REPORT NO. 35

# CONSTRUCTION MATERIALS INVENTORY

# RILEY COUNTY, KANSAS

DEPARTMENT OF TRANSPORTATION
KANSAS

Kansas Department of Transportation
Engineering Services Department
Planning and Development Department

# CONSTRUCTION MATERIALS INVENTORY

# OF

# RILEY COUNTY, KANSAS

by

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Prepared in Cooperation with the
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Construction Materials Inventory Report No. 35

Copies are available from the Planning & Development Department
Kansas Department of Transportation

the **WHY?**

**WHAT?**

and **HOW?**

**of This REPORT**

This report was compiled for use as a guide for locating construction materials in Riley County.

> *Construction materials include all granular material, consolidated rock, and mineral filler suitable for use in highway construction.*

Known open and prospective sites, both sampled and unsampled, and all geologic deposits considered to be a source of construction material are described and mapped.

> *Prospective sites are select geologic locations where construction materials may be found.*

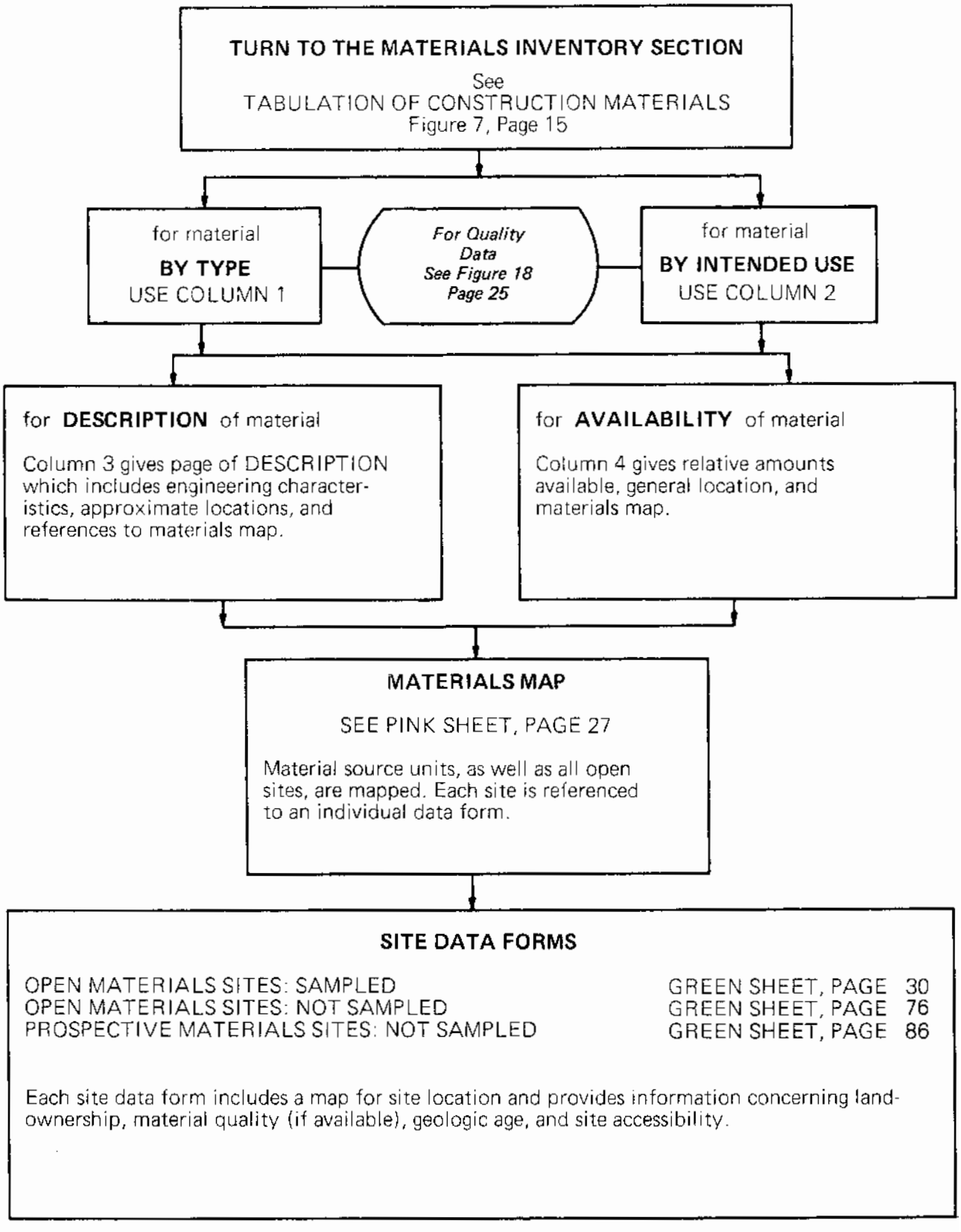
The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to evaluate and locate mapped sites.

Material found in individually mapped sites represents only a small portion of the construction materials resources in the county. Although data used to evaluate the material are based on limited sampling, these can be used to assess the general characteristics of the material source units elsewhere in the county.

Beginning on page 5 is a section explaining the geology of the county. This information (along with the maps, descriptions, and test data) provides the means of evaluating and locating additional construction materials sources in the geologic units throughout Riley County.

## TO LOCATE AND EVALUATE

## A MAPPED SITE OF CONSTRUCTION MATERIAL IN RILEY COUNTY



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## PREFACE

This report is one of a series compiled for the Highway Planning and Research Program, "Materials Inventory by Photo Interpretation." The program is a cooperative effort of the Federal Highway Administration and the Kansas Department of Transportation, financed by highway planning and research funds. The objective of the project is *to provide a statewide inventory of construction materials*, on a county basis, to help meet the demands of present and future construction and maintenance needs.

Publications issued by the State Geological Survey of Kansas, concerning Riley and surrounding counties, provided the basic geologic information used in this investigation. Detailed geologic and soil data were obtained from centerline geologic profiles and soil surveys prepared for design of major highways in the county by the Kansas Department of Transportation.

Appreciation is extended to Mr. John Griffith, First District Materials Engineer, Mr. Dan Horden, Riley County Engineer, and Eric Shoults, Assisstant County Engineer, for verbal information concerning construction materials discussed in this report.

This report was prepared under the guidance of R.R. Jones, P.E., Engineer of Engineering Services, A.H. Stallard, Chief, Environmental Support Section, Engineering Services, L. D. Myers, Geologist III, George E. Petersen, Geologist II, and members of the Environmental Support Section.

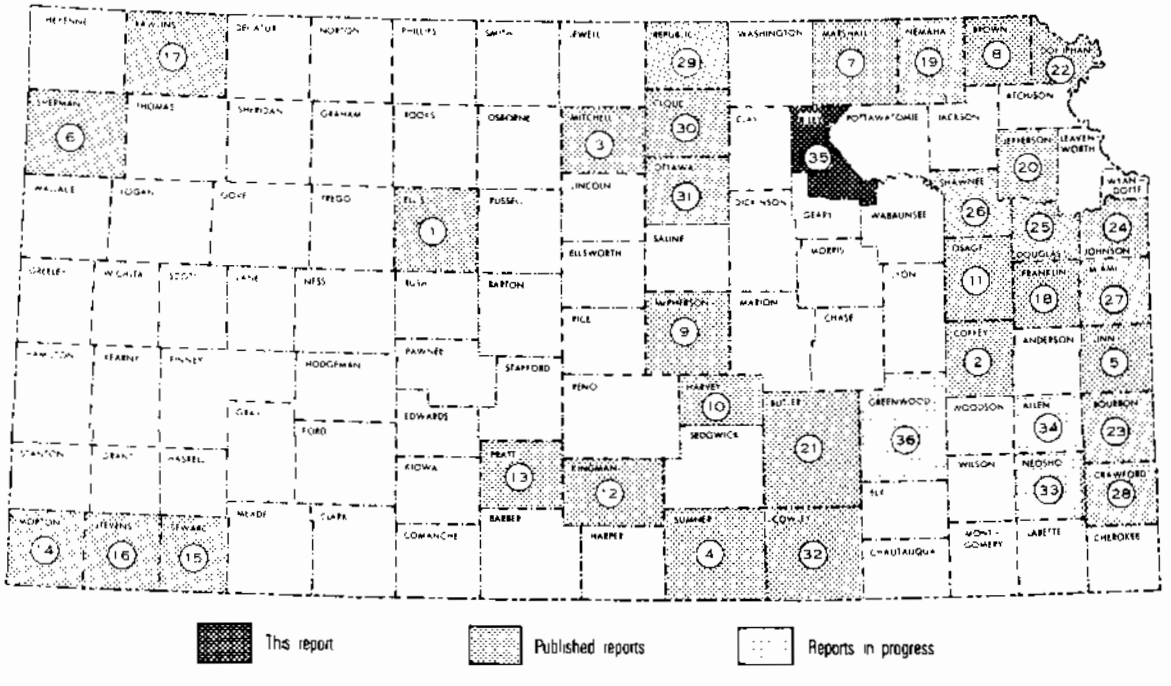



*Figure 1. Index map of Kansas showing the location of Riley County along with the report numbers and location of counties for which reports have been or are being completed.*

## ABSTRACT

Riley County is near the western boundary of the Central Lowland physiographic province in the subdivision known as the Flint Hills. Major topographic features of the county include the gently rolling upland plains, hills and steep valley walls formed by the erosion of lower Permian limestones and shales along major drainage channels. Many of these limestones form conspicuous hillside benches. The shales are more rapidly eroded than the limestones and form steep slopes between adjacent limestone benches.

Deposits of glacial sediments, both till and outwash, occur in the eastern part of the county. Terrace deposits are found along all of the streams, and extensive silt deposits occupy the tops of many divides.

The Kansas and Blue Rivers and their tributaries drain most of Riley County. Wildcat Creek and other large tributaries originate in the western part of the county and join the Kansas River south of Manhattan. Major tributaries of the Blue River, which drain the northwest corner of the county, are Mill, Fancy, and Swede Creeks.

Sources of construction materials in Riley County are limited to thicker limestone beds of lower Permian and upper Pennsylvanian ages, siliceous sand and gravel from the Kansas and Blue River valleys, and very limited amounts of locally derived chert and limestone gravel from small tributaries.

Glacial deposits in the northeast part of the county could possibly provide a limited amount of sand and gravel.

Large quantities of water are available in the alluvium and terrace deposits of the Kansas and Blue River valleys. Consolidated rock aquifers of lower Permian and upper Pennsylvanian ages yield minimal quantities which are generally satisfactory only for domestic uses.

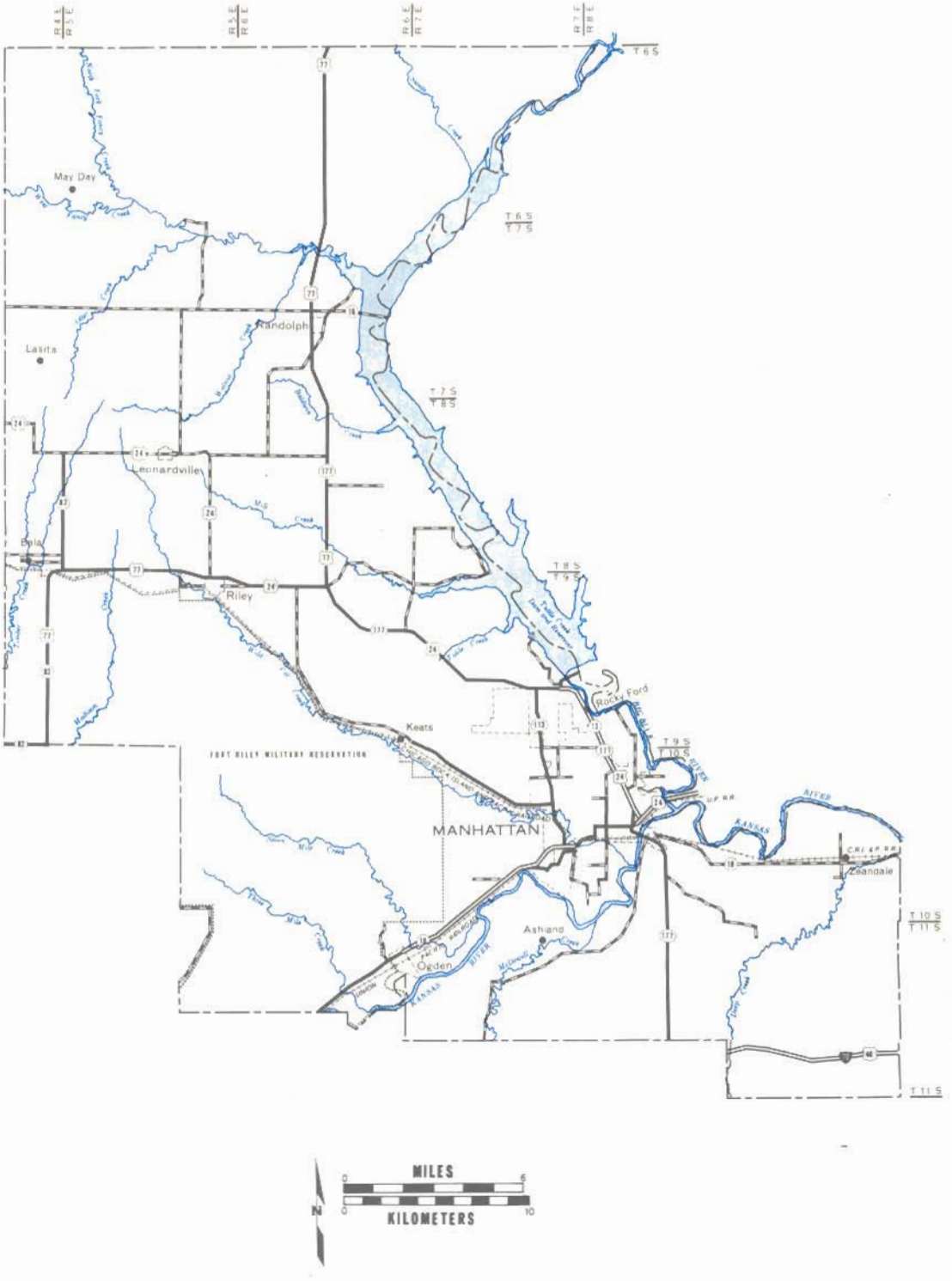



*Figure 2. Drainage and major transportation facilities in Riley County.*

## FACTS ABOUT RILEY COUNTY

Riley County is located in northeast Kansas (figure 1, page v), and has an area of 597 square miles (1546.2 square kilometers) and a population of 56,788 according to the 1977 records of the Kansas State Board of Agriculture. Elevation of terrain above mean sea level ranges from a high of 1440 feet (438.9 meters) in NE ¼ sec. 1, T8S, R4E, to a low of 980 feet (298.7 meters) where the Kansas River leaves the county in sec. 15, T10S, R9E.

A primary road system connects all major communities and a well developed secondary road system provides access to small communities. Figure 2 illustrates major drainage and transportation facilities in the county.

## METHODS OF INVESTIGATION

Investigation and preparation of this report consisted of three phases: (1) research and review of available information, (2) photo interpretation, and (3) field reconnaissance.

Phase One: Relevant information concerning geology, soils, and construction materials of the county was reviewed and the general geology determined. Quality-test results of samples taken in Riley County were then correlated with the various geologic units and unconsolidated deposits.

Phase Two: A study and interpretation of aerial photographs taken by the Kansas Department of Transportation at a scale of one inch equals 2,000 feet (1 cm = 240 meters), was accomplished. Figure 3 illustrates aerial photographic coverage of Riley County. Geologic source beds and all open materials sites were mapped and classified on aerial photographs. All material sites were then correlated with the geology of the county.

Phase Three: This phase was conducted after the initial study of aerial photographs. A field reconnaissance was conducted by the authors to examine construction materials, to verify doubtful mapping situations, and to acquire supplemental geologic information. Geologic classification of open sites was confirmed, and prospective sites were observed.

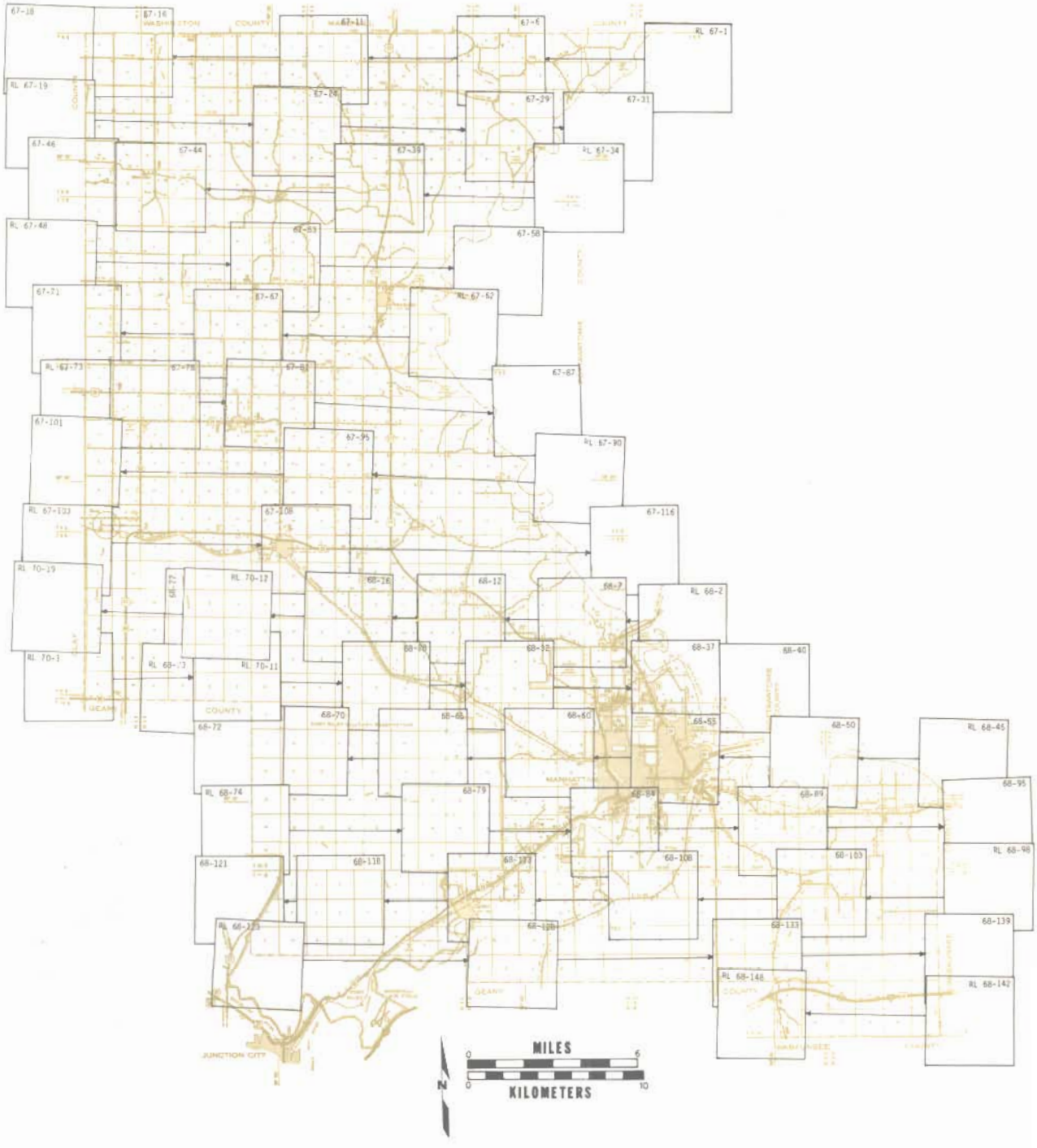
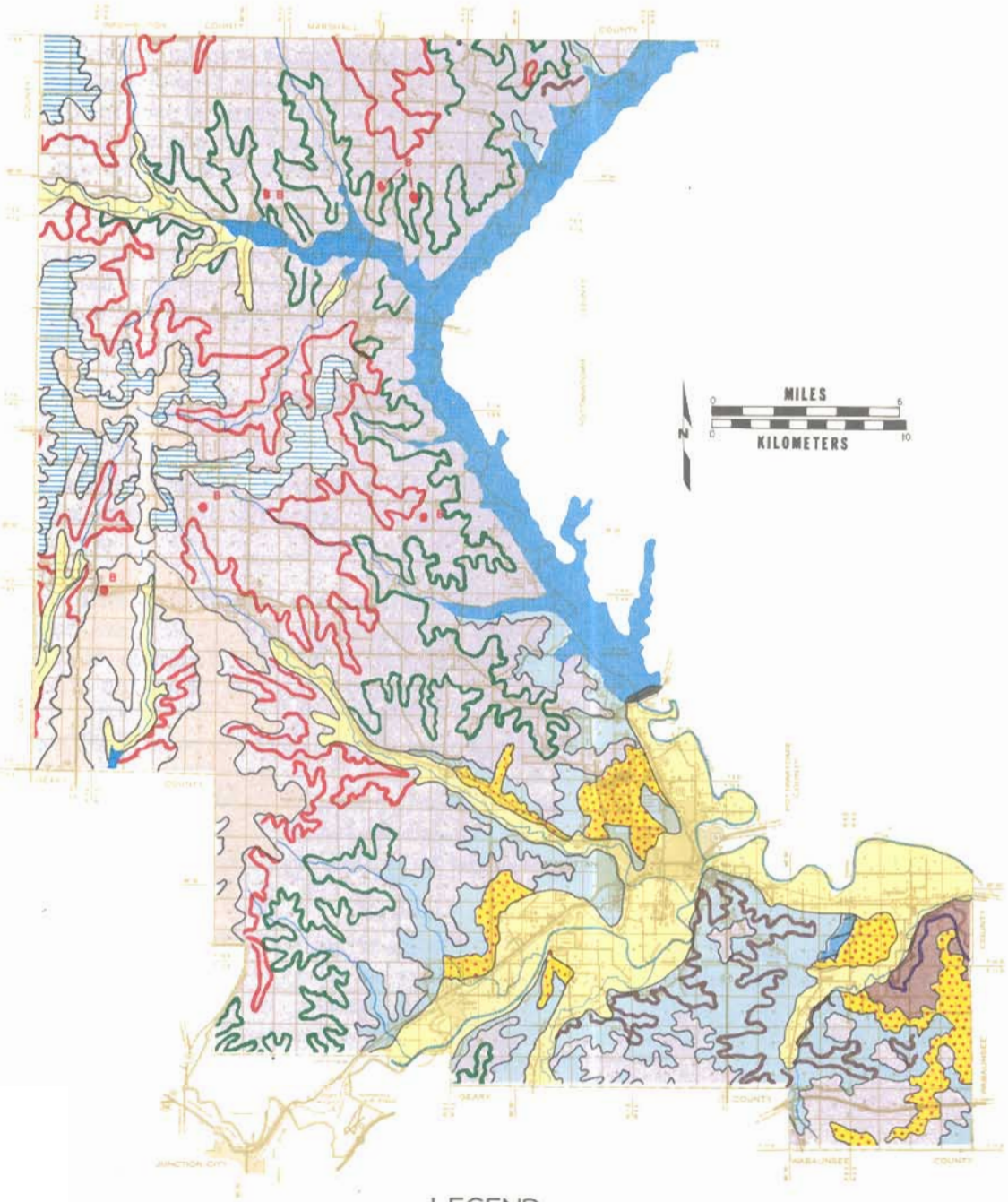



*Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Riley County. The numbers refer to photographs taken by the Photogrammetry Section, Kansas Department of Transportation on 3-14-77, 3-31-77 and 4-26-77 at a scale of 1" = 2000' (1 cm = 240 meters). Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.*




## LEGEND

- Alluvium
- Loess
- Drift
- Summer Group
- Chase Group
  - Winfield Limestone (WF)
  - Fort Riley Limestone (FR)
  - Barneston Limestone (BA)
- Council Grove Group
  - Beattie Limestone (BE)
- Admire Group
- Wabaunsee Group
  - Stotler Limestone (ST)
  - Zeandale Limestone
- Igneous Rock
  - Basic intrusive rock (B)

## GENERAL GEOLOGY

GEOLOGY is the basis for this materials inventory. Knowledge of the geology makes it possible to: (1) ascertain the general properties of the material source, (2) identify and classify each source according to current geologic nomenclature, and (3) establish a uniform system of material-source-bed classification. By knowing the geologic age, origin, landform, and quality information of the source units, one can derive general information for untested materials sites and prospective locations.

*It is important to note that the quality of material from a given source may vary from one location to another.*

Material for this discussion is based on information obtained from field observations and reports on Riley and surrounding counties compiled by the Kansas Geological Survey, United States Geological Survey, and the Kansas Department of Transportation. The geologic timetable, figure 4, shows in graphic form the major time periods and the approximate duration of each. Figure 5, page 7, illustrates the surface geology and stratigraphic position of each material source unit in Riley County.

Paleozoic sediments consisting of limestones, sandstones, and shales and ranging in age from Cambrian to Pennsylvanian overlie the Precambrian rocks in the county. It is generally believed that this area was inundated by a sea during early Paleozoic time and remained so until the end of Mississippian time. At the close of Mississippian time the eastern portion of the county was subjected to the rise of the Nemaha anticline. The uplift of the anticline subjected sedimentary rocks of Mississippian and older ages to varying degrees of erosion. According to indications very little, if any, Mississippian rock in the eastern portion of Riley County survived this severe erosion and, in most places, all Devonian, Silurian, and Ordovician rocks were removed down to the Precambrian granite. Mississippian rocks are present only in the western portion of Riley and eastern edge of Geary Counties (Jewett, 1941).

During Pennsylvanian and early Permian time, limestone, dolomite, shale, sandstone, and coal were deposited. Limestones of the upper Pennsylvanian and lower Permian Systems are the most abundant and important materials source units in the county.

The Mesozoic Era is represented by a few Triassic and Jurassic units found mostly in the subsurface of the western one-fifth of the state. Eastern Kansas, including Riley County, was probably a land mass during the Triassic and Jurassic Periods inasmuch as no deposits of these ages are found in the area. Presumably, the sea made its final invasion of Kansas during Cretaceous time. Although this sea may have spread over most of Kansas, erosion has removed all rock of this age from Riley County, except for small outliers of the Dakota Formation which are found in the extreme northwestern corner of the county.

In Riley County six plug-like intrusions of basic igneous rock (Kimberlite) crop out in an area of lower Permian sedimentary rocks. There may have been a cover of only a few hundred feet of Cretaceous rock overlying the lower Permian host rocks into which the Kimberlites were intruded and it is possible that the Kimberlites may have come close to or even reached the surface (Merriam 1963).

| ERAS | PERIODS | ESTIMATED LENGTH IN YEARS | TYPE OF ROCK IN KANSAS | PRINCIPAL MINERAL RESOURCES |
|---|---|---|---|---|
| CENOZOIC | QUATERNARY (PLEISTOCENE) | 1,800,000 | Glacial drift, river silt, sand, and gravel, dune sand; wind-blown silt (loess); volcanic ash. | Sand and gravel; volcanic ash; agricultural soils; water. |
| | TERTIARY | 63,500,000 | Silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone. | Sand and gravel; volcanic ash; diatomaceous marl; water. |
| MESOZOIC | CRETACEOUS | 71,000,000 | Chalky shale, dark shale, vari-colored clay, sandstone, conglomerate; outcropping igneous rock. | Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; ceramic materials; water. |
| | JURASSIC | 59,000,000 | Sandstone and shale, chiefly subsurface. | |
| | TRIASSIC | 30,000,000 | | |
| PALEOZOIC | PERMIAN | 55,000,000 | Limestone, shale, evaporites (salt, gypsum, anhydrite), red sandstone and siltstone, chert, and some dolomite. | Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; natural gas, salt, gypsum, water. |
| | PENNSYLVANIAN | 40,000,000 | Alternating marine and non-marine shale; limestone, sandstone, coal, and chert. | Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and limestone and shale for cement; ceramic materials; oil, coal, gas, and water. |
| | MISSISSIPPIAN | 25,000,000 | Mostly limestone, predominantly cherty. | Chat and other construction materials; oil, zinc, lead, and gas. |
| | DEVONIAN | 50,000,000 | Subsurface only. Limestone and black shale. | Oil. |
| | SILURIAN | 45,000,000 | Subsurface only. Limestone. | Oil. |
| | ORDOVICIAN | 60,000,000 | Subsurface only. Limestone, dolomite, sandstone, and shale. | Oil, gas, and water. |
| | CAMBRIAN | 70,000,000 | Subsurface only. Dolomite and sandstone. | Oil. |
| PRE-CAMBRIAN | (Including PROTEROZOIC and ARCHEOZOIC ERAS) | 4,600,000,000 + | Subsurface only. Granite, other igneous rocks, and metamorphic rocks. | Oil and gas. |

*Figure 4, Geologic Timetable*

| System | Series | Stage or Group | Graphic Legend | Formation and Members | | Map Symbol | Thickness | General Description | Construction Materials |
|---|---|---|---|---|---|---|---|---|---|
| Quaternary | Pleistocene | Recent | | Alluvium | | Qal | 0-80'± (0-24.4m) | Clay, silt, sand, sand and gravel. Sand and gravel composed of quartz, chert and limestone gravel. | Fine and coarse aggregate, light type surfacing. Concrete aggregate if sweetner added to pass wetting and drying test. |
| | | | | Dune Sand | | Qds | 0-10'± (0-3.0m) | Cross-bedded, tan to gray fine-grained quartz sand. | Limited use as mortar sand. |
| | | Wisconsinan | | Terrace Deposit (Newman) | | Qtw | 0-70'± (0-21.3m) | Clay, silt and sand grading downward to coarse gravel. | Construction aggregate, light type surfacing. |
| | | Illinoisan | | Terrace Deposit (Buck Creek) | | Qbc | 0-90'± (0-27.4m) | Clay, silt and gravel grading downward to coarse gravel. | Construction aggregate, light type surfacing. |
| | | | | Loveland Formation | | | 0-10'± (0-3.0m) | | |
| | | Kansan | | Glacial Drift | | Qgd | 0-15'± (0-4.6m) | Clay, silt and sandy clay. Contains scattered sand, gravel, cobble and boulders. | Light type surfacing. |
| | | | | Atchison Formation | | | 0-60'± (0-18.3m) | | |
| Cretaceous | Upper Cretaceous | | | Igneous Rock | | Kbi | | | |
| | | | | Dakota Formation | | | 5'± (1.5m) | | |
| Permian | Lower Permian | Sumner Group | | Wellington Formation | Hollenberg Ls. Mbr. | | 36'± (11.0m) | | |
| | | Chase Group | | Nolans Limestone | Herington Ls. Mbr. | | 8'± (2.4m) | | |
| | | | | | Paddock Sh. Mbr. | | 9'± (2.7m) | | |
| | | | | | Krider Ls. Mbr. | | 1'± (.3m) | | |
| | | | | Odell Shale | | | 21-25'± (6.4-7.6m) | | |
| | | | | Winfield Limestone | Cresswell Ls. Mbr. | | 13-20'± (4.0-6.1m) | | |
| | | | | | Grant Sh. Mbr. | | 8'± (2.4m) | | |
| | | | | | Stovall Ls. Mbr. | | 2'± (.6m) | | |
| | | | | Doyle Shale | Gage Sh. Mbr. | | 33-46'± (10.1-14.0m) | | |
| | | | | | Towanda Ls. Mbr. | Pdt | 15-22'± (4.6-6.7m) | Limestone, light gray, upper one half platy, lower one half blocky, weathers platy, may contain one or more lensing shale partings. | Light type surfacing, concrete and bituminous aggregate. |
| | | | | | Holmesville Sh. Mbr. | | 13-24'± (4.0-7.3m) | | |
| | | | | "Rimrock" Barneston L.S. | Fort Riley Ls. Mbr. | Pbfr | 22-28'± (6.7-8.5m) | Limestone, light gray, upper portion platy and shaly, may contain two or more shale partings; lower portion unit-bedded, joints run from NE to SW, vertical joints are 10.00 to 12.0 feet (3.0-6.1m) apart, produces prominent outcrop (Rimrock). Weathers tan. | Light type surfacing, concrete and bituminous aggregate, "Rimrock" building stone and riprap. |
| | | | | | Oketo Sh. Mbr. | | 9-14'± (2.4-4.3m) | | |
| | | | | | Florence Ls. Mbr. | Pbf | 28'± (8.5m) | | |
| | | | | Matfield Shale | Blue Springs Sh. Mbr. | | 20-35'± (6.1-10.7m) | | |
| | | | | | Kinney Ls. Mbr. | | 20'± (6.1m) | | |
| | | | | | Wymore Sh. Mbr. | | 17-22'± (5.2-6.7m) | | |
| | | | | Wreford Limestone "Reef" | Schroyer Ls. Mbr. | | 8-13'± (2.4-4.0m) | | |
| | | | | | Havensville Sh. Mbr. | Pwh | 20'± (6.1m) | | |
| | | | | | Threemile Ls. Mbr. | | 8'± (2.4m) | | |
| | | Council Grove Group | | Speiser Shale | | | 17'± (5.2m) | | |
| | | | | Funston Limestone | | | 9'± (2.7m) | | |
| | | | | Blue Rapids Shale | | | 12-20'± (3.7-6.1m) | | |
| | | | | Crouse Limestone | | | 9-13'± (2.7-4.0m) | | |
| | | | | Early Creek Shale | | | 23'± (7.0m) | | |
| | | | | Bader Limestone | Middleburg Ls. Mbr. | | 3'± (.9m) | | |
| | | | | | Hooser Sh. Mbr. | | 8'± (2.4m) | | |
| | | | | | Eiss Ls. Mbr. | | 6'± (1.8m) | | |
| | | | | Stearns Shale | | | 14-20'± (4.3-6.1m) | | |
| | | | | Beattie Limestone | Morrill Ls. Mbr. | | 1-4'± (.3-1.2m) | | |
| | | | | | Florena Sh. Mbr. | | 6'± (1.8m) | | |
| | | | | | Cottonwood Ls. Mbr. | Pbc | 6'± (1.8m) | Limestone, light gray, massive, chert nodules, weathers tan, produces prominent outcrop. | Light type surfacing material, concrete and bituminous aggregate, building stone and riprap. |
| | | | | Eskridge Shale | | | 29-38'± (8.8-11.6m) | | |
| | | | | Grenola Limestone | Neva Limestone Mbr | Pgn | 17'± (5.2m) | | |
| | | | | | Salem Point Shale Mbr. | | 8'± (2.4m) | | |
| | | | | | Burr Limestone Mbr. | | 6'± (1.8m) | | |
| | | | | | Legion Sh. Mbr. | | 2'± (.6m) | | |
| | | | | | Sallyards Ls. Mbr. | | 1'± (.3m) | | |
| | | | | Roca Shale | | | 23'± (7.0m) | | |
| | | | | Red Eagle Limestone | Howe Ls. Mbr. | | 2'± (.6m) | | |
| | | | | | Bennett Sh. Mbr. | | 11'± (3.4m) | | |
| | | | | | Glenrock Ls. Mbr. | | 2'± (.6m) | | |
| | | | | Johnson Shale | | | 24'± (7.3m) | | |
| | | | | Foraker Limestone | Long Creek Ls. Mbr. | | 4'± (1.2m) | | |
| | | | | | Hughes Creek Sh. Mbr. | | 38'± (11.6m) | | |
| | | | | | Americus Ls. Mbr. | | 4'± (1.2m) | | |
| | | Admire Group | | Janesville Shale | Hamlin Sh. Mbr. | | 47'± (14.3m) | | |
| | | | | | Five Points Ls. Mbr. | | 3'± (.9m) | | |
| | | | | | West Branch Sh. Mbr. | | 29'± (8.8m) | | |
| | | | | Falls City Limestone | | | 11'± (3.6m) | | |
| | | | | Onaga Shale | Hawxby Sh. Mbr. | | 9'± (2.7m) | | |
| | | | | | Aspinwall Ls. Mbr. | | 3'± (.9m) | | |
| | | | | | Towle Sh. Mbr. | | 12'± (3.7m) | | |
| Pennsylvanian | Upper Pennsylvanian | Wabaunsee Group | | Wood Siding Formation | Brownville Ls. Mbr. | | 2'± (.6m) | | |
| | | | | | Ponycreek Sh. Mbr. | | 16'± (4.9m) | | |
| | | | | | Grayhorse Ls. Mbr. | | 4'± (1.2m) | | |
| | | | | | Plumb Sh. Mbr. | | 15'± (4.6m) | | |
| | | | | | Nebraska City Ls. Mbr. | | 2'± | | |
| | | | | Root Shale | French Creek Sh. Mbr. | | 20'± (6.1m) | | |
| | | | | | Jim Creek Ls. Mbr. | | 1'± (.3m) | | |
| | | | | | Friedrich Sh. Mbr. | | 12'± (3.7m) | | |
| | | | | Stotler Limestone | Grandhaven Ls. Mbr. | | 2'± (.6m) | | |
| | | | | | Dry Sh. Mbr. | | 11'± (3.4m) | | |
| | | | | | Dover Ls. Mbr. | | 2'± (.6m) | | |
| | | | | Pillsbury Shale | | | 11'± (3.4m) | | |
| | | | | Zeandale Limestone | Maple Hill Ls. Mbr. | | 1'± (.3m) | | |
| | | | | | Wamego Sh. Mbr. | | 13'± (4.0m) | | |
| | | | | | Tarkio Ls. Mbr. | Pzt | 12'± (3.7m) | Limestone, gray, upper interval usually broken into irregular layers about 0.5' thick, (0.2m); lower interval angular fracture with rough surface, sometimes weathers to reddish brown. | Light type surfacing, concrete and bituminous aggregate, riprap. |

*Figure 5. Generalized geologic column of the surface geology in Riley County.*

The uplift of the Rocky Mountains marked the end of the Mesozoic Era and the beginning of the Cenozoic Era. Erosion has been predominant in Riley County since that time.

The Pleistocene Epoch of the Quaternary Period was a period of repeated glacial and interglacial cycles. Figure 6 is a geologic timetable which indicates the divisions of the Quaternary Period and the approximate length of each.

**Divisions of the Quaternary Period**

| Period | Epoch | Age | Estimated length of age duration in years | Estimated time in years elapsed to present |
|---|---|---|---|---|
| Quaternary | Pleistocene | Recent | | 10,000 |
| | | Wisconsinan Glacial | 80,000 | 90,000 |
| | | Sangamonian Interglacial | 160,000 | 250,000 |
| | | Illinoisan Glacial | 110,000 | 360,000 |
| | | Yarmouthian Interglacial | 160,000 | 520,000 |
| | | Kansan Glacial | 280,000 | 800,000 |
| | | Aftonian Interglacial | 450,000 | 1,250,000 |
| | | Nebraskan Glacial | 550,000 | 1,800,000 + |

*Figure 6. Geologic timetable of the Quaternary Period.*

The Nebraskan, Kansan, Illinoisan, and Wisconsinan Ages represent major glacial advances; however, only the Kansan glacier reached Riley County. The Aftonian, Yarmouthian, and Sangamonian Ages are periods of major glacial retreats. Alluvium of the Kansas and Big Blue Rivers in Riley County is composed of silt, sand, and gravel of late Wisconsinan and Recent age. Other unconsolidated sand and gravel deposits of Quaternary age are represented by the Buck Creek and Newman Terraces. These are of limited value as a source of construction material because of the excessive depth to a good supply of sand and gravel.

## GEOENGINEERING

This section provides a general appraisal of the geoengineering problems that may be encountered in Riley County during highway construction. Potential ground water problems and the quality of water available for concrete are briefly reviewed, along with engineering soil types present in the area. *Detailed field investigations may be necessary to ascertain the severity of specific problems and to make recommendations for design and construction procedures.*

Geoengineering problems encountered in Riley County are associated with the alluvium and terrace deposits of major drainage channels, thick limestones and shale units of Pennsylvanian or Permian age, and variations in soil mantle type and thickness.

The major escarpment forming units in Riley County are the Tarkio Limestone of the Pennsylvanian System and the Americus, Cottonwood, Eiss, Threemile, and Fort Riley Limestones of the Permian System. Large quantities of rock excavation will be encountered in deep cut sections through these escarpments. The magnitude and difficulty of rock excavation will depend on limestone thickness, bedding and joint patterns, weathering conditions, topographic location relevant to the grade line and the amount and character of overlying shales.

Stability problems in subgrades and backslopes will be encountered in the Florena, upper Easly Creek, Speiser, Havensville and Holmesville Shales. The severity of these problems will be depended upon the weathering. Problems may also occur in other shales within the section; however, detailed field studies will be needed to delineate the full areal extent and magnitude of these problems.

Pleistocene loess deposits (Loveland and Peoria Formations) vary from 0 to +25 feet (0 to 7.6 m) in thickness and cap the higher elements of topography in the northern half of the county. The plasticity index for most loess deposits is in the 20 to 30 range. Soils occuring over limestones of Pennsylvanian and Permian age generally have a thickness ranging up to 10 feet (3.0 m). These soils have poor engineering characteristics due to their high clay content. Varying thicknesses $\pm$ 3 feet (.9m) of soil and talus will be encountered on steeper slopes. Soils derived from shales generally have a plasticity index of approximately 30 while soils developed over limestones have a plasticity index in the vicinity of 40.

Alluvium and terrace deposits that will be encountered in the Kansas and Big Blue River valleys and their major tributaries are composed of silt and clay with lenses or pockets of sand and gravel. The alluvium and terraces of the Kansas and Big Blue Rivers include many old meander scars which contain unconsolidated silts and clays. Where fill sections are contemplated, these areas will require detailed study to determine construction procedures that will minimize the effect of differential consolidation. The need for borrow for fill construction in alluvium will require exploration to acquire sufficient material above the water table unless dewatering operations are comtemplated. Loess and granular material found along the Kansas River valley walls are susceptible to erosion which will require special design practices and construction techniques.

Sand dune areas located in the Kansas River valley may present construction and maintenance problems due to severe erosion when vegetation is removed. Binder

material such as soil or asphalt may be needed to provide a stable subgrade for vehicular construction traffic.

Twelve dry oil and gas wells were drilled in Riley County between 1915 and 1938. Since 1959 a number of producing oil wells have been drilled in the southeast corner of the county. Many early wells have been drilled in the southeast corner of the county. Many early wells were not cased and their locations were not accurately recorded. For the general location of these wells see State Geological Survey of Kansas Bulletin 39, the Geology of Riley and Geary Counties, Kansas. If wells are encountered during construction they should be plugged.

Water supplies from less than 3 gal/min (.2 l/s) to several hundred gal/min are available from aquifers in Riley County. Limestones of the upper Pennsylvanian and lower Permian usually yield minimal quantities of water which are generally satisfactory only for domestic use. However, it should be noted that the cities of Riley and Leonardville, in western Riley County, obtain their water from wells that penetrate the Barneston Limestone Formation. The wells at Riley produce 25 to 45 gal/min (1.6 to 2.8 l/s) and one of the wells at Leonardville produced as much as 89 gal/min (5.6 l/s) (Jewett, 1941). Alluvium and terrace deposits of the Kansas and Big Blue Rivers will yield from 15 to +1,000 gal/min (.9 to 63 l/s).

Water produced from limestone, sandstone, and shale sequences of upper Pennsylvanian and lower Permian age is generally high in bicarbonate and in some locations contains excessive chlorides and sulfates. Water from Quaternary deposits is generally very hard containing total iron in concentrations that range from 0 to 58 mg/l (Fader, 1974).