

GEOHYDROLOGIC CHARACTERISTICS AND HYDROCARBON CONTAMINATION OF THE SHALLOW ALLUVIAL/TESUQUE FORMATION AQUIFER, SANTA FE, NEW MEXICO

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Abstract—The city of Santa Fe, New Mexico is underlain by Quaternary alluvium, the Pliocene/Pleistocene Ancha Formation, and the Miocene Tesuque Formation. The principal aquifer for Santa Fe is Tesuque Formation sediments located at a depth of greater than 200 ft below the surface. The Tesuque is overlain by 5 to 40 ft of Quaternary alluvium within the study area. Shallow groundwater in the Santa Fe area occurs either at or within 20 ft of the contact between Quaternary alluvium and Tesuque Formation sediments. This shallow groundwater is locally controlled by the location of buried channels, faults, and higher permeability zones at the top of the Tesuque Formation and is generally present within 1.5 mi of the mountain front. The shallow aquifer has very low productivity and an estimated hydraulic conductivity of 0.2 to 0.4 ft/day. The shallow groundwater is vulnerable to contamination by near-surface sources, most commonly by leaking underground storage tanks. Groundwater flow velocities and maximum solute transport rates in the aquifer range from 0.015 to 0.09 ft/day (5.5 to 33 ft/year). At locations where a strong vertical gradient exists, the shallow, contaminated groundwater may migrate vertically through high-permeability faults, fractures and bedding planes to deeper portions of the Tesuque Formation aquifer.

INTRODUCTION

West of the Sangre de Cristo Mountain front, the city of Santa Fe, New Mexico is underlain by Quaternary sediments and the Quaternary/Tertiary Santa Fe Group, which includes the Pliocene/Pleistocene Ancha Formation and the Miocene Tesuque Formation (Spiegel and Baldwin, 1963; Kelley, 1978). Because of historic settlement patterns in Santa Fe,

many older gasoline stations and other commercial enterprises were located along the Cerrillos Road corridor (Fig. 1). Numerous shallow borings, predominantly for environmental investigations, have been completed in this area. The purpose of these investigations generally was to determine if "soil" and/or groundwater beneath these sites had been contaminated by hydrocarbons. Most investigations have been performed

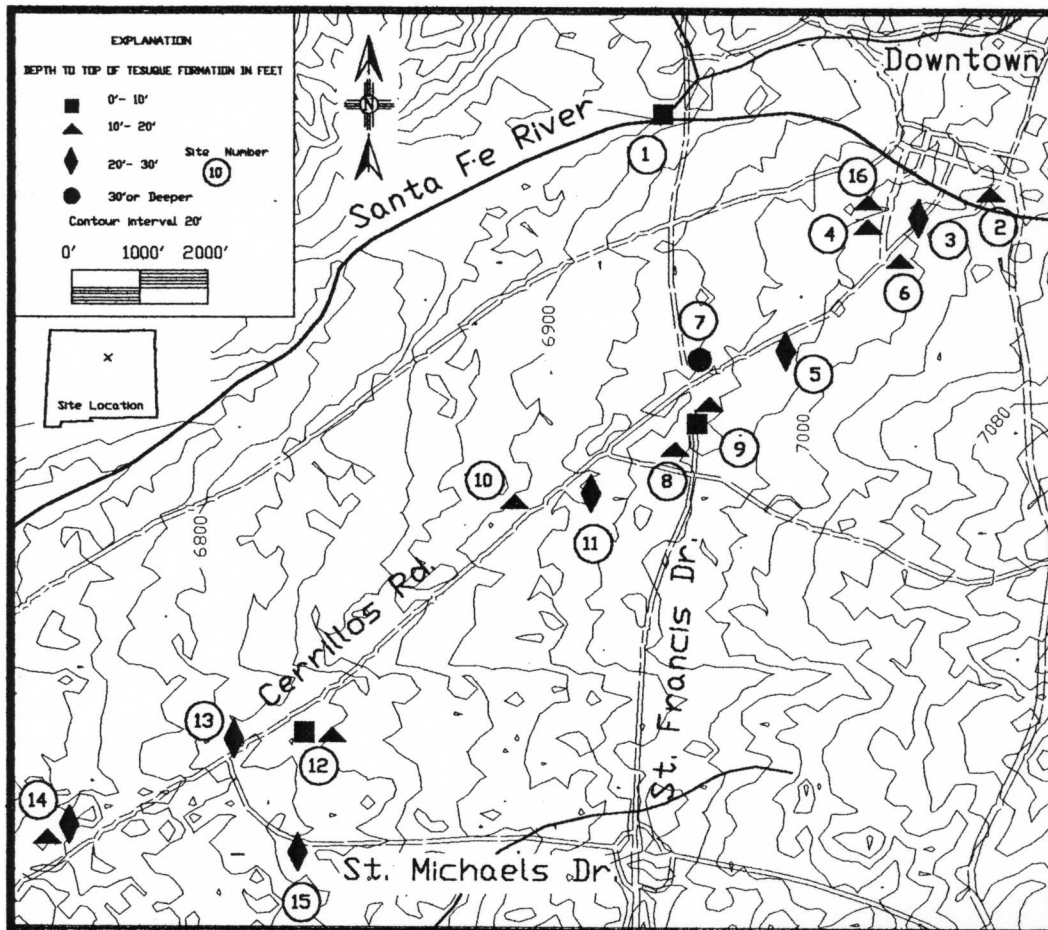


FIGURE 1. Site location and depth to top of Tesuque Formation in the Santa Fe area.

under regulatory requirements (i.e., to investigate possible releases of gasoline or diesel fuel), or were performed for completion of due diligence for real estate transactions.

This paper focuses on the geologic and hydrologic characteristics of the Quaternary alluvium and the Tesuque Formation. Although much of the information utilized is publicly available, we avoid identification of which specific sites are or were contaminated, and accordingly, refer only to sites by site numbers (Table 1). For further information on specific sites, readers are encouraged to contact Glorieta Geoscience, Inc.

The data for this report include reports completed by the authors and other investigators in the city of Santa Fe. We emphasize that field investigations were performed by investigators with different levels of experience in the Santa Fe River basin, and with differing interpretations and descriptions of shallow subsurface geology. We reviewed numerous lithologic logs and selected 16 sites with logs that clearly described sedimentary units that could be identified as Quaternary alluvium and Tesuque Formation. Because of the lack of precise vertical control at most locations, the 20-ft topographic contour interval on the USGS 7.5 min Santa Fe Quadrangle and the presence of man-made fill at many locations in the downtown Santa Fe area, no attempt was made to contour the top of the Tesuque Formation or depth to groundwater.

GEOLOGIC SETTING

The study area is located near the eastern margin of the Española Basin within the Rio Grande rift and is underlain by basin-fill sediments

(Kelley, 1978). Quaternary alluvium is dominantly composed of unconsolidated sand, silt, clay, gravel and boulders. The Ancha Formation was derived from erosion of Tesuque Formation sediments, Precambrian crystalline rocks, and possibly upper Paleozoic sediments (Spiegel and Baldwin, 1963). The Tesuque Formation is a pink, tan, buff-colored silty to conglomeratic sand and sandstone typically interbedded with clay and siltstone beds, deposited as alluvial-fan, fluvial and isolated lacustrine deposits. Because most of the Tesuque and Ancha Formations were deposited by broad interfingering alluvial fans, subsurface correlation of these formations is problematic. The Ancha Formation is undeformed, whereas Tesuque strata locally dip from 10° to 25° to the west. In describing cuttings and split spoon samples from borings in the Santa Fe area, we have generally identified the alluvium as brown sandy gravel, and Tesuque Formation as red, orange-brown, or red-brown semi-consolidated sandstone (Table 2). The Ancha Formation, which generally crops out south of the Cerrillos Road corridor (Spiegel and Baldwin, 1963), has not been identified in the lithologic logs used.

Based on available data, the Tesuque Formation is unconformably overlain by 5 to 40 ft of Quaternary alluvium within the study area (Figs. 1, 3). Unconsolidated Quaternary terrace deposits were deposited from both meandering and braided streams. Alluvium represents deposits underlying three fluvial terraces flanking the Santa Fe River and/or local tributaries (Spiegel and Baldwin, 1963) and alluvial fan deposits along the Sangre de Cristo mountain front. The absence of soil development at the top of the Tesuque Formation and the irregular contact between the

TABLE 1. Depth to top of Tesuque Formation in ft below ground surface

Site Number	Maximum Depth of Boring	Depth to Top of Tesuque Fm.	Groundwater Encountered	Depth to Groundwater	Groundwater Gradient
1	80	7-17	YES	14-30	Toward SF River
2	25	12-18	YES	20	UNKNOWN
3	36	23-25	YES	20-23	Toward SF River
4	30	15-18	YES	17	Toward SF River
5	90	20-26	NO	N/A*	N/A
6	31	11-14	NO	N/A	N/A
7	82	30-34	YES	12	UNKNOWN
8	20	15-20	NO	N/A	N/A
9	62	6-12	YES	56	To/Parallel to SF River
10	82	20	NO	N/A	N/A
11	51	21	NO	N/A	N/A
12	60	10	NO	N/A	N/A
13	135	27-29	YES	107	N/A
14	32	10-25	NO	N/A	N/A
15	70	15-20	NO	N/A	N/A
16	20	20	YES	20	N/A

*N/A No groundwater encountered

TABLE 2. Sedimentology of Alluvium and Tesuque Formation described from cuttings and split spoon samples at selected GGI sites in the Santa Fe area.

Site Number	Description of Alluvium	Description of Tesuque Formation
1	Brown sandy gravel.	Medium to coarse, orange-brown and red-brown sand and clay
3	Brown sandy gravel. Gravel composition- granite, quartzite, foliated metamorphics (amphibolite).	Red sandy gravel, sandy clay, and medium to coarse sand.
4	Yellow-brown sandy gravel with minor interbedded clay.	Reddish-brown, medium to coarse sand.
6	Brown or reddish-brown sandy gravel with minor clay. Gravel composition- granite and metamorphics. Predominantly cobble-size gravel with some boulders present.	Red, gravelly, semi-consolidated (weathered) sandstone.
13	Brown sandy gravel, sandy clay, and sand.	Reddish-brown sand, sandy gravel, and clay. Thick section (67 ft) of interbedded greenish-brown clay and pink sand encountered in one bore hole.

