is part of the dynamic flow system.

Dissolved-solids concentrations in the ground water (table 2; fig. 12) indicate that flow in the upper part of the Central Basin aquifer system is made up of many isolated cells. Locally, relatively fresh water can be obtained from wells within several hundred feet of wells with water that contains more than 10,000 mg/L dissolved solids. This fresher water represents a much more dynamic flow system, with significant recharge from precipitation and ground-water discharge to streams and springs. The saline water identifies zones in the aquifer system that are hydrologically isolated and separate from the fresher zones. The isolated zones are not recharged, and under steady-state conditions, flow rates are negligible.

Where present, the Chattanooga Shale separates the Central Basin aquifer system from the overlying Highland Rim aquifer system and is important to the hydrology of both of these aquifer systems. The shale is commonly less than 50 feet thick but is a very effective barrier to vertical movement of ground-water into or out of the aquifer system. In the rocks underlying the Chattanooga Shale, flow is restricted and water generally contains a much higher concentration of dissolved solids.

The hydrologic boundaries of the Central Basin aquifer system play a significant, if incompletely defined, role in the development of the aquifer as a drinking-water source. The Tennessee River acts as a constant-head hydrologic boundary to the west, where the Mississippian siliceous limestones overlie Devonian to Ordovician rocks of the Central

Basin aquifer system. Beyond the western limit of Mississippian formations, slightly west of the river, Cretaceous deposits overlie the Central Basin aquifer system. The Cretaceous deposits are highly variable in lithology, ranging from clays to gravels, and the hydraulic connection between them and the Devonian to Ordovician rocks of the Central Basin aquifer system varies considerably also.

A zone of faulting along the eastern escarpment of the Cumberland Plateau marks the eastern extent of the Central Basin aquifer system. In the Valley and Ridge province, the formations have been subjected to the intense faulting and deformation, which makes this area hydrologically distinct. The nature and extent of ground-water flow across this zone of faulting has not been documented.

Outside the Central basin, the basal confining unit between the Central Basin aquifer system and the Knox Group includes the Pierce Limestone and the Pond Spring Formation. At some locations, particularly in the Central Basin, the Knox probably receives recharge by leakage through joints in these formations. At other locations, it appears the Ordovician limestones and the Knox Group are hydrologically distinct and separate.

WATER QUALITY

Water of the Central Basin aquifer system is often suitable for drinking-water supplies (dissolved-solids concentrations generally less than 500 mg/L), but a wide range of water-quality conditions occurs in the system. Consequently, many wells have been drilled that are not suitable for drinking-water supplies. For example, water having dissolved-solids concentrations greater than 10,000 mg/L is found in the same formation within several miles of water with dissolved-solids concentrations less than 500 mg/L. The areal distribution of dissolved-solids concentrations in the aquifer system is shown in figure 12, and the variation by depth and formation is presented in table 2. Table 2 and figure 12 do not contain all available data, but do include all extremes and those data that are considered representative for each formation.

Several factors seem to be responsible for the areal and stratigraphic variability of water quality. Most important, the aquifer system is highly anisotropic, and flow within formations commonly is localized. Recharge from leakage, particularly near the Highland Rim escarpment, may account for the introduction of significant quantities of water with high dissolved solids into the Central Basin aquifer system (C.R. Burchett, USGS, written commun., 1981). The source of these high dissolved solids is thought to be water that has been in contact with evaporite beds in the overlying Fort Payne Formation of Mississippian age. Near the escarpment, the confining bed of Chattanooga Shale has been breached, and the more mineralized waters of the Fort Payne Formation recharge the Central Basin aquifer system. Likewise, recharge from the underlying, more mineralized Knox Group through abandoned exploration holes may have locally altered the water quality (Luke Ewing and Terry Brashears, Tennessee Division of Water Resources, oral commun., 1981).

In the shallow flow zone, water from half of the wells sampled had dissolved-solids concentrations exceeding 500 mg/L. In addition to the areal and stratigraphic variability in dissolved solids, ground water in the Central Basin is commonly hard and contains hydrogen sulfide gas. More than two-thirds of the wells sampled had hardness in the range of 200 to 500 mg/L, and about 20 percent contained detectable amounts of hydrogen sulfide.

DRINKING-WATER SUPPLIES

The Central Basin aquifer system is used extensively in its outcrop area as a source of drinking water (table 3; fig. 13). This aquifer system is also an important local source of drinking water for domestic use in most of the Central Basin, in the Sequatchie Valley, and in the Highland Rim where it occurs at shallow depths.

Area of potential use defined as the area where water contains less than 10,000 mg/L dissolved solids and is not now being used, is shown in figure 13. Inasmuch as very few data to delineate this boundary exist, it is estimated on the map. Several drinking-water supplies shown are not currently using this resource but did use the aquifer system previously.

CONTAMINATION

Contamination at five sites in the Central Basin aquifer system is documented (fig. 14; table 4). One contaminated area is associated with a shallow municipal landfill in Davidson County. Contaminated water from formations of the Nashville Group has high dissolved-solids concentrations, is hard, and has high biochemical oxygen demand, as well as a petroliferous odor (Residual Waste Study, Tennessee Division of Water Quality Control). The extent of this contamination is not known.

Effluent from septic tanks has caused the contamination of ground water at Hendersonville, LaVergne, and Mt. Juliet (Tennessee Division of Water Quality Control, written commun., 1981). Near Williamsport, in Maury County, the ground-water was contaminated when the bottom of a phosphate tailings pond collapsed; after the collapse, phosphatic mud appeared in springs about a mile away.

Another area of contamination delineated on the basis of well driller's reports only, includes parts of Smith and Wilson Counties (Luke Ewing and Terry Breshears, Tennessee Division of Water Resources, oral commun., 1981). This was a general area of extensive zinc exploration with exploratory test holes drilled into the Knox. In this area, dissolved-solids concentrations in water from many wells in the overlying Devonian-Ordovician aquifer system reportedly increased after the zinc exploration program. Also, many Ordovician wells that were at one time a source of drinking water became too salty for use and were abandoned. The underlying Knox Group in this vicinity has dissolved-solids concentrations in the range of several thousand milligrams per liter and has hydraulic heads greater than those in overlying Ordovician aquifer systems. The cause of the change in water quality has been attributed to recharge of the Ordovician formations from the underlying Knox through unplugged exploration drill holes.

HYDROCARBON, MINERAL, AND GEOTHERMAL RESOURCE USE

At the present time (1982), some of the Ordovician formations in the western part of the Central Basin are mined for phosphate (fig. 15). This is the only known present usage of mineral or geothermal resources from the aquifer. Fluorite was once mined from the Ordovician rocks in the northern part of the Central Basin. Hydrocarbon resource exploration is being actively pursued throughout the State. The formations of the Central Basin aquifer system have produced oil and gas in the Cumberland Plateau and in the Highland Rim. Actual and potential petroleum and gas resources are also located in figure 15.

SUMMARY

The Central Basin aquifer system is an important source of drinking water throughout its area of outcrop in the Central Basin and the Sequatchie Valley as well as parts of the western Highland Rim and western Valley of the Tennessee River. The aquifer is not used as a drinking-water source beneath the northern, eastern, and southern Highland Rim or beneath the Cumberland Plateau. Ground-water is highly variable both in quantity and quality. Most water occurs within 300 feet of the land surface along joints, fractures, bedding planes, and weathered zones within the solid rock mass.

Where the aquifer system is part of a dynamic flow system, dissolved-solids concentrations are generally less than 500 mg/L. Below the zone of dynamic flow, dissolved-solids concentrations may reach thousands or tens of thousands of milligrams per liter. Water from areas near the northwestern and southeastern escarpments of the Highland Rim has concentrations of dissolved solids that can exceed tens of thousands of milligrams per liter.

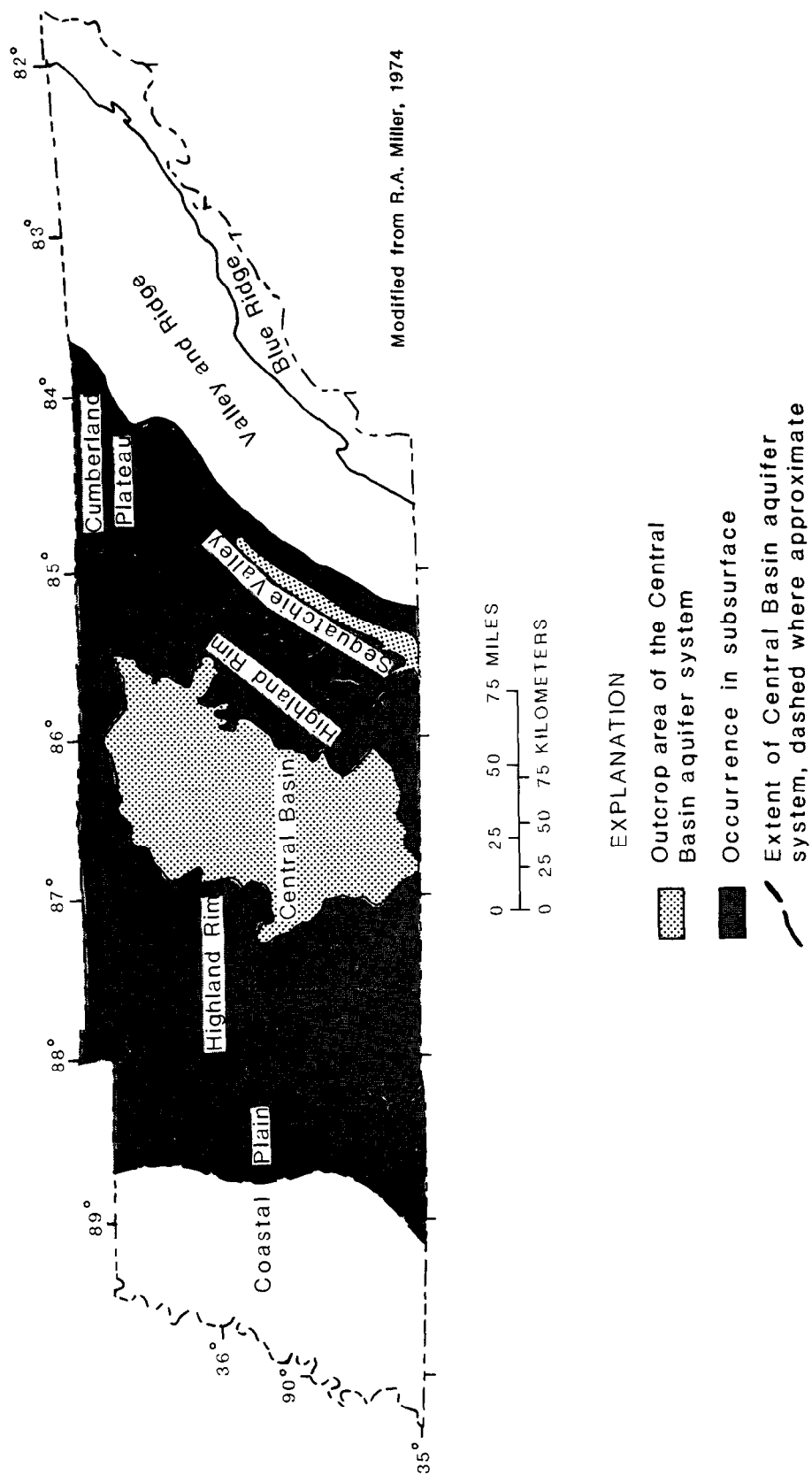
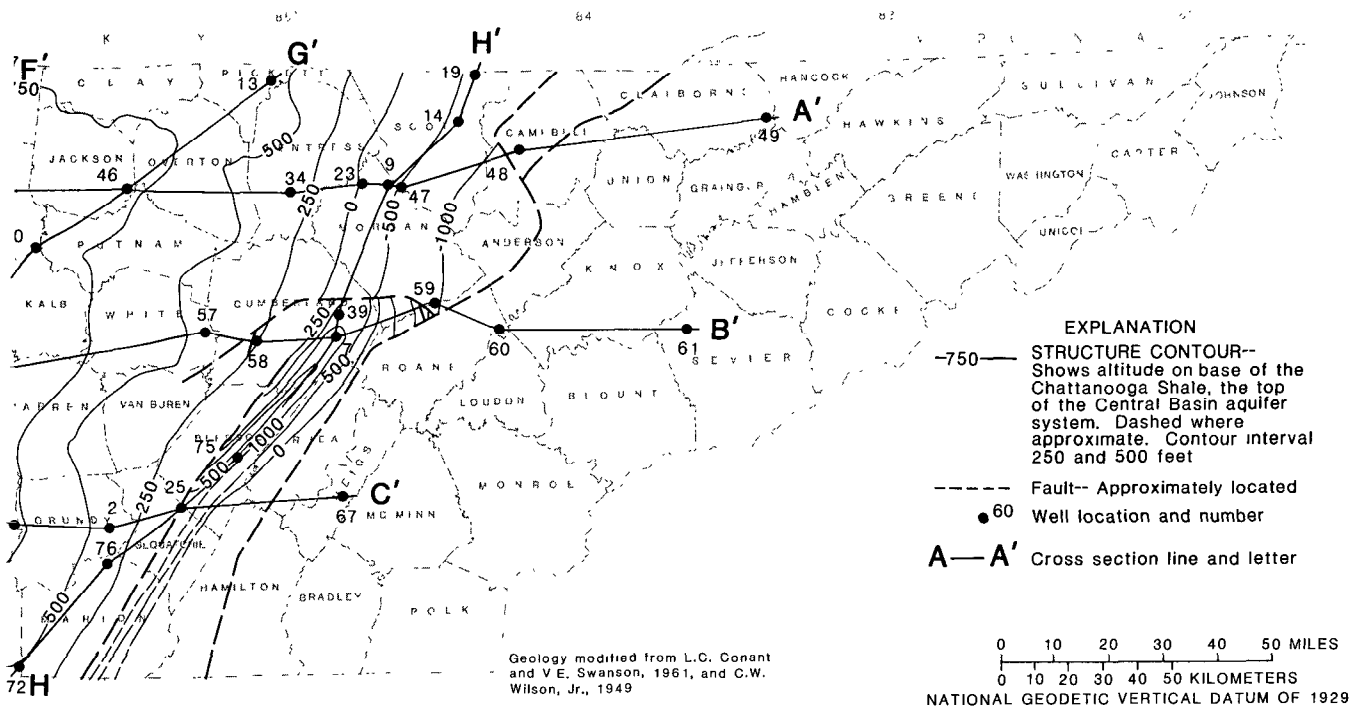


Figure 1.-- Areal extent of the Central Basin aquifer system and physiographic provinces in Tennessee.



the top of the Central Basin aquifer system.

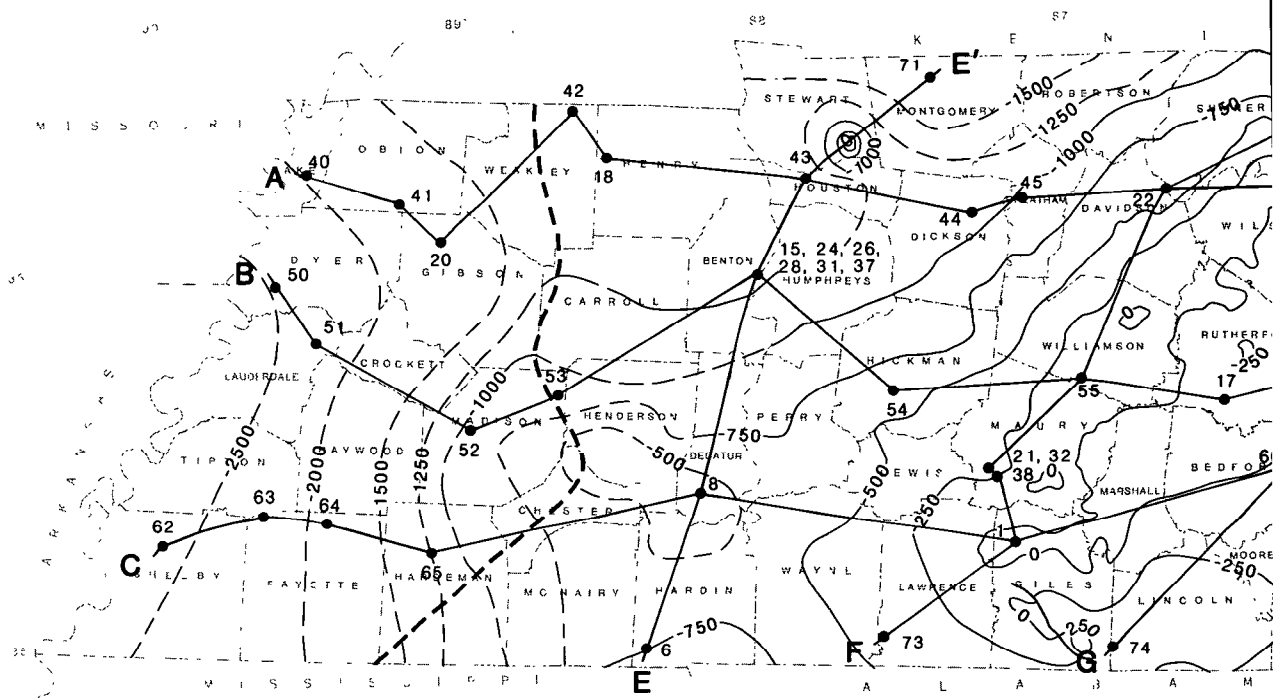
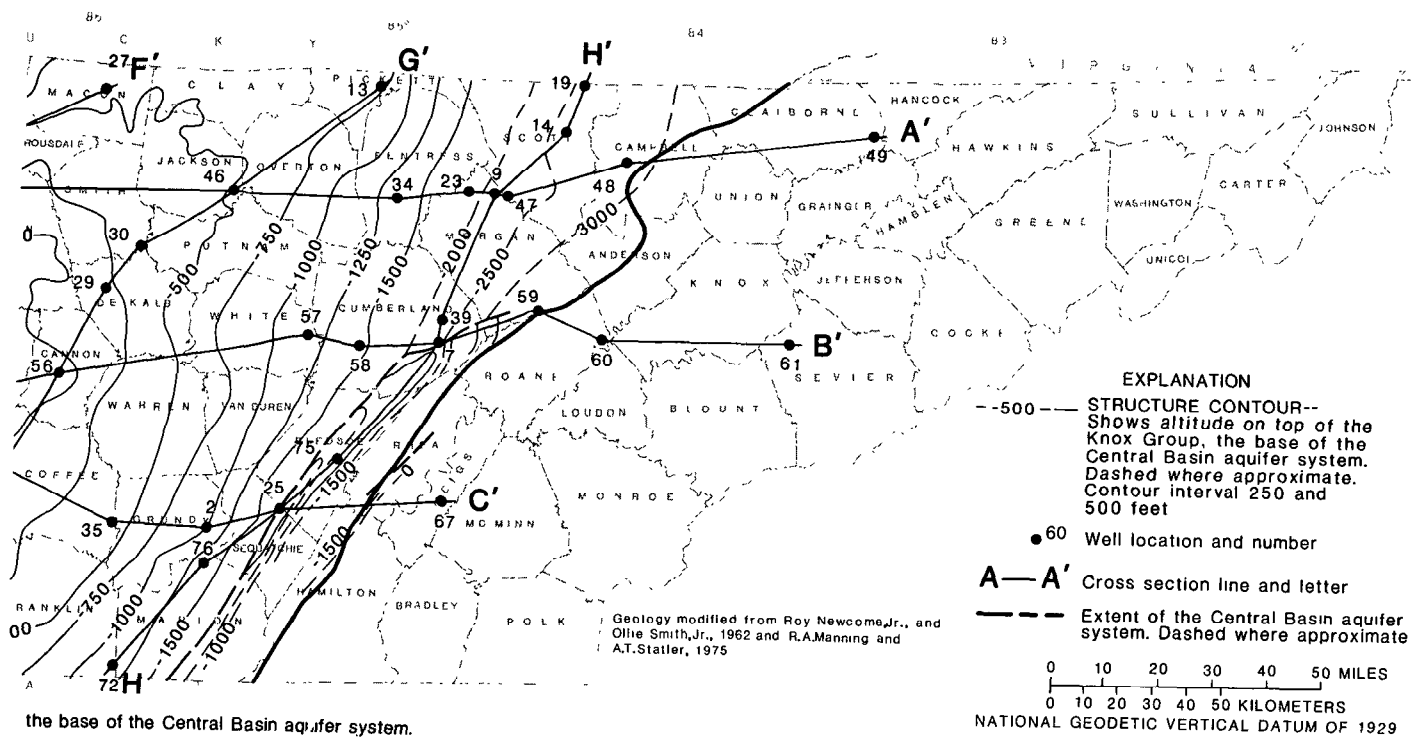


Figure 3.-- Structure contours on the top of the Knox Group

Geological Survey
 State Bureau of Geology
 revised 1973



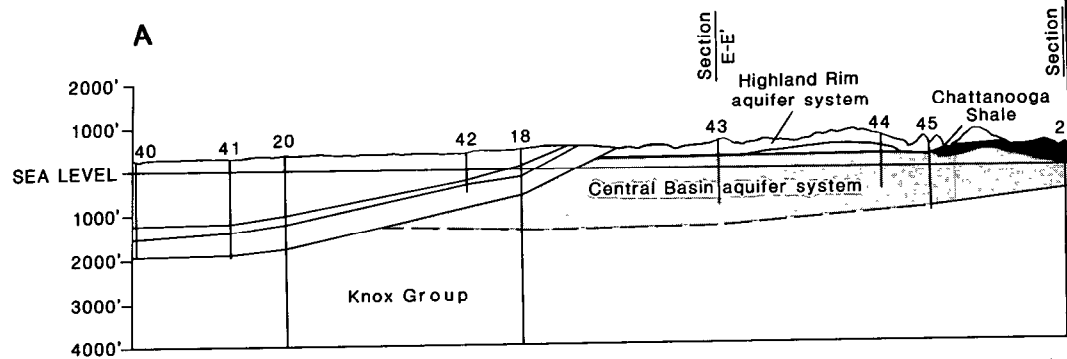


Figure 4-- Geohydrologic section showing water quality

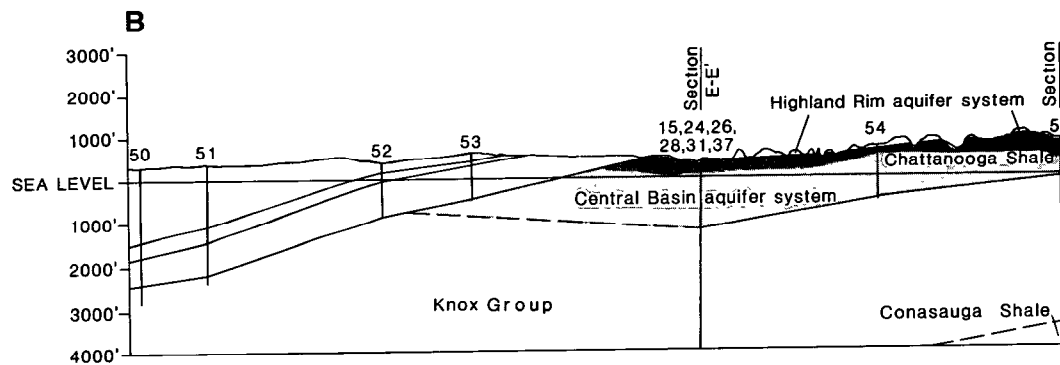


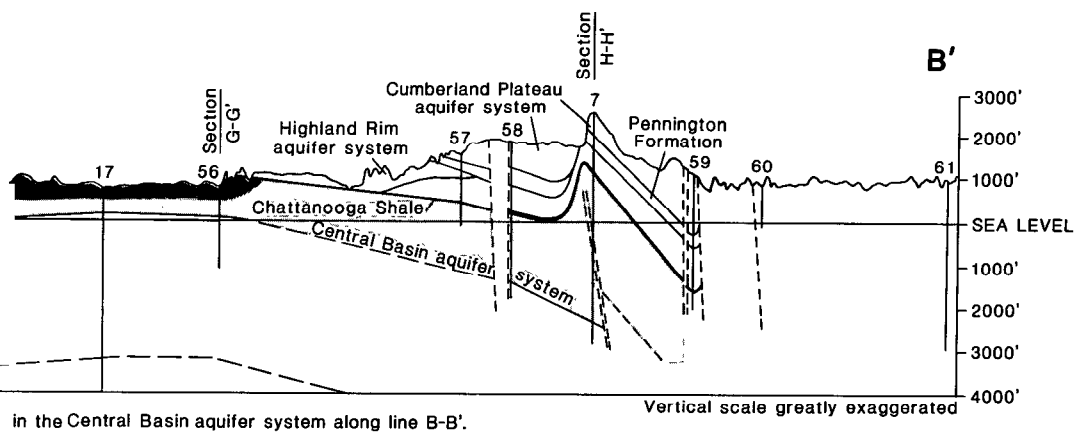
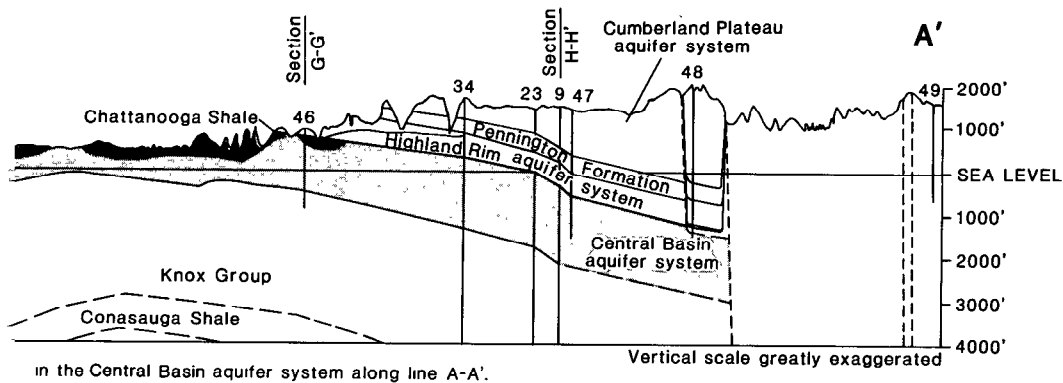
Figure 5-- Geohydrologic section showing water quality

EXPLANATION

DISSOLVED-SOLIDS CONCENTRATIONS,
IN MILLIGRAMS PER LITER

- 0 to 1000. Isolated pockets greater than 1000 may occur
- Few analyses, estimated greater than 1000. May be greater than 10,000 with depth

50
Well and number
Fault



0 10 20 30 40 50 MILES
 0 10 20 30 40 50 KILOMETERS
 NATIONAL GEODETIC VERTICAL
 DATUM OF 1929

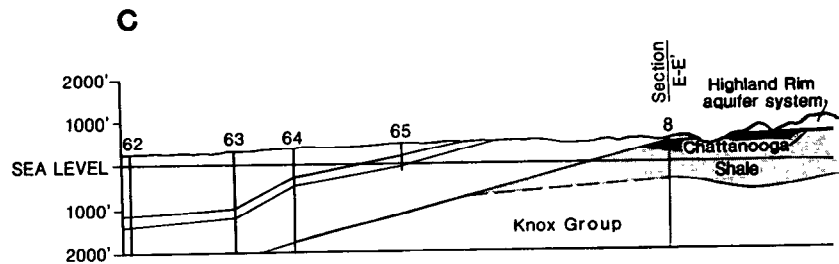


Figure 6.-- Geohydrologic section showing water

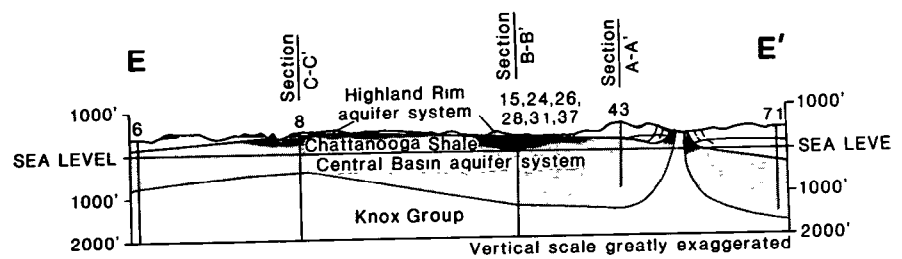


Figure 7.-- Geohydrologic section showing water quality in the Central Basin aquifer system along line E-E'.

EXPLANATION

65

Well and number

Fault

DISSOLVED-SOLIDS CONCENTRATIONS,
IN MILLIGRAMS PER LITER

0 to 1000. Isolated pockets
greater than 1000 may occur

Few analyses, estimated greater than 1000
May be greater than 10,000 with depth

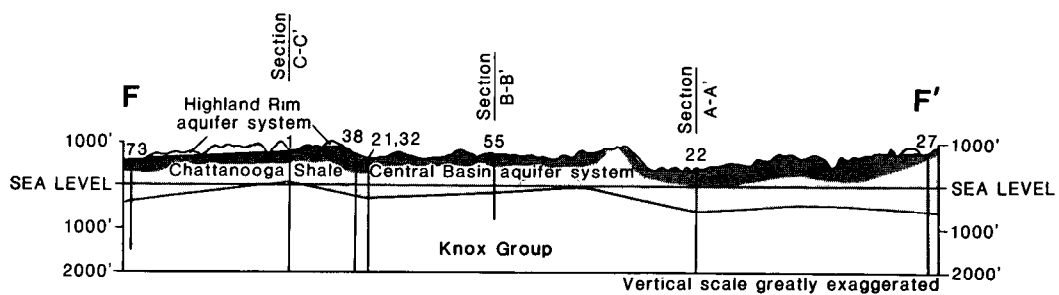
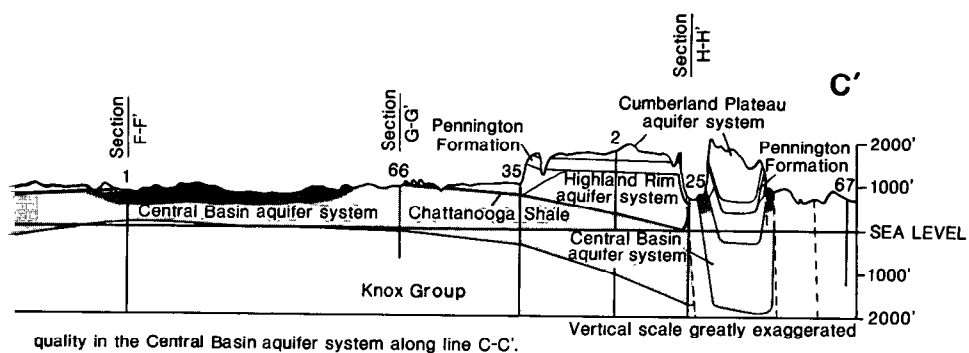


Figure 8.-- Geohydrologic section showing water quality in the Central Basin aquifer system along line F-F'.

0 10 20 30 40 50 MILES
 0 10 20 30 40 50 KILOMETERS
 NATIONAL GEODETIC VERTICAL DATUM OF 1929

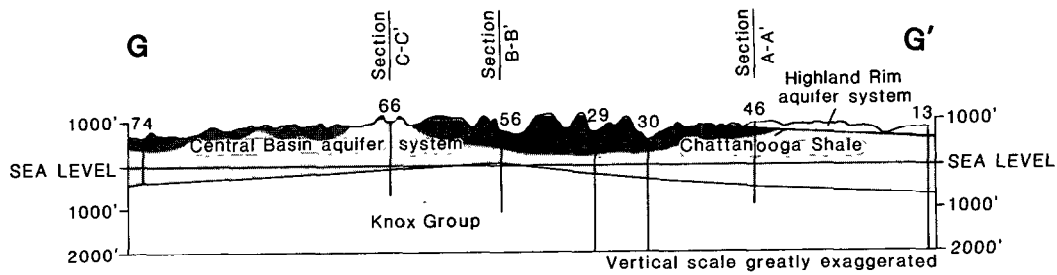


Figure 9.-- Geohydrologic section showing water quality in the Central Basin aquifer system along line G-G'.

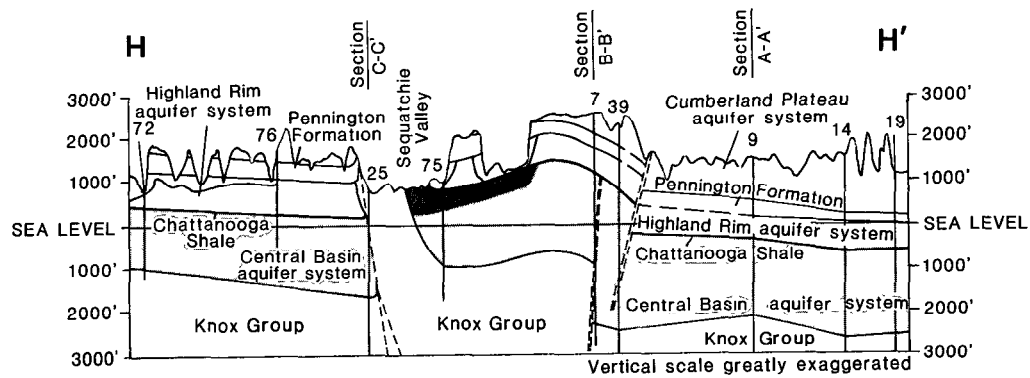
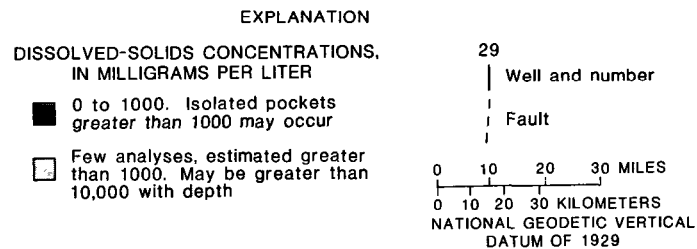


Figure 10.-- Geohydrologic section showing water quality in the Central Basin aquifer system along line H-H'.



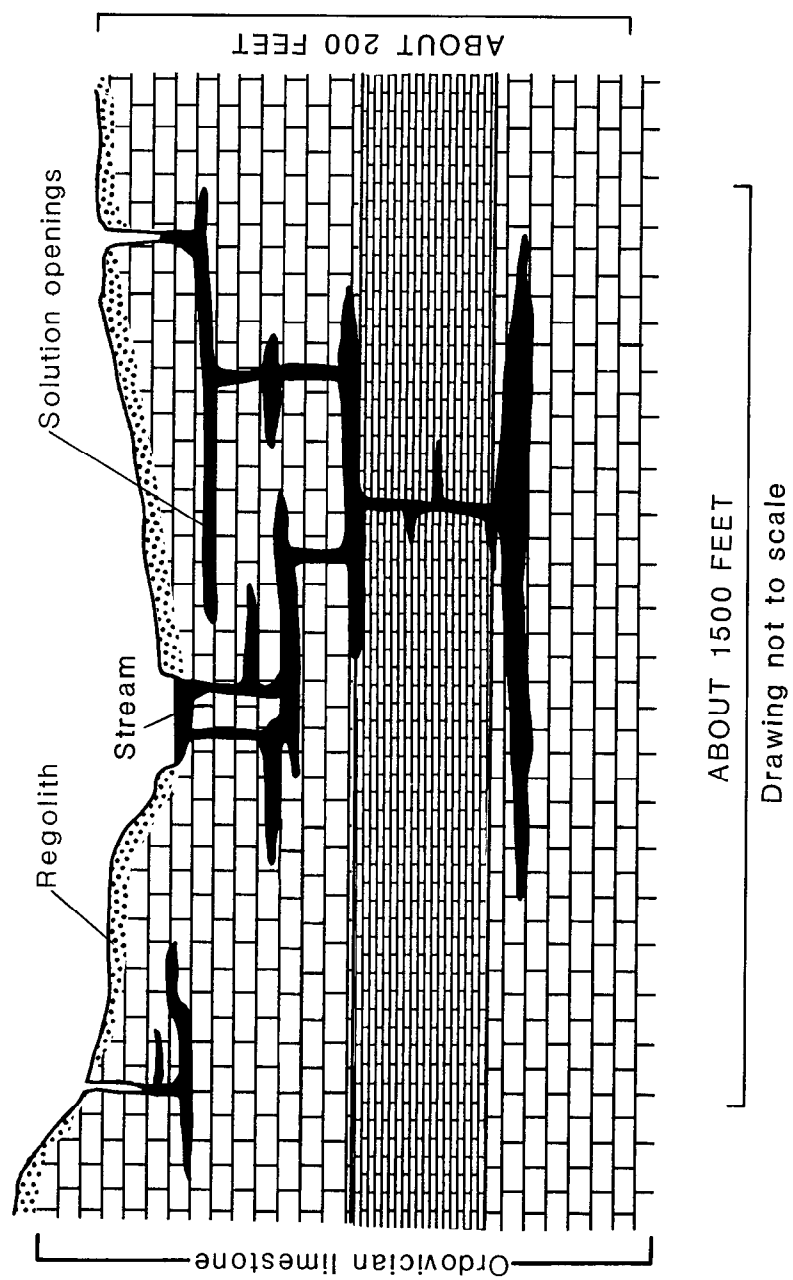


Figure 11.-- Conceptual model of ground-water occurrence in the Central Basin aquifer system.

Table 1.--Geohydrology of the formations comprising the Central Basin aquifer system, and confining units
[Sources: Miller (1974), Hardeman (1966), Newcome (1958), Rima and others (1977), and Wilson (1949)]

SYSTEM	SERIES	Stratigraphic unit	Geologic description	Hydrologic significance		
				Occurrence in Tennessee	Hydrologic classification and character	Yield
DEVONIAN	Upper	Chattanooga Shale	Shale, black carbonaceous fissile. It is divided into three members. The thickness ranges from 0 to more than 600 feet, averages about 20 to 30 feet throughout most of the area.	Extends from beneath Highland Rim on east to west of the Tennessee River in the sub-surface. Exposed around the margin of Central Basin.	Not an aquifer. It is a regional confining unit.	Yields little or no water to wells.
	Middle	Pegram Formation	Limestone and sandstone, thick-bedded, gray. Thickness from 0 to 30 feet.	Surface exposures extend from Jackson and Macon Counties on the northeast to Wayne County to the southwest. Occurs in the subsurface in the western valley of the Tennessee River.	A local aquifer. Supplies water to domestic wells where fractures have been enlarged by solution. Low intergranular porosity and permeability.	Yields adequate for domestic supplies. Generally from 5 to 20 gallons per minute.
	Lower	Camden Formation	Chert, novaculitic, light gray, tripolitic clay, and minor siliceous limestone. Thickness 0 to 50 feet.	Widely exposed in Benton County and parts of surrounding counties. It has not been recorded farther south than Decatur County.	A local aquifer. Fractures provide porosity and permeability.	Variable yields. From 0 to more than 100 gallons per minute.
		Harriman Formation	Chert, novaculitic, light gray, tripolitic clay, and minor siliceous limestone. Thickness 0 to about 100 feet.	Occurs in northern Decatur County and isolated outcrops in Hardin County. Limited in areal extent.	A local aquifer. Fractures provide porosity and permeability.	Variable yields. From 0 to more than 100 gallons per minute.
		Flat Gap Limestone	Limestone, thick-bedded, coarse-grained, gray with red and brown grains. Thickness 0 to 20 feet.	Occurs in Benton and Humphreys Counties. Few isolated occurrences in western Tennessee.	A local aquifer that supplies water to domestic wells by solution enlarged fractures. Low intergranular porosity and permeability.	Variable yields. From 0 to more than 100 gallons per minute.
		Ross Formation	Siliceous limestone occurs in south, changes to shale in north. It also contains glauconitic limestone. Thickness 0 to 75 feet. Includes Olive Hill and Birdsong Formations of others.	Occurs in Houston, Humphreys, Perry, Decatur, and Benton Counties and south into Hardin County. Limited to the western valley of the Tennessee River.	A local aquifer with general low porosity and permeability.	Yields generally less than 10 gallons per minute.

SILURIAN				
Middle				
Decatur Limestone	Limestone, thick-bedded, medium- to coarse-grained, gray to reddish-brown. Thickness 0 to 70 feet.	Occurs in limited areas in the western valley of the Tennessee River.	A local aquifer. Supplies water to domestic wells where fractures have been enlarged by solution. Low intergranular porosity and permeability.	Yields are adequate for small supplies. Generally less than 10 gallons per minute.
Brownsport Formation	Limestone and shale in alternating thin beds. It includes Beech River, Bob, and Lobelville Limestone members. Thickness 0 to 80 feet.	Generally restricted to western Highland Rim.	A local aquifer. Supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
Dixon Limestone Member or Formation	Shale, limestone, argillaceous and silty. Red to greenish-gray. Part of Wayne Formation or Group of others. Thickness 0 to 40 feet.	Limited to a line from Montgomery to Hardin Counties.	A local confining unit. General low porosity and permeability.	Small yields. Generally less than several gallons per minute.
Lego Limestone Member or Limestone	Limestone, gray, even-bedded. Part of Wayne Formation or Group of others. Thickness 0 to 45 feet.	Eastern margin of western Highland Rim.	A local aquifer. Supplies domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
Waldren Clay Member or Shale	Shale and shaly limestone, greenish-gray, fossiliferous. Part of Wayne Formation or Group of others. Thickness 0 to 5 feet.	Eastern margin of western Highland Rim.	A local confining unit. General low porosity and permeability.	Yields little or no water to wells.
Laurel Limestone Member or Limestone	Limestone, even-bedded. Part of Wayne Formation or Group of others. Thickness 0 to 30 feet.	Eastern margin of western Highland Rim.	A local aquifer. Supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
Osgood Limestone Member or Formation	Shale and limestone, argillaceous, greenish- and reddish-gray. Part of Wayne Formation or Group of others. Thickness 0 to 15 feet.	Eastern margin of western Highland Rim.	A local aquifer. Supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields little water to wells.
Brassfield Limestone	Limestone, cherty and locally glauconitic. Thin-bedded, white and brown. Thickness 0 to 130 feet.	Northern, western, and southern margin of Central Basin, and parts of Sequatchie Valley.	A local aquifer that supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
Lower				

Table 1.--Geohydrology of the formations comprising the Central Basin aquifer system, and confining units--Continued

SYSTEM	SERIES	Stratigraphic unit	Geologic description	Hydrologic significance		
				Occurrence in Tennessee	Hydrologic classification and character	Yield
ORDOVICIAN	Upper	Mannie Shale	Shale and limestone, argillaceous. Thickness 0 to 20 feet.	Northern, western, and southern margin of Central Basin, and parts of Sequatchie Valley.	Local confining unit. General low porosity and permeability.	Yields little or no water to wells.
		Fervale Limestone	Limestone and shale. Coarse-grained, thick-bedded, gray with varicolored grains. Thickness 0 to 30 feet.	Northern and southern flanks of Nashville Dome.	Local aquifer. Supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
		Sequatchie Formation	Mudstone and limestone with some sand, shale, and silty limestone. Greenish-gray to green. Thickness 0 to 160 feet.	Limited to northern and eastern flank of Nashville Dome.	Local confining unit. General low porosity and permeability.	Yields little or no water to wells.
		Arnheim Formation	Limestone, silty with interbedded shale. Fossiliferous. Thickness from 10 to 20 feet.	Limited to northwestern flank of Nashville Dome.	Local aquifer. Supplies water to domestic wells by solution openings. Low intergranular porosity and permeability.	Yields generally less than 10 gallons per minute.
		Leipers Formation	Limestone, granular, blue, interbedded shale. Phosphatic in the western part of the Central Basin. Thickness 0 to 75 feet.	Restricted to margin of Central Basin, near boundary with Highland Rim.	Local aquifer. Original porosity and permeability are low. Large solution cavities generally don't develop.	Springs furnish domestic water supply. Yields generally range from 0 to 20 gallons per minute.
		Inman Formation	Limestone, thin to thick-bedded, locally oolitic. Commonly with shale. Thickness ranges from 0 to 100 feet.	Restricted to southeastern margin of Highland Rim and Sequatchie Valley.	Local aquifer. Original porosity and permeability are low. Large solution cavities generally don't develop.	Yields generally range from 0 to more than 20 gallons per minute.

ORDOVICIAN		Middle		Stones River Group		Nashville Group	
Pond Spring Formation	Murfreesboro Limestone	Limestone, silty dolomite, and dolomitic limestone. Some shales, and local conglomeratic zones. Thickness from 0 to 150 feet. It is equivalent to the Wells Creek Formation.	Limited to Sequatchie Valley, western Central Basin, and Highland Rim. Pinches out to east.	Confining unit. Variable characteristics. Generally low porosity and permeability, but solution features develop locally.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Pierce Limestone	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Ridley Limestone	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Lebanon Limestone	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Carters Limestone	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Hermitage Formation	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Bigby and Cannon Limestones	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.
Catheys Formation	Murfreesboro Limestone	Limestone, massive, dense, dark blue to bluish-gray, cherty. Total thickness is about 425 feet.	Areally extensive. Present from beneath Cumberland Plateau to west of the Tennessee River.	Large solution openings occur between shaly zones within the limestone in outcrop area. Only 20 percent of wells obtain water where formation is deeply buried.	Where it occurs at depth, commonly doesn't yield water to wells. Yields may be in excess of 100 gallons per minute in outcrop.	Yields generally less than 5 gallons per minute.	Does not generally yield water to wells.

Table 2.--Dissolved-solids concentrations in water from selected wells
in the Central Basin aquifer system

[Data source codes: 1, Piper (1932); 2, Wells (1933); 3, Theis (1936);
4, Newcome (1958); 5, Rima and Goddard (1979); 6, Smith (1962)]

County	Location	Depth (feet)	Water- bearing unit	Dissolved solids (milligrams per liter)	Data source
Bedford	Bell Buckle 1.5 mi S	36	Carters	10,813	3
	Haley	155	Lebanon	30,830	3
	Shelbyville 11 mi N	102	Ridley	384	3
	Shelbyville	120	Lebanon	476	3
	Wartrace	185	Lebanon	1,103	3
Benton	Big Sandy	11	Camden	128	2
	Camden 5.1 mi E	22	Devonian rocks	106	2
Carroll	Bruceton	298	Devonian rocks	276	2
Cheatham	Pegram 0.5 mi N	79	Silurian rocks	70	1
Davidson	Ashland City 8 mi SE	Spring	Silurian rocks	178	1
	Bellevue 1.25 mi W	144	Catheys	6,474	1
	Nashville 4.25 mi NW	1491	Hermitage, Lebanon	979	1
	Nashville 4.5 mi S	125	Carters	469	1
	Whites Creek 2 mi S	63	Leipers	412	1
	Brentwood 0.5 mi N	90	Bigby and Cannon	1960	4
Decatur	Bath Springs	60	Decatur	276	2
	Decaturville 0.5 mi SE	107	Decatur	516	2
	Decaturville	30	Harriman	224	2
	Perryville	72	Decatur	609	2
Franklin	Winchester 5 mi W	Spring	Silurian rocks	141	3
Giles	Aspen Hill	185	Lebanon	286	3
	Campbellsville 3 mi N	Spring	Catheys	152	3
	Lynnville	37	Carters	424	3
	Minor Hill	619	Ordovician rocks	130	6
	Tarpley 1 mi E	Spring	Hermitage	190	3
Hardin	Savannah	128	Hermitage	98	2
Hickman	Centerville 1.5 mi SE	Spring	Leipers	56	3
	Coble 2.5 mi NW	Spring	Brownsport	97	3
	Pinewood	100	Leipers	1,614	3
Humphreys	Denver 4.25 mi S	Spring	Silurian rocks	160	1

Table 2.--Dissolved-solids concentrations in water from selected wells
in the Central Basin aquifer system--Continued

County	Location	Depth (feet)	Water- bearing unit	Dissolved solids (milligrams per liter)	Data source
Lewis	Gordonsburg 5.5 mi NE	84	Catheys	19,160	3
	Gordonsburg 6.5 mi NE	50	Leipers	257	3
Lincoln	Belleville	66	Hermitage	7,724	3
	Delrose 0.5 mi NE	Spring	Fernvale	110	3
	Fayetteville 4 mi S	Spring	Bigby and Cannon	106	3
	Howell	Spring	Fernvale	193	3
	Petersburg	40	Carters	434	3
Marshall	Chapel Hill 2.5 mi S	96	Lebanon	270	3
	Chapel Hill	540	Murfreesboro	236	4
	Lewisburg 2 mi SE	21	Carters	609	3
Macon	Lafayette 3.5 mi SW	63	Leipers	435	4
	Lafayette 6 mi S	30	Bigby and Cannon	310	4
Maury	Carters Creek 1 mi E	29	Hermitage	200	3
	Columbia 3.5 mi SW	70	Hermitage	311	3
	Kettle Mills	83	Bigby and Cannon	1,300	4
	Mt. Pleasant 6 mi SE	85	Lebanon	290	3
	Springhill 4 mi SE	73	Lebanon	955	3
	Match 5 mi E	75	Lebanon	3,283	3
Moore	Lynchburg 2 mi NE	Spring	Bigby and Cannon	138	3
	Lynchburg 1 mi W	25	Bigby and Cannon	280	4
Perry	Beardstown	137	Brownsport	3,121	3
	Beardstown 3 mi E	Spring	Ross	79	3
	Linden	Spring	Ross	118	3
	Linden 0.5 mi S	202	Silurian rocks	185	6
	Pope 9 mi SE	Spring	Brownsport	108	3
Rutherford	Christiana 9 mi W	Spring	Lebanon	300	1
	Eagleville 2 mi E	Spring	Lebanon	256	1
	Halls Hill	115	Ridley	357	5
	Murfreesboro 2.5 mi W	175	Murfreesboro	1,240	1
	Murfreesboro 0.75 mi NW	217	Murfreesboro	356	1
	Murfreesboro 1.5 mi N	1930	Murfreesboro	322	1
	Murfreesboro 6 mi SE	253	Ridley	282	5
	Rucker		Ridley	297	5
	Rocky Ford 0.25 mi W	112	Lebanon	367	5

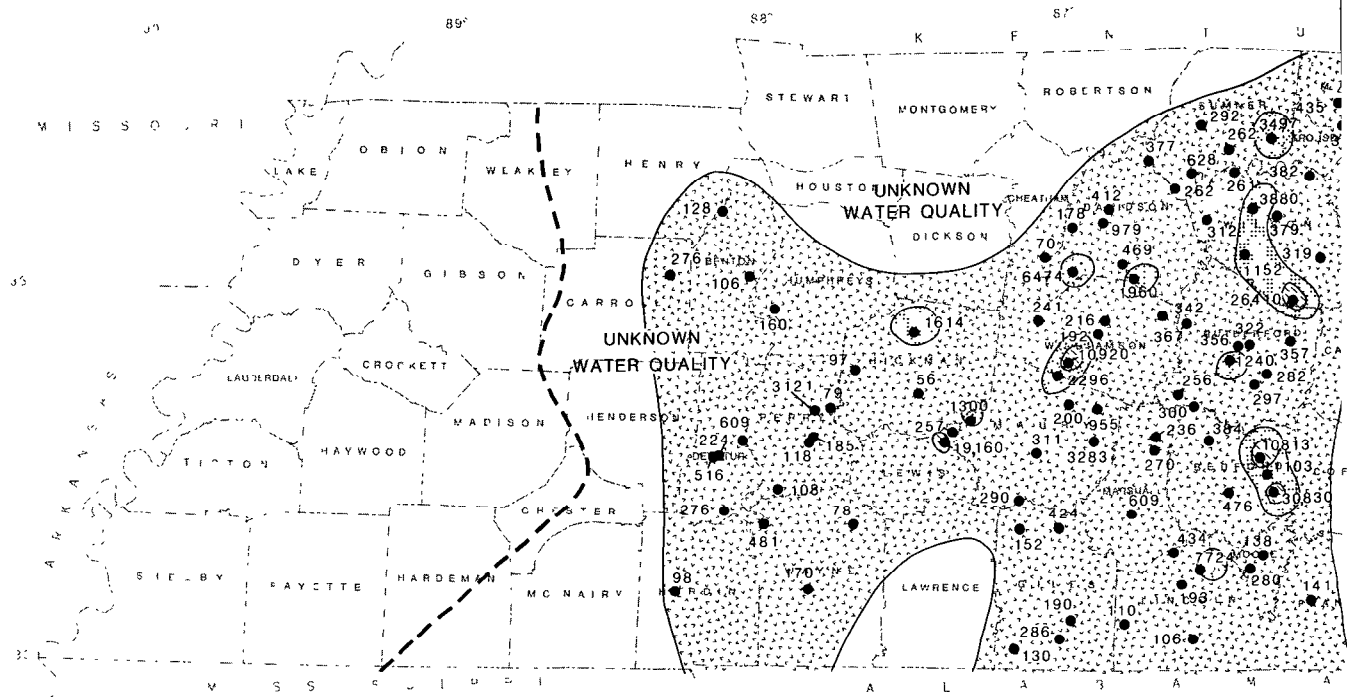
Table 2.--Dissolved-solids concentrations in water from selected wells
in the Central Basin aquifer system--Continued

County	Location	Depth (feet)	Water- bearing unit	Dissolved solids (milligrams per liter)	Data source
Smith	Kempville	123	Bigby and Cannon	300	4
Sumner	Castalian Springs	Spring	Bigby and Cannon, Hermitage	3,497	1
	Cottontown	60	Leipers	292	1
	Gallatin	300	Bigby and Cannon	262	1
	Hendersonville	315	Bigby and Cannon	262	5
	Millersville 2 mi S	35	Bigby and Cannon	377	5
	Saundersville	50	Leipers	628	1
Wayne	Clifton 3 mi NE	42	Silurian rocks	481	3
	Collinwood 5 mi NW	Spring	Brownsport	170	3
	Riverside 5 mi SW	Spring	Silurian rocks	78	3
Williamson	Boston 5 mi E	45	Bigby and Cannon	10,920	1
	Boston 4.75 mi SE	105	Catheys	2,296	1
	Franklin	150	Carters	216	5
	Franklin 1 mi S	Spring	Hermitage	192	1
	Nolensville	160	Ridley	342	1
	Fairview 5 mi SE	Spring	Fernvale	241	1
Wilson	Gladeville 0.75 mi E	28	Lebanon	1,152	1
	Hornsprings	Spring	Hermitage	3,880	1
	Lebanon 9 mi NE	118	Lebanon	382	1
	Lebanon	205	Ridley	379	1
	Mt. Juliet	47	Carters	312	1
	Norene 5.5 mi S	152	Lebanon	26,410	1
	Watertown 0.5 mi W	251	Ridley	319	1
	Woods Ferry	60	Lebanon	261	5

Table 3.--Summary of public drinking-water supplies
derived from the Central Basin aquifer system

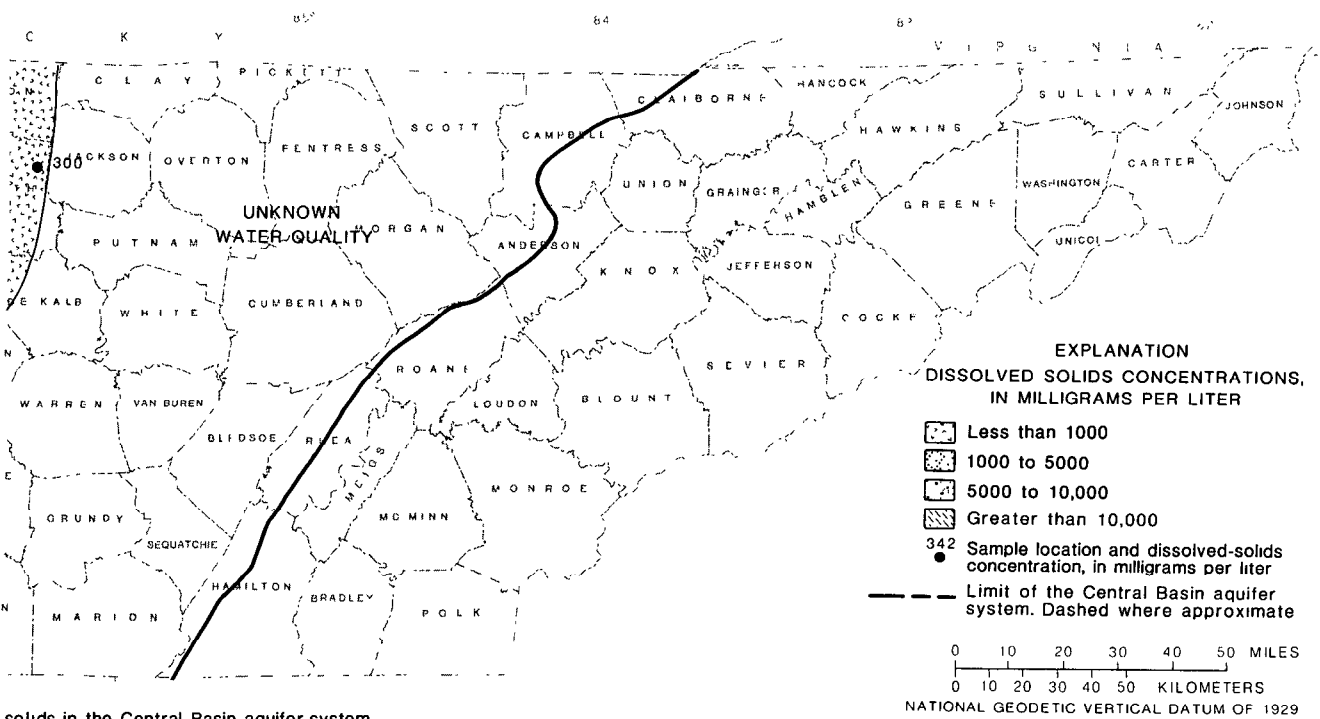
[Data source codes: 1, Tennessee comprehensive joint water and related
land resources planning, Tennessee Division of Water Resources; 2,
Tennessee Division of Water Quality Control; 3, Tennessee Division of
Water Resources]

System	County	Data source
Chapel Hill	Marshall	1, 2
College Grove	Williamson	1, 2, 3
Dowelltown-Liberty	DeKalb	1, 2, 3
Eagleville	Rutherford	1, 2, 3
Lynnville	Giles	1, 3
Mt. Pleasant	Maury	1
Murfreesboro	Rutherford	1, 2, 3
Nolensville	Williamson	1, 2, 3
Petersburg	Marshall	1, 2, 3
Pikeville	Bledsoe	1, 2, 3
Sequatchie	Marion	1, 2, 3
Wartrace	Bedford	1, 2, 3
Watertown	Wilson	1, 2, 3
Woodbury	Cannon	2, 3

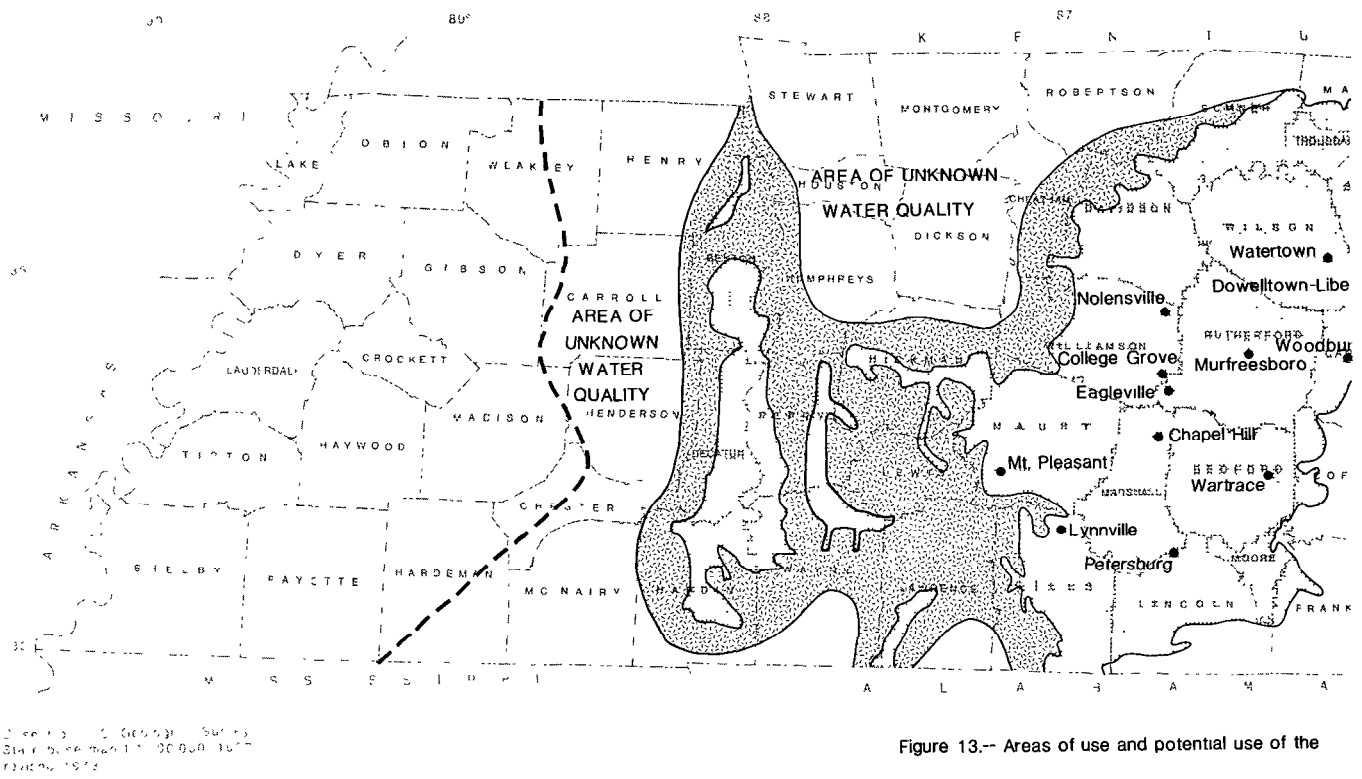


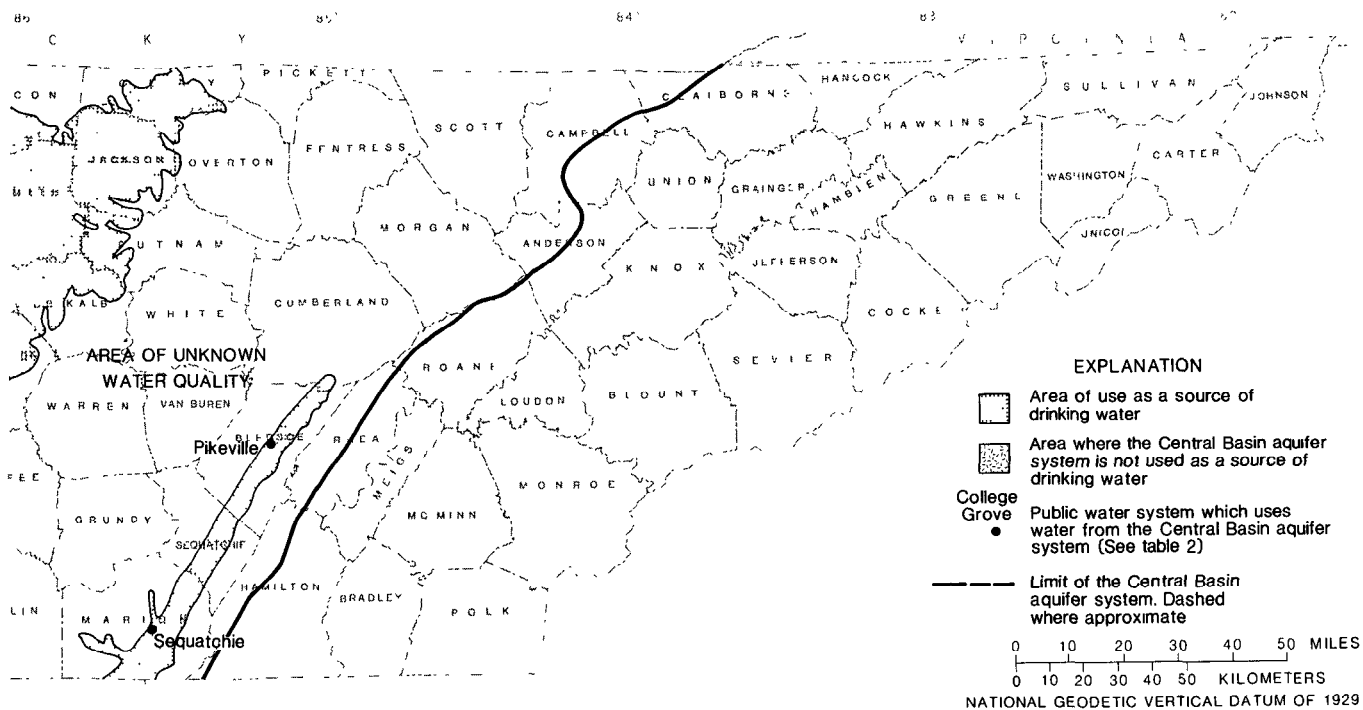
Missouri Geological Survey
State Bureau of Geology
Revised 1973

Figure 12.-- Concentrations of dissolved



solids in the Central Basin aquifer system.





Central Basin aquifer system as a source of drinking water.

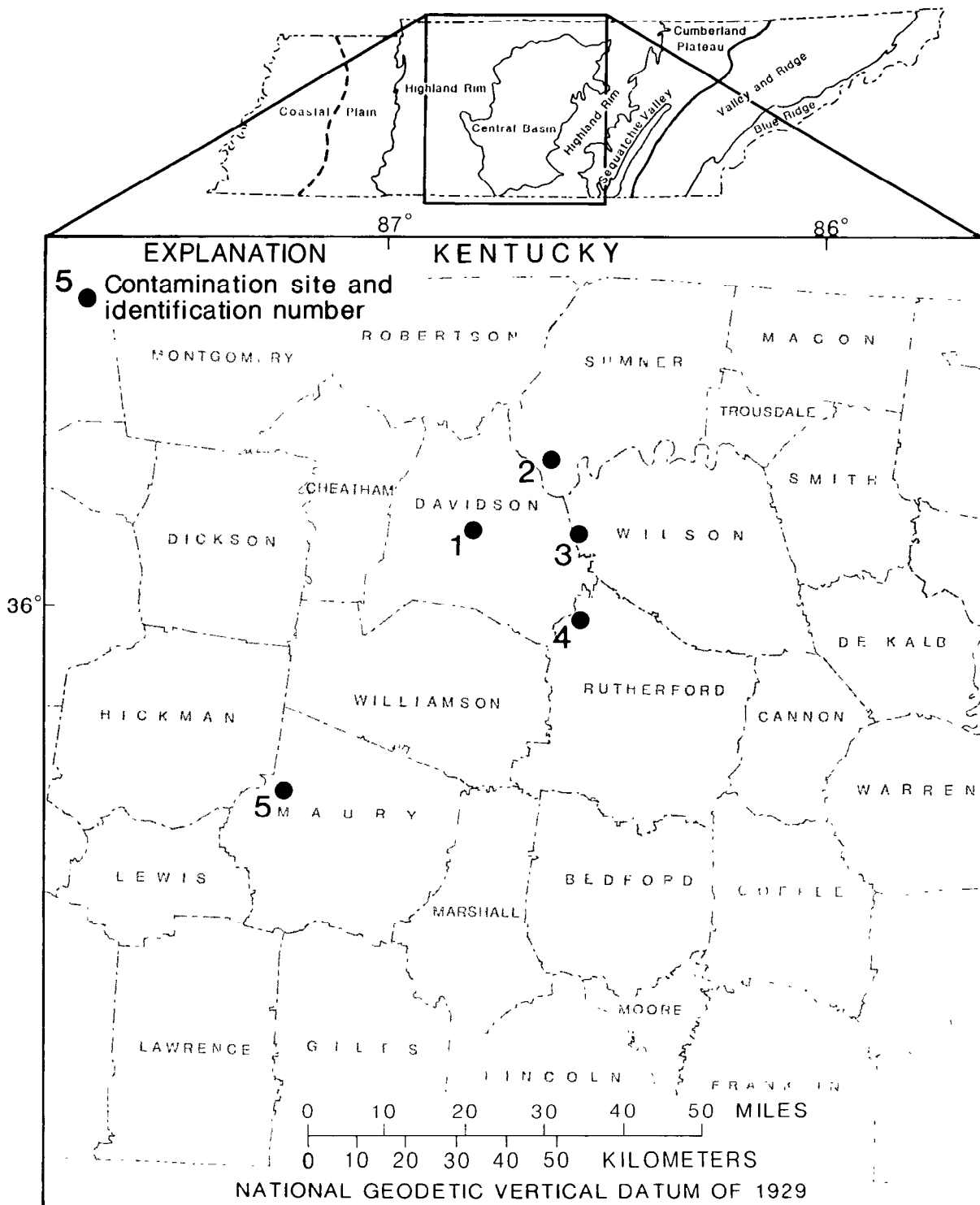


Figure 14.-- Contamination sites in the Central Basin aquifer system.

Table 4.--Description of contamination sites in the Central Basin aquifer system

Site identification No.	Location	Type of contamination	Data source	Stratigraphic interval contamination	Comments
1	Bordeaux Landfill, Municipal waste Davidson County.	Municipal waste	Residual Waste Study, Tennessee Division of Water Quality Control.	Perched water table in the alluvium and the water table within the bed rock of the Nashville Group.	Noticeably higher hardness, higher BOD, and higher concentrations of dissolved solids. A petroliferous odor was noticed in one well. Monitoring to be continued throughout the life of the landfill.
2	Hendersonville, Sumner County.	Domestic waste	Tennessee Division of Water Quality Control.	The regolith and bedrock of the Upper Ordovician formations.	The contamination at sites 2, 3, and 4 is due to the effluent from the large number of septic tanks under most municipal areas.
3	Mt. Juliet, Wilson County.	Domestic waste	do	The regolith and bedrock of the Carters Limestone.	
4	LaVergne, Rutherford County.	Domestic waste	do	The regolith and bedrock of the Lebanon Limestone.	
5	Williamsport, Maury County.	Industrial waste	do	The water table within the Leipers to Catheys Formation.	The bottom of a phosphate tailings pond collapsed and phosphate mud was found in springs one-half to 1 mile away.

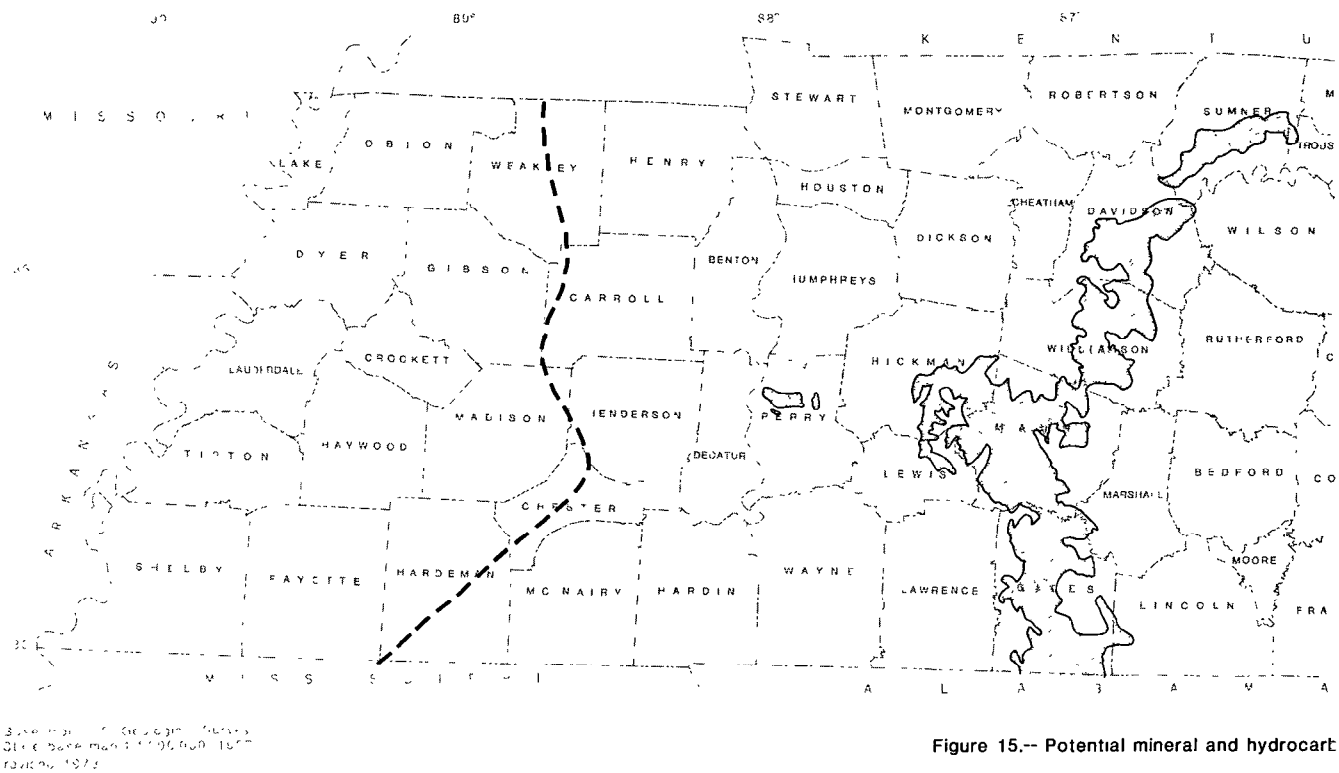
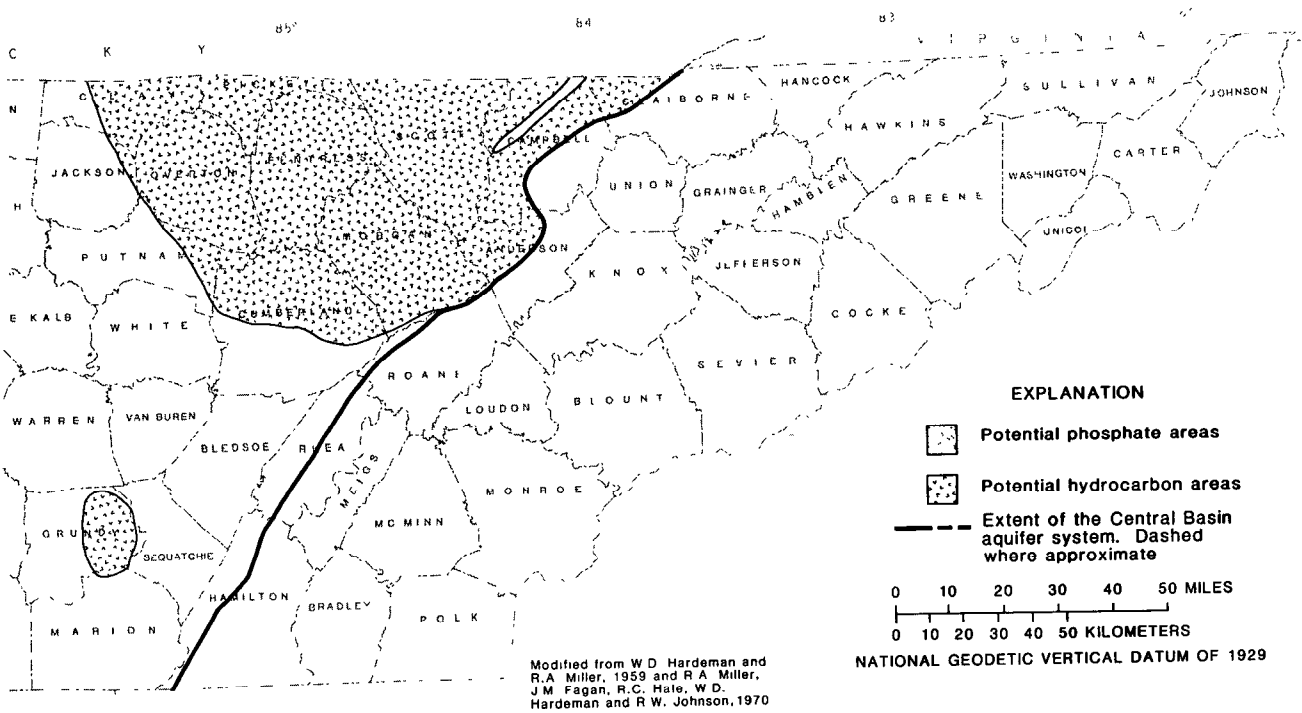


Figure 15.-- Potential mineral and hydrocarbon resources.



resources in the Central Basin aquifer system.

SELECTED REFERENCES

- Bassler, R.S., 1932, The stratigraphy of the Central Basin of Tennessee: Tennessee Division of Geology Bulletin 38, 268 p.
- Bingham, R.H., 1963, Summary of ground-water levels in Tennessee, 1952-61: Tennessee Academy of Science Journal, v. 38, no. 4, p. 126-132.
- Bloyd, R.M., Jr., 1974, Summary appraisals of the Nation's ground-water resources - Ohio Region: U.S. Geological Survey Professional Paper 813-A, 41 p.
- Burchett, C.R., 1977, Water resources of the upper Duck River Basin, central Tennessee: Tennessee Division of Water Resources, Water Resources Series no. 12, 103 p.
- Conant, L.C., and Swanson, V.E., 1961, Chattanooga shale and related rocks of central Tennessee and nearby areas: U.S. Geological Survey Professional Paper 357, 91 p.
- Feth, J.H., and others, 1965, Preliminary map of conterminous United States showing depth to and quality of shallowest ground water containing more than 1,000 parts per million dissolved solids: U.S. Geological Survey Hydrologic Investigations Atlas HA-199, scale 1:3,168,000.
- Freeman, L.B., 1953, Regional subsurface stratigraphy of the Cambrian and Ordovician in Kentucky and vicinity: Kentucky Geological Society Series IX, plates for Bulletin 12.
- Galloway, J.J., 1919, Geology and natural resources of Rutherford County, Tennessee: Tennessee Division of Geology Bulletin 22, 81 p.
- Glenn, L.C., 1903, [Notes on the ground-water resources of] Tennessee: U.S. Geological Survey Water-Supply Paper 102, pp. 358-367.
- Hardeman, W.D., 1966, Geologic map of Tennessee, west, west-central and east-central sheets: Tennessee Division of Geology, scale 1:250,000.
- Hardeman, W.D., and Miller, R.A., 1959, Mineral resources and mineral industries of Tennessee: Tennessee Division of Geology, scale 1:500,000, 1 sheet.
- Hass, W.H., 1956, Age and correlation of the Chattanooga Shale and the Maury Formation: U.S. Geological Survey Professional Paper 286, 47 p.
- Krieger, R.A., Hatchett, J.L., and Poole, J.L., 1957, Preliminary Survey of the saline-water resources of the United States: U.S. Geological Survey Water-Supply Paper 1374, 172 p.
- Milhous, H.C., 1959, Well logs in Tennessee: Tennessee Division of Geology Bulletin 62, 606 p.
- Milici, R.C., 1970, Middle Ordovician stratigraphy in central Sequatchie Valley, Tennessee: Reprinted from Southeastern Geology, V. 11, no. 2, pp. 111-127, Tennessee Division of Geology, Report of Investigations no. 30.
- Miller, R.A., 1974, The Geologic History of Tennessee: Tennessee Division of Geology Bulletin 74, 63 p.
- Miller, R.A., Fagan, J.M., Hale, R.C., Hardeman, W.D., and Johnson, R.W., 1970, Mineral resources of the Tennessee Valley region: Tennessee Valley Authority.
- Miller, R.A., and Maher, S.W., 1972, Geologic evaluation of sanitary landfill sites in Tennessee: Tennessee Division of Geology, Environmental Geology Series No. 1, 38 p.
- Moore, G.K., Burchett, C.R., and Bingham, R.H., 1969, Limestone hydrology in the upper Stones River basin, central Tennessee: Tennessee Division of Water Resources Research Series 1, 58 p.
- Moore, G.K., and Wilson, J.M., 1972, Water Resources of the Center Hill Lake Region, Tennessee: Tennessee Division of Water Resources, Water Resources Series no. 9, 77 p.
- Newcome, Roy, Jr., 1958, Ground water in the Central Basin of Tennessee: Tennessee Division of Geology Report, Inv. 4, 80 p.

- Piper, A.M., 1932, Ground water in north-central Tennessee: U.S. Geological Survey Water-Supply Paper 640, 238 p.
- Reesman, A.L., and Godfrey, A.E., 1970a, Chemical erosion and denudation rates in middle Tennessee: Tennessee Division of Water Resources, Water Resources Research 4, 35 p.
- _____, 1970, Chemical quality of streams draining the Central Basin of Tennessee: Tennessee Division of Water Resources, Water Resources Research 2, 72 p.
- Rima, D.R., and Goddard, P.L., 1979, Ground-water resources in the Metropolitan Region of Nashville, Tennessee: U.S. Army Corps of Engineers, Nashville District, 44 p.
- Rima, D.R., Moran, M.S., and Woods, E.J., 1977, Ground-water supplies in the Murfreesboro area, Tennessee: U.S. Geological Survey Water-Resources Investigations Report 77-86, 76 p.
- Schlumberger Well Surveying Corp, 1958, Introduction to Schlumberger well logging: Schlumberger Document No. 8, 176 p.
- Smith, Ollie, Jr., 1962, Ground-water resources and municipal water supplies of the Highland Rim in Tennessee: Tennessee Division of Water Resources, Water Resources Series no. 3, 257 p.
- Statler, A.T., Bloss, P., and Zurawski, R.P., 1975, Subsurface information catalog of Tennessee 1866-1974: Tennessee Division of Geology Bulletin 76, 146 p.
- Stearns, R.G., 1974, Porosity and hydrology of jointed Middle Ordovician Limestones in the J. Percy Priest Dam area of central Tennessee: Tennessee Water Resources Research Center Report no. 33, 86 p.
- Theis, C.V., 1936, Ground water in south-central Tennessee, U.S. Geological Survey Water-Supply Paper 677, 182 p.
- U.S. Department of the Interior, Bureau of Mines, 1978, Minerals in the economy of Tennessee: U.S. Department of the Interior, Bureau of Mines, 18 p.
- Wells, F.G., 1933, Ground-water resources of western Tennessee: U.S. Geological Survey Water-Supply Paper 656, 319 p.
- Wiethe, J.D., and Sitterly, P.D., 1978, Recently discovered Upper Ordovician-Lower Mississippian stratigraphic section in which the Chattanooga Shale is absent: Tennessee Academy Science Journal, v. 53, no. 1, p. 12-13.
- Wilson, C.W., Jr., 1948, The geology of Nashville, Tennessee: Tennessee Division of Geology Bulletin 53, 172 p.
- _____, 1949, Pre-Chattanooga stratigraphy in central Tennessee: Tennessee Division of Geology Bulletin 56, 407 p.
- Zurawski, Ann, 1978, Summary appraisals of the nation's ground-water resources--Tennessee region: U.S. Geological Survey Professional Paper 813-L, 35 p.