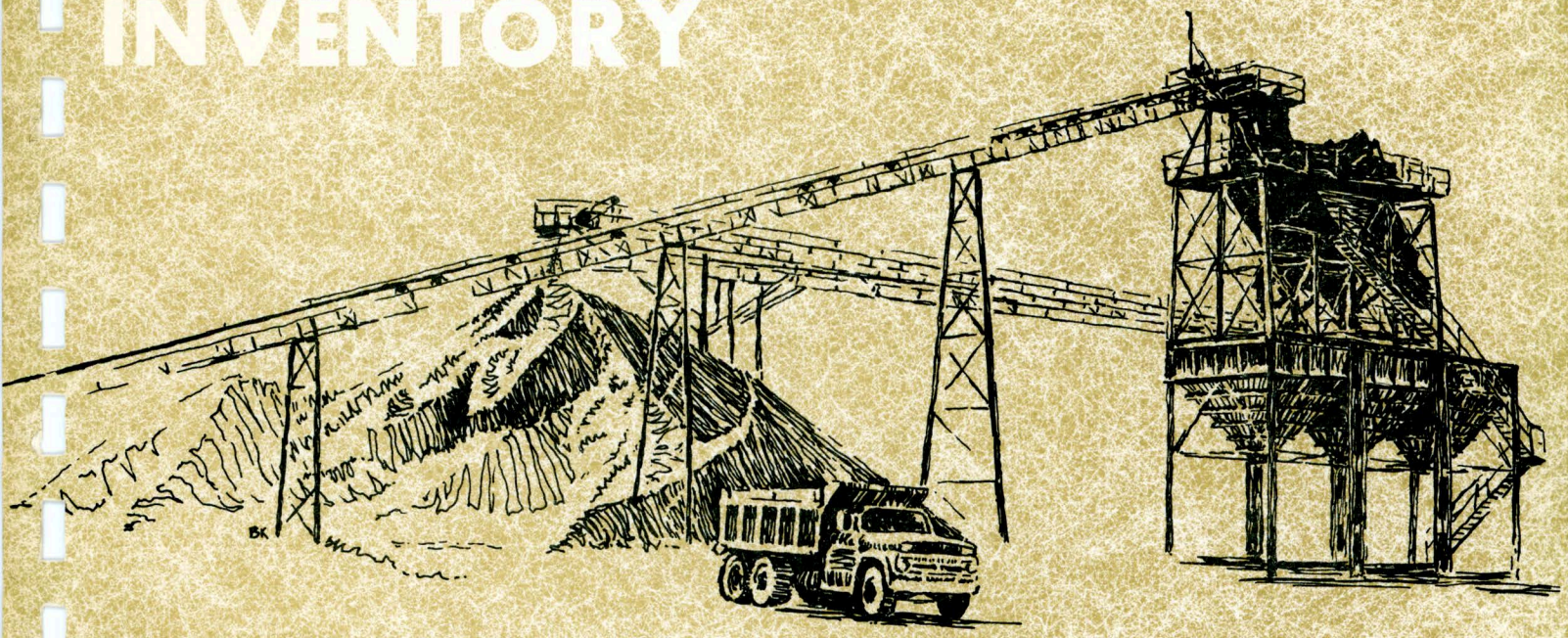
REPORT NO. 28

CONSTRUCTION MATERIALS INVENTORY



CRAWFORD COUNTY, KANSAS

Kansas Department of Transportation
Location and Design Concepts Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY OF CRAWFORD COUNTY, KANSAS

by

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assisted by
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Prepared in Cooperation with the
U. S. Department of Transportation
Federal Highway Administration

1975

Construction Materials Inventory Report No. 28

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 material in Crawford 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.***

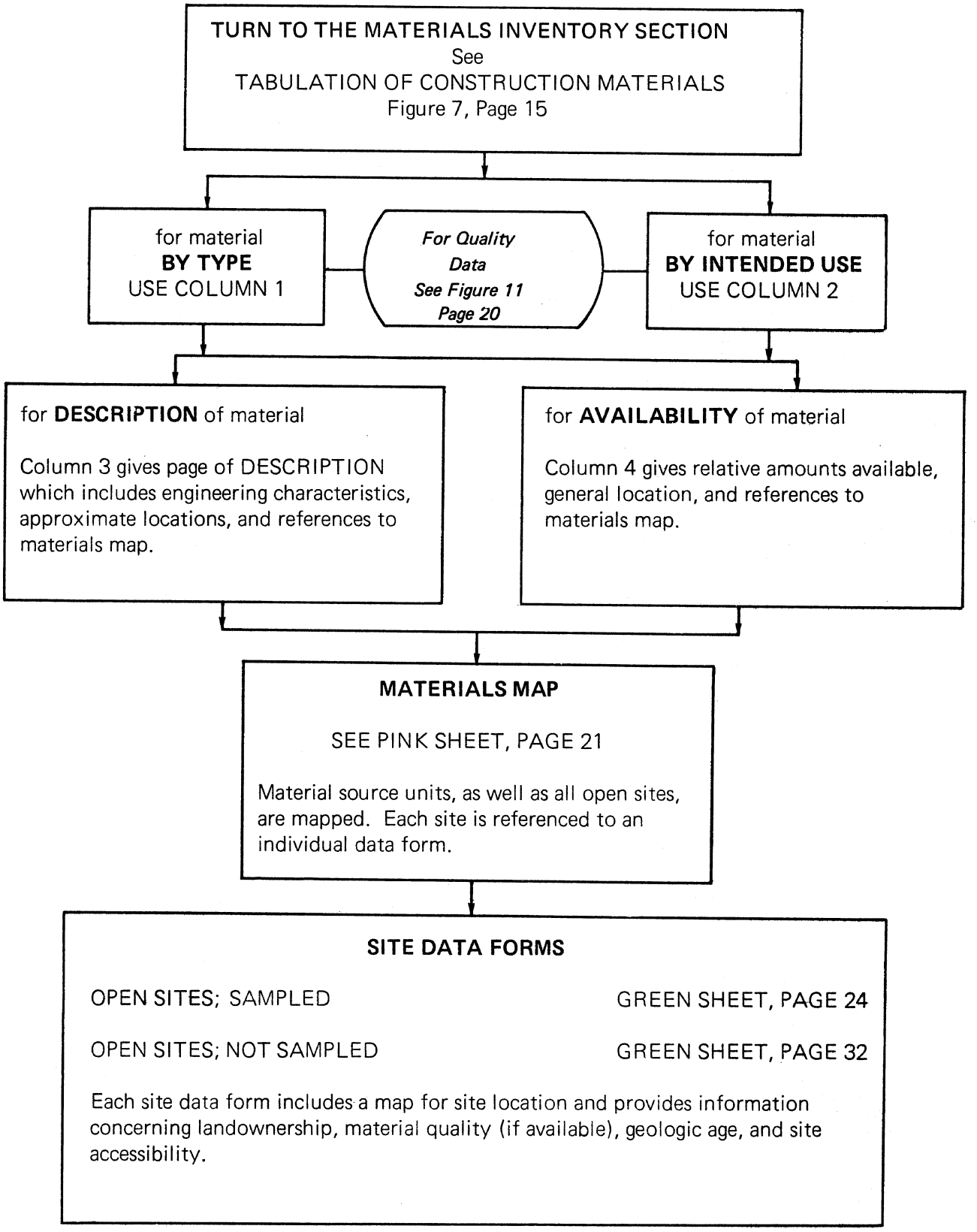
The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to evaluate and locate ***mapped sites.***

The individually mapped sites certainly do not constitute the total construction materials resources of the county. And, the data outlined in the diagram may be used for purposes other than the evaluation and location of these sites.

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 Crawford County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN CRAWFORD COUNTY



CONTENTS

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 Crawford 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. Larry Pommier, Crawford County Road Supervisor, Leonard Imhof, Kansas State Department of Health, James L. Farrell, Fourth Division Materials Engineer, and Walt Fredrickson, Regional Geologist, Kansas Department of Transportation, for verbal information concerning construction materials discussed in this report.

This report was prepared under the guidance of R. R. Biege, Jr., P.E., Engineer of Location and Design Concepts, A. H. Stallard, Chief, Remote Sensing Section, Location and Design Concepts Department and L. D. Myers, Geologist III, Remote Sensing Section, Location and Design Concepts Department.

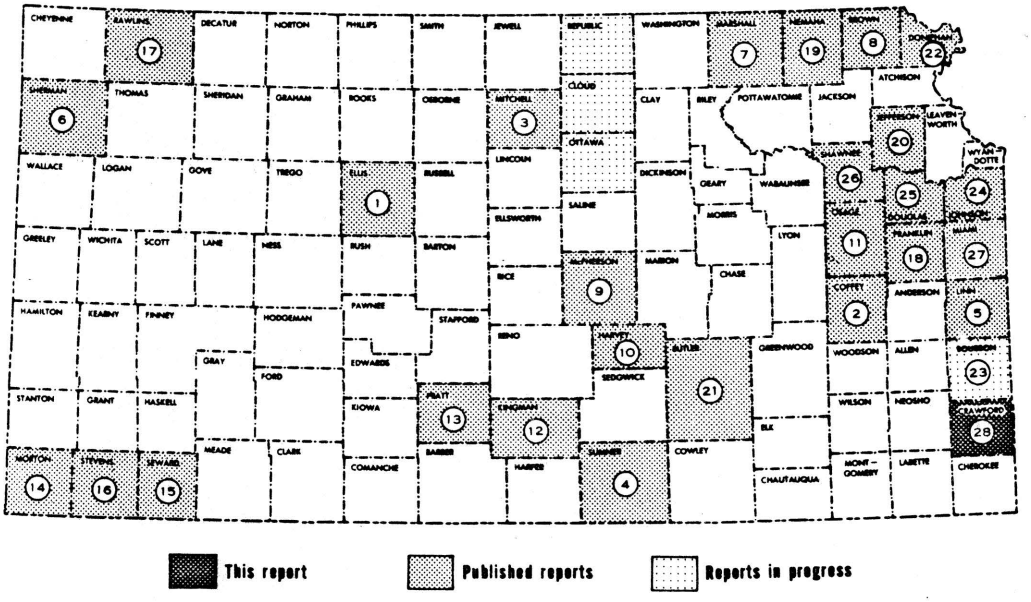


Figure 1. Index map of Kansas showing the location of Crawford County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Crawford County lies in the Central Lowlands physiographic province. Major topographic features of the county include gently sloping upland-plains and steep valley walls formed by erosion of thick limestones and shales of the Osage Cuesta Plains section, and the relatively flat lying surface of the Cherokee Plains section. The Cherokee Plains also contain large tracts of land which have been disturbed by strip mining operations which left large spoil piles and elongated bodies of water. Limited strip mining has also occurred in the Osage Cuesta Plains section.

Tributaries of the Neosho River drain the western half of Crawford County while tributaries of the Marmaton and Spring Rivers drain the eastern half of the county.

Sources of construction aggregate in Crawford County are limited to thick limestones of the Marmaton Group of Pennsylvanian age. The quality and thickness of these limestones vary within the county and quality tests should be completed before production is started at a new location.

Chat is transported from the lead-zinc mining areas of Cherokee County and adjacent counties in Missouri for construction aggregate. Chert gravel is produced from alluvium of the Neosho River to the west; however, neither chert gravel, chat, nor sand and gravel is produced in Crawford County.

Water supplies in Crawford County are generally provided by rural water districts who obtain their supply from deep wells in Ordovician limestones and dolomites in the southeastern part of the county. Water is available from strip pits although the quality is highly variable. Limited amounts of water are available from alluvial deposits and consolidated rock aquifers. Water from these sources is often hard and may contain a high iron or carbonate content.

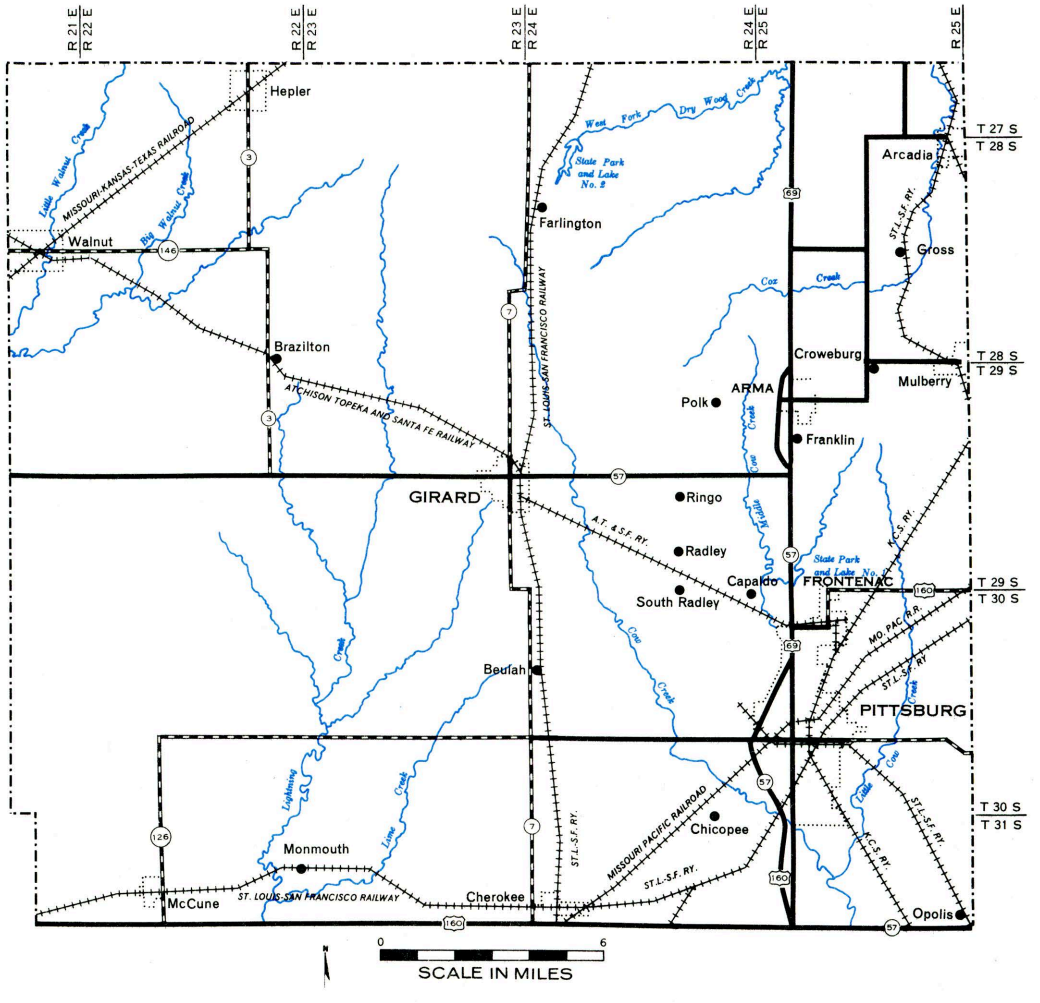


Figure 2. Drainage and major transportation facilities in Crawford County.

FACTS ABOUT CRAWFORD COUNTY

Crawford County has an area of approximately 598 square miles and a population of 38,127 in 1975 according to the Kansas State Board of Agriculture. The geographic location of Crawford and other counties currently included in the construction materials inventory program are shown in Figure 1 on page v. Figure 2, page 1 shows the major drainage and transportation facilities in Crawford County.

Surface features in many areas of the county have been permanently altered by the practice of strip mining for coal. The first mining began before the Civil War when coal was taken from strip and slope workings in the southeastern part of the county. The first coal shaft was sunk in 1877 on the townsite of Pittsburg. The mining activity resulted in a well developed rail network in the county, most of which was abandoned with the decline of mining activity.

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.

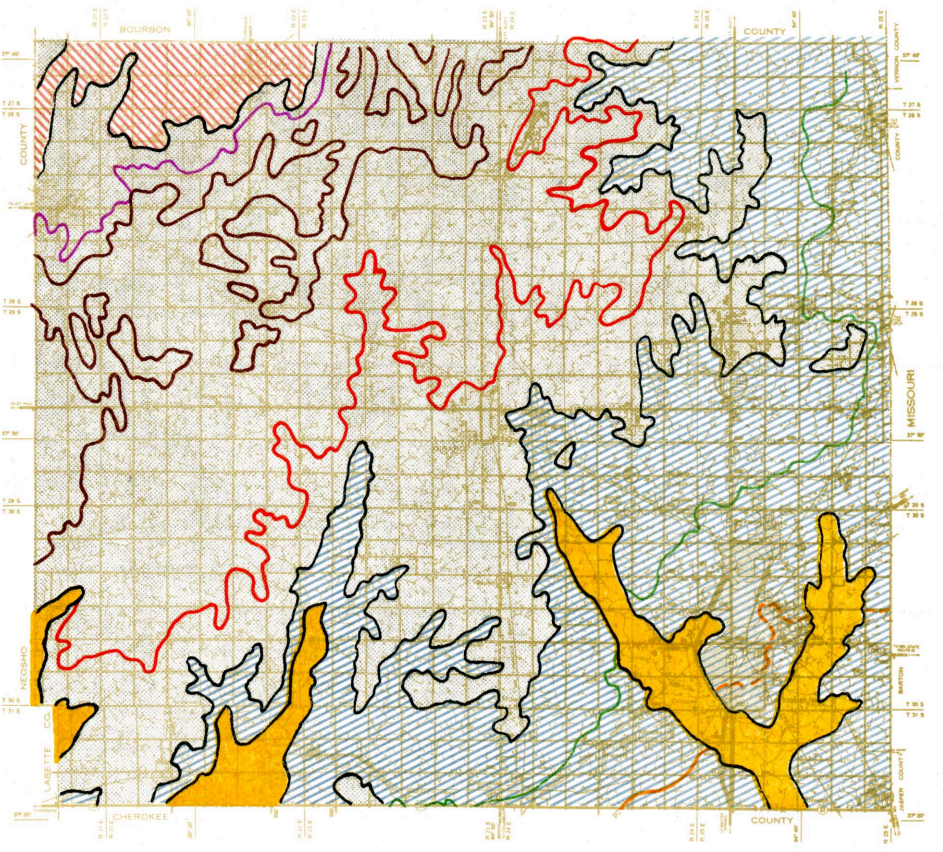
Phase One: Relevant information concerning geology, soils and construction materials of the county was reviewed and the general geology was determined. Quality test results of samples taken in Crawford County were then correlated with the various geologic units.

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 was accomplished. Figure 3 illustrates aerial photographic coverage of Crawford County. Geologic source beds and all open materials sites were mapped and classified on aerial photographs. All materials sites were then correlated with the geology of the county.

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

Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Crawford County. The numbers refer to photographs taken by the Photogrammetry Section, Kansas Department of Transportation, on 5-17-72, 5-19-72 and 11-28-72 at a scale of 1" = 2000'. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION



LEGEND

- Alluvium
- Cherokee
- Verdigris
- Cabaniss
- Marmaton
- Lenapah
- Altamont
- Pawnee
- Pleasanton

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.

This discussion is based primarily on information obtained from field observation data, reports of the Kansas Department of Transportation, and Kansas Geological Survey bulletins relating to Crawford and surrounding counties. 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 Crawford County.

Subsurface rocks in Crawford County range in age from Precambrian to Pennsylvanian. The Precambrian rocks are granitic as evidenced by samples from a well drilled in sec. 20, T 28 S, R 25 E, (Cole, 1961) where red granite was encountered at a depth of 1838 feet below the surface. Paleozoic rocks consisting of limestones, dolomites, sandstones and shales overlie the older Precambrian basement rocks.

Several aquifers occur in the Paleozoic rocks of Crawford County. The chief waterbearing formations are, in ascending order, the Lamotte Sandstone (upper Cambrian), Roubidoux and Jefferson City - Cotter Dolomites (lower Ordovician) and Fern Glen Limestone (Mississippian). Depth to the aquifers ranges from 400 to 1,700 feet. These aquifers are capable of producing several million gallons of water a day. Water in these aquifers moved down slope from the recharge area located to the east on the edge of the Ozark Uplift in Missouri (Abernathy 1941).

During late Mississippian or early Pennsylvanian time, the seas advanced from the south onto the eroded surface of late Mississippian rocks. Detritus from the eroded surface was reworked and redeposited as long narrow sand filled channels in low lying areas or as bar deposits in a shallow offshore environment. Sequences of coal and other swamp deposits found in the Cherokee Group indicate the area was at or near sea level during this period. Coal beds deposited during this period were of sufficient quality and quantity to be extensively mined over much of the eastern half of the county. Marine and non-marine deposits of middle Pennsylvanian age are the oldest rocks exposed in Crawford County. Limestone units of this age are the most important construction materials source units in the county.

ERAS	PERIODS	ESTIMATED LENGTH IN YEARS	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE)	1,000,000	Glacial drift; river silt, sand, and gravel; dune sand; wind-blown silt (loess); volcanic ash.	Sand and gravel; volcanic ash; agricultural soils; water.
	TERTIARY	59,000,000	Silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.	Sand and gravel; volcanic ash; diatomaceous marl; water.
MESOZOIC	CRETACEOUS	70,000,000	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	25,000,000	Sandstone and shale, chiefly subsurface.	
	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN	25,000,000	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	25,000,000	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	30,000,000	Mostly limestone, predominantly cherty.	Chat and other construction materials; oil, zinc, lead, and gas.
	DEVONIAN	55,000,000	Subsurface only. Limestone and black shale.	Oil.
	SILURIAN	40,000,000	Subsurface only. Limestone.	Oil.
	ORDOVICIAN	80,000,000	Subsurface only. Limestone, dolomite, sandstone, and shale.	Oil, gas, and water.
	CAMBRIAN	80,000,000	Subsurface only. Dolomite and sandstone.	Oil.
PRE-CAMBRIAN	(Including PROTEROZOIC and ARCHEOZOIC ERAS)	1,600,000,000 +	Subsurface only. Granite, other igneous rocks, and metamorphic rocks.	Oil and gas.

Figure 4. Geologic Timetable

System	Series	Stage or Group	Graphic Legend	Formations and Members		Map Symbol	Thickness	General Description	Construction Materials
Quaternary	Pleistocene	Recent		Alluvium and Terrace Deposits		Qal	0'-30'+		
Pennsylvanian	Upper Pennsylvanian	Kansas City Group		Ladore Shale					
				Hertha Limestone	Sniabar Ls. Mbr.	Ph	8'-12'	A light-gray to light-brown, wavy-bedded crystalline limestone that weathers to a tan-brown and is fossiliferous.	Light-type Surfacing
					Mound City Sh. Mbr.				
					Critzer Ls. Mbr.		2'-5'	Two thin beds separated by a thin shale bed. The limestone units are blue-gray and weather to a light-brown.	Light-type Surfacing
		Pleasanton Group		Tacket Fm.					
				Seminole Formation	South Mound Sh.Mbr.				
					Hepler Ss. Mbr.				
	Middle Pennsylvanian	Marmaton Group		Holdenville Shale					
				Lenapah Limestone	Idenbro Ls. Mbr.				
					Perry Farm Sh. Mbr.				
					Norfleet Ls. Mbr.				
				Nowata Shale					
				Altamont Limestone Formation	Worland Ls. Mbr.	Pa	10'±	A thin, wavy-bedded, mottled, fine-grained, iron stained, hard gray limestone. It is Oölitic near the top and weathers to a buff to tan.	Concrete and bituminous aggregate, riprap and light-type surfacing.
					Lake Neosho Sh. Mbr.				
					Amoret Ls. Mbr.		6'±	An upper and lower limestone unit separated by a shale parting. The lower unit is dark-gray, dense and sparsely fossiliferous. The upper unit is dark-gray, fossiliferous and has a brecciated appearance.	Light-type Surfacing
				Bandera Shale					
					Bandera Quarry Ss. Mbr.				
				Pawnee Limestone	Laberdie Ls. Mbr.	Pp	18'-35'±	A dark gray to gray, crystalline limestone that weathers to a rust-brown. Sometimes divided into two units by a thin intermittent shale. The unit is massive in the lower part and thin-bedded near the top. It is sparsely fossiliferous.	Concrete and bituminous aggregate, riprap and light-type surfacing.
					Mine Creek Sh. Mbr.		0'-4'		
					Myrick Station Ls. Mbr.		5'-7.5'		
					Anna Sh. Mbr.		16'±	A dark-gray, sparsley fossiliferous limestone that weathers to a rust-brown. It contains some colonies of 'Chaetetes.'	Concrete and bituminous aggregate, riprap and light-type surfacing.
				Labette Shale					
				Fort Scott Limestone	Higginsville Ls. Mbr.	Pf	4'-22'	A light-gray to brownish-gray, dense, massive to wavy-bedded limestone. Iron staining is prominent in the upper portion and large colonies are found thru the unit.	Concrete and bituminous aggregate, light-type surfacing, riprap.
					Little Osage Sh. Mbr.		3'-4'		
					Blackjack Creek Ls. Mbr.		10'-14'	Generally divided into three sections by thin intermittent shale partings. It is light-gray, fine-grained, finely crystalline, fossiliferous unit that weathers yellowish-tan.	Light-type Surfacing
		Cherokee Group		Cabaniss Formation	Mulky Coal Bed				
					Breezy Hill Ls. Mbr.				
					Bevier Coal Bed				
					Verdigris Ls. Mbr.				
					Croweburg Coal Bed				
					Fleming Coal Bed				
					Mineral Coal Bed				
					Scammon Coal Bed				
					Chelsea Ss. Mbr.				
					Weir-Pittsburg Coal Bed				
				Krebs Formation	Bluejacket Ss. Mbr.				
					Drywood Coal Bed				
					Rowe Coal Bed				
					Neutral Coal Bed				

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

Mesozoic sediments are absent in Crawford County. During the Triassic and Jurassic Periods of the Mesozoic Era, it is assumed that Crawford County was part of a landmass where large amounts of older Paleozoic rocks were removed by erosion. During the Cretaceous Period, the sea made its final advancement into Kansas; however, any sediments which may have been deposited in Crawford County have been removed by erosion.

Events that occurred during the Cenozoic Era had a profound influence on the construction materials resources of Crawford County. Late and post-Pennsylvanian deposits were eroded and middle Pennsylvanian limestones were exposed as present day drainage systems were developed. Easily eroded Cherokee Shales in the eastern half of Crawford County form the low relief Cherokee Plains portion of Osage Plains Physiographic Section of Eastern Kansas. More resistant limestone and sandstone units of the Marmaton and Pleasanton Groups form the subdued Osage Cuesta subdivision of the Osage Plains in the western half of the county. Chert gravel, which is found on higher elements of topography in the county, are remnants of alluvial terraces deposited during early Pleistocene time. Continuous erosion since that time has thinned the deposits until they are of little or no economic value.

GEO-ENGINEERING

This section provides a general appraisal of the geo-engineering problems that may be encountered in Crawford 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 investigation may be necessary to ascertain the severity of specific problems and to make recommendations in design and construction procedures.***

Geo-engineering problems in Crawford County are associated with alluvium of major drainage channels; limestones, shales, and sandstones along valley walls; and clay soils capping upland areas. Additional geo-engineering problems peculiar to this part of the state will be encountered in areas where coal seams occur. Spoil piles and undermined areas associated with strip and shaft mining operations are widespread except in the northwest part of the county.

Limestone outcrops are characterized by thin intermittent units found throughout the section, to thick, massive limestones belonging to the Fort Scott, Pawnee, Altamont, and Hertha Formations. The thicker limestones are mapped on plate I through V; however, extensive rock excavation and steeper valley walls which are associated with the thicker limestone units, are generally encountered in the northern half of the county.

Alluvium in Crawford County is restricted to valleys of the tributary streams which flow into the Neosho River to the west, the Marmaton River to the north, and the Spring River to the southeast. Alluvial material is composed predominantly of silts and clays with scattered lenses of fine sand and limestone gravel. Because of the relatively high groundwater table in some of the alluvium, extensive exploration will have to be completed during borrow investigation in order to acquire sufficient material above the water table.

Well developed soils with thick 'C' horizons (4 feet plus) are generally found overlying thicker shale beds in the upland areas and on the Cherokee Plains. These soils generally have a maximum plasticity index of 30. Soils which have developed over limestones rarely exceed three feet in thickness and have an approximate plasticity index of 40. As a general rule soils developed over shales display better characteristics for earthwork construction than those derived from limestones.

In Crawford County, hydrology problems are encountered in sandstone lens; at the bases of most limestones; at soil mantle - shale contacts; in black shales, such as the Excello Formation; and in coal beds. The top and base of the Breezy Hill Limestone and the Mulky Coal are prolific water bearing zones. The Englevale Sandstone, the 'Squirrel Sandstone' (upper Cherokee), and other units carry sufficient water to warrant installation of underdrains on construction projects.

Strip - and shaft - mined areas depicted on plates A through D present unique geo-engineering problems which are encountered in other parts of the state on a very limited basis. The plates (A-D) illustrate the enormous acreage of spoil piles left by the strip mining operations and the locations of known shaft mine entrances. Coal beds ranging from a few inches to more than 4 feet in thickness were mined in these areas.

Figure 6. Strip mining operation in the Cherokee Group, located in the SW ¼, sec. 15, T 28 S, R 25 E.

Settlement in shaft-mined areas, most of which were abandoned in the 1930's, has produced little surface effect; however, some evidence of subsidence may be detected on aerial photography. If sewage or other waste fluids are disposed of in these abandoned workings, it may cause subsidence or renewed settlement in some areas. A detailed study should be made to determine the extent of any existing subsurface mine works in areas where construction is contemplated.

Spoil piles left by stripping methods used to retrieve coal consist of limestone, shale, sandstone, and soil; and range from a few feet in thickness to nearly 100 feet in some areas. Deep, water filled channels and ditches are scattered along and through many of the stripped areas. In general, before construction is contemplated in these areas, extensive testing should be done to determine the extent and condition of the disturbed material, as well as its swell potential and shear strength. If the thickness of the disturbed material is not excessive, it should be removed and recompacted. Due to the excessive amount of recompaction that will be necessary through much of the stripped area, it is highly desirable to avoid those areas when possible.

Water supplies varying from less than 10 gpm to millions of gallons per day are available in Crawford County. Alluvial deposits generally yield less than 10 gpm and may contain objectionable mineral content such as iron and carbonates. Deep wells located southeast of a line from Mulberry to Arma to Cherokee penetrate the Roubidoux Formation of Ordovician age. These wells have yielded large quantities of water to supply Pittsburg and the rural water districts which supply all of rural Crawford County. To the northwest of the previously mentioned boundary, the Roubidoux water has an objectionally high chloride content. Water for construction purposes might be obtained from many of the strip pits located in the eastern third of the county. The water quality of all of these sources should be checked before use.

Oil and gas have been commercially produced in the western part of Crawford County since 1917; however, the first gas well was discovered near Girard in 1904. Primary production has been from 'Bartlesville Sands', in the Cherokee Group, which range from 300 to 600 feet in depth. Most production of gas has been from small pools located near the towns of Walnut, Monmouth, and McCune; however, gas has also been produced for local use from the Fort Scott Limestone in the western part of the county. Many early wells were not cased and their locations were not recorded. If these wells are encountered during construction, they should be plugged to prevent inducement of water into fill sections in areas where secondary recovery repressuring operations exist.

There are many coal beds located in the county and some of the beds are of sufficient thickness to make them economical to mine. The economic value should be considered in any proposed construction. The coal associated underclay may be a construction hazard due to its highly plastic nature.

CRAWFORD COUNTY COAL MINING ACTIVITY MAP

PLATE A

R 23 E | R 24 E | R 24 E | R 25 E | R 25 E

BOURBON COUNTY

VERNON COUNTY

T 27 S

T 28 S

BARTON COUNTY

MISSOURI

Farlington

State Park & Lake No. 2

Englevale

Arcadia
POP. 507

Gross

Groweburg

ST.L.-S.F. RY.

69

7

FAS

Creek

Coe

LEGEND

- MINE SHAFT OR DRIFT
- STRIP-MINED AREA

	A
	B
C	D

CRAWFORD COUNTY

MILES

1 0 1 2 3 4

KILOMETERS

1 0 1 2 3 4 5

CRAWFORD COUNTY COAL MINING ACTIVITY MAP

PLATE B

R 23 E
R 24 E
R 24 E
R 25 E

T 29 S

ARMA
Polk
Mulberry
GIRARD
Franklin
Ringo
Fuller
Radley
Yale
Dunkirk
Capaldo
South Radley
State Park Lake
FRONTENAC
Cornell

RAILWAY
Creek
Cow
ATCHISON, TOPEKA AND SANTA FE RAILWAY
ST. LOUIS-SAN FRANCISCO
Middle Cow Creek
K.C.S. RY.
MO. PAC. R.R.

ALT. 69
57
69
160
7
FAS

BARTON COUNTY
MISSOURI

T 29 S
T 30 S

MILES
KILOMETERS

LEGEND

MINE SHAFT OR DRIFT

STRIP-MINED AREA

A
B
C
D

CRAWFORD COUNTY

CRAWFORD COUNTY COAL MINING ACTIVITY MAP

PLATE C

R 21 E | R 22 E | R 22 E | R 23 E

T 30 S
T 31 S

NEOSHO COUNTY

LABETTE COUNTY

CHEROKEE COUNTY

McCune
POP 433

Monmouth

Lime Creek

ST.L.-S.F. RY.

ST. LOUIS-SAN FRANCISCO RAILWAY

126

160

160

MILES
1 0 1 2 3 4

KILOMETERS
1 0 1 2 3 4 5

LEGEND

STRIP-MINED AREA

	A
	B
C	D

CRAWFORD COUNTY

CRAWFORD COUNTY COAL MINING ACTIVITY MAP

PLATE D

R 23 E
R 24 E
R 24 E
R 25 E

Beulah
Filler
Chicopee
Klondike
Fleming
Kirkwood
Cherokee
Kniveton
Opolis
KOAM
KSEK
PITTSBURG

MO. PAC. R.R.
ST. L.-S.F. RY.
K.C.S. RY.
ST. LOUIS-SAN FRANCISCO RAILWAY
MISSOURI PACIFIC RAILROAD
ST. L.-S.F. RY.
FAS 184 SPUR
ALT. 69

126
7
57
69
160
FAS
RC
C
U

BARTON COUNTY
MISSOURI
JASPER COUNTY

T 30 S
T 31 S

CHEROKEE COUNTY

MILES
1 0 1 2 3 4
KILOMETERS
1 0 1 2 3 4 5

LEGEND

MINE SHAFT OR DRIFT

STRIP-MINED AREA

	A
	B
C	D

CRAWFORD COUNTY

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Pennsylvanian limestones make up the construction materials resources of Crawford County. Chat can be imported from the lead-zinc district of the Tri-State area and chert gravel is available from the Neosho River Valley in Neosho County to the west.

Construction materials types, their uses, and availability are tabulated in figure 7. Test results from a limited amount of sampling and testing are presented in figure 11, page 20.

CONTENTS
MATERIALS INVENTORY SECTION

Type Material and Geologic Source	Use	Page	Availability
LIMESTONE			
Fort Scott Limestone Formation	Concrete and bituminous aggregate. Light type surfacing, riprap.	16	Good source central and north central Crawford County. Plates 2, 3, 4, 5, & 6
Pawnee Limestone Formation	Concrete and bituminous aggregate. Light type surfacing, riprap.	17	Good source in central and north central Crawford County. Plates 1, 2, 3, 4, & 5
Altamont Limestone Formation	Concrete and bituminous aggregate. Light type surfacing.	18	Moderate source western half of county. Plates 1, 2, & 3
Hertha Limestone Formation	Light type surfacing	19	Limited source in northwestern corner of county. Plate 1

Figure 7. Tabulation of construction materials types and their availability in Crawford County.

DESCRIPTION OF CONSTRUCTION MATERIALS

Limestone

Fort Scott Limestone Formation

The Fort Scott Limestone is composed of two limestone members and one shale member. These members are, in ascending order, the Blackjack Creek Limestone, the Little Osage Shale, and the Higginsville Limestone. The Fort Scott Limestone has an average thickness of 33 feet in Crawford County. During the time this investigation was in progress, production of construction aggregate was limited to material from the Higginsville Member.

The Blackjack Creek Limestone member varies from 10 to 14 feet in thickness in Crawford County and is generally divided into three sections by thin, intermittent shale partings. The lower 1 to 2 feet is a light-gray, fine-grained, silty appearing, wavy-to slabby-bedded limestone. It weathers yellowish-tan and contains brachiopods and large cephalopods. The middle zone is approximately 2 feet thick and is a yellowish-tan layer containing numerous small brachiopods. The upper zone is light-gray, finely-crystalline limestone that varies from 10 to 11 feet in thickness. Pockets of small, well formed calcite crystals are also found in this zone. Large colonies of tabulate coral (Chaetetes) are common throughout the bed. The Blackjack Creek has not been quarried commercially in Crawford County. No quality test data are available for the Blackjack Creek; however, it should be suitable for light type surfacing and may meet other aggregate specifications.

The Higginsville Member is a light-gray to brownish-gray, dense limestone that varies in thickness from 4 to 22 feet. It is a massive-to wavy-bedded unit containing numerous fossils including large colonies of chaetetes and large crinoid stems. Iron staining is prominent in the upper part of the bed. Scattered thin zones of crystalline calcite, often iron stained, occur throughout the member.

Figure 8. Higginsville Limestone Member exposed in a quarry in the SE ¼ sec. 12, T 30 S, R 22 E.

Quality test data available for the Higginsville Limestone in Crawford County indicate the member is suitable for concrete and bituminous aggregate.

The outcrop pattern of the Fort Scott Limestone Member is shown on plates II through VI.

Pawnee Limestone Formation

The Pawnee Limestone Formation is composed of two limestone and two shale members. These members are, in ascending order, the Anna Shale, Myrick Station Limestone, Mine Creek Shale, and the Laberdie Limestone. The total thickness of the formation in Crawford County is in excess of 35 feet; however, due to incomplete exposures, it was not possible to obtain an accurate measurement of the total thickness.

The Myrick Station is a dark-gray, hard, dense, sparsely fossiliferous limestone that weathers to a rusty brown. It contains black and white wavy streaks which are caused by light colored colonies of the fossil Chaetetes. The thickness of the member varies from 5 to 7.5 feet. The Myrick Station is separated from the overlying Laberdie Limestone Member by the black platy shale of the Mine Creek Shale Member which has a thickness of 0 to 4 feet.

Quality test data on samples of the Myrick Station from open sites indicate the material will meet all current highway specifications for construction aggregate. The Myrick Station Member outcrops in the areas shown on plates I through V.

The Laberdie Member is a dark-gray to gray, crystalline limestone that is sometimes divided into two units by a thin irregular shale break. The thickness varies from 18'to 35'. The upper portion weathers to a rust brown and becomes thin-bedded near the top. The lower part is a light-gray, massive, soft limestone that weathers thin and platy and contains large crinoid stems. It appears brecciated and contains shaly zones.

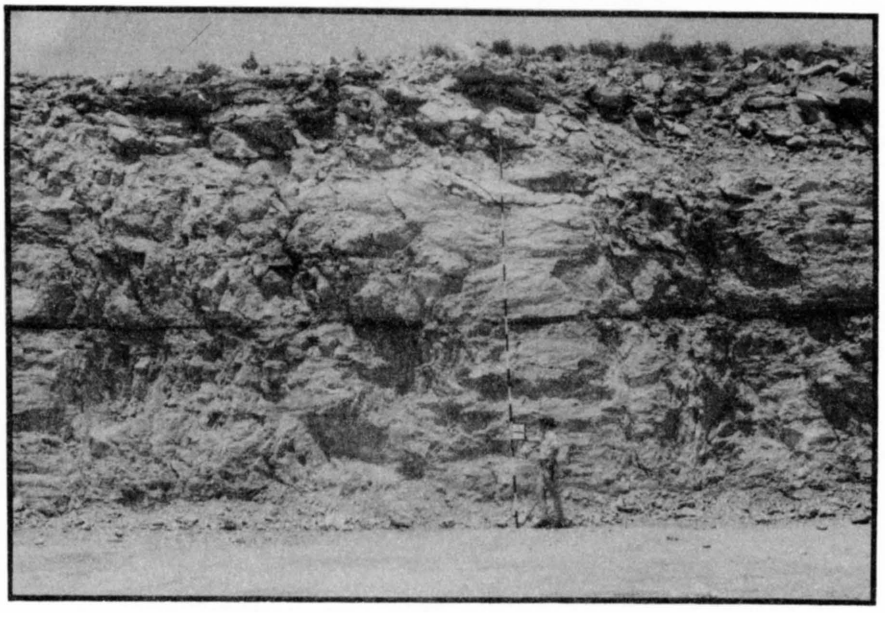


Figure 9. Laberdie Limestone exposed in a quarry in the SW ¼, sec. 31, T 27 S, R 24 E.

The Laberdie Limestone contains colonies of Chaetetes and has a well developed joint system. Quality data from tested locations indicate the material will meet all current highway specifications for construction aggregate.

Altamont Limestone Formation

The Altamont Limestone Formation is composed of three members which are, in ascending order, the Amoret Limestone, Lake Neosho Shale, and Worland Limestone. The Altamont Formation has not been quarried commercially in Crawford County; however, the Worland Member is being quarried in eastern Neosho County. The outcrop pattern of the Altamont Formation is shown on plates I through III.

The Amoret Member consists of an upper and lower limestone with a shale parting separating the two zones. The upper unit is a dark-gray, fossiliferous limestone that weathers to a tan-brown and has a brecciated appearance. The lower unit is a dark-gray, dense, fine-grained limestone that weathers to a light-gray to tan, and is sparsely fossiliferous. The average thickness of the Amoret is approximately 6 feet in Crawford County. The Amoret was not being quarried in Crawford or surrounding counties at the time this report was prepared. No quality test data were available for the member; however, in the field the material appears suitable for light type surfacing. The Amoret Limestone is separated from the Worland Limestone by approximately 4.5 feet of Lake Neosho Shale.

The Worland Member is a thin, wavy-bedded, mottled, fine-grained, iron stained, hard, gray limestone. It has crystalline calcite and pyrite, and an oolitic zone at the top. It weathers buff to tan and contains limited brachiopods with numerous fusilinids in the lower part. It is approximately 10 feet thick in Crawford County.

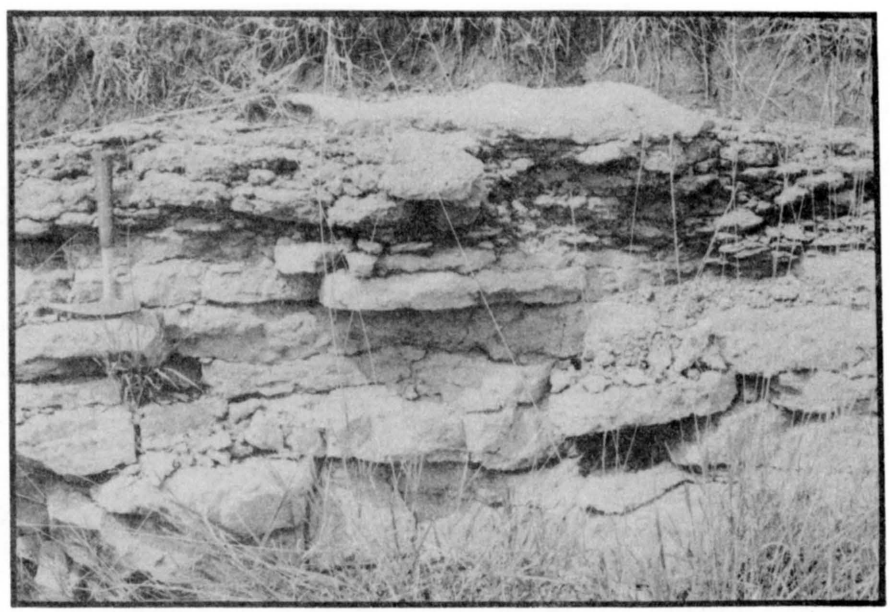


***Figure 10.** Worland Limestone Member exposed in a road cut on K-57, SW ¼, sec. 18, T 29 S, R 21 E.*

Quality test data for the Worland Limestone are not available for Crawford County. Tests on aggregate from sites in Neosho County show that the material sampled met all current highway specifications for construction aggregate.

Hertha Limestone Formation

The Hertha Limestone Formation is composed of two limestone members and one shale member. These members are, in ascending order, the Critzer Limestone, Mound City Shale, and Sniabar Limestone. The Hertha Formation forms a very sharp scarp in northwestern Crawford County. The outcrop pattern of the Hertha is shown on plate I.

Although the Hertha has been mapped in this report, there were insufficient exposures to obtain either an accurate measurement or description of the members in the county. The following description was obtained in Bourbon County on Highway K-3 near Uniontown.

The Critzer Member consists of two thin limestone beds separated by a shale bed and has a thickness of 2 to 5 feet. The limestone beds are blue-gray and weather light-gray to light-brown. This member has not been quarried commercially in Crawford or adjacent counties.

The Sniabar Member is a light-gray to light-brown, wavy-bedded, crystalline limestone which weathers to a tan-brown. It contains many fossils and becomes thin bedded near the top. It contains thin veins of crystalline calcite and has an average thickness of 8 to 12 feet.

No quality test data are available for the Hertha Formation in Crawford County.

Site Data Form No.	Material Type	Date of Test	SP.GR. Sat.	SP.GR. Dry	% Wear	Soundness	Absorption	Source of Data	Type of Sample
Source of Material: Pawnee Limestone Formation (Laberdie) Ppl									
LS+1	Limestone	2-06-75	2.58	2.52	26.0	0.99	2.40	KDOT Lab No. 75-84	Crushed
LS+5		1-07-60	2.61	2.57	27.6	0.98	1.72	9973	Crushed
		3-19-62	2.61	2.58	28.9	0.98	1.55	21288	Crushed
Source of Material: Pawnee Limestone Formation (Myrick Station) Ppm									
LS+4	Limestone	4-14-67	2.62	2.57	29.4	0.98	1.83	KDOT Lab No. 67-1222	Crushed
		6-26-67	2.62	2.57	26.6	0.99	1.96	67-2264	Crushed
LS+5		1-07-60	2.60	2.54	25.3	0.98	2.20	9974	Crushed
		3-19-62	2.60	2.55	25.3	0.97	2.19	21287	Crushed
Source of Material: Fort Scott Limestone Formation (Higginsville) Pfh									
LS+2	Limestone	3-14-69	2.53	2.48	34.6	0.98	2.02	69-537	Crushed
		9-09-68	2.53	2.48	35.1	0.98	2.11	68-2902	Crushed
LS+3		9-16-70	2.56	2.56	27.2	0.96	2.10	70-2618	Crushed
LS+6		2-03-75	2.63	2.58	23.0	0.99	2.00	75-81	Crushed

Figure 11. Results of tests completed on samples of material from the various geologic source beds in Crawford County.