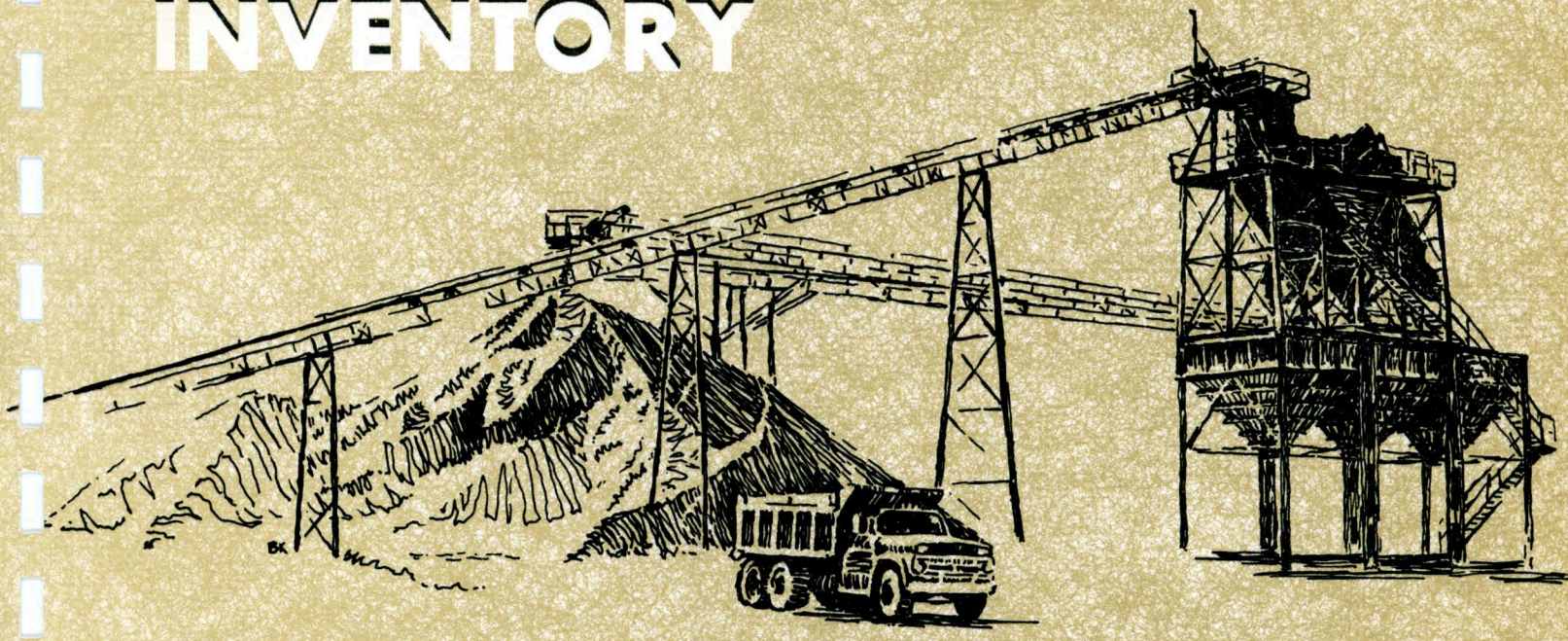
REPORT NO. 29

CONSTRUCTION MATERIALS INVENTORY



REPUBLIC COUNTY, KANSAS

DEPARTMENT OF TRANSPORTATION
KANSAS

Kansas Department of Transportation
Engineering Services Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY OF REPUBLIC COUNTY, KANSAS

by

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

1976

Construction Materials Inventory Report No. 29

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 Republic 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 represent 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 Republic County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN REPUBLIC COUNTY

TURN TO THE MATERIALS INVENTORY SECTION

See
TABULATION OF CONSTRUCTION MATERIALS
Figure 8, Page 15

for material
BY TYPE
USE COLUMN 1

For Quality Data
See Figure 15
Page 23

for material
BY INTENDED USE
USE COLUMN 2

for **DESCRIPTION** of material

Column 3 gives page of DESCRIPTION which includes engineering characteristics, approximate locations, and references to materials map.

for **AVAILABILITY** of material

Column 4 gives relative amounts available, general location, and references to materials map.

MATERIALS MAP

SEE PINK SHEET, PAGE 25

Material source units, as well as all open sites, are mapped. Each site is referenced to an individual data form.

SITE DATA FORMS

OPEN MATERIALS SITES; SAMPLED	GREEN SHEET, PAGE 28
OPEN MATERIALS SITES; NOT SAMPLED	GREEN SHEET, PAGE 48
PROSPECTIVE MATERIALS SITES; SAMPLED	GREEN SHEET, PAGE 74
PROSPECTIVE MATERIALS SITES; NOT SAMPLED	GREEN SHEET, PAGE 78

Each site data form includes a map for site location and provides information concerning landownership, material quality (if available), geologic age, and site accessibility.

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 Republic 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. Clarence W. Smith, Republic County Engineer, Donald L. Jarboe, Second District Materials Engineer, John A. Sandusky, Resident Engineer and personnel of the Remote Sensing Section, Kansas Department of Transportation.

This report was prepared under the guidance of the project leader, Robert R. Jones, P.E., Engineer of Engineering Services, A. H. Stallard, Chief, Remote Sensing Section, and Lewis D. Myers, Geologist III, Remote Sensing Section, Engineering Services Department.

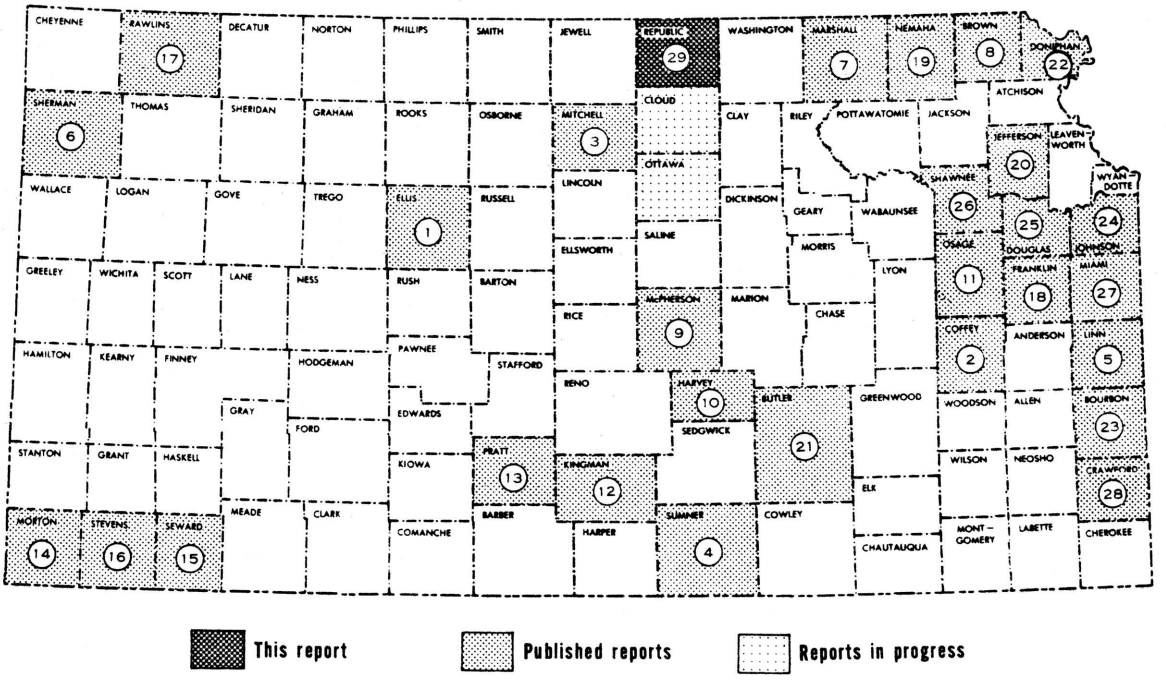


Figure 1. Index map of Kansas showing the location of Republic County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Republic County lies within the Dissected High Plains portion of the Great Plains physiographic province. Major topographic features of the county include the gently sloping upland plains and steep valley walls formed by the erosion of upper Cretaceous limestones and shales along major drainage channels, and the gently to moderately rolling land surface formed by the erosion of the Dakota Formation.

The Republican River and its tributaries drain most of the county; however, the northeast corner is drained by small streams flowing northeastwardly into Nebraska and eastwardly into Washington County.

Sources of construction material in Republic County are limited to sand and gravel deposits in the alluvium of the Republican River valley and sand deposits of the Meade Formation. Limestones of the Greenhorn Formation are too thin to be of value as construction aggregate. Untested calcite cemented sandstones have been located in the southeast corner of the county; however, the extent of these deposits is unknown.

Moderate quantities of water are available in the alluvial and terrace deposits of the Republican River valley; however, in some areas the water contains a high nitrate content. A limited water supply is available in the alluvium of smaller streams; however, the chloride content is high in areas where the Dakota Formation is encountered. Moderate quantities of good quality water are produced from sand and gravel deposits of the Meade Formation. Consolidated rock aquifers yield minimal quantities of water which is generally satisfactory for domestic use; however, water from limestone formations may contain high concentrations of nitrate, bicarbonate, or iron; and water from sandstones generally has a high chloride content.

GENERAL INFORMATION SECTION

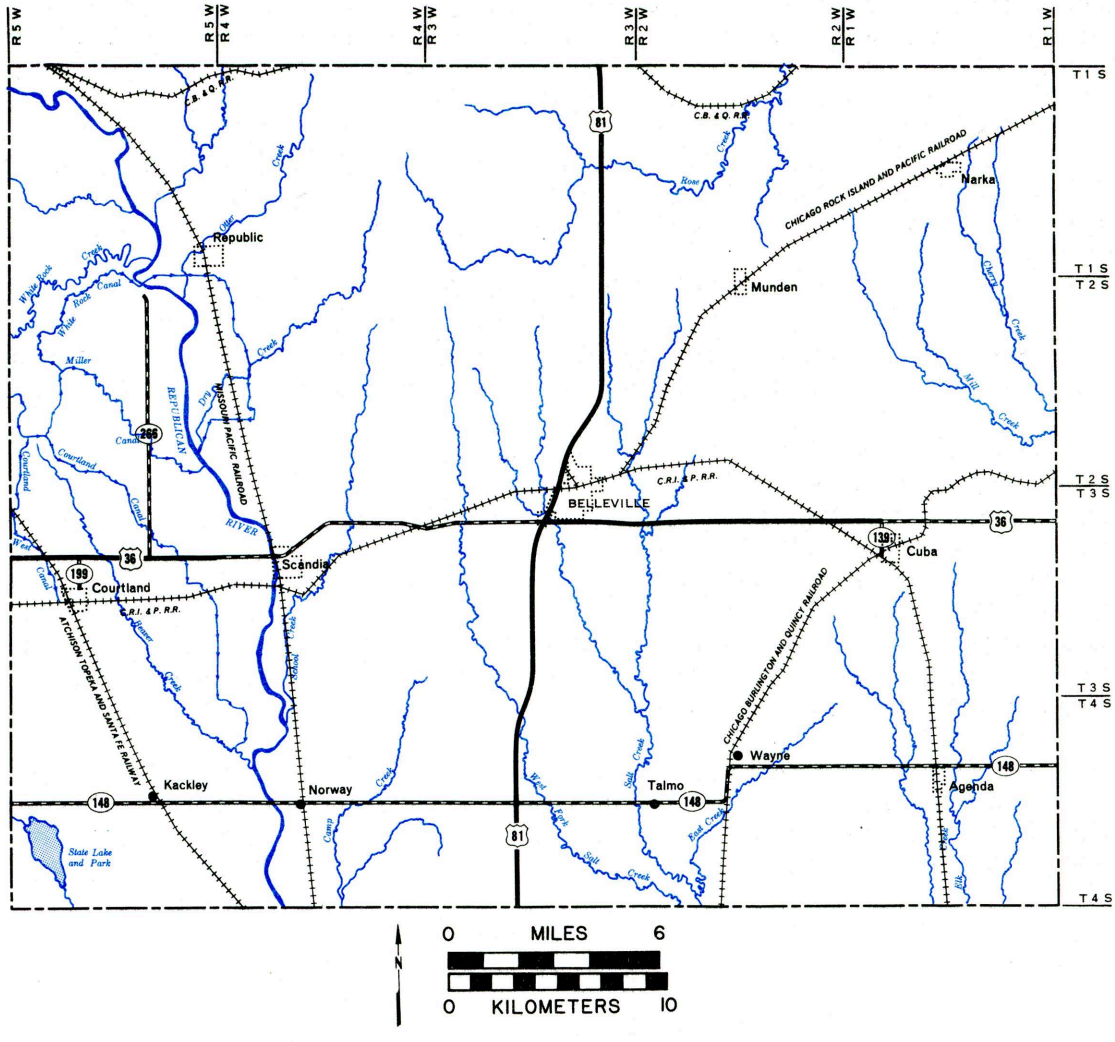


Figure 2. Drainage and major transportation facilities in Republic County

FACTS ABOUT REPUBLIC COUNTY

Republic County is located along the Nebraska border in northcentral Kansas, and has an approximate area of 719 square miles (1,862 square kilometers). In 1975, the population of the county was 8,272, according to the Kansas State Board of Agriculture.

The highest element of topography, which is 1,680 feet (512 meters) above sea level, is located along the crest of drainage divides in the northcentral part of the county. The lowest point of elevation, which is 1,320 feet (402 meters) above sea level is located where Elk Creek leaves the county near the southeast corner. The geographic location of Republic and other counties currently in the construction materials inventory program is shown in Figure 1 on page v.

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 Republic 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 Republic 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 (1cm = 240 meters) was accomplished. Figure 3 illustrates aerial photographic coverage of Republic 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 classifications of open sites were confirmed, and prospective sites were observed.

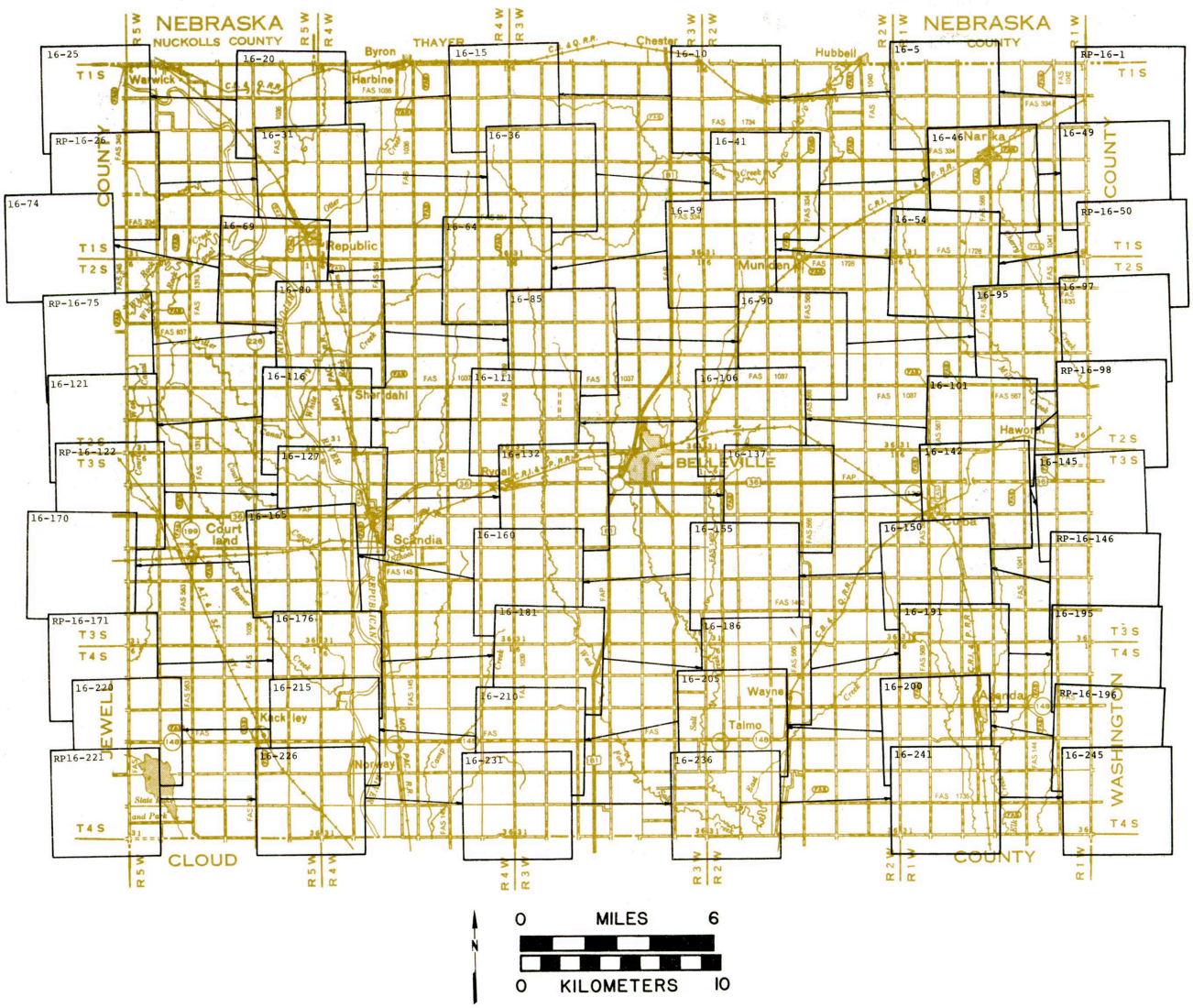
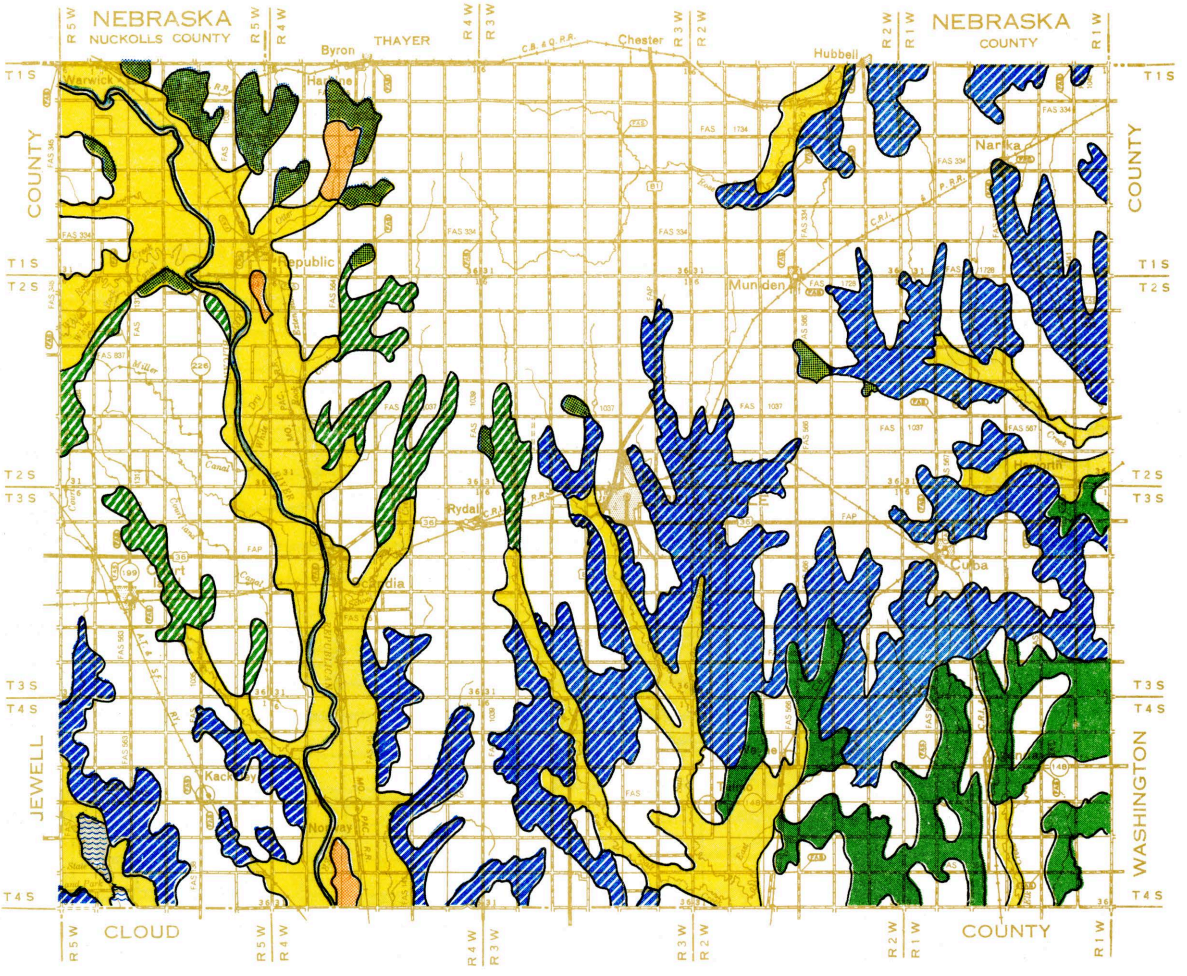
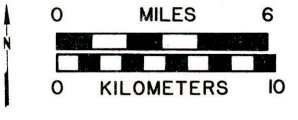


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Republic County. The numbers refer to photographs taken by the Photogrammetry Section, Kansas Department of Transportation, on 11-14-75 at a scale of 1"=2000'. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION





LEGEND

- Alluvium
- Dune Sand
- Wisconsinan Terrace
- Loess
- Carlile Shale
- Greenhorn Limestone
- Dakota Formation

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 Republic 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 Republic County.

Although no wells drilled in Republic County have penetrated the Precambrian, information from wells in neighboring counties indicates the Precambrian rocks are composed of granites and quartzitic sediments (Merriam, 1963).

Paleozoic sediments consisting of limestones, sandstones, and shales and ranging in age from Cambrian to Devonian and Pennsylvanian to Permian overlie the Precambrian rocks in the county. Rocks of Mississippian age are believed to be absent in Republic County (Wing, 1931). Any sediments which may have been deposited during Mississippian time were subsequently removed by erosion during the emergence of the land surface at the end of Mississippian time. In Republic County, Pennsylvanian sediments consisting of alternating marine shales and limestones have an approximate thickness of 1,300 feet (396 meters) (Fishel, 1948). Permian deposits consisting of marine shales, anhydrite, gypsum, salt, limestone, and non-marine red beds overlie the Pennsylvanian sediments.

An uplifting of the land surface during the close of Paleozoic time and the beginning of Mesozoic time brought about an erosional cycle which is thought to have lasted into Cretaceous time. This erosional period removed any sediments which may have been deposited during Triassic, Jurassic, or early Cretaceous time (Wing, 1931). During late Cretaceous time, fresh water or marginal sea sediments of the Dakota Formation were deposited. Gradual subsidence during this period allowed the seas to advance over the Dakota Formation and deposit the Graneros Shale, Greenhorn Limestone, and Carlile Shale Formations in Republic County. The Dakota Formation, consisting of shales and sandstone lenses, is the oldest rock unit exposed in the county.

The Graneros Shale was deposited in a sublittoral environment as the seas advanced over the Dakota sediments. The contact between the units is difficult to determine due to the transitional nature of the deposits near the contact. The Greenhorn lies disconformably on the Graneros Shale over most of western Kansas; however, in Washington County just to the east of Republic County, the contact is nearly conformable (Hattin, 1975). The top of the Greenhorn is generally described as the top of the Fencepost Limestone bed due to its ease of recognition in the field. The Greenhorn Formation is overlain conformably by the Carlile Shale which has a similar lithology.

ERAS	PERIODS	ESTIMATED LENGTH IN YEARS	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE)	1,500,000	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		Alluvium		Qal	0-100'± (0-30.5m)	Silt, clay, sand, sand and gravel. Sand and gravel composed of quartz, chert, and limestone gravel.	Bituminous aggregate, light type surfacing, concrete aggregate if sweetner added to pass wetting and drying test.
				Dune Sand		Qds	0-80'± (0-24.4m)	Cross-bedded, tan to gray fine-grained quartzitic sand.	Limited use as mortar sand.
		Wisconsinan Stage		Wisconsinan Terrace		Qt	0-50'± (15.2m)	Silt, clay and scattered lenses of sand and gravel.	Light type surfacing. Use limited by size of deposits.
				Peorian Loess			0-30'± (0-9.1m)		
		Illinoisan Stage		Loveland Loess			0-100'± (0-30.5m)		
		Kansan Stage		Meade Formation		Qm	0-120'± (0-36.6m)	Cross-bedded lenses of quartzitic sand and gravel, scattered lenses of silt, clay and fine sand. Color tan gray to rust brown.	Where the material meets gradational requirements it is acceptable as construction aggregate.
Cretaceous	Upper Cretaceous			Carlile Shale	Blue Hill Shale Mbr.		0-230'± (0-70.1m)		
					Fairport Chalk Mbr.				
				"Fencepost Is Bed"	Pfeifer Shale Mbr.			Alternating thick shales and thin limestones with scattered seams of bentonite. Limestones are gray to tan gray and weather yellowish brown. Abundant fossil clam shells and some sharks teeth found throughout. The Fencepost bed weathers with a rust-brown streak thru the center portion of bed. Shellrock and Fencepost beds case harden on exposure.	Fencepost and Shellrock beds suitable for building stone but too thin for economical production of construction aggregate.
				"Shellrock Bed" Greenhorn Ls.	Jetmore Chalk Mbr.	Kg	68-75'± (20.7-22.9m)		
					Lincoln-Hartland Mbr.				
				Graneros Shale			10-30'± (3.1-9.1m)		
	Lower Cretaceous			Dakota Formation		Kd	100-300'± (30.5-91.4m)	Shale with thin to massive layers of cross-bedded sandstone. Sandstone lenses are tan to tan gray, brown, and reddish brown. Some iron stains. Bentonite seams. Iron and calcite cementation.	Calcite cemented sandstone appears suitable for construction aggregate.

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

According to Lohman, early Cenozoic time was a period of uplift and erosion. This erosional period removed any sediments which may have been deposited during early Tertiary time (Fishel, Lohman, and Stoltenberg, 1948), and left a major hiatus between the Cretaceous sediments and deposits of the Quaternary. Materials which may have been deposited during late Tertiary time were probably removed by post-Pliocene erosion.

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	45,000	55,000
		Sangamonian Interglacial	135,000	190,000
		Illinoisan Glacial	100,000	290,000
		Yarmouthian Interglacial	310,000	600,000
		Kansan Glacial	100,000	700,000
		Aftonian Interglacial	200,000	900,000
		Nebraskan Glacial	100,000 +	1,000,000 +

Figure 6. Geologic timetable of the Quaternary Period.

Events that occurred during the Quaternary Period of the Cenozoic had a profound influence on the construction materials resources of Republic County. Such events included the aggradation and degradation of major streams, deposition of loess and major drainage changes that occurred during late Pliocene or early Pleistocene time.

During early Pleistocene time the ancestral Republican River flowed in a northeasterly direction, entering the county some 10 miles (16 kilometers) north of Courtland and leaving the county directly north of Belleville near Chester, Nebraska on the state line. An early Pleistocene glacier blocked the northeastwardly flowing river (Fishel, Lohman and Stoltenberg, 1948) causing the deposition of a blanket of sand, gravel, silt, and clay over much of the northern half of Republic County. Early studies by Wing and by Fishel, Lohman, and Stoltenberg referred to this deposit as the "Belleville Formation" of Kansan age. Literature of this period equated the "Belleville" with the Grand Island Formation. Following a study of Pleistocene geology by Frye and Leonard (1952), the "Belleville" has been reclassified as a part of the Meade Formation.

The damming of the ancestral Republican River by glacial ice caused the river to change its course to the south creating the present day drainage pattern. Erosion during the Pleistocene exposed Cretaceous sediments ranging from the Dakota through the Carlile Formation. Terrace Deposits were formed in the drainage valleys and then incised by recent surface water erosional processes. During the Pleistocene, loess was deposited over most of the county. In some areas its thickness is in excess of 100 feet (30.5m). Sand dunes were formed from reworked river deposits and from the Meade Formation.

GEO–ENGINEERING

This section provides a general appraisal of the geo–engineering problems that may be encountered in Republic 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 in design and construction procedures.***

Geo–engineering problems in Republic County are associated with alluvium and terrace deposits of the major drainage channels; limestone, sandstone, and shale outcrops along valley walls; and thick deposits of loess which cap the upland areas. Additional geo–engineering problems can be expected in the limited areas where dune sand is located.

Limestone outcrops are found in most of the steeper valley walls along drainage channels. These outcrops are composed of alternating thin limestones, thick limy shale and shale beds along with associated thin seams of bentonite. Moderate amounts of rock excavation can be expected in areas where the limestones and unweathered shales outcrop. Additional rock excavation will be encountered in areas where calcite and iron cemented sandstones of the Dakota outcrop. The iron cemented sandstones tend to case harden upon weathering which may cause difficulty in their removal.

Shales of the Dakota, Graneros, and Greenhorn formations contain thin seams of bentonite which vary in thickness from .01 to .5 feet (.3 cm to 15.2 cm). Failure to remove or modify the bentonite seams may result in slope failures such as have developed in sec. 1, T3S, R1W. This failure is shown in the following sterogram.

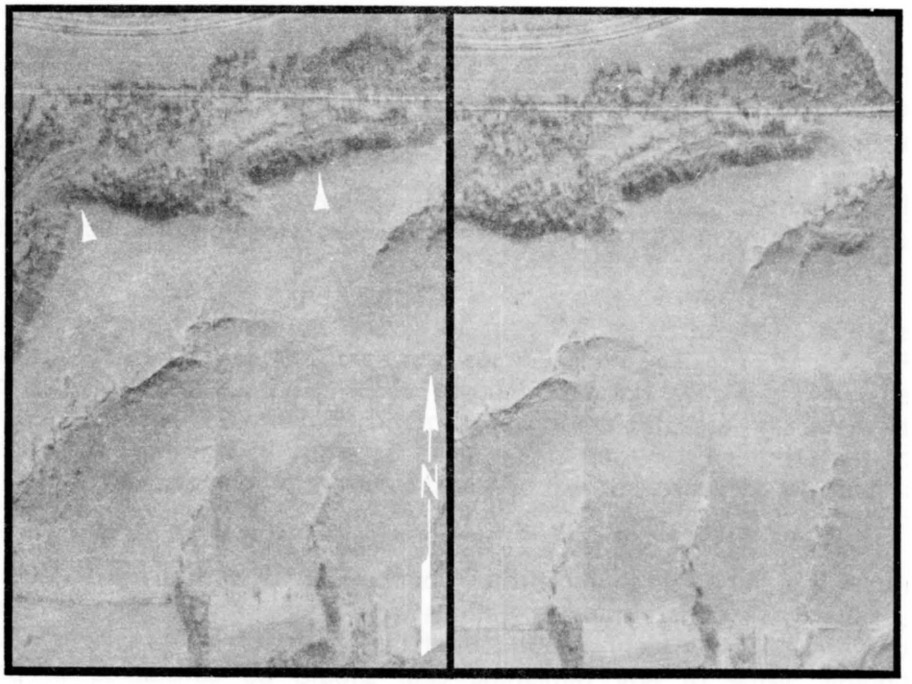


Figure 7. Slope failure in Graneros Shale, sec. 1, T3S, R1W.

Thick loess deposits cap the higher terrain in the northern half of the county with thinner deposits located over much of the remainder of the county. Cuts in the loess will be common excavation and the material can provide select borrow for embankment and subgrade construction. The plasticity index for most of the loess deposits will be in the 20 to 30 range; however, in some areas such as site Si + 4, located north of Scandia, the P.I. ranges from 3 to 5 and is usable as mineral filler.

The alluvium and terrace deposits encountered in the Republican River valley and its major tributaries are composed of silt and clay with lenses of sand and gravel. Cut off meanders containing unconsolidated and organic material are located in the flood plains and terraces. 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.

Hydrology problems of a limited nature can be anticipated along bentonite seams, limestones, bedrock-soil mantle contacts, and buried soil profiles. Additional problems may be encountered in sandstones of the Dakota Formation and in limited areas where coal beds are encountered. A perched water table is encountered in much of the upland area west of the Republican River (Fader, 1968). An excessive amount of water was observed by the author in sections 7 and 8, T1S, R5W. Drainage ditches were being dug in this area to relieve

the problem by lowering the water table. A high water table will present problems when trying to obtain borrow. Slope stability problems may arise in cut or fill sections because of reduced shear strength of saturated soils.

Sand dunes located in the Republican River valley and northeast of the town of Republic may present a construction hazard due to severe wind erosion when vegetation is removed.

Water supplies from less than 10 gpm to several hundred gpm are available from aquifers in Republic County. The alluvial deposits of the Republican River and the sand and gravel deposits of the Meade Formation north of Belleville are the highest producing aquifers with generally acceptable mineral contents. Small yield wells produce from sandstones of the Dakota Formation. These wells generally have a high mineral content which limits their use. All sources should be tested for objectionable mineral content before use in construction.

Lignite coal was mined in southcentral Republic County and along the Republican River valley. These were shaft mining operations which have been inoperative for over 40 years. The coal deposits are highly erratic in thickness and areal extent; however, the possible economic value of any remaining coal should be considered in proposed construction. Associated underclay may be a construction hazard due to its highly plastic nature.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Sand and gravel deposits of Quarternary age make up the major portion of the available construction materials of Republic County. Loess deposits of Quaternary age are also found in the county and in some areas the plasticity index is low enough to permit the use of the material as mineral filler.

Limestones of Cretaceous age are found in the county; however, the thin nature of the limestone units within the Greenhorn Formation limit the use of this material to light type surfacing and as a minor source of building stone. Small deposits of calcite cemented sandstone of the Dakota Formation are found in the Agenda area. Limited tests and field observations indicate the material might be suitable as construction aggregate; however, the full extent of these deposits has not yet been defined.

Construction materials types, their uses, and availability are tabulated in figure 8. Test results from a limited amount of sampling and testing are presented in figure 15, page 23.

CONTENTS
MATERIALS INVENTORY SECTION

TYPE material and Geologic Source	USE	Page	AVAILABILITY
SANDSTONE **Dakota Formation**	Concrete and bituminous aggregate and light type surfacing.	16	Limited source in southeastern part of the county near Agenda. Plate 9.
LIMESTONE **Greenhorn Limestone Formation**	Light type surfacing. Fencepost member suitable for building stone.	17	Moderate source in southern and eastern half of the county. Plates 2-9.
SAND AND GRAVEL Meade Formation	Concrete and bituminous aggregate and light type surfacing with proper processing.	20	Moderate source in northern half of the county. Limited outcrops. Plates 1-6.
Wisconsinan Terrace	Light type surfacing.	21	Very limited source along major drainage channels. All plates.
Dune Sand	Used as sweetner or mortar sand.	22	Limited source in western third of the county. Plates 1, 4, and 7.
Quaternary Alluvium	Concrete and bituminous aggregate and light type surfacing.	22	Moderate source along Republican River. Plates 1, 4, and 7.

Figure 8. Tabulation of the construction materials types and their availability in Republic County.

DESCRIPTION OF CONSTRUCTION MATERIALS

Sandstone

Dakota Formation

The Dakota Formation of Cretaceous age is the oldest geological unit that crops out in Republic County. It underlies the entire county but is exposed in only the southeastern part.

The formation is composed predominately of shale with thin to massive layers of cross-bedded sandstone. The total thickness is estimated at 150 feet (45.7 meters) (Byrne, 1948); however, few outcrops exceed 50 to 60 feet (15 to 18 meters). The shales vary in color from light to dark gray, tan, brown, and are often iron stained red. Thin seams of bentonite are found scattered throughout the unit. Salt and gypsum are also found in varying amounts throughout the shale. Beds of lignite coal having thicknesses up to two feet (.6 meters) are also found in the formation.

The sandstone lenses are light to tan gray, brown, and sometimes reddish brown to red. The thickness varies from a few inches to many feet and the areal extent is highly variable. The sandstones are generally composed of fine to coarse quartz grains, which are cemented with calcium carbonate, iron oxide, or in isolated instances, silica (Byrne, 1948). The degree of cementation ranges from a very loosely cemented sand to a very dense hard cemented sandstone. The author did not observe any silica cemented sandstone during the course of the investigation.

The iron cemented sandstones have been used as light type surfacing in the area; however, due to poor durability of the stone, it is not suitable as a construction aggregate. Calcite cemented sandstone such as is found in the area near Agenda (Ss-45) appears from field observations and very limited testing (Byrne, 1948) to be useful as construction aggregate.

The deposits appear to be limited in extent; however, test drilling will be needed to accurately determine the limits of the deposit. Additional quality tests should also be completed on the material before use due to the highly variable nature of the Dakota Formation.

Due to the poor exposure pattern, cover by loess and terrace deposits, and the erratic nature of the sandstone deposits, the Dakota Formation was not mapped. Specific prospective materials sites are located on plate 9. The Dakota Formation outcrops to the south and east of the base of the Greenhorn Limestone which is mapped on plates 2 thru 9.

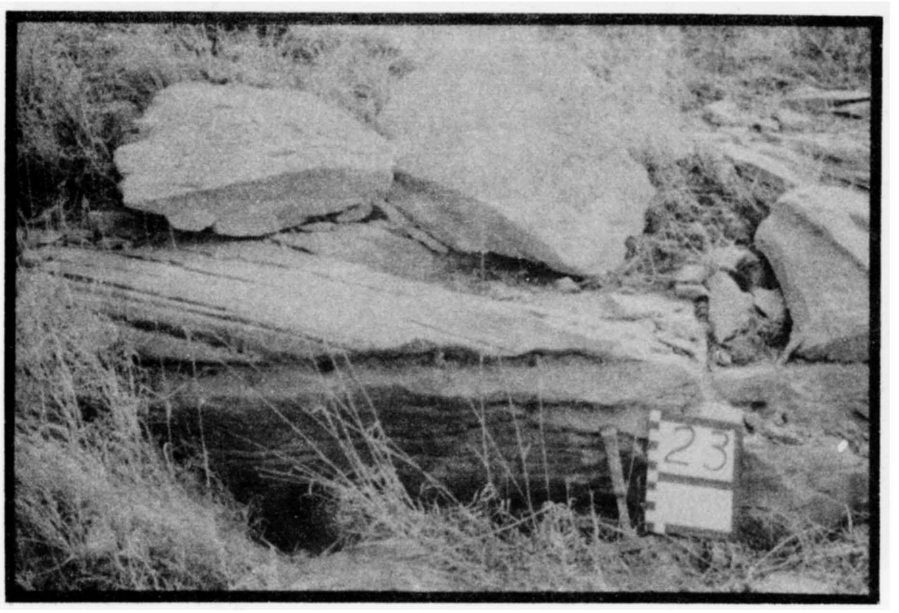


Figure 9. Calcite cemented sandstone in the Dakota Formation located in the NW ¼, sec. 28, T4S, R1E, Republic County, Kansas.

Limestone

Greenhorn Limestone

The Greenhorn Limestone Formation of upper Cretaceous age is composed of four members which are, in ascending order, the Lincoln Limestone, Hartland Shale, Jetmore Chalk, and Pfeifer Shale. The formation has been mapped as a single unit for this report and the exposure pattern of the formation is shown on plates 2 thru 9. The total thickness of the formation in the county varies from 68 to 75 feet (21 to 23 meters).

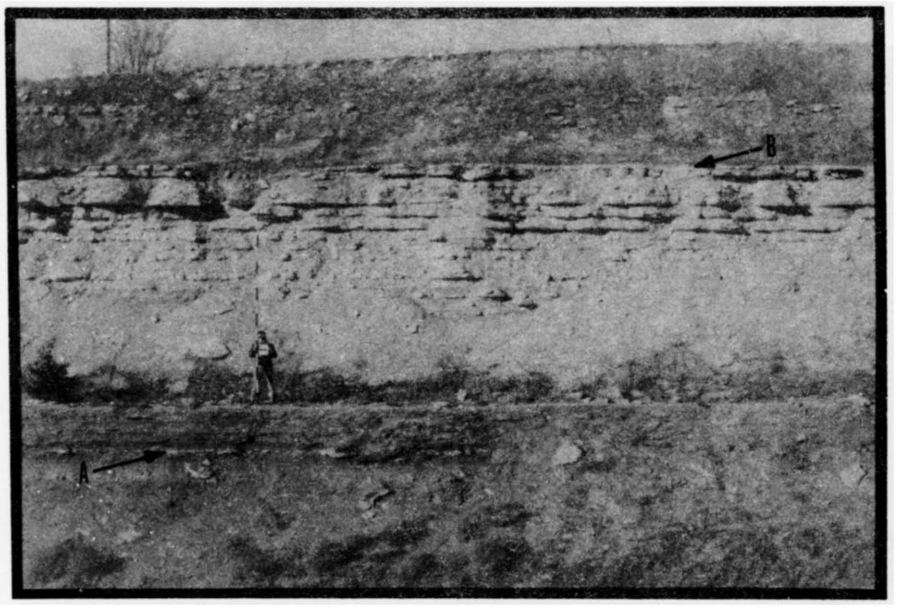


Figure 10. Greenhorn Limestone Formation from lower Lincoln Limestone (A) to the Shellrock bed (B) in road cut located in the SW ¼ sec. 1, T3S, R1W, Republic County, Kansas.

The undifferentiated Lincoln Limestone and Hartland Shale members consist of alternating beds of shale, thin limestone, and seams of bentonite and have an approximate thickness of 40 feet (12.2 meters). The shales are thin bedded, buff to gray blue and calcareous. Thin beds of limestone are more numerous in the lower part and are crystalline and hard. They are tan gray to dark gray, weathering to buff or light gray. The freshly broken surface of the Lincoln Limestone yields a petroliferous odor. The Lincoln Limestone should not be confused with the term "Lincoln Quartzite" which is a calcite cemented sandstone of the Dakota Formation. Limited invertebrate fossils, fossilized sharks teeth, and fossil vertebrate of bony fish have been collected from the Lincoln-Hartland zone (Byrne and others, 1948). Abundant thin beds of bentonite varying in thickness from 0.01 to 0.5 feet (.3 cm to 15 cm) in thickness are found throughout the Lincoln-Hartland zone. The unweathered bentonite is white to light gray, contains limonite stains and weathers to an orange gray.

The Jetmore chalk member is composed of thick layers of tan-gray to blue-gray, chalky shale interbedded with thinner layers of yellow-tan, chalky limestone. Abundant fossil clam shells are found throughout the member. The uppermost chalk member is commonly called the "Shellrock bed" because of the numerous fossil clam shells.

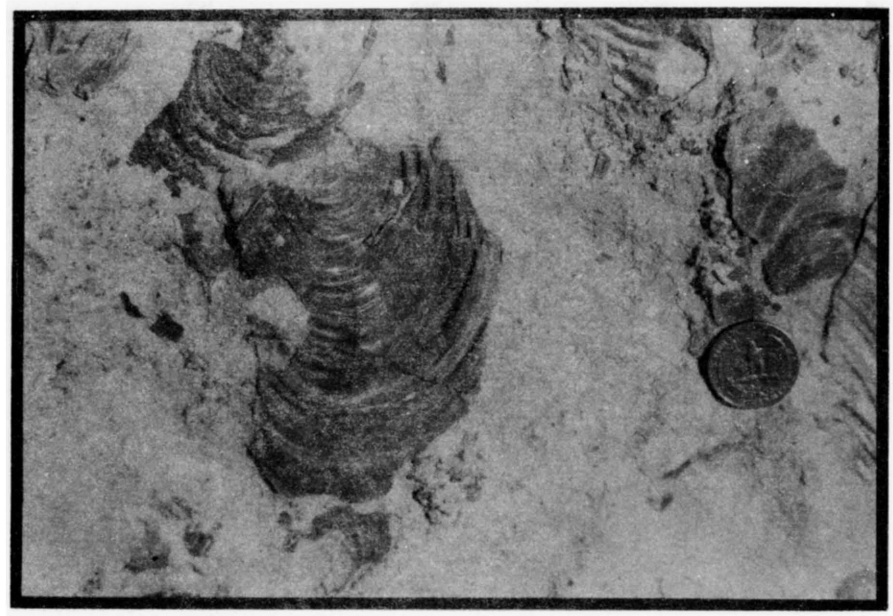


Figure 11. Fossil clam shells in the "Shellrock bed" of the Jetmore Chalk Member, SW ¼, sec. 1, T3S, R1W, Republic County, Kansas.

The "Shellrock" is a prominent outcrop forming ledge approximately one foot (.3 meters) thick. The unweathered rock is soft but it case hardens when exposed to the elements and forms a hard durable surface. The "Shellrock" has been used as building stone and for fenceposts in Republic County. The total thickness of the Jetmore chalk is approximately 20 feet (6.1 meters).

The uppermost member of the Greenhorn Limestone is the Pfeifer Shale. It consists of thick beds of chalky shale alternating with thinner beds of chalky limestone. The total thickness of the member is about 20 feet (6.1 meters). Shale units contained within the Pfeifer are chalky, tan gray to yellowish gray, fossiliferous and thin bedded. Thin seams of bentonite occur within the shale and are generally a white or light gray which weathers to a rust orange gray. The "Fencepost Limestone bed" is the topmost unit of the Pfeifer Shale and has a thickness of about one foot (.3 meters). The Fencepost is a good terrace forming ledge approximately 20 feet (6.1 meters) above the "Shellrock bed". It is fossilferous and easily distinguished by a characteristic rust brown band in the center portion of the ledge. The unit case hardens on exposure and produces a very useful and distinctive building stone.

Figure 12. Typical Fencepost Limestone quarry located in the NW ¼, sec. 36, T3S, R2W, Republic County, Kansas.

The Greenhorn Formation has been used locally as light type surfacing and as building stone but the limestone beds are too thin to be useful as construction aggregate. The exposure pattern of the Greenhorn has been mapped on plates 2 thru 9.

Sand and Gravel

Meade Formation

The Meade Formation was probably deposited as a result of the damming of the ancestral Republican River by a glacier of early Pleistocene age. Sediments deposited were primarily derived from reworked material from the west; however, pebbles of quartzite indicate that some glacial outwash was also a source of sediments (Bryne, 1948).

The Meade Formation includes cross-bedded lenses of quartzitic sand and gravel, with scattered lenses of clay, silt, and very fine sand. The color of the deposit varies from tan gray to rust brown. Thickness of the formation varies from 0 to in excess of 100 feet (30.5 meters) and averages 30 to 40 feet (9.1 to 12.2 meters) along the northern edge of Republic County (Bryne, 1948). A water well near Chester, Nebraska is reported to have penetrated 120 feet (36.6 meters) of the formation. The formation was not mapped because of very limited exposures; however, it has been tested and the results are shown in figure 15, page 23.

Figure 13. Exposed Meade Formation located in the NW ¼, sec. 22, T2S, R3W, Republic County, Kansas.

Wisconsinan Terrace

Terrace deposits of Quaternary Age are present in most of the stream valleys in Republic County. Although there is more than one terrace in some areas of the Republican River valley, all terrace deposits have been mapped as Wisconsinan Terraces. The terraces consist predominately of silt and clay; however, some lenses of cross-bedded sand and gravel are found within the deposits. The thickness is estimated to range from 10 to 50 feet (3 to 15.2 meters). The terraces are of little or no economic value as construction aggregate; however, limited quantities of silt would probably meet specifications for mineral filler. Terrace deposits are mapped on all plates.

Sand and gravel from the Republican River valley is classified as a reactive aggregate by the Kansas Department of Transportation. Siliceous aggregate from this source when used with cement is highly susceptible to expansion, cracking, and distress in concrete. The cement reacts with the silica which then hydrates to produce a silica gel that causes the concrete to expand and deteriorate. To alleviate these problems prescribed amounts of sweetner such as limestone, sandstone, or specified sand and gravel must be added to meet K.D.O.T. standard specifications.

The thickness of the alluvium in the Republican River valley varies from a few feet to more than 100 feet (30.5 meters) in the vicinity of Norway. The thickness of the alluvium in other stream valleys is generally less than 50 feet (15.2 meters), and is composed primarily of silt with only scattered deposits of fine sand contained within. The alluvium has been mapped on plates 1, 4, and 7.

Dune Sand

Dune sand of recent age and of undetermined thickness occurs in the Republican River valley and along Otter Creek northeast of Republic. These eolian deposits are composed primarily of fine quartz grains. The dunes are cross bedded, tan gray to tan in color and range up to 50 feet (15.2 meters) in elevation above the surrounding topography. Use of the dune material is very limited due to its well sorted, fine gradation. Dune deposits are mapped on plates 1, 4, and 7.

Quaternary Alluvium

The alluvium of the Republican River valley is an excellent source of large quantities of granular material ranging from silt to gravel size. The sand and gravel is composed of quartz, feldspar, calcite, chert, limestone fragments, and minor particles of igneous rocks. A large volume of the sand and gravel which has been used in Republic County has been produced by pumping operations located near Scandia. The alluvium has been mapped on plates 1, 4 and 7.

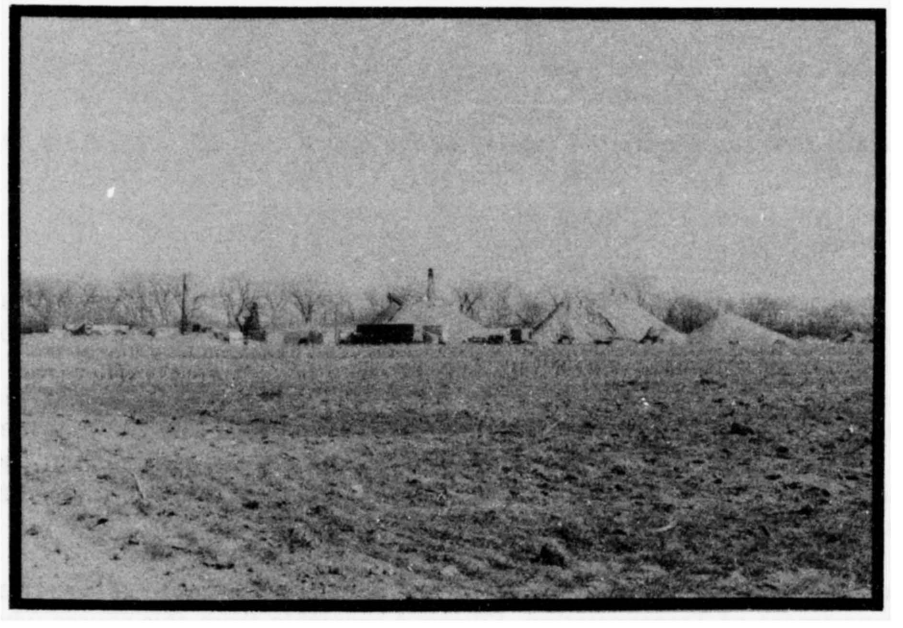


Figure 14. Sand plant located in the W ½, sec. 17, T3S, R4W, Republic County, Kansas.

Site Data Form No.	Material Type	Date of Test	Percent Retained									Wash	G.F.	Sp. Gr. (Sat.)	Sp. Gr. (Dry)	Weight Cu. Ft.	% Wear	% Soundness	% Absorption	Source of Data KDOT Lab No.	Type of Sample
			1½	3/4	3/8	4	8	16	30	50	100										
Source of Material: Wisconsinan Terrace-Qt																					
SG + 1	Sand-Gravel	4-72			0	1	2	5	13	53	95	8.0	1.69	2.58(I)			32(D)	.99	.68(I)	72-720	
			0	4	6	14	27	43	60	80	94	2.8	3.28	2.60(II)					.30(II)		
Source of Material: Dune Sand-Qds																					
SG + 2	Sand-Gravel	2-71			0	3	9	20	42	86	96		2.56								
					0	3	8	16	30	70	97		2.24								
					0	6	10	20	48	84	98		2.66								
Source of Material: Loess-Ql																					
Si + 4	Silt	3-71					0	1	1	1	1	96	.04								
									0	1	1	97	.02								
										0	1	98	.01								
									0	1	1	97	.02								
							0	1	1	1	2	95	.05								
Source of Material: Alluvium-Qal																					
SG + 5	Sand-Gravel	11-71		0	1	8	35	75	88	93	94	5	3.94	2.57			34(D)	.97	.91	68-230	Stockpile
			0	2	9	33	69	91	96	98	99	1	4.92								
SG - 6	Sand-Gravel	2-71	0	1	4	13	31	55	75	93	99		3.71							65-3997	
				0	1	7	24	49	73	94	98		3.46	2.59			33(D)	.97	.40	65-4040	
SG + 7	Sand-Gravel	1-75		0	4	17	45	79	95	98	99	1	4.37							70-275	
				0	1	10	30	58	81	96	99		3.75	2.55(I)			39(D)	.99	.80(I)	74-269	
														2.60(II)					.30(II)		
SG + 8	Sand-Gravel	2-71	0	1	4	13	31	55	75	93	99		3.71							65-3997	
				0	1	7	24	49	73	94	98		3.46	2.59			33(D)	.97	.40	70-275	
Source of Material: Belleville Formation-Qb																					
SG + 9	Sand-Gravel	2-71				0	2	5	11	20	30	59	.70	2.61		108.1	29(D)	.98		56181	
				0	1	4	21	45	73	92	97	2	3.33							62664	
SG + 10	Fine Sand & Sand-Gravel	4-72		0	1	5	20	44	64	85	94	5	3.13								
SG + 11	Sand-Gravel	2-71					0	4	14	24	36	37	.78	2.59		102.8	36(D)	.96		62071	
				0	1	3	16	42	69	88	94	4	3.13								
SG + 12	Sand-Gravel	2-71					0	1	8	14	26	42	.91								
				0	1	3	16	42	72	82	91	1	3.07								
SG + 13	Sand-Gravel	11-75			0	1	4	17	46	81	90	9	2.39	2.60(II)			49(D)	.96	.30	75-1092	
			0	2	2	4	17	43	64	81	90	8	3.03								
SG + 14	Sand-Gravel	11-75			0	1	5	21	47	76	89	9	2.39	2.56(I)			44(D)	.97	.80(I)	75-1091	
					0	5	28	61	82	92	95	4	3.63	2.60(II)					.30(II)		
SG + 16	Sand-Gravel	2-71					0	2	5	15	34	57	.56								
			0	2	6	10	22	46	68	80	90	9	3.24								
Source of Material: Dakota Formation-Kd																					
Ss + 15	Sandstone	2-71								0	10		.10								
									0	1	89		.90								

NOTE: (I) Coarse Aggregate
(II) Intermediate Aggregate

Figure 15. Results of tests completed on samples of material from the various source beds in Republic County.