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Geohydrology for Urban Planning in
Johnson County, Northeastern Kansas

by

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State Geological Survey of Kansas
Open-File Report

1973

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INTRODUCTION

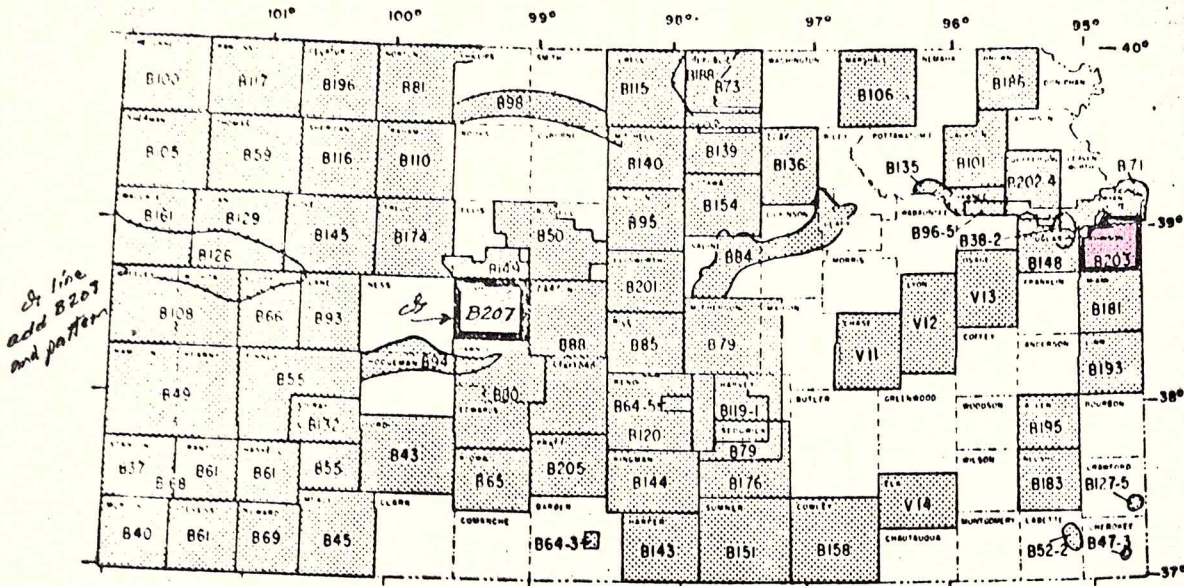
Reports describing the geology and ground-water resources of about three-quarters of the state have been published by the State Geological Survey of Kansas and the U.S. Geological Survey, in cooperation with the Division of Environmental Health of the Kansas State Department of Health and the Division of Water Resources of the Kansas State Board of Agriculture (fig. 1). These reports have been written primarily for such users as water

Figure 1 near here. Caption on following page.

well drillers, persons interested in developing industrial, municipal or irrigation ground-water supplies, and farmers interested in domestic and stock-water supplies. Utilization of the reports has also been extensive among the oil and gas industry, quarry operators and rock producers, bankers, realtors, pump and pipe companies, power companies, and State and Federal agencies such as the State Highway Commission, State Department of Economic Development, State Board of Agriculture, State Water Resources Board, State Forestry, Fish and Game Commission, U.S. Corps of Engineers, U.S. Bureau of Reclamation, and Fish and Wildlife Service.

This report is the first of a series which will be directed at a different group of users, --- persons primarily involved with planning, administering and developing land in areas which are now urban or are expected to be urbanized in the near future. The report is an experiment to determine what types of information could be assembled from other agencies and combined with available geologic and hydrologic information to prepare maps useful to the urban planner, administrator, and developer. All information used in preparation of this report was obtained from the Geological Survey's files and from published and unpublished information of other agencies.

Figure 1.--Index maps showing area of this report and areas for which ground-water reports have been published or are in preparation.



EXPLANATION



This report

Published report and number



State Geological Survey of Kansas

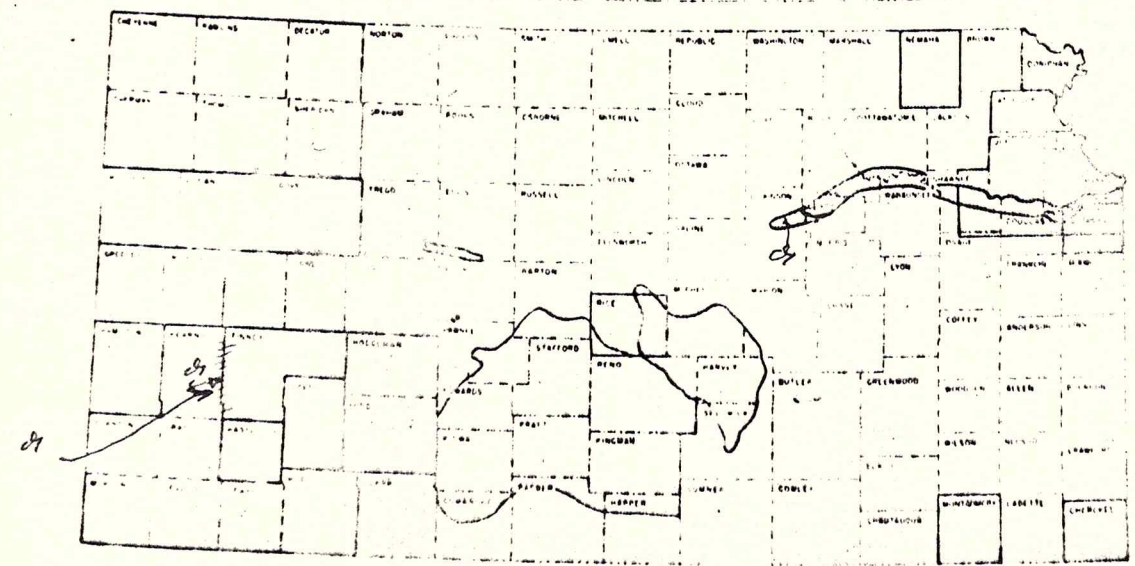
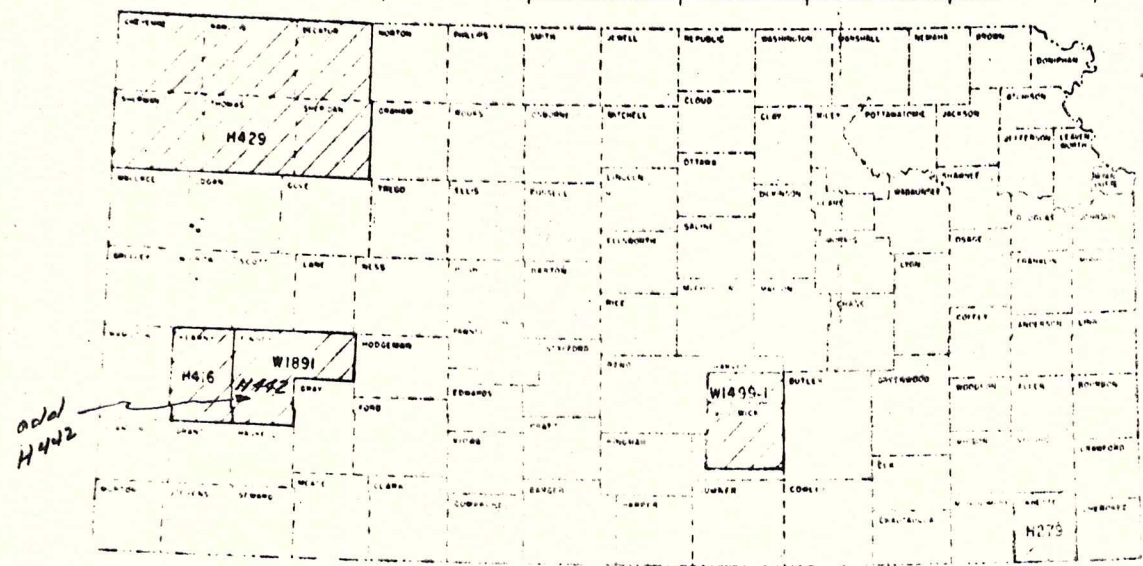
B-Bulletin, V-Volume



U.S. Geological Survey

W - Water-Supply Paper, H - Hydrologic Investigations Atlas

Investigations in progress



0 30 60 MILES

Figure 1.--Index maps showing area of this report and areas for which ground-water reports have been published or are in preparation.

As work progressed, it was realized that some parts of the report were impractical to include at the $\frac{1}{4}$ -inch per mile map scale chosen for publication, some parts required data that were not available within the time and no-field-work restrictions set for compilation, and some parts had already been published by other agencies. Ideas for several kinds of maps developed as the report was being prepared and will be utilized in subsequent reports describing geohydrologic information for urban planning.

It is becoming more apparent daily that our mineral resources, water resources, and land resources are finite and limited. Land uses compatible with the geology and hydrology result in lower costs to the public, higher property values, a better environment, and the conservation of mineral and water resources needed for quality urban development.

ACKNOWLEDGMENTS

The author gratefully acknowledges the assistance of the following persons who supplied information or prepared parts of this report. Mr. Robert O. Plins^key, Soil Scientist, U.S. Department of Agriculture prepared the section on soils and the soils map. Mr. Jack R. Carter, Engineer, U.S. Geological Survey prepared most of the section on surface water. Dr. Paul Hilpman and Mr. Stan Felipe, Environmental Geology Section, State Geological Survey of Kansas, prepared the drainage basin map and basin area computation. Mrs. Margaret Oros, Mineral Resources Section, State Geological Survey of Kansas, supplied the information for the oil, gas, and petroleum products pipeline map. Mr. Thomas Neal, Engineer, Mid-America Regional Council provided the information for the map showing Rural Water Districts and other public water supplies.

GEOLOGY

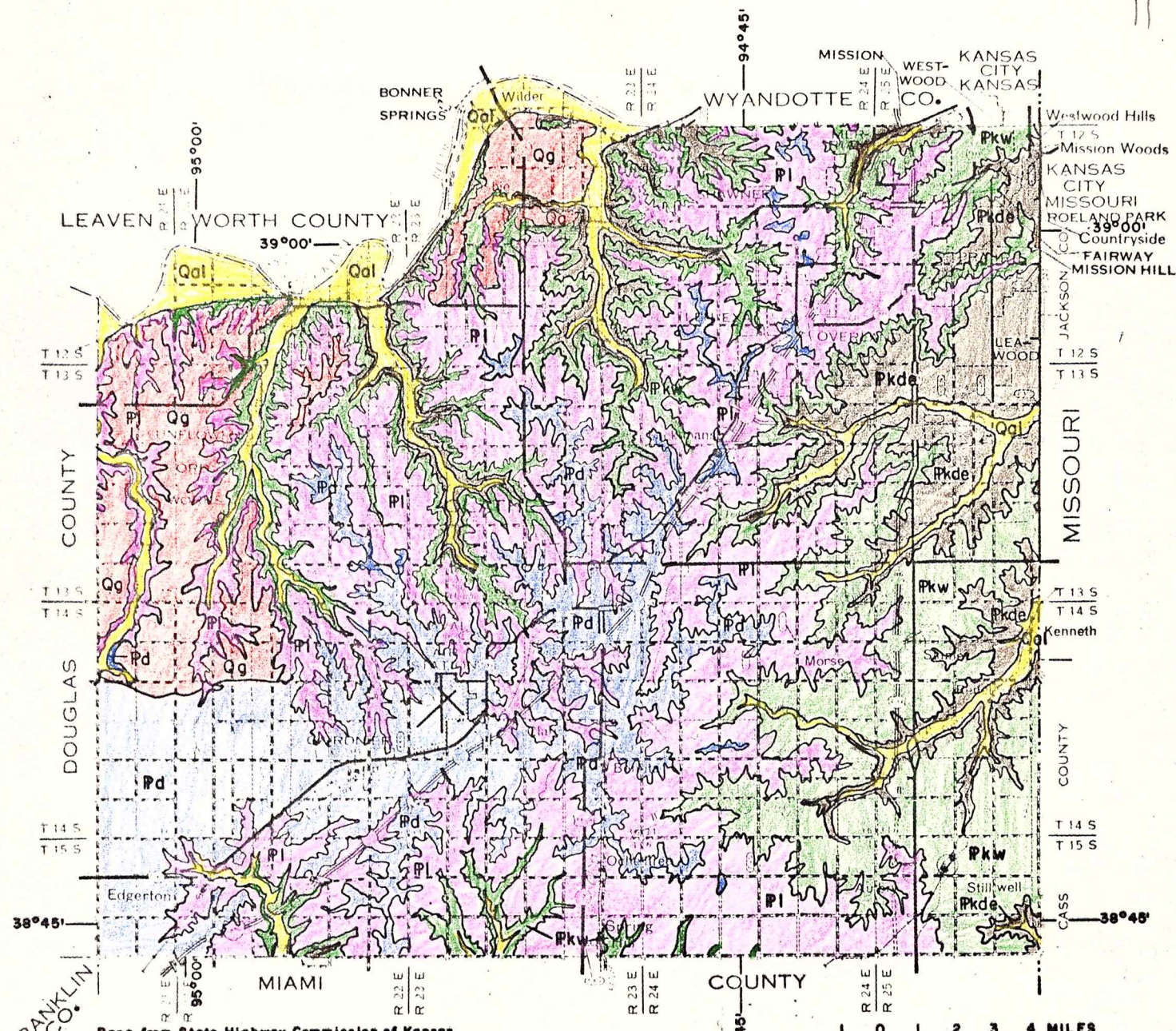
The geology of Johnson County is relatively simple. All the rocks at or near the land surface are sedimentary rocks. The exposed rocks consist of two general groups, (1) rocks of Pennsylvanian age, which are mainly alternating beds of limestones and shales, and (2) deposits of Quaternary age, which are primarily loose soft deposits of gravel, sand, silt, and clay (fig. 2, Table 1).

Figure 2 and Table 1 near here. Caption on following page.

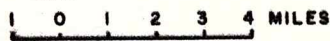
The Pennsylvanian rocks, although chiefly limestones and shales, include some local sandstones. These rocks are in beds or layers that range from a fraction of a foot to about 100 feet in thickness. They appear to be nearly level, but actually have an average slope of about 12 feet per mile north-westward across the county. Locally the rocks slope gently in other directions.

The Quaternary deposits, where present, overlie the layered Pennsylvanian rocks. These deposits, which underlie the floodplains and terraces consist of variable mixtures of gravel, sand, silt and clay that range from a few feet to about 100 feet in thickness. The deposits are chiefly water-laid (fluvial) sediments that contain important ground-water supplies and provide sand and gravel for construction material. Along the Kansas River valley, there are local glacial, fluvial, and lacustrine deposits, including the Atchison Formation and the Kansan till, that generally are less than 30 feet thick. These deposits may be as much as 100 feet thick locally.

Figure 2.--Geologic map.



Base from State Highway Commission of Kansas



EXPLANATION	
QUATERNARY	<div style="display: inline-block; border: 1px solid black; background-color: yellow; width: 30px; height: 20px; margin-right: 5px;"></div> Qa1 Wisconsinan and Recent alluvium and terrace deposits
	<div style="display: inline-block; border: 1px solid black; background-color: pink; width: 30px; height: 20px; margin-right: 5px;"></div> Qg Kansan glacial, fluvial and lacustrine deposits
PENNSYLVANIAN	<div style="display: inline-block; border: 1px solid black; background-color: lightblue; width: 30px; height: 20px; margin-right: 5px;"></div> Pd Lawrence Formation and Stranger Formation
	<div style="display: inline-block; border: 1px solid black; background-color: lightpink; width: 30px; height: 20px; margin-right: 5px;"></div> Pl Stanton Limestone, Vilas Shale, and Plattsburg Limestone
	<div style="display: inline-block; border: 1px solid black; background-color: lightgreen; width: 30px; height: 20px; margin-right: 5px;"></div> Pkw Bonner Springs Shale and Wyandotte Limestone
	<div style="display: inline-block; border: 1px solid black; background-color: #c8e6c9; width: 30px; height: 20px; margin-right: 5px;"></div> Pkde Lane Shale, Iola Limestone, Chanute Shale, Drum Limestone, Cherryvale Shale, and Dennis Limestone
	<div style="display: inline-block; border: 1px solid black; width: 30px; height: 20px; margin-right: 5px;"></div> Pl Stanton Limestone, Vilas Shale, and Plattsburg Limestone

Contact

Figure 2.--Geologic map.

Table 1.--Physical and hydrological characteristics of outcropping rocks.

System	Series	Stage	Group	Formation or rock unit	Member	Thickness	Physical Characteristics	Hydrological Characteristics ^{1/}		
QUATERNARY	PLEISTOCENE	Wisconsinan and Recent		Kansas River alluvium and terrace deposits		0-70	Arkosic sand and gravel with some lenses of silt and clay.	Yields large quantities of hard water to wells. Well yields generally range from 150 to 1,000 gpm.		
				Other stream alluvium and terrace deposits		0-76	Chiefly locally derived silt and clay containing a thin sandy or gravelly zone at the base.	Yields small to moderate quantities of water to wells, generally 25 to 100 gpm in large tributary valleys and 1 to 10 gpm in the small tributary valleys.		
		Illinoian	Wisconsinan		Peoria Formation		0-15	Yellowish brown wind-deposited silt on uplands. Thickest along Kansas River valley and in North-eastern part of county.	Not an aquifer.	
					Loveland Formation		0-40	Reddish brown silt. Fluvial deposits are sandy or clayey.	Yields only small water supplies locally to wells.	
					Unnamed sand and gravel deposits		0-5	Silty sand and gravel in terrace deposits of tributary streams.	Restricted occurrence. Yields only small water supplies.	
		Kansan			Atchison Formation, Kansan till and undifferentiated fluvial and Lacustrine deposits		0-100	Well-sorted sand and gravel; poorly sorted sand and gravel; unsorted sandy or gravelly silt and clay.	Where extensive, the deposits generally include a saturated sand or gravel zone. Elsewhere may be above the water table or drained. Yields to wells range from 0 to 100 gpm.	
					Lawrence Formation	Ireland Sandstone	0-49	Fine to very fine grained sandstone containing minor amounts of shale, conglomerate and coal.	Yields as much as 20 gpm locally to wells.	
		PENNSYLVANIAN	UPPER PENNSYLVANIAN	Virgilian	Douglas	Stranger Formation	Weston Shale	30-100	Grayish-blue and gray clayey shale.	Yields little or no water to wells.
						Lansing		Stanton Limestone	South Bend Limestone	1.5-5
				Rock Lake Shale	2-14					
Stoner Limestone	13-18									
Eudora Shale	6-11									
Captain Creek Limestone	4.5-10									
				Plattsburg Limestone	Spring Hill Limestone	8-23	Chiefly limestone and one or more thin shale beds.	Yields small water supplies where weathered, otherwise yields little or no water to wells.		
					Hickory Creek Shale	0-3				
					Merriam Limestone	0.8-6				
Missourian	Kansas City				Bonner Springs Shale		1-80	Chiefly gray shale and fine-grained sandstone. Minor amounts of limestone, conglomerate and coal.	Yields as much as 3 gpm to wells in sandstone or weathered shale.	
					Wyandotte Limestone	Farley Limestone	0-35	Chiefly limestone with minor amounts of shale.	Well yields range from 0 to 40 gpm. Springs in the area of karst topography may flow as much as 100 gpm after heavy rains.	
						Island Creek Shale	0-16			
						Argentine Limestone	7-50			
						Quindaro Shale	0-7.5			
						Frisbie Limestone	1-5			
					Lane Shale		3-95	Chiefly shale. Locally contains some fine-grained sandstone.	Yields only small water supplies locally to wells.	
					Iola Limestone	Raytown Limestone	4-14	Chiefly limestone, but includes one or more thin shale beds.	Yields only small water supplies locally to wells.	
						Muncie Creek Shale	0.1-2.2			
		Paola Limestone	1-2.4							
			Chanute Shale		12-33	Shale, fine-grained sandstone and a thin impure limestone.	Well yields range from 0 to 3 gpm.			
			Drum Limestone		4-15	Gray massive to medium-bedded limestone, locally cherty.	Yields little or no water to wells.			
			Cherryvale Shale	Quivira Shale	2-11	Chiefly gray shale, but includes some green, red, and black shale and two limestone beds. Upper limestone locally replaced by sandstone.	Yields 1 to 3 gpm locally to wells in black shale or sandstone beds. Elsewhere yields little or no water to wells.			
Westerville Limestone	0-30									
Wea Shale	7-35									
Block Limestone	0.5-3									
Fontana Shale	2-12									
	Dennis Limestone	Winterset Limestone	25-31	Gray limestone, cherty limestone and interbedded gray shale. Basal part is black fissile shale.						
		Stark Shale	3-4							
	Galesburg Shale		1-4	Gray argillaceous shale.	Yields 1/2 to 5 gpm of fresh to slightly saline water to wells in black fissile shale in part of eastern Johnson County.					
	Swope Limestone	Bethany Falls Limestone	20	Chiefly limestone. Includes a black fissile shale in lower part.						
		Hushpuckney Shale	4							
		Middle Creek Limestone	1							

^{1/} Small quantities of water means generally less than 10 gpm, moderate quantities 10 to 100 gpm, and large quantities more than 100 gpm.

Wind-laid (eolian) deposits of yellowish-brown or reddish-brown silt of the Peoria and Loveland Formations mantle much of the upland. The deposits are generally less than 6 feet thick and are not shown on the geologic map, although in the northeastern part of the county and along bluffs of the Kansas River the deposits are as much as 15 feet thick.

The suitability and the use of land is affected by the geology in two ways. Certain rock units are important for the mineral resources and the ground water that they contain. Zoning should be planned to allow production of gravel and limestone in areas where these important construction materials can be obtained at low cost. Large quantities of concrete, utilizing gravel, sand, and crushed limestone aggregate are used in urban areas and planners should consider both the present and the future needs for these materials. Haulage costs are passed on to the cities, industries, and individuals, so nearby sites ideally should be reserved for use by the communities involved.

The second way the geology affects urban areas relates to the physical and hydrologic characteristics of the rocks, such as thickness, hardness, strength, stability, erodability, and permeability. A rock unit may be useful as an aquifer, but its susceptibility to pollution and flooding are factors to be considered. Whether a rock unit discharges appreciable amounts of ground-water seepage along its outcrop causing roadway and foundation problems is related to the geology and hydrology.

An area of karst topography in southeastern Johnson County presents special problems to urban development. Soil cover is thin or absent in parts of this area, thus making basements impractical or expensive. Small tract developments utilizing septic tank systems for sewage disposal may create health hazards owing to inadequate soil cover for effective absorption of the sewage effluent. Pollution of local water supplies may occur when the effluent either runs off to streams or percolates through creviced and solutioned limestone to the water table.

The geology as shown on figure 2 is too generalized and too small a scale (1:250,000) to be useful for detailed planning, but the map does indicate the areal distribution of the various rock units. The geologic map published with an earlier report (O'Connor, 1971) is more useful in that it shows more detail at a larger scale.

MINERAL RESOURCES

The most important mineral resources in Johnson County from the standpoint of both availability and use in an urban or urbanizing area are limestone, sand, and gravel. These are low value, bulky items used in large quantities in roads, buildings and other structures both during the period of urbanization and after an area becomes urban.

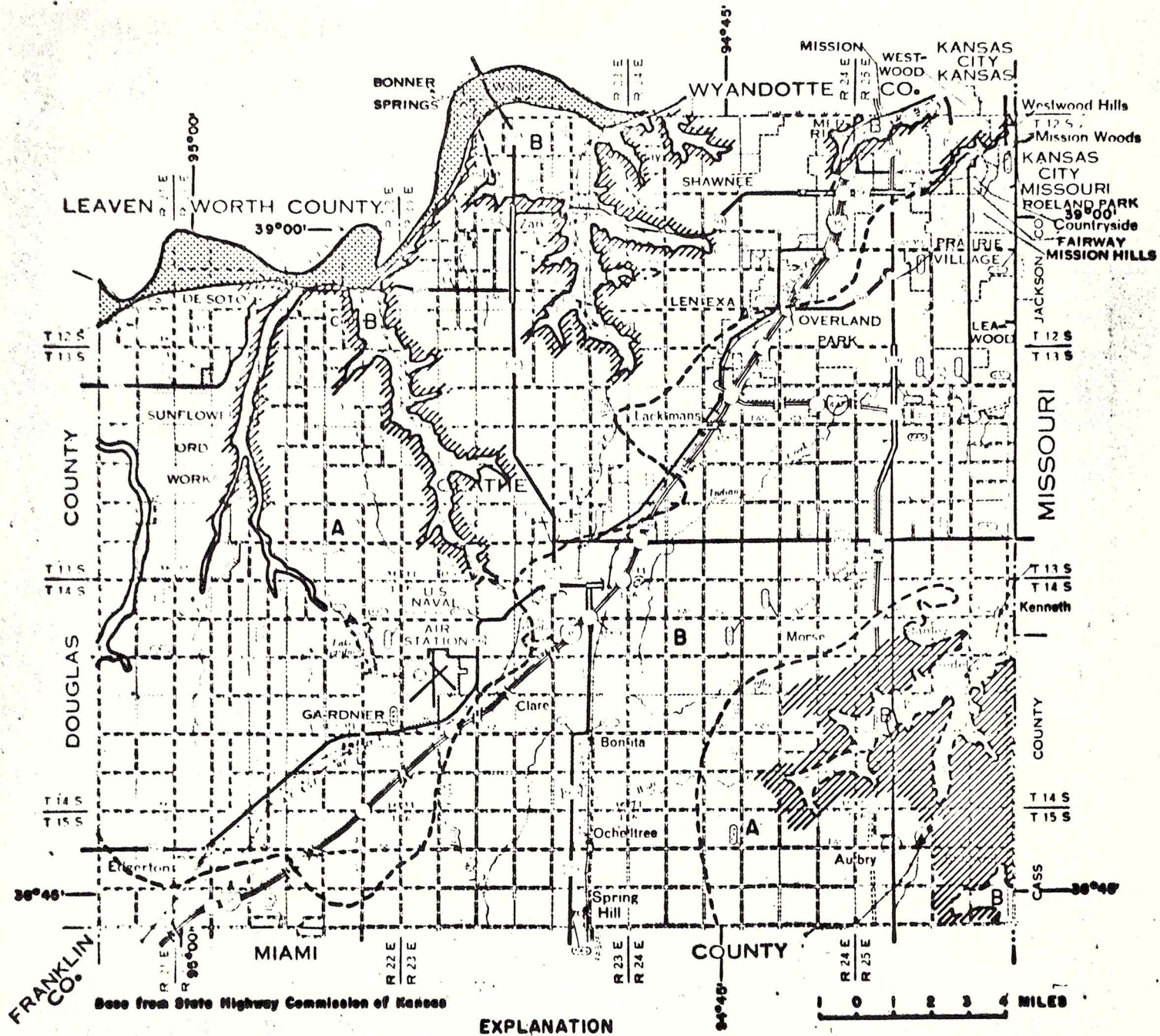
Most of the limestone is quarried from the Wyandotte Limestone in the areas shown in figure 3. The Stanton and Plattsburg Limestones also are

Figure 3 near here. Caption on following page.

quarried in the Olathe area. The Stanton Limestone occurs in the upper part of the Lansing Group and the Plattsburg Limestone occurs at the base of the Lansing Group, which is shown on the geologic map (fig. 2). Although the production of limestone varies from year to year, the annual value of limestone quarried for concrete aggregate, roadstone, and agricultural limestone has averaged about 2 million dollars in recent years.

Sand and gravel produced for building and paving sand, fill sand, filtration sand, and building gravel are produced almost exclusively from the abundant supplies in the alluvium of the Kansas River Valley. Other stream valleys have no production of building and paving sand.

Figure 3.--Map showing principal areas of sand, gravel and limestone resources.



EXPLANATION


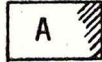

- 
 Area of arkosic sand and gravel
- 
 Area where Wyandotte Limestone is more than 40 feet thick and includes 1 bed of limestone at least 20 feet thick in Argentine or Farley Limestone Members. Hachures indicate area where limestone can be quarried, remaining area has potential for underground mining.
- 
 Approximate area where limestone in Wyandotte Limestone is absent or thin and of noncommercial value

Figure 3.--Principal areas of sand, gravel, and limestone resources.

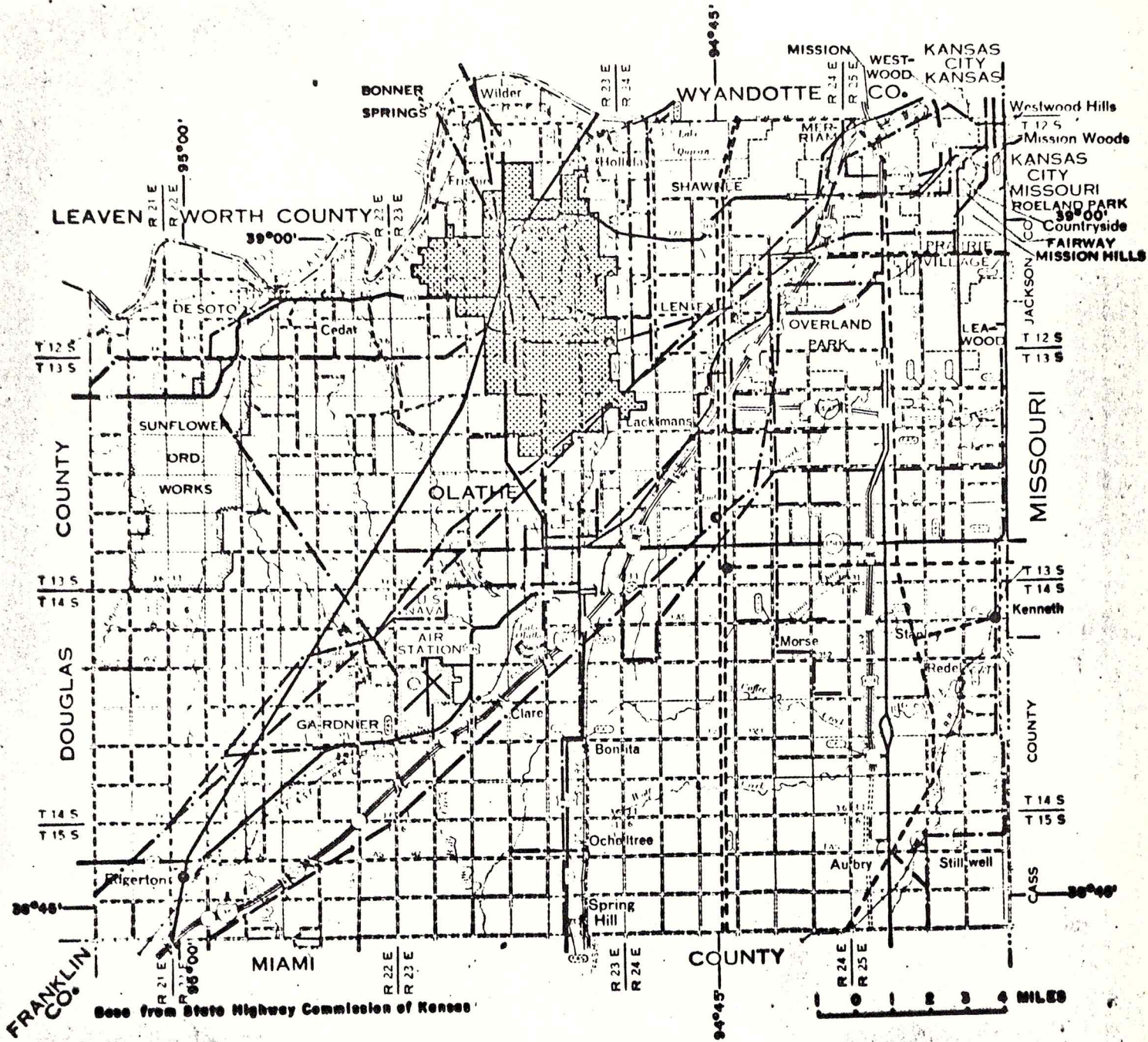
Oil and gas are produced from 10 areas described by O'Connor (1971), and gas also is produced from several areas outside the named fields. However, there is no commercial gas production in Johnson County. Neither oil nor gas production at the present time has much affect on urban planning and urban growth, although for certain kinds of industrial development proximity to large gas supplies is important. The oil, gas, and petroleum products pipelines and the Craig gas-storage field are shown on figure 4. The Craig

Figure 4 near here. Caption on following page.

gas-storage field is important to the metropolitan Kansas City area for maintenance of adequate nearby gas reserves for peak periods of use. Urban planning and developments in the Craig field should be compatible with continued use of this facility.

A detailed inventory of construction materials in Johnson County has been prepared by Hilmes (1970).

Figure 4.--Map showing ^{of} [the] pipelines and gas-storage fields for oil,
gas, and petroleum products.



EXPLANATION







- | | | | |
|---|-----------------------------|---|--------------------|
|  | Craig gas storage field |  | Pipe lines |
|  | Pumping station or terminal |  | Crude oil |
| | |  | Natural gas |
| | |  | Petroleum products |

Figure 4.--Pipelines and gas-storage fields for oil, gas, and petroleum products.

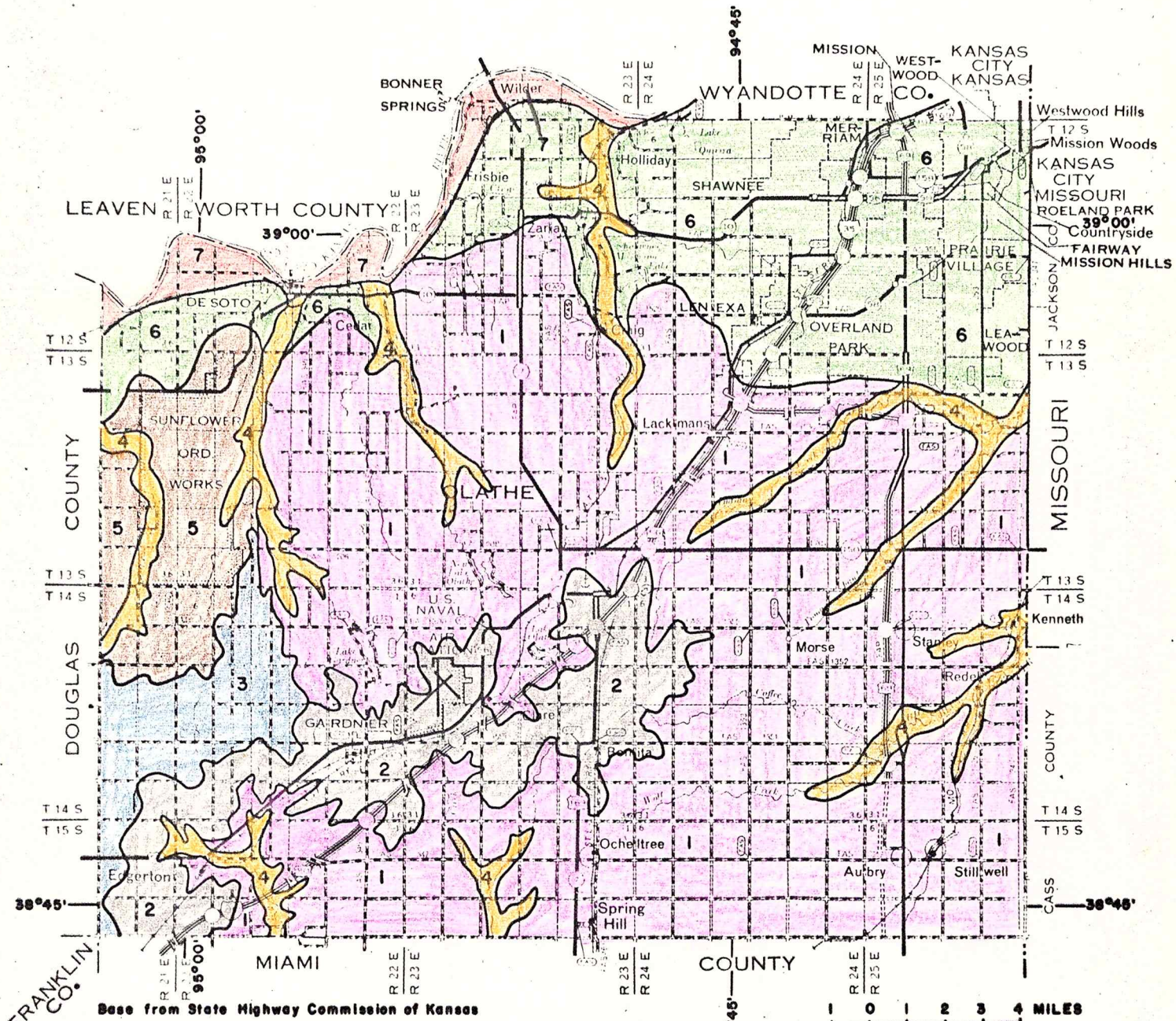
SOILS

Planners have found that detailed soils maps at relatively large scales (i.e. 1:20,000) are very useful. Maps of this type are currently being prepared by the U.S. Department of Agriculture, but have not yet been published for Johnson County. A general soil-association map of the county is shown in figure 5. A soil association is a landscape that has a dis-

Figure 5 near here. Caption on following page.

tinctive proportional pattern of soils. Each association consists of two or more major soils and at least one minor soil, which is named for the major soils. The soils in one association may occur in another, but usually are in a different pattern. The map is useful to people who want a general idea of the soils in the area, who want to compare different parts of the area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is not suitable for planning the management of a farm or field because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Figure 5.--Generalized map showing soil associations.



EXPLANATION
Soil Associations

1	Martin - Oska - Sogn	5	Woodson - Pawnee - Morrill
2	Woodson - Martin	6	Sharpsburg - Welda - Sogn
3	Martin - Elmont - Sibleyville	7	Eudora - Sarpy - Kimo
4	Reading - Kennebec - Chase		

Figure 5.--Generalized map showing soil associations.

The explanation that accompanies figure 5 indicates the major soils in each association. Table 2 describes selected soil characteristics and

Table 2 near here. Caption on following page.

features that affect the use of the major soils for specific purposes. The predictions as to how the soils will behave cannot be applied to any particular area within an association, but they do give information about the potential and limitations of the soils in the association. Information about some of the minor soils in an association can be obtained by referring to another association in which the soil occurs as a major soil. However, some of the minor soils listed do not occur as a major soil in any association. For further information contact your local Soil Conservation Service office.

Table 2.--Soil characteristics, major soil features and limitations for the soil associations in Johnson County.

Composition of Soil Associations	Selected Soil Characteristics		Major Soil Features Affecting Use For			Degree of Limitation and Major Soil Features Affecting Use For					
	Soil Association, Its Approximate Extent, and Names of Component Soils	Estimated Percent of Assoc.	Predominant Slope (percent)	Depth to Bedrock (feet)	Pond Reservoir Area	Pond Embankment	Local and Streets	Dwellings	Septic Tank Filter Fields	Sewage Lagoons	(Trench Type) Sanitary Landfill
1. Martin-Oska-Sogn association (165,000 acres)											
Martin	50	1-7	5+	Local seepage	Poor stability, high shrink-swell potential	Severe: local seepage, high shrink-swell potential	Severe: high shrink-swell potential	Severe: slow permeability, local seepage	Moderate for slopes of 7% or less, Severe for slopes over 7%	Moderate to severe high clay content	
Oska	15	1-6	2-3½	Shallow depth to bedrock	Fair to poor stability, moderate to high shrink-swell potential	Severe: local seepage, high shrink-swell potential, bedrock at less than 40"	Severe: high shrink-swell potential	Severe: slow permeability, shallow to bedrock	Severe: shallow to bedrock	Severe: shallow to bedrock	
Sogn	15	1-8	less than 20"	Bedrock within 20"	Limited available material	Severe: bedrock within 20", local seepage	Severe: bedrock within 20"	Severe: bedrock within 20"	Severe: bedrock within 20"	Severe: bedrock within 20"	
Other soils (mostly of Elmont, Detlor & Woodson series)	20	---	---	---	---	---	---	---	---	---	
2. Woodson-Martin assoc. (27,600 acres)											
Woodson	45	1-3	5+	Very slow permeability	Poor stability, high shrink-swell potential	Severe: high plasticity, high shrink-swell potential	Severe: high shrink-swell potential	Severe: very slow permeability	Slight	Severe: high clay content	
Martin	30	1-7	5+	Local seepage	Poor stability, high shrink-swell potential	Severe: local seepage, high shrink-swell potential	Severe: high shrink-swell potential	Severe: slow permeability, local seepage	Moderate: for slopes of 7% or less, Severe: slopes over 7%	Moderate to severe high clay content	
Other soils (mostly of the Elmont, Oska and Detlor series)	25	---	---	---	---	---	---	---	---	---	

Composition of Soil Associations	Selected Soil Characteristics			Major Soil Features Affecting Use For		Degree of Limitation and Major Soil Features Affecting Use For					
	Soil Association, Its Approximate Extent, and Names of Component Soils	Estimated Percent of Assoc.	Predominant Slope (percent)	Depth to Bedrock (feet)	Pond Reservoir Area	Pond Embankment	Local Streets	Dwellings	Septic Tank Filter Fields	Sewage Lagoons	(Trench Type) Sanitary Landfill
3. Martin-Elmont-Sibleyville association (11,900 acres)											
Martin	40	1-7	5+	Local seepage	Poor stability, high shrink-swell potential	Severe: local seepage, high shrink-swell potential	Severe: high shrink-swell potential	Severe: slow permeability, local seepage	Moderate: for slopes of 7% or less, Severe: slopes over 7%	Moderate to severe: high clay content	
Elmont	20	3-7	5+	Shallow to shale in places, possible seepage	Fair stability, compaction and shear strength	Moderate: local seepage, moderate shrink-swell potential	Moderate: moderate shrink-swell potential	Severe: slow permeability	Moderate: depth to shale	Moderate: less than 60" to rippable shale bedrock	
Sibleyville	20	3-15	1½-3½	Rapid seepage in some areas	High erodibility, limited amount of material	Severe: sandstone or shale within 40", local seepage	Moderate: bedrock within 40", Moderate shrink-swell potential	Severe: depth to sandstone	Severe: slope, depth to sandstone	Severe: depth to sandstone	
Other soils of the Detlor & Woodson series	20	---	---	---	---	---	---	---	---	---	
4. Reading-Kennebec-Chase association (22,200 acres)											
Reading	40	0-2	5+	Moderately slow permeability	Fair stability, compaction and shear strength. Moderate to high shrink-swell potential	Moderate: moderate shrink-swell potential	Moderate: Moderate shrink-swell potential	Severe to moderate: moderately slow permeability	Slight	Moderate: silty clay loam texture	
Kennebec	30	0-2	5+	Permeability	Fair stability, compaction, and shear strength	Severe: subject to occasional flooding	Severe: to flooding	Severe: occasional flooding	Severe: occasional flooding	occasional flooding	
Chase	20	0-2	5+	Permeability	Poor stability, high shrink-swell potential	Moderate to severe: high shrink-swell potential, occasional flooding	Severe: high shrink-swell potential, occasional flooding	Severe: occasional flooding	Severe: occasional flooding	Severe: occasional flooding	
Other soils (mostly of the Moniteau & Doxie series)	10	---	---	---	---	---	---	---	---	---	

Composition of Soil Associations		Selected Soil Characteristics		Major Soil Features Affecting Use For		Degree of Limitation and Major Soil Features Affecting Use For				
Soil Association, Its Approximate Extent, and Names of Component Soils	Estimated Percent of Assoc.	Predominant Slope (percent)	Depth to Bedrock (feet)	Pond Reservoir Area	Pond Embankment	Local and Streets	Dwellings	Septic Tank Filter Fields	Sewage Lagoons	(Trench Tyne) Sanitary Landfill
5. Woodson-Pawnee-Morrill association (15,900 acres)										
Woodson	50	1-3	5+	Very low permeability	Poor stability, high shrink-swell potential	Severe: high plasticity, high shrink-swell potential	Severe: high shrink-swell potential	Severe: very slow permeability	Slight	Severe: high clay content
Pawnee	25	3-7	5+	Few sand pockets	Poor stability, compaction & shear strength, high shrink-swell potential	Severe: high plasticity, high shrink-swell potential	Severe: high shrink-swell potential	Severe: slow permeability	Moderate: possible local seepage (sand pockets)	Severe: high clay content
Morrill	15	3-8	5+	Gravel and sand pockets cause rapid seepage	Fair stability and compaction	Moderate: moderate shrink-swell potential	Moderate: moderate shrink-swell potential	Moderate to severe: moderately slow permeability	Severe: sand & gravel pockets cause rapid seepage	Moderate: clay loam texture
Other soils (mostly of the Martin & Oska series)	10	---	---	---	---	---	---	---	---	---
6. Sharpsburg-Welda-Sogn association (56,600 acres)										
Sharpsburg	35	1-10	5+	Slope and permeability	Fair stability, compaction & shear strength	Moderate: moderate to high shrink-swell potential	Moderate: moderate to high shrink-swell potential	Severe: moderately slow permeability	Slight: slopes under 2% moderate on slopes 2-7% severe on slopes over 7%	Moderate: silty clay loam texture
Welda	25	3-15	5+	Slope gradients of 3-15 percent	Poor stability, compaction & shear strength, high shrink-swell potential	Moderate: highly erosive, moderate shrink-swell potential	Moderate: moderate shrink-swell potential	Severe: slow permeability	Moderate to severe: slopes over 2%	Moderate: silty clay loam texture
Sogn	20	1-8	Less than 20"	Bedrock within 20"	Limited available material	Severe: bedrock within 20"	Severe: bedrock within 20"	Severe: bedrock within 20"	Severe: bedrock within 20"	Severe: bedrock within 20"
Other soils (mostly of the Martin & Pawnee series)	20	---	---	---	---	---	---	---	---	---

Composition of Soil Associations	Selected Soil Characteristics			Major Soil Features Affecting Use For		Degree of Limitation and Major Soil Features Affecting Use For					
	Soil Association, Its Approximate Extent, and Names of Component Soils	Estimated Percent of Assoc.	Predominant Slope (percent)	Depth to Bedrock (feet)	Pond Reservoir Area	Pond Embankment	Local and Streets	Dwellings	Septic Tank Filter Fields	Sewage Lagoons	(Trench Type) Sanitary Landfill
7. Eudora-Sarpy-Kimo association (5,400 acres)											
Eudora	65	0-2	5+	Rapid permeability in upper 40"	High erodibility	Moderate: exposed embankment moderately erodible, moderate susceptibility to frost heave	Moderate: infrequently flooded	Moderate: moderate permeability, slight chance of pollution	Severe: moderately rapid permeability below 40"	Severe: moderately rapid permeability below 40"	
Sarpy	10	0-5	5+	Rapid permeability	High erodibility	Severe: hazard of soil blowing occasional flooding	Severe: occasional flooding	Severe: flooding, pollution hazard	Severe: flooding high permeability pollution hazard	Severe: rapid permeability, pollution hazard flooding	
Kimo	10	0-1	5+	Rapid seepage below 20-40 inches	Fair to poor stability, compaction and shear strength	Severe: somewhat poorly drained, possible flooding	Moderate to severe: somewhat poorly drained possible flooding	Severe: slow permeability in upper part, possible flooding	Severe: moderately rapid permeability below 20", possible flooding	Severe: possible flooding	
Other soils (series not known)	15	---	---	---	---	---	---	---	---	---	

The soil is evaluated only to a depth of five feet or less. Soils are rated on the basis of three classes of soil limitations:

Slight - Relatively free of limitations or limitations are easily overcome

Moderate - Limitations need to be recognized, but can be overcome with good management

Severe - Limitations are severe enough to make use questionable

WATER RESOURCES

Both ground water and surface water are used to supply the rural and urban requirements of Johnson County. Ground-water aquifers capable of large yields to wells for urban supplies are present only in the Kansas River valley. Likewise, the Kansas River is the only stream in Johnson County that has baseflow adequate for urban supplies without the construction of storage reservoirs. Thus the principal source of water is along the northern boundary of the county and outside the county in adjacent Wyandotte County. The principal direction of urban growth is from the northeast corner toward the south and west, resulting in increasing distance and a shifting center of usage away from the source of supply.

Ground Water

Ground-water supplies in most of Johnson County are small and adequate only for domestic and stock use. The yields to be expected from wells and the range of depths for wells in various parts of Johnson County are shown in figure 6. The water-bearing characteristics of all the bedrock formations

Figure 6 near here. Caption on following page.

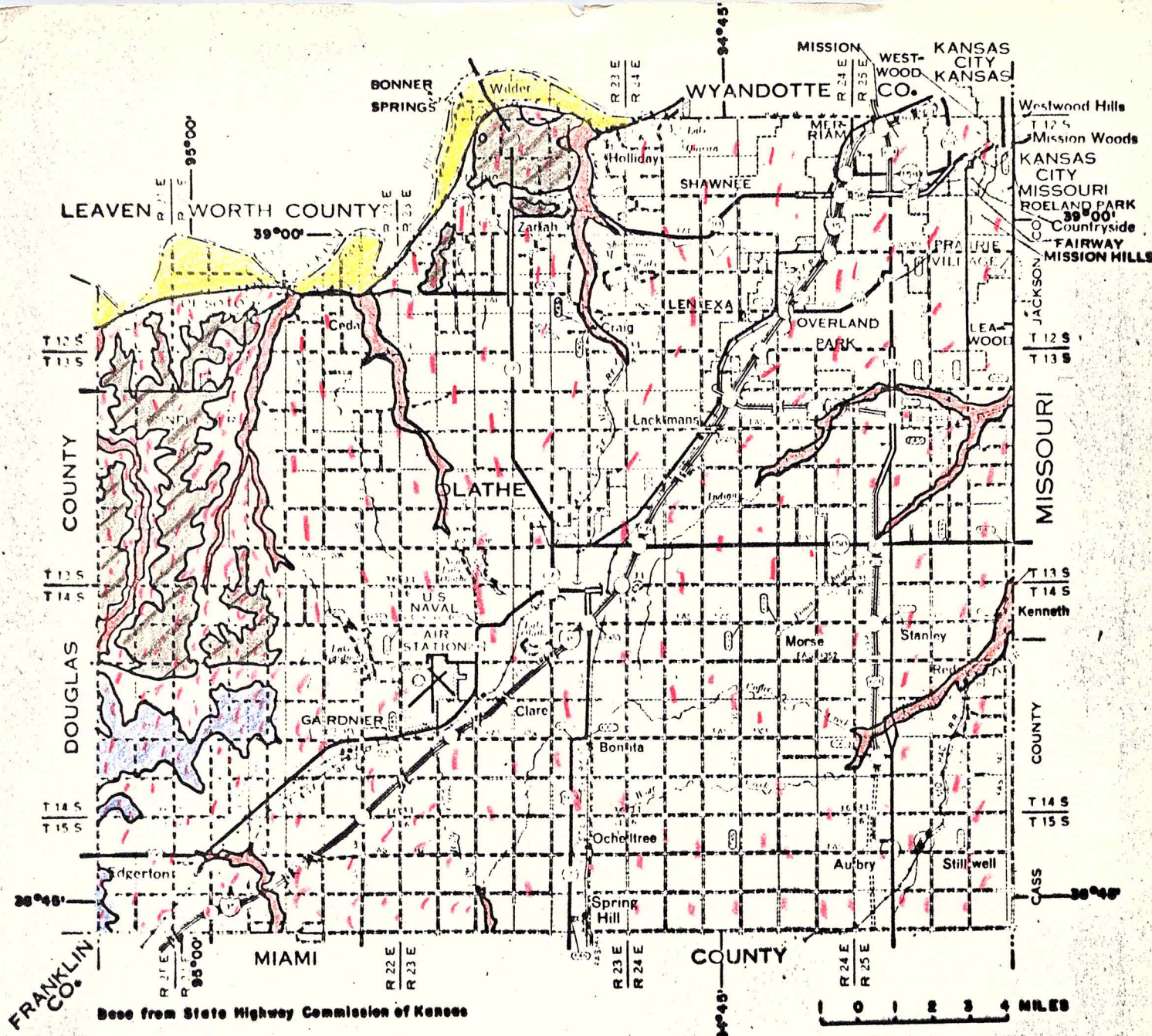
that underlie Johnson County are summarized in figure 7.

Figure 7 near here. Caption on following page.

Comprehensive studies for future water and sewer expansions being made by the Mid-America Regional Council should include planning and zoning for the Kansas River valley in order to maintain the ground-water quality and to prevent developments that might result in pollution of the alluvial aquifer.

Figure 6.--Potential yields of water from wells.

Figure 7.--Water-bearing characteristics of Pennsylvanian and older rocks
(from Kansas Geological Survey Bulletin 203, p. 48).



Base from State Highway Commission of Kansas

EXPLANATION

Potential yields to wells, in gallons per minute






- 
 150 to 1,000 gpm generally available to wells from 40 to 70 feet of saturated alluvial deposits.
- 
 1 to 10 gpm generally available, locally as much as 100 gpm, to wells from 20 to 70 feet of saturated alluvial deposits.
- 
 1 to 10 gpm generally available to wells from 20 to 100 feet of saturated glacial deposits. Locally, may yield no water or as much as 100 gpm.
- 
 1 to 20 gpm generally available from wells as deep as 50 feet in sandstone of the Lawrence Formation.
- 
 1/5 to 5 gpm of fresh to slightly saline water generally available from wells less than 250 feet deep in limestone, sandstone, and shale. About 15 percent of wells yield less than 1/5 gpm, about 5 percent yield 5 to 50 gpm.

Figure 6.--Potential yields of water from wells.

DEPTH, IN FEET BELOW LAND SURFACE

	Stratigraphic unit	Water quality	Estimated well yield (gpm)
0	Douglas, Lansing, and Kansas City Groups	Fresh or slightly saline at depths less than 100 feet, locally to depths of 250 feet. Moderately to very saline at depths greater than 250 feet.	0-50, commonly less than 10
500	Pleasanton Group	Very saline	0-20
	Marmaton Group	Very saline	0-150
	Cherokee Group	Very saline or briny	0-200
1000	Mississippian rocks	Very saline	50-500
	Chattanooga Shale	-----	---
1500	"Hunton Group" and Viola Limestone	Very saline or briny	0-100
	Simpson Group	Very saline or briny	0-300
2000	Arbuckle Group and Lamotte Sandstone	Very saline or briny	200-1,000

Figure 7.--Water-bearing characteristics of Pennsylvanian and older rocks (from Kansas Geological Survey Bulletin 203, p.48).

Surface Water

Although the average annual precipitation in Johnson County is about 36 inches, the area is subject to floods and droughts and great variability in streamflow. The lack of extensive ground-water aquifers in most of the county results in very low or no flow in the streams between periods of precipitation except the flow provided by discharge of sewage effluent.

Knowledge of the flow characteristics of streams is vital to the urban planner who is analyzing the dependability of the water supply and the magnitude and the frequency of floods in the planning area. Sometimes a knowledge of the average flow of a stream is important, but usually the extremes of flow, both high and low, are of most concern to the planner.

Probably the best method of predicting the flow characteristics of streams in an area is to study the records of past flows. The U.S. Geological Survey, in cooperation with the Kansas Water Resources Board, has operated a gaging station on Indian Creek at 103rd Street in Overland Park, Kansas, since March 1963. Although this period of record is relatively short, a study of the Indian Creek record in conjunction with records of other streams in eastern Kansas and western Missouri can give reasonable estimates of flow characteristics for streams in Johnson County. An examination of the flow of Indian Creek shows that the discharge goes to zero at times during most years. In fact, during prolonged dry periods the flow of all streams in the county, except the Kansas River, probably consists entirely of sewage effluent.

Flooding is a natural characteristic of rivers. Floods occur when the stream overflows its banks. It is when man competes with the river for space on the valley floor that floods become a problem. We can be sure that floods periodically will cover the flat low-lying portion of the river valley. Only wise use of this flood plain will prevent repeated property loss. Parks, green belt areas, parking lots, and gravel pits are some of the better uses of flood plains, whereas the construction of buildings is a very unwise and ultimately costly use.

Urbanization has a marked effect on streamflow. Streets, sidewalks, parking lots, and roofs of buildings cover the land surface and prevent infiltration of rainwater. Most of this water runs off quickly to streams by way of gutters and storm sewers. As a consequence, flood peaks are higher and occur sooner after the rainfall. This effect of urbanization is illustrated in figure 8. Another effect of urbanization is that the sustained

Figure 8 near here. Caption on following page.

or low flow of streams is less because of the loss of recharge to the ground water system.

Figure 8.--Hypothetical unit hydrograph showing effect of urbanization on flood peaks.

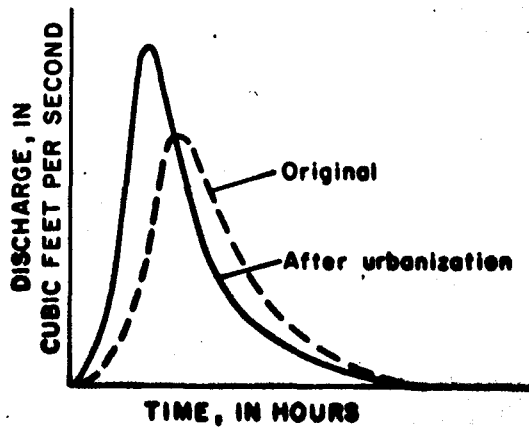


Figure 8.--Hypothetical unit hydrograph showing effect of urbanization on flood peaks.

The yield of sediment to streams generally is increased greatly during urbanization and is higher for urbanized areas than for the same areas when they were rural. The chemical quality of surface-water runoff from urban areas also commonly is affected adversely by urbanization. Large amounts of petroleum products are flushed to the streams from streets and paved areas after each rainfall. In winter salt used on streets is subsequently flushed into the streams. The dissolved solids content of the water increases and the dissolved oxygen content tends to decrease.

The urban planner, therefore, should obtain information on the flow characteristics of the streams in his area, and should be aware of the changes in peak flow, low flow, sediment yield, and chemical quality that could result from urbanization of a drainage basin.

WATER DISTRICTS

Probably more than 98 percent of the population of Johnson County is presently served by some sort of public water-supply facility (figs. 9 and 10).

Figures 9 and 10 near here. Captions on following page.

Some of the small municipal and rural water district supplies are obtained from surface-water impoundments, but most of the water provided by public water supplies is obtained from the Kansas River and from wells in the Kansas River valley. A small area in the northeast corner of Johnson County (fig. 9) is served by the J. C. Nichols Water Company and the Westport Annex Water Company, each of which purchases treated Missouri River water from Kansas City, Missouri.

In some Kansas counties conflicts and deflation of services have occurred in areas initially served by rural water district systems and subsequently annexed into cities. Good planning can benefit citizens in both the annexed areas and the cities by reducing the costs of these transitions.

Figure 9.--Map showing areas served by rural water districts and other public water supplies, 1972. (Data from Mid-America Regional Council, 1972).

Figure 10.--Map showing location of townships and incorporated cities, 1970.

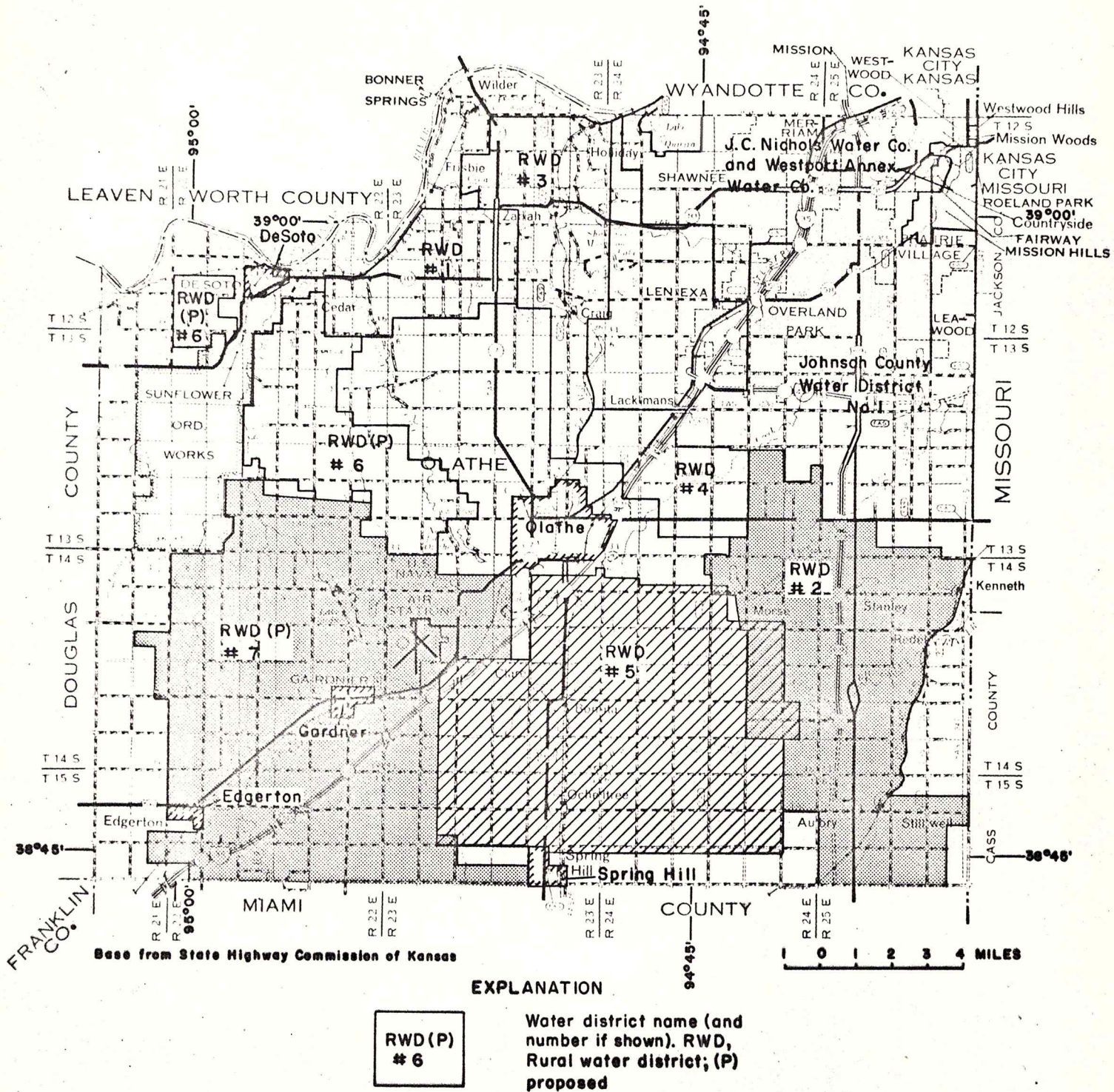


Figure 9.--Areas served by rural water districts and other public water supplies, 1972. (Data from Mid-America Regional Council, 1972).

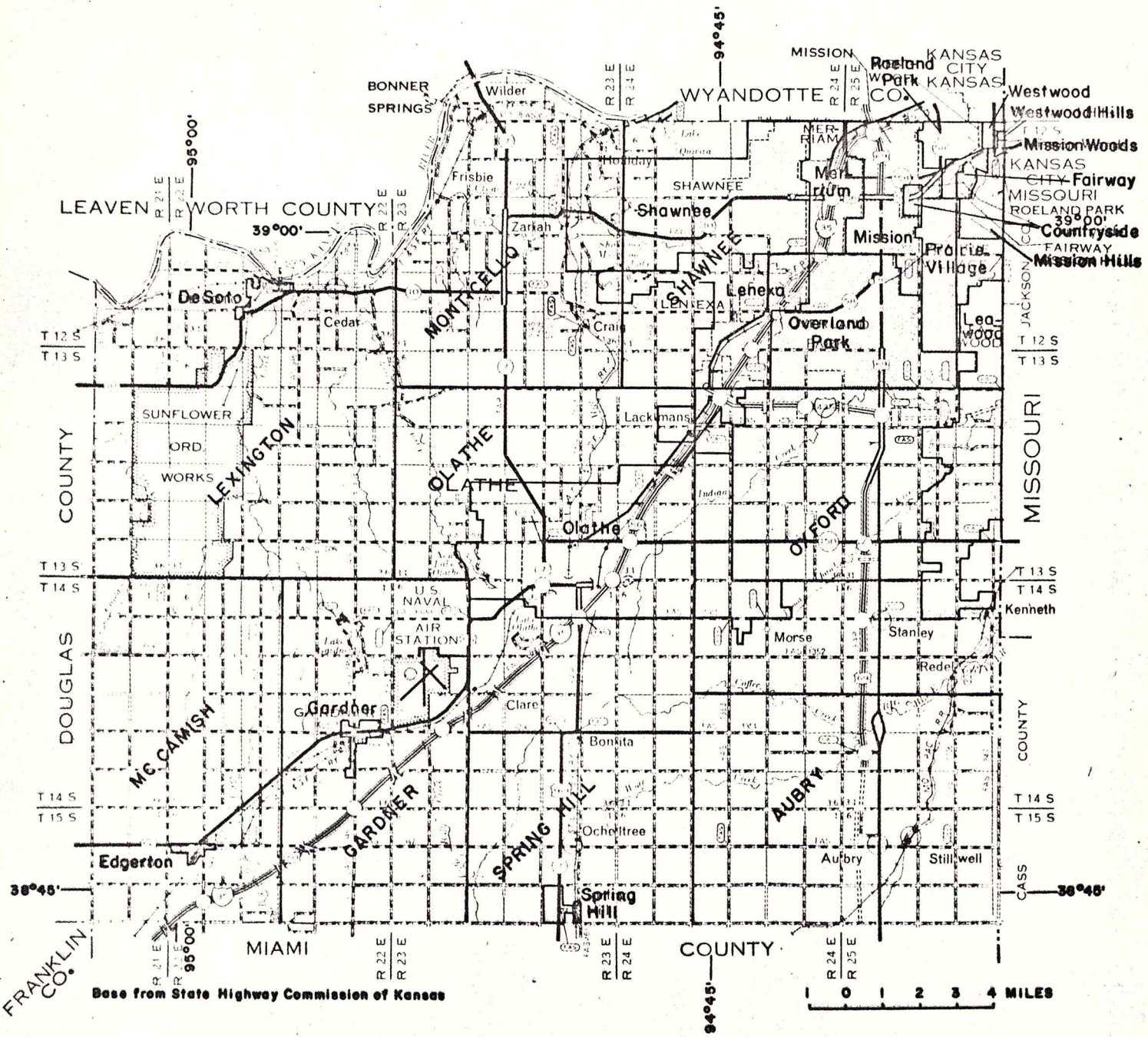


Figure 10.--Location of townships and incorporated cities, 1970.

POPULATION

Johnson County is one of the most rapidly growing areas in Kansas. The 1970 population was 217,662 (U.S. Bureau of the Census, 1971). The Mid-America Regional Council has projected the population in the year 1990 to be approximately 630,000. The growth will be largely in the northeastern quarter of the county and in the vicinity of Olathe. The increased availability of water from rural water districts will result in an increase in the population on small tracts in the suburban areas.

LAND USE

As the population of an area increases, new land areas are required for homes, business, industry, transportation routes, parks, schools and all of the associated uses that are part of urban growth. The most pleasing growth is that which is well planned to take advantage of the natural physical environment -- the topography, woodlands, drainage, soils, and geology.

For purposes of planning, natural drainage basins are ideal planning units because storm drainage and sanitary sewers are least expensive and operate best when designed as simple gravity-flow systems. Streets, residential developments, and many other urban activities can take advantage of the terrain and the natural drainage system even though urban developments in the basin are not built or developed uniformly across the basin. With planning, the entire drainage basin can become an integrated unit. The drainage basins, their areas, and the percent of the county area are shown in figure 11. Developments that are discordant with the physical environment

Figure 11 near here. Captions on following page.

are generally more expensive, esthetically less pleasing, and may be hazardous.

Planning for land use, therefore, has become a necessity on the local, county, and regional levels and is being implemented by zoning at the local and county levels. The Metropolitan Planning Commission, Kansas City Region, has prepared a regional land-use plan that incorporates local plans of the cities and counties in the regional framework.

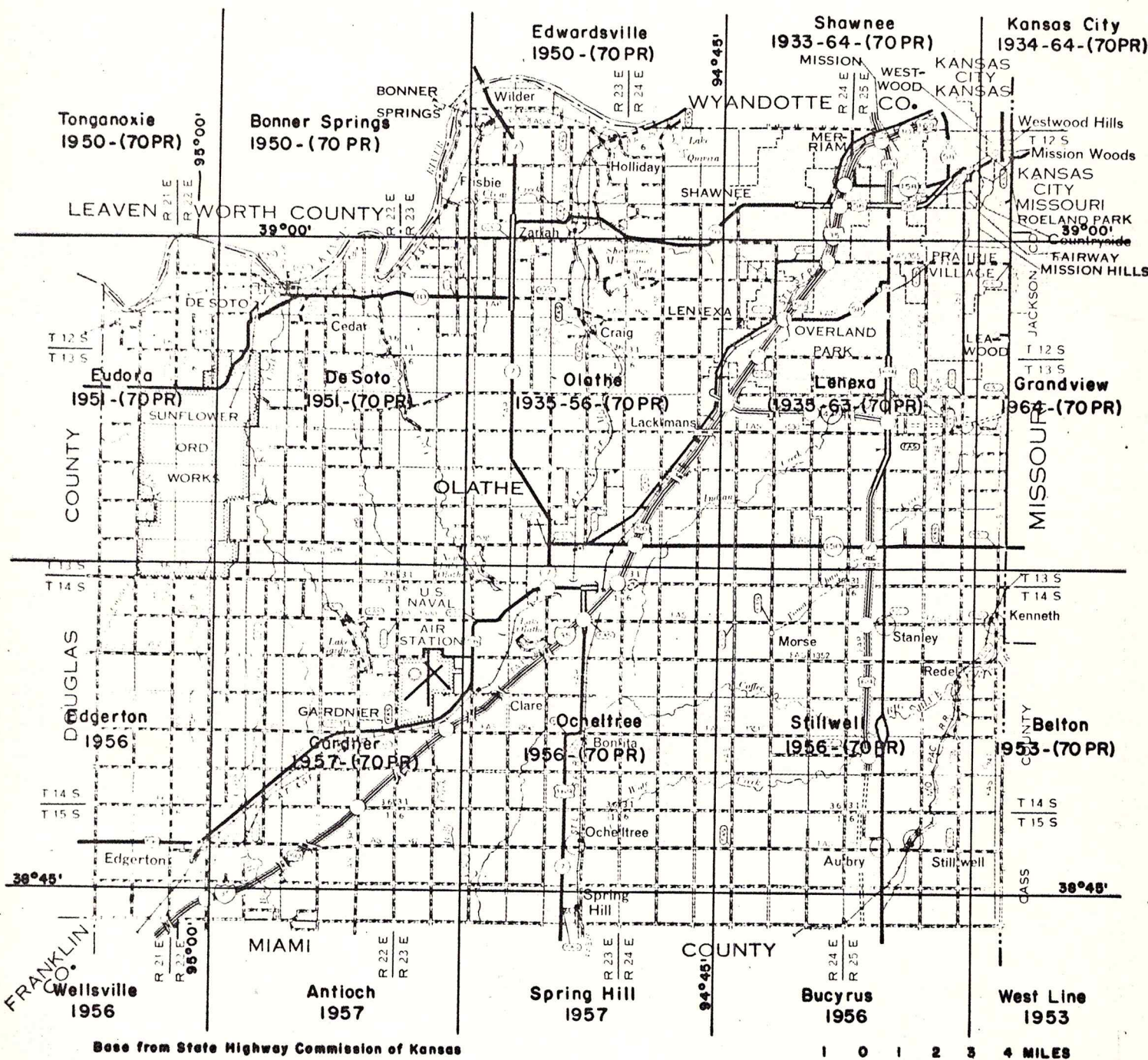
Figure 11.--Location of drainage basins, area, and percentage of total area.

The present (1972) land use in Johnson County has been compiled into an atlas on a 1:20,000 scale base map. Six categories of land use are shown including (1) single family residential, (2) multi-family residential, (3) commercial, (4) industrial, (5) public, and (6) vacant or agricultural. Because large-scale maps showing the present land uses are already available and a regional plan for the 7-county Kansas City Region has been prepared that projects land use patterns to 1990, no land-use maps were prepared for this report. All or parts of 20 standard 7½-minute topographic quadrangles are included in the 478-square-mile area of Johnson County (fig. 12).

Figure 12 near here. Caption on following page.

Some land use in the past has been poorly suited to the environment. An example is the construction of houses on the flood plains of streams. Floodplain information for the Blue River and tributaries and for the Kansas River has been prepared by the Corps of Engineers, U.S. Army (1970, 1965). These reports show the extent of various floods such as the 1951 flood, the Standard Project Flood, and the Intermediate Regional Flood. Flooding susceptibility maps, prepared mainly from modern 7½-minute topographic maps, can be used to plan developments that will be compatible with the physical environment and to prevent flood plains from being developed as residential areas through zoning regulations. The general flood-prone areas for the principal streams are shown by the map unit titled "Wisconsinan and Recent Alluvium and Terrace Deposits" on the geologic map (fig. 2). The map does not show the flood-prone areas in the headwaters of the tributary streams. Perhaps the most important point to stress in land use planning is that zoning and subdivision regulations are needed to prevent or minimize flood damage on the stream floodplains.

Figure 12.--Index to topographic mapping.



Base from State Highway Commission of Kansas

EXPLANATION

Olathe
1935-56-
(70 PR)

Topographic map published
showing name and date or
dates of 7.5' quadrangles.
(70 PR): Map photorevised 1970

Figure 12.--Index to topographic mapping.

"Conservation areas" are areas where development should be restricted because of the natural characteristic of the land. Special land-use controls should be used in these areas. The flood plains and steep slopes along the valley walls are examples of areas where development should be controlled. The Regional Comprehensive Plan prepared by the Metropolitan Planning Commission for the Kansas City Region, including Johnson County, shows that the present undeveloped flood plains and adjacent steep slopes are planned as conservation areas.

NEED FOR ADDITIONAL STUDIES AND RECOMMENDATIONS

Several additional types of maps would be desirable for planning. Detailed soil maps, modern topographic maps, and detailed geologic maps can be utilized to prepare several kinds of suitability maps. A large scale detailed soils map (scale 1:20,000) is being prepared for Johnson County by the U.S. Department of Agriculture and will soon be available. A depth to bedrock and a sanitary landfill suitability map are other kinds of maps that would be useful to a planner. Maps of this type are planned by the State Geological Survey of Kansas in the near future.

It would be desirable to have detailed topographic maps (1:20,000 scale or larger) that show flood prone areas in all of Johnson County. These areas, together with the adjacent steep bluffs, termed conservation areas, should have restricted development and controlled usage compatible with the natural environment.

Sites in the urban growth areas where sand, gravel, and limestone are abundant should be zoned to protect low-cost supplies of these mineral resources for future use.

The Kansas River valley should be recognized as the present and future chief source of water for the area and the alluvial aquifer should be protected from developments that would significantly reduce recharge to the aquifer or that might result in pollution of water in the aquifer.

SELECTED REFERENCES

- Hilmes, G. E., 1970, Construction Materials Inventory of Johnson County, Kansas: State Highway Commission of Kansas Construction Materials Inventory Report No. 24, 96 p.
- Leopold, L. B., 1968, Hydrology for Urban Land Planning - A Guidebook on the Hydrologic Effects of Urban Land Use: U.S. Geol. Survey Cir. 554, 18 p.
- Mid-America Regional Council, 1971, Regional Plan: Metropolitan Planning Commission - Kansas City Region.
- O'Connor, H. G., 1971, Geology and Ground-Water Resources of Johnson County, Northeastern Kansas: State Geological Survey of Kansas Bull. 203, 68 p.
- Spieken, A. M., 1970, Water in Urban Planning, Salt Creek Basin, Illinois: U.S. Geological Survey Water Supply Paper 2002, 147 p.
- U.S. Army Engineer District, Kansas City Corps Engineers, 1965, Report on Flood Plain Information, Kansas River, Kansas, Junction City to the Mouth: U.S. Army Corps of Engineers, 11 p., appendix, 30 plates.
- _____, 1970, Flood Plain Information, Blue River and Tributaries, Johnson County, Kansas: U.S. Army Corps Engineers, 38 p., 12 figs., 23 plates.
- Walton, Graham, 1962, Problems in Ground Water Pollution: U.S. Dept. of Health, Education, and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, 6 p.