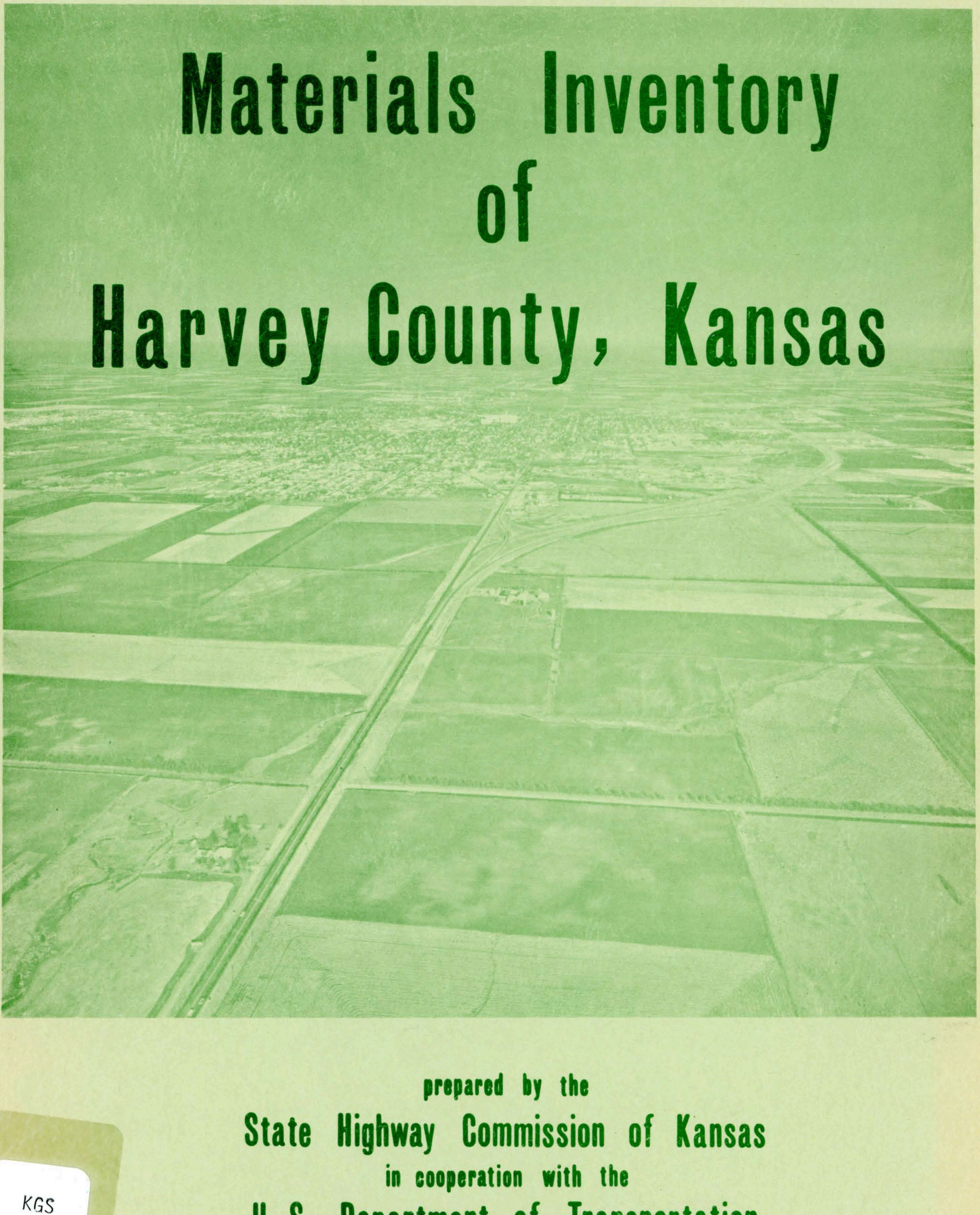
Materials Inventory of Harvey County, Kansas



prepared by the

State Highway Commission of Kansas

in cooperation with the

U. S. Department of Transportation

Federal Highway Administration

Bureau of Public Roads

State Highway Commission of Kansas
Planning and Research Department - Photronics Department

MATERIALS INVENTORY OF HARVEY COUNTY, KANSAS

BY

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

1966

Materials Inventory Report No. 10

COVER - An aerial view of Newton, Kansas, county seat of Harvey County.

SUGGESTED USE OF THE REPORT

The *Materials Inventory of Harvey County* is the tenth report of a series of county materials inventories prepared by the State Highway Commission of Kansas in cooperation with the Bureau of Public Roads. The report includes: 1. an introduction which describes the nature of the report and gives general information concerning Harvey County; 2. an explanation of the procedures used in compiling the information contained herein; 3. a brief explanation of the origin of the geologic units that are source beds for construction materials in the county, and a detailed description of the materials which have been produced from these units; 4. a geo-engineering section to acquaint the engineer with geologic problems which may be encountered in highway construction; 5. county materials maps (plates I through IV) which show the geographic locations where the various source beds can be found in the county, along with the locations of all open and prospective material sites; 6. appendix I through IV which contain site data forms for each open and prospective materials site. Each site data form has a sketch showing the material site and surrounding landmarks, the name of the landowner, the name of the geologic source bed, and a resume' of all test data available for the site.

When this report is used as a guide for planning an exploration program or making an assessment of the material resources of Harvey County, the reader may find the following suggestions helpful.

After becoming familiar with the nature of the report, the reader may wish to refer to the section "Construction Material Resources of Harvey County." In this portion of the report, a geologic history of

Harvey County is presented which describes the geologic events that led to the deposition of the various source beds and sets forth the geologic nomenclature used throughout the report. The construction material resources of Harvey County are also inventoried in this portion of the report. A study of the inventory will reveal the type of materials available in the county, their geologic source beds, the localities where they are found, and a description of their engineering properties.

When the reader has determined which geologic source bed may contain material that will meet his requirements, he should then refer to the county materials maps. From these maps, he can find the best areas in which this bed is present, the locations of sites which have produced material from this source, the locations of prospective sites in this source bed, and references to site data forms for each open and prospective site.

For example, the reader determines from the study of the Construction Materials Inventory that sand and gravel in the Grand Island Formation may fulfill the materials specifications for a project in the southwestern part of the county. The materials map (plate III) shows several pits in this area. If the reader is interested in site $\frac{\text{SG+23}}{\text{Qsgi}}$, he refers to appendix II where detailed information about this particular site is given on a site data form. This information will enable him to plan his exploration program in an orderly fashion.

PREFACE

This is one of a series of county construction materials reports compiled as a product of the Highway Planning and Research Program, Project 64-6, "Materials Inventory by Photo Interpretation," a co-operative effort between the Bureau of Public Roads and the State Highway Commission of Kansas financed by Highway Planning and Research funds. The materials inventory program was initiated to provide a survey of all existing construction materials in Kansas on a county basis to help meet the demands of present and future construction needs.

The objectives of the program are to map and describe all materials source beds in the respective counties and to correlate them with geologic nomenclature for classification purposes. The program does not propose to eliminate field investigations, but it should substantially reduce and help to organize field work.

Previous to this time, no extensive or county wide materials investigations had been completed in Harvey County. Two reports of particular usefulness included Frye and Leonard, "Pleistocene Geology of Kansas" (1952) and Williams and Lohman, "Geology and Ground-Water Resources of a Part of South-Central Kansas With Special Reference to the Wichita Municipal Water Supply" (1949). In addition, several preliminary soil surveys have been made and centerline profiles prepared for road design purposes by the State Highway Commission of Kansas along the major highways which traverse Harvey County; however, available information on materials suitable for construction purposes has been very meager.

Aggregate quality test results, pertinent information pertaining to the materials produced, and some geologic data on Harvey County used in this report were supplied by the Materials Department and

the Geology Section of the Design Department. This report was prepared under the guidance of J. D. NcNeal, Engineer of Planning and Research, the project leader, R. R. Biege, Jr., Engineer of Aerial Surveys and the Photogrammetry Section, and A. H. Stallard of the Photogrammetry Section. Appreciation is extended to R. E. Fry, Division Materials Engineer and W. R. Sloan, Harvey County Engineer for verbal information on the material resources of the county.

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ABSTRACT

Harvey County, with an area of 540 square miles, had a population of 27,311 in 1967. It is located in central Kansas and lies in the Great Bend Prairie physiographic division of Kansas. A well developed system of roads and railroads serves the county.

Material resources in Harvey County are restricted to the Grand Island Formation, Sappa Formation, Dune Sand and Alluvium. Most construction materials are currently being obtained from the Grand Island Formation.

The Grand Island Formation underlies most of the western two-thirds of the county. It is composed of siliceous sand and arkosic gravel with some limestone and ironstone gravels. This material has been used in concrete and bituminous mixes as well as for surfacing material on lightly traveled rural roads. Production must be accomplished by pumping, because of the high water table. The widespread distribution of this material has greatly contributed to the exploitation of this source unit.

The Sappa Formation is commonly found overlying the Grand Island Formation. It is composed of tan colored clayey silt and may contain a volcanic ash zone (Pearlette) of variable thickness. The Pearlette ash zone was produced for mineral filler purposes in McPherson County, but was neither used or identified in Harvey County at the time of the investigation.

The Dune Sand which occurs in southwest Harvey County is a source of mineral filler and base course material. This material is produced by dry pit methods.

The Alluvium of the Little Arkansas River and some of its tributaries have some material significance as aggregate, base course material, and mineral filler. To date, only fine aggregate has been produced from this unit. Production could be wet or dry depending on the depth of the water table.

Although all geologic units exposed in Harvey County have properties that may present geo-engineering problems under adverse climatic conditions, the most severe problems are encountered in the Wellington Shale Formation. The Wellington, which is exposed in the eastern portion of the county, weathers to a soft, clayey material and usually has a high plastic index. Such material is undesirable for embankment and subgrade purposes and may cause problems in bridge foundations. Potential ground-water difficulties exist along limy zones that are found in the Wellington, especially during and after periods of heavy rainfall.

No geo-engineering problems of any significance are encountered in unconsolidated deposits in Harvey County; however, wind-blown, clayey silt (Loess), which forms a thin blanket over most of the county, often has a high plastic index and may cause problems if used in subgrade construction. This type of problem is more prevalent in eastern Harvey County where the Loess covers the Wellington Shale, and

the terrain is hilly. Because of this underlying shale, highway improvements in this area will encounter a non-uniform base. The shifting of sand dunes may be a problem in the southwestern part of the county if the dunes are disturbed by construction activity. When the vegetational cover is removed, the sand is vulnerable to wind erosion and may drift or cause damage to the roadway.

Large quantities of reasonably good quality water is available in the Grand Island Formation which occupies a large part of the McPherson buried valley. Water from this source, as well as from other geologic formations in Harvey County, has a low enough chloride and sulfate content to be acceptable for use in Portland Cement concrete.

INTRODUCTION

Purpose and Scope

The purpose of this investigation is to present information concerning the availability, location, and nature of deposits of material for use, primarily, in highway construction. However, this information could be used for dam, airport runways, and other construction projects in Harvey County. All geologic deposits considered to be a source of construction material or a potential geoengineering problem are mapped and described. The term construction material, as used in this report, includes all of the granular material which, in its natural state or through various stages of processing, can be used in some phase of road construction. Mineral filler of high quality is also included in the term.

Nature of the Report

Because all material source beds are products of geologic agents, the materials inventory program is based largely on the geology of the county being investigated. By adopting geologic nomenclature to materials inventories, a uniform system of materials source bed classification is established; however, the quality of material that can be produced from a given source bed may vary from one county to another, especially with unconsolidated deposits. In most cases, the geologic classification attached to unconsolidated deposits denotes age and not material type. Therefore, deposits which were laid down during the same time in different parts of the state may have the same geologic name or classification, but may vary in composition because of different parent material. The sorting and gradation of materials are greatly affected by the mode of deposition and the carrying capacity or energy of the depositing agent.

In essence, the geology of the county provides a basis for mapping material source beds and criteria for evaluating the general qualities of the material.

Mapping the various geologic units was accomplished on aerial photography of the county. Because of their continuous nature, most consolidated geologic units can be mapped with a minimum amount of field checking. Unconsolidated deposits of silt, sand, and gravel are very abundant in Harvey County, but are somewhat difficult to map because of their erratic nature. However, some mapping of the unconsolidated deposits can be done on aerial photographs by having a knowledge of the county geology and by interpreting significant terrain features that are discernible on the photographs.

By knowing the mode of deposition, source bed, type of landform associated with a particular materials site, and the results of quality tests completed on samples obtained from similar deposits, one can derive general information concerning material in prospective sites. Consequently, prospective sites can be selected for development on the basis of the general merits of the material.

General Information

Harvey County has an area of 540 square miles and a population of 27,311 according to figures compiled in 1967 by the Kansas State Board of Agriculture. It lies in the Great Bend Prairie physiographic division of Kansas and is bounded by parallels 37° 55' and 38° 10' north latitude and meridians 97° 09' and 97° 42' west longitude. The county is bordered on the north by McPherson and Marion Counties, on the east by Marion and Butler Counties, on the south by Sedgwick County and on the west by Reno County.

An index map showing the location of Harvey County, along with the location of other counties currently included in the materials inventory program, is shown in figure 1.

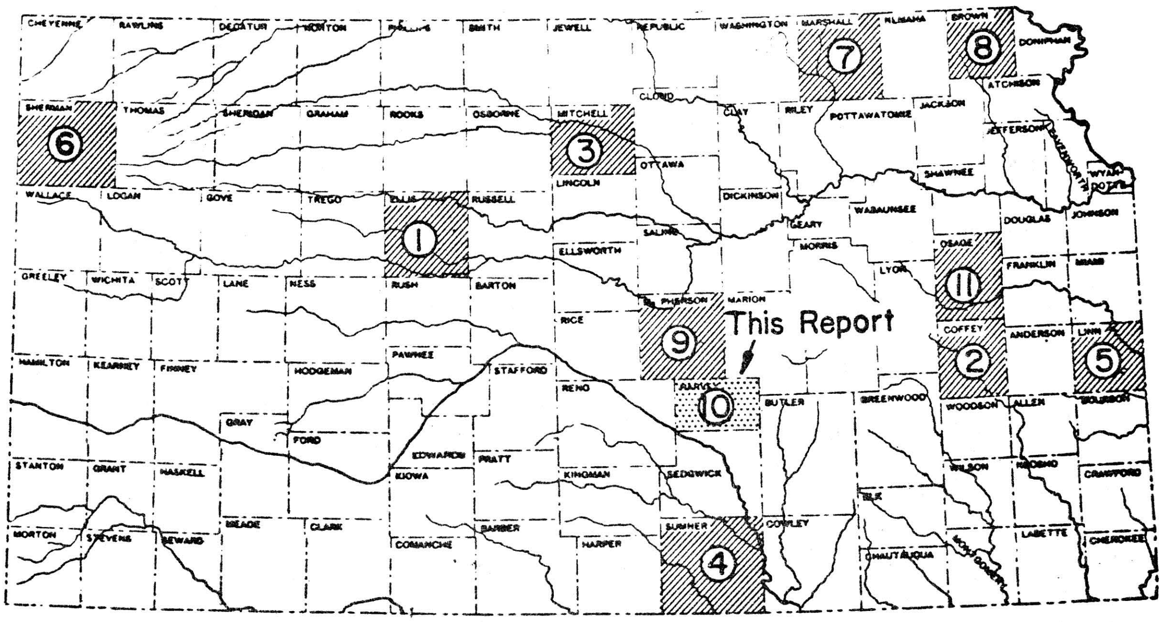

Figure 1. Index map of Kansas showing the location of Harvey County along with the report number and location of counties for which reports are completed or in process.

Harvey County is dissected by the southern portion of the broad, flat McPherson valley. This ancient buried valley, which once carried most of the water of the Kansas River drainage system, contains large, buried deposits of sand and gravel. Within and on the margin of this ancient valley, a system of southward trending streams has developed. The major streams in the county include the Little Arkansas River, Emma Creek, Kisiwa Creek, Sand Creek, Doyle Creek, West Whitewater Creek, East Whitewater Creek, Gypsum Creek and Wildcat Creek. All the drainage eventually empties into the Arkansas River which traverses Reno and Sedgwick Counties to the southwest and south.

Harvey County is served by four railroad systems with the city of Newton being the major railroad center. The Atchison, Topeka and Santa Fe Railroad extends to the east from the west boundary through Burrton and Halstead, thence northeast through Newton and Walton. Another section of this railroad extends south from Newton through the city of Wichita. A line of the Missouri Pacific Railroad enters the county from the north near Hesston and continues diagonally to the southeast corner of the county serving the cities of Newton and Whitewater. The extreme southeastern corner of Harvey County is traversed by a line of the Chicago, Rock Island, and Pacific Railroad Company. The St. Louis and San Francisco Railroad extends diagonally across the southwest corner of the county serving the towns of Burrton and Patterson.

The county is served by U. S. 50 and K-196 Highway in a general east-west trending direction. U. S. 81 and K-15 Highways serve the county in a north-south direction. Newton, the county seat of Harvey County, is the major highway transportation center. A well developed system of county and township roads serve the area with a section line road nearly every mile. A few of the county roads have bituminous surfaces and many are covered with some sort of light type surfacing material.

PROCEDURES

The investigation procedure for this report was organized into the following four phases; first, research and review of available information; second, photo interpretation; third, field reconnaissance and fourth, final correlation of data, map compilation, and report writing. With the exception of the first, these phases were not handled as separate operations but were completed contemporaneously as each section of the report required.

An analysis of the county was completed on aerial photographs acquired by the State Highway Commission of Kansas on March 31 and July 9, 1964 at a scale of 1:12,000 (one inch represents 1,000 feet). Figure 2 (page 6) is a photographic coverage map index of Harvey County which illustrates the approximate portion of the county covered by the various aerial photographs.

Geologic source units along with material site locations were mapped and classified on the aerial photographs. Some supplementary geological information (e.g. Kansas Geological Survey data) was used in this stage of the mapping. The mapping procedure is illustrated in figure 3 (page 7) which delineates the Grand Island Formation (sand and gravel) in southwestern Harvey County.

The Harvey County materials map was divided into four parts, approximately equal in area (plates I through IV). The map units were based, primarily, on geologic age. All existing material sites are identified on the materials map by designation and symbol. The site designation conveys to the reader the type of material, the estimated quantity, the number of the corresponding data sheet for the site, and the geologic age and unit name of the source bed. The site symbol indicates whether or not the site has been sampled. The map legend, accompanying each of the four plates, explains all letter and map symbols used in the site designations.

A data form was completed for each material site to provide the reader with a comprehensive coverage of information on each location included on the materials map. The site data forms are included as appendices I through IV in this report. Appendix I contains data

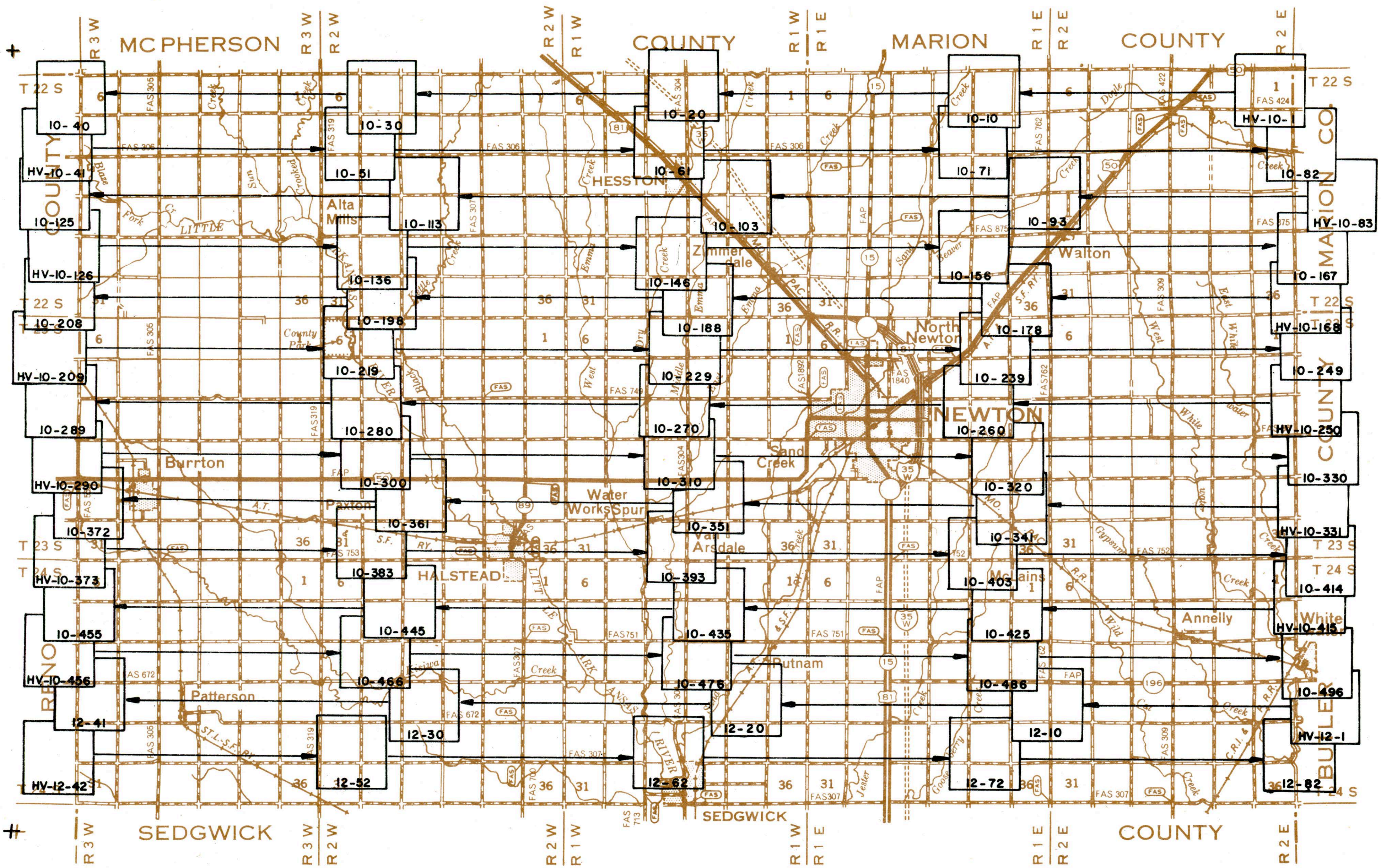

Figure 2. Aerial photographic coverage map for Harvey County. The numbers indicate print numbers of aerial photography obtained by the Photogrammetry Section, State Highway Commission of Kansas. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

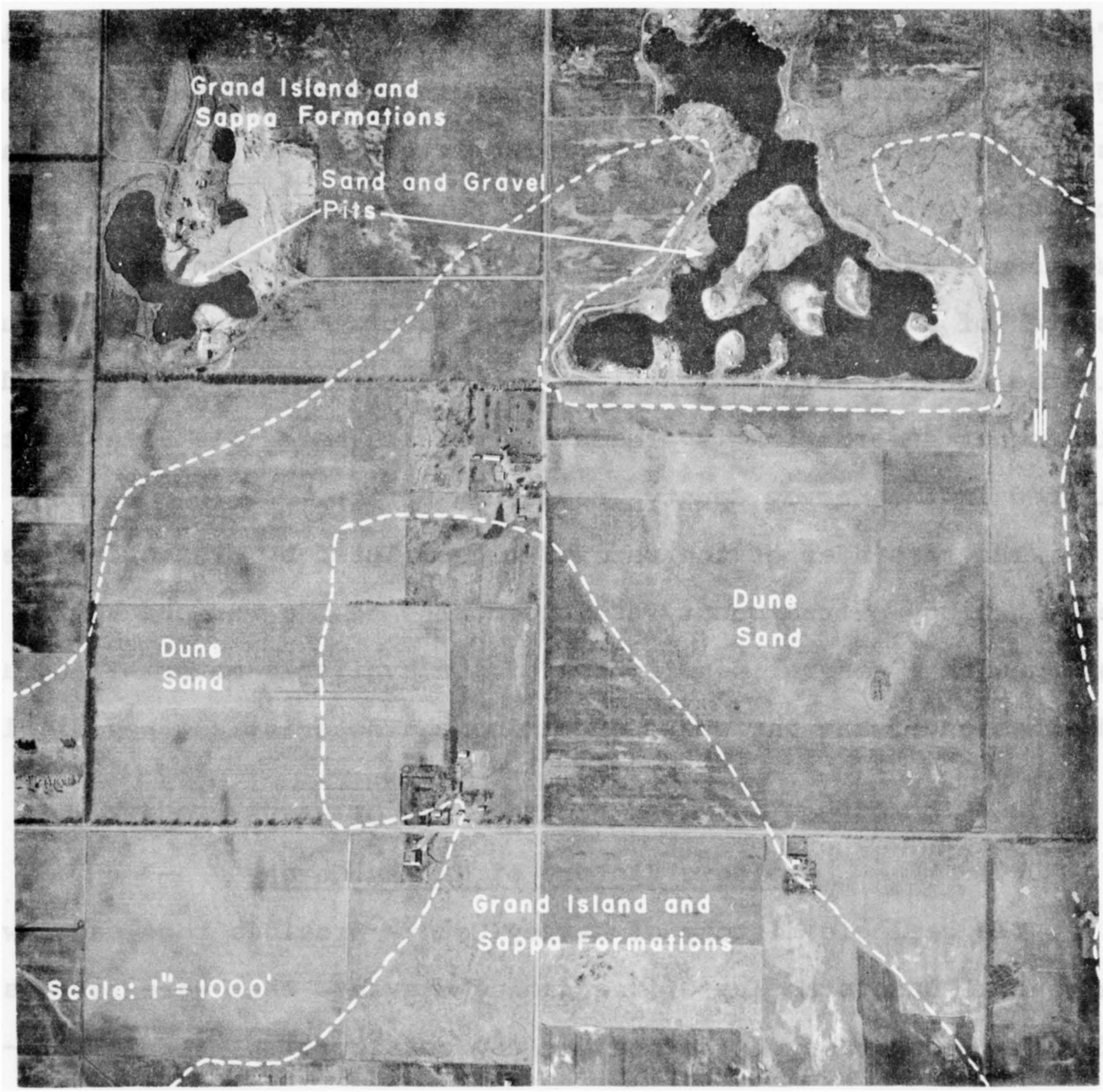

Figure 3. Aerial photograph taken in southwestern Harvey County which illustrates the method of delineation between the Dune Sand areas and the area occupied by the Grand Island and Sappa Formations. Note the two large sand and gravel pits in the Grand Island Formation.

forms for "open sites; not tested" by the State Highway Commission, while appendix II includes forms for those sites designated as "open and sampled." Test data are presented on the forms for each site in this appendix. Appendix III contains data forms for each site shown on the materials map as "prospective sites; not sampled" and appendix IV contains a form for each location depicted on the materials map as "prospective sites; sampled." Test information is also available for each location in the latter appendix. Geologic data are presented on each site data form to facilitate future correlation and on occasion, references are made to nearby locations where test results are available on samples taken from the same source bed. A sketch of each site illustrates major natural and cultural features in the general area to assist in field location. As a final aid, landowner information is presented for each materials site as it is listed in the Harvey County Treasurers office.

The remainder of the report was completed by presenting the general geology of the county as it pertains to the various source beds along with a general description of the available material and a discussion of the various engineering characteristics they display.

CONSTRUCTION MATERIAL RESOURCES OF HARVEY COUNTY

Geologic History of Harvey County

The geologic history of Harvey County provides the reader with a general understanding of the geologic events that were responsible for the deposition of the present day construction materials resources. Figure 4 (page 9) is a timetable reproduced with the permission of the State Geological Survey of Kansas which shows the division of geologic time and the approximate length of each period. Most periods on the geologic timetable represent several million years and the total age of the earth probably exceeds two billion years. Climatic and geographic conditions during this long history varied widely from those which exist at the present time.

Geologic units exposed in Harvey County total only a few hundred feet in thickness. From these, the geologic history of the near surface deposits may be interpreted; however, the history of the older

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.*	Water, agricultural soils, sand and gravel, volcanic ash.
CENOZOIC	TERTIARY	59,000,000	*River silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.*	Water, sand and gravel, volcanic ash, diatomaceous marl.
MESOZOIC	CRETACEOUS	70,000,000	*Chalk, chalky shale, dark shale, vari-colored clay, sandstone, conglomerate. Outcropping igneous rock.*	Ceramic materials; building stone, concrete aggregate, and other construction rock; water.
MESOZOIC	JURASSIC	25,000,000	*Sandstones and shales, chiefly subsurface.*	
MESOZOIC	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN	25,000,000	*Limestone; shale; evaporites (salt, gypsum, anhydrite); red sandstone and siltstone; chert; some dolomite.*	Natural gas; salt; gypsum; building stone, concrete aggregate, and other construction materials; water.
PALEOZOIC	PENNSYLVANIAN	25,000,000	*Alternating marine and non-marine shale, limestone, and sandstone; coal; chert.*	Oil, coal, limestone and shale for cement manufacture, ceramic materials, construction rock, agricultural lime, gas, water.
PALEOZOIC	MISSISSIPPIAN	30,000,000	*Mostly limestone, predominantly cherty.*	Oil, zinc, lead, gas, chat and other construction materials.
PALEOZOIC	DEVONIAN	55,000,000	*Subsurface only. Limestone, black shale.*	Oil
PALEOZOIC	SILURIAN	40,000,000	*Subsurface only. Limestone.*	Oil
PALEOZOIC	ORDOVICIAN	80,000,000	*Subsurface only. Limestone, dolomite, sandstone, shale.*	Oil, gas, water.
PALEOZOIC	CAMBRIAN	80,000,000	*Subsurface only. Dolomite, 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.

(Not scaled for geologic time or thickness of deposits)

*Committee on Measurement of Geologic Time, National Research Council

State Geological Survey of Kansas

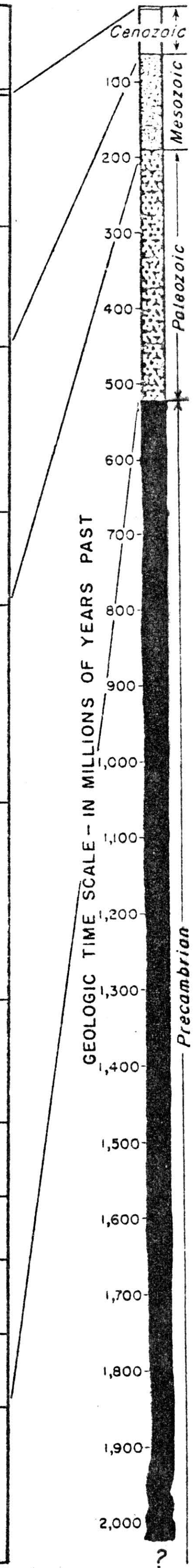

Figure 4. Geologic timetable

deposits must be studied through the use of drillhole information or from the surface exposure of the units found in other areas of the country.

Harvey County, like the remainder of Kansas, is underlain by igneous and metamorphic rock of Pre-Cambrian age. According to Williams and Lohman (1949) the area which includes Harvey County is underlain by 4,000 to 4,500 feet of limestone, sandstone, shale, clay, silt, sand, and gravel and small amounts of salt and gypsum.

Geologic studies show that each period of the Paleozoic Era is represented in the subsurface of Harvey County; however, rocks of Silurian and Devonian age may be missing in some localities.

Only one Paleozoic bed, the Wellington Formation, is found exposed in Harvey County. Generally, the Wellington is shale, but in eastern Harvey County, thin limy zones are a prominent feature. This formation generally represents a regressive sea inasmuch as isolated sea deposits (salt and gypsum) are commonly associated with it.

Uplift in the Appalachian Mountain region in the eastern United States ended the Paleozoic and marked the beginning of the Mesozoic Era. Severe erosion and deposition occurred in Kansas during this era. Although Mesozoic sediments are not found in Harvey County today, undoubtedly some late Mesozoic (Cretaceous) shale, chalky shale, and sandstone were deposited.

The Rocky Mountain uplift marked the end of the Mesozoic and ushered in the Cenozoic Era. Following this uplift, erosion removed much of the Cretaceous sediments from central Kansas (all from Harvey County). This erosional activity was active until late Tertiary time (Pliocene) when the Ogallala Formation was deposited over western and central Kansas. To the north in McPherson County, the Delmore Formation, also of Pliocene age, was deposited along the margins of the ancient McPherson valley. If Pliocene sediments were deposited in Harvey County, they have been removed by subsequent erosion.

The Pleistocene Epoch of the Quaternary Period represents a period of glacial and interglacial cycles. Figure 5 (page 12) is a geologic timetable which indicates the divisions of the Quaternary Period and the approximate duration of each. The glacial stages (Nebraskan, Kansan, Illinoisan, and Wisconsinan) represent times of major glacial advancement while the three interglacial stages (Aftonian, Yarmouthian, and Sangamonian) represent times of major glacial recession and stability. Glacial activity in Kansas was restricted to the northeastern portion of the state. Although no glaciers reached Harvey County, the sequence of glaciation which occurred during this time has played a controlling role in the development of Pleistocene nomenclature and a classification of Pleistocene deposits throughout the state. The geologic history of the Pleistocene Epoch as discussed here is based chiefly on reports by Williams and Lohman (1949) and Frye and Leonard (1952).

Central Kansas was an area of subdued relief at the beginning of Nebraskan time with broad alluviated valleys joined by alluviated tributaries. A considerable amount of downcutting took place in other areas of Kansas as the Nebraskan glacial activity occurred, but geologic evidence indicates that only a slight amount of degradation occurred along the major streams flowing through Harvey County.

The Kansan glacial ice entered the state from the northeast and advanced beyond the southern limit of the Nebraskan glacial activity, overriding the Flint Hills in Washington, Marshall, and Pottawatomie Counties. Evidence reveals that meltwater from the Washington and

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 5. Geologic timetable of the Quaternary Period.

Marshall County area flowed southwestward through three important spillways, one of which was a reverse course of the present Smoky Hill River past Junction City, and spilled into the headwaters of the established channel which traversed McPherson and Harvey Counties. Just south of Harvey County, the waters of the McPherson channel entered the newly established Arkansas River drainage system. Because of the tremendous amount of water rushing down these streams, wide, deep valleys were formed; but, as the ice began to retreat, stream velocities became slower and these valleys became alluviated with clay, silt, sand, and gravel.

As the ice mass continued to retreat, a decreasing amount of water flowed through the McPherson valley. Eventually, the westward flowing spillway near the site of Junction City was abandoned and the water began flowing eastward along the present Smoky Hill River valley. The McPherson valley in Harvey County was filled with more than 300 feet of material at some locations, dated as Kansan age and referred to in this report as the Grand Island and Sappa Formations.

During Illinoisan time, the Kansas River system continued to develop. The divide which existed in the Smoky Hill River valley continued to shift westward until all the former tributaries of the McPherson valley were captured by the new drainage system. This probably resulted in complete abandonment of the McPherson valley by a southward flowing stream.

Soon after the McPherson valley was abandoned, the channel began to be filled with colluvial material as well as with material deposited by local tributaries. This continuing process has resulted in most of the granular material being covered by a layer of silt and clay.

In late Illinoisan and Sangamonian time part of the upland area of western and northern Kansas was covered by wind-blown silts which were probably derived from the barren floodplains of the major stream valleys. These deposits are referred to in this report as the Loveland Formation.

Very few drainage changes occurred in central Kansas during the Wisconsinan stage; however, wind continued to deposit silt over much of Kansas. In this report, these deposits are referred to as the Peoria and Bignell Formations.

In Harvey County, as in the remainder of Kansas, geomorphic processes have reworked some older deposits. Sand dunes have been active in the western half of the county with the most prominent dunes being on the south side of the Little Arkansas River. Most of the dunes are stabilized; however, some small areas do show some activity. Undrained depressions, which are believed to be associated with the subsurface solutioning of salt in the Wellington Formation, are pre-

Graphic Legend	Thickness	System	Series	Stage	Formations	Generalized Description	Construction Materials
	0 - 3'	Quaternary	Pleistocene	Recent	Soil Mantle		
	0 - 75'				Alluvium	Clay, silt, sand, and gravel composed of siliceous material, arkose, pieces of limestone, ironstone, and sandstone; light tan.	Aggregate Mineral Filler Base Course Material
	0 - 150'				Dune Sand	Fine sand with varying amounts of silt and clay; cross bedded; light tan.	Mineral Filler Base Course Material
	0-- 1.5'			Wisconsinan	Bignell Formation	Clayey silt, tan-brown, may contain caliche.	None
	0 - 40'				Peoria Formation	Clayey silt, tan, contains zones and nodules of caliche. May have the "Brady Buried Soil" at the top.	None
	0 - 90'			Sangamonian and Illinoisan	Loveland Formation	Silt and sandy silt, slightly clayey, contains zones and nodules of caliche. May have "Sangamon Buried Soil" at the top.	None
	0 - 260'			Kansan and Yarmouthian	Sappa Formation	Clayey silt, tan-brown, may contain a volcanic ash zone (Pearlette Ash) of variable thickness and purity.	Mineral Filler
					Grand Island Formation	Siliceous silt, sand, and arkosic gravel with some pieces of limestone and ironstone; cross bedded; light tan to brown.	Aggregate Road Surfacing Material Mineral Filler
	200' - 550'	Permian	Lower Permian	Cimarronian	Wellington Shale Formation	Clayey, silty, gypsiferous, and limy shale; mostly gray; however, may be maroon and green near the top. The Milan Dolostone marks the top of the formation but was not found in Harvey County. A thick bed of salt occurs near the center and the fossil insect bearing Carlton Limestone Member occurs a short distance below the salt.	None

Figure 6. Generalized geologic column of the surface geology in Harvey County.

sent throughout the county. During Recent time, streams and gullies have modified the land surface into its present-day topography.

Construction Materials Inventory

This section of the report inventories the construction material resources of Harvey County. Figure 6 (page 14) is a generalized geologic column of the surface geology in Harvey County which shows the relative stratigraphic position of each source bed. The county materials maps (plates I through IV) show the geographic areas where construction material source beds are exposed or near the surface.

A tabulation of quality test results is shown in figure 7 (page 17) for material taken from the Grand Island Formation and the Dune Sand. In general, material with the same basic engineering characteristics can be found throughout each source bed.

Figure 8 (page 17) shows a tabulation of the various types of material available in Harvey County. The source beds from which each material type can be produced are listed along with the page number where the engineering characteristics of these geologic source beds are described.

Wellington Formation

The areal distribution of the Wellington Shale is shown on the Harvey County materials map, primarily, for geo-engineering purposes. However, the unit may be a potential source of raw material for lightweight aggregate, but at the time of this investigation (April, 1966) no construction material had been produced.

The exposed Wellington Formation is a gray to blue-gray, clayey shale with thin zones of limestone and gypsum. Some beds of maroon and green shale occur near the top of the formation. Although the

Hutchinson Salt Member is not exposed, it may underlie some portions (especially the western part) of Harvey County. The thin, impure Carlton Limestone Member may be found in the eastern part of the county but has been removed by erosion elsewhere. The exposed portion of the Wellington probably does not exceed 200 feet; however, oil well records in this portion of the state indicate the total thickness to be as great as 550 feet.

Grand Island and Sappa Formations

The Grand Island and Sappa Formations are ancient floodplain deposits which occur in the old McPherson valley. Eolian and colluvial deposits of varying thickness mask most of these deposits and make the production of the desired granular material costly or impossible.

The Grand Island Formation is composed of tan colored silt, siliceous sand, and arkosic gravel with pieces of limestone and ironstone being common in the unit. The texture of the material ranges from fine to coarse with the fine fraction being more prominent. As in other alluvial deposits, cross-bedding is common.

Extensive geologic investigations for water supply purposes have been made by the State Geological Survey of Kansas in the "Equus Beds" (Grand Island and Sappa Formations). These thick deposits of saturated sand and gravel, located in south-central Harvey County, are used for the Wichita municipal water supply. Extensive deposits of sand and gravel that extend to depths exceeding 250 feet in some places, yield over 2,000 gallons per minute to wells in this area (Williams and Lohman, 1949, p. 208). It is probable that the areas which yield large quantities of water from the Grand Island gravel also contain a suitable construction material but may be too deep

Location	Material Type	Percent Retained										Wash	G.F.	L.L.	P.I.	Wet SP.GR.	Dry SP.GR	Weight per cubic foot	LA Wear	Soundness	Absorption	Source of Data
		2	1½	3/4	3/8	4	8	16	30	50	100											
Source of Material: Grand Island Formation																						
NW¼ Sec. 5, T24S, R3W	Sand & Gravel	0	0	0	3	10	27	59	84	95	98	1.15	3.76	-	-	2.61	-	111.4	34.8	0.97	-	SHC Form 619, No. 40-1
NE¼ SE¼ Sec. 25, T22S, R1W	Sand & Gravel	0	0	0	0	1	7	24	56	86	92	7.0	-	19	3	-	-	-	-	-	-	SHC Form 619, No. 40-4,
SW¼ Sec. 16, T24S, R2W	Sand & Gravel	0	0	0	2	4	28	61	87	97	100	0.28	4.19	-	-	2.61	-	110.83	35.4	0.99	-	Rev. SHC Form 619, No. 40-8
NE¼ Sec. 6, T24S, R2W	Sand & Gravel	0	0	1	5	17	39	69	90	97	99	-	4.17	-	-	2.60	-	113.08	34.5	0.98	0.40	Rev. SHC Form 619, No. 40-9
Source of Material: Dune Sand																						
SE¼ Sec. 23, T22S, R3W	Fine Sand	0	0	0	0	0	0	0	0	20	62	14.0	-	-	-	-	-	-	-	-	-	SHC Form 619, No. 40-7
NW¼ Sec. 5, T24S, R1W	Fine Sand	0	0	0	0	0	0	0	1	22	76	-	-	-	-	-	-	-	-	-	-	Ave. SHC Form 619, No. 40-3

Figure 7. Results of tests completed on some samples of construction material in Harvey County.

Material Type	Geological Source	Description	Locality Where Available
Mineral Filler and (or) Base Course Material	Grand Island Formation	Page 16	Western two-thirds of county
	Sappa Formation	Page 16	Western two-thirds of county
	Dune Sand	Page 20	West and southwest part of county
	Alluvium	Page 21	Little Arkansas River valley, Kisiwa Creek, Black Kettle Creek, Sand Creek, Emma Creek, Blaze Creek, Sun Creek.
Sand & Gravel	Grand Island Formation	Page 16	Western two-thirds of county
	Alluvium	Page 21	Little Arkansas River valley, Kisiwa Creek, Black Kettle Creek, Sand Creek, Emma Creek, Blaze Creek, Sun Creek.

Figure 8. A summary of the construction material types and their availability in Harvey County.

for feasible recovery. It is noted that only the southwest portion of the county produces large quantities of construction aggregate, and it is reasonable to assume that this section contains the least overburden and, thus, the most easily recoverable material. Figure 9 illustrates a large materials pit in southwestern Harvey County where large amounts of sand and gravel have been removed.

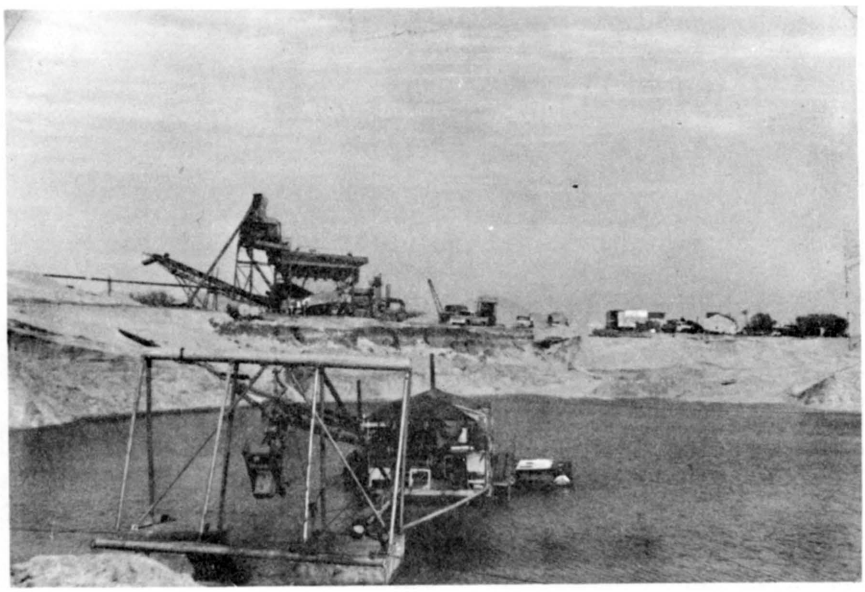

Figure 9. Sand and gravel pit in the Grand Island Formation; NE¼ SE¼ sec.27, T23S, R3W.

The Sappa Formation is commonly found overlying the Grand Island Formation and, in this report, is included in the same map unit. The formation is composed of as much as 60 feet of tan colored, clayey silt and may contain a volcanic ash zone (Pearlette). The Pearlette Ash zone was produced for mineral filler purposes in McPherson County, but was not identified in this Harvey County investigation.

The Grand Island Formation is the best source of sand and gravel and nearly the only type of material available in Harvey County. The material produced from most of the pits is suitable for use in bituminous and concrete construction as well as for light type surfacing material on rural roads. Some bituminous and concrete aggregate is produced to supply surrounding counties with suitable construction material. The water table is high in much of the buried valley area in Harvey County and, thus, it is necessary to produce most material by pumping methods. Available quality information on this unit shows the Los Angeles wear to range from 34.8 to 35.2 percent, the soundness loss ratio from 0.97 to 0.99, and the absorption on one sample was 0.40 percent. Additional test information is shown in chart form in figure 7 (page 17).

Dune Sand

There are many sand dune areas located in the western two-thirds of Harvey County. Primarily, the dunes are composed of cross-bedded, tan colored, fine sand with varying amounts of silt and clay. According to Williams and Lohman (1948) the Dune Sand in this portion of Kansas may be as much as 150 feet thick. The dunes are associated with the Little Arkansas River in Harvey County and possibly the Arkansas River which traverses Reno and Sedgwick Counties to the west and southwest. A ground photograph of a Dune Sand pit in southwestern Harvey County is shown in figure 10 (page 21).

Material from this source may possibly be used for mineral filler or as a base course material. A high plastic index or to small of a percentage passing the No. 200 sieve often limits the use of this sand as mineral filler. Gradation information on one sample is shown in figure 7 (page 17). Usually the Dune Sand area is characterized by a relatively high ground-water table; however, because of the fineness of the material, only a small quantity of water can be produced. If Dune Sand is to be used as a construction material, ground-water problems can be avoided during production by limiting the depth of excavation.

Figure 10. Pit in Dune Sand; NW¼ sec. 5, T24S, R1W.

Alluvium

Most of the Alluvium is a tan-brown, fine textured material which is erratically bedded. The thickness is variable, but probably does not exceed 75 feet any place in the county.

Alluvium in Harvey County is found in the floodplain of the Little Arkansas River, Kisiwa Creek, Sand Creek, Emma Creek, Blaze Creek, Sun Creek, and Black Kettle Creek. A small area in the extreme southwestern corner of the county contains Alluvium associated with the Arkansas River which traverses Reno County to the south. In Harvey County, the production of such material, suitable for road construction, has been restricted to Kisiwa Creek.

One sand and gravel pit in the Kisiwa Creek Alluvium is presently in operation in Harvey County and possibly other areas could be located if the need arises for additional material. Figure 11 (page 22) illustrates some granular material in the floodplain of Kisiwa Creek. The material obtained from this Alluvium may extend into the underlying Grand Island Formation with increased depth. A distinction between the two beds may be difficult but it is probable

Figure 11. Sand and gravel in the Alluvium of Kisiwa Creek, NW¼ sec.23, T24S, R2W.

that a coarser material may be found in the Grand Island.

In Harvey County, the location of the major drainage channels is important in the prospecting of material since the streams have eroded away varying thicknesses of fine-textured overburden. Because of this relatively thin mantle, it is economically feasible to produce the Grand Island sand and gravel in some areas.

No quality information is available on material taken from the Alluvium, but some of the sand and gravel found in this unit is similar to the Grand Island because it was probably derived from it. However, most alluvial sand and gravel is finer textured than the Grand Island.

Geo-Engineering

The purpose of this section of the report is to list and briefly describe the geologic units exposed in Harvey County that, through past experience, are known to consist of material possessing unsound engineering properties. A general discussion is also presented pertaining to possible ground-water problems that may be encountered during road construction and the quality of the water available for concrete mix purposes.

<u>Material Usage in Road Construction</u>

The usage of material is considered from three points of view: 1. embankment and subgrade construction, 2. backslope steepness and stabilization, and 3. bridge foundation support.

Embankment and Subgrade Construction

All of the exposed geologic units in Harvey County have been used at some time in the construction of highway embankment or subgrade; however, clay shale or any of the highly plastic soils are not recommended for subgrade or shoulder construction due to their shrinkage and swell characteristics. Such material may be beneficial if the development of a turf is desired. If used for embankment, the highly plastic material should be placed in the lower portion; however, consideration must also be given to the height of the fill to insure that the shear strength of the material is not exceeded by the weight from above. It is desirable for the backfill material to have low swell and shrinkage properties but frequently, such material cannot be found within a feasible hauling distance of the project. In most cases, it is necessary to utilize material available along the project which may have high plasticity values. Lime may be added to increase the stability of such plastic material.

The oldest unit which may be encountered during road construction in Harvey County is the Wellington Shale Formation. This unit, which is found in the eastern part of the county, is composed of clay shale with thin limestone and gypsum zones. The clay shale is of prime concern, inasmuch as, it often displays a high plastic index. It may be necessary to waste some of this material during road construction if weathering has penetrated the shale to some depth.

The broad flat McPherson valley occupies much of the western two-thirds of Harvey County. The surface material in this valley is a clayey silt represented mostly by the Sappa Formation, loess deposits, and colluvium. Although this material may have undesirable plastic properties, its uniform nature and the nearly flat terrain of the valley floor lessens the effects of the adverse engineering characteristics.

Wind-blown, clayey silt deposits also cover some of the upland bedrock in eastern Harvey County. Like the McPherson valley eolian deposits, they have undesirable plastic properties. However, the rougher terrain and non-uniform bedrock profile underlying the loess has increased the severity of engineering problems that are encountered in this area.

Backslope Steepness and Stabilization

The relatively flat terrain in Harvey County prevents severe engineering problems in backslope construction. However, the same general precautions on backslope construction should be followed as in other counties.

Backslopes constructed in the soil mantle should be set on approximately a 3:1 slope and seeded to prevent erosion. Extreme precaution should be exercised to stabilize the backslope in a Dune Sand area, inasmuch as, disturbing a stabilized dune may cause the wind to start shifting the sand and damage to the road may result. Slopes in the Wellington Formation will vary with the properties exhibited by the shale. Soft weathered material should be set on a 3:1 slope while parts of the formation which exhibits a hard shale with thin limestone zones may be set on a steeper slope.

Bridge Foundation Support

It is probable that the Wellington Shale will be the only bedrock unit encountered for bridge footing support in Harvey County. The Wellington may exhibit variation in support qualities inasmuch as both hard shale and soft weathered clay shale may be encountered. On pile footings one might expect adequate support on hard shale within a foot or so of the contact while soft clay shale may exhibit inadequate support properties extending several feet into the unit. If the Wellington Shale is exposed at the surface (without soil cover) the shale is fairly hard; thus, bearing for a spread footing can generally be acquired at a shallow depth without too much difficulty. However, if the shale is covered and ground-water has saturated this cover, deep weathering can be anticipated. Bearing for a spread footing, in this case, may require fairly deep excavation into the shale.

Limestone is rare in this county except for a few thin zones in the Wellington Formation. This rock should provide a good support for bridge structures; however, consideration should be given to the nature of the material underlying the limestone zones inasmuch as unsatisfactory support can result if this material has been weathered.

In many areas of the buried McPherson valley (mapped as the Grand Island and Sappa Formations) the mantle is too thick for bedrock support of either spread footing or point bearing piling. In such cases, frictional type piling will be necessary. Estimating frictional pile lengths for structures is generally much more difficult than estimating pile lengths when support is obtained on bedrock. Presently, the State Highway Commission of Kansas is relying on information gained through the use of a No. 2 McKiernan-Terry Air Hammer, operated by the Geology Section of the Design Department, to help estimate the elevation at which a given bearing could be reached. The use of this equipment has enabled the designer to make relatively accurate estimates of pile tip elevation; but due to variation in composition of the unconsolidated deposits, deviation from the estimated depth can be anticipated.

Hydrology Problems in Road Construction

All the geologic units which are exposed in Harvey County have properties which could contribute to ground-water problems in road construction when encountered under adverse conditions. It is beyond the scope of this report to make specific recommendations; however, the undesirable characteristics of certain formations are briefly discussed herein. Detailed surface investigations should be conducted with these facts in mind to ascertain the extent and severity of ground-water problems in any area where a construction project is planned.

The Wellington Shale contains some limy zones which may carry water during and after periods of heavy rainfall. To prevent subgrade failures, care should be taken to assure proper drainage of any ground-water encountered in these zones when they are intercepted in the construction of a road bed. An example of such limy zones in the Wellington is shown in figure 12 (page 27).

The unconsolidated deposits found in Harvey County consist of varying amounts of clay, silt, sand, and gravel. In some instances, lenses of silt and clay may prevent the downward percolation of water and result in a perched water table. Such a condition may accentuate the undesirable characteristics of overlying soil and lead to even-

Figure 12. Limy zones in the Wellington Formation which may carry ground-water; NE¼ sec. 3, T22S, R1E.

tual subgrade failure.

If a road construction project is proposed, a geologic field check should be made to ascertain if any water carrying zones will be encountered along the proposed alignment. If troublesome conditions are found to exist, some of the following courses of action should be taken to prevent road failure due to water being induced into the subgrade:

1. Construct special ditches to intercept water-carrying zones and drain the ground-water away. The base of these ditches should be well below the source of the ground-water and should have sufficient grade to drain the water away before it can saturate the roadbed.
2. Construct underdrains beneath the roadbed to intercept the water before it can enter the subgrade and cause damage to the roadbed.

3. Adjust proposed alignments and grades to avoid areas where troublesome ground-water situations exist.

Mineralization of Water Resources

Engineering problems pertaining to ground-water are discussed here mainly on the basis of information reported by Williams and Lohman (1949). The primary consideration is given to the main sources of water and the degree of mineralization which can generally be expected from the various aquifers. Special emphasis is placed on the degree of sulfate and (or) chloride ion concentration in water with reference to specifications for Portland Cement concrete.

The Wellington Formation provides only a limited amount of water in Harvey County. Water from this unit is comparatively high in dissolved solids, especially the sulfate ion; however, the content of sulfate and chloride in samples tested was not high enough to preclude its use in Portland Cement concrete.

The Grand Island Formation comprises the principal source of ground-water in this area. The quantity of water that may be derived from the Grand Island is variable due to differences in thickness and physical characteristics of the sand and gravel. Large quantities of good quality water are obtained from the Grand Island Formation (so called Equus beds) in the south-central portion of Harvey County for the Wichita municipal water supply. Overall, the chemical characteristic of the water varies widely, but, in general, the water is of comparatively good quality except in areas where salt has entered the formation from natural or industrial sources. Most wells will yield water that is low enough in sulfate and chloride for use in concrete construction.

Inasmuch as the scattered Dune Sand areas are composed of relatively fine-grained material, only a limited amount of water has been produced from this source. Tests indicate that ground-water from this material is comparatively soft, but may contain undesirable quantities of iron; however, the sulfate and chloride content is generally low and the water should be acceptable for use in Portland Cement concrete.

Some ground-water is also produced from Alluvial deposits in the major drainage channels of Harvey County. A sufficient quality is obtained from the Little Arkansas River Alluvium to supply several towns. Tests indicate the water from this source is hard but not highly mineralized. Evidence indicates a low sulfate and chloride content which should make it acceptable for use as mix water in concrete construction.

GLOSSARY OF SIGNIFICANT TERMS

Absorption: Determined by tests performed in accordance with A.A.S.H.O. (American Association of State Highway Officials) designation T 85.

Aggrade: To raise the grade or level of a river valley or stream bed by depositing particles of clay, silt, sand, and gravel.

Alluvium: A deposit of clay, silt, sand, or gravel laid down by flowing water.

Aquifer: Water-bearing geologic unit.

Arkosic gravel: Gravel composed of mineral fragments derived from weathered granite.

Chert: A dull, flint-like, siliceous rock.

Colluvium: Heterogenous mixture of material resulting from the transportation action of gravity (i.e. talus at the base of a slope).

Concretion: Oddly shaped nodules that occur in sedimentary rocks which form gradually by precipitation around definite nuclei.

Consolidated deposit: Deposit of limestone, shale, or sandstone. In Kansas, this term generally applies to rock older than Pliocene age.

Cross-bedding: Sedimentary deposits which show oblique layering extending diagonally across the individual beds.

Eolian Deposits: Wind-deposited beds of clayey silt.

Geologic period: A unit of geologic time, Mississippian, Pennsylvanian, and Permian are examples.

Geologic unit: This term is used in this report to denote: 1. a geologic formation, 2. a geologic member, and 3. an unconsolidated deposit of Pleistocene age.

Glacial deposit: Deposits of clay, silt, sand, gravel, and boulders laid down by glaciers or glacial meltwater.

Gradation factor: The value obtained by adding the percentages of material retained on the 1 1/2", 3/4", 3/8", 4, 8, 16, 30, 50, and 100 sieves respectively and dividing the sum by 100.

Igneous rocks: Rocks produced under conditions involving great heat; as rocks crystallized from a molten material.

Light type surfacing: A surface course constructed from aggregate which is not bound by water, cement, or bituminous material.

Liquid limit: Determined by tests performed in accordance with section Y1-18 of the State Highway Commission of Kansas Standard specifications, 1966 edition.

Los Angeles wear: Determined by tests performed in accordance with A.A.S.H.O. designation T 96 as modified by section Y1-14 of the State Highway Commission of Kansas Standard Specifications, 1966 edition.

Material source bed: A particular geologic unit, consolidated or unconsolidated, that provides material for construction purposes.

Matrix: The binding material such as that which bonds or encloses sand and gravel particles at their place of deposition.

Metamorphic rock: Rock which has been altered, crystallized or otherwise, altered by intense heat and pressure.

Open materials site: A pit or quarry which has produced or is producing material suitable for some phase of road construction.

Plastic index: Determined by tests performed in accordance with section Y1-18 of the State Highway Commission of Kansas Standard Specifications, 1966 edition.

Pleistocene Series: Deposits laid down during the Quaternary Period.

Prospective materials site: A geographical location where the geologic conditions are favorable for the discovery of construction material.

Soundness: Determined by tests performed in accordance with section Y1-15 of the State Highway Commission of Kansas Standard Specifications, 1966 edition.

Specific gravity: Determined by tests performed in accordance with A.A.S.H.O. designation T 84 for sand and gravel and T 85 for crushed stone.

Stereoscopic vision: Vision through a stereoscope in which objects appear in three dimensions.

Terrace: A plain built up by the deposition of sediments by water.

Unconsolidated deposits: Deposits of clay, silt, sand, or gravel. These deposits may be laid down by wind or water action.

Wash: (Material passing the No. 200 sieve) Determined by tests performed in accordance with A.A.S.H.O. designation T 11.

Weight per cubic foot: Determined by tests performed in accordance with A.A.S.H.O. designation T 19-45.

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