GEOHYDROLOGIC UNITS AND WATER-LEVEL CONDITIONS IN THE TERRACE ALLUVIAL AQUIFER AND PALUXY AQUIFER, MAY 1993 AND FEBRUARY 1994, NEAR AIR FORCE PLANT 4, FORT WORTH AREA, TEXAS

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 96–4032

Prepared in cooperation with the
U.S. AIR FORCE AERONAUTICAL SYSTEMS CENTER, ENVIRONMENTAL MANAGEMENT DIRECTORATE

GEOHYDROLOGIC UNITS AND WATER-LEVEL CONDITIONS IN THE TERRACE ALLUVIAL AQUIFER AND PALUXY AQUIFER, MAY 1993 AND FEBRUARY 1994, NEAR AIR FORCE PLANT 4, FORT WORTH AREA, TEXAS

By G.A. Rivers, E.T. Baker, Jr., and L.S. Coplin

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 96–4032

Prepared in cooperation with the
U.S. AIR FORCE AERONAUTICAL
SYSTEMS CENTER, ENVIRONMENTAL
MANAGEMENT DIRECTORATE

Austin, Texas
1996

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
8011 Cameron Rd.
Austin, TX 78754–3898

Copies of this report can be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Box 25286, Mail Stop 517
Denver Federal Center
Denver, CO 80225–0046

CONTENTS

PLATES

[Plates are at back]

FIGURES

TABLE

VERTICAL DATUM

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Geohydrologic Units and Water-Level Conditions in the Terrace Alluvial Aquifer and Paluxy Aquifer, May 1993 and February 1994, near Air Force Plant 4, Fort Worth Area, Texas

By G.A. Rivers, E.T. Baker, Jr., *and* L.S. Coplin

Abstract

The terrace alluvial aquifer underlying Air Force Plant 4 and the adjacent Naval Air Station (formerly Carswell Air Force Base) in the Fort Worth area, Texas, is contaminated locally with organic and metal compounds. Residents south and west of Air Force Plant 4 and the Naval Air Station are concerned that contaminants might enter the underlying Paluxy aquifer, which provides water to the city of White Settlement, south of Air Force Plant 4, and to residents west of Air Force Plant 4. The U.S. Environmental Protection Agency has qualified Air Force Plant 4 for Superfund cleanup.

The pertinent geologic units include—from oldest to youngest—the Glen Rose, Paluxy, and Walnut Formations, Goodland Limestone, and terrace alluvial deposits. Except for the Glen Rose Formation, all units crop out at or near Air Force Plant 4 and the Naval Air Station. The terrace alluvial deposits, which nearly everywhere form the land surface, range from 0 to about 60 feet thick. These deposits comprise a mostly unconsolidated mixture of gravel, sand, silt, and clay. Mudstone and sandstone of the Paluxy Formation crop out north, west, and southwest of Lake Worth and total between about 130 and about 175 feet thick.

The terrace alluvial deposits and the Paluxy Formation comprise the terrace alluvial aquifer and the Paluxy aquifer, respectively. These aquifers are separated by the Goodland-Walnut confining unit, composed of the Goodland Limestone and (or) Walnut Formation. Below the Paluxy aquifer, the Glen Rose Formation forms the Glen Rose confining unit.

Water-level measurements during May 1993 and February 1994 from wells in the terrace alluvial aquifer indicate that, regionally, ground water flows toward the east-southeast beneath Air Force Plant 4 and the Naval Air Station. Locally, water appears to flow outward from ground-water mounds maintained by the localized infiltration of precipitation and reportedly by leaking water pipes and sanitary and (or) storm sewer lines beneath the assembly building at Air Force Plant 4. North of Farmers Branch, the terrace alluvial aquifer discharges into Lake Worth, Meandering Road Creek, Farmers Branch, and the West Fork Trinity River. South of Farmers Branch, ground water appears to flow mostly north-northeastward. Greater precipitation prior to the May 1993 measurements caused water levels to average approximately 5 ft higher in May 1993 than in February 1994.

Regional ground-water gradients indicate west to east-southeastward flow in the Paluxy aquifer, with a dominant southeastward component beneath Air Force Plant 4. Water-level maps for the Paluxy "upper sand" reveal an elongated ground-water mound beneath southeastern parts of Air Force Plant 4, which indicates a localized, vertical conduit through which contaminated water from the terrace alluvial aquifer might enter upper parts of the Paluxy aquifer. The Paluxy "upper sand" apparently is mostly unsaturated and hydraulically separated from the deeper, regionally extensive parts of the Paluxy aquifer, most of which are fully saturated. While water levels in the "upper sand"

were as much as 10 ft higher in May 1993 than in February 1994, water levels in most deeper parts of the Paluxy aquifer were slightly higher in February 1994 than they were in May 1993.

INTRODUCTION

The terrace alluvial aquifer underlying Air Force Plant 4 (AFP4), Fort Worth, Texas, and the adjacent Naval Air Station (NAS), Carswell Field, is contaminated locally with organic and metal compounds (Geo-Marine, Inc., 1995; RUST Geotech, 1995). In 1990, the U.S. Environmental Protection Agency (USEPA) qualified AFP4 for Superfund cleanup action. In 1994, the U.S. Navy assumed control of Carswell Field—formerly Carswell Air Force Base—from the U.S. Air Force (USAF).

Nearby residents are concerned that contaminants from AFP4 might enter municipal and domestic water-supply wells south and west of AFP4. The city of White Settlement, south of AFP4, operates five to seven municipal water-supply wells in the Paluxy aquifer, with each well reportedly yielding at least 50 gallons per minute (gal/min) (Joey Highfill, City of White Settlement, oral commun., 1995). Residents along the south shore of Lake Worth and west of AFP4 use water from domestic wells in the Paluxy aquifer. Water from the terrace alluvial aquifer is not used for municipal or domestic water supply.

The USAF has retained control over environmental clean-up efforts at AFP4. As part of the site Remedial Investigation and to assist in the design of remediation, the U.S. Geological Survey (USGS) was requested to (1) collect geohydrologic data and prepare water-level maps of the terrace alluvial aquifer and the Paluxy aquifer; (2) determine ground-water-flow direction in each aquifer and determine any changes in water levels in 2 years; and (3) make these data and interpretations available for the development of a ground-water-flow model. The water-level maps indicate possible directions of contaminant migration and are being used to calibrate a ground-water-flow model currently (1996) under development for the USAF. The study was made in cooperation with the U.S. Air Force Aeronautical Systems Center, Environmental Management Directorate.

Purpose and Scope

This report describes the geohydrologic units and the water-level conditions in the terrace alluvial aquifer at Air Force Plant 4 and at the adjacent Naval Air Station (AFP4/NAS) and in the Paluxy aquifer in the northwestern part of Tarrant County, including AFP4/NAS. Water-level maps were prepared from measurements made during May 1993 and February 1994.

Study Area

The study area is in northwest Tarrant County, on the northwestern edge of Fort Worth (fig. 1). Population centers include Fort Worth (population about 450,500) mostly to the east of the study area, White Settlement (population about 15,500) adjacent to AFP4/NAS on the south, and a residential development west of AFP4.

The topography generally is a low-relief, east-southeast sloping terrain incised by the West Fork Trinity River and its tributaries. The AFP4/NAS is located on an alluvial terrace, which is bounded on the north by Lake Worth and on the east by the West Fork Trinity River.

The mean annual temperature in the study area is about 66 °F (degrees Fahrenheit), and mean annual precipitation is about 32 inches per year (in/yr). Overall, the climate is classified as subhumid (Leggat, 1957).

Data-Collection and Interpretive Methods

Many wells tapping the surficial terrace alluvial aquifer and the underlying Paluxy aquifer were inventoried and monitored for water-level information during 1993 and 1994. This was done mostly to ascertain the directions of ground-water flow and to track water-level changes. About one-half of the Paluxy aquifer wells were domestic (mostly household) water-supply wells in rural and urban areas outside the perimeter of AFP4/NAS, and about one-half were observation wells (not used for water supply) on AFP4/NAS.

Six terrace alluvial aquifer wells and 10 Paluxy aquifer wells were drilled by the USGS between November 1993 and January 1994 to establish additional sites for water-level measurements and water sampling points as well as to provide data for a future ground-water model of the two aquifers. All wells in the terrace alluvial aquifer are located on AFP4/NAS. Four of the Paluxy aquifer wells are located on AFP4/NAS; two were completed in the middle zone and two were

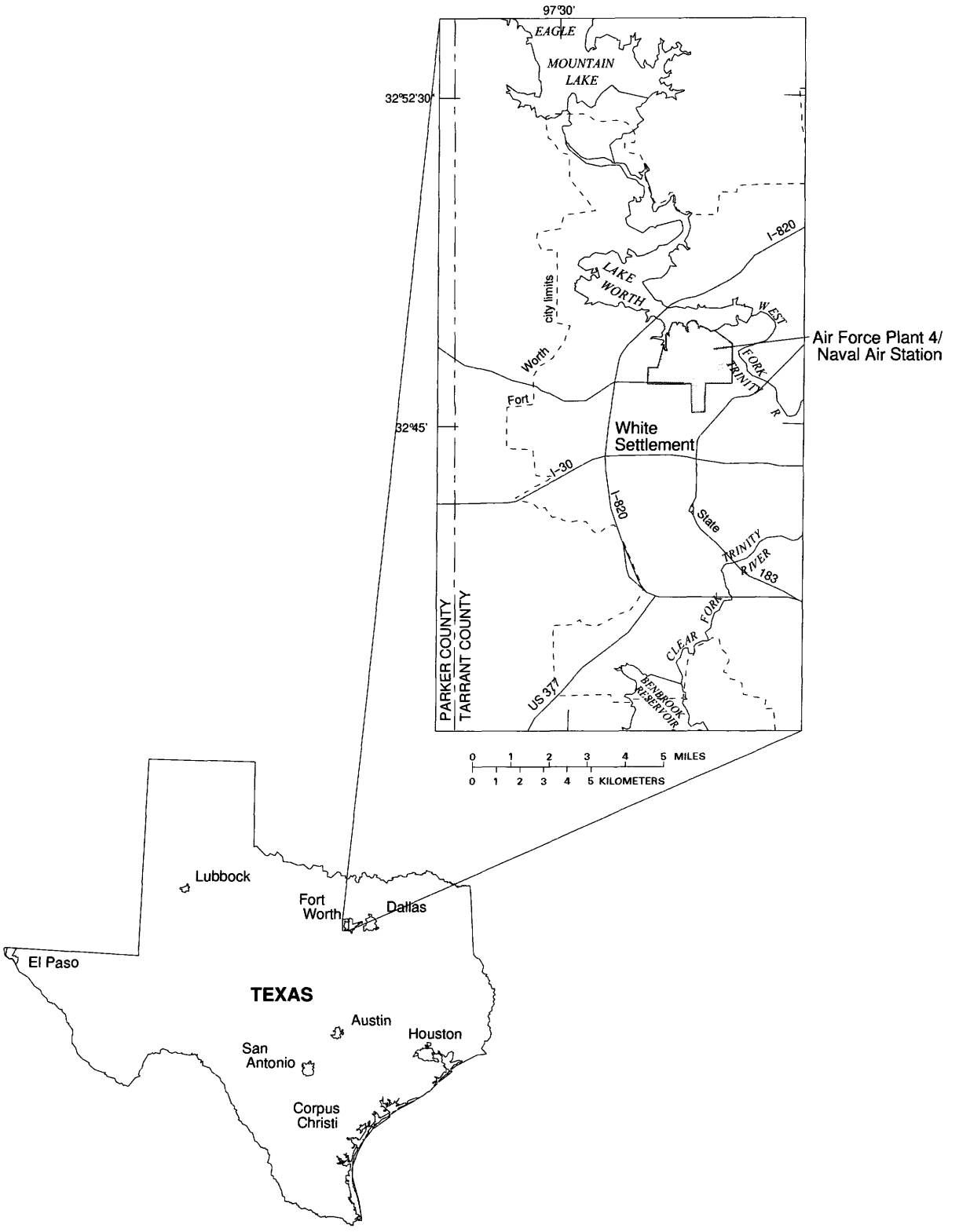

Figure 1. Location of the study area.

completed in the upper zone of the Paluxy aquifer. The other six Paluxy aquifer wells were drilled at two nested well sites (three wells per site) about 1,400 feet (ft) (USGS08P, pls. 1 and 2) and about 2,500 ft (USGS09P, pls. 1 and 2) west of AFP4. At each site, the three wells were completed in the upper, middle, and lower zones of the Paluxy aquifer.

Water levels in about 160 wells in the terrace alluvial aquifer and about 90 wells completed in all zones of the Paluxy aquifer were measured during May 1993. During February 1994, water levels were measured in about 50 wells (including the 6 USGS drilled wells) from the terrace alluvial aquifer and about 60 wells (including the 10 USGS drilled wells) completed in all zones of the Paluxy aquifer. Locations of wells on and adjacent to AFP4/NAS are shown on plate 1, and locations of wells outside AFP4/NAS are shown on plate 2.

Water-level maps for the terrace alluvial aquifer, the regional Paluxy aquifer, and the Paluxy "upper sand" at AFP4/NAS (designated "US" on pl. 1) were constructed from the data collected during May 1993 and February 1994. At the nested well sites, only water levels from the middle zone (designated "M" on pls. 1 and 2) were selected to construct the regional Paluxy aquifer water-level map.

Streamflow measurements were made during September 1993, February 1994, and February 1995 (fig. 2, table 1) to ascertain whether ground water might discharge from the terrace alluvial aquifer into streams on and (or) adjacent to AFP4/NAS. The measurements were made during periods of no precipitation to minimize the effects of surface-water runoff. Although the measurements must be considered estimates (because of non-ideal water depths and minimal water velocities), the results indicate that ground water does discharge from the terrace alluvial aquifer into nearby streams and lakes, including Lake Worth.

Acknowledgment

The authors are indebted to Jacobs Engineering Group for providing water-level measurements used in this report. This firm made all the water-level measurements at AFP4/NAS during May 1993.

GEOHYDROLOGIC UNITS

Geologic units pertinent to the study include, from oldest to youngest, the Glen Rose, Paluxy, and Walnut Formations and Goodland Limestone (all of Cretaceous age) and terrace alluvial deposits of Quaternary age. These geologic units form aquifers or confining units in the study area (fig. 3).

Geologic Units

The Glen Rose Formation—consisting mostly of limestone, with interbeds of clay, marl, and sand (Barnes, 1988)—ranges in thickness from about 250 to about 450 ft in the Fort Worth area. The Glen Rose Formation, which everywhere underlies the Paluxy Formation in the study area, crops out several miles west of AFP4/NAS and dips toward the east-southeast at about 30 to 40 feet per mile (ft/mi).

The Paluxy Formation, which mainly consists of mudstone and light-gray to greenish-gray, fine to very fine-grained sandstone, ranges from about 130 to about 175 ft in thickness. The unit extends several miles north and south of the study area and dips toward the east-southeast at about 37 ft/mi (Leggat, 1957). The Paluxy Formation crops out around the northern, western, and southwestern margins of Lake Worth.

The Walnut Formation typically consists of clay and near-equal amounts of limestone (Barnes, 1988). Where not reduced by erosion, the thickness of the unit is about 30 ft. The Walnut Formation, which dips east-southeastward at 20 to 30 ft/mi, is nearly breached by an erosional channel known as the "window" (Chem-Nuclear Geotech, Inc., 1992) beneath eastern parts of AFP4 (fig. 3). The Walnut Formation crops out along the western boundary of AFP4, within the stream channels of Meandering Road Creek, Farmers Branch, and Kings Branch and in the channel of the West Fork Trinity River below Lake Worth Dam.

The Goodland Limestone consists of massive limestone beds and thin clay beds that are coarsely nodular in places (Barnes, 1988). Thickness ranges from zero, where completely eroded in ancient and modern stream channels, to about 40 ft where partly eroded near AFP4/NAS (Chem-Nuclear Geotech, Inc., 1992). Except for stream-channel outcrops along Meandering Road Creek, Farmers Branch, and Kings Branch and an exposed outlier along the southwestern edge of the main runway on the NAS, the remnants of Goodland Limestone are covered by terrace alluvial deposits and have not been completely mapped beneath AFP4/NAS.

The terrace alluvial deposits comprise a mostly unconsolidated mixture of gravel, sand, silt, and clay that was deposited by the ancestral West Fork Trinity River (Barnes, 1988). In addition, reworked aggregations of loose sediment were incorporated within

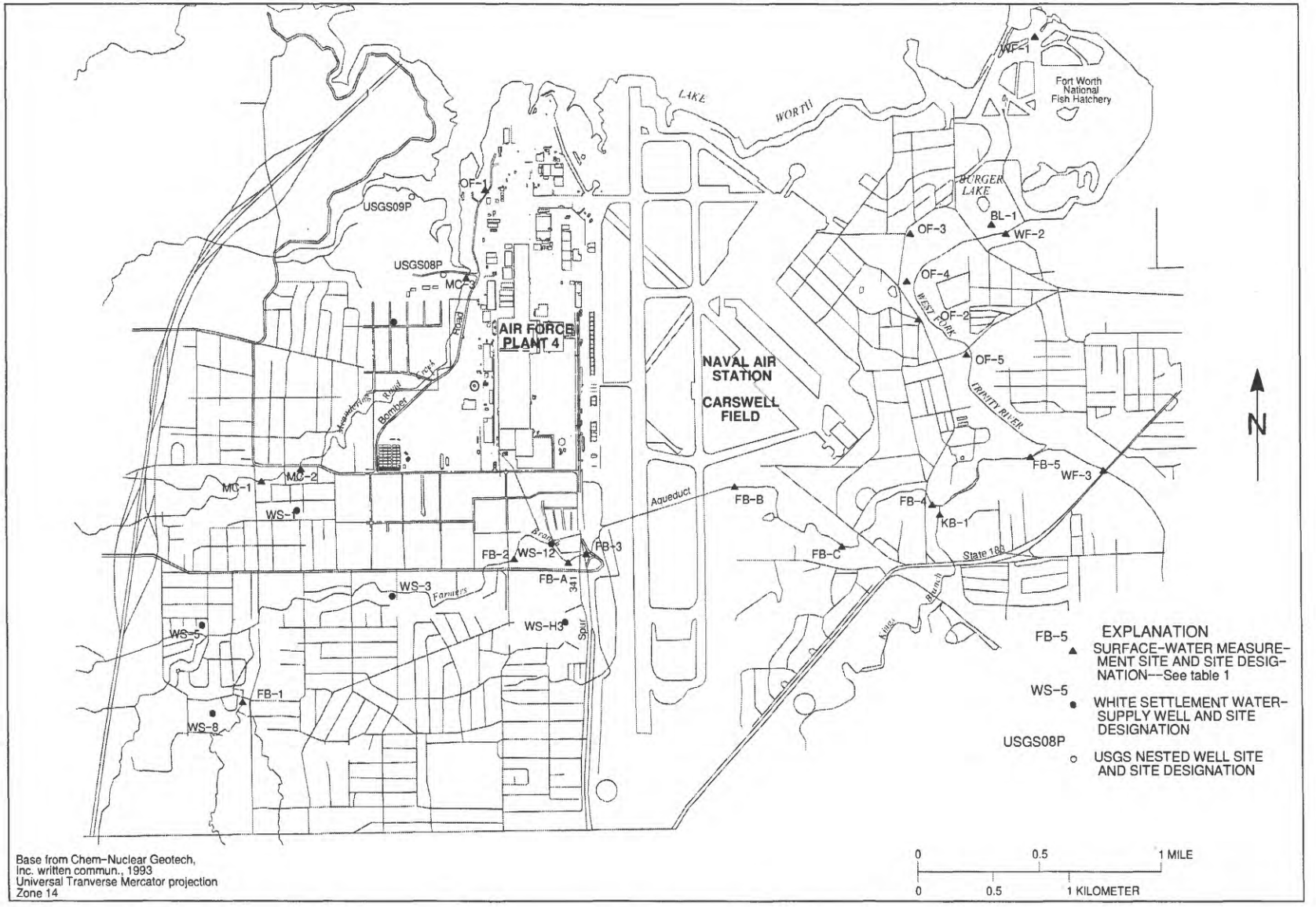

Figure 2. Locations of surface-water sites having flow estimates, White Settlement water-supply wells, and U.S. Geological Survey nested well sites at Air Force Plant 4 and Naval Air Station and vicinity, Fort Worth area, Texas (E.L. Kuniansky, U.S. Geological Survey, written commun., 1995).

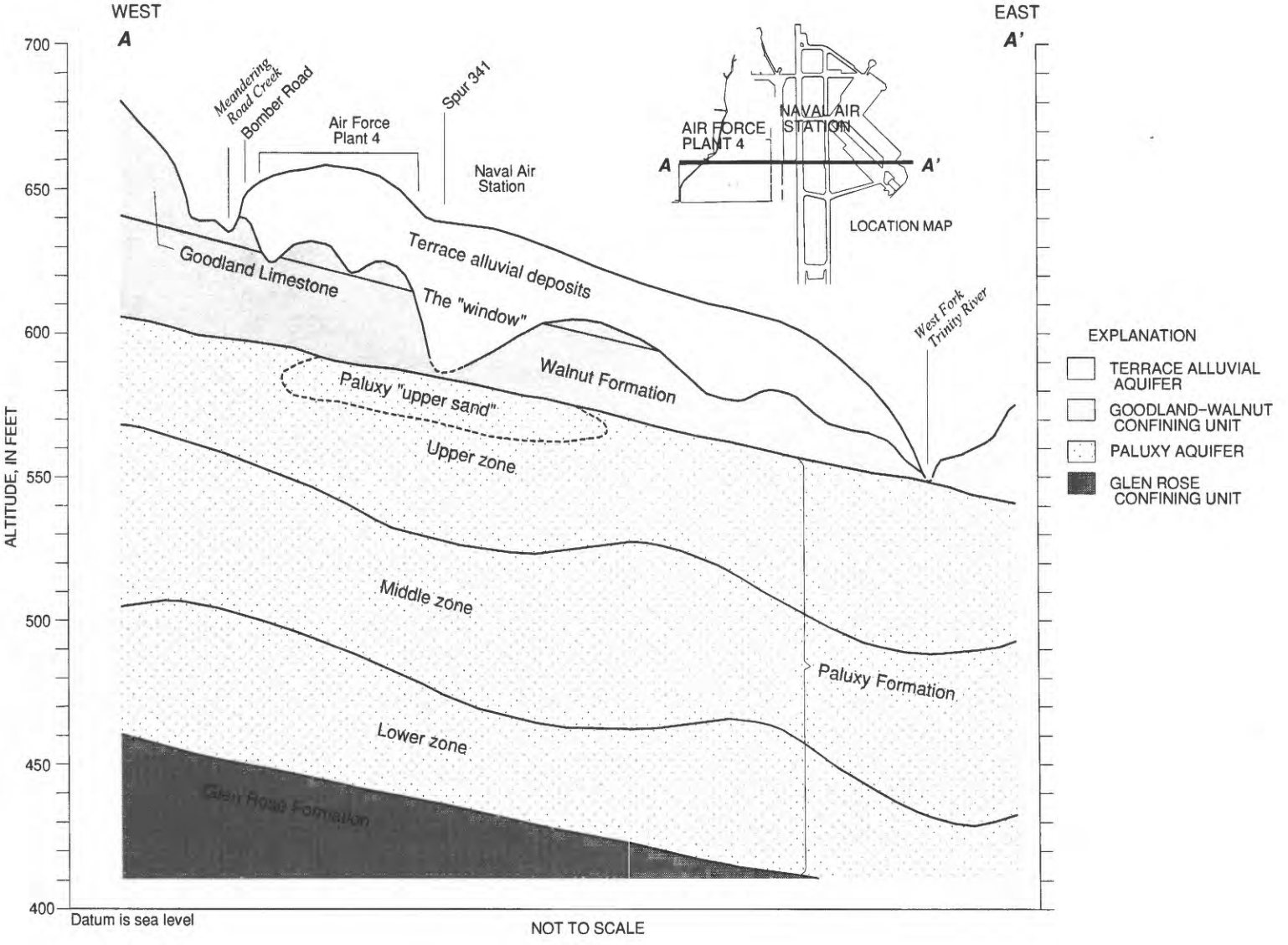

Figure 3. Generalized geohydrologic section at Air Force Plant 4 and Naval Air Station, Fort Worth area, Texas (E.L. Kuniansky, U.S. Geological Survey, written commun., 1995).

Table 1. Estimated surface-water flow at Air Force Plant 4 and Naval Air Station and vicinity, Fort Worth area, Texas

[ft^3/s, cubic feet per second; Dry, no water in streambed; --, not measured; No flow, water might be pooled in streambed but not flowing]

Site and measurement number	Discharge (ft^3/s)		
	September 1993	February 1994	February 1995
Farmers Branch (terrace alluvial aquifer discharge)			
FB–1	Dry	0.18	--
FB–2	Dry	.37	--
FB–A	--	--	0.9
FB–3	0.02	.54	--
FB–B	--	--	1.8
FB–C	--	--	1.8
FB–4	.02	.81	1.3
FB–5	.46	1.28	--
West Fork Trinity River (below Lake Worth Dam)			
WF–1	.09	.21	--
WF–2	.42	2.29	--
WF–3	1.04	5.20	--
Meandering Road Creek (terrace alluvial aquifer discharge)			
MC–1	Dry	.05	--
MC–2	Dry	.05	--
MC–3	.002	.31	--
Burger Lake outflow (terrace alluvial aquifer discharge)			
BL–1	.31	.63	--
Kings Branch (terrace alluvial aquifer discharge)			
KB–1	Dry	No flow	.5
Outfalls			
OF–1	.005	.01	--
OF–2	Dry	.02	--
OF–3	Dry	.07	--
OF–4	.002	.06	--
OF–5	.15	.19	--

the alluvium during construction of AFP4/NAS (Chem-Nuclear Geotech, Inc., 1992). From zero thickness along Meandering Road Creek, directly west-northwest of AFP4, the unit ranges up to 60 ft thick along an erosional channel beneath the main runway on the NAS.

The alluvial deposits appear to be dissected into northern and southern lobes at Farmers Branch, where the two lobes are connected only by the younger alluvium that fills the erosional channel running from northwest to southeast beneath the runway.

Hydrologic Units

An aquifer is a body of rock that is sufficiently permeable to transmit ground water and to yield economically significant quantities of water to wells and (or) springs. Because the terrace alluvial deposits and the Paluxy Formation meet these criteria, they are classified as aquifers.

Terrace Alluvial Aquifer

The terrace alluvial deposits generally are absent southwest of the runway on the NAS and less than 30 ft thick west of AFP4. The deposits are thickest above the paleochannnel, known as the "window," through the Goodland Limestone and through most of the Walnut Formation (fig. 3). Although the alluvial deposits are not developed for water supply, they readily transmit ground water and collectively are known as the terrace alluvial aquifer (pl. 1).

The terrace alluvial aquifer is nearly everywhere exposed at land surface. The base of this unconfined aquifer is the top of the underlying Goodland Limestone or the top of the Walnut Formation where the Goodland Limestone is absent (fig. 3).

Paluxy Aquifer

The Paluxy aquifer is confined between the overlying Goodland-Walnut confining unit and the underlying Glen Rose confining unit (fig. 3). The aquifer at AFP4/NAS is composed of three hydrogeologic zones that might correspond to stratigraphic members of the Paluxy Formation (Owen, 1979). From top to bottom, these hydrogeologic zones (each roughly 40 to 60 ft thick) are known as the upper, middle, and lower zones of the Paluxy aquifer (Hargis & Associates, Inc., 1989a, b; E.L. Kuniansky, U.S. Geological Survey, written commun., 1995). The mostly fine-grained sediments of the upper zone generally are less permeable than the typically coarser grained sediments of the middle and lower zones; accordingly, most municipal and most domestic water-supply wells draw ground water from the middle and lower zones. The uppermost part of the upper zone is composed predominantly of low-permeability mudstone, with a few sandy lenses. An apparently isolated sandy lens of undetermined lateral extent, known as the Paluxy "upper sand," directly underlies the "window" that nearly breaches the Goodland-Walnut confining unit (fig. 3). Although the Paluxy "upper sand" is physically part of the upper zone of the Paluxy aquifer, it is hydraulically separated from the deeper, regionally extensive parts of the aquifer and is unsaturated, except directly below the "window."

Confining Units

A confining unit is a body of impermeable or distinctly low-permeability rock adjacent to one or more aquifers. Although confining units might absorb and (or) store water, they do not transmit appreciable amounts of water. Because confining units obstruct ground-water flow, they can block or substantially retard the migration of water containing undesirable constituents.

The Goodland Limestone and (or) the Walnut Formation separate the overlying terrace alluvial aquifer from the underlying Paluxy aquifer. Water cannot move readily through the Goodland-Walnut confining unit, except perhaps through the "window," where the confining unit essentially is breached. The "window" appears to provide a hydraulic connection between permeable, saturated sediments of the terrace alluvial aquifer and permeable, saturated sediments of the underlying Paluxy aquifer. Elsewhere, the Paluxy aquifer essentially is isolated from the terrace alluvial aquifer by relatively thick sequences of the Goodland Limestone and (or) Walnut Formation. Similarly, the Glen Rose Formation is a barrier to the exchange of ground water between the Paluxy aquifer and underlying aquifers.

WATER-LEVEL CONDITIONS: MAY 1993 AND FEBRUARY 1994

Maps of water-level conditions during May 1993 and February 1994 were constructed for the terrace alluvial aquifer and for the Paluxy aquifer. These maps show the distributions of water-level altitude and indicate the directions of ground-water flow between the higher altitude areas of recharge and the lower altitude areas of discharge. The directions of ground-water flow are approximately perpendicular to the water-level contours on plates 3–6.

Terrace Alluvial Aquifer

The configuration of water levels in the terrace alluvial aquifer did not change appreciably between May 1993 and February 1994 (pls. 3, 4). Since ground water was not recently withdrawn from the aquifer prior

to either May 1993 or February 1994, both water-level maps should represent nearly static conditions. The most notable changes probably result from different amounts of antecedent precipitation and a different number and distribution of water-level measurements for May 1993, compared to those for February 1994. Greater precipitation during May 1993 caused water levels to average approximately 5 ft higher during May 1993 than during February 1994. Because about 110 more water levels were measured during May 1993 than during February 1994, the 1993 water-level map (pl. 3) generally supports more detail than the 1994 counterpart. On the other hand, additional water-level control from four USGS wells drilled during November 1993 provides additional detail on the northeastern part of the February 1994 map (pl. 4).

Both water-level maps for the terrace alluvial aquifer (pls. 3, 4) show that ground water directly beneath AFP4/NAS generally flows toward the east-southeast. The regional gradient is influenced by the dip of the bedrock and the slope of land surface. Flow directions can vary locally, however. Ground water appears to flow outward, away from ground-water mounds beneath the assembly building at AFP4. At Farmers Branch, the aquifer appears divided into northern and southern lobes. The water-level contours for the northern lobe of the aquifer (north of Farmers Branch) indicate that the aquifer discharges westward and northward into Lake Worth (near the northwestern part of AFP4/NAS), westward into Meandering Road Creek, southeastward into Farmers Branch, and eastward into West Fork Trinity River. Water-level data for the southern lobe of the terrace alluvial aquifer (south of Farmers Branch) are limited to a few measurements that indicate water flowing from south to north-northeast, into Farmers Branch and (or) the associated aqueduct.

The apparent ground-water mounds in the terrace alluvial aquifer beneath AFP4 (pls. 3, 4) reportedly result from localized recharge from leaking water pipes and sanitary and (or) storm sewer lines (Chem-Nuclear Geotech, Inc., 1992). The water-level contours also indicate a small recharge area near the southwestern corner of AFP4, where the water table is elevated below an isolated topographic high. The elevated water table here probably results from the infiltration of precipitation falling upon the topographic high. The water-level contours on plate 4 also indicate that water from Lake Worth might recharge the terrace alluvial aquifer along the northeastern boundary of the NAS.

Paluxy Aquifer

Water-level conditions in the Paluxy "upper sand" beneath AFP4 (figs. 4, 5) are mapped and discussed separately from those in the deeper, regionally extensive parts of the Paluxy aquifer (pls. 5, 6). The separate maps and discussions are necessary because the Paluxy "upper sand" apparently is mostly unsaturated and hydraulically separated from the upper, middle, and lower zones of the aquifer, most of which are saturated.

Water levels in the Paluxy "upper sand" were as much as 10 ft higher in May 1993 (fig. 4) than in February 1994 (fig. 5). The differences are similar to those in the terrace alluvial aquifer between May 1993 and February 1994 (pls. 3, 4).

The water-level contours on figures 4 and 5 reveal an elongated ground-water mound beneath southeastern parts of AFP4. Although the control data imply that ground water flows away from the crest of the mound, the data are too sparse to delineate the absolute extent and exact shape of the mound or to track the ultimate destination of the implied flowpaths. The location of this ground-water mound in the Paluxy "upper sand" approximately coincides with the "window" in the Goodland-Walnut confining unit (fig. 3) and with water-level highs in the overlying terrace alluvial aquifer (pls. 3, 4).

Figures 4 and 5 indicate that the Paluxy "upper sand" probably is recharged through the "window," via downward leakage from the terrace alluvial aquifer (Chem-Nuclear Geotech, Inc., 1992). Thus, the "window" might provide a conduit through which contaminated water from the terrace alluvial aquifer might enter upper parts of the Paluxy aquifer. Nearby, unsaturated sections of the Paluxy "upper sand" indicate, however, that uppermost parts of the Paluxy Formation are relatively impermeable and perhaps hydraulically isolated from the deeper, regionally extensive parts of the Paluxy aquifer.

Water levels in the upper, middle, and lower zones of the Paluxy aquifer at well USGS08P (fig. 2) were 593, 589, and 583 ft above sea level, respectively, in February 1994. At the same time, water levels in the upper, middle, and lower zones at well USGS09P were 587, 584, and 575 ft above sea level, respectively. Because water levels in the upper, middle, and lower zones are above the relatively impermeable base of the Paluxy "upper sand, " the Paluxy aquifer is confined near wells USGS08P and USGS09P.

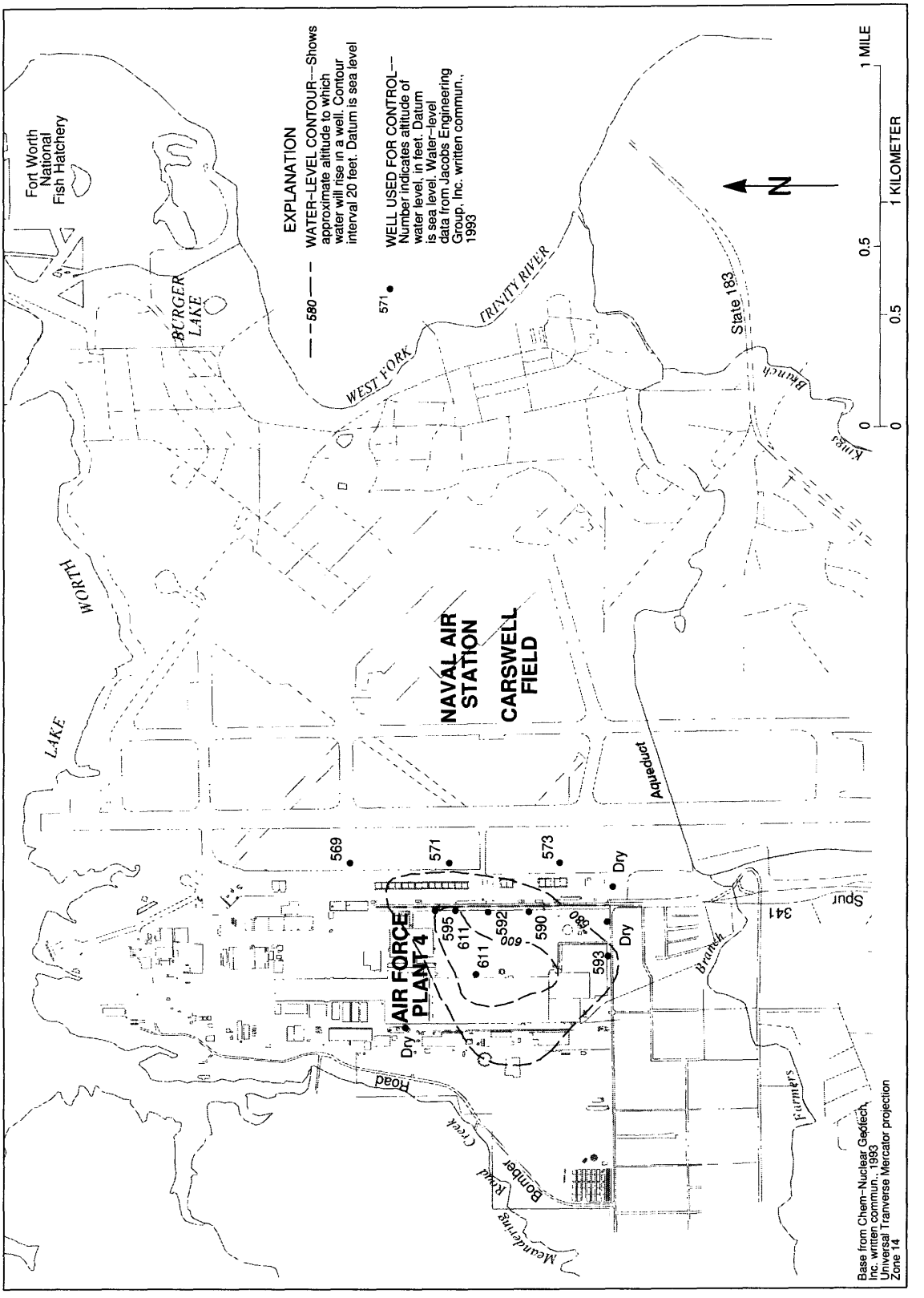

Figure 4. Altitude of water levels in wells in the Paluxy "upper sand" aquifer at Air Force Plant 4, Fort Worth area, Texas, May 1993.

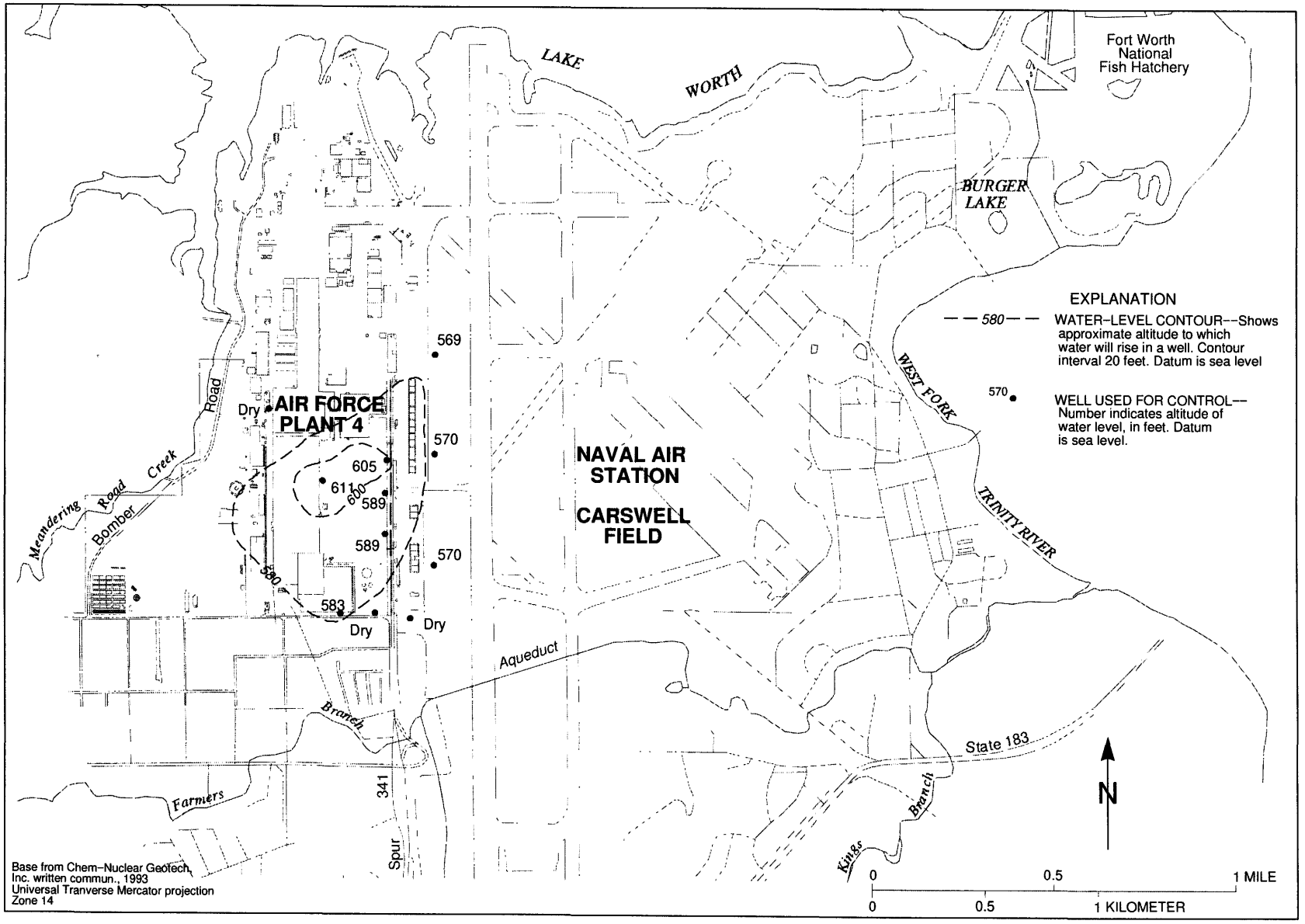

Figure 5. Altitude of water levels in wells in the Paluxy "upper sand" aquifer at Air Force Plant 4, Fort Worth area, Texas, February 1994.

Water levels in the deeper zones of the Paluxy aquifer generally did not undergo major changes between May 1993 and February 1994 (pls. 5, 6). Most water levels were slightly higher when measured in February 1994 than when measured in May 1993. The direction of these differences was opposite those noted over the same period in the terrace alluvial aquifer and in the Paluxy "upper sand." Water-level differences observed in the deeper zones of the Paluxy aquifer might have resulted from relatively large withdrawals of ground water from these zones to irrigate lawns and gardens during May 1993.

Water in the Paluxy aquifer flows from west to east-southeast beneath northwestern Tarrant County (pls. 5, 6). The overall, regional pattern of flow is consistent with the dip of the Paluxy Formation and with recharge from precipitation on the outcrop area in western parts of the study area. The water-level map reveals a southeastern shift from the regional direction of flow that begins near the Lake Worth embayment along the northwestern edge of AFP4. The dominant southeastward flow beneath AFP4/NAS might reflect the effects of recharge to the Paluxy aquifer from the embayment area and (or) water-level drawdown caused by pumpage from municipal water-supply wells at White Settlement (fig. 2).

SUMMARY

The terrace alluvial aquifer underlying Air Force Plant 4 and the adjacent Naval Air Station (AFP4/NAS) in the Fort Worth area, Texas, is contaminated locally with organic and metal compounds. Residents south and west of AFP4/NAS are concerned that contaminants might enter the underlying Paluxy aquifer, which provides water to the city of White Settlement, south of AFP4, and to residents west of AFP4. In 1990, the U.S. Environmental Protection Agency (USEPA) qualified AFP4 for Superfund cleanup action.

Geologic units pertinent to the study include (from oldest to youngest) the Glen Rose, Paluxy, and Walnut Formations, Goodland Limestone, and terrace alluvial deposits. All but the Glen Rose Formation crop out on or near AFP4/NAS. The terrace alluvial deposits, which range from 0 to about 60 ft thick, comprise a mostly unconsolidated mixture of gravel, sand, silt, and clay. Mudstone and sandstone of the Paluxy Formation crop out north, west, and southwest of Lake Worth and total between about 130 and 175 ft thick.

The terrace alluvial deposits and the Paluxy Formation are aquifers. Although the terrace alluvial aquifer is not developed for water supply, the Paluxy aquifer is tapped by many wells for municipal and domestic water supplies. The Goodland Limestone and Walnut Formation underlie the terrace alluvial aquifer and compose the Goodland-Walnut confining unit, which confines ground water within most of the underlying Paluxy aquifer. The top of the Glen Rose confining unit is the base of the Paluxy aquifer and retards movement of water from the Paluxy aquifer to deeper aquifers.

Water levels were measured during May 1993 and during February 1994 from a variety of wells in the terrace alluvial aquifer. Greater precipitation prior to the May 1993 measurements caused water levels to average approximately 5 ft higher in May 1993 than in February 1994.

Ground water in the terrace alluvial aquifer generally flows toward the east-southeast. Water-level contours indicate that water from Lake Worth might recharge the terrace alluvial aquifer along the northeastern boundary of the NAS. Water from the aquifer discharges northward and westward into Lake Worth, westward into Meandering Road Creek, southeastward into Farmers Branch, and eastward into the West Fork Trinity River. Ground-water mounds in the terrace alluvial aquifer result from the infiltration of precipitation and reportedly from leaking water pipes and sanitary and (or) storm sewer lines. Ground water appears to flow outward, away from ground-water mounds beneath the assembly building at AFP4.

Water levels in most deeper, regionally extensive parts of the Paluxy aquifer were slightly higher in February 1994 than in May 1993. The direction of these differences was opposite those noted over the same period in the terrace alluvial aquifer and in the Paluxy "upper sand." Water levels in the Paluxy "upper sand" were as much as 10 ft higher in May 1993 than in February 1994. The "upper sand" probably is recharged through the "window," an erosional channel nearly breaching the Goodland-Walnut confining unit—along which contaminated water from the terrace alluvial aquifer might enter upper parts of the Paluxy aquifer. Nearby, unsaturated sections of the Paluxy "upper sand" indicate that uppermost parts of the Paluxy Formation are relatively impermeable and perhaps hydraulically isolated from the deeper, regionally extensive parts of the Paluxy aquifer.

Water in the deeper parts of the Paluxy aquifer flows from west to east-southeast across northwestern

Tarrant County, which is consistent with the dip of the Paluxy Formation and with the recharge from precipitation in western parts of the study area. Water-level maps reveal a southeastern shift from the regional direction of flow that begins near the Lake Worth embayment along the northwestern edge of AFP4. The dominant southeastward flow beneath AFP4/NAS might reflect the effects of recharge to the Paluxy aquifer from the embayment area and (or) water-level drawdown caused by pumpage from municipal water-supply wells at White Settlement.

SELECTED REFERENCES

Baker, Bernard, Duffin, Gail, Flores, Robert, and Lynch, Tad, 1990, Evaluation of water resources in part of north-central Texas: Texas Water Development Board Report 318, 67 p.

Barnes, V.E., 1988, Geologic atlas of Texas, Dallas sheet: Austin, University of Texas, Bureau of Economic Geology, 9 p., 1 sheet, scale 1:250,000.

Chem-Nuclear Geotech, Inc., 1992, Preliminary assessment/site inspection and remedial investigation report: Fort Worth, Air Force Plant 4, v. 1, 423 p.

Environmental Science & Engineering, Inc., 1994, Characterization of trichloroethene plume, Air Force Plant 4 and Carswell Air Force Base, Fort Worth, Texas: U.S. Army Corps of Engineers, Fort Worth District, 108 p.

Geo-Marine, Inc., 1995, Groundwater survey and subsurface soil delineation, hydrant fueling system, Carswell Air Force Base, SE, Fort Worth, Texas—phase I and II: Prepared for U.S. Army Corps of Engineers, Fort Worth District, Contract No. DACA63–93–D–0014, Modification to Delivery Order No. 055, 93 p.

Hargis & Associates, Inc., 1989a, Final draft work plan, remedial investigation and feasibility study: Fort Worth, U.S. Air Force Plant No. 4.

_____1989b, Summary of interim remedial investigations, January 1987 to April 1989: Fort Worth, U.S. Air Force Plant No. 4.

Leggat, E.R., 1957, Geology and ground-water resources of Tarrant County, Texas: Texas Board of Water Engineers Bulletin 5709, 182 p.

Nordstrum, P.L., 1982, Occurrence, availability, and chemical quality of ground water in the Cretaceous aquifers of north-central Texas: Texas Department of Water Resources Report 269, v. 1 and 2, 496 p.

Owen, M.T., 1979, The Paluxy Sand in north-central Texas: Waco, Tex., Baylor University, Baylor Geological Studies Bulletin 36, 36 p.

RUST Geotech, 1995, Air Force Plant 4, Remedial investigation and preliminary assessment/site inspection report, v. I: Prepared for U.S. Air Force, Headquarters Aeronautical Systems Center, Wright-Patterson Air Force Base, Ohio, Department of Energy Contract No. DE–AC04–861D12584, GJPO–WMP–75, 545 p.

Taylor, H.D., 1976, Water-level and water-quality data from observation wells in northeast Texas: Texas Water Development Board Report 198, 294 p.

Winton, W.M., and Adkins, W.S., 1919, The geology of Tarrant County: Austin, University of Texas, Bulletin 1939, 122 p.

☆ U.S. GOVERNMENT PRINTING OFFICE — 1996 - 706-352