EXHIBIT I – PART 1

Data from a Thick Unsaturated Zone Underlying Oro Grande and Sheep Creek Washes in the Western Part of the Mojave Desert, near Victorville, San Bernardino County, California

By John A. Izbicki, Dennis A. Clark, M. Isabel Pimentel, Michael Land, John Radyk, *and* Robert L. Michel

---

U.S. GEOLOGICAL SURVEY

Open-File Report 00-262

Prepared in cooperation with the

MOJAVE WATER AGENCY

Sacramento, California
2000

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

Distsrict Chief
U.S. Geological Survey
Placer Hall, Suite 2012
6000 J Street
Sacramento, CA 95819-6129

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Federal Center
Denver, CO 80225

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
acre-foot (acre-ft)	4047	cubic meter (m^3)
acre-foot per year (acre-ft/yr)	4047	cubic meter per year (m^3/yr)
bar	~10^2	kilopascal (kPa)
foot (ft)	0.3048	meter (m)
foot per year (ft/yr)	0.3048	meter per year (m/yr)
gallon (gal)	3.7854	liter (L)
gallon (gal)	3785.4	milliliter (mL)
gallon (gal)	3.7854×10^6	microliter (µL)
gallon per minute (gal/min)	3.7854	liter per minute (L/min)
inch (in.)	25.4	millimeter (mm)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
micromho per centimeter at 25°Celsius (µmho/cm)	1	microsiemen per centimeter at 25° Celsius (µS/cm)
mile (mi)	1.609	kilometer (km)
pound (lb)	0.4535	kilogram (kg)
pound (lb)	453.5	gram (g)
pound (lb)	4.535×10^5	milligram (mg)

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\,(°C) + 32.$$

Note Regarding Units of Measurement: The inch-pound system of units is generally used in this report. However, data that were acquired in the International System of Units (abbreviated SI)—the modernized metric system—are reported herein in SI units.

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

Water Quality Units

Concentrations of constituents in water samples are given in either milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is equivalent to "parts per million" and micrograms per liter is equivalent to "parts per billion.

Data from a Thick Unsaturated Zone Underlying Oro Grande and Sheep Creek Washes in the Western Part of the Mojave Desert, near Victorville, San Bernardino County, California, 1994–99

By John A. Izbicki, Dennis A. Clark, M. Isabel Pimentel, Michael Land, John Radyk, *and* Robert L. Michel

ABSTRACT

This report presents data on the physical properties of unsaturated alluvial deposits and on the chemical and isotopic composition of soil water and soil gas collected at 12 monitoring sites in the western part of the Mojave Desert, near Victorville, California. Sites were installed using the ODEX air-hammer method. Seven sites were located in the active channels of Oro Grande and Sheep Creek Washes. The remaining five sites were located away from the active washes. Most sites were drilled to a depth of about 100 feet below land surface; two sites were drilled to the water table almost 650 feet below land surface. Drilling procedures, lithologic and geophysical data, and site construction and instrumentation are described. Core material was analyzed for water content, bulk density, water potential, particle size, and water retention. The chemical composition of leachate from almost 1,000 subsamples of cores and cuttings was determined. Water extracted from selected subsamples of cores was analyzed for tritium and the stable isotopes of oxygen and hydrogen. Water from suction-cup lysimeters and soil-gas samples also were analyzed for chemical and isotopic composition. In addition, data on the chemical and isotopic composition of bulk precipitation from five sites and on ground water from two water-table wells are reported.

INTRODUCTION

The study area is in the western part of the Mojave Desert, about 100 miles (mi) east of Los Angeles (fig. 1) in San Bernardino County, California. Population in the area has increased threefold, from about 90,000 in 1980 to more than 300,000 in 1999 (Ron Rector, High Desert Regional Economic Development Authority, oral commun., 2000). Water supply in the area is derived almost entirely from ground water, and pumping has increased to meet the needs of the expanding population. In the past, most ground water was pumped from alluvial deposits along the Mojave River. In recent years, ground-water pumping from the surrounding regional aquifer, composed of partly consolidated alluvial fan and basin-fill deposits, has increased.

Prior to ground-water pumping, recharge to the regional aquifer in the study area occurred primarily near the front of the San Gabriel and San Bernardino Mountains to the south of the basin (Hardt, 1971). The quantity of recharge was small in relation to the water stored within the alluvial aquifer and the water pumped from the aquifer. In recent years, water levels in some parts of the regional aquifer have declined more than one foot per year (ft/yr) (Mendez and Christensen, 1997).

Previous studies (Friedman and others, 1992; Gleason and others, 1992) showed that ground water in the regional aquifer is isotopically lighter [more negative delta deuterium (δD) and delta oxygen-18 ($\delta^{18}O$) values] than present-day precipitation and may have been recharged at some time in the past when the climate was wetter and cooler. Izbicki and others (1995) confirmed this interpretation and showed that most ground water in the regional aquifer was recharged

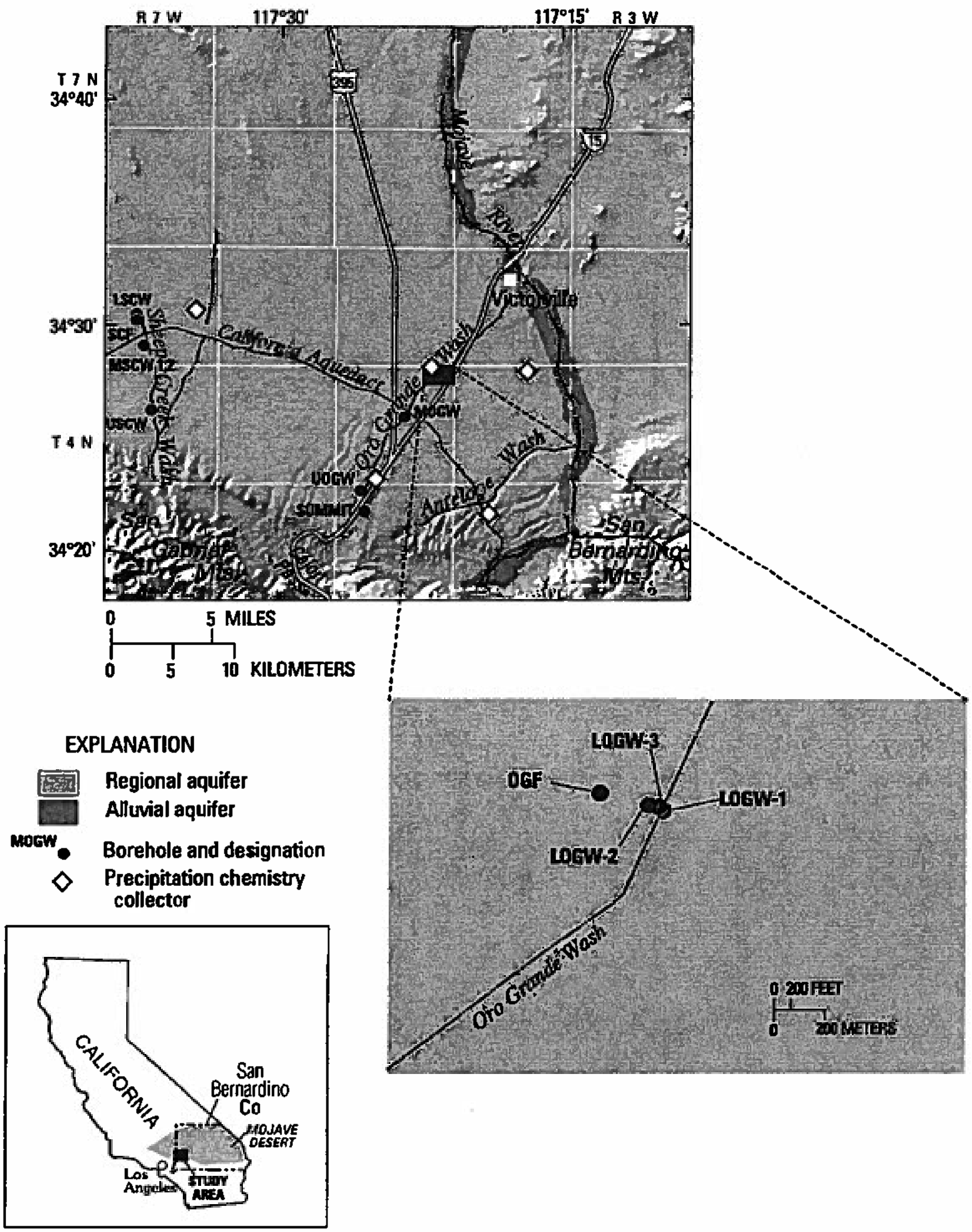


Figure 1. Location of study area, unsaturated-zone monitoring sites, and bulk precipitation collectors, near Victorville, San Bernardino County, California.

many thousands of years ago. However, they also identified areas where ground water was isotopically heavier (less negative δD and $\delta^{18}O$ values) and younger in age than most water in the regional aquifer. On the basis of predevelopment water-level maps (Hardt, 1971), this younger, isotopically heavier water could not have been recharged by infiltration of streamflow in the Mojave River and therefore must have been recharged from some other source. Izbicki and others (1998) showed that water was recharged as infiltration of flow in intermittent streams such as Oro Grande Wash. Water from these streams must infiltrate below the root zone and through a thick unsaturated zone (from 500 to more than 1,000 ft in thickness) to reach the water table and recharge the regional aquifer. The quantity of recharge from this source is unknown and its contribution to the water budget of the regional aquifer has not been incorporated into ground-water flow models developed for the area (Hardt, 1971). In addition, it may be possible to use imported water from the California Aqueduct to supplement natural recharge through the thick unsaturated zone beneath stream channels (Izbicki and others, 1998).

Water movement through thick unsaturated zones in desert environments has received increasing scientific study since it was proposed that these areas might be suitable for the disposal of radioactive and other hazardous wastes. Extensive studies of thick unsaturated zones have been done in the Mojave Desert at the proposed U.S. Department of Energy high-level nuclear waste repository at Yucca Mountain, Nevada; near an existing low-level nuclear waste disposal site at Beatty, Nevada; and near a proposed low-level nuclear waste disposal site at Ward Valley, California. Studies at other sites in the United States also have focused on the suitability of the unsaturated zone for the storage of radioactive material and other hazardous wastes. However, none of these studies have addressed water-supply or water-management issues associated with ground-water recharge through thick unsaturated zones. Data collected as part of this study focus on the unsaturated zone underlying intermittent streams in the Mojave Desert where present-day ground-water recharge may occur.

Description of the Study Area

The study area is the upper part of the Mojave River Basin near Victorville, California, in the western part of the Mojave Desert about 100 mi east of Los Angeles, California (fig. 1), in San Bernardino County. The climate of the study area is characterized by low precipitation, low humidity, and high summer temperatures. Precipitation in most of the area is generally less than 6 inches per year (in/yr); however, precipitation near Cajon Pass, a gap between the San Bernardino and the San Gabriel Mountains, can exceed 30 in/yr. Moist air from the Pacific Ocean can enter the Mojave Desert through Cajon Pass and precipitate without passing over the San Bernardino and the San Gabriel Mountains to the south of the study area. In these mountains, precipitation—much of it snow—can exceed 40 in/yr in liquid water equivalent.

The study area contains alluvial deposits along the Mojave River. These deposits are extensively pumped for water supply and are readily recharged by infiltration from the Mojave River. This aquifer, known locally as the shallow alluvial aquifer, is surrounded and underlain by older alluvial deposits that compose the regional aquifer. The regional aquifer is extensively pumped and pumping has increased with population growth. In some places water levels in the regional aquifer have declined more than one ft/yr over the last several years (Mendez and Christensen, 1997). Prior to ground-water pumping, most recharge to the regional aquifer in the study area occurred near the front of the mountains (Hardt, 1971) and as infiltration along intermittent streams (Izbicki and others, 1998). The unsaturated zone overlying the regional aquifer ranges from about 180 ft thick on the bluffs overlooking the Mojave River to more than 1,000 ft thick along the western slopes on the alluvial fans near the base of the San Gabriel Mountains (Stamos and Predmore, 1995). As a result of ground-water pumping, recharge from the shallow alluvial aquifer along the Mojave River into the surrounding and underlying regional aquifer has increased.

Runoff from the mountains, and from precipitation that falls on the desert floor, allows intermittent streamflow in the two washes studied—Oro Grande Wash and Sheep Creek Wash. Oro Grande Wash is deeply incised (about 30 to 60 ft) into the surface of the alluvial fan deposits, and streamflow along the wash has followed nearly the same course since the opening of Cajon Pass during the geologic past (Izbicki and others, 1998). As a result of erosion and changes in the regional drainage pattern near Cajon Pass during the last 500,000 years (Meisling and Weldon, 1989), Oro

Grande Wash no longer drains the mountains and flows only as a result of runoff from precipitation near the pass and from precipitation that falls on the desert floor. On the basis of channel-geometry data developed by Lines (1996), average annual flow in Oro Grande Wash is estimated to be about 500 acre-feet per year (acre-ft/yr).

In contrast, Sheep Creek Wash is farther from Cajon Pass and drains the San Gabriel Mountains. Sheep Creek Wash flows as a result of runoff from the higher altitudes in the San Gabriel Mountains and from precipitation that falls on the desert floor. Sediment from the wash is deposited on an actively aggrading alluvial fan, and the channel of Sheep Creek Wash is not incised into the surface of the fan. Under predevelopment conditions, streamflow in Sheep Creek Wash did not necessarily follow the same course every year, but rather, occasionally changed course in response to deposition and subsequent changes in the slope of the alluvial fan. In recent years, a series of flood-control levees has restricted the course of Sheep Creek Wash and streamflow has been confined to fewer active channels. On the basis of channel-geometry data developed by Lines (1996) average annual flow in Sheep Creek Wash is estimated to be about 2,200 acre-ft/yr.

Purpose and Scope

This report presents data collected as part of a cooperative study of infiltration and ground-water recharge to the regional aquifer near Victorville, California The study was funded by the U.S. Geological Survey (USGS) and the Mojave Water Agency. This report contains data on drilling, instrument installation, the physical properties of unsaturated earth materials, and the chemical and isotopic composition of leachate from cores and cuttings, soil water, and soil gas collected at sites underlying Oro Grande and Sheep Creek Washes in the Mojave Desert. The report also presents similar data collected at sites on the alluvial fan near these washes and at a site near Cajon Pass. The sites on the alluvial fan and near Cajon Pass served as controls for the study and allow for comparison with data from previous studies. In addition, the report presents data on the chemical and isotopic composition of bulk precipitation, and on ground-water levels and quality. Interpretation of these data is beyond the scope of this report.

Site Names and Instrument-Numbering System

Each unsaturated-zone monitoring site had a name assigned by the USGS at the time the site was built. In addition, each piece of instrumentation at each site has two unique numbers assigned according to its location in the rectangular system for the subdivision of public lands and according to its location in the grid system of latitude and longitude, respectively (table 1).

Each unsaturated-zone monitoring site was named according to the wash in which it is located or to which it is near—OG for Oro Grande Wash and SC for Sheep Creek Wash. Sites in the washes (and sites in the incised channel of Oro Grande Wash near the active wash) were identified by the suffix W. Sites farther away from the wash, on the alluvial fan, were identified by the suffix F. Sites in the washes also were named according to their relative position along the wash. The most upstream site was assigned the prefix U, the middle site was assigned the prefix M, and the most downstream site was assigned the prefix L. If more than one site was present in the same general area, the sites were assigned a sequence number; 1, 2, or 3. The site near Cajon Pass is away from the active channel of nearby Oro Grande Wash and is located near the summit of Cajon Pass. The climate at this site is much different from the typical desert environments studied at OGF and SCF, and as a result the site was assigned the name SUMMIT.

Each piece of instrumentation at each site was named according to the site, type of instrumentation, and its depth. Wells were named WELL, neutron access tubes were named NEUTRON, gas samplers were named GAS, and suction-cup lysimeters were named LYS. In this system the site name LOGW-1 identifies a downstream site in the active channel of Oro Grande Wash, and the instrument name LOGW-1 GAS @ 86 is a gas sampler 86 ft below land surface at that site. Bulk precipitation collectors were not assigned names using this system.

Instrumentation at each unsaturated-zone monitoring site and bulk precipitation collectors also were named according to their location in the system for the subdivision of public lands in the same manner as wells. Each name consists of the township number, north or south; the range number, east or west; and the section number. Each section is divided into sixteen 40-acre tracts lettered consecutively (except I and O), beginning with "A" in the northeast corner of the section and progressing in a sinusoidal manner to "R" in

Table 1. Site names, instrumentation names and numbers, and description of instrumentation for unsaturated-zone monitoring sites near Victorville, San Bernardino County, California

[Location of sites shown in figure 1. All depths below land-suface datum. ft, foot]

Site name	Instrumentation names and numbers			Description of instrumentation
	Descriptive name	System for the subdivision of public lands number	Latitude-longitude grid number	
		Upstream Oro Grande Wash		
UOGW	UOGW NEUTRON	3N/5W-5N1 NEUTRON	342208117255101	Neutron access tube, total depth 103 ft
	UOGW GAS @ 105	3N/5W-5N2 GAS @ 105	342208117255102	Gas sampler at 105 ft
	UOGW GAS @ 91	3N/5W-5N3 GAS @ 91	342208117255103	Gas sampler at 91 ft
	UOGW LYS @ 82	3N/5W-5N4 LYS @ 82	342208117255104	Suction-cup lysimeter at 82 ft
	UOGW GAS @ 69	3N/5W-5N5 GAS @ 69	342208117255105	Gas sampler at 69 ft
	UOGW GAS @ 52	3N/5W-5N6 GAS @ 52	342208117255106	Gas sampler at 52 ft
	UOGW LYS @ 38	3N/5W-5N7 LYS @ 38	342208117255107	Suction-cup lysimeter at 38 ft
	UOGW GAS @ 22	3N/5W-5N8 GAS @ 22	342208117255108	Gas sampler at 22 ft
	UOGW LYS @ 11	3N/5W-5N9 LYS @ 11	342208117255109	Suction-cup lysimeter at 11 ft
		Middle Oro Grande Wash		
MOGW	MOGW WELL	4N/5W-21H1	342519117240701	Well, perforated from 630 to 670 ft. Upper 100 ft used as neutron access tube.
	MOGW GAS @ 500	4N/5W-21H2 GAS @ 500	342519117240702	Gas sampler at 500 ft
	MOGW GAS @ 300	4N/5W-21H3 GAS @ 300	342519117240703	Gas sampler at 300 ft
	MOGW GAS @ 150	4N/5W-21H4 GAS @ 150	342519117240704	Gas sampler at 150 ft
	MOGW LYS @ 140	4N/5W-21H5 LYS @ 140	342519117240705	Suction-cup lysimeter at 140 ft
	MOGW LYS @ 92	4N/5W-21H6 LYS @ 92	342519117240706	Suction-cup lysimeter at 92 ft
	MOGW GAS @ 80	4N/5W-21H7 GAS @ 80	342519117240707	Gas sampler at 80 ft
	MOGW LYS @ 65	4N/5W-21H8 LYS @ 65	342519117240708	Suction-cup lysimeter at 65 ft
	MOGW GAS @ 50	4N/5W-21H9 GAS @ 50	342519117240709	Gas sampler at 50 ft
	MOGW LYS @ 43	4N/5W-21H10 LYS @ 43	342519117240710	Suction-cup lysimeter at 43 ft
	MOGW GAS @ 26	4N/5W-21H11 GAS @ 26	342519117240711	Gas sampler at 26 ft
	MOGW LYS @ 22	4N/5W-21H12 LYS @ 22	342519117240712	Suction-cup lysimeter at 22 ft
		Lower Oro Grande Wash		
LOGW-1	LOGW-1 NEUTRON	4N/5W-1C2 NEUTRON	342803117212501	Neutron access tube, total depth 103 ft
	LOGW-1 GAS @ 103	4N/5W-1C3 GAS @ 103	342803117212502	Gas sampler at 103 ft
	LOGW-1 GAS @ 86	4N/5W-1C4 GAS @ 86	342803117212503	Gas sampler at 86 ft
	LOGW-1 LYS @ 76	4N/5W-1C5 LYS @ 76	342803117212504	Suction-cup lysimeter at 76 ft
	LOGW-1 GAS @ 73	4N/5W-1C6 GAS @ 73	342803117212505	Gas sampler at 73 ft
	LOGW-1 LYS @ 64	4N/5W-1C7 LYS @ 64	342803117212506	Suction-cup lysimeter at 64 ft
	LOGW-1 GAS @ 59	4N/5W-1C8 GAS @ 59	342803117212507	Gas sampler at 59 ft
	LOGW-1 GAS @ 38	4N/5W-1C9 GAS @ 38	342803117212508	Gas sampler at 38 ft
	LOGW-1 LYS @ 22	4N/5W-1C10 LYS @ 22	342803117212509	Suction-cup lysimeter at 22 ft
	LOGW-1 LYS @ 14	4N/5W-1C11 LYS @ 14	342803117212510	Suction-cup lysimeter at 14 ft
LOGW-2	LOGW-2 NEUTRON	4N/5W-1C12 NEUTRON	342802117212801	Neutron access tube, total depth 103 ft
	LOGW-2 GAS @ 103	4N/5W-1C13 GAS @ 103	342802117212802	Gas sampler at 103 ft
	LOGW-2 LYS @ 100	4N/5W-1C14 LYS @ 100	342802117212803	Suction-cup lysimeter at 100 ft

Table 1. Site names, instrumentation names and numbers, and description of instrumentation for unsaturated-zone monitoring sites near Victorville, San Bernardino County, California—Continued

Site name	Instrumentation names and numbers: Descriptive name	System for the subdivision of public lands number	Latitude-longitude grid number	Description of instrumentation
		Lower Oro Grande Wash—Continued		
	LOGW-2 GAS @ 82	4N/5W-1C15 GAS @ 82	342802117212804	Gas sampler at 82 ft
	LOGW-2 LYS @ 74	4N/5W-1C16 LYS @ 74	342802117212805	Suction-cup lysimeter at 74 ft
	LOGW-2 LYS @ 55	4N/5W-1C17 LYS @ 55	342802117212806	Suction-cup lysimeter at 55 ft
	LOGW-2 GAS @ 40	4N/5W-1C18 GAS @ 40	342802117212807	Gas sampler at 40 ft
	LOGW-2 GAS @ 15	4N/5W-1C19 GAS @ 15	342802117212808	Gas sampler at 15 ft
LOGW-3	LOGW-3 NEUTRON	4N/5W-1C20 NEUTRON	342802117212601	Neutron access tube, total depth 50 ft
		Oro Grande Fan		
OGF	OGF NEUTRON	4N/5W-1D1 NEUTRON	342804117213301	Neutron access tube, total depth 103 ft
	OGF GAS @ 83	4N/5W-1D2 GAS @ 83	342804117213302	Gas sampler at 83 ft
	OGF GAS @ 70	4N/5W-1D3 GAS @ 70	342804117213303	Gas sampler at 70 ft
	OGF GAS @ 50	4N/5W-1D4 GAS @ 50	342804117213304	Gas sampler at 50 ft
	OGF GAS @ 30	4N/5W-1D5 GAS @ 30	342804117213305	Gas sampler at 30 ft
	OGF GAS @ 12	4N/5W-1D6 GAS @ 12	342804117213306	Gas sampler at 12 ft
		Upper Sheep Creek Wash		
USCW	USCW WELL	4N/7W-16J1 NEUTRON	342551117363501	Neutron access tube, total depth 100 ft
	USCW GAS @ 98	4N/7W-16J2 GAS @ 98	342551117363502	Gas sampler at 98 ft
	USCW LYS @ 94	4N/7W-16J3 LYS @ 94	342551117363503	Suction-cup lysimeter at 94 ft
	USCW GAS @ 80	4N/7W-16J4 GAS @ 80	342551117363504	Gas sampler at 80 ft
	USCW GAS @ 63	4N/7W-16J5 GAS @ 63	342551117363505	Gas sampler at 63 ft
	USCW LYS @ 58	4N/7W-16J6 LYS @ 58	342551117363506	Suction-cup lysimeter at 58 ft
	USCW LYS @ 48	4N/7W-16J7 LYS @ 48	342551117363507	Suction-cup lysimeter at 48 ft
	USCW GAS @ 38	4N/7W-16J8 GAS @ 38	342551117363508	Gas sampler at 38 ft
	USCW LYS @ 28	4N/7W-16J9 LYS @ 28	342551117363509	Suction-cup lysimeter at 28 ft
	USCW GAS @ 20	4N/7W-16J10 GAS @ 20	342551117363510	Gas sampler at 20 ft
	USCW LYS @ 15	4N/7W-16J11 LYS @ 15	342551117363511	Suction-cup lysimeter at 15 ft
		Middle Sheep Creek Wash		
MSCW-1	MSCW-1WELL	4N/7W-28L1	342923117370601	Well, perforated from 606 to 626 ft. Upper 100 ft used as neutron access tube
	MSCW-1 GAS @ 500	5N/7W-28L2 GAS @ 500	342923117370602	Gas sampler at 500 ft
	MSCW-1 GAS @ 405	5N/7W-28L3 GAS @ 405	342923117370603	Gas sampler at 405 ft
	MSCW-1 GAS @ 300	5N/7W-28L4 GAS @ 300	342923117370604	Gas sampler at 300 ft
	MSCW-1 LYS @ 270	5N/7W-28L5 LYS @ 270	342923117370605	Suction-cup lysimeter at 270 ft
	MSCW-1 LYS @ 160	5N/7W-28L6 LYS @ 160	342923117370606	Suction-cup lysimeter at 160 ft
MSCW-2	MSCW-2 NEUTRON	5N/7W-28L7 NEUTRON	342925117370701	Neutron access tube, total depth 280 ft
	MSCW-2 GAS @ 226	5N/7W-28L8 GAS @ 226	342925117370702	Gas sampler at 226 ft

Table 1. Site names, instrumentation names and numbers, and description of instrumentation for unsaturated-zone monitoring sites near Victorville, San Bernardino County, California—Continued

Site name	Instrumentation names and numbers: Descriptive name	System for the subdivision of public lands number	Latitude-longitude grid number	Description of instrumentation
		Middle Sheep Creek Wash—Continued		
	MSCW-2 GAS @ 148	5N/7W-28L9 GAS @ 148	342925117370703	Gas sampler at 148 ft
	MSCW-2 LYS @ 122	5N/7W-28L10 LYS @ 122	342925117370704	Suction-cup lysimeter at 122 ft
	MSCW-2 LYS @ 99	5N/7W-28L11 LYS @ 99	342925117370705	Suction-cup lysimeter at 99 ft
	MSCW-2 GAS @ 83	5N/7W-28L12 GAS @ 83	342925117370706	Gas sampler at 83 ft
	MSCW-2 LYS @ 52	5N/7W-28L13 LYS @ 52	342925117370707	Suction-cup lysimeter at 52 ft
	MSCW-2 GAS @ 48	5N/7W-28L14 GAS @ 48	342925117370708	Gas sampler at 48 ft
	MSCW-2 LYS @ 30	5N/7W-28L15 LYS @ 30	342925117370709	Suction-cup lysimeter at 30 ft
	MSCW-2 LYS @ 14	5N/7W-28L16 LYS @ 14	342925117370710	Suction-cup lysimeter at 14 ft
		Lower Sheep Creek Wash		
LSCW	LSCW NEUTRON	5N/7W-17K1 NEUTRON	343106117375501	Neutron access tube, total depth 100 ft
	LSCW GAS @ 108	5N/7W-17K2 GAS @ 108	343106117375502	Gas sampler at 108 ft
	LSCW LYS @ 90	5N/7W-17K3 LYS @ 90	343106117375503	Suction-cup lysimeter at 90 ft
	LSCW GAS @ 65	5N/7W-17K4 GAS @ 65	343106117375504	Gas sampler at 65 ft
	LSCW LYS @ 58	5N/7W-17K5 LYS @ 58	343106117375505	Suction-cup lysimeter at 58 ft
	LSCW GAS @ 46	5N/7W-17K6 GAS @ 46	343106117375506	Gas sampler at 46 ft
	LSCW LYS @ 41	5N/7W-17K7 LYS @ 41	343106117375507	Suction-cup lysimeter at 41 ft
	LSCW GAS @ 32	5N/7W-17K8 GAS @ 32	343106117375508	Gas sampler at 32 ft
	LSCW LYS @ 27	5N/7W-17K9 LYS @ 27	343106117375509	Suction-cup lysimeter at 27 ft
	LSCW GAS @ 20	5N/7W-17K10 GAS @ 20	343106117375510	Gas sampler at 20 ft
	LSCW LYS @ 11	5N/7W-17K11 LYS @ 11	343106117375511	Suction-cup lysimeter at 11 ft
		Sheep Creek Fan		
SCF	SCF NEUTRON	5N/7W-17Q1 NEUTRON	343054117374901	Neutron access tube, total depth 80 ft
	SCF GAS @ 77	5N/7W-17Q2 GAS @ 77	343054117374902	Gas sampler at 77 ft
	SCF GAS @ 50	5N/7W-17Q3 GAS @ 50	343054117374903	Gas sampler at 50 ft
	SCF GAS @ 20	5N/7W-17Q4 GAS @20	343054117374904	Gas sampler at 20 ft
	SCF GAS @ 8	5N/7W-17Q5 GAS @ 8	343054117374905	Gas sampler at 8 ft
		Cajon Summit		
SUMMIT	SUMMIT NEUTRON	3N/5W-8M1 NEUTRON	342137117255201	Neutron access tube, total depth 50 ft
	SUMMIT GAS @ 49	3N/5W-8M2 GAS @ 49	342137117255202	Gas sampler at 49 ft
	SUMMIT GAS @ 35	3N/5W-8M3 GAS @ 35	342137117255203	Gas sampler at 35 ft
	SUMMIT LYS @ 20	3N/5W-8M4 LYS @ 20	342137117255204	Suction-cup lysimeter at 20 ft
	SUMMIT GAS @ 9	3N/5W-8M5 GAS @ 9	342137117255205	Gas sampler at 9 ft
	SUMMIT LYS @ 7	3N/5W-8M6 LYS @ 7	342137117255206	Suction-cup lysimeter at 7 ft

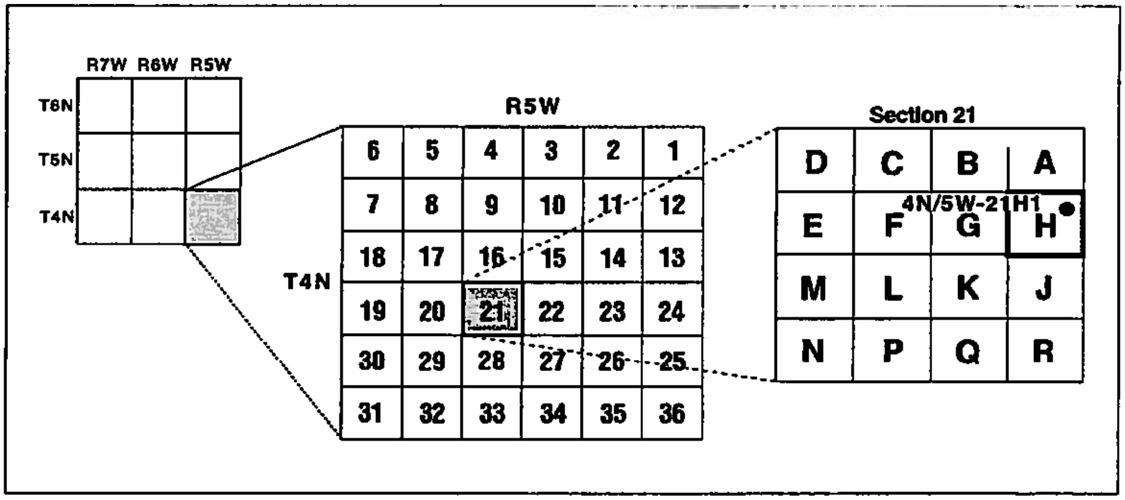


Figure 2. Site-numbering system.

the southeast corner. Within the 40-acre tract, wells and instruments installed as part of this study (except bulk precipitation collectors) are sequentially numbered in the order in which they were inventoried. The final letter refers to the base line and meridian. In California, there are three base lines and meridians; Humboldt (H), Mount Diablo (M), and San Bernardino (S). All wells and instrumentation in the study area are referenced to the San Bernardino base line and meridian (S). These numbers consist of 15 characters and follow the format 004N005W21H001S. In this report these numbers are abbreviated and written 4N/5W-21H1. This numbering system is shown in figure 2. The suffixes NEUTRON, GAS, LYS, and PRECIP are used instead of sequence numbers to identify neutron access tubes, gas samplers, suction-cup lysimeters, and precipitation collectors, respectively.

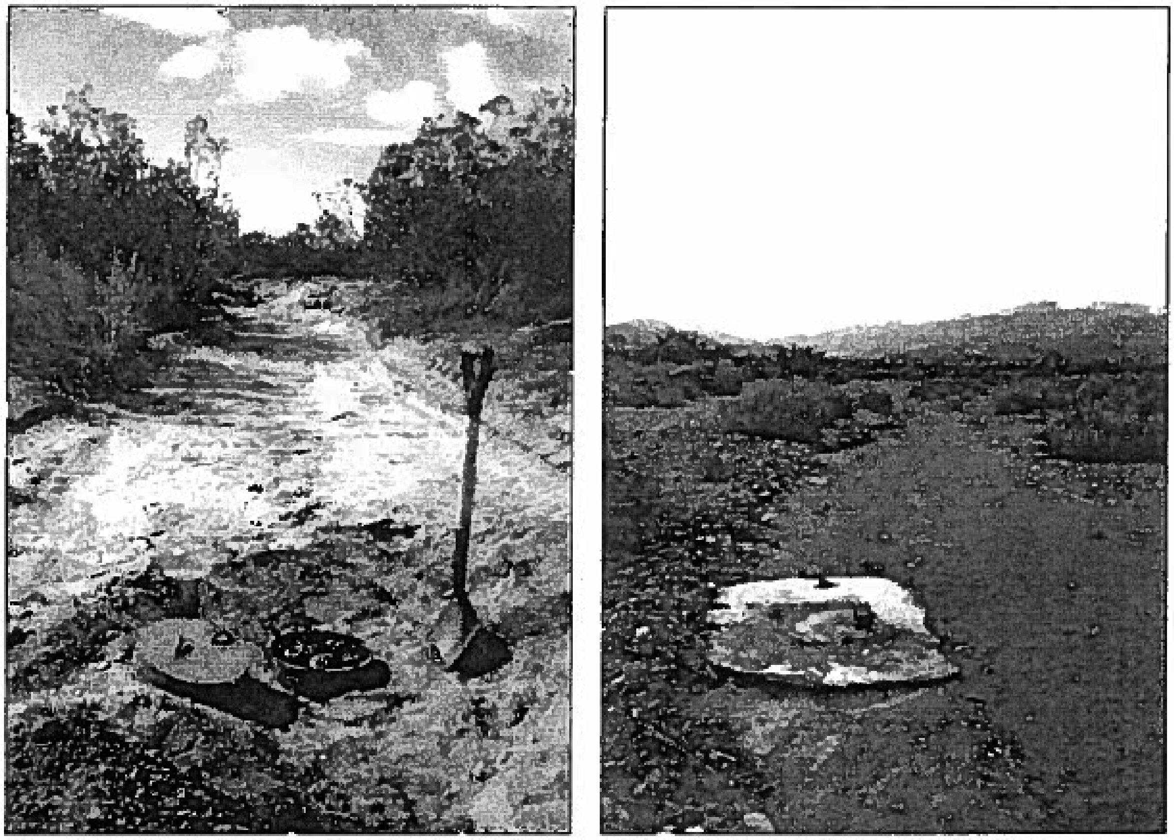
Instrumentation at each unsaturated-zone monitoring site and bulk precipitation collection site also was named according to its location in the grid system of latitude and longitude. The number consists of 15 digits. The first six digits denote degrees, minutes, and seconds of latitude; the next seven digits denote degrees, minutes, and seconds of longitude; and the last two digits (assigned sequentially from bottom to top in a borehole) identify different instruments at a site. This station number once assigned has no locational significance. As a result, if an error was made in the field location of a site and that error resulted in an incorrect calculation of latitude and longitude, the identification number associated with that site will not be changed after the error is discovered. However, the latitude and longitude associated with that site will be corrected in the USGS's computerized National Water Information System (NWIS).

Acknowledgments

This study was funded by the Mojave Water Agency. The authors thank the many individuals and public agencies who gave permission for installing instrumentation on their property. The authors also thank William Albright, Craig Shadel, and Scott Tyler of the Desert Research Institute for their participation in analysis of core material. Colleague review was done by Matthew Bailey, USGS, Tucson, Arizona and Angela Paul, USGS, Carson City, Nevada. Additional review was done by Rick Iwatsubo, USGS, Sacramento, California. The report was greatly improved by their constructive comments and criticisms.

DRILLING PROCEDURES AND DATA COLLECTION

Twelve unsaturated-zone monitoring sites were installed as part of this study of infiltration and ground-water recharge from intermittent streams. Seven sites were located in the active channels of Oro Grande (UOGW, MOGW, LOGW-1) and Sheep Creek (USCW, MSCW-1, MSCW-2, and LSCW) Washes, two sites were located in the incised channel of Oro Grande Wash near the active channel (LOGW-2 and LOGW-3), two sites were located on the alluvial fan away from the active channel of the wash (OGF and



A. B.

Figure 3. Selected unsaturated-zone monitoring sites LOGW (A.) and USCW (B.), near Victorville, San Bernardino County, California.

SCF), and one site was located near Cajon Pass (SUMMIT). All sites were installed using the ODEX air-hammer method, also known as the under-reamer method (Driscoll, 1986; Hammermeister and others, 1986) using a USGS drill rig and crew. Drill depths ranged from about 50 to 700 ft. The diameter of all ODEX holes drilled as part of this study was 8 in. The ODEX drilling method minimized disturbance of the unsaturated material near the drill hole, reduced contamination from drilling fluids, and allowed the collection of high-quality cuttings and cores. At night, and other times when drilling was not occurring, the ODEX pipe was sealed to prevent the movement of air into and out of the drill hole. The location of drill sites is shown in figure 1 and photographs of selected sites are shown in figure 3.

At depths less than 100 ft, cuttings were collected every one ft in buckets from the "cyclone" discharge. At depths greater than 100 ft, cuttings were collected less frequently. Sample collection was coordinated with drilling rates to allow collection of cuttings from discrete intervals. After collection, the material was subsampled and saved in a heat-sealable aluminum pouch to retain moisture. The site, date, time, and depth of the cuttings were recorded on the pouch.

At depths less than 100 ft, 2-foot-long cores were collected within every 5-foot interval using a 3.5- or a 4-inch-diameter piston-core barrel. The 4-inch-diameter core barrel was preferred and used in most drill holes because of the larger volume of material collected with each core. The 3.5-inch-diameter piston-core barrel was used in drill holes where material was more consolidated and coring more difficult. At depths greater than 100 ft, cores were collected less frequently. Prior to core collection, the core barrel was lined with four 6-inch-long aluminum or brass core liners. A core catcher was used to help retain loose unconsolidated material while the core was being retrieved. Immediately after the core was collected, (1) the core barrel was retrieved and disassembled, (2) material in the nose of the core barrel was collected and saved in a heat-sealable aluminum pouch, (3) cores and core liners were extruded from the core barrel, (4) the cores were capped with plastic end-caps and sealed with electrical tape, (5) the depth and orientation of the core was recorded on the end-caps, (6) the core was wrapped in plastic and placed into a heat-sealable aluminum pouch, and (7) the site, date, time, and depth of the core were recorded on the pouch. Four pouches, one for each 6-inch-long core liner, were required for each core. Plastic and heat-sealable aluminum pouches used to store cuttings and cores are commercially available and were used because they were specifically designed and tested to retain moisture in core material.

For the deepest sites (MOGW and MSCW-1), it was not possible to advance the ODEX casing to the bottom of the hole. At MOGW, the ODEX casing was advanced to 200 ft below land surface, and below this depth cuttings were lifted from the hole using a combination of air and foam. To minimize contamination of the core material from these sites, air only (no foam) was used in the 5-foot interval above the interval to be cored. At MSCW-2, this approach was not successful; the first hole, MCSW-2, collapsed below 280 ft during drilling and a second hole, MSCW-1, was drilled at the site. At MSCW-1, ODEX casing was advanced to 400 ft below land surface and drilling below that depth proceeded with air and foam. Wells for both MOGW and MSCW-1 are completed in saturated aquifer material near the water table.

Lithologic Data

Detailed lithologic logs were compiled from descriptions of drill cuttings and core material collected at each borehole (tables 2–12 at end of this report). In the field, cuttings and core material were described by texture, sorting, rounding, color, mineralogy, and any other significant feature. In addition to lithologic data, the specific conductance of a mixture of 50 milliliters (mL) of distilled water and cuttings and core material that passed through a 1-mm-mesh-size sieve, about 50 grams (g), was measured and recorded in the field. In the office, cuttings and core material were reexamined and described in greater detail.

Texture (fig. 4) was determined on all cuttings using a method developed by Folk (1954), and particle-size descriptions follow the National Research Council (1947) classification. This classification allows for the correlation of general grain-size terms (such as "sand") to size limits in millimeters or inches. Color, determined on dry cuttings (except for those parts of the deeper hole that were drilled using an air and foam mixture), follows the numerical designation in the Munsell Soil Color Charts (Munsell Color, 1975, 1994).

Geophysical Logs

Holes drilled using the ODEX method are continuously cased with the steel ODEX pipe. As a result, it was not possible to collect an extensive suite of geophysical logs. However, natural gamma logs and neutron logs were collected in the ODEX drill holes prior to instrument installation.

Natural gamma logs measure the intensity of gamma-ray emissions resulting from natural decay of potassium-40 and the daughter products of uranium and thorium. These logs are used primarily as lithologic indicators and for geologic correlation. Clay, as well as feldspar-rich gravel, generally has more intense gamma-ray emissions than gravels with less feldspar (Schlumberger, 1972; Hearst and Nelson, 1985; Driscoll, 1986). Natural gamma logs for the drill holes are shown in figures 5–15 at end of report.

Neutron logs measured the backscattering of neutrons generated from a nuclear source in the borehole. A direct relation exists between the water content and the neutron log measurement (Schlumberger, 1972; Hearst and Nelson, 1985; Troxler, 1994). Prior to instrument installation, neutron logs were collected from within the 8-inch-diameter ODEX pipe in the borehole. At each measurement depth, the logs were affected by differences in the position of the neutron source within the pipe and by differences in the thickness of the ODEX pipe. As a result, neutron logs collected prior to instrument installation were used only for site construction and instrumentation placement. Neutron logs collected from neutron access tubes installed in the drill holes were used to determine changes in moisture content in the unsaturated zone. These data are not presented in this report but are available on request.

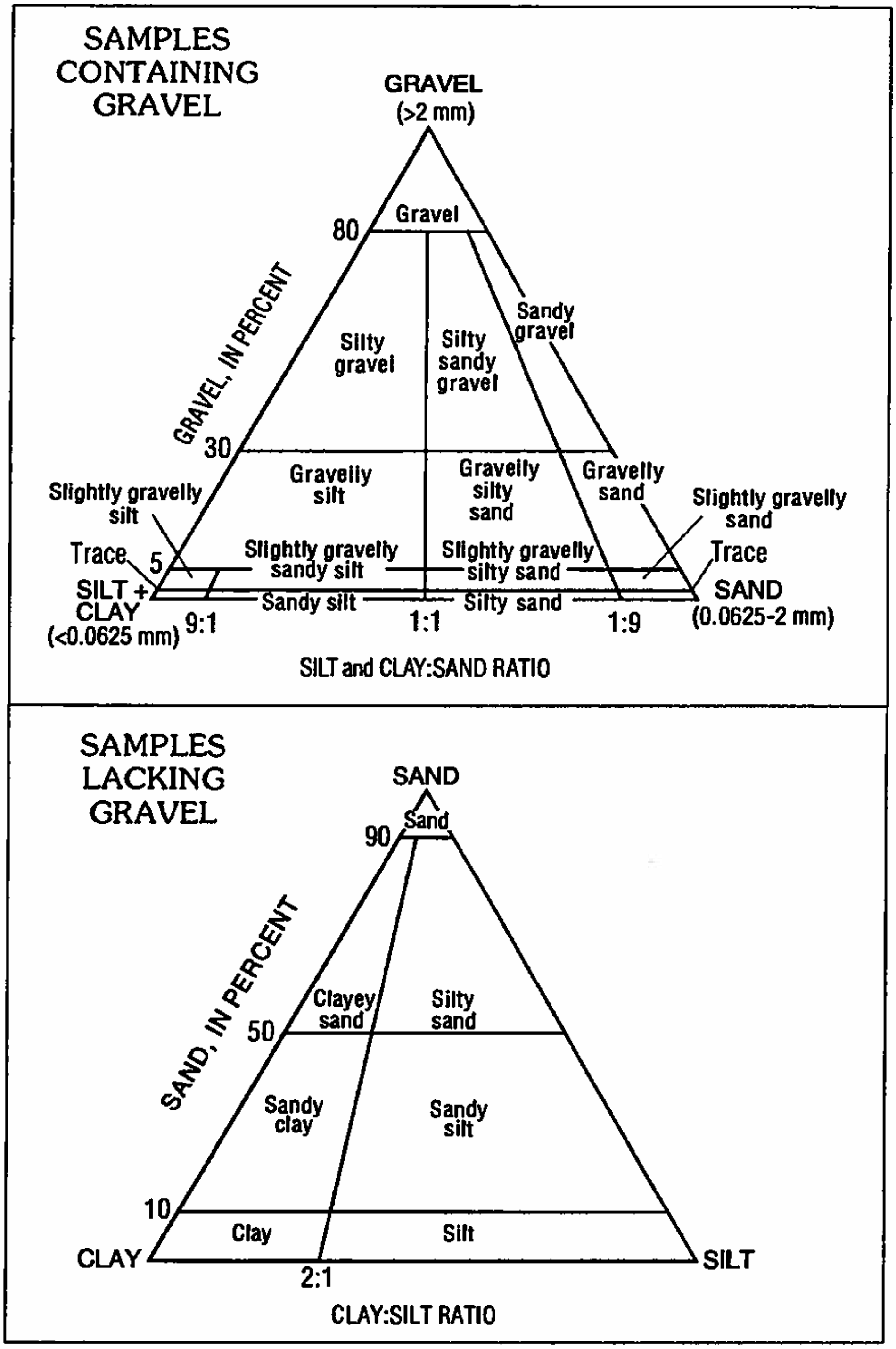


Figure 4. Nomenclature used for description of texture in lithologic logs. (Modified from Folk, 1954. For samples containing gravel, the description silt includes silt and clay)

Site Construction and Instrumentation

The design of each unsaturated-zone monitoring site was determined on the basis of (1) data needs at the site, (2) examination of cuttings and core material (both lithology and specific conductance of leachate from the cuttings and cores), gamma logs, and neutron logs, and (3) limitations on the amount of instrumentation that can be placed in a single 8-inch-diameter drill hole. All sites were instrumented with a neutron access tube. Most sites contain suction-cup lysimeters and gas samplers in addition to the neutron access tubes. Site construction and instrumentation information is given in table 1 and shown in figures 5–15.

The neutron access tube was the first piece of instrumentation placed in the drill hole. The tube consists of 2-inch-diameter, 21-foot-long sections of threaded galvanized steel pipe. The diameter of the pipe is only slightly larger than the diameter of the neutron source—minimizing differences in neutron measurements resulting from differences in the position of the source within the pipe. The pipe was steam cleaned prior to installation to prevent contamination from cutting oil used in the manufacturing process. A threaded end-cap was used to seal the bottom of the neutron-access tube. For most sites, the access tube was less than 100 ft long. For sites MOGW and MSCW-1, the access tube was several hundred feet long and extended to near the water table. A 2-inch-diameter stainless steel screen was attached to the bottom of the pipe, and at these sites the neutron access tube also served as a water-table well. At MSCW-2, the hole collapsed before the 2-inch-diameter pipe and screen could be installed at the water table, and therefore the screen is in the unsaturated zone above the water table. The tops of the neutron access tubes were sealed with removable air-tight caps. Suction-cup lysimeters and gas samplers were installed in the same drill hole in which the neutron access tubes were installed.

Two types of commercially available suction-cup lysimeters were used in this study. Both types were made of 1.5-foot-long, 2-inch-diameter polyvinyl chloride (PVC) with porous-ceramic cups. Suction-cup lysimeters used at shallow depths (generally less than 60 ft) had a single chamber with pressure/vacuum and sample tubes at different depths in the same chamber. Suction-cup lysimeters used at greater depths were equipped with two chambers separated by stainless steel one-way valves. The pressure/vacuum and sample tubes were located in the different chambers. These lysimeters were designed to withstand the higher pressures needed to lift sample water from greater depths (as great as 300 ft). Gas samplers used in this study were 10 in. long and 0.5 in. in diameter, and had a 0.004-slot stainless steel well screen with a threaded end.

Depths of suction-cup lysimeter and gas sampler placement were determined on the basis of examination of cuttings and core material (both lithology and specific conductance of leachate from the cuttings and cores), gamma logs, and neutron logs. In general, suction-cup lysimeters were installed at depths at which neutron-log data indicated that soil moisture was relatively high—especially above fine-grained layers that may act to slow infiltration or create perched conditions. Suction-cup lysimeters were not installed at sites farther away from the washes (OGF or SCF) because the unsaturated zone at these sites was too dry to yield water to lysimeters. Gas samplers were installed in dryer and (or) coarser layers where soil moisture was not great enough for suction-cup lysimeters. At several sites, lysimeters and gas samplers were placed at similar depths to allow comparison of data from each instrument.

Suction-cup lysimeters were installed in diatomaceous earth to ensure good contact between the porous-ceramic cup of the lysimeter and the unsaturated-zone materials. Gas samplers were installed in graded number 3 Monterey Sand to ensure good air flow near the sampler. Gas samplers were isolated from each other by a layer of grout and bentonite chips placed at depths at which fine-grained layers were present between the samplers. At the first four sites (UOGW, MOGW, LOGW, and OGF), the grout and chips were installed partly hydrated and allowed to completely hydrate with moisture from the unsaturated zone after installation. For the remaining sites, the grout and chips were installed dry and allowed to hydrate with moisture from the unsaturated zone after installation. Where backfill was required, graded number 3 Monterey Sand was used. Sand and grout were installed through a tremmie pipe; diatomaceous earth and bentonite chips were poured into the hole from land surface. All drill holes were sounded frequently to determine the depth of the hole before, during, and after installation of diatomaceous earth, grout, bentonite chips, and sand.

At most sites, pressure/vacuum and sample tubes connecting lysimeters to the surface, as well as sample tubes connecting gas samplers to the surface, were 0.25-inch-diameter, refrigeration-grade copper tubing. Copper tubing was used to minimize the potential for chlorofluorocarbon (CFC) contamination from instrumentation in the drill hole. At deeper sites (MOGW and MSCW), nylon tubing was used because it was not possible to place copper tubes in the deeper parts of these holes. Prior to installation, the nylon tubing was tested to determine that it would not contaminate samples with CFC's (Eurybiades Busenberg, U.S. Geological Survey, written commun., 1995).

On the surface, sites were finished in vaults or risers set at or below land surface with concrete surface seals. Tubes for gas samplers were color coded and arranged from deepest to shallowest to the left of the neutron access tube (when viewed from the hasp of the vault or riser). Gas sampler tubes were sealed with compression fittings. Pressure/vacuum tubes for suction-cup lysimeters were color coded and arranged from deepest to shallowest to the right of the neutron access tube. Sample tubes for suction-cup lysimeters were color coded and arranged from deepest to shallowest to the right of the pressure/vacuum tubes. Suction-cup lysimeter tubes were sealed with radiator hose and washers.

PHYSICAL AND HYDRAULIC PROPERTIES OF UNSATURATED MATERIALS

Physical properties of unsaturated materials, such as water content (gravimetric and volumetric), bulk density, and water potential, are relatively easy and inexpensive to measure. These properties were determined on all cores collected as part of this study. Other physical properties, such as particle-size distribution and moisture-retention curves, also are relatively easy, but more expensive, to measure. These properties were determined on fewer cores. Measurements were made at the Desert Research Institute, University of Nevada, Reno.

Water content (gravimetric and volumetric), particle-size distribution, and water-retention were measured using American Society for Testing and Materials (1987) methods. Water potential was measured using three different methods. For wet core material (less negative than −1,000 kPa), water potential was measured using tensiometers or the filter-paper method (Campbell and Gee, 1986). For dry core material (more negative than −1,000 kPa), water potential was measured using a water-activity meter commonly known as a "chilled-mirror hygrometer" (Gee and others, 1992). Water retention data were measured using a pressure-plate extractor (American Society for Testing and Materials, 1987). For coarse-textured samples, it was necessary to remove the gravel and repack the sample to its original bulk density to measure water retention.

Results of laboratory analysis for water content, bulk density, and water potential are given in table 13 at end of report. Results of particle-size analysis for selected cores are given in tables 14 and 15 at end of report. Water-retention data are given in tables 16 and 17 at end of report.

CHEMICAL AND ISOTOPIC DATA

Extractions from Core Material and Cuttings

The chemical and isotopic composition of soil and soil water was determined on soluble salts or on water extracted by various methods from core material and cuttings. Each core selected for analysis contained material from the nose cone of the core and material encased in four separate core liners. Not all cores collected were analyzed for all chemical constituents and isotopic composition.

Chemical Data

Soluble anions in the soil (and dissolved in soil water) were determined from analysis of leachate extracted from the nose cone of selected cores and from selected cuttings with distilled water.

Prior to extraction, core material and cuttings were sieved to obtain 50 (±0.005) grams of material having a particle size less than 1 millimeter (mm). The sieved sample was mixed with 50 mL of distilled water. The resulting mixture was shaken vigorously for 30 seconds, allowed to stand with occasional shaking for about 24 hours, and centrifuged at 4,000 revolutions per minute (rpm) for 20 minutes to allow the remaining solids to settle. The supernatant was pressure filtered, using a syringe, through a 0.45-mm pore-sized disk-filter. The first 10 mL of sample was used to rinse the filter and discarded. The remaining sample was filtered and analyzed for chloride, sulfate, nitrate, and nitrite by ion chromatography (American Public

Health Association, 1992) at the USGS laboratory in San Diego, California. Sample handling and extraction procedures were similar to those used by Prudic (1994), except in this study the ratio of core material to distilled water was greater and the samples were centrifuged prior to filtration and analysis. The ratio of core material to distilled water used for laboratory extractions was based on a weight per volume ratio, whereas the ratio used in the field for specific-conductance measurements was based on a volume per volume ratio. However, the results are believed to be comparable. Concentrations of selected constituents in leach water extracted from cores and cuttings for field and laboratory data are given in table 18 at end of report.

Replicate analyses were done on samples of supernatant selected at random from each batch of extract water to determine the precision associated with sample analyses. Replicate samples were not analyzed sequentially but instead were distributed throughout the sample run. On the basis of the analysis of replicate samples, the precision of chloride analysis was about ±0.4 milligram per liter (mg/L) for chloride concentrations less than 10 mg/L and about ±5 percent for chloride concentrations greater than 10 mg/L. Duplicate extractions were done on 21 samples and analyzed to determine precision associated with sample extract preparation and variation in the extractable anions in subsamples from the cores and cuttings. On the basis of the duplicate extractions, the overall precision of chloride extractions was about ±10 percent. One sample was held for 4 months to determine if any additional anions could be extracted from the material with time. After 4 months, chloride concentrations did not change. In contrast, sulfate concentrations increased from 67 to 840 mg/L, and fluoride concentrations increased from 2.7 to 4.8 mg/L.

Delta Oxygen-18 and Delta Deuterium Data

Delta Oxygen-18 ($\delta^{18}O$) and delta deuterium (δD) isotopic composition was determined on water extracted from soil cores by azeotropic distillation (Revesz and Woods, 1990) with toluene using analytical methods described by Epstein and Mayeda (1953) at the USGS laboratory in Menlo Park, California. An azeotropic mixture of water and toluene has a lower boiling point than that of a pure solution of either compound. The lower boiling point allows water to be distilled from the core material at a lower temperature (about 85°C in comparison with 100°C) and reduces the potential for contamination of pore water with water of hydration from minerals such as anhydrite. Only core material was used for $\delta^{18}O$ and δD extractions. This material was not sieved prior to extraction; however, if large rocks were present they were removed.

For moist cores, 100 g of material was placed in a round-bottom boiling flask, covered with 200 mL of toluene, and stoppered. For dry cores, 300 g of material was used. The core material was removed from the core liner, weighed, and placed in the boiling flask as quickly as possible to minimize evaporation. During distillation, the core material, soil water, and toluene mixture was initially heated to about 80°C; as the distillation progressed, the temperature was gradually increased to about 85°C, until completion in about 30 to 45 minutes. Distillation of fine-grained material took longer than distillation of coarse-grained material. At completion, the temperature was increased to 100°C for 15 minutes to ensure complete recovery of soil water and to reduce fractionation. Actual yields from azeotropic distillation were within ±12 percent of expected yields (based on gravimetric water content measured on subsamples of material from the same core liner). Comparison of yields from duplicate extractions agreed within ±10 percent. Delta oxygen-18 and delta deuterium analyses of duplicate extractions of material from the same core liner agreed within ± 0.2 and ±1.9 per mil, respectively. Results of $\delta^{18}O$ and δD analyses are presented in table 19 at end of report.

Tritium Data

Tritium was measured in water extracted from soil cores by vacuum extraction. Only core material was used for tritium extractions and this material was not sieved. However, if large rocks were present they were removed prior to extraction. Azeotropic distillation was not used to extract water for tritium analyses because of the larger volume of water required for tritium analyses in comparison with $\delta^{18}O$ and δD analyses. It was possible to use vacuum extraction because, unlike delta oxygen-18 and delta deuterium, tritium is not sensitive to fractionation during sample extraction.

Water was extracted from about 2 kilograms (kg) of core material (the weight of material in a typical core liner) using a combination of vacuum and heat. The material was weighed, placed in a tray, and heated to about 85°C while subjected to vacuum of about

−100 kilopascal (kPa) until it was dry and no more water was yielded from the sample. Water was trapped in a series of collection flasks located between the oven and the vacuum pump. The first flask was cooled with a mixture of dry ice and isopropanol. The second flask was cooled with liquid nitrogen. This procedure generally required about 4 hours for sandy material and as much as 8 hours for finer grained material. In some cases, if 2 kg of material did not yield enough water for analysis, additional water was extracted from another core liner within the same 2-foot interval and the samples were composited. Care was taken to ensure that the sample was minimally exposed to the atmosphere (and potential contamination or evaporation) during sample preparation and handling. However, this was less of a concern for tritium extractions than for delta deuterium and delta oxygen-18 extractions. After extraction, samples were concentrated using electrolytic enrichment and tritium was measured by liquid scintillation (Thatcher and others, 1977) at the USGS laboratory in Menlo Park, California. The precision (tritium error count) of individual measurements changed with sample volume and ranged from ± 0.3 TU for moist core samples to ± 8 TU for dryer core samples. Results of tritium analyses on water extracted from core material are presented in table 19.

Suction-Cup Lysimeter Data

The chemical and isotopic compositions of unsaturated zone water were measured on samples collected from suction-cup lysimeters at selected sites. Suction-cup lysimeters were not installed at sites away from the washes (OGF and SCF) because the unsaturated zone at these sites was too dry to yield water to lysimeters. Five suction-cup lysimeters installed at sites near, but not directly underlying, a wash (sites LOGW-2 and SUMMIT) did not yield water during this study because the unsaturated zone at these sites also was too dry. At the remaining sites, water was collected from 16 of the 29 lysimeters installed as part of this study. The lysimeters installed in the unsaturated zone underlying Oro Grande Wash yielded water more frequently, and in greater volumes, than did lysimeters installed in the unsaturated zone underlying Sheep Creek Wash. Some of the lysimeters yielding water were as deep as 140 ft below land surface.

Suction-cup lysimeters were sampled by applying a vacuum (about 60 centibars), which induces water to flow from the unsaturated zone into the lysimeter. If the matrix potential of the unsaturated zone near the lysimeter is more negative, then water will not enter the lysimeter. For most lysimeters it was necessary to apply vacuum many times over a period of several months before the lysimeter yielded water and the first sample could be collected. Once in the lysimeter, the water was forced to land surface by applying nitrogen gas pressure to one tube of the two-tube system. Although water-yielding characteristics varied considerably from one lysimeter to another, about 2 to 4 weeks was required after the application of a vacuum to ensure maximum accumulation of water within most lysimeter cups. Umari and others (1995) found that shorter sampling periods resulted in incomplete water recovery, and longer sampling periods resulted in partial loss of the sample through leakage back into the soil. Results of analysis of water from suction-cup lysimeters for major ions, selected trace elements, and the stable isotopes of oxygen, hydrogen, and carbon are given in table 20 at end of report. These analyses were done by the USGS National Water Quality Laboratory in Arvarda, Colorado.

There is some uncertainty about whether samples from suction-cup lysimeters are representative of water in the unsaturated zone. Possible problems with suction-cup lysimeter data include contamination of the sample by lysimeter materials, inability to collect sufficient sample volume for analysis, variability in sample collection because of variability in applied vacuum, and changes that occur in the sample, such as chemical precipitation, during collection and storage within the body of the lysimeter (Umari and others, 1995).

Soil Water Vapor and Other Gases

Delta Oxygen-18 and Delta Deuterium Data

The $\delta^{18}O$ and δD composition of water vapor was measured on samples collected from 21 gas samplers as deep as 500 ft below land surface at three sites underlying Oro Grande Wash (UOGW, MOGW, and LOGW) and at the nearby alluvial fan site (OGF). At most sites, samples were collected only once. At the LOGW site, samples were collected as often as six times to determine if there were seasonal variations in the composition of water vapor in the unsaturated zone. Data are given in table 21 at end of report.

Gas samplers were purged at a rate of 1 to 2 liters per minute (L/min) for several hours prior to sample collection using peristaltic pumps. Samples for δD and $\delta^{18}O$ analyses were collected in evacuated glass bulbs placed in-line between the copper tube that connects the gas sampler to the surface and the peristaltic pump. The bulbs ranged in size from 1 to 2 liters (L). Samples were collected by slowly opening the stopcock and allowing the bulb to fill with gas. After the bulb equilibrated for about 5 minutes the stopcock was closed, the bulb was removed from the copper tube and peristaltic pump, and the sample bulb was prepared for overnight shipment to the Desert Research Institute Isotope Laboratory in Las Vegas, Nevada.

At the laboratory, sample bulbs were placed in liquid nitrogen for about 45 minutes, after which the remaining unfrozen gases were evacuated from the bulb. Bulbs were then allowed to warm to room temperature. Carbon dioxide for $\delta^{18}O$ analyses was collected from the sample bulbs in glass tubes. Water for δD analyses was collected from the bulb in capillary tubes. The bulbs yielded about 10 to 15 microliters (µL) of liquid water per liter of air collected. The δD analyses were done using the sealed-tube zinc-reduction method described by Kendall and Coplen (1985). This method allowed for the small sample volumes obtained from the water vapor samples. The $\delta^{18}O$ analyses were done using constant-temperature equilibration with carbon dioxide gas (Epstein and Mayeda, 1953). To optimize the performance of the mass spectrophotometer, analytical standards were analyzed using volumes similar to the sample volumes. Duplicate samples collected as part of this study, and results from other studies, suggest that the analytical precision for $\delta^{18}O$ and δD analyses of water vapor is ±0.2 and ±1 per mil, respectively (Craig Shadel, Desert Research Institute, written commun., 1996). These values are slightly greater than the analytical precision of ±0.05 and ±1.5 estimated in other studies for $\delta^{18}O$ and δD in larger volume samples (Izbicki, 1996), such as those obtained from soil cores and suction-cup lysimeters.

Tritium Data

The tritium composition of water vapor was measured on samples collected from 21 gas samplers as deep as 500 ft below land surface at three sites underlying Oro Grande Wash (sites UOGW, MOGW, and LOGW) and at the nearby alluvial fan site (OGF).

To collect the sample, air was pumped from the gas samplers using a peristaltic pump at a rate of 1 to 2 L/min, and water vapor was condensed in glass tubes known as "cold fingers." The "cold fingers" were placed in-line between the copper tube that connects the gas sampler to the surface and the peristaltic pump. To condense the water vapor during sample collection the "cold fingers" were placed in a mixture of dry ice and isopropanol. The temperature of this mixture was maintained near –25°C (temperatures as low as –70°C could be achieved in the field). After about 8 hours, the sample was removed from the dry ice-isopropanol mixture and allowed to thaw. Typically, 4 to 5 mL of water was collected at a time and it was necessary to repeat the sample collection procedure three times over a period of several months to obtain enough sample for analyses. Samples were concentrated by electrolytic enrichment and analyzed by liquid scintillation (Thatcher and others, 1977) at the USGS isotope laboratory in Menlo Park, California in the same manner as water samples collected from core material and from suction-cup lysimeters. Because of the small sample volume, however, lower precision and higher detection limits were obtained for tritium analyses of water vapor than for larger volume samples from core material and suction-cup lysimeters discussed previously. Tritium data are given in table 21.

Chlorofluorocarbon Data

Chlorofluorocarbons (CFC's) are synthetic organic carbons used as refrigerants, aerosol propellants, cleaning agents, and solvents. They were first manufactured in the 1930's and are believed to be entirely manmade. Unlike δD, $\delta^{18}O$, and tritium, chlorofluorocarbons are not part of the water molecule and are present in the unsaturated zone as gases or dissolved in water. In this study, three chlorofluorocarbons, CFC-11 (trichlorofluoromethane), CFC-12 (dichlorodifluoromethane), and CFC-113 (trichlorotrifluoroethane), were measured from gas samplers as deep as 500 ft below land surface at seven sites underlying Oro Grande Wash (UOGW, MOGW, and LOGW) and Sheep Creek Wash (USCW, MSCW-1, MSCW-2, and LSCW), and at the alluvial fan sites near Oro Grande Wash (OGF) and Sheep Creek Wash (SCF).

Prior to collection of chlorofluorocarbon samples, gas samplers were purged for about 3 to 6 hours at a rate of 1 to 2 L/min using a peristaltic pump. Purge times were less for shallow samplers and more for deeper samplers. Samples were collected using a diaphragm pump and a sample-collection apparatus similar to that designed by Busenberg and Plummer (1992) to prevent contamination during sample collection. The diaphragm pump was tested prior to use to ensure that it did not contaminate samples with chlorofluorocarbons. A three-way valve, between the peristaltic pump and the tube that connects the air sample to the surface, was used to connect the diaphragm pump and sample-collection apparatus to the purge line. Samples were collected in glass ampules that were welded closed in the field while connected to the sample apparatus. Because of potential breakage and inadequate welds that do not completely seal the glass ampules, contamination with ambient atmosphere was a concern. To ensure that at least one uncontaminated sample was collected, three replicate samples were collected from each gas sampler. After collection, samples were shipped to the USGS Chlorofluorocarbon Laboratory in Reston, Virginia, for analysis using a purge-and-trap gas chromatography procedure with an ECD detector (Busenberg and Plummer, 1992). Chlorofluorocarbon data are given in table 21.

OTHER DATA

Precipitation Data

Bulk precipitation (wet fallout plus dry fallout) was collected at five sites between December 1994 and November 1997 (fig. 1). Collectors were based on a design by Friedman and others (1992) and consisted of a 75-mm (3 in.) straight-sided Buchner funnel supported on a stake about 3 ft above the ground. The funnel was connected using copper tubing to 1-L plastic bottles placed below the ground. The bottles contained a thin layer of mineral oil, which prevented evaporation of the water. All sample collectors were located in gated areas secure from vandalism.

To ensure comparability of data from these five sites with regionalized precipitation data collected during previous studies (Friedman and others, 1992), bulk precipitation was collected semiannually, in April and November (at the end of the rainy season and the end of summer, respectively). Large amounts of precipitation during the winters of 1994–95 and 1996–97 required an additional sample collection during the middle of the rainy season to ensure that the 1-L bottles did not overflow.

After collection, samples of bulk precipitation were returned to the USGS laboratory in San Diego, California for sample preparation and chemical analysis. The volume of sample was measured and was subsampled for measurement of specific conductance, pH, chemical constituents, and isotopic composition. Chloride and sulfate and other anions were determined by ion chromatography (American Public Health Association, 1992). Delta oxygen-18 and delta deuterium were determined by mass spectrometry at the USGS Isotope Laboratory in Reston, Virginia (Epstein and Mayeda, 1953; Coplen and others, 1991). Results of chemical and isotopic analyses are given in table 22 at end of report.

Ground-Water-Level and Ground-Water-Quality Data

Ground-water levels were measured periodically at MOGW and MSCW using a calibrated electric tape. Water-level data for the period 1995–99 are given in table 23 at the end of this report and plotted in figure 16.

The wells were developed by a combination of bailing and pumping. Development was not difficult because mud was not used as a drilling fluid. Water-quality samples were collected, using a positive-displacement piston pump, after at least three casing volumes were pumped and temperature, specific conductance, and pH had stabilized. Samples were sent to the USGS National Water Quality Laboratory in Arvarda, Colorado, for analysis of major cations, anions, nutrients, and selected trace elements using methods by Fishman (1993). Samples for δD, $\delta^{18}O$, and $\delta^{13}C$ were analyzed using mass spectrophotometry. Samples for tritium were analyzed in Menlo Park, California using electrolytic enrichment and liquid scintillation (Thatcher and others, 1977). Samples for carbon-14 were analyzed using accelerator mass-spectrophotometry (AMS). Results of chemical and isotopic analyses are given in table 24 at the end of this report.

REFERENCES CITED

American Public Health Association, 1992, Standard methods for the examination of water and wastewater, 18th ed., variously paged.

American Society for Testing and Materials, 1987, Annual book of ASTM standards; Volume 04.08. American Society for Testing and Materials, Philadelphia, Pa.

Busenberg, Eurybiades, and Plummer, L.N., 1992, Use of chlorofluorocarbons (CCl3F and CCl2F2) as hydrologic tracers and age-dating tools: the alluvium and terrace system of Central Oklahoma: Water Resources Research, v. 28, no. 9, p. 2257–2283.

Campbell, G.S., and Gee, W.G., 1986, Water potential measurement using the filter paper technique, *in*: Klute, A.L., ed., Methods of soil analysis, Part 1, Physical and mineralogical methods (2d ed.): Madison, Wisc., American Society of Agronomy, chap. 25, p. 628–630.

Coplen, T.B., Wildman, J.D., and Chen, J., 1991, Improvements in the gaseous hydrogen-water equilibration technique for hydrogen isotope ratio analysis: Analytical Chemistry, v. 63, p. 910–912.

Driscoll, F.G., 1986, Groundwater and wells: Saint Paul, Minn., Johnson Filtration Systems, Inc., 1,089 p.

Epstein, S., and Mayeda, T.K., 1953, Variations of ^{18}O content of waters from natural sources: Geochimica et Cosmochimica Acta, v. 4, p. 213–224.

Fishman, M.J., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.

Folk, R.L., 1954, The distinction between grain size and mineral composition in sedimentary rock nomenclature: Journal of Geology, v. 62, no. 4, p. 344–359.

Friedman, Irving, Smith, G.I., Gleason, J.D., Warden, Augusta, and Harris, J.M., 1992, Stable isotope composition of waters in southeastern California: 1. Modern precipitation: Journal of Geophysical Research, v. 97, no. D5, p. 5795–5812.

Gleason, J.D., Veronda, Guida, Smith, G.I., Friedman, Irving, and Martin, Peter, 1992, Deuterium concentrations of water from wells and perennial springs, southeastern California: U.S. Geological Survey Open-file Report 91-470, 22 p., 1 over-size sheet.

Gee, G.W., Campbell, M.D., Campbell, G.S., and Campbell. J.H., 1992, Rapid measurement of low soil water potentials using a water activity meter: Soil Science Society of America Journal, v. 56, p. 1069–1070.

Hammermeister, D.P., Blout, D.O., and McDaniel, J.C., 1986, Drilling and coring methods that minimize the disturbance of cuttings, core, and rock formations in the unsaturated zone, Yucca Mountain, Nevada, *in* Proceedings of the NWWA Conference on Characterization and Monitoring of the Vadose (Unsaturated) Zone: National Water Well Association, Worthington, Ohio, p. 507–541.

Hardt, W.F., 1971, Hydrologic analysis of Mojave River basin, California, using electric analog model: U.S. Geological Survey Open-File Report 72-08, 84 p.

Hearst, J.R., and Nelson, P.H., 1985, Well logging for physical properties: New York, McGraw-Hill Book Company, 571 p.

Izbicki, J.A., 1996, Use of $\delta^{18}O$ and δD to define seawater intrusion, *in* Bathala, C.T., ed., North American Ground Water and Environmental Congress, Anaheim, Calif., June 23–28, Proceedings: New York, American Society of Civil Engineers, 1 CD-ROM.

Izbicki, J.A., Michel, R.L., and Martin, Peter, 1995, Source, movement, and age of groundwater in the upper part of the Mojave River basin, California, USA, *in* Adair, E.M., and Leibungut, Christian, eds., Application of tracers in arid zone hydrology, Proceedings of the Vienna Symposium, August 1994, p. 43–56.

Izbicki, J.A., Michel, R.L., and Martin, Peter, 1998, Chloride and tritium concentrations in a thick unsaturated zone underlying an intermittent stream in the Mojave Desert, southern California, USA, *in* Brahama, J., and others, eds., Gambling with groundwater—physical, chemical, and biological aspects of aquifer-stream relations, p. 81–88.

Kendall, Carrol, and Coplen, T.B., 1985, Multisample conversion of water to hydrogen by zinc for stable isotope determination: Washington, D.C., Analytical Chemistry, v. 57, p. 1437–1440.

Lines, G.C., 1996, Ground-water and surface-water relations along the Mojave River, southern California: U.S. Geological Survey Water-Resources Investigations Report 95-4189, 43 p.

Meisling, K.E., and Weldon, R.J., 1989, Late Cenozoic tectonics of the northwestern San Bernardino Mountains, southern California: Geological Society of America Bulletin, v. 101, p. 106–128.

Mendez, G.O., and Christensen, A.H., 1997, Regional water table (1996) and water-level changes in the Mojave River, the Morongo, and the Fort Irwin ground-water basins, San Bernardino County, California: U.S. Geological Survey Water-Resources Investigations Report 97-4189, 34 p., 1 pl. in pocket.

Munsell Color, 1975, Munsell soil color charts: Baltimore, Md., Munsell Color, Inc.

———,1994, Munsell soil color charts: Baltimore, Md., Munsell Color, Inc.

National Research Council, 1947, Report of the subcommittee on sediment terminology: American Geophysical Union Transactions, v. 28, no. 6, p. 936–938.

Prudic, D.E., 1994, Estimates of percolation rates and ages of water in the unsaturated zone near the low-level radioactive-waste burial site south of Beatty, Nevada: U.S. Geological Survey Open-File Report 96-110, 19 p.

Revesz, Kinga, and Woods, P.H., 1990, A method to extract soil water for stable isotope analysis: Journal of Hydrology, v. 115, p. 397–406.

Schlumberger, Inc., 1972, Log interpretation, Volume 1—principles: New York, Schlumberger Limited, 112 p.

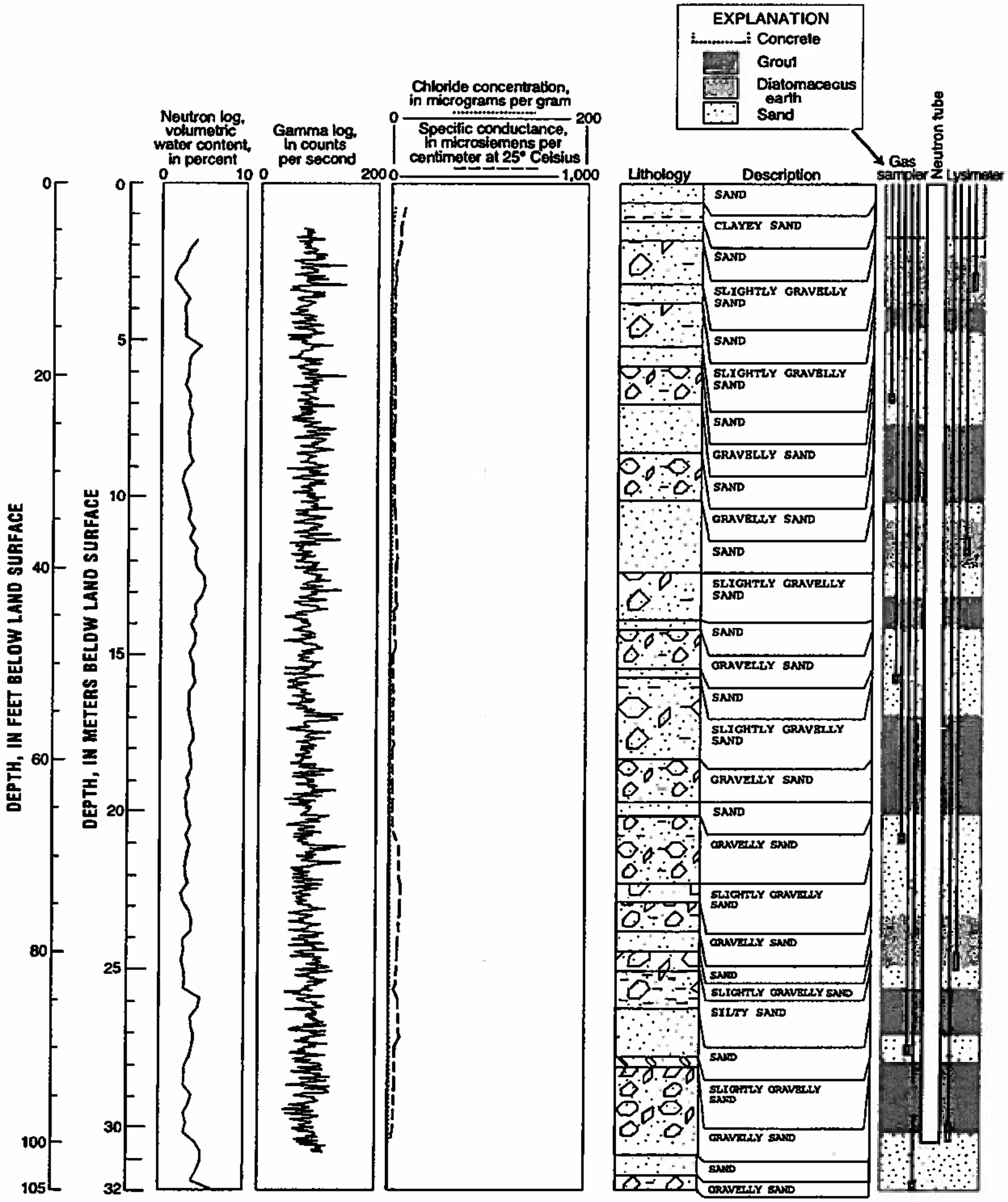
Stamos, C.L., and Predmore, S.K., 1995, Data and water-table map of the Mojave River ground-water basin, San Bernardino County, California, November 1992: U.S. Geological Survey Water-Resources Investigations Report 95-4148, 1 oversize sheet.

Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for determination of radioactive substances in water and fluvial sediments: Techniques of Water-Resources Investigations of the U.S. Geological Survey, chap. A-5, 95 p.

Troxler, Inc., 1994, Manual of operation and instruction Model 4300 depth moisture gage: Research Triangle Park, N.C., Troxler Electronic Laboratories, Inc., 150 p.

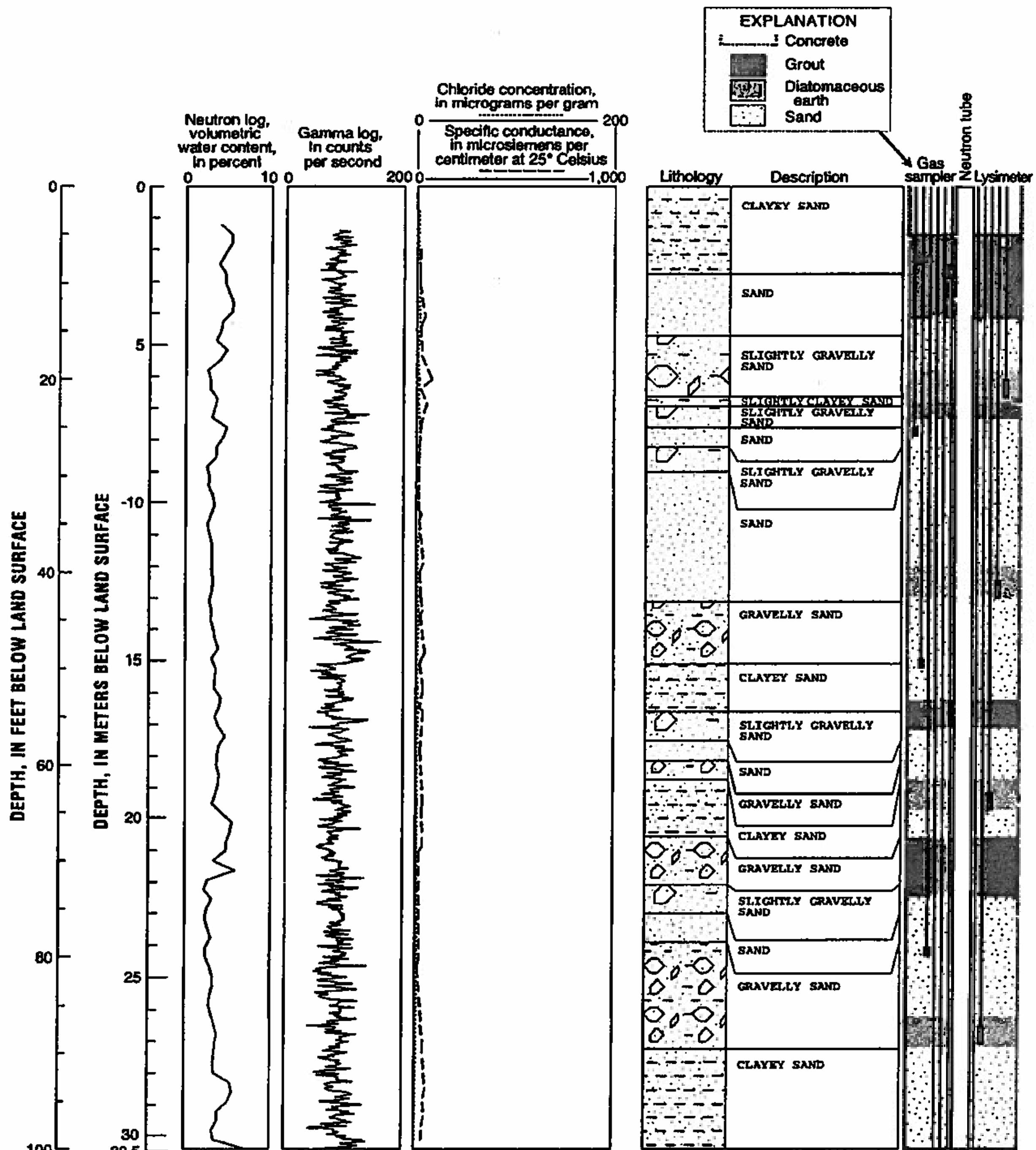
Umari, A.M.J., Martin, Peter, Schroeder, R.A., Duell, L.F.W, Jr., and Fay, R.G., 1995, Potential for ground-water contamination from movement of wastewater through the unsaturated zone, upper Mojave River Basin, California: U.S. Geological Survey Water-Resources Investigations Report 93-4137, 83 p.

FIGURES 5–15



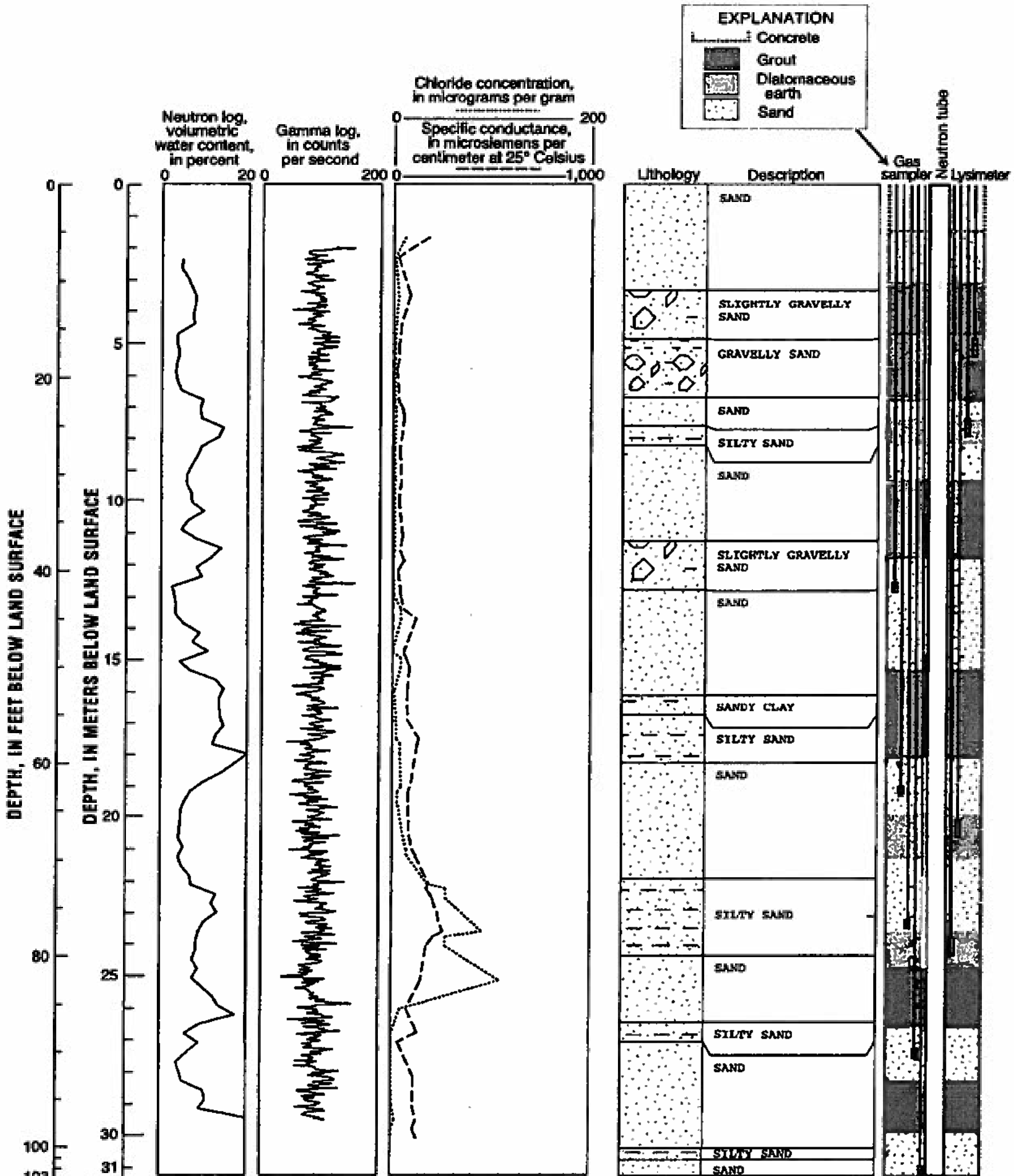
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 5. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site UOGW near Victorville, San Bernardino County, California.



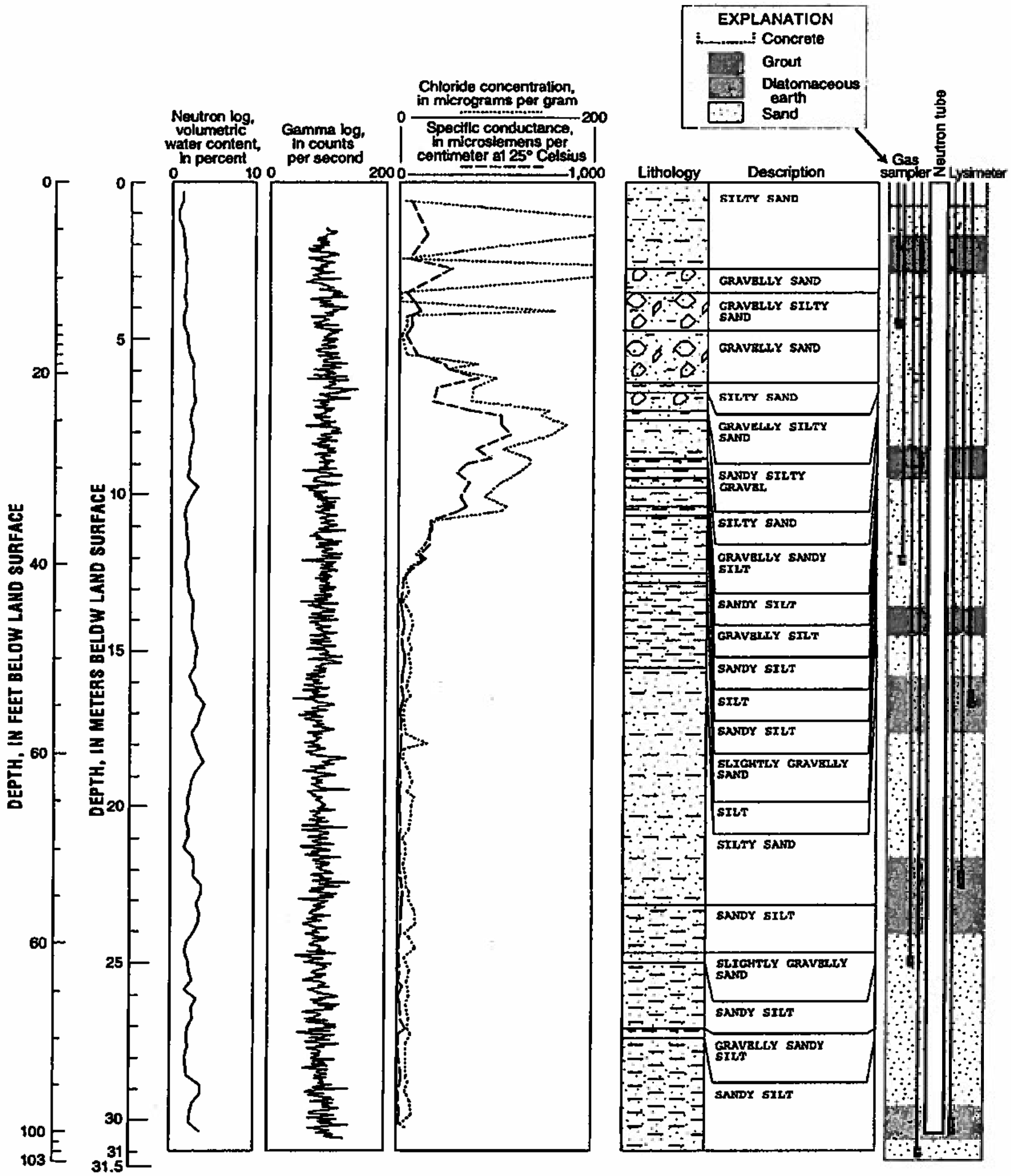
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table. Total depth 700 feet. Drilling data and instrumentation deeper than 100 feet are not shown.

Figures 6. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site MOGW near Victorville, San Bernardino County, California.



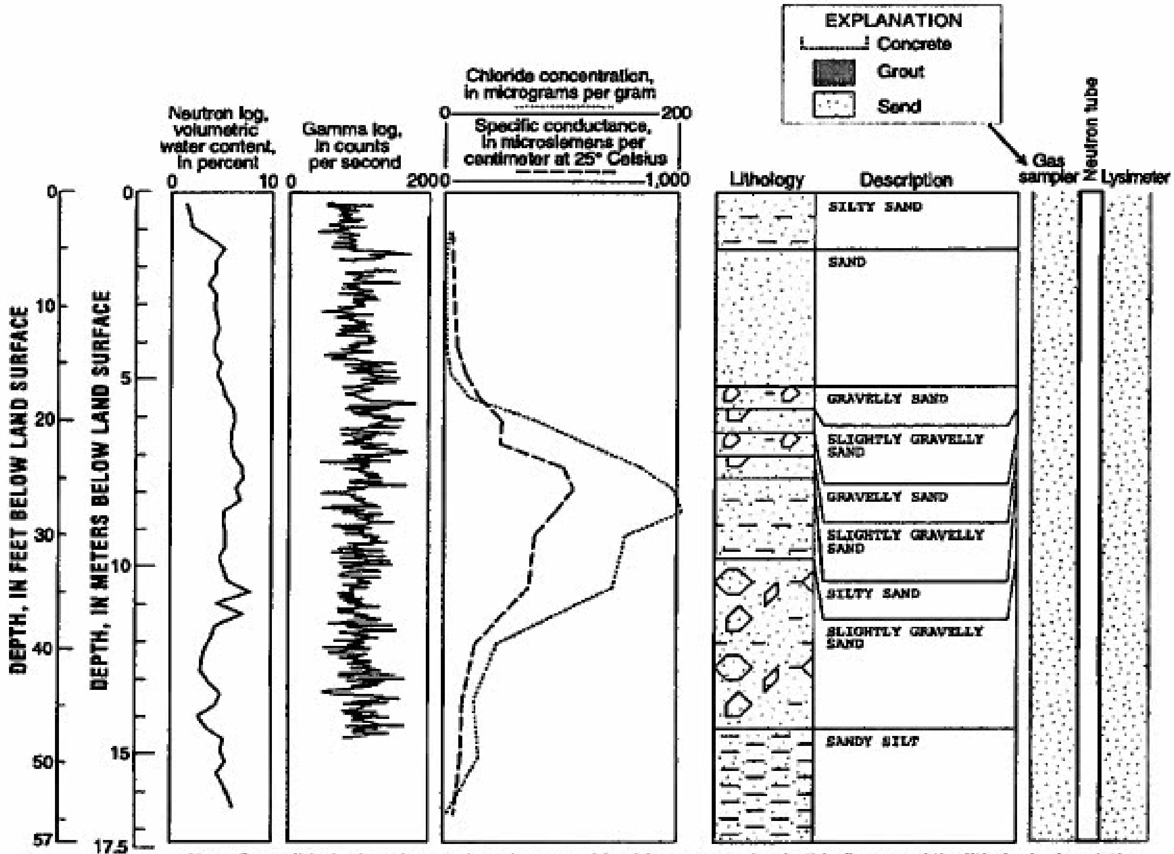
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 7. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site LOGW-1 near Victorville, San Bernardino County, California.



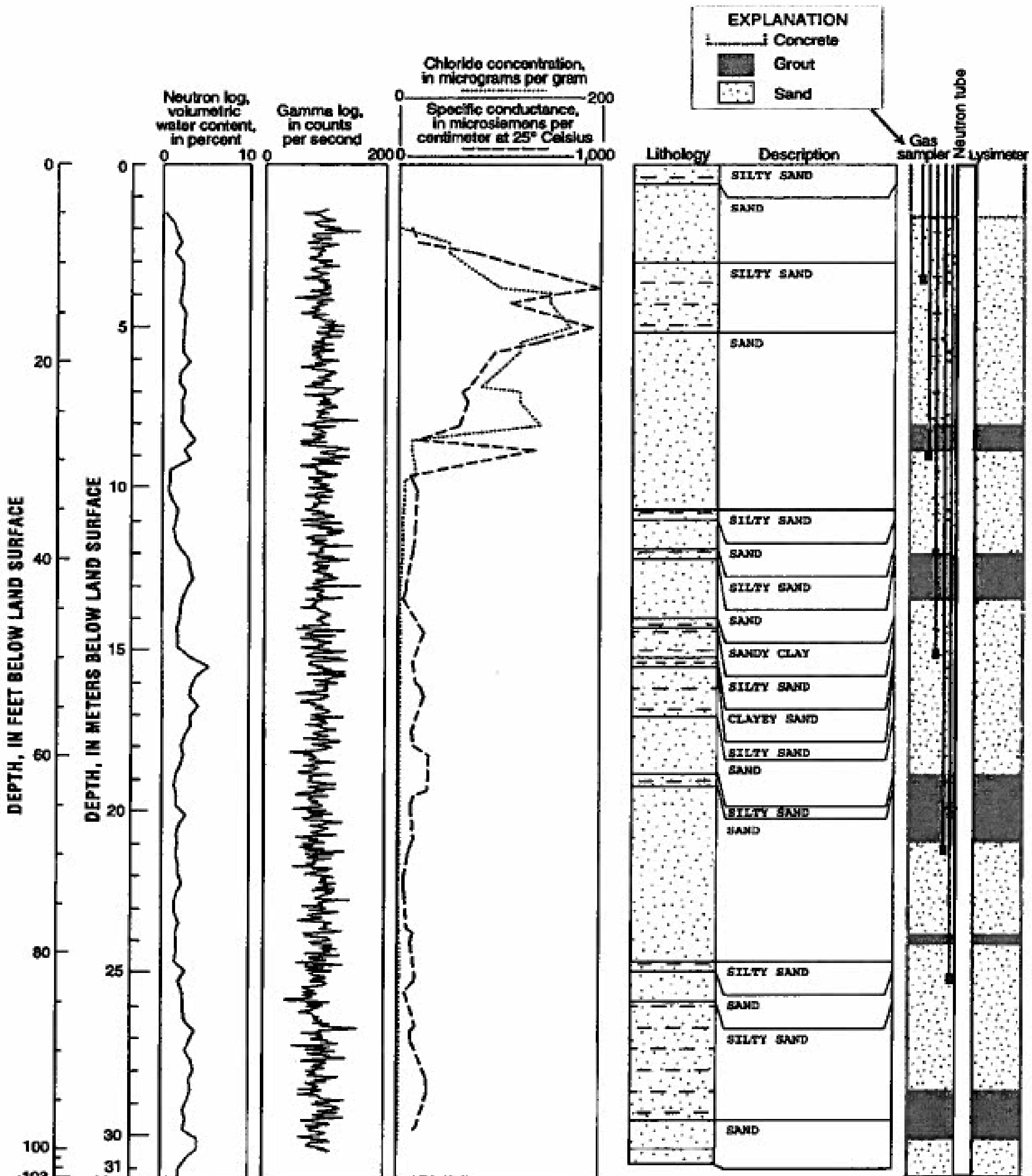
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 8. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California.



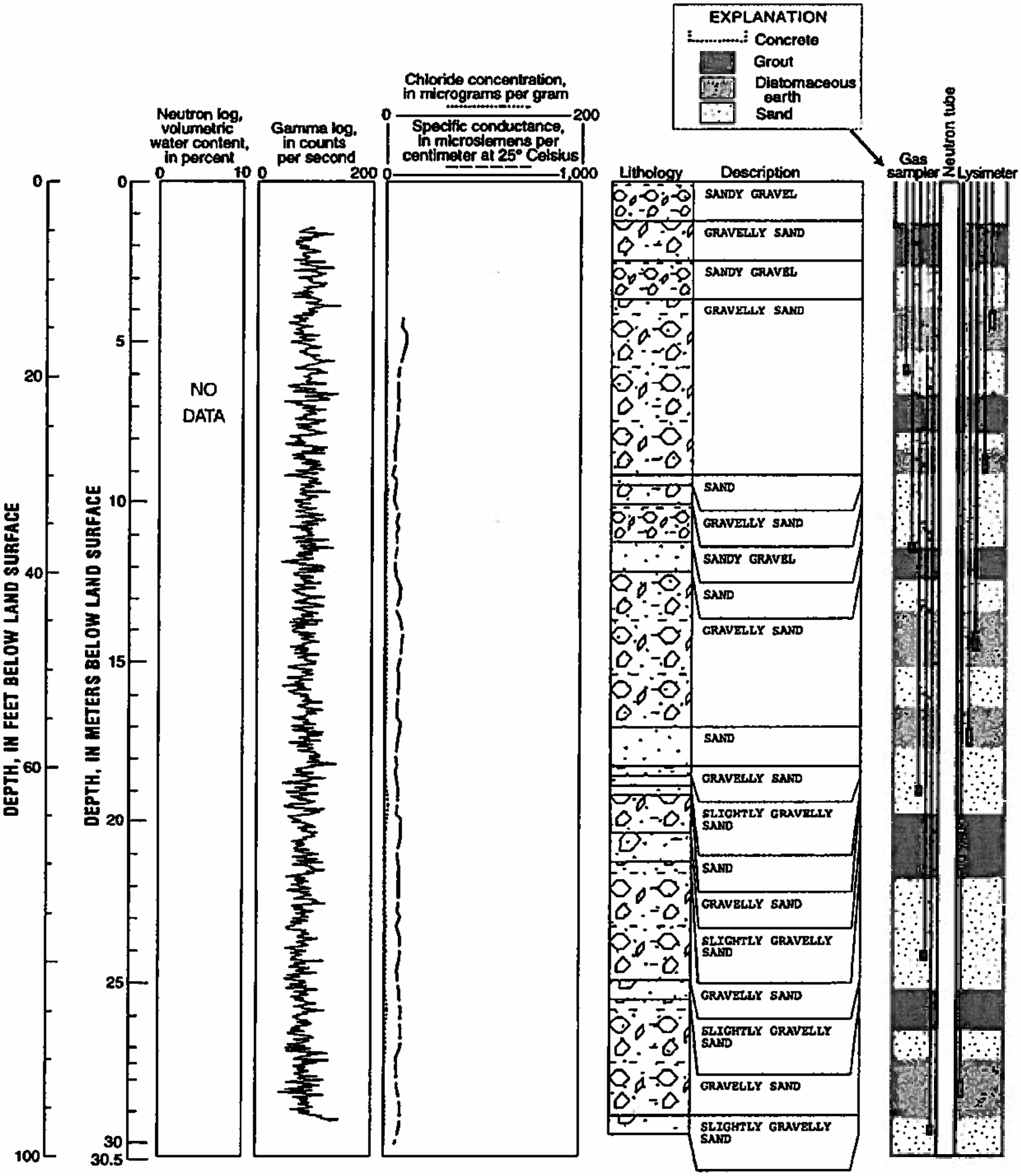
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 9. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site LOGW-3 near Victorville, San Bernardino County, California.



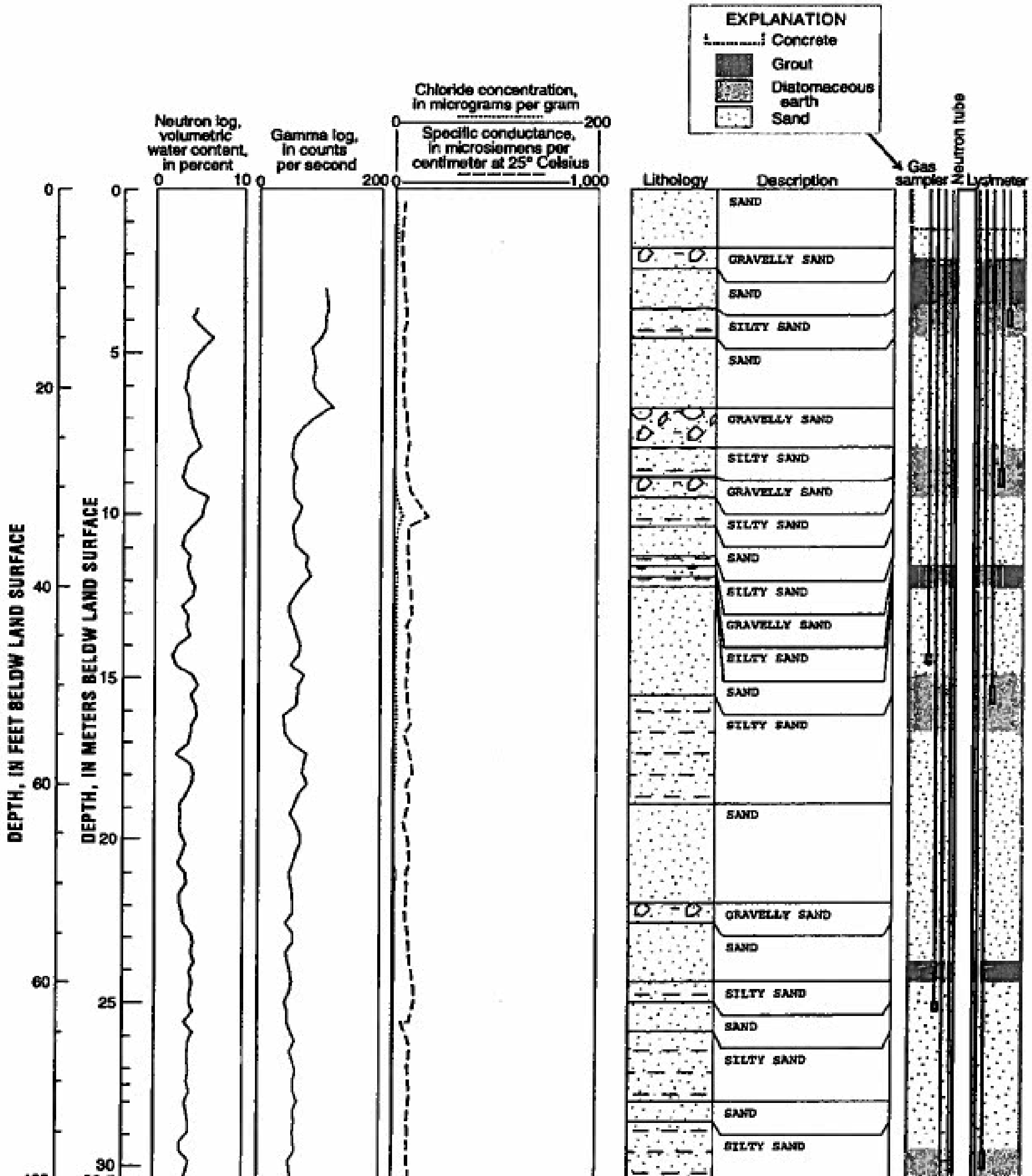
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 10. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site OGF near Victorville, San Bernardino County, California.



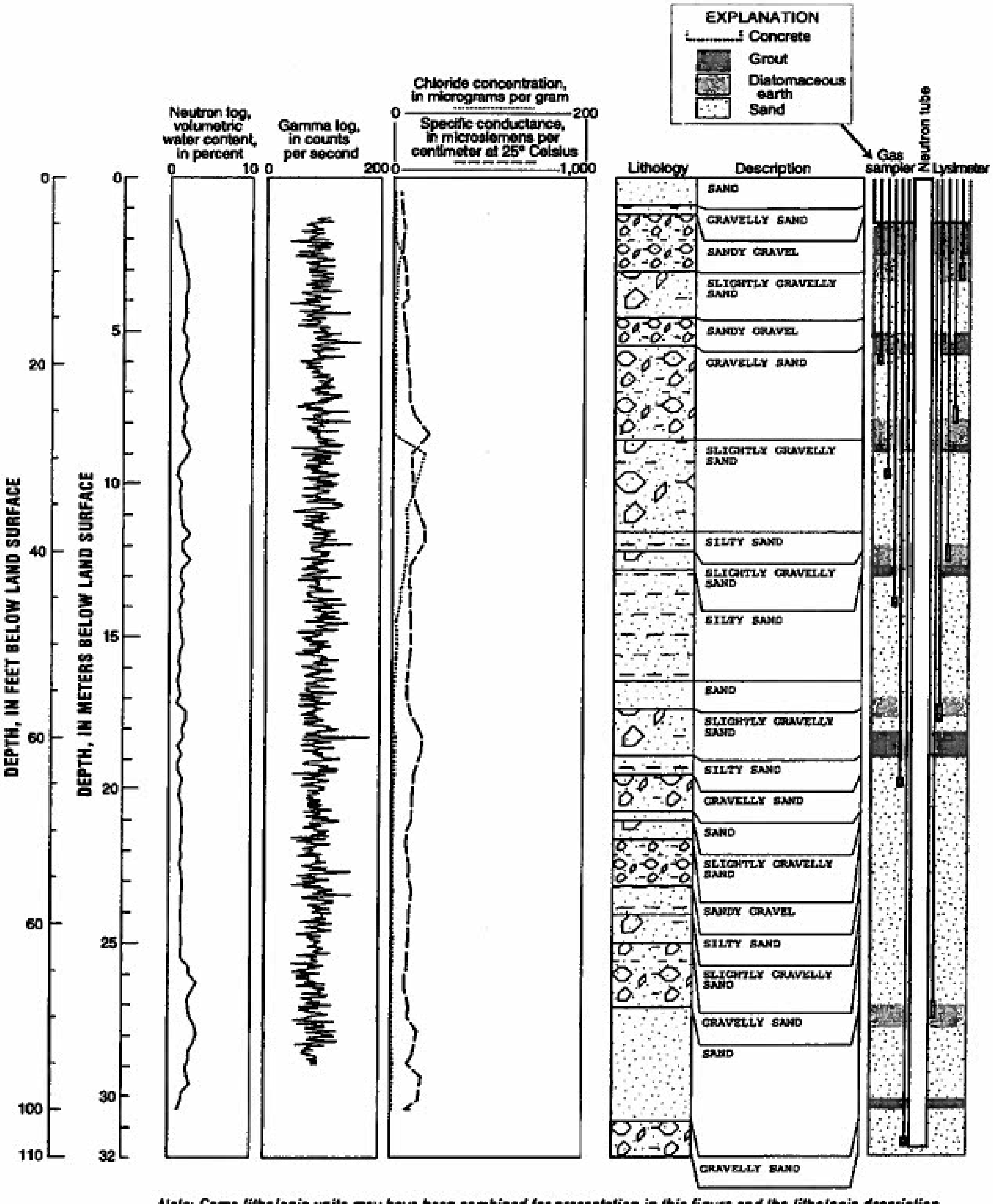
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 11. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site USCW near Victorville, San Bernardino County, California.



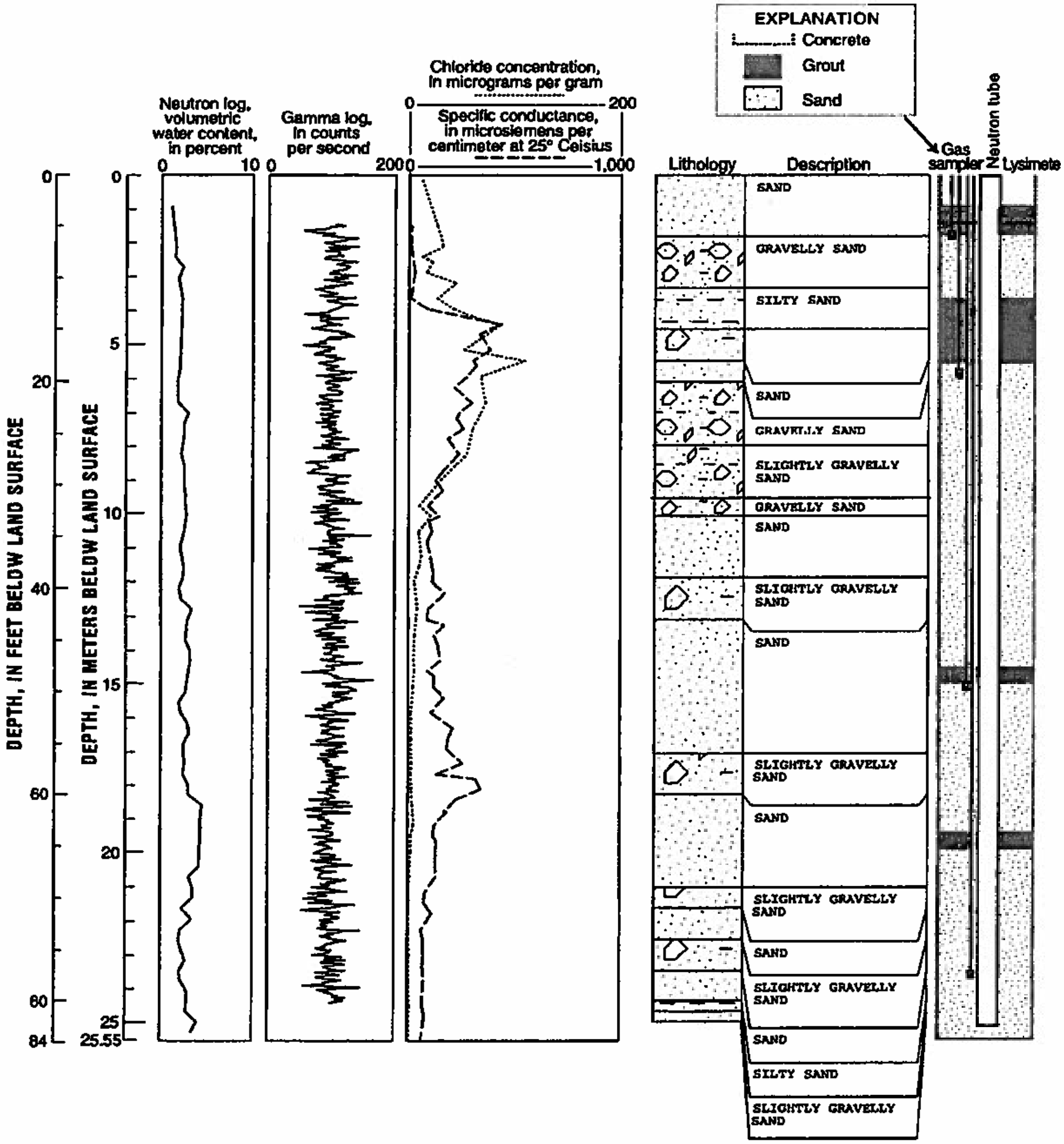
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table. Total depth 660 feet. Drilling data and instrumentation deeper than 100 feet are not shown. Gamma log collected at 1 foot intervals.

Figures 12. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site MSCW near Victorville, San Bernardino County, California.



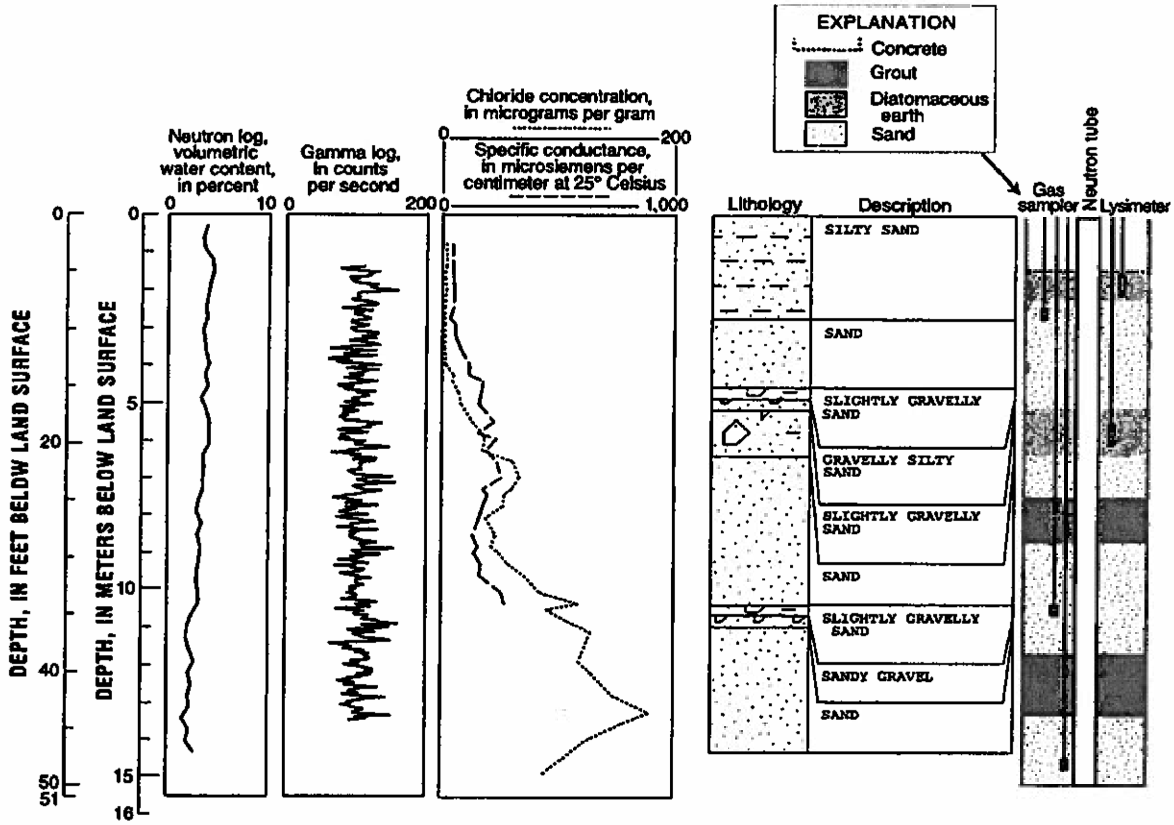
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 13. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site LSCW near Victorville, San Bernardino County, California.



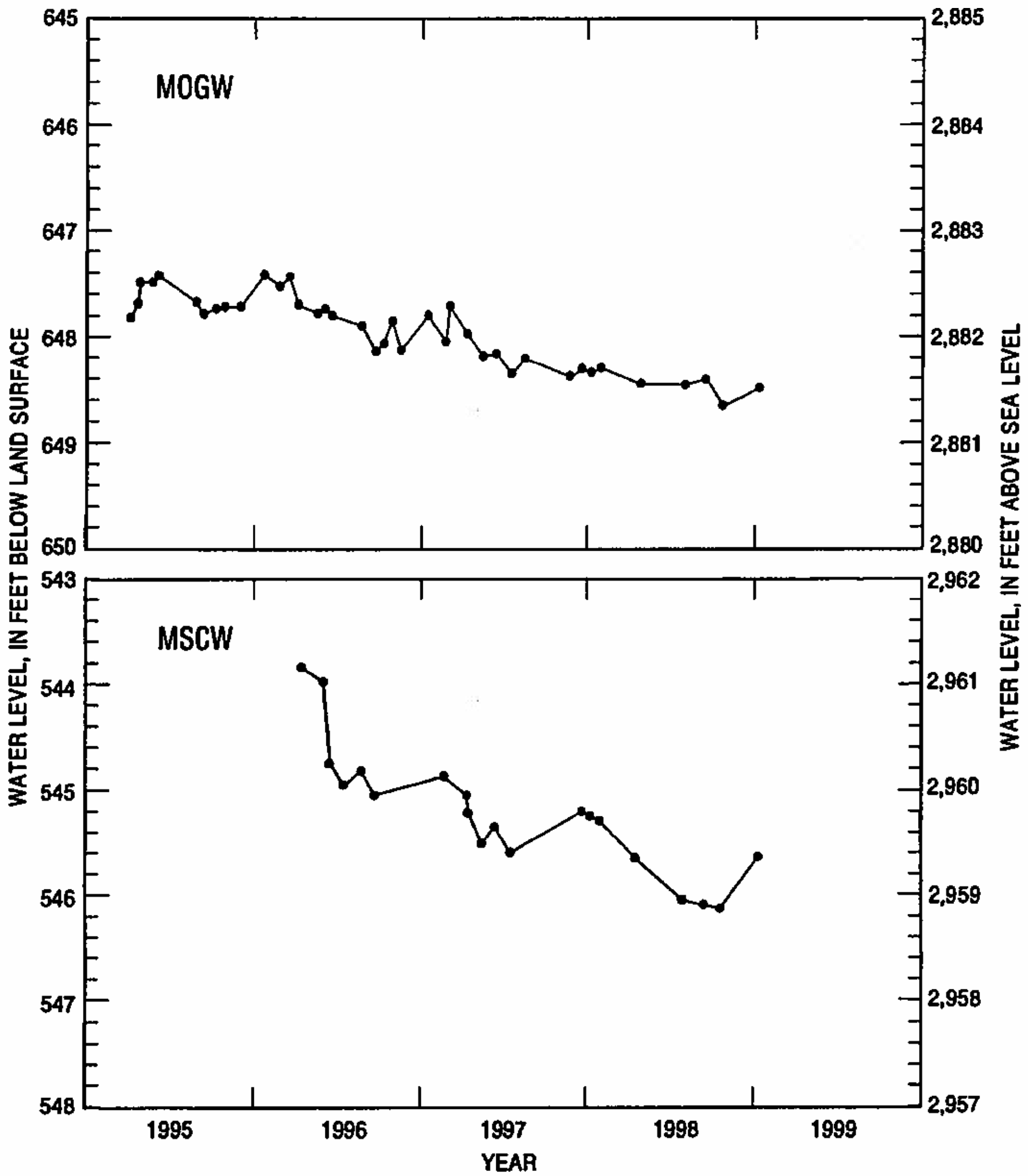
Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 14. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site SCF near Victorville, San Bernardino County, California.



Note: Some lithologic units may have been combined for presentation in this figure and the lithologic description may not correspond exactly to the description in the lithologic log shown in table.

Figures 15. Neutron log, gamma log, chemical data, lithology, and instrumentation for unsaturated-zone monitoring site SUMMIT near Victorville, San Bernardino County, California.



Figures 16. Water-level hydrographs for 4N/5W-21H1 (MOGW) and 5N/7W-28L1 (MSCW) near Victorville, San Bernardino County, California.

TABLES 2–24

Table 2. Lithologic log for unsaturated-zone monitoring site UOGW near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,225 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, December 5–8, 1994. Total depth drilled 104.5 ft. Construction data and instrumentation given in table 1 and figure 5. ft, foot]

Depth (ft)		Description
From	To	
0	2	Sand, medium to coarse, with some fine to very coarse sand and occasional granule-sized gravel; poorly sorted; subangular to rounded; rock fragments, schist; brown (7.5YR 5/4)
2	4	Clayey sand, fine to medium, with some very fine sand, coarse to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to rounded; schist; brown (7.5YR 5/4)
4	6	Sand, medium to coarse, with some fine to very coarse sand and granule- to small pebble-sized gravel, minor clay; poorly sorted; subangular to subrounded; schist; brown (7.5YR 5/4)
6	7.5	Slightly gravelly sand, medium to coarse, with some very coarse sand, granule- to large pebble-sized gravel, and minor very fine to fine sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
7.5	10.5	Slightly gravelly sand, fine to medium, with some coarse to very coarse sand, granule- to medium pebble-sized gravel, and minor very fine sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
10.5	11.5	Sand, fine to medium, with some coarse to very coarse sand and minor granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
11.5	12.5	Sand, fine to coarse, with some very coarse sand, minor very fine sand, and granule-to small pebble-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
12.5	17	Slightly gravelly sand, fine to coarse, with some very coarse sand, and granule- to small pebble-sized gravel, and minor very fine sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
17	18	Sand, fine to coarse, with some minor very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
18	19	Sand, fine to coarse, with minor very coarse sand and granule-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
19	22	Gravelly sand, medium to coarse, with some fine and minor very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
22	23	Gravelly sand, medium to coarse, and granule- to large pebble-sized gravel with minor fine and very coarse sand; poorly sorted; subangular to rounded; brown (7.5YR 5/4)
23	24	Sand, medium to coarse, with some fine and very coarse sand and minor granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; brown (7.5YR 5/4)
24	27	Sand, medium to coarse, with some fine and minor very coarse sand, and granule-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
27	28	Sand, medium to coarse, with some fine and minor very coarse sand to small pebble-sized gravel; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
28	32	Gravelly sand, medium to coarse, granule- to medium pebble-sized gravel, and minor fine and very coarse sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)

Table 2. Lithologic log for unsaturated-zone monitoring site UOGW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
32	33	Gravelly sand, fine to coarse, granule- to medium pebble-sized gravel with minor very coarse sand; poorly sorted; subangular to rounded; brown (7.5YR 5/4)
33	35.5	Sand, coarse, with some fine to medium and minor very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
35.5	36.5	Sand, medium to coarse, with some very coarse and minor fine sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
36.5	37.5	Sand, fine to medium, with some minor very fine and coarse to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
37.5	40.5	Sand, fine to medium, with some coarse, minor very fine and very coarse sand, and occasional granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
40.5	41.5	Slightly gravelly sand, fine to medium, with some granule- to large pebble-sized gravel, coarse and minor very coarse sand; poorly sorted; subangular to rounded; dark brown (7.5YR 3/2)
41.5	42.5	Slightly gravelly sand, fine to medium, with some coarse sand and granule- to medium pebble-sized gravel, and minor very coarse sand; poorly sorted; angular to subrounded; dark brown (7.5YR 3/2)
42.5	45.5	Slightly gravelly sand, fine to coarse, with some granule- to large pebble-sized gravel, and minor very coarse sand; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
45.5	46.5	Sand, fine to medium, with some very fine, some coarse, and minor very coarse sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
46.5	50.5	Gravelly sand, medium to coarse, with granule to medium pebble-sized gravel; minor fine and very coarse sand; poorly sorted; subangular to subrounded; dark brown (7.5YR 3/2)
50.5	51.5	Sand, very fine to fine, with some silt, minor medium to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; angular to rounded; sand is made of schist; gray (10YR 5/1)
51.5	57	Slightly gravelly sand, very fine to medium, with some minor coarse to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; grayish brown (10YR 5/2)
57	58	Slightly gravelly sand, very fine to medium, with minor coarse to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
58	60	Slightly gravelly sand, fine to coarse, with some very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
60	61	Gravelly sand, fine to coarse, granule- to medium pebble-sized gravel, with some very fine and very coarse sand; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
61	64.5	Gravelly sand, fine to medium, with granule- to large pebble-sized gravel, minor very fine and coarse to very coarse sand; poorly sorted; subangular to rounded; grayish brown (10YR 5/2)
64.5	66	Sand, fine to medium, with some coarse sand, minor very fine and very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)

Table 2. Lithologic log for unsaturated-zone monitoring site UOGW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
66	73	Gravelly sand, fine to medium, and granule- to large pebble-sized gravel with some very fine and coarse to very coarse sand; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
73	75	Slightly gravelly sand, very fine to fine, with minor granule- to small pebble-sized gravel, some medium to very coarse sand; poorly sorted; angular to subrounded; grayish brown (10YR 5/2)
75	78	Gravelly sand, very fine to fine, and granule- to medium pebble-sized gravel, minor medium to very coarse sand; poorly sorted; angular to subrounded; grayish brown (10YR 5/2)
78	80	Sand, very fine to fine, with minor medium to coarse sand, occasional very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
80	82	Slightly gravelly sand, very fine to medium, with some granule- to medium pebble- sized gravel, minor coarse to very coarse sand; poorly sorted; angular to subrounded; grayish brown (10YR 5/2)
82	86	Silty sand, very fine to fine, with trace to minor clay; poorly sorted; angular to subrounded; grayish brown (10YR 5/2)
86	88	Sand, very fine to fine, with some medium, minor coarse to very coarse sand, and occasional granule or small pebble-sized gravel; poorly sorted; angular to subrounded; grayish brown (10YR 5/2)
88	90	Sand, fine to medium, with some very fine and coarse to very coarse sand, minor granule- to small pebble-sized gravel; poorly sorted; angular to subrounded; brown (10YR 5/3)
90	91	Sand, very fine to fine, with minor medium to very coarse sand, occasional granule- to large pebble-sized gravel; moderately sorted; subangular to subrounded; brown (10YR 5/3)
91	92	Slightly gravelly sand, fine to medium, with minor granule- to medium pebble-sized gravel, minor coarse to very coarse sand; poorly sorted; subangular to subrounded; brown (10YR 5/3)
92	93	Gravelly sand, fine to medium, and granule- to medium pebble-sized gravel, with some coarse and very coarse sand; poorly sorted; angular to subrounded; brown (10YR 5/3)
93	95	Slightly gravelly sand, fine to medium, with minor granule- to medium pebble-sized gravel and coarse to very coarse sand; poorly sorted; subangular to subrounded; brown (10YR 5/3)
95	96	Gravelly sand, fine to medium, granule- to medium pebble-sized gravel with some coarse to very coarse sand; poorly sorted; subangular to subrounded; brown (10YR 5/3)
96	97	Slightly gravelly sand, fine to coarse, minor granule- to small pebble-sized gravel, some very coarse sand; poorly sorted; subangular to subrounded; brown (7.5YR 5/4)
97	101	Gravelly sand, fine to medium, granule- to large pebble-sized gravel with some minor coarse to very coarse sand; poorly sorted; angular to rounded; brown (7.5YR 5/4)
101	102	Sand, fine to medium, with some very fine, minor coarse sand, some occasional very coarse sand, and granule- to medium pebble-sized gravel; moderately sorted; subangular to subrounded; brown (7.5YR 5/4)
102	103	Sand, fine to medium, with some very fine, minor coarse to very coarse sand, and occasional granule- to medium pebble-sized gravel; moderately sorted; subangular to subrounded; brown (10YR 5/3)
103	104.5	Gravelly sand, fine to medium, granule- to large pebble-sized gravel, minor coarse to very coarse sand; poorly sorted; angular to subrounded; schist; grayish brown (2.5 YR 5/2)

Table 3. Lithologic log for unsaturated-zone monitoring site MOGW near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,530 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX to 200 feet and air rotary to 700 feet, January 1995. Total depth drilled 700 ft. Screened interval: 630–670 ft. Construction data and instrumentation given in table 1 and figure 6. ft, foot]

Depth (ft)		Description
From	To	
0	6	Clayey sand, fine to medium, with some coarse to very coarse sand; poorly sorted; angular to subrounded; reddish brown (5YR 4/4)
6	9	Clayey sand, very fine to fine, with some clay and medium to coarse sand; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
9	12	Sand, very fine to fine, with some medium to very coarse sand and silt; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
12	15.5	Sand, fine, with some very fine to very coarse sand and silt; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
15.5	17.5	Slightly gravelly sand, medium to very coarse, with some fine sand and some granule- to small pebble-sized gravel; very poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
17.5	21	Slightly gravelly sand, fine to medium, with some very fine to very coarse sand and granule- to small pebble-sized gravel; very poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
21	22	Slightly gravelly sand, fine to medium, with some clay, very fine and coarse to very coarse sand, and granule-sized gravel; very poorly sorted; subangular to rounded; yellowish brown (10YR 5/4)
22	23	Slightly clayey sand, fine to medium, very fine and coarse to very coarse sand, and occasional granule-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
23	24	Gravelly sand, fine to medium, with some silt, very fine and coarse to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
24	25	Slightly gravelly sand, fine to medium, with some silt, very fine and coarse to very coarse sand, and granule- to medium pebble-sized gravel; very poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
25	27	Sand, fine to medium, some very fine and coarse to very coarse sand, and occasional granule-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
27	29.5	Slightly gravelly sand, fine to coarse, with some silt, very fine and very coarse sand, and granule- to small pebble-sized gravel, and occasional medium to large pebble; very poorly sorted; subangular to rounded; yellowish brown (10YR 5/4)
29.5	32.5	Sand, coarse to very coarse, with some fine to medium sand; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
32.5	37.5	Sand, coarse to very coarse, with some fine to medium sand; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
37.5	43	Sand, coarse, with some medium to very coarse sand and occasional granule-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
43	49.5	Gravelly sand, medium to coarse, with some fine and very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)

Table 3. Lithologic log for unsaturated-zone monitoring site MOGW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
49.5	52.5	Clayey sand, fine to medium, with some coarse to very coarse sand; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
52.5	54.5	Clayey sand, medium to coarse, with some very coarse and granule-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
54.5	57.5	Slightly gravelly sand, medium with some clay, fine and coarse to very coarse sand, and granule- to large pebble-sized gravel; very poorly sorted; subangular to rounded; yellowish brown (10YR 5/4)
57.5	59.5	Sand, medium to coarse, with some fine and very coarse sand and granule- to small pebble-sized gravel; poorly sorted, subangular to subrounded; yellowish brown (10YR 5/4)
59.5	61.5	Gravelly sand, medium to coarse, with some fine and very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
61.5	67.5	Clayey sand, fine to medium, with some occasional coarse to very coarse sand; moderately sorted; subangular to subrounded; yellowish brown (10YR 5/4)
67.5	72.5	Gravelly sand, fine to medium, with some clay, coarse to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
72.5	75.5	Slightly gravelly sand, medium, with some fine and coarse to very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
75.5	78.5	Sand, fine to medium, with some very fine and coarse to very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
78.5	90	Gravelly sand, fine to medium, with some coarse to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; dark grayish brown (10YR 4/2)
90	100	Clayey sand, very fine to fine, with occasional medium to very coarse sand; moderately sorted; subangular to subrounded; yellowish brown (10YR 5/4)
100	105	Clayey sand, fine, with very fine to coarse sand; moderately sorted; subangular to subrounded; yellowish red (5YR 5/6)
105	115	Gravelly sand, fine to coarse, with some very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
115	125	Sand, fine to medium, with some very fine and coarse to very coarse sand and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark grayish brown (10YR 4/2)
125	155	Slightly gravelly sand, fine to coarse, with some very coarse sand and granule-sized gravel; poorly sorted; subangular to subrounded; schist; dark grayish brown (10YR 4/2)
155	160	Sand, fine to medium, with some very fine sand and silt; well-sorted; angular to subrounded; grayish brown (10YR 5/2)
160	183.5	Sand, fine to medium, with some silt, very fine and very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to rounded; very pale brown (10YR 7/4)

Table 3. Lithologic log for unsaturated-zone monitoring site MOGW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
183.5	198.5	Sand, fine to medium, with some silt, and very fine and coarse sand; moderately sorted; angular to subrounded; very pale brown (10YR 7/4)
198.5	219.5	Sand, very fine to fine, with some silt and medium to very coarse sand; poorly sorted; subangular to rounded; light brownish gray (10YR 6/2)
219.5	245	Silty sand, very fine to fine, with some medium to very coarse sand and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
245	265	Sand, fine, with some very fine and medium to very coarse sand and some slight clay and granule-sized pebbles; very poorly sorted; subangular to rounded; yellowish brown (10YR 5/4)
265	285	Slightly gravelly sand, fine to medium, with some silt, very fine and coarse to very coarse sand, and granule- to medium pebble-sized gravel; very poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
285	290	Sand, fine, with some medium, and occasional very fine and coarse to very coarse sand; moderately sorted; subangular to subrounded; yellowish brown (10YR 5/4)
290	295	Sand, very fine to fine, with some silt and medium to very coarse sand; poorly sorted; angular to subrounded; pale brown (10YR 6/3)
295	300	Sand, very fine to fine, with some silt and occasional medium sand; well-sorted; angular to subrounded; pale brown (10YR 6/3)
300	310	Slightly gravelly sand, fine, with some silt, very fine and medium to very coarse sand, and granule- to small pebble-sized gravel; very poorly sorted; angular to subrounded; pale brown (10YR 6/3)
310	340	Sand, very fine to fine, with some silt and medium sand; moderately sorted; angular to subrounded; yellowish brown (10YR 5/4)
340	350	Slightly gravelly sand, very fine to fine, with some silt, medium to very coarse sand, and granule-sized gravel; poorly sorted; subangular to subrounded; pale brown (10YR 6/3)
350	370	Sand, coarse, with some fine to medium and very coarse sand and occasional granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; light yellowish brown (10YR 6/4)
370	380	Silty sand, very fine to fine, with silt and some medium to very coarse sand and occasional granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; pale brown (10YR 6/3)
380	390	Gravelly sand, coarse to very coarse, with some fine to medium sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; pale brown (10YR 6/3)
390	400	Gravelly sand, fine, with some silt, very fine and medium to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; light brownish gray (10YR 6/2)
400	410	Gravelly sand, coarse, with some fine to medium and very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to rounded; yellowish brown (10YR 5/4)
410	430	Sandy gravel, granules to large pebbles, with some fine to very coarse sand; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)

Table 3. Lithologic log for unsaturated-zone monitoring site MOGW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
430	450	Gravelly sand, fine to medium, with some silt, very fine and coarse to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; grayish brown (10YR 5/2)
450	470	Silty sand, very fine to fine, with occasional medium to very coarse sand; poorly sorted; subangular to rounded; pale brown (10YR 6/3)
470	480	Silty sand, very fine to fine, with occasional medium to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; pale brown (10YR 6/3)
480	490	Sand, coarse to very coarse, with some silt to medium sand and occasional granule- to small pebble-sized gravel; poorly sorted; angular to subrounded; yellowish brown (10YR 5/6)
490	540	Gravelly sand, very fine to fine, with some silt, medium to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; light brownish gray (2.5Y 6/2)
540	560	Gravelly sand, medium to coarse, with some very fine to fine sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; olive gray (5Y 5/2)
560	590	Gravelly sand, fine to medium, with some silt, very fine and coarse to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; light brownish gray (10YR 6/2)
590	660	Gravelly sand, fine to coarse, with some silt, very fine and very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; light brownish gray (10YR 6/2)
660	670	Sand, very fine to fine, with some silt and occasional medium to very coarse sand; moderately sorted; subangular to subrounded; light brownish gray (10YR 6/2)
670	690	Slightly gravelly sand, medium to coarse, with some fine and very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; light brownish gray (10YR 6/2)
690	700	Gravelly sand, medium to coarse, with granule to large pebble-sized gravel and some fine sand; poorly sorted; angular to subrounded; light brownish gray (10YR 6/2)

Table 4. Lithologic log for unsaturated-zone monitoring site LOGW-1 near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,190 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, December 1–4, 1994. Total depth drilled 103 ft. Construction data and instrumentation given in table 1 and figure 7. ft, foot]

Depth (ft)		Description
From	To	
0	4	Sand, coarse, some medium; well-sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
4	11	Sand, medium, some fine to very coarse; moderately sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
11	16	Slightly gravelly sand, medium, with some fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
16	22	Gravelly sand, medium, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
22	24	Sand, medium to coarse, with some fine sand and occasional granule- to small pebble-sized gravel; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
24	25	Sand, medium to coarse, some fine; well-sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
25	26	Silty sand, fine to medium, with some coarse and clayey silt; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
26	27	Silty sand, very fine to medium, with some clay and silt; poorly sorted; subangular to subrounded; dusky yellowish brown (10YR 2/2)
27	30	Sand, medium, with some very fine to coarse; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
30	31	Sand, medium to coarse, with occasional fine and coarse sand; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
31	37	Sand, fine to medium, with some very fine and occasional coarse to very coarse sand; well-sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
37	38	Slightly gravelly sand, fine to medium, with some very fine and coarse to very coarse, and occasional granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
38	40	Sand, medium, with some fine and occasional coarse to very coarse; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
40	41	Slightly gravelly sand, medium to coarse, with some fine and very coarse, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
41	42	Gravelly sand, medium, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
42	46	Sand, fine to medium, with some coarse to very coarse, and occasional granule- to small pebble-sized gravel; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
46	47	Sand, medium, with some fine and occasional coarse to very coarse sand, and granule- to small pebble-sized gravel; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)

Table 4. Lithologic log for unsaturated-zone monitoring site LOGW-1 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
47	48	Slightly gravelly sand, fine to medium, with some coarse to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
48	50	Sand, fine to medium, with some very fine to very coarse; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
50	53	Sand, very fine to fine, with some medium; well-sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
53	55	Sandy clay, with some very fine to fine sand; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
55	60	Silty sand, fine to medium, some very fine sand and clayey silt; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
60	65	Sand, fine to medium, with some very fine to coarse; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
65	72	Sand, fine to medium, with some very fine; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
72	75	Silty sand, very fine to fine; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
75	76	Sand, very fine to fine, with occasional medium; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
76	77	Clayey sand, very fine, with some clay; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
77	80	Silty sand, fine, with some very fine sand and clayey silt; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
80	82	Sand, very fine to fine; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
82	85	Sand, very fine to fine; well-sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
85	86	Sand, fine, with some very fine to coarse sand and occasional medium pebble-sized gravel; poorly sorted; subangular to rounded; dark yellowish brown (10YR 4/2)
86	87	Sand, very fine to fine, with some medium to very coarse sand; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
87	89	Silty sand, very fine to fine, with some clayey silt; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
89	90	Sand, medium, some very fine to coarse; moderately sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
90	91	Sand, fine, some very fine to medium; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
91	92	Sand, very fine to fine; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)

Table 4. Lithologic log for unsaturated-zone monitoring site LOGW-1 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
92	95	Sand, very fine to fine, some silt; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
95	100	Sand, very fine to fine, well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
100	101	Silty sand, very fine, with clayey silt; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)
101	103	Sand, very fine to fine, with some medium; well-sorted; subangular to subrounded; dark yellowish brown (10YR 4/2)

Table 5. Lithologic log for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,205 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, January 10–11, 1997. Total depth drilled 104 ft. Construction data and instrumentation given in table 1 and figure 8. ft, foot]

Depth (ft)		Description
From	To	
0	4	Sandy silt, with some very fine and minor fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dark yellowish orange (10YR 6/6)
4	7	Silty sand, very fine, minor fine to very coarse sand and granule- to small pebble- sized gravel; poorly sorted; angular to subrounded; approximately 20 percent gray clay flakes; dark yellowish orange (10YR 6/6)
7	9	Silty sand, very fine, with minor fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to rounded; schist rock fragments; moderate yellowish brown (10YR 5/4)
9	11.5	No sample
11.5	13.5	Gravelly silty sand, very fine to fine, with medium to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to rounded; rock fragments; grayish orange (10YR 7/4)
13.5	14.5	Gravelly silty sand, very fine to fine, with medium to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to rounded; schist rock fragments; grayish orange (10YR 7/4)
14.5	15.5	Gravelly silty sand, very fine to medium, with some coarse to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist rock fragments; grayish orange (10YR 7/4)
15.5	17	Gravelly sand, fine to coarse, with granule- to medium pebble-sized gravel, some silt, and very fine and very coarse sand; poorly sorted; angular to rounded; schist and granite rock fragment mix; moderate yellowish brown (10YR 5/4)
17	19	Gravelly sand, fine to coarse, granule- to medium pebble-sized gravel with some silt, and very fine and very coarse sand; poorly sorted; angular to subrounded; schist and granite rock fragments; moderate yellowish brown (10YR 5/4)
19	20	Sandy gravel, granule- to large pebble-sized gravel, with some silt and very fine to very coarse sand; poorly sorted; angular to rounded; schist rock fragments; moderate yellowish brown (10YR 5/4)
20	21	Sandy gravel, granule- to large pebble-sized gravel, with some silt and very fine to very coarse sand; poorly sorted; angular to rounded; moderate yellowish brown (10YR 5/4)
21	22	Silty sand, very fine, with some minor fine to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
22	24	Gravelly silty sand, very fine to fine, with some granule- to medium pebble-sized gravel and medium to very coarse sand; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
24	25	Sandy silty gravel, granule- to large pebble-sized gravel, with some silt and minor very fine to very coarse sand; poorly sorted; angular to subrounded; rock fragments; grayish orange (10YR 7/4)
25	26	Silty sand, very fine, with some minor fine to very coarse sand; poorly sorted; subangular to subrounded; grayish orange (10YR 7/4)
26	27	Silty sand, very fine, with some minor fine to very coarse sand; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)

Table 5. Lithologic log for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
27	29	Sandy silt, very fine, with minor fine to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; grayish orange (10YR 7/4)
29	30	Slightly gravelly sandy silt, with very fine sand, some minor fine to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
30	31	Sandy silt, with some very fine to very coarse sand, and minor granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
31	32	Gravelly silt, with some granule- to medium pebble-sized gravel and very fine to very coarse sand; poorly sorted; angular to rounded; grayish orange (10YR 7/4)
32	34	Sandy silt, with some very fine to very coarse sand, and occasional granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
34	35	Silt, with minor very fine to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
35	36	Sandy silt, with very fine and minor fine to very coarse sand and occasional granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; grayish orange (10YR 7/4)
36	37	Sandy silt, with very fine to fine sand, and some medium to very coarse sand, and minor granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; grayish orange (10YR 7/4)
37	39	Silty sand, medium to very coarse, with some very fine to fine sand and minor granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
39	40	Sandy silt, with very fine, and some fine to very coarse sand and occasional granule- to small pebble-sized gravel; poorly sorted; angular to subrounded; grayish orange (10YR 7/4)
40	41	Sandy silt, with very fine and some fine to very coarse sand, and minor granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish gray (5Y 7/2)
41	42	Slightly gravelly sand, very fine to fine, with some granule- to medium pebble-sized gravel, some silt, and medium to very coarse sand; poorly sorted; subangular to rounded; grayish orange (10YR 7/4)
42	44	Silt, with minor very fine to very coarse sand and granule- to small pebble-sized gravel; moderately sorted; angular to subrounded; dusky yellow (5Y 6/4)
44	45	Silt, with minor very fine to very coarse sand and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; dusky yellow (5Y 6/4)
45	46	Silt, with occasional very fine sand to granule-sized gravel; moderately sorted; subangular to subrounded; dusky yellow (5Y 6/4)
46	47	Silt, with occasional very fine sand to granule-sized gravel; well-sorted; subangular to subrounded; dusky yellow (5Y 6/4)
47	51	Silt, with occasional very fine to very coarse sand; well-sorted; subangular to subrounded; grayish orange (10YR 7/4)

Table 5. Lithologic log for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
51	52	Sandy silt, with some very fine and occasional fine to coarse sand; well-sorted; subangular to subrounded; dark yellowish orange (10YR 6/6)
52	54	Sandy silt, with very fine and some fine to very coarse sand; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
54	55	Sandy silt, with some very fine to fine and occasional medium to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
55	56	Sandy silt, with some very fine to fine sand and occasional medium sand to small pebble-sized gravel; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
56	57	Sandy silt, with some very fine sand and occasional fine to very coarse sand; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
57	59	Sandy silt, with some very fine to fine sand and occasional medium to very coarse sand; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
59	60	Sandy silt, with very fine to fine sand and occasional medium to very coarse sand and granule-sized gravel; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
60	61	Silty sand, very fine, with minor fine to very coarse sand and occasional granule-sized gravel; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
61	62	Sandy silt, with very fine, minor fine to coarse, and occasional very coarse sand; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
62	66	Sandy silt, with very fine and minor fine to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
66	67	Sandy silt, with very fine and minor fine to coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
67	69	Sandy silt, with very fine and minor fine to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
69	70	Sandy silt, with very fine and minor fine to coarse with occasional very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
70	71	Silty sand, very fine, minor fine to coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
71	72	Silty sand, very fine, with some minor fine to medium and occasional coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
72	74	Sandy silt, very fine sand, with minor fine to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
74	75	Sandy silt, very fine sand with minor fine to coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)

Table 5. Lithologic log for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
75	76	Sandy silt, with very fine, minor fine to medium, and occasional coarse to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
76	77	Silt, with minor very fine to very coarse sand; well-sorted; subangular to subrounded; grayish orange (10YR 7/4)
77	81	Sandy silt, with very fine and minor fine to very coarse sand; moderately sorted; subangular to subrounded; grayish orange (10YR 7/4)
81	82	Slightly gravelly sand, fine to medium, with granule- to medium pebble-sized gravel, some silt, and very fine to very coarse sand; poorly sorted; angular to rounded; schist; pale yellowish brown (10YR 6/2)
82	84	Sandy silt, with very fine, minor fine to medium, and occasional coarse to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
84	85	Sandy silt, with very fine, and minor fine to very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)
85	86	Sandy silt, with very fine and some fine to very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to rounded; schist; pale yellowish brown (10YR 6/2)
86	87	Silty sand, very fine to fine, with some minor medium to very coarse sand and granule-sized gravel; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
87	89	Sandy silt, very fine, with minor fine to medium, occasional coarse to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; schist; pale yellowish brown (10YR 6/2)
89	90	Slightly gravelly sandy silt, with very fine and minor fine to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
90	91	Sandy silt, with very fine, and some fine to very coarse sand, and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
91	92	Sandy silt, with very fine to fine, and minor medium to very coarse sand; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
92	94	Sandy silt, with very fine and some fine to very coarse sand and occasional granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
94	95	Silt, with minor very fine and occasional medium to very coarse sand; well-sorted; subangular to subrounded; schist; pale yellowish brown (10YR 6/2)
95	96	Sandy silt, with very fine and minor fine sand; well-sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)
96	97	Silt, with minor very fine sand; well-sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)
97	99	Sandy silt, with very fine, minor fine, and occasional medium to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)

Table 5. Lithologic log for unsaturated-zone monitoring site LOGW-2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
99	100	Sandy silt, with very fine, minor fine to medium sand, and occasional coarse sand; well-sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)
100	101	Silty sand, very fine, with fine and minor medium to coarse; well-sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)
101	102	Silty sand, very fine, some fine to medium; well-sorted; subangular to subrounded; pale yellowish brown (10YR 6/2)

Table 6. Lithologic log for unsaturated-zone monitoring site LOGW-3 near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,195 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, January 12, 1997. Total depth drilled 57 ft. Construction data and instrumentation given in table 1 and figure 9. ft, foot]

Depth (ft)		Description
From	To	
0	5	Silty sand, very fine to fine, with some medium to very coarse sand, granule to medium to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
5	10	Sand, fine to medium, with some very fine, coarse to very coarse sand, and granule- to medium pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
10	15	Sand, fine, with some very fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; yellowish brown (10YR 5/4)
15	17	Sand, fine to medium, with some very fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; schist rock fragments; yellowish brown (10YR 5/4)
17	19	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
19	21	Slightly gravelly sand, fine to medium, with some very fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; pale yellowish brown (10YR 6/2)
21	23	Gravelly sand, fine to medium, with some silt, very fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; pale yellowish brown (10YR 6/2)
23	25	Slightly gravelly sand, fine, with some silt, very fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; pale yellowish brown (10YR 6/2)
25	27	Silty sand, very fine to fine, with some medium to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
27	29	Silty sand, very fine to fine, with some medium to very coarse sand and occasional granule- to small pebble-sized gravel; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
29	32	Silty sand, very fine to fine, with some medium to very coarse sand and granule-sized gravel; moderately sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)
32	37	Slightly gravelly sand, fine to coarse, with some silt, very fine to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; yellowish brown (10YR 5/4)
37	47	Slightly gravelly sand, fine to medium, with some silt, very fine to very coarse sand, and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
47	57	Sandy silt, with some very fine, minor fine to very coarse sand, and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; moderate yellowish brown (10YR 5/4)

Table 7. Lithologic log for unsaturated-zone monitoring site OGF near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,225 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, December 5–8, 1994. Total depth drilled 103 ft. Construction data and instrumentation given in table 1 and figure 10. ft, foot]

Depth (ft)		Description
From	To	
0	2	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
2	9	Sand, very fine to very coarse, skewed toward medium, minor silt; moderately well sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
9	10	Sand, very fine to very coarse, skewed toward fine, some silt; moderately well sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
10	11	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
11	15	Silty sand, very fine to very coarse, skewed toward fine; moderately well sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
15	16	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
16	17	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
17	19	Sand, very fine to very coarse, with some gravel granules, minor silt; poorly sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
19	20	Sand, very fine to very coarse, with minor gravel granules, minor silt; moderately sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
20	22	Sand, very fine to very coarse, with some gravel granules and pebbles, minor silt; poorly sorted; even size distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
22	24	Sand, very fine to very coarse, skewed toward fine, with some silt; well-sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
24	26	Sand, very fine to coarse, skewed toward fine, with some silt; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
26	27	Sand, very fine to coarse, skewed toward fine; moderately well sorted; angular biotite to subrounded quartz; dark yellowish brown (10YR 4/2)
27	29	Sand, very fine to very coarse, with minor gravel granules; poorly sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
29	32	Sand, fine to very coarse, with minor gravel granules; poorly sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
32	33	Sand, very fine to very coarse, skewed toward fine, some silt; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)

Table 7. Lithologic log for unsaturated-zone monitoring site OGF near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
33	34	Sand, fine to very coarse, with some gravel granules and pebbles; poorly sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
34	35	Sand, very fine to medium, skewed toward fine, some silt, trace gravel granules; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
35	36	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
36	39	Sand, very fine to very coarse, some silt, some gravel granules; poorly sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
39	40	Silty sand, very fine to very coarse, skewed toward fine, with trace gravel granules; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
40	41	Sand, very fine to very coarse, skewed toward medium; moderately well sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
41	42	Sand, fine to very coarse, with some gravel granules and pebbles; poorly sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
42	44	Sand, fine to very coarse, with minor gravel granules; poorly sorted; even distribution; angular to subrounded; moderate yellowish brown (10YR 5/4)
44	45	Sand, fine to very coarse, skewed toward medium; moderately well sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
45	46	Sand, fine to very coarse, skewed toward coarse, with some gravel granules; moderately sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
46	47	Sandy clay, very fine to very coarse, with some gravel granules and pebbles; poorly sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
47	49	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
49	50	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
50	51	Clayey sand, very fine to medium, skewed toward fine, some silt; well-sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
51	52	Silty sand, very fine to medium, skewed toward fine, with minor to trace clay; well-sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
52	54	Silty sand, very fine to coarse, skewed toward fine; moderately well sorted; angular to rounded; light olive brown (5YR 5/6)
54	56	Silty sand, very fine to very coarse, skewed toward fine; moderately well sorted; angular to subrounded; light olive brown (5Y 5/6)

Table 7. Lithologic log for unsaturated-zone monitoring site OGF near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
56	57	Sand, very fine to coarse, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
57	61	Sand, fine to very coarse, skewed toward coarse, with some gravel granules; moderately sorted; angular to subrounded; light olive brown (5Y 5/6)
61	62	Sand, very fine to very coarse, skewed toward fine, with some silt; moderately sorted; angular to subrounded; moderate olive brown (5Y 4/4)
62	63	Silty sand, very fine to medium, skewed toward fine; very well sorted; angular to subrounded; moderate olive brown (5Y 5/4)
63	66	Sand, fine to very coarse; poorly sorted; even distribution; angular to subrounded; light olive brown (5Y 5/6)
66	67	Sand, fine to very coarse, skewed toward medium. with some gravel granules and pebbles; moderately sorted; angular to rounded; moderate olive brown (5Y 4/4)
67	68	Sand, fine to very coarse, skewed toward medium; moderately well sorted; angular to subrounded; moderate olive brown (5Y 4/4)
68	70	Sand, fine to very coarse, skewed toward medium, with trace gravel granules; moderately well sorted; moderate olive brown (5Y 4/4)
70	71	Sand, fine to very coarse, with some gravel granules; poorly sorted; even distribution; angular to subrounded; moderate olive brown (5Y 4/4)
71	73	Sand, fine to very coarse, skewed toward medium; moderately well sorted; angular to subrounded; moderate olive brown (5Y 4/4)
73	74	Sand, fine to very coarse, skewed toward medium, with trace of gravel, pebbles; moderately sorted; angular to subrounded; moderate olive brown (5Y 4/4)
74	75	Sand, fine to very coarse, skewed toward coarse, with some gravel granules; moderately sorted; angular to subrounded; moderate olive brown (5Y 4/4)
75	77	Sand, fine to very coarse, skewed toward medium; moderately sorted; angular to subrounded; light olive brown (5Y 5/6)
77	80	Sand, very fine to coarse, skewed toward fine, with minor silt; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
80	81	Sand, very fine to very coarse, skewed toward fine, with some silt; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
81	82	Silty sand, very fine to coarse, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
82	84	Sand, very fine to very coarse, with minor silt; poorly sorted; angular to subrounded; moderate olive brown (5Y 4/4)
84	85	Sand, very fine to very coarse, skewed toward fine, minor silt; moderately well sorted; angular to subrounded; moderate olive brown (5Y 4/4)

Table 7. Lithologic log for unsaturated-zone monitoring site OGF near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
85	87	Silty sand, very fine to coarse, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
87	89	Sand, very fine to coarse, skewed toward medium; moderately sorted; angular to subrounded; moderate yellowish brown (10YR 5/4)
89	91	Silty sand, very fine to coarse, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
91	96	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)
96	103	Sand, very fine to coarse, skewed toward fine; well-sorted; angular to subrounded; moderate olive brown (5Y 4/4)

Table 8. Lithologic log for unsaturated-zone monitoring site USCW near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 4,180 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX, December 5–13, 1995. Total depth drilled 101 ft. Construction data and instrumentation given in table 1 and figure 11. ft, foot]

Depth (ft)		Description
From	To	
0	2	Sandy gravel, granule to large pebbles, with some fine to very coarse sand; poorly sorted; subangular to rounded; schist, quartz, micas; dark greenish gray (5G 4/1)
2	4	Sandy gravel, granule- to large pebble-sized gravel with some fine to very coarse sand; poorly sorted; angular to rounded; schist, quartz, micas; greenish black (5G 2/1)
4	6	Gravelly sand, coarse, with some fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; angular to subrounded; schist, quartz, micas; greenish black (5G 2/1)
6	8	Gravelly sand, coarse, with some fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; schist; greenish black (5G 2/1)
8	9	Sandy gravel, granule- to large pebble-sized, with some fine to very coarse sand; poorly sorted; angular to subrounded; schist; greenish black (5G 2/1)
9	10	Sandy gravel, granule- to large pebble-sized, with some medium to very coarse sand; poorly sorted; angular to rounded; schist; greenish black (5G 2/1)
10	11	Sandy gravel, granule- to medium pebble-sized, with some fine to very coarse sand; poorly sorted; angular to subrounded; schist; greenish black (5G 2/1)
11	12	Sandy gravel, granule- to medium pebble-sized, and some coarse to very coarse sand; poorly sorted; angular to subrounded; schist; greenish black (5G 2/1)
12	13	No sample collected
13	15	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; schist; dark yellowish brown (10YR 4/2)
15	16	Gravelly sand, medium to very coarse, with some fine sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; schist: dark yellowish brown (10YR 4/2)
16	17	Gravelly sand, fine to coarse, with some very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; schist; dark yellowish brown (10YR 4/2)
17	18	Gravelly sand, fine to coarse, with some very coarse sand and granule- to large pebble-sized gravel; poorly sorted; angular to subrounded; schist: dark yellowish brown (10YR 4/2)
18	20	Gravelly sand, fine to coarse, with some very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; dark yellowish brown (10YR 4/2)
20	21	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; schist; dark yellowish brown (10YR 4/2)
21	22	Slightly gravelly sand, medium to coarse, with some fine to very coarse sand and granule-sized gravel; moderately sorted; subangular to subrounded; schist; dusky yellowish brown (10YR 2/2)
22	23	Gravelly sand, medium to very coarse, with some granule- to medium pebble-sized gravel; poorly sorted; angular to rounded; schist; dusky yellowish brown (10YR 2/2)

Table 8. Lithologic log for unsaturated-zone monitoring site USCW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
23	25	Gravelly sand, very coarse, with some granule- to medium pebble-sized gravel; moderately sorted; angular to rounded; olive gray (5Y 3/2)
25	26	Slightly gravelly sand, fine to coarse, with some very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
26	27	Gravelly sand, fine to coarse, with some very coarse sand and granule- to small pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
27	28	Gravelly sand, coarse to very coarse, with some medium sand and granule- to small pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
28	30	Gravelly sand, fine to coarse, with some very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
30	31	Sand, fine to medium, with some very fine to coarse sand, occasional very coarse sand, and granule- to large pebble-sized gravel; moderately sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
31	32	Gravelly sand, fine to coarse, with some very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
32	33	Gravelly sand, coarse to very coarse, with some medium sand and granule- to small pebble-sized gravel; moderately sorted; angular to subrounded; schist; olive gray (5Y 3/2)
33	35	Sandy gravel, granule- to medium pebble-sized, with some fine to very coarse sand; poorly sorted; angular to subrounded; schist; grayish olive green (5GY 3/2)
35	36	Sandy gravel, granule- to large pebble-sized, with some coarse to very coarse sand; poorly sorted; subangular to rounded; grayish olive green (5GY 3/2)
36	37	Gravelly sand, coarse to very coarse, with some medium sand and granule- to large pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
37	38	Sand, medium to coarse, some fine; well-sorted; angular to subrounded; schist; olive gray (5Y 3/2)
38	40	Sand, medium to coarse, with some fine to very coarse sand; moderately sorted; angular to subrounded; schist; olive gray (5Y 3/2)
40	41	Gravelly sand, coarse to very coarse, with some fine to medium sand and granule-sized gravel; moderately sorted; angular to subrounded; schist; olive gray (5Y 3/2)
41	42	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; olive gray (5Y 3/2)
42	43	Gravelly sand, fine to coarse, with some very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; olive gray (5Y 3/2)
43	45	Gravelly sand, medium, with some fine to very coarse sand and granule- to medium pebble-sized gravel, poorly sorted; angular to subrounded; schist; olive gray (5Y 3/2)

Table 8. Lithologic log for unsaturated-zone monitoring site USCW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
45	46	Gravelly sand, medium, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; schist; olive gray (5Y 3/2)
46	47	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; schist; olive gray (5Y 3/2)
47	48	Gravelly sand, medium, with some fine to coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
48	50	Gravelly muddy sand, coarse, with some medium to very coarse sand and granule- to large pebble-sized gravel mixed with silty clayey mud; very poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
50	51	Gravelly sand, coarse to very coarse, with some granule- to medium pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
51	52	Slightly gravelly sand, coarse, with some medium to very coarse sand and occasional granule-sized gravel; moderately sorted; angular to subrounded; olive gray (5Y 3/2)
52	53	Gravelly sand, medium to coarse, with some fine to very coarse sand and some granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; schist; olive gray (5Y 3/2)
53	56	Gravelly sand, medium to coarse, with some fine to very coarse sand and some granule- to medium pebble-sized gravel; poorly sorted; schist; olive gray (5Y 3/2)
56	58	Sand, medium to coarse, with some fine sand and occasional granule- to small pebble-sized gravel; moderately sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
58	60	Sand, medium to coarse, some fine sand; well-sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
60	61	Gravelly sand, fine to coarse, with some granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
61	62	Slightly gravelly sand, medium, with some fine to coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
62	63	Sand, coarse, with some medium sand and occasional small pebble-sized gravel; well-sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
63	65	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
65	66	Gravelly sand, coarse to very coarse, with some fine to medium sand and granule- to small pebble-sized gravel; poorly sorted; angular to subrounded; schist; olive gray (5Y 3/2)
66	67	Gravelly sand, coarse to very coarse, with some fine to medium sand and granule- to small pebble-sized gravel; poorly sorted; angular to rounded; schist; olive gray (5Y 3/2)
67	68	Slightly gravelly sand, coarse, with some medium to very coarse sand and occasional granule- to small pebble-sized gravel; moderately sorted; angular to subrounded; schist; olive gray (5Y 3/2)

Table 8. Lithologic log for unsaturated-zone monitoring site USCW near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
68	70	Slightly gravelly sand, medium, with some fine to very coarse sand and occasional granule- to small pebble-sized gravel; moderately sorted; subangular to rounded; schist; olive gray (5Y 3/2)
70	71	Gravelly sand, coarse to very coarse, with some fine to medium sand and granule- to large pebble-sized gravel; poorly sorted; schist; olive gray (5Y 3/2)
71	72	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
72	73	Gravelly sand, medium to coarse, with some fine to very coarse sand and some granule- to medium pebble-sized gravel; poorly sorted; subangular to rounded; schist; olive gray (5Y 3/2)
73	76	Gravelly sand, fine to coarse, with some very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; olive gray (5Y 3/2)
76	77	Gravelly sand, fine to coarse, with some very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; subangular to rounded; olive gray (5Y 3/2)
77	78	Sandy gravel, granule- to medium pebble-sized, with some medium to coarse sand; poorly sorted; subangular to rounded; olive gray (5Y 3/2)
78	80	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to rounded; olive gray (5Y 3/2)
80	82	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; angular to rounded; olive gray (5Y 3/2)
82	84	Slightly gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to medium pebble-sized gravel; poorly sorted; angular to subrounded; olive gray (5Y 3/2)
84	86	Gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to very large pebble-sized gravel; poorly sorted; subangular to rounded; olive gray (5Y 3/2)
86	88	Sandy gravel, granule- to small pebble-sized, with some medium pebble-sized gravel and fine to very coarse sand; poorly sorted; subangular to rounded; olive gray (5Y 3/2)
88	90	Gravelly sand, medium to very coarse, with some granule- to medium pebble-sized gravel; poorly sorted; angular to rounded; olive gray (5Y 3/2)
90	92	Gravelly sand, medium to very coarse, with some granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; olive gray (5Y 3/2)
92	94	Gravelly sand, medium to very coarse, with some granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; olive gray (5Y 3/2)
94	96	Gravelly sand, fine to medium, with some coarse to very coarse sand and granule- to large pebble-sized gravel; poorly sorted; subangular to subrounded; schist; olive gray (5Y 3/2)
96	98	Slightly gravelly sand, medium to coarse, with some fine to very coarse sand and granule- to small pebble-sized gravel; poorly sorted; subangular to subrounded; schist; olive gray (5Y 3/2)

Table 9. Lithologic log for unsaturated-zone monitoring site MSCW-1 and 2 near Victorville, San Bernardino County, California

[Location shown in figure 1. Altitude of land surface, approximately 3,505 ft. Depth is in feet below land surface. Soil and rock color notation from Munsell Color (1994). Drilled by U.S. Geological Survey using ODEX to 400 ft, air rotary to 660 ft; March–April 1996. Total depth drilled 660 ft. Screened interval: 606–626 ft. Construction data and instrumentation given in table 1 and figure 12. ft, foot]

Depth (ft)		Description
From	To	
0	2	Sand, very fine to very coarse, skewed toward fine, some gravel granules and minor pebbles; moderately sorted; angular to subangular; dusky green (5Y 3/2)
2	6	Sand, very fine to very coarse, skewed toward medium; moderately sorted; angular to subangular; grayish green (5G 4/2)
6	8	Gravelly sand, very fine to very coarse, abundant gravel granules and pebbles; poorly sorted; angular to subangular; grayish green (5G 4/2)
8	9	Sand, some gravel granules, minor gravel pebbles; poorly sorted; angular to subangular; grayish green (5G 4/2)
9	12	Sand, very fine to very coarse, skewed toward fine, trace gravel granules and pebbles; moderately sorted; angular to subangular; grayish green (5G 4/2)
12	14	Silty sand, very fine to very coarse, skewed toward fine, minor gravel granules; moderately sorted; angular to subrounded; grayish olive (10Y 4/2)
14	15	Sand, very fine to very coarse, skewed toward medium, minor gravel granules; moderately sorted; angular to subrounded; dusky green (5G 3/2)
15	16	Sand, very fine to very coarse, skewed toward coarse, minor gravel granules and pebbles; moderately sorted; angular to subangular; dusky green (5G 3/2)
16	22	Sand, very fine to very coarse, minor gravel granules; poorly sorted; angular to subangular; grayish green (5G 4/2)
22	26	Gravelly sand, very fine to very coarse; poorly sorted; angular to subangular; grayish green (5G 4/2)
26	27	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subrounded; dusky yellow green (5GY 5/2)
27	29	Sand, very fine to very coarse, skewed toward medium, minor gravel granules; moderately sorted; angular to subangular; grayish green (5G 4/2)
29	31	Gravelly sand, very fine to very coarse; poorly sorted; angular to subangular; grayish green (5GY 5/2
31	34	Silty sand, very fine to very coarse, skewed toward fine, minor gravel granules and pebbles; well-sorted; angular to subangular; dusky yellow green (5G 5/2)
34	35	Sand, very fine to very coarse, some gravel granules and minor pebbles; poorly sorted; angular to subangular; grayish green (5G 4/2)
35	36	Sand, some silt, some gravel granules; poorly sorted; angular to subangular; grayish green (5G 4/2)
36	37	Sand, very fine to very coarse, some gravel granules and pebbles; poorly sorted; angular to subangular; grayish green (5G 4/2)
37	38	Silty sand, very fine to medium, skewed toward fine; well-sorted; angular to subangular; dusky yellow green (5GY 5/2)

Table 9. Lithologic log for unsaturated-zone monitoring site MSCW-1 and 2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
38	39	Gravelly sand, very fine to very coarse; poorly sorted; angular to subangular; grayish green (5G 5/2)
39	40	Silty sand, skewed toward fine, minor gravel granules and pebbles; moderately sorted; angular to subrounded; grayish olive green (5GY 3/2)
40	41	Sand, very fine to very coarse, some gravel granules, minor pebbles; poorly sorted; angular to subrounded; dusky green (5G 3/2)
41	42	Sand, very fine to very coarse, skewed toward medium, some gravel granules, minor pebbles; moderately sorted; angular to subangular; grayish olive green (5GY 3/2)
42	45	Sand, very fine to very coarse, skewed toward fine, some pebbles and granules, some silt; moderately sorted; angular to subangular; grayish olive green (5GY 3/2)
45	46	Sand, very fine to very coarse, some gravel granules and pebbles, minor silt; poorly sorted; angular to subangular; grayish olive green (5GY 3/2)
46	50	Gravelly sand, very fine to very coarse, skewed toward coarse; moderately sorted; angular to subrounded; grayish green (5G 4/2)
50	51	Sand, very fine to very coarse, skewed toward medium, minor gravel granules; well-sorted; angular to subangular; grayish olive green (5GY 3/2)
51	52	Silty sand, very fine to fine; very well sorted; angular; dusky yellow green (5GY 5/2)
52	60	Silty sand, skewed toward fine, minor gravel granules and pebbles; well-sorted; angular to subrounded; dusky yellow green (5GY 5/2)
60	62	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular; dusky yellow green (5GY 5/2)
62	63	Silty sand, some gravel granules and pebbles; poorly sorted; angular to subrounded; grayish olive green (5GY 3/2)
63	64	Sand, skewed toward coarse, some gravel granules and pebbles; moderately sorted; angular to subrounded; dark greenish gray (5GY 3/1)
64	73	Sand, very fine to very coarse, skewed toward fine, some silt; very well sorted; angular to subangular; dusky yellow green (5GY 5/2)
73	75	Gravelly sand, very fine to very coarse; poorly sorted; angular to subangular; dark greenish gray (5GY 3/1)
75	76	Sand, very fine to very coarse, skewed toward medium, minor gravel granules; well-sorted; angular to subangular; dark greenish gray (5GY 3/1)
76	80	Sand, very fine to very coarse, skewed toward fine, some silt, minor gravel granules and pebbles; well-sorted; angular to subangular; grayish olive green (5GY 3/2)
80	82	Silty sand, very fine to very coarse, skewed toward fine, trace gravel granules and pebbles; well-sorted; angular; grayish olive green (5GY 3/2)

Tabla 9. Lithologic log for unsaturated-zone monitoring site MSCW-1 and 2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
82	85	Sand, skewed toward fine, some silt, some gravel granules and pebbles; well-sorted; angular to subangular; dusky yellow green (5GY 5/2)
85	88	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular; dusky yellow green (5GY 4/2)
88	91	Silty sand, very fine to very coarse, skewed toward fine, minor gravel granules and pebbles; well-sorted; angular to subrounded; grayish olive green (5GY 3/2)
91	92	Silty sand, very fine to medium, skewed toward fine; very well sorted; angular; grayish olive green (5GY 3/2)
92	94	Sand, very fine to very coarse, skewed toward medium, minor gravel granules; moderately sorted; angular to subangular; dusky yellow green (5GY 5/2)
94	105	Silty sand, very fine to coarse, skewed toward fine, minor to trace clay; well-sorted; angular; dusky yellow green (5GY 5/2)
105	108	Silty sand, minor gravel granules and pebbles; poorly sorted; angular to subangular; dusky yellow green (5GY 5/2)
108	118	Sand, very fine to very coarse, skewed toward coarse, some gravel granules and pebbles, minor to trace silt; moderately sorted; angular to subangular; grayish olive green (5GY 3/2)
118	120	Silty sand, very fine to coarse, skewed toward fine; well-sorted; angular; grayish olive green (5GY 3/2)
120	122	Silty sand, very fine to very coarse, skewed toward fine, some clay, trace gravel granules and pebbles; well-sorted; angular to subangular; moderate yellowish brown (10YR 5/4)
122	128	Silty sand, very fine to fine; very well sorted; angular; grayish olive green (5GY 3/2)
128	136	Silty sand, fine, trace granules and pebbles; well-sorted; angular to subrounded; grayish olive green (5GY 3/2)
136	140	Gravelly sand, very fine to very coarse, skewed toward coarse; well-sorted; angular to subrounded; greenish black (5GY 2/1)
140	144	Silty sand, very fine to medium, skewed toward fine; very well-sorted; angular; grayish olive green (5GY 3/2)
144	148	Sand, very fine to very coarse, some gravel granules and pebbles; poorly sorted; angular; greenish black (5GY 2/1)
148	150	Gravelly sand, very fine to very coarse, skewed toward coarse; moderately sorted; angular to subrounded; greenish black (5GY 2/1)
150	152	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subangular; grayish olive green (5GY 3/2)
152	154	Sand, very fine to very coarse, skewed toward coarse, minor gravel granules; moderately sorted; angular to subangular; dark olive gray (5Y 3/1)
154	158	Silty sand, very fine to coarse, skewed toward fine; well-sorted; angular; dusky yellow green (5GY 5/2)

Table 9. Lithologic log for unsaturated-zone monitoring site MSCW-1 and 2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
158	160	Sand, very fine to very coarse, skewed toward medium, some silt; moderately sorted; angular; grayish olive green (5GY 3/2)
160	164	Silty sand, very fine to coarse, skewed toward fine, trace gravel granules; well-sorted; angular; grayish olive green (5GY 3/2)
164	166	Sand, some silt, minor gravel granules and small pebbles; poorly sorted; angular; grayish olive green (5GY 3/2)
166	168	Silty sand, very fine to fine, some clay; very well sorted; angular; dusky yellow green (5GY 5/2)
168	170	Sand, very fine to very coarse, minor gravel granules; poorly sorted; angular to subrounded; grayish olive green (5GY 3/2)
170	172	Sand, fine to very coarse, skewed toward coarse; well-sorted; angular to subrounded; grayish olive green (5GY 3/2)
172	176	Sandy gravel, granules and pebbles, very fine to very coarse sand; poorly sorted, angular to subrounded, grayish olive green (5GY 3/2)
176	180	No sample
180	190	Sand, very fine to very coarse
190	200	Sandy silty gravel, granules to coarse pebbles
200	215	Sand, very fine to medium; well-sorted; gray (10Y 5/1)
215	235	Sand, very fine to medium; well-sorted; greenish gray (10Y 5/2)
235	240	Sand, very fine to medium; well-sorted; greenish gray (10Y 5/2), increase in coarse sand
240	250	Silty sand, fine to medium; well-sorted; olive gray (5Y 4/2)
250	260	Silty sand, increase of very coarse sand and gravel
260	265	Sand, very coarse
265	280	Silty sand, fine to medium; well-sorted; olive gray (5Y 5/2)
280	290	Silty sand; yellowish brown (10YR 5/4)
290	300	Sandy gravel, very coarse
300	315	Silty sand, very fine to medium; well-sorted; olive gray (5Y 5/2)
315	320	Silty sand, some gravel
320		CORE: Silty sand, very fine to very coarse, minor granules to pebbles; moderately sorted; angular to subangular; greenish gray (10Y 6/1)

Table 9. Lithologic log for unsaturated-zone monitoring site MSCW-1 and 2 near Victorville, San Bernardino County, California—Continued

Depth (ft)		Description
From	To	
320	325	Silty sand, very fine to medium; well-sorted
325	340	Silty sand, very fine to coarse; poorly sorted; greenish gray (5GY 6/2)
340	370	Silty sand, very fine to very coarse, skewed toward fine, trace gravel; well-sorted; angular to subangular; olive (5Y 5/3)
370	380	Silty sand, very fine to very coarse, skewed toward fine; well-sorted; angular to subangular; increase in coarse sand and minor gravel granules; olive (5Y 5/3)
380	385	Color change to yellowish brown (10YR 5/4)
385	395	Color change to olive (5Y 5/3)
395	400	Increase in coarse sand
400		CORE: Sand, very fine to very coarse, some granules; poorly sorted; angular to subangular; greenish gray (5GY 5/1)
400	440	Silty sand, fine to coarse; moderately sorted
440	500	Silty sand, very fine to fine; well-sorted
500	540	Silty sand, very fine to very coarse, abundant granules
540	660	No sample