INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with the Cheyenne and Arapaho Tribes, conducted the present study to determine the vulnerability to contamination of ground water beneath tribal lands within the 3,991-acre Concho Reserve in Canadian County, Oklahoma (map A).

Purpose and Scope

The purpose of this project is to provide information on the hydrologic characteristics of the aquifer and sources of potential ground-water contamination needed to make improvement and protection-planning decisions. Cheyenne-Arapaho tribal managers are planning to improve and protect the public water supply of the Concho Reserve. These plans include a possible relocation the existing well field. Ground-water wells in this well field within the Reserve produce water for public use.

This report gives the results of field reconnaissance observations, provides a compilation of hydrologic data from files of the USGS, and includes data on ground-water hydrology and geology of the area within and immediately surrounding the Concho Reserve. Current land use and potential sources of contamination of ground water are identified. Tables of water-quality data from 1943 through 1980 have been compiled from files of the USGS. The location of the study area is shown on figure 1.

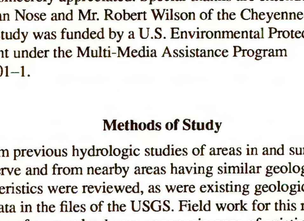

Figure 1.—Location of study area.

Previous Studies

Mogg, Schoff, and Reed (1960) described the ground-water resources of Canadian County, Oklahoma. Records of well and test-hole data, results of chemical analyses of ground water, analyses of aquifer tests and test-hole cores, and estimates of annual recharge are included in their report. Contour maps showing bedrock elevations, the static water-table elevation, the thickness of alluvial and terrace deposits, and the saturated thickness of alluvial deposits are presented in the report. Their report contains hydrologic data and available ground-water-quality analyses for alluvial and terrace deposits along the North Canadian River in Canadian County. Many of the data contained in their report were collected in the alluvium within and adjacent to the Concho Reserve.

Christenson (1983) studied the hydrologic system of the alluvial and terrace deposits along the North Canadian River to determine the maximum annual yield of ground water. His report describes the use of a digital model to simulate the hydrologic system of the alluvial and terrace aquifer along the North Canadian River valley from Canton Dam, located 85 river miles upstream from the Concho Reserve, to Lake Overholser, located 23 river miles downstream from the Concho Reserve.

Jacobsen and Reed (1949) compiled information to the end of 1943 on the ground-water resources of the Oklahoma City area. Their report contains a discussion of the hydrologic properties of the North Canadian River alluvium and low terraces, including Pleistocene terrace deposits in the vicinity of Lake Overholser. Comparison of maps by Jacobsen and Reed (1949) with maps by Mogg, Schoff, and Reed (1960, pl. I) shows that alluvial and terrace deposits in the Lake Overholser area are lithologically similar to deposits on the Concho Reserve.

An appraisal of the potential impact of agricultural practices in the vicinity of the current water-supply wells of the Concho Reserve was conducted by the Oklahoma Department of Agriculture (written commun. to the Cheyenne-Arapaho Tribes, 1989). This survey did not include water-quality analyses, and therefore did not identify existing contamination. A recommended action was to monitor for the pesticides Glean[1] and 2,4-D by water-quality analysis of samples from the Cheyenne-Arapaho wells during early spring months.

Acknowledgments

Cooperation extended by members of the Cheyenne-Arapaho Tribe Public Works Department in obtaining local information and access to tribal land is sincerely appreciated. Special thanks are extended to Mr. Melvin Roman Nose and Mr. Robert Wilson of the Cheyenne-Arapaho Tribes. This study was funded by a U.S. Environmental Protection Agency Region 6 grant under the Multi-Media Assistance Program NI–006423–01–1.

Methods of Study

Data from previous hydrologic studies of areas in and surrounding the Concho Reserve and from nearby areas having similar geologic and hydrologic characteristics were reviewed, as were existing geologic maps and hydrologic data in the files of the USGS. Field work for this report included documentation of current land uses, reconnaissance of existing springs and seeps draining the terrace within the Reserve, an inventory of ground-water wells in and adjacent to the Concho Reserve, and identification of potential sources of ground-water contamination within the Reserve.

Explanation of the Local Identifier

Locations of data sites are specified by latitude and longitude to the nearest second and by a local identifier based upon the Oklahoma public-land survey. Local identifiers include the township and range followed by the section number and a series of letters that designate the quarter-section subdivisions from largest to smallest. A sequence number is added to make each local identifier unique. As illustrated in figure 2, the public-land survey description of the site indicated by the dot is NW 1/4 NW 1/4 NW 1/4 sec. 19, T. 13 N., R. 07 W.; the USGS local identifier is 13N-07W-19 BBB. If the sequence number is 1, the complete identifier is 13N-07W-19 BBB 1.

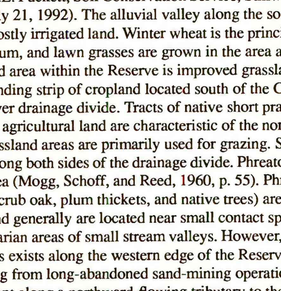

Figure 2.—Local identifier numbering sequence.

PHYSIOGRAPHY

The Concho Reserve covers 3,991 acres in the Central Redbed Plains region of Canadian County, Oklahoma. The Reserve lies along a prominent drainage divide between the Cimarron River to the north and the North Canadian River to the south. Land-surface altitudes vary from 1,258 feet above the National Geodetic Vertical Datum of 1929 (NGVD) along a streambed at the northern boundary of the Reserve to about 1,430 feet at the crest of the drainage divide. The area north of the drainage divide is upland prairie dissected by many deeply eroded gullies and small streams. The area south of the drainage divide is upland prairie with many small valleys that only extend to the alluvial floodplain within the southern part of the study area. A land-surface profile *A–A′* extending from the south boundary of the Concho Reserve to the north boundary of the Reserve across the highest part of the drainage divide within the Reserve is shown on figure 3. The location of the profile is shown on map A.

LAND USE

The Reserve includes 2,710 acres of pasture, 1,209 acres of cropland, and 72 acres of roads (Cross and Associates, Inc, Norman, Okla., written commun., 1975). Tribal administrative buildings, small repair and maintenance shops, warehouses, a childrens' day-care facility, and about 20 residences and structures of the inactive Concho Indian school occupy the west-central side of the tract. Commercial locations are a Bingo Hall located in the gymnasium of the inactive school and a tribal smoke shop located at the eastern entrance to the Reserve. A small hog farm and grain-storage bins are located near the center of the Reserve. An abandoned hydroponics installation is located near the southwest corner of the Reserve.

Vegetation in the study area varies from natural grasses to cultivated farm land (W.E. Puckett, Soil Conservation Service, Stillwater, Okla., written commun., July 21, 1992). The alluvial valley along the southern part of the Reserve is mostly irrigated land. Winter wheat is the principal crop, but corn, alfalfa, sorghum, and lawn grasses are grown in the area also. Most of the central upland area within the Reserve is improved grassland except for an east-west-trending strip of cropland located south of the Cimarron-North Canadian River drainage divide. Tracts of native short prairie grasses and non-irrigated agricultural land are characteristic of the northern part of the Reserve. Grassland areas are primarily used for grazing. Small stock ponds are located along both sides of the drainage divide. Phreatophytes are present within the area (Mogg, Schoff, and Reed, 1960, p. 55). Phreatophytes (generally cedars, scrub oak, plum thickets, and native trees) are scarce over much of the area and generally are located near small contact springs or seeps in the upper riparian areas of small stream valleys. However, a dense growth of phreatophytes exists along the western edge of the Reserve within depressions resulting from long-abandoned sand-mining operations.Phreatophytes also are present along a northward-flowing tributary to the Cimarron River that has eroded a steep-sloped narrow valley through most of the terrace to near the drainage divide of the Cimarron and North Canadian Rivers. The general distribution of grassland, cropland, and brush within and surrounding the Concho Reserve is shown on map B.

[1]Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government

Map A.—Geology and ground-water well locations in the area of the Concho Reserve.

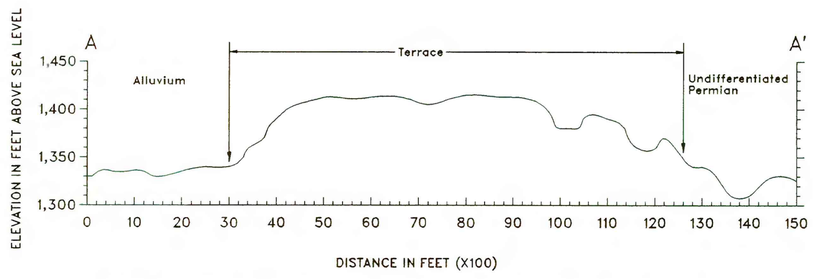

Figure 3.—Land-surface profile and surficial geology extending from the south boundary (*A*), to the north boundary (*A′*) of the Concho Reserve. Surficial geology from Mogg, Schoff, and Reed (1960).

Table 1.—*Selected records of wells and test-holes in and adjacent to the Concho Reserve*

[Depth of well and water levels are reported as depth in feet below land-surface datum. Principal aquifer codes: 110ALVM, North Canadian River alluvium; 112TRRCH, high terrace deposits; 313ELRN is synonymous with Permian undifferentiated rocks as used in this report. Use of water: H, domestic; I, irrigation; N, industrial; O, observation well; P, Public supply; S, livestock; T, institutional; U, unused. Source of depth data: D, drillers' reports; R, reported; S, U.S. Geological Survey]

Site number on map A	Local well number	Site-id	Aquifer code	Altitude of land surface (feet)	Depth of well (feet)	Source of depth data	Water level (feet)	Date water level measured	Primary use of water
1	13N-07W-09 ABB 1	353724097565801	313ELRN	1250	15.5	S	3.29	04-07-92	H
2	13N-07W-09 CBA 1	353657097572201	313ELRN	1270	--	--	1.70	04-07-92	S
3	13N-07W-16 CDC 1	353544097565201	313ELRN	1350	68.8	S	3.58	04-07-92	U
4	13N-07W-17 DCC 1	353543097575601	112TRRCH	1335	27	S	13.7	05-06-92	S
5	13N-07W-19 BBB 1	353527097591901	110ALVM	1335	40	S	11.3	04-06-52	P
6	13N-07W-19 BBC 1	353531097593901	110ALVM	1335	44	S	8.4	05-06-92	P
7	13N-07W-19 BCB 1	353524097593601	110ALVM	1315	45	S	--	--	P
8	13N-07W-19 CCD 1	353701097590101	110ALVM	1335	47	T	18	- -19	U
9	13N-07W-20 CDD 1	353700097580002	110ALVM	1323	36	T	12	- -19	U
10	13N-07W-21 DDD 1	353701097570101	110ALVM	1322	40	T	9.75	- -19	U
11	13N-07W-28 ABD 1	353437097564301	110ALVM	1318	--	--	40.5	07-14-80	I
12	13N-07W-28 ADB 1	353432097564901	--	1315	50	D	15	03-20-73	H
13	13N-07W-28 BBD 1	353436097571601	110ALVM	1320	47	D	12	03-00-80	I
14	13N-07W-28 DCA 1	353403097565301	110ALVM	1310	48	D	12	11-29-73	I
15	13N-07W-28 DCD 1	353402097564901	--	1320	44	D	8	05-15-85	P
16	13N-07W-29 ACC 1	353426097580001	110ALVM	1325	48	D	16	05-30-79	S
17	13N-07W-29 ADA 1	353429097573501	110ALVM	1320	43	D	15	09-25-72	I
18	13N-07W-29 ADD 1	353425097573601	110ALVM	1320	47	D	15	09-23-72	I
19	13N-07W-29 CCC 1	353500097580001	110ALVM	1329	26	S	18.7	03-30-42	U
20	13N-07W-30 ABA 1	353500097590001	110ALVM	1330	38	S	14	- -19	U
21	13N-07W-30 ADD 1	353429097584401	110ALVM	1325	45	D	15	05-09-80	N
22	13N-07W-32 AAB 1	353356097574601	110ALVM	1325	--	-	21	04-07-92	H
23	13N-07W-33 BBA 1	353353097571901	110ALVM	1315	--	-	20	04-07-92	H
24	13N-07W-33 BBA 2	353352097571801	110ALVM	1315	--	-	17.2	04-07-92	H
25	13N-07W-33 BBC 1	353350097572301	110ALVM	1315	--	-	20.4	04-07-92	U
26	13N-08W-01 DCC 1	353729098000701	112TRRCH	1350	11.7	S	1.98	04-07-92	U
27	13N-08W-01 DDD 1	353728097594401	112TRRCH	1350	53	D	18	02-07-84	N
28	13N-08W-12 ACC 1	353700098000701	110ALVM	1380	30.34	S	8.12	04-07-92	H
29	13N-08W-12 BBA 1	353714098003401	112TRRCH	1400	35	S	8.45	01-27-54	S
30	13N-08W-12 CCB 1	353643098004401	112TRRCH	1423	37.8	S	29.1	04-23-80	U
31	13N-08W-12 DDC 1	353637097594301	112TRRCH	1405	86	S	21.6	05-06-92	U
32	13N-08W-13 ABA 1	353632098000001	110ALVM	1402	12.6	S	3.65	01-27-54	U
33	13N-08W-13 CBC 1	353610098004301	110ALVM	1349	47	R	17	- -19	U
34	13N-08W-13 CCB 2	353550098004001	110ALVM	1345	40	S	23	- -47	P
35	13N-08W-13 CCC 1	353545098003501	110ALVM	1345	41	R	27	08-01-48	P
36	13N-08W-13 DCD 1	353547098000001	110ALVM	1340	40	R	15	- -19	U
37	13N-08W-24 ABB 1	353534098001001	110ALVM	1346	49	R	28	- -19	U
38	13N-08W-24 ADA 1	353527097594401	110ALVM	1340	47	R	25	- -19	U
39	13N-08W-24 BBB 1	353540098004101	110ALVM	1347	46	R	18	- -19	U
40	13N-08W-24 BCC 1	353517098004101	110ALVM	1344	46.5	R	16	- -19	U
41	13N-08W-24 CCB 1	353500098004101	110ALVM	1336	47	S	18	01-05-49	U
42	13N-08W-24 CCD 1	353453098003301	110ALVM	1336	55	S	22	07-00-54	I
43	13N-08W-24 CDC 1	353451098002101	110ALVM	1341	44	R	15	- -19	U
44	13N-08W-24 CDC 2	353452098002201	110ALVM	1341	54	S	24	05-00-53	I
45	13N-08W-24 DCC 1	353454098001201	110ALVM	1335	43.5	S	15.3	04-07-92	H
46	13N-08W-24 DCD 1	353452098000701	110ALVM	1337	45	R	17	- -19	U
47	13N-08W-24 DDC 1	353452097573401	110ALVM	1336	44	R	18	- -19	U
48	13N-08W-25 BCD 1	353426098003201	112TRRCH	1335	43	D	15	12-19-79	S

EXPLANATION

Qal

ALLUVIUM

Silt, clay, sand, and gravel. Generally the more permeable deposits are below the water table. Water from alluvial deposits is generally hard and contains excessive amount of sulfate in some areas

Qt

TERRACE DEPOSITS

Silt, clay, sand, and gravel in variable proportions with predominantly fine-grained sand. Yields good-quality water for domestic use in some areas of Canadian County

QUATERNARY

Pu

UNDIFFERENTIATED PERMIAN ROCKS OF THE EL RENO GROUP

Reddish-brown shale, siltstone, and fine-grained sandstone, with thin layers of gypsum and dolomite. Well yields sufficient for domestic and stock use can generally be obtained. In some areas the water is highly mineralized

PERMIAN

BOUNDARY OF THE CONCHO RESERVE

DRAINAGE DIVIDE—Separates North Canadian and Cimarron River drainage areas

A — A′

LOCATION OF LAND-SURFACE PROFILE (fig. 3)

21

GROUND-WATER WELL—Number by well is well site number listed in table 1

SPRING

▲07239500

STREAM-GAGING STATION—Number is station identification number

CLIMATE

The study area has a dry subhumid climate. Average annual precipitation is about 29.50 inches (Department of Commerce, monthly summaries). Precipitation is greatest during spring and early summer months and least during late summer and winter months. Consecutive years of lower-than-normal rainfall are common, when annual precipitation is only 55 to 60 percent of average. Average wind velocity is 12 miles per hour. Winds generally are from the south except during winter months, when frequent regional weather fronts from the north and northwest pass through the area. Average annual pan evaporation is 61 inches.

GEOLOGY

In the Concho Reserve, Permian rocks of the El Reno Group are overlain partially by Quaternary terrace deposits along a topographic drainage divide running east to west across the Reserve (map A) (Mogg, Schoff, and Reed, 1960, pl. I). Alluvial deposits of the North Canadian River are present along the southern edge of the area. Permian rocks of the area are locally referred to as red beds because of their reddish-brown to red color. Red beds within the study area are described as a single unit in this report and are not differentiated by formation.

The Permian red-bed sequence within the study area consists of alternating layers of marine deposits ranging from reddish-brown silty clay shale and reddish-brown silty shale to fine-grained sandstone with interbedded evaporites (Mogg, Schoff, and Reed, 1960, p. 23–28). The red beds are exposed over the northeast third of the study area,and along a road cut above the North Canadian River alluvium near the southwest corner of the main Reserve area.

Terrace deposits are probably of Pleistocene age and overlie the red beds along the drainage divide between the Cimarron River and the North Canadian River (Mogg, Schoff, and Reed, 1960, p. 35–41). These deposits are mainly lenticular beds of silt, sand, and clay with some gravel near the base. Because of insufficient data, accurate estimates of the thickness of terrace deposits throughout the Reserve cannot be made. Field observations indicate that the thickness varies from a thin veneer along the edges of the deposits to a maximum of about 60 feet in a small area near the water towers on the west-central edge of the Reserve. Field observations suggest that the average terrace thickness over the Reserve is about 30 feet.

Alluvial deposits form a strip about half a mile wide within the southern boundary of the study area (Mogg, Schoff, and Reed, 1960, p. 41–45). These deposits are a segment of the 2.5–mile wide North Canadian River alluvial valley. The alluvial deposits are not uniform, but are composed of interfingering lenses of silt, clay, and fine to coarse sand and gravel. Alluvial deposits of the North Canadian River are the principal source of municipal, industrial, and irrigation water supplies in Canadian County (Mogg, Schoff, and Reed, 1960).

HYDROLOGY

Surface Water

The Concho Reserve lies along the drainage divide between the Cimarron River, about 22 miles to the north, and the North Canadian River, about 2.5 miles to the south. There are no perennial streams within the Reserve. Surface water flowing north of the divide to the Cimarron River is conveyed by many deep, narrow tributaries that have eroded upstream to near the drainage divide and have removed much of the terrace deposit that overlies the Permian rocks. Surface water flowing south of the divide is conveyed by many smaller valleys that extend only to the adjacent alluvium of the North Canadian River, where water ponds and subsequently percolates into the alluvium or is lost to evaporation and transpiration.

The availability of surface water within the boundaries of the Reserve is limited to impoundment in small stock ponds during periods of direct surface runoff. Drainage areas above these ponds are small and provide only enough direct surface runoff to maintain storage in ponds for stock and wildlife use.

Springs

Small springs and seeps within the Reserve are ephemeral and discharge ground water in response to seasonal variations in precipitation and evapotranspiration. Small springs and seeps are present near the contact of the terrace with the less permeable Permian rocks near the upper end of most tributaries draining the north slope of the Reserve. Similar seeps are located along the south slope of the terrace within the Reserve above two small stock ponds and along a road cut where the terrace-red bed contact is exposed. Ground water from the terrace probably recharges the alluvium along the terrace-alluvium contact where red beds are not exposed.

Caddo Spring (see map A), which is the only named spring within the Reserve, is of historical significance to the Cheyenne-Arapaho Tribes (Melvin Roman Nose, personal commun., 1992). Caddo Spring is a depression spring located on a steep hillside of a stream valley. The most significant ground-water outflow within the Reserve is to a small wetland area below Caddo Spring. The wetland is formed behind the remains of a small earthen dam beside the stream. This outflow is probably from several small springs at the base of the more permeable terrace deposits within the wetted area in addition to the discharge from Caddo Spring a short distance upstream. Total outflow from this wetted area was estimated to range from 20 to 30 gallons per minute from March through July 1992. The discharge from Caddo Spring was no more than 5 percent of the total outflow during this period, and there was no flow at times.

LAND-USE AND GROUND-WATER DATA, CHEYENNE-ARAPAHO TRIBES, CONCHO RESERVE, CANADIAN COUNTY, OKLAHOMA

By

D.L. Bergman and M.E. Savoca

1993