NEW MEXICO STATE HIGHWAY DEPARTMENT

AGGREGATE RESOURCES AND SOILS STUDY

NEW MEXICO INTERSTATE ROUTE 40

Prepared in cooperation
with the
United States Bureau of Public Roads

SANTA FE, N. M.

1961

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40

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NEW MEXICO STATE HIGHWAY DEPARTMENT
MATERIALS AND TESTING LABORATORY
AND PLANNING DIVISION

IN COOPERATION WITH

U. S. BUREAU OF PUBLIC ROADS

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NEW MEXICO INTERSTATE ROUTE 40

INTRODUCTION

The Aggregate Resources and Soils Study was started in 1959 by the Soils and Geology Section, Materials and Testing Laboratory, New Mexico State Highway Department. This work was carried on as a Research Project in cooperation with the United States Bureau of Public Roads by the use of 1½% Federal Planning and Research Funds through the Planning Division of the New Mexico State Highway Department. The purpose of this study is to make a survey of soils, geology, and construction materials along Interstate, Primary, and Secondary Routes in New Mexico. The final objective is a compilation of permanent records containing engineering and geologic data relating to soils, rock formation, and construction materials existing along these routes for the construction of highways.

Prior to the work done by the Soils and Geology Section, the search for highway aggregate resources was conducted only as the immediate situation demanded. Thus, only limited areas were surveyed and no over-all picture of aggregate resources in the state was available.

The following report is a study of Interstate Route 40 which has been divided into 21 sections beginning at the Arizona-New Mexico State Line and ending at the New Mexico-Texas State Line. Each section is approximately 16 miles in length and 3 to 4 miles in width on each side of the route. In many places the Construction Materials Inventory Maps cover greater widths in order to include all sources of construction materials which may be hauled economically for use in construction of Interstate Route 40.

All aggregate resources and soils tests were run according to American Society for Testing Materials (ASTM) and American Association of State Highway Officials (AASHO) standard methods by the Materials and Testing Laboratory. All base maps and final drafting of mapped sections were done by the Planning Division of the New Mexico State Highway Department.

The study is prefaced by a Table of Contents, a Location Map of Interstate Route 40, a Legend, a Geological Time Chart, four Nomenclature Charts of New Mexico Geologic Names, and a Structural Units Map.

Each Section of Interstate Route 40 contains information as follows:

Introduction: Brief general description of the section.

General Geology: Principal regional and local geologic features, their expression and development. This work was done with the aid of field reconnaissance, aerial photographs, and geologic publications and maps.

Soils: Derivation, development, and characteristics of the soils. Soils were sampled by augering and by sampling soil profiles in deep arroyos or other cuts. Soil contacts were then mapped separating areas of different soil classification.

Ground Water: Ground water conditions are discussed when significant.

Stratigraphy: Geologic column, age, and description of formations and their members.

Construction Materials: Construction materials column, age, and description of formations from which they are derived. Construction materials were located by field reconnaissance, aerial photographic interpretation, geologic interpretation, and sampling and testing.

Soil Summary Table: Shows log and classification of soil samples.

Selected References: Literature cited.

Soils and Geology Map: Shows the areal distribution of soils and their related formations. These maps were compiled from Material and Testing Laboratory data on soils, field reconnaissance, aerial photographs, geologic publications and maps, and random sampling of soils and prospective construction materials deposits.

Construction Materials Inventory Table: Description of tested and prospective pit sites.

Construction Materials Inventory Map: Shows the distribution of tested and prospective pit sites.

For maximum benefit the maps, tables, and reports should be studied simultaneously.

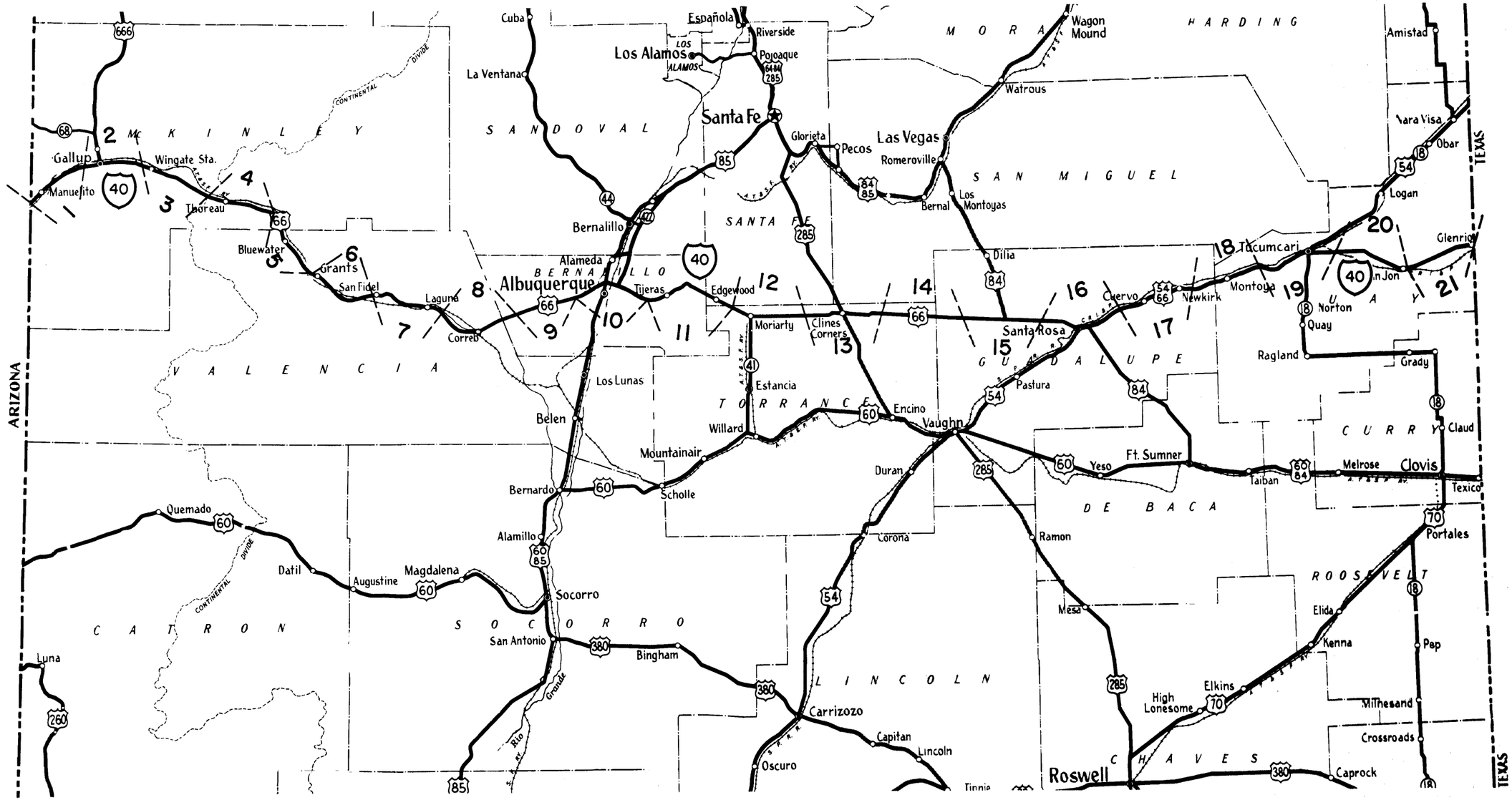
It is felt that the information contained in these reports will be of much value to the Maintenance Division and Location, Design, and Materials Sections of the New Mexico State Highway Department in selecting the most suitable route locations and aggregate materials sources for construction and maintenance of New Mexico highways.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40

TABLE OF CONTENTS

Location Map of Interstate Route 40
Legend
Geological Time Chart
Four Nomenclature Charts of New Mexico Geologic Names
Structural Units of New Mexico

Location of Section	Section	Pages
ARIZONA-NEW MEXICO STATE LINE - TWIN BUTTES	40-1	1 - 4
TWIN BUTTES - WINGATE STATION	40-2	1 - 5
WINGATE STATION - CONTINENTAL DIVIDE	40-3	1 - 5
CONTINENTAL DIVIDE - PREWITT	40-4	1 - 5
PREWITT - GRANTS	40-5	1 - 5
GRANTS - SAN FIDEL	40-6	1 - 5
SAN FIDEL - MESITA	40-7	1 - 6
MESITA - RIO PUERCO	40-8	1 - 5
RIO PUERCO - WEST MESA ALBUQUERQUE	40-9	1 - 5
WEST MESA ALBUQUERQUE - CARNUE	40-10	1 - 7
CARNUE - EDGEWOOD	40-11	1 - 7
EDGEWOOD - MORIARTY RADAR STATION	40-12	1 - 7
MORIARTY RADAR STATION - PALMA	40-13	1 - 5
PALMA - ANTON CHICO GRANT	40-14	1 - 7
ANTON CHICO GRANT - SANTA ROSA WEST	40-15	1 - 6
SANTA ROSA WEST - SANTA ROSA EAST	40-16	1 - 9
SANTA ROSA EAST - NEWKIRK	40-17	1 - 5
NEWKIRK - PALOMAS	40-18	1 - 5
PALOMAS - TUCUMCARI AIRPORT	40-19	1 - 5
TUCUMCARI AIRPORT - SAN JON	40-20	1 - 6
SAN JON - NEW MEXICO-TEXAS STATE LINE	40-21	1 - 5



LEGEND

2 — SECTION NUMBER
SECTION TERMINI

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LOCATION MAP
INTERSTATE ROUTE 40

N

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT
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LEGEND

IGNEOUS ROCKS

Intrusive		
Granite	Light colored, coarse grained, equigranular intrusive rock. *Quartz and feldspar dominant.*	
Gabbro	Dark colored, coarse grained, intrusive rock. *No quartz, dark minerals abundant.*	
Intrusive Bodies	Intrusive bodies of varied composition and form. Includes dikes, sills, etc.	
Undivided Intrusive Rocks	All intrusive rocks intermediate in composition between granite and gabbro. Includes syenites, diorites, etc. Also includes all formations of intrusive igneous rocks of varied composition not mapable as a single rock unit.	
Extrusive		
Rhyolite	Light colored, fine grained extrusive rock.	
Basalt	Dark colored, fine grained extrusive rock.	
Glasses	All extrusive glasses. Includes obsidian, pumice, etc.	
Volcanic Ejecta	All fragmental volcanic rocks. Includes volcanic breccia, agglomerate, ash, tuff, cinders, malpais, etc.	
Undivided Extrusive Rocks	All extrusive igneous rocks not listed above. Includes latite, andesite, etc. Also includes all extrusive igneous formations of varied composition not mapable as a single rock unit.	

SEDIMENTARY ROCKS

Mechanical or Fragmental Origin *Clastic*		
Claystone	Sedimentary rock made up of extremely minute mineral particles. No cleavage parallel to the bedding.	
Shale	Fine grained, soft, sedimentary rock with cleavage parallel to the bedding. High in clayey materials.	
Siltstone	Silt converted to rock. Intermediate in grain size between shale and sandstone.	
Sandstone	Sedimentary rock consisting of sand grains more or less firmly cemented together.	
Conglomerate	Sedimentary rock consisting of gravel that has become firmly cemented. The pebbles are more or less rounded.	
Breccia	Sedimentary rock consisting of coarse, angular fragments firmly cemented.	
Unconsolidated Surface Deposits	Unconsolidated sedimentary material. Includes alluvium, dune sands, talus, landslides, terrace gravels, etc.	
Consolidated Surface Deposits	Surface material which has become consolidated.	
Undivided Sedimentary Rocks of Mechanical or Fragmental Origin	Includes all sedimentary rocks of mechanical or fragmental origin not listed above and all formations of sedimentary rock of mechanical and fragmental origin not mapable as a single rock unit.	
Chemical or Organic in Origin *Caliche*	Lime rich deposit formed near the surface.	
Limestone	Calcium carbonate precipitated from solution, or through intervention of organisms.	
Dolomite	A carbonate rock which consists dominantly of dolomite. *Calcium, magnesium carbonate.*	
Evaporites	Rocks formed by the evaporation of water. Includes gypsum, rock salt, potash, etc.	
Coal	A compact mass of carbonized, ancient plant debris.	
Undivided Sedimentary Rocks of Chemical or Organic Origin	All sedimentary rocks of chemical or organic origin not listed above such as chalk, marl, chert, flint, oölite, coquinas, sinter, travertine, tufa, etc. Also includes all formations of sedimentary rocks of chemical or organic origin not mapable as a single rock unit.	

METAMORPHIC ROCKS

Gneiss	Imperfectly foliated, generally coarse grained, metamorphic rock.	
Schist	Well foliated, metamorphic rock.	
Quartzite	A firm, compact, metamorphic rock composed of grains of quartz.	
Slate	An extremely fine grained metamorphic rock with excellent foliation.	
Undivided Metamorphic Rocks	All metamorphic rocks not listed above. Includes all metamorphic formations not mapable as a single rock unit.	

STRUCTURES

GEOLOGIC CONTACT

SOILS CONTACT

FAULT
Dashed where approximately located
Downthrown side on normal
T Upthrown side on thrust

LINE of CROSS-SECTION

ANTICLINE

SYNCLINE

MONOCLINE

GEOLOGIC AGES

Q	Quaternary	P	Permian	S	Silurian
T	Tertiary	C	Carboniferous	O	Ordovician
K	Cretaceous	ℙ	Pennsylvanian	Є	Cambrian
J	Jurassic	M	Mississippian	P-Є	Precambrian
Tr	Triassic	D	Devonian		

Small letters are used to indicate specific formations, e.g. Kd, which means Cretaceous Dakota sandstone, or P-Єg which means Precambrian granite *wherein that particular granite has no specific formation name.*

SOILS

Location of soil sample or section of geologic formation. *(Number refers to explanation in soils summary table)* (2)

Soil type based on AASHO Classification:

A-1-a, A-1-b, Stone Fragments, Gravel & Sand	1
A-2-4, A-2-5, A-2-6, A-2-7, Silty or Clayey Gravel & Sand	2
A-3, Fine Sand	3
A-4, Silty Soils	4
A-5, Silty Soils	5
A-6, Clayey Soils	6
A-7, Clayey Soils	7

In areas containing two or more soil types, e.g. A-2, A-4, etc., where A-2 is predominate, the soil unit is shown as 2-4. Where A-4 is predominate, the soil unit is shown as 4-2.

In profiles containing two or more soil types, e.g. A-4 over A-6, the soil unit is shown as $\frac{4}{6}$.

Geologic age and formation or landform are depicted in the first portion of the map unit, and the soil type is shown in the second portion, e.g. Qal - $\frac{4}{6}$ which means alluvium that is Quaternary in age is the parent formation with a soil classification of A-4 over A-6. Where geologic age and formation are not followed by a soil unit the area is considered as non soils or the soils are insignificant to area mapped.

CONSTRUCTION MATERIALS INVENTORY

Tested pit or quarry

Prospect pit or quarry

Tested pits are designated by year, pit number and type of pit, e.g., 57-100-S, which means Surfacing Pit (S), number 100 was explored in 1957. Prospect Pits are designated by route number, section number and prospect number, e.g., 40-16-5, which means Interstate Route 40, Section 16, Prospect number 5.

GEOLOGIC TIME CHART

ERAS	PERIODS (of time) or SYSTEMS (of rock)	EPOCHS (of time) or SERIES (of rock)	APPROXIMATE TIME IN YEARS SINCE BEGINNING OF EACH	PHYSICAL AND BIOLOGICAL FEATURES
CENOZOIC	QUATERNARY (Q)	Recent	50,000	Development of modern man.
		Pleistocene	1,000,000	Ice sheets over Europe and North America; appearance of early man.
	TERTIARY (T)	Pliocene	12,000,000	Development of modern plants and animals; formation of mountains in western America.
		Miocene	30,000,000	Highest development of larger mammals; formation of mountains, including the Alps, Andes, and Himalayas.
		Oligocene	40,000,000	Development of higher mammals.
		Eocene and Paleocene	60,000,000	Rise to dominance of mammals; appearance of ancestral horse and primates.
MESOZOIC	CRETACEOUS (K)		120,000,000	Extinction of dinosaurs; development of early mammals and flowering plants; deposit of chalk beds.
	JURASSIC (J)		155,000,000	Appearance of flying reptiles and birds; dominance of dinosaurs; appearance of primitive mammals; abundance of coniferous trees.
	TRIASSIC (Tr)		190,000,000	Appearance of dinosaurs; dominance of reptiles; appearance of cycadaceous trees.
PALEOZOIC	PERMIAN (P)		215,000,000	Development of reptiles; decline of huge plants of the Mississippian and Pennsylvanian.
	PENNSYLVANIAN (IP)		300,000,000	Age of coal; formation of coal beds from luxuriant plant life in warm, swampy forest; great fernlike trees; appearance of primitive conifers; abundance of insect life; first appearance of reptiles; development of amphibians.
	MISSISSIPPIAN (M)			
	DEVONIAN (D)		350,000,000	Age of fish; appearance of primitive amphibians; development of primitive plant life on dry continents.
	SILURIAN (S)		390,000,000	Appearance of scorpions, the first animals to live on land; extensive coral reefs.
	ORDOVICIAN (O)		480,000,000	Floods and recessions of shallow seas; deposits of limestone, lead, and zinc ores; abundance of marine invertebrate life; appearance of a few primitive fishlike vertebrates.
	CAMBRIAN (Є)		550,000,000	Shallow seas over much of the land; formation of sedimentary rocks; development of marine invertebrate life, including brachiopods, snails, sponges, and trilobites.
PRECAMBRIAN (PЄ)	PROTEROZOIC		1,200,000,000	Formation of mountains; deposits of iron ore; abundance of lime-secreting algae; appearance of sponges.
	ARCHEOZOIC		2,000,000,000	Great volcanic activity; formation of igneous rocks; some microscopic algae; probably some protozoa.

NOMENCLATURE CHART OF NEW MEXICO GEOLOGIC NAMES AND HIGHWAY DEPARTMENT EQUIVALENTS

SYSTEM	SERIES	NORTHEAST		HIGHWAY DEPARTMENT EQUIVALENTS	
QUATERNARY -	Pleistocene & Recent	Alluvium		Alluvium	
		Bolson deposits		Bolson deposits	
		Caliche		Caliche	
		Extrusive igneous rocks		Extrusive igneous rocks	
		Intrusive igneous rocks		Intrusive igneous rocks	
		Landslides		Landslides	
		Pediment gravels		Pediment gravels	
		Spring deposits		Spring deposits	
		Terrace deposits		Terrace deposits	
TERTIARY	Pliocene	SANTA FE fm	OGALLALA fm	Santa Fe fm	Ogallala fm
	Miocene				
	Oligocene				
	Eocene	GALISTEO fm		Tertiary rocks undifferentiated	
		POISON CANYON fm		Poison Canyon fm	
	Paleocene	RATON fm		Raton fm	
CRETACEOUS	Upper	MONTANA group	VERMEJO fm / RAIL CANYON ss mbr	Vermejo fm	
			TRINIDAD ss	Trinidad ss	
			PIERRE shale	Pierre shale	
		COLORADO group	NIOBRARA fm	SMOKEY HILL marl (APISHAPA sh)	Niobrara fm
				FORT HAYS limestone (TIMPAS limestone)	Apishapa sh / Fort Hays limestone
			BENTON sh	CARLILE sh / Juana Lopez ss mbr	Benton sh
				GREENHORN limestone	Carlile shale / Greenhorn ls
				GRANEROS shale	Graneros shale
		DAKOTA sandstone		Dakota sandstone	
	Lower	PURGATOIRE fm	PAJARITO sh mbr / MESA RICA ss mbr / TUCUMCARI sh mbr	Purgatoire fm	
JURASSIC	Upper	MORRISON fm		Morrison fm	
		WANAKAH fm	WANAKAH marl / BILK CREEK ss		
		TODILTO limestone			
	Mid.	*Ocate ss	EXETER (*Exter) ss	Wingate sandstone	
	Low.	WINGATE ss	ENTRADA ss		
		NARANJO fm (Sheep Pen Canyon ss)			
TRIASSIC	Upper	Sloan Canyon fm			
		DOCKUM group	REDONDO ss mbr / CHINLE fm	Dockum group	Chinle fm
			SANTA ROSA sandstone		Santa Rosa ss
	Low.				

SYSTEM	SERIES		
PERMIAN	Ochoa		
	Guadalupe		
		BERNAL fm	Bernal fm
		SAN ANDRES fm	San Andres fm
		GLORIETA ss	Glorieta ss
	Leonard	YESO fm / SAN YSIDRO mbr	Yeso fm
		YESO fm / MESETA BLANCA mbr	
	Wolfcamp	SANGRE de CRISTO fm	Sangre de Cristo fm
PENNSYLVANIAN	Virgil	MADERA limestone	Madera limestone
	Missouri		
	Des Moines	MAGDALENA group	Magdalena group
	Atoka		
	Morrow	SANDIA fm	Sandia fm
	Chest.		
MISSISSIPPIAN	Merm.	ARROYO PENASCO fm	LEADVILLE ls / Mississippian rocks undif
	Osage		
	Kind.		
DEVONIAN	Upper	OURAY ls	Devonian rocks undifferentiated
		ELBERT fm / McCraken sandstone mbr	
	Mid.		
SIL	Mid.		
ORDOVICIAN	Upper		
	Low.		
CAM	U.		

Names printed in caps are currently accepted for use by the U.S. Geological Survey.

Names printed in caps and lower case are those which the survey has not accepted or has no occasion to consider for use.

Names preceded by * have either been abandoned by their authors or rejected by the survey.

Names preceded by ✱ are recommended for suppression by the survey or the New Mexico Bureau of Mines and Mineral Resources.

NOMENCLATURE CHART OF NEW MEXICO GEOLOGIC NAMES AND HIGHWAY DEPARTMENT EQUIVALENTS

SYSTEM	SERIES	NORTHWEST	HIGHWAY DEPARTMENT EQUIVALENTS
QUATERNARY	Pleistocene & Recent	Alluvium	Alluvium
		Bolson deposits	Bolson deposits
		Extrusive igneous rocks	Extrusive igneous rocks
		Intrusive igneous rocks	Intrusive igneous rocks
		Landslides	Landslides
		Morainal deposits	Morainal deposits
		Pediment gravels	Pediment gravels
		Spring deposits	Spring deposits
		Terrace deposits	Terrace deposits
		Puye gravels; Tuerto gravels; ANCHA fm; FLORIDA gravels	
TERTIARY	Pliocene	SANTA FE fm: Abiquiu fm; Picurius tuff	Santa Fe fm
		TESUQUE fm: BISHOPS LODGE mbr	
		GILA congl	Gila congl
	Miocene	CHUSKA ss	Chuska ss
	Oligocene	DATIL fm: La Jara Peak mbr; Hells Mesa mbr; Spears mbr	Datil fm
		POTOSI volcanic series	Extrusive rocks undif.
	Eocene	BACA fm; GALISTEO fm	Tertiary rocks undifferentiated
		WASATCH (San Jose) fm	Wasatch fm
	Paleocene	TORREJON fm; PUERCO fm	Torrejon and Puerco fms
		NACIMIENTO fm / ANIMAS fm	Nacimiento fm / Animas fm
CRETACEOUS	Upper	OJO ALAMO ss	Ojo Alamo ss
		TOHATCHI fm	Tohatchi fm
		McDERMOTT fm	McDermott fm
		KIRTLAND sh; FARMINGTON ss mbr	Kirtland sh; Farmington ss mbr
		FRUITLAND fm	Fruitland fm
		PICTURED CLIFFS ss	Pictured Cliffs ss
		LEWIS sh	Lewis sh
		MESAVERDE group: CLIFF HOUSE ss (*Chacra ss): Baker Dome tongue; BEECHATUDA tongue; CHOLLA CANYON tongue; NORTH HOGBACK tongue; UTE CANYON tongue; LA VENTANA ss mbr	Cliff House ss
		MESAVERDE group: MENEFEE fm: ALLISON barren mbr; CLEARY coal mbr	Menefee fm
		MESAVERDE group: POINT LOOKOUT ss	Point Lookout ss
		MESAVERDE group: HOSTA tongue; SATAN tongue; CREVASSE CANYON fm (*Chamiso fm): GIBSON coal mbr; BARTLETT barren mbr; DALTON ss; MULATTO tongue; DILCO coal mbr; GALLEGO ss mbr	Crevasse Canyon fm
		MESAVERDE group: GALLUP ss: PESCADO tongue; D-CROSS tongue; *Tocito ss lentil	Gallup ss
		MANCOS sh: Sanastee mbr; Horsehead tongue; Atarque mbr; GREENHORN mbr; Twowells ss mbr; GRANEROS mbr; TRES HERMANOS mbr	Mancos sh
		MANCOS shale	
		DAKOTA ss	Dakota ss
	Lower		
JURASSIC	Upper	MORRISON fm: BRUSHY BASIN sh	Morrison fm
		MORRISON fm: WESTWATER CANYON ss (Prewitt mbr); RECAPTURE sh (Chavez mbr); SALT WASH ss mbr	
		ZUNI (Cow Springs) ss	
		SAN RAFAEL group: Navajo ss: BLUFF ss; SUMMERVILLE (Red Mesa fm); Thoreau fm	Navajo ss
	Mid.	SAN RAFAEL group: TODILTO fm	Todilto fm
		SAN RAFAEL group: ENTRADA fm	Wingate fm
	Low.	SAN RAFAEL group: CARMEL fm	
		GLEN CANYON group: WINGATE ss: LUKACHUKAI mbr; ROCK POINT mbr	
TRIASSIC	Upper	CHINLE fm: OWL ROCK mbr; CORREO ss mbr; PETRIFIED FOREST mbr; Sonsela ss bed; POLEO ss lentil; SALITRAL sh mbr; AGUA ZARCA ss mbr	Chinle fm: Upper mbr; Middle mbr; Lower mbr
	Low.	SHINARUMP congl	Shinarump congl
		MOENKOPI fm	Moenkopi fm

SYSTEM	SERIES		
PERMIAN	Ochoa		
	Guadalupe	** MANZANO group: * CHUPADERA fm: SAN ANDRES fm; GLORIETA ss; DE CHELLY ss	Manzano group: Chupadera fm: San Andres fm; Glorieta ss; De Chelly ss
		YESO fm: LOS VALLOS mbr; SAN YSIDRO mbr; ORGAN ROCK mbr	Yeso fm
	Leonard	YESO fm: MESETA BLANCA mbr; CEDAR MESA mbr	Cutler fm
		CUTLER fm	
	Wolfcamp	ABO fm; HALGAITO mbr	Abo fm
		BURSUM fm	Bursum fm
PENNSYLVANIAN	Virgil	MAGDALENA group: RED TANKS mbr	Magdalena group: Madera ls
	Missouri	MADERA ls: ATRASADO mbr	
	Des Moines	MADERA ls: GRAY MESA mbr	
	Atoka	SANDIA fm	Sandia fm
		Log Springs fm	
MISSISSIPPIAN	Chest.		
	Merm.	ARROYO PENASCO fm	Mississippian rocks undif.
		Kelley ls	
	Osage		
	Kind.	Caloso fm	Mississippian rocks undif.
DEVONIAN	Upper		
	Mid.		
SILURIAN	Mid.		
ORDOVICIAN	Upper		
	Low.		
CAM	U.	IGNACIO quartzite	Ignacio quartzite

NOMENCLATURE CHART OF NEW MEXICO GEOLOGIC NAMES AND HIGHWAY DEPARTMENT EQUIVALENTS

SYSTEM	SERIES	SOUTHWEST		HIGHWAY DEPARTMENT EQUIVALENTS	
QUATERNARY	Pleistocene & Recent	Alluvium		Alluvium	
		Bolson deposits		Bolson deposits	
		Caliche		Caliche	
		Extrusive igneous rocks		Extrusive igneous rocks	
		Intrusive igneous rocks		Intrusive igneous rocks	
		Landslides		Landslides	
		Pediment gravels		Pediment gravels	
		Spring deposits		Spring deposits	
		Terrace deposits		Terrace deposits	
		PALOMAS gravels			
TERTIARY	Pliocene	SANTA FE fm	GILA conglomerate	Santa Fe fm	Gila congl.
	Miocene				
	Oligocene	Bell Top fm Thurman fm Palm Park fm	DATIL fm	Tertiary rocks undifferentiated	Datil fm
	Eocene	BACA fm		Tertiary rocks undifferentiated	
	Paleocene	McRae fm	Hall Lake mbr Jose Creek mbr	McRae fm	
CRETACEOUS	Upper		Ash Canyon mbr		
		MESAVERDE fm		Mesaverde fm	
		MANCOS sh	COLORADO sh	Mancos sh	Colorado sh
		DAKOTA ss		Dakota ss	
		BEARTOOTH quartzite		Beartooth quartzite	
	Lower	SARTEN ss		Sarten ss	
		Trinity gp: SKUNK RANCH conglomerate		Lower Cretaceous undifferentiated	
		Trinity gp: PLAYAS PEAK fm			
		Trinity gp: CORBETT ss			
		Trinity gp: HOWELLS RIDGE fm			
		Trinity gp: HIDALGO fm			
		Trinity gp: RINGBONE sh			
		Trinity gp: BROKEN JUG ls			
		Bisbee group: Johnny Bull ss			
		Bisbee group: Still Ridge fm			
		Bisbee group: Carbonate Hill ls			
		Bisbee group: McGhee Peak fm			
JURASSIC	Upper				
	Mid.				
	Low.				
TRIASSIC	Upper	DOCKUM group		Dockum group	
	Low.				

SYSTEM	SERIES		
PERMIAN	Ochoa		
	Guadalupe		
	Leonard	MANZANO group: CHUPADERA fm: SAN ANDRES fm	San Andres fm
		GLORIETA sandstone	Glorieta sandstone
		YESO fm: CONCHA limestone	Yeso fm
		SCHERRER fm	
		EPITAPH dolomite	
		COLINA limestone	
	Wolfcamp	ABO (LOBO) fm	Abo fm
		HUECO ls	Hueco ls
		GYM ls	
		EARP fm	
PENNSYLVANIAN		BURSUM fm / Agua Torres fm	Bursum fm
	Virgil	MAGDALENA group: MADERA limestone: Fresnal group: Bruton fm	Madera limestone
		Keller group: Moya fm	
		Keller group: Del Cuerto fm	
	Missouri	Hanson-burg gp: Storey fm	
		Hanson-burg gp: Burrego fm	
		Veredas group: Council Springs ls	
		Veredas group: Adobe fm	
		Veredas group: Coane ls	
	Des Moines	Bolander group	
		Armendaris group: Garcia fm	
		Armendaris group: Whiskey Canyon ls	
		Armendaris group: Elephant Butte fm	
		Armendaris group: Warmington mbr	
	Atoka	Mud Springs group: Cuchillo Negro fm	
		Mud Springs group: Fra Cristobal fm (*Hot Springs fm)	Sandia fm
	Morrow	Green Canyon gp: Apodaca fm	
		Green Canyon gp: Arrey fm	
MISSISSIPPIAN	Chest	HELMS fm / PARADISE fm	Mississippian rocks undifferentiated
	Merm	Rancheria fm	
		Las Cruces fm	
	Osage	Kelley limestone	
		LAKE VALLEY fm: Dona Ana mbr	Lake Valley fm
		LAKE VALLEY fm: Arcente mbr	
		LAKE VALLEY fm: Tierra Blanca mbr	
		LAKE VALLEY fm: Nunn mbr	
		LAKE VALLEY fm: Alamogordo mbr	
		LAKE VALLEY fm: Andrecito mbr	
	Kind	Caballero fm	Mississippian rocks undif.
DEVONIAN	Upper	PERCHA fm: Box mbr	Percha fm
		PERCHA fm: Ready Pay mbr	
		Contadero fm	Devonian rocks undifferentiated
		Sly Gap fm	
	Mid.	Onate fm	
		Canutillo fm	
SIL	Mid.	FUSSELMAN limestone	Fusselman limestone
ORDOVICIAN	Upper	MONTOYA group: Cutter fm: Raven mbr	Montoya group
		MONTOYA group: Aleman fm: Par Value mbr	
		MONTOYA group: Upham dolomite: Second Value mbr	
		MONTOYA group: Cable Canyon ss	
	Low.	EL PASO group: Bat Cave fm	El Paso group
		EL PASO group: Sierrite limestone	
CAM	U.	BLISS sandstone	Bliss sandstone
		BOLSA quartzite	Bolsa quartzite

NACO group: HORQUILLA limestone

Magdalena group: SANDIA fm: La Tuna mbr; Bernio fm; Bishops Cap fm; Nakaye fm; Red House fm; Oswaldo fm; Bar-B fm; Syrena fm

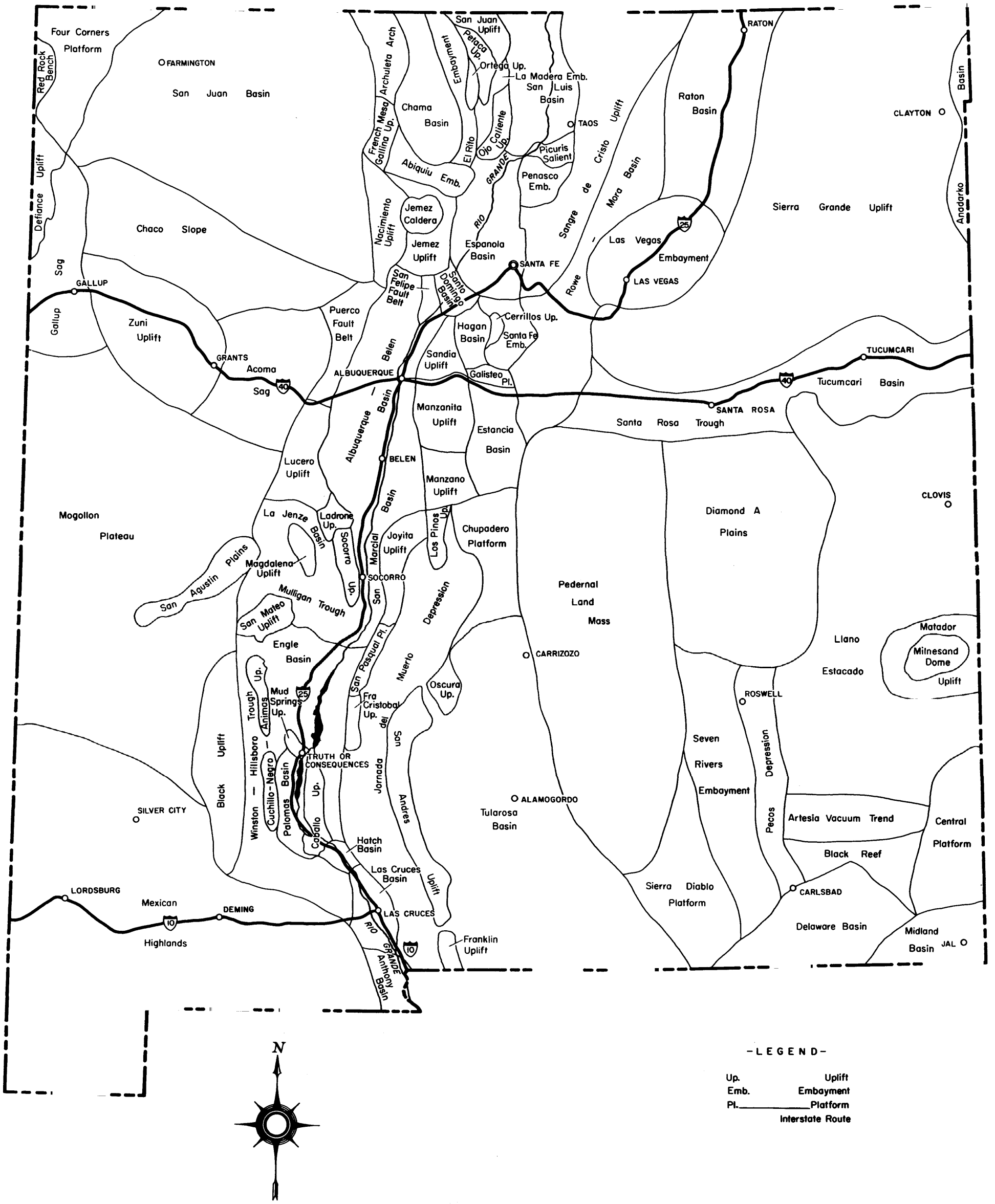
NOMENCLATURE CHART OF NEW MEXICO GEOLOGIC NAMES AND HIGHWAY DEPARTMENT EQUIVALENTS

SYSTEM	SERIES	SOUTHEAST		HIGHWAY DEPARTMENT EQUIVALENTS	
QUATERNARY	Pleistocene & Recent	Alluvium		Alluvium	
		Bolson deposits		Bolson deposits	
		Caliche		Caliche	
		Extrusive igneous rocks		Extrusive igneous rocks	
		Intrusive igneous rocks		Intrusive igneous rocks	
		Landslides		Landslides	
		Pediment gravels		Pediment gravels	
		Spring deposits		Spring deposits	
		Terrace deposits		Terrace deposits	
TERTIARY	Pliocene	SANTA FE fm	OGALLALA fm	Santa Fe fm	Ogallala fm
	Miocene				
	Oligocene				
	Eocene	Cub Mountain fm		Tertiary rocks undif	
	Paleocene				
CRETACEOUS	Upper	MESAVERDE fm		Mesaverde fm	
		MANCOS (EAGLE FORD) fm		Mancos shale	
		DAKOTA ss		Dakota ss	
	Lower	BUDA ls		Lower Cretaceous undifferentiated	
		DEL RIO fm			
		GEORGETOWN fm			
		EDWARDS ls	FINLAY ls		
		COX fm			
JURASSIC	Upper				
	Mid.				
	Low.				
TRIASSIC	Upper	DOCKUM group		Dockum group	
			SANTA ROSA sandstone		
			TECOVAS shale		
	Low.		PIERCE CANYON red beds		Shinarump conglomerate

SYSTEM	SERIES			
PERMIAN	Ochoa	DEWEY LAKE fm		Ochoa evaporites
		RUSTLER fm	MAGNETA dolomite mbr	
			CULEBRA dolomite mbr	
			Vaca Triste mbr	
		SALADO fm	McNutt zone	
			COWDEN anhydrite mbr	
			LA HUERTA silt mbr	
			FLECHER anhydrite mbr	
		CASTILE fm		
	Guadalupe	WHITEHORSE group: Ocotillo silt mbr; TANSILL fm; YATES ss; AZOTEA tongue; SEVEN RIVERS fm	THREE TWINS mbr; CARLSBAD group	Carlsbad group
		CHALK BLUFF fm: CAPITAN limestone: LAMAR ls; McCOMBS mbr; RADER mbr; PINERY mbr; HEGLER limestone	BELL CANYON fm; CHERRY CANYON fm; DELAWARE MOUNTAIN group	Capitan ls; Delaware Mountain group
		QUEEN fm: Shattuck mbr; Yoakum dol mbr	GOAT SEEP ls: MANZANITA ls mbr; SOUTH WELLS mbr	Chalk Bluff fm; Goat Seep ls
		GRAYBURG fm	GETAWAY mbr	
		BERNAL fm	Sandstone tongue Cherry Canyon fm	San Andres fm
		SAN ANDRES fm: Hondo ss mbr	BRUSHY CANYON fm	
		GLORIETA ss		Glorieta ss
	Leonard	YESO fm: JOYITA ss mbr; CANAS gypsum; TORRES mbr; MESETA BLANCA mbr	BONE SPRING ls: CUTOFF shaley mbr; VICTORIA PEAK gray mbr	Yeso fm; Bone Spring ls
	Wolfcamp	ABO fm: LEE RANCH tongue; Danley Ranch tongue; DEER MOUNTAIN sh; Pendejo tongue; POWWOW congl	HUECO fm	Abo fm; Hueco fm
		BURSUM (Laborcita) fm		Bursum fm
PENNSYLVANIAN	Virgil	MAGDALENA group: Holder fm; Panther Seep fm		Magdalena group: Madera limestone
	Missouri	Beeman fm		
	Des Moines	Gobbler fm; Bug Scuffle ls mbr		
	Atoka	SANDIA fm		Sandia fm
	Morrow			
MISSISSIPPIAN	Chest.	HELMS fm		Mississippian rocks undif
	Merm.	Rancheria fm		
		Las Cruces fm		
	Osage	LAKE VALLEY fm: Dona Ana mbr; Arcente mbr; Tierra Blanca mbr; Nunn mbr; Alamogordo mbr; Andrecito mbr		Lake Valley fm
	Kind.	Caballero fm		Mississippian rocks undif
DEVONIAN	Upper	PERCHA (WOODFORD) fm		Percha fm
		Contadero fm		Devonian rocks undifferentiated
		Sly Gap fm		
	Mid.	Onate fm		
SIL	Mid.	FUSSELMAN ls		Fusselman limestone
ORDOVICIAN	Upper	Valmont dolomite		Montoya group
		MONTOYA group: Aleman fm; Upham dolomite; Cable Canyon ss		
	Low.	EL PASO fm (ELLENBURGER group)		El Paso fm
CAM	U.	Bliss sandstone		Bliss sandstone

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

STRUCTURAL UNITS OF NEW MEXICO



AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
ARIZONA-NEW MEXICO STATE LINE - TWIN BUTTES

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies between the Arizona line and Twin Buttes west of Gallup. It is situated in the flat, alluvial-filled valley of the Rio Puerco of the West with adjacent sandstone cliffs of Cretaceous and Jurassic age.

General Geology:

The dominant geological features of this area are the Pinon Springs Anticline, which lies west of Manuelito, and the Torrivio Anticline west of Twin Buttes. The adjoining sandstone and shale beds in this area have folded into these structural features. The rocks consist of alternating layers of sandstone and shale. The land forms are largely an expression of the relative resistance and dip of these beds. In areas of steeper dip the shale has eroded faster than the sandstone, which has formed prominent cuestas.

The areal distribution of the formations and members are shown on Map 40-1. Their succession and character are given under the section termed "Stratigraphy".

Soils:

The soils within this region are predominantly sand, silt, and clay situated along the drainage patterns of the Rio Puerco and its tributaries.

The soils of the surrounding cliffs are represented by sandstone outcrops with a residual silty sand cover. The surface soils are usually thin, ranging from one to three feet on the mesas to eleven feet in the local dune sand deposits southwest of Manuelito.

In the higher and sandy regions of the Mancos shale and Crevasse Canyon formation, the soils represented are mainly silt (A-4). The soils along the main channel of the Rio Puerco are clayey (A-6 to A-7). The areal distribution of the soils and their related formations are shown on Map 40-1. Table No. 40-1-1 shows the log and classification of the soil samples taken along this portion of Interstate 40.

Stratigraphy:

Quaternary: Alluvium - (Qal) valley fill consisting of sand, silt, and clay.

Bolson deposits - (Qab) windblown sand deposits.

Tertiary: Intrusive rocks - (Ti) (Basaltic) necks of tuff-breccia with fragments of sedimentary rocks.

Cretaceous: Crevasse Canyon formation - (Kcc) alternating beds of tan, irregularly bedded lenticular sandstone, drab shale, claystone, and coal.
Thickness: Total - 500 to 700 feet; Coal beds - 2 to 6 feet.

Gallup sandstone - (Kg) tan, brown, and pinkish-gray sandstone with lesser amounts of brown carbonaceous shale and coal.
Thickness: 180 to 250 feet.

Mancos shale - (Km) light to dark gray shale with lesser amounts of tan, fine-grained sandstone and siltstone.
Thickness: 800 to 900 feet.

Dakota sandstone - (Kd) tan, brown, and gray sandstone; conglomeratic sandstone with minor amounts of brown carbonaceous shale and lesser amounts of coal.
Thickness: 100 to 230 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation - (Jm) white and brown fine- to medium-grained sandstone, siltstone, and conglomerate.
Thickness: ?

Navajo sandstone - (Jn) greenish-gray to light yellowish-gray, fine- to medium-grained crossbedded sandstone which intertongues with members of the Morrison formation.
Thickness: 200 feet.

Triassic: ? Wingate formation - (TrJw) reddish-brown fine-grained crossbedded sandstone.
Thickness: 200 to 240 feet.

Construction materials:

Quaternary: Alluvium (Qal) and Bolson deposits (Qab) - this formation contains material suitable for hot mix and P.I, reducing filler in localized areas.

Tertiary: Intrusive rocks (Ti) basaltic necks of the Twin Buttes area. Material suitable for riprap, surfacing, and concrete aggregate can be produced from this intrusive; however, it will be difficult to work because the basalt is well-seated in the consolidated sedimentary strata surrounding the necks. There is also some tuff and brecciated material surrounding the necks.

Soils Summary:

Table No. 40-1-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Bolson Deposits	1	A	0.0	3.0	A-2-4	Silty sandy soil
"	Bolson Deposits	2	A	0.0	5.0	A-3	Fine sandy soil
"	Alluvium		B	5.0	21.0	A-4	Silty soil
"	Bolson Deposits	3	A	0.0	8.0	A-3	Fine sandy soil
"	Alluvium	4	A	0.0	35.0	A-6	Clayey soil
"	"	5	A	0.0	20.0	A-6	Clayey soil
"	"	6	A	0.0	20.0	A-7	Clayey soil
"	"	7	A	0.0	8.0	A-6	Clayey soil
"	"	8	A	0.0	6.0	A-6	Clayey soil
"	"	9	A	0.0	17.0	A-7	Clayey soil
"	"	10	A	0.0	6.0	A-4	Silty soil
"	"	11	A	0.0	6.0	A-4	Silty soil
"	"	12	A	0.0	20.0	A-6	Clayey soil
"	"	13	A	0.0	18.0	A-4	Silty soil
"	"	14	A	0.0	20.0	A-7	Clayey soil
"	"	15	A	0.0	12.0	A-4	Silty soil
"	"	16	A	0.0	35.0	A-6	Clayey soil

Selected References

Sears, J. D., Geology and Coal Resources of Gallup-Zuni Basin, New Mexico, U.S.G.S. Bulletin 767, 1925.

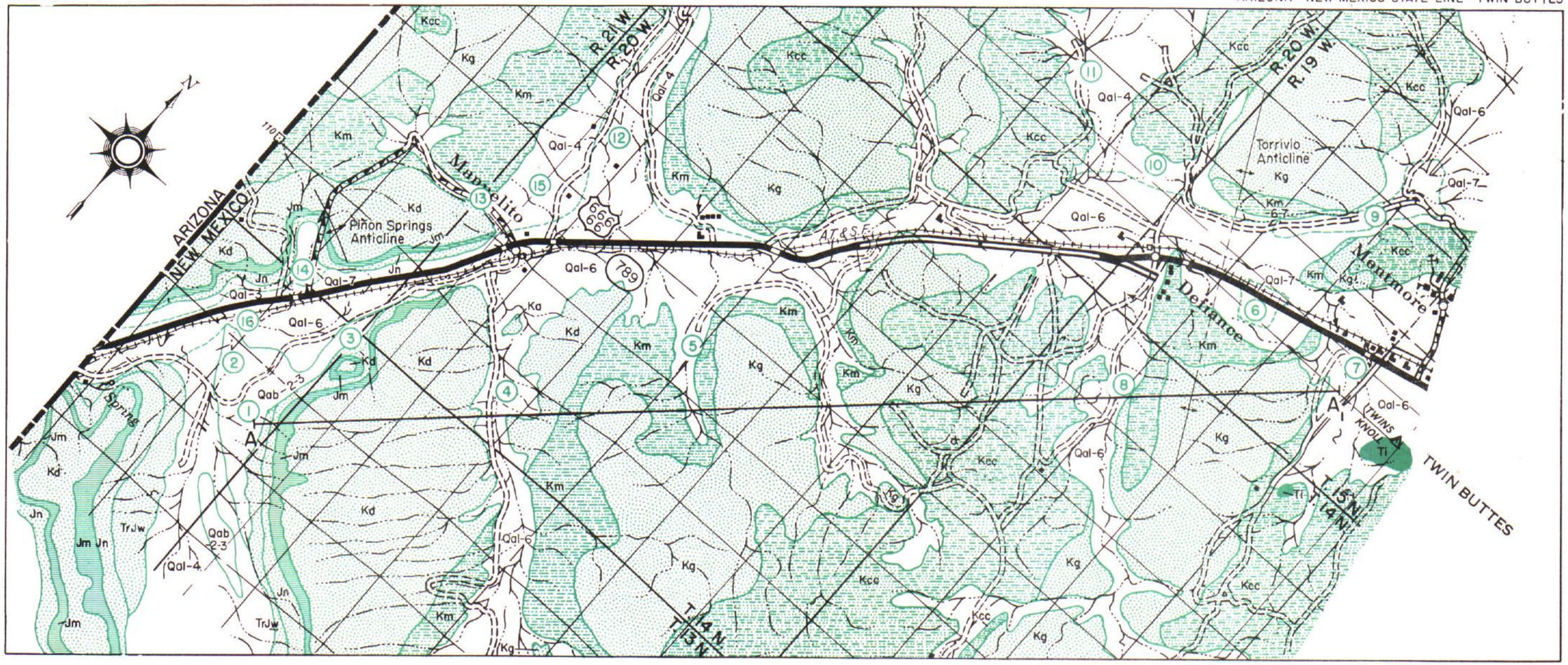
O'Sullivan and Beaumont, Oil and Gas Investigations U.S.G.S. Map O.M. 190.

Darton, N. H., Red Beds and Associated Formations in New Mexico, 1928.

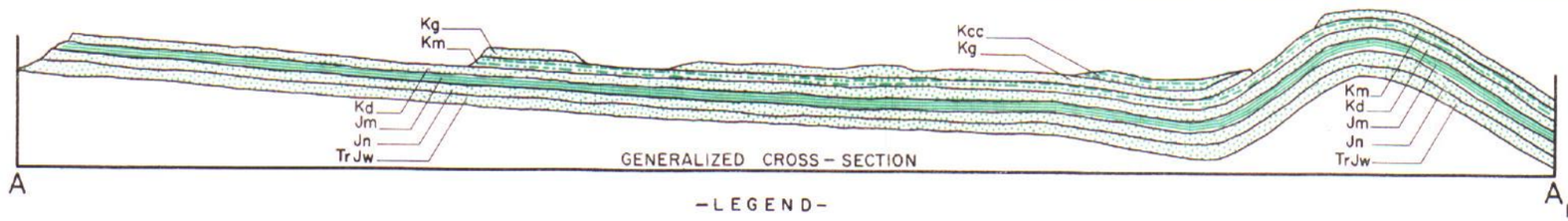
AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-1

INTERSTATE ROUTE 40
ARIZONA – NEW MEXICO STATE LINE – TWIN BUTTES



GEOLOGY MAPPED IN 1959



– LEGEND –

SEDIMENTARY ROCKS

QUATERNARY
- Qab — Bolson and wind blown deposits
- Qal — Alluvium

CRETACEOUS
- Mesaverde group
  - Kcc — Crevasse Canyon formation
  - Kg — Gallup sandstone
- Km — Mancos shale
- Kd — Dakota sandstone

TRIASSIC(?) JURASSIC
- Jm — Morrison formation
- Jn — Navajo sandstone
- TrJw — Wingate formation

IGNEOUS ROCKS

TERTIARY
- Ti — Intrusive Rocks

0
STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
ARIZONA-NEW MEXICO STATE LINE - TWIN BUTTES

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-1-2

Pit Number		57-18-S	57-39-S	58-97-S	59-57-S	59-52-S
Location	Part of Sec.	Not Sectionalized	NW¼	NE¼	NW¼	S½
	Section		3	33	26	22
	Twnshp. & Range		14N, 19W	23N, 31E	25N, 30E	1N, 6W *
	State	Arizona	New Mexico	Arizona	Arizona	Arizona
	County	Apache	McKinley	Apache	Apache	Apache
Geologic Age		Tertiary	Tertiary	Quaternary	Pre-Cambrian	Pre-Cambrian
Formation		Intrusive	Intrusive	Alluvium	-	Quartzite
Type of Pit		Quarry	Quarry	Gravel	Quarry	Quarry
Kind of Material		Basalt	Basalt	Sandstone & Concretions	Granite	Quartzite
Quality of Material		Good	Good	Fair	Good	Excellent
Thickness of Material		100+ ft.	228+ ft.	20 to 25 ft.	20 to 30 ft.	60+ ft.
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		Good	-	-	Good	Excellent
Uniformity		Fair	Good	Fair	Fair	Excellent
Impurities		Some Mineralization	None Noted	Some silty lenses	Minute Mineralization	None
Type Material Underlying Formation		-	-	Shale & Sandstone	-	-
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		None	None	5' Average	None	None
P.I. (Overburden)		None	None	-	-	None
Est. Quantity Remaining		200,000+ Cu. Yds.	60,000 Cu. Yds.	100,000 Cu. Yds.	250,000 Cu. Yds.	500,000+ Cu. Yds.
Est. Extension Possibilities		500,000 Cu. Yds.	None	None	None	500,000+ Cu. Yds.
Approx. Haul to Nearest Point		31.4 Mi.	1.9 Mi.	1.1 Mi.	18.3 Mi.	35.6 Mi.
L. A. Wear		36.8	35.2	60.8	16.0	12.8
Maximum Size		-	-	1"	-	-
% Retained on 2" Sieve		-	-	None	-	-
Pit Average % Passing	Crushed to	3/4 in.	1 in.	-	3/4 in.	2 in.
	2"	-	-	100	-	100
	1"	-	100	90	-	33.25
	3/4"	100	92	85	100	22
	1/2"	61	56	78	70	15
	#4	45	21	71	27	7
	#10	15	13	67	14.5	4
	#200	3	3	7	2.5	1
P. I.		N.P.	N.P.	N.P.	N.P.	N.P,
Accept For		Crushed stone	Crushed stone	Filler	Crushed stone	Crushed stone
Lab. Numbers		57-3703 to 3705	57-6599-A	58-18852 to 18854	59-6872 to 7538	59-6739 to 6742

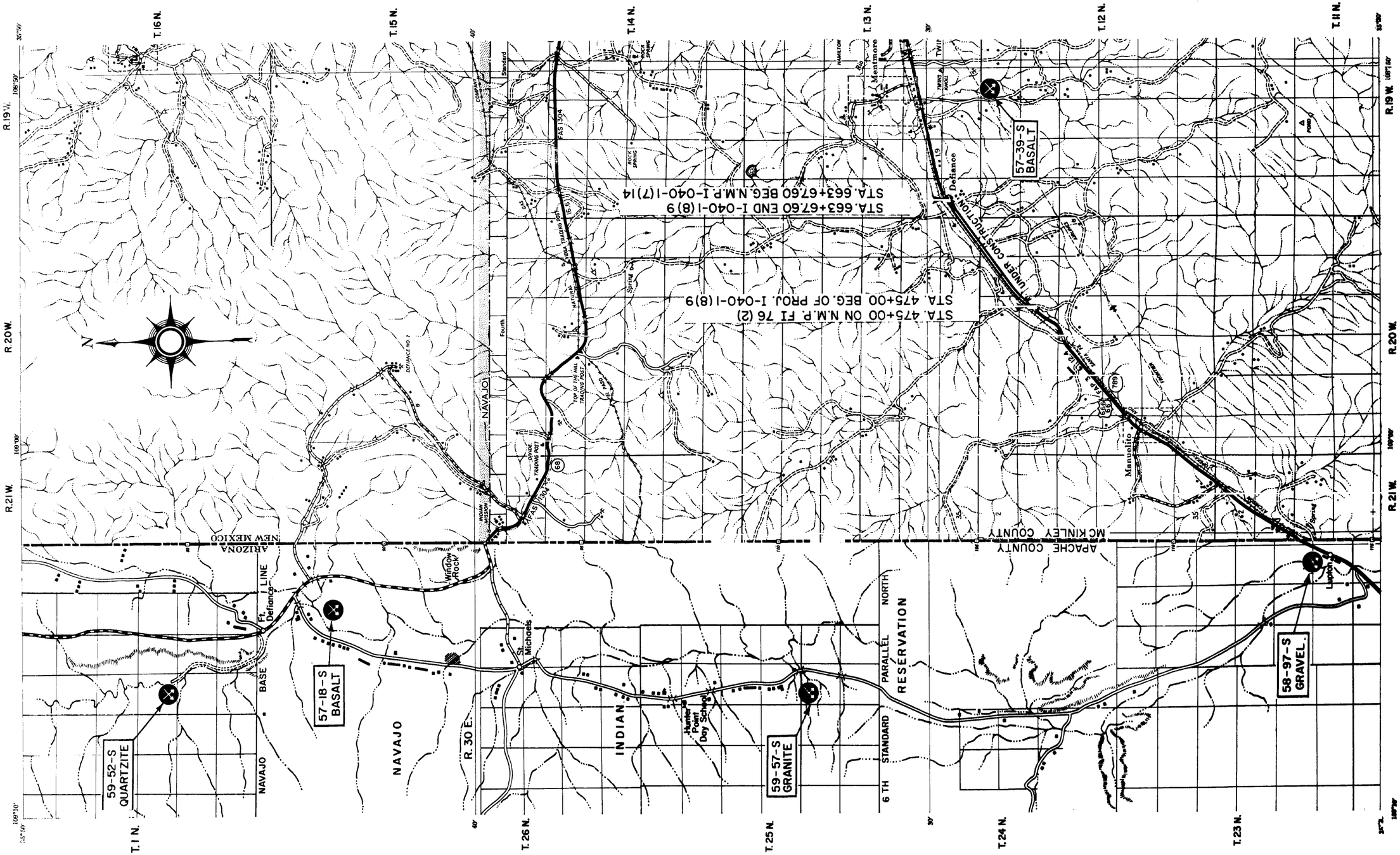
Remarks:

57-18-S - Located 4665' Lt. Sta. 217+00 on Project 12-A in State of Arizona.

57-39-S - Located 1.9 Mi. Rt. Sta. 814+77 on old Project F.I. 141(5).

58-97-S - Located 1.0 Mi. West on U.S. 66 from BOP Sta. 0+00 on Project I-IG-040-1(13)0, thence 570' North.

59-52-S - Located 2.8 Mi. N.W. of Ft. Defiance in Quartzite Canyon. *Navajo Survey. This material is exposed in 60' depths along the narrow canyon walls and approximately 30' back from the face there is a soft sandstone bed lying unconformably over the quartzite.



AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
TWIN BUTTES - WINGATE STATION

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies between Twin Buttes and Wingate Station. The area is a trough-type valley drained by the Rio Puerco of the West and bounded on the north by sandstone cliffs of Triassic, Jurassic, and Cretaceous age.

General Geology:

The regional geology consists of sedimentary beds of the Gallup-Zuni Basin which have been folded and warped by movements during the Zuni uplift. The results are the structural folds of the Nutria Monocline and the Gallup Anticline. The formational dips change from an easterly direction to a westerly direction and expose sediments ranging from Jurassic to Quaternary in age.

Geology and Soils Map 40-2 and the accompanying cross-section show the principal features of distribution and structure of this region. Their succession and character are given under the section termed "Stratigraphy".

Soils:

The soils of the Twin Buttes - Wingate Station area are derived from several distinct formations.

Soils produced from the Chinle formation are red clays of an A-7 classification. This formation forms the valley floor in this locale and is a very unstable foundation material.

Soils derived from the Crevasse Canyon formation and the Mancos shale are characteristic of the parent material from which they were developed. Both formations are predominantly clay shale with minor amounts of fine-grained sandstone. In the higher and sandy regions of the area silty soils (A-4) were noted while deposits within the main channel of the Rio Puerco were predominantely clays of an A-6 classification.

The adjacent sandstone formations are partly covered with residual sand and blow sand deposits of an A-2-4 classification. The surface soil near the margins of the Rio Puerco is silty sand and varies in depth from six to eight inches. The local dune deposits, adjoining the sandstone cliffs, reach depths of eight feet.

The areal distribution of the soils and their related formations are shown on Geology and Soils Map 40-2. Table # 40-2-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary: Alluvium - (Qal) valley fill consisting of sand, silt, and clay.

Bolson deposits - (Qab) wind-blown sand deposits.

Terrace gravel - (Qt) sand and gravel deposits.

Tertiary: Intrusive rocks (Ti) (Basaltic) necks of tuff-breccia with fragments of sedimentary rocks.

Cretaceous: Mesaverde group.

Menefee formation - (Kmf) alternating beds of tan and brownish-gray shale with lesser amounts of sandstone and coal.
Thickness: 1600 + feet.

Crevasse Canyon formation - (Kcc) alternating beds of tan, irregularly bedded drab shale, lenticular sandstone, claystone and coal.
Thickness: 500 to 700 feet, Coal beds 2 to 6 feet.

Gallup sandstone - (Kg) tan, brown, and pinkish-gray sandstone with lesser amounts of brown carbonaceous shale and coal.
Thickness: 180 to 250 feet.

Mancos shale - (Km) light- to dark-gray shale with lesser amounts of tan, fine-grained sandstone and siltstone.
Thickness: 700 feet.

Dakota sandstone - (Kd) tan, brown, and gray sandstone with minor amounts of brown carbonaceous shale and lesser amounts of coal.
Thickness: 120 to 200 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation - (Jm) grayish-red claystone, shale, and white, clean, fine- to medium-grained massive sandstone in alternating units.
Thickness: 150 to 300 feet.

Navajo sandstone - (Jn) greenish-gray to light yellowish-gray, fine- to medium-grained cross-bedded sandstone and moderate reddish-brown, fine-grained sandstone and siltstone.
Thickness: 400 feet.

Todilto formation - (Jt) gray, thin-bedded limestone and reddish-brown, sandy shale and siltstone.
Thickness: Limestone 1 foot, shale and siltstone 10 feet.

Triassic: ? Wingate formation - (TrJw) massive, friable, well sorted, crossbedded, brownish-orange sandstone.
Thickness: 300 feet.

Triassic: Chinle formation.

Upper member - (Trcu) red, purple, shale topped by conglomeratic limestone cemented by sandy silty mudstone.
Thickness: Shale body 300 + feet, Limestone 6 feet.

Middle member - (Trcm) medium to thick-bedded, hard yellow-gray, cross-bedded conglomeratic sandstone with partings of purple-gray shale.
Thickness: ?

Lower member - (Trcl) thin-bedded, purple-white silty shale with lenses of fine-grained sandstone and mudstone.
Thickness: ?

Construction materials:

Quaternary: Terrace deposits (Qt) - in the high terrace region east of the Nutria Monocline and north of U.S. 66. This formation contains a sandy gravel that has been accepted for select borrow and filler. The material is composed of sandstone gravel with large amounts of clean sand. This sand is covered by a thick sediment of soil with an average thickness of 12 feet. The thickness of the sand varies from 6 to 12 feet.

Bolson deposits (Qab) wind blown sand. This formation contains material acceptable for P.I. reducing filler in localized areas.

SOILS AND GEOLOGY

Jurassic: Todilto formation (Jt) - gray, thin-bedded limestone and reddish-brown sandy shale and siltstone. This formation pinches out in the Nutria Monocline and is too thin in this area to produce any construction material: however, it becomes thicker to the east and contains a great quantity of construction material reserves.

Triassic: Chinle formation - Upper member (Trcu). This formation contains shale capped by thin conglomeratic limestone. The limestone stratum is of poor quality and is impregnated with lenses of shale and mudstone. It has been accepted for maintenance use and is more suitable for this purpose than new construction because of the special treatment needed to produce acceptable material.

Soils Summary:

Table No. 40-2-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	8	A	0.0	6.0	A-4	Silty soil
"	"	9	A	0.0	3.0	A-4	Silty soil
"	"	10	A	0.0	3.0	A-6	Clayey soil
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"	12	A	0.0	3.0	A-6	Clayey soil
"	"	13	A	0.0	0.5	A-4	Silty soil
"	"	13	B	0.5	3.0	A-6	Clayey soil
"	"	14	A	0.0	3.0	A-6	Clayey soil
"	"	15	A	0.0	3.0	A-4	Silty soil
"	"	16	A	0.0	3.0	A-7	Clayey soil
"	"	17	A	0.0	12.0	A-6	Clayey soil
"	"	18	A	0.0	12.0	A-6	Clayey soil
"	"	19	A	0.0	12.0	A-7	Clayey soil
"	"	20	A	0.0	6.0	A-6	Clayey soil
"	"	21	A	0.0	3.0	A-7	Clayey soil
"	"	22	A	0.0	8.0	A-4	Silty soil
"	"	23	A	0.0	3.0	A-6	Clayey soil
"	"	24	A	0.0	3.0	A-4	Silty soil
"	"	25	A	0.0	3.0	A-4	Silty soil
"	Bolson Deposits	29	A	0.0	5.0	A-2-4	Silty sandy soil
"	"	30	A	0.0	3.0	A-4	Silty soil
"	"	31	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	32	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	33	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	34	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	35	A	0.0	3.0	A-2-4	Silty sandy soil
"	Terrace Deposits	26	A	0.0	12.0	A-2-4	Silty sandy soil
"	"	26	B	12.0	25.0	A-1-b	Gravel
"	"	27	A	0.0	10.0	A-4	Silty soil
"	"	27	B	10.0	14.0	A-1-b	Gravel
"	"	28	A	0.0	4.0	A-2-4	Silty sandy soil
"	"	28	B	4.0	13.0	A-3	Fine sand
Cretaceous	Menefee Fmn.	6	A	0.0	20.0	Solid Rock	Sandstone
"	"	6	B	20.0	160.0	A-7	Shale
"	"	7	A	0.0	20.0	Solid Rock	Sandstone
"	"	7	B	20.0	50.0	A-7	Shale
"	Crevasse Canyon	3	A	0.0	4.0	A-6	Clayey soil
"	"	3	B	4.0	6.0	A-7	Shale
"	"	3	C	6.0	9.0	Solid Rock	Sandstone
"	"	3	D	9.0	13.0	A-7	Shale
"	"	3	E	13.0	14.0	A-4	Coal
"	"	3	F	14.0	29.0	A-7	Shale
"	"	4	A	0.0	24.0	Solid Rock	Sandstone
"	"	4	B	24.0	30.0	A-7	Shale
"	"	4	C	30.0	33.0	Solid Rock	Sandstone
"	"	4	D	33.0	37.0	A-7	Shale
"	"	4	E	37.0	38.0	Solid Rock	Sandstone
"	"	4	F	38.0	83.0	A-7	Shale
"	"	4	G	83.0	87.0	Solid Rock	Sandstone
"	"	4	H	87.0	123.0	A-6	Shale
Cretaceous	Crevasse Canyon	4	I	123.0	137.0	Solid Rock	Sandstone
"	"	4	J	137.0	--	A-6	Shale
"	"	5	A	0.0	6.0	Solid Rock	Sandstone
"	"	5	B	6.0	42.0	A-7	Shale
"	"	5	C	42.0	44.0	A-4	Coal
Jurassic	Morrison	2	A	0.0	60.0	A-4	Shale
Triassic	Chinle	1	A	0.0	20.0	A-4	Silty soil
"	"	1	B	20.0	32.0	Solid Rock	Mudstone
"	"	1	C	32.0	40.0	Solid Rock	Limestone Conglomerate
"	"	1	D	40.0	52.0	A-4	Shale

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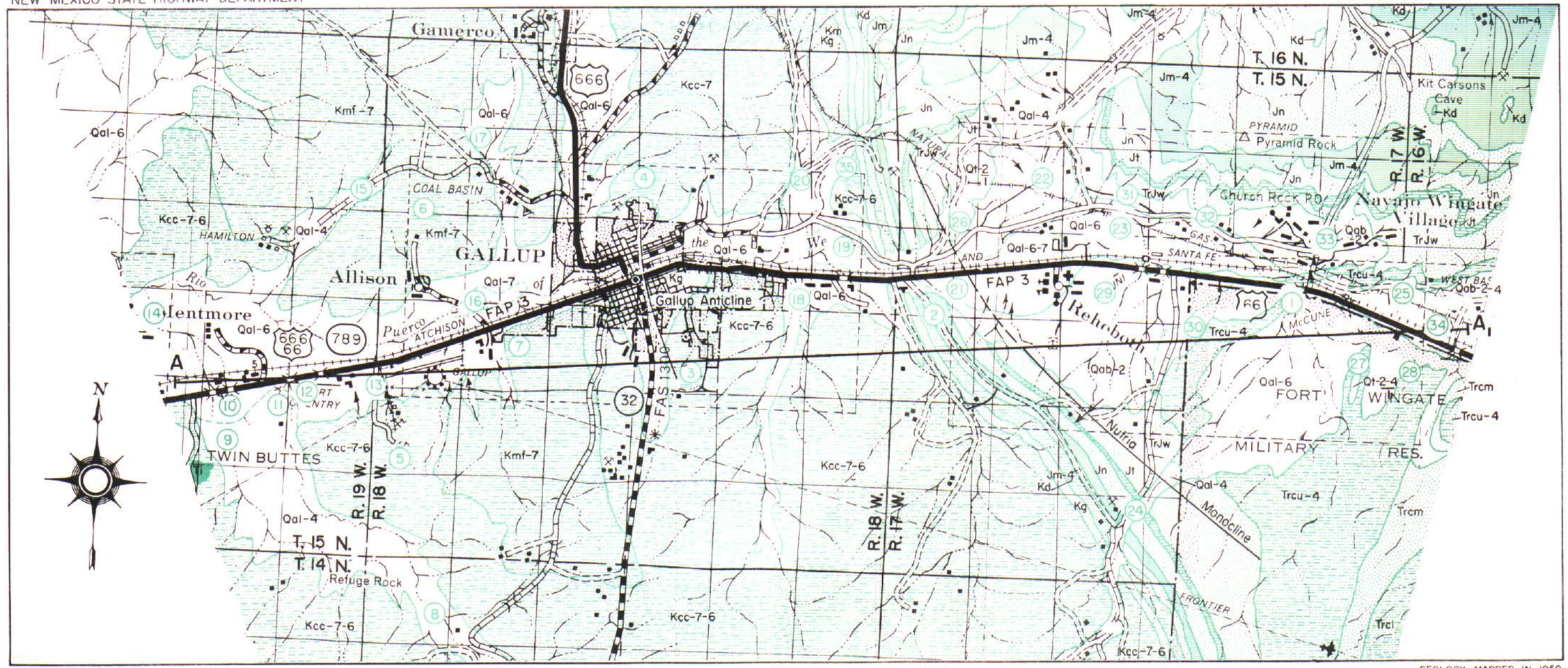
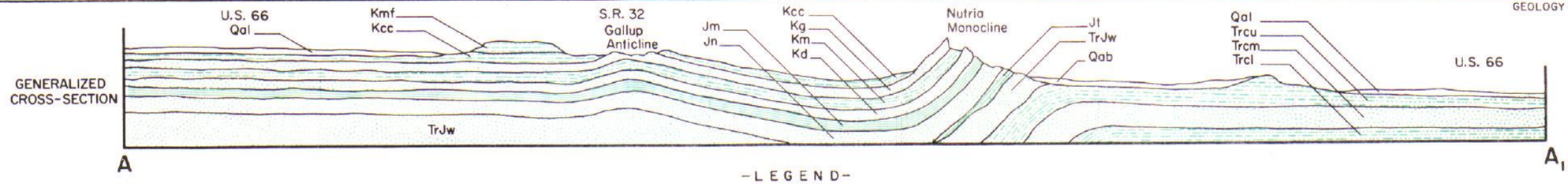
Sears, J. D., Geology and Coal Resources of Gallup-Zuni Basin, New Mexico, U.S.G.S. Bulletin 767, 1925.

SOILS AND GEOLOGY MAP 40-2





GEOLOGY MAPPED IN 1959

-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qab — Bolson and wind blown deposits
- Qal — Alluvium
- Qt — Terrace gravel

CRETACEOUS
- Mesoverde group
  - Kmf — Menefee formation
  - Kcc — Crevasse Canyon formation
  - Kg — Gallup sandstone
- Km — Mancos shale
- Kd — Dakota sandstone

JURASSIC
- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation
- TrJw — Wingate formation

TRIASSIC
- Trcu — Chinle formation Upper member
- Trcm — Chinle formation Middle member
- Trcl — Chinle formation Lower member

IGNEOUS ROCKS

TERTIARY
- Ti — Intrusive Rocks

0
STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
TWIN BUTTES - WINGATE STATION

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-2-2

Pit or Prospect No.		58-98-F	58-68-S		55-59-S	40-2-1 (Prospect)
Location	Part of Sec, Section	SE¼ 7	NE¼ 13	NW¼ 18	-- 32	SW¼ 22
	Twnshp. & Range	T15N. R17W	T15N. R17W	T15N. R16W	T16N. R18W	T15N, R17W
	County	McKinley	McKinley		McKinley	McKinley
	State	New Mexico	New Mexico		New Mexico	New Mexico
Owner		Navajo Indian Res.	Navajo Indian Res,		Private Property	Indian Allotment
Geologic Age		Quaternary	Triassic		--	Triassic
Formation		Alluvium	Chinle		--	Chinle
Type of Pit		Gravel	Quarry		Mine Tailings	Quarry
Kind of Material		Sandstone & concretions	Limestone conglomerate		"Red Dog"	Limestone conglomerate
Quality of Material		Fair	Poor		Poor	Poor
Thickness of Material		6 to12 ft,	6 to 8 ft,		Approx. 75 ft,	6 to 8 ft,
Thickness of Cap (Caliche)		--	--		--	--
Blasting Qualities		--	Fair		--	Fair
Uniformity		Poor	Good		Good	Good
Impurities		Clayballs*	Clay shale approx. 30%		--	Clay shale approx. 30%
Type of Material Underlying Formation		Sandstone	Clay shale		Soil	Clay shale
Moisture Condition		Dry	Dry		Dry	Dry
Depth of Overburden		3 to 15 ft,	0 to 15 ft,		--	0 to 15 ft,
P. I, (Overburden)		7	Yes		--	Yes
Est. Quantity Remaining		50,000 cu, yds.	None		100.000 + cu. yds,	--
Est. Extension Possibilities		300.000 cu. yds,	50,000 cu, yds,		--	**
Est. Quantity (prospect)						50,000 cu. yds.
Approx, Haul to Nearest Point		3/4 Mi.	1,5 Mi,		3,0 Mi,	1,5 Mi,
L. A. Wear		49,2	27,2		35.6	27,2
Maximum Size		2"	--		12"	--
% Retained on the 2" Sieve		less than 1%	--		Approx, 25%	--
Pit Average % Passing	Crushed to	--	5/8"		--	5/8"
	2"	100	--		--	--
	1"	97	--		--	--
	3/4"	95	--		--	--
	1/2"	93	76		--	76
	#4	81	27		--	27
	#10	75	12		--	12
	#200	7	6		--	6
P. I,		N,P,	8		N.P.	8
Lab, Numbers		58-19241. 19268	58-13349, 13353		55-8474, 8481	58-13349. 13353

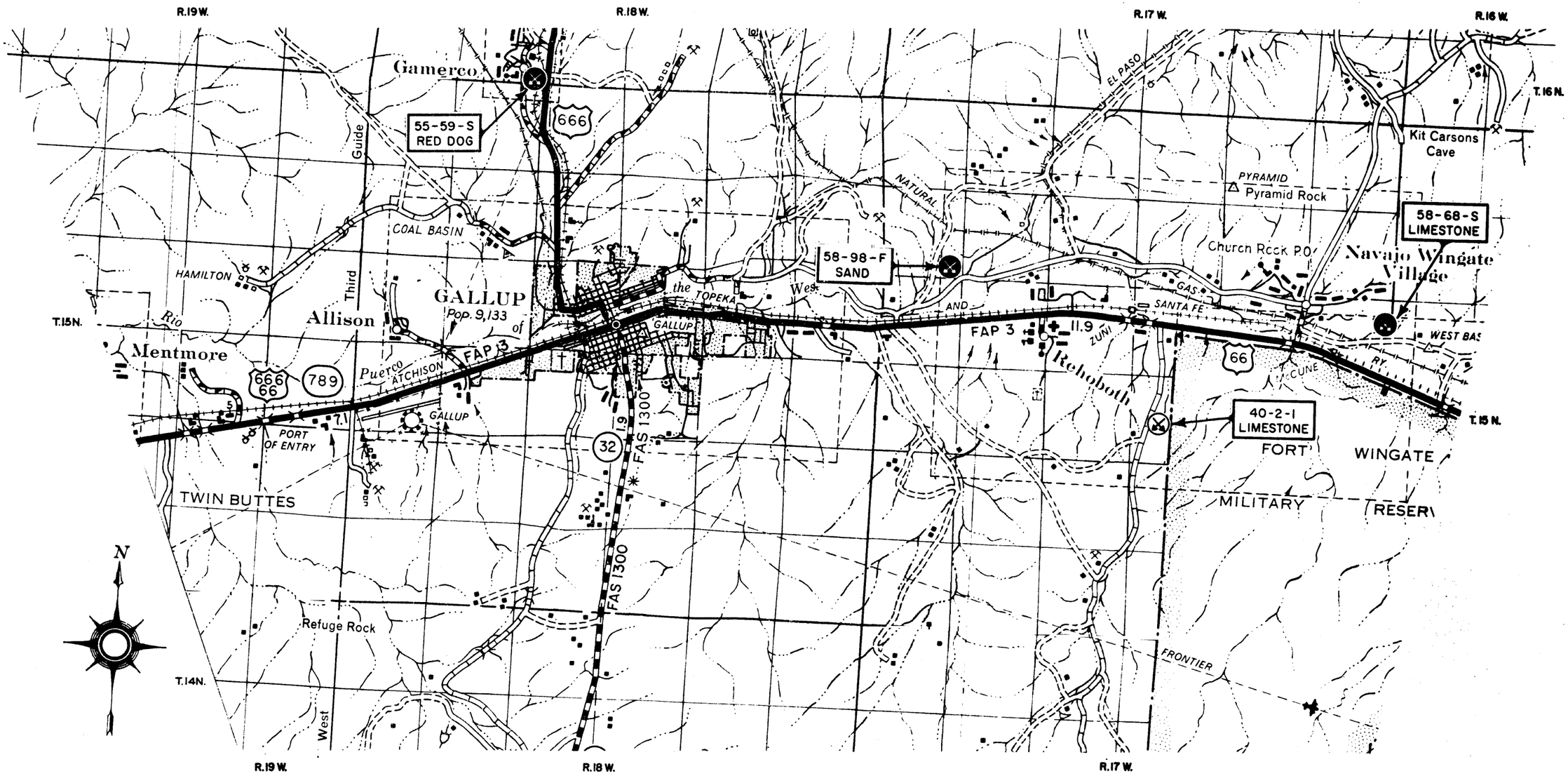
Remarks:

Pit No. 58-98-F - located 4615' N. Sta. 56+00 on old Proj. F.A.P.-27(6). Material consists of a gravelly sand. *Clay balls noted are situated at the contact of the soil overburden. Extension can be made in a northeasterly direction.

Pit No. 58-68-S - located 2681' N. and E. of R/W Sta. 350+80 on FL-8-A. This limestone is badly fractured and impregnated by clay and shale. It is more suitable for maintenance work than new construction because the fines are very difficult to waste.

Pit No. 55-59-S - located 910' Lt. Sta. 144+00 on F-031-1(1). Material consists of "Red Dog" - burned shale - mine tailings - from coal mine at Gamerco.

Prospect 40-2-1 is badly impregnated by clay and shale lenses. Recommended for sealing and maintenance only. It will have to have special treatment if used for new construction. **Further exploration needed to determine quantity.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
WINGATE STATION - CONTINENTAL DIVIDE

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies in a broad shallow valley bounded on the south by the Zuni Mountain Uplift and on the north by cliffs of Triassic, Jurassic, and Cretaceous rocks. The dominant geological feature of the area is the Zuni Uplift.

General Geology:

The Zuni Mountains were formed from a northwest-trending uplift, extending 80 miles east-west and approximately 35 miles north-south. This mountain uplift is generally considered to be the southern boundary line of the San Juan Basin. The mountains are strongly asymetrical, with vertical to overturned dips on the southwest flanks, and gentle dips of less than 10 degrees on the northwest side. Rocks ranging in age from Pre-Cambrian to Quaternary are exposed by erosion in this uplifted mass.

Soils:

Soils of this area are distributed in three distinct geological features. Two of the features are noted on Geology and Soils Map 40-3 as alluvium (Qal), and bolson and wind-blown deposits (Qab). The third feature, residual soils, is not mapped as a single unit, but it is to be interpreted as the soils developed, in place, on top of their parent materials. Residual soils change in accordance with the rock type of the formation specified. Soils of this area are poorly developed and have no distinctive profile.

Residual soils of the Chinle formation vary from stony-silty soils to stony-clay soils, each depending on the uppermost exposure of parent materials for its composition. The classifications of these soils range from A-2-4 (minor) to A-7. The residual soils of other formations were not studied in this investigation in that they have no relation to the engineering problems of this area.

Alluvial soils of this area occur in the lowlands, the floodplains, and along the banks of low gradient streams. These soils are predominantly clay; however, they grade into silt in some places. Classifications range from A-4 (minor) to A-7. These soils are derived from Chinle shales and finer sediments of the escarpment.

Bolson and wind-blown deposits occur along the foot of the escarpment north of U.S. 66. These deposits are a combination of stream and intermittent wind-blown sediments. The predominant materials are a mixture of sand and silt. Classifications range from A-2-4 to A-4. Parent materials exposed in this escarpment, sandstone and siltstone, are of Jurassic and Triassic age. The finer sediments of these parent materials are deposited in the valley floor.

Table No. 40-3-1 shows the log and classification of the soils samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-3.

Stratigraphy:

Quaternary: Alluvium (Qal) - consists of valley fill material composed mostly of sand, silt, and clay.
Thickness: ?

Bolson and wind-blown deposits (Qab) - wind-blown sand and intermittent stream deposits.
Thickness: ?

Cretaceous: Dakota sandstone (Kd) - tan, brown, gray, strongly cemented sandstone with intertongueing lenses of brown carbonaceous shale.
Thickness: 150 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation (Jm) - white and brown fine-to medium-grained sandstone, siltstone, and conglomerate.
Thickness: 300 feet.

Navajo formation (Jn) - white, brown, and red thick-bedded sandstone. Lower portions of the formation are represented by shale and siltstone.
Thickness: 380 feet.

Todilto formation (Jt) - thin-bedded, dark gray, dense, fine-grained limestone with sandstone and siltstone laminations in the lower part.
Thickness: 12 feet.

Triassic: ? Wingate sandstone (TrJw) - even-bedded, red to white silty sandstone and cross-bedded orange sandstone.
Thickness: 200 to 240 feet.

Triassic: Chinle formation:

Upper member (Trcu) - red, purple shale topped by conglomeratic limestone cemented by sandy and silty mudstone.
Thickness: Shale 300+ feet, Limestone 2 feet.

Middle member (Trcm) - medium to thick-bedded conglomeratic sandstone with lenses of purple-gray shales.
Thickness: 100 to 200 feet.

Lower member (Trcl) - thin-bedded, purple-white silty shale with lenses of fine-grained sandstone and mudstone.
Thickness: 300 to 400 feet.

Shinarump conglomerate (Trs) - yellowish-gray sandstone, conglomerate, and shale.
Thickness: ?

Moenkopi formation (Trm) - sandy red shale and siltstone.
Thickness: ?

Unconformity ----------Period of Erosion----------

Permian: San Andres formation (Psa) - massive-bedded, chalky limestone with buff and red sandstones. Also includes some shale partings.
Thickness: 100+ feet.

Construction Materials:

Quaternary: Bolson and wind-blown deposits (Qab) combination of stream platting and wind-blown sediments. Local areas will produce filler material suitable for hot-mix and for reducing P.I. Select borrow has been developed in some of the streams draining the escarpment north of U.S. 66.

Jurassic: Todilto formation (Jt) thin-bedded dark-gray, dense, fine-grained limestone in the upper portion; thin partings of green-gray, limy shale and siltstone in the lower portion; limestone 4 to 12 feet. Concrete aggregate, surfacing aggregate and hot-mix material have been produced from this formation.

The Todilto formation forms a continuous ledge capping the Wingate sandstone bluff north of U.S. 66. This ledge approximately parallels the highway from four to six miles north along this section. Because of the steepness and elevation of the Wingate bluff this area is not readily accessible from all points; however, there are various places that haul roads can be built, and this formation contains an almost inexhaustible supply of construction material.

Permian: San Andres formation (Psa) consists of three members; an upper limestone member, a middle sandstone member and a lower limestone member.

Upper member - massive gray limestone, pinkish and cherty in upper portion, locally contains thin sandstone lenses, distinguished from the lower member by its pinkish color and abundant fossil remains, 20 to 80 feet thick.

SOILS AND GEOLOGY

Middle member - gray to yellow, medium-grained, friable sandstone, 10 to 25 feet thick, resembles Glorieta sandstone.

Lower member - massive, blue-gray to white limestone 20 to 35 feet thick. This member is sandy near its base and grades upward into pure limestone with nodules and veinlets of calcite and lesser amounts of chert fragments.

The upper limestone member of this formation has a soft chalky portion on top (thickness variable). The softness of this upper portion and its stripping depths have made tested pit sites unsuitable for construction use. Exposures of practical quantities of the usable material have not been discovered in this area.

The lower limestone member of this formation contains the better construction material, in that it presents less impurities and is harder. Exposures of practical quantities of this member have not been discovered in this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-3. Test data and other related information are shown in Material Pit Summary Table No. 40-3-2.

Soils Summary:

Table No. 40-3-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	2	A	0.0	6.0	A-7	Clay soil
"	"	5	A	0.0	3.0	A-6	Clay soil
"	"	6	A	0.0	3.0	A-6	Clay soil
"	"	7	A	0.0	3.0	A-6	Clay soil
"	"	8	A	0.0	3.0	A-6	Clay soil
"	"	9	A	0.0	3.0	A-6	Clay soil
"	"	10	A	0.0	3.0	A-7	Clay soil
"	"	11	A	0.0	3.0	A-7	Clay soil
"	"	12	A	0.0	3.0	A-7	Clay soil
"	"	13	A	0.0	3.0	A-6	Clay soil
"	"	14	A	0.0	3.0	A-6	Clay soil
"	"	16	A	0.0	3.0	A-6	Clay soil
"	"	17	A	0.0	3.0	A-6	Clay soil
"	"	18	A	0.0	3.0	A-7	Clay soil
"	"	19	A	0.0	3.0	A-7	Clay soil
"	Bolson Deposits	15	A	0.0	3.0	A-4	Silty soil
"	"	20	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	21	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	22	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	23	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	25	A	0.0	3.0	A-4	Silty soil
"	"	26	A	0.0	3.0	A-3	Fine sand
"	"	27	A	0.0	3.0	A-2-4	Silty sandy soil
"	"	28	A	0.0	3.0	A-2-4	Silty sandy soil
Triassic	Upper Chinle	24	A	0.0	3.0	A-7	Clay soil
"	"	29	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	15.0	N.S.	Sandstone
"	"		C	15.0	18.0	A-6	Clay shale
"	"		D	18.0	--	A-5	Shale
"	"	31	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	10.0	A-6	Shale
"	"		C	10.0	--	A-4	Shale
"	"	32	A	0.0	6.0	A-4	Silty shale
"	"		B	6.0	11.0	N.S.	Sandstone
"	"		C	11.0	16.0	A-6	Clay shale
"	"		D	16.0	--	N.S.	Sandstone
"	Middle Chinle	1	A	0.0	3.0	A-6	Clay soil
"	"	3	A	0.0	6.0	A-2-4	Silty sandy soil
"	"	4	A	0.0	1.0	A-4	Silty soil
"	"	30	A	0.0	0.5	A-4	Silty soil
Triassic	Middle Chinle	30	B	0.5	5.0	N.S.	Sandstone
"	"		C	5.0	14.0	A-7	Clay shale
"	"		D	14.0	--	N.S.	Sandstone

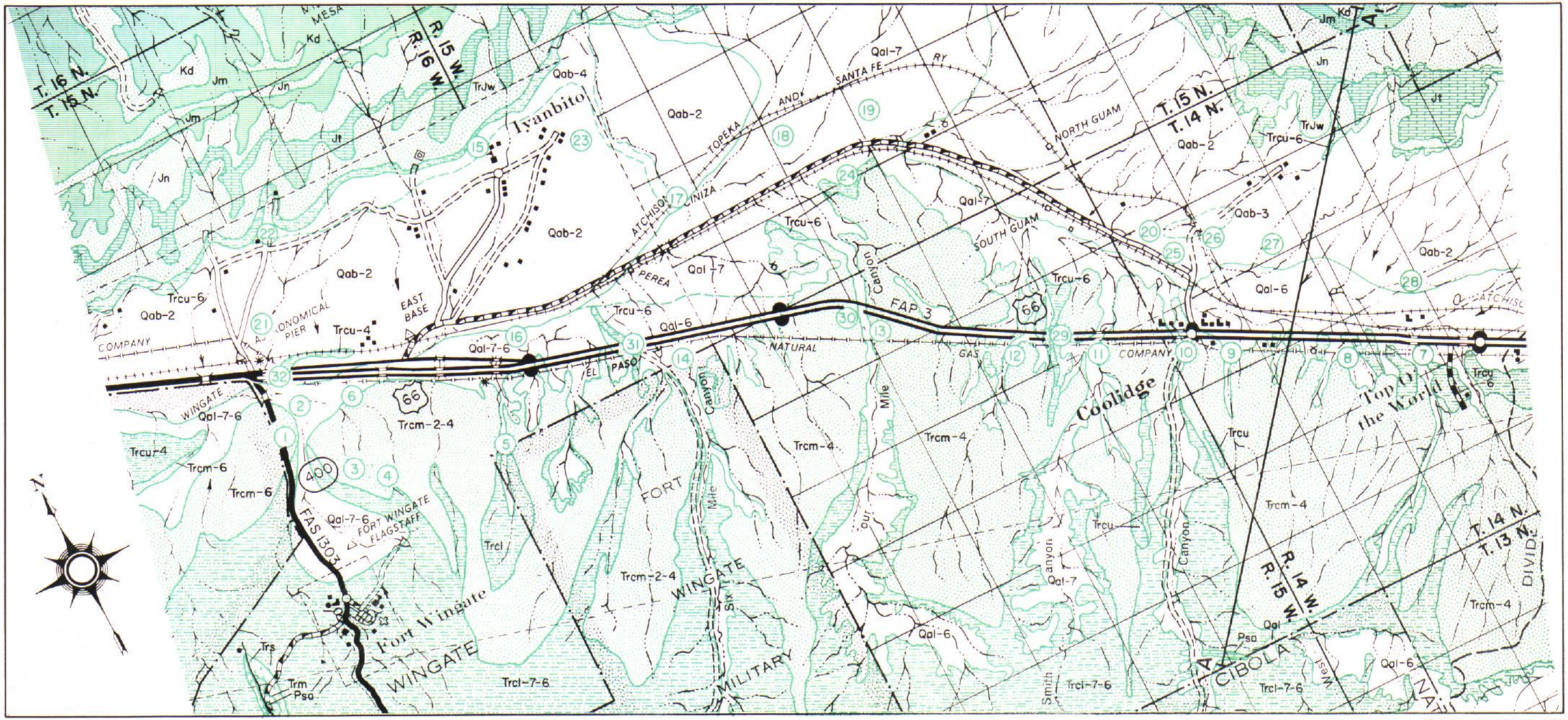
Selected References

Darton, N. H., Red Beds and Associated Formations in New Mexico, 1928.

O'Sullivan and Beaumont, Oil and Gas Investigations U.S.G.S. Map O.M. 190.

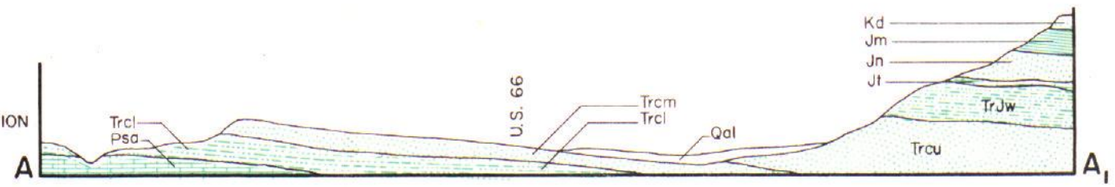
Smith, C.T., Geology of Foster Canyon Quadrangle, Valencia and McKinley Counties, New Mexico, 1959.

SOILS AND GEOLOGY MAP 40-3



GEOLOGY MAPPED IN 1959

GENERALIZED CROSS-SECTION



-LEGEND-

SEDIMENTARY ROCKS

- Qab — Bolson and wind blown deposits
- Qal — Alluvium

QUATERNARY

- Kd — Dakota sandstone

CRETACEOUS

- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation

JURASSIC

- TrJw — Wingate formation
- Trcu — Chinle formation Upper member
- Trcm — Chinle formation Middle member

TRIASSIC

- Trcl — Chinle formation Lower member
- Trs — Shinarump conglomerate
- Trm — Moenkopi formation

TRIASSIC

- Psa — San Andres formation

PERMIAN

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STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
WINGATE STATION - CONTINENTAL DIVIDE

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-3-2

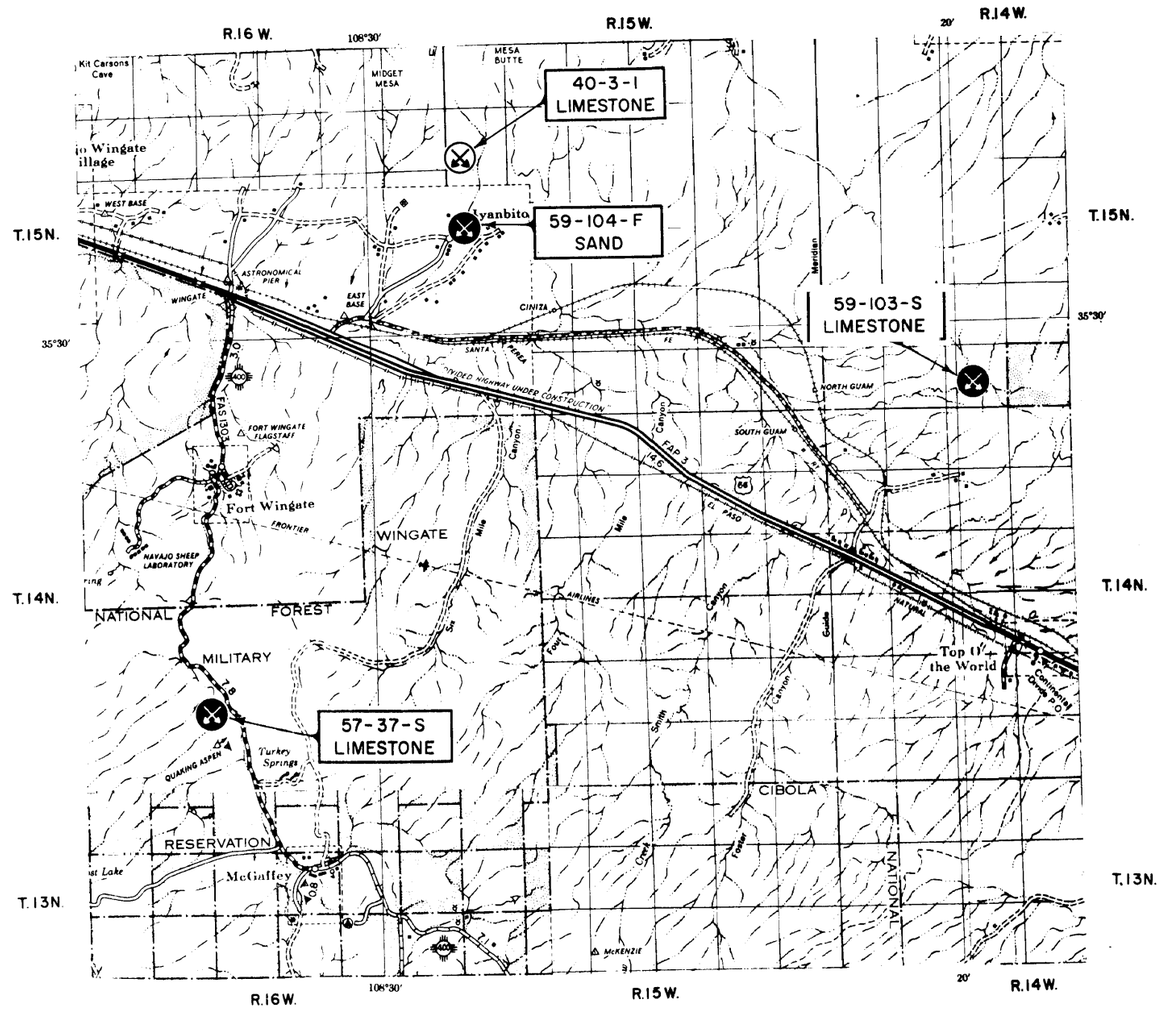
Pit or Prospect No.		40-3-1 (Prospect)	57-37-S	59-103-S	59-104-F
Location	Part of Sec.	SW¼	Not Sectionalized	S½	Not Sectionalized
	Section	7		33	
	Twnshp. & Range	T15N, R15W	T14N, R16W	T15N, R14W	--
	County	McKinley	McKinley	McKinley	McKinley
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		U.S. Government	Forest Land	U.S. Indian Allotment	Navajo Indian Reservation
Geologic Age		Jurassic	Permian	Jurassic	Quaternary
Formation		Todilto Limestone	San Andres (Upper Member)	Todilto Limestone	Alluvium
Type of Pit		Quarry	Quarry	Quarry	Sand
Kind of Material		Limestone	Limestone	Limestone	Sand
Quality of Material		Good	Good	Excellent	Fair
Thickness of Material		4 ft. average	20+ feet	13 feet	7 to 10 feet,
Thickness of Cap (Caliche)		--	--	--	--
Blasting Qualities		Good	Good	Excellent	--
Uniformity		Good	Good	Excellent	Fair
Impurities		None	None noted	None	Minor Silt Lenses
Type of Material Underlying Formation		Limy Siltstone	Sandstone	Sandstone	Clay
Moisture Condition		Dry	Dry	Dry	Dry
Depth of Overburden		2 to 10 feet est.	?	4 to 6 feet	--
P.I. (Overburden)		8	?	0 to 8	--
Est. Quantity Remaining		--	500,000 Cu. Yds.	250,000 Cu. Yds.	25,000 Cu. Yds,
Est. Extension Possibilities		--	--	500,000+ Cu. Yds,	None
Est. Quantity (Prospect)		200,000 Cu. Yds.	--		
Approx. Haul to Nearest Point		5.4 Mi.	7.5 Mi.	5.1 Mi,	3.2 Mi,
L. A. Wear		32.8	42.0	24.4	--
Maximum Size		--	--	--	2"
% Retained on 2" Sieve		--	--	--	Less than 1%
	Crushed to	1"	1"	1"	--
	2"	--	--	--	94
Pit	1"	100	100	100	91
Average	3/4"	81	94	84	84
% Passing	1/2"	44	61	56	74
	#4	18	26	19	52
	#10	10	16	11	35
	#200	3	2	3	3
P.I.		N.P.	N.P.	N.P,	0 to 12
Accept for				Surfacing	Filler
Lab. Numbers		59-18971 to 18974	57-6601 to 6602	59-16566 to 16580	59-16799 to 16829

Remarks:

57-37-S - located 131' Rt. Sta. 362+65.8 on F.A.S. 1303, State Road 400 toward McGaffey. The more desirable material is known to be covered by a soft chalky limestone that becomes thicker as the slope grades upward from the face on the creek. Further sub-surface investigation needed to determine the condition of this area.

59-103-S - located 5.1 Mi. Lt. Sta. 1210+00 on I-093-1(4). Pit can be extended in an easterly direction.

59-104-F - located 16,738 ft. Lt. Sta. 547+00 on Project I-IG-040-1(6)33. This pit is representative of the type material that may be located in the small arroyos draining the escarpment of this section



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

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AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
CONTINENTAL DIVIDE-PREWITT

SOILS AND GEOLOGY

Introduction:

Interstate Route 40 follows a broad east-west valley extending from the Continental Divide to Prewitt, New Mexico. Occasionally the highway cuts through the middle member of the Chinle formation, but generally, it is situated upon recent soils derived predominantly from the Chinle formation. The highway is bordered on the north by sandstone cliffs formed by rocks of Jurassic and Cretaceous age and to the south by gently sloping land composed of the Chinle formation of Triassic age.

General Geology:

The dominant geological feature of this area is the Zuni uplift which is a strongly asymmetrical mountain range that forms the central southern margin of the San Juan Basin. Pre-cambrian rocks in the core of the mountains are overlain successively by Pennsylvanian, Permian, Triassic, Jurassic, Cretaceous, and younger sedimentary rocks. In the area mapped only the Triassic and later sediments are exposed. These beds dip gently northward or northeastward, from three to five degrees, except where interrupted by several fault zones of small throw which radiate in a northeasterly or northerly direction from the core of the mountains.

Geology and Soils Map 40-4 and the accompanying cross-section show the principal features of distribution and structure of this region. Their succession and character are given under the section termed "Stratigraphy".

Soils:

The soils of this area are recognized in three geological features. Two of the features are noted on Geology and Soils Map 40-4 as alluvium (Qal) and bolson and wind-blown deposits (Qab). The third feature, residual soils, is not mapped as a single unit, but is to be interpreted as soils developed on top of their parent materials. The differences among these soils are caused mainly by differences in parent materials, drainage, and topography. The soils of this area are of recent origin and have not been in place long enough to have developed distinct profiles.

The most extensive study of residual soils was made parallel to and south of U. S. 66. These soils are derived from the Chinle formation, and they vary from stony-silty soils to clay soils. The engineering classification ranges from A-2-4 (minor) to A-7. Soils developed from the upper and lower members of the Chinle are predominantly clay (A-7). Soils developed from the middle member range from silty sand (A-2-4) to silt (A-4). Residual soils of other formations are considered insignificant to the engineering problems of this area.

The alluvial soils occur in the lowlands, the floodplains, and along the banks of low gradient streams. These soils are prodominantly clay; however, minor variations are likely to occur within each classification shown on the map. The soil classification ranges from A-4 (minor) to A-7. These soils are derived from the red clay shales of the Chinle formation combined with the finer sediments eroded from the escarpment north of the highway.

Bolson and wind-blown deposits occur along the foot of the escarpment north of U.S. 66 and, in most places, extends as far south as the A.T.& S.F. railroad. These soils are a combination of stream and intermittent wind-blown sediments and are composed of a mixture of sand and silt. Classifications range from A-4 (minor) to A-2-4. Variations are likely to occur within each classification shown on the map.

Table 40-4-1 shows the log and classification of the soils samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-4.

Stratigraphy:

Quaternary: Alluvium (Qal) - sand, silt, and clay.

Bolson deposits (Qab) - wind-blown sand and intermittant stream sediments.

Unconformity ---------- Period of Erosion ----------

Cretaceous: Dakota sandstone (Kd) - massive, cross-bedded, buff to brown conglomeratic sandstone with thin, gray, shale layers.
Thickness: 140 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation (Jm) - alternating, variegated and greenish siltstone, purplish to reddish sandy mudstone, and massive, reddish-brown sandstone.
Thickness: 450 feet.

Navajo sandstone (Jn) - alternating, poorly-sorted, thin-bedded, brown, red, and white siltstone and massive sandstone.
Thickness: 275 feet.

Todilto formation (Jt) - thin-bedded (1 to 6 inches) dark-gray, dense, fine-grained limestone with limy siltstone and shale lenses near the bottom.
Thickness: 12 to 20 feet.

Triassic: ? Wingate formation (TrJw) - massive, orange-red, friable, cross-bedded, medium to coarse-grained, cliff forming, sandstone.
Thickness: 300 feet.

Triassic: Chinle formation:

Upper member (Trcu) - red, purple, shale topped by conglomeratic limestone cemented by sandy silty mudstone.
Thickness: 1,000 feet.

Middle member (Trcm) - medium to thick-bedded, hard yellow-gray, cross-bedded conglomeratic sandstone with partings of purple-gray shale.
Thickness: 160 feet.

Lower member (Trcl) - thin-bedded, purple-white silty shale with lenses of fine-grained sandstone and mudstone.
Thickness: 400 feet.

Construction Materials:

Quaternary: Alluvium (Qal) - This formation contains a coarse sand in local areas in some of the streams draining the escarpment. This material has been accepted for filler and select borrow.

Jurassic: Todilto formation (Jt) - Thin-bedded, dark-gray, dense, fine-grained limestone in the upper portion; thin partings of green-gray, limy shale and siltstone in lower portion; limestone 12 to 20 feet. Concrete aggregate, surfacing aggregate and hot mix material have been produced from this formation.

The Todilto formation forms a continuous ledge capping the Wingate sandstone bluff north of U.S. 66. This ledge approximately parallels the highway from four to six miles north along this section. Because of the steepness and elevation of the Wingate bluff this area is not readily accessible from all points. There are various places where haul roads can be built, and this formation contains an almost inexhaustible supply of construction materials.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-4. Test data and other related information are shown in Material Pit Summary Table 40-4-2.

Soils Summary:

Table 40-4-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	3.0	A-7	Clayey soil
"	"	2	A	0.0	3.0	A-7	Clayey soil
"	"	3	A	0.0	3.0	A-2-4	Silty sand
"	"	4	A	0.0	3.0	A-7	Clayey soil
"	"	5	A	0.0	3.0	A-4	Silty soil
"	"	6	A	0.0	3.0	A-6	Clayey soil
"	"	7	A	0.0	3.0	A-7	Clayey soil
"	"	9	A	0.0	3.0	A-6	Clayey soil
"	"	10	A	0.0	3.0	A-6	Clayey soil
"	"	12	A	0.0	3.0	A-6	Clayey soil
"	"	14	A	0.0	3.0	A-6	Clayey soil
"	"	15	A	0.0	3.0	A-7	Clayey soil
"	"	16	A	0.0	3.0	A-7	Clayey soil
"	"	17	A	0.0	3.0	A-6	Clayey soil
"	"	22	A	0.0	3.0	A-7	Clayey soil
"	"	23	A	0.0	3.0	A-4	Silty soil
"	"	28	A	0.0	3.0	A-6	Clayey soil
"	"	29	A	0.0	3.0	A-7	Clayey soil
"	"	33	A	0.0	3.0	A-7	Clayey soil
"	"	41	A	0.0	5.0	A-4	Silty soil
"	"	42	A	0.0	3.0	A-4	Silty soil
"	"	43	A	0.0	3.0	A-7	Clayey soil
"	"	44	A	0.0	3.0	A-4	Silty soil
"	Bolson	18	A	0.0	3.0	A-4	Silty soil
"	"	19	A	0.0	3.0	A-2-4	Silty sand
"	"	20	A	0.0	3.0	A-4	Silty soil
"	"	21	A	0.0	3.0	A-2-4	Silty sand
"	"	24	A	0.0	3.0	A-2-4	Silty sand
"	"	25	A	0.0	3.0	A-2-4	Silty sand
"	"	26	A	0.0	3.0	A-2-4	Silty sand
"	"	27	A	0.0	3.0	A-2-4	Silty sand
"	"	30	A	0.0	3.0	A-2-4	Silty sand
"	"	31	A	0.0	3.0	A-2-4	Silty sand
"	"	45	A	0.0	3.0	A-2-4	Silty sand
The following residual soil samples represent soils derived from parent formations.							
Triassic	Middle Chinle	8	A	0.0	3.0	A-4	Silty soil
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"	13	A	0.0	3.0	A-4	Silty soil
"	"	34	A	0.0	2.0	A-2-4	Silty sand
"	"	35	A	0.0	3.0	A-4	Silty soil
"	"	36	A	0.0	1.0	A-2-4	Silty sand
"	"	37	A	0.0	2.0	A-4	Silty soil
"	"	38	A	0.0	0.5	A-4	Silty soil
"	"	39	A	0.0	3.0	A-4	Silty soil
"	Lower Chinle	40	A	0.0	3.0	A-6	Clayey soil
"	"	46	A	0.0	1.0	A-6	Clayey soil
"	"		B	1.0	--	Solid Rock	Sandstone
Jurassic	Todilto	32	A	0.0	6.0	A-4	Silty soil
The following sections show the material that may be encountered when cuts are made in the respective formations.							
Triassic	Upper Chinle	47	A	0.0	1.0	A-6	Clayey soil
"	"		B	1.0	5.0	A-6	Shale
"	"		C	5.0	16.0	Solid Rock	Sandstone
"	"		D	16.0	--	A-4	Shale
"	Middle Chinle	48	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	14.0	Solid Rock	Sandstone
"	"		C	14.0	30.0	A-6	Shale
"	"		D	30.0	37.0	Solid Rock	Sandstone
"	"		E	37.0	--	A-4	Shale
"	"	49	A	0.0	0.5	A-4	Silty soil
"	"		B	0.5	16.0	Solid Rock	Sandstone
"	"		C	16.0	--	A-4	Shale

Selected References

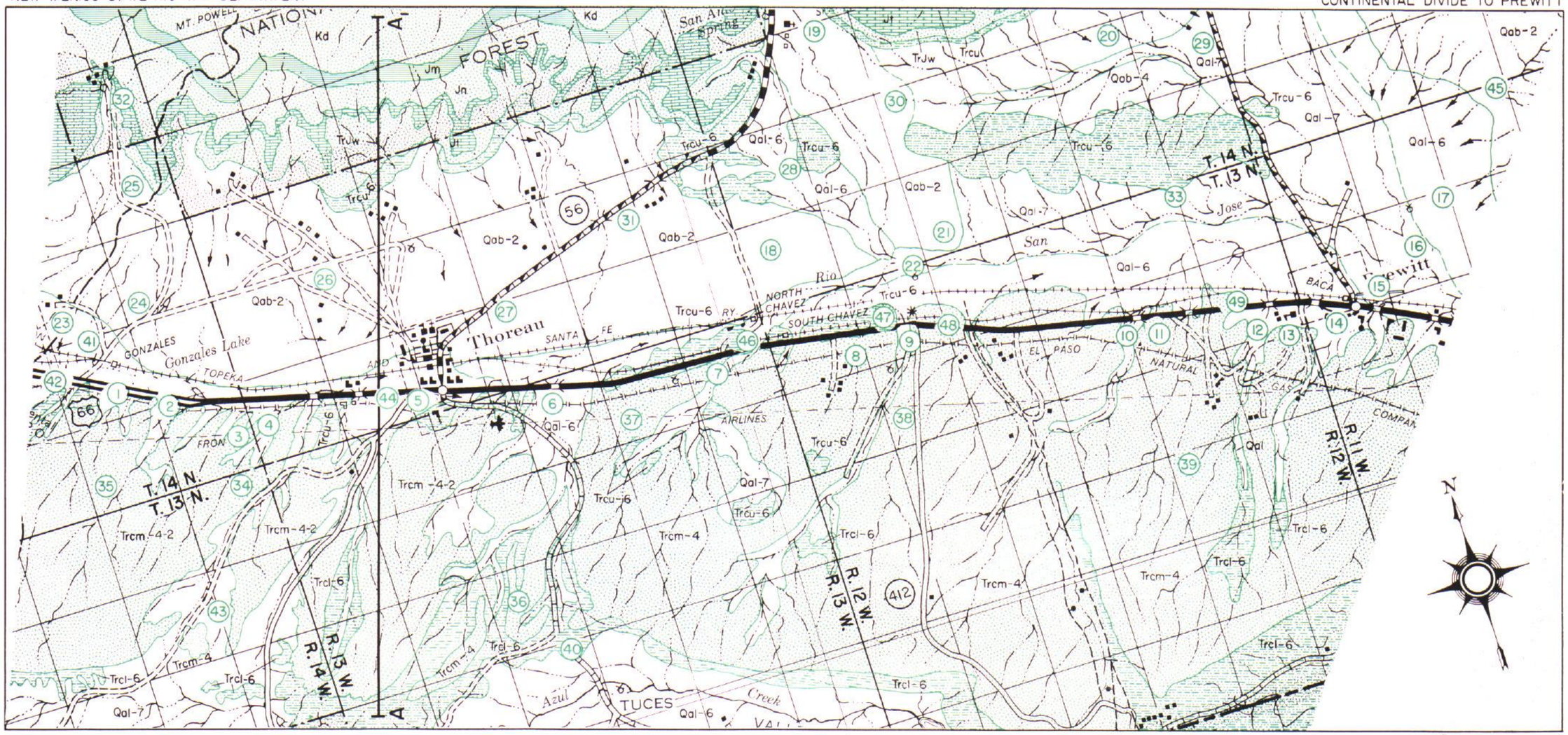
Smith, Clay T., 1954, Geology of the Thoreau Quadrangle, McKinley and Valencia Counties, New Mexico, State Bureau of Mines and Mineral Resources, Bulletin 31.

Darton, N. H., 1928, "Red Beds" and associated formations in New Mexico; U. S. Geol. Survey Bull. 794.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

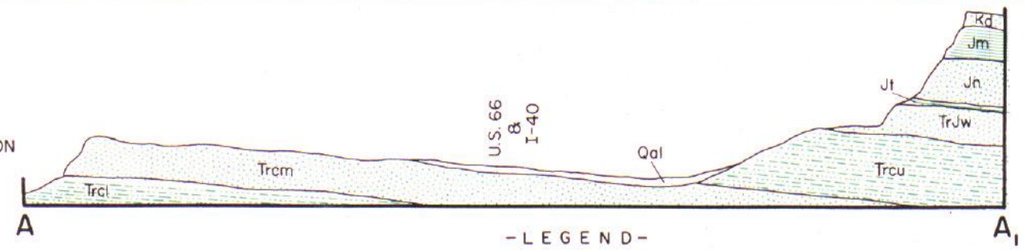
SOILS AND GEOLOGY MAP 40-4

INTERSTATE ROUTE 40
CONTINENTAL DIVIDE TO PREWITT



GEOLOGY MAPPED IN 1959

GENERALIZED CROSS-SECTION



-LEGEND-

SEDIMENTARY ROCKS

- Qab — Bolson and wind blown deposits
- Qal — Alluvium

QUATERNARY

- Kd — Dakota sandstone

CRETACEOUS

- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation

JURASSIC

- TrJw — Wingate formation
- Trcu — Chinle formation Upper member
- Trcm — Chinle formation Middle member

TRIASSIC

- Trcl — Chinle formation Lower member

TRIASSIC

0
STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
CONTINENTAL DIVIDE-PREWITT

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-4-2

Pit or Prospect No.		55-111-S	57-130-S	57-145-S	40-4-1 (Prospect)
Location	Part of Sec.	SE¼	SW¼ NW¼	SE¼	NW¼
	Section	18	17 20	12	19
	Twnshp. & Range	14N, 12W	14N, 12W	14N. 14W	14N. 12W
	County	McKinley	McKinley	McKinley	McKinley
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		T. L. Elkins	D. J. Elkins & Indian Allotment	Government Land	Elkins Estate
Geologic Age		Jurassic	Quaternary	Jurassic	Jurassic
Formation		Todilto	Alluvium	Todilto	Todilto
Type of Pit		Quarry	Sand	Quarry	Quarry
Kind of Material		Limestone	Sand	Limestone	Limestone
Quality of Material		Excellent	Good	Excellent	Excellent
Thickness of Material		6 to 12 ft.	8 ft.	6 to 12 ft.	15 to 20 ft.
Thickness of Cap (Caliche)		--	--	--	--
Blasting Qualities		Excellent	--	Excellent	Excellent
Uniformity		Good	Fair	Good	Excellent
Impurities		Siltstone partings lower part	Minor silt pockets	Siltstone partings lower part	Siltstone partings lower part
Type of Material Underlying Formation		Limy siltstone	Silt	Limy siltstone	Limy siltstone
Moisture Condition		Dry	Dry	Dry	Dry
Depth of Overburden		2 ft.	None	3 ft. average	2 ft.
P. I. (Overburden)		N.P. to 12	N.P.	N.P.	6
Est. Quantity Remaining		Worked out	70,000 cu. yds.	150.000 cu. yds.	--
Est. Extension Possibilities		100,000+ cu. yds.	More exploration needed	500.000+ cu. yds.	--
Est. Quantity (Prospect)		--	--	--	500.000+ cu. yds.
Approx. Haul to Nearest Point		7.0 Mi.	6.35 Mi.	3.6 Mi.	3.5 Mi. via North Chavez
L. A. Wear		32.0	68	30.0	22.8
Maximum Size		--	2"	--	--
% Retained on 2" Sieve		--	None	--	--
	Crushed to 2"	2" 100	1" --	1" --	2" 100
Pit Average % Passing	1"	34	100	100	60
	3/4"	28	99	96	41
	1/2"	20	94	66	29
	#4	10	82	26	13
	#10	6	74	15	7
	#200	2	5	4	3
P. I.		N.P.	N.P.	N.P.	N.P.
Lab. Numbers		55-17501 to 17509	57-19162 to 19174	57-20526 to 20544	60-158

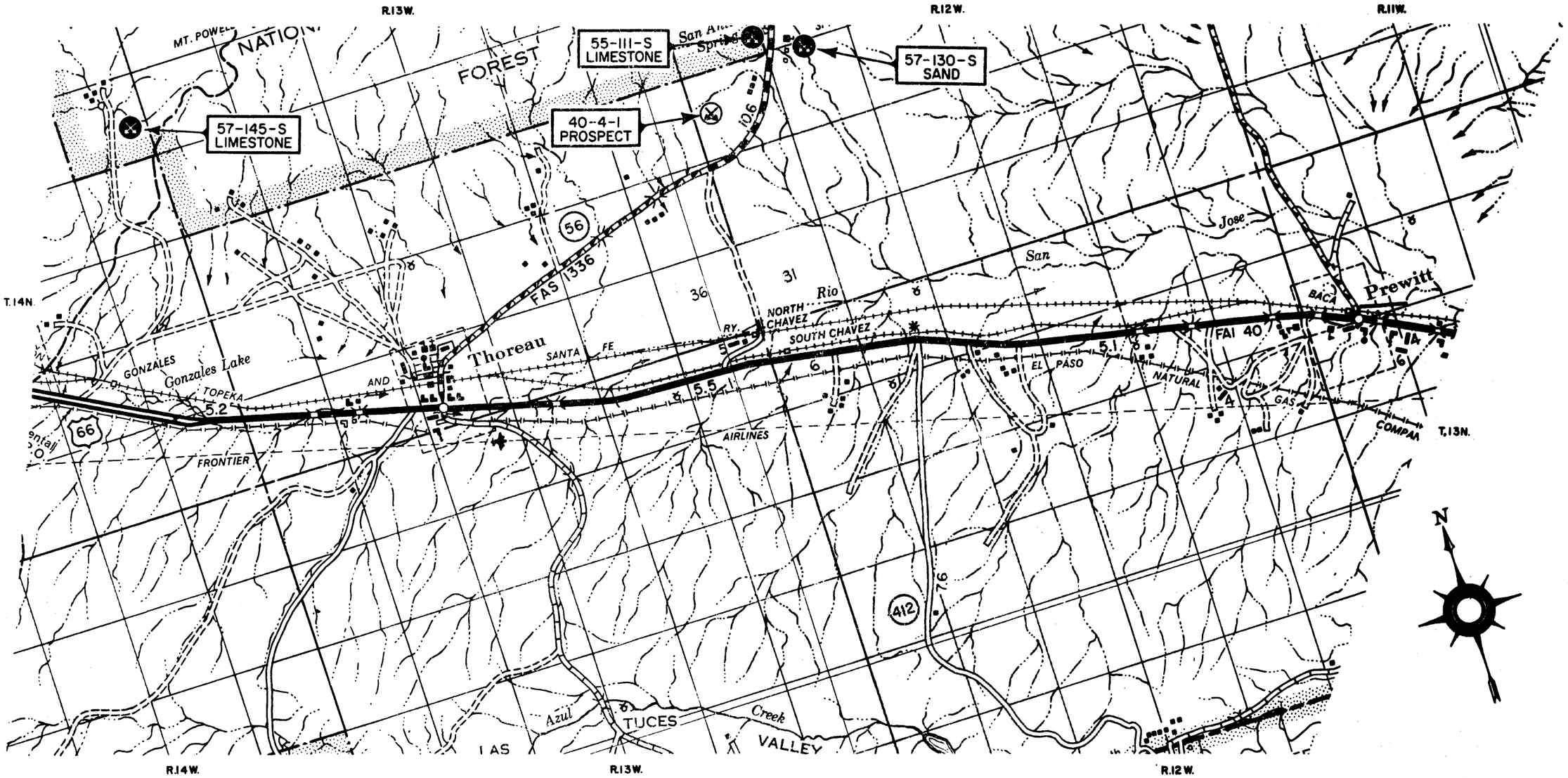
Remarks:

55-111-S - Located 535 feet left Station 123+00 on Project S-1336 (3). Extension area on Forest Land. Mineral rights owned by T. L. Elkins.

57-130-S - Is entered to show the type material that may be located in local areas of the streams draining the escarpment. Located 1764 feet right of P.I. Station 113+40.9 on Project S-1336 (1).

57-145-S - Located 3.6 Miles north of Station 319+62.6 on Project I-040-1(1)47.

40-4-1 - (Prospect) - Access may be made to this area by driving north of Thoreau approximately 7.0 Miles to old Pit No. 55-111-S, then take trail road to top of rim. We have the owners permission to develop this area at any time.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
PREWITT-GRANTS

SOILS AND GEOLOGY

Introduction:

The Prewitt-Grants section of Interstate Route 40 lies in a broad, shallow valley bounded on the south by the Zuni Mountain Uplift, and on the north by cliffs of Triassic, Jurassic, and Cretaceous age. This section is characterized by widespread early Quaternary and late Tertiary lava flows.

General Geology:

The Quaternary basalt flow in the vicinity of Bluewater is probably derived from El Tintero volcano, whose extinct cone lies north of U.S. 66 near Haystack Butte. This basalt covers a large area and intertongues with the McCartys flow south of Grants. Tertiary basalt, which caps the high mesas north of Grants, is derived from Mt. Taylor, an extinct volcano which lies northeast of this section.

Permian rocks, which form the northern flank of the Zuni mountains outcrop south of U.S. 66. They are particularly noticeable in the fault scarp in Bluewater Canyon, where an almost complete regional section of Permian rocks can be observed.

The areal distribution of the formations and members are shown on map 40-5. Their succession and character are given under the section termed "Stratigraphy".

Soils:

The soils of the Prewitt-Grants area lie in a valley formed by the Bluewater and San Mateo drainage systems. Streams which contribute sediments to the Bluewater area flow through formations ranging in age from pre-Cambrian to Permian. Discharges of the San Mateo region drain formations of Cretaceous age. All of the soils occur within an area having a uniform climate. The differences of the sediments are contributed mainly to differences in materials, drainage, and topography.

The alluvial soils are variable, and in some places the soil types are so intermixed that it is not practical to map them separately. They are shown on the map as A-4 to A-6 etc. Most of the sediments deposited along Bluewater Creek originated from the red to reddish-brown clay shales of the Chinle formation, though there are admixtures of materials from formations of Jurassic and Permian age. As the nature of the parent material indicates, the sediments are predominantly reddish-brown clay (A-7). Sediments of the San Mateo drainage basin are derived from Dakota sandstone, Mancos shale and Mesaverde formation. They form silty, sandy, and clayey soils (A-2-4 to A-7). The sediments northeast of Prewitt are derived from the adjacent Jurassic rocks and have been effected by wind erosion. Soils of this area are predominantly silty sand (A-2-4).

Aeolian or wind-blown deposits occur at the base of the landslide debris west of Grants. These deposits consist of a fine sand (A-3).

The residual soils of this area, that were studied, overlie Quaternary basalt and rocks of Triassic and Permian age. Examination of the rocks of the recent basalt flows showed very little weathering, however, they are covered with a veneer of silty soil (A-4). The soils covering the Chinle formation are predominantly clayey (A-7). Stony-silty soils (A-4) and stony-clay soils (A-7) overlie the San Andres formation and vary in depth from 0.0 feet to 4.0 feet. Other residual soils are considered insignificant to the engineering problems of this section.

Table 40-5-1 shows the log and classification of the soils samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-5.

Stratigraphy:

Quaternary: Alluvium (Qal) - valley-fill of gravel, sand, silt, and clay.

Aeolian deposits (Qa) - wind-blown sand.

Landslide debris (Qls) - basalt boulders, sand, and clay.

Vesicular basalt (Qvb) - extremely rough and broken flows.
Thickness: 90 feet.

Cinders (Qc) - basaltic cinders which formed El Tintero volcano.

Tertiary: Basalt (Tb) - massive, dense, crystalline basalt with a vesicular cap.
Thickness: 40 feet.

Unconformity ----------Period of Erosion----------

Cretaceous: Dakota sandstone (Kd) - buff to brown, medium to course-grained sandstone with interbedded conglomerate and gray shale.
Thickness: 100 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation (Jm) - interbedded greenish siltstone, purple to red sandy mudstone, and white to buff to reddish-brown course-grained sandstone.
Thickness: 450 feet.

Navajo formation (Jn) - massive, medium-grained, poorly-sorted, cross-bedded, red and white sandstone with thin, red, brown, and white siltstone beds near the base.
Thickness: 200 feet.

Todilto formation (Jt) - thin-bedded, impure, gray, dense limestone with sandstone and siltstone laminae in lower part.
Thickness: 12 to 20 feet.

Triassic: ? Wingate sandstone (TrJw) - reddish-brown, crossbedded sandstone.
Thickness: 160 feet.

Triassic: Chinle formation:

Upper member (Trcu) - concealed by Quaternary basalt.

Middle member (Trcm) - medium to thick-bedded, yellow to gray, conglomeratic sandstone with lenses of purplish shale.
Thickness: 100 to 200 feet.

Lower member (Trcl) - soft, red and purplish shales, with minor amounts of gray and buff shale and gray sandstone.
Thickness: 400 to 500 feet.

Unconformity ----------Period of Erosion----------

Permian: San Andres formation (Psa):

Upper member - massive gray limestone, cherty in upper portion, locally contains sandstone lenses.
Thickness: 20 to 80 feet.

Middle member - gray to yellow, medium-grained, friable sandstone. Resembles Glorieta sandstone.
Thickness: 10 to 25 feet.

Lower member - blue-gray to white, massive limestone. Sandy near base; and grades upward into pure limestone.
Thickness: 20 to 35 feet.

Glorieta sandstone (Pg) - massive, well-sorted, white to buff, cross-bedded, quartz sandstone.
Thickness: 120 feet.

Yeso formation (Py) - poorly-sorted, variegated pink, medium to course-grained sandstone and siltstone. With well-sorted, medium-grained, white to buff sandstone near the top.

Construction Materials:

Quaternary: Alluvium (Qal) sand and gravel. Sandy pits of filler and select borrow have been developed in some parts of these sediments. The small quantities remaining in these pits should not be considered as aggregate reserves. However, further exploration may reveal local usable quantities.

SOILS AND GEOLOGY

Quaternary Con't Terrace deposits (Qt) sand and gravel. These sediments are outside the boundaries of the Soils and Geology Map. These deposits are along streams which drain the highland north of Interstate Route 40 and east of State Road 53. Sandy aggregate pits may be located in these terraces. An explored pit site in a terrace is shown on the Construction Materials Inventory Map.

Aeolian deposits (Qa) blow sand. This sand occurs in local areas north of Interstate Route 40 and east of State Road 53. P. I. reducing filler may be obtained from this formation.

Tertiary: Basalt (Tb). This basalt caps the mesa west of Grants. Although the upper 6 to 10 feet is vesicular, the underlying dense basalt is accessible and usable as aggregate. However, the San Andres limestone in this mapped area should take precedence over the basalt for economic reasons.

Jurassic: Todilto formation (Jt) predominantly limestone. This is a valuable source of aggregate in this section. It crops out and forms a nearly continuous bench along the scarp north of Interstate Route 40. It becomes more distant from the highway as one travels east. Therefore it becomes a less economical source, due to the increasing haul. The San Andres formation is used when the Todilto limestone is not economical to use.

Permian: San Andres formation (Psa) limestone. Exposures of usable quantities of limestone may be found locally in this formation. Along the walls of some of the drainageways, the chert and sandstone lenses of the upper portion have been weathered back far enough to expose the massive limestone in areas large enough to locate aggregate pits. There are also local areas of thinner-bedded limestone which will make excellent surfacing material. The lower member would be a more desirable construction material because of its density and lack of impurities. However, exposures of usable quantities of this member have not been discovered.

Soils Summary:

Table No. 40-5-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	6.0	A-2-4	Silty sand
"	"	2	A	0.0	9.0	A-2-4	Silty sand
"	"	4	A	0.0	10.0	A-7	Clayey soil
"	"	7	A	0.0	6.0	A-7	Clayey soil
"	"	8	A	0.0	4.0	A-7	Clayey soil
"	"	10	A	0.0	3.0	A-2-4	Silty sand
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"	12	A	0.0	4.0	A-6	Clayey soil
"	"	13	A	0.0	1.0	A-2-4	Silty sand
"	"	13	B	1.0	3.0	A-6	Clayey soil
"	"	14	A	0.0	3.0	A-6	Clayey soil
"	"	15	A	0.0	2.0	A-7	Clayey soil
"	"	16	A	0.0	4.0	A-4	Silty soil
"	"	17	A	0.0	3.0	A-7	Clayey soil
"	"	18	A	0.0	6.0	A-4	Silty soil
"	"	19	A	0.0	12.0	A-6	Clayey soil
"	"	19	B	12.0	16.0	A-2-4	Silty sand
"	"	21	A	0.0	6.0	A-4	Silty soil
"	"	22	A	0.0	4.0	A-7	Clayey soil
"	"	24	A	0.0	3.0	A-2-4	Silty sand
"	"	24	B	3.0	15.0	A-4	Silty soil
"	"	25	A	0.0	2.0	A-4	Silty soil
"	"	26	A	0.0	6.0	A-7	Clayey soil
"	"	27	A	0.0	5.0	A-7	Clayey soil
"	"	30	A	0.0	6.0	A-4	Silty soil
"	"	31	A	0.0	4.5	A-4	Silty soil
"	"	32	A	0.0	5.0	A-4	Silty soil
"	"	33	A	0.0	1.5	A-6	Clayey soil
"	"	33	B	1.5	4.0	A-2-4	Silty sand
"	"	34	A	0.0	5.0	A-4	Silty soil
"	"	35	A	0.0	1.5	A-4	Silty soil
"	"	36	A	0.0	4.0	A-4	Silty soil
"	"	38	A	0.0	2.0	A-2-4	Silty sand
"	"	39	A	0.0	3.0	A-2-4	Silty sand
"	"	40	A	0.0	1.5	A-2-4	Silty sand
"	"	41	A	0.0	1.5	A-6	Clayey soil
"	Aeolian	23	A	0.0	3.0	A-3	Fine sand
"	"	37	A	0.0	3.0	A-3	Fine sand
The following residual soil samples represent soils derived from parent formations,							
Quaternary	Vesicular Basalt	3	A	0.0	4.0	A-4	Silty soil
"	"	5	A	0.0	0.5	A-4	Silty soil
"	"	9	A	0.0	0.5	A-4	Silty soil
Triassic	Middle Chinle	6	A	0.0	3.0	A-7	Clayey soil
"	"	29	A	0.0	5.0	A-2-6	Clayey sand
Permian	San Andres	20	A	0.0	1.5	A-4	Silty soil
The following sections of formations show the material that may be encountered when cuts are made in the respective formations.							
Triassic	Middle Chinle	28	A	0.0	10.0	Solid Rock	Sandstone
"	"	28	B	10.0	50.0	A-7	Shale
"	"	28	C	50.0	51.0	Solid Rock	Sandstone
"	"	28	D	51.0	81.0	A-7	Shale
"	"	28	E	81.0	82.0	Solid Rock	Sandstone
"	"	28	F	82.0	--	A-7	Shale
Permian	San Andres	42	A	0.0	1.5	A-6	Shale
"	"	42	B	1.5	9.0	Solid Rock	Limestone

Selected References

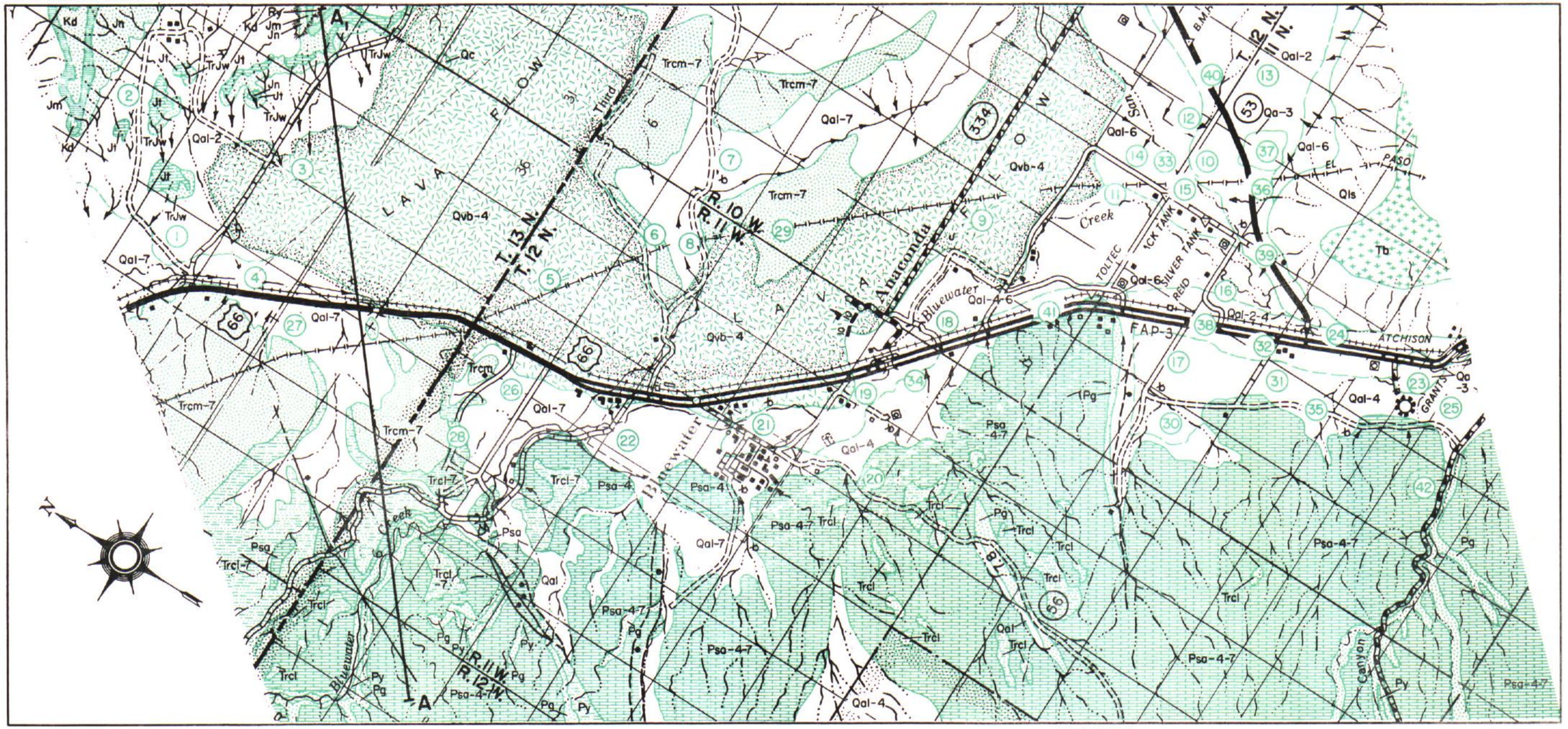
Darton, N.H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Survey Bull. 794.

New Mexico Geological Society, 1959, Tenth Field Conference, West-central New Mexico.

Smith, C. T., 1954, Geology of the Thoreau Quadrangle, McKinley and Valencia Counties, New Mexico, New Mexico State Bureau of Mines Bull. 31.

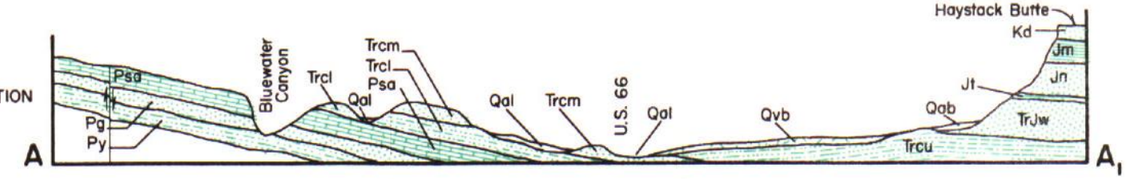
United States Department of Agriculture, 1958, Soil Survey-Bluewater Area New Mexico, Soil Conservation Service, Series 1955, No. 2.

SOILS AND GEOLOGY MAP 40-5



GEOLOGY MAPPED IN 1960

GENERALIZED CROSS-SECTION



-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qa — Aeolian deposits
- Qls — Landslide debris

CRETACEOUS
- Kd — Dakota sandstone

JURASSIC
- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation

TRIASSIC
- TrJw — Wingate formation
- Trcu — Chinle formation Upper member
- Trcm — Chinle formation Middle member
- Trcl — Chinle formation Lower member

PERMIAN
- Psa — San Andres formation
- Pg — Glorieta sandstone
- Py — Yeso formation

IGNEOUS ROCKS

QUATERNARY
- Qvb — Malpais
- Qc — Cinders

TERTIARY
- Tb — Basalt flows

0 STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
PREWITT-GRANTS

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-5-2

Pit or Prospect No.		40-5-1 (Prospect)	40-5-2 (Prospect)	40-5-3 (Prospect)	40-5-4 (Prospect)	55-58-S	57-83-S	57-127-F
	Part of Sec.	NW¼	E½ 8, W½ 9	SW¼	All *	See Remarks	E½	SW¼
	Section	15	8 and 9	17	32	" "	29	25
Location	Twnshp. & Range	13N. 11W	12N. 11W	11N. 10W	11N. 10W	" "	11N. 10W	12N. 10W
	County	McKinley	Valencia	Valencia	Valencia	Valencia	Valencia	Valencia
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Elkins Estate	Blake Bowlin	Quinta Corp.	State Land	U. S. Government	Annie Pickard	G. P. Roundy
Geologic Age		Jurassic	Permian	Permian	Permian	Permian	Permian	Quaternary
Formation		Todilto	San Andres	San Andres	San Andres	San Andres (Upper)	San Andres (Upper)	Terrace deposit
Type of Pit		Quarry	Quarry	Quarry	Quarry	Quarry	Quarry	Sand
Kind of Material		Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Sandy Gravel
Quality of Material		Excellent	Good	Good	Good	Excellent	Good	Fair
Thickness of Material		10 to 12 ft.	6 ft. ?	20 ft. +	Variable	12 ft. (Approximately)	8 ft.	6 to 12 ft.
Thickness of Cap (Caliche)		--	--	--	--	--	--	--
Blasting Qualities		Excellent	Excellent	?	?	Excellent	Excellent	--
Uniformity		Excellent	Good	Good	Good	Good	Good	Fair
Impurities		None	None	None	?	Minor Shale Lenses	Cherty Pockets (Minor)	Silt Lenses
Type of Mat'l Underlying Formation		Limy siltstone	Sandstone	Sandstone	Sandstone	Sandstone & Shale	Sandstone	?
Moisture Condition		Dry	Dry	Dry	Dry	Dry	Dry	Dry
Depth of Overburden		1.5 + ft.	1 to 2 ft.	0.0 ft.	?	0.5 ft.	0.5 ft. to 1.5 ft.	3 to 5 ft.
P. I. (Overburden)		None	6	--	?	8 to 12	8 to 12	None
Est. Quantity Remaining		--	--	--	--	100.000 cu.yds.	250.000 cu.yds.	60.000 cu.yds.
Est. Extension Possibilities		--	--	--	--	250.000 cu.yds.	--	250.000 cu.yds.
Est. Quantity (Prospect)		500,000 cu.yds.	200,000 cu.yds. *	500,000 cu.yds.	500,000 cu.yds.	--	--	--
Approx. Haul to Nearest Point		1.2 Mi.	2.5 Mi.	1.5 Mi.	3.5 Mi.	3.2 Mi.	2.2 Mi.	5.0 Mi.
L. A. Wear		26	33.2	50.0 *	?	32.8	20.4	?
Maximum Size		--	--	--	--	--	--	2"
% Retained on 2" Sieve		--	--	--	--	--	--	--
	Crushed to	1"	1"	1"	--	3/4"	1"	--
	2"	--	--	--	--	--	--	87
Pit	1"	100	100	100	--	--	100	81
Average	3/4"	64	73	91	--	100	86	76
% Passing	1/2"	38	43	54	--	65	54	67
	#4	16	16	24	--	26	22	47
	#10	9	7	15	--	14	13	36
	#200	2	1	5	--	4	4	10
P.I.		3	NP	NP Sandy	--	0 to 8	NP	NP Sandy
Lab. Numbers		60-654-655	60-1680-1682	60-2462	--	55-8448-8463	57-11689-11709	57-19329-19347

Remarks:

Prospect 40-5-1: Est. Quantity NW¼15 = 300,000 cu.yds; SW¼10 = 200,000 cu.yds.
Note: E½, Sec. 9, T13N, R11W also worthy of exploration. Approximately 500,000 cu.yds. exposed near the surface.

Prospect 40-5-2: Drive southwest on Bluewater Lake road 2.0 miles, thence 0.5 miles south to old quarry. * Further exploration needed to determine exact quantity. Area 0.5 miles east also prospective.

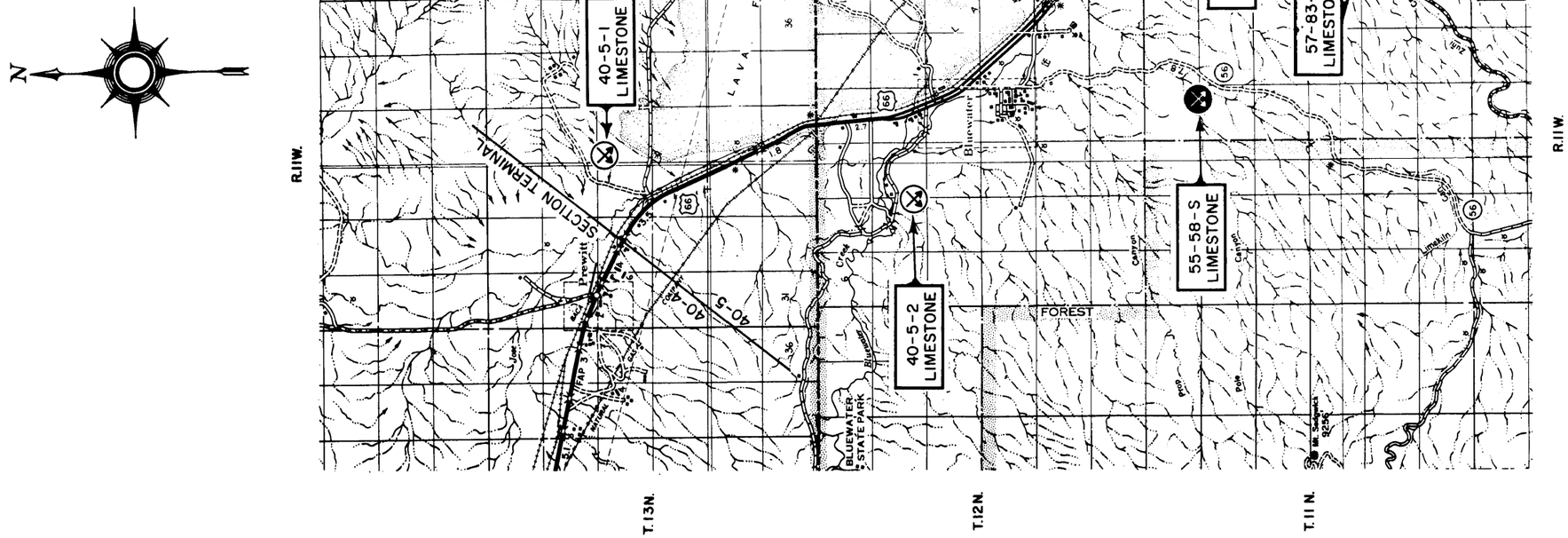
Prospect 40-5-3: Pit may be developed along the walls of the canyon that cuts through the SW¼ of Sec. 17. There is also a good exposure of limestone along the walls of the canyon that cuts through the center of the W½ of Sec. 18. * Further exploration needed to determine the true L.A. Wear.

Prospect 40-5-4: * Entire section is prospective; no samples have been taken in this area. Further exploration needed.

Pit No. 55-58-S is located 3.2 miles S.E. Station 156+84 in SE¼, Sec. 3 and NE¼, Sec. 10, T11N, R11W. Pit can be extended westerly or southerly direction.

Pit No. 57-83-S is located 2.0 miles west of Jct. S.R. 63 and Zuni Canyon road. This pit has not been worked. Owner does not wish to sell.

Pit No. 57-127-F: Extension of this pit cannot be made in the immediate vicinity; however, approximately 0.5 miles northeast there is a continuation of this terrace that will yield several thousand cubic yards.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
GRANTS-SAN FIDEL

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies within the San Jose Valley, which is bounded on the north by Mount Taylor and on the south by extensive lava flows. The region is characterized by mesa-type topography, consisting of sedimentary rocks overlain by volcanic accumulations from the extinct cones of the Mount Taylor region. The dominant geologic features in this area are the lava flows and a structural embayment named the Acoma Sag.

General Geology:

Extensive lava flows of late Tertiary and Quaternary age cover much of this section. Their ages are determined by their topographic relationships. The flows capping the mesas north of U. S. 66 are presumed to be Tertiary in age because of their relief above the surrounding country and the quantity of basaltic landslide material which has accumulated on the slopes of the mesas. These flows originated in the Mount Taylor volcanic region. The McCartys flow, which occupies the San Jose Valley between Grants and McCartys, is assumed to be of Quaternary or possible historic age, by reason of its almost complete lack of weathering.

The Acoma Sag lies between the Zuni Uplift on the west and the Lucero Uplift on the east, and is part of a general structural trend forming the southern boundary of the San Juan Basin. The embayment is about 25 miles wide and 50 miles long. This sag plunges very gently northward and is strongly asymmetrical, with a relatively steep, short western limb.

Between Grants and McCartys the area is broken by numerous northeast trending faults. The displacements on them range up to 1,000 feet, but generally are much less.

The areal distribution of the formations and members are shown on map 40-6. Their succession and character are given under the section termed "Stratigraphy".

Soils:

Soils of this area lie in a narrow valley formed by the San Jose River and its tributaries. The San Jose River is a continuance of Bluewater Creek below its confluence with San Mateo Creek. The river's ability for developing soils has been altered by lava flows which cover a large percent of the valley floor. Therefore, the soil types are greatly influenced by each tributary. Drainageways of this section flow past rocks of varied composition, which range in age from pre-Cambrian to Quaternary. Sediments of the immediate valley floor contain volcanic ash which is derived from the igneous region south of Grants.

Alluvial soils in the basin east of Grants are derived from several formations. The clay soils (A-6) adjacent to Lobo Canyon are formed by the Chinle formation, which underlies the basalt cap. The other silts and clays of the basin are derived from mixtures of material from the Morrison, Mancos, and Mesaverde formations. Soils of the Rinconado Creek area are mixtures of material which is derived from the sandstone and shale of the Mancos and Mesaverde formations.

Alluvial soils along the San Jose River vary greatly in composition, and parent formations cannot be designated.

Local terrace deposits occur in the upper Rinconado Creek area. These deposits are composed of sand and gravel (A-1-a) with a silty soil (A-4) cover.

No attempt has been made to classify the soils of the landslide areas of this section because of the varied mixture of boulders and landslide debris.

Observations made of residual soils and their parent formations in this section:

Quaternary:	Vesicular basalt (Qvb) - Very little weathering, veneer of silty soil (A-4).
Cretaceous:	Mancos formation (Km) - Stony-silty (A-4) to stony-clayey (A-7). Thickness: 0 to 4 feet.
	Dakota sandstone (Kd) - Veneer of silty soil (A-4).
Permian:	San Andres formation (Psa) - Stony-silty (A-4) to stony-clayey (A-7). Thickness: 0 to 4 feet.

Table 40-6-1 shows the log and classification of the soils samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-6.

Stratigraphy:

Quaternary:	Alluvium (Qal) - valley-fill deposits of sand, silt, and clay.
	Spring deposits (Qs) - travertine.
	Landslide debris (Qls) - basalt overlying shales results in landslide material composed of basalt and sandstone boulders, sand, and clay.
	Terrace deposits (Qt) - unconsolidated gravel, sand, and clay deposited on old terrace surfaces.
	Basalt flows (Qvb) (Malpais) - three distinct flows of vesicular basalt with an extremely rough surface, broken by flow movement. The McCartys flow is very recent and is black, in contrast to the slightly reddish, oxidized color of the older flows. Thickness: 90 feet.
Unconformity ---------- Period of Erosion ----------	
Tertiary:	Basalt flows (Tb) - lavas which cap the high mesas north of U. S. 66. Thickness: 40 to 50 feet.
	Intrusive rocks (Ti) - basalt dike near McCartys. Thickness: 12 to 20 feet.
Unconformity ---------- Period of Erosion ----------	
Cretaceous:	Cretaceous rocks undifferentiated (K) - outcrops of Dakota sandstone and Mancos shale which cannot be mapped separately.
	Mesaverde formation (Kmv) - tan, brown, and gray, thin to massive-bedded sandstone, and drab shale and claystone.
	Mancos shale (Km) - light gray to dark gray shale, with four beds of prominent, medium and fine-grained, buff sandstone which weathers yellowish-brown. Thickness: 1,000 feet.
	Dakota sandstone (Kd) - buff to brown, medium to course-grained sandstone, with some interbedded gray shales and thin conglomeratic beds. Thickness: 150 feet.
Unconformity ---------- Period of Erosion ----------	
Jurassic:	Morrison formation (Jm) - greenish-gray clay, with some maroon clay and thin sandstones. Contains large amounts of bentonitic clay. (The Navajo formation, which consists of cross-bedded, buff to white sandstone, was mapped with the Morrison formation in the area because of the small areal extent of the outcrops.)
	Todilto formation (Jt) - thin, impure, gray limestone. Thickness: 12 to 15 feet.
Triassic: ?	Wingate sandstone (TrJw) - reddish-brown, cross-bedded sandstone.
Triassic:	Chinle formation (Trc) - small outcrops of this formation are found in the mesa north of Grants. But this formation was not mapped as a separate unit since it is covered by extensive landslide debris.
Unconformity ---------- Period of Erosion ----------	

SOILS AND GEOLOGY

Stratigraphy: Con't

Permian: San Andres formation (Psa) - pinkish to red and gray, massive, cherty, fossiliferous limestone near the top. Buff and red sandstones in the middle, and blue-gray to white limestone near the base.
Thickness: 120 feet.

Construction Materials:

Quaternary: Terrace deposits (Qt) sand and gravel - Surfacing material pits have been located in the terraces along upper Rinconado Creek.

Aeolian deposits (Qa) wind-blown sand - These deposits occur locally along the border of the lava flow, at the base of the escarpment adjacent to State Road 117, south of Interstate Route 40. Filler pits for improving the grading of hot mix have been developed in this area. (These deposits are not mapped as a separate unit, but are included under (Qal) on the Soils and Geology Map.)

Jurassic: Todilto formation (Jt) predominantly limestone - This formation crops out in the basin east of Grants, where 15 to 20 feet of usable material is exposed.

Soils Summary:

Table No. 40-6-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	4.0	A-4	Silty soil
"	"	2	A	0.0	3.0	A-6	Clayey soil
"	"	3	A	0.0	6.0	A-4	Silty soil
"	"	4	A	0.0	3.0	A-4	Silty soil
"	"	5	A	0.0	9.0	A-6	Clayey soil
"	"	6	A	0.0	3.0	A-4	Silty soil
"	"	7	A	0.0	3.0	A-2-4	Silty sand
"	"	8	A	0.0	6.0	A-6	Clayey soil
"	"	9	A	0.0	4.0	A-7	Clayey soil
"	"	10	A	0.0	3.0	A-4	Silty soil
"	"	14	A	0.0	9.0	A-2-4	Silty sand
"	"	15	A	0.0	6.0	A-4	Silty soil
"	"	16	A	0.0	12.0	A-6	Clayey soil
"	"	17	A	0.0	3.0	A-4	Silty soil
"	"	18	A	0.0	12.0	A-4	Silty soil
"	"	19	A	0.0	4.0	A-4	Silty soil
"	"	20	A	0.0	11.0	A-2-4	Silty sand
"	"	21	A	0.0	7.5	A-4	Silty soil
"	"	22	A	0.0	5.0	A-2-4	Silty sand
"	"	23	A	0.0	6.0	A-4	Silty soil
"	"	25	A	0.0	6.0	A-2-4	Silty sand
"	"	26	A	0.0	13.0	A-4	Silty soil
"	"	27	A	0.0	12.0	A-4	Silty soil
"	"	28	A	0.0	3.0	A-4	Silty soil
"	"	30	A	0.0	3.0	A-4	Silty soil
"	"	31	A	0.0	4.0	A-6	Clayey soil
"	"		B	4.0	12.0	A-4	Silty soil
"	"	32	A	0.0	4.0	A-6	Clayey soil
"	"	33	A	0.0	3.0	A-6	Clayey soil
"	"	34	A	0.0	6.0	A-4	Silty soil
"	"	35	A	0.0	4.0	A-4	Silty soil
"	"	36	A	0.0	14.0	A-6	Clayey soil
"	"	37	A	0.0	6.0	A-6	Clayey soil
"	"	39	A	0.0	3.5	A-4	Silty soil
"	"	43	A	0.0	9.0	A-6	Clayey soil
"	"	44	A	0.0	13.0	A-4	Silty soil
"	Terrace	45	A	0.0	7.0	A-4	Silty soil
"	"		B	7.0	12.0	A-2-4	Silty sand
Quaternary	Terrace	45	C	12.0	14.0	A-1-a	Gravel

The following residual soil samples represent soils derived from parent formations.

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Basalt	11	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	--	Solid Rock	Basalt
"	"	12	A	0.0	5.0	A-4	Silty soil
"	"		B	5.0	--	Solid Rock	Basalt
"	"	13	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	--	Solid Rock	Basalt
Cretaceous	Mancos	24	A	0.0	4.0	A-6	Clayey soil
"	"		B	4.0	--	Solid Rock	Sandstone
"	Dakota	29	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	--	Solid Rock	Sandstone
"	Mancos	38	A	0.0	1.5	A-6	Clayey soil
"	"		B	1.5	3.5	A-4	Silty soil
"	"		C	3.5	--	Solid Rock	Sandstone

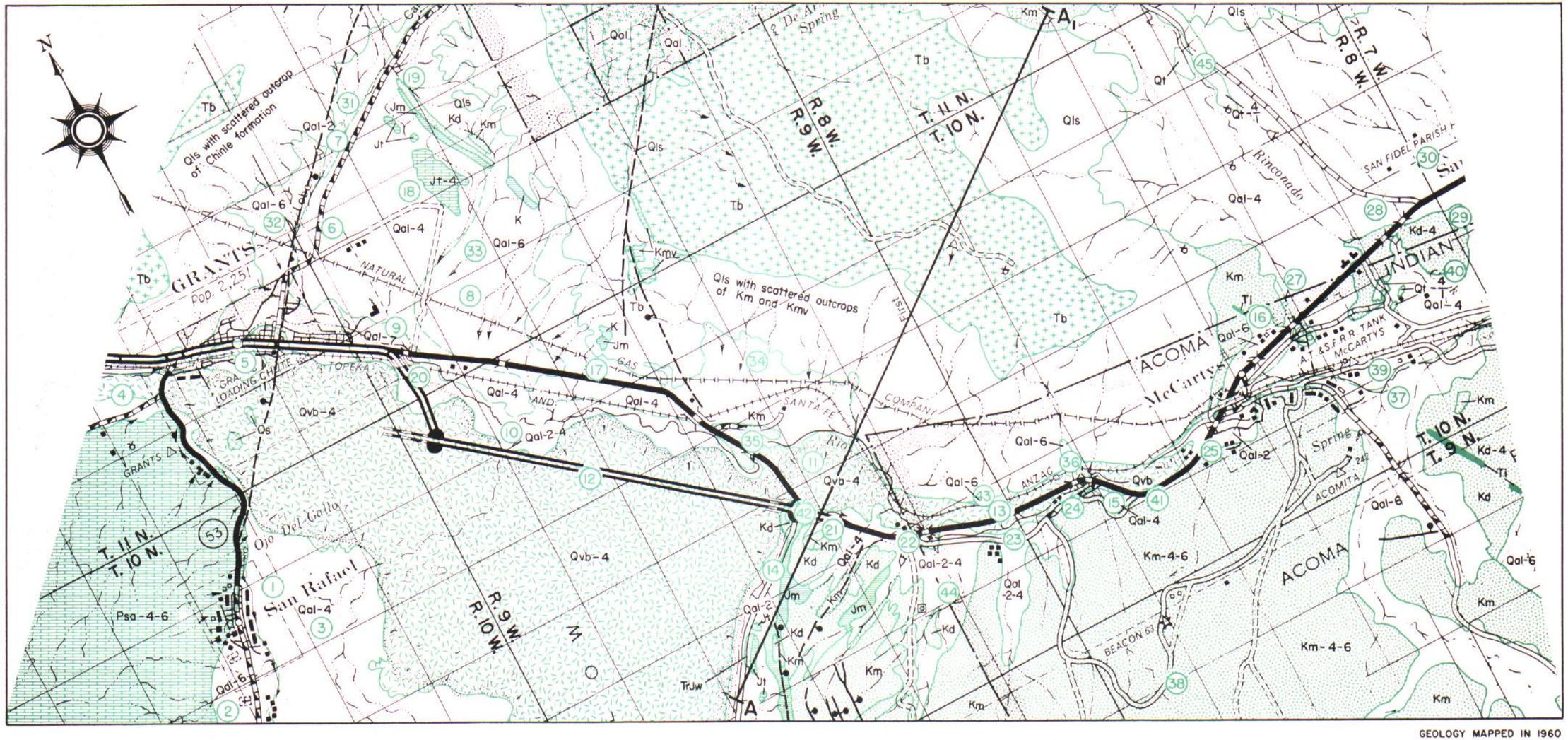
The following sections show the material that may be encountered when cuts are made in the respective formations.

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Cretaceous	Dakota	40	A	0.0	17.0	Solid Rock	Sandstone
"	"		B	17.0	21.0	A-6	Shale
"	"		C	21.0	50.0	A-6	Shale
"	Mancos	41	A	0.0	50.0	Solid Rock	Sandstone
"	"		B	50.0	90.0	A-6	Shale
"	"		C	90.0	120.0	Solid Rock	Sandstone
"	"		D	120.0	130.0	A-4	Shale
"	"		E	130.0	150.0	A-6	Shale
"	Dakota	42	A	0.0	3.0	Solid Rock	Sandstone
Jurassic	Morrison		B	3.0	6.0	A-6	Bentonitic shale
"	"		C	6.0	8.0	A-6	Bentonitic shale
"	"		D	8.0	11.0	Solid Rock	Sandstone
"	"		E	11.0	15.0	A-7	Bentonitic shale

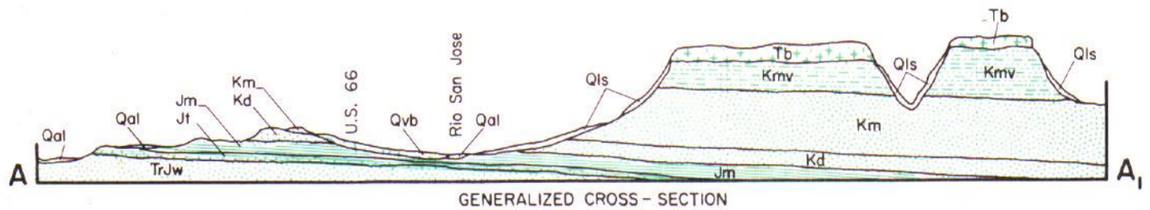
Selected References

Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U. S. Geol. Survey Bull. 794.

SOILS AND GEOLOGY MAP 40-6



GEOLOGY MAPPED IN 1960



GENERALIZED CROSS-SECTION

-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — QUATERNARY
- Qs — Spring deposits — QUATERNARY
- Qls — Landslide debris — QUATERNARY
- Qt — Terrace gravel — QUATERNARY
- K — Cretaceous rocks Undifferentiated — CRETACEOUS
- Kmv — Mesaverde group — CRETACEOUS
- Km — Mancos shale and sandstone — CRETACEOUS
- Kd — Dakota sandstone — CRETACEOUS
- Jm — Morrison formation — JURASSIC
- Jt — Todilto formation — JURASSIC
- TrJw — Wingate formation — TRIASSIC(?)
- Psa — San Andres formation — PERMIAN

IGNEOUS ROCKS

- Qvb — Vesicular basalt flows (Malpais) — QUATERNARY
- Tb — Basalt flows — TERTIARY
- Ti — Intrusive rocks — TERTIARY

0 — STATUTE MILES

CONSTRUCTION MATERIALS INVENTORY

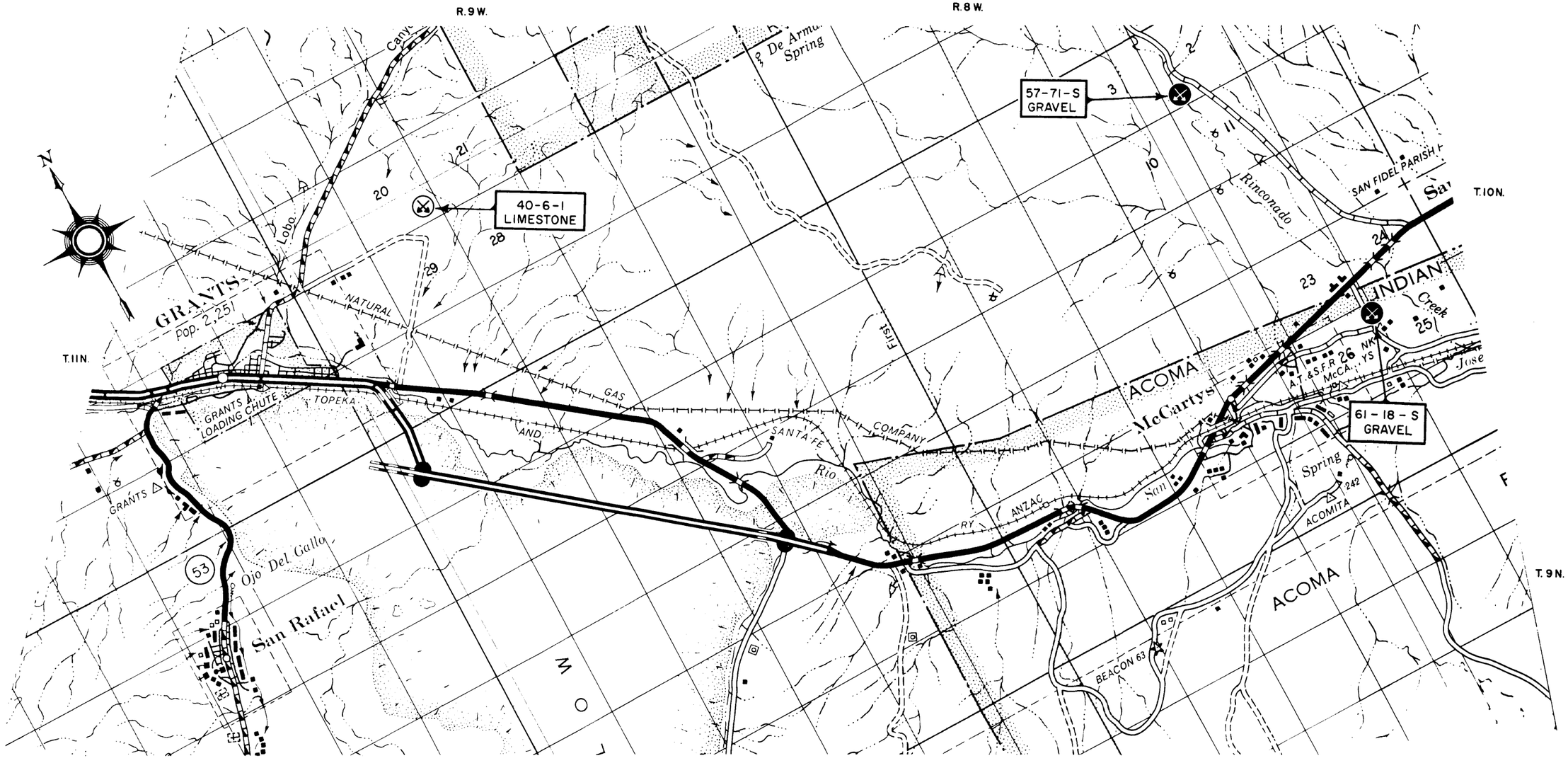
Material Pit Summary:

Table 40-6-2

Pit or Prospect No.		40-6-1 (Prospect)	57-71-S	61-18-S
Location	Part of Sec.	SE¼	SW¼	NW NE
	Section	20	2	25 26
	Twnshp. & Range	T11N, R9W	T10N, R8W	T 10 N, R 8 W
	County	Valencia	Valencia	Valencia
	State	New Mexico	New Mexico	New Mexico
Owner		State Highway Department	State of New Mexico	Indian Land
Geologic Age		Jurassic	Quaternary	Quaternary
Formation		Todilto	Terrace Deposit	Terrace Deposit
Type of Pit		Quarry	Gravel	Gravel
Kind of Material		Limestone	Basalt, Granite, Sandstone, Etc.	Basalt and sandstone (minor)
Quality of Material		Excellent	Good	Good
Thickness of Material		15 feet	14+ feet	25 feet maximum
Thickness of Cap (Caliche)		--	--	--
Blasting Qualities		Excellent	--	--
Uniformity		Good	Fair	Fair
Impurities		None	None	Silt (minor)
Type of Mat'l Underlying Formation		Sandstone	Silt and Clay	Sandstone
Moisture Condition		Dry	Dry	Dry
Depth of Overburden		3 feet	4 feet	8" to 6'
P. I. (Overburden)		7	5	6 to 14
Est. Quantity Remaining		--	300,000 cu. yds.	170,000 cu. yds.
Est. Extension Possibilities		--	None	--
Est. Quantity (Prospect)		250,000+ cu. yds.	--	--
Approx. Haul to Nearest Point		3.5 miles	3.0 miles	870 feet to I-40
L. A. Wear		24	33	24.4
Maximum Size		--	12"	12" average
% Retained on 2" Sieve		--	35	--
Pit Average % Passing	Crushed to 2"	1"	--	2"
	1"	100	65	100
	3/4"	82	50	92
	1/2"	54	45	79
	#4	25	40	67
	#10	13	31	42
	#200	4	23	38
P. I.		N.P.	3	5
Lab. Numbers		60-2003 and 60-2004	N.P. 57-12201 to 57-12260	N.P. 61-5836 - 5860

Remarks:

57-71-S - Material from this pit will eventually be used on four highway projects. This will pretty well deplete the usable material, and any reserve quantity will have to be mapped at a later date.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SAN FIDEL - MESITA

SOILS AND GEOLOGY

Introduction:

The mesa-type topography of section 40-6 continues into this section of Interstate Route 40. This section lies within the San Jose Valley. Mount Taylor is to the north and a mesa and butte landscape is to the south. The dominant geologic feature of the area is the Acoma Sag.

General Geology:

This section of Interstate Route 40 is marked by extensive igneous activity which occurred during Tertiary and Quaternary time. The mesas north of the highway are capped by Tertiary basalt which originated at Mount Taylor. The Laguna basalt flowed down the San Jose Valley and crossed the highway near Laguna. Numerous Tertiary dikes and sills cut most of the pre-Tertiary sediments of the area. These intrusives are especially numerous in the Todilto formation south of the highway, where they have intruded and replaced most of the gypsum.

This area is within the Acoma Sag, which is a general structural low that borders the San Juan Basin to the north. The sag is about 25 miles wide and 50 miles long. Overall, this embayment plunges very gently northward, and is strongly asymmetrical with a relatively steep, short western limb.

The areal distribution of the formations and members are shown on map 40-7. Their sucession and character are given under the section termed "Stratigraphy".

Soils:

The soils of the San Fidel-Mesita section are similar to those of the Grants area, in that they lie within the narrow valley of the San Jose river and its tributaries. Each tributary contains its own soils type, and influences the composition of the soils where each joins the San Jose river. The soils are young and varied in composition. Although somewhat stratified, they have not developed a definite profile. The streams flow through rocks which range in age from Triassic to Quaternary. Each formation contributes to the sediments of the valley floor.

The alluvial soils north of Interstate Route 40 are derived predominantly from the Mesaverde and Mancos formations, and are composed of silts and clays (A-2-4, A-4, and A-6). These soils constitute alluvial fans which have formed at the base of an escarpment. South of Interstate 40, the alluvial soils are derived from the Dakota, Morrison, and Navajo formations. The clayey soils are derived from shale and siltstone of the Morrison formation. The Navajo and Dakota sandstones are the parent formations of the silty sandy soils.

Wind-blown deposits occur southeast of Laguna. These soils are predominantly fine sand (A-3), and are derived from the Navajo sandstone.

Terrace deposits in this section constitute remnants of sand and gravel terraces which are severely weathered. The soil types are generally silty soil (A-4) overlying gravel (A-1-a) and clayey soil (A-6).

West of Laguna, along the A.T.&S.F. railroad, there is a local deposit of silty pediment gravel. The silty gravel bears a soils classification of (A-2-4) with an overlying silty soil (A-4) cover.

Observations made of residual soils and their parent formations in this section:

Quaternary:	Basalt (Qb) - silty soil (A-4), not of basaltic origin. Thickness: 0-6 feet.
Cretaceous:	Mancos formation (Km) - stony-silty soil (A-4) to stony-clayey soil (A-7). Thickness: 0-4 feet.
	Dakota sandstone (Kd) - stony-silty soil (A-4). Thickness: 0-4 feet.
Jurassic:	Morrison formation (Jm) - stony-silty-sandy soil (A-2-4) to stony-clayey soil (A-7). Thickness: 0-4 feet.
	Navajo sandstone (Jn) - silty-sandy soil (A-2-4) to fine sand (A-3). Thickness: 0-15 feet.

Table 40-7-1 shows the log and classification of the soils samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-7.

Stratigraphy:

Quaternary:	Alluvium (Qal) - valley-fill material of sand, silt, and clay.
	Landslide debris (Qls) - basalt overlying shales results in landslide material composed of basalt and sandstone boulders, sand, and clay.
	Pediment gravel (Qpg) - gravel and sand deposited on old pediment surfaces.
	Terrace deposits (Qt) - gravel, sand, and clay deposited on old terrace surfaces
	Aeolian deposits (Qa) - wind-blown sand which forms dunes.
	Basalt (Qb) - flows of basaltic lava. Thickness: 10-25 feet.
Unconformity	----------Period of Erosion----------
Tertiary:	Basalt (Tb) - flows of basaltic lava. Thickness: 40-50 feet.
	Cinders (Tc) - basaltic cinders which form the cinder cone near Budville.
	Intrusive rocks (Ti) - intrusive monzonite, diabase, and basalt in stocks, sills, dikes, and necks. Thickness: varies with form of intrusive.
Unconformity	----------Period of Erosion----------
Cretaceous:	Mancos shale (Km) - light gray to dark gray shale, with four prominent beds of medium and fine-grained, buff sandstone which weathers yellowish-brown. Thickness: 1000 feet.
	Dakota sandstone (Kd) - buff to brown, medium to coarse-grained sandstone, with some interbedded gray shales and thin conglomeratic beds. Thickness: 150 feet.
Unconformity	----------Period of Erosion----------
Jurassic:	Morrison formation (Jm) - variegated, gray-green mudstone and shale; maroon siltstone; with gray or tan, cross-bedded sandstone interbedded throughout. Thickness: 250 feet.
	Navajo formation (Jn) - upper part is light tan, fine to medium-grained, cross-bedded, cliff-forming sandstone. Lower part is red, fine to medium-grained, cross-bedded, cliff-forming sandstone with red, flat-bedded siltstone interbeds. Thickness: 200-250 feet.
	Todilto formation (Jt) - gray gypsum overlying gray, slabby limestone. Thickness: gypsum: 10-70 feet. limestone: 5-15 feet.
Triassic: ?	Wingate sandstone (TrJw) - fine to medium-grained, cross-bedded sandstone. Upper part is white and lower is red. Thickness: 150 feet.
Triassic:	Chinle formation (Trc) - maroon and tan, fine to coarse-grained sandstone and and maroon siltstone. Thickness: ?

SOILS AND GEOLOGY

Construction Materials:

Quaternary: Wind-blown Sand (Qa) consists of a fine clean sand with very little -200 material. Filler pits for improving the grading of hot-mix aggregate and reducing plastic content of gravel may be obtained from this deposit.

Pediment Gravel (Qpg) this material consists of local sand and gravel deposited on the Navajo formation N.W. of Laguna. It is not very extensive and will probably be exhausted on the project that it is presently planned for.

Terrace deposits and alluvium (Qt) and (Qal). In the vicinity of the volcanic plug, northeast of Cubero, there occur sand and gravel accumulations deposited on terraces and in alluvial fans. Sub-surface exploration of these features indicates that this material is quite extensive and that it will be the most valuable source of aggregate for new construction in the San Fidel-Laguna areas. This area is not included on the Soils and Geology map of this section; however, it is included on the Construction Materials Inventory map.

Tertiary: Intrusives (Ti). Volcanic necks composed of columnar basalt. There are two areas of this dense volcanic material considered as a resource; one located three miles north of Cubero and the other eight and one-half miles south of the Mesita Interchange.

Jurassic: Todilto formation (Jt). The limestone member of this formation is exposed south of Mesita along the escarpment. It is generally covered by a thick stratum of gypsum that varies from 10 to 30 feet in depth. The stripping depths of the gypsum have made the limestone impractical for use as a construction material; however, as other sources become exhausted, this limestone may be a valuable source of aggregate.

Triassic: Chinle formation (Trc). The numerous intrusives (sills and dykes) south of Mesita have metamorphosed various formations of Jurassic and Triassic age. The Chinle formation has been altered to an impure, limy quartzite with burnt shale partings. Physical test results indicate that this material can be used as an aggregate; however, the rock tends to fracture into slabby particles. Further study is needed to determine its quality as a construction material.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-7. Test data and other related information are shown in Material Pit Summary Table 40-7-2.

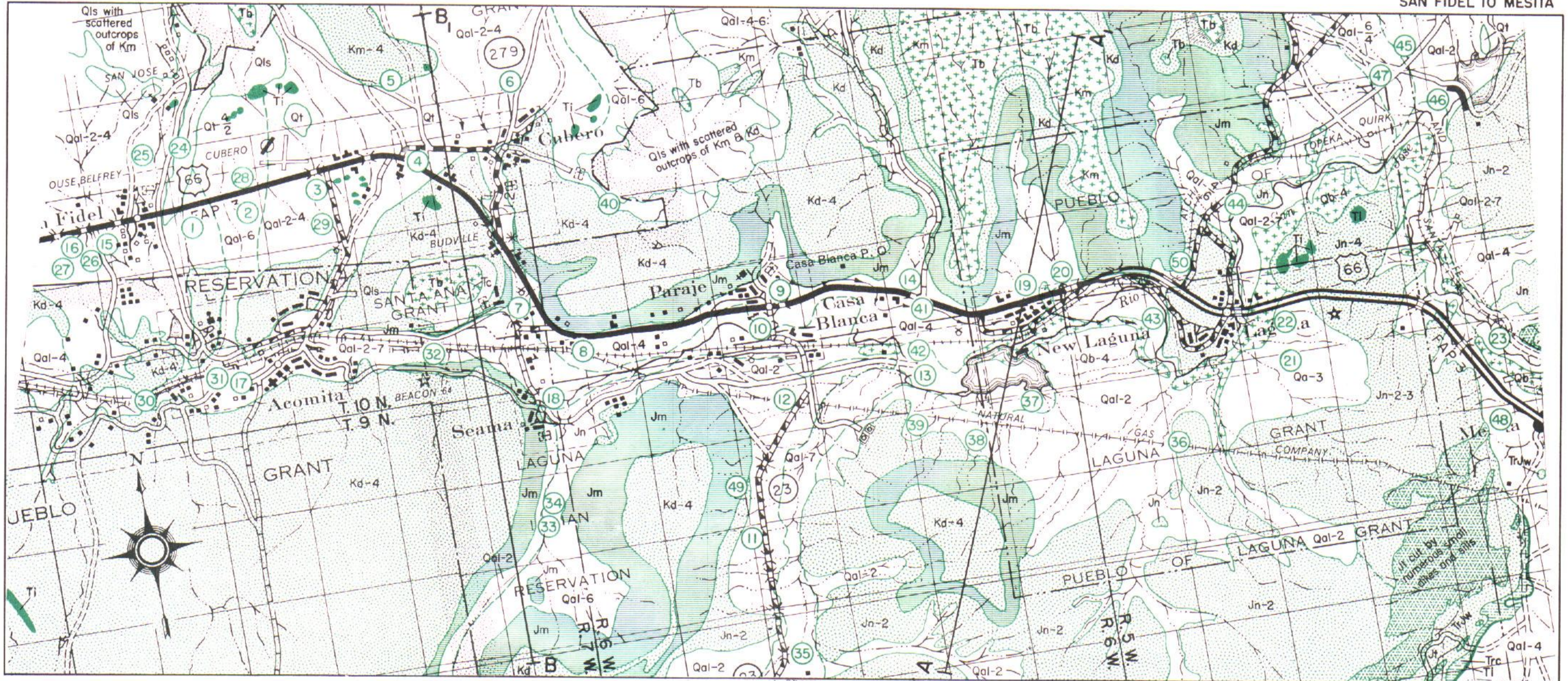
Table No. 40-7-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	2.0	A-4	Silty soil
"	"	2	A	0.0	3.0	A-6	Clayey soils
"	"	3	A	0.0	2.5	A-2-4	Silty sand
"	"	4	A	0.0	2.0	A-7	Clayey soil
"	"	6	A	0.0	3.0	A-4	Silty soil
"	"	7	A	0.0	20.0	A-4	Silty soil
"	"	8	A	0.0	6.0	A-4	Silty soil
"	"	9	A	0.0	6.0	A-2-4	Silty sand
"	"	10	A	0.0	7.0	A-4	Silty soil
"	"	11	A	0.0	20.0	A-2-4	Silty sand
"	"	12	A	0.0	6.0	A-2-4	Silty sand
"	"	13	A	0.0	3.0	A-7	Clayey soil
"	"	14	A	0.0	5.0	A-4	Silty soil
"	"	15	A	0.0	4.0	A-4	Silty soil
"	"	16	A	0.0	3.0	A-7	Clayey soil
"	"	17	A	0.0	6.0	A-6	Clayey soil
"	"	18	A	0.0	3.0	A-4	Silty soil
"	"	19	A	0.0	2.0	A-4	Silty soil
"	"	20	A	0.0	3.0	A-4	Silty soil
"	"	22	A	0.0	2.5	A-4	Silty soil
"	"	23	A	0.0	3.0	A-2-4	Silty sand
"	"	24	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	3.5	A-2-6	Clayey sand
"	"	25	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	8.0	A-6	Clayey soil
"	"		C	8.0	13.0	A-1-a	Gravel
"	"	26	A	0.0	4.0	A-2-4	Silty sand
"	"	27	A	0.0	3.0	A-2-4	Silty sand
"	"	28	A	0.0	5.0	A-6	Clayey soil
"	"	29	A	0.0	1.5	A-4	Silty soil
"	"	30	A	0.0	4.0	A-6	Clayey soil
"	"	31	A	0.0	4.0	A-4	Silty soil
"	"	32	A	0.0	4.0	A-6	Clayey soil
"	"	33	A	0.0	20.0	A-2-4	Silty sand
"	"	34	A	0.0	15.0	A-6	Clayey soil
"	"	35	A	0.0	8.0	A-7	Clayey soil
"	"	37	A	0.0	4.0	A-4	Silty soil
"	"	38	A	0.0	2.0	A-2-4	Silty sand
"	"		B	2.0	20.0	A-4	Silty soil
"	"	39	A	0.0	3.5	A-2-4	Silty sand
"	"	40	A	0.0	2.0	A-6	Clayey soil
"	"	41	A	0.0	10.0	A-4	Silty soil
"	"	42	A	0.0	3.0	A-2-4	Silty sand
"	"	43	A	0.0	15.0	A-7	Clayey soil
"	"	44	A	0.0	9.0	A-4	Silty soil
"	"		B	9.0	15.0	A-6	Clayey soil
"	"	45	A	0.0	4.0	A-2-4	Silty sand
"	"	46	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	12.0	A-7	Clayey soil
"	"	47	A	0.0	1.6	A-6	Clayey soil
"	"		B	1.6	3.6	A-4	Silty soil
"	"	48	A	0.0	12.0	A-4	Silty soil
"	Aeolian	21	A	0.0	25.0	A-3	Fine sand
"	Pediment Gravels	50	A	0.0	7.0	A-4	Silty soil
"	"		B	7.0	9.0	A-2-4	Silty sand
"	"		C	9.0	13.5	A-2-4	Silty gravel
The following residual soil samples represent soils derived from parent formations.							
Cretaceous	Mancos	5	A	0.0	3.0	A-4	Silty soil
"	Navajo	36	A	0.0	4.0	A-2-4	Silty sand
The following sections of formations show the material that may be encountered when cuts are made in the respective formations							
Cretaceous	Dakota	49	A	0.0	228.0	Solid Rock	Sandstone
Jurassic	Morrison		B	228.0	232.0	Solid Rock	Sandstone
"	"		C	232.0	279.0	A-7	Shale
"	"		D	279.0	333.0	Solid Rock	Sandstone
"	"		E	333.0	404.0	A-7	Shale
"	"		F	404.0	422.0	Solid Rock	Sandstone
"	"		G	422.0	470.0	A-6	Shale
"	Navajo		H	470.0	561.0	Solid Rock	Sandstone

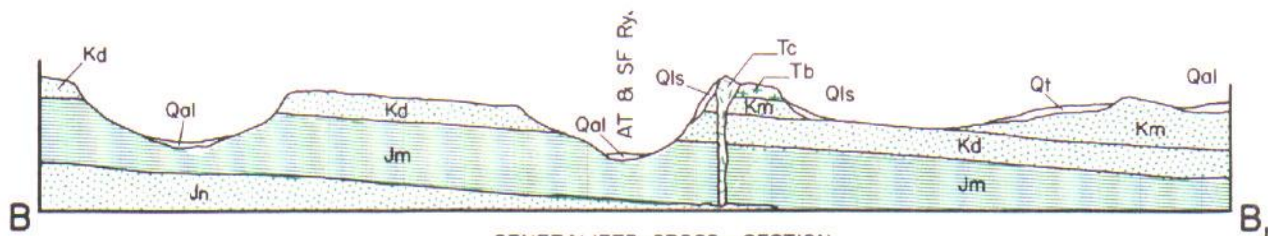
Selected References

Darton, N.H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Survey Bull. 794.

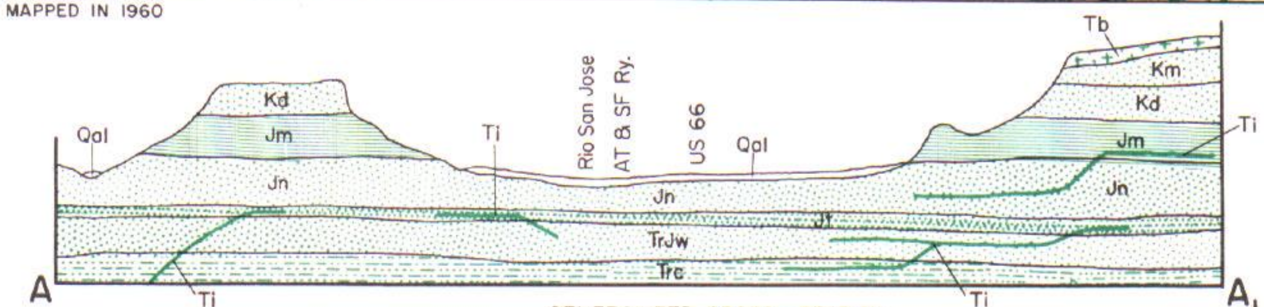
SOILS AND GEOLOGY MAP 40-7



GEOLOGY MAPPED IN 1960



GENERALIZED CROSS-SECTION



GENERALIZED CROSS-SECTION

-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qls — Landslide debris
- Qpg — Pediment gravel

QUATERNARY
- Qt — Terrace gravel
- Qa — Aeolian deposits

CRETACEOUS
- Km — Mancos shale and sandstone
- Kd — Dakota sandstone

JURASSIC
- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation

TRIASSIC
- TrJw — Wingate formation
- Trc — Chinle formation

IGNEOUS ROCKS

QUATERNARY
- Qb — Basalt

TERTIARY
- Tb — Basalt flows
- Tc — Cinders

TERTIARY
- Ti — Intrusive rocks

1 0 1 STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SAN FIDEL - MESITA

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Pit or Prospect No.		40-7-1	40-7-2	40-7-3	40-7-4	40-7-5 (Prospect)
	Part of Sec.	S½	- (in Cubero Grant)	- (in Cubero Grant)	- (in Cubero Grant)	S½
	Section	5	6	5	34	33
Location	Twnshp. & Range	10N. 6W.	10N. 6W.	10N. 6W.	10N. 6W.	11N. 6W.
	County	Valencia	Valencia	Valencia	Valencia	Valencia
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Laguna Indian Land	Cubero Land Grant	Cubero Land Grant	Cubero Grant	Laguna Indian Land
Geologic Age		Tertiary	Quaternary	Quaternary	Quaternary	Quaternary
Formation		Intrusive Plug	Alluvium	Terrace	Alluvium	Terrace Deposit
Type of Pit		Quarry	Gravel	Gravel	Gravel	Gravel
Kind of Material		Basalt	Over 50% Igneous Rock	Over 50% Igneous Rock	50% Igneous Rock	Over 50% Igneous Rock
Quality of Material		Excellent	Excellent	Excellent	Excellent	Good
Thickness of Material		300 + ft.	15 + ft.	15 + ft.	15 + Feet.	15 + ft.
Thickness of Cap (Caliche)			-	-	-	-
Blasting Qualities		Excellent	-	-	-	-
Uniformity		Excellent	Good	Good	Good	See Remarks
Impurities		None	Silt lenses (non-plastic)	Silt lenses	Sily lenses (minor)	"
Type of Mat'l Underlying Formation		Unknown	Shale ?	Shale ?	Shale and Sandstone ?	Shale
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		None	3 to 6 ft.	3 Feet	3 to 5 Feet	See Remarks
P, I, (Overburden)		None	17	13	15	"
Est. Quantity Remaining		-	-	-	-	-
Est. Extension Possibilities		-	-	-	-	-
Est. Quantity (Prospect)		500,000 + Cu. Yds.	300,000 + Cu. Yds.	200,000 + Cu. Yds.	300,000 + Cu. Yds.	300,000 + Cu. Yds.
Approx. Haul to Nearest Point			4.5 Mi.		5.0 Mi.	6.5 Mi.
L. A. Wear		15.6	35.2	34.6	33.8	See remarks
Maximum Size		-	4' boulders	4' dia.	4' Dia.	"
% Retained on 2" Sieve		-	Appx. 35%	25%	35%	"
	Crushed to	1"	-	-	-	"
	2"		62	38	41	"
Pit	1"	100	44	20	32	"
Average	3/4"	84	41	18	30	"
% Passing	1/2"	44	36	16	28	"
	#4	15	25	13	24	"
	#10	7	17	11	21	"
	#200	2	3	3	3	"
P. I.		N.P.	N.P.	N.P.	N.P.	"
Lab. Numbers		60-464	60-2451-2454	60-2455-2457	60-2458-2461	"

Remarks:

40-7-1 - This basalt occurs in pentagonal horizontal columns of a volcanic plug that rises above the valley floor approximately 500 ft. The talus slopes around this plug will produce approximately 150,000 cu. yds.

40-7-2 - Located approximately ½ mi. N.W. of volcanic plug.

40-7-3 - Located on high terrace due north of volcanic plug.

40-7-4 - Located along present arroyo approximately 1 mi. north of volcanic plug.

40-7-5 - (Prospect) This material has a surface appearance similar to that of the tested areas north at the volcanic plug. Further exploration is needed to determine exact conditions.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SAN FIDEL - MESITA

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-7-2

Pit or Prospect No.		40-7-6 (Prospect)	54-81-P	57-77-S	57-78-S	59-2-S
Location	Part of Sec.	NE¼	SW¼	SE¼	SW¼	SW¼
	Section	35	4	14	26	32
	Twnshp. & Range	8N, 5W	9N, 5W	9N - 5W	9N, 5W	10N, 5W
	County	Valencia	Valencia	Valencia	Valencia	Valencia
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Indian Land	Indian Land	Laguna Indian Land	Laguna Indian Land	Indian Land
Geologic Age		Tertiary	Quaternary	Jurassic	Triassic	Quaternary
Formation		Volcanic Plug	Dune Sand	Todilto	U. Chinle	Pediment Gravel
Type of Pit		Quarry	Sand	Quarry	Quarry	Gravel
Kind of Material		Basalt	Blow Sand	Limestone	Quartzite & Burned Shale ?	Over 75% Igneous Rock
Quality of Material		Excellent	Good	Good	Good	Good
Thickness of Material		50 ft. +	10 + ft.	5' Max.	30 ft.	15 + ft.
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		Excellent	-	Good	Good	-
Uniformity		Excellent	Good	Poor	Good	Good
Impurities		None	None	Diabase Intrusives	None	Silt lenses (minor)
Type of Mat'l Underlying Formation		-	Sandstone	Diabase	Diabase Sill	Navajo Sandstone
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		None	-	-	-	4 to 6 feet
P. I. (Overburden)		-	-	-	-	11 to 16
Est. Quantity Remaining		-	Unlimited Supply	30,000 Cu.Yds.	300,000 + Cu. Yds.	300,000 Cu. Yds.
Est. Extension Possibilities		-	"	None	200,000 + Cu. Yds.	None
Est. Quantity (Prospect)		500,000 Cu.Yds.	-	-	-	-
Approx. Haul to Nearest Point		7.5 Mi.	0.5 Mi.	1.0 Mi.	4.3 Mi.	0.5 Mi.
L. A. Wear		16.8	-	25.2	20.8	26.4
Maximum Size		-	-	-	-	2' Boulders
% Retained on 2" Sieve		-	-	-	-	Appx. 20%
Pit Average % Passing	Crushed to	1"	-	2"	2"	1"
	2"		-	100	100	-
	1"	100	-	72	35	100
	3/4"	75	-	67	25	87
	1/2"	41	-	61	16	60
	#4	13	-	51	8	34
	#10	6	100	44	5	21
	#200	1	3	19	2	5
P. I.		N.P.	N.P.	N.P.	N.P.	9
Lab. Numbers		60-33-80	54-12368-12370	57-10789-10801	57-10806-10810	59-316-337

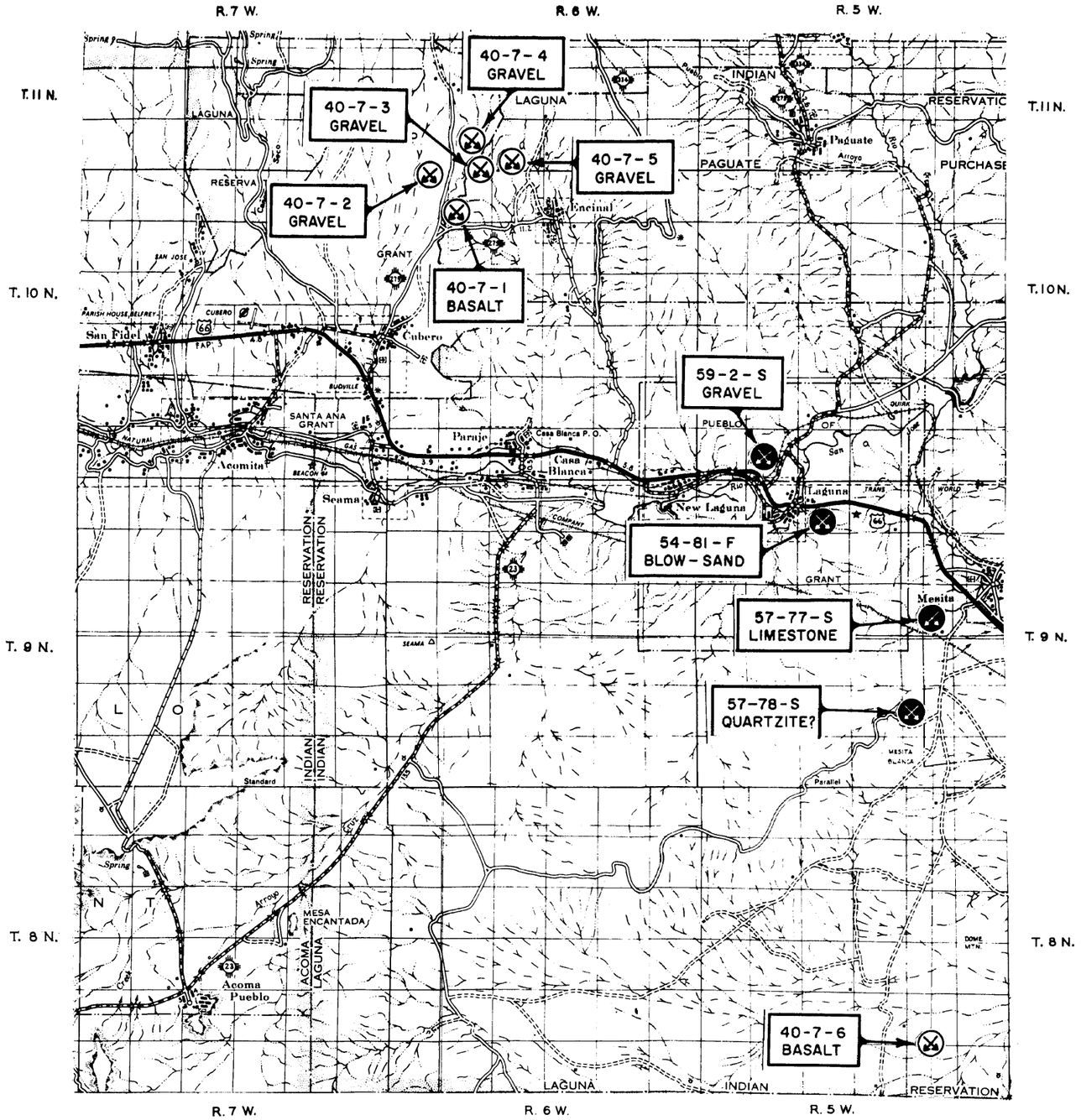
Remarks:

40-7-6 - * No tests have been made for blasting qualities; however the crystalline nature and columnar jointing of this rock indicates that it will be excellent.

57-77-S - It would be inadvisable to set this pit up for heavy construction because of the inconsistancy of the thickness and several irregular intrusive sills and dikes. However, it would make an excellent maintenance pit.

57-78-S - This material, as the gradation indicates, has a slabby fracture plane; this characteristic has caused the engineers to doubt its value as a surfacing material. Further study and experiment may prove this aggregate to be usable. The underlying igneous intrusive sill has cooked the original sandstone and shale into an impure quartzite without changing the original bedding planes. It is a very hard crystalline calcareous rock.

59-2-S - This pit is proposed for use on new construction on Project I-040-2(1)105.



AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
MESITA - RIO PUERCO

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies within a butte-type topography. Cliffs of Triassic, Jurassic, and Cretaceous rocks lie north of the highway. To the south is the Lucero Uplift. The highway passes through the Rio Puerco fault zone which is a transitional zone between the Lucero Uplift to the south, and the Nacimiento Uplift to the north.

General Geology:

The dominant geologic feature of this area is the Rio Puerco fault zone. This is a transitional zone between typical Colorado Plateau structure and the Rio Grande trough. It is an adjustment between the Nacimiento Uplift and the Lucero Uplift. The fault zone, as a whole, has a northerly trend. Most of the faults are normal, with the downthrown side on the west. Vertical displacements along the faults generally are small; however, vertical displacement along a few faults is as much as 2,000 feet.

Rolling-hill-type topography exists in the eastern part of this area. It may be attributed to an old erosional surface of the Rio Grande River.

Soils:

The soils of the Mesita-Rio Puerco area are within the Rio San Jose watershed. The Rio San Jose is a low-gradient, meandering, intermittent stream with a narrow channel. Most of its tributaries decrease in gradient as they approach the river, and thus form alluvial fans. Stream braiding and ponding in these areas result in a mixture of soil types.

Soils of this area are derived from rocks which range in age from upper Triassic to Quaternary. Much of the valley floor is covered with a shallow, residual soil which is derived from the Chinle formation. The soils along the escarpment north of the present highway and west of the fault zone, originated from the Wingate, Navajo, and Morrison formations. The soils within the fault zone are derived from formations of that area.

This entire section has been affected by wind action. This has resulted in local dune deposits which are not large enough to be mapped as separate units on the Soils and Geology Map.

Alluvial soils of this area range from silty sandy soil (A-2-4) to clayey soil (A-7).

Local pediment deposits occur in the eastern portion of this section. These deposits are composed of pea-gravel (A-1-a) and sand (A-3), with a silty sandy soil (A-2-4) cover.

Residual soils and their parent formations:

Quaternary: Basalt (Qb) - very little weathering, veneer of clayey soil (A-6), (western portion). Thicker deposits of silty sandy soil (A-2-4), (eastern portion). Neither soils originated from the basalt.

Tertiary: Santa Fe formation (Tsf) - silty sandy soil (A-2-4).
Thickness: 0-15 feet.

Cretaceous: Mesaverde formation (Kmv) - silty soil (A-4) to clayey soil (A-6).
Thickness: 0-4 feet.

Mancos formation (Km) - silty sandy soil (A-2-4). This is an alluvial soil on the Mancos formation southwest of Conyoncito Interchange. Soils developed from the Mancos formation are predominantly clay (A-7).
Thickness: 0-15 feet.

Table 40-8-1 shows the log and classification of the soils samples taken along this portion of the Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-8.

Stratigraphy:

Quaternary: Alluvium (Qal) - valley-fill deposits of sand, silt, and clay.

Pediment gravel (Qpg) - gravel and sand deposited on old pediment surfaces.

Basalt (Qb) - flows of basaltic lava.

Unconformity ----------Period of Erosion----------

Tertiary: Santa Fe formation (Tsf) - gray, brown, and red gravel, sand, and silt. Usually uncemented, but locally cemented with limy material. Weathers brown.

Unconformity ----------Period of Erosion----------

Cretaceous: Mesaverde group (Kmv) - members undifferentiated on map:

Gibson coal member- continental shale, sandstone, and coal.
Thickness: 1000-1300 feet.

Dalton sandstone member- massive and thick-bedded sandstone.
Thickness: 75-100 feet.

Mulatto tongue member- light gray to dark gray marine shale.
Thickness: 250-400 feet.

Dilco coal member- continental shale, sandstone, and thin coal beds.
Thickness: 75-100 feet.

Gallup sandstone member- massive and thick-bedded sandstone.
Thickness: 50-100 feet.

Mancos shale (Km) - light gray to dark gray shale, with several prominent beds of medium and fine-grained, buff sandstone.
Thickness: 1000 feet.

Dakota sandstone (Kd) - buff to brown, medium to coarse-grained sandstone, with some interbedded gray shales and thin conglomeratic beds.
Thickness: 100 feet.

Unconformity ----------Period of Erosion----------

Jurassic: Morrison formation (Jm) - variegated, gray-green mudstone and shale; maroon siltstone; with gray or tan, cross-bedded sandstone interbedded throughout. (South of U.S. 66 the Navajo formation has been mapped with the Morrison formation. This is due to poor exposures, and the southward thinning of Jurassic beds.)
Thickness: 300 feet.

Navajo formation (Jn) - upper part is light tan, fine to medium-grained, cross-bedded, cliff-forming sandstone. Lower part is red, fine to medium-grained, cross-bedded, cliff-forming sandstone with red, flat-bedded siltstone interbeds.
Thickness: 200-250 feet.

Todilto formation (Jt) - gray gypsum and gray, slabby limestone.
Thickness: gypsum: 20-70 feet.
limestone: 0-4 feet.

Triassic: ? Wingate sandstone (TrJw) - fine to medium-grained, cross-bedded sandstone. Upper part is white, and lower is red to tan-brown.
Thickness: 180 feet.

Triassic: Chinle formation (Trc) - dark brown and buff, bedded to massive, cross-bedded sandstone; maroon siltstone; and soft, red-brown shale.
Thickness: 1000 feet.

SOILS AND GEOLOGY

Construction materials:

Quaternary:

Alluvium (Qal) - sand and gravel. A usable deposit occurs along the southern margin of the basalt flow. It consists of chalcedony pea-gravel and medium-grained quartz sand. Cement treated base course has been developed from this deposit.

There are many local silty sand deposits along the Rio San Jose and at the base of the escarpment north of Interstate Route 40. This material has been used for P.I. reducing filler, and for improving the grading of hot-mix aggregate.

Basalt (Qb) - vesicular in upper portions. This is the most extensive aggregate source in the area, but due to its vesicular character it is impractical for highway use.

Pediment gravel (Qpg) - pea-gravel and coarse sand. Local deposits occur in the eastern portion of this section. Filler for improving the grading of crushed rock has been developed from this material.

Tertiary:

Intrusives (Ti) - columnar basalt plug. This plug is located on the western slope of Mesa Gigante, approximately 10 miles north of Mesita. It is the best quality aggregate in the area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-8. Test data and other related information are shown in Material Pit Summary Table No. 40-8-2.

Table No. 40-8-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	1.0	A-2-4	Silty sand
"	"		B	1.0	4.0	A-6	Clayey soil
"	"	2	A	0.0	3.5	A-4	Silty soil
"	"	3	A	0.0	4.0	A-2-4	Silty sand
"	"	4	A	0.0	2.5	A-6	Clayey soil
"	"		B	2.5	4.0	A-2-4	Silty sand
"	"	5	A	0.0	4.0	A-4	Silty soil
"	"	6	A	0.0	4.0	A-6	Clayey soil
"	"	7	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	4.0	A-2-4	Silty sand
"	"	9	A	0.0	4.0	A-7	Clayey soil
"	"	10	A	0.0	4.0	A-7	Clayey soil
"	"	11	A	0.0	4.0	A-7	Clayey soil
"	"	12	A	0.0	4.0	A-2-4	Silty sand
"	"	13	A	0.0	3.0	A-4	Silty soil
"	"	18	A	0.0	2.0	A-6	Clayey soil
"	"		B	2.0	7.0	A-7	Clayey soil
"	"	22	A	0.0	8.0	A-4	Silty soil
"	"	23	A	0.0	6.0	A-4	Silty soil
"	"	24	A	0.0	3.0	A-4	Silty soil
"	"	25	A	0.0	2.5	A-4	Silty soil
"	"	26	A	0.0	3.0	A-6	Clayey soil
"	"	27	A	0.0	3.0	A-7	Clayey soil
"	"	29	A	0.0	2.5	A-4	Silty soil
"	"	30	A	0.0	2.5	A-6	Clayey soil
"	"	31	A	0.0	3.0	A-2-4	Silty sand
"	"	32	A	0.0	4.0	A-2-4	Silty sand
"	"		B	4.0	15.0	A-7	Clayey soil
"	"	33	A	0.0	2.5	A-6	Clayey soil
"	"	34	A	0.0	6.0	A-6	Clayey soil
"	"	35	A	0.0	3.0	A-2-4	Silty sand
"	"	36	A	0.0	2.0	A-2-4	Silty sand
"	"	38	A	0.0	3.0	A-2-4	Silty sand
"	"	39	A	0.0	3.0	A-2-4	Silty sand
"	"	40	A	0.0	3.0	A-6	Clayey soil
"	"	41	A	0.0	8.0	A-4	Silty soil
"	"		B	8.0	15.0	A-7	Clayey soil
"	"	42	A	0.0	1.0	A-2-4	Silty sand
"	"		B	1.0	10.0	A-4	Silty soil
"	"	43	A	0.0	4.0	A-7	Clayey soil
"	"	44	A	0.0	4.0	A-2-4	Silty sand
"	"	45	A	0.0	2.0	A-4	Silty soil
"	"	47	A	0.0	3.0	A-4	Silty soil
"	"	48	A	0.0	6.0	A-2-4	Silty sand
"	"	49	A	0.0	6.0	A-7	Clayey soil
"	"	51	A	0.0	4.0	A-4	Silty soil
"	"	52	A	0.0	4.0	A-4	Silty soil
"	"	53	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	12.0	A-6	Clayey soil
"	"	54	A	0.0	3.0	A-4	Silty soil
"	"	55	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	2.5	A-2-4	Silty sand

The following samples represent residual soils derived from parent formations.

Quaternary	Basalt	28	A	0.0	0.5	A-6	Clayey soil
"	"		B	0.5	-	Unclassified	Basalt
"	"	50	A	0.0	3.0	A-2-4	Silty sand
"	"	56	A	0.0	2.5	A-2-4	Silty sand

Note: The above samples are not of basaltic origin.

Quaternary	Pediment Gravels	46	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	-	A-1-a	Gravel
Cretaceous	Mesaverde	14	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	-	Unclassified	Shale
"	"	15	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	2.0	A-6	Clayey soil
"	"		C	2.0	-	Unclassified	Shale
"	"	16	A	0.0	1.5	A-4	Silty soil

The following sections show the material that may be encountered when cuts are made in the respective formations.

Tertiary	Santa Fe	8	A	0.0	1.5	A-2-4	Silty sand
"	"		B	1.5	50.0	A-2-4	Siltstone
"	"	37	A	0.0	12.0	A-2-4	Silty sand
"	"		B	12.0	20.0	A-4	Silty soil
Cretaceous	Mesaverde	17	A	0.0	2.0	A-2-4	Silty sand
"	"		B	2.0	42.0	A-7	Shale
"	"	19	A	0.0	2.0	A-6	Clayey soil
"	"		B	2.0	15.0	A-6	Shale
"	Mancos	20	A	0.0	20.0	Unclassified	Sandstone
"	"		B	20.0	40.0	A-6	Shale
Triassic	Chinle	21	A	0.0	67.0	Unclassified	Sandstone
"	"		B	67.0	240.0	A-4	Shale

Selected References

Darton, N.H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Survey Bull. 794.

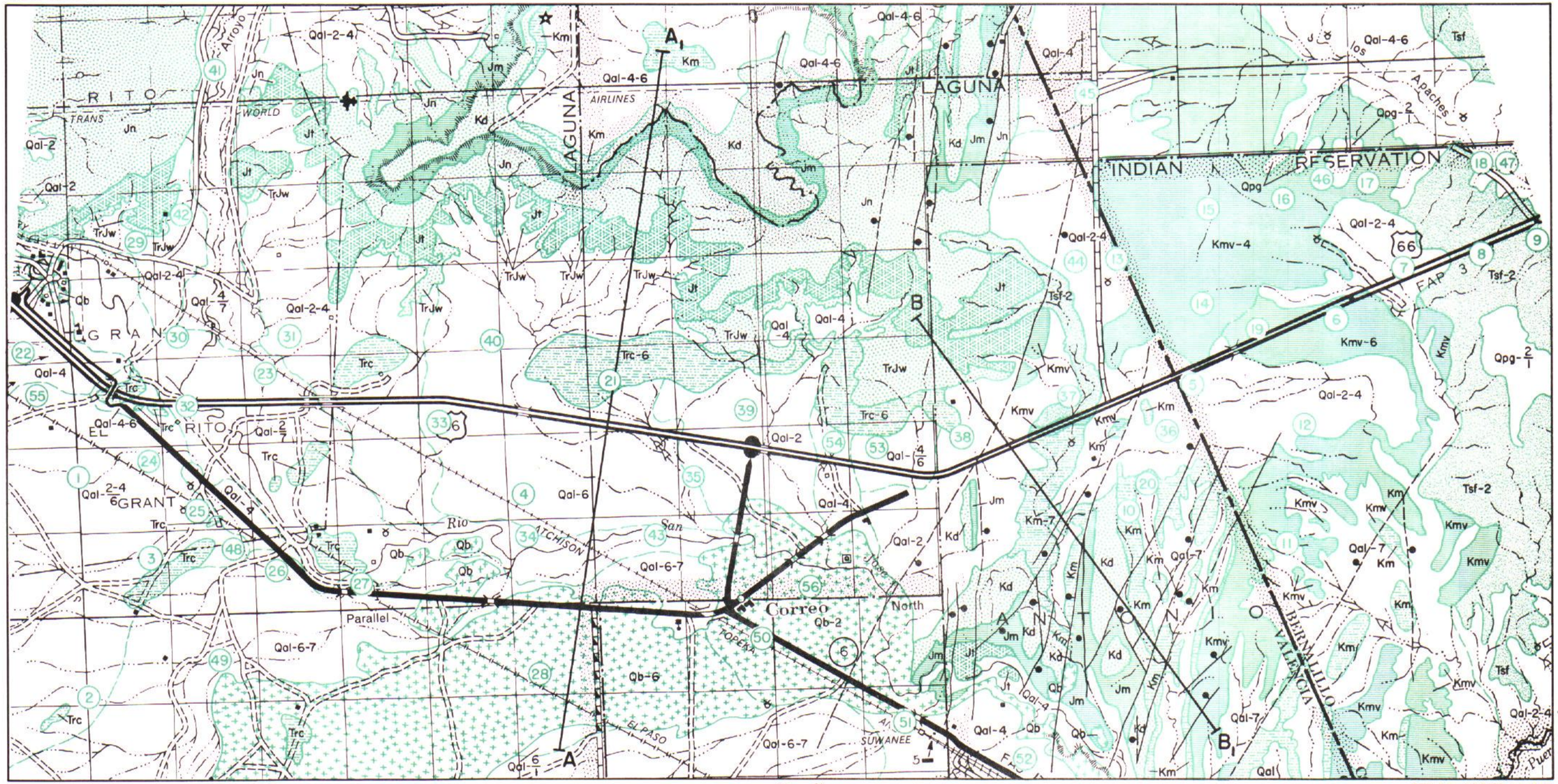
Kelley, V.C. and Wood, G.H., 1951, Oil and Gas Investigations Preliminary Map 47, U.S. Geol. Survey.

Moench, R.H. and Puffett, W.P., 1957, Preliminary Geologic Map of the Luguna 4 SW Quadrangle Bernalillo and Valencia Counties, New Mexico, Mineral Investigations Field Studies Map MF 134, U.S. Geol. Survey.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

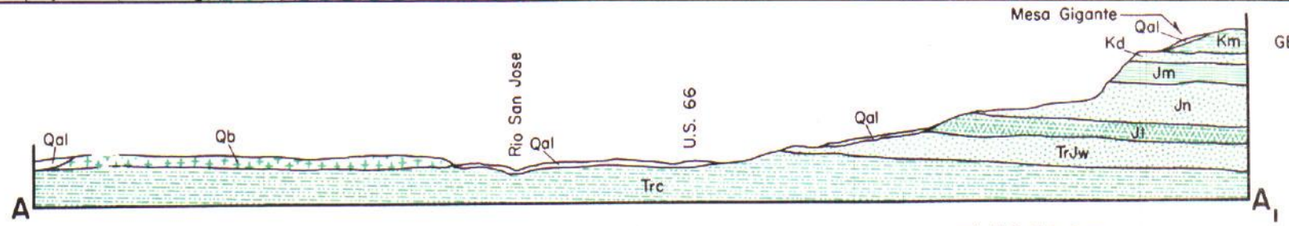
SOILS AND GEOLOGY MAP 40-8

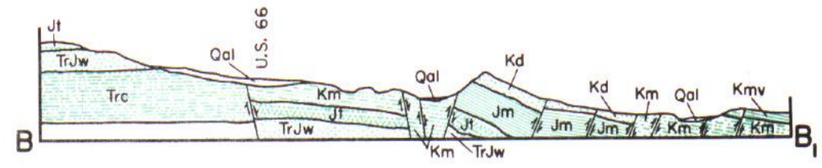
INTERSTATE ROUTE 40
MESITA TO RIO PUERCO



GEOLOGY MAPPED IN 1960

GENERALIZED CROSS-SECTIONS





-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qpg — Pediment gravels
- Qal — Alluvium

TERTIARY
- Tsf — Santa Fe formation

CRETACEOUS
- Km — Mancos shale
- Kd — Dakota sandstone

JURASSIC
- Kmv — Mesaverde group
- Jm — Morrison formation
- Jn — Navajo sandstone
- Jt — Todilto formation

TRIASSIC
- TrJw — Wingate formation
- Trc — Chinle formation

IGNEOUS ROCKS

QUATERNARY
- Qb — Basalt flows

0 STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
MESITA - RIO PUERCO

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Pit or Prospect No.		56-100-S	57-76-F	57-79-S	57-124-S	40-8-1 (Prospect)	40-8-2 (Prospect)
Location	Part of Sec.	See remarks	NW¼	W½	E½	NW¼	South center
	Section	" "	29	33	12	35	32
	Twnshp. & Range	" "	9N, 4W	9N, 3W	8N, 4W	11N, 4W	8N. 4W
	County	Bernalillo	Valencia	Valencia	Valencia	Valencia	Valencia
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Laguna Indian Land	Laguna Indian Land	Laguna Indian Land	Indian Land	Indian Land	Indian Land
Geologic Age		Quaternary	Quaternary	Quaternary	Quaternary	Tertiary	Quaternary
Formation		Pediment Gravel	Dune Sand	Vesicular Basalt (malpais)	Alluvium	Volcanic Plug	Terrace
Type of Pit		Gravel	Sand	Quarry	Gravel	Quarry	Gravel
Kind of Material		Varied (Quartzite, Chalcedony, etc.)	Blow-sand	Basalt	Mixed, Igneous & Chalcedony	Basalt	Varied
Quality of Material		Good	Good	Poor	Good	Excellent	-
Thickness of Material		30 ft.	10 to 15 ft.	20 ft.	25 + ft.	?	-
Thickness of Cap (Caliche)		-	-	-	-	-	-
Blasting Qualities		-	-	Poor	-	?	-
Uniformity		Good	Good	Good	Good	Excellent	-
Impurities		None	None	Clay in crevices	None	None	-
Type of Mat'l Underlying Formation		Shale	Clay	Clay	?	?	Shale
Moisture Condition		Dry	Dry	Dry	Dry	Dry	Dry
Depth of Overburden		0 to 15 ft.	-	0 to 3 ft.	6 to 10 ft.	None	-
P. I. (Overburden)		N.P.	-	6	7 to 12	None	-
Est. Quantity Remaining		200,000 cu. yds.	50,000 + cu. yds.	150,000 cu. yds.	300,000 + cu. yds.	-	-
Est. Extension Possibilities		100,000 cu. yds.	Unlimited	150,000 cu. yds.	300,000 + cu. yds.	-	-
Est. Quantity (Prospect)		-	-	-	-	500,000 + cu. yds.	-
Approx. Haul to Nearest Point		1.4 mi.	0.3 mi.	1.5 mi.	3.8 mi.	10.0 mi.	8.5 mi.
L. A. Wear		30.4	-	40.8	22.8	14.0	-
Maximum Size		1"	-	-	4"	-	-
% Retained on 2" Sieve		None	-	-	0.8%	-	-
Pit Average % Passing	Crushed to	-	-	2"	-	1"	-
	2"	100	-	100	85		-
	1"	94	-	40	79	100	-
	3/4"	90	-	29	77	61	-
	1/2"	83	-	22	74	34	-
	#4	64	-	12	62	12	-
	#10	51	100	8	49	6	-
	#200	3	6 to 8	2	7	1	-
P. I.		N.P.	N.P.	N.P.	N.P.	N.P.	-
Lab. Numbers		56-16744-16765	57-10802-10805	57-11076-11086	57-18339-18583	60-3113	-

Remarks:

56-100-S Located 7,222 feet left of Station 200+00 on Project I-093-3(5).

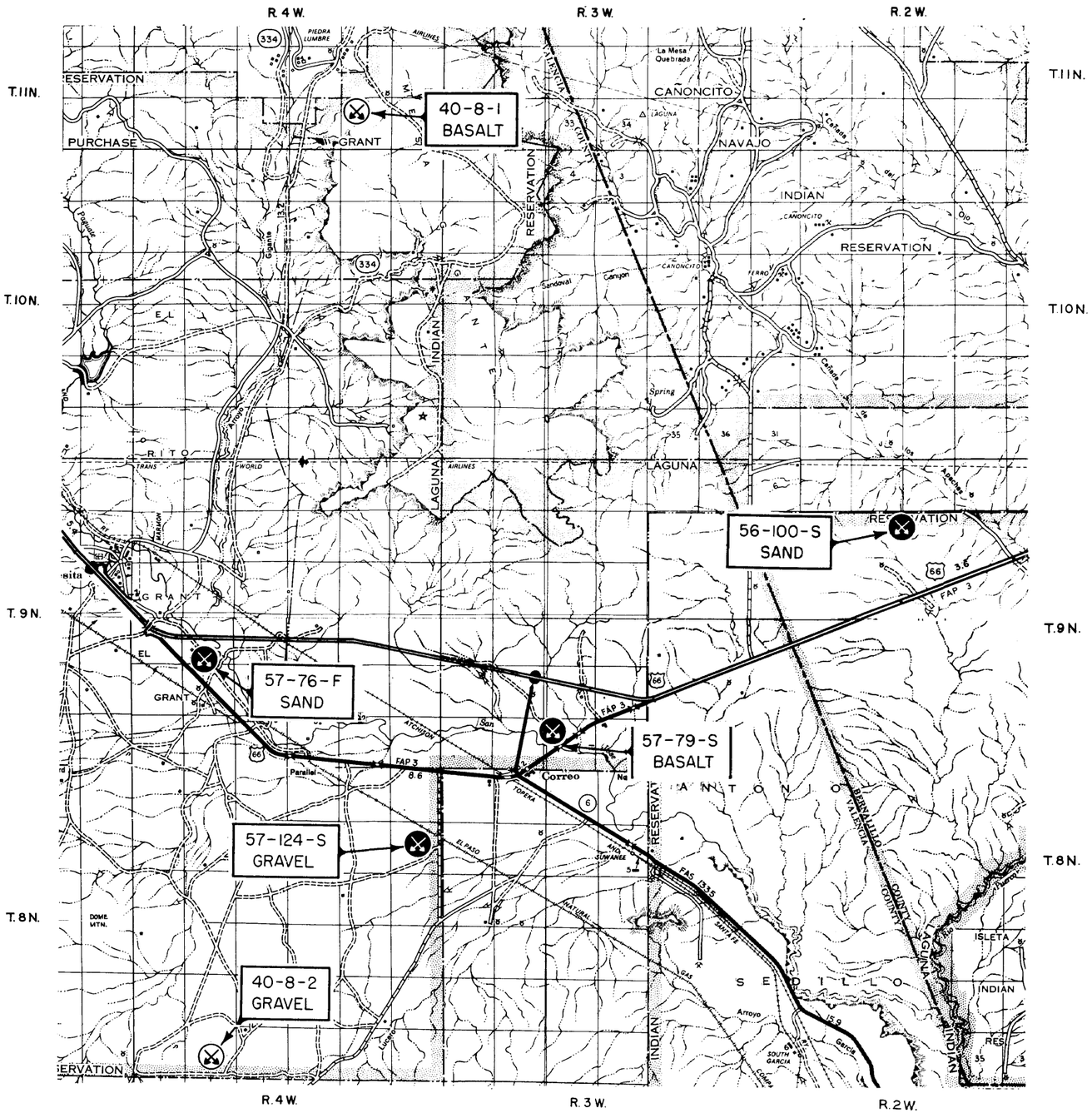
57-76-F This pit is indicative of the sandy materials in dune deposits of this area.

57-79-S This material is fairly consistant having about 10 feet of vesicular basalt over 10 feet of dense basalt. Blasting qualities are very poor and crushing qualities are also very poor because of the spongy nature of the rock.

57-124-S Located 3.8 miles south of Station 698+73 on Project I-IG-093-2(9).

40-8-1 There are several thousand cubic yards of talus on the western flank of this plug that can be used; however, any large quantities will probably have to enter into a quarry operation.

40-8-2 Further exploration needed to determine the condition of this area.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
RIO PUERCO - WEST MESA ALBUQUERQUE

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40, is within the Rio Grande Depression. This is a north trending trough which is bounded in this area by the Puerco Fault Belt to the west and the Sandia and Manzanita Uplifts to the east. The Puerco Fault Belt and the Llano de Albuquerque are the major structural features of this section.

General Geology:

The Llano de Albuquerque, which forms the divide between the Puerco Fault Belt and the Rio Grande Depression, is a flat-topped remnant of the oldest erosion surface formed by the Rio Grande River in this area. The Llano de Albuquerque is a smooth, grassy plain which is dissected by a few broad, shallow valleys which trend southeast and it slopes gently to the south and east. The plain is terminated on the west by a scarp which breaks into the Rio Puerco Valley. On the east, a lower, irregular and more gradual escarpment forms the limits of the plain.

The western margin of the plain, near the brink of the escarpment, is characterized by a line of sand hills which are 50 to 70 feet high. These are typical cliff dunes. The wind blown sand which forms them thins rapidly eastward, so that they disappear as a topographic feature within a few hundred feet. Prevailing westerly winds sweep the sand upward from the Santa Fe formation and form these dunes.

The Rio Puerco is a pirate stream which has cut through the soils on the Llano de Albuquerque and into the underlying Santa Fe formation. Changes in base level of the Rio Puerco have produced several erosional surfaces in its vicinity. The veneer of sediments which rest on these surfaces are included in the Santa Fe formation in this report; since exposures of the sediments are poor and it is not always possible to differentiate between these deposits and the Santa Fe formation.

The silty valley fill of the Rio Puerco Valley is incised by the present Rio Puerco channel to a depth of 20 to 40 feet.

Soils:

There are five stages of soil development in this section: (1) mature soils of the Llano de Albuquerque, (2) immature soils formed by intermittent high velocity streams eroding the edge of the plain, (3) soils in the valley floor of the Rio Puerco derived from low gradient deposition, (4) dune sands deposited along the western rim of the plain, and (5) residual soils of the Mesaverde, Santa Fe and basaltic formations.

The mature soils of the Llano de Albuquerque, which is a plain or mesa dividing the Rio Grande and the Rio Puerco Valleys, have a well developed profile with distinct horizons. "A" horizon consists of a loamy, silty soil (A-4), 0.0 to 10.0 feet in depth. "B" horizon consists of a calcified, silty soil (A-4), 10.0 to 18.0 feet in depth. "C" horizon usually consists of sand and pea gravel, identified as the Santa Fe formation. Even though there is an obvious chemical change between "A" and "B" horizons it has no influence on the engineering classification of the soils. A veneer of silty, sandy soils (A-2-4) occurs locally over this plain and is a result of wind erosion. The topography of the plain is fairly flat with a few low undulating hills and blown out depressions.

The highly eroded sloping land adjacent to the rim of the Llano de Albuquerque contains a poorly developed, heterogeneous mixture of silty, sandy gravel (A-2-4). This is a result of the recent deposition of the sands, silts and gravels derived from the Santa Fe formation. The topography is rough, highly dissected and subject to tremendous mass wasting during each rain storm.

The incised valley of the Rio Puerco displays stratified silts and clays (A-4 to A-7) derived from the Mancos and Mesaverde formations that lie north and west of this drainage.

Dunes formed along the western rim of the plain contain a homogeneous mixture of clean fine sand (A-3), which is derived from the eroded slope west of the rim. The topography is typical of dune areas that form along cliffs with elongated ridges and undulating hills from 50 to 70 feet high.

Observations made of residual soils and their parent formations in this section follow:

Quaternary: Basalt (Qb) - veneer of silty soil (A-4), not of basaltic origin.

Tertiary: Santa Fe formation (Tsf) - silt (A-4) and silty sand (A-2-4) overlying sand and pea gravel (A-1-a).
Thickness: Silt and silty sand, 0 to 4 feet.
Thickness: Sand and pea gravel, 10 to 20 feet.

Cretaceous: Mesaverde formation (Kmv) - clay soil (A-7).
Thickness: 0 to 4 feet.

The areal distribution of the soils and their related formations are shown on Geology and Soils Map 40-9. Table No. 40-9-1 shows the logs and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary: Alluvium (Qal) - valley fill of gravel, sand, silt and clay.

Aeolian deposits (Qa) - wind blown sand which forms dunes along the western rim of Llano de Albuquerque.
Thickness: 0 to 70 feet.

Landslide debris (Qls) - boulders of basalt, and finer material, along scarp slope of the basalt in northeastern corner of section 40-9.

Basalt flows (Qb) - from Albuquerque volcanoes, and deposited on Llano de Albuquerque erosional surface and next lower surface.
Thickness: 20 to 50 feet.

Unconformity----------Period of Erosion----------

Quaternary - Tertiary: Older terrace deposits (TQt) - caliche, covered by a veneer of alluvial sand and gravel, and aeolian sand.
Thickness: 4 to 22 feet.

Unconformity----------Period of Erosion----------

Tertiary (?): Non-basaltic volcanics (Te) - Trachytic lavas and pyroclastics interbedded with sandstone and intruded by a quartz-latite plug, surrounded by an apron of non-basaltic cinders.

Tertiary: Basalt (Tb) - lava flow interbedded with Santa Fe formation.
Thickness: 20 to 30 feet.

Santa Fe formation (Tsf) - unconsolidated to poorly consolidated Rio Grande Basin sediments. Coarse, gray to tan gravel and sand. Buff to reddish-brown silt and clay.

Unconformity----------Period of Erosion----------

Cretaceous: Mesaverde formation (Kmv) - alternating beds of sandy, carbonaceous, yellow to dark gray shale and pink to buff sandstone.

Construction Materials:

Quaternary: Alluvium (Qal) - local accumulation of sand and pea gravel cropping out along the Rio Puerco. This deposit, although local in nature will produce several thousand cubic yards of aggregate. Material of this type has been developed for select borrow for improving the grading of crushed rock.

Tertiary: Non-Basaltic volcanics (Te) - volcanic cinders surrounding the basal part of the Cerro Colorado, composed of brick-red fragments intermixed with silt and clay. This material has not been accepted as an aggregate; however, further research may develop some use for it.

Basalt (Tb) - consists of two rather small basaltic mesas near the Rio Puerco. "La Mesita Negra" is the more desirable aggregate. It consists of a hard, dense, crystalline trap rock, somewhat vesicular in its upper portions. Excellent surfacing aggregates have been produced from this basalt.

SOILS AND GEOLOGY

Santa Fe formation (Tsf) - crops out extensively along the scarp slopes of the Llano de Albuquerque and west of the Rio Puerco Valley. It consists of a lenticular sand and pea gravel overlying silty material. Select material for improving the grading of crushed rock has been produced from this formation.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-9. Test data and other related information are shown in Material Pit Summary Table No. 40-9-2.

Soils Summary:

Table No. 40-9-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	1	A	0.0	4.0	A-6	Clay soil
"	"	2	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	6.5	A-7	Clay soil
"	"		C	6.5	9.0	A-4	Silty soil
"	"	4	A	0.0	3.5	A-4	" "
"	"	5	A	0.0	2.5	A-2-4	Silty sand
"	"		B	2.5	---	Unclassified	Gravel
"	"	11	A	0.0	3.0	A-6	Clayey soil
"	"	13	A	0.0	4.5	A-2-4	Silty sand
"	"	15	A	0.0	1.5	A-7	Clay soil
"	"	16	A	0.0	4.5	A-2-4	Silty sand
"	"	23	A	0.0	8.0	A-2-4	" "
"	"	28	A	0.0	4.0	A-2-4	" "
"	"	38	A	0.0	2.0	A-7	Clay soil
"	"		B	2.0	5.0	A-6	" "
"	"		C	5.0	21.0	A-2-4	Silty sand
"	"	39	A	0.0	4.5	A-2-4	" "
"	"	40	A	0.0	4.0	A-2-4	" "
"	"	41	A	0.0	3.0	A-6	Clay soil
"	"	42	A	0.0	3.0	A-7	" "
"	"		B	3.0	7.0	A-4	Silty soil
"	"		C	7.0	22.0	A-2-4	Silty sand
"	"		D	22.0	27.0	A-4	Silty soil
"	"	43	A	0.0	1.0	A-2-4	Silty sand
"	"		B	1.0	8.0	A-7	Clay soil
"	"	45	A	0.0	3.5	A-2-4	Silty sand
"	"	46	A	0.0	4.0	A-2-4	" "
"	"	47	A	0.0	4.5	A-2-4	" "
"	Aeolian	37	A	0.0	5.0	A-3	Fine sand
Quaternary-Tertiary	Terrace	7	A	0.0	4.5	A-2-4	Silty sand
"	"	8	A	0.0	10.0	A-2-4	" "
"	"		B	10.0	12.0	A-1-b	Sandy gravel
"	"		C	12.0	16.0	A-3	Fine sand
"	"	18	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	3.5	A-6	Clay soil
"	"	19	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	4.5	A-2-4	Silty sand
"	"	20	A	0.0	3.0	A-4	Silty soil
"	"	21	A	0.0	3.0	A-4	" "
"	"	22	A	0.0	1.0	A-4	" "
"	"		B	1.0	3.0	A-6	Clay soil
"	"		C	3.0	4.7	A-4	Silty soil
"	"	24	A	0.0	4.0	A-2-4	Silty sand
"	"	25	A	0.0	4.5	A-2-4	" "
"	"	26	A	0.0	5.0	A-2-4	" "
"	"	27	A	0.0	3.5	A-4	Silty soil
"	"		B	3.5	4.0	A-2-4	Silty sand
"	"	29	A	0.0	1.5	A-2-4	" "
"	"		B	1.5	4.0	A-4	Silty soil
"	"	30	A	0.0	2.0	A-4	" "
"	"		B	2.0	4.5	A-2-4	Silty sand
"	"	33	A	0.0	4.0	A-4	Silty soil
Quaternary-Tertiary	Terrace	34	A	0.0	2.5	A-4	Silty soil
"			B	2.5	4.0	A-2-4	Silty sand
"		35	A	0.0	3.0	A-4	Silty soil
"		36	A	0.0	3.0	A-4	" "

The following residual soil samples represent soils derived from parent formations.

Tertiary	Santa Fe	3	A	0.0	8.5	A-3	Fine sand
"	" "		B	8.5	---	Solid rock	Sandstone
"	" "	10	A	0.0	3.0	A-2-4	Silty sand
"	" "		B	3.0	---	Solid rock	Sandstone
"	" "	14	A	0.0	2.5	A-6	Clay soil
"	" "		B	2.5	4.5	A-4	Silty soil
"	" "	17	A	0.0	4.0	A-2-4	Silty sand
"	" "	44	A	0.0	4.0	A-2-4	" "
"	" "	48	A	0.0	4.0	A-4	Silty soil

The following sections of formations show the material that may be encountered when cuts are made in the respective formations.

Tertiary	Santa Fe	6	A	0.0	6.0	A-4	Silty soil
"	" "		B	6.0	---	Unclassified	Caliche
"	" "	9	A	0.0	30.0	A-2-4	Silty sandstone
"	" "		B	30.0	69.0	A-4	Shale
"	" "		C	69.0	83.0	A-2-4	Silty sandstone
"	" "		D	83.0	----	Solid rock	Sandstone
"	" "	12	A	0.0	27.0	A-2-4	Silty sandstone
Cretaceous	Mesaverde		B	27.0	32.0	A-3	Fine sandstone
"	"		C	32.0	65.0	A-2-4	Silty sandstone
"	"		D	65.0	76.0	A-7	Shale
"	"		E	76.0	----	A-7	"

Selected References

Bryan, Kirk and McCann, 1937, The Ceja del Rio Puerco, a Border Feature of the Basin and Range Province in New Mexico, Jour. Geol., Vol. 46, p. 1-16.

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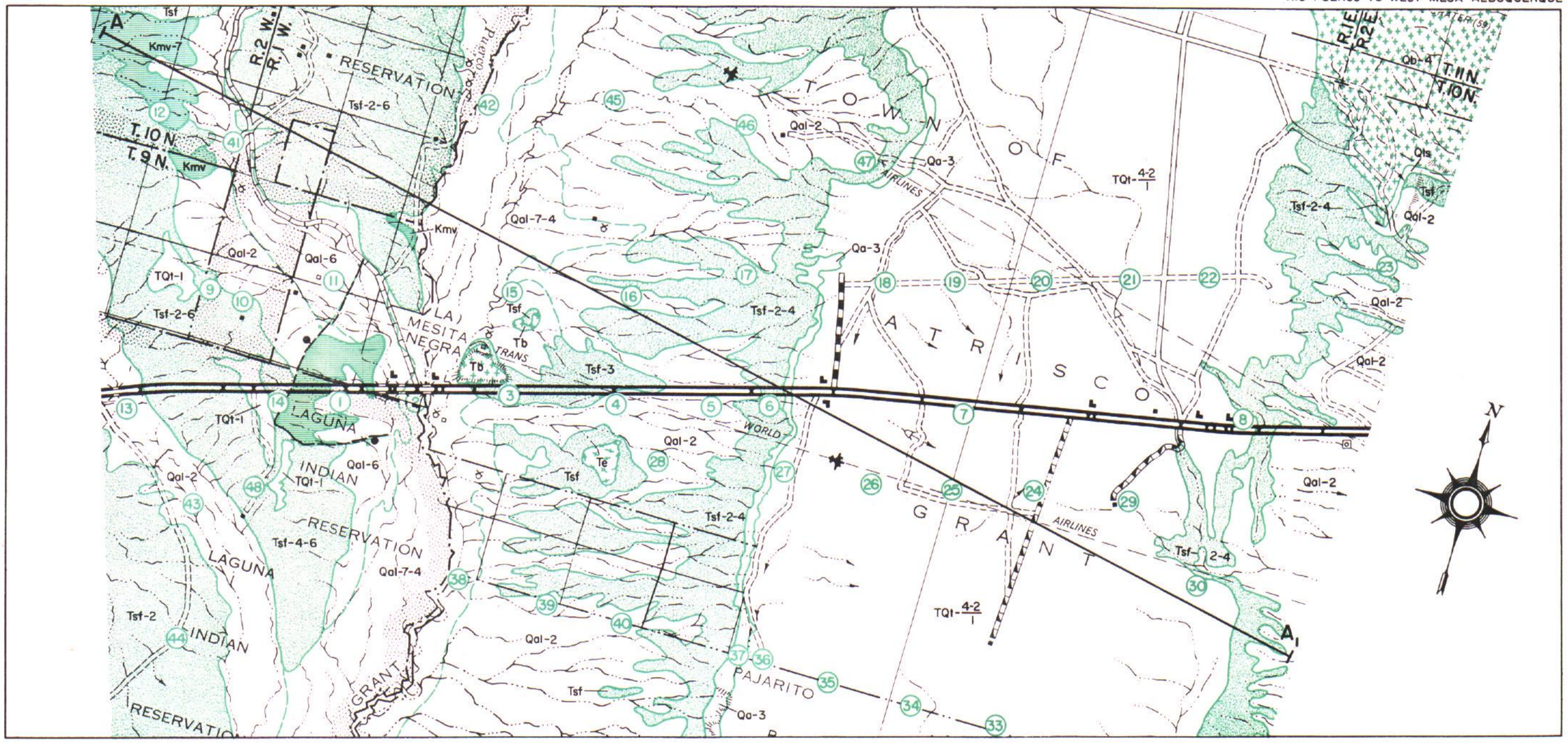
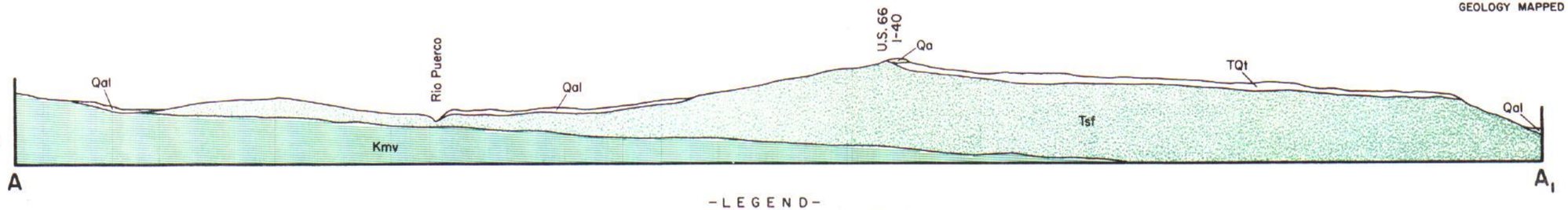
SOILS AND GEOLOGY MAP 40-9



GEOLOGY MAPPED IN 1960

GENERALIZED CROSS-SECTION



-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — QUATERNARY
- Qa — Aeolean deposits — QUATERNARY
- Qls — Landslide debris — QUATERNARY
- TQt — Terrace-deposits — QUATERNARY
- Tsf — Santa Fe formation — TERTIARY
- Kmv — Mesaverde group — CRETACEOUS

IGNEOUS ROCKS

- Qb — Basalt — QUATERNARY
- Te — Non-basaltic volcanics — QUATERNARY
- Tb — Basalt — TERTIARY

0 — STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
RIO PUERCO - WEST MESA ALBUQUERQUE

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-9-2

Pit or Prospect No.		55-12-S	55-13-S	55-14-S	55-38-S	40-9-1 (prospect)
Location	Part of Sec.	See remarks	Town of Atrisco Grant	Town of Atrisco Grant	Town of Atrisco Grant	NE 1/4 SW 1/4
	Section	See remarks	-	-	-	33
	Twnshp. & Range	See remarks	-	-	-	T 10 N, R 1 W
	County	Bernalillo	Bernalillo	Bernalillo	Bernalillo	Bernalillo
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Matias Sanchez	?	?	?	?
Geologic Age		Tertiary	Tertiary ?	Tertiary	Tertiary	Quaternary
Formation		Basalt	Extrusive	Santa Fe	Basalt	Alluvium
Type of Pit		Quarry	Quarry	Gravel	Quarry	Gravel
Kind of Material		Basalt	Cinders (non-basaltic)	Sand and pea gravel	Basalt	Sand and pea gravel
Quality of Material		Excellent	Poor	Fair	Excellent	Fair
Thickness of Material		20 feet	?	10 to 20 feet	12 feet ?	25 feet
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		Fair (see remarks)	-	-	?	-
Uniformity		Good	Poor	Fair	Good	Fair
Impurities		None	Clay particles (minor)	None	Calcite filled vesicles	None
Type of Mat'l Underlying Formation		Shale	?	Silt and clay	?	Shale
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		0 to 4 feet	-	1 to 3 feet	-	0-to 12 feet
P. I. (Overburden)		-	-	0 to 10 feet	-	0 to 10 feet
Est. Quantity Remaining		100,000 cu. yds.	200,000 cu. yds.	See remarks	100,000+ cu. yds.	See remarks
Est. Extension Possibilities		500,000+ cu. yds.	-	Unlimited	-	See remarks
Est. Quantity (Prospect)		-	-	-	-	-
Approx. Haul to Nearest Point		600 feet	0.7 mi.	0.6 mi.	1.0 mi.	1.3 mi.
L. A. Wear		20.0	-	Not reported	21.6	?
Maximum Size		-	-	" "	-	See remarks
% Retained on 2" Sieve		-	-	" "	-	" "
	Crushed to	1"	-	" "	3/4"	" "
	2"	-	-	" "	-	" "
Pit Average % Passing	1"	100	-	" "	-	" "
	3/4"	83	-	" "	100	" "
	1/2"	45	-	" "	84	" "
	#4	16	-	" "	33	" "
	#10	8	-	" "	16	" "
	#200	1	-	" "	3	" "
P. I.		N.P.	-	" "	N.P.	" "
Lab. Numbers		56-16408 to 16410-A	-	55-1541 to 1547	55-4032 to 3041	" "

Remarks:

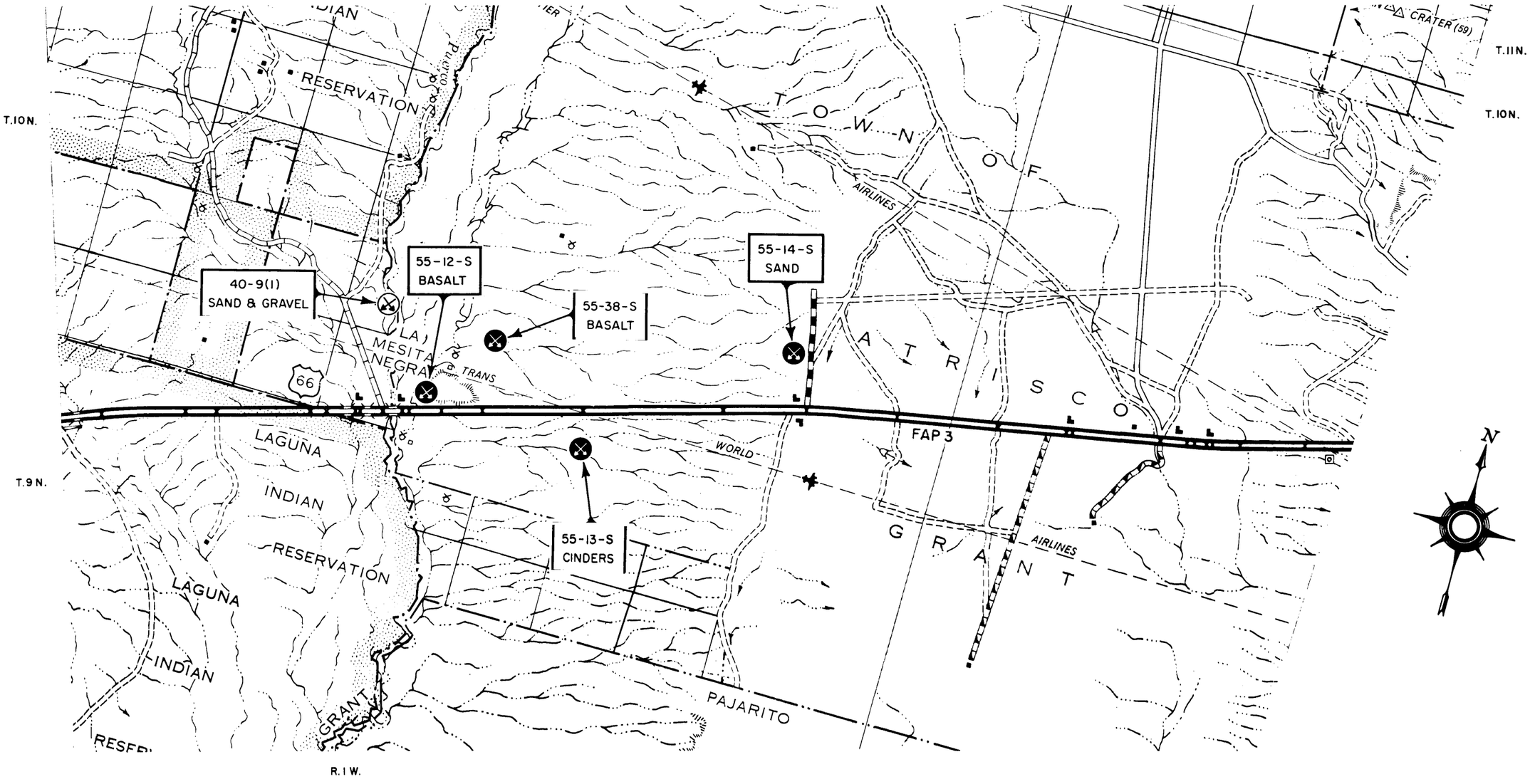
55-12-S - Located 1120 feet north Sta. 121+33.3 on Project F.I. 003-3(4), in the Atrisco Grant. The joint pattern of the upper portion of this rock indicates that much of the material will break into boulder size rock of over two feet in diameter.

55-13-S - Located 3585 feet south of Sta. 213+59 in a lense of volcanic cinders which surround the basal part of Cerro Colorado. Material is presently rejected as highway aggregate; however, further research may develop some use for them.

55-14-S - Located 3025 feet north of Sta. 340+00 on Project F.I. 003-3(4). For all practical purposes this pit can be considered worked out. It can be extended northerly to an almost unlimited supply.

55-38-S - Located 5000 feet north Sta. 153+11. This pit is similar in composition to 55-12-S. It has not been used to date.

40-9-1 (prospect) - This material is similar to 55-14-S in composition and gradation. Further exploration is needed to determine exact conditions.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
WEST MESA ALBUQUERQUE - CARNUE

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40, extends from the West Mesa, through Albuquerque, to Carnue in Tijeras Canyon which separates the Sandia and Manzano Mountains. This section is within the Rio Grande Depression, a complex structural basin filled with alluvium.

General Geology:

The Rio Grande Depression is not a single trough, but a series of north trending basins arranged en echelon along the course of the Rio Grande. The area covered by this report is within the Albuquerque-Belen Basin, which is the largest of this series of basins. This basin is characterized by a relatively broad flood plain which has been cut below older, once broad flood plains. These older flood plains represent successive stabilized grades of the ancestral Rio Grande. Remnants of these older surfaces are now terraces which are at various elevations above the present valley floor. These terraces are in various degrees of preservation, depending upon the erosion by the Rio Grande and intermittent streams.

Fault block mountains border the Albuquerque-Belen Basin on the east. The block is tilted to the east and is dissected by cross faults. In this section the Sandia and Manzano Mountains represent part of this fault block. The Sandia Mountains, which are approximately 18 miles in length, were uplifted along a fault line which is near the western base of the mountains. The vertical displacement on this fault ranges from 4,000 to 10,000 feet. This uplift is balanced by a complex series of normal faults at the northern end of the mountains. At the southern end is the diagonal Tijeras Fault along Tijeras Canyon. South of this are the lower lying Manzano Mountains.

The Rio Grande flood plain was initiated by the meandering Rio Grande. Alternating spurs developed; later, when grade was attained, lateral cutting became dominant and the valley floor was widened by sharpening, blunting and trimming off the spurs in turn. The stream or streams flowed freely over the flood plain shifting channels frequently. This action caused sediments of various natures to be deposited on the plain. At times of high water when the stream overflowed its banks, its velocity was checked at the edge of its channel and deposits of gravel and coarse material were immediately dropped producing natural levees. The finer sediments were carried out farther and spread over the flood plain.

The areal distribution of formations is shown on Soils and Geology Map 40-10. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The main divisions of this area are the West Mesa, the Rio Grande flood plain, the East Mesa and the Sandia and Manzano uplifts as far as Carnue, New Mexico. Here the Rio Grande flood plain lies in the Albuquerque-Belen Basin, one of several that lie as linked basins along the course of the river. The flood plain lies below the levels of older erosion surfaces which are now represented as terraces and small basaltic mesas along the western margin of the area.

The basalt mesas of the western margin are capped by silty soils (Qb-4) not of basaltic origin. Landslide debris occurs on the slopes of the mesas and in the northwestern portion of this area gravel (Qtg) occurs which was deposited by the Rio Grande.

Sloping east toward the flood plain, the West Mesa is covered principally by silty gravel and sand and sandy silt.

The Rio Grande flood plain consists of various soils from gravel to clay. Along the main channel of the river and the western margin of the flood plain silty soils predominate with lesser occurrences of silty sand (Qal-2-4). In the middle of the valley in the southern portion of the map and east of the present stream channel clay soils are the major type probably indicating the remains of an old channel site where clay has been deposited in the slack water areas and during times of overflow onto the adjacent areas. In the northern part of the flood plain clay overlies silty soils indicating that the stream channel may have once also been there and later changed its site.

The East Mesa consists of many soil types controlled by the Rio Grande flood plain, the Santa Fe formation, Tijeras Arroyo, and the Sandia and Manzano uplifts. Adjacent to the flood plain a highly dissected terrace of Quaternary alluvium is predominant. Above this lies a terrace which has an engineering profile of silt and silty sand over gravel. In the southern one half of the East Mesa the Santa Fe formation and Quaternary terrace deposits predominate. They have been cut through by Tijeras Arroyo and in this area have a well developed silt and gravel soil. The silty soils (Qt-4) of the central part of the mesa occur in a transition zone which has been influenced by former channel sites of the Rio Grande and the alluvial fans of the Sandia Mountains. The surface has been and is being reworked by sheet flooding and wind erosion. The area of silty sandy soils is due to the action of Embudo Arroyo and other arroyos which flow from the mountains with greater velocity because of the increased gradient in this area. The heads of the alluvial fans adjacent to the mountains are composed of silty sand and gravel which contain in places very coarse materials (A-1-b). The alluvial soils of Tijeras Arroyo are silty gravel (A-2-4) and sandy gravel (A-1-a).

Residual soils occur at the entrance to Tijeras Canyon. These soils are derived from Precambrian granite and various metamorphic rocks such as gneiss, schist, quartzite, and greenstone (an altered basic igneous rock which owes its color to the presence of chlorite, hornblende, and epidote). Soils developed from the granite, gneiss and quartzite are primarily stony silty soils (A-2-4). Clay soils are derived from the schist and greenstone. There are local accumulations of gravel in the canyons of this area that are not shown on the soils and geology map. The topography of this area is rugged and steep and is highly affected by erosion, consequently, the soils have little time to develop before they are removed to lower elevations.

Table No. 40-10-1, shows the log and classification of the soil samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-10.

Ground Water:

Ground water conditions of the Rio Grande flood plain may be significant in relation to possible engineering problems. Sources of ground water are: (1) underflow from bordering mesas; (2) seepage from the river; (3) seepage from canals and irrigated lands; and (4) local precipitation.

There is doubtless general percolation of water toward the flood plain throughout the length of the valley, but the major contributions come from the arroyo channels which intermittently carry large quantities of water. The medium through which ground water moves in the Rio Grande Valley is chiefly alluvium and in this way it is slowly and constantly moving in a down stream direction. It receives new supplies at some places and loses water at others. This movement can be explained in that the aggrading Rio Grande deposits coarse material in its channel and deposits finer material on the adjacent flood plain. When a shift in course occurs, it scours out some of the finer flood plain material and deposits coarse material in its place while simultaneously depositing fine material over the coarse material in its abandoned channel. Water moves through the coarse deposits with relative ease.

The irrigated areas receive water during the growing season in excess of what they normally hold; consequently, the water table rises in the summer. In nonirrigated areas vegetation draws heavily on the ground water and the water table falls. After the growing season the reverse is true; the water table falls in irrigated areas and rises in nonirrigated areas.

In May 1960, samples were taken in the valley vicinity. At holes 11 to 14 (see map), water was encountered in sandy strata from 4.5 to 5.0 feet. A ground water report by Theis (1938) on the Middle Rio Grande Valley states that in 50% of the valley the water table is encountered from 4 to 6 feet and in 13% of the valley it is encountered at over 8 feet.

Stratigraphy:

Quaternary:

Alluvium (Qal) - valley fill of gravel, sand, silt, and clay.

Landslide debris (Qls) - large boulders of basalt along the scarp of the basalt flow in the northwestern part of this section.

Terrace deposits (Qt) - gravel, sand, silt, and caliche deposited on old erosion surfaces of the Rio Grande.

Alluvial fan deposits (Qaf) - poorly sorted, angular to subangular boulders, gravel, and sand mostly derived from Precambrian granite and deposited by intermittent streams which issue from the Sandia Mountains.

Basalt (Qb) - a small flow of basalt which came from the Albuquerque volcanoes. Thickness: 20 to 30 feet.

SOILS AND GEOLOGY

Terrace gravels (Qtg) - highly dissected gravels adjacent to the flood plain.

Unconformity----------Period of Erosion----------

Tertiary: Santa Fe formation (Tsf) - late Tertiary, structurally deformed, unconsolidated to poorly consolidated basin deposits which occupy the Rio Grande Depression and adjacent areas. This formation varies abruptly both laterally and vertically from coarse conglomerate and gravel to sand, silt and clay. The gravel and sand strata are usually gray to tan and contain much clay and calcite cement. The silt and clay beds are buff, light-brown, pink, and reddish-brown.

Unconformity----------Period of Erosion----------

Pennsylvanian: Madera formation (Pm) - gray limestone.

Sandia formation (Ps) - alternating, irregularly bedded sandstone and conglomerate; shale which is sometimes carbonaceous, and occasional beds of impure limestone. Thickness: 250 feet.

Unconformity----------Period of Erosion----------

Precambrian: Granite (PCgr) - red and gray granite which, with the Precambrian metamorphics, comprises the core of the Sandia Mountains. The granite grades into gneiss; therefore, the contact can be approximately located.

Gneiss (PCgn) - gray to brownish-red.

Greenstone and schist (PCgs) - greenstone, chlorite schist and various mica schists.

Quartzite (PCqz) - gray quartzite.

Construction Materials:

Quaternary: Alluvium (Qal) - outwash sand and gravel from the Santa Fe formation. In some areas this material is suitable for filler.

Terrace gravels (Qtg) - gravel terraces located on both sides of the Rio Grande. There are large quantities of this excellent surfacing material. However, many of the best deposits are commercial gravel sources.

Tertiary: Santa Fe formation (Tsf) - sand and gravel exposed between the Rio Grande flood plain and the terraces on the eastern side of the river. Exposures also along Tijeras Arroyo. There are moderate amounts of this good filler and surfacing material.

Pennsylvanian: Madera limestone (Pm) - local outcrops of dense limestone approximately 2.5 miles northwest of Carnue. There is approximately 750,000 cubic yards of this excellent surfacing material available.

Precambrian: Quartzite (PCqz) - dense, hard, pure quartzite 3 miles south of Carnue. An unlimited supply of this excellent surfacing material is available here.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-10. Test data and other related information are shown in Material Pit Summary Table 40-10-2.

Soils Summary:

Table No. 40-10-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	9	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	---	Unclassified	" "
"	"	10	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Unclassified	Clay soil
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	4.5	A-3	Fine sand
"	"	12	A	0.0	4.0	A-2-4	Silty sand
"	"	13	A	0.0	5.0	A-2-4	" "
"	"	14	A	0.0	4.5	A-4	Silty soil
"	"	16	A	0.0	3.0	A-4	" "
"	"	17	A	0.0	8.0	A-2-4	Silty sand
"	"	19	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	4.5	A-2-4	Silty sand
"	"	20	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	6.0	A-3	Fine sand
"	"	21	A	0.0	8.0	A-4	Silty soil
"	"	22	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	2.5	A-4	Silty soil
"	"	23	A	0.0	4.5	A-6	Clay soil
"	"	29	A	0.0	3.0	A-6	" "
"	"		B	3.0	4.5	A-4	Silty soil
"	"	30	A	0.0	4.5	A-4	" "
"	"	31	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	3.5	A-4	Silty soil
"	"	32	A	0.0	8.0	A-4	" "
"	"	34	A	0.0	4.0	A-3	Fine sand
"	"	35	A	0.0	4.0	A-6	Clay soil
"	"	44	A	0.0	3.5	A-2-4	Silty sand
"	"		B	3.5	8.0	A-4	Silty soil
"	"	50	A	0.0	8.0	A-4	" "
"	"		B	8.0	16.0	A-2-4	Silty sand
"	Terrace	1	A	0.0	4.5	A-2-4	" "
"	"	2	A	0.0	4.0	A-2-4	" "
"	"	3	A	0.0	4.5	A-2-4	" "
"	"	4	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	4.0	A-6	Clay soil
"	"	5	A	0.0	1.5	A-2-4	Silty sand
"	"		B	1.5	3.0	A-4	Silty soil
"	"		C	3.0	4.0	A-2-4	Silty sand
"	"	6	A	0.0	3.0	A-2-4	" "
"	"	7	A	0.0	5.0	A-2-4	" "
"	"	8	A	0.0	2.0	A-2-4	" "
"	"		B	2.0	3.0	A-4	Silty soil
"	"	15	A	0.0	4.5	A-2-4	Silty sand
"	"	18	A	0.0	3.5	A-2-4	" "
"	"	24	A	0.0	2.5	A-2-4	" "
"	"		B	2.5	9.0	A-1-b	Sandy gravel
"	"	26	A	0.0	4.0	A-2-4	Silty sand
"	"	27	A	0.0	4.5	A-2-4	" "
"	"	28	A	0.0	4.5	A-2-4	" "
"	"	36	A	0.0	4.0	A-2-4	" "
"	"	37	A	0.0	4.2	A-2-4	" "
"	"	38	A	0.0	3.5	A-4	Silty soil
"	"		B	3.5	5.0	A-3	Fine sand
"	"	39	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	4.0	A-6	Clay soil
"	"	40	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	4.0	A-6	Clay soil
"	"	41	A	0.0	3.0	A-4	Silty soil
"	"	42	A	0.0	3.5	A-2-4	Silty sand
"	"	45	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	8.0	A-1-b	Sandy gravel
"	"	46	A	0.0	10.0	A-2-4	Silty sand
"	"	47	A	0.0	6.5	A-4	Silty soil
"	"	48	A	0.0	4.0	A-4	" "
"	"	49	A	0.0	50.0	A-1-a	Gravel

Table No. 40-10-1 continued

Table No. 40-10-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Terrace	43	A	0.0	15.0	A-1-b	Sandy gravel
The following residual soil samples represent soils derived from parent formations.							
Quaternary	Basalt	25	A	0.0	4.5	A-4	Silty soil
"	"		B	4.5	---	Solid rock	Basalt
Tertiary	Santa Fe	33	A	0.0	3.5	A-4	Silty soil
"	" "		B	3.5	10.0	A-1-b	Sandy gravel
Precambrian	Gneiss	51	A	0.0	2.5	A-2-4	Silty sand
"	Granite	52	A	0.0	4.0	A-1-b	Sandy gravel
"	"	54	A	0.0	5.0	A-2-4	Silty sand
"	Greenstone	53	A	0.0	3.0	A-6	Clay soil

Selected References

Bryan, Kirk and McCann, F. T., 1937, The Ceja del Rio Puerco, a Border Feature of the Basin and Range Province in New Mexico, Jour. of Geol., V. 46, p. 1-16.

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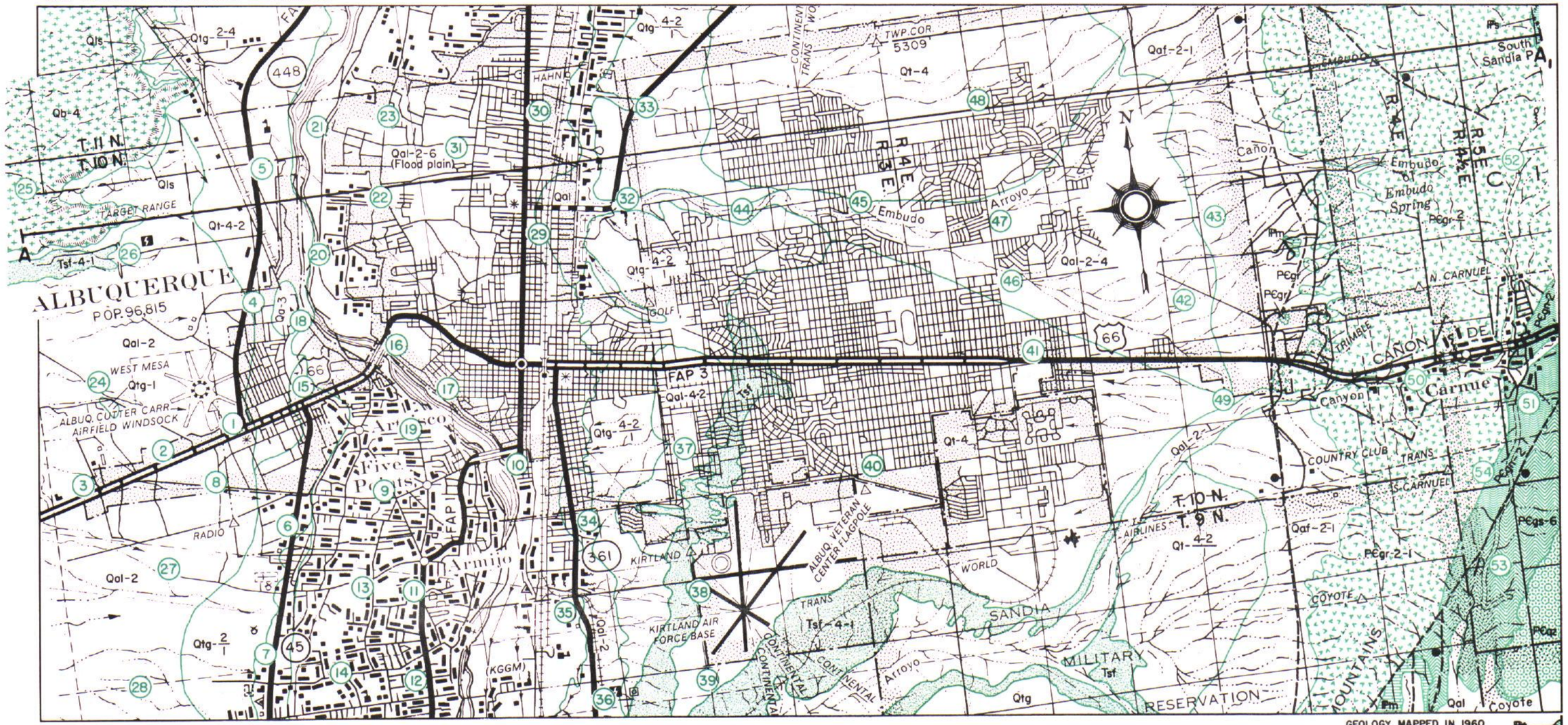
AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

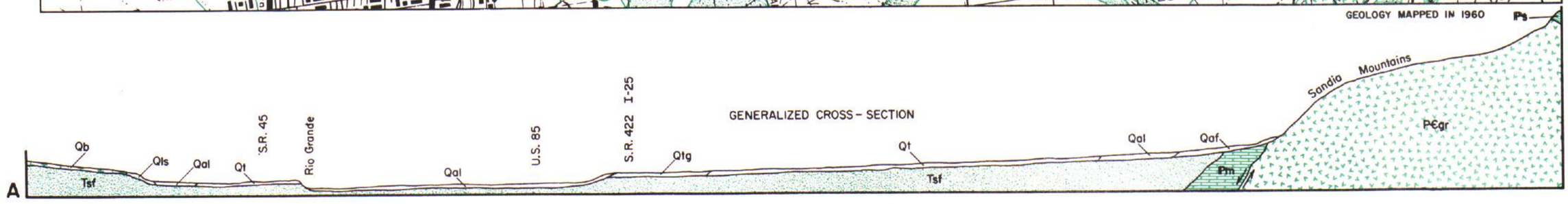
SOILS AND GEOLOGY MAP 40-10

INTERSTATE ROUTE 40
WEST MESA ALBUQUERQUE TO CARNUE



GEOLOGY MAPPED IN 1960

GENERALIZED CROSS-SECTION



-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qls — Landslide debris
- Qt — Terrace deposits
- Qtg — Terrace gravels (Highly dissected)
- Qaf — Alluvial fan material

TERTIARY
- Tsf — Santa Fe formation

PENNSYLVANIAN
- Pm — Madera limestone
- Ps — Sandia formation

IGNEOUS ROCKS

QUATERNARY
- Qb — Basalt

PRECAMBRIAN
- Pegr — Granite

METAMORPHIC ROCKS

PRECAMBRIAN
- Pegn — Gneiss
- Pegs — Greenstone and Schist
- Pqz — Quartzite

STATUTE MILES

SECTION 40-10
Page 4

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
WEST MESA ALBUQUERQUE - CARNUE

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-10-2

Pit or Prospect No.		54-87-S	54-89-S	54-90-S	55-10-S	57-25-S	58-43-S
Location	Part of Sec.	Not sectionalized	NE 1/4	SE 1/4 | NE 1/4	SE 1/4 | SW 1/4	SE 1/4	See remarks
	Section	" "	27	14 | 23	34 | 35	27	14 & 23
	Twnshp. & Range	" "	T 11 N, R 2 E	T 11 N, R 2 E	T 10 N, R 2 E	T 10 N, R 4 E	T 10 N, R 4 E
	County	Bernalillo	Bernalillo	Bernalillo	Bernalillo	Bernalillo	Bernalillo
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Commercial	Paul S. Godfrey & Assoc.	Paul S. Godfrey & Assoc.	A. J. Giannini	Wiley S. Johnson	See remarks
Geologic Age		Quaternary	Quaternary	Quaternary	Tertiary	Quaternary	Pennsylvanian
Formation		Terrace	Terrace	Terrace	Santa Fe	Alluvium	Madera
Type of Pit		Gravel	Gravel	Gravel	Gravel	Gravel	Quarry
Kind of Material		Quartzite	Quartzite & various	Quartzite & various	Quartzite & various	Varied	Limestone
Quality of Material		Excellent	Excellent	Excellent	Excellent	Good	Excellent
Thickness of Material		15+ feet	11 feet	20+ feet	13+ feet	Approx. 12 feet	50+ feet
Thickness of Cap (Caliche)		-	-	-	-	-	-
Blasting Qualities		-	-	-	-	-	?
Uniformity		Excellent	Good	Excellent	Excellent	Good	Excellent
Impurities		None	None	None	None	None	Minor shale lenses
Type of Mat'l Underlying Formation		Siltstone, sandstone, & clay	Silt & clay	Silt & clay	Silt & Clay	Silt & clay	?
Moisture Condition		Dry	Dry	Dry	Dry	Variable water table	Dry
Depth of Overburden		0.0 - 2.0 feet	1.0 - 3.0 feet	0.0 - 2.0 feet	4 feet	None	None
P. I. (Overburden)		N.P.	N.P.	N.P.	0 - 5	-	N.P.
Est. Quantity Remaining		100,000 cu. yds.	75,000 cu. yds.	150,000+ cu. yds.	250,000 cu. yds.	200,000 cu. yds.	750,000 cu. yds.
Est. Extension Possibilities		See remarks	500,000 cu. yds.	300,000+ cu. yds.	See remarks	See remarks	None
Est. Quantity (Prospect)		-	-	-	-	-	-
Approx. Haul to Nearest Point		3.0 miles	5.0 miles	6.5 miles	2.4 miles	0.7 miles	1.6 miles
L. A. Wear		26.4	25.2	27.2	25.6	32.0	30.0
Maximum Size		Not reported	6"	8"	6"	3"	-
% Retained on 2" Sieve		" "	?	Not reported	Less than 5	5	-
Pit Average % Passing	Crushed to	" "	-	" "	-	-	2"
	2"	" "	-	" "	-	74	100
	1"	" "	-	" "	-	68	54
	3/4"	" "	100	" "	100	65	35
	1/2"	" "	77	" "	83	61	25
	#4	" "	45	" "	50	50	11
	#10	" "	36	" "	36	36	6
	#200	" "	2	" "	3	6	1
P. I.		" "	N.P.	" "	N.P.	N.P.	N.P.
Lab. Numbers		" "	54-15728 - 15742	" "	55-1383 - 1392	57-4392 - 4414	58-10691 - 10693A

Remarks:

54-87-S - Located 100 feet left of Station 71+77.4 on Osuna Connection. This pit has not been used to date. It is now a commercial source and no longer available under the original agreement.

54-89-S - See letter and sketch of this area or recommendations for acquiring this property.

54-90-S - Located approximately 5.0 miles north of junction of present U.S. 66 and Coors Road, thence 1.1 miles west of Station 364+55. Refer to letter and new sketch of area for recommendations.

55-10-S - Located immediately west of Station 541+62.6 on Project No. S-22(1). This pit may be extended north, south, and west provided the landowners are agreeable.

57-25-S - Has been accepted for select material to mix with limestone on Base and Sub-base design. Pit is located 2395 feet south R/W Station 379+31 on NMP-F-151(7). Pit can be extended down stream for an approximate 250,000 cu. yds. addition provided the landowner is agreeable.

58-43-S - Located 6028 feet north of Station 418+97.3 on Project No. I-040-3(8)169, thence, 2641 feet east. Owners are University Hights Development Company (Section 14), R. P. Scott (NW 1/4 NE 1/4 Section 23), and Sweringer (NE 1/4 NW 1/4 Section 23).

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-10-2

Pit or Prospect No.		58-56-S	60-2-S	60-23-S	60-62-S	40-10-1 (Prospect)
Location	Part of Sec.	Sandia Pueblo Grant	NW 1/4	Not sectionalized	-	S 1/2 | N 1/2
	Section	" " "	4	" "	36	6 | 7
	Twnshp. & Range	" " "	T 9 N, R 3 E	" "	T 12 N, R 3 E	T 9 N, R 5 E
	County	Bernalillo	Bernalillo	Bernalillo	Sandoval	Bernalillo
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Commercial	University of New Mexico	A. J. Giannini	Indian Land	Government (forest)
Geologic Age		Quaternary	Quaternary	Quaternary	Quaternary	Precambrian
Formation		Terrace	Alluvium	Terrace	River terrace	Quartzite
Type of Pit		Gravel	Sand	Gravel	Gravel	Quarry
Kind of Material		Quartzite & various	Quartzite & various	Quartzite & various	Quartzite	Quartzite
Quality of Material		Excellent	Fair	Excellent	Excellent	Excellent
Thickness of Material		20+ feet	15+ feet	20+ feet	20+ feet	200 feet
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		-	-	-	-	-
Uniformity		Excellent	Fair	Excellent	Excellent	Excellent
Impurities		None	None	None	None	None
Type of Mat'l Underlying Formation		Sandstone, siltstone, & clay	Siltstone & sandstone	Silt & clay	Silt & clay	Schist
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		0.0 - 9.0 feet	None	10 feet average	0.0 - 8.0 feet	None
P. I. (Overburden)		N.P.	N.P.	0 - 7	0 - 6	None
Est. Quantity Remaining		50,000 cu. yds.	100,000 cu. yds.	300,000 cubic yds.	500,000 + cu. yds.	Unlimited
Est. Extension Possibilities		-	None	300,000 cubic yds.	-	-
Est. Quantity (Prospect)		-	-	-	-	-
Approx. Haul to Nearest Point		-	?	3.5 miles	9.0 miles	3.8 miles
L. A. Wear		24.4	27.2	25.6	25.2	22
Maximum Size		8"	2"	6"	12"	-
% Retained on 2" Sieve		Less than 35	0	Less than 5	15	-
Pit Average % Passing	Crushed to 2"	-	-	-	-	1"
	2"	73	100	95	73	-
	1"	61	98	80	57	100
	3/4"	57	87	72	52	76
	1/2"	51	77	62	46	40
	#4	12	56	45	36	13
	#10	36	45	33	29	6
	#200	5	5	3	3	1
P. I.		N.P.	N.P.	N.P.	N.P.	N.P.
Lab. Numbers		58-10905	60-18 - 43	60-3234 - 3247	60-11449 - 11466	60-5385 - 5386

Remarks:

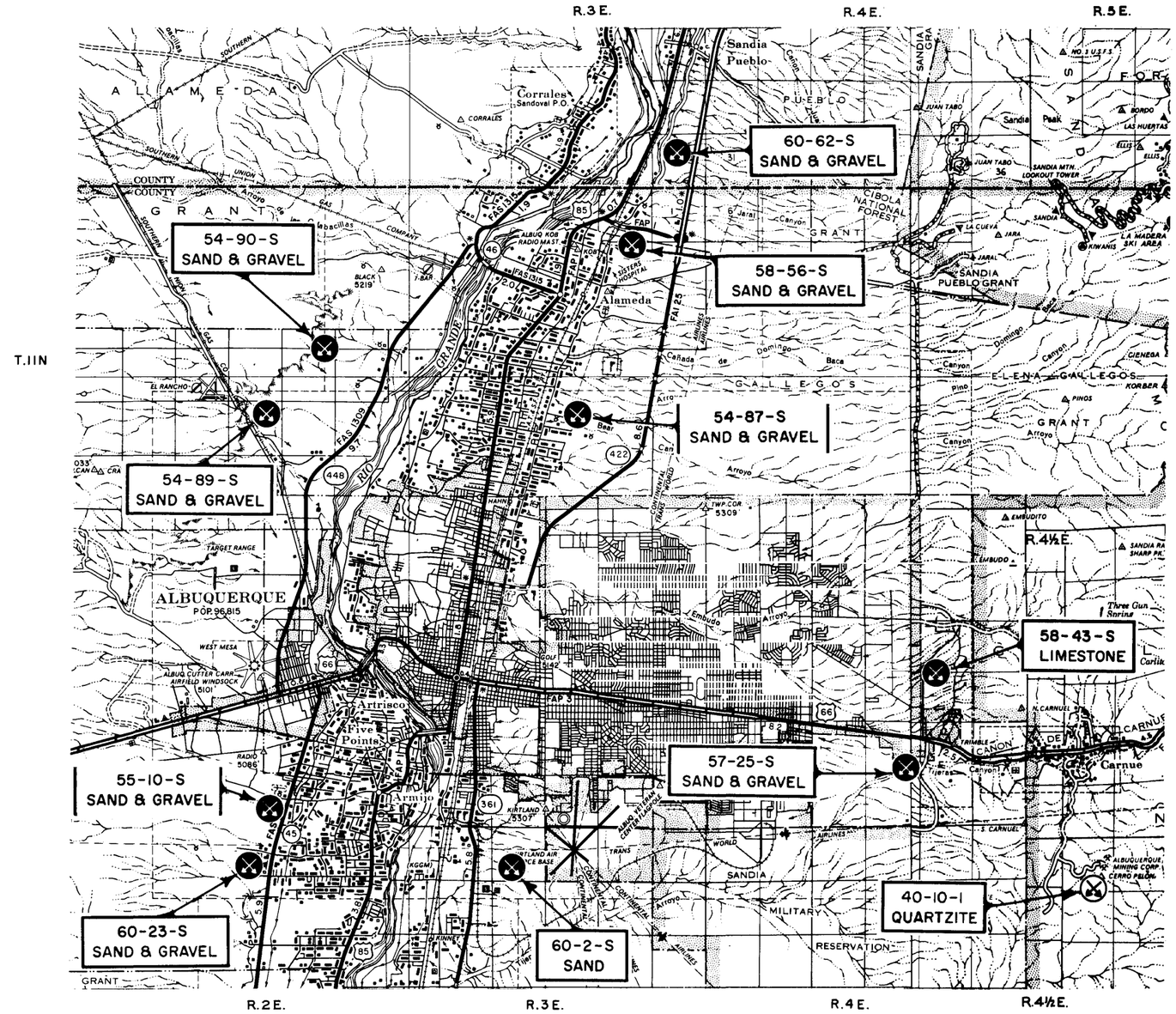
58-56-S - Located 40 feet south R/W Station 53+35.5 on Project No. FI-001-4(9) in the Sandia Pueblo Grant. This pit has not been used to date; however, it is now a commercial source and is no longer available under the original terms.

60-2-S - Located 7115 feet south of Station 193+00 on Project No. I-025-4(13)219. This pit is listed to show the type of material that may be located in local areas of the outwash from the Santa Fe formation.

60-23-S - Located 2990 feet west of the junction of Barcelona Road and State Road 45 (Coors Road), thence 880 feet north in the Atrisco Grant. The pit may be extended provided the landowner is agreeable.

60-62-S - Located 1380 feet left of Station 559+22 on Project No. I-025-4(15)230.

40-10-1 (Prospect) - Drive south of Carnue on trail road approximately 2.5 miles to the divide of the watershed in the canyon, turn left at fork in road and drive to quartzite bluff.



AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
CARNUE - EDGEWOOD

SOILS AND GEOLOGY

Introduction:

Section 40-II extends from Carnue in Tijeras Canyon through the Sandia and Manzano Mountains to Edgewood which lies on the western edge of the Estancia Valley. Physiographically this section lies in the Basin and Range Province. The landforms vary from mountainous regions at the western margin to limestone woodland hills and alluvial valleys on the east.

General Geology:

The Sandia and Manzano Mountains are part of a large eastward tilted block which separates the Rio Grande Depression and the Estancia Valley. The Sandia Mountains which are approximately 18 miles in length were uplifted along a fault line which is near the western base of the mountains. The vertical displacement of this fault ranges from 4,000 to 10,000 feet. This uplift is balanced at the northern end by a complex series of normal faults and at the southern end by the diagonal Tijeras Fault along Tijeras Canyon. South of the Sandia Mountains are the relatively lower lying Manzano Mountains.

On the eastern margin of the Sandia Mountains a small wedge shaped block known as the Tijeras Coal Basin has been considerably folded and dropped along the Tijeras Fault.

The areal distribution of the formations and members are shown on Soils and Geology map 40-II. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils from the western margin of this area to Edgewood are primarily residual. They include those derived from : (1) Precambrian schist and greenstone, clay soils, (2) Precambrian granite, gneiss and quartzite; stony sandy soils, (3) Pennsylvanian limestone and shale, clay soils, (4) Permian sandstones and shales, silty soils, (5) Cretaceous shales, clay soils. The thickness of the residual soils of this area will vary from zero to four feet. There are local accumulations of alluvial soils in this area that are impractical to map as separate geologic units. They are closely related to the residual soils and bear the same engineering classification.

The transported soils of this section have two primary stages of development: (1) relatively young alluvium derived from the Madera formation deposited by streams and arroyos draining the back slopes of the Sandia and Manzano Mountains, and the Tijeras Canyon sediments derived from rocks ranging in age from Precambrian to Cretaceous, (2) older alluvial terraces in the northeast portion of the area derived from Pennsylvanian rocks at a time when the mountains to the west were much higher.

The terraces are an accumulation of sand, gravel, silt, and clay probably formed by stream braiding in their early stages of development. They contain local accumulations that exhibit an engineering profile with silt (A-4) and clay (A-6) overlying a more granular soil (A-1-a and A-1-b).

The younger alluvium of the Tomas Canyon and Edgewood area is predominantly clay soil (A-6) with lesser amounts of silty soil (A-4).

The soils from Carnue to Sedillo Hill lie in a narrow canyon formed by Tijeras Arroyo, its tributaries, and Tijeras Fault. Northeast of State Road 10, the sediments are derived from shale bearing members of the Mesaverde, Mancos, and Yeso formations. High velocity streams have carried most of the clay size particles to lower elevations, therefore, the remaining soil is predominantly silt (A-4). West of State Road 10, the soils of the canyon are influenced by discharges from steep scarp slopes which carry a varied mixture of debris from outcrops of Precambrian and Pennsylvanian rocks. The granular soils (A-1-a and A-1-b) are displayed in alluvial fans at the toe of each tributary and on the floor of the main channel. Finer sediments (A-4) accumulate in the slack water areas along the banks of Tijeras Arroyo.

The areal distribution of the soils and their related formations are shown on Soils and Geology Map 40-II. Table No. 40-II-1 shows the log and classification of soil samples and geologic sections taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary:	Alluvium (Qal) - sand, silt, clay, and gravel deposited in arroyo channels. Thickness: ?
Unconformity----------Period of Erosion----------	
Quaternary and Tertiary:	Terrace deposits (TQt) - Sand, silt, clay, and unconsolidated to poorly consolidated limestone gravel deposited by ancient streams draining from the Sandia Mountains. Where the material is consolidated the cementing agent is usually calcium carbonate and clay. Thickness: ?
Unconformity----------Period of Erosion----------	
Cretaceous:	Mesaverde formation (Kmv) - buff and gray sandstone with interbedded gray shale and some thin coal beds. Thickness: 1000 feet.
	Mancos shale (Km) - tan, fine grained sandstone and siltstone and light-gray to dark-gray shale. Thickness: 2,000 feet.
	Dakota sandstone (Kd) - conglomeratic sandstone with iron cement. Thickness: 50 to 80 feet.
Unconformity----------Period of Erosion----------	
Jurassic:	Morrison formation (Jm) - variegated shale with several beds of sandstone. Also mapped in this area is the Todilto formation which here is included with the Morrison formation. The Todilto formation consists of platy-bedded fetid limestone and massive gypsum. Thickness: Morrison formation - 400 feet, Todilto formation - 50 feet.
Triassic: ?	Wingate sandstone (TrJw) - light-red or gray, cross-bedded sandstone. Thickness: 100 feet.
Unconformity----------Period of Erosion----------	
Permian:	San Andres limestone (Psa) - upper portion contains fine sandstone and siltstone with occasional limestone beds. The lower portion contains dark-gray, finely crystalline limestone. Thickness: Upper portion - 50 to 100 feet, Lower portion - 150 feet.
	Glorieta sandstone (Pg) - white to gray, medium to coarse grained sandstone. Thickness: 200 feet.
	Yeso formation (Py) - fine grained, light-red sandstone and siltstone with occasional thin limestone beds. Thickness: 400 to 600 feet.
	Abo formation (Pa) - red shale, red or reddish-brown sandstone, arkosic sandstone and conglomerate. Thickness: 800 feet.
Unconformity----------Period of Erosion----------	
Pennsylvanian:	Madera formation (Pm) - upper portion contains alternating red or brown arkosic sandstone and shale, and gray limestone. The lower portions contain dark-gray, cherty limestone with very minor beds of sandstone and calcareous shale. Thickness: Upper portion - 1,000 feet, Lower portion - 800 feet.
	Sandia formation (Ps) - irregularly bedded, coarse grained sandstone, carbonaceous shale, and occasional impure beds of limestone. Thickness: 250 feet.
Unconformity----------Period of Erosion----------	

SOILS AND GEOLOGY

Stratigraphy continued

Precambrian: Granite (P€gr) - red and gray granite.

Gneiss (P€gn) - gray and brown-red gneiss.

Greenstone and schist (P€gs) - greenstone (an altered basic igneous rock which owes its color to the presence of chlorite, hornblende, and epidote), chlorite schist, and various mica schists.

Quartzite (P€qz) - gray quartzite.

Construction Materials:

Tertiary ?: Terrace (TQt) - poorly sorted limestone and sandstone gravel derived from the Madera formation and deposited at the western margin of Estancia Valley. In some areas this gravel is partly cemented in its upper portion by calcium carbonate and clay. The more desirable material is inconsistant and occurs in buried channels. It was deposited in a transitional zone between the highlands to the west and the Estancia Valley and is composed of sediments deposited by coalescing streams. Surfacing pits have been developed in this area and further sub-surface exploration may prove several thousand cubic yards of usable material.

Pennsylvanian: Madera limestone (Pm) - thick-bedded, dense limestone with minor amounts of interbedded shale. It is the predominant formation in this area, however, the limestone is often overlain by sandstone and shale beds. Erosion has exposed numerous local areas of this massive limestone that will yield from 200,000 to 500,000 cubic yards of excellent material.

Precambrian: Quartzite (P€qz) - brittle, massive, dense quartzite. A 100-foot vertical face of this material is exposed one-half mile north of U.S. 66 in Tijeras Canyon. Even though the quality of this material is excellent other resources may prove more economical because of the inaccessibility of this site. The basal part of this material is approximately 100 feet higher than present U.S. 66.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-11. Test data and other related information are shown in Material Pit Summary Table No. 40-11-2.

Soils Summary:

Table No. 40-11-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	2	A	0.0	11.0	A-4	Silty soil
"	"	6	A	0.0	9.0	A-4	" "
"	"	11	A	0.0	5.0	A-4	" "
"	"	12	A	0.0	5.0	A-6	Clay soil
"	"	17	A	0.0	4.5	A-4	Silty soil
"	"	18	A	0.0	4.5	A-6	Clay soil
"	"	19	A	0.0	3.0	A-6	" "
"	"	20	A	0.0	4.0	A-6	" "
"	"		B	4.0	4.5	A-7	" "
"	"	24	A	0.0	4.5	A-6	" "
"	"	26	A	0.0	4.0	A-6	" "
"	"		B	4.0	---	Solid rock	Caliche
"	"	28	A	0.0	4.0	A-6	Clay soil
"	"	29	A	0.0	1.5	A-6	" "
"	"		B	1.5	4.0	A-6	" "
"	"		C	4.0	5.0	A-6	" "
"	"	31	A	0.0	1.5	A-6	" "
"	"		B	1.5	4.5	A-6	" "
"	"	32	A	0.0	4.5	A-6	" "
"	"	33	A	0.0	4.5	A-4	Silty soil

Table No. 40-11-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	34	A	0.0	3.5	A-6	Clay soil
"	"	35	A	0.0	4.5	A-6	" "
"	"	40	A	0.0	4.5	A-6	" "
"	"	42	A	0.0	4.5	A-6	" "
"	"	43	A	0.0	4.5	A-4	Silty soil
"	"	44	A	0.0	4.5	A-6	Clay soil
Quaternary-Tertiary	Terrace	25	A	0.0	5.0	A-4	Silty soil
"	"	27	A	0.0	2.3	A-6	Clay soil
"	"		B	2.3	3.0	A-4	Silty soil
"	"	30	A	0.0	3.0	A-6	Clay soil
The following soil samples represent soils derived from parent formations.							
Cretaceous	Mancos	7	A	0.0	1.0	A-7	Clay soil
"	"		B	1.0	4.0	A-4	Shale
"	"		C	4.0	---	Unclassified	"
Permian	Yeso	5	A	0.0	1.3	A-4	Silty soil
"	"		B	1.3	---	Solid rock	Sandstone
"	Abo	4	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	---	Solid rock	Shale
Pennsylvanian	Madera	8	A	0.0	4.5	A-6	Clay soil
"	"		B	4.5	---	Solid rock	Limestone
"	"	9	A	0.0	0.6	A-7	Clay soil
"	"		B	0.6	---	Solid rock	Limestone
"	"	10	A	0.0	4.5	A-7	Clay soil
"	"		B	4.5	---	Solid rock	Limestone
"	"	13	A	0.0	4.5	A-6	Clay soil
"	"		B	4.5	5.0	Solid rock	Caliche
"	"		C	5.0	---	Solid rock	Limestone
"	"	14	A	0.0	2.0	A-6	Clay soil
"	"		B	2.0	4.5	A-6	" "
"	"		C	4.5	---	Unclassified	" "
"	"	15	A	0.0	2.5	A-6	" "
"	"		B	2.5	---	Solid rock	Limestone
"	"	16	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Solid rock	Limestone
"	"	37	A	0.0	4.0	A-6	Clay soil
"	"		B	4.0	---	Unclassified	" "
"	"	38	A	0.0	0.6	A-6	" "
"	"		B	0.6	---	Solid rock	Limestone
"	"	39	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	---	Solid rock	Limestone
"	"	41	A	0.0	2.0	A-6	Clay soil
"	"		B	2.0	---	Solid rock	Limestone
"	"	45	A	0.0	0.5	A-4	Silty soil
"	"		B	0.5	---	Solid rock	Limestone
Precambrian	Gneiss	1	A	0.0	3.0	A-1-b	Stony soil
"	"		B	3.0	---	Solid rock	Gneiss
"	Greenstone	3	A	0.0	0.5	A-6	Clay soil
"	"		B	0.5	---	Solid rock	Greenstone
The following sections show the materials that may be encountered when cuts are made in the respective formations.							
Cretaceous	Mesaverde	22	A	0.0	73.0	Solid rock	Sandstone
"	Mancos		B	73.0	147.0	A-4	Sandstone & shale
"	"		C	147.0	149.0	Solid rock	Sandstone
"	"		D	149.0	190.0	A-4	Shale
"	"		E	190.0	192.0	Solid rock	Sandstone
"	"		F	192.0	204.0	A-4	Shale
"	"		G	204.0	205.0	Solid rock	Sandstone

Table No. 40-II-1 continued

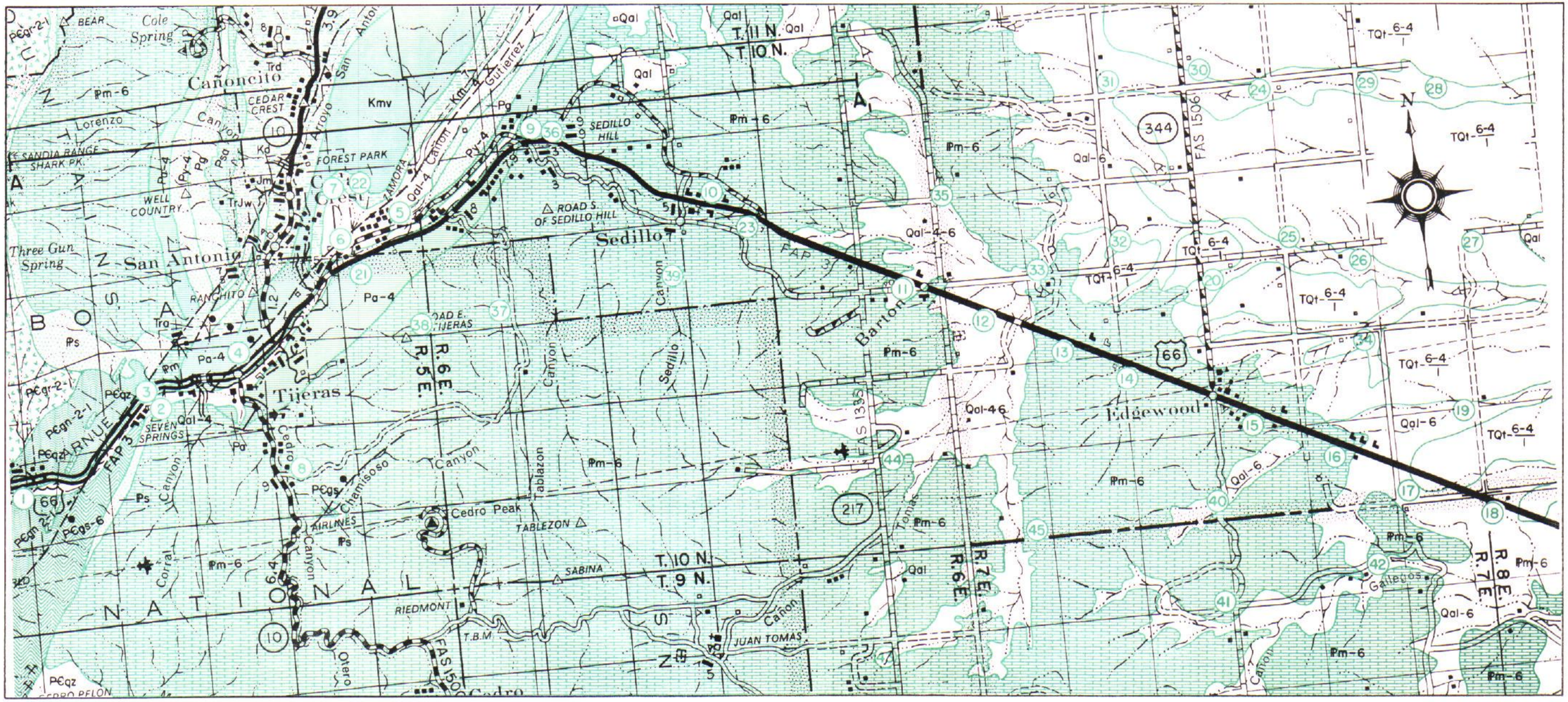
Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Permian	Abo	21	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	6.0	Solid rock	Silty sandstone
"	"		C	6.0	9.0	Solid rock	Sandstone
"	"		D	9.0	10.0	Solid rock	Limestone
"	"		E	10.0	12.0	A-4	Shale
"	"		F	12.0	14.0	Solid rock	Limestone
"	"		G	14.0	15.0	A-4	Shale
"	"		H	15.0	18.0	Solid rock	Limestone
"	"		I	18.0	21.0	Solid rock	Shale
Pennsyl-vanian	Madera	23	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	5.0	Solid rock	Sandstone
"	"		C	5.0	32.0	A-6	Shale
"	"		D	32.0	33.0	Solid rock	Sandstone
"	"		E	33.0	38.0	A-4	Shale
"	"		F	38.0	45.0	Solid rock	Limestone
"	"	36	A	0.0	11.0	Solid rock	Sandstone
"	"		B	11.0	22.0	A-6	Shale
"	"		C	22.0	67.0	Solid rock	Sandstone, lime-stone & shale
"	"		D	67.0	89.0	A-6	Shale & shaly limestone
"	"		E	89.0	130.0	A-4	Limestone & shale
"	"		F	130.0	174.0	Solid rock	Limestone
"	"		G	174.0	206.0	A-7	Shale
"	"		H	206.0	218.0	Solid rock	Silty limestone
"	"		I	218.0	236.0	A-7	Shale
"	"		J	236.0	367.0	Solid rock	Sandstone, lime-stone & shale
"	"		K	367.0	389.0	A-6	Shale
"	"		L	389.0	444.0	---	Gap or fault
"	"		M	444.0	451.0	Solid rock	Limestone
"	"		N	451.0	470.0	A-4	Shale
"	"		O	470.0	633.0	Solid rock	Limestone & shale

Selected References

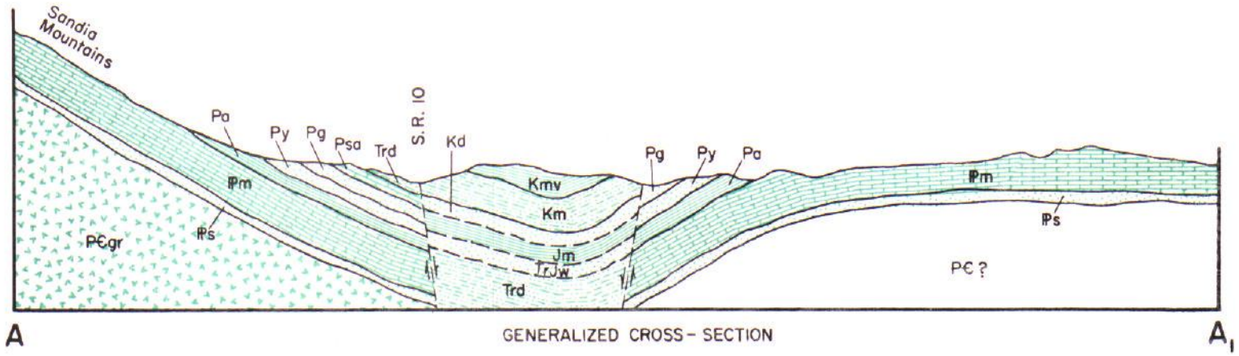
Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Surv., Bull. 794.

Kelley, V. C., 1951, Tectonics of the Rio Grande Depression of Central New Mexico, 3rd Field Conference Guidebook of the Rio Grande Country, Central New Mexico, New Mexico Geol. Soc., p. 93-105.

SOILS AND GEOLOGY MAP 40-II



GEOLOGY MAPPED IN 1960



GENERALIZED CROSS-SECTION

STATUTE MILES

-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — TERTIARY QUATERNARY
- TQt — Terrace deposits — TERTIARY QUATERNARY
- Kmv — Mesaverde group — CRETACEOUS
- Km — Mancos shale — CRETACEOUS
- Kd — Dakota sandstone — CRETACEOUS
- Jm — Morrison formation — JURASSIC
- TrJw — Wingate formation — TRIASSIC
- Trd — Dockum group — TRIASSIC
- Psa — San Andres limestone — PERMIAN
- Pg — Glorieta sandstone — PERMIAN
- Py — Yeso formation — PERMIAN
- Pa — Abo formation — PERMIAN
- Pm — Madera limestone — PENNSYLVANIAN
- Ps — Sandia formation — PENNSYLVANIAN
- Magdalena group

IGNEOUS ROCKS

- PEgr — Granite — PRECAMBRIAN

METAMORPHIC ROCKS

- PEgn — Gneiss — PRECAMBRIAN
- PEgs — Greenstone and schist — PRECAMBRIAN
- PEqz — Quartzite — PRECAMBRIAN

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-II-2

Pit or Prospect No.		57-26-S	58-9-S	40-II-1 (Prospect)	40-II-2 (Prospect)	40-II-3 (Prospect)
	Part of Sec.	N 1/2	N 1/2 of SE 1/4	NE 1/4	SE 1/4 of SE 1/4	See remarks
	Section	8	9	21	34	" "
Location	Twnshp. & Range	T 10 N, R 6 E	T 10 N, R 6 E	T 10 N, R 5 E	T 10 N, R 5 E	" "
	County	Bernalillo	Bernalillo	Bernalillo	Bernalillo	Bernalillo
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		N. M. State Highway Dept.	Private Property	Forest Land	Forest Land	Forest Land
Geologic Age		Pennsylvanian	Pennsylvanian	Precambrian	Pennsylvanian	Pennsylvanian
Formation		Madera	Madera	Quartzite	Madera	Madera
Type of Pit		Quarry	Quarry	Quarry	Quarry	Quarry
Kind of Material		Limestone	Limestone	Quartzite	Limestone	Limestone
Quality of Material		Good	Excellent	Excellent	Good	Good
Thickness of Material		30 feet	30+ feet	100 feet	100 feet	30+ feet
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		Excellent	Good	Excellent	?	?
Uniformity		Good	Good	Good	Good	Good
Impurities		Shale lenses (Minor)	Shale lenses (Minor)	Mica	Shale (Minor)	Shale lenses (Minor)
Type of Mat'l Underlying Formation		?	?	Gneiss	?	?
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Depth of Overburden		0.0 to 2.0 feet	1 to 2.5 feet	None	Trace	0.0 to 0.5 feet
P. I. (Overburden)		11	-	-	-	14
Est. Quantity Remaining		200,000 cu. yds.	180,000 cu. yds.	500,000 cu. yds.	500,000 cu. yds.	500,000 cu. yds.
Est. Extension Possibilities		-	500,000 cu. yds.	-	-	-
Est. Quantity (Prospect)		-	-	-	-	-
Approx. Haul to Nearest Point		On I-40 or present U.S. 66	On U.S. 66	0.5 miles	Approx. 3 miles to U.S. 66	4 miles
L. A. Wear		26.8	22.8	25.2	23.6	23.4
Maximum Size		-	-	-	-	-
% Retained on 2" Sieve		-	-	-	-	-
	Crushed to 2"	1" -	1" -	1" -	1" -	1" -
Pit	1"	100	100	100	100	100
Average	3/4"	77	89	75	74	84
% Passing	1/2"	42	52	34	40	45
	#4	16	20	11	14	16
	#10	8	10	6	7	8
	#200	1	1	1	1	2
P. I.		N.P.	N.P.	N.P.	N.P.	N.P.
Lab. Numbers		60-12822 - 12823	58-1447 - 1454	12821	60-12820	60-12818 - 12819

Remarks:

57-26-S - Located 195 feet west of R/W Station 1006+06.26 on FAP 151(6) present U.S. 66. The material consists of a 30-foot road cut exposure of limestone with alternating shale lenses. The shale lenses are calcareous, laminated, and gray to brownish-gray in color. They do contain clay size particles, but they are not sufficient in number to cause P.I. The pit is located within the present R/W fence and cannot be extended.

58-9-S - Located immediately right of R/W Station 1043+64 on FI-151(6) present U.S. 66. Pit has not been used to date. It can be extended to approximately 500,000 cu. yds.

40-II-1 (Prospect) - Located approximately 0.5 miles northwest of Station 620+00. Haul road will be difficult to build. The area may possibly be accessible from two points, the canyon at Station 620+00 and the canyon west of the big granite cut.

40-II-2 (Prospect) - Located 3.5 miles south of the Junction of State Road 10 and U.S. 66 at Tijeras. Outcrops extensively on northwest rim of Tunnel Canyon. Further exploration needed to determine blasting qualities.

40-II-3 (Prospect) - Located in SE 1/4 Sec. 24, N 1/2 N 1/2 Sec. 25, T 10 N, R 5 E, and reaches into SW 1/4 SW 1/4 Sec. 19, T 10 N, R 6 E, and represents the north canyon wall and rim of Chamisoso Canyon. This area may be reached by driving south of the Junction of State Road 10 and U.S. 66 at Tijeras to the Chamisoso Canyon rim road. Drive east on trail road to Cedro Peak telephone line, thence, northeast 3/4 mile to Forest Vegetation Study area, a fenced in area 100 feet by 100 feet. Limestone outcrops on the north canyon wall south of the road. Further exploration is needed to determine the exact qualities of this material.

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-II-2 continued

Pit or Prospect No.		40-II-4 (Prospect)	40-II-5 (Prospect)	40-II-6 (Prospect)	40-II-7 (Prospect)
Location	Part of Sec.	SW 1/4	NW 1/4	NW 1/4 of NE 1/4	See remarks
	Section	36	15	2	" "
	Twnshp. & Range	T 10 N, R 6 E	T 10 N, R 7 E	T 9 N, R 7 E	" "
	County	Bernalillo	Santa Fe	Torrance	Torrance
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State	Private Property	State	Private Property
Geologic Age		Pennsylvanian	Quaternary	Pennsylvanian	Pennsylvanian
Formation		Madera	Terrace	Madera	Madera
Type of Pit		Quarry	Sand & gravel	Quarry	Quarry
Kind of Material		Limestone	Limestone gravel	Limestone	Limestone
Quality of Material		Good	Fair	Excellent	Excellent
Thickness of Material		50 feet	9+ feet	30 feet	30 feet
Thickness of Cap (Caliche)		-	-	-	-
Blasting Qualities		?	-	?	?
Uniformity		Good	Fair	Good	Good
Impurities		Shale lenses (Minor)	Silt	Shale lenses (Minor)	Shale lenses (Minor)
Type of Mat'l Underlying Formation		?	Silt & clay	?	?
Moisture Condition		Dry	Dry	Dry	Dry
Depth of Overburden		0.5 to 1.0 feet	1.0 to 4.0 est.	0.5 to 1.0 feet	0.5 to 1.0 feet
P. I. (Overburden)		12	6	11	None
Est. Quantity Remaining		250,000+ cu. yds.	100,000 cu. yds.	500,000+ cu. yds.	500,000+ cu. yds.
Est. Extension Possibilities		-	-	-	-
Est. Quantity (Prospect)		-	-	-	-
Approx. Haul to Nearest Point		3.2 miles	2.5 miles	0.75 miles	1.0 mile
L. A. Wear		24.6	24.4	26.4	29.2
Maximum Size		-	4"	-	-
% Retained on 2" Sieve		-	Less than 10	-	-
Crushed to	2"	-	1"	1"	1"
Pit Average % Passing	1"	100	100	100	100
	3/4"	84	79	78	85
	1/2"	44	49	46	49
	#4	14	29	18	15
	#10	7	18	9	7
	#200	1	4	2	1
P. I.		N.P.	8	N.P.	N.P.
Lab. Numbers		60-12828 - 12829	60-12824 - 12825	60-12826 - 12827	60-12830 - 12831

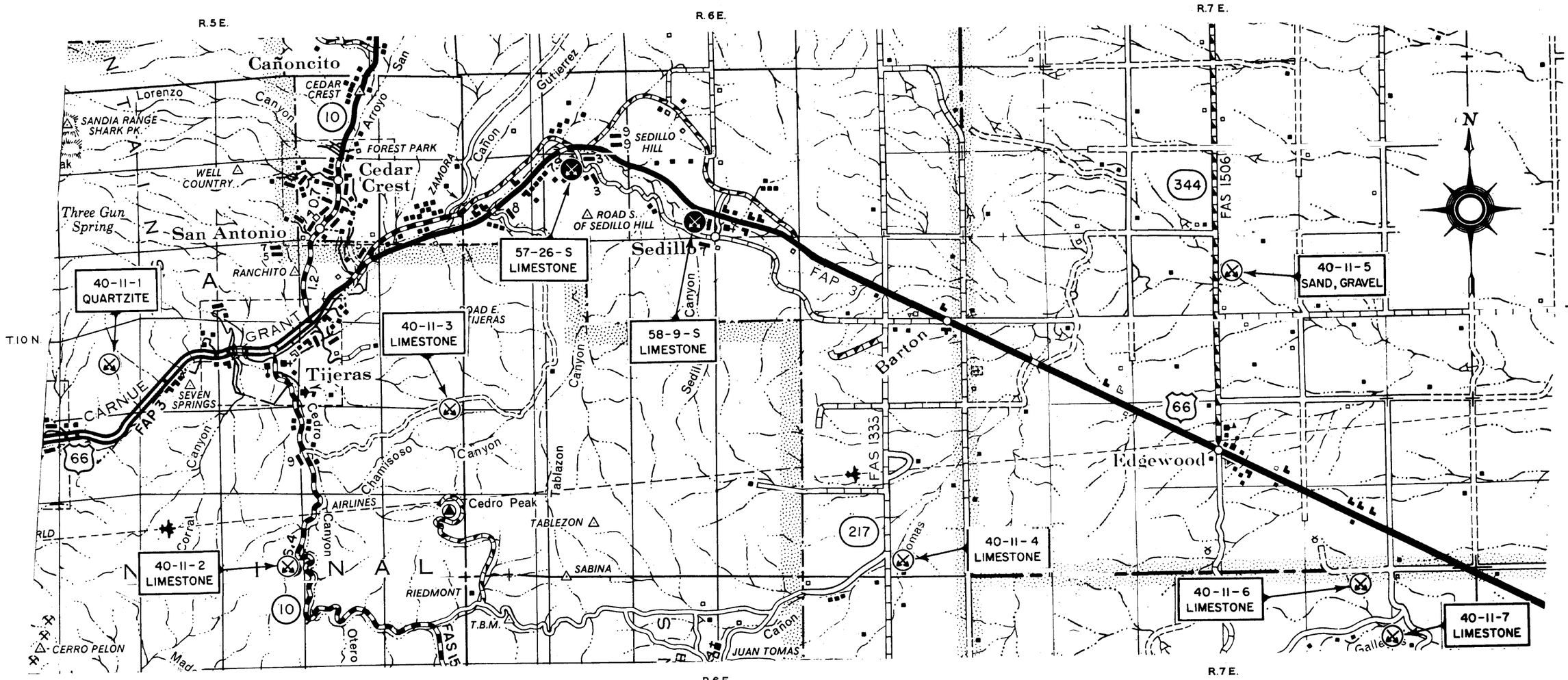
Remarks:

40-II-4 (Prospect) - Located approximately 3.2 miles south of U.S. 66 on State Road 217. Further exploration needed to determine blasting qualities, etc.

40-II-5 (Prospect) - Located 600 feet east of R/W marker 120+00 on State Road 344. An old pit exists in the area exposing an 8-foot face of gravel. Approximately 5,000 cubic yards have been removed from the area. The fines of this pit contain P.I., but it appears that they will waste easily. Further sub-surface exploration is needed to determine the conditions of this area.

40-II-6 (Prospect) - Located 0.5 miles south of U.S. 66 on section line road, thence, west 0.25 miles on the county line. Limestone occurs in the northeast triangular portion of the 40 acres. Further exploration is needed to determine the exact conditions of the material.

40-II-7 (Prospect) - Located in the N 1/2 NW 1/4 SW 1/4 of Section 1 and N 1/2 NE 1/4 SE 1/4 of Section 2, T 9 N, R 7 E. Approximately 1.0 mile south of present U.S. 66. Further exploration is needed to determine the exact conditions of the material.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
EDGEWOOD - MORIARTY RADAR STATION

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 lies physiographically in the Basin and Range province. It extends across Estancia Valley, the main physical feature of Torrance County, from Edgewood on the western end to Moriarty Radar Station on the eastern end.

General Geology:

The Estancia Valley is a broad relatively flat floored basin of interior drainage which is surrounded by higher land. To the west lies the Manzano uplift, to the north the valley merges with a plateau in southern Santa Fe County, to the east lie the eastern uplands and the Pedernal Hills, and to the south lies Chupadera Mesa. The plateau in southern Santa Fe County, the Pedernal Hills and Chupadera Mesa will not appear on the strip maps, however, their influence on the basin is important since they are sources of sediments. Cerrito del Lobo, a Precambrian quartzite outcrop in the south central portion of the strip represents a western exposure of the Pedernal Hills.

The Estancia Valley proper is about 50 miles long and 12 miles wide; its main axis trends north and south. The valley fill consists of deposits of sand, silt, clay, and gravel which are partly lacustrine in origin and their maximum thickness is more than 300 feet (Smith, 1957). Pennsylvanian and Permian strata which dip gently eastward underlie this valley fill. The surrounding highlands contributed material for the valley fill which is mostly late Tertiary in age. The greater part of this material was from the mountains to the west with lesser contributions from the structural features on the north, east, and south. Numerous playas occupy the lowest part of the valley. Laguna del Perro is the largest and is about 12 miles long and may be as much as 1 mile wide.

The areal distribution of formations is shown on Soils and Geology Map 40-12. Their succession and character are given under the section termed "Stratigraphy."

Soils:

Estancia Valley, an enclosed basin, lies in an arid to semi-arid region. The valley has reached the stage of maturity, the streams have approached grade and the development processes are somewhat dormant. The amount of precipitation over a long period of years will average 10 or 12 inches annually. But the rainfall at a given place may be as much as 15 to 20 inches in one year and none or very little in following years.

During late Tertiary time the primary basin contained a vast amount of water as evidenced by the occurrance of almost obscure beach ridges, beginning approximately 3 miles south of Moriarty and reaching as far south as Juamas Mesa which lies on the northern end of Chupadera Mesa. This indicates that there was more precipitation during Tertiary time and consequently the erosional processes were accelerated. The precipitation was probably in the nature of cloudbursts with two, three or even more inches of rainfall descending in an hour or two. The consequence of such tremendous downpours was water courses filled with violent short-lived floods, followed by long periods of completely dry water courses. When the torrential floods of the steep, confined, gorge sections bordering the valley reached lower basin areas with gentler gradients, they spread, sank underground, or evaporated, and the sediment they brought was deposited. Alluvial fans were built up near the base of the mountain and fine sediment spread out over the basin floor. Playas have from time to time had a temporary existence over the lowest depressions; as they dried up, their bottoms became horizontal floors.

As indicated by the development processes, the more granular soils are contained in old stream terraces and buried channels throughout the area, while the clays, silts and salts are contained in the swales and old playa areas.

The alluvial soils of the valley are generally well developed and present a profile of silty-clay loam over calcareous clay and silt. They do not display any uniform engineering profile because of the complex nature in which they were deposited. They become more silty in the eastern portion of the valley because of the silty nature of the rocks from which they originated and because of wind erosion of the valley floor. There are local exposures of more granular soils that were deposited along channels when the streams were of greater velocity, but which are now almost obscured by finer sediments of lower velocity deposition.

The terrace deposits west of Moriarty are probably remnants of alluvial fans that were formed during the early stages of valley development. They contain a non-uniform profile of silt and clay over sand and gravel. In some instances the upper portion of the gravel is partly consolidated by calcium carbonate and clay.

The terrace deposits southeast of Moriarty show some indication that they were developed partly from wave action when the primary basin was filled with water. They contain a profile of silt overlying sand and gravel.

The residual soils of this area are predominantly silt (A-4); however, the profile of Cerrito del Lobo contains silt (A-4) over clay (A-6) indicating that clay is derived from the Precambrian rocks which make it up and that the silt is transported from the valley floor by wind erosion.

Table No. 40-12-1, shows the log and classification of the soil samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-12.

Ground Water:

Ground water conditions are pertinent to the engineering problems of this area in the vicinity of Salt Draw which is approximately 2.5 miles east of Moriarty.

In a ground water report for Estancia Valley, wells checked periodically show that in the northwestern part of the area, north of U.S. 66 and west of State Road 44, the water table is from 44 to 80 feet. In the southwest portion of the area, south of U.S. 66 and west of State Road 41, the water table is 37 to 82 feet. In the vicinity of Salt Draw soils investigations revealed the water table from 4.5 to 10.0 feet. Apparently the water table is fairly uniform and is nearer the surface in the lower elevations of the central portion of the valley, but in the surrounding areas it is relatively deeper.

Valley fill of sand, gravel, and clay is the main aquifer for Estancia Valley; however, in some parts of the basin large quantities of water are provided by underlying bedrock.

Precipitation is the source of ground water recharge whether by direct penetration or by runoff from the surrounding highlands. Water moves in a southerly direction toward the playa lakes where it is discharged and lost by evaporation. Large quantities of water are drawn from the ground water reservoir for irrigation causing the ground water level to fluctuate seasonally. The water level decreases in the spring when pumping starts; in the summer and fall when pumping ends the water level increases. The deficient precipitation in the Estancia Valley plus additional irrigated lands have caused net declines in ground water levels from year to year since 1947. Declines would be less if precipitation returned to normal and agricultural development did not increase significantly in ensuing years.

Stratigraphy:

Quaternary:	Alluvium (Qal) - valley fill of sand, gravel, silt, and clay in which caliche has formed locally. In the south central portion it is partly lacustrine in origin. Local gravel deposits in the eastern portion are derived from Permian and Triassic strata. Thickness: 10-350 feet.
Unconformity----------Period of Erosion----------	
Tertiary (?) and Quaternary	Terrace deposits (TQt) - deposits of poorly sorted limestone sand, and gravel in the western portion which are remnants of the terraces derived from Paleozoic and Mesozoic strata of the Manzano uplift. Deposits of well sorted sand and gravel derived from Permian and Triassic sedimentary rocks and adjacent Precambrian rocks in the eastern portion. Thickness: 6-20 feet. Caliche (TQc) - white to grayish-orange, pink, nodular, caliche. The bedding and structure are highly irregular. Thickness: 10-15 feet. Older alluvium, caliche and gravel (TQcg) - mixture of sand, gravel, silt, and clay covered locally by soft, poorly consolidated caliche.

SOILS AND GEOLOGY

Stratigraphy continued

Unconformity----------Period of Erosion----------

Triassic: Dockum group (Trd) - gray and conglomeratic sandstone and red shale. Thickness: 300 feet.

Unconformity----------Period of Erosion----------

Permian rocks undivided: San Andres formation (Psa) and Glorieta sandstone (Pg) - San Andres; upper part contains tan or gray friable sandstone and red or pink and buff siltstone, lower part contains finely crystalline limestone, massive, white gypsum, and white to yellow medium grained sandstone. Thickness: Upper part, 0-50 feet; Lower part, 0-200 feet. Glorieta sandstone; white to yellow, well cemented sandstone. Thickness: 150-200 feet.

Permian: Yeso formation (Py) - orange-red, buff and yellow sandstone; white and gray gypsum; red to pink and gray siltstone and gray limestone. Thickness: 600-700 feet.

Unconformity----------Period of Erosion----------

Precambrian: Metamorphic rocks undivided (P€) - a complex series of metamorphic rocks making up Cerrito del Lobo. Thickness: ?

Construction Materials:

Quaternary: Alluvium (Qal) - local exposures of fine sand and gravel are contained in old buried channels in the eastern portion of this area. They are almost obscured by later valley fill deposits that are less granular in nature. Material of this type has been developed for select borrow to improve the grading of crushed rock.

Tertiary (?) and Quaternary: Terrace deposits (TQt) - in this area terraces of two different origins contain construction materials; (1) the terraces that flank the western part of the valley consist of a poorly sorted, non-uniform, limestone sand and gravel; (2) the terrace bordering Cerrito del Lobo consists of partly beach worn, clean, fine, sand and gravel. Material pits of fair quality have been developed in both areas.

Caliche (TQc) - a pink, nodular, loosely consolidated caliche that has formed over Permian rocks in the eastern portion of this area. Material pits of fair quality have been developed from this formation.

Permian: San Andres formation (Psa) - an exposure of the hard, crystalline, gray, thin bedded, limestone that occurs in the lower portion of this formation exists approximately 3 miles north of Longhorn Ranch. It outcrops extensively in section 31, T 10 N, R 10 E, and exposes thicknesses up to 10 feet.

Precambrian: Quartzite (P€qz) - a massive outcrop of this rock occurs in section 7, T 8 N, R 10 E, approximately 4.5 miles south of U.S. 66 and Interstate 40. It represents the highest peak of Cerrito del Lobo and juts above the valley floor approximately 300 feet. A vast supply of high grade, hard, crystalline quartzite exists in this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-12. Test data and other related information are shown in Material Pit Summary Table No. 40-12-2.

Soils Summary:

Table No. 40-12-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	2	A	0.0	5.0	A-6	Clay soil
"	"	3	A	0.0	4.0	A-6	" "
"	"		B	4.0	5.0	A-4	Caliche soil
"	"		C	5.0	---	Unclassified	" "
"	"	4	A	0.0	3.5	A-6	Clay soil
"	"		B	3.5	5.0	A-7	Caliche soil
"	"		C	5.0	---	Unclassified	Caliche "
"	"	5	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	5.0	A-7	Clay soil
"	"	6	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	3.0	A-6	Clay soil
"	"		C	3.0	4.5	A-6	" "
"	"	7	A	0.0	5.0	A-4	Silty soil
"	"	8	A	0.0	3.0	A-4	" "
"	"	9	A	0.0	3.0	A-4	" "
"	"		B	3.0	4.0	A-6	Caliche soil
"	"	10	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	3.5	A-6	Clay soil
"	"		C	3.5	4.5	A-6	Caliche soil
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"	12	A	0.0	4.0	A-4	Silty soil
"	"	14	A	0.0	3.0	A-4	" "
"	"		B	3.0	4.5	A-6	Clay soil
"	"	15	A	0.0	3.5	A-4	Silty soil
"	"	17	A	0.0	4.0	A-4	" "
"	"	18	A	0.0	1.5	A-7	Clay soil
"	"		B	1.5	3.5	A-6	" "
"	"		C	3.5	4.5	A-6	" "
"	"	20	A	0.0	4.5	A-4	Silty soil
"	"	22	A	0.0	4.5	A-6	Clay soil
"	"	24	A	0.0	3.5	A-4	Silty soil
"	"		B	3.5	5.0	A-2-4	Silty sand
"	"	25	A	0.0	3.5	A-4	Silty soil
"	"		B	3.5	5.0	A-6	Clay soil
"	"	26	A	0.0	5.0	A-4	Silty soil
"	"	27	A	0.0	4.5	A-6	Clay soil
"	"	28	A	0.0	3.7	A-4	Silty soil
"	"	29	A	0.0	3.0	A-4	" "
"	"		B	3.0	4.5	A-4	" "
"	"	32	A	0.0	2.5	A-4	" "
"	"		B	2.5	5.0	A-4	" "
"	"	34	A	0.0	5.0	A-4	" "
"	"	36	A	0.0	4.0	A-6	Clay soil
"	"		B	4.0	5.0	A-6	" "
"	"	37	A	0.0	5.0	A-6	" "
"	"	38	A	0.0	5.0	A-7	" "
"	"	40	A	0.0	2.5	A-7	" "
"	"		B	2.5	5.0	A-6	" "
"	"	41	A	0.0	4.0	A-4	Silty soil
Quaternary and Tertiary	Terrace	1	A	0.0	4.0	A-7	Clay soil
"	"	35	A	0.0	4.5	A-6	" "
"	"	39	A	0.0	5.0	A-6	" "
"	Caliche	13	A	0.0	2.0	A-4	Silty soil
"	"	19	A	0.0	2.5	A-6	Clay soil
"	"		B	2.5	---	A-4	Caliche

Table No. 40-12-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
The following samples represent soils derived from their parent formations.							
Quaternary	Caliche	16	A	0.0	2.5	A-4	Silty soil
and Tertiary	"	33	A	0.0	5.0	A-4	" "
Permian	San Andres and Glorieta	23	A	0.0	1.8	A-4	Silty soil
"	Yeso	30	A	0.0	5.0	A-4	Silty soil
Precambrian	Schist	21	A	0.0	3.5	A-4	" "
"	"		B	3.5	5.0	A-6	Clay soil

Selected References

Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Survey, Bull. 794.

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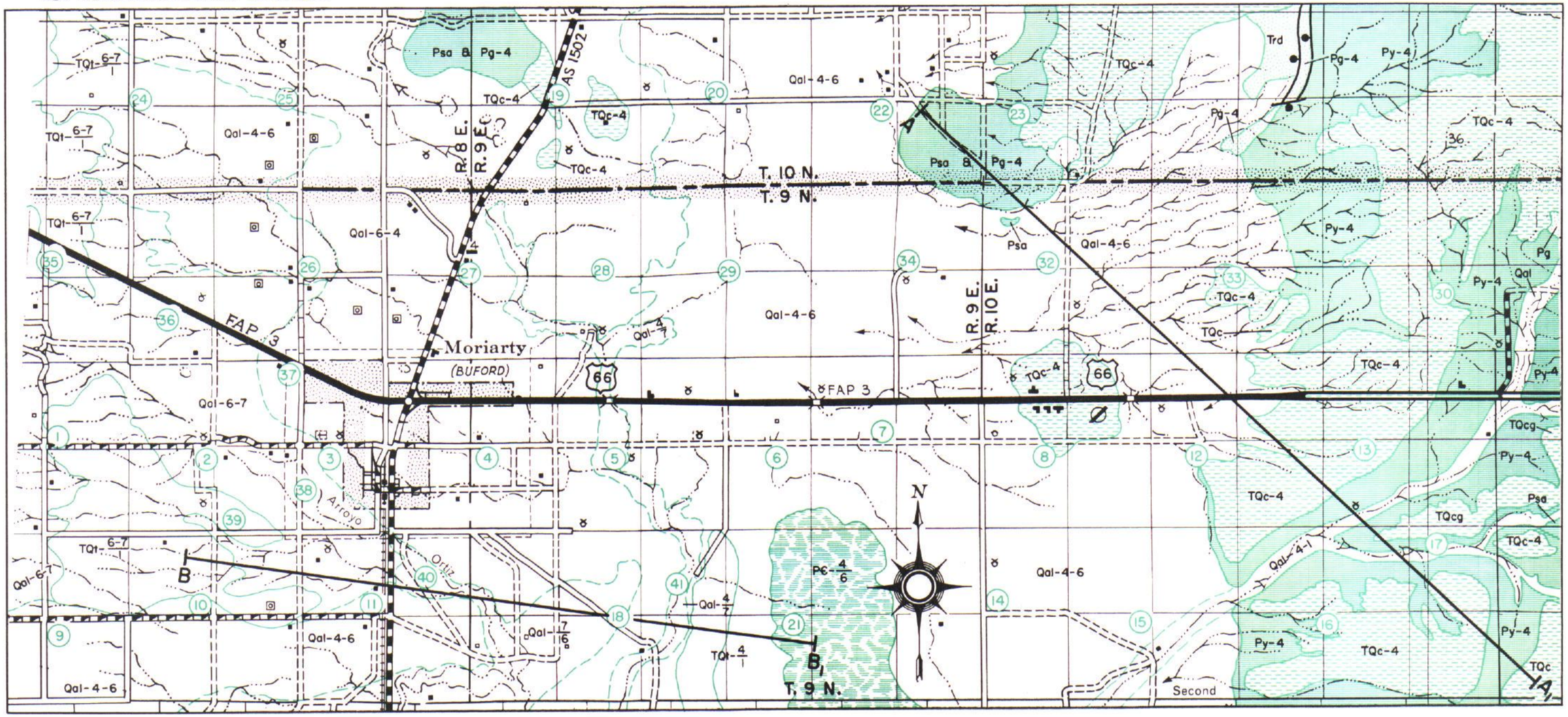
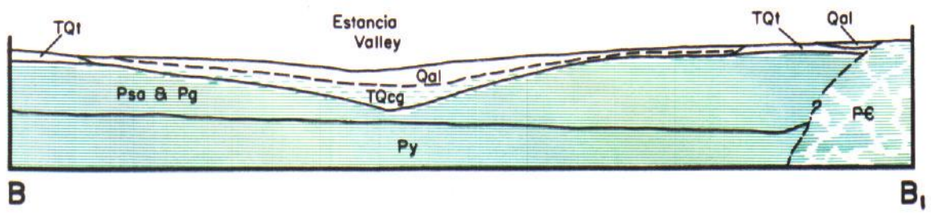
AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

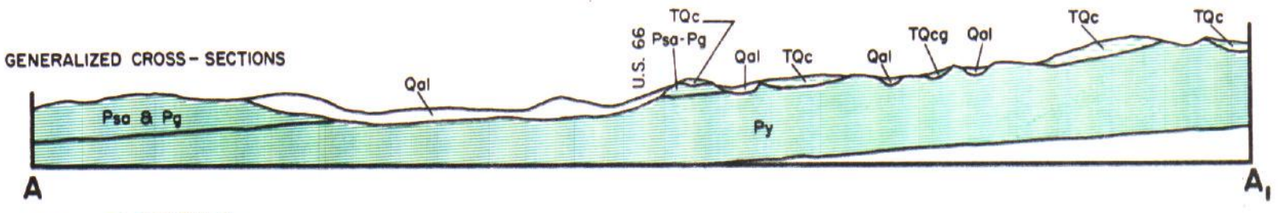
SOILS AND GEOLOGY MAP 40-12

INTERSTATE ROUTE 40
EDGEWOOD TO MORIARTY RADAR STATION





GENERALIZED CROSS-SECTIONS



-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — QUATERNARY
- TQt — Terrace deposits
- TQc — Caliche
- TQcg — Older Alluvium Caliche & gravel — QUATERNARY & TERTIARY
- Trd — Dockum group — TRIASSIC
- Psa Pg — Undivided San Andres formation & Glorieta sandstone
- Pg — Glorieta sandstone — PERMIAN
- Py — Yeso formation — PERMIAN

METAMORPHIC ROCKS

- Pε — Metamorphic rocks Undifferentiated — PRECAMBRIAN

0 — STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
EDGEWOOD - MORIARTY RADAR STATION

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-12-2

Pit or Prospect No.		55-83-S	59-10-S	59-11-S	59-14-S	59-16-S
Location	Section	NW 1/4, 14	27 and 28	NW 1/4, 7	SW 1/4, 13	NE 1/4, 33
	Twnshp. & Range	T 9 N, R 10 E	T 9 N, R 10 E	T 8 N, R 10 E	T 9 N, R 9 E	T 9 N, R 9 E
	County	Torrance	Torrance	Torrance	Torrance	Torrance
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State Land	Private property	Private property	State Highway Department	Private property
Geologic Age		Tertiary ?	Quaternary	Precambrian	Quaternary	Tertiary ?
Formation		Caliche	Alluvium	Quartzite	Alluvium	Terrace
Type of Pit		Quarry	Sand & gravel	Quarry	Sand & gravel	Sand & gravel
Kind of Material		Caliche	Variable	Quartzite	Variable	Variable
Quality of Material		Fair	Fair	Excellent	Fair	Good
Thickness of Material		15 feet maximum	15 feet	30 + feet	15 feet	10 feet
Thickness of Cap (Caliche)		See remarks	-	-	-	-
Blasting Qualities		" "	-	Excellent	-	-
Uniformity		Fair	Fair	Excellent	Fair	Good
Impurities		Silt	Silt lenses	None	Silt lenses	None
Type of Mat'l. Underlying Formation		Sandstone & shale	Clay	Unknown	Silt & clay	Clay & silt
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Vegetation		Grass & scattered cedar trees	Grass	Grass	Grass	Grass
Local Terrain		Mesa	Plain	Hilly	Plain, undulating	Terrace
Depth of Overburden		0.0 to 3.0 feet	1.5 to 6 feet	None	0.0 to 9.5 feet	0,0 to 4,5 feet
P.I. (Overburden)		Less than 10	N.P. to 8	None	N.P. to 15	N,P,
Est. Reserve Quantity		170,000 + cu. yds.	200,000 ± 50,000 cu. yds.	500,000 cu. yds.	500,000 cu. yds.	200,000 + cu. yds.
Approx. Haul to Nearest Point		0.25 miles	2.6 miles	4.8 miles	1750 feet	2.8 miles
L.A. Wear		27.2	33,6	20.0	37.2	25,6
Maximum Size		-	2"	-	3"	2"
% Retained on 2" Sieve		See remarks	Less than 5	-	Less than 3	Less than 1 average
Pit Average % Passing	Crushed to 2"	" "	93	-	-	-
	1"	" "	81	100	100	100
	3/4"	" "	74	92	94	90
	1/2"	" "	67	58	81	78
	#4	" "	49	21	59	49
	#10	" "	40	11	49	33
	#200	" "	3	1	4	1
P.I.		" "	N.P.	N.P.	N.P.	N.P.
Lab. Numbers		" "	59-1951 to 2013	59-1945 to 1950	See remarks	59-2641 to 2655

Remarks:

55-83-S - This pit has not been used to date; the original records are not available. Material consists of a poorly consolidated nodular caliche that may be worked without blasting.

59-10-S - This pit has not been used to date; it is composed of a fine sand and gravel, and was developed to be used with crushed rock.

59-11-S - This pit has not been used to date.

59-14-S - This pit has not been worked to date; it is composed of a fine sand and gravel, and was developed to use with crushed rock. Lab numbers are 59-2238 to 2290, 2590 to 2596, 2600 to 2620.

59-16-S - This pit has not been used to date; it is composed of a very clean, fine sand and gravel, and was developed to be used with crushed rock. It may possibly be extended to the south.

Material Pit Summary:

Table No. 40-12-2 continued

Pit or Prospect No.		40-12-1 (Prospect)	40-12-2 (Prospect)	40-12-3 (Prospect)	40-12-4 (Prospect)
Location	Section	SE 1/4, 11	Center 31	NW 1/4, 5	SW 1/4, 5
	Twnshp. & Range	T 9 N, R 10 E	T 10 N, R 10 E	T 10 N, R 8 E	T 10 N, R 8 E
	County	Torrance	Santa Fe	Torrance	Torrance
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State Land	Private property	Private property	Private property
Geologic Age		Tertiary ?	Permian	Tertiary ?	Tertiary ?
Formation		Caliche	San Andres	Terrace	Terrace
Type of Pit		Quarry	Quarry	Sand & gravel	Sand & gravel
Kind of Material		Caliche	Limestone	Predominantly limestone	Predominantly limestone
Quality of Material		Fair	Good	See remarks	See remarks
Thickness of Material		15 feet maximum	6 to 8 feet	" "	" "
Thickness of Cap (Caliche)		See remarks	-	-	-
Blasting Qualities		" "	See remarks	-	-
Uniformity		Fair	" "	See remarks	See remarks
Impurities		Silt	" "	Silt lenses	Silt lenses
Type of Mat'l. Underlying Formation		Sandstone & shale	Sandstone	Clay	Clay
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		Grass & scattered cedar trees	Grass	Grass	Grass
Local Terrain		Mesa	Low mesa	Flat to slightly undulating	Flat to slightly undulating
Depth of Overburden		2 feet	See remarks	See remarks	See remarks
P.I. (Overburden)		Less than 10	" "	Exceeds 12	Exceeds 12
Est. Reserve Quantity		See remarks	" "	See remarks	See remarks
Approx. Haul to Nearest Point		0.5 miles	3.0 miles	0.5 miles	0.5 miles
L.A. Wear		28	See remarks	See remarks	See remarks
Maximum Size		-	" "	" "	" "
% Retained on 2" Sieve		-	" "	" "	" "
	Crushed to	1"	" "	" "	" "
	2"	100	" "	" "	" "
Pit	1"	100	" "	" "	" "
Average	3/4"	62	" "	" "	" "
% Passing	1/2"	37	" "	" "	" "
	#4	15	" "	" "	" "
	#10	8	" "	" "	" "
	#200	2	" "	" "	" "
P.I.		N.P.	" "	" "	" "
Lab. Numbers		60-6306	" "	" "	" "

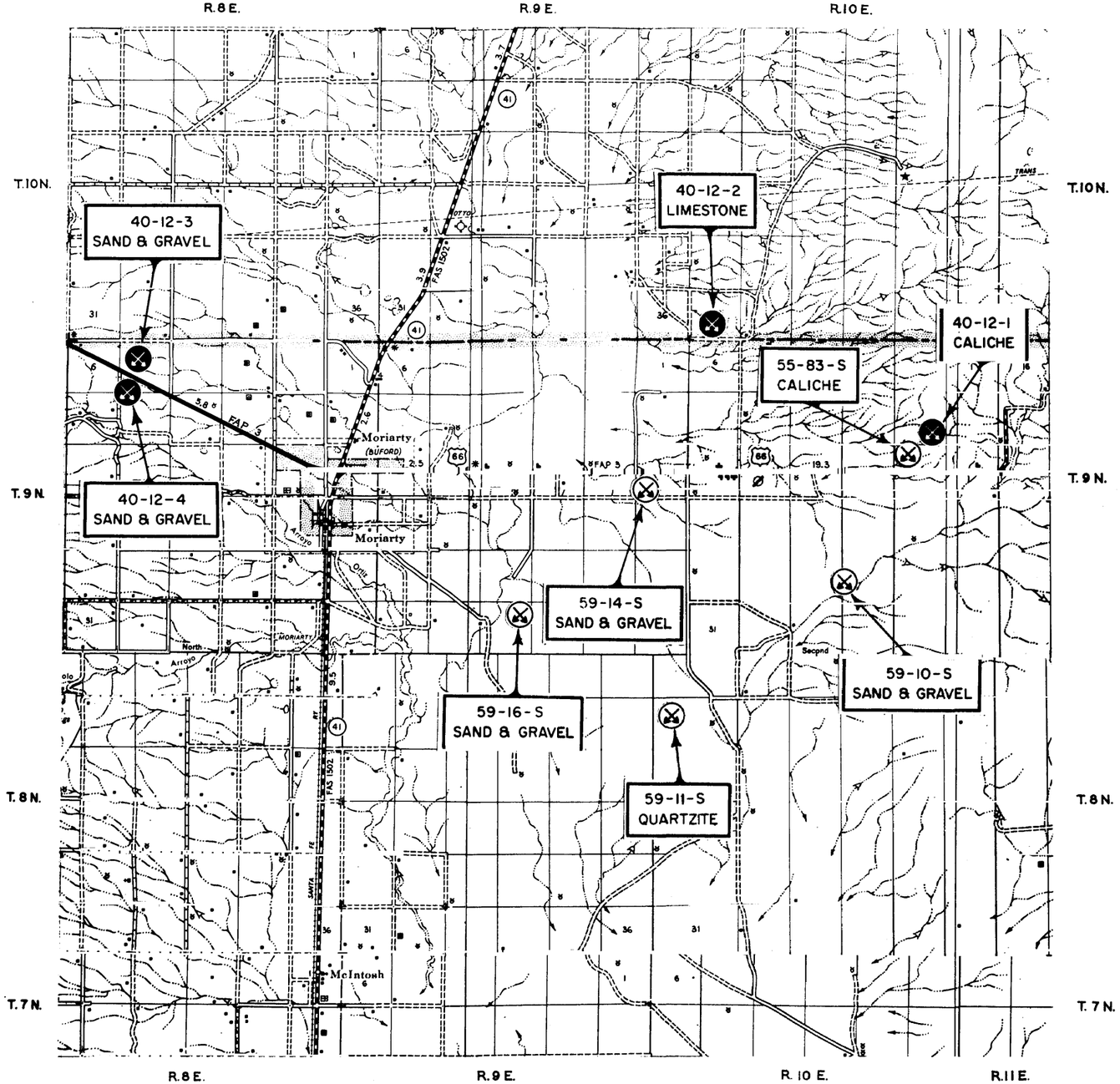
Remarks:

40-12-1 (Prospect) - This material is composed of a poorly consolidated nodular caliche that might possibly be worked without blasting. Further exploration is needed to determine the exact conditions of this area.

40-12-2 (Prospect) - This material is exposed near the center of Section 31 and is composed of a thin bedded, crystalline, gray limestone with thin silty shale partings. Further exploration needed to determine quantity, quality, etc.

40-12-3 (Prospect) - An old pit exists in this area and further exploration is needed to determine remaining quantities, etc. There is no evidence that the remaining material would be the same as material that has been used from the old pit site. There is a possibility that the pit may be extended in its immediate vicinity.

40-12-4 (Prospect) - An old pit exists in this area and further exploration is needed to determine remaining quantities, etc. Even though material used from the old pit area was satisfactory there is no evidence that remaining qualities will be the same. Pit may possibly be extended in a southerly direction.



AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
MORIARTY RADAR STATION - PALMA

SOILS AND GEOLOGY

Introduction:

Interstate Route 40 and U.S. 85 intersect at Clines Corners in the central part of this strip. The principal feature in this area is the eastern uplands. The generally north trending boundary between the Basin and Range province and the Great Plains province is approximately 3 miles west of Clines Corners.

General Geology:

The eastern uplands form the greater part of this section. They rise as a well defined escarpment above the eastern margin of the Estancia Valley. The eastern margin of the valley has exposures of Permian rocks which are mostly covered by alluvium derived from the eastern uplands. In contrast to the alluvial filled Estancia Valley and its alluvial covered margins, the eastern uplands of this strip expose Permian and Triassic rocks covered only locally by alluvium. The surface is almost flat or gently rolling.

The strata in this section lie essentially horizontal except along the fault scarp where they appear to be monoclinally folded.

The areal distribution of formations is shown on Soils and Geology Map 40-13. Their succession and character are given under the section termed "Stratigraphy."

Soils:

Soils of this strip area occur in three different stages of development: (1) older alluvium (TQcg), mature in age, in which definite profiles have developed, (2) young alluvium (Qal), and (3) residual soils of Triassic and Permian sediments.

A narrow shallow valley apparently existed west of the fault zone in the western portion of this strip during Tertiary time. This valley was filled with sediments of gravel, sand, silt, and clay. Later caliche was formed locally over these sediments and it is presently being reworked by water erosion.

Mature soils usually exist on top of the slightly undulating hills of the older alluvium and present definite horizons. "A" horizon is predominantly clay soil (A-6) ranging in thickness from 1.5 to 3.5 feet. "B" horizon, in which caliche has formed locally, consists of silty soil (A-4) and thicknesses range from 2 to 6 feet. A heterogeneous mixture of gravel, sand, silt, and clay exists in "C" horizon and the maximum thickness has not been determined, however, it probably is as much as 50 feet in local areas.

Silty soils occur on the slopes and in the floors of intermittent drainage ways. The younger alluvium is subjected to erosion during each rain storm and does not accumulate to any great depths. Younger alluvium thicknesses vary from 3 to 15 feet.

The following observations were made of residual soils and their respective formations:

Tertiary ? and Quaternary:	Caliche (TQc) - silty soils (A-4). Thickness: 1 - 2 feet.
Triassic:	Dockum group (Trd) - Silty soil (A-4) with minor amounts of clay soil (A-6). Thickness: 0 - 5 feet.
Permian undivided:	San Andres formation (Psa) and Glorieta sandstone (Pg). (See below)
Permian:	San Andres formation (Psa) - ranges from silt (A-4) to clay (A-6). Local formations of caliche occur over this formation in the vicinity of Clines Corners. The caliche is poorly consolidated and bears a classification of silt (A-4). Thickness: 0 - 4.5 feet. Glorieta sandstone (Pg) - predominantly silt (A-4) with minor amounts of clay (A-6). Thickness: 0 - 5 feet. Yeso formation (Py) - predominantly silt (A-4) with minor amounts of clay (A-6). Thickness: 0 - 5 feet.

The areal distribution of the soils and their related formations are shown on Geology and Soils Map 40-13. Table No. 40-13-1 shows the logs and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary:	Alluvium (Qal) - small stream sediments of silt and clay. Thickness: 3 - 16 feet.
Unconformity----------Period of Erosion----------	
Tertiary ? and Quaternary:	Older alluvium, caliche, and gravel (TQcg) - mixture of sand, gravel, silt, and clay covered locally by soft poorly consolidated caliche. Caliche (TQc) - poorly consolidated, nodular caliche. Thickness: 3 - 15 feet.
Unconformity----------Period of Erosion----------	
Triassic:	Dockum group (Trd) - red-brown and red-gray sandstone of the lower Santa Rosa sandstone. This is underlain by red-brown shale of the same formation which rests upon the San Andres formation. Thickness: 75 feet.
Unconformity----------Period of Erosion----------	
Permian undivided:	San Andres formation (Psa) and Glorieta sandstone (Pg). (See below)
Permian:	San Andres formation (Psa) - upper part is tan to gray, friable sandstone and red-buff to pink-buff siltstone. Lower part contains finely crystalline limestone; massive, white gypsum; and white to yellow, medium-grained sandstone. Thickness: Upper - 50 feet, lower - 200 feet. Glorieta sandstone (Pg) - usually well cemented, white to yellow, quartzose sandstone. Thickness: 150 to 200 feet. Yeso formation (Py) - orange-red, buff, and yellow sandstone interbedded with yellow-gray and maroon shale; white and gray gypsum; and gray limestone. Thickness: 600 feet.

Construction Materials:

Tertiary ? and Quaternary:	Older alluvium, gravel, and caliche (TQcg) - large areas in the vicinity of Los Norios contain sand and gravel capped by a veneer of soft poorly consolidated caliche. This area is unexplored, however, inspection of erosional scars and side hill slopes indicates that they contain an excellent grade of sand and gravel up to 30 feet thick.
Permian:	San Andres formation (Psa) - the limestone member of this formation crops out extensively along the eastern part of the fault zone in the western portion of this strip. It is generally a thin-bedded, hard, crystalline rock of excellent quality. This limestone also crops out in local areas north of Clines Corners. A gypsum member of this formation generally covers the vicinity of the central portion of this area. Yeso formation (Py) - limestone member of this formation crops out locally in the vicinity of Palma. Material pits of fair quality have been developed in this limestone; however, it is very inconsistant and non-uniform and no remaining usable quantities have been discovered in this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-13. Test data and other related information are shown in Material Pit Summary Table No. 40-13-2.

SOILS AND GEOLOGY

Soils Summary:

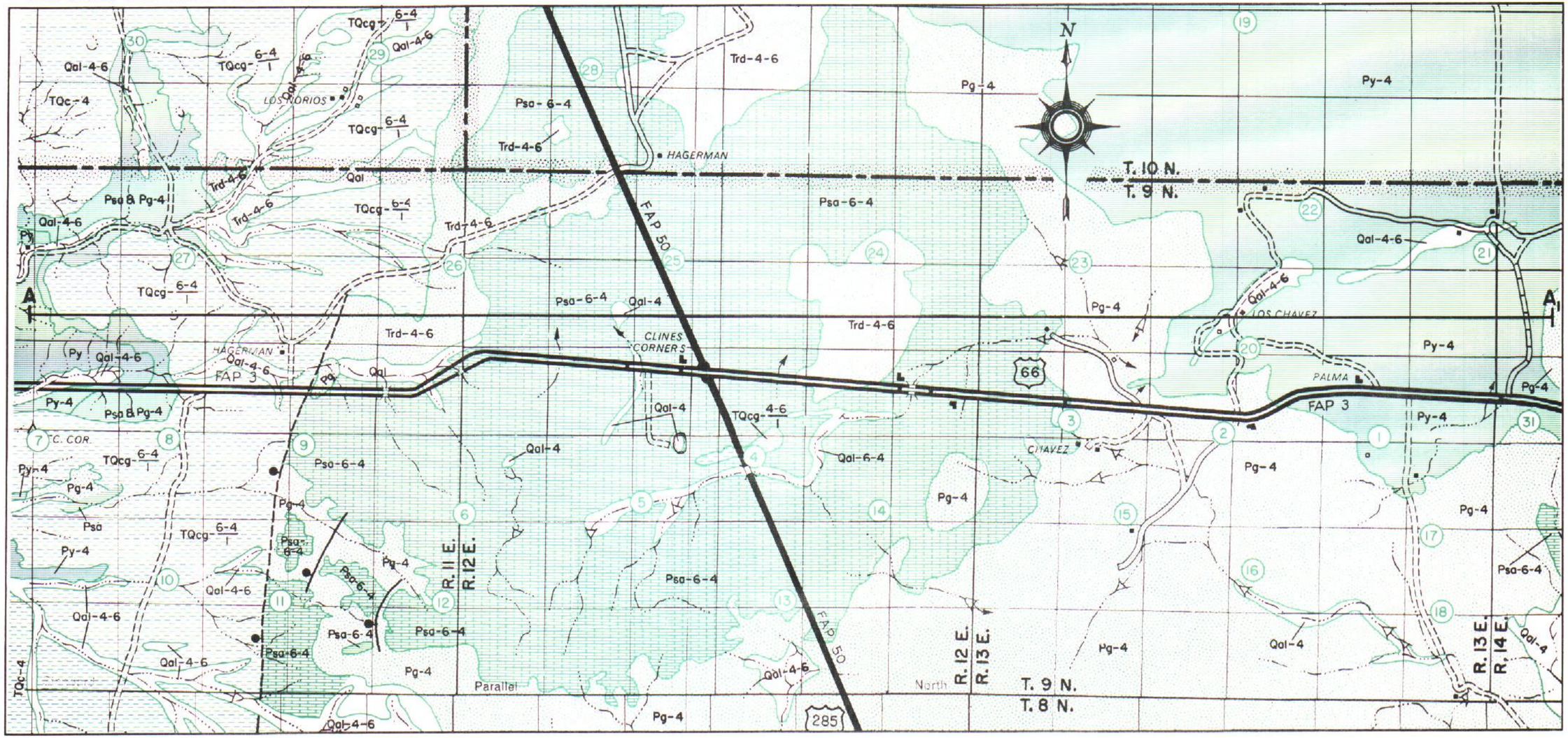
Table No. 40-13-1

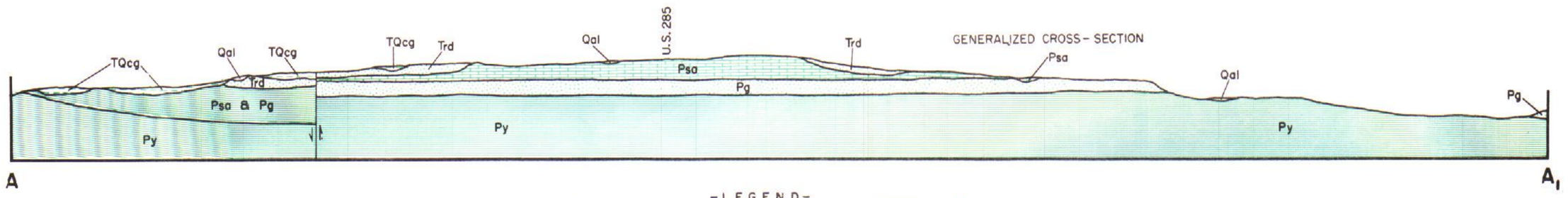
Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	4	A	0.0	5.0	A-4	Silty soil
"	"	5	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	3.0	A-4	Silty soil
"	"	29	A	0.0	5.0	A-4	" "
"	"	30	A	0.0	5.0	A-4	" "
Tertiary ? and	Caliche-gravel	7	A	0.0	5.0	A-4	" "
Quaternary	" "	8	A	0.0	3.5	A-6	Clay soil
"	" "		B	3.5	4.5	A-4	Silty soil
"	" "	10	A	0.0	5.5	A-4	" "
"	" "	27	A	0.0	4.0	A-4	" "
The following samples represent residual soils derived from parent formations.							
Triassic	Dockum group	24	A	0.0	5.0	A-4	Silty soil
"	" "		B	5.0	---	Unclassified	Sandstone
"	" "	26	A	0.0	4.5	A-6	Clay soil
"	" "		B	4.5	---	Unclassified	Caliche
Permian	San Andres	6	A	0.0	5.0	A-6	Clay soil
"	" "	9	A	0.0	0.8	A-4	Silty soil
"	" "		B	0.8	---	Unclassified	Gypsum
"	" "	11	A	0.0	4.5	A-4	Silty soil
"	" "	12	A	0.0	2.0	A-6	Clay soil
"	" "		B	2.0	---	Unclassified	Limestone
"	" "	13	A	0.0	2.0	A-4	Silty soil
"	" "		B	2.0	---	Unclassified	Bed rock
"	" "	14	A	0.0	3.5	A-6	Clay soil
"	" "		B	3.5	---	Unclassified	Bed rock
"	" "	25	A	0.0	1.7	A-6	Clay soil
"	" "		B	1.7	---	Unclassified	Bed rock
"	" "	28	A	0.0	4.5	A-4	Silty soil
"	Glorieta	2	A	0.0	4.5	A-6	Clay soil
"	"	3	A	0.0	3.5	A-6	" "
"	"		B	3.5	---	Unclassified	Sandstone
"	"	15	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	---	Unclassified	Sandstone
"	"	16	A	0.0	4.5	A-4	Silty soil
"	"	17	A	0.0	2.0	A-4	" "
"	"		B	2.0	4.0	A-4	Caliche
"	"	18	A	0.0	4.5	A-4	Silty soil
"	"	23	A	0.0	2.5	A-4	" "
"	"		B	2.5	---	Unclassified	Sandstone
"	Yeso	1	A	0.0	2.5	A-6	Clay soil
"	"		B	2.5	3.0	A-4	Silty soil
"	"		C	3.0	---	Unclassified	Sandstone
"	"	19	A	0.0	5.0	A-4	Silty soil
"	"	20	A	0.0	4.5	A-4	" "
"	"	21	A	0.0	1.5	A-4	" "
"	"		B	1.5	---	Unclassified	Caliche
"	"	22	A	0.0	4.5	A-4	Silty soil
The following section shows the material that may be encountered when cuts are made in the Yeso formation.							
Permian	Yeso	31	A	0.0	0.6	A-4	Silty soil
"	"		B	0.6	50.0	Unclassified	Interbedded sandstone & shale
"	"		C	50.0	65.0	A-4	Yellow-gray shale
"	"		D	65.0	73.0	A-4	Maroon shale

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-13

INTERSTATE ROUTE 40
MORIARTY RADAR STATION TO PALMA





-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — QUATERNARY
- TQc — Caliche
- TQcg — Caliche & Gravel Older Alluvium — QUATERNARY & TERTIARY
- Trd — Dockum group — TRIASSIC
- Psa — San Andres formation
- Psa Pg — Undivided San Andres & Glorieta — PERMIAN
- Pg — Glorieta sandstone
- Py — Yeso formation — PERMIAN

0 STATUTE MILES

SECTION 40-13
Page 3

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
MORIARTY RADAR STATION - PALMA

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-13-2

Pit or Prospect No.		55-79-S	59-23-S	59-71-S	40-13-1 (Prospect)	40-13-2 (Prospect)	40-13-3 (Prospect)
Location	Section	SW 1/4, 23	NW 1/4, 15	NE 1/4, 32	NW 1/4, 35	SW 1/4, 26	See remarks, 26
	Twnshp. & Range	T 9 N, R 11 E	T 9 N, R 12 E	T 10 N, R 12 E	T 10 N, R 11 E	T 10 N, R 11 E	T 9 N, R 11 E
	County	Torrance	Torrance	San Miguel	Santa Fe	Santa Fe	Torrance
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State land	State land	State land	State land	State Land	State land
Geologic Age		Permian	Tertiary ?	Permian	Quaternary ?	Quaternary ?	Permian
Formation		San Andres	Gravel	San Andres	Alluvium	Alluvium	San Andres
Type of Pit		Quarry	Sand & gravel	Quarry	Sand & gravel	Sand & gravel	Quarry
Kind of Material		Limestone	Variable	Limestone	Variable	Varied	Limestone
Quality of Material		Excellent	Fair	Excellent	Unexplored	Unexplored	Excellent
Thickness of Material		12 feet	20 + feet	12 feet	"	"	6 to 12 feet
Thickness of Cap (Caliche)		-	-	-	"	"	-
Blasting Qualities		Good	-	Excellent	"	"	Good
Uniformity		Good	Fair	Good	"	"	Good
Impurities		Minor shale lenses	Minor silt	Gypsum minor	"	"	?
Type of Mat'l. Underlying Formation		Sandstone	?	Sandstone	"	"	Sandstone
Moisture Condition		Dry	Dry	Dry	Dry	Dry	Dry
Vegetation		Grass & Cedars	Grass	Scattered Pinon & Cedar	Grass	Grass	Grass & scattered Cedars
Local Terrain		Rough, broken	Flat	Plateau	Rolling hills	Rolling hills	Rough, broken
Depth of Overburden		1 to 4 feet	0.0 to 6.0 feet	2.5 feet	Unexplored	Unexplored	2 feet average
P.I. (Overburden)		9	12 to 40	12	"	"	?
Est. Reserve Quantity		None	60,000 cu. yds.	100,000 cu. yds.	"		Unexplored
Approx. Haul to Nearest Point		-	1.0 mile	3.5 miles	"	3.5 miles	3.0 miles
L.A. Wear		24	30.0	20.0	"	Unexplored	Unexplored
Maximum Size		-	2"	-	"	"	"
% Retained on 2" Sieve		-	Less than 1	-	"	"	"
Crushed to	2"	3/4"	-	2"	"	"	"
Pit	1"	-	100	100	"	"	"
Average	3/4"	100	97	97	"	"	"
% Passing	1/2"	71	95	53	"	"	"
	#4	28	92	40	"	"	"
	#10	15	84	30	"	"	"
	#200	2	77	18	"	"	"
P.I.		N.P.	28	14	"	"	"
Lab. Numbers		55-11277 - 11283	N.P. to 7	7	"	"	"
			59-3084 - 3096	N.P.	"	"	"
				59-8373 - 8378	"	"	"

Remarks:

55-79-S - This pit is shown to represent the type pit that may be located in the San Andres limestone. Refer to Prospect 40-13-3 for further reference.

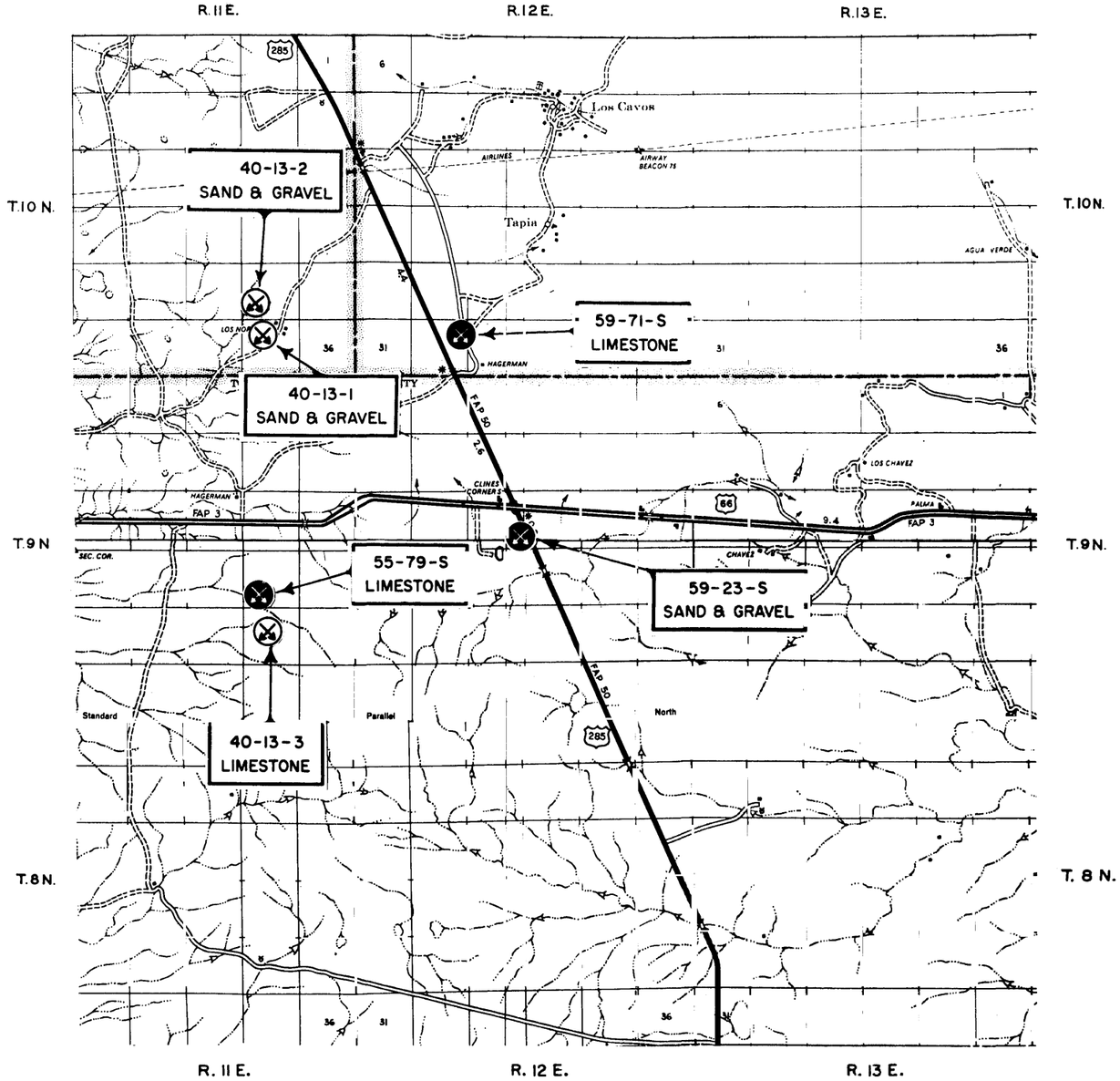
59-23-S - Located 110 feet west of Station 1385+50 on U.S. 285 and was developed to use with crushed rock for base, sub-base, and plant mix surface courses.

59-71-S - Can be extended in a southerly direction; there is approximately 60,000 cu. yds. remaining in the old pit area. Pit is located 640 feet right of Station 1600+00 on U.S. 285.

40-13-1 (Prospect) - This area is composed of slightly eroded granular terraces. Erosion scars along the slopes of these terraces indicate that they consist of a fairly coarse gravel approximately 20 feet deep that is covered by soil and partly consolidated caliche. The E 1/2 of this section also has areas that look promising.

40-13-2 (Prospect) - This area is composed of slightly eroded granular terraces. Erosion scars along the slopes of these terraces indicate that they consist of a fairly coarse gravel approximately 20 feet deep covered by a veneer of soil and partly consolidated caliche. Sub-surface exploration is needed to determine the conditions of the area.

40-13-3 (Prospect) - This material lies directly across the canyon south of Pit No. 55-79-S. It is comparable to Pit No. 55-79-S in quality, wear, gradation, etc. Refer to Pit No. 55-79-S in this report for similar results. Further exploration is needed to determine the quantity, however, extensive outcrops indicate that there is a large supply.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
PALMA - ANTON CHICO GRANT

SOILS AND GEOLOGY

Introduction:

Section 40-14 begins on the west in the vicinity of Palma and extends eastward to the western edge of the Anton Chico Grant. Most of this section is characterized by flat to rolling topography which has been modified by solution depressions. Glorieta Mesa, the most outstanding physical feature, interrupts the general topography along the western edge of this section and south of Interstate Route 40.

General Geology:

A monocline extends along the western edge of this section; evidence of it can be seen in a cut on Interstate Route 40 near Palma. The Permian strata dip gently eastward from this monoclinal flexure and are overlain by the Triassic Dockum group. North of Interstate Route 40, along State Road 3, there is a slight warping of the strata.

On the southwestern edge of this section the eastern most projection of Glorieta Mesa forms a sinuous escarpment capped by the Glorieta sandstone. This surface is an erosional surface of the Llano Estacado. The mesa fades into the surrounding terrain to the south and the San Andres limestone overlies the Glorieta sandstone.

From the Glorieta Mesa escarpment eastward the surface is covered by a layer of caliche except where the Santa Rosa sandstone caps the higher hills. The topography is rolling but becomes rough in areas where solution of the San Andres limestone and ultimate collapse of the overlying strata have modified it. The process of solution and collapse of the overlying material forms structures referred to as solution depressions or sink holes. They are circular to elongate, deep to shallow depressions, which vary in size from a few feet to several hundred feet across and from a few feet to 50 feet deep. In areas where the San Andres limestone is exposed at the surface these sink holes are very numerous.

In addition to the modification of the section by solution depressions intermittent streams have dissected this once plateau-like region. These streams are the tributaries of the eastward flowing Pintada Creek and are the main drainage of this section. Pintada Creek lies south of the mapped section.

Solution depressions or sink holes and shallow basins play an important part in the drainage of this region. Since these structures are usually circular, centripetal drainage is very characteristic and ephemeral lakes form in the depressions. The water, in most cases, disappears rapidly because of evaporation and seepage. During dry periods these basins are subjected to rapid deflation thus removing the sediments which have accumulated during wet periods.

The Santa Rosa trough possibly underlies the northeast corner of this section. It is a structural feature formed in late Paleozoic time. The axis of the elongated and wide depression probably trends northwest-southeast and connects the Rowe-Mora basin on the northwest with the Tucumcari basin to the southeast.

The areal distribution of formations and their members is shown on Soils and Geology Map 40-14. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils of this section are: (1) young alluvium (Qal), (2) older alluvium, caliche, and gravel (TQcg), and (3) residual. They began to develop during late Tertiary and have continued to develop to the present.

The late Tertiary and Quaternary alluvial soils that exist in this section were deposited as an apron by southeasterly flowing streams. During these periods the climate was humid and the extent of these sediments indicates that the streams had a high gradient and carried large volumes of water from the highlands to the north and west. They are partly composed of well rounded igneous and metamorphic rocks which indicate that their parent materials also lie to the north and west. Well developed profiles of mature soils are exposed along the slopes of these deposits. "A" horizon consists of 2 to 4 feet of silty soil (A-4) and clay soil (A-6). "B" horizon consists of silt, sand, and gravel in which caliche has formed. This material will vary from a soft, nodular caliche soil to a well consolidated, hard caliche cap rock and it will vary in thickness from a few inches to 15 feet. In many cases the caliche of "B" horizon immediately overlies bedrock. "C" horizon contains a variable mixture of sand, silt, and gravel and the thickness will vary from a few inches to 30 feet. Where the caliche cap rock has been removed the underlying sand, silt, and gravel have been recently eroded and locally redistributed.

Young alluvial soils have formed in intermittent stream channels, solution depressions, and on the lowlands. They are derived from late Tertiary and Quaternary sediments and Triassic and Permian rocks. They are predominantly silty soil (A-4); however, a fairly high percentage of clay soil (A-6) occurs northwest of Milagro. They will vary in thickness from 2 to 15 feet.

Observations made of residual soils:

Triassic: Santa Rosa sandstone (Trsr) - silty-sandy soil (A-2-4) and silty soil (A-4). Local depressions contain clay soil (A-6). Local areas are affected by wind-blown sediments.
Thickness: Residual, 0 to 4 feet; Local accumulation of wind-blown sediments, 15 feet maximum.

Permian: San Andres limestone (Psa) - silty soil (A-4) and clay soil (A-6).
Thickness: 0 to 4 feet.

Glorieta sandstone (Pg) - silty soil (A-4) and clay soil (A-6).
Thickness: 0 to 4.5 feet.

Yeso formation (Py) - silty soil (A-4).
Thickness: 0 to 8 feet.

Table No. 40-14-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-14.

Stratigraphy:

Quaternary: Alluvium (Qal) - sand, silt, and clay with small amounts of gravel deposited along streams and in depressions:
Thickness: 15 feet.

Unconformity----------Period of Erosion----------

Tertiary (?)-Quaternary: Older alluvium, caliche, and gravel (TQcg) - mixture of sand, silt, clay, and gravel covered by a soft to well consolidated deposit of caliche.

Unconformity----------Period of Erosion----------

Triassic: Dockum group:

Santa Rosa sandstone (Trsr)

Upper member - a brown to gray, dense, calcareous, platy to massive sandstone. It contains a thin limestone pebble conglomerate near its base. (Gorman and Roebeck, 1946).
Thickness: 10 to 115 feet.

Shale member - dark red to gray shale (Gorman and Roebeck, 1946).
Thickness: 0 to 50 feet.

Middle member - gray to brown, medium- to coarse-grained, platy to massive sandstone. A thin limestone pebble and quartz conglomerate with petrified wood occurs at or near its base (Gorman and Roebeck, 1946).
Thickness: 10 to 135 feet.

Lower member - friable, platy, micaceous, silty, salt and pepper sandstone. It is purplish-red and contains bone fragments. A chocolate-red and gray shale occur in the upper part of this member (Gorman and Roebeck, 1946).
Thickness: 0 to 110 feet.

Unconformity----------Period of Erosion----------

SOILS AND GEOLOGY

Stratigraphy continued

Permian: San Andres limestone (Psa) - light to dark gray, cavernous limestone; contains marine invertebrate fossils; dolomitic and cherty in its upper and basal parts. A tongue of gypsum occurs in this locale. Thickness: 50 to 100 feet.

Glorieta sandstone (Pg) - light gray to buff, medium- to coarse-grained, quartz sandstone. Several sink holes and other solution features are exposed on the surface of this sandstone. These were probably formed by the solution of the carbonate cement of this sandstone. Thickness: 200 to 400 feet.

Yeso formation (Py) - red shale and gypsum in its basal parts; gypsum grades into limestone in local areas. Fine-grained, orange to gray, silty sandstone with interbedded shales in its upper portion. Thickness: 700 to 1250 feet.

Construction Materials:

Tertiary (?)-Quaternary: Caliche (TQcg) - a well consolidated to partly consolidated caliche cap has formed over most of the central area of this region. It is transitional to a conglomeratic caliche in some areas, and in many local areas it will produce good quality of surfacing aggregate. Investigations of the past have proven that the best material lies south of Interstate Route 40 and west of the Torrance and Guadalupe County line. Good quality material up to 15 feet thick has been discovered and further investigation may prove an inexhaustible supply.

Gravel (TQcg) - local areas of good quality gravel have been discovered in this area. The best known supply, near Flying "C" Cafe, is almost depleted. A high percentage of igneous and metamorphic rocks are contained in this gravel and it is usually overlain by a caliche cap. Further investigation may prove usable quantities of this material in an area that lies 2 miles west and 3.5 miles north of Milagro Interchange.

Existing roads usually are the best access to these areas; however, new roads are easily built if needed.

Permian: San Andres limestone (Psa) - this limestone is exposed north and south of Interstate Route 40 in the western portion of this region. The area south, adjacent to State Road 3, has the better material. It is generally a thin-bedded, hard, crystalline rock of excellent quality and it is underlain by a gypsiferous sandstone and gypsum. Investigations showed it to be approximately 15 feet thick. Solution depressions have caused the bedding to be warped and irregular in some places. A fairly dense growth of juniper and cedar trees cover the landscape of the better limestone areas. State Road 3 is the best access to this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-14. Test data and other related information are shown in Material Pit Summary Table No. 40-14-2.

Soils Summary:

Table No. 40-14-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	2	A	0.0	3.0	A-4	Silty soil
"	"	8	A	0.0	5.0	A-4	" "
"	"	10	A	0.0	3.0	A-7	Clay soil
"	"	19	A	0.0	3.0	A-6	" "
Tertiary (?)-Quaternary	Older alluvium, caliche, & gravel	4	A	0.0	1.5	A-4	Silty soil
			B	1.5	---	Unclassified	Caliche
"	"	6	A	0.0	5.0	A-4	Silty soil
"	"		B	5.0	9.0	A-4	Caliche soil
"	"		C	9.0	12.0	A-2-4	Silty sand

Table No. 40-14-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	Classification	Material Type
Tertiary (?)-Quaternary	Older alluvium, caliche, & gravel	11	A	0.0	3.5	A-6	Clay soil
			B	3.5	---	Unclassified	Caliche
"	"	15	A	0.0	3.0	A-4	Silty soil
"	"	17	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	---	Unclassified	Caliche
"	"	18	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Unclassified	Caliche
"	"	20	A	0.0	2.0	A-6	Clay soil
The following samples represent residual soils and their parent formations:							
Triassic	Santa Rosa	5	A	0.0	4.5	A-4	Silty soil
"	" "		B	4.5	---	Bedrock	Sandstone
"	" "	7	A	0.0	4.5	A-6	Clay soil
"	" "		B	4.5	---	Bedrock	Shale
"	" "	9	A	0.0	4.5	A-2-4	Silty sand
"	" "		B	4.5	---	Bedrock	Sandstone
"	" "	21	A	0.0	4.0	A-6	Clay soil
"	" "		B	4.0	---	Bedrock	Shale
"	" "	22	A	0.0	3.0	A-6	Clay soil
"	" "		B	3.0	---	Bedrock	Shale
"	" "	23	A	0.0	3.0	A-4	Silty soil
"	" "		B	3.0	---	Bedrock	Sandstone
Permian	San Andres	3	A	0.0	0.8	A-4	Silty soil
"	" "		B	0.8	---	Bedrock	Caliche
"	" "	12	A	0.0	1.8	A-4	Silty soil
"	" "		B	1.8	---	Bedrock	Limestone
"	" "	14	A	0.0	1.0	A-6	Clay soil
"	" "		B	1.0	---	Bedrock	Limestone
"	Glorieta	13	A	0.0	3.5	A-6	Clay soil
"	"		B	3.5	---	Bedrock	Sandstone
"	"	16	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Bedrock	Sandstone
"	Yeso	1	A	0.0	4.5	A-4	Silty soil

Selected References

Gorman and Roebeck, 1946, Oil and Gas Investigations, Preliminary Map 44, U.S. Geol. Surv.

Guidebook, Nov. 1949, Field Trip of the Cenozoic Geology of the Llano Estacado and Rio Grande Valley, West Texas Geological Society.

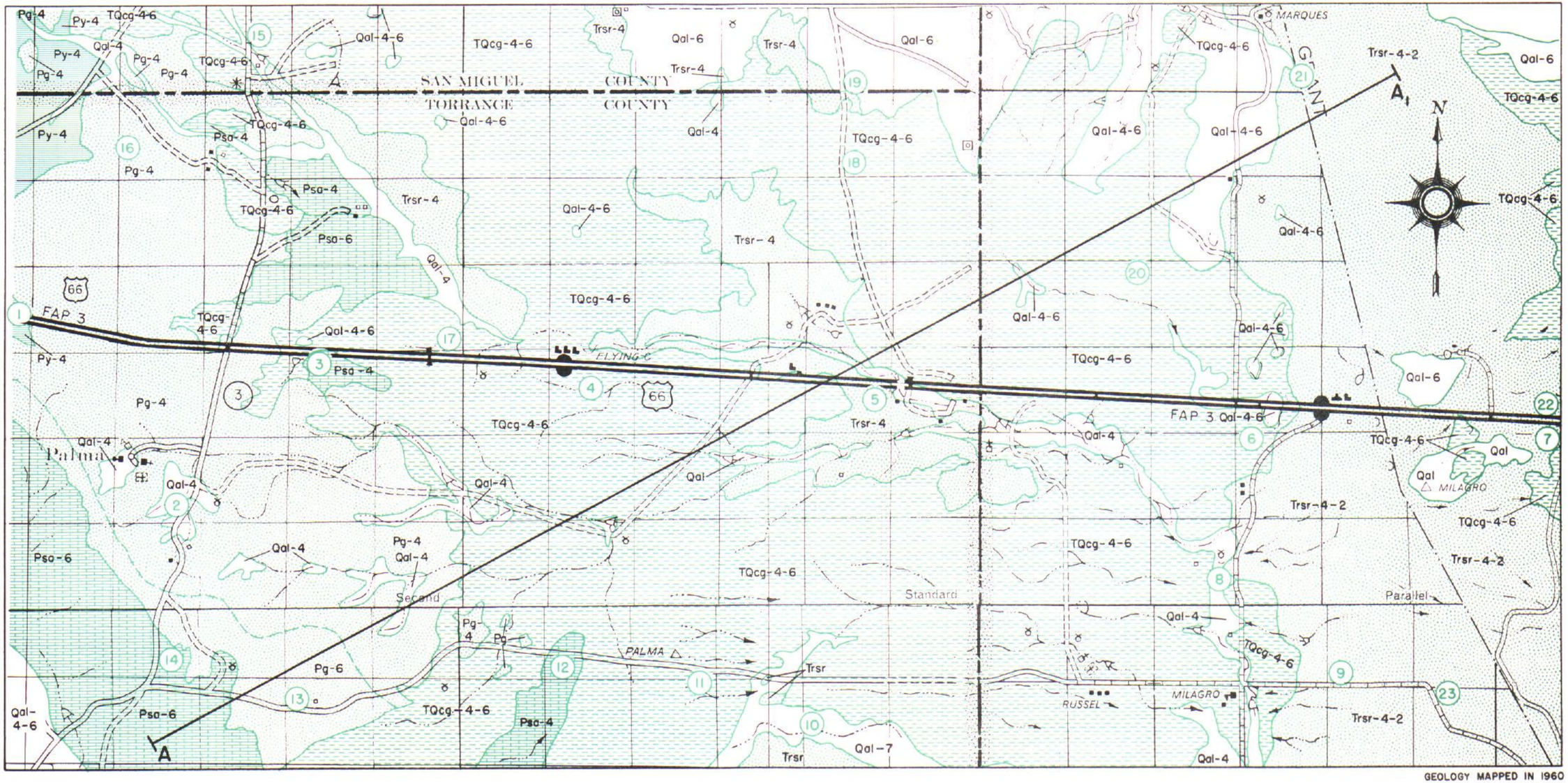
Guidebook, May 1959, Northeastern New Mexico, Panhandle Geological Society.

Smith, R. E., 1957, Geology and Ground-Water Resources of Torrance County, New Mexico, Ground-Water Report No. 5, New Mexico Bureau of Mines and Mineral Resources.

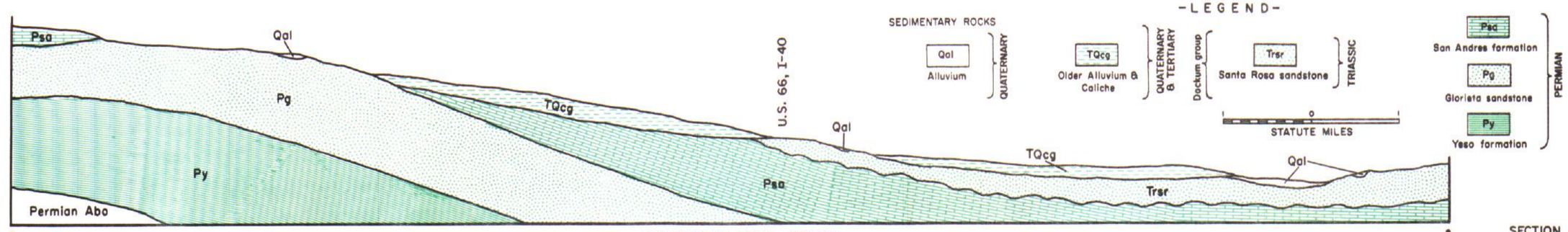
AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-14

INTERSTATE ROUTE 40
PALMA TO ANTON CHICO GRANT



GEOLOGY MAPPED IN 1960



GENERALIZED CROSS-SECTION

-LEGEND-

SEDIMENTARY ROCKS

Qal	Alluvium	QUATERNARY	
TQcg	Older Alluvium & Caliche	QUATERNARY & TERTIARY	
Trsr	Santa Rosa sandstone	Dockum group	TRIASSIC
Psa	San Andres formation		PERMIAN
Pg	Glorieta sandstone		
Py	Yeso formation		

STATUTE MILES

SECTION 40-14
Page 3

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-14-2

Pit or Prospect No.		55-128-S	57-1-S	57-40-S	57-41-S
Location	Section	NE 1/4 Sec. 23	3	SE 1/4 Sec. 4	NE 1/4 Sec. 21
	Twnshp. & Range	T 9 N, R 14 E	T 9 N, R 14 E	T 8 N, R 14 E	T 9 N, R 15 E
	County	Torrance	Torrance	Torrance	Torrance
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State land	Private land	State land	State land
Geologic Age		Tertiary & Quaternary	Permian	Permian	Tertiary & Quaternary
Formation		Caliche cap rock	San Andres	San Andres	Caliche cap rock
Type of Pit		Quarry	Quarry	Quarry	Quarry
Kind of Material		Caliche	Limestone	Limestone	Caliche
Quality of Material		Excellent	Fair to poor	Good	Excellent
Thickness of Material		13 feet	11.0 feet	15.0 feet	8.0 to 12.0 feet
Thickness of Cap (Caliche)		3 to 6 feet	-	-	6 feet
Blasting Qualities		Good	Poor	Good	Good
Uniformity		Good	Fair	Fair	Good
Impurities		None	Silt filled fractures	None	None
Type of Mat'l. Underlying Formation		Limestone (?)	Sandstone	Sandstone (gypsiferous)	Sandstone
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		Grass & small shrubbery	Sparse juniper & cedar trees	Juniper & cedar trees	Grass & cacti
Local Terrain		Flat to rolling	Hilly	Hilly	Flat to rolling
Depth of Overburden		0.8 to 4.0 feet	0.0 to 1.5 feet	0.0 to 4.0 feet	1.0 to 3.0 feet
P.I. (Overburden)		8 - 18	N.P. to 8	8 to 13	N.P. to 16
Est. Reserve Quantity		100,000 cu. yds.	-	100,000 cu. yds.	100,000 cu. yds.
Approx. Haul to Nearest Point		2.3 miles	2.75 miles	3.75 miles	900 feet
L.A. Wear %		Soft caliche - 39.6, caliche cap 34.4	28	26.8	Caliche cap - 36.0, nodular caliche - 27.2
Maximum Size		-	-	-	-
% Retained on 2" Sieve		-	-	-	-
	Crushed to	3/4"	1"	1"	2"
	2"	-	-	-	100
Pit	1"	-	100	100	55
Average	3/4"	100	68	89	40
% Passing	1/2"	87	38	53	29
	#4	47	15	18	14
	#10	26	10	9	9
	#200	5	1	2	2
P.I.		N.P.	N.P. to 15	N.P.	N.P.
Lab. Numbers		55-24574 - 594, 55-24815 - 843	57-480 - 496, 57-385 - 410	57-6955 - 6959, 57-7085 - 7099, 57-7100 - 7110	57-7439 - 7477

Remarks:

55-128-S - This pit has not been worked to date (4-1-61). It consists of a 3 to 6 foot cap rock overlying a nodular caliche with a matrix of soft caliche.

57-1-S - Further use of this pit is not recommended because of silt impurities and difficulty in blasting. It is shown to demonstrate the type material that exists in this area.

57-40-S - To date (4-1-61) this pit has not been worked. Possibility of extension west around adjacent sink hole.

57-41-S - This pit consists of a 3 to 6 foot cap overlying a nodular caliche with a matrix of soft caliche. Further exploration needed to determine extension possibilities.

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-14-2 continued

Pit or Prospect No.		57-46-S	58-16-S		40-14-1 (Prospect)	40-14-2 (Prospect)
Location	Section	NE 1/4 Sec. 20	N 1/2 Sec. 25		SE 1/4 Sec. 8	NW 1/4 Sec. 4
	Twnshp. & Range	T 9 N, R 15 E	T 9 N, R 16 E		T 8 N, R 14 E	T 9 N, R 16 E
	County	Torrance	Guadalupe		Torrance	Guadalupe
	State	New Mexico	New Mexico		New Mexico	New Mexico
Owner		Private land	Private land		State land	?
Geologic Age		Tertiary & Quaternary	Tertiary & Quaternary		Permian	Tertiary & Quaternary
Formation		Terrace with a caliche cap	Caliche		San Andres	Terrace
Type of Pit		Gravel	Quarry		Quarry	Gravel
Kind of Material		Igneous & metamorphic	Caliche		Limestone	Igneous & metamorphic
Quality of Material		Good	Good		Good	See remarks
Thickness of Material		31.0 feet	6 to 12 feet		15.0 feet (estimated)	" "
Thickness of Cap (Caliche)		5.0 to 8.0 feet	3 to 5 feet		-	-
Blasting Qualities		-	Good		See remarks	-
Uniformity		Good	Good		" "	See remarks
Impurities		Clay pockets	Silt (minor)		" "	" "
Type of Mat'l. Underlying Formation		Sandstone	Sandstone		Sandstone	Sandstone or shale
Moisture Condition		Dry	Dry		Dry	Dry
Vegetation		Grass	Scattered cedar		Juniper & cedar trees	Grass
Local Terrain		Flat to rolling	Rolling		Hilly	Flat to rolling
Depth of Overburden		0.0 to 12.0 feet	2 feet		See remarks	See remarks
P.I. (Overburden)		N.P. to 12	N.P. to 7		" "	" "
Est. Reserve Quantity		17,600 cu. yds.	400,000 cu. yds.		200,000 cu. yds.	" "
Approx. Haul to Nearest Point		1,000 feet	700 feet		4.5 miles	5.2 miles
L.A. Wear		34.8	Caliche cap 25, soft caliche 48		See remarks	See remarks
Maximum Size		6"	-		-	" "
% Retained on 2" Sieve		Less than 20	-		-	" "
	Crushed to	2"	2"		See remarks	" "
	2"	100	B lift - 100	C lift - 100	" "	" "
Pit	1"	61	86	93	" "	" "
Average	3/4"	50	66	83	" "	" "
% Passing	1/2"	40	42	71	" "	" "
	#4	27	23	47	" "	" "
	#10	21	15	35	" "	" "
	#200	4	8	13	" "	" "
P.I.		N.P.	N.P.	N.P.	" "	" "
Lab. Numbers		57-7482 - 7518, 57-9467 - 9481	58-3221 - 3331		" "	" "

Remarks:

57-46-S - With further investigations this could possibly be extended to the east and south. However, the caliche cap shows evidence of thickening to the south. Clay pockets may be avoided by working with shovel.

58-16-S - This pit has not been used to date (4-1-61). Pit cannot be extended. "C" lift contains traces of P.I.

40-14-1 (Prospect) - This material is similar to Pit No. 57-40-S. Further exploration needed to determine exact conditions.

40-14-2 (Prospect) - Further exploration needed to determine exact conditions of this area.

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

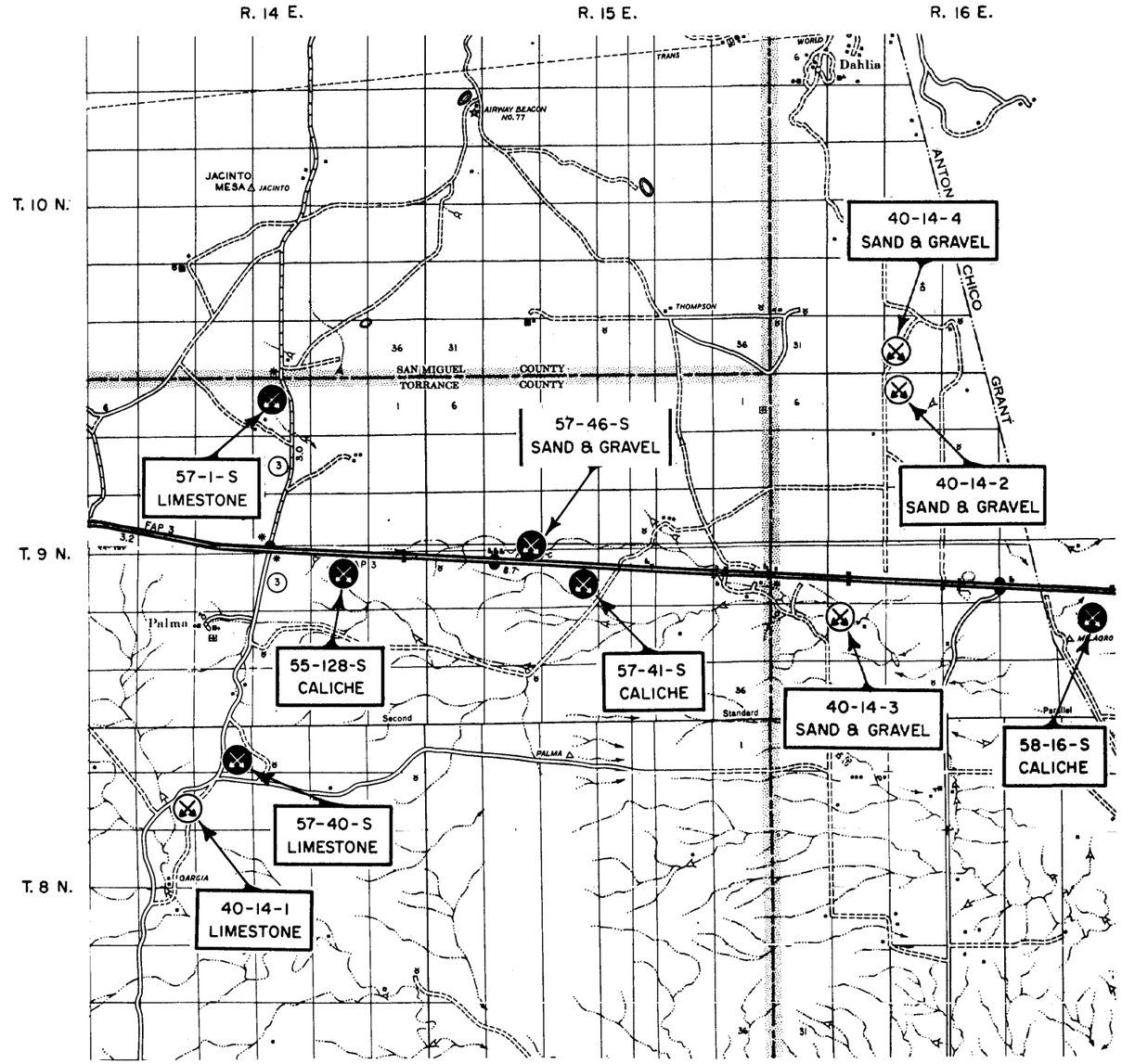
Table No. 40-14-2 continued

Pit or Prospect No,		40-14-3 (Prospect)	40-14-4 (Prospect)
Location	Section	N 1/2 Sec. 29	SW 1/4 Sec, 33
	Twnshp, & Range	T 9 N, R 16 E	T 10 N. R 16 E
	County	Guadalupe	Guadalupe
	State	New Mexico	New Mexico
Owner		?	?
Geologic Age		Tertiary & Quaternary	Tertiary (?)-Quaternary
Formation		Terrace	Terrace
Type of Pit		Gravel	Gravel
Kind of Material		Igneous & metamorphic	Igneous & metamorphic
Quality of Material		See remarks	See remarks
Thickness of Material		" "	20 feet (estimated)
Thickness of Cap (Caliche)		" "	-
Blasting Qualities		-	-
Uniformity		See remarks	See remarks
Impurities		" "	" "
Type of Mat'l. Underlying Formation		Sandstone & shale	Sandstone
Moisture Condition		Dry	Dry
Vegetation		Grass	Grass
Local Terrain		Hilly	Hilly
Depth of Overburden		See remarks	See remarks
P.I. (Overburden)		" "	" "
Est. Reserve Quantity		" "	" "
Approx. Haul to Nearest Point		0.8 miles	5.8 miles
L.A. Wear		See remarks	See remarks
Maximum Size		" "	" "
% Retained on 2" Sieve		" "	" "
Pit Average % Passing	Crushed to	" "	" "
	2"	" "	" "
	1"	" "	" "
	3/4"	" "	" "
	1/2"	" "	" "
	#4	" "	" "
	#10	" "	" "
	#200	" "	" "
P.I.		" "	" "
Lab. Numbers		-	-

Remarks:

40-14-3 (Prospect) - This area is composed of a series of gravel hills and only further exploration will determine the value of this deposit.

40-14-4 (Prospect) - Consists of a sand and gravel overlying sandstone. Further exploration needed to determine exact conditions.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
ANTON CHICO GRANT- SANTA ROSA WEST

SOILS AND GEOLOGY

Introduction:

Section 40-15 lies physiographically in the Great Plains province. It extends from the western edge of the Anton Chico Grant to a point approximately 9 miles west of Santa Rosa, New Mexico. The principal features are the gently rolling uplands, the eastward trending Pintada Canyon, and the Guadalupe anticline.

General Geology:

The flat to gently rolling topography of this area is covered by an irregular layer of caliche. In some cases this caliche is underlain by a layer of sand, silt, clay, and gravel which overlies Permian and Triassic formations; in other cases this caliche lies directly over the Permian and Triassic formations. The flat to gently rolling topography becomes rough where solution depressions have modified it. These solution depressions occur because of removal of soluble material by ground water from the San Andres limestone. Cavities occur after this material is removed and the overlying strata collapse. These solution depressions or sink holes are circular to elongate and vary in width from a few feet to several hundred feet and in depth from a few feet to more than 50 feet. These features are underlain by sedimentary rocks that dip gently to the east.

In the southeastern portion of this section along the southern boundary Pintada Creek has cut a steep-walled canyon into the upland. In some places it is a few hundred feet deep. It is rimmed by Santa Rosa sandstone and beneath the rim the Bernal formation makes up the greater portion of the walls and floor. Pintada Creek and its tributaries are the principal drainage of this area. It flows into the Rio Agua Negra to the east.

The areal distribution of formations and their members is shown on Soils and Geology Map 40-15. Their succession and character are given under the section termed "Stratigraphy."

Soils:

Soils of this section occur in three different stages of development: (1) young alluvium (Qal), (2) older alluvium (TQg and TQalc) mature in age, with developed mature profiles, and (3) residual soils formed on the Santa Rosa and Bernal formations.

Young alluvial soils have formed in intermittent stream channels, in solution depressions, and in the broad, flat swales of the plain. They are derived primarily from the older alluvium and Santa Rosa sandstone. They are composed of silty soil (A-4) and clay soil (A-6). The alluvial soils that cover the floor of Pintada Canyon are predominantly clay (A-6). They are derived from the shale, gypsum, and siltstone of the Bernal formation.

In the extreme western portion of this section remnants of gravel deposits occur in the form of hills. These late Tertiary and early Quaternary sediments were deposited as an apron by southeasterly flowing streams. During these periods the climate was humid and the characteristics of the sediments indicate that some of their parent materials lie many miles to the north and west and that the streams had a high gradient and carried large volumes of water. Recent erosion has reworked this material and in most cases it has been completely removed from the surface. Well developed profiles of mature soils are exposed along the slopes of the hills. "A" horizon is silty soil (A-4) approximately 2.5 feet thick. "B" horizon consists of sand, silt, and gravel in which caliche has formed. This material varies from a soft, nodular caliche soil to a well consolidated hard caliche cap rock and it varies in thickness from 3 to 9 feet. "C" horizon consists of sand, silt, and gravel up to 90 feet thick.

The older alluvium in which caliche has formed usually has a well developed profile of mature soils. "A" horizon varies from silty soil (A-4) to clay soil (A-6) and it varies in thickness from a few inches to 4 feet. "B" horizon consists of silt, sand, and clay in which caliche has formed. This material varies from a soft, nodular caliche soil to a well consolidated caliche cap rock. It varies in thickness from a few inches to 15 feet. In local areas the caliche of "B" horizon lies directly over bedrock. "C" horizon contains a variable mixture of fine sand, coarse sand, and silty soil and it varies in thickness from a few inches to 15 feet. The older alluvium is partly a result of the redistribution of late Tertiary and early Quaternary sediments.

Observations made of residual soils:

Triassic: Santa Rosa sandstone (Trsr) - silty soil (A-4) with minor amounts of silty sandy soil (A-2-4).
Thickness: 0 to 4 feet.

Permian: Bernal formation (Pb) - varies from silty soil (A-4) to clay soil (A-6).

Table No. 40-15-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40. The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-15.

Stratigraphy:

Quaternary: Alluvium (Qal) - a mixture of sand, silt, and clay deposited in stream channels, solution depressions, and in broad, flat swales.

Unconformity----------Period of Erosion----------

Tertiary (?)-Quaternary: Gravel (TQg) - isolated gravel hills composed of igneous and metamorphic river gravels.
Thickness: 100 feet.

Older alluvium and caliche (TQalc) - sand, silt, clay, and gravel in its lower portion. Sand, silt, clay, and gravel in which caliche has formed in its upper portion. In local areas caliche cap rock overlies bedrock.
Thickness: Estimated maximum 25 feet.

Unconformity----------Period of Erosion----------

Triassic: Dockum group:

Santa Rosa sandstone (Trsr)

Upper member - brown to gray, dense to fine-grained, calcareous, platy to massive sandstone. A thin limestone pebble conglomerate exists at or near its base (Gorman and Roebeck, 1946).
Thickness: 10 to 115 feet.

Shale member - dark red to gray shale (Gorman and Roebeck, 1946)

Middle member - a gray to brown, medium- to coarse-grained, platy to massive sandstone. A thin limestone pebble and quartz conglomerate with petrified wood occurs at or near its base (Gorman and Roebeck, 1946).
Thickness: 10 to 135 feet.

Lower member - friable, purplish-red, fine-grained, platy to thin bedded, micaceous, silty sandstone with a salt and pepper appearance. Chocolate-red shale exists in the upper portion (Gorman and Roebeck, 1946).
Thickness: 0 to 110 feet.

Unconformity----------Period of Erosion----------

Permian: Bernal formation (Pb) - consists of orange-red and light gray siltstone, shale, and fine-grained sandstone. Contains lentils of gypsum and limestones in its basal parts.
Thickness: 50 to 175 feet.

Construction Materials:

Tertiary (?)-Quaternary: Gravel (TQg) - small isolated hills that contain sand and gravel occur approximately 1.75 miles north of Interstate Route 40 in sections 17 and 18, T 9 N, R 17 E. This is an excellent grade of igneous and quartzite river gravel. The existing road built for removing it is the best access to the area.

SOILS AND GEOLOGY

Construction Materials continued

Tertiary (?) - Quaternary: Ten and three-tenths miles north of Interstate Route 40 on U.S. 84 gravel occurs east and west of the highway. This material is similar in nature to the above described gravel; however, further exploration is needed to determine its qualities.

Caliche (TQalc) - a well consolidated to partly consolidated caliche cap has formed over most of this section. Past exploration has proven that the best aggregates can be produced in local areas east of U.S. 84 and State Road 219. The cap rock is much thicker and more uniform in this area. Good quality pits up to 12 feet thick have been developed and further subsurface investigation may prove an inexhaustible supply. Existing roads provide the best access to these areas.

Permian: San Andres formation (Psa) - the limestone member of this formation caps a highly dissected rock terrace that lies among buttes and mesas along the Pecos River breaks, west of the old village of La Junta and south of the river. It covers an approximate 3 mile square area. The material is a thin-bedded, hard, crystalline, grayish limestone. It varies from 8 to 15 feet in thickness and it overlies a friable, massive-bedded sandstone. Further exploration may develop an inexhaustible supply of construction material in this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-15. Test data and other related information are shown in Material Pit Summary Table No. 40-15-2.

Soils Summary:

Table No. 40-15-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	2	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	4.0	A-4	" "
"	"	4	A	0.0	3.0	A-4	" "
"	"	6	A	0.0	3.5	A-6	Clay soil
"	"	12	A	0.0	10.0	A-6	" "
"	"	16	A	0.0	1.5	A-4	Silty soil
Tertiary (?)-	Alluvium and		B	1.5	---	Unclassified	Caliche
Quaternary	caliche	1	A	0.0	2.5	A-6	Clay soil
"	"		B	2.5	---	Unclassified	Caliche
"	"	7	A	0.0	0.8	A-4	Silty soil
"	"		B	0.8	---	Unclassified	Caliche
"	"	8	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	---	Unclassified	Caliche
"	"	9	A	0.0	4.5	A-4	Silty soil
"	"	14	A	0.0	3.5	A-4	" "
"	"		B	3.5	4.5	A-4	Caliche soil
"	"	15	A	0.0	0.6	A-4	Silty soil
"	"		B	0.6	---	Unclassified	Caliche
"	"	17	A	0.0	2.5	A-6	Clay soil
"	"	18	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	---	Unclassified	Caliche
The following samples represent soils derived from their parent formations:							
Triassic	Santa Rosa	5	A	0.0	3.0	A-4	Silty soil
"	" "		B	3.0	---	Bedrock	Sandstone
"	" "	10	A	0.0	4.5	A-2-4	Silty sand
"	" "		B	4.5	---	Bedrock	Sandstone
Permian	Bernal	11	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	3.0	A-4	Caliche soil
"	"		C	3.0	---	Bedrock	Gypsum
"	"	13	A	0.0	3.0	A-4	Silty soil

Table No. 40-15-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	Classification	Material Type
The following section shows the material that may be exposed when cuts are made in the formation.							
Triassic	Santa Rosa	19	A	0.0	0.6	A-4	Silty soil
"	" "		B	0.6	5.0	Solid rock	Sandstone
"	" "		C	5.0	8.0	" "	Conglomerate
"	" "		D	8.0	20.0	A-4	Shale
"	" "		E	20.0	21.0	Solid rock	Sandstone
"	" "		F	21.0	24.0	A-4	Shale
"	" "		G	24.0	27.0	Solid rock	Sandstone
"	" "		H	27.0	----	" "	"

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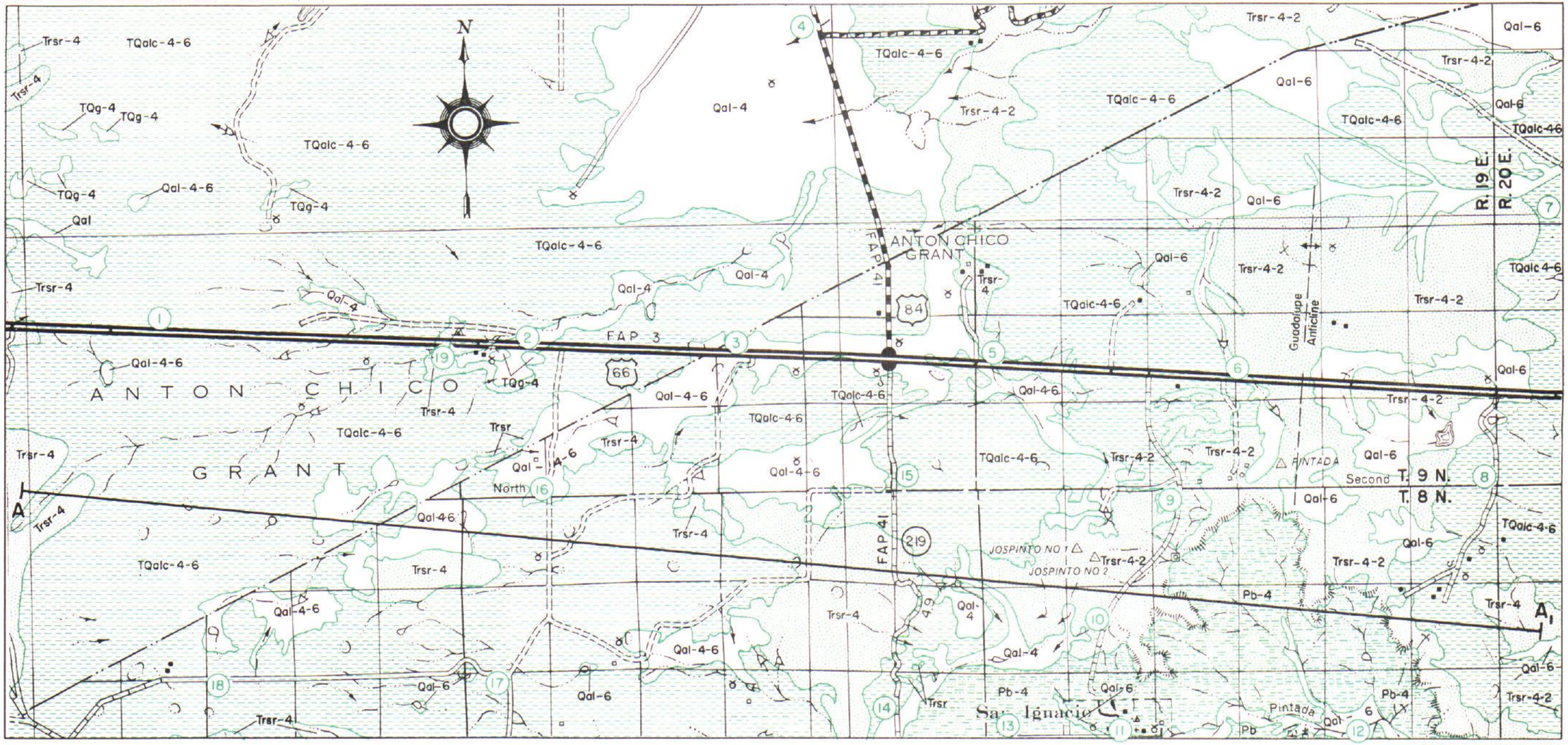
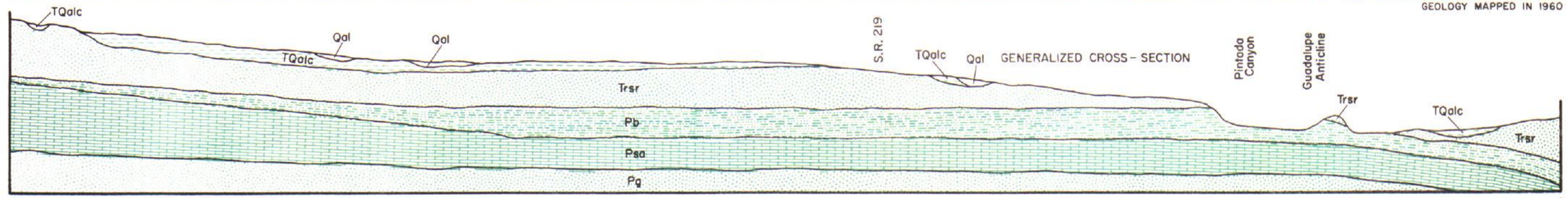
AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40 - 15

INTERSTATE ROUTE 40
ANTON CHICO GRANT TO SANTA ROSA WEST



GEOLOGY MAPPED IN 1960



-LEGEND-

SEDIMENTARY ROCKS

- Qal — Alluvium — QUATERNARY
- TQg — Gravel deposits
- TQalc — Alluvium & caliche — QUATERNARY & TERTIARY
- Dockum group: Trsr — Santa Rosa sandstone — TRIASSIC
- Pb — Bernal formation — PERMIAN
- Psa — San Andres formation — PERMIAN
- Pg — Glorieta sandstone — PERMIAN

0 STATUTE MILES

SECTION 40-15
Page 3

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-15-2

Pit or Prospect No.		57-5-S	58-1-S	58-55-S	40-15-1 (Prospect)	
Location	Section	NE 1/4 Sec. 33	NE 1/4 Sec. 18	NW 1/4 Sec. 17	West Central Sec. 3	
	Twnshp. & Range	T 9 N, R 19 E	T 9 N, R 17 E	T 9 N, R 17 E	T 10 N, R 18 E	
	County	Guadalupe	Guadalupe	Guadalupe	Guadalupe	
	State	New Mexico	New Mexico	New Mexico	New Mexico	
Owner		Private land	State land	Private land	?	
Geologic Age		Tertiary (?)-Quaternary	Tertiary (?)-Quaternary	Tertiary (?)-Quaternary	Tertiary (?)-Quaternary	
Formation		Caliche	Terrace	Hill (Terrace deposit)	Older Terrace deposits	
Type of Pit		Quarry	Sand & Gravel	Gravel	Sand and Gravel	
Kind of Material		Caliche	Igneous, quartzite, etc.	Quartzite, igneous, etc.	Igneous, quartzite, etc.	
Quality of Material		Good	Excellent	Excellent	See remarks	
Thickness of Material		12 feet maximum	100 feet	90 feet	" "	
Thickness of Cap (Caliche)		3 feet average	-	-	-	
Blasting Qualities		Good	-	-	-	
Uniformity		Good	Good	Good	See remarks	
Impurities		None	None	None	" "	
Type of Mat'l. Underlying Formation		Sandstone	Sandstone	Sandstone	Shale and siltstone	
Moisture Condition		Dry	Dry	Dry	Dry	
Vegetation		Grass & dotted with junipers	Grass	Grass	Grass	
Local Terrain		Rolling to rough	Hilly	Hilly to rolling	Dissected terrace	
Depth of Overburden		0.0 to 4.0 feet	9 feet	9 feet	See remarks	
P.I. (Overburden)		N.P. to 15	5 to 15	N.P. to 16	" "	
Est. Reserve Quantity		80,000+ cu. yds.	See remarks	200,000+ cu. yds.	" "	
Approx. Haul to Nearest Point		3500 feet	1,8 miles	1,8 miles	10 miles	
L.A. Wear		Cap 32,8, Soft caliche 51.2	25.6	29.6	See remarks	
Maximum Size		-	6"	4"	" "	
% Retained on 2" Sieve		-	Less than 25	Less than 20	" "	
	Crushed to	1"	2"	2"	" "	
	2"	-	100	100	" "	
Pit	1"	100	81	74	" "	
Average	3/4"	86	70	61	" "	
% Passing	1/2"	55	60	48	" "	
	#4	26	42	33	" "	
	#10	16	33	26	" "	
	#200	2	1	3	" "	
P.I.		Cap N.P. to 13, Soft caliche N.P. to 20	N.P.	N.P.	" "	
Lab. Numbers		57-855 - 962	58-1511 - 1539, 58-1940 - 1977	58-11501 - 11568	-	

Remarks:

57-5-S - Pit may possibly be extended to the east.

58-1-S - Old pit area is worked out. Except for a small portion in the northeast corner; may be extended to the north.

58-55-S - Pit can be extended to the east. Excavated area has been worked to a depth of 90 feet.

40-15-1 (Prospect) - These deposits are similar in appearance to Pit No. 58-55-S. Further exploration is needed to determine the exact conditions of the area.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
ANTON CHICO GRANT - SANTA ROSA WEST

CONSTRUCTION MATERIALS INVENTORY

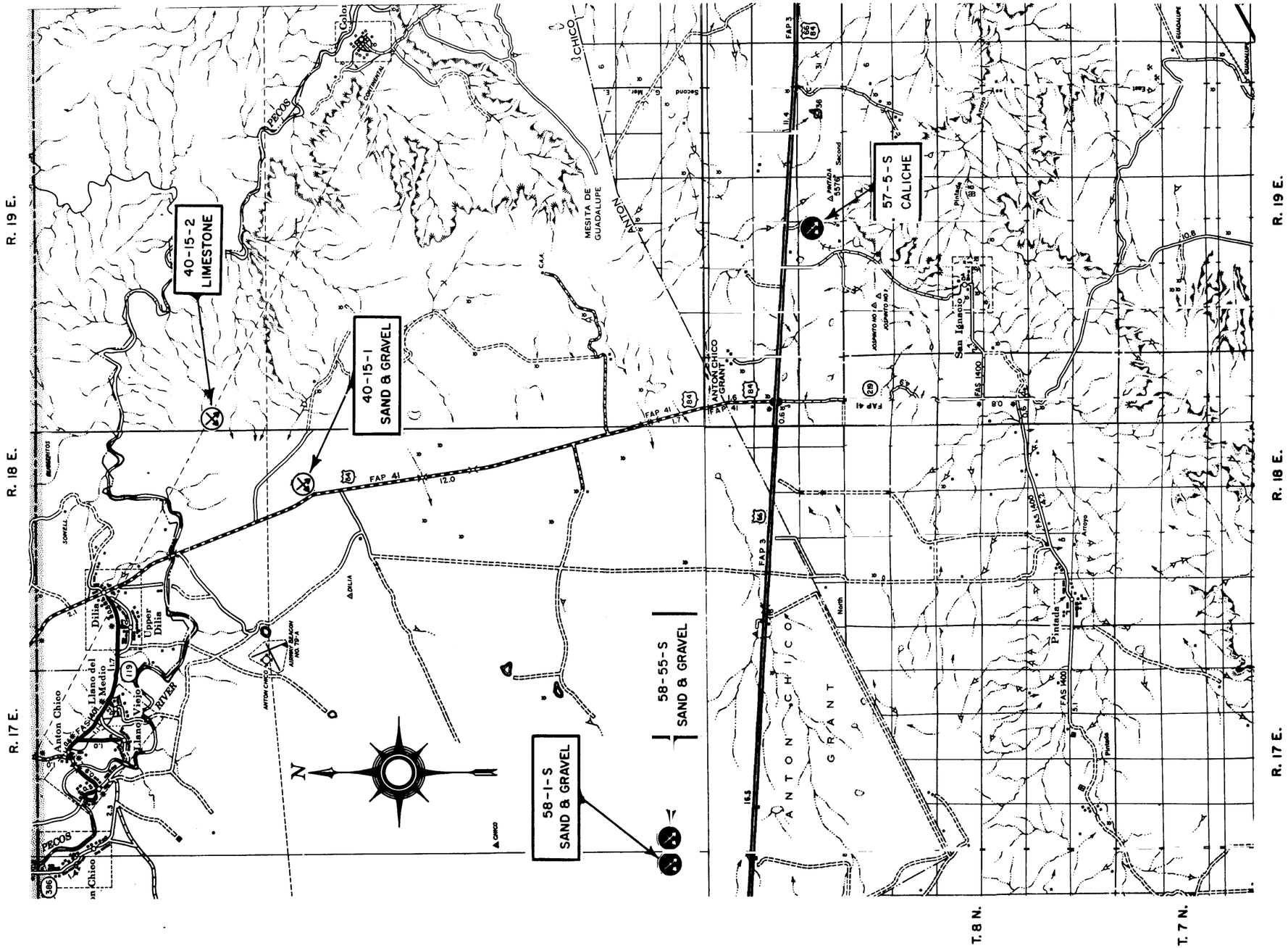
Material Pit Summary:

Table No. 40-15-2 continued

Pit or Prospect No.		40-15-2 (Prospect)
Location	Section	-
	Twnshp. & Range	T 11 N, R 18 E
	County	Guadalupe
	State	New Mexico
Owner		Private land
Geologic Age		Permian
Formation		San Andres
Type of Pit		Quarry
Kind of Material		Limestone
Quality of Material		Good
Thickness of Material		8 to 15 feet
Thickness of Cap (Caliche)		-
Blasting Qualities		See remarks
Uniformity		Good
Impurities		See remarks
Type of Mat'l. Underlying Formation		Sandstone
Moisture Condition		Dry
Vegetation		Cedar and pinon
Local Terrain		rough, broken
Depth of Overburden		See remarks
P.I. (Overburden)		" "
Est. Reserve Quantity		Unlimited
Approx. Haul to Nearest Point		15 miles
L.A. Wear		See remarks
Maximum Size		-
% Retained on 2" Sieve		-
Pit Average % Passing	Crushed to	-
	2"	-
	1"	-
	3/4"	-
	1/2"	-
	#4	-
	#10	-
	#200	-
P.I.		-
Lab. Numbers		-

Remarks:

40-15-2 (Prospect) - Further exploration needed to determine exact conditions.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SANTA ROSA WEST - SANTA ROSA EAST

SOILS AND GEOLOGY

Introduction:

Physiographically section 40-16 lies within the Great Plains province and is characterized by highlands west of the Pecos River, karst topography of the Pecos River basin in the vicinity of Santa Rosa, and highlands east of the Pecos River.

General Geology:

The stratigraphic sequence exposed in this section includes Permian and Triassic sedimentary rocks overlain by Tertiary and Quaternary poorly consolidated to unconsolidated sediments.

The highlands west of the Pecos River basin are part of the eastward dipping limb of the Guadalupe anticline which was formed in the late Mesozoic era. The Santa Rosa sandstone and a fairly uniform layer of caliche crop out on the surface of this highland. Numerous solution depressions or sink holes interrupt the flat to rolling topography and cause it to become rough in some places. Cavities were formed where ground-water has removed soluble material from the underlying San Andres limestone and the overlying strata have collapsed into these cavities. On the surface they are usually circular to elongated.

The Pecos River basin is an erosional feature modified by solution depressions that have developed a karst topography. In this area the depressions are caused by solution and removal of gypsum from the Bernal formation and limestone from the San Andres formation.

South of Santa Rosa at the confluence of El Rito Creek and the Pecos River a flood plain exists. The flood plain probably developed in this locality because a great deal of solution of the underlying Bernal and San Andres formations caused the area to sink. Therefore, it is not primarily due to lateral cutting by a meandering Pecos River. However, subsequent flooding by the Pecos River and El Rito Creek has deposited characteristic floodplain materials over the surface.

The highlands east of the Pecos River are characterized by mesas and buttes which rise above broad valley floors. They are outliers of the Llano Estacado or Staked Plains. The Llano Estacado is a caliche capped plateau which represents the southernmost extension of the Great Plains province. It extends from eastern New Mexico eastward into Texas. These mesas and buttes have been carved out by tributaries of the Pecos and Canadian Rivers.

The eastern margin of this section lies on the western rim of the Tucumcari structural basin.

The areal distribution of formations and their members is shown on Soils and Geology Map 40-16. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils of this section are: older alluvium, caliche, and gravel (TQalc and TQcg), alluvial terrace gravels (Qtg), floodplain deposits (Qfp), wind-blown deposits (Qa), young alluvium (Qal), young alluvium in which caliche has formed (Qalc), and residual soils overlying formations of Permian, Triassic, and Tertiary age. The Ogallala formation, Tertiary in age, may be correlated in part with the older alluvium, caliche, and gravel that lie west of the Pecos River; however, it is referred to as a formation rather than a soil east of the Pecos River.

Caliche has formed in the older alluvium that covers the rolling plain in the western one-third of this section. The alluvium usually has a well developed profile of mature soils. "A" horizon varies from a silty soil (A-4) to clay soil (A-6) and varies in thickness from a few inches to 4 feet. "B" horizon consists of silt, sand, and clay in which the caliche has formed. This material varies from a soft, nodular caliche soil to a well consolidated caliche cap rock. It varies in thickness from a few inches to 15 feet. In local areas the caliche of "B" horizon lies directly over bedrock. "C" horizon contains a variable mixture of sand, silt, and clay and varies in thickness from a few inches to 15 feet. The older alluvium is partly a result of the redistribution of late Tertiary and Quaternary sediments.

The older caliche and gravel deposits (TQcg) adjacent to Interstate Route 40 in the vicinity of the airport are equivalent in age to the older alluvium and caliche (TQalc). They were deposited by heavily loaded streams meandering widely over a gradually decreasing gradient in early Pliocene. By middle Pliocene an increasingly arid climate greatly reduced the surface flow of streams and this climatic change made possible the conditions necessary for the formation of caliche in the upper portion of this deposit. The characteristics of these sediments indicate that some of their parent materials lie many miles to the north and west. The Pecos River and its tributaries have recently cut through these deposits and redistributed part of them to lower terrace surfaces. They are presently in the form of moderately dissected terraces bordering the Pecos River breaks. Well developed profiles of mature soils are exposed along the grassy slopes of these terraces. "A" horizon varies from silt (A-4) to clay (A-6) and it varies in thickness from a few inches to 2 feet. "B" horizon consists of sand, silt, and gravel in which caliche has formed. Usually the caliche has weathered to a soft, nodular cap rock and its thickness varies from a few inches to 6 feet. "C" horizon consists of partly consolidated, stratified, silt, sand and gravel. Its average thickness has not been determined. An especially good exposure of these soils is shown in a road cut on Interstate Route 40 approximately 2 miles northwest of Santa Rosa.

Terrace gravels (Qtg) occur in several different stages of development in this section. Highly dissected, broadly distributed deposits lie south and west of Interstate Route 40. They are partly a result of the redistribution by small streams of the older alluvial soils (TQalc and TQcg). They have a poorly developed profile of silt and clay over a heterogeneous mixture of clay, silt, sand, and gravel. Numerous clay balls, derived from the underlying shales and clays of the Santa Rosa formation were noted throughout these deposits. Scattered remnants of terrace deposits occur adjacent to the flood plain along State Road 91 and south of Interstate Route 40 along U.S. 84. Along the flood plain near the Pecos River they are of recent origin and they contain a variable mixture of silt, sand, and gravel. Along U.S. 84 they may be weathered outliers of the Ogallala formation since the weathered caliche cap and underlying silt, sand, and gravel are very similar to the Ogallala formation. Terrace deposits adjacent to the Pecos River in the vicinity of Santa Rosa contain a clean, well sorted sand and gravel overlain by a veneer of silty soil.

A floodplain exists in the area of confluence of El Rito Creek and the Pecos River. El Rito Creek and the Pecos River have flooded this relatively flat area covering it with clay, silt, and sand. A 6 to 12 inch layer of hardpan covers this floodplain. This hardpan layer is caused by rapid downward percolation and evaporation of water. The soils are predominantly silt (A-4) with lesser amounts of sand (A-3) and clay (A-7). The water table is approximately 2.5 feet below the surface in this area.

Wind-blown deposits and occasionally sand dunes occur along the extreme south central portion of this section. Prevailing westerly winds have swept this sand and silt from the floor of the Rio Agua Negra to the southwest and deposited them in this area. These deposits are silty sand (A-2-4) and their depths will vary. The dunes consist of a clean, fine-grained quartz sand (A-3).

Younger alluvium and caliche occur in two areas. The western area has a well developed profile of mature soils. "A" horizon is silty soil (A-4) and varies in thickness from a few inches to 4 feet. "B" horizon consists of silt, sand and gravel in which a soft, nodular caliche has formed and it averages 6 feet in thickness. "C" horizon contains a variable mixture of silt, sand, and gravel that is equivalent to the materials that surround this deposit. In the eastern area this alluvium has a fairly mature profile; however, there is very little difference in the soil texture. "A" horizon usually is a reddish-brown clay soil (A-6) approximately 2 feet thick. "B" horizon is a soft, nodular, clay caliche soil (A-6) and it varies from 3 to 10 feet. "C" horizon consists of decomposed shales and clays of the Chinle formation and sheet wash material that is also derived from the Chinle formation. Even though "A" and "B" horizons are both clay there is usually a slight difference in plastic index.

The alluvial soils of Rio Agua Negra are predominantly clay (A-6) derived primarily from the shales and clays of the Bernal and Santa Rosa formations. Scattered bars of silt and sand occur on the floor of this stream.

In the extreme eastern portion of this section the alluvial soils are clay (A-6) derived from the shales and clays of the Chinle formation.

Near the arroyos northwest of Santa Rosa adjacent to Interstate Route 40 the alluvial soils are predominantly silt (A-4) derived from Quaternary sediments and the Santa Rosa formation.

Observations made of residual soils:

Tertiary:	Ogallala formation (To) - clay soils (A-6) with lesser amounts of silty soils (A-4). Thickness: 0 to 3 feet.
Triassic:	Chinle formation (Trc) - clay soils (A-6). Thickness: 0 to 5 feet.
	Santa Rosa formation (Trsr) - silty soils (A-4) are developed when bedrock consists of sandstone and siltstone; clay soils (A-6) are developed when bedrock consists of shales and siltstone. Thickness: 0 to 8 feet.

SOILS AND GEOLOGY

Soils continued

The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-16. Table No. 40-16-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Ground-Water:

Ground-water conditions that may cause difficulty in highway construction are: perched water tables, artesian water, and the high water table of the flood plain. Recharge for underground water is furnished by underflow from the bordering highlands, seepage from streams, lakes and ponds, and migration of meteoric waters, such as rain or melted snow and ice.

The Santa Rosa sandstone contains alternate beds of relatively permeable rocks which are aquifers, and relatively impermeable shales and clays or aquicludes. The horizontal and vertical arrangement of these aquifers and aquicludes often present ideal conditions for perched water tables and artesian water. When the hydrostatic head is sufficient to cause a resultant upward pressure an aquiclude tends to channel the flow of water along its under surface and it becomes a positive confining bed. If this bed is removed or tapped the water will rise to a height determined by the hydrostatic pressure and an artesian flow will result in instances where the height of rise is greater than the distance to the ground surface. In some cases this trapped water will migrate along the dip of the beds and finally escape through cracks and fractures and rise to the surface as springs. Another type of spring that exists in this area is gravity fed and will discharge where an outcrop of the water table occurs. The above conditions may be frequently encountered along the flanks of the dipping strata in the vicinity of El Rito Creek.

A high water table exists in the flood plain area. Sampling in the area revealed that the water table is about 2.5 feet below the surface. However it will fluctuate depending upon the amount of precipitation and lateral seepage.

Stratigraphy:

Quaternary:

Alluvium (Qal) - unconsolidated sand, silt, and clay formed along intermittent streams, in solution depressions, and in the low areas.

Aeolian deposits (Qa) - wind-blown sands and silts occasionally in the form of dunes.

Alluvium and caliche (Qalc) - unconsolidated sands, silts, and clays in which caliche has formed.

Floodplain deposits (Qfp) - unconsolidated sands, silts, and clays deposited on the flood plain surface at the confluence of El Rito Creek and the Pecos River.

Terrace gravels (Qtg) - sand, silt, and gravel deposited on terrace surfaces. In some areas it contains many clay balls.

Unconformity----------Period of Erosion----------

Tertiary - Quaternary:

Older alluvium and caliche (TQalc) - silt, clay, and sand in its lower portion. Silt, clay, and sand in which caliche has formed in its upper portion. In local areas caliche cap rock overlies bedrock.
Thickness: Estimated maximum - 25 feet.

Older alluvium, caliche and gravel (Tqcg) - partly consolidated, stratified silt, sand, and gravel in its lower portion. Sand, silt, and gravel in which caliche has formed in its upper portion.

Ogallala formation (To) - partly consolidated sand, silt, clay, and gravel overlain by a dense to soft, nodular caliche cap rock. In some locales caliche has been eroded away leaving caliche pebbles and the lower sand and gravel exposed. The older alluvium and caliche may be correlated to this formation.

Unconformity----------Period of Erosion----------

Triassic:

Dockum group:

Chinle formation (Trc) - locally it contains purplish- to chocolate-red and gray to red shale and variegated siltstone. A thin limestone conglomerate lense occurs near its base.
Thickness: 850 feet.

Santa Rosa sandstone (Trsr)

Upper member - a brown to gray, dense, calcareous, platy to massive sandstone; contains a thin limestone pebble conglomerate near its base. (Gorman and Roebeck, 1946)
Thickness: 10 to 115 feet.

Shale member - dark red and gray shale with variable thickness (Gorman and Roebeck, 1946).

Middle member - a gray to brown, medium- to coarse-grained, platy to massive sandstone. A thin quartz and limestone pebble conglomerate with petrified wood occurs at or near the base (Gorman and Roebeck, 1946).
Thickness: 10 to 135 feet.

Lower member - purplish-red, friable, platy, micaceous, silty, salt and pepper sandstone. Occasionally contains bone fragments; a chocolate-red and gray shale occurs in its upper part (Gorman and Roebeck, 1946).
Thickness: 0 to 110 feet.

Unconformity----------Period of Erosion----------

Permian:

Bernal formation (Pb) - terra cotta, orange-red, and light gray siltstone, shale, and fine-grained sandstone with stringers of gypsum and lentils of limestone in its basal part.
Thickness: 200 feet.

San Andres formation (Psa) - light to dark gray, cavernous limestone; contains marine invertebrate fossils; dolomitic and cherty in its upper and basal parts. A tongue of gypsum occurs in this locale.
Thickness: 50 to 100 feet.

Construction Materials:

Quaternary:

Aeolian deposits (Qa) - wind-blown, fine clean sand and silty sand. Dunes approximately 30 feet high and 60 feet long occur on the lee side of Rio Agua Negra near the Pecos River. This material may be suitable for filler.

Terrace gravel (Qtg) - recent Pecos River terrace deposits that lie north of the city of Santa Rosa are the best source of gravel for this section. However the quantity in this area is limited. The gravels are composed of an excellent grade of quartzite and igneous river gravel and are confined to terrace surfaces within a few hundred feet of the Pecos River channel. Scattered terrace remnants along U.S. 84 may contain a suitable material; however, further exploration is needed to determine their quality.

Other deposits west and south of Interstate Route 40 contain a high percent of clay balls; although, they may be useful for some maintenance purposes. Existing roads are the best access to these areas.

Pecos River channel deposits (Qal) - near the old village of Colonias the floor of the Pecos River is covered by large quantities of coarse, clean sand. This material may be suitable as select borrow for improving the grading of crushed rock and as concrete sand. The best access to this area is the existing road, State Road 379, which has a fairly steep grade along the Pecos River breaks.

SOILS AND GEOLOGY

Construction Materials continued

Tertiary - Quaternary:

Caliche (TQalc) - a well consolidated to partly consolidated caliche cap rock has formed over most of the plain in the western part of this section. Past exploration has proven that good aggregates can be produced in local areas adjacent to Interstate Route 40. Good quality pits up to 12 feet thick have been developed in this area and further exploration may prove an inexhaustible supply.

Gravel (TQcg) - a fair grade of gravel is exposed on the slopes of this deposit east of the airport. Further exploration is needed to determine the quality, quantity, etc.

Ogallala (To) - this formation contains a fair grade of quartzite and igneous river gravels in its lower portion. Gravel hills are exposed along the western flank of this formation. The material is partly consolidated in local areas and some clay balls were noted in the diggings of old pit areas. Further sub-surface investigation is needed to determine quality, quantity, etc.

Basalt (Te) - a basalt dike is exposed north and east of Santa Rosa. It is a dark, dense, crystalline rock and it rises above the valley floor approximately 200 feet. Rock is exposed on the surface in an area approximately 200 feet wide and 500 to 600 feet long. Further exploration may prove this area to be much larger. It lies one and one-half miles east of State Road 20 approximately seven and one-half miles north of Interstate Route 40.

Triassic:

Rock asphalt (Trsr) - this rock occurs in the Santa Rosa sandstone. The asphalt is a residual product derived from oil in the underlying San Andres limestone that has migrated up through sink holes and channels and accumulated in the sandstone. By enriching its asphalt content this material was made suitable for surfacing roads in the past and further research may prove it to be a suitable material for future use.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-16. Test data and other related information are shown in Material Pit Summary Table No. 40-16-2.

Soils Summary:

Table No. 40-16-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	5	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	4.0	A-4	" "
"	"	16	A	0.0	2.0	A-4	" "
"	"		B	2.0	---	Bedrock	Sandstone
"	"	25	A	0.0	3.0	A-6	Clay soil
"	Aeolian	19	A	0.0	4.0	A-3	Fine sand
"	Alluvium and	12	A	0.0	2.5	A-6	Clay soil
"	caliche	18	A	0.0	4.0	A-4	Silty soil
"	Floodplain	13	A	0.0	2.5	A-4	" "
"	"		B	2.5	---	Water table	-
"	Terrace gravel	6	A	0.0	3.5	A-4	Silty soil
"	" "		B	3.5	---	Bedrock	Sandstone
"	" "	17	A	0.0	4.0	A-4	Silty soil
"	" "		B	4.0	---	A-1-a	Gravel
"	" "	20	A	0.0	4.0	A-6	Clay soil
"	" "		B	4.0	---	A-1-a	Gravel
"	" "	21	A	0.0	2.5	A-4	Silty soil
"	" "		B	2.5	---	A-1-a	Gravel
Tertiary -	Older alluvium	1	A	0.0	4.0	A-6	Clay soil
Quaternary	and caliche		B	4.0	---	Cap rock	Caliche
"	"	2	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	---	Cap rock	Caliche
"	"	3	A	0.0	1.5	A-6	Clay soil
"	"		B	1.5	---	Cap rock	Caliche

Table No. 40-16-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Tertiary - Quaternary:	Older alluvium and caliche	23	A	0.0	0.8	A-4	Silty soil
			B	0.8	---	Cap rock	Caliche

The following residual soil samples represent soils derived from parent formations:

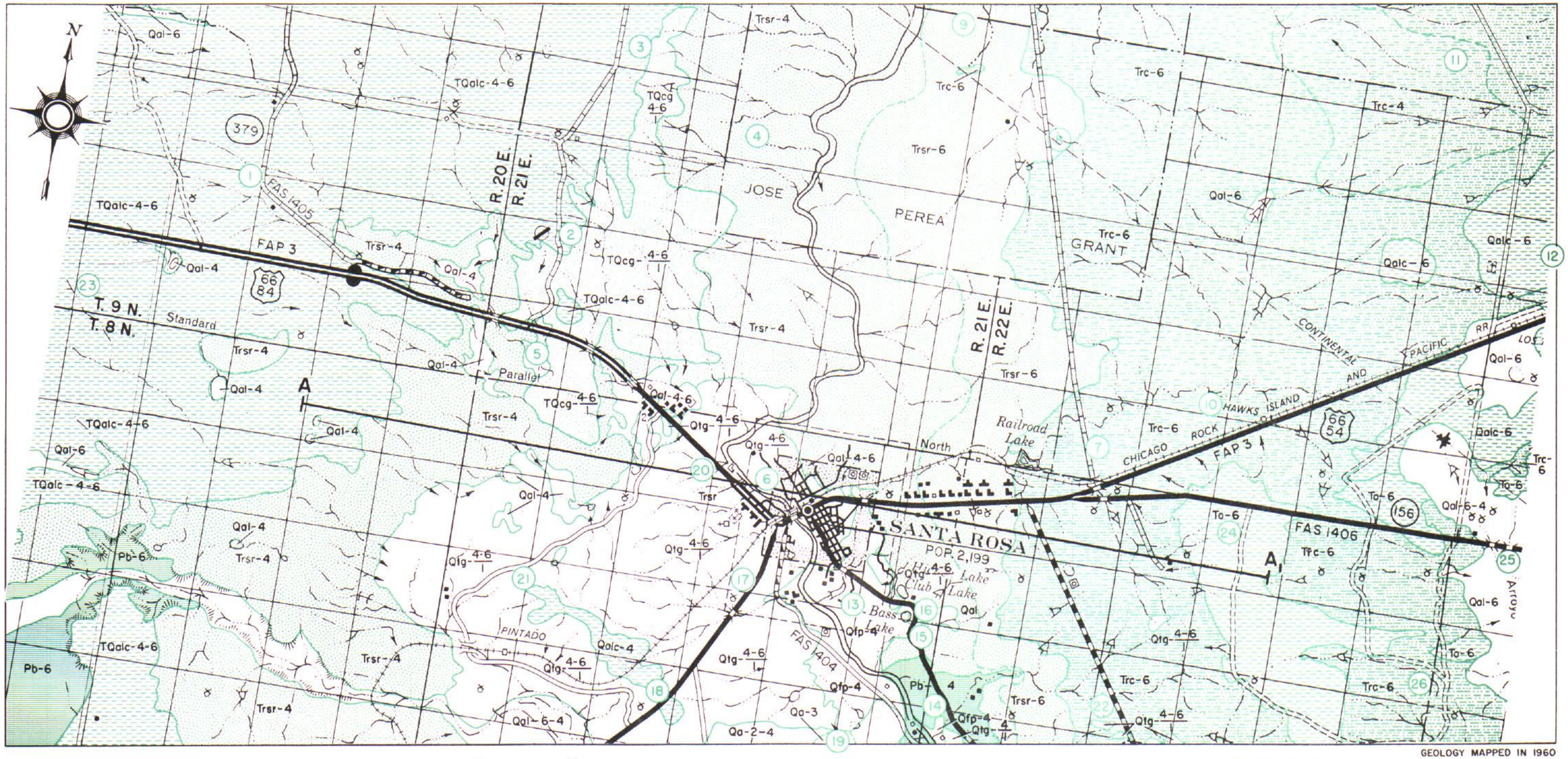
Tertiary	Ogallala	24	A	0.0	2.0	A-6	Clay soil
"	"		B	2.0	---	Cap rock	Caliche
Triassic	Chinle	7	A	0.0	3.0	A-6	Clay soil
"	"	10	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	---	Bedrock	Siltstone
"	"	11	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	3.0	A-4	" "
"	"		C	3.0	---	Bedrock	Siltstone
"	"	22	A	0.0	2.5	A-6	Clay soil
"	"		B	2.5	---	Bedrock	Shale
"	"	26	A	0.0	3.0	A-6	Clay soil
"	"		B	3.0	---	Bedrock	Shale
"	Santa Rosa	4	A	0.0	1.5	A-4	Silty soil
"	" "		B	1.5	---	Bedrock	Sandstone
"	" "	8	A	0.0	1.0	A-6	Clay soil
"	" "		B	1.0	---	Bedrock	Sandstone
"	" "	9	A	0.0	3.0	A-6	Clay soil
"	" "		B	3.0	---	Bedrock	Sandstone
"	" "	15	A	0.0	0.6	A-4	Silty soil
"	" "		B	0.6	---	Bedrock	Siltstone
Permian	Bernal	14	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Bedrock	Siltstone

Selected References

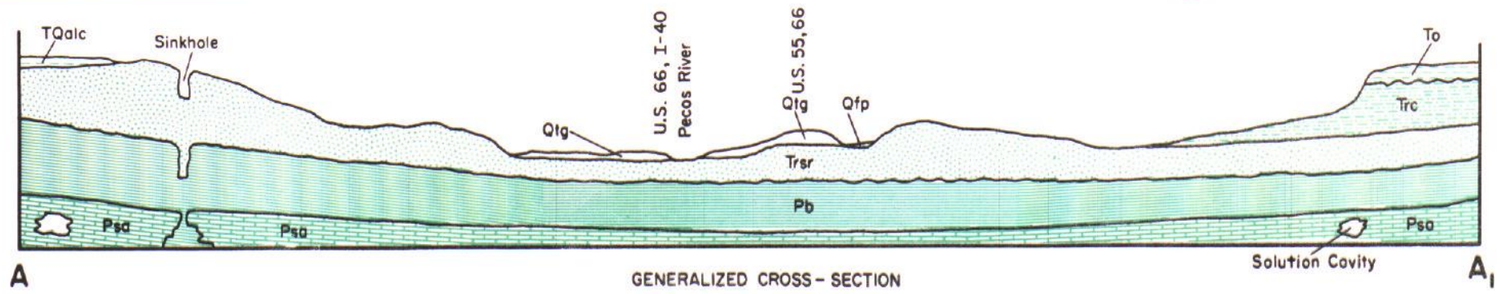
Gorman, J. M. and Roebeck, R. C., 1946, Geology and Asphalt Deposits of North Central Guadalupe County, New Mexico, U.S.G.S. Oil and Gas Investigations, Preliminary Map No. 44.

Wood, G. H., Kelley, V. C. and Read, C. A., 1949, Road Log - Ragland to Santa Fe, Guidebook, Cenozoic Geology of the Llano Estacado and Rio Grande Valley, West Texas Geol. Society, pp. 25-38.

SOILS AND GEOLOGY MAP 40-16



GEOLOGY MAPPED IN 1960



GENERALIZED CROSS-SECTION

0
STATUTE MILES

-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qa — Wind-blown deposits
- Qfp — Flood-plain deposits
- Qalc — Alluvium & Caliche

QUATERNARY
- Qtg — Terrace gravel

TERTIARY & QUATERNARY
- TQalc — Older Alluvium & Caliche
- TQag — Older Alluvium, Caliche & Gravel

TERTIARY
- To — Ogallala formation

TRIASSIC
- Trc — Chinle formation
- Trsr — Santa Rosa sandstone (Dockum Group)

PERMIAN
- Pb — Bernal formation
- Psa — San Andres formation

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SANTA ROSA WEST - SANTA ROSA EAST

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-16-2

Pit or Prospect No.		55-4-S	56-47-S	56-90-S	57-6-S
Location	Section	NW 1/4 Sec. 16	SE 1/4 Sec, 4	NE 1/4 Sec, 35	SE 1/4 Sec, 4
	Twnshp. & Range	T 7 N, R 22 E	T 8 N, R 21 E	T 9 N, R 20 E	T 8 N, R 21 E
	County	Guadalupe	Guadalupe	Guadalupe	Guadalupe
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State land	Private	Private	Private
Geologic Age		Quaternary	Quaternary	Tertiary and Quaternary	Quaternary
Formation		Terrace	Terrace	-	Terrace
Type of Pit		Gravel	Gravel and sand	Quarry	Gravel
Kind of Material		Sand & gravel	Metamorphic & igneous	Caliche	Metamorphic and igneous
Quality of Material		Fair	Poor	Good	Poor
Thickness of Material		4 to 13 feet	1.5 to 15 feet	2.5 to 9 feet	5 to 16 feet
Thickness of Cap (Caliche)		-	-	-	-
Blasting Qualities		-	-	-	-
Uniformity		Fair	Fair	Good	Fair
Impurities		Silt and sand	Silt and clay balls	None	Silt and clay
Type of Mat'l. Underlying Formation		Silt, shale, & sandstone	Sandstone	Sandstone	Shale
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		-	Scattered cedars	Grass and cedars	Scattered cedars
Local Terrain		River terrace	Gravel hills	Flat to rolling	Gravel hills
Depth of Overburden		0 to 4 feet	0 to 1.5 feet	0 to 2.5 feet	0 to 5 feet
P.I. (Overburden)		N.P. to 9	N.P. to 12	N,P, to 11	N,P. to 15
Est. Reserve Quantity		1,850 cu. yds.	30,000 cu. yds.	80,000 cu, yds,	15,000 cu, yds,
Approx. Haul to Nearest Point		?	2,000 feet to Sta. 824+00	1,600 feet north of U.S. 66	8,7 miles to Sta. 387+00
L.A. Wear		28	35.2	Caliche cap - 31,2, Soft caliche - 74,8	34,4
Maximum Size		1.5"	6"	-	7"
% Retained on 2" Sieve		-	-	-	-
Pit Average % Passing	Crushed to 2"	3/4"	2"	2"	1"
	1"	-	100	100	-
	3/4"	100	96	66	100
	1/2"	79	90	56	94
	#4	46	86	45	81
	#10	35	76	24	55
	#200	4	69	14	41
P.I.		N,P,	6	2	7
Lab. Numbers		55-869 - 878	N.P.	N.P.	9
			56-6911 - 6934, 56-14192 - 14212	56-14826 - 14863	57-1244 - 1283

Remarks:

55-4-S - Possible extension to north and northwest. A heavy overburden of sand dunes blankets the northern portion and thins to the northwest.

56-47-S - Northern tip can be extended to northeast and lower isolated portion can be extended east. Interbedded silt layers and feldspars of igneous rocks were in stages of alteration to clay as seen in vertical face of excavated area.

56-90-S - From Station 11+00 pit can be extended west approximately 150 feet west of Station 12+80. No possible extension to east as caliche thins very rapidly.

57-6-S - Can be extended to south. Interbedded layers of silt were noted on a face in the excavated area.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SANTA ROSA WEST - SANTA ROSA EAST

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-16-2 continued

Pit or Prospect No.		57-54-S	57-84-S	40-16-1 (Prospect)	40-16-2 (Prospect)	40-16-3 (Prospect)
Location	Section	SW 1/4 Sec. 4	NW 1/4 Sec. 3	SW 1/4 Sec, 24	West central of Sec, 30	NE 1/4 Sec. 29
	Twnshp. & Range	T 8 N, R 21 E	T 8 N, R 21 E	T 8 N, R 21 E	T 9 N, R 21 E	T 10 N, R 22 E
	County	Guadalupe	Guadalupe	Guadalupe	Guadalupe	Guadalupe
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Private land	Private land	Private land	Private land	Private land
Geologic Age		Quaternary	Tertiary & Quaternary	Quaternary	Tertiary & Quaternary	Tertiary (?)
Formation		Terrace	Terrace	Wind-blown sand	Alluvium & caliche	Dike
Type of Pit		Sand and gravel	Gravel	Sand	Quarry	Quarry
Kind of Material		Quartzite and igneous	Metamorphic & igneous	Sand	Caliche	Basalt
Quality of Material		Poor	Good	Good	Good	Good
Thickness of Material		16+ feet	4 to 16 feet	35 feet estimated	6+ feet	?
Thickness of Cap (Caliche)		-	0 to 3 feet	-	3+ feet	-
Blasting Qualities		-	-	-	-	Good
Uniformity		Fair	Good	Good	Good	Good
Impurities		Clay and silt	None	None	None	None
Type of Mat'l. Underlying Formation		?	Sandstone	Sand and gravel	Gravel and sandstone	-
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Vegetation		Scattered cedars	Cedar	-	-	-
Local Terrain		Hilly	Hilly	Small rolling hills	Flat	Rolling to hilly
Depth of Overburden		0 to 6 feet	0 to 4 feet	-	0 to 1.5 feet	0
P.I. (Overburden)		12	4 to 7	-	-	-
Est. Reserve Quantity		120,000 cu. yds.	See remarks	See remarks	See remarks	See remarks
Approx. Haul to Nearest Point		2.000 feet	5000 feet	4 miles to U.S. 54	1.6 miles to U.S. 66	10 miles
L.A. Wear		36.0	35.6	-	-	12
Maximum Size		2"	8"	-	-	-
% Retained on 2" Sieve		less than 1	-	-	-	-
	Crushed to	-	2"	2"	-	1"
	2"	100	100	-	-	-
Pit	1"	89	60	-	-	100
Average	3/4"	84	46	-	-	81
% Passing	1/2"	78	36	-	-	45
	#4	63	22	-	-	13
	#10	53	16	100	-	6
	#200	7	3	10	-	2
P.I.		N.P.	N.P.	N.P.	-	N.P.
Lab. Numbers		57-9001 - 9028	57-11910 - 11920	60-12024	-	60-12918

Remarks:

57-54-S - Pit contains numerous clay balls. Has not been used to date (4-7-61).

57-84-S - Newly explored area of this pit has not been worked to date (4-1-61); however, centerline of new urban job will cross this area. Can be extended north to next lower bench with further investigation.

40-16-1 (Prospect) - This material is a sand dune with approximately 30,000 cu. yds. It is shown to demonstrate the type material that may be developed in the local dunes of the area.

40-16-2 (Prospect) - Located north of U.S. 66 in the vicinity of an abandoned airport; 0.3 miles west and 0.2 miles south of the hanger. However, any site in this area is a prospective site. Further exploration needed to determine conditions.

40-16-3 (Prospect) - This dike extends about 200 feet above the surrounding terrain and runs for approximately 500 feet. There is no information on the width of this dike because it is covered with talus.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SANTA ROSA WEST - SANTA ROSA EAST

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-16-2 continued

Pit or Prospect No.		40-16-4 (Prospect)	40-16-5 (Prospect)	40-16-6 (Prospect)	40-16-7 (Prospect)	40-16-8 (Prospect)
Location	Section	East central Sec. 33	SE 1/4 Sec. 2	Central portion Sec. 20	South central Sec. 36, North central Sec. 1	E 1/2 Sec. 4
	Twnshp. & Range	T 9 N, R 22 E	T 7 N, R 22 E	T 9 N, R 21 E	T 10 N, R 21 E T 9 N, R 21 E	T 8 N, R 22 E
	County	Guadalupe	Guadalupe	Guadalupe	Guadalupe	Guadalupe
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Private land	State land	Private land	Private land	Private
Geologic Age		Tertiary	Quaternary	Tertiary & Quaternary	Triassic	Tertiary
Formation		Ogallala	Terrace	Terrace	Santa Rosa sandstone	Ogallala
Type of Pit		Gravel	Gravel	Gravel	Quarry	Gravel
Kind of Material		Sand & gravel	Sand & gravel	Sand & gravel	Rock asphalt	Sand & gravel
Quality of Material		-	Good	-	Good	Fair
Thickness of Material		20 feet	6 to 10 feet	-	50+ feet	12 feet
Thickness of Cap (Caliche)		-	-	-	-	-
Blasting Qualities		-	-	-	Good	-
Uniformity		See remarks	-	-	Good	Fair
Impurities		" "	-	-	None	Clayballs (minor)
Type of Mat'l. Underlying Formation		Siltstone	Shale & conglomerate	Sandstone	Sandstone	Siltstone and sand
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Vegetation		Cedars	-	Grass	Cedars	Grass and scattered cedars
Local Terrain		Flat to rolling	Hilly	Hilly	Rolling to hilly	Hilly
Depth of Overburden		0 to 1 foot	-	-	-	0 to 5 feet
P.I. (Overburden)		Plastic	-	-	-	12
Est. Reserve Quantity		See remarks	-	-	500,000+ cu. yds.	-
Approx. Haul to Nearest Point		1.5 miles	5.5 miles	2.8 miles	6.2 miles	2 miles
L.A. Wear		-	-	-	34.8	30.8
Maximum Size		5"	-	-	-	3"
% Retained on 2" Sieve		-	-	-	1"	1"
Pit Average % Passing	Crushed to	-	-	-	-	-
	2"	-	-	-	100	100
	1"	-	-	-	73	84
	3/4"	-	-	-	38	68
	1/2"	-	-	-	19	43
	#4	-	-	-	13	29
	#10	-	-	-	2	4
	#200	-	-	-	N.P.	N.P.
P.I.		-	-	-	61-1135	61-1342 - 1345
Lab. Numbers		-	-	-		

Remarks:

40-16-4 (Prospect) - Located in the northwest corner of the mesa east of Santa Rosa. This gravel forms a very resistant ridge and looks to be very uniform; however, gravel 0.5 miles south is interbedded with silt. Further exploration needed to determine quality, quantity, etc. Material will be similar to 40-16-8 (Prospect).

40-16-5 (Prospect) - Consists of a series of gravel ridges. Some show evidence of not being too thick. In road cut to south gravel is irregularly bedded with silt. Only further investigation can determine the quality and quantity of material.

40-16-6 (Prospect) - East of the airport gravel crops out on side hill slopes. Further investigation needed to determine exact conditions.

40-16-8 (Prospect) - Maintenance is presently operating a pit in this area. There are numerous weathered hills scattered along the escarpment of the mesa. Further exploration needed to determine quality, quantity, etc.

CONSTRUCTION MATERIALS INVENTORY

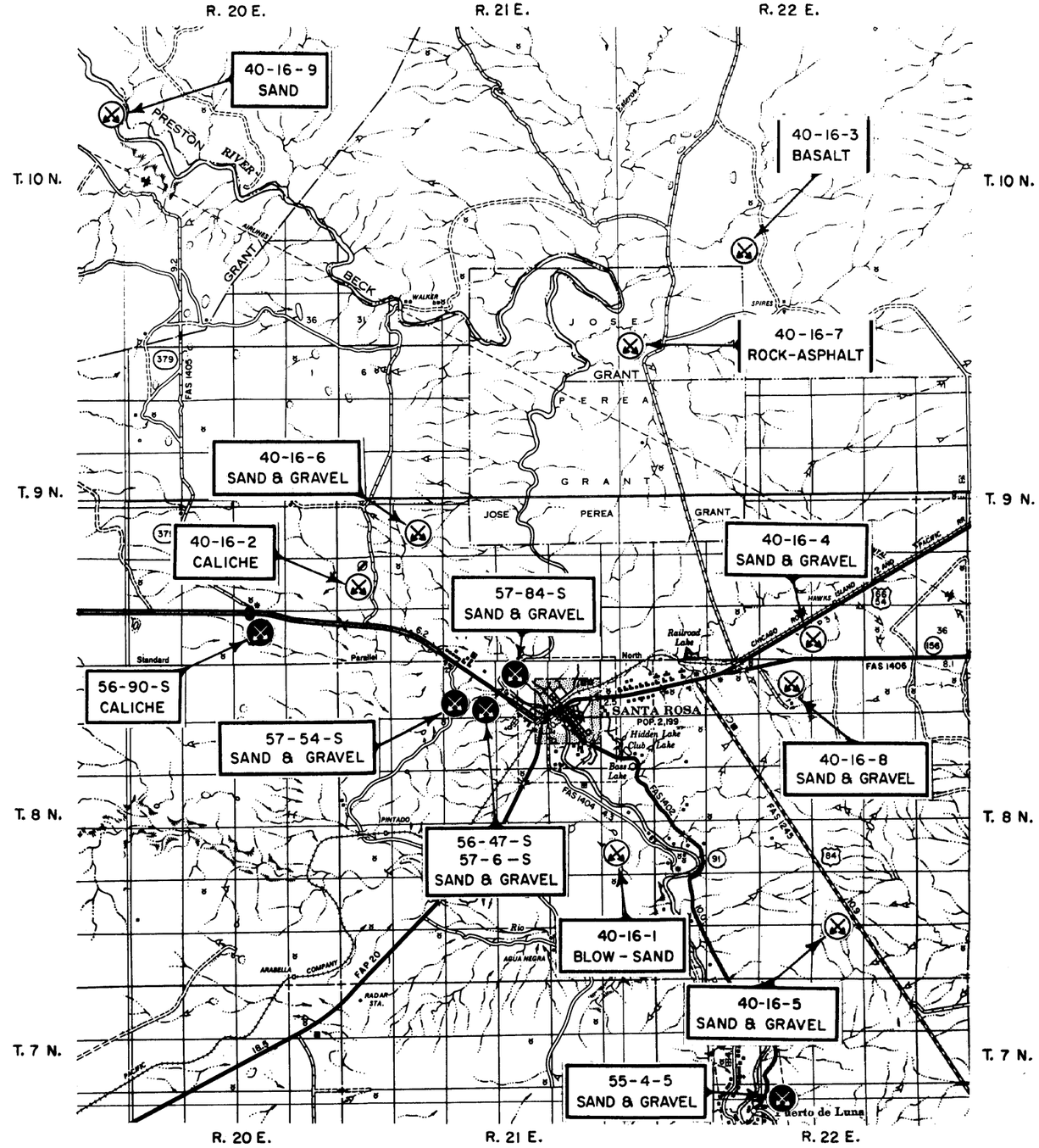
Material Pit Summary:

Table No. 40-16-2 continued

Pit or Prospect No.		40-16-9 (Prospect)
Location	Section	See remarks
	Twnshp. & Range	" "
	County	Guadalupe
	State	New Mexico
Owner		?
Geologic Age		Quaternary
Formation		River channel deposit
Type of Pit		Channel sands and gravel
Kind of Material		Coarse sand
Quality of Material		Good
Thickness of Material		10+ feet
Thickness of Cap (Caliche)		-
Blasting Qualities		-
Uniformity		Good
Impurities		None
Type of Mat'l. Underlying Formation		?
Moisture Condition		Damp
Vegetation		None
Local Terrain		River channel
Depth of Overburden		None
P.I. (Overburden)		None
Est. Reserve Quantity		500,000+ cu. yds.
Approx. Haul to Nearest Point		See remarks
L.A. Wear		-
Maximum Size		1/2"
% Retained on 2" Sieve		-
	Crushed to	-
	2"	-
Pit	1"	-
Average	3/4"	100
% Passing	1/2"	99 #40 = 35
	#4	98 #80 = 7
	#10	93
	#200	3
P.I.		N.P.
Lab. Numbers		61-1334 - 1335

Remarks:

40-16-9 (Prospect) - This prospect is located 0.5 miles east of Colonias, New Mexico, in Pecos River channel. It is composed of clean, coarse river sand. Water table may be encountered, however, the river was dry at this time of sampling (2-8-61).



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SANTA ROSA EAST - NEWKIRK

SOILS AND GEOLOGY

Introduction:

Section 40-17 of Interstate Route 40 lies within the Great Plains province and extends from a point 3 miles east of Santa Rosa eastward to Newkirk, New Mexico. Mesas and buttes with intervening valleys characterize the topography. Hidden beneath these surface features lies the Tucumcari basin.

General Geology:

The mesas and buttes that rise above the alluvium covered valley floors form physiographic outliers of the Llano Estacado. The Llano Estacado or Staked Plains is the southernmost extension of the Great Plains province. The Llano is essentially a plateau which is located in the eastern portion of New Mexico and extends eastward into Texas. It is bounded on the north by the Canadian River escarpment and on the west by the Pecos River.

The mesas and buttes have been carved out by tributaries of the Canadian and Pecos Rivers. This "carving out" took place quite rapidly during glacial stages of the Pleistocene. These glacial stages alternated with relatively dry conditions and relatively little erosion during interglacial stages (Evans, 1956).

The irregular surfaces of the intervening broad valleys are covered by alluvium and were carved out of the shale, siltstone, and sandstone of the Chinle formation.

Cuervo and Pajarito Creeks are the main drainage system of this section. These two tributaries of the Canadian River are intermittent and remain dry through most of the year.

The Tucumcari basin is a structural and sedimentary basin located principally in Quay, Guadalupe, and San Miguel Counties.

The areal distribution of formations is shown on Soils and Geology Map 40-17. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils of this area are young alluvium (Qal), older alluvium and caliche (Qalc), landslide debris (Qls), and residual.

Alluvial soils occur on the valley floors, in intermittent stream channels, and on the lowlands of this section. These soils are young in age and have developed no definite profile. They are composed of clay soils (A-6 and A-7) and are up to 15 feet deep. Shales and clays of the Chinle formation are the parent materials of these soils.

The soils of the older alluvium and caliche are mature in age and have a well developed pedological profile. The "A" horizon is predominantly a reddish-brown clay and averages 2.5 feet thick. The "B" horizon is a grayish, calcareous clay soil (A-6) averaging 6 feet thick. A slightly consolidated nodular caliche has formed in local areas of the "B" horizon. Even though "A" and "B" horizons have the same engineering soils classification their chemical differences usually cause slight differences in plasticity. The "C" horizon consists of decomposed siltstones and shales of the Chinle formation and the horizon varies in thickness.

No attempt has been made to classify the soils of the landslide debris because they have a complex variety of boulders, clay, shale, etc. The landslide debris occurs on the slopes of the mesa just south of Cuervo.

The terrace deposit adjacent to Pajarito Creek has a poorly developed engineering profile of silty soil (A-4) and clay soil (A-6) overlying a heterogeneous mixture of sand, silt, clay, and gravel. This deposit is derived partly from Chinle shales, clays, and conglomeratic sandstones.

The following observations were made of residual soils and their parent formations:

Tertiary: Ogallala (To) - predominantly clay soils (A-6 and A-7) with minor silty soil (A-4) accumulations. The silty soil accumulations are caused by wind and water removing the clay size particles.
Thickness: 0 - 5 feet.

Triassic: Chinle formation (Trc) - predominantly clay soil (A-6) with local accumulations of silty soil (A-4). Other soils occur in small local areas on this formation and are not residual in nature. They are wind-blown sediments of silty sandy soil (A-2-4).
Thickness: 0 - 6 feet.

The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-17. Table No. 40-17-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary:

Alluvium (Qal) - consists of silt and clay with minor amounts of sand. Formed along streams, in valleys, and on lowlands.

Terrace deposits (Qt) - irregularly bedded gravel with silty clay lenses. This gravel is composed of large quantities of sandstone pebbles with smaller amounts of igneous and metamorphic gravel.

Older alluvium and caliche (Qalc) - uncemented surface silt and clay overlying calcareous silt, sand, and clay.

Landslide debris (Qls) - composed of a heterogeneous mixture of siltstone boulders and unconsolidated sand, silt, and clay.

Unconformity----------Period of Erosion----------

Tertiary: Ogallala formation (To) - consists of sand, silt, clay, and gravel overlain by a dense to soft, nodular layer of caliche. In some locales caliche has been eroded away leaving caliche pebbles as remnants. Color ranges from tan to pink.
Thickness: 30 - 75 feet.

Unconformity----------Period of Erosion----------

Triassic: Dockum group

Chinle formation (Trc) - consists of chocolate-brown to red siltstone, shale, and sandstone.
Thickness: 850 feet.

Construction Materials:

Quaternary: Terrace deposits (Qt) - sand and gravel containing a high percentage of sandstone pebbles with lesser amounts of igneous and metamorphic gravels. It is usually fine-graded and is not considered coarse enough to be used as an aggregate for surfacing without special treatment; however, it may be used as a select material for improving the grading of crushed rock.

Tertiary: Ogallala formation (To) - the dense, hard caliche formed on top of this formation is the primary aggregate resource for this section. It usually has a variable 3 to 6 foot cap of well consolidated caliche overlying a nodular caliche with a matrix of soft, silty to sandy caliche soil. In some cases this formation contains channel gravels; however, no usable quantities of them have been discovered in this area. The better caliche is extensively distributed on the mesa directly south of Cuervo and it extends easterly from this point. Better access roads should be built to the mesa because the existing roads do not present the shortest haul distances to Interstate Route 40.

Distribution of tested and prospective pit sites for construction materials is shown on Construction Materials Map 40-17. Test data and other related information are shown in Material Pit Summary Table No. 40-17-2.

SOILS AND GEOLOGY

Soils Summary:

Table No. 40-17-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	3	A	0.0	4.0	A-6	Clay soil
"	"		B	4.0	---	A-6	" "
"	"	4	A	0.0	2.5	A-6	" "
"	"		B	2.5	4.5	A-6	" "
"	"		C	4.5	---	A-6	" "
"	"	7	A	0.0	4.5	A-6	" "
"	"		B	4.5	---	A-6	" "
"	"	9	A	0.0	4.5	A-6	" "
"	"		B	4.5	---	A-6	" "
"	"	12	A	0.0	4.0	A-7	" "
"	"		B	4.0	---	A-7	" "
"	"	16	A	0.0	4.5	A-6	" "
"	"		B	4.5	---	A-6	" "
"	"	20	A	0.0	4.0	A-6	" "
"	"		B	4.0	---	A-6	" "
"	"	21	A	0.0	10.0	A-6	" "
"	"		B	10.0	---	A-6	" "
"	Terrace	17	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	4.0	A-6	Clay soil
"	"		C	4.0	---	Unclassified	Caliche
The following residual soil samples represent soils derived from parent formations:							
Tertiary	Ogallala	2	A	0.0	4.0	A-6	Clay soil
"	"		B	4.0	---	A-6	" "
"	"	5	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	4.5	A-4	" "
"	"		C	4.5	---	A-4	" "
"	"	6	A	0.0	2.5	A-4	" "
"	"		B	2.5	4.5	A-6	Clay soil
"	"		C	4.5	---	A-6	" "
"	"	8	A	0.0	4.5	A-4	Silty soil
"	"		B	4.5	---	A-4	" "
"	"	10	A	0.0	2.0	A-7	Clay soil
"	"		B	2.0	---	Unclassified	Caliche
"	"	11	A	0.0	2.0	A-6	Clay soil
"	"		B	2.0	---	Unclassified	Caliche
Triassic	Chinle	1	A	0.0	1.0	A-6	Clay soil
"	"		B	1.0	3.0	A-6	" "
"	"		C	3.0	---	A-6	" "
"	"	13	A	0.0	2.5	A-6	" "
"	"		B	2.5	4.0	A-6	" "
"	"		C	4.0	---	A-6	" "
"	"	14	A	0.0	4.0	A-6	" "
"	"		B	4.0	---	Unclassified	Siltstone
"	"	15	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	---	Unclassified	Siltstone
"	"	18	A	0.0	2.0	A-2-4	Silty sand
"	"		B	2.0	3.0	A-2-4	" "
"	"		C	3.0	---	Unclassified	Siltstone
"	"	19	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	---	Unclassified	Sandstone
"	"	22	A	0.0	2.0	A-2-4	Silty sand
"	"		B	2.0	3.5	A-2-4	" "
"	"		C	3.5	---	Unclassified	Sandstone

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AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-17

INTERSTATE ROUTE 40
SANTA ROSA EAST TO NEWKIRK

GEOLOGY MAPPED IN 1960

-LEGEND-

SEDIMENTARY ROCKS

Qal — Alluvium	QUATERNARY	Qls — Landslide debris	QUATERNARY
Qalc — Older Alluvium - Caliche	QUATERNARY	Qt — Terrace gravel	QUATERNARY
To — Ogallala formation	TERTIARY		
Trc — Chinle formation (Upper Dockum group)	TRIASSIC		

STATUTE MILES

GENERALIZED CROSS-SECTION

SECTION 40-17
Page 3

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-17-2

Pit or Prospect No.		57-51-S	40-17-1 (Prospect)	40-17-2 (Prospect)	40-17-3 (Prospect)
Location	Section	NE 1/4, Sec. 33 & NW 1/4, Sec. 34	See remarks	SE 1/4, Sec. 21 & SW 1/4, Sec. 22	Sec. 3
	Twnshp. & Range	T 10 N, R 25 E	" "	T 9 N, R 24 E	T 9 N, R 24 E
	County	Guadalupe	Guadalupe	Guadalupe	Guadalupe
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Private land	Private land	Private land	Private land
Geologic Age		Quaternary	Tertiary	Tertiary	Tertiary
Formation		Terrace	Ogallala	Ogallala	Ogallala
Type of Pit		Gravel	Quarry	Quarry	Quarry
Kind of Material		Sand & gravel	Caliche	Caliche	Caliche
Quality of Material		Fair	?	Good	Good
Thickness of Material		13 feet maximum	1.0 to 12.0 feet	10.0 to 15.0 feet	10 feet
Thickness of Cap (Caliche)		-	-	-	-
Blasting Qualities		-	?	-	Good
Uniformity		Poor	?	Good	Good
Impurities		Silt (minor)	?	None	None
Type of Mat'l. Underlying Formation		Siltstone & shale	Siltstone	Siltstone, shale & gravel	Gravel & siltstone
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		Junipers	Grass	Grass	Cedars
Local Terrain		Hilly	Mesa	Escarpment	Mesa
Depth of Overburden		5 feet	?	0.0 to 2.0 feet	1 foot
P.I. (Overburden)		N.P. to 8	More than 10	-	13
Est. Reserve Quantity		See remarks	See remarks	See remarks	Unlimited
Approx. Haul to Nearest Point		0.85 miles	5.8 miles north to Newkirk	3 miles to U.S. 66	0.75 miles
L.A. Wear		42.4	-	-	36.8
Maximum Size		4"	-	-	-
% Retained on 2" Sieve		Less than 1	-	-	-
	Crushed to	-	-	-	1"
	2"	100	-	-	-
Pit	1"	92	-	-	100
Average	3/4"	89	-	-	82
% Passing	1/2"	84	-	-	48
	#4	68	-	-	21
	#10	54	-	-	12
	#200	4	-	-	3
P.I.		N.P.	-	-	N.P.
Lab. Numbers		57-8068 - 8082	-		61-1346 - 1348

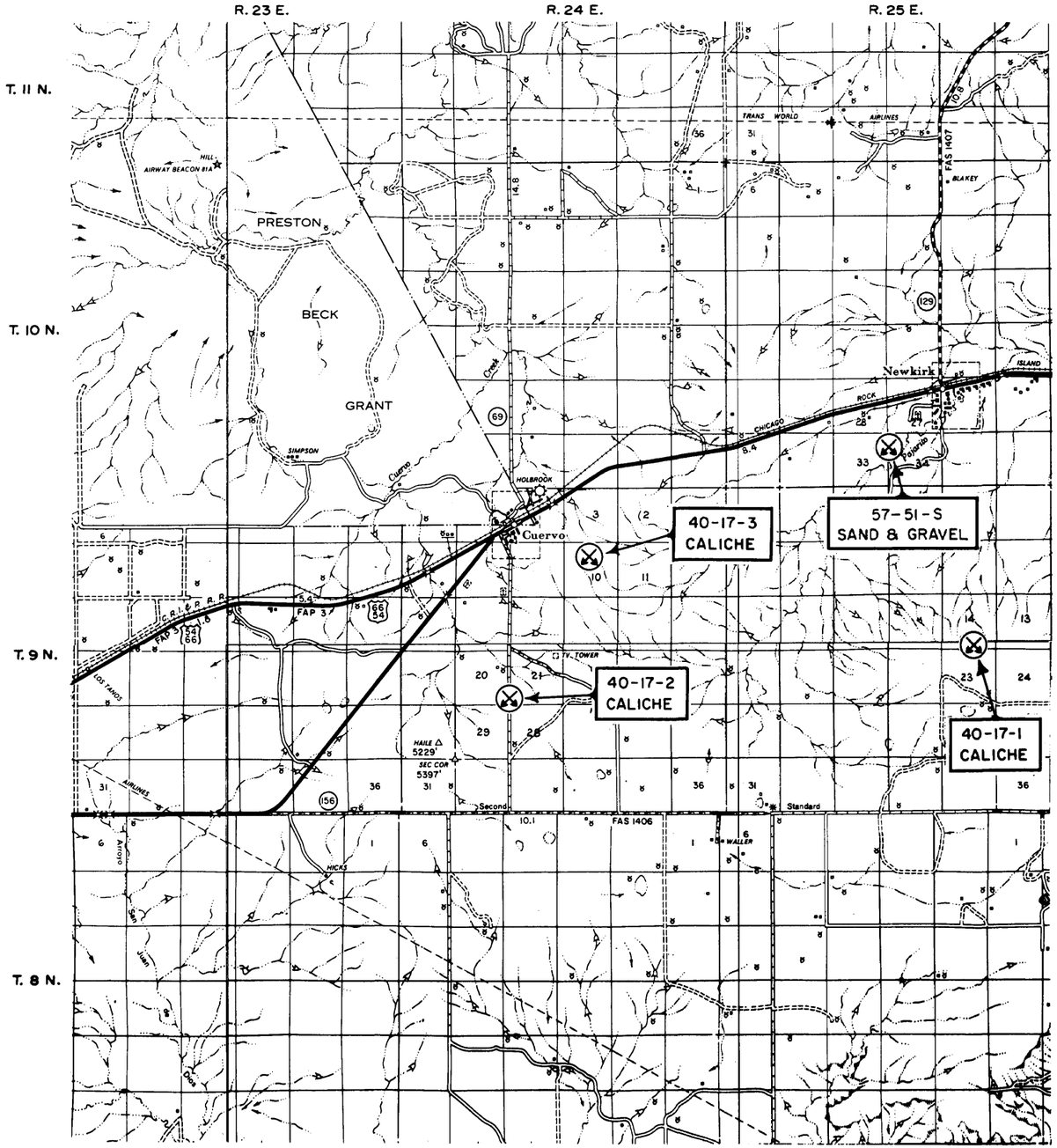
Remarks:

57-51-S - Has not been worked to date. With further investigation there is a possibility of extension to the north. Siltstone, sandstone, and shale where noted in piling from test holes.

40-17-1 (Prospect) - Located in central portion of the E 1/2, T 9 N, R 25 E. Further exploration needed to determine quality, quantity, etc.

40-17-2 (Prospect) - Crops out extensively along the rim of the escarpment south of Cuervo. The weathered face of this caliche indicates that it is much softer than the caliche that lies to the east; however, further investigation may develop a usable material in this area.

40-17-3 (Prospect) - A good quality of material is formed over most of the mesa. Samples were lifted from the weathered face of the escarpment for computing the data furnished here. Further sub-surface exploration is needed to determine the true condition of the area.



AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
NEWKIRK - PALOMAS

SOILS AND GEOLOGY

Introduction:

This section of Interstate Route 40 is characterized by mesa and valley topography and lies within the Great Plains province. The mesas consist of slightly eastward dipping beds of Triassic, Jurassic, and Cretaceous formations. The valley floor is underlain by the Triassic Chinle formation.

General Geology:

The formations in this section are part of the western slope of the Tucumcari basin, a structural feature.

North of Montoya, Mesa Rica stands above the surrounding terrain as an outlier of the Canadian escarpment. South of Montoya, Montoya Mesa is an outlier of the Llano Estacado or Staked Plains. The Llano Estacado is a caliche and sand capped plateau which is the southernmost extension of the Great Plains and it extends from eastern New Mexico eastward into Texas.

Mesa Rica and Montoya Mesa were originally one surface. Erosional action of the Canadian River tributaries, Laguna Arroyo and Pajarito Creek, has carved out these mesa areas. They are left as erosional remnants composed of sandstone, siltstone, and shale of Triassic, Jurassic, and Cretaceous formations capped by caliche and sand.

Thick alluvium covers the valleys along the major streams; these streams are presently cutting through the Chinle formation.

The areal distribution of formations is shown on Soils and Geology Map 40-18. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils of this section are alluvium, terrace deposits, landslide debris, and residual.

Laguna Arroyo and Pajarito Creek contain young alluvial deposits of clay (A-6) with minor amounts of silty sand and gravel (A-2-4). This soil is primarily derived from the shales and clays of the Chinle formation; however, minor amounts of debris are carried from the outcropping Jurassic and Cretaceous rocks exposed on the scarp slope of the mesas north and south of this area.

A weathered terrace deposit in the eastern part of this section contains silty sand and gravel that is also derived from Jurassic and Cretaceous rocks.

The landslide debris has not been classified because it has a complex variety of boulders, shale, clay, etc.

The following observations were made of residual soils and their respective formations:

Tertiary:	Ogallala (To) - clay soil (A-6) and silty soil (A-4, minor). Thickness: 0 - 4 feet.
Cretaceous:	Purgatoire formation (Kp) - silty soil (A-4). Thickness: 0 - 5 feet.
Jurassic:	Morrison formation (Jm) - silty soil (A-4) and clay soil (A-6, minor). Thickness: 0 - 5 feet.
Triassic-Jurassic:	Wingate sandstone (TrJw) - silty sand (A-2-4) and lesser amounts of silty soil (A-4). Thickness: 0 - 4 feet.
Triassic:	Chinle formation (Trc) - silty soil (A-4) and lesser amounts of clay soil (A-6).

The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-18. Table No. 40-18-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary:	Alluvium (Qal) - stream deposits of clay, silt, and silty sand and gravel. Thickness: 25 feet maximum.
	Terrace deposits (Qt) - a small, isolated, weathered remnant of silty sand and gravel. Thickness: 8 feet.
	Landslide debris (Qls) - slump blocks, boulders, and finer material originating from slumping and weathering of Tertiary, Cretaceous, and Jurassic rocks along the escarpment north of Montoya.
Tertiary:	Ogallala formation (To) - channel gravels, silts, clays, and wind-blown sands usually capped by a non-uniform layer of hard, nodular caliche.
Unconformity----------Period of Erosion----------	
Cretaceous:	Purgatoire formation (Kp) - light-colored, interbedded sandstone; and yellow-orange, hard sandstone containing hematite concretions; and fossiliferous, gray shale. Thickness: 210 feet.
Unconformity----------Period of Erosion----------	
Jurassic:	Morrison formation (Jm) - hard, mottled, yellow-brown sandstone; variegated, greenish-gray to reddish-gray shale; and interbedded, fine-grained, yellow sandstone and reddish-brown shale. Thickness: 345 feet.
Triassic-Jurassic:	Wingate sandstone (TrJw) - light-yellow to gray, friable, fine-grained sandstone. Thickness: 170 feet.
Unconformity----------Period of Erosion----------	
Triassic:	Chinle formation (Trc) - interbedded green, limy shale and reddish-brown shale; and light-reddish-buff sandstone. Thickness: 550+ feet.

Construction Materials:

Tertiary:	Ogallala formation (To) - a non-uniform 3 to 6 foot cap of hard caliche has formed on top of this formation. It is usually underlain by a softer, nodular caliche. Mesa Rica and Montoya Mesa are the nearest source of this caliche; however, it generally covers the Llano Estacado which lies to the south of this area. Good quality pits have been developed on both mesas and further exploration may develop areas of inexhaustible supply. Existing roads, which were built for removing this material, are the best access to these areas.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-18. Test data and other related information are shown in Material Pit Summary Table No. 40-18-2.

Soils Summary:

Table No. 40-18-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	3	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	10.0	A-6	Clay soil
"	"	10	A	0.0	5.0	A-4	Silty soil
"	"		B	5.0	20.0	A-6	Clay soil
"	"	11	A	0.0	10.0	A-4	Silty soil
"	"		B	10.0	13.0	A-1-b	Sandy gravel
"	"	12	A	0.0	12.0	A-6	Clay soil
"	"		B	12.0	17.0	A-2-4	Silty sand
The following samples represent residual soils derived from parent formations:							
Tertiary	Ogallala	13	A	0.0	3.4	A-6	Clay soil
Jurassic	Morrison	1	A	0.0	4.0	A-6	" "
Triassic-	Wingate	2	A	0.0	2.5	A-2-4	Silty sand
Jurassic	"		B	2.5	---	Unclassified	Sandstone
Triassic	Chinle	4	A	0.0	4.5	A-4	Silty soil
"	"	5	A	0.0	3.5	A-4	" "
"	"		B	3.5	4.0	A-2-4	Silty sand
"	"		C	4.0	---	Unclassified	Sandstone
"	"	6	A	0.0	1.0	A-4	Silty soil
"	"		B	1.0	4.5	A-6	Clay soil
"	"	7	A	0.0	4.0	A-4	Silty soil
"	"	8	A	0.0	1.0	A-4	" "
"	"		B	1.0	---	Unclassified	Sandstone
"	"	9	A	0.0	1.5	A-2-4	Silty sand
"	"		B	1.5	---	Unclassified	Sandstone

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SOILS AND GEOLOGY MAP 40-18

GEOLOGY MAPPED IN 1960

-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qt — Terrace gravel
- Qls — Landslide debris

TERTIARY
- To — Ogallala formation

CRETACEOUS
- Kp — Purgatoire formation

JURASSIC
- Jm — Morrison formation
- TrJw — Wingate formation

TRIASSIC
- Trc — Chinle formation

GENERALIZED CROSS-SECTION

STATUTE MILES

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

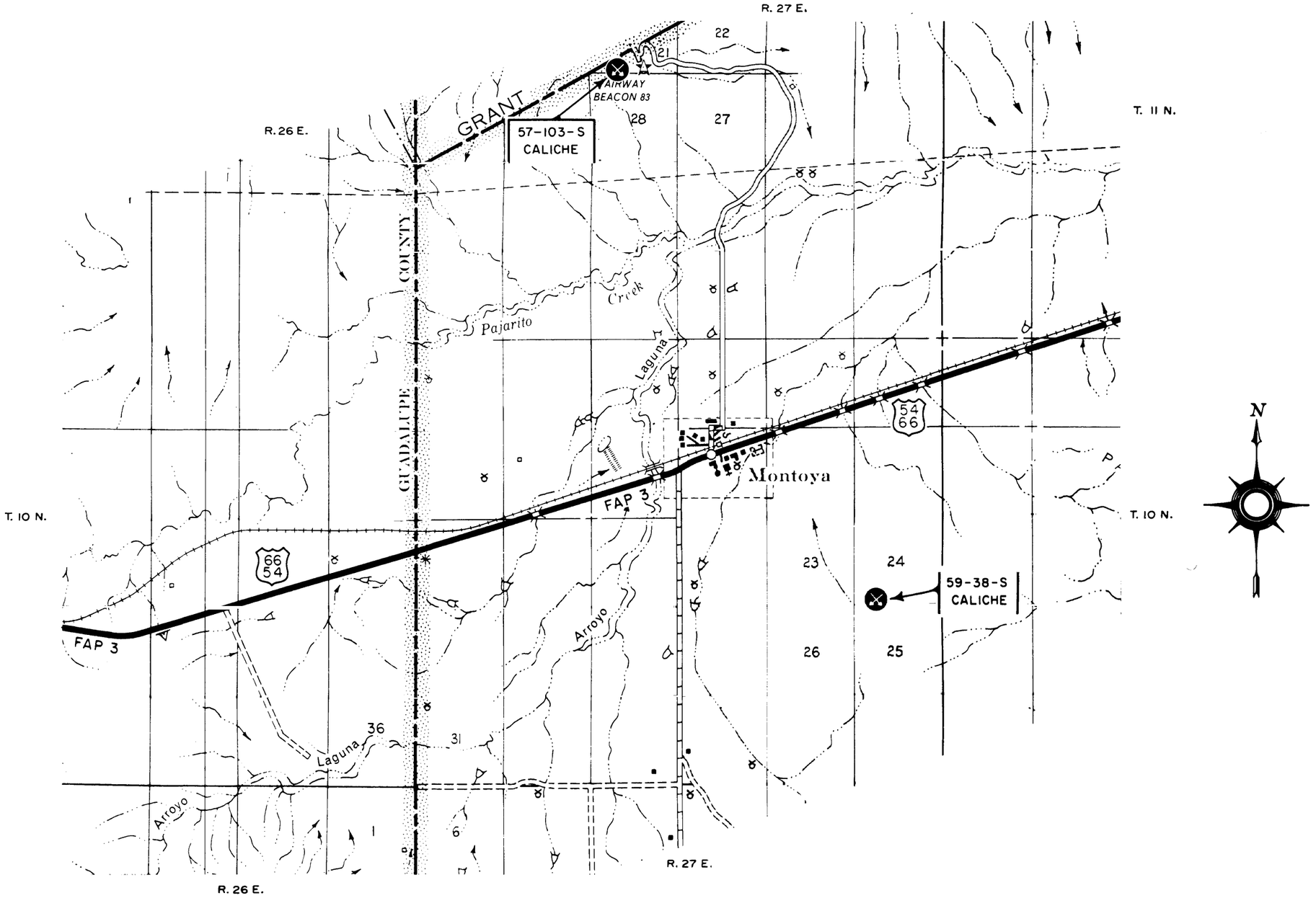
Table No. 40-18-2

Pit or Prospect No.		57-103-S	59-38-S
Location	Section	SW 1/4, Sec, 21	SE 1/4, Sec, 24
	Twnshp, & Range	T 11 N, R 27 E	T 10 N, R 27 E
	County	Quay	Quay
	State	New Mexico	New Mexico
Owner		State	Private land
Geologic Age		Tertiary	Tertiary
Formation		Ogallala	Ogallala
Type of Pit		Quarry	Quarry
Kind of Material		Caliche	Caliche
Quality of Material		Good	Good
Thickness of Material		12 feet	9.0 feet
Thickness of Cap (Caliche)		4 feet	2.5 feet
Blasting Qualities		Good	Good
Uniformity		Good	Good
Impurities		None	Silt
Type of Mat'l. Underlying Formation		Sandstone	Sandstone
Moisture Condition		Dry	Dry
Vegetation		Juniper, cedar, & grass	Cedar & grass
Local Terrain		Flat topped mesa	Flat topped mesa
Depth of Overburden		2.0 feet	0 to 3 feet
P.I. (Overburden)		9	9
Est. Reserve Quantity		180,000 cu. yds.	200,000 cu. yds.
Approx. Haul to Nearest Point		7.0 miles	4.0 miles
L.A. Wear		Hard caliche 26, soft caliche 55.6	Caliche cap 26.8, soft caliche 48.0
Maximum Size		-	-
% Retained on 2" Sieve		-	-
Pit Average % Passing	Crushed to 2"	1"	1"
	1"	100	100
	3/4"	95	82
	1/2"	70	54
	#4	30	28
	#10	18	17
	#200	1	4
P.I.		N.P.	N.P.
Lab. Numbers		57-14705 - 63	59-5223 - 51

Remarks:

57-103-S - Pit can be extended along mesa edges to northwest and southwest.

59-38-S - No excavation to date. Pit can be extended to the southwest and southeast. Development will determine blasting qualities.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
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CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
PALOMAS - TUCUMCARI AIRPORT

SOILS AND GEOLOGY

Introduction:

This section begins near Palomas and extends 6 miles east of Tucumcari. It lies in the Great Plains province and is bounded on the north by the Canadian escarpment and on the south by the Llano Estacado. Mesozoic formations crop out throughout the area and are especially well exposed on the north side of Tucumcari Mountain.

General Geology:

This section lies in the Tucumcari structural basin. It is a large basin with its center in the northwest part of this section.

Pajarito Creek and its tributaries have greatly dissected the Mesozoic formations which crop out in this section. The formations are well exposed along these water courses.

A probable fault parallels and occurs on the east side of State Road 18. Just east of this fault is Tucumcari Mountain which has been elevated above the surrounding terrain by the faulting. Mesozoic formations are also well exposed on Tucumcari Mountain.

Eastward from Tucumcari, the Chinle formation forms a gently rolling surface.

The areal distribution of formations is shown on Soils and Geology Map 40-19. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils of this area are represented as terrace deposits (Qt), alluvium (Qal), landslide debris (Qls), residual, and a complex variety of alluvium and residual soil overlying the Chinle formation mapped as Triassic Chinle (Trc) because of its local variations and complicated areal pattern.

Terrace deposits adjacent to Pajarito Creek are composed of poorly sorted granular soils of fairly recent stream deposition. They are immature in age and have a poorly developed engineering profile of silty-sandy soil overlying a heterogeneous mixture of sand, silt, and gravel.

Alluvial soils occur on the floors of Pajarito Creek and its tributaries. These soils are immature and have developed no definite profiles. They are composed of silty sand and gravel derived from rocks ranging in age from Quaternary to Triassic and they are subject to local alterations during each rain storm.

The complex residual and alluvial soil cover of the Chinle formation has developed profiles in local areas. "A" horizon usually has silty soil (A-4) derived primarily from the Chinle formation with the clay size particles somewhat diminished by sheetwash and wind erosion. "B" horizon also has silty soil (A-4) discolored locally by calcium carbonate or caliche soil. "C" horizon varies from the decomposed siltstones, sandstones, and shales of the Chinle formation to thin intermittent stream deposits that are also of Chinle origin. "A" horizon has also been affected by local wind-blown sediments of silty-sandy soil (A-2-4). "A" and "B" horizons do not usually have a different soil classification; however, there is usually a minor difference in their plasticity.

No attempt has been made to determine the soil classification of the landslide debris because of its many local variations and complex nature.

The following observations were made of residual soils and their respective formations:

Tertiary: Ogallala formation (To) - silty soil (A-4) and clay soil (A-6).
Thickness: 0 - 2 feet.

Cretaceous: Purgatoire formation (Kp) - silty soil (A-4).
Thickness: 0 - 4 feet.

Jurassic: Morrison formation (Jm) - silty soil (A-4).
Thickness: 0 - 5 feet.

Jurassic-Triassic: Wingate formation (TrJw) - silty-sandy soil (A-2-4) and silty soil (A-4).
Thickness: 0 - 3 feet.

Triassic: Chinle formation (Trc) - see previously mentioned description of residual and alluvial soil complex covering this formation.

The areal distribution of soils and their related formations is shown on Soils and Geology Map 40-19. Table No. 40-19-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary: Alluvium (Qal) - clay, silt, and fine sand and gravel.
Thickness: 5 - 20 feet.

Terrace deposits (Qt) - silt, clay, and fine sand and gravel.

Landslide debris (Qls) - various mixture of talus blocks, clay, sand, shale, and other debris surrounding Tucumcari Mountain.

Unconformity----------Period of Erosion----------

Tertiary: Ogallala formation (To) - channel gravels, silts, and clays usually capped by a non-uniform layer of hard, nodular to soft caliche.
Thickness: 15 feet.

Unconformity----------Period of Erosion----------

Cretaceous: Purgatoire formation (Kp) - light-colored, interbedded, sandstone and shale; yellow-orange, hard sandstone containing hematite concretions, and fossiliferous shale.
Thickness: 210 feet.

Unconformity----------Period of Erosion----------

Jurassic: Morrison formation (Jm) - hard, mottled, yellow-brown, siliceous sandstone; variegated, greenish-gray to reddish-gray shale; and interbedded, fine-grained, yellow sandstone and reddish-brown shale.
Thickness: 345 feet.

Triassic-Jurassic: Wingate sandstone (TrJw) - friable, light-buff colored, fine-grained, massive sandstone.
Thickness: 170 feet.

Unconformity---------- Period of Erosion----------

Triassic: Chinle formation (Trc) - reddish-brown shale with green shale interbeds, and light-reddish-buff sandstone.
Thickness: 550 feet.

Construction Materials:

Quaternary: Alluvium (Qal)-local areas in Pajarito Creek will produce a fine-graded sand and gravel that may be used for filler.

Terrace deposits (Qt) - poor quality, poorly sorted, fine-graded, silt, sand, and gravel adjacent to Pajarito Creek. Surfacing pits for sealing, maintenance, and construction have been developed in these deposits.

Terrace gravels (Qtg) - Canadian River deposits are the best source of construction materials for this section. They are composed of an excellent grade of igneous and quartzite river gravels. Extensive deposits parallel both sides of this meandering stream. South of the river they are generally confined to terrace surfaces within one-half mile of the main channel. The main channel has recently cut a deep gorge into the Triassic rocks of the region and it is

SOILS AND GEOLOGY

Construction Materials continued

presently floored by fine- to coarse-graded sand. Numerous impurities consisting of clay balls and silt particles occur in the terrace deposits from the vicinity of Conchas Dam to the San Miguel-Quay County line. Clay and silt percentages seem to diminish east of the county line. Excellent materials pits may be located at various intervals in these deposits from the county line to the New Mexico-Texas border.

Tertiary: Ogallala formation (To) - an extensive formation of caliche capping Mesa Redondo, approximately 18 miles south of Tucumcari, is an excellent prospective source of material. It crops out at the top of the scarp slope and exposes 3 to 6 feet of hard caliche cap overlying a non-uniform soft nodular caliche.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-19. Test data and other related information are shown in Material Pit Summary Table No. 40-19-2.

Soils Summary:

Table No. 40-19-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	Classification	Material Type
Quaternary	Alluvium	10	A	0.0	15.0	A-4	Silty soil
"	"	13	A	0.0	5.0	A-4	Silty soil
"	"		B	5.0	10.0	A-6	Clay soil
"	"	14	A	0.0	6.0	A-4	Silty soil
"	"		B	6.0	8.0	A-2-4	Silty sand
"	"		C	8.0	11.0	A-6	Clay soil
"	"		D	11.0	----	Unclassified	Gravel
The following samples represent residual soils derived from parent formations.							
Cretaceous	Purgatoire	8	A	0.0	4.5	A-4	Silty soil
"	"	11	A	0.0	4.5	A-4	" "
"	"		B	4.5	---	Unclassified	Sandstone
Jurassic	Morrison	7	A	0.0	5.0	A-4	Silty soil
"	"		B	5.0	---	Unclassified	Sandstone
"	"	9	A	0.0	2.0	A-4	Silty soil
"	"		B	2.0	---	Unclassified	Sandstone
"	"	12	A	0.0	3.5	A-4	Silty soil
Jurassic-Triassic	Wingate	4	A	0.0	3.5	A-4	" "
"	"	6	A	0.0	3.0	A-4	" "
"	"		B	3.0	---	Unclassified	Sandstone
Triassic	Chinle	1	A	0.0	5.0	A-4	Silty soil
"	"	2	A	0.0	1.0	A-2-4	Silty sand
"	"		B	1.0	5.0	A-4	Silty soil
"	"	3	A	0.0	5.0	A-4	" "
"	"	5	A	0.0	5.0	A-4	" "
"	"	15	A	0.0	5.0	A-4	" "
The following section shows the material that may be encountered when cuts are made in the respective formations:							
Tertiary	Older alluvium	16	A	0.0	2.0	Unclassified	Silt, sand, & gravel
"	Ogallala		B	2.0	21.0	"	Caliche
Cretaceous	Purgatoire		C	21.0	36.0	Unclassified	Sandstone
"	"		D	36.0	101.0	"	Sandy shale
"	"		E	101.0	189.0	"	Sandstone
"	"		F	189.0	231.0	A-6	Shale
Jurassic	Morrison		G	231.0	311.0	Unclassified	Sandstone
"	"		H	311.0	471.0	A-4	Shale

Table No. 40-19-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	Classification	Material Type
Jurassic	Morrison		I	471.0	506.0	Unclassified	Silty sandstone
"	"		J	506.0	576.0	"	Shale
Triassic-Jurassic	Wingate		K	576.0	746.0	"	Friable sandstone
"	"		L	746.0	856.0	A-4	Red-brown shale
"	"		M	856.0	1045.0	A-4	Red shale with green interbeds.

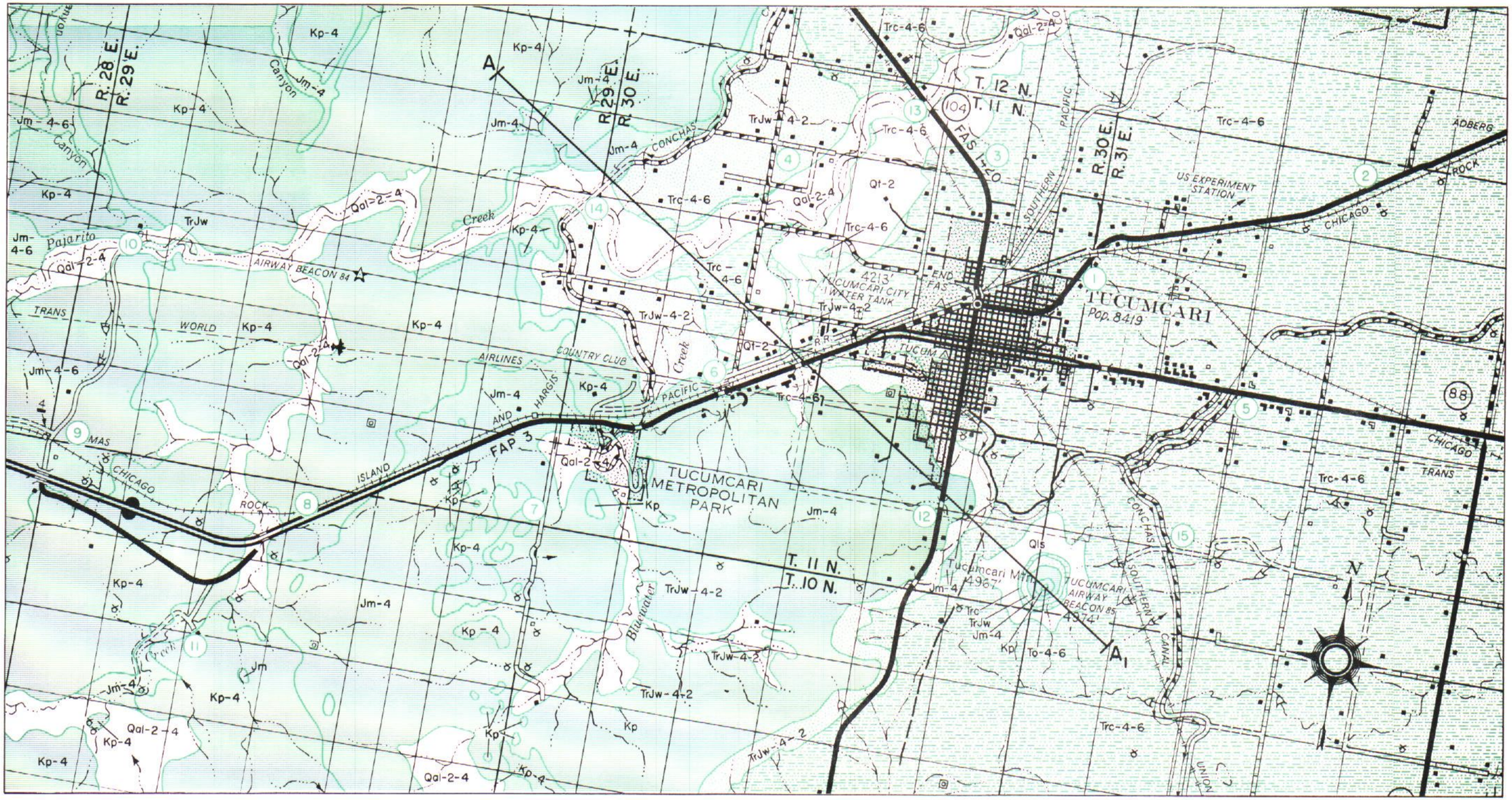
Selected References

Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U. S. Geol. Surv. Bull. 794.

Dobrovolny, E. and Summerson, C. H., 1946, Oil and Gas Investigations Preliminary Map 62, U.S. Geol. Surv.

Guidebook, 1949, Road Log - Ragland to Santa Fe, New Mexico, Cenozoic Geology of the Llano Estacado and Rio Grande Valley, West Texas Geological Society, pp. 25-38.

SOILS AND GEOLOGY MAP 40-19

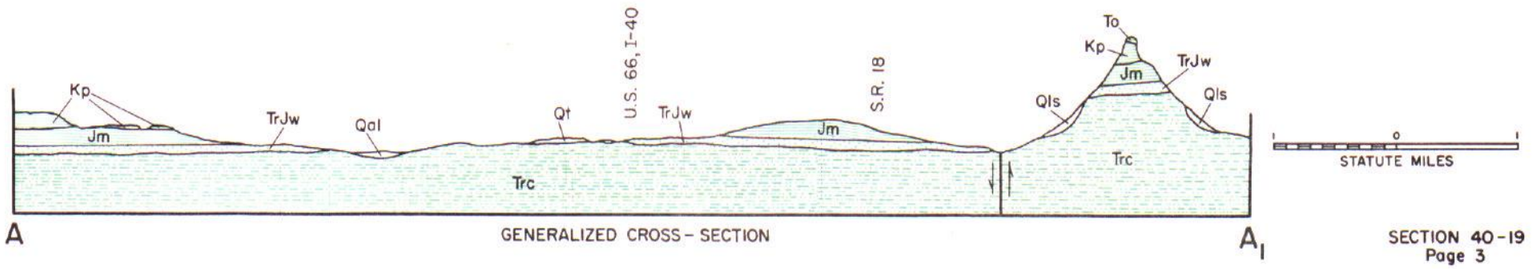


GEOLOGY MAPPED IN 1960

-LEGEND-

SEDIMENTARY ROCKS

Qal	Alluvium	QUATERNARY	
Qt	Terrace gravel		
Qls	Landslide debris		
To	Ogallala formation	TERTIARY	
Kp	Purgatoire formation	CRETACEOUS	
Jm	Morrison formation	JURASSIC	
TrJw	Wingate formation		
Trc	Chinle formation	TRIASSIC	



GENERALIZED CROSS-SECTION

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
PALOMAS - TUCUMCARI AIRPORT

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table 40-19-2

Pit or Prospect No, Section Twnshp. & Range County State	57-49-S SE 1/4, Sec. 16 T 11 N, R 30 E Quay New Mexico	59-39-F Sec. 19 T 11 N, R 29 E Quay New Mexico	40-19-1 (Prospect) W 1/2, Sec. 31 T 9 N, R 31 E Quay New Mexico	40-19-2 (Prospect) N 1/2 Sec. 23 & S 1/2 Sec. 14 T 13 N, R 31 E Quay New Mexico
Owner	Private Property	Private Property	Private Property	Private Property
Geologic Age	Quaternary	Recent	Tertiary	Quaternary
Formation	Terrace	Alluvium	Ogallala	Terrace
Type of Pit	Gravel	Sand and gravel	Quarry	Gravel
Kind of Material	Various	Quartzite, sandstone, & various	Caliche	Quartzite & igneous
Quality of Material	Fair	Fair	Good	Good
Thickness of Material	4 to 7 feet	0 to 10 feet	15 feet	10 to 30 feet
Thickness of Cap (Caliche)	-	-	3 to 6 feet	-
Blasting Qualities	-	-	Good	-
Uniformity	Fair	Fair	Good	Good
Impurities	Silt lenses	Silt	Silt	See remarks
Type of Mat'l. Underlying Formation	Shale	Sand & gravel	Sandstone and shale	Shale and sandstone
Moisture Condition	Dry	Intermittently wet	Dry	Dry
Vegetation	Grass & scattered brush	None	Junipers, cedars, and grass	Grass
Local Terrain	Rough, broken	Rough, broken	Mesa top	River terrace
Depth of Overburden	0 to 7 feet	No overburden	0 to 3 feet	0 to 3 feet
P.I. (Overburden)	7	-	6	See remarks
Est. Reserve Quantity	See remarks	See remarks	See remarks	400,000 cu. yds.
Approx. Haul to Nearest Point	1.0 mile	3.5 miles	18.0 miles	12.0 miles
L.A. Wear	31.1	-	B lift - 27,2, C lift - 40,8	See remarks
Maximum Size	4"	6"	-	12"
% Retained on 2" Sieve	Less than 5	Less than 1	-	Less than 10
Pit Average % Passing — Crushed to 2"	2"	-	-	See remarks
1"	100	90	1" B lift - C lift -	" "
3/4"	90	81	- -	" "
1/2"	86	78	100 100	" "
#4	80	75	92 88	" "
#10	64	70	53 59	" "
#200	53	67	19 27	" "
P.I.	10	12	10 17	" "
Lab. Numbers	N.P. 57-8083 - 8101	N.P. 59-5255 - 5258	2 5 N.P. N.P. 60-12501 - 503	" "

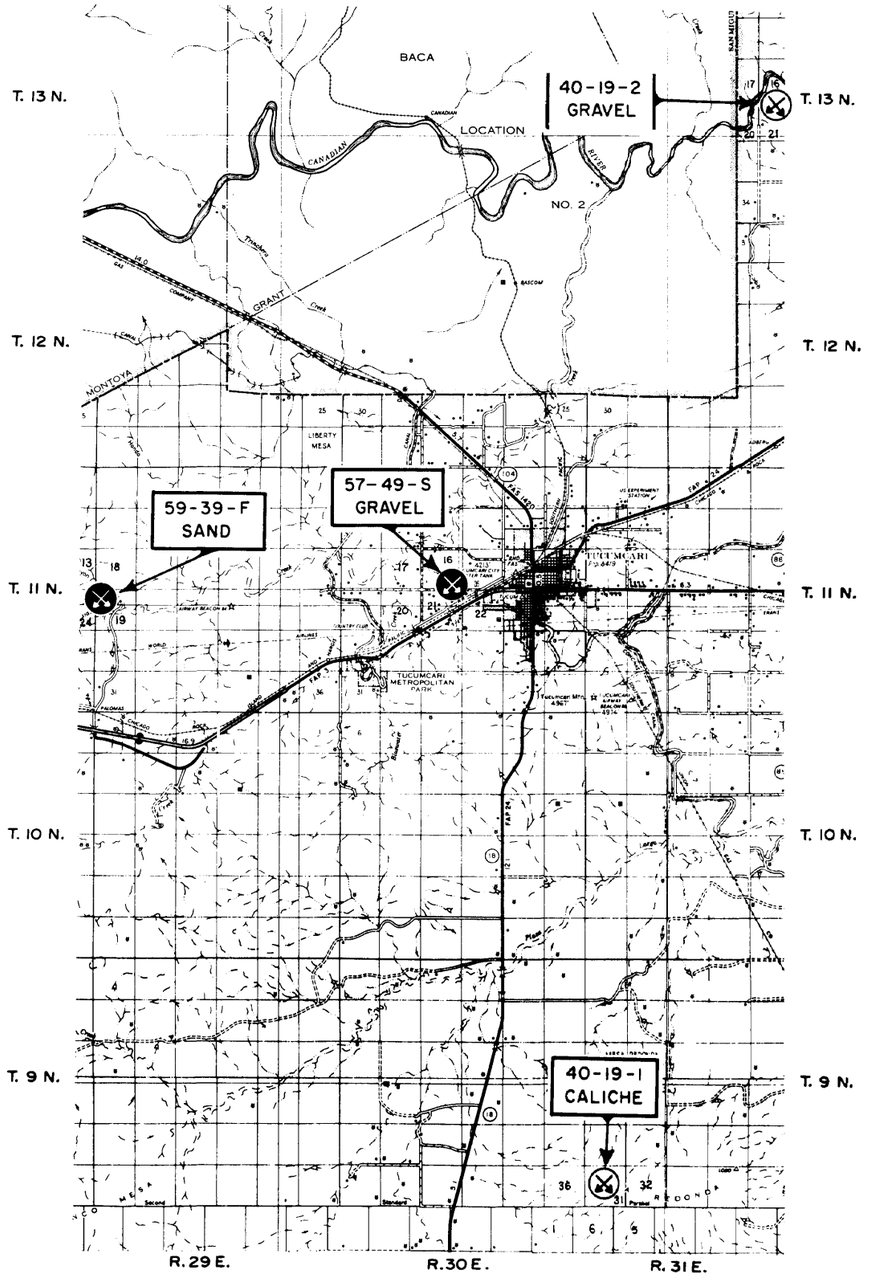
Remarks:

57-49-S - This pit is an example of the terrace gravels along Pajarito Creek and its tributaries. It has been worked out, but can possibly be extended to the northeast.

59-39-F - This pit is shown to demonstrate the type material that may be developed in local areas of Pajarito Creek.

40-19-1 (Prospect) - This caliche caps most of the mesa. Test results were run on samples lifted from the weathered scarp face of the mesa. Further exploration is needed to determine quality, quantity, etc.

40-19-2 (Prospect) - A very small percent of clay balls were noted in an exposed face. They readily crumble when dry. Further exploration needed to determine quality, quantity, L.A. wear, etc.



N

LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U. S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
TUCUMCARI AIRPORT - SAN JON

SOILS AND GEOLOGY

Introduction:

Section 40-20 extends from the vicinity of Tucumcari Airport to San Jon. It lies in the Great Plains region and is bounded on the north by the Canadian escarpment and on the south by the Llano Estacado.

General Geology:

This section has the physiographic expression of a gently undulating valley which slopes slightly to the east and in which the relief does not exceed 200 feet.

In early Pliocene time streams meandered across this section and deposited clays, sands, and gravels over a nearly mature erosional surface of Permian and Mesozoic beds. In late Pliocene time the climate became more arid and reduced stream flow; the cap rock caliche of the surface of the Llano Estacado began to form. The Llano Estacado is the southernmost extension of the Great Plains region.

At the beginning of the Pleistocene epoch the present major drainage began to develop. The Canadian River on the north began to erode the Llano and finally cut through eastward into Texas. Tributaries flowed across this section northward into the Canadian River. Alternating wet and dry climatic conditions existed during this glacial epoch. During wet periods the tributaries eroded the area until at present the Chinle formation forms most of the surface.

Dry climatic conditions have prevailed in recent time and the surface has been modified by wind action which has built sand dunes in some areas and reworked the surface in other areas.

The areal distribution of formations is shown on Soils and Geology Map 40-20. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The characteristic soil types occur on four different landforms. They are comprised of the following: (1) alluvium (Qal), (2) dune sands (Qa), (3) terrace deposits (Qt), and (4) a complex variety of alluvium and residual soil overlying the Chinle formation mapped as Triassic Chinle (Trc) because of local variations and irregular areal patterns of the soil.

Alluvial soils occur on the floors of the intermittent streams and they are composed of silt (minor), silty sand, and gravel. They are young in age, present no definite profile, and are derived from the sandstones and shales of the Chinle formation.

A small isolated, extremely weathered terrace remnant exists two and one-half miles west of San Jon. It is similar in origin to the more recent alluvium, but has a more mature profile of caliche soil over silty-sandy gravel.

Dry climatic conditions and prevailing westerly winds have created dune sands north of San Jon. They are predominantly clean, fine sand (A-3) with minor accumulations of silty sand (A-2-4) in the depressions.

The more complex residual and alluvial soil cover of the Chinle formation is derived from sheet wash, wind erosion, decomposed bedrock, and small intermittent stream deposition. Profiles have developed over most of the area and they usually have well defined pedological units; however, there is no great contrast in the engineering soils classification. "A" horizon is usually silty soil (A-4) derived primarily from the Chinle formation in which the clay size particles have been somewhat diminished by leaching, sheet wash, and wind erosion. "B" horizon is also silty soil (A-4) discolored locally by calcium carbonate or caliche and the plastic content is usually slightly different than "A" horizon. "C" horizon varies from the decomposed siltstones, sandstones, and shales of the Chinle formation to thin intermittent stream deposits that are also of Chinle origin. "A" horizon is also affected locally by wind-blown sediments of silty sandy soil (A-2-4). This residual and alluvial cover seldom exceeds 12 feet in thickness.

The areal distribution of the soils and their related formations is shown on Soils and Geology Map 40-20. Table No. 40-20-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary:

Alluvium (Qal) - intermittent stream deposits of sand, silt, and fine gravel.
Thickness: 15 feet maximum.

Terrace deposits (Qt) - silt, sand, and fine gravel deposited on old terrace surfaces.
Thickness: 10 feet maximum.

Aeolian deposits (Qa) - dune sand, well sorted, fine, clean sand.
Thickness: 0 to 15 feet.

Unconformity----------Period of Erosion----------

Triassic:

Chinle formation (Trc) - light reddish-buff sandstone, interbedded with red-brown and greenish shales and siltstones. A dark fossiliferous conglomerate crops out locally in this section.
Thickness: 120+ feet.

Construction Materials:

Quaternary:

Alluvium (Qal) - small quantities of fine-graded silty sand and gravel occur in the bed of Barranca Creek. This material is the result of the creek depositing the coarse sediments washed from the escarpment of Mesa Redondo and the Llano Estacado that lie south of this region. Small pits (5,000 to 10,000 cu. yds.) of poor quality surfacing material may be located in local areas of the creek.

Aeolian deposits (Qa) - dune sands three miles north of San Jon along State Road 39 may be used for filler. It is a clean, fine quartz sand.

Terrace gravels (Qtg) - Canadian River deposits are the best source of construction materials for this section. They are composed of an excellent grade of igneous and quartzite river gravels. Extensive deposits parallel both sides of this meandering stream. South of the river they are generally confined to terrace surfaces within one-half mile of the main channel. The main channel has recently cut a deep gorge into the Triassic rocks of the region and it is presently floored by a fine- to coarse-grained sand. Impurities are slight to none in the deposits adjacent to this section and the natural material will probably produce concrete quality aggregates with a minimum amount of special treatment. Existing roads usually are the best access to these deposits; however, they become poorly maintained trail roads as one approaches the river. Haul distances will vary from 13 to 20 miles. A gravel of fair quality occurs along the terrace surfaces of Revuelto Creek near the Canadian River; however, it has not been considered a reserve source for this section of Interstate Route 40.

Tertiary:

Ogallala formation (To) - a non-uniform 3 to 6 foot cap of hard caliche has formed near the top of this formation. It is underlain by a softer, nodular caliche and it is usually considered a secondary feature of the Ogallala formation even though it is of primary importance to construction materials studies. Caliche crops out extensively along the scarp slope of the Llano Estacado approximately 8 miles south of San Jon and extends easterly and westerly along the rim of the escarpment. Existing roads usually are the best access; however, if extensive use of this caliche is preferred to the Canadian River deposits, other access roads may be made along section lines.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-20. Test data and other related information are shown in Material Pit Summary Table No. 40-20-2.

SOILS AND GEOLOGY

Soils Summary:

Table No. 40-20-I

Age	Formation	Hole No.	Horizon	Depths From	Depths To	Classification	Material Type
Quaternary	Alluvium	11	A	0.0	5.0	A-2-4	Silty sand
"	"	18	A	0.0	2.0	A-2-4	" "
"	"		B	2.0	5.0	A-1-b	Gravel
"	Aeolian	6	A	0.0	5.0	A-3	Fine sand
"	"	16	A	0.0	4.5	A-2-4	Silty sand
The following samples represent residual soils derived from parent material:							
Triassic	Chinle	1	A	0.0	2.5	A-4	Silty soil
"	"		B	2.5	---	Unclassified	Sandstone
"	"	2	A	0.0	5.0	A-4	Silty soil
"	"	3	A	0.0	1.5	A-4	" "
"	"		B	1.5	---	Unclassified	Sandstone
"	"	4	A	0.0	5.5	A-4	Silty soil
"	"	5	A	0.0	4.5	A-4	" "
"	"	7	A	0.0	5.0	A-4	" "
"	"	8	A	0.0	1.0	A-6	Clay soil
"	"	9	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	---	Unclassified	Sandstone
"	"	10	A	0.0	2.0	A-6	Clay soil
"	"	13	A	0.0	5.0	A-2-4	Silty sand
"	"	14	A	0.0	1.5	A-6	Clay soil
"	"	15	A	0.0	1.0	A-2-4	Silty sand
"	"		B	1.0	3.5	A-4	Silty soil
"	"	17	A	0.0	4.5	A-2-4	Silty sand
"	"		B	4.5	5.5	A-4	Silty soil
"	"	19	A	0.0	1.5	A-4	" "
"	"		B	1.5	---	Unclassified	Shale
The following section shows the material that may be exposed when cuts are made in the Chinle formation:							
Triassic	Chinle	12	A	0.0	11.0	Unclassified	Sandstone
"	"		B	11.0	17.0	Unclassified	Calcareous conglomerate
"	"		C	17.0	42.0	A-4	Shale
"	"		D	42.0	83.0	Unclassified	Sandstone
"	"		E	83.0	91.0	Unclassified	Conglomerate & pea gravel
"	"		F	91.0	122.0	A-6	Shale

Selected References

Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Surv. Bull. 794.

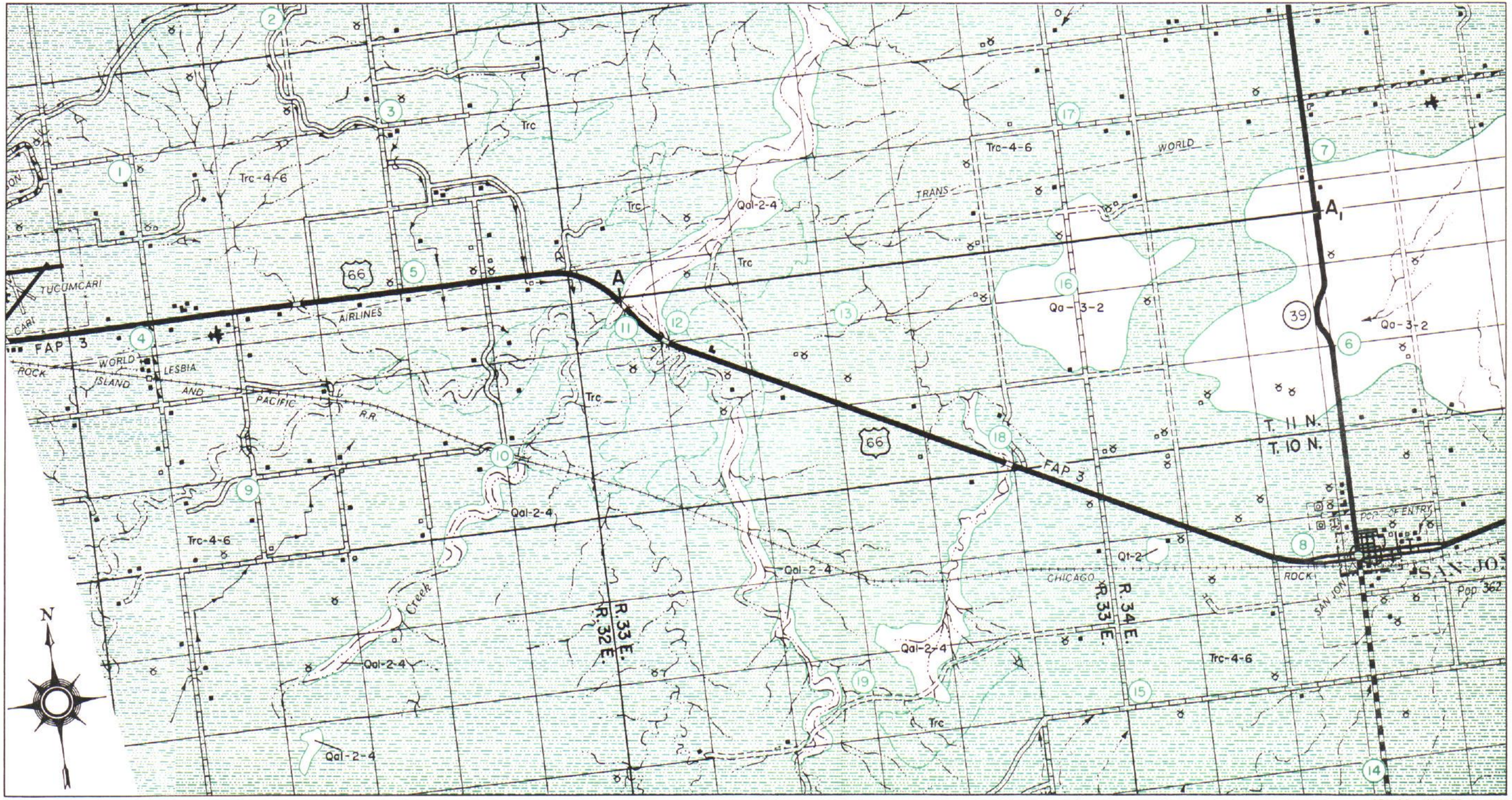
Judson, Sheldon, 1953, Geology of the San Jon Site, Eastern New Mexico, Smithsonian Miscellaneous Collections, Vol. 121, No. 1, pp. 1-23.

Roberts, Frank H. H. Jr., 1942, Archeological and Geological Investigations in the San Jon District, Eastern New Mexico, Smithsonian Miscellaneous Collections, Vol. 103, No. 4.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-20

INTERSTATE ROUTE 40
TUCUMCARI AIRPORT TO SAN JON



GEOLOGY MAPPED IN 1960

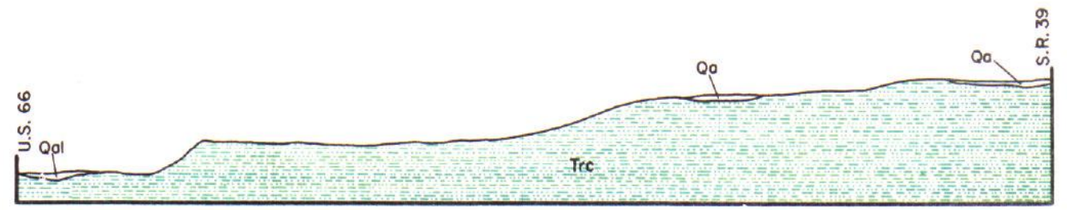
-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qa — Eolian deposits
- Qt — Terrace gravel

TRIASSIC
- Trc — Chinle formation

STATUTE MILES



GENERALIZED CROSS-SECTION

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
TUCUMCARI AIRPORT - SAN JON

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-20-2

Pit or Prospect No.		56-58-S	57-50-S	57-58-S	57-156-S	57-157-S
Location	Section	NE 1/4 Sec. 29	W 1/2, Sec. 21	SW 1/4, Sec. 24	See remarks	See remarks
	Twnshp. & Range	T 9 N, R 34 E	T 13 N, R 32 E	T 13 N, R 33 E	" "	" "
	County	Quay	Quay	Quay	Quay	Quay
	State	New Mexico	New Mexico	New Mexico	New Mexico	New Mexico
Owner		State land	Private land	Private land	Private land	Private land
Geologic Age		Tertiary	Quaternary	Quaternary	Quaternary	Quaternary
Formation		Ogallala	Terrace	Terrace	Terrace	Terrace
Type of Pit		Quarry	Gravel	Gravel	Gravel	Gravel
Kind of Material		Caliche	Quartzite & igneous	Variable	Quartzite & igneous	Igneous & quartzite
Quality of Material		Good	Excellent	Fair	Excellent	Good
Thickness of Material		8 to 20 feet	12 feet	15 feet	15 feet	10 feet
Thickness of Cap (Caliche)		4 to 6 feet	-	-	-	-
Blasting Qualities		Excellent	-	-	-	-
Uniformity		Good	Good	Fair	Good	Good
Impurities		Silt (minor)	None	Silt lenses	None	Silt lenses (minor)
Type of Mat'l. Underlying Formation		Soft caliche	Sandstone & shale	Sandstone	Sandstone & shale	Shale
Moisture Condition		Dry	Dry	Dry	Dry	Dry
Vegetation		Grass	Grass	Grass	Grass	Grass
Local Terrain		Broken, irregular escarpment	Rough, broken	Eroded terrace	River terrace	River terrace
Depth of Overburden		1.5 feet	1 to 9 feet	4.0 to 7.5 feet	5 feet	3 feet
P.I. (Overburden)		10	N.P.	N.P.	8	N.P.
Est. Reserve Quantity		See remarks	25,000 cu. yds.	37,000 cu. yds.	70,000 cu. yds.	120,000 cu. yds.
Approx. Haul to Nearest Point		8.5 miles	13 miles	17.0 miles	12.0 miles	12.5 miles
L.A. Wear		46.0	32.8	28.0	33.2	33.2
Maximum Size		-	12"	12"	6"	12"
% Retained on 2" Sieve		-	Less than 10	Less than 5	13	Less than 15
Pit Average % Passing	Crushed to	2"	-	2"	-	1"
	2"	100	88	100	87	-
	1"	83	73	82	70	100
	3/4"	77	64	77	63	84
	1/2"	68	53	70	52	56
	#4	54	35	58	39	31
	#10	44	27	51	28	23
	#200	12	3	5	4	3
P.I.		N.P.	N.P.	N.P.	N.P.	N.P.
Lab. Numbers		56-7951 - 7968	57-14255 - 14279	57-9242 - 9258	57-22852 - 22883	57-22827 - 22851

Remarks:

56-58-S - There is approximately 43,000 cu. yds. of material remaining in the original surveyed area; it may be extended to the southeast. Further exploration needed to determine quality, quantity, etc.

57-50-S - Pit cannot be extended in the immediate vicinity; however, other areas along this river may be developed.

57-58-S - This pit is shown to demonstrate the type material that may be developed in the terrace deposits along Revuelto Creek.

57-156-S - Located in the SE 1/4 Sec. 14 and the NE 1/4 Sec. 23, T 13 N, R 32 E. Pit cannot be extended in its immediate vicinity; however, other generous deposits occur in this locality.

57-157-S - Located in the SW 1/4, Sec. 13 and the SE 1/4 Sec. 14, T 13 N, R 32 E. It is essentially an extension of old pit 57-156-S which lies to the west. It is currently being operated, 2-22-61.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
TUCUMCARI AIRPORT - SAN JON

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

Table No. 40-20-2 continued

Pit or Prospect No,		58-41-S	40-20-1 (Prospect)	40-20-2 (Prospect)	40-20-3 (Prospect)
Location	Section	SE 1/4 Sec. 16	SW 1/4 Sec. 3	W 1/2 Sec. 27	S 1/2 Sec. 20
	Twnshp. & Range	T 10 N, R 32 E	T 13 N, R 34 E	T 11 N, R 34 E	T 9 N, R 34 E
	County	Quay	Quay	Quay	Quay
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Private land	Private land	?	?
Geologic Age		Quaternary	Quaternary	Quaternary	Tertiary
Formation		Alluvium	Terrace	Dune sands	Ogallala
Type of Pit		Sand and Gravel	Gravel	Sand	Quarry
Kind of Material		Variable	Igneous & quartzite	Quartz sand	Caliche
Quality of Material		Fair	Excellent	Excellent	Good
Thickness of Material		8 feet	8 to 30 feet	0 to 15 feet	10 to 20 feet
Thickness of Cap (Caliche)		-	-	-	3 to 6 feet
Blasting Qualities		-	-	-	Good
Uniformity		Fair	Good	Excellent	Good
Impurities		Silt (minor)	None	None	Silt (minor)
Type of Mat'l. Underlying Formation		Sandstone	Sandstone & shale	Silt & clay soil	Sandstone
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		None	Grass	None	Grass, cacti & cedar
Local Terrain		Stream channel	Rough, broken	Moderately undulating	Broken, irregular escarpment
Depth of Overburden		-	3 to 6 feet	None	0 to 3 feet
P.I. (Overburden)		-	Sandy	-	13
Est. Reserve Quantity		20,000 cu. yds.	300,000 cu. yds.	See remarks	Unlimited
Approx. Haul to Nearest Point		6.0 miles	19.5 miles	3.0 miles	9.5 miles
L.A. Wear		31.6	See remarks	-	cap 26.0
Maximum Size		4"	12"	100% -40	-
% Retained on 2" Sieve		-	Less than 15	-	-
	Crushed to 2"	1"	See remarks	-	1"
Pit	1"	-	" "	-	-
Average	3/4"	100	" "	-	100
% Passing	1/2"	95	" "	-	89
	#4	79	" "	-	53
	#10	49	" "	-	17
	#200	33	" "	-	7
P.I.		2	" "	4	1
Lab. Numbers		N.P.	" "	N.P.	N.P.
		58-7217 - 7223	" "	60-11478	61-1652 - 1654

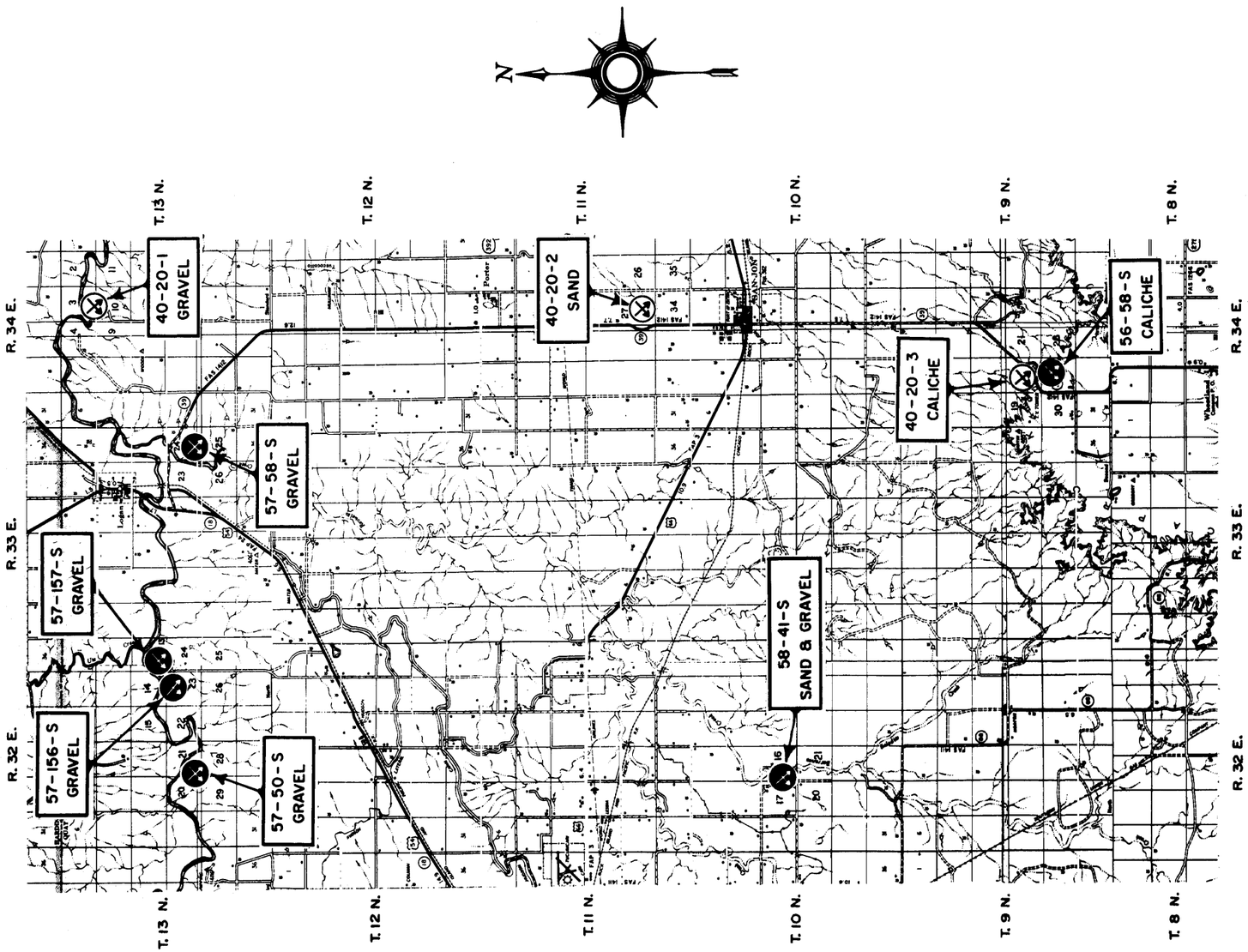
Remarks:

58-41-S - This is an example of the type of construction material which is available along Barranca Creek and similar streams in this locality.

40-20-1 (Prospect) - The material in this pit is comparable to 57-157-S in quality, grading, & L.A. wear.

40-20-2 (Prospect) - This pit is shown to demonstrate the type material that may be developed in the dune sand area north of San Jon.

40-20-3 (Prospect) - The results for this pit area were computed from samples lifted from the weathered face of the escarpment. A better analysis of the type material that may be located in this area is demonstrated by Pit No. 56-58-S.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

AGGREGATE RESOURCES AND SOILS STUDY
PREPARED BY
NEW MEXICO STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH
U.S. BUREAU OF PUBLIC ROADS

CONSTRUCTION MATERIALS INVENTORY
INTERSTATE ROUTE 40

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SAN JON - NEW MEXICO-TEXAS STATE LINE

SOILS AND GEOLOGY

Introduction:

Section 40-21 extends from San Jon to Glenrio at the New Mexico-Texas state line. It lies in the Great Plains region and is bounded on the north by the Canadian plateau and on the south by the Llano Estacado.

General Geology:

This section has the physiographic expression of a gently undulating valley with a slight slope to the east and the relief does not exceed 200 feet.

In early Pliocene time streams meandered across this section and deposited clays, sands, and gravels over a nearly mature erosional surface of Permian and Mesozoic beds. In late Pliocene time the climate became more arid and reduced stream flow, and the cap rock caliche (Ogallala formation) of the surface of the Llano Estacado began to form.

At the beginning of the Pliestocene epoch the present major drainage began to develop. The Canadian River on the north began to erode the Llano and finally cut through it eastward into Texas. Tributaries flowed across this section northward into the Canadian River. Alternating wet and dry climatic conditions existed during this glacial epoch. During wet periods the tributaries eroded the section until at present the Chinle formation forms most of the surface.

Dry climatic conditions have prevailed in Recent time and the surface has been modified by wind action which has produced sand dunes in some areas and reworked the surface in other areas.

The areal distribution of formations is shown on Soils and Geology Map 40-21. Their succession and character are given under the section termed "Stratigraphy."

Soils:

The soils represented in this strip area are alluvial (Qal), terrace deposits (Qt), dune sands (Qa), and a variety of sheet wash alluvium and residual soil overlying the Chinle formation mapped as Triassic Chinle (Trc) because of their complicated areal pattern and local accumulations.

The most conspicuous accumulation of alluvium lies in the floor of San Juan Creek and is composed of silt, silty sand, and fine gravel. It is derived from the various shales, sandstones, and siltstones of the scarp face of the Llano Estacado and sandstones and shales of the Chinle formation. These soils are young and do not present a uniform profile; however, they are somewhat cross-bedded.

Isolated terrace deposits occur north of Glenrio near the New Mexico-Texas border. They are composed of a poorly sorted, silty sand and gravel with a silty soil cover. They are severly weathered and less than ten feet deep in most places.

Prevailing westerly winds have swept the plains and dry washes of this area to form dune sands. Vast accumulations of this sand occur north of Bard and smaller local accumulations occur in the vicinity of San Juan Creek. These dunes are essentially clean, fine sand (A-3) with minor silty-sandy soils accumulated in the depressions.

The residual and alluvial soil cover of the Chinle formation will vary in thickness from two to ten feet. It is predominantly silt (A-4) and clay (A-6) and has developed profiles of silty sand over silt in minor areas. This profile development is caused by minor accumulations of blow-sand which exist throughout the area. More silt than clay exists on the Chinle formation because sheet wash and wind erosion have removed the clay size particles of the soil.

The areal distribution of the soils and their related formations is shown on Soils and Geology Map 20-21. Table No. 40-21-1 shows the log and classification of the soil samples taken along this portion of Interstate Route 40.

Stratigraphy:

Quaternary: Alluvium (Qal) - intermittent stream deposits of sand, silt, and silty sand and gravel.
Thickness: 0 to 20 feet.

Quaternary: Terrace deposits (Qt) - silty sand and gravel.
Thickness: 0 to 8 feet.

Aeolian deposits (Qa) - dune sand, well sorted, fine, clean sand with minor amounts of silty sand.
Thickness: 0 to 15 feet.

Unconformity----------Period of Erosion----------

Triassic: Chinle formation (Trc) - interbedded light reddish-buff sandstone and reddish-brown shale. Green shale beds and dark, fossiliferous conglomerate occur locally.

Construction Materials:

Quaternary: Aeolian deposits (Qa) - wind-blown sands in the vicinity of San Juan Creek and north of Bard contain a clean, fine sand that may be used for filler in surfacing material.

Terrace gravels (Qtg) - Canadian River terrace deposits are the best source of construction materials for this section. They are composed of an excellent grade of igneous and quartzite river gravels. Extensive deposits parallel both sides of this meandering stream. South of the river they are generally confined to terrace surfaces within one-half mile of the main channel. The main channel has recently cut a deep gorge into the Triassic rocks of the region and it is presently floored by fine- to coarse-graded sand. Impurities are slight to none in the deposits adjacent to this section and the natural material will probably produce concrete quality aggregates with a minimum amount of special treatment. Existing roads usually present the best access to these deposits; however, they become poorly maintained trail roads as one approaches the river. Excellent pits may be located at various intervals south of the river and haul distances to Interstate Route 40 will vary from 14 to 18 miles.

Tertiary: Ogallala formation (To) - a non-uniform, 3 to 6 foot cap of hard caliche has formed near the top of this formation. It is underlain by a softer, nodular caliche and its is usually considered a secondary feature of the Ogallala formation. Caliche crops out extensively along the scarp slope of the Llano Estacado, a physiographic feature, which almost parallels Interstate Route 40 from 9 to 15 miles south. It is secondary in quality to the Canadian River terrace deposits; however, it is considered a source of material for this area.

Distribution of tested and prospective pit sites for construction materials is shown on Construction and Materials Map 40-21. Test data and other related information are shown in Material Pit Summary Table No. 40-21-2.

Soils Summary:

Table No. 40-21-1

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Quaternary	Alluvium	3	A	0.0	2.0	A-2-4	Silty sand
"	"		B	2.0	15.0	A-4	Silty soil
"	"	17	A	0.0	10.0	A-2-4	Silty sand
"	Aeolian	4	A	0.0	8.0	A-3	Fine sand
"	"	12	A	0.0	5.5	A-4	Silty soil
"	"	14	A	0.0	5.5	A-2-4	Silty sand
The following samples represent residual soils derived from parent formations:							
Triassic	Chinle	1	A	0.0	4.5	A-4	Silty soil
"	"	2	A	0.0	3.0	A-4	" "

Soils Summary continued

Table No. 40-21-1 continued

Age	Formation	Hole No.	Horizon	Depths From	Depths To	AASHO Classification	Material Type
Triassic	Chinle	5	A	0.0	1.5	A-4	Silty soil
"	"		B	1.5	---	Unclassified	Sandstone
"	"	6	A	0.0	1.5	A-2-4	Silty sand
"	"		B	1.5	---	Unclassified	Caliche
"	"	7	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Unclassified	Siltstone
"	"	9	A	0.0	4.0	A-4	Silty soil
"	"		B	4.0	---	Unclassified	Caliche
"	"	10	A	0.0	4.5	A-6	Clay soil
"	"	11	A	0.0	3.0	A-4	Silty soil
"	"		B	3.0	---	Unclassified	Sandstone
"	"	13	A	0.0	5.0	A-4	Silty soil
"	"	15	A	0.0	4.0	A-2-4	Silty sand
"	"		B	4.0	---	Unclassified	Sandstone
"	"	16	A	0.0	4.5	A-4	Silty soil

The following sections show the material that may be exposed when cuts are made in the respective formations:

Quaternary	Terrace	8	A	0.0	3.0	A-2-4	Silty gravel
Triassic	Chinle		B	3.0	12.0	Unclassified	Sandstone
"	"		C	12.0	14.0	A-4	Siltstone
"	"		D	14.0	20.0	Unclassified	Sandstone
"	"		E	20.0	25.0	A-6	Shale
"	"		F	25.0	32.0	Unclassified	Conglomerate
"	"		G	32.0	43.0	A-6	Shale
"	"		H	43.0	44.5	Unclassified	Sandstone
"	"		I	44.5	47.0	A-6	Shale
"	"		J	47.0	52.0	Unclassified	Sandstone

Selected References

Darton, N. H., 1928, Red Beds and Associated Formations in New Mexico, U.S. Geol. Surv. Bull. 794.

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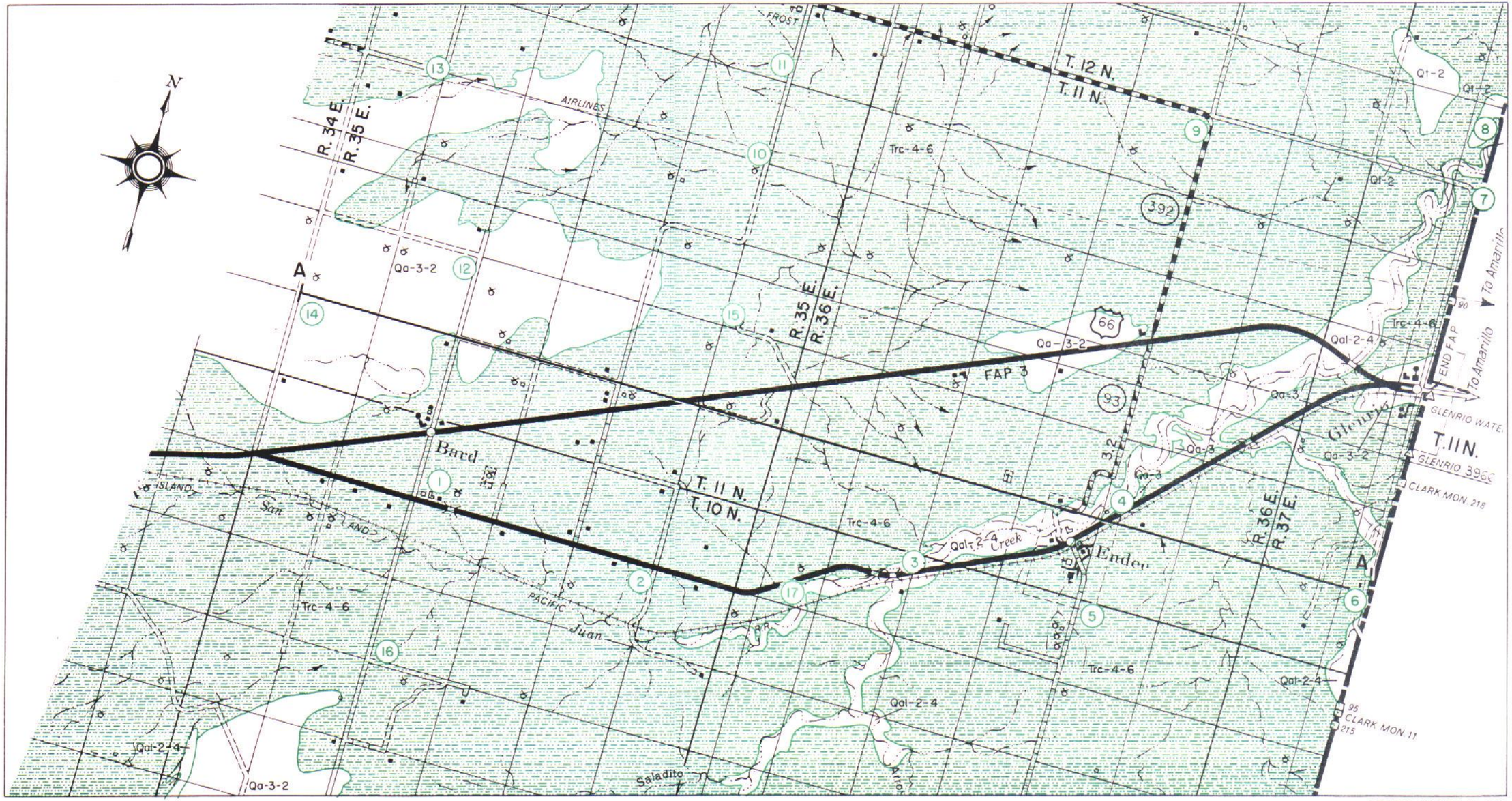
Roberts, Frank H. H. Jr., 1942, Archeological and Geological Investigations in the San Jon District, Eastern New Mexico, Smithsonian Miscellaneous Collections, Vol. 103, No. 4.

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO STATE HIGHWAY DEPARTMENT

SOILS AND GEOLOGY MAP 40-21

INTERSTATE ROUTE 40
SAN JON TO TEXAS - NEW MEXICO LINE



GEOLOGY MAPPED IN 1960

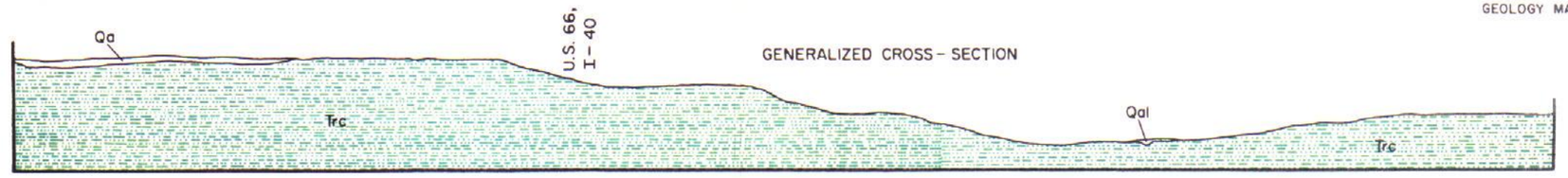
-LEGEND-

SEDIMENTARY ROCKS

QUATERNARY
- Qal — Alluvium
- Qa — Eolian deposits
- Qt — Terrace gravel

TRIASSIC
- Trc — Chinle formation

GENERALIZED CROSS-SECTION



STATUTE MILES

AGGREGATE RESOURCES AND SOILS STUDY
NEW MEXICO INTERSTATE ROUTE 40
SAN JON - NEW MEXICO-TEXAS STATE LINE

CONSTRUCTION MATERIALS INVENTORY

Material Pit Summary:

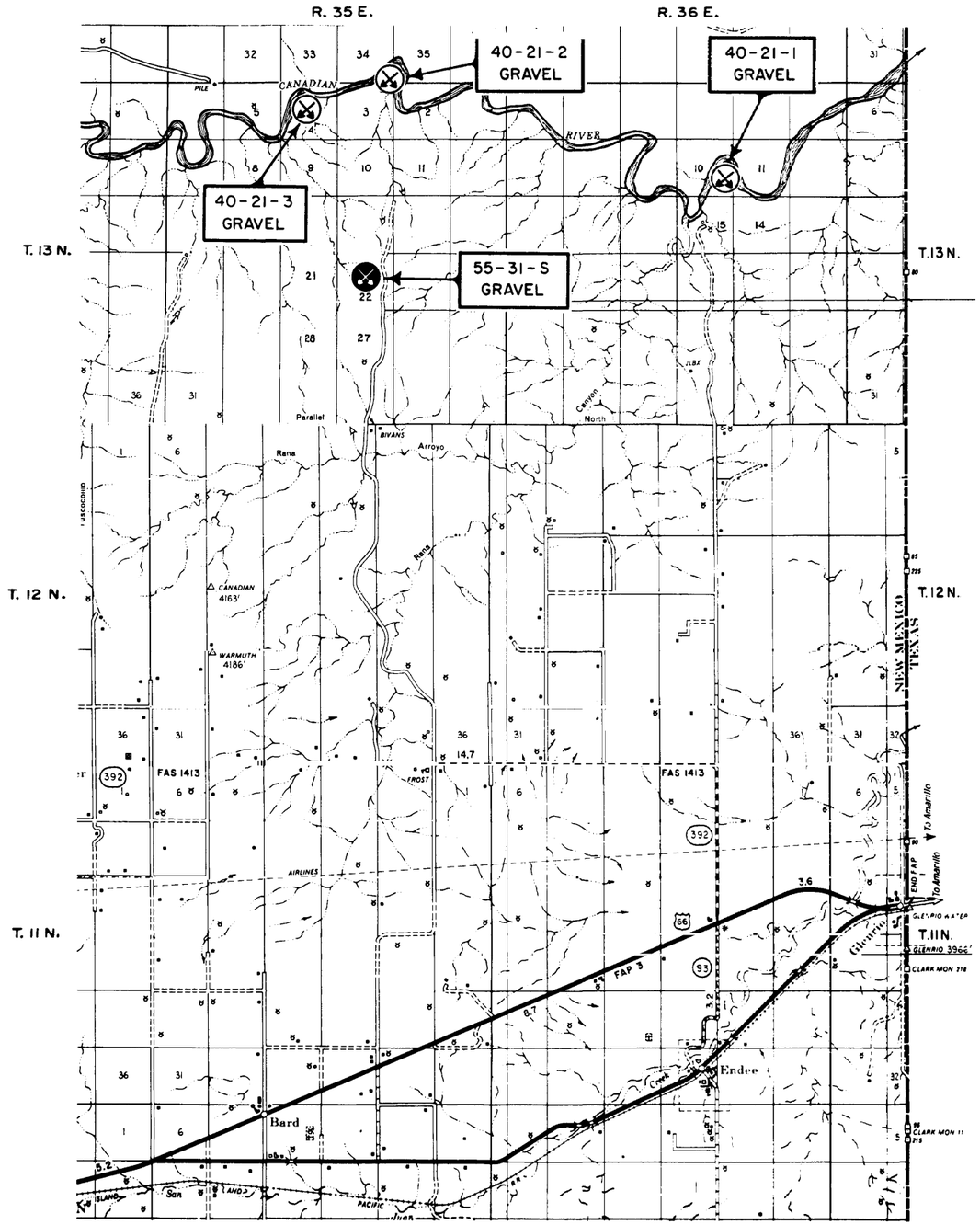
Table No. 40-21-2

Pit or Prospect No.		55-31-S	40-21-1 (Prospect)	40-21-2 (Prospect)	40-21-3 (Prospect)
Location	Section	NE 1/4 Sec. 22	SE 1/4 Sec. 10	SE 1/4 Sec. 34	N 1/2 Sec. 4
	Twnshp. & Range	T 13 N, R 35 E	T 13 N, R 36 E	T 14 N, R 35 E	T 13 N, R 35 E
	County	Quay	Quay	Quay	Quay
	State	New Mexico	New Mexico	New Mexico	New Mexico
Owner		Private land	State & private land	Private land	Private land
Geologic Age		Quaternary	Quaternary	Quaternary	Quaternary
Formation		Terrace	Terrace	Terrace	Terrace
Type of Pit		Gravel	Gravel	Gravel	Gravel
Kind of Material		Quartzite & igneous	Quartzite & igneous	Quartzite & igneous	Quartzite & igneous
Quality of Material		Good	Excellent	Excellent	Excellent
Thickness of Material		10 feet	15 feet	15 feet	15 feet
Thickness of Cap (Caliche)		-	-	-	-
Blasting Qualities		-	-	-	-
Uniformity		Good	Excellent	Excellent	Excellent
Impurities		Silt lenses (minor)	None	None	None
Type of Mat'l. Underlying Formation		Shale & conglomerate	Sandstone	Sandstone	Sandstone
Moisture Condition		Dry	Dry	Dry	Dry
Vegetation		Grass	Grass	Grass	Grass
Local Terrain		Terrace remnant	Rough, broken	Rough, broken	Rough, broken
Depth of Overburden		3 feet	2.0 to 6.0 feet	2.0 to 6.0 feet	2.0 feet
P.I. (Overburden)		10	N.P.	N.P.	-
Est. Reserve Quantity		124,000 cu. yds.	500,000+ cu. yds.	400,000 cu. yds.	500,000+ cu. yds.
Approx. Haul to Nearest Point		13.5 miles	13.0 miles	18.0 miles	18.0 miles
L.A. Wear		30.2	30.0	26.4	-
Maximum Size		12"	12"	12"	12"
% Retained on 2" Sieve		Less than 5	Less than 15	Less than 15	Less than 15
Pit Average % Passing	Crushed to 2"	3/4"	-	1"	-
	2"	-	66	-	See remarks
	1"	-	45	100	" "
	3/4"	100	38	85	" "
	1/2"	84	31	54	" "
	#4	47	20	27	" "
	#10	32	14	19	" "
	#200	9	1	5	" "
P.I.		N.P.	N.P.	N.P.	-
Lab. Numbers		55-3000 - 3015	60-11815 - 11816	60-12506 - 12507	-

Remarks:

55-31-S - This pit has been partially used and certain limitations were placed on its use. (Consult pit sketch for details)

40-21-3 (Prospect) - Refer to prospective pit No. 40-21-2 for estimating quality, grading, etc. Material is identical in nature.



LEGEND

- TESTED PIT OR QUARRY
- PROSPECT PIT OR QUARRY

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INTERSTATE ROUTE 40