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URBAN GEOLOGY OF CLOVIS

by

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INTRODUCTION

Clovis, the county seat of Curry County, New Mexico, is located within an extensive area of large-scale irrigation farming that developed on the Llano Estacado of eastern New Mexico and western Texas following World War II and is the principal center for trade and agricultural services for much of the northwestern part of this region. The city is also a rail transportation center, a major center for marketing livestock, and a center for processing agricultural commodities, particularly grain, livestock, milk, and poultry. It is the largest city in east-central New Mexico.

TOPOGRAPHY AND DRAINAGE

The city of Clovis is on a southeastward-sloping regionally extensive plain of low relief that occupies a large part of eastern New Mexico and western Texas. Characteristically, this plain has a smooth and very gently sloping to gently undulating surface on which scattered, normally dry, nearly circular, essentially flat-bottomed depressions are commonly the dominant features of relief. In the vicinity of Clovis these saucer-like features commonly extend to depths of 20 feet or more below the general level of the plain, and in several instances the area within the depression exceeds 50 acres. Natural surface drainage is neither integrated nor well developed in the vicinity of the city, consequently, essentially all runoff from storms flows to local depressions where it is ultimately lost to evaporation, transpiration, and infiltration.

ENGINEERING GEOLOGY

Surface and subsurface materials that are of prime importance to a discussion of the urban geology of Clovis consist of the zone of weathering, or soil profile, which has developed on Tertiary sediments that underlie the city and the Ogallala Formation, of late Tertiary age, which extends to depths ranging from 350 to 400 feet in the vicinity of the city. The Dockum Group of late(?) Triassic age locally immediately underlies the Ogallala Formation.

Zone of Weathering: The dominant soil within and contiguous to Clovis is moderately permeable and is developed in moderately sandy calcareous materials that commonly have been reworked by the wind. Typically it has a well-developed profile in which the surface layer (A horizon) consists of about 6 inches of brown, friable, noncalcareous loam; the subsoil (B horizon) consists of about 40 inches of reddish-brown, friable to firm, non-calcareous to calcareous sandy clay loam; and the substratum (C horizon) consists of white to pink, chalky to massive, strongly calcareous sandy clay loam and hard brown caliche nodules. The physical properties of this soil are favorable for founding streets and highways and low-rise structures and its depth and usual ease of excavation are also favorable for emplacing buried cables and conduits. Metal pipelines emplaced in this soil are reportedly not ordinarily subject to excessive rates of corrosion. Embankment for earthern reservoirs and lagoons can be constructed readily from this soil and with proper selection and compaction, parts of the soil can be successfully employed as a relatively impervious lining material for earthen reservoirs. If this soil is left in its natural state, however, limitations with respect to constructing filter fields and lagoons appear to be few. The suitability of this soil for use as "roadfill" and for use as "topsoil" is "fair" and "good," respectively.

Significant departures from soil conditions described in the preceding paragraph are relatively localized and are confined, for the most part, to interior areas of some of the more prominent depressions wherein soil is either absent or poorly developed on the side slopes and the soil profile on and near the floor of the depression is developed wholly, or in part, in fine-textured sediments washed from higher lying soils. The usual soil found on the side slopes of these depressions is permeable and well drained but in most other respects is basically similar to the soil described in the preceding paragraph. In the case of floor and near-floor areas of these depressions, however, the usual soil is poorly drained and typically consists of a dark grayish-brown, strongly calcareous, clay-loam surface layer, which usually exceeds 6 inches in thickness, that commonly is underlain by light brownish-gray, strongly calcareous subsoil composed principally of clay and silt. The latter soil, for reason of high shrink-swell potential and potential lack of stability when wet, is considered to be generally unsuited for use as construction material. Accumulated mineral salts in this soil can result also in excessive rates of corrosion of buried metal pipes.

Ogallala Formation: The Ogallala Formation is a complex sequence of alluvial strata deposited during Miocene and Pliocene time. These strata constitute the surfacy formation over much of eastern New Mexico and western Texas and are well exposed at many localities along the usually bold escarpments that characteristically define the physiographic limits of the Llano Estacado. In the vicinity of Clovis, as in most other areas of the region, the formation includes lenticular beds of silt, sand, and mixtures of sand and gravel. Caliche, which in many instances consists of well-developed accumulations of almost pure calcium carbonate, is normally present in the uppermost par of the formation. Mixtures of coarse-grained sand and fine gravel that exhibit varying degrees of cementation by calcium carbonate are usually present near the base of the formation. Most of the formation, however, has been found to consist of poorly cemented, light-tan to brown, fine- to medium-grained sand. Basal beds containing significant quantities of gravel range from 15 to 40 feet in thickness in the immediate vicinity of Clovis.

Dockum Group: The rocks immediately underlying the Ogallala Formation at Clovis are a series of "red beds" of late(?) Triassic age usually assigned to the Dockum Group. It is known from the results of exploratory test drilling for deep water zones in the general area that at least the top several hundred feet of these "red beds" is composed basically of red-brown siltstone and claystone and interbedded silty to argillaceous, very fine to fine-grained sandstone.

MISCELLANEOUS CONSTRUCTION MATERIALS

Sand and gravel in sizes and of a quality suitable for most engineering uses has been produced in quantity for many years from alluvial fill at several sites southwest of Clovis. Operations at these sites, however, appear to have declined in recent years and at the present time considerable quantities of aggregate are being hauled to the Clovis area via truck from pits near Fort Sumner. Caliche, for use in road construction or for other purposes, can usually be readily extracted from the uppermost part of the Ogallala Formation in many areas near the city.

WATER SUPPLY

Water used for municipal and industrial purposes at Clovis is derived from the Ogallala Formation and is produced from cased wells that in most instances have been completed in the gravel and coarse-grained sand commonly found at the base of the formation. Except for being rather "hard"—about 185 mg/1 (millegrams per liter) as $Ca\ CO_3$,—and containing about 2.2 mg/1 of fluoride which is slightly in excess of the 1.5 mg/1 recommended by U.S. Public Health Service Standards, the water supply is considered, in general, to be of good chemical quality. Total dissolved solids in the water normally do not exceed 350 mgl.

Water in the Ogallala Formation occurs under water-table conditions and is recharged solely by precipitation that falls on the surface of the Llano Estacado. During most of the past two decades annual diversions of water for irrigation and other purposes in the general region have exceeded by several times the annual recharge to this formation, consequently, a significant part of present pumpage in the region is literally "mined" from water stored in the formation. As of 1962, the thickness of saturated sediments in the formation within the general limits of the city averaged about 120 feet, and since that time water levels have declined at a rate of about 2 feet per year.

Ground water is scarce in rocks of the Dockum Group in the vicinity of Clovis: Experience has shown that the maximum yield of water from wells completed in the formation is generally less than five gallons per minute, commonly is less than 1gpm, and rarely exceeds 50 gallons per minute. Water produced from this formation is also of poor chemical quality and typically contains more than 500 mg/1 each of sodium, chloride, and sulfate, and total dissolved solids in excess of 2000 mg/1. For these reasons the contact between the Chinle and the overlying Ogallala Formation is considered to be the practical lower limit of strata from which significant quantities of potable water can be produced for municipal and industrial purposes.

POLLUTION POTENTIAL

No specific data are available to this writer with respect to known or reported causes of ground-water contamination in the vicinity of Clovis. In view of occurrences experienced in other areas of the Llano Estacado, however, it would appear that the following activities and/or conditions may ultimately prove to be conducive to at least local pollution of this vital resource: (1) a local practice, at least in the past, of sometimes storing, and in some cases disposing, raw or inadequately treated waste water in earthen lagoons; (2) the presence, locally, of high concentrations of coliform organisms and other pollutants in accumulations of fecal matter at stock pens and livestock feeding operations; and (3) concentration of a wide variety of contaminants in accumulated runoff in local depressions following periods of heavy or sustained precipitation. It would appear reasonable to assume, therefore, that pollutants are a normal constituent of water infiltrating the ground-water reservoir in the vicinity of the city.

NATURAL HAZARDS

The Clovis area normally receives considerable wind in the spring, and thunderstorms, which may occasionally produce hail and/or damaging winds, are common both in late spring and throughout the summer. During an average year, approximately two-thirds of the annual precipitation occurs during the months of May through September and in this period of the year some streets and low-lying areas in the city may be occasionally flooded during or following periods of intense or prolonged precipitation. The city is not considered to be particularly susceptible to damage from earthquakes; however, it should be noted that at least seven seismic disturbances have been recorded in the general region during the past 55 years that attained maximum intensities of either 5 or 6 on the Modified Mercalli Scale (see Northrop and Sanford, this Guidebook).

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