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REPORTS

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Offsite Environmental Monitoring Report:

Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1990

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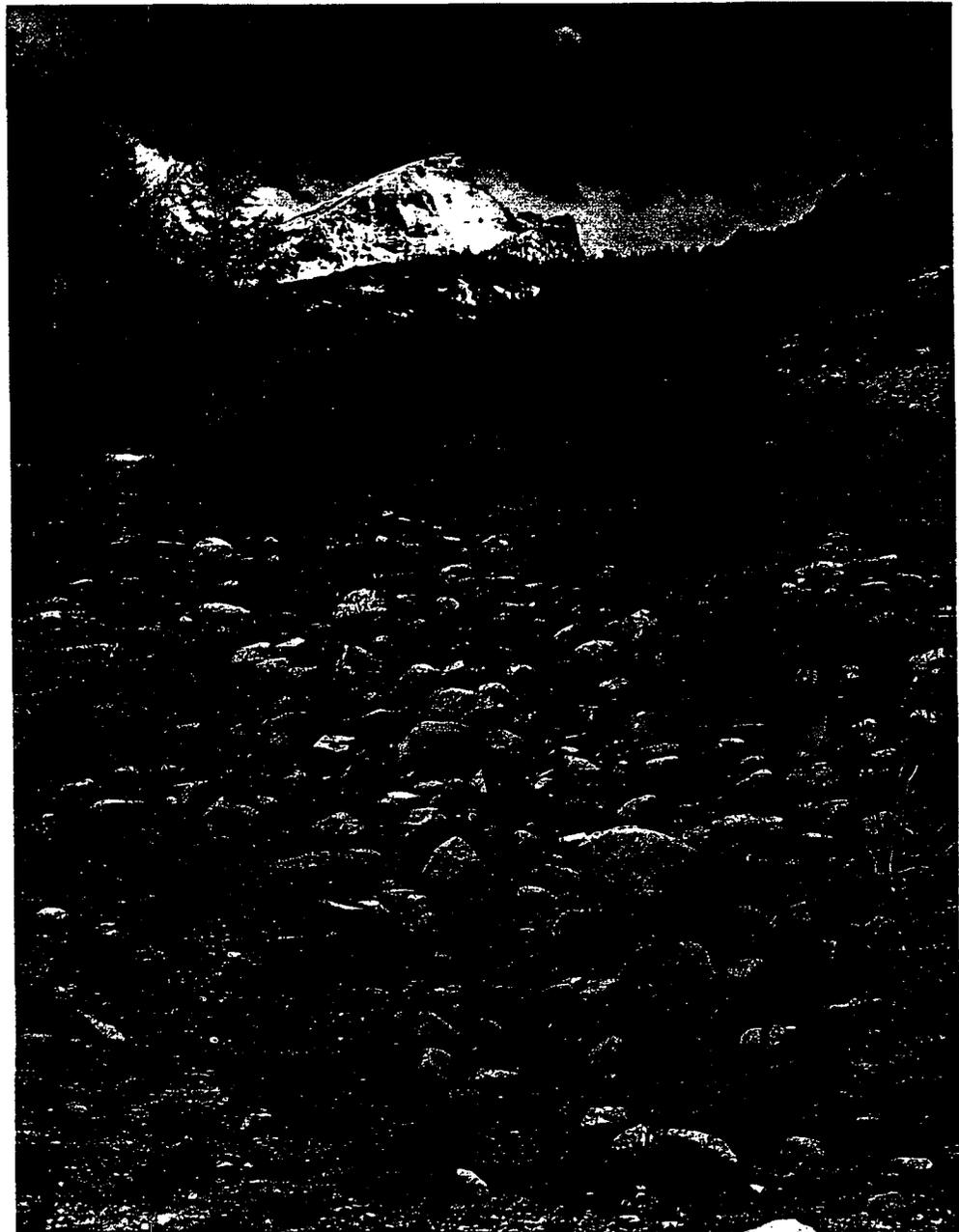
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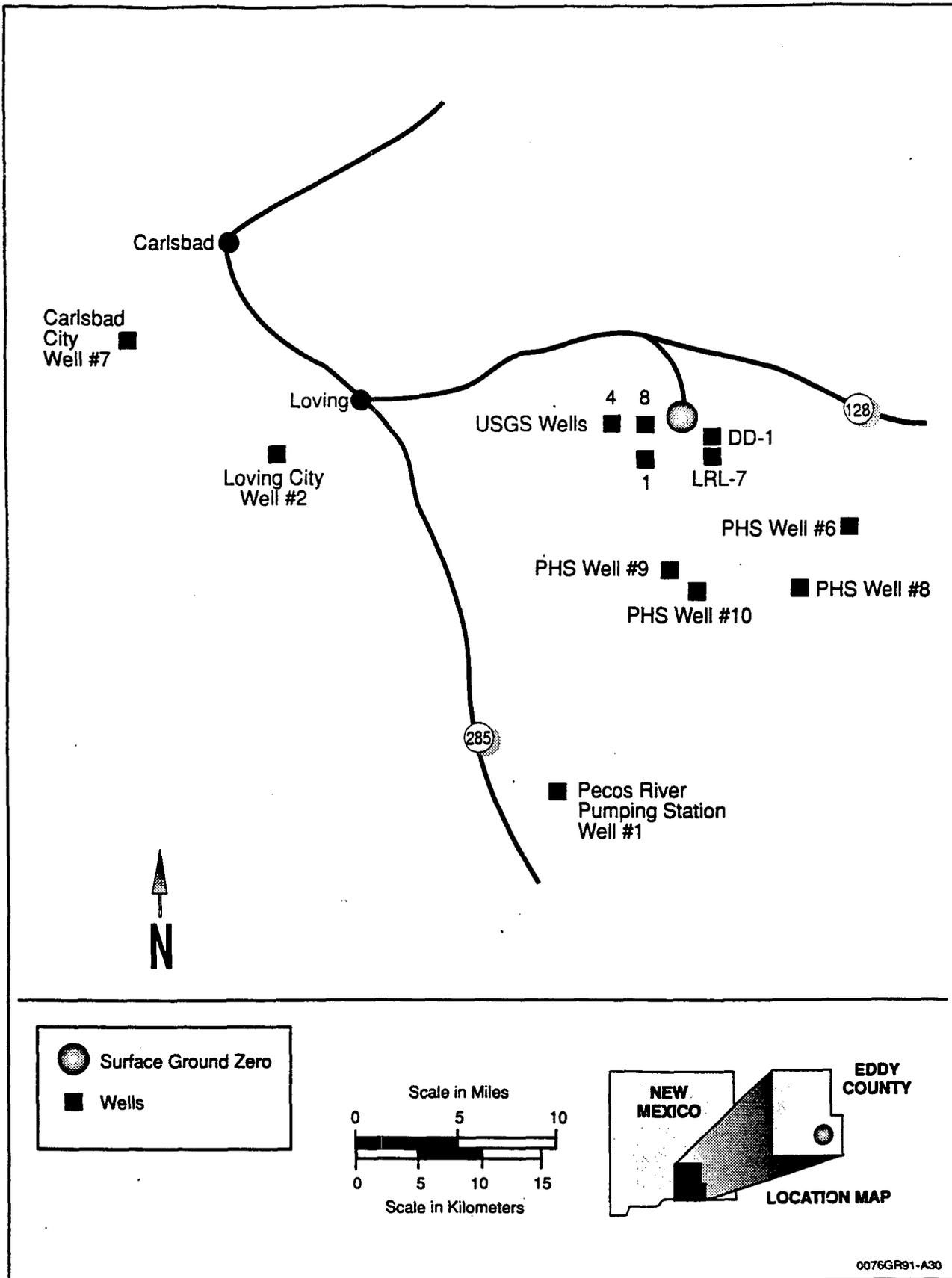


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EPA 600/4-91/03



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Figure A30. Long-Term Hydrological Monitoring Program sampling locations for Project GNOME.

**TABLE 11. WATER ANALYSIS
QUALITY CONTROL**

ANALYSIS	FREQ. (% BLANK)	FREQ. (%DUP.)	FREQ. (%SPIKE)	FREQ. (% BLIND)
³ H (conventional)	4	3	2	1
³ H (enrichment)	3	3	3	1
⁸⁹ Sr, ⁹⁰ Sr	3	3	3	1
Gross Alpha/ Gross Beta	3	3	3	1
Gamma Scan	8	10	3	1

**TABLE 12. WATER ANALYSIS
CONTROL LIMITS**

ANALYSIS	CONTROL LIMIT (±%)
³ H (conventional)	10%
³ H (enriched)	20%
⁸⁹ Sr, ⁹⁰ Sr	20%
Gross Alpha, Gross Beta	20%
Gamma Scan	20%
MATRIX SPIKE CONTROL LIMITS	
³ H (conventional)	10%
³ H (enriched)	20%
⁸⁹ Sr, ⁹⁰ Sr	20%
Gross Alpha, Gross Beta	20%
Gamma Scan	20%

**TABLE 13. SAMPLING LOCATIONS WHERE WATER SAMPLES
CONTAINED MANMADE RADIOACTIVITY**

SAMPLING LOCATION	RADIONUCLIDE	CONCENTRATION 10 ⁻⁶ μCi/mL
PROJECT GNOME NM		
Well DD-1	³ H	2.8 x 10 ⁷
	¹³⁷ Cs	7.9 x 10 ⁵
	⁴⁰ K	7.6 x 10 ³
	⁸⁹ Sr	-1.9 x 10 ¹
	⁹⁰ Sr	8.2 x 10 ³
	²³⁸ Pu ²³⁹⁻²⁴⁰ Pu	5.4 x 10 ⁻² 1.1 x 10 ⁰
Well LRL-7	³ H	1.4 x 10 ⁴
	¹³⁷ Cs	1.8 x 10 ²
Well USGS 4	³ H	1.5 x 10 ³
Well USGS 8	³ H	1.2 x 10 ⁵
	¹³⁷ Cs	6.4 x 10 ¹
PROJECT GASBUGGY NM		
Well EPNG-10-36	³ H	2.3 x 10 ²
PROJECT RIO BLANCO CO		
CER No. 1 BLACK SULFUR	³ H	3.5 x 10 ²
PROJECT DRIBBLE MS		
Well HMH-1	³ H	4.0 x 10 ³
Well HMH-2	³ H	8.2 x 10 ³
Well HMH-5	³ H	1.9 x 10 ³
Well HMH-16	³ H	9.7 x 10 ²
Well HMH-L	³ H	1.1 x 10 ³
Well HMH-S	³ H	9.4 x 10 ³
Half Moon Creek	³ H	3.0 x 10 ²
Half Moon Creek Overflow	³ H	4.5 x 10 ²
Lower Little Creek	³ H	6.8 x 10 ²

Handwritten notes:
 $2.8 \times 10^7 \mu\text{Ci/mL}$
 $7.9 \times 10^5 = 7.9 \times 10^{-4} \text{ mCi/mL}$

**TABLE A8. TRITIUM RESULTS FOR THE LONG-TERM HYDROLOGICAL
MONITORING PROGRAM — 1990**

SAMPLING LOCATION	COLLECTION DATE 1990	CONC. ± 1 S.D. pCi/L (10 ⁶ µCi/mL) ^a	% OF CONC. GUIDE
<u>PROJECT GNOME</u>			
CARLSBAD NM WELL 7 CITY	08/01	2.9 ± 3.0 ^b	0.01
LOVING NM WELL 2 CITY	08/01	8.1 ± 3.4 ^b	0.04
MALAGA NM			
WELL 1 PECOS PUMPING STATION	08/01	7 ± 3.7 ^a	0.03
WELL DD-1	08/02	28000000 ± 100000	140000 (3)
WELL LRL-7	08/02	14000 ± 190	71.4 (1)
WELL PHS 8	08/01	27 ± 4.5	0.13
WELL PHS 9	08/02	13 ± 4.2 ^a	0.07
WELL PHS 10	08/03	4.6 ± 4.0 ^a	0.02
WELL USGS 1	08/01	-1.6 ± 2.2 ^a	<0.01
WELL USGS 4	08/02	150000 ± 490	767
WELL USGS 8	08/02	120000 ± 440	603 (2)
<u>PROJECT DRIBBLE</u>			
BAXTERVILLE MS			
HALF MOON CREEK	04/21	300 ± 4.5	1.54
	04/23	19 ± 3.4	0.09
HALF MOON CREEK OVRFLW	04/21	450 ± 4.3	2.27
	04/23	390 ± 5.1	1.97
LITTLE CREEK #1	04/20	7.1 ± 3.7 ^a	0.04
LOWER LITTLE CREEK	04/18	680 ± 140	3.38
	04/18	14 ± 3.3	0.07
POND WEST OF GZ	04/21	2.3 ± 2.2 ^b	0.01
	04/23	25 ± 3.2	0.13
REECO PIT DRAINAGE-A	04/23	21 ± 3.0	0.10
REECO PIT DRAINAGE-B	04/23	130 ± 3.3	0.69
REECO PIT DRAINAGE-C	04/23	150 ± 4.7	0.79
SALT DOME HUNTING CLUB	04/21	6.9 ± 2.5 ^b	0.03
SALT DOME TIMBER CO.	04/18	19 ± 3.7	0.09
ANDERSON POND	04/21	5.4 ± 3.0 ^b	0.03
ANDERSON, BILLY RAY	04/21	11 ± 3.3	0.06
ANDERSON, REGINA	04/20	7.9 ± 3.6 ^b	0.04
ANDERSON, ROBERT HARVEY	04/21	17 ± 2.9	0.08
ANDERSON, ROBERT LOWELL	04/20	12 ± 3.7	0.06
BURGE, JOE	04/21	6.3 ± 5.1 ^b	0.03
CHAMBLISS, B.	04/19	3.1 ± 5.6 ^b	0.02
DANIELS, RAY	04/18	20 ± 3.6	0.10
DANIELS, WEBSTER JR.	04/18	31 ± 2.8	0.15
DANIELS - WELL #2	04/18	25 ± 2.9	0.13
KELLY GERTRUDE	04/19	-1.4 ± 3.8 ^b	<0.01
KING, RHONDA	04/21	13 ± 2.2	0.07
LEE, P. T.	04/19	23 ± 3.6	0.11
MILLS, A. C.	04/19	0 ± 4.5 ^b	<0.01
MILLS, ROY	04/19	29 ± 5.0	0.15
NOBLES POND	04/19	21 ± 3.1	0.10
NOBLES QUAIL HOUSE	04/21	44 ± 3.4	0.22
NOBLE, W. H., JR.	04/19	30 ± 2.6	0.15
READY, R C	04/18	12 ± 2.7	0.06
SAUCIER, DENNIS	04/18	18 ± 3.2	0.09

(continued)

TABLE A8. Continued

SAMPLING LOCATION	COLLECTION DATE 1990	CONC. ± 1 S.D. pCi/L (10 ⁻⁹ µCi/mL) ^a	% OF CONC. GUIDE
RIO BLANCO CO (con't)			
WELL JOHNSON ARTESIAN	06/17	0.99 ± 2.7 ^b	<0.01
WELL RB-D-01	06/18	3.3 ± 3.8 ^b	0.02
WELL RB-D-03	06/17	0.65 ± 2.8 ^b	<0.01
WELL RB-S-03	06/18	4.1 ± 4.3 ^b	0.02
B-1 EQUITY CAMP	06/18	71 ± 5.5	0.36
<u>NTS SEMIANNUAL NETWORK</u>			
HIKO NV			
CRYSTAL SPRINGS	07/02	49.1 ± 142 ^b	0.25
BLUE JAY NV			
HOT CREEK RANCH SPRING	03/09	6.5 ± 2.5 ^b	0.03
MAINTENANCE STATION	03/09	-1.8 ± 3.1 ^b	<0.01
WELL BIAS	03/09	-4.3 ± 2.9 ^b	<0.01
WELL HTH-1	03/23	0.88 ± 4.5 ^b	<0.01
WELL HTH-2	03/23	2.3 ± 3.0 ^b	0.01
WELL SIX MILE	03/09	1.2 ± 3.8 ^b	<0.01
FRENCHMAN STATION NV			
HUNT'S STATION	02/26	-2.7 ± 2.8 ^b	<0.01
SMITH/JAMES SPRGS	02/26	70 ± 3.7	0.35
WELL FLOWING	02/26	-4.4 ± 2.6 ^b	<0.01
WELL H-3	02/26	^c	
WELL HS-1	02/26	-1.3 ± 3.4 ^b	<0.01
AMARGOSA VALLEY NV			
WELL MARY NICKELL'S	02/08	1.4 ± 3.0 ^b	<0.01
	08/07	-39 ± 140 ^b	<0.01
SHOSHONÉ CA			
SHOSHONE SPRING	01/02	1.1 ± 3.2 ^b	<0.01
	02/06	-2.0 ± 3.6 ^b	<0.01
	08/07	-67 ± 140 ^b	<0.01
ADAVEN NV			
ADAVEN SPRING	01/09	43 ± 3.4	0.22
	07/02	-40 ± 140 ^b	<0.01
ALAMO NV			
WELL 4 CITY	01/11	-2.3 ± 3.2 ^b	<0.01
	07/02	-110 ± 140 ^b	<0.01
ASH MEADOWS NV			
	05/09	-0.19 ± 2.8 ^b	<0.01
	11/21	310 ± 140 ^b	1.59
FAIRBANKS SPRINGS	05/09	-0.96 ± 3.5 ^b	<0.01
	11/21	160 ± 140 ^b	0.84
SPRING 17S-50E-14CAC	05/09	^d	
	12/12	-36 ± 140 ^b	<0.01
WELL 18S-51E-7DB	05/09	4.9 ± 2.8 ^b	0.02
	11/21	32 ± 140 ^b	0.16
	05/09	87 ± 5.0	0.43
BEATTY NV			
LOW LEVEL WASTE SITE	06/14	0.99 ± 3.7 ^b	<0.01
	12/05	-260 ± 14 ^b	<0.01

(continued)

TABLE A8. Continued

SAMPLING LOCATION	COLLECTION DATE 1990	CONC. ± 1 S.D. pCl/L (10 ⁻⁶ µCl/mL)	% OF CONC. GUIDE
BEATTY NV (con't)			
SPECIE SPRINGS	02/07	170 ± 14 ^b	0.87
	07/10	20 ± 2.9	0.10
TOLICHA PEAK	02/07	81 ± 130 ^b	0.40
	08/01	0.12 ± 3.8 ^b	<0.01
WELL 11S-48-1DD COFFERS	01/04	2.2 ± 2.7 ^b	0.01
	07/11	4.8 ± 2.0 ^b	0.02
WELL 12S-47E-7DBD CITY	02/09	-58 ± 130 ^b	<0.01
	07/12	4.2 ± 2.9 ^b	0.02
WELL ROAD D SPICERS	01/08	d	
	02/08	210 ^d ± 140 ^b	1.06
	08/08	-0.89 ± 3.0 ^b	<0.01
YOUNGHANS RCH (HOUSE WELL)	06/13	0.42 ± 3.2 ^b	<0.01
	12/05	-0.37 ± 2.5 ^b	<0.01
BOULDER CITY NV			
LAKE MEAD INTAKE	03/13	-150 ± 130 ^b	<0.01
	09/14	44 ± 3.7	0.22
CLARK STATION NV			
WELL 6 TTR	02/07	-35 ± 130 ^b	<0.01
	08/09	-2.0 ± 2.6 ^b	<0.01
FURNACE CREEK CA	04/24	d	
NAVARES SPRINGS			
HIKO NV			
CRYSTAL SPRINGS	01/11	-9.1 ± 140 ^b	<0.01
	07/02	49 ± 140 ^b	0.24
INDIAN SPRINGS NV			
TROUGH SPRGS-TOIYABE	06/01	28 ± 2.9	0.14
WELL 1 SEWER COMPANY	03/05	81 ± 130 ^b	0.40
	05/01	36 ± 140 ^b	0.18
	09/04	-1.1 ± 3.0 ^b	<0.01
WELL 2 US AIR FORCE	03/05	31 ± 130 ^b	0.15
	05/01	260 ± 140 ^b	1.30
	09/04	-2.2 ± 2.4 ^b	<0.01
LAS VEGAS NV			
WELL 28 WATER DISTRICT	03/14	96 ± 140 ^b	0.48
	09/14	-2.1 ± 4.4 ^b	<0.01
LATHROP WELLS NV			
CITY 15S-50E-18CDC	04/03	1.5 ± 3.5 ^b	<0.01
NYALA NV			
SHARP'S RANCH	02/06	69 ± 130 ^b	0.35
	08/08	-2.3 ± 4.0 ^b	<0.01
OASIS VALLEY NV			
GOSS SPRINGS	02/08	-58 ± 130 ^b	0.29
	08/14	-4.2 ± 3.0 ^b	<0.01
PAHRUMP NV			
CALVADA WELL	02/06	-1.2 ± 2.8 ^b	<0.01
	08/10	-110 ± 140 ^b	<0.01
	09/04	-120 ± 140 ^b	<0.01

(continued)

TABLE A8. Continued

SAMPLING LOCATION	COLLECTION DATE 1990	CONC. ± 1 S.D. pCi/L (10 ³ µCi/mL) ^a	% OF CONC. GUIDE
RACHEL NV	04/11	-73.8 ± 136 ^b	<0.01
WELLS 7 AND 8	10/01	0.6 ± 3.2 ^b	<0.01
PENOYER	10/01	0.58 ± 3.2 ^b	<0.01
	04/11	-74 ± 130 ^b	<0.01
WELL 13 PENOYER	10/01	6.3 ± 3.4 ^b	0.03
	04/11	180 ± 130 ^b	0.91
WELL PENOYER CULINARY	10/01	-3.6 ± 3.9 ^b	<0.01
	04/04	310 ± 130 ^b	1.57
TEMPIUTE NV			
UNION CARBIDE WELL	2/07	-58 ± 130 ^b	<0.01
	08/08	-0.65 ± 3.1 ^b	<0.01
TONOPAH NV			
CITY WELL	03/07	-19 ± 130 ^b	<0.01
	09/06	-2.6 ± 2.8 ^b	<0.01
WARM SPRINGS NV			
TWIN SPRINGS RANCH	09/05	-51 ± 140 ^b	0.25
	04/03	100 ± 130 ^b	0.52
	11/12	3.2 ± 3.0 ^b	0.02
NEVADA TEST SITE (AREA) NV			
WELL 6A ARMY	01/11	150 ± 140 ^b	0.79
	07/19	3.3 ± 3.5 ^b	0.02
WELL C-1	04/16	0.78 ± 2.9 ^b	<0.01
	11/20	-260 ± 140 ^b	<0.01
WELL D TEST	01/03	5.1 ± 3.3 ^b	0.03
	07/19	-8.9 ± 140 ^b	<0.01
WELL HTH-1	06/07	39 ± 3.6	0.19
WELL UE1C	01/04	0.0 ± 3.2 ^b	0.00
	07/19	-1.6 ± 1.9 ^b	<0.01
WELL UE5C	03/05	4.4 ± 3.2 ^b	0.02
	09/10	-0.55 ± 4.6 ^b	<0.01
WELL UE-5N	12/07	70 ± 4.6	0.35
WELL UE6E	03/06	33 ± 2.7	0.17
WELL UE15D	04/16	8.4 ± 2.5	0.04
	11/20	270 ± 140 ^b	1.36
WELL UE16D	05/15	-0.27 ± 2.7 ^b	<0.01
	11/19	0.0 ± 140 ^b	0.00
WELL UE-16F	05/14	9.2 ± 3.0 ^b	0.05
	11/19	250 ± 140 ^b	1.30
WELL UE-17A	05/14	2.9 ± 2.6 ^b	0.01
	12/11	-140 ± 140 ^b	<0.01
WELL UE18R	06/06	1.5 ± 2 ^b	<0.01
	12/11	-140 ± 140 ^b	<0.01
WELL UE-18T	06/06	210 ± 3.5	1.05

^a Multiply by 3.7 x 10⁻² to convert to Bq/L.

^b Concentration is less than the minimum detectable concentration (MDC).

^c No sample.

^d Gamma spectra negligible.

(continued)

TABLE A8. Continued

ANALYSIS		RESULT ± 1 S.D. (pCi/L)	(10 ⁻⁶ µCi/mL) = pCi/L
(1)	¹³⁷ Cs	180	7.9
(2)	¹³⁷ Cs	64	6.7
(3)	³ H(avg.)	28,000,000	100,000
	⁴⁰ K	7,600	1,500
	⁸⁹ Sr	790,000	30,000
	⁹⁰ Sr	-19	48
	²³⁸ Pu	0.054	0.07
	²³⁹⁻²⁴⁰ Pu	1.1	0.17
(4)	¹³⁷ Cs	13	3.8

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USGS-1

723 ft

USGS-1 is a test hole drilled to determine the ground-water conditions in the Project Gnome area (Cooper, 1961). The borehole was drilled and completed in August 1960 to a total depth of 220.4 m BGS. A 24-inch hole was drilled from the surface to a depth of 35.3 m BGS and cased with 20-inch casing. An additional 57.4 m were drilled to a diameter of 19 inches and cased with 18-inch casing. From 92.8 to 175.9 m BGS, the borehole was drilled to a 17-1/2-inch diameter. The hole was cased from the surface to 175.9 m BGS with 12-3/4-inch casing. A 12-inch hole was drilled from 175.9 m BGS to a total depth of 220.4 m BGS. The borehole was plugged with cement from total depth to 172.8 m BGS. The 12-3/4-inch casing was perforated from 158.5 to 162.5 m BGS across the Culebra dolomite. The upper 3.0 m of annular space between the 12-3/4-inch, 18-inch, and 20-inch casing were then filled with cement. Currently, a windmill pumps water from this well for use by local ranchers.

The significant-borehole activities affecting interpretation of Culebra equivalent-freshwater heads are:

08/15/60: Casing perforation at the Culebra interval.

08/17/60 - 08/18/60: 24-hour pumping and recovery test. The borehole was pumped at a rate of 6.3 L/s. (No water-quality data.)

03/16/63 - 03/17/63: 24-hour pumping and recovery test. The borehole was pumped at a rate of 3.4 L/s. (No water-quality data.)

04/12/88: Water-quality sampling. Water samples were collected from a port on the discharge pipe which empties into a storage tank. The specific gravity of the water collected was 1.003 at 20.8°C ($\rho = 1.001 \text{ g/cm}^3$).

07/07/88: Water-quality sampling. Water samples were collected from a siphon set near the bottom of the storage tank. The specific gravity of the water collected was 1.006 at 22.8°C ($\rho = 1.004 \text{ g/cm}^3$).

For the purpose of equivalent-freshwater-head calculations, the borehole-fluid density in USGS-1 is estimated to be 1.000 g/cm^3 from the time the Culebra interval was perforated to 06/16/89. This density value was determined based on total dissolved

USGS-4

USGS-4 was drilled in November and December 1961 downgradient from the detonation point of the Gnome Project experiment (Cooper and Glanzman, 1971). The well was drilled to observe water levels and other hydrologic conditions in the Culebra dolomite before, during, and after the explosion. The borehole was drilled to a total depth of 157.9 m BGS and cased with 8-5/8-inch casing from the surface to the top of the Culebra dolomite (145.7 m BGS). From 145.7 to 157.9 m BGS, the borehole was left open hole with a diameter of 8 inches. In January 1963, the borehole was cleaned and developed in preparation for a tracer test conducted to study physical and chemical adsorption reactions of radionuclides introduced into the Culebra dolomite in relationship to the ground-water velocities in the Culebra. During the tracer test, which was conducted from February 9, 1963 to March 9, 1963, USGS-4 was used as the discharge well in a discharge-recharge system (USGS-8 was the recharge well). The tracer test consisted of injecting a mixture of tritiated water, iodine-131, strontium-90, and cesium-137 into the Culebra dolomite. This tracer study resulted in the contamination of USGS-4.

For the purpose of equivalent-freshwater-head calculations, the borehole-fluid density in USGS-4 is estimated to be 1.000 g/cm^3 for the time period of 03/09/63 to 06/16/89. This density value was determined based on total dissolved solid and specific conductance measurements made on fluid collected from the borehole as part of the Long-Term Hydrologic Monitoring Program for the Gnome site which was initiated on February 3, 1972.

An estimate of the borehole-fluid density uncertainty was not made.

Summary of Estimated Borehole-Fluid Densities and Related Density and Head Uncertainties for USGS-4

Time Period	Borehole-Fluid Density (g/cm^3)	Density Uncertainty (g/cm^3)	Related Head Uncertainty (m)
03/09/63 - 06/16/89	1.000	unknown	N/A

USGS-8

USGS-8 was drilled from October 1962 to January 1963 downgradient from the detonation point of the Gnome Project experiment (Cooper and Glanzman, 1971). The well was drilled to obtain undisturbed core at the Gnome site and to act as the recharge well for a tracer study. The borehole was drilled to a total depth of 220.0 m BGS and cased with 8-5/8-inch casing from the surface to 141.1 m BGS. From 141.1 to 220.0 m BGS, the borehole was left open hole with a diameter of 7-7/8 inches. The borehole was plugged with cement from total depth to 151.0 m BGS and left uncased over the Culebra dolomite located 140.2 to 150.6 m BGS. After drilling, USGS-8 was cleaned and developed in preparation for a tracer test conducted to study physical and chemical adsorption reactions of radionuclides introduced into the Culebra dolomite in relationship to the ground-water velocities in the Culebra. During the tracer test, which was conducted from February 9, 1963 to March 9, 1963, USGS-8 was used as the recharge well in a discharge-recharge system (USGS-4 was the discharge well). The tracer test consisted of injecting a mixture of tritiated water, iodine-131, strontium-90, and cesium-137 into the Culebra dolomite. This tracer study resulted in the contamination of USGS-8.

For the purpose of equivalent-freshwater-head calculations, the borehole-fluid density in USGS-8 is estimated to be 1.000 g/cm^3 for the time period of 03/09/63 to 06/16/89. This density value was determined based on total dissolved solid and specific conductance measurements made on fluid collected from the borehole as part of the Long-Term Hydrologic Monitoring Program for the Gnome site which was initiated on February 3, 1972.

An estimate of the borehole-fluid density uncertainty was not made.