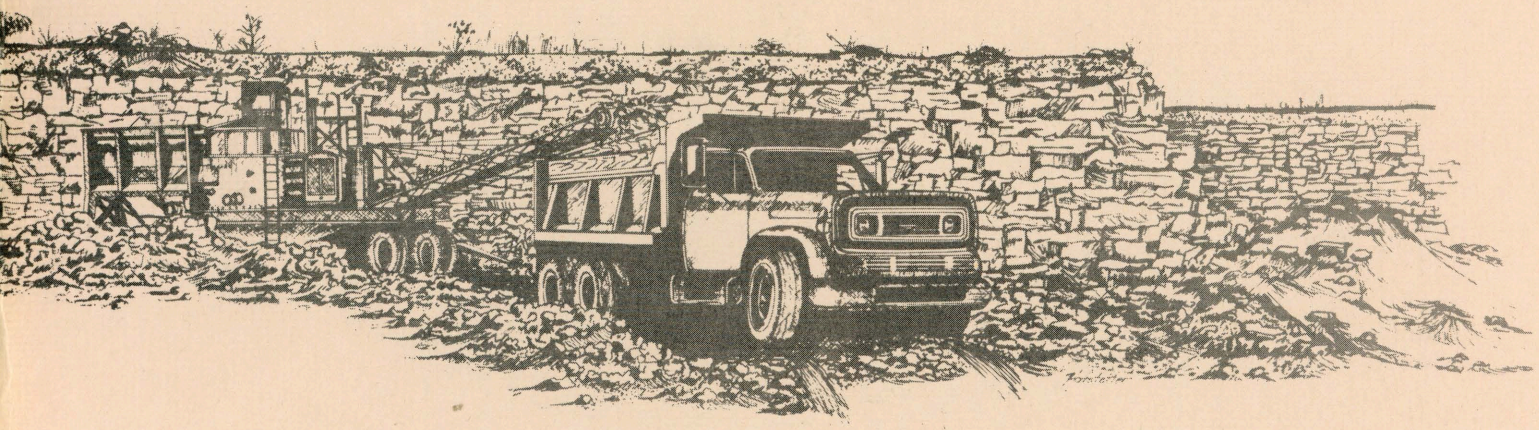
REPORT NO. 33

CONSTRUCTION MATERIALS INVENTORY



NEOSHO COUNTY, KANSAS

Kansas Department of Transportation
Engineering Services Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY

OF

NEOSHO COUNTY, KANSAS

by

George E. Petersen, Geologist
assisted by
Robert J. Wassenberg & Roger E. Carman
Engineering Technicians
Environmental Support Section

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

1978

Construction Materials Inventory Report No. 33

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

CONTENTS

the Why?

WHAT?

and HOW?

of This REPORT

This report was compiled for use as a guide for locating construction materials in Neosho 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.*

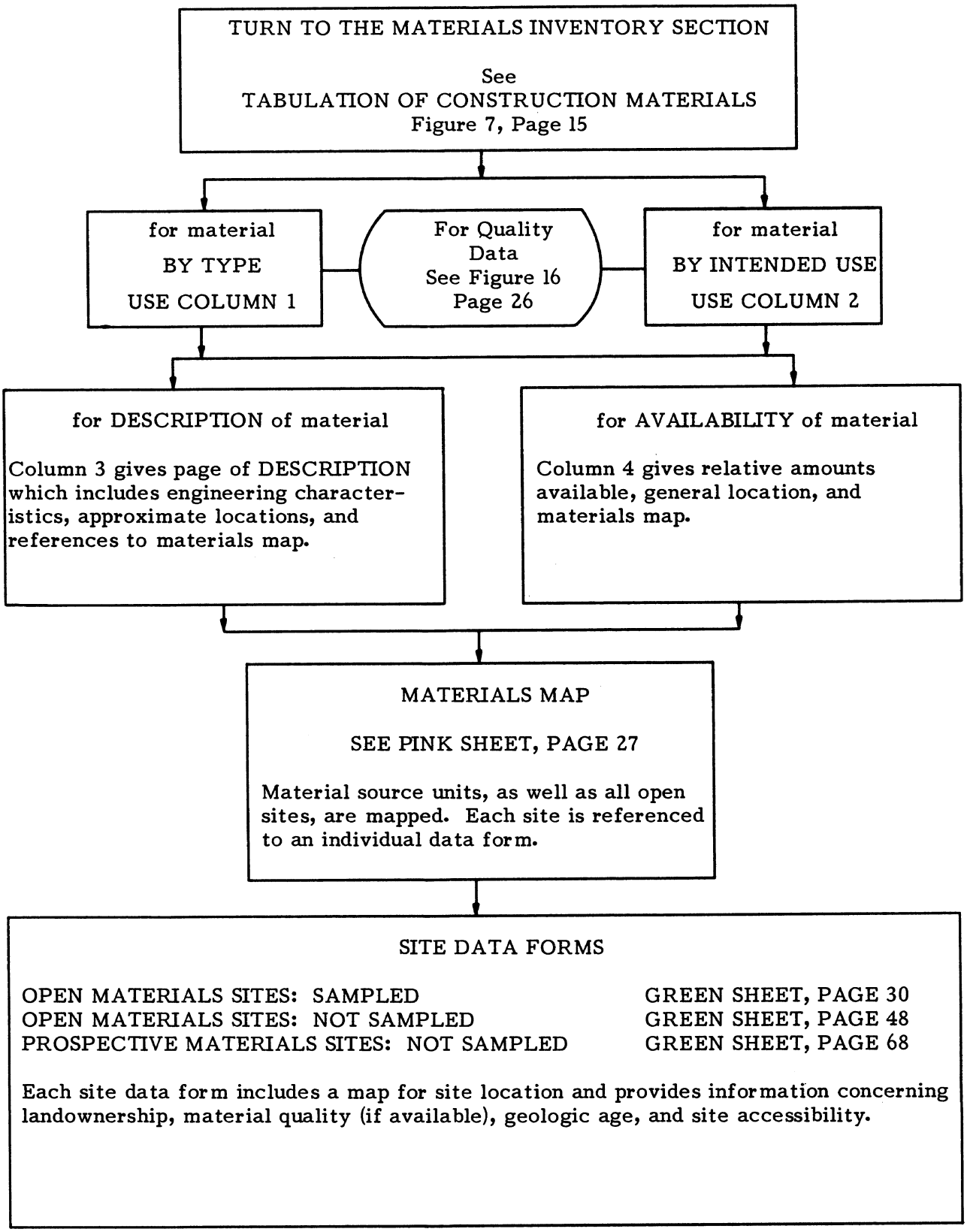
The diagram on page iv shows how the MATERIALS INVENTORY SECTION may be used to locate and evaluate mapped sites.

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 Neosho County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN NEOSHO COUNTY



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 Neosho 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. Charles Ingle, Neosho County Engineer, James L. Farrell, Fourth District Materials Engineer, Kansas Department of Transportation, Mr. Bill Ives, Mining Geologist and Mr. John E. McMeekin, Superintendent of the Ash Grove Cement Company, Chanute, Kansas for verbal information, concerning construction materials, used in this report.

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

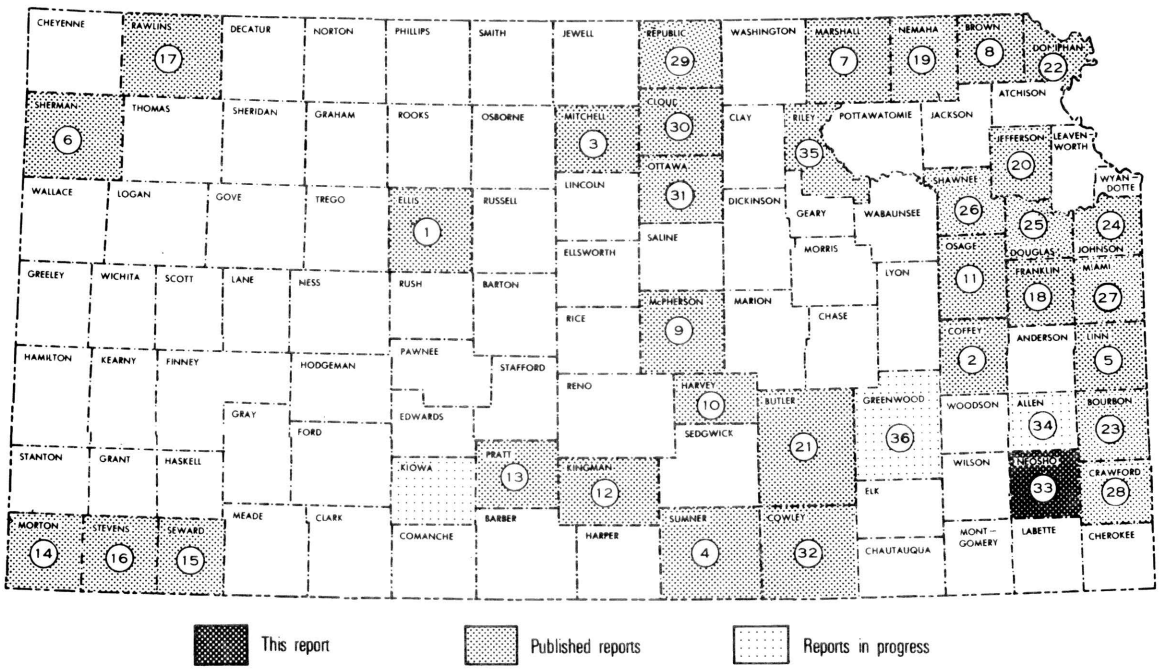


Figure 1. Index map of Kansas showing the location of Neosho County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Neosho County lies within the Osage Cuesta division of the Osage Plains section of 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 division, and the southeast trending alluvial plain of the Neosho River Valley.

The Neosho River and its tributaries drain all but the southwestern corner of the county. This area is drained to the south and west by tributaries of the Verdigris River.

Sources of construction materials in Neosho County are limestones of middle and upper Pennsylvanian age and limited amounts of chert gravel from Undifferentiated Quaternary Terraces and Wisconsinan and alluvial deposits of the Neosho River flood plain. Limestone aggregate which can be used as light type surfacing on local roads, can be produced from almost all of the limestone units exposed in the county.

Large quantities of good quality water are available from the Neosho River. Moderate quantities of water are available in the alluvial and terrace deposits of the Neosho River. Limited to moderate quantities of water are available from consolidated rock aquifers; however, water from these sources may have a high bicarbonate or iron content.

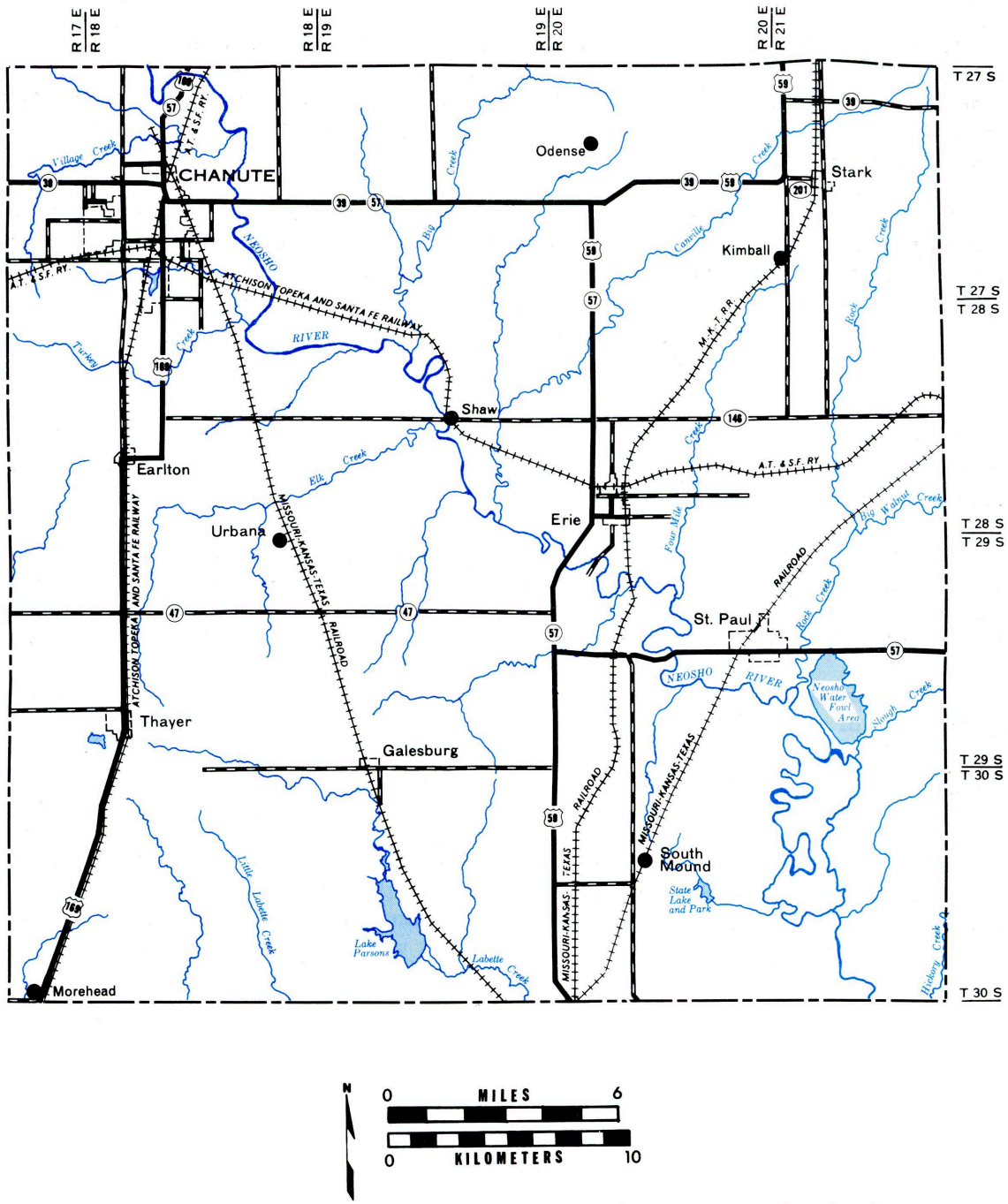


Figure 2. Drainage and major transportation facilities in Neosho County.

FACTS ABOUT NEOSHO COUNTY

Neosho County is located in southeastern Kansas. It has an approximate area of 587 square miles (1520 sq. km.) and a population of 17,862 in 1977 according to the Kansas State Board of Agriculture. The geographic location of Neosho and other counties currently included in the construction materials inventory program are shown in figure 1 on page v.

Maximum relief in the county is approximately 250 feet (76.2 m) with the highest point, 1090 feet (332.2 m) above mean sea level, located near the Bourbon County line in northeastern Neosho County. The lowest point of elevation is approximately 840 feet (256.0 m) and is located where the Neosho River leaves the county near the southeast corner.

A primary road system connects all major communities and a well developed secondary road system provides access to small communities. Figure 2, page 1 shows the major drainage and transportation facilities in Neosho 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 was determined. Quality test results of samples taken in Neosho 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 Neosho 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 author to examine construction materials, to verify doubtful mapping situations, and to acquire supplemental geologic information. Geologic classification of open sites was confirmed.

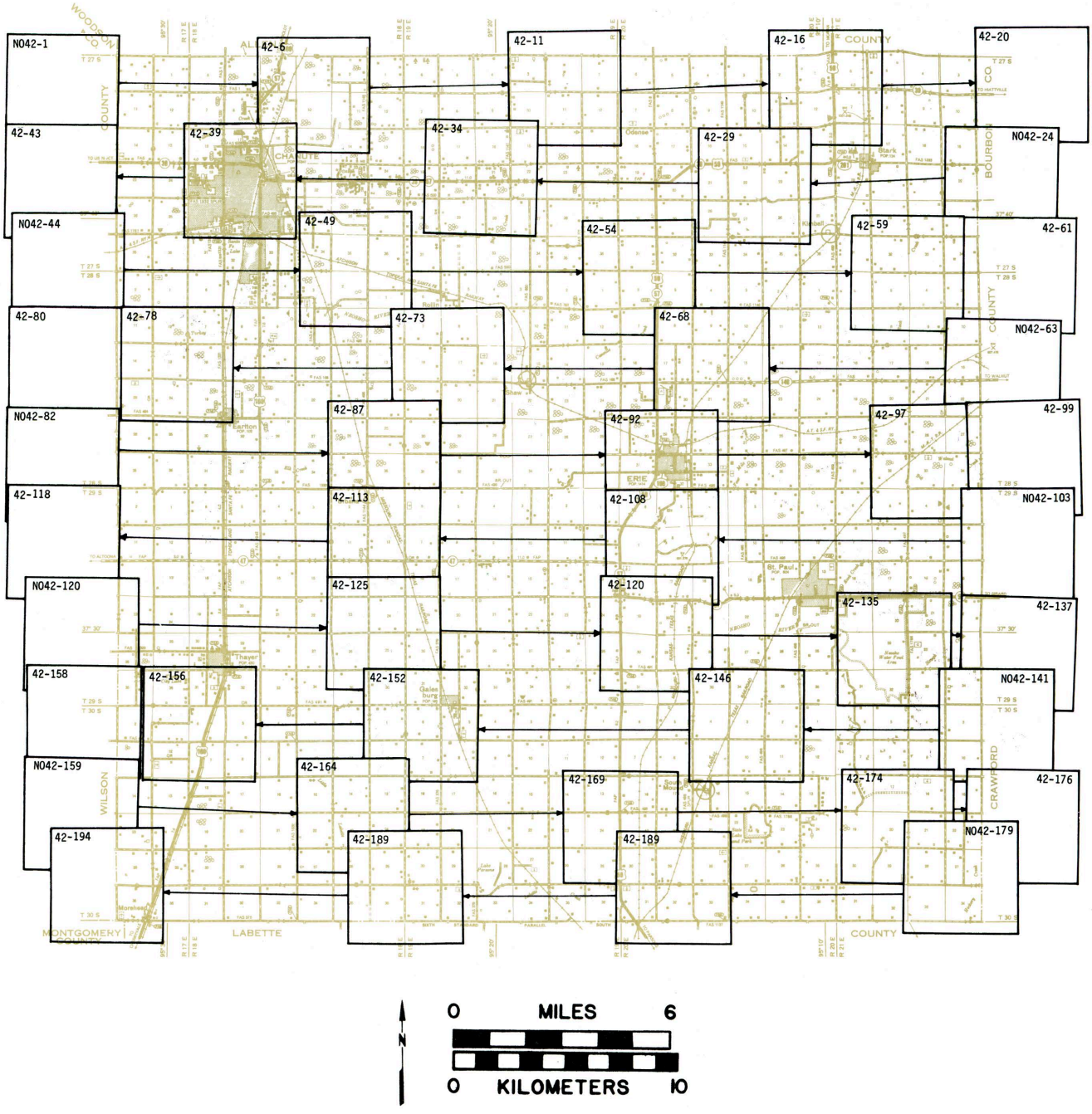
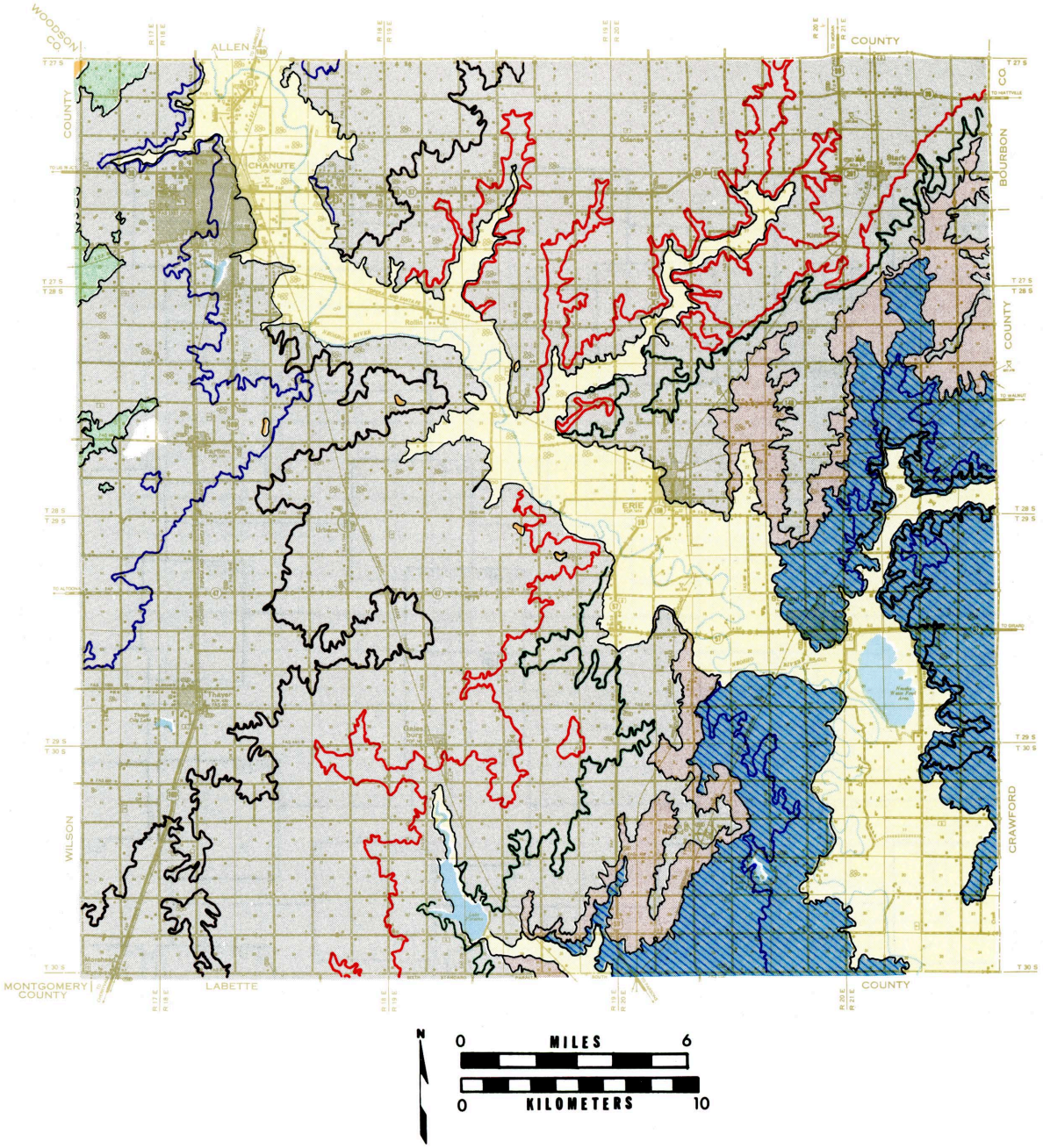


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Neosho County. The numbers refer to photographs taken by the Photogrammetry Section, Engineering Services Department, Kansas Department of Transportation on 3-9-77 at a scale of 1" = 2000' (1 cm. = 240 m). Aerial photographs are on file in the KDOT Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION



Quarternary Alluvium

Quarternary Terrace

Lansing Group

Kansas City Group
- I — Iola Limestone
- CH — Chanute Shale
- DN — Dennis Limestone
- SW — Swope Limestone

Pleasanton Group

Marmaton Group
- LE — Lenapah Limestone
- A — Altamont Limestone

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, especially in unconsolidated deposits.

Material for this discussion is based on information obtained from field observations and reports on Neosho and surrounding counties compiled by the Kansas 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 materials source unit in Neosho County.

Subsurface rocks in Neosho County range in age from Precambrian to Ordovician and Devonian to Pennsylvanian. Granitic Precambrian rocks have been recovered from several oil wells in the county at depths ranging from 1980 to 2235 feet (603.5 - 681.2 m) below the surface (Cole & Ebanks, 1974). According to Lee and Merriam (1954), rocks of upper Ordovician and Silurian age are missing in the county indicating a prolonged hiatus of pre-Devonian or early Devonian age. The Chattanooga Shale of late Devonian or early Mississippian age lies unconformably on Cambrian sediments (Jungmann, 1966). Mississippian limestones, dolomites, and shales having a total thickness in excess of 300 feet (91.4 m), lie conformably on the Chattanooga Shale. Subsurface Pennsylvanian sediments consisting of the Cherokee Shale and having an average thickness of 420 feet (128.0 m), lie on the eroded surface of the Mississippian limestones. The "Squirrel" and "Bartlesville" sands, from which much of the oil and gas was produced in Neosho County, are found in the Cherokee Shale.

Alternating beds of limestone and shale along with scattered beds of sandstone, all of Middle Pennsylvanian age, comprise the exposed consolidated surface rocks of Neosho County. Limestones of this age form the most important sources of construction materials in Neosho County.

Late Paleozoic and Mesozoic sediments are absent in Neosho County. During most of Mesozoic time (Triassic and Jurassic Periods) it is assumed that this area was part of a landmass where erosional processes removed large amounts of Paleozoic sediments and any sediments that may have been deposited during the Mesozoic Era. During Cretaceous time, the sea made its final advance into Kansas; however, if any sediments were deposited in Neosho County during this time, they were subsequently removed by erosional processes which took place during Cenozoic time.

Events that occurred during the Cenozoic Era had a profound influence on the construction materials resources of Neosho County. Late and post-Pennsylvanian deposits were eroded and middle Pennsylvanian limestones were exposed as present day drainage systems were developed. The resistant limestones and sandstones of the

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	Formations and Members		Map Symbol	Thickness	General Description	Construction Materials
Quaternary	Pleistocene	Recent and Wisconsinan		Alluvium		Qal	18-40′ (5.5-12.2m)	Silts and clays, fine to coarse sand and very coarse chert pebbles.	Construction aggregate.
		Illinoisan		Illinoisan Terrace		Qti	25′± (7.6m)	Fine silts and clays, some fine to medium sand in lower part.	Light type surfacing.
		Nebraskan		Undifferentiated Quaternary Terraces (Nebraskan-Kansan?)		Qtu	0-12′ (0-3.7m)	Angular to subrounded, tan to brown chert in clay matrix.	Construction aggregate.
Pennsylvanian System	Upper Pennsylvanian Series	Kansas City Group		Vilas Shale			0-3± (0-.9m)		
				Plattsburg Limestone	Spring Hill Ls. Mbr.	Pp	20′± (6.1m)	Thin to thick bedded, light-bluish-gray, finely crystalline limestone.	Light type surfacing.
					Hickory Creek Sh. Mbr.		3.5′± (1.1m)		
					Merriam Ls. Mbr.		1.5′ (.5m)	Gray to dark gray, finely crystalline, moderately fossiliferous limestone.	Light type surfacing.
				Lane Shale and Bonner Springs Shale			±60′ (18.3m)		
				Iola Limestone	Raytown Ls. Mbr.	Pi	4-44′ (1.2-13.4m)	Light-gray to tan, finely crystalline, massive bedded limestone containing coarsely crystalline calcite veins.	Construction aggregate and riprap.
					Muncie Creek Shale Mbr.		2-5′ (.6-1.5m)		
					Paola Ls. Mbr.		.1-2′ (.03-.6m)		
				Chanute Shale	Cottage Grove Ss. Mbr.	Pc	10′± (3.0m)		
					Thayer Coal Bed		0-1′ (0-.3m)		
					Unnamed Shale		0-7′ (0-2.1m)		
					Noxie Ss. Mbr.		6-110′ (1.8-33.5m)		
				Drum Limestone			3-10′ (.9-3.0m)		
				Cherryvale Shale			0-24′ (0-7.3m)		
				Dennis Limestone	Winterset Ls. Mbr.	Pd	35-60′ (10.7-18.3m)	Medium to very thick bedded, massive, Semi-lithographic to fine crystalline gray limestone containing some chert nodules.	Construction aggregate and riprap.
					Stark Sh. Mbr.		3-5′ (.9-1.5m)		
					Canville Ls. Mbr.		3-5′ (.9-1.5m)	A massive, dense finely crystalline limestone displaying prominent joints	Light type surfacing.
				Galesburg Shale	?		20-80′ (6.1-24.4m)		
					Dodds Creek Ss. Mbr.				
					Unnamed Sh.				
				Swope Limestone	Bethany Falls Ls. Mbr.	Ps	5-25′ (1.5-7.6m)	A fine to medium crystalline, massive, fossiliferous, light-gray to light-brown limestone containing some cross bedded oolitic limestone in upper part.	Construction aggregate and riprap.
					Hushpuckney Sh. Mbr.		3′-6′ (.9-1.8m)		
					Middle Creek Ls. Mbr.		0-4′ (0-1.2m)	Finely crystalline, medium to dark-gray, moderately fossiliferous limestone	Light type surfacing.
				Ladore Shale			40′ (12.2m)		
				Hertha Limestone	Sniabar Ls. Mbr.	Ph	4-38′± (1.5-11.6m)	Medium-bedded, finely crystalline, medium-gray limestone containing veins of coarsely crystalline calcite, and some chert.	Construction aggregate and riprap.
					Mound City Sh. Mbr.		0-6′ (0-1.8m)		
					Critzer Ls. Mbr.		±3′ (+1.9m)	Moderately crystalline, bluish-gray to gray limestone, which may be silty.	Light type surfacing.
		Pleasanton Group		Tacket Formation			25-60′ (7.6-18.3m)		
				Checkerboard Limestone			.4-2′ (.1-.6m)		
				Seminole Formation	South Mound Sh. Mbr.		.3-2′ (.09-.6m)		
					Hepler Ss. Mbr.		.3-3′ (.09-.9m)		
	Middle Pennsylvanian	Marmaton Group		Holdenville Shale			0-15′ (0-4.6m)		
				Lenapah Limestone	Idenbro Ls. Mbr.		6′± (1.8m)		
					Perry Farm Shale Mbr.		.8-4′ (.2-1.2m)		
					Norfleet Limestone Mbr.		.5-7′ (.2-2.1m)		
				Nowata Shale			16-22′ (4.9-6.7m)		
				Altamont Limestone	Worland Ls. Mbr.	Pa	9′± (2.7m)	Light gray, fossiliferous, finely crystalline, massive, thin bedded limestone containing thin shale seams.	Construction aggregate.
					Lake Neosho Sh. Mbr.		3′± (.9m)		
					Amoret Limestone Mbr.		3-16′ (.9-4.9m)	Massive bedded, tan to brown, moderately fossiliferous limestone with shale separation.	Light type surfacing.
				Bandera Shale			60-90′ (18.3-27.4m)		
				Pawnee Limestone	Laberdie Ls. Mbr.		20′± (6.1m)		

Figure 5. Generalized geologic column of the surface geology in Neosho County, Kansas.

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.

exposed Pennsylvanian sediments form the Osage Cuesta division of the Osage Plains in the county. Pre-Kansan chert gravels are found at several locations in the northern half of the county. These deposits rest 100-120 feet (30.5 - 36.6 m) above the existing flood plain and indicate that extensive erosion has occurred during the Pleistocene. Remnants of Kansan, Illinoisan, and Wisconsinan age terraces are also found along the major drainange channels in the county.

GEOENGINEERING

This section provides a general appraisal of the geoengineering problems that may be encountered in Neosho County during highway construction. Potential groundwater 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 in Neosho County are associated with alluvium of major drainage channels, escarpments formed by limestones and sandstones of Pennsylvanian age, and variations in soil mantle type and thickness. Additional geoengineering problems will be encountered in areas where oil or gas has been produced.

Alluvium and terrace deposits encountered in the valleys of the Neosho River and its tributaries are composed of silts and clays with lenses of sand and gravel. Cut-off meanders containing unconsolidated and sometimes organic soils are located in the Quaternary alluvium of the Neosho River valley. This material is conducive to differential consolidation under fill sections. Detailed studies should be conducted in these areas to determine construction procedures which will minimize the effects of this consolidation. The need for borrow for fill construction in alluvium will require exploration to acquire sufficient material above the water table unless pumping operations are contemplated. Alluvial deposits also are susceptible to seasonal flooding and terraces of Illinoisan age may be inundated during periods of major flooding. This will create a hazardous condition to fill sections and borrow areas during construction.

Major scarp forming units are the Altamont, Hertha, Swope, Dennis, Drum, Iola and Plattsburg Limestone Formations. Large quantities of rock excavation will be encountered in deep cut sections in these escarpments. The magnitude of rock excavation will depend on the limestone thickness, topographic relationships, and the character of overlying shales. Additional problems can be expected where the thick sandstones found within the Bandera Shale, Galesburg Shale, and Chanute Shale Formations are encountered. These sandstones vary from a very soft, poorly cemented unit to hard calcite or silica cemented beds.

Soil mantle varies in thickness from more than 40 feet (12.2 m) of alluvium in the valley of the Neosho River to a few inches of cover over limestones of the Marmaton and Kansas City Groups. Based on information gathered through photo interpretation and field observation, and field data obtained by our Soils and Geology Sections, a generalized concept of soil mantle thickness over upland areas was formulated. Soils occurring over limestones and on slopes with a 3 percent or steeper slope average less than 3 feet (.9 m) in thickness, while soils developed over shales on relatively flat areas average 10 feet (3.0 m) in thickness. Soils developed over limestones generally have a higher PI (40 plus) and exhibit poorer engineering characteristics than those soils developed over shales which generally have a PI of about 30.

Hydrology problems are associated with nearly every geologic member encountered in the county. Water movement is along the base of limestones, bedrock-soil mantle contacts, through sandstones and along well developed joint patterns such as those found in the Hertha, Swope and Dennis Formations. More persistent problems will occur during prolonged periods of heavy precipitation. Local variations in dip are common and may create traps for vadose water which will require underdrains on a highway alignment.

Oil and gas have been commercially produced in the county since their discovery in the 1890's. Production has generally been from the "Bartlesville Sands", in the Cherokee Group with the primary areas of production being located in the western half 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. This will also prevent brine or saline waters being introduced into surface streams and water supplies.

Limestone and shale aquifers generally yield less than 5 gpm (.32 l/s). The water from these aquifers is generally suitable for human consumption. Water from pre-Pennsylvanian aquifers is generally high in chlorides or nitrates. Hydrogen sulfide (H_2S) is common in water produced from the Stark Shale Member of the Dennis Limestone. Sulfates, fluorides, and carbonates are also common in water from most wells located in the consolidated aquifers. Yields and chemical content of these wells limit use to local domestic purposes. Wells located in the Wisconsinan and Recent Alluvium may yield up to 50 gpm (3.2 l/s); however, an average of 10 gpm (.64 l/s) is more common. Water from wells producing from the alluvial deposits along the smaller tributaries may be high in calcium and magnesium salts (hard water).

Cities and towns in Neosho County obtain their water supplies from surface water sources such as the Neosho River and the Thayer city lake.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Limestones of the Pennsylvanian System make up the major portion of the available construction materials of Neosho County. Chert gravels are produced from the flood plain of the Neosho River near St. Paul and chat can be imported from the lead-zinc district of the Tri-State area to the southeast.

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 16, page 26.

CONTENTS

MATERIALS INVENTORY SECTION

TYPE Material and Geologic Source	USE	PAGE	AVAILABILITY
LIMESTONE Altamont Limestone Formation	Concrete and bituminous aggregate. Light type surfacing.	16	Moderate source in eastern part of county. Plates IV and VI.
Hertha Limestone Formation	Concrete and bituminous aggregate. Light type surfacing and riprap.	17	Good source in eastern part of county. Plates II, IV, V, and VI.
Swope Limestone Formation	Concrete and bituminous aggregate. Light type surfacing and riprap.	18	Moderate source in eastern part of county. Plates II, III, IV, V, and VI.
Dennis Limestone Formation	Concrete and bituminous aggregate. Light type surfacing and riprap.	19	Good source in central part of county. All plates.
Iola Limestone Formation	Concrete and bituminous aggregate. Light type surfacing and riprap.	22	Limited source in northwestern part of county. Plates I and III.
Plattsburg Limestone Formation	Light type surfacing.	23	Very limited source along western edge of county. Plates I and III.
SAND AND GRAVEL Undifferentiated Quaternary Terrace (Nebraskan-Kansan?)	Concrete and bituminous aggregate. Light type surfacing.	24	Very limited source on higher topography along Neosho River. Plates III, IV, and VI.
Illinoisan Terrace	Light type surfacing.	24	Very limited source along Neosho River Valley. Plates I, IV, and VI.
Quaternary Alluvium	Concrete and bituminous aggregate. Light type surfacing.	24	Moderate source in Neosho River Valley. All plates.

Figure 7. Tabulation of construction material types and their availability in Neosho County.

DESCRIPTION OF CONSTRUCTION MATERIALS

Limestone

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 thickness of the Altamont varies from 20 to 30 feet (6.1-9.1 m). The outcrop pattern of the Altamont Limestone is shown on plates IV and VI.

Amoret Limestone Member

The Amoret Limestone Member in Neosho County generally consists of a massive-bedded, tan to brown, dense, moderately fossiliferous limestone having a thickness of 3 to 16 feet (.9 - 4.9 m). Locally, as in the vicinity of the Neosho County State Lake, the Amoret is composed of two limestone beds separated by a 1 foot (.3 m) gray, clay shale. The lowermost limestone is wavy-bedded, light-gray, weathers to a tan and has a thickness of about 10 feet (3.0 m). The limestone overlying the shale separation is a massive, light-gray to bluish-brown bed having a thickness of approximately 5 feet (1.5 m). This bed may also contain a .5 foot (.2 m) thick shale parting 1.5 feet (.5 m) from the top. The Amoret has not been quarried in this area due to its variable thickness, and because of easier access to the overlying Worland Member; however, field observations indicate the material will probably meet Kansas Department of Transportation specifications for construction aggregate if taken from selected outcrops.

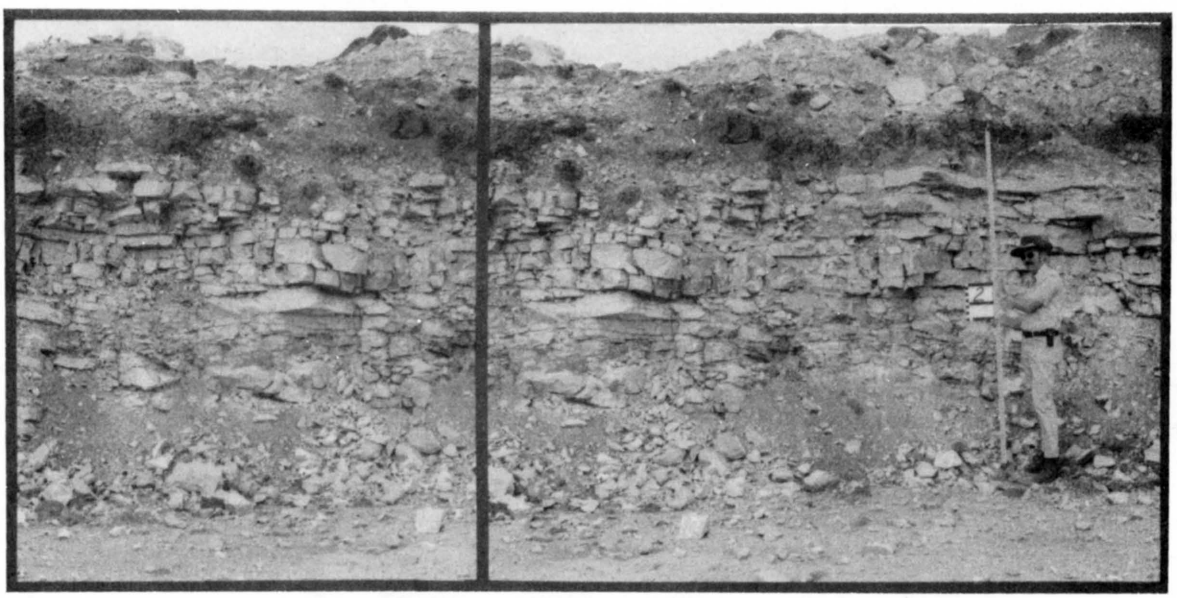


Figure 8. Worland Limestone Member exposed in a quarry in the E½, sec. 34, T28S, R21E. (stereogram)

Worland Limestone Member

The Worland Limestone Member is a light-gray, fossiliferous, finely crystalline, massive limestone that has a mottled appearance in the upper part. The upper 3 to 4 feet (.9 - 1.2 m) of the member is commonly thin bedded with thin shale seams throughout. The total thickness of the member is about 9 feet (2.7 m) in Neosho County.

Quality test data available from site LS + 11 and LS + 12 (plate IV) indicates that the material meets all KDOT standard specifications for construction aggregate.

Hertha Limestone Formation

The Hertha Limestone Formation is composed of three members which are, in ascending order, the Critzer Limestone, Mound City Shale, and Sniabar Limestone. The Hertha is one of the prominent escarpment-forming units in Neosho County. The formation varies from about 7 feet (2.1 m) to more than 44 feet (13.4 m) near the town of South Mound (plate VI). The outcrop pattern of the Hertha Formation is shown on plates II, IV, and VI. The only observed production of construction aggregate from this formation has been from the Sniabar Member (site no. LS + 15, plate VI).

Critzer Limestone Member

The Critzer Limestone and overlying Mound City Shale are absent from the Hertha Formation in the northeastern part of the county with the base of the Sniabar lying directly on rocks of the Pleasanton Group. In the southern portion of the outcrop area where the Critzer is present, it has a thickness of 3 feet (.9 m). The Critzer is moderately crystalline, bluish-gray to gray, may be silty with a yellowish-brown color and contains a moderate amount of crinoid remains. The Critzer has not been quarried in Neosho or surrounding counties due to its limited thickness. Field observations indicate the material would be suitable for light type surfacing.

Sniabar Limestone Member

The Sniabar is a medium-bedded, finely crystalline, medium-gray limestone that weathers to a light tan. Thin veins of coarsely crystalline calcite are found throughout the unit. Brachiopods are common in the lower part of the member and large crinoid stems are found in the upper portion. The unit is very hard and dense and contains some chert nodules. The member varies from about 4 feet (1.2 m) in the northern part of the outcrop to more than 38 feet (11.6 m) in the area just northeast of South Mound (plate VI).

Quality test data available from site LS + 15 indicate the material at that location will meet all KDOT specifications for construction aggregate. Material from other locations along the outcrop pattern of the unit should be tested before use.

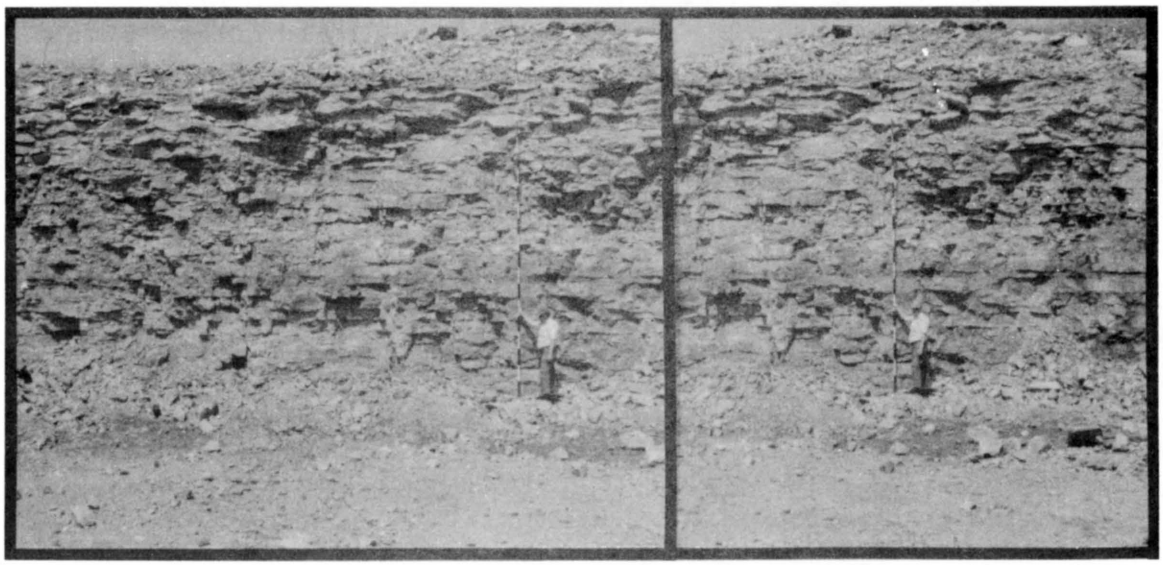


Figure 9. Sniabar Limestone Member exposed in quarry face in the NE¼, sec. 16, T30S, R20E. (stereogram)

Swope Limestone Formation

The Swope Limestone is composed of two limestone members separated by a shale member in Neosho County. These members are, in ascending order, the Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone. The average thickness of the formation in the county ranges from 7 to 13 feet (2.1 - 4.0 m); however, Mossler (1973) reports the thickness can vary from 5 to 35 feet (1.5 - 10.7 m).

Middle Creek Limestone Member

The Middle Creek Limestone has an average thickness of 3 feet (.9 m) in Neosho County although there are areas where both the Middle Creek Limestone and overlying Hushpuckney Shale are absent. The Middle Creek is finely crystalline, medium to dark-gray and is moderately fossiliferous. Crystalline calcite occurs throughout the member. The member is suitable for light type surfacing and based on field observation, it should have the characteristics necessary to qualify as construction aggregate. Because of the position of the member in relation to the Bethany Falls Limestone, it is doubtful that any quarry operation would be feasible unless it was produced in conjunction with the overlying Bethany Falls Member.

Bethany Falls Limestone Member

The Bethany Falls Limestone is the only member of the Swope Formation that is present throughout the entire outcrop area in Neosho County. It is a fine to medium crystalline, massive, fossiliferous, light-gray to light-brown limestone that weathers to a tan brown. It may contain some cross bedded oolitic limestone in the upper part in the eastern part of the outcrop area. It has a thickness ranging from about 5 feet (1.5 m) in the northeastern part of the county to approximately 25 feet (7.6 m) near the Labette County line.

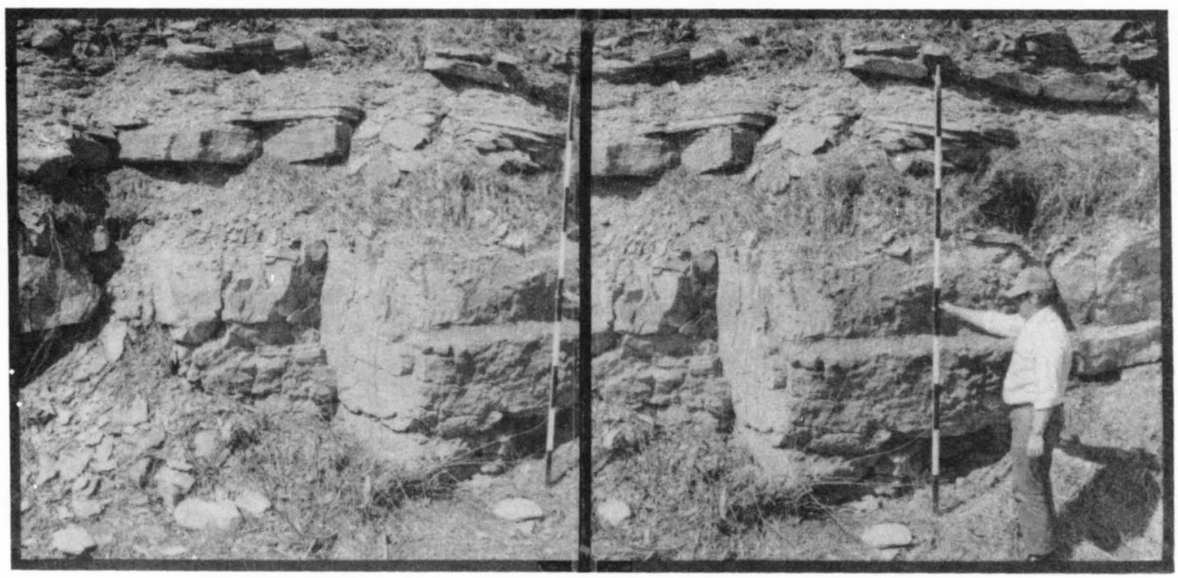


Figure 10. Bethany Falls Limestone Member exposed in a road ditch in the NE ¼, sec. 19, T28S, R20E. (stereogram)

Quality test data are not available for the Bethany Falls Member in Neosho County; however, tests in northern Bourbon County indicate the material will meet all KDOT specifications for construction aggregate when taken from selected outcrops. Field observations in Neosho County indicate the material will probably be very similar to that tested in Bourbon County and should meet all KDOT specifications for construction aggregate; however, tests should be run at each location before use.

Dennis Limestone Formation

The Dennis Limestone in Neosho County consists of three members which are, in ascending order, the Canville Limestone, Stark Shale, and Winterset Limestone. The formation ranges from 6 to 70 feet (1.8 - 21.3 m) in thickness and has been mapped on all plates.

Canville Limestone Member

The Canville is a massive, dense, finely crystalline, light to tan-gray limestone. It is sparsely fossiliferous, exhibits prominent joints and the thickness varies from 3 to 5 feet (.9 - 1.5 m). The member is suitable for light type surfacing and, based on field observation, should have the characteristics necessary to qualify as construction aggregate. It should be possible to produce this unit in conjunction with the Winterset Member as they are separated by approximately 3 to 5 feet (.9 - 1.5 m) of Stark Shale.

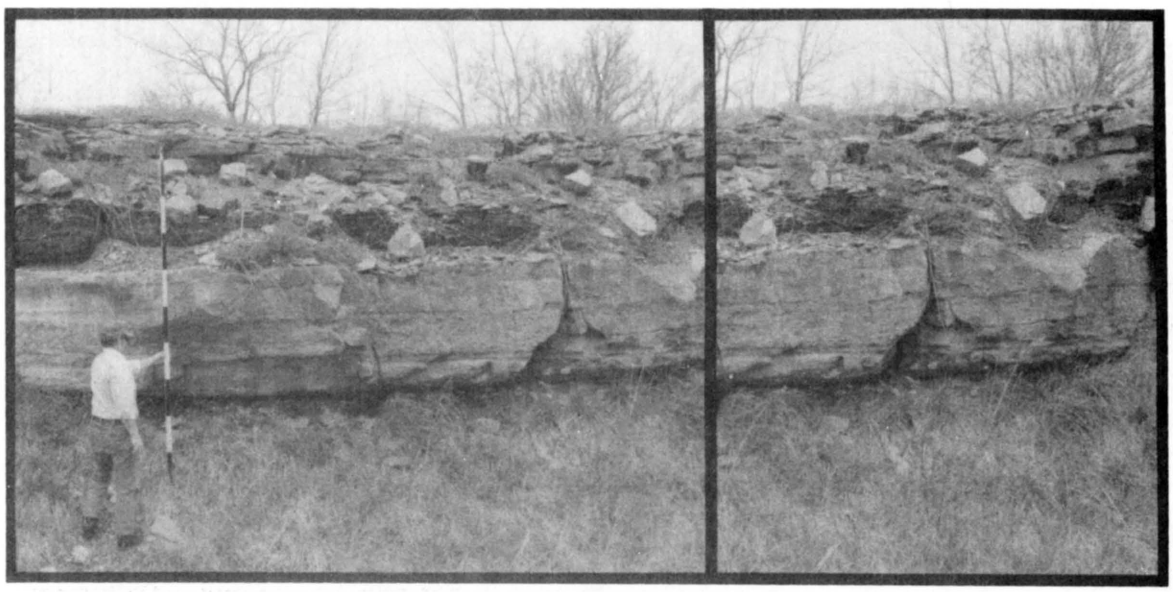


Figure 11. Canville Limestone - Stark Shale exposed in north road ditch, S½, sec. 13, T27S, R20E. (stereogram)

Winterset Limestone Member

The thickness of the Winterset Limestone varies from a 1 foot (.3 m) thick weathered cobble surface where pre-Chanute erosion has cut into the Winterset along the Neosho River east of Chanute, to approximately 60 feet (18.2 m) in some localities in the central and south central parts of the county.

The Winterset can generally be divided into an upper and lower zone within the county. The lower zone is a very thick-bedded, massive, medium-gray, finely crystalline, fossiliferous limestone. It contains abundant white chert nodules, is oolitic in the upper 3 to 5 feet (.9 - 1.5 m) of the zone and weathers light-gray to white.

The upper zone is thin to medium bedded, light-gray to brownish-gray, and is very finely crystalline to semi-lithographic in texture. It ranges from 15 to 30 feet (4.6 - 9.1 m) in thickness. Voids within the thin bedded part of the unit are commonly filled with coarsely crystalline calcite. Brownish-yellow mottling is often observed in the broken weathered surface. Algal material is present in the upper part of the zone

Figure 12. Crossbedding in Winterset Limestone exposed in the NE¼, sec. 23, T27S, R20E. (stereogram)

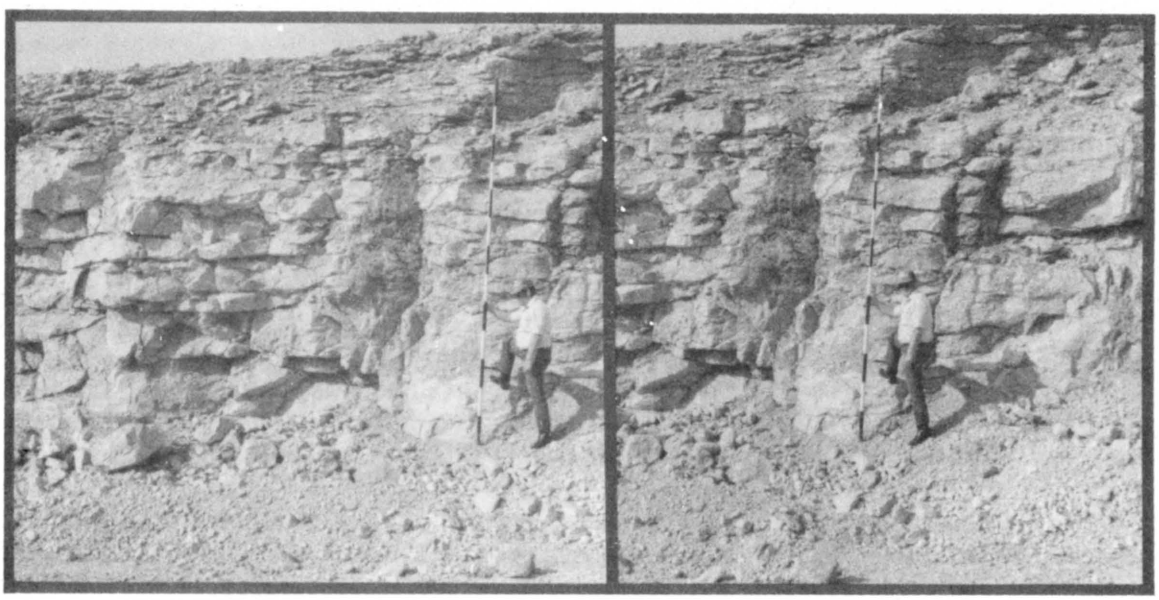


Figure 13. Winterset Limestone Member exposed in a quarry located in the E½, sec. 9, T29S, R19E. (stereogram)

in some areas and in many of these algal zones, dolomite has replaced the calcite. The dolomite has a white to light pink color (Jungmann, 1966). A shale zone approximately 3 feet (.9 m) thick is found above 12 feet (3.7 m) about the base of the thin-bedded zone.

The Winterset is the most important source of construction aggregate in the county. Numerous quality tests indicate the material will generally meet all KDOT standard specifications for construction aggregate; however, L.A. wear values are generally 30% or higher, soundness values range from 90 to 98% and absorption values vary from 2.66 to 4.81. Material should only be taken from select outcrops due to the presence of discontinuous shale seams found in many parts of the member.

Iola Limestone Formation

In Neosha County, the Iola Limestone is composed of, in ascending order, the Paola Limestone, Muncie Creek Shale, and Raytown Limestone Members. The formation varies in thickness from less than 6 feet (1.8 m) on the county line west of Thayer to a maximum of more than 51 feet (15.5 m) northwest of Chanute. The base of the Iola Formation has been mapped on plates I and II.

Paola Limestone Member

The Paola Limestone varies from 0 to 2 feet (0 - .6 m) in thickness in Neosho County. It is a finely crystalline, light tannish-gray limestone that weathers to a yellowish-brown. Abundant fossils are common near the base. In the southern part of the outcrop the Paola becomes thin and flaggy and is limited in thickness to a few inches. The Paola has very limited value as a source of construction aggregate due to the excellent quality and thickness of the overlying Raytown Member.

Raytown Limestone Member

The Raytown Limestone varies in thickness from less than 8 feet (2.4 m) at its southern limit near Thayer (plate III) to more than 37 feet (11.3 m) just west of Chanute. It is a light-gray, tan weathering, finely crystalline, massive-bedded limestone that contains many coarsely crystalline veins of calcite. Weathered surfaces exhibit bedding planes approximately 8 inches (.02 m) apart. As the Raytown thins to the south, it becomes a single massive-bedded unit. Its low magnesium content and great thickness in the area of Chanute have made the Raytown Limestone a prime source of rock for the manufacture of cement.

Quality test data avilable for the Raytown Limestone in Neosho County indicate the member is suitable for all construction aggregate. Quality test data available for the Raytown in Allen County immediately to the north, indicate that in some areas absorption and wear values may become marginal for bituminous aggregate. Tests should be run before use from each location to insure the material will meet all KDOT standard specifications for construction aggregate.

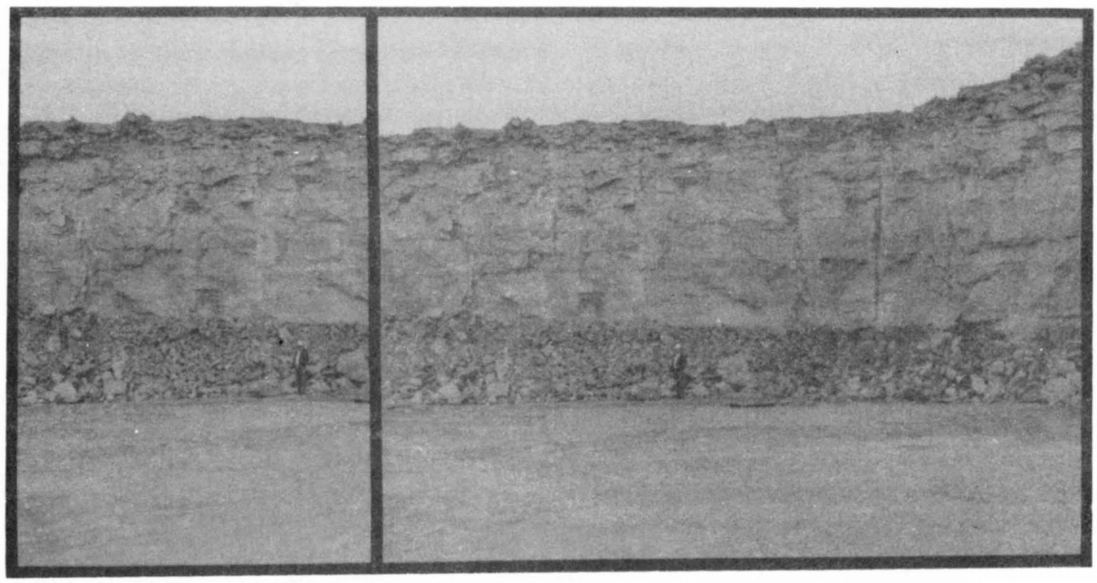


Figure 14. Raytown Limestone Member exposed in the Ash Grove quarry in the W½, sec. 24, T27S, R17E. (stereogram)

Plattsburg Limestone Formation

The Plattsburg Limestone is composed of three members which are, in ascending order, the Merriam Limestone, Hickory Creek Shale, and Spring Hill Limestone. The Plattsburg Limestone has a very limited areal extent in Neosho County (plates I and III) and varies in thickness from 25 to 50 feet (7.6 - 15.2 m). The Plattsburg has not been quarried in Neosho County due to the availability of good construction aggregate from the underlying Raytown Member of the Iola Formation and a lack of sufficient thickness and areal extent.

Merriam Limestone Member

The Merriam is a gray to dark-gray, finely crystalline, moderately fossiliferous limestone having an average thickness of 1.5 feet (.5 m). It contains very prominent vertical joints which cause the unit to appear blocky in the outcrop.

The Merriam has not been quarried in Neosho or surrounding counties; however, field observations indicate the unit would be suitable for limited local use as light type surfacing.

Spring Hill Limestone Member

The Spring Hill is a light bluish-gray to medium-gray limestone that weathers to a light tan. The Spring Hill, where present, varies from 3 feet (.9 m) to 20 feet (6.1 m) in thickness. It can generally be divided into a lower, finely crystalline thin-bedded unit having a thickness up to 12 feet (3.7 m), and an upper very thick-bedded limestone which exhibits some cross bedded oolite in the upper 2 to 3 feet (.6 - .9 m).

The Spring Hill has been quarried to the west in Wilson County. Quality test data from that location show the Spring Hill to have absorption values from 1.2 to 1.8. The unit will probably meet all KDOT specifications for construction aggregate; however, tests should be run before use from any location.

Sand and Gravel

Undifferentiated Quaternary Terrace

Fluvial chert gravel deposits ranging in thickness from a few inches to more than 12 feet (3.7 m) are found at several locations in Neosho County according to William L. Jungmann (KGS Bull. 183, 1966). These deposits flank the Neosho River southeast of St. Paul (CG + 31 and CG +32, plate VI) and cap bedrock from 100 to 120 feet (30.5 - 36.6 m) above the present flood plain. The chert is angular to subrounded, tan to brown in color and ranges in size from .5 to 2 inches (1.3 cm - 5.1 cm). These deposits are discontinuous, small in areal extent and have a heavy clay matrix. Most of those deposits are not economical to produce for any use other than local light type surfacing.

These deposits have been mapped on plates III, IV and VI.

Illinoisan Terrace

Illinoisan Terrace deposits which have been mapped on plates I, IV, and VI are discontinuous throughout the county. In areas where these terraces are found they have a thickness of about 25 feet (7.6 m) and approximately 15 feet (4.6 m) of relief above the existing alluvial flood plain. The Illinoisan terraces are composed of fine silts and clays with some fine to medium sand in the lower parts. Some areas contain small amounts of fine chert pebbles.

The terrace deposits are not considered as a source of construction aggregate in the county but were mapped as an aid to the understanding of the local geology and geologic history.

Quaternary Alluvium

Deposits of Wisconsinan and Recent ages were mapped together as Quaternary Alluvium in this report. These deposits are located along the Neosho River and its major tributaries and have been mapped on all plates. The alluvium is composed of silts and clays, fine to coarse sand and very coarse chert pebbles. The chert is generally confined to the base of the deposit in a zone with an average thickness of 3 feet (.9 m). The alluvium has a thickness that ranges from 18 to 40 feet (5.5 - 12.2 m).

A zone of chert gravel approaching 20 feet (6.1 m) in thickness is located just west of St. Paul (figure 15) and is currently being produced for construction aggregate. The material from this deposit, when mixed with the proper amounts of limestone sweetner, meets all KDOT standard specifications for construction aggregate. Difficulty will be encountered in sawing joints in concrete pavement constructed with the chert gravel aggregate.

An extensive exploratory drilling program must be undertaken to delineate the size and areal extent of these deposits within the Quaternary Alluvium due to the lack of surface manifestation.

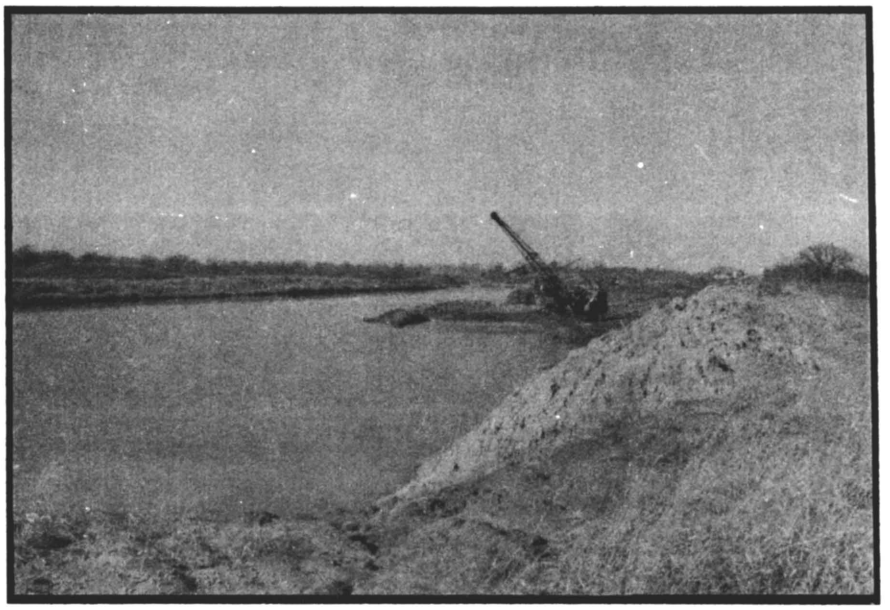


Figure 15. Chert gravel pit located near St. Paul in the SE¼, sec. 15, T29S, R20E.

Site Data Form No.	Material Type	Date of Test	Sp. Gr. Sat.	Sp. Gr. Dry	% Wear	% Soundness	% Absorption	Source of Data SHC Lab No.
Source of Material: Alluvium - Qal								
CG+10	Chert Gravel & Sand - Gravel	5-2-77	2.54 2.53 2.56	2.48 2.47	19.0	0.99	2.4 2.7 2.0	77-73
Source of Material: Iola Limestone (Raytown Mbr.) Pi								
LS+1	Limestone	2-27-75 1-23-76 2-9-77	2.64 2.66 2.64 2.66	2.60 2.61 2.63 2.60	30.0 27.0 30.0	0.96 0.97 0.96	1.7 1.5 1.8 1.0	75-145 76-46 77-89
LS+2	Limestone	2-8-60	2.47	2.38	38.7	0.96	3.61	10266
LS+3	Limestone	2-8-60	2.54 2.56	2.46 2.47	32.0 33.0	0.94 0.91	3.19 3.52	100524 73-605
LS+4	Limestone	5-17-77	2.53	2.43	38.0	0.99	3.8	77-896
LS+5	Limestone	3-20-62 6-30-60 2-21-62 11-5-64	2.54 2.57 2.55 2.56	2.46 2.50 2.47 2.48	33.6 33.8 39.8 36.2	0.93 0.95 0.97	3.21 2.66 3.08 2.82	100527 11995 21111 37421
LS+6	Limestone	4-1-66 11-3-65	2.55 2.56	2.48 2.47	36.6 36.4	0.98 0.96	2.81 3.39	66-3970 65-4880
LS+7	Limestone	2-25-60 2-23-62 5-10-77	2.56 2.46 2.56	2.49 2.34 2.48	35.1 43.3 37	0.93 0.93 0.93	3.06 4.81 3.3	10515 21112 77898
LS+8	Limestone	7-1-76 2-3-77	2.59 2.56	2.53 2.48	30 34	0.97 0.99	2.4 3.1	76-1487 77-75
LS+9	Limestone	11-16-59 12-27-61	2.53 2.53	2.46 2.46	38.8 38.1	0.97 0.99	3.04 3.10	9430 20597
LS+13	Limestone	2-4-60	2.54	2.45	41.0	0.98	3.51	10157
LS+14	Limestone	1-26-60 12-28-61 2-20-62 11-5-63 12-31-63	2.54 2.52 2.53	2.46 2.43 2.44	38.1 41.6 37.7 37.9 36.8	0.98 0.98 0.90 0.96	3.40 3.85 3.97	10156 20595 21113 31260 32147
Source of Material: Hertha Limestone Ph								
LS+15	Limestone	5-27-63 8-29-63 2-7-77	2.64 2.64 2.62	2.61 2.60 2.58	27.3 26.8 25	0.98 0.97 0.97	1.24 1.61 1.8	28396 30102 77-76
Source of Material: Altamont Limestone Pa								
LS+11	Limestone	7-3-75 1-8-76 2-3-77	2.63 2.62 2.58	2.58 2.59 2.54	27 24 27	0.98 0.98 0.98	1.7 1.3 1.8	75-1450 75-3575 77-74
LS+12	Limestone	1-26-60 2-1-62 12-31-63 1-25-65	2.61 2.62 2.56 2.61	2.57 2.58 2.51 2.58	24.6 24.4 24.6 21.3	0.98 0.99 0.98 0.99	1.70 1.52 1.99 1.16	10229 20922 32148 38411

Figure 16. Results of Tests.