GEOHYDROLOGIC SITE CHARACTERIZATION OF THE MUNICIPAL SOLID WASTE LANDFILL FACILITY, U.S. ARMY AIR DEFENSE ARTILLERY CENTER AND FORT BLISS, EL PASO COUNTY, TEXAS

By Cynthia G. Abeyta

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch	25.40	millimeter
foot	0.3048	meter
mile	1.609	kilometer
acre	4,047	square meter
quart	0.9464	liter
gallon	3.785	liter
gallon per minute	0.06309	liter per second
foot squared per day	0.09290	meter squared per day
ton	907.1848	kilogram

Temperature in degrees Celsius (°C) or degrees Fahrenheit (°F) can be converted as follows:

$$°F = 1.8\ (°C) + 32$$
$$°C = 5/9\ (°F - 32)$$

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.

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ABSTRACT

Geohydrologic conditions of the Municipal Solid Waste Landfill Facility (MSWLF) on the U.S. Army Air Defense Artillery Center and Fort Bliss, El Paso County, Texas, were evaluated by the U.S. Geological Survey in cooperation with the U.S. Army. The 106.03-acre MSWLF has been in operation since January 1974. The landfill contains household refuse, Post solid wastes, bulky items, grass and tree trimmings from family housing, refuse from litter cans, construction debris, classified waste (dry), dead animals, asbestos, and empty oil cans.

The MSWLF, located about 1,200 feet east of the nearest occupied structure, is estimated to receive an average of approximately 56 tons of municipal solid waste per day and, at a fill rate of 1-4 acres per year, is expected to reach its capacity by the year 2004. The MSWLF is located in the Hueco Bolson, 4 miles east of the Franklin Mountains. Elevations at the MSWLF range from 3,907 to 3,937 feet above sea level. The climate at the MSWLF and vicinity is arid continental, characterized by an abundance of sunny days, high summer temperatures, relatively cool winters typical of arid areas, scanty rainfall, and very low humidity throughout the year. Average annual temperature near the MSWLF and vicinity is 63.3 degrees Fahrenheit and annual precipitation is 7.8 inches. Potential evaporation in the El Paso area was estimated to be 65 inches per year. Soils at and adjacent to the MSWLF are nearly level to gently sloping, have a fine sandy loam subsoil, and are moderately deep over caliche.

The MSWLF is underlain by Hueco Bolson deposits of Tertiary age and typically are composed of unconsolidated to slightly consolidated interbedded sands, clay, silt, gravel, and caliche. Individual beds are not well defined and range in thickness from a fraction of an inch to about 100 feet. The primary source of ground water in the MSWLF area is in the deposits of the Hueco Bolson. A relatively thick vadose zone of approximately 300 feet overlies the aquifer of the Hueco Bolson deposits in the vicinity of the MSWLF. A deep water table prevails for all of the study area. Whether any perched water zones exist below the MSWLF is unknown. Under current conditions, extensive ground-water development by the City of El Paso encompasses the MSWLF. Hydraulic characteristics of the Hueco Bolson vary significantly as a result of the nonuniform nature of the individual beds. Wells in the vicinity of the MSWLF range in depth from about 600 feet to greater than 1,200 feet. Recharge resulting from direct infiltration of precipitation is minor due to the high evaporation and low precipitation rates. The hydraulic gradient in the vicinity of the MSWLF is generally to the south but may vary due to pumpage of a well located on the northeast corner of the perimeter boundary. Ground-water monitoring data for the MSWLF vicinity show a water-level decline of 55.65 feet from November 1958 to December 1987. Depth to water at the northeast corner of the MSWLF as of July 26, 1994, was 325.8 feet below land surface.

The city-operated Shearman Well Field, located north of the MSWLF, is a primary source of ground water for the City of El Paso. The test-pumping rate of well JL-49-05-914 (the well nearest to the MSWLF having test-pumping data) was 1,972 gallons per minute on July 20, 1992; the static water level prior to pumping was 317.54 feet below land surface. El Paso Water Utilities reports that the pumping level after 8 hours of pumping was 367.80 feet below land surface, resulting in a drawdown of 50.26 feet, transmissivity of 22,200 feet squared per day (166,000 gallons per day per foot), and specific capacity of 39.2 gallons per minute per foot of drawdown.

After the well was shut off, the well recovered to a static water level of 317.46 feet below land surface on July 21, 1992.

Ground water in the El Paso area is chemically suitable for most uses. El Paso Water Utilities reports that concentrations of dissolved solids in the vicinity of the MSWLF generally range from 297 to 625 milligrams per liter (wells JL-49-05-904 and JL-49-05-915, respectively).

INTRODUCTION

The U.S. Army Air Defense Artillery Center and Fort Bliss (USAADACENFB) is evaluating geohydrologic conditions of the Municipal Solid Waste Landfill Facility (MSWLF) to implement requirements of Federal and State of Texas regulatory programs. In 1994, the U.S. Geological Survey, in cooperation with the U.S. Army, initiated a study of the USAADACENFB MSWLF to identify geohydrologic conditions at the facility. Results of this study will be used by the U.S. Army to aid in fulfilling regulatory requirements at the facility as specified in Title 40 of the Federal Code of Regulations, Part 258 (40 CFR 258) and Part 30 of the Texas Administrative Code, Section 330 (30 TAC 330) (Texas Natural Resources Conservation Commission, 1993). The MSWLF is located in Texas, within El Paso County (fig. 1) on Federal land administered by the USAADACENFB.

Purpose and Scope

The primary objectives of this report are to: (1) present information on the boundaries, area, and contents of the MSWLF; (2) present information on the environmental setting of the MSWLF and vicinity, including a description of the physiography, climate, and soils; (3) describe geologic and hydrologic characteristics of the unsaturated zone and shallow aquifer; and (4) describe the ground-water quality in the vicinity of the MSWLF.

Information presented in this report will result in a better understanding of the hydrogeology at the MSWLF. The hydrogeology of the MSWLF is characterized on the basis of existing data. Water-level data were compiled for wells located in the vicinity of the MSWLF. Water-quality data were compiled for wells within a 1-mile radius of the MSWLF.

Description of the U.S. Army Air Defense Artillery Center and Fort Bliss and Municipal Solid Waste Landfill Facility

The USAADACENFB military reservation is located within the extraterritorial jurisdiction of the City of El Paso and extends into unincorporated portions of El Paso County, Texas, and the counties of Doña Ana and Otero in New Mexico (fig. 1). The primary missions of the USAADACENFB are air defense artillery training, senior noncommissioned officers training, administrative and logistical support of tenant activities, and provision of training facilities for reserve components.

The USAADACENFB military reservation serves a total Post population of more than 90,000 people (Population Performance Factors, March 1994, USAADACENFB, written commun., April 26, 1994). The total Post population includes military and civilian personnel (17,934 and 7,903 people, respectively), on- and off-Post family members (8,420 and 15,738 people, respectively), and retirees and retiree family members (14,502 and 26,465 people, respectively).

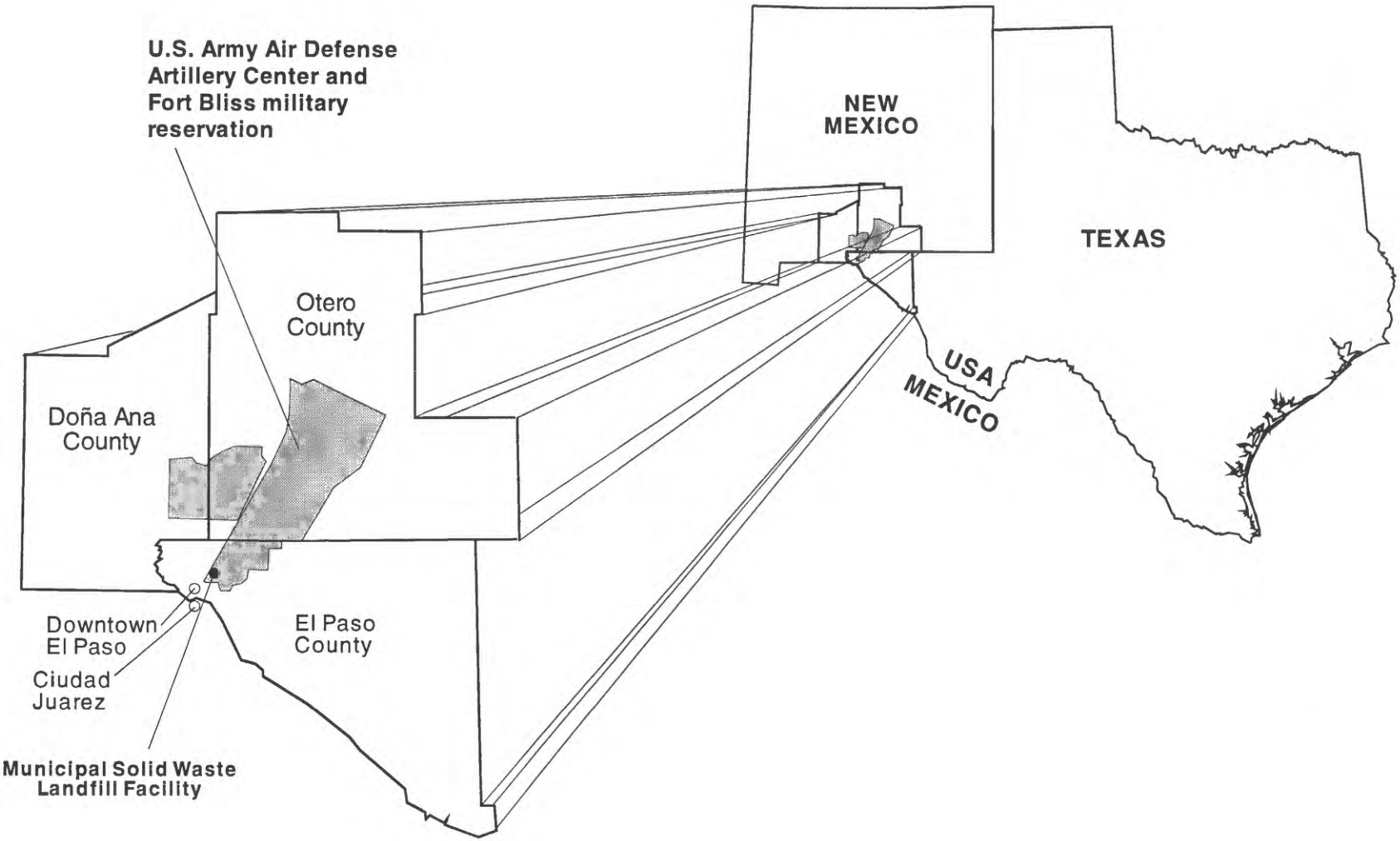


Figure 1.--Location of U.S. Army Air Defense Artillery Center and Fort Bliss military reservation, Texas and New Mexico.

On November 1, 1982, the USAADACENFB received Texas Department of Health Permit No. 1422 for operation of an existing Type I and Type IV municipal solid waste disposal facility. As defined by the TAC, a Type I facility is a standard landfill for the disposal of municipal solid waste; a Type IV facility is authorized for the disposal of brush, construction-demolition waste, and rubbish that are free of putrescible and household wastes (30 TAC §330.41.b and 30 TAC §330.41.e). The permit was issued pursuant to the provisions of the Texas Solid Waste Disposal Act and the Texas Department of Health Municipal Solid Waste Management Regulations for the 106.03-acre existing site.

The MSWLF is located northwest of Biggs Army Airfield, and 300 feet east of the Southern Pacific Railroad tracks, in El Paso County, Texas (fig. 2). The MSWLF is about 1,200 feet east of the nearest occupied structure. Occupied structures include residential and commercial areas located on the west side of the MSWLF (fig. 2). An all-weather road is accessible to the MSWLF year round. A 10-foot-high chain link fence with barbed wire outriggers surrounds the entire perimeter of the facility. A 6-foot 4-inch by 12-foot 4-inch by 10-foot-high enclosed guard shack is located on the facility near the entrance. No utilities are within the perimeter of the MSWLF. Existing boundary conditions of the MSWLF are shown in figure 3.

Types of solid wastes disposed of at the MSWLF include household refuse, Post solid wastes, bulky items, grass and tree trimmings from family housing, refuse from litter cans, construction debris, classified waste (dry), dead animals, asbestos, and empty oil cans (1-quart and 5-gallon sizes). The USAADACENFB Directorate of Public Works and Logistics manages contract operation of the MSWLF. Operation of the MSWLF is by a private contractor who also provides refuse collection and disposal services. The method of landfilling at the MSWLF is progressive trench where excavation and filling occur simultaneously in trenches 40 feet wide by 30 feet deep. Refuse is dumped at the end of the trench, then spread and covered by use of a crawler tractor. Daily cover of a minimum of 6 inches of compacted earth and a final cover of 2 to 3 feet are provided.

Two ground-water production wells are located about 350 feet north of the MSWLF. Well W3 has been in operation for several years; well W3A is a newly completed well located adjacent to W3 (figs. 2 and 3). These wells are used as public supply wells and are owned by the U.S. Army. To comply with Resource Conservation and Recovery Act (RCRA) and Texas Natural Resource Conservation Commission (TNRCC) regulations, a methane-gas monitoring network was installed at the MSWLF. Ten methane-gas monitoring probes were installed within the perimeter of the MSWLF. The methane-monitoring program is discussed in the Soils and Soil Gas section of this report.

The MSWLF was established in January 1974 and is estimated to receive an average of approximately 56 tons of municipal solid waste per day. The landfill fill rate is 1-4 acres per year; the MSWLF is expected to reach its capacity by the year 2004 at this fill rate (approximately 15 acres of the permitted area will not be filled).

A permit modification regarding soil and plastic liners has been approved by the TNRCC to construct a landfill cell within the MSWLF (labeled Subtitle D in fig. 3), complying with current federal requirements (RCRA, Subtitle D is discussed in the Federal Regulatory Program and Resource Conservation and Recovery Act Subtitle D and State of Texas Programs sections of this report). When construction of the cell is completed and approved in approximately October 1994, future wastes will be disposed of in the Subtitle D area (fig. 3).

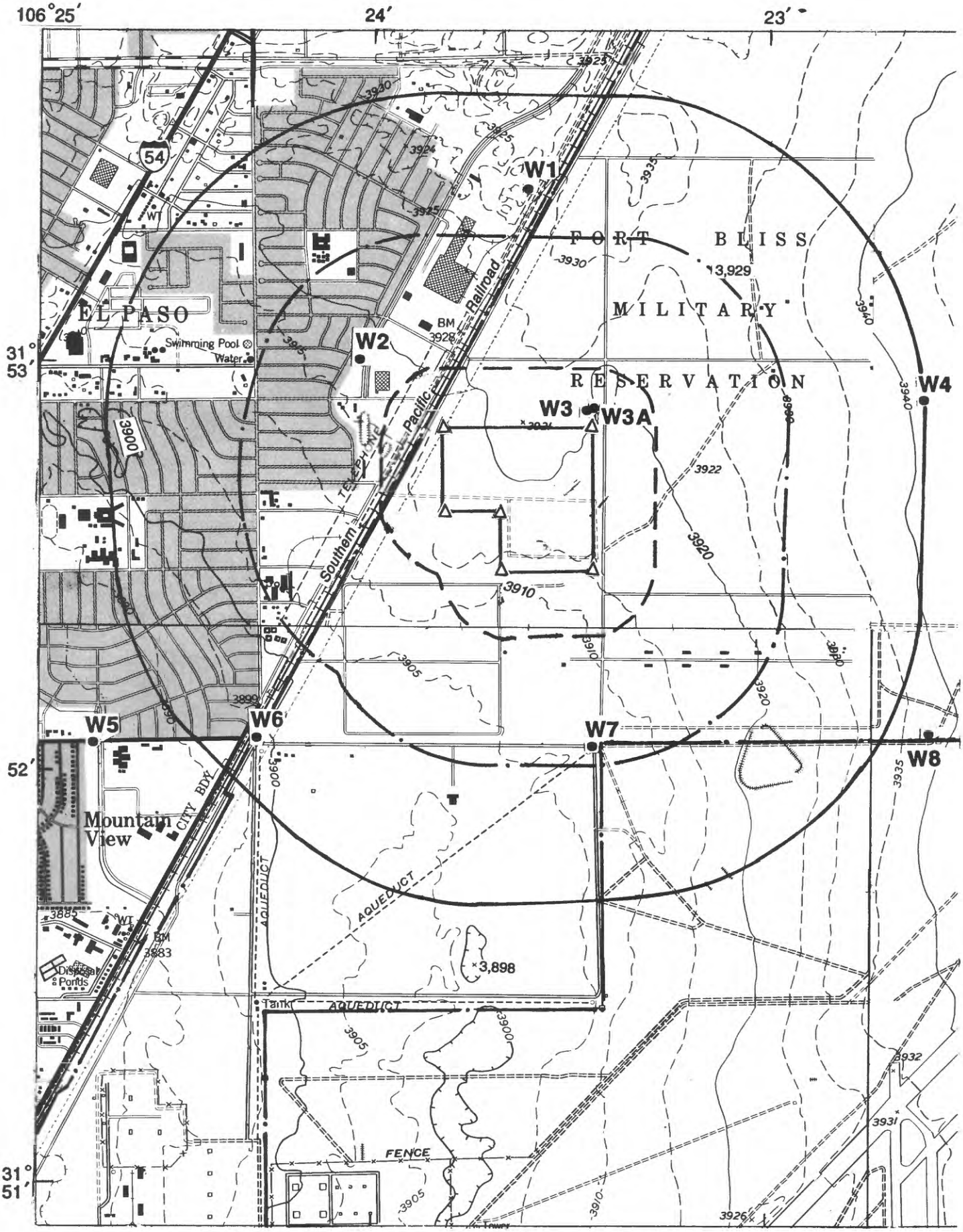
Federal Regulatory Program

In June 1980 the Department of Defense (DOD) issued Defense Environmental Quality Program Policy Memorandum 80-6, which mandated that hazardous waste material sites on DOD installations be identified. DOD policy is to identify and evaluate suspected problems associated with past hazardous contamination and to control hazards to the public health and welfare. The USAADACENFB implemented the DOD mandate in February 1983 by initiating an Installation Restoration Program (IRP) to identify the location and contents of past hazardous material disposal or spill sites and to control hazards to public health and the environment. The IRP is the basis for response actions on DOD installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, the Superfund Amendment and Reauthorization Act (SARA) of 1986, the RCRA of 1976, the Hazardous and Solid Waste Amendments of 1984, and Executive Order 12316. The SARA confirms that CERCLA is applicable to Federal facilities and defines the process by which Federal agencies are required to initiate remedial actions at their facilities.

Previous IRP investigations at the USAADACENFB, in compliance with the above mandates, began with a USAADACENFB Headquarters installation assessment (Environmental Science and Engineering, Inc., 1983). The initial assessment was followed by an evaluation of solid waste management units (U.S. Army Environmental Hygiene Agency, 1987) and an RCRA Facility Assessment (RFA) (A.T. Kearney, Inc., 1989; U.S. Army Environmental Hygiene Agency, 1989; and Environmental Science and Engineering, Inc., 1991). Initial assessments included a literature search of published and unpublished reports, discussions with key installation personnel, examination of topographic maps and aerial photographs, identification of potentially hazardous sites, and initial assessments of those sites.

On January 17, 1991, a permit for industrial solid waste management for Class I hazardous waste storage, processing, and Post-closure care at the USAADACENFB military reservation was issued by the Texas Water Commission (TWC, now called the TNRCC) under provisions of the Texas Health and Safety Code Announcement, Chapter 361 (Vernon). The permit is referred to as Texas permit number HW-50296/Environmental Protection Agency permit number TX4213720101. Provisions in the permit stem from State and Federal authority and are subject to TNRCC rules and orders and Texas laws.

A requirement of the permit was that an RCRA Facility Investigation (RFI) be conducted at specified units identified in the permit. The MSWLF, identified as RFI Unit No. 1 in the permit and the previous RFA, was identified as one of the units to be included in the RFI. On the basis of findings in the RFA studies, a field phase of the RFI was conducted during May through June 1990. Work performed at the MSWLF included collection and analysis of soil cuttings at various locations within the MSWLF. Soil samples were analyzed for total petroleum hydrocarbons, total metals, volatile organic carbons, semivolatile organic carbons (by base-neutral-acid extraction), and polychlorinated biphenyls. Volume I of the RFI report of the USAADACENFB sites was completed in December 1991 (Environmental Science and Engineering, Inc., 1991). Findings of the RFI pertaining to the MSWLF indicated that "all of the constituents analyzed for were below action levels" (Environmental Science and Engineering, Inc., 1991, p. 5-1). The RFI reports were submitted to the TWC in February 1992. On the basis of the results of the RFI reports, the TWC, in a March 4, 1992, correspondence, prescribed "no additional efforts at this time" for RFI Unit No. 1 (MSWLF).



Base from U.S. Geological Survey, 1:24,000 quadrangles: El Paso, Texas; Fort Bliss SE, Texas; Fort Bliss NE, Texas; North Franklin Mountains, Texas

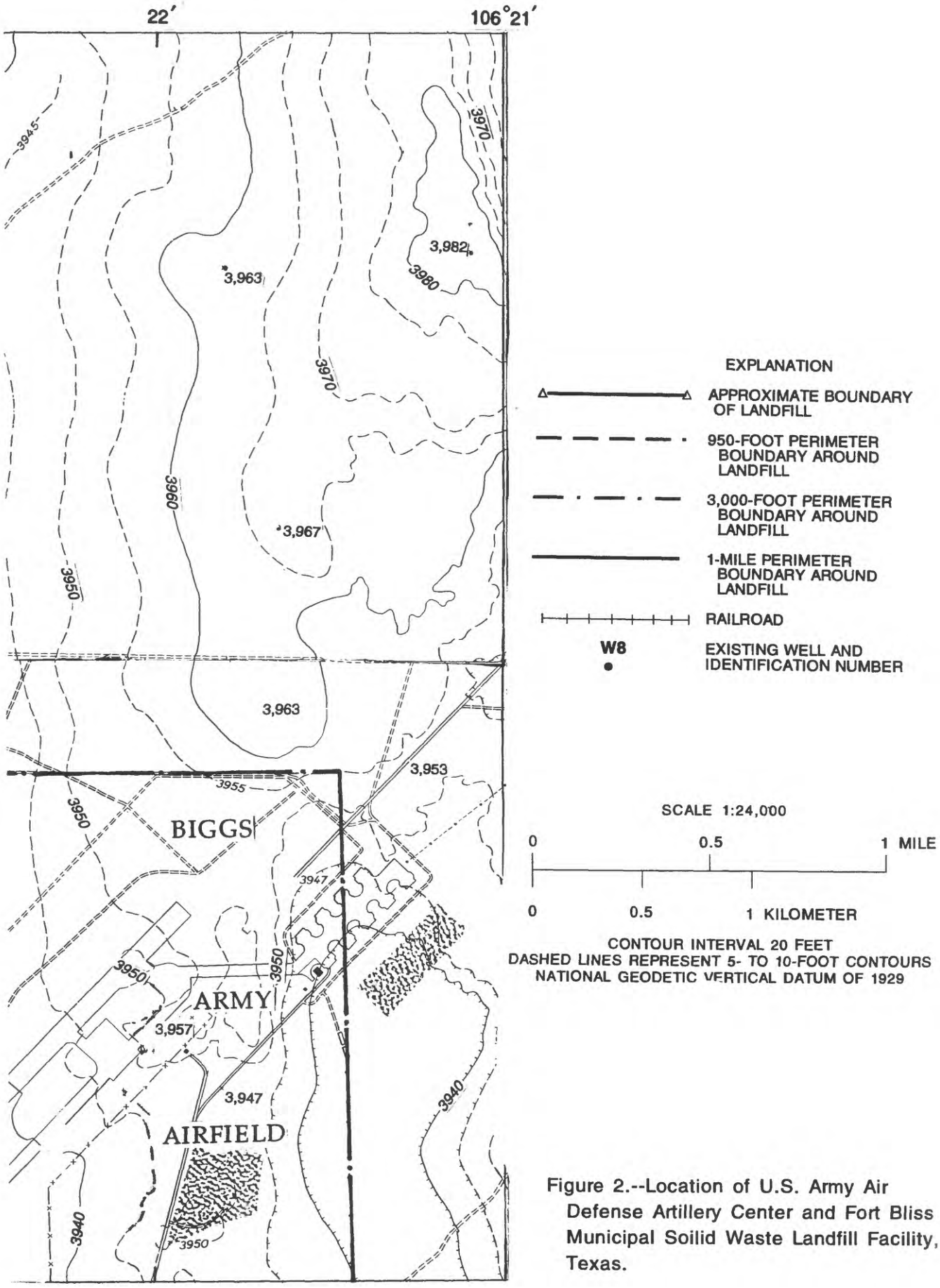
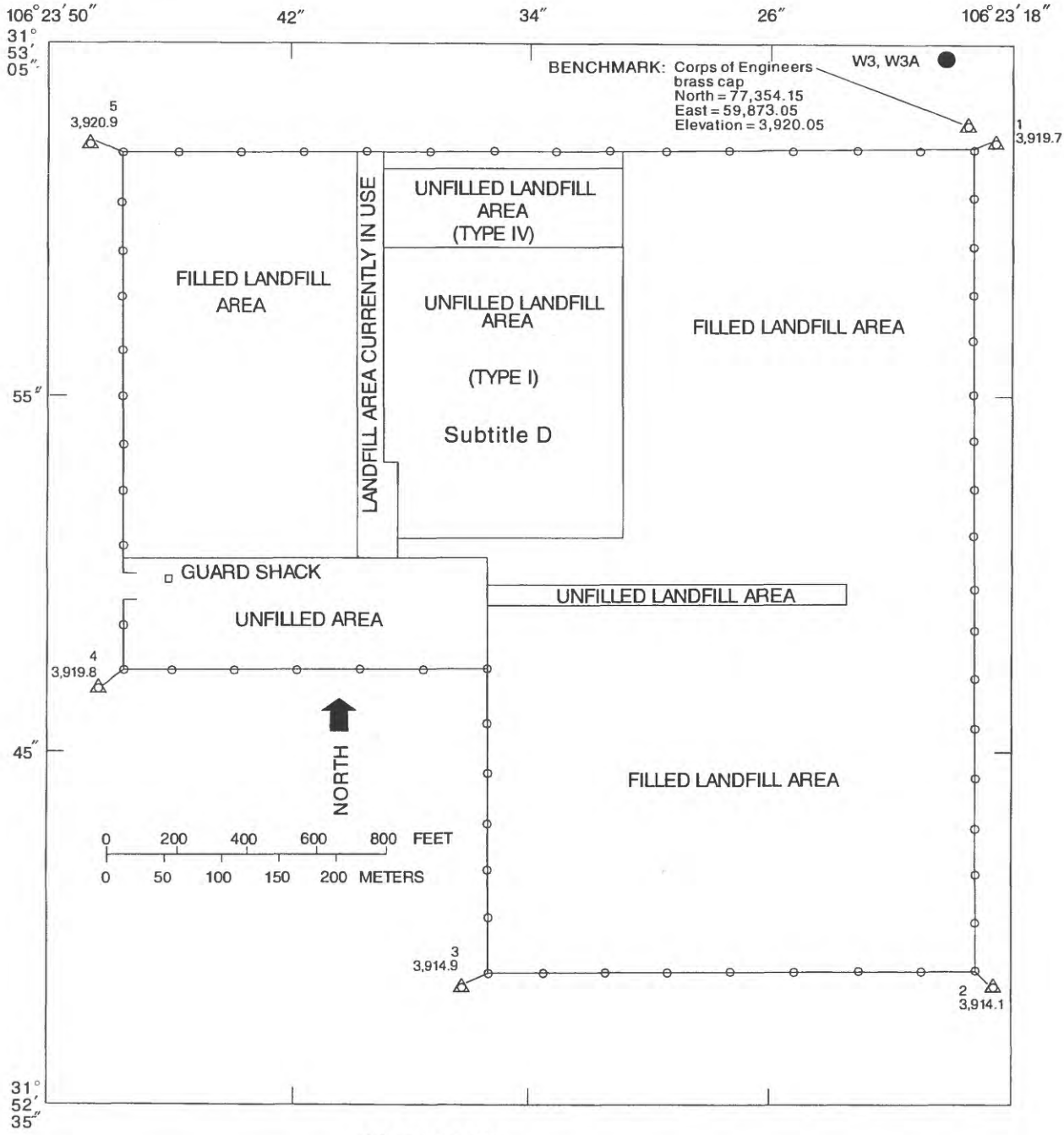


Figure 2.--Location of U.S. Army Air Defense Artillery Center and Fort Bliss Municipal Soilid Waste Landfill Facility, Texas.



EXPLANATION

FENCE/LANDFILL BOUNDARY

3,919.8 (4) CONTROL POINT -- Identification number and elevation, in feet above sea level

W3, W3A GROUND-WATER PRODUCTION WELL AND IDENTIFICATION NUMBER

TYPE I STANDARD LANDFILL FACILITY FOR DISPOSAL OF MUNICIPAL SOLID WASTE

TYPE IV FACILITY AUTHORIZED FOR DISPOSAL OF BRUSH, CONSTRUCTION-DEMOLITION WASTE, AND RUBBISH THAT ARE FREE OF PUTRESCIBLE AND HOUSEHOLD WASTES

Figure 3.--Existing Municipal Solid Waste Landfill Facility boundary conditions.

Resource Conservation and Recovery Act Subtitle D and State of Texas Programs

On October 9, 1991, the RCRA of 1976 was officially expanded to include revisions to the Criteria for Classification of Solid Waste Disposal Facilities and Practices set forth in 40 CFR Part 257, and to add RCRA Subtitle D (40 CFR Part 258). These revisions that implement minimum Federal criteria for municipal solid waste landfill facilities are referred to as Subtitle D of the RCRA. On October 9, 1993, Chapter 330 Municipal Solid Waste of the 30 TAC became effective in the State of Texas. The 30 TAC includes the Subtitle D requirements and covers all aspects of municipal solid waste management under the authority of the TNRCC. Although Texas State permit HW-50296 remains in force, the USAADACENFB is initiating studies to comply with the requirements in 30 TAC Chapter 330 (30 TAC 330).

This study of the MSWLF was conducted to compile existing geohydrologic information to characterize the site, which is under the regulatory jurisdiction of the TNRCC. The study was conducted in accordance with recommendations presented in the TNRCC's Municipal Solid Waste Regulations, 30 TAC 330, which implement requirements of Subtitle D of the RCRA.

Well-Numbering System

The well-numbering system in Texas was developed by the Texas Water Development Board for use throughout the State (fig. 4). The well number is divided into five segments; in this report the first four segments are divided by hyphens. The first segment is a two-letter prefix that identifies the county. The second segment indicates a 1-degree quadrangle that is given a number consisting of two digits ranging from 01 to 89. Each 1-degree quadrangle is divided into 7.5-minute quadrangles that are given a two-digit number from 01 to 64; this two-digit number is the third segment of the well number. Each 7.5-minute quadrangle is divided into 2.5-minute quadrangles that are given a single-digit number from 1 to 9; this one digit number is the fourth segment of the well number. Finally, each well within a 2.5-minute quadrangle is given a two-digit number in the order in which it was inventoried, starting with 01; this two-digit number is the fifth segment of the well number.

ENVIRONMENTAL SETTING

The Fort Bliss Post Headquarters and MSWLF are located in Texas, within the extraterritorial jurisdiction of the City of El Paso (fig. 5). The population of the El Paso metropolitan area is greater than 600,000. Ciudad Juarez, Mexico, lies directly south of El Paso across the Rio Grande and has a population greater than 1,000,000.

Physiography

Fort Bliss military reservation lies in the Hueco Bolson intermontane valley (fig. 5). The Hueco Bolson intermontane valley was produced by numerous diverse faults and folds and is divided into two distinct parts. The northern extension of the Hueco Bolson is referred to as the Tularosa Basin; the southern extension is referred to as the Hueco Bolson proper (Knowles and Kennedy, 1958, p. 8), hereafter referred to as the Hueco Bolson. The Tularosa Basin and Hueco Bolson are divided indefinitely a few miles north of the New Mexico-Texas border. The Tularosa Basin has no external drainage; the Hueco Bolson is partly drained by the Rio Grande. Elevations of the Fort Bliss military reservation range from 3,800 feet to more than 8,000 feet above sea level.

The MSWLF is 4 miles east of the rugged Franklin Mountains. The Franklin Mountains have peaks from 4,600 feet to greater than 7,000 feet above sea level. Geographic coordinates of the MSWLF are 31°52'54.51" north latitude, 106°25'33.09" west longitude. Elevations at the MSWLF range from 3,907 to 3,937 feet above sea level.

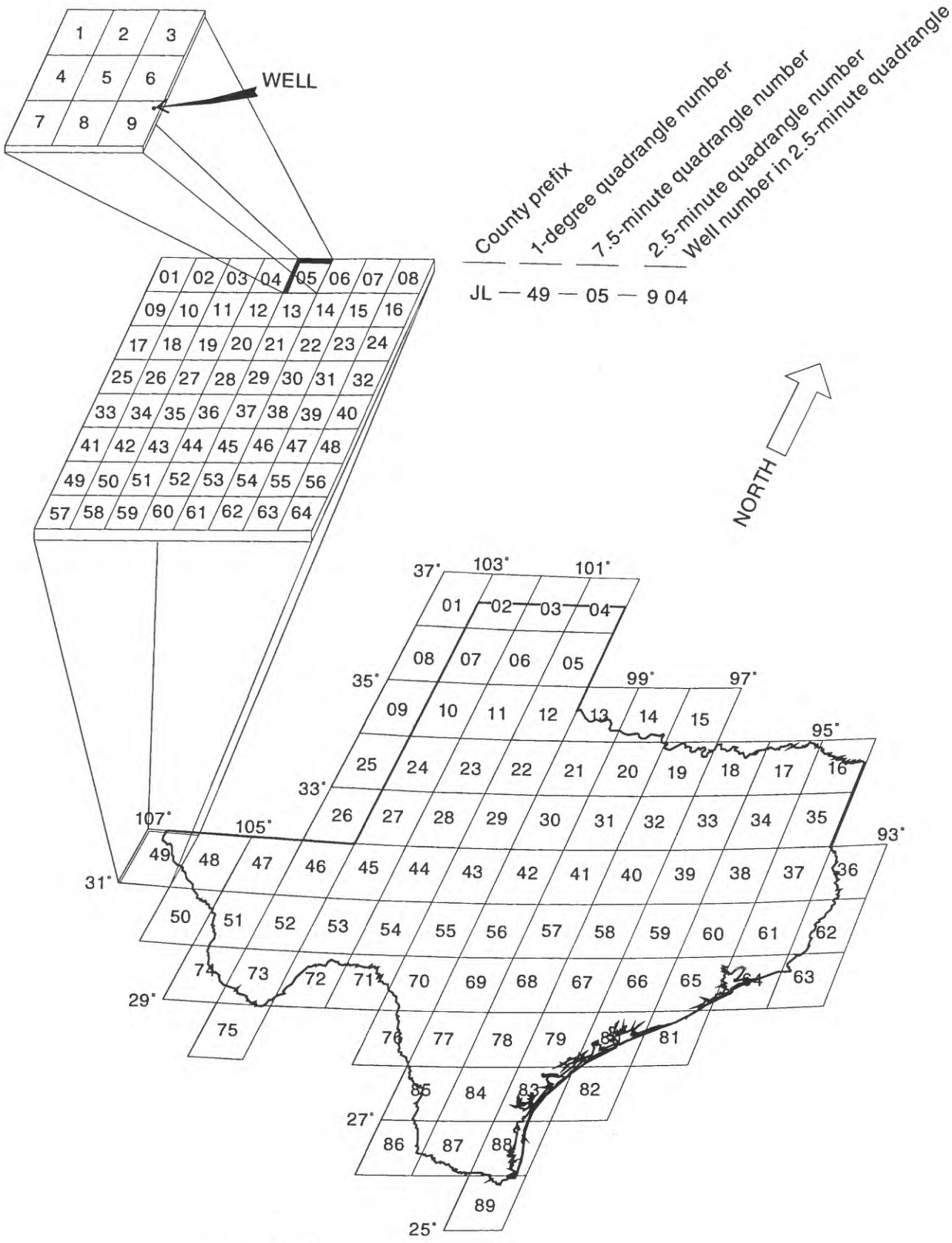


Figure 4.--Texas well-numbering system.

Figure 5.--Physiographic structures of the Tularosa Basin and Hueco Bolson (modified from Sayre and Livingston, 1945). See figures 9 and 11 for explanation of A - A'.

Climate

The climate of the MSWLF and vicinity, classified as arid continental, is characterized by an abundance of sunny days, high summer temperatures, relatively cool winters typical of arid areas, scanty rainfall, and very low humidity throughout the year. Temperature and precipitation data are recorded at El Paso International Airport by the National Weather Service and reported in monthly and annual reports by the National Oceanic and Atmospheric Administration. El Paso International Airport is approximately 4.5 miles southeast of the MSWLF.

Average annual precipitation in the El Paso area is 7.8 inches (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1992). Average monthly precipitation ranges from less than 1 inch during October through June to more than 1.2 inches in July, August, and September. Winter months are typically dry, and monthly snowfalls seldom exceed 3 inches (approximately 0.25 inch of water). Snow rarely lasts longer than 24 hours in the nonmountainous areas. Typically rainy months receive almost half of the annual precipitation in the form of brief but locally heavy thunderstorms. Prolonged periods of continuous precipitation are rare.

Average annual temperature at El Paso International Airport is 63.3 °F, ranging from a mean monthly low of 44.2 °F in January to a mean monthly high of 82.5 °F in July (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1992). Summer daytime temperatures are frequently above 90 °F and occasionally rise above 100 °F. Summer night minimum temperatures are usually 60 to 65 °F. Winter days are cool and mild with temperatures rising to 55 to 60 °F. Night temperatures drop to below freezing during several nights in December and January.

The prevailing wind direction in the winter months is from the north and in the summer months is from the south. Dust and wind storms are frequent in March and April and wind speeds occasionally exceed 35 miles per hour.

Evaporation records from a class A evaporation pan at Ysleta, Texas, for 1985-92 are given in table 1. Ysleta, Texas, is located in El Paso County southeast of El Paso and 16 miles southeast of the MSWLF. Average annual pan evaporation for 1985-92 was about 93 inches. Sixty-one percent of evaporation occurred during April through August. Potential evaporation is calculated using the pan evaporation figure and the conservative factor of 0.70, resulting in an estimate of 65 inches per year. Relative humidity in the Fort Bliss/El Paso area is generally low. No studies have been identified that discuss pollution characteristics of ambient air quality at the MSWLF.

Soils and Soil Gas

Soils of El Paso County, described by Jaco (1971), constitute generally the first 5 feet of unconsolidated material below land surface. The following is a description of soils at and adjacent to the MSWLF as described by Jaco. The soil descriptions are not applicable to the deeper part of the vadose zone (Hueco Bolson) through which potential contaminants would migrate toward the water table. Because soils do provide much of the material readily available for engineering purposes, however, estimated engineering properties (Jaco, 1971) are shown in table 2 for each soil series.

Soils on the MSWLF and vicinity are mapped in figure 6. Although soils are described by association, soils are highly variable in the field and mapping units generally include areas that have more than one soil series. Soils on the MSWLF are nearly level to gently sloping, have a fine sandy loam subsoil, and are moderately deep over caliche. Loam denotes a mixture of clay (7 to 27 percent), silt (28 to 50 percent), and sand (less than 52 percent). West and north of the MSWLF soils are also nearly level and gently sloping. These soils have a clay loam subsoil and are moderately deep over soft caliche. The following is a brief description of each mapping unit, including the percentages of each series (Jaco, 1971).

Table 1.--Evaporation, in inches, from class A evaporation pan at Ysleta, Texas, 1985-92

[Records of U.S. Weather Bureau. --, no record; B, estimated total]

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1985	--	--	B 7.55	10.37	12.72	13.52	B 12.50	11.03	7.69	5.47	3.09	B 2.58	--
1986	3.51	4.72	7.27	9.48	11.15	9.61	9.94	9.77	8.34	5.45	--	--	--
1987	--	--	B 6.65	8.95	12.34	13.49	13.77	B 9.94	7.31	5.98	--	--	--
1988	--	B 4.56	8.77	10.40	13.24	--	11.24	B 8.16	7.56	6.37	4.64	--	--
1989	--	4.54	7.60	10.96	12.53	13.76	12.43	9.87	8.28	6.02	B 4.25	--	--
1990	--	--	B 6.62	B 10.01	12.75	15.10	11.19	9.01	7.22	6.21	B 3.61	--	--
1991	5.07	B 3.94	B 7.07	11.38	B 13.76	13.07	9.97	9.71	B 6.45	6.57	3.53	B 3.32	B 93.84
1992	B 2.33	B 3.38	6.41	9.67	B 8.92	13.50	B 13.00	10.22	9.32	5.69	B 3.80	--	--
Average	B 3.64	B 4.23	B 7.24	B 10.15	B 12.18	13.15	B 11.76	B 9.71	B 7.77	5.97	B 3.82	B 2.95	B 92.57

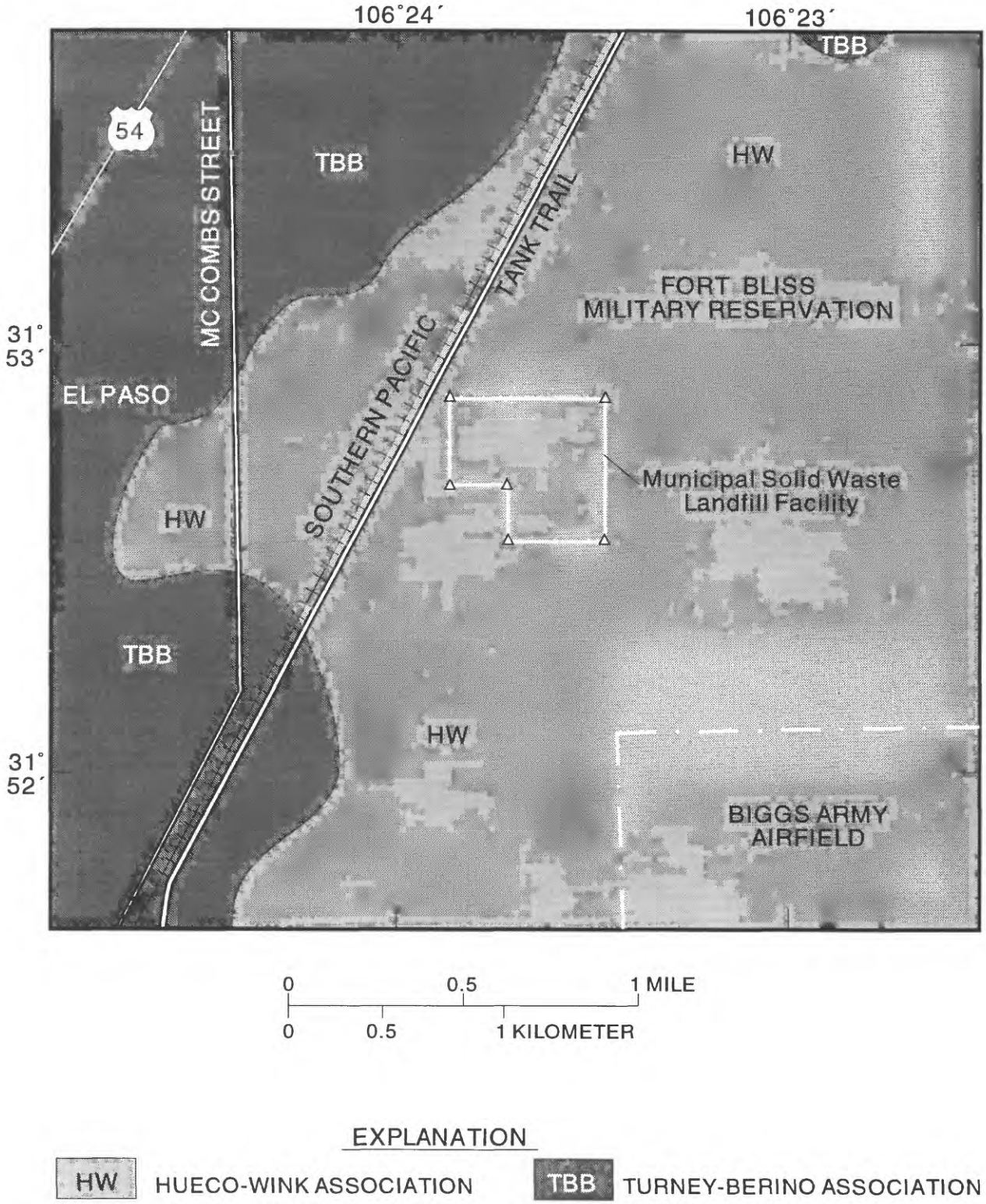


Figure 6.--Soils of the Municipal Solid Waste Landfill Facility and vicinity (modified from Jaco, 1971).

Table 2.--Engineering classification and estimated engineering properties of soil at the Municipal Solid Waste Landfill Facility and vicinity

[Engineering properties from Jaco (1971). TBB, Turney-Berino; HW, Hueco-Wink. The unified system of soil classification is used by Soil Conservation Service engineers. SM, SP, and SC are coarse-grained soils; CL is fine-grained soils. USDA, U.S. Department of Agriculture; AASHO, American Association of State Highway Officials; mm, millimeter; no., number; --, no data]

Soils and map symbols (fig. 6)	Depth below land surface (inches)	Classification			Percentage passing sieve				Permeability (inches per hour)	Available water capacity (inches per inch of soil)	Shrink-swell potential
		USDA texture	Unified	AASHO	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)			
Berino, TBB	0-8	Fine sandy loam	SM or SM-SC	A-2 or A-4	100	100	90-100	25-45	0.63-2.00	0.10	Low.
	8-13	Loam	CL	A-6	100	100	85-95	60-75	0.63-2.00	0.15	Moderate.
	13-37	Clay loam	CL	A-6	100	95-100	65-80	55-70	0.20-0.63	0.16	Moderate.
	37-82	Loam	SC or CL	A-6	90-100	85-95	60-70	45-65	0.63-2.00	0.15	Low to moderate.
	82-100	Fine sandy loam	SM or SM-SC	A-2 or A-4	100	100	90-100	25-45	0.63-2.00	0.10	Low.
Hueco, HW	0-4	Loamy fine sand	SP or SP-SM	A-3	100	100	70-85	0-10	2.00-6.30	0.08	Low.
	4-26	Fine sandy loam	SM or SM-SC	A-2-4	100	100	80-95	15-30	2.00-6.30	0.10	Low.
	26-60	Indurated caliche									
Turney, TBB	0-3	Fine sandy loam	SM or SM-SC	A-2 or A-4	100	100	90-100	25-45	0.63-2.00	0.10	Low.
	3-10	Loam	CL	A-6	100	95-100	85-95	50-65	0.63-2.00	0.15	Moderate.
	10-34	Clay loam	CL	A-6	100	95-100	75-90	55-70	0.20-0.63	0.16	Moderate.
	34-60	Caliche (about clay loam texture)	CL	A-6	95-100	95-100	75-90	55-70	0.20-0.63	0.15	Moderate.
	60-80	Fine sandy loam	SM or SM-SC	A-2 or A-4	100	100	90-100	25-45	0.63-2.00	0.10	Low.
Wink,HW	0-24	Fine sandy loam	SM-SC	A-2-4	100	95-100	95-100	20-35	0.63-2.00	0.10	Low.
	24-73	Cemented caliche	--	--	--	--	--	--	--	--	--
	73-100	Gravelly loam	SM or SM-SC	A-2 or A-4	90-95	70-85	65-80	25-45	2.00-6.30	0.08	Low.

HW--Hueco-Wink Association, hummocky. The Hueco-Wink Association includes Hueco and Wink soils. In El Paso County, the Hueco-Wink Association constitutes 41 percent of the soils. Hueco soils constitute 42 percent of the association; Wink soils constitute 38 percent, and minor soils constitute 20 percent.

Hueco soils--typically have a brown, loamy, fine sand surface layer, about 4 inches thick, that is mildly alkaline and noncalcareous. The subsoil is brown and yellowish-brown, calcareous, fine sandy loam about 22 inches thick. A layer of indurated caliche is about 32 inches thick at a depth of 26 inches.

Wink soils--typically have a pale-brown surface layer about 6 inches thick and a light yellowish-brown subsoil about 18 inches thick. Both layers are calcareous, fine sandy loam. Cemented caliche begins at a depth of about 24 inches.

TBB--Turney-Berino Association, undulating. The Turney-Berino Association includes Turney and Berino soils. In El Paso County, the Turney-Berino Association constitutes 5 percent of the soils. Turney soils constitute 68 percent of the association, Berino soils constitute 18 percent, and minor soils constitute 14 percent.

Turney soils--typically have a moderately alkaline, calcareous surface layer about 10 inches thick. They are light-reddish-brown, fine sandy loam to a depth of about 3 inches and are light-brown loam below. The subsoil is light-brown, calcareous clay loam. Depth to soft caliche is about 34 inches.

Berino soils--are similar to Turney soils but their surface layer is noncalcareous and mildly alkaline, and their clay loam subsoil contains clay films on the soil particles.

To determine the location and concentration of vapor-phase gases generated by the MSWLF that may have migrated upward to the surface, laterally toward the MSWLF perimeter, or to the MSWLF guard shack, a soil-gas survey was conducted June 15-16, 1994, by the USAADACENFB. At 30 points around the perimeter of the MSWLF and 4 points adjacent to the four walls of the guard shack (fig. 7), a 1/4-inch-diameter rod was driven to 4 feet below land surface and then extracted. A probe was inserted into the resultant hole. Dirt was used to seal the annular space of the hole at the land surface. A portable gas meter (Gastech GT201) calibrated to methane was used to measure the concentration of methane and hydrocarbons at each probe site. Methane and hydrocarbon concentrations in the ambient air in the guard shack also were measured using the portable gas meter. Results of data collected during the soil-gas survey are presented in table 3. In all cases methane was less than 1 percent by volume. Hydrocarbon concentrations ranged from 80 to 1,160 parts per million.

A methane-gas monitoring network was installed at the MSWLF in November 1994. The monitoring network was designed to collect representative samples of explosive gases (specifically methane) generated by the facility and to monitor whether these gases exceed maximum allowable levels as defined in RCRA Subtitle D (40 CFR 258.23 (d)) and 30 TAC §330.56(n)(2). The methane-monitoring probes are screened from 5 to 30 feet below land surface. Locations of methane-monitoring probes and ambient-air methane-monitoring sites are shown in figure 8. These sites are monitored quarterly.

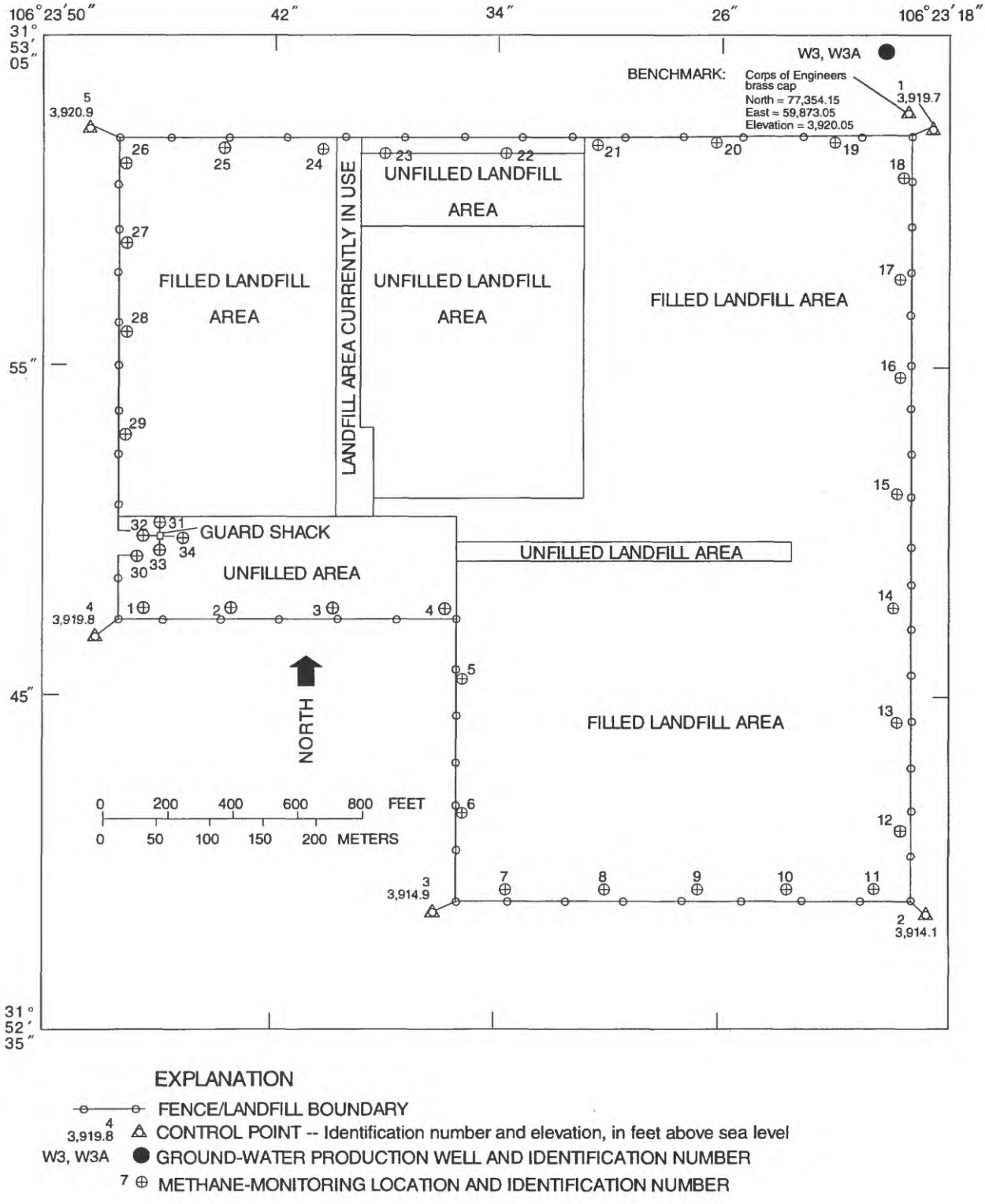


Figure 7.--Methane-monitoring locations of soil-gas survey conducted June 15-16, 1994, by the U.S. Army Air Defense Artillery Center and Fort Bliss.

Table 3.--Results of soil-gas survey conducted June 15-16, 1994, by U.S. Army Air Defense Artillery Center and Fort Bliss[1]

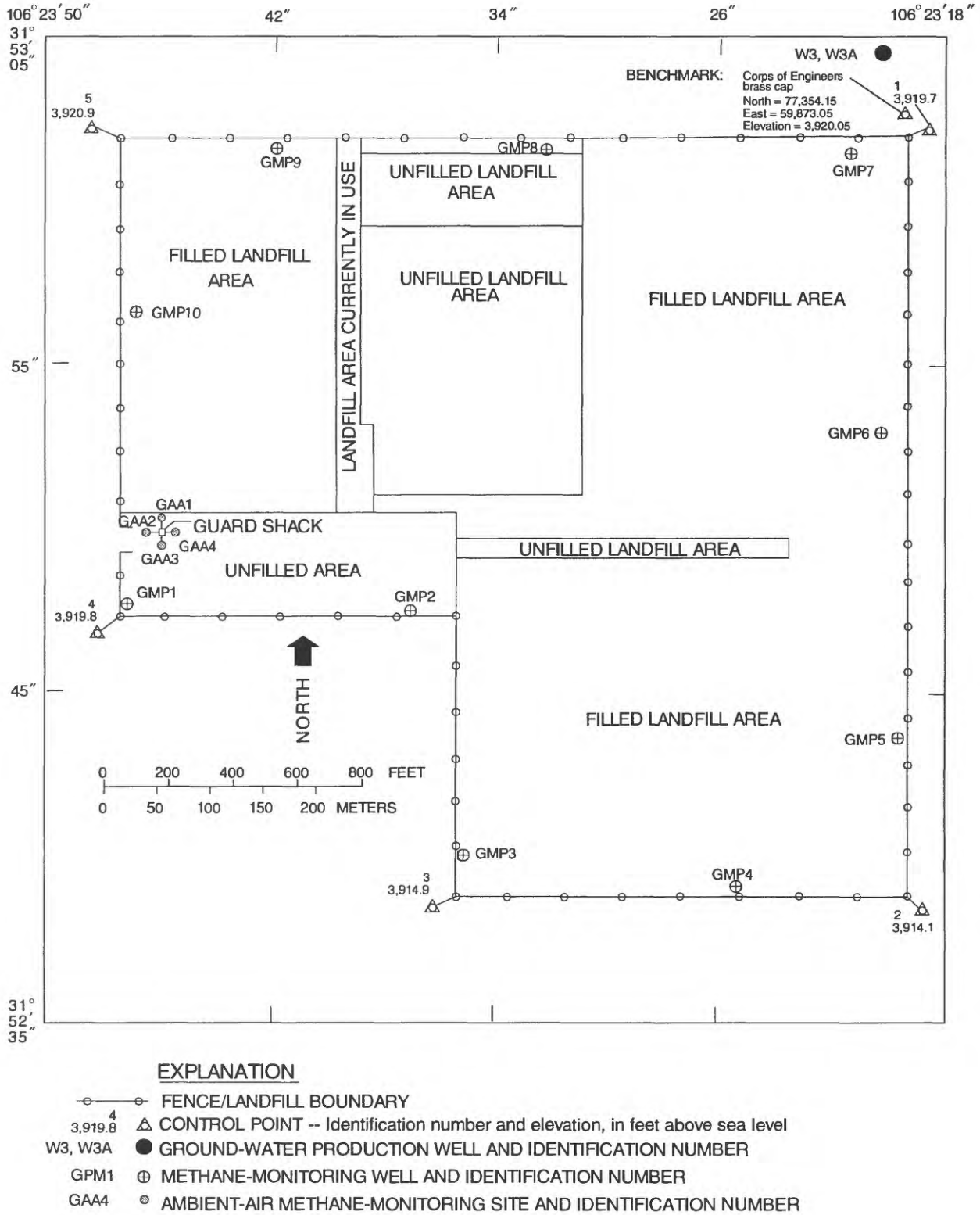
[<, less than]

Map number (fig. 7)	Date	Time	Percent by volume methane[2]	Hydrocarbon concentration (parts per million)
1	6-15-94	0818	<1	320
2	6-15-94	0837	<1	380
3	6-15-94	0850	<1	360
4	6-15-94	0906	<1	360
5	6-15-94	0917	<1	340
6	6-15-94	0936	<1	240
7	6-15-94	0950	<1	280
8	6-15-94	1002	<1	260
9	6-15-94	1012	<1	300
10	6-15-94	1027	<1	280
11	6-15-94	1040	<1	260
12	6-15-94	1113	<1	260
13	6-15-94	1134	<1	240
14	6-15-94	1148	<1	80
15	6-15-94	1405	<1	260
16	6-15-94	1417	<1	200
17	6-15-94	1429	<1	200
18	6-15-94	1440	<1	280
19	6-15-94	1452	<1	320
20	6-15-94	1501	<1	380
21	6-15-94	1511	<1	380
22	6-15-94	1523	<1	400
23	6-15-94	1535	<1	380
24	6-15-94	1543	<1	480
25	6-15-94	1557	<1	460
26	6-16-94	0820	<1	260
27	6-16-94	0835	<1	1,160
28	6-16-94	0855	<1	480
29	6-16-94	0908	<1	600
30	6-16-94	0925	<1	440
[3]31	6-16-94	0939	<1	500
[3]32	6-16-94	0946	<1	580
[3]33	6-16-94	0956	<1	580
[3]34	6-16-94	1005	<1	600

[1]Samples collected from a depth of 4 feet. Measurements made with a Gastech GT201 gas monitor calibrated to methane.

[2]1 percent by volume equals 10,000 parts per million methane.

[3]Measured within 5 feet of each of the four walls of the guard shack. All measurements of methane in the ambient air in the guard shack were zero.



EXPLANATION

- FENCE/LANDFILL BOUNDARY
- 4 / 3,919.8 — CONTROL POINT -- Identification number and elevation, in feet above sea level
- W3, W3A — GROUND-WATER PRODUCTION WELL AND IDENTIFICATION NUMBER
- GPM1 — METHANE-MONITORING WELL AND IDENTIFICATION NUMBER
- GAA4 — AMBIENT-AIR METHANE-MONITORING SITE AND IDENTIFICATION NUMBER

Figure 8.--Location of methane-monitoring sites at the Municipal Solid Waste Landfill Facility.

GEOHYDROLOGY

Data describing the geohydrologic characteristics of the deposits in the MSWLF area were compiled from existing sources and during installation of the MSWLF methane-monitoring system. A summary of the information available on the geohydrology of the MSWLF and vicinity is presented in the following sections.

Geology

The MSWLF is underlain by Hueco Bolson deposits of locally derived materials. The Hueco Bolson is a clastic-filled graben extending from a few miles north of the New Mexico-Texas border to several miles south into Mexico (fig. 5). Hueco Bolson deposits are of Tertiary age and primarily include fluvial and lacustrine deposits, but alluvial-fan material and aeolian sediments also are present (Cliett, 1969). Hueco Bolson deposits are reported to have a maximum thickness of about 9,000 feet within a deep structural trough (fig. 9) paralleling the east base of the Franklin Mountains (Mattick, 1967, p. 85-91).

Hueco Bolson deposits typically are composed of fine- to medium-grained sand with interbedded lenses of clay, silt, gravel, and caliche. These deposits range from unconsolidated to slightly consolidated. Sand fragments are composed primarily of chert, granite, and porphyry. Individual beds are not well defined and range in thickness from a fraction of an inch to about 100 feet.

Consolidated igneous and sedimentary rocks ranging in age from Precambrian to Tertiary are exposed in the Franklin and Hueco Mountains (fig. 5). Igneous rocks are predominately granitic and are composed of coarse grains of quartz and feldspar. These granitic rocks are easily weathered and are a primary source material of the bolson deposits.

Hydrology

A summary of information available on the hydrology of the MSWLF and vicinity is presented in the following sections. Tabulated data were compiled from El Paso Water Utilities and U.S. Geological Survey data bases.

Ground Water

The three primary sources of ground water in the El Paso area are Hueco Bolson deposits, Mesilla Bolson deposits, and Rio Grande alluvium (Alvarez and Buckner, 1980, p. 4). The primary source of ground water in the MSWLF area is the unconsolidated and semiconsolidated sedimentary deposits of the Hueco Bolson. Wells completed in the Hueco Bolson supply water for the City of El Paso, Ciudad Juarez, Fort Bliss military reservation, private industries, and agricultural areas. Wells discharging large amounts of water usually are drilled at least 200 feet into water-yielding material. City of El Paso and Fort Bliss municipal water-supply wells completed in the Hueco Bolson range in depth from about 600 feet to greater than 1,200 feet.

A relatively thick unsaturated zone of approximately 300 feet overlies the aquifer of the Hueco Bolson deposits in the vicinity of the MSWLF. A deep water table prevails for all of the study area. Whether any perched water zones exist below the MSWLF is unknown. Under current conditions, extensive ground-water development by the City of El Paso encompasses the MSWLF (fig. 10).

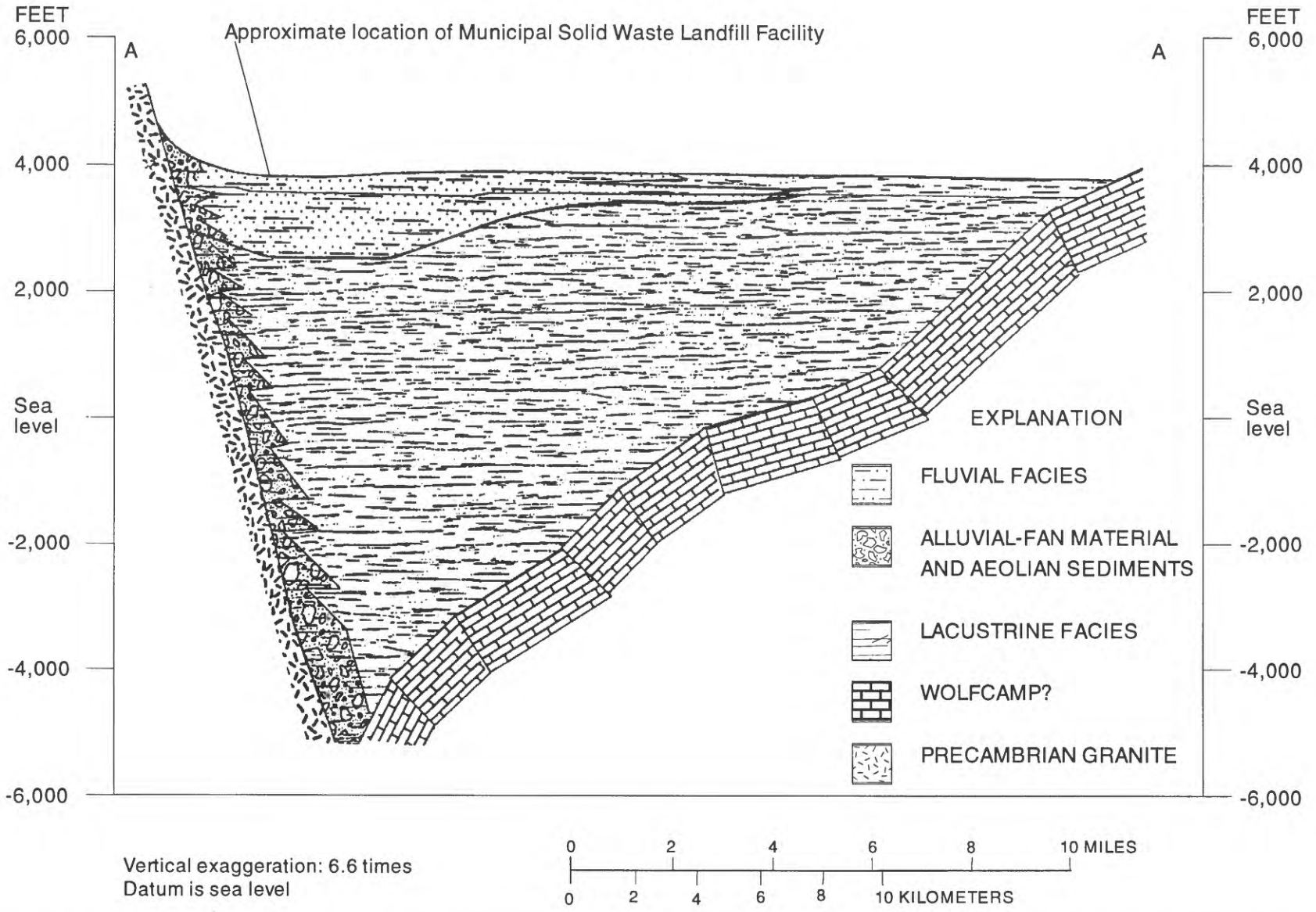
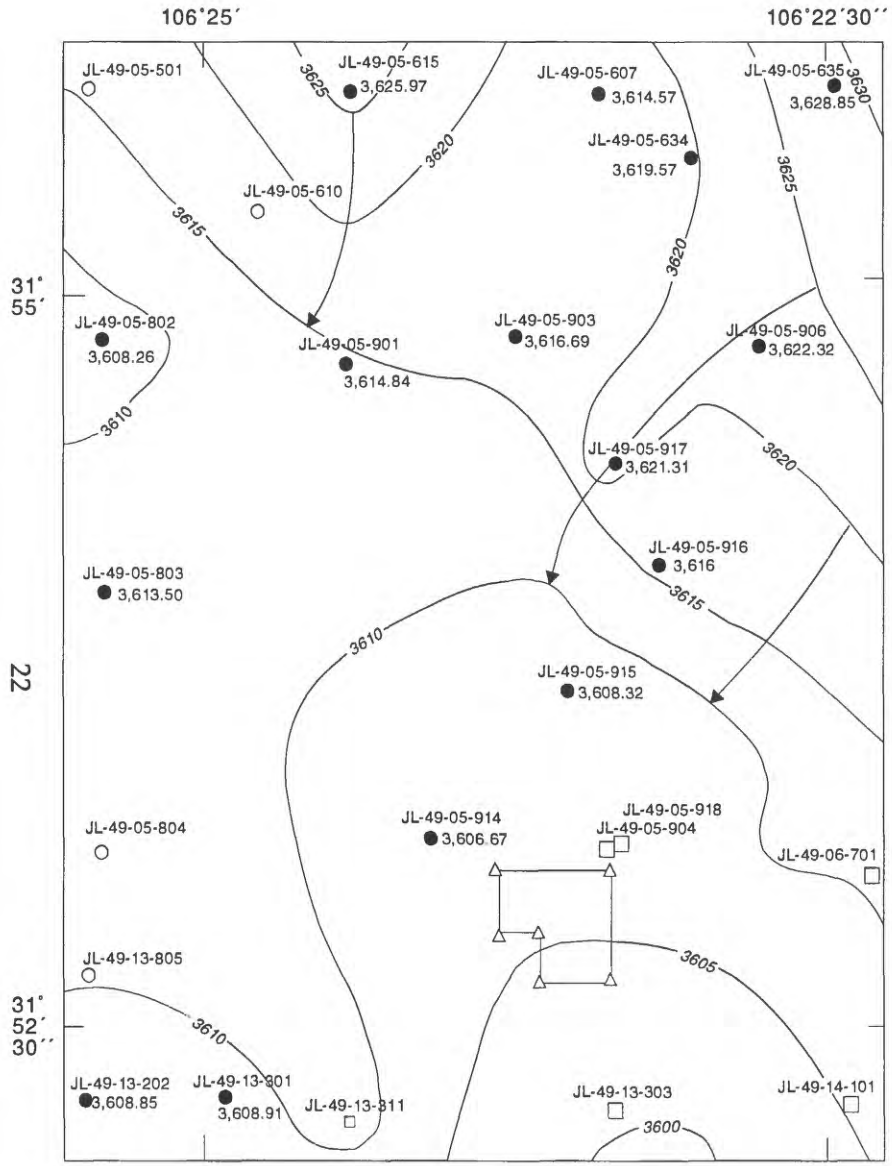


Figure 9.--Geologic section of the Hueco Bolson (trace shown in fig. 5; modified from Cliett, 1969, fig. 2, and published with permission).



EXPLANATION

3,625 — WATER-LEVEL CONTOUR--Shows altitude at which water level would have stood in tightly cased wells, December 1993 to February 1994. Contour interval: 5 feet. Datum is sea level

APPROXIMATE DIRECTION OF GROUND-WATER FLOW

APPROXIMATE BOUNDARY OF U.S. ARMY AIR DEFENSE ARTILLERY CENTER AND FORT BLISS MUNICIPAL SOLID WASTE LANDFILL FACILITY

JL-49-05-906 ● 3,622.32 — CITY OF EL PASO WELL--Upper number is well number; lower number is elevation of water level, in feet above sea level

JL-49-05-804 ○ — CITY OF EL PASO WELL--Well number; water-level data not available for period December 1993 to February 1994

JL-49-06-701 □ — U.S. ARMY WELL--Well number; water-level data not available for period December 1993 to February 1994

Figure 10.--Approximate water-level altitude and directions of ground-water flow from December 1993 to February 1994 (water-level contours from Roger Sperka, El Paso Water Utilities, written commun., 1994).

Hydraulic characteristics of the Hueco Bolson vary significantly because of the nonuniform nature of the individual beds (Alvarez and Buckner, 1980). On a regional scale the Hueco Bolson can be considered a single aquifer, but on a local scale the rate and volume of water flowing through individual beds probably vary considerably. Transmissivities of Hueco Bolson deposits under water-table conditions in the El Paso area are estimated to be 1,340 to 37,500 feet squared per day (10,000 to 280,000 gallons per day per foot) (Alvarez and Buckner, 1980, p. 6).

The Hueco Bolson aquifer underlying the MSWLF is recharged primarily by inflow from the mountainous areas to the north, west, and east. Recharge resulting from direct infiltration of precipitation may be minor due to the high evaporation and low precipitation rates discussed earlier in this report. The regional direction of ground-water flow in the Hueco Bolson deposits is generally south and southwest, toward the Rio Grande. Hydraulic gradients have been altered locally due to extensive pumping of ground water in the El Paso area. Ground-water flow direction at a given location may change from time to time due to pumpage of City of El Paso and U.S. Army production wells. The direction of flow in various strata of the aquifer at a given location generally is somewhat difficult to determine due to the three-dimensional nature of the aquifer. An inventory of wells located within a 1-mile radius of the MSWLF is given in table 4.

Water levels have been declining in the El Paso area. Water pumped from wells in the vicinity of the MSWLF is mostly for municipal use. Ground-water monitoring data in the vicinity of the MSWLF show a water-level decline of 55.65 feet from November 1958 to December 1987 (well JL-49-05-904, table 4). Depth to water in the MSWLF area is currently 325.8 feet below land surface (newly completed U.S. Army well JL-49-05-918 located adjacent to U.S. Army well JL-49-05-904, July 26, 1994). The hydraulic gradient in the MSWLF area is variable due to pumpage of well JL-49-05-918, located near the northeast corner of the perimeter boundary (well W3A in fig. 2). A water-level map (fig. 10) of ground water underlying the MSWLF and vicinity indicates that flow is generally to the south.

The city-operated Shearman Well Field is a primary source of ground water for the City of El Paso. The Shearman Well Field is located north of the MSWLF and includes wells JL-49-05-914, JL-49-05-915, JL-49-05-916, JL-49-05-917, JL-49-05-906, JL-49-05-634, and JL-49-05-635 (fig. 10). Well JL-49-05-906 has been in operation for several years; ground-water monitoring data at this well indicate a water-level decline of 48.34 feet from March 1966 to December 1993 (El Paso Water Utilities, El Paso, Texas, written commun., 1995). Shearman Well Field wells JL-49-05-914, JL-49-05-915, JL-49-05-916, JL-49-05-917, JL-49-05-634, and JL-49-05-635 were installed from 1990 to 1992 and are planned to begin operation from mid-October 1994 through December 1995.

Test-pumping rates at wells in the Shearman Well Field range from 1,800 to 2,400 gallons per minute; drawdowns in the wells ranged from 39.83 feet (well JL-49-05-917 after 24 hours of pumping at 1,930 gallons per minute, August 18-19, 1992) to 73.40 feet (well JL-49-05-916 after 20 hours of pumping at 1,994 gallons per minute, June 30, 1992). Transmissivities of the seven Shearman Well Field wells range from 16,200 to 25,600 feet squared per day (121,000 to 191,000 gallons per day per foot) (El Paso Water Utilities, written commun., 1995). The test-pumping rate of well JL-49-05-914, the well nearest to the MSWLF having test pumping data (fig. 10), was 1,972 gallons per minute on July 20, 1992; the static water level prior to pumping was 317.54 feet below land surface; the pumping level after 8 hours of pumping was 367.80 feet below land surface, resulting in a drawdown rate of 50.26 feet, transmissivity of 22,200 feet squared per day (166,000 gallons per day per foot), and specific capacity of 39.2 gallons per minute per foot of drawdown. After the well was shut off, the well recovered to a static water level of 317.46 feet below land surface on July 21, 1992.

Table 4.--Records of wells in the vicinity of the Municipal Solid Waste Landfill Facility

[Data from El Paso Water Utilities and U.S. Geological Survey files. N, north; W, west; --, no data]

Well identification number (fig. 2)	Well number (fig. 10)	Latitude-longitude	Use	Owner	Well depth (feet)	Elevation of well (feet above sea level)	Date water level measured	Depth to water (feet below land surface)	Elevation of water level (feet above sea level)
W1	JL-49-05-915	31°53'37"N-106°23'31"W	Public supply	City of El Paso	1,202.0	3,925.0	08-Aug-92	322.05	3,602.95
							22-Jan-93	317.69	3,607.31
							22-Dec-93	316.68	3,608.32
W2	JL-49-05-914	31°53'09"N-106°24'03"W	Public supply	City of El Paso	935.0	3,917.0	20-July-92	317.54	3,599.46
							21-July-92	317.46	3,599.54
							22-Jan-93	311.12	3,605.88
							22-Dec-93	310.33	3,606.67
W3	JL-49-05-904	31°53'03"N-106°23'22"W	Public supply	U.S. Army	826.0	3,920.0	18-Nov-58	249.00	3,671.00
							18-Jan-80	291.50	3,628.50
							28-Dec-81	293.34	3,626.66
							23-Jan-83	295.65	3,624.35
							23-Dec-83	294.72	3,625.28
							09-Feb-85	297.71	3,622.29
							31-Dec-85	299.63	3,620.37
							30-Dec-86	303.22	3,616.78
							23-Dec-87	304.65	3,615.35
W3A	JL-49-05-918	31°53'05"N-106°23'20"W	Public supply	U.S. Army	940.0	3,920.0	26-July-94	325.8	3,594.2
W4	JL-49-06-701	31°53'05"N-106°22'20"W	Public supply	U.S. Army	819.0	3,944.0	02-Dec-59	274.00	3,670.00
							18-Jan-79	305.75	3,638.25
							26-Dec-79	308.40	3,635.60
							29-Dec-80	309.15	3,634.85
							24-Dec-81	312.16	3,631.84
							21-Jan-83	315.46	3,628.54
							23-Dec-83	314.72	3,629.28
							29-Jan-85	315.27	3,628.73
							31-Dec-85	320.19	3,623.81
							02-Jan-86	318.64	3,625.36
							29-Dec-86	321.16	3,622.84
							23-Dec-87	323.24	3,620.76
							12-Dec-88	326.19	3,617.81
							08-Dec-89	327.69	3,616.31
							12-Dec-90	326.87	3,616.31
							14-Jan-92	327.74	3,616.26
							22-Dec-92	330.07	3,613.93

Table 4.--Records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Continued

Well identification number (fig. 2)	Well number (fig. 10)	Latitude-longitude	Use	Owner	Well depth (feet)	Elevation of well (feet above sea level)	Date water level measured	Depth to water (feet below land surface)	Elevation of water level (feet above sea level)
W5	JL-49-13-301	31°52'12"N-106°24'51"W	Observation	City of El Paso	612.0	3,882.0	15-Feb-64	228.48	3,653.52
							31-Dec-64	228.89	3,653.11
							31-Dec-66	233.55	3,648.45
							31-Dec-67	234.08	3,647.92
							31-Dec-68	235.55	3,646.45
							31-Dec-69	235.02	3,646.98
							31-Dec-70	237.83	3,644.17
							31-Dec-71	241.11	3,640.89
							31-Dec-72	238.80	3,643.20
							31-Dec-73	247.28	3,634.72
							31-Dec-74	246.75	3,635.25
							19-Dec-75	248.42	3,633.58
							20-Dec-76	251.55	3,630.45
							19-Dec-77	250.53	3,631.47
							20-Dec-78	253.11	3,628.89
							20-Dec-79	255.03	3,626.97
							19-Dec-80	258.58	3,623.42
							21-Dec-81	257.56	3,624.44
							21-Dec-82	259.69	3,622.31
							13-Dec-83	260.73	3,621.27
							20-Dec-84	262.45	3,619.55
							17-Dec-85	265.06	3,616.94
							24-Dec-86	266.32	3,615.68
							21-Dec-87	266.89	3,615.11
							19-Dec-88	268.55	3,613.45
							14-Dec-89	269.96	3,612.04
							18-Dec-90	270.90	3,611.10
							15-Dec-91	271.89	3,610.11
							17-Dec-92	271.85	3,610.15
							21-Dec-93	273.09	3,608.91
W6	JL-49-13-311	31°52'11"N-106°24'19"W	Observation	U.S. Army	812.0	3,900.0	18-Jan-79	267.04	3,632.96
							15-Jan-80	269.98	3,630.02
							24-Dec-80	270.62	3,629.38
							24-Dec-81	272.12	3,627.88
							21-Jan-83	274.09	3,625.91
							23-Dec-83	274.93	3,625.07
							28-Jan-85	277.96	3,622.04
							31-Dec-85	277.99	3,622.01

Table 4.--Records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Concluded

Well identification number (fig. 2)	Well number (fig. 10)	Latitude-longitude	Use	Owner	Well depth (feet)	Elevation of well (feet above sea level)	Date water level measured	Depth to water (feet below land surface)	Elevation of water level (feet above sea level)
W6 (Continued)							29-Dec-86	281.75	3,618.25
							29-Dec-87	284.01	3,615.99
							12-Dec-88	285.32	3,614.68
							10-Dec-89	286.30	3,613.70
							12-Dec-90	287.12	3,612.88
							14-Jan-92	287.17	3,612.83
							22-Dec-92	290.07	3,609.93
W7	JL-49-13-303	31°52'11"N-106°23'22"W	Public supply	U.S. Army	813.0	3,908.0	23-Dec-87	297.06	3,610.94
W8	JL-49-14-101	31°52'14"N-106°22'21"W	Public supply	U.S. Army	819.0	3,940.0	21-Aug-59	274.00	3,666.00
							18-Jan-80	321.31	3,618.69
							24-Jan-81	308.60	3,631.40
							23-Dec-83	314.52	3,625.48
							02-Jan-86	318.95	3,621.05
							19-Dec-86	322.82	3,617.18

Ground water in the El Paso area is chemically suitable for most uses. Concentrations of dissolved solids in water from the Hueco Bolson fluvial deposits (fig. 11) range from 300 parts per million to more than 1,500 parts per million; concentrations of dissolved solids in water from underlying lake deposits are as much as 50,000 parts per million (Cliett, 1969, p. 210). El Paso Water Utilities reports that dissolved-solids concentration in the MSWLF vicinity generally ranges from 297 to 625 milligrams per liter (wells JL-49-05-904 and JL-49-05-915, respectively) but concentrations have been measured as high as 1,312 milligrams per liter (well JL-49-05-914, April 7, 1992) (table 5).

Surface Water

The Rio Grande is the only perennial stream in the El Paso area. Streamflow in the Rio Grande at El Paso is regulated by upstream reservoirs and diversions. Flow in the Rio Grande at El Paso averaged 543 cubic feet per second from 1938 to 1988 (International Boundary and Water Commission, 1988, p. 9). Runoff from the western and southern slopes of the Franklin Mountains drains into the Rio Grande. Runoff from the eastern slopes of the Franklin Mountains drains into the Hueco Bolson where it infiltrates and/or evaporates (Alvarez and Buckner, 1980, p. 6).

No perennial or ephemeral streams are on or in the vicinity of the MSWLF. Moderately defined arroyos extend from the Franklin Mountains and drain into the Hueco Bolson 2 or more miles west of the MSWLF. The arroyos flow only in response to intense precipitation during thunderstorms. Surface outflow at the MSWLF is assumed to be negligible due to the absence of surface-water flow in the vicinity of the facility.

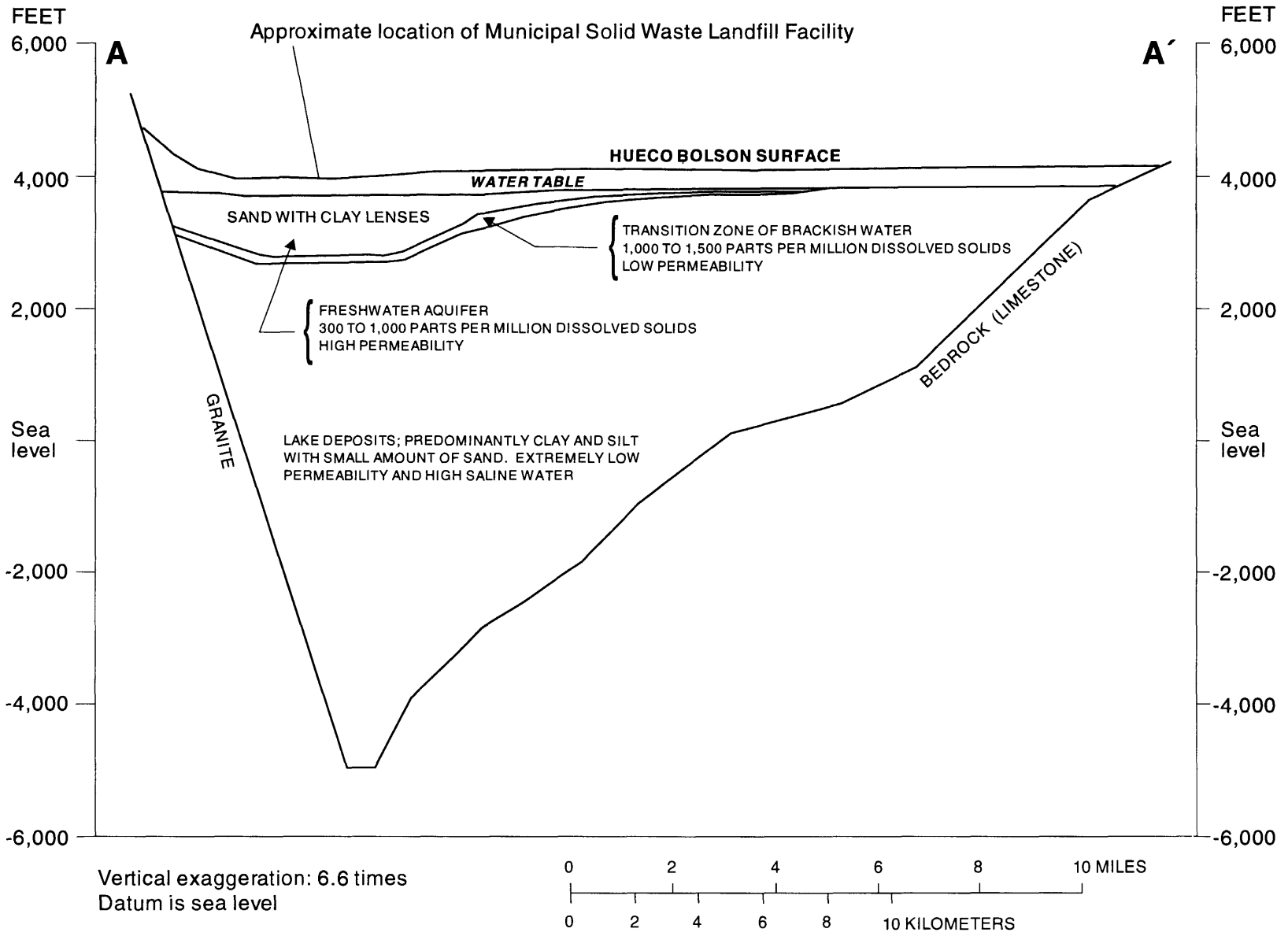


Figure 11.- -Ground-water occurrence in the Hueco Bolson (trace shown in fig. 5; modified from Cliett, 1969, fig. 3, and published with permission).

Table 5.--Water-quality records of wells in the vicinity of the Municipal Solid Waste Landfill Facility

[µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; DS, dissolved solids; EPWU, El Paso Water Utilities; USGS, U.S. Geological Survey; --, no data; <, less than; µg/L, micrograms per liter]

Well identification number (fig. 2)	Well number (fig. 10)	Analyst	Depth (feet below land surface)	Date	Specific conductance (µS/cm)	pH	Hardness (mg/L)	Reported DS (mg/L)	Calculated DS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)
Field properties and inorganic constituents																					
W1	JL-49-05-915	EPWU[1]	1,005-1,015	04-May-92	674	8.69	58	395	481	16	4.4	123	8.7	168	7.2	58	88	1.3	18	6.2	<0.09
		EPWU[1]	1,175-1,185	04-May-92	1,180	8.46	86	625	678	26	5.3	203	8.4	105	7.2	41	280	0.8	20	<0.1	1.3
		EPWU[1]	443-1,202	09-Aug-92	582	8.20	79	338	414	24	4.8	93	8.9	150	0	52	72	1.0	36	7.9	<0.09
W2	JL-49-05-914	EPWU[1]	960-970	06-Apr-92	772	8.43	80	425	495	22	5.8	126	9.6	139	7.2	55	125	1.0	30	4.6	<0.09
		EPWU[1]	1,008-1,016	08-Apr-92	787	8.49	66	436	498	20	3.8	134	10	124	9.6	62	130	1.0	32	3.6	<0.09
		EPWU[1]	1,094-1,104	07-Apr-92	834	8.50	80	492	567	30	1.5	151	8.5	146	7.2	73	143	1.0	35	5.2	0.1
		EPWU[1]	1,194-1,204	07-Apr-92	2,420	8.05	319	1,312	1,354	111	10	366	13	83	4.8	101	660	0.8	32	4.3	<0.09
		EPWU[1]	371-935	23-July-92	664	8.08	95	384	477	26	7.3	100	9.9	184	0	72	68	1.1	35	8.8	<0.09
W3	JL-49-05-904	USGS	260-815	24-Feb-59	595	7.6	88	358	413	23	7.5	92	--	165	0	61	61	0.9	32	3.0	--
		USGS	260-815	14-June-61	554	7.5	81	338	379	21	6.9	84	--	154	0	52	54	0.9	34	5.8	--
		USGS	260-815	22-June-81	470	8.2	69	314	353	18	5.8	73	8.9	146	0	47	43	0.6	35	10	--
		USGS	260-815	08-Aug-85	530	7.7	73	316	357	19	6.2	75	9.2	142	0	45	52	0.9	31	8.0	--
		USGS	260-815	18-Aug-87	545	8.30	70	310	362	18	6.1	73	9.6	149	--	48	49	0.90	29	8.0	--
		EPWU	260-815	18-Aug-87	520	8.09	86	363	364	23	6.9	72	9.5	149	0	44	50	0.83	38	8.4	<0.09
		USGS	260-815	13-Sept-89	506	8.20	72	304	357	19	6.0	73	9.0	152	0	45	45	0.90	31	7.5	--
		USGS	260-815	14-May-91	515	7.9	72	307	359	19	6.0	72	10	144	0	44	55	0.90	29	8.4	--
		USGS	260-815	16-Jan-92	476	7.9	71	297	350	19	5.7	70	9.4	148	0	44	45	0.9	30	8.4	--
W4	JL-49-06-701	USGS	293-810	16-May-61	505	6.9	70	306	342	18	6.1	78	--	136	0	40	56	1.1	31	6.3	--
		USGS	293-810	11-Apr-66	627	7.3	97	362	403	24	9.0	91	--	142	0	39	92	0.9	31	5.3	--

Table 5.--Water-quality records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Continued

Well identification number (fig. 2)	Well number (fig. 10)	Analyst	Depth (feet below land surface)	Date	Specific conductance (µS/cm)	pH	Hardness (mg/L)	Reported DS (mg/L)	Calculated DS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)
Field properties and inorganic constituents--Continued																					
W4	JL-49-06-701	USGS	293-810	22-June-81	615	8.0	93	371	407	25	7.4	87	7.0	134	0	37	100	0.8	32	8.4	--
		USGS	293-810	06-June-83	625	8.1	93	363	401	25	7.4	87	6.4	134	0	33	99	0.9	30	8.0	--
		EPWU	293-810	06-June-83	600	8.05	92	397	397	28	5.0	90	6.6	127	0	30	100	0.84	30	9.1	<0.03
		USGS	293-810	01-Sept-84	670	7.8	99	387	421	27	7.7	93	7.2	126	0	31	120	0.9	30	8.0	--
		USGS	293-810	22-May-85	632	8.1	93	363	393	25	7.4	87	6.3	118	0	30	110	0.8	30	8.0	--
		USGS	293-810	18-Aug-87	695	8.2	93	370	415	25	7.5	89	8.3	126	0	30	120	0.90	29	8.0	--
		EPWU	293-810	18-Aug-87	640	8.23	98	405	404	28	6.8	89	6.6	124	0	28	112	0.80	24	9.1	<0.09
		USGS	293-810	23-May-88	641	8.10	94	365	408	25	7.6	83	7.5	127	0	39	110	0.80	30	8.0	0.06
		USGS	293-810	07-June-90	751	8.00	100	396	433	28	8.5	100	6.6	122	0	30	130	0.60	30	7.5	--
		USGS	293-810	16-June-93	658	7.9	96	381	415	26	7.5	89	7.3	124	0	33	120	0.8	29	7.5	--
W6	JL-49-13-311	USGS	324-807	05-June-81	745	8.1	96	463	529	25	8.1	120	10	195	0	84	76	1.2	33	9.7	--
		USGS	324-807	06-June-83	720	8.0	100	447	511	26	8.5	110	9.0	195	0	84	68	1.3	35	9.3	--
		EPWU	324-807	06-June-83	715	7.96	100	516	516	28	7.0	115	9.2	190	0	82	73	1.2	33	11	<0.03
		USGS	324-807	01-Sept-84	745	7.8	100	456	518	27	8.6	110	10	190	0	87	75	1.3	34	9.3	--
		USGS	324-807	06-May-86	770	8.0	97	450	519	25	8.5	110	9.8	192	0	86	77	1.3	34	9.3	--
		USGS	324-807	23-May-88	736	8.10	100	412	515	27	8.9	110	10	192	0	79	78	1.5	3.5	8.9	0.06
		USGS	324-807	29-May-91	741	7.9	100	439	512	27	8.4	110	9.4	192	0	78	77	1.2	34	9.3	--
W7	JL-49-13-303	USGS	260-690	20-Apr-53	599	7.7	90	356	416	22	8.5	92	--	169	0	63	55	0.9	36	5.9	--
		USGS	260-690	24-July-56	511	7.9	68	328	364	18	5.6	83	--	161	0	48	42	1.0	38	5.5	--
		USGS	260-690	05-June-57	569	7.5	76	358	402	20	6.6	92	--	166	0	58	51	0.9	38	7.1	--
		USGS	260-690	16-May-61	533	7.4	74	340	375	19	6.4	84	--	160	0	54	44	1.0	37	7.0	--
		USGS	260-690	05-June-81	490	8.1	68	336	385	18	5.7	83	9.8	159	0	52	47	0.9	32	9.7	--
		USGS	260-690	06-June-83	505	8.1	69	318	365	18	5.8	75	8.8	159	0	49	39	1.0	33	9.7	--
		EPWU	260-690	06-June-83	490	8.08	70	356	356	19	5.5	74	8.4	159	0	38	40	0.95	35	11	<0.03
		USGS	260-690	22-May-85	508	8.1	68	303	347	18	5.7	75	7.8	150	0	40	40	1.0	32	9.3	--

Table 5.--Water-quality records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Continued

Well identification number (fig. 2)	Well number (fig. 10)	Analyst	Depth (feet below land surface)	Date	Specific conductance (µS/cm)	pH	Hardness (mg/L)	Reported DS (mg/L)	Calculated DS (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)
Field properties and inorganic constituents--Concluded																					
W7	JL-49-13-303	USGS	260-690	18-Aug-87	525	8.30	86	300	361	17	5.7	75	9.4	161	--	46	37	1.0	30	8.9	--
		EPWU	260-690	18-Aug-87	495	8.14	72	366	366	19	6.0	74	9.5	162	0	46	40	0.96	33	8.8	<0.09
		USGS	260-690	19-Sept-88	534	8.20	73	317	378	19	6.1	76	9.9	165	0	52	40	0.90	32	8.9	--
		USGS	260-690	04-June-90	503	8.10	68	308	365	18	5.7	75	8.4	160	0	48	40	0.80	32	8.9	--
		USGS	260-690	09-June-92	499	7.8	68	305	364	18	5.5	73	9.6	163	0	48	37	1.0	32	9.3	--
W8	JL-49-14-101	USGS	289-810	24-Aug-59	473	7.5	67	297	341	18	5.4	77	--	146	0	43	45	0.8	30	5.8	--
		USGS	289-810	16-May-61	487	7.2	65	298	339	17	5.6	78	--	141	0	44	46	1.0	31	6.5	--
		USGS	289-810	19-May-67	530	7.4	70	324	372	19	5.4	86	--	160	0	48	49	1.4	28	3.5	--
		USGS	289-810	05-June-81	520	8.2	77	336	380	20	6.5	78	7.9	146	0	43	69	0.8	30	8.4	--
		USGS	289-810	06-June-83	560	8.1	84	345	388	22	7.0	82	7.9	148	0	40	74	0.8	31	8.0	--
		EPWU	289-810	06-June-83	553	8.05	86	368	368	22	7.5	78	7.8	138	0	30	75	0.80	30	9.3	<0.03
		USGS	289-810	22-May-85	562	8.1	83	329	363	22	6.7	78	7.2	129	0	38	75	0.8	30	6.6	--
		USGS	289-810	18-Aug-87	680	8.20	89	370	415	23	7.6	90	8.7	140	0	38	99	0.90	29	8.0	--
		EPWU	289-810	18-Aug-87	630	8.20	92	423	424	27	6.0	91	8.5	142	0	36	104	0.80	25	8.4	<0.09
		USGS	289-810	13-Sept-89	580	8.10	84	332	379	22	7.1	79	7.9	138	0	38	79	0.80	30	7.1	--
		USGS	289-810	14-May-91	575	7.9	86	338	387	23	6.9	80	9.2	137	0	37	85	0.80	29	8.0	--
		USGS	289-810	16-June-93	574	8.0	86	341	379	23	6.9	79	9.0	134	0	40	79	0.8	30	7.5	--

Table 5.--Water-quality records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Continued

Well identification number (fig. 2)	Well number (fig. 10)	Analyst	Depth (feet below land surface)	Date	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Zinc (µg/L)
								Metals											
W1	JL-49-05-915	EPWU[1]	1,005-1,015	04-May-92	<10	109	128	<0.5	<10	<10	4,110	16	73	158	<1	--	<10	<1	423
		EPWU[1]	1,175-1,185	04-May-92	<10	198	84	<5	20	<10	2,330	12	89	115	<1	--	<10	<1	266
		EPWU[1]	443-1,202	09-Aug-92	<10	69	117	<0.5	<10	<10	68	<5	51	3	<1	--	<10	<1	37
W2	JL-49-05-914	EPWU[1]	960-970	08-Apr-92	<10	325	112	<0.5	<10	<10	816	<5	64	34	<1	--	<10	<1	201
		EPWU[1]	1,008-1,018	08-Apr-92	<10	61	99	<0.5	<10	<10	425	44	68	30	<1	--	<10	<1	168
		EPWU[1]	1,094-1,104	07-Apr-92	<10	104	280	<0.5	<10	<10	174	<5	438	70	<1	--	<10	<1	138
		EPWU[1]	1,194-1,204	07-Apr-92	<10	133	542	<0.5	<10	<10	813	8	173	40	<1	--	<10	<1	334
		EPWU[1]	371-935	23-July-92	<10	55	145	<0.5	<10	<10	835	<5	62	140	<1	--	<10	<1	47
W3	JL-49-05-904	USGS	260-815	14-May-91	--	--	120	--	--	--	--	--	--	--	--	--	--	--	--
		EPWU	260-815	16-June-92	<10	67	114	<0.5	<10	<10	<10	<5	48	<2	<1	--	<10	<1	19
		USGS	260-815	16-June-92	--	--	120	--	--	1	--	<1	--	--	--	--	--	--	--
W4	JL-49-06-701	EPWU	293-810	06-June-83	--	--	--	<10	<10	<10	<10	<10	--	<10	--	<10	--	<10	<10
		USGS	293-810	22-May-85	--	--	--	--	10	--	--	<1	--	--	--	--	--	--	--
		USGS	293-810	23-May-88	--	--	90	--	--	--	--	--	--	--	--	--	--	--	--
		USGS	293-810	16-June-93	--	--	100	--	--	<1	--	1	--	--	--	--	--	--	--
		EPWU	293-810	16-June-93	5.7	107	87	<0.5	6.8	<5	<20	<5	36	<10	<1	--	<5	<0.5	<10
W6	JL-49-13-311	EPWU	324-807	06-June-83	--	--	--	<10	<10	<10	<10	<10	--	<10	--	<10	--	<10	<10
		USGS	324-807	23-May-88	--	--	150	--	--	--	--	--	--	--	--	--	--	--	--
		USGS	324-807	29-May-91	--	--	150	--	--	--	--	--	--	--	--	--	--	--	--
W7	JL-49-13-303	EPWU	260-690	06-June-83	--	--	--	<10	<10	<10	<10	<10	--	<10	--	<10	--	<10	<10
		USGS	260-690	22-May-85	--	--	--	--	10	--	--	2	--	--	--	--	--	--	--

Table 5.--Water-quality records of wells in the vicinity of the Municipal Solid Waste Landfill Facility--Concluded

Well identification number (fig. 2)	Well number (fig. 10)	Analyst	Depth (feet below land surface)	Date	Arsenic (µg/L)	Barium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Zinc (µg/L)
								Metals--Concluded											
W7	JL-49-13-303	USGS	260-690	19-Sept-88	--	--	130	--	--	--	--	--	--	--	--	--	--	--	--
		USGS	260-690	04-June-90	--	--	130	--	--	--	--	--	--	--	--	--	--	--	--
		EPWU	260-690	09-June-92	<10	52	129	<0.5	<10	<10	12	<5	56	<2	<1	--	<10	<1	7
		USGS	260-690	09-June-92	--	--	210	--	--	2	--	<1	--	--	--	--	--	--	--
W8	JL-49-14-101	EPWU	289-810	06-June-83	--	--	--	<10	<10	<10	<10	<10	--	<10	--	<10	--	<10	<10
		USGS	289-810	22-May-85	--	--	--	--	<10	--	--	2	--	--	--	--	--	--	--
		USGS	289-810	14-May-91	--	--	100	--	--	--	--	--	--	--	--	--	--	--	--
		USGS	289-810	16-June-93	--	--	110	--	--	<1	--	<1	--	--	--	--	--	--	--
		EPWU	289-810	16-June-93	<5	86	98	<0.5	6.7	<5	<20	<5	45	<10	<1	--	<5	<0.5	<10

[1]Sample was air lifted during interval sampling; sampling method was probably not an appropriate method for detailed chemical analyses because of screen corrosion or incrustation effects on the water sample (high metal concentrations). These analyses should be considered not representative of natural water conditions (Roger Sperka, El Paso Water Utilities, oral commun., 1995).

SUMMARY

Geohydrologic conditions of the MSWLF on the USAADACENFB were evaluated by the U.S. Geological Survey in cooperation with the U.S. Army. The report includes: (1) information on the boundaries, areas, and contents of the MSWLF; (2) information on the environmental setting of the MSWLF and vicinity including a description of the physiography, climate, and soils; (3) description of geologic and hydrologic characteristics of the unsaturated zone and the shallow part of the aquifer; and (4) description of the ground-water quality in the vicinity of the MSWLF.

The 106.03-acre MSWLF has been in operation since January 1974 and is located about 1,200 feet east of the nearest occupied structure. The MSWLF is estimated to receive an average of approximately 56 tons of municipal solid waste per day. The landfill fill rate is about 1-4 acres per year and at this fill rate is expected to reach its capacity by the year 2004.

Types of solid wastes disposed of at the MSWLF include household refuse, Post solid wastes, bulky items, grass and tree trimmings from family housing, refuse from litter cans, construction debris, classified waste (dry), dead animals, asbestos, and empty oil cans. Operation, refuse collection, and disposal services are provided by a private contractor. The method of landfilling is progressive trench where excavation and filling occur simultaneously in trenches 40 feet wide by 30 feet deep. Refuse is dumped at the end of the trench, then spread and covered by use of a crawler tractor. Daily cover of a minimum of 6 inches of compacted earth and a final cover of 2 to 3 feet are provided.

The MSWLF is located in the Hueco Bolson proper 4 miles east of the Franklin Mountains. The Franklin Mountains have peaks ranging from 4,600 to greater than 7,000 feet above sea level. Elevations at the MSWLF range from 3,907 to 3,937 feet above sea level. The climate of the MSWLF, classified as arid continental, is characterized by an abundance of sunny days, high summer temperatures, relatively cool winters typical of arid areas, scanty rainfall, and very low humidity throughout the year. Average annual temperature is 63.3 °F in the El Paso area; mean annual precipitation is 7.8 inches. Typically rainy months receive almost half of the annual precipitation in the form of brief but locally heavy thunderstorms. Prolonged periods of continuous precipitation are rare. The prevailing wind direction in the winter months is from the north and in the summer months is from the south. Potential evaporation in the El Paso area is estimated to be 65 inches per year. Soils at and adjacent to the MSWLF are nearly level to gently sloping, have a fine sandy loam subsoil, and are moderately deep over caliche.

The MSWLF is underlain by Hueco Bolson deposits of Tertiary age and typically are composed of fine- to medium-grained sand with interbedded lenses of clay, silt, gravel, and caliche. The deposits range from unconsolidated to slightly consolidated. Individual beds are not well defined and range in thickness from a fraction of an inch to about 100 feet. Hueco Bolson deposits are reported to have a maximum thickness of 9,000 feet within a deep structural trough paralleling the east base of the Franklin Mountains.

The primary source of ground water in the MSWLF area is the unconsolidated and semiconsolidated sedimentary deposits of the Hueco Bolson. A relatively thick vadose zone of approximately 300 feet overlies the aquifer of the Hueco Bolson deposits in the vicinity of the MSWLF. A deep water table prevails for all of the study area. Whether any perched water zones exist below the MSWLF is unknown. Under current conditions, extensive ground-water development by the City of El Paso encompasses the MSWLF. An inventory of nine wells located within a 1-mile radius of the MSWLF was compiled. These wells are owned and operated by the City of El Paso or the U.S. Army. Wells discharging large amounts of water usually are drilled at least 200 feet into water-yielding material. The municipal water system of the City of El Paso and Fort Bliss is supplied by wells ranging in depth from about 600 feet to greater than 1,200 feet.

Hydraulic characteristics of the Hueco Bolson vary significantly as a result of the nonuniform nature of the individual beds. On a regional scale the Hueco Bolson can be considered a single aquifer, but on a local scale the rate and volume of water flowing through individual beds probably vary considerably. Recharge resulting from direct infiltration of precipitation may be minor due to the high evaporation and low precipitation rates. Hydraulic gradients have been altered locally due to extensive pumping of ground water in the El Paso area. The hydraulic gradient in the MSWLF vicinity is generally to the south but may vary due to pumpage of a well on the northeast corner of the perimeter boundary. Ground-water flow direction at a given location may change from time to time due to pumpage of City of El Paso and U.S. Army production wells. Ground-water monitoring data in the MSWLF vicinity showed a water-level decline of 55.65 feet from November 1958 to December 1987. Depth to water at the northeast corner of the MSWLF as of July 26, 1994, was 325.8 feet below land surface.

The city-operated Shearman Well Field, located north of the MSWLF, is a primary source of ground water for the City of El Paso. Currently, one well in the Shearman Well Field is in operation; the rest of the well field is planned to be in full operation by December 1995. Records from El Paso Water Utilities report that the test-pumping rate of well JL-49-05-914 (the well nearest to the MSWLF having test-pumping data) was 1,972 gallons per minute on July 20, 1992; the static water level prior to pumping was 317.54 feet below land surface. The pumping level after 8 hours of pumping was 367.80 feet below land surface, resulting in a drawdown rate of 50.26 feet, transmissivity of 22,200 feet squared per day (166,000 gallons per day per foot), and specific capacity of 39.2 gallons per minute per foot of drawdown. After the well was shut off, the well recovered to a static water level of 317.46 feet below land surface on July 21, 1992.

Ground water in the El Paso area is chemically suitable for most uses. Records from El Paso Water Utilities report concentrations of dissolved solids in the MSWLF vicinity ranging from 297 to 625 milligrams per liter (wells JL-49-05-904 and JL-49-05-915, respectively), but concentrations have been measured as high as 1,312 milligrams per liter (well JL-49-05-914, April 7, 1992). No perennial or ephemeral streams are on or in the vicinity of the MSWLF.

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