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GEOLOGICAL SURVEY

HYDROLOGIC DATA FOR A SUBSURFACE WASTE-INJECTION SITE AT MULBERRY, FLORIDA, 1972-76

By William E. Wilson

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HYDROLOGIC DATA FOR A SUBSURFACE WASTE-INJECTION SITE AT MULBERRY, FLORIDA, 1972-76

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ABSTRACT

Beginning in October 1972, industrial waste has been injected into a limestone and dolomite brine aquifer 4,000-5,000 feet below land surface. During October 1975 through December 1976, the injection rate was about 8.2 million gallons per month. To determine what effect, if any, the injected waste is having on the ground-water body, water levels have been measured and water samples collected from two monitor wells that tap two different permeable zones above the injection zone, and from a satellite monitor well that taps the injection zone. The two monitor wells are installed in the annulus of the injection well and the satellite monitor well is 2,291 feet distant from the injection well.

Water levels in the satellite monitoring well fluctuate in response to changes in the injection rate. Water levels in the monitor wells fluctuate in response to variations in recharge to and discharge from aquifers above the injection interval, from seasonal rainfall and from well discharge. In the shallow annulus monitor well, water levels fluctuate about 25 feet annually compared with about 2 feet in the deep annulus monitor well.

Chemical analyses of water samples from all monitor wells show variations in concentration of constituents from time to time but no overall change.

CONVERSION FACTORS

Factors for converting English units to metric units are shown to four significant figures.

English	Multiply by	Metric
ft (feet)	3.048×10^{-1}	m (meters)
mi (miles)	1.609	km (kilometers)
Mgal (million gallons)	3.785×10^{3}	m^3 (cubic meters)

INTRODUCTION

A waste-injection well was drilled in 1972 at the Kaiser Aluminum and Chemical Corporation Plant at Mulberry, Florida, about 30 miles east of Tampa (fig. 1). Acidic, high-chloride liquid industrial wastes are injected into limestone and dolomite between about 4,000 and 5,000 ft below the land surface. Two monitor wells, installed in the annulus of the injection well, tap two permeable zones above the injection zone. The deeper of the two annulus monitors is open to the interval 2,775-2,788 ft and the shallower is open to 1,254-1,264 ft. In 1974, a satellite monitor well was drilled 2,291 ft distant from the injection well and was finished open-hole in the same depth interval as the injection well.

At the request of the Florida Department of Environmental Regulation, the U. S. Geological Survey participated in the collection and evaluation of hydrologic data during initial injection tests in 1972. The investigation was part of the Geological Survey research program to evaluate the effects of underground waste injection on the Nation's subsurface environment. Test results were reported by Wilson, Rosenshein, and Hunn (1973). Since 1972, the Geological Survey has continued its testing and data-collection activities as part of a cooperative program with the Florida Department of Environmental Regulation and as part of the federal research program. Hydrologic data collected during 1972-75 were reported by Wilson (1976).

DATA PRESENTED

This report updates hydrologic data collected by the Geological Survey to include October 1975 through December 1976. Included is a table of well data (table 1), a graph showing the volume of waste effluent injected each month (fig. 2), and hydrographs of annulus monitor wells (fig. 3) and the satellite monitor well (fig. 4). Tables 2-5 show chemical analyses of samples from all wells and of the waste effluent. All analyses were made by the U. S. Geological Survey. Data on the amount of waste injected are based on records of the Kaiser Aluminum and Chemical Corporation.

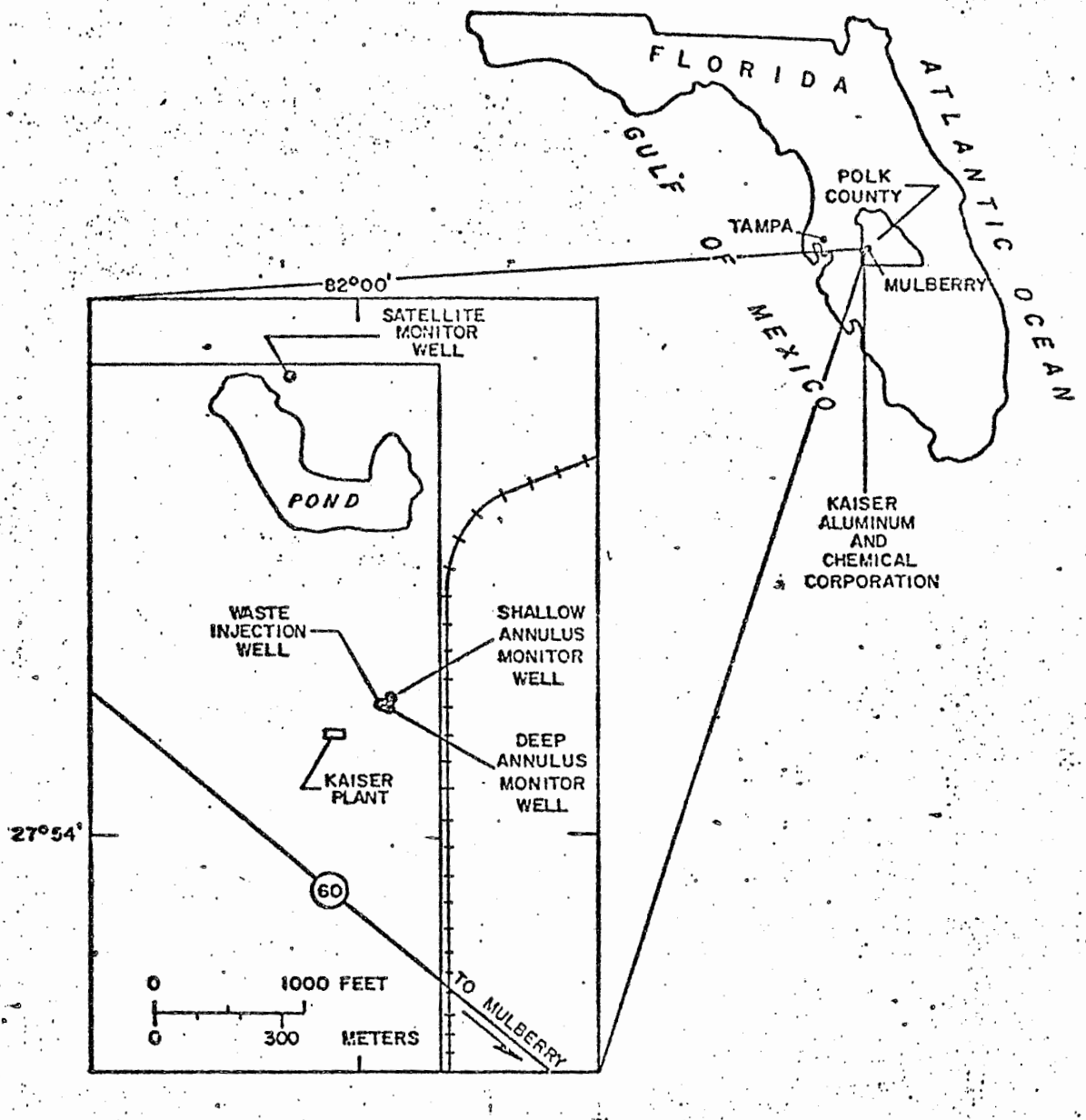

Figure 1. Location of waste-injection system, Kaiser Aluminum and Chemical Corporation, Mulberry, Florida.

Table 1. Well data, Kaiser Aluminum and Chemical Corporation, Mulberry, Florida.
(All depths are in feet below land surface.)

Well name	Geological Survey number	Date drilled	Land surface altitude	Total depth	Casing		Finish	
					Diameter (in)	Depth interval	Type	Open interval
Waste injection well	275408N0815957.1	8-72	120	4,984	10-3/4 7-7/8	0-2,937 2,937-3,996	9-7/8-inch open hole	3,996-4,984
Deep annulus monitor	275408N0815957.2	8-72	120	2,904	2-3/8 2-3/8	0-2,775 2,788-2,904	Perforations	2,775-2,788
Shallow annulus monitor	275408N0815957.3	8-72	120	1,332	2-3/8 2-3/8	0-1,254 1,264-1,332	Perforations	1,254-1,264
Satellite monitor	275430N0820004.1	3-75	105	5,000	4-1/2	0-4,016	7-7/8 inch open hole	4,016-5,000

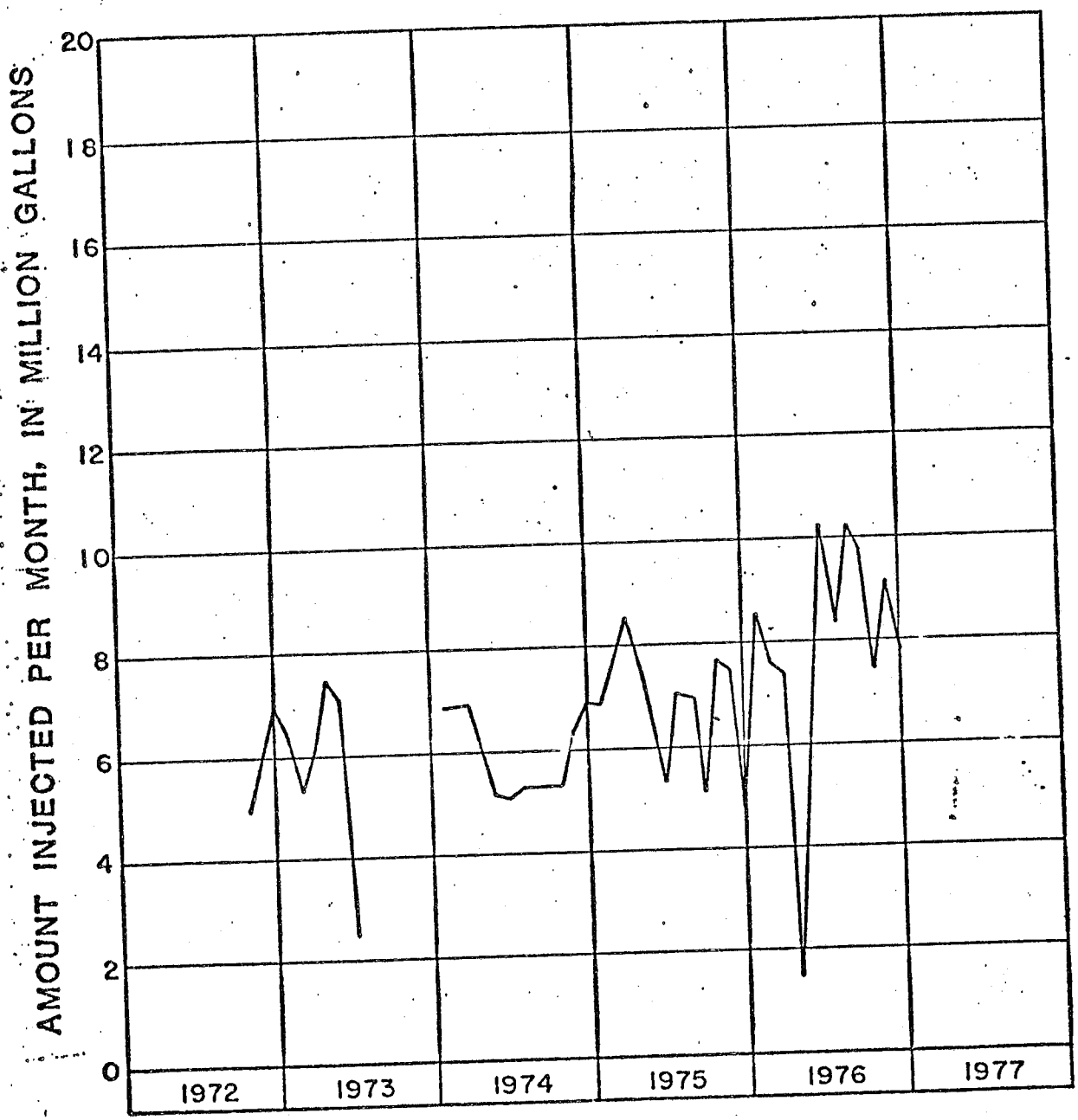

Figure 2. Monthly volume of waste fluid injected.

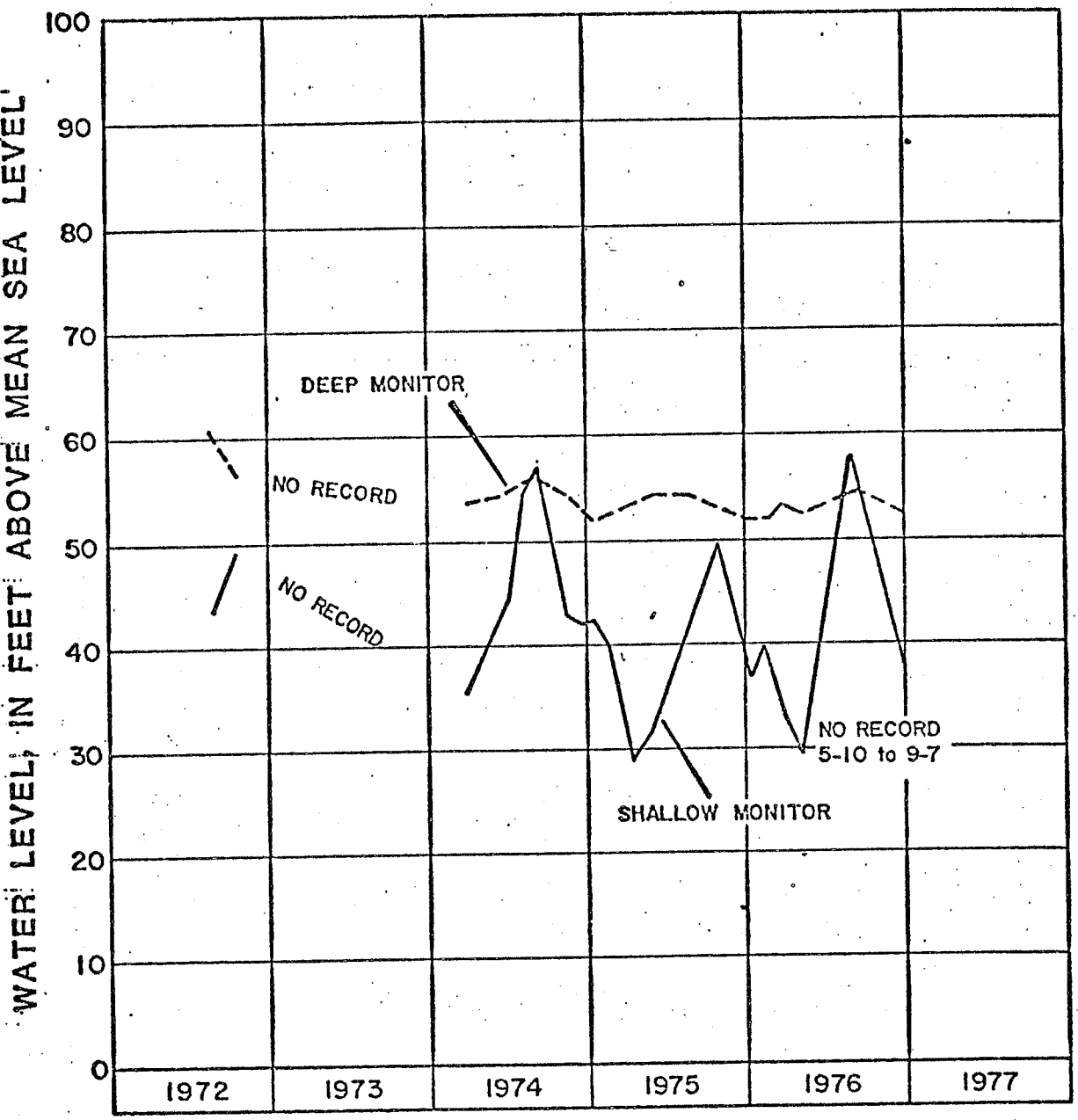

Figure 3. Hydrographs of shallow and deep annulus monitor wells.

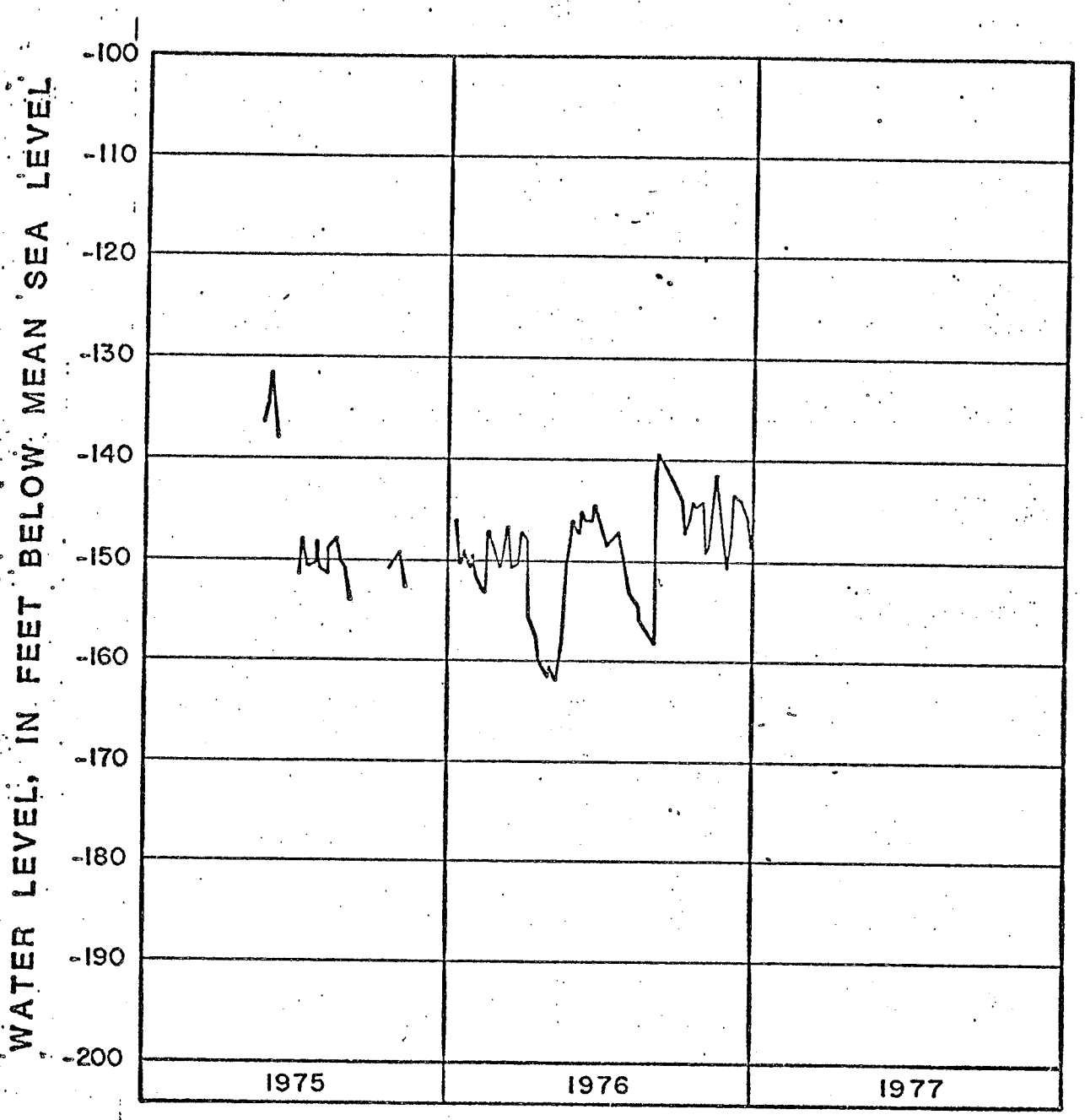

Figure 4. Hydrograph of satellite monitor well.

Table 2. Chemical analyses, waste effluent (concentrations in milligrams per liter, except as noted).

Date of Collection	Specific Conductance (micromhos at 25° C)	pH (units)[1]	Temperature (°C)[1]	Color (Pt-Co units)	Turbidity	Suspended Solids at 110° C	Density at 20° C (gm/ml)	Specific Gravity	Sodium Absorption Ratio (SAR)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)[2]	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)[1]	Carbonate (CO_3)[1]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)
9-26-72	352,000	1.0	-	-	-	-	-	1.052	-	-	-	-	-	-	-	-	-	-	68,000	-
10-10-72	364,000	1.5	-	-	210	-	-	1.053	-	12	400	400	10,000	16,000	45	0	0	55	66,000	1500
4-10-74	209,000	.2	24.0	-	-	-	1.040	-	-	11	29	31	660	7,000	16	0	0	1100	47,000	1.5
9-30-74	298,000	.8	-	-	-	-	1.035	-	-	-	-	-	-	-	-	-	-	720	45,000	3800
1- 9-75	325,000	.0	26.5	-	-	374	1.046	-	296	3.0	82	39	520	13,000	100	0	-	3100	64,000	2000
3-11-75	390,000	.0	-	-	-	-	1.040	-	249	4.5	59	34	440	9,700	14	0	-	2600	56,000	2300
6-24-75	29,900	1.3	28.0	-	-	-	1.006	-	38	920	170	68	3,000	2,300	19	0	-	510	5,000	1500
12-16-75	359,000	.0	32.5	-	-	193	1.043	-	204	4.6	220	25	500	12,000	58	0	-	130	57,000	2100
4-12-76	-	.0	32.5	-	-	-	1.043	-	-	-	-	-	-	-	-	-	-	143	46,000	2300
7-01-76	294,000	.0	33.0	-	-	-	1.030	-	160	5.5	140	42	250	8,400	38	0	-	1100	46,000	3000

1 Determined in field at time of sample collection

2 Micrograms per liter

Table 2. Chemical analyses, waste effluent (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Dissolved Solids		Non-Carbonate Hardness ($CaCO_3$)	Total Hardness ($CaCO_3$)	Alkalinity as $CaCO_3$	Acidity (H^{+1})	Nitrogen Species					Dissolved Organic Carbon (DOC)	Total Organic Carbon (TOC)	Total Inorganic Carbon	Total Carbon	Chemical Oxygen Demand (COD)	Total Phosphorus as P	Orthophosphorus as P	Arsenic $(As)_{Dissolved}$[2]	Arsenic $(As)_{Total}$[2]	Boron $(B)_{Dissolved}$[2]
	Calculated sum of determined constituents	Residue at 180° C					Nitrate NO_3 as N	Nitrite NO_2 as N	Ammonia NH_4 as N	Organic Nitrogen as N	Total Nitrogen as N										
9-25-72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-10-72	24,400	42,000	2700	2700	0	1530	.00	.03	-	-	-	-	84	-	84	96	13	-	7400	7800	-
4-10-74	56,300	33,400	200	200	0	1020	.00	.00	4.4	-	.72	60	60	10	70	1200	770	700	5100	-	390
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	530	520	-	-	-
1- 9-75	83,700	38,200	370	370	-	1400	.75	.01	55	-	-	56	-	-	-	-	960	960	9700	-	21,000
3-11-75	71,500	28,700	290	290	-	1320	.43	.01	7.0	.00	-	61	67	-	-	-	880	760	8500	-	5,000
6-24-75	10,700	8,330	710	710	-	130	.74	.04	7.4	-	-	37	38	-	-	0	88	88	360	-	630
12-16-75	74,300	31,500	650	650	0	2740	.81[3]	.01[3]	26[3]	-	.00	-	56	-	-	-	680[3]	540[3]	8000	10000	5,400
4-12-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-01-76	-	-	520	520	0	1100	.67	.02	14	-	.00	62	68	-	-	-	490	490	9500	9900	1,600

2 Micrograms per liter

Table 2. Chemical analyses, waste effluent (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Cadmium (Cd) Dissolved[2]	Cadmium (Cd) Total[2]	Chromium (Cr) Dissolved[2]	Chromium (Cr) Hexavalent[2]	Chromium (Cr) Total[2]	Cobalt (Co) Dissolved[2]	Cobalt (Co) Total[2]	Copper (Cu) Dissolved[2]	Copper (Cu) Total[2]	Iron (Fe) Dissolved[2]	Iron (Fe) Total[2]	Lead (Pb) Dissolved[2]	Lead (Pb) Total[2]	Lithium (Li) Dissolved[2]	Lithium (Li) Total[2]	Manganese (Mn) Dissolved[2]	Mercury (Hg) Dissolved[2]	Mercury (Hg) Total[2]	Molybdenum (Mo) Dissolved[2]	Molybdenum (Mo) Total[2]	Nickel (Ni) Dissolved[2]	Nickel (Ni) Total[2]	Zinc (Zn) Dissolved[2]	Zinc (Zn) Total[2]
9-26-72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10-10-72	10	10	230	0	-	3	7	600	600	19,000	19,000	79	-	10	10	590	6.0	-	19	-	830	950	650	-
4-10-74	0	-	2	0	270	19	-	4	90	85,000	62,000	0	0	0	-	990	0.0	-	-	-	750	-	20	650
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1-.9-75	650	2300	1200	1	1200	50	-	720	640	44,000	41,000	260	260	31	-	820	1.0	3.0	-	-	820	-	5700	5100
3-11-75	650	-	700	0	700	14	-	840	940	43,000	41,000	850	860	20	-	600	0.0	0.0	-	-	870	-	2300	2300
6-24-75	31	-	0	0	140	8	-	83	15	1,800	1,800	180	180	70	-	170	0.0	0.0	-	-	180	-	320	410
12-16-75	1700	-	1800	0	1000	8	-	750	740	17,000	17,000	110	150	20	-	860	0.0	0.0	-	-	740	-	1500	1200
4-12-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-01-76	1300	-	36	0	800	19	-	750	790	-	45,000	170	180	30	-	530	0.8	0.8	-	-	520	-	1600	1900

2 Micrograms per liter

Table 3. Chemical analyses, injection well and satellite monitor (concentrations in milligrams per liter, except as noted).

Date of Collection	Specific Conductance (micromhos at 25° C)	pH (units)[1]	Temperature (°C)[1]	Color (Pt-Co units)	Turbidity	Suspended Solids at 110° C	Density at 20° C (gm/ml)	Specific Gravity	Sodium Absorption Ratio (SAR)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)[2]	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)[1]	Carbonate (CO_3)[1]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)
Chemical analyses, injection well																				
8-29-72	131,000	6.6	41.0	250	85	139	-	-	-	20	4800	1600	120,000	39,000	1200	340	0	3200	72,000	13
Chemical analyses, satellite monitor																				
3-18-75	140,000	6.6	31.0	-	-	-	1.083	-	123	18	4400	1700	93,000	38,000	1300	222	-	3600	66,000	3.2
6-25-75	143,000	6.2	32.5	-	-	-	1.086	-	152	18	4000	1600	35,000	45,000	1400	273	0	2900	73,000	2.9
9-30-75	130,000	7.2	27.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2700	75,000	6.0
12-18-75	158,000	-	-	-	-	-	1.088	-	141	15	4800	1600	87,000	44,000	1300	368	-	2500	30,000	4.9
4-01-76	144,000	6.4	34.0	-	-	-	1.086	-	-	-	-	-	-	-	-	-	-	-	-	4.5
7-01-76	156,000	7.1	25.0	-	-	-	1.085	-	138	5.5	4200	1700	84,000	42,000	1400	251	-	3900	80,000	5.8
11-04-76	115,000	6.3	25.0	-	-	-	1.088	-	-	-	-	-	-	-	-	-	-	2200	74,700	3.2
11-18-76[3]	140,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2500	72,000	2.7

1 Determined in field at time of sample collection

2 Micrograms per liter

3 Point sample from 4302 ft

Table 3. Chemical analyses, injection well and satellite monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Dissolved Solids		Non-Carbonate Hardness ($CaCO_3$)	Total Hardness ($CaCO_3$)	Alkalinity as $CaCO_3$	Acidity (H^{+1})	Nitrogen Species					Dissolved Organic Carbon (DOC)	Total Organic Carbon (TOC)	Total Inorganic Carbon	Total Carbon	Chemical Oxygen Demand (COD)	Total Phosphorus as P	Orthophosphorus as P	Arsenic (As) Dissolved[2]	Arsenic (As) Total[2]	Boron (B) Dissolved[2]
	Calculated sum of determined constituents	Residue at 180° C					Nitrate NO_3 as N	Nitrite NO_2 as N	Ammonia NH_4 as N	Organic Nitrogen as N	Total Nitrogen as N										
Chemical analyses, injection well																					
8-29-72	-	124,000	18,000	19,000	279	-	.00	.00	9.6	.40	10	-	440	92	530	76	.70	.10	-	10	-
Chemical analyses, Satellite monitor																					
3-18-75	121,000	120,000	18,000	18,000	230	2.9	.06	.01	10	-	-	-	-	-	-	140	.44	.08	1	-	1100
6-25-75	130,000	130,000	16,000	17,000	260	.0	.00	.02	12	.13	-	3.0	3.0	-	-	160	.05	.08	0	-	3500
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-18-75	135,000	132,000	18,000	19,000	302	.0	-	-	-	-	.01	-	-	-	-	-	1.6	-	0	0	12000
7-01-76	146,000	-	17,000	16,000	206	.0	-	-	12	-	0	10.0	4.0	-	-	-	.10	-	1	1	1800
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11-18-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2 Micrograms per liter

Table 3. Chemical analyses, injection well and satellite monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Cadmium (Cd) Dissolved[2]	Cadmium (Cd) Total[2]	Chromium (Cr) Dissolved[2]	Chromium (Cr) Hexavalent[2]	Chromium (Cr) Total[2]	Cobalt (Co) Dissolved[2]	Cobalt (Co) Total[2]	Copper (Cu) Dissolved[2]	Copper (Cu) Total[2]	Iron (Fe) Dissolved[2]	Iron (Fe) Total[2]	Lead (Pb) Dissolved[2]	Lead (Pb) Total[2]	Lithium (Li) Dissolved[2]	Lithium (Li) Total[2]	Manganese (Mn) Dissolved[2]	Mercury (Hg) Dissolved[2]	Mercury (Hg) Total[2]	Molybdenum (Mo) Dissolved[2]	Molybdenum (Mo) Total[2]	Nickel (Ni) Dissolved[2]	Nickel (Ni) Total[2]	Zinc (Zn) Dissolved[2]	Zinc (Zn) Total[2]
Chemical analyses, injection well																								
8- 9-72	210	210	150	-	150	740	750	70	110	53,000	53,000	-	-	1700	1700	610	-	0.5	-	-	690	780	240	-
Chemical analyses, satellite monitor																								
3-18-75	0	-	8	0	100	3	-	1	4	6,000	5,800	10	9	1600	-	700	0.0	0.0	-	-	2	-	70	7700
6-25-75	0	-	8	0	90	0	-	0	8	910	1,400	0	9	560	-	160	0.0	0.0	-	-	1	-	40	1300
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-18-75	0	-	0	0	90	0	-	0	6	1,400	12,000	2	26	900	-	560	0.0	0.0	-	-	-	0	40	130
7-01-76	1	-	0	0	130	0	-	0	1100	-	-	0	170	1100	-	1200	0.3	0.8	-	-	0	-	-	-
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11-18-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2 Micrograms per liter

Table 4. Chemical analyses, shallow annulus monitor (concentrations in milligrams per liter, except as noted).

Date of Collection	Specific Conductance (micromhos at 25° C)	pH (units)[1]	Temperature (°C)[1]	Color (Pt-Co units)	Turbidity	Suspended Solids at 110° C	Density at 20° C (gm/ml)	Specific Gravity	Sodium Absorption Ratio (SAR)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)[2]	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)[1]	Carbonate (CO_3)[1]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)
10- 4-72	3440	7.7	28.0	5	10	-	-	1.005	-	21	670	200	14,000	26	6	230	0	1800	-	2.7
9-10-73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1700	-	-
7-25-74	2950	7.2	29.5	-	52	-	0.999	-	.2	20	550	170	12,000	23	3.4	184	0	1800	45	2.3
9-30-74	3000	8.0	28.0	-	-	-	1.001	-	-	-	-	-	-	-	-	-	-	-	42	3.6
1- 9-75	2800	7.7	27.5	-	-	-	1.000	-	.2	20	570	160	13,000	20	3.2	175	-	1800	33	2.3
3-11-75	3020	7.7	26.5	-	-	-	1.001	-	.2	20	570	170	-	19	3.4	183	-	1800	33	2.1
6-24-75	3020	7.8	28.5	-	-	-	1.001	-	.2	20	560	170	12,000	18	3.2	175	0	1800	44	2.2
9-30-75	3390	8.4	-	-	-	-	1.001	-	-	-	-	-	-	-	-	-	-	1700	41	3.0
12-16-75	2910	-	-	-	-	-	1.001	-	.2	7.4	530	170	13,000	22	3.3	79	-	1900	40	2.8
4-01-76	2800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.8
7-01-76	3400	7.7	29.5	-	-	-	1.001	-	.2	21	530	170	9,900	18	3.0	144	-	1900	37	4.6
11-04-76	2900	7.6	-	-	-	-	1.001	-	-	-	-	-	-	-	-	-	-	1500	37	2.3

1. Determined in field at time of sample collection

2 Micrograms per liter

Table 4. Chemical analyses, shallow annulus monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Dissolved Solids: Calculated sum of determined constituents	Dissolved Solids: Residue at 180° C	Non-Carbonate Hardness ($CaCO_3$)	Total Hardness ($CaCO_3$)	Alkalinity as $CaCO_3$	Acidity (H^{+1})	Nitrogen Species: Nitrate NO_3 as N	Nitrogen Species: Nitrite NO_2 as N	Nitrogen Species: Ammonia NH_4 as N	Nitrogen Species: Organic Nitrogen as N	Nitrogen Species: Total Nitrogen as N	Dissolved Organic Carbon (DOC)	Total Organic Carbon (TOC)	Total Inorganic Carbon	Total Carbon	Chemical Oxygen Demand (COD)	Total Phosphorus as P	Orthophosphorus as P	Arsenic (As) Dissolved[2]	Arsenic (As) Total[2]	Boron (B) Dissolved[2]
10- 4-72	3100	-	2300	2500	189	-	.00	.00	.76	.04	.80	16	18	31	49	20	.01	.00	10	10	-
9-10-73	-	3000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-25-74	2720	3110	1900	2100	151	-	.02	.00	.68	.00	.70	-	-	-	-	12	.03	.00	1	-	60
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.09	.09	-	-	-
1- 9-75	2710	1560	2000	2100	180	-	.00	.00	.76	.01	-	9.0	3.0	-	-	-	.02	.01	0	-	60
3-11-75	2710	3000	2000	2100	180	.2	.00	.00	.91	.10	-	3.0	3.0	-	-	9	.13	.03	1	-	100
6-24-75	2720	2820	2000	2100	144	0	.01	.00	.93	.12	-	1.0	2.0	-	-	8	.02	.00	0	-	60
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-16-75	2730	2960	2000	2000	65	0	.03	.01	.76	-	.87	-	4.0	-	-	-	.04	.01	2	2	50
7-01-76	2770	-	1900	2000	118	0	.00	.00	.71	-	.09	2.0	2.0	-	-	-	.01	.01	2	2	10
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2. Micrograms per liter

Table 4. Chemical analyses, shallow annulus monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Cadmium (Cd) Dissolved[2]	Cadmium (Cd) Total[2]	Chromium (Cr) Dissolved[2]	Chromium (Cr) Hexavalent[2]	Chromium (Cr) Total[2]	Cobalt (Co) Dissolved[2]	Cobalt (Co) Total[2]	Copper (Cu) Dissolved[2]	Copper (Cu) Total[2]	Iron (Fe) Dissolved[2]	Iron (Fe) Total[2]	Lead (Pb) Dissolved[2]	Lead (Pb) Total[2]	Lithium (Li) Dissolved[2]	Lithium (Li) Total[2]	Manganese (Mn) Dissolved[2]	Mercury (Hg) Dissolved[2]	Mercury (Hg) Total[2]	Molybdenum (Mo) Dissolved[2]	Molybdenum (Mo) Total[2]	Nickel (Ni) Dissolved[2]	Nickel (Ni) Total[2]	Zinc (Zn) Dissolved[2]	Zinc (Zn) Total[2]
10- 4-72	0	1	20	0	-	0	1	0	10	100	1500	0	5	20	20	80	0	-	3	3	0	1	10	-
9-10-73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-25-74	0	-	0	0	80	1	-	0	1	40	2800	0	-	21	-	78	0.1	-	-	-	6	-	10	30
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1- 9-75	0	-	1	1	10	1	-	0	0	160	180	5	3	23	-	35	0.0	0.1	-	-	0	-	0	20
3-11-75	1	-	0	0	10	0	-	0	4	70	2100	0	4	20	-	60	0.0	0.1	-	-	0	-	6	40
6-24-75	1	1	0	0	10	1	-	0	10	160	730	3	16	60	-	90	0.0	0.1	-	-	3	-	1	50
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-16-75	0	-	0	0	0	0	-	0	6	0	9200	2	38	10	-	220	0.0	0.5	-	-	2	-	0	80
7-01-76	0	-	0	0	20	0	-	0	8	-	-	6	12	20	-	30	0.1	0.6	-	-	0	-	20	30
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2 Micrograms per liter

Table 5. Chemical analyses, deep annulus monitor (concentrations in milligrams per liter, except as noted).

Date of Collection	Specific Conductance (micromhos at 25° C)	pH (units)[1]	Temperature (°C)[1]	Color (Pt-Co units)	Turbidity	Suspended Solids at 110° C	Density at 20° C (gm/ml)	Specific Gravity	Sodium Absorption Ratio (SAR)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Strontium (Sr)[2]	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)[1]	Carbonate (CO_3)[1]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)
10-4-72	8750	7.4	28.5	50	40	-	-	1.001	-	15	850	200	15,000	1200	50	144	0	2400	1800	3.0
9-10-73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2400	-	-
7-25-74	8810	8.0	29.5	-	10	-	1.000	-	9.0	18	810	190	14,000	1100	48	143	0	2600	1700	2.7
9-30-74	8700	8.2	29.0	-	-	-	1.004	-	-	-	-	-	-	-	-	-	-	2600	1800	2.9
1- 9-75	8500	8.1	27.0	-	-	-	1.004	-	8.9	17	850	190	15,000	1100	47	146	-	2500	1800	3.3
3-11-75	9200	8.0	26.0	-	-	-	1.004	-	8.1	16	840	190	-	1000	52	146	-	2400	1700	2.5
6-24-75	8740	8.0	29.0	-	-	-	1.003	-	9.7	17	840	190	13,000	1200	47	144	0	2500	1800	3.6
9-30-75	8940	7.9	28.5	-	-	-	1.004	-	-	-	-	-	-	-	-	-	-	2200	1800	3.5
12-16-75	8590	-	-	-	-	-	1.004	-	8.8	17	900	170	14,000	1100	44	141	-	2300	1900	6.0
4-01-76	8600	-	28.0	-	-	-	1.004	-	-	-	-	-	-	-	-	-	-	-	1800	2.6
7-01-76	8880	8.2	29.0	-	-	-	1.004	-	8.9	20	850	190	9,300	1100	46	112	-	2600	2000	4.2
11-04-76	8450	7.9	-	-	-	-	1.002	-	-	-	-	-	-	-	-	-	-	2200	1900	2.9

1 Determined in field at time of sample collection

2 Micrograms per liter

Table 5. Chemical analyses, deep annulus monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Dissolved Solids: Calculated sum of determined constituents	Dissolved Solids: Residue at 180° C	Non-Carbonate Hardness ($CaCO_3$)	Total Hardness ($CaCO_3$)	Alkalinity as $CaCO_3$	Acidity (H^{+1})	Nitrogen Species: Nitrate NO_3 as N	Nitrogen Species: Nitrite NO_2 as N	Nitrogen Species: Ammonia NH_4 as N	Nitrogen Species: Organic Nitrogen as N	Nitrogen Species: Total Nitrogen as N	Dissolved Organic Carbon (DOC)	Total Organic Carbon (TOC)	Total Inorganic Carbon	Total Carbon	Chemical Oxygen Demand (COD)	Total Phosphorus as P	Orthophosphorus as P	Arsenic (As) Dissolved[2]	Arsenic (As) Total[2]	Boron (B) Dissolved[2]
10- 4-72	6600	-	2900	3000	118	-	.00	.00	.50	1.4	1.9	9.0	12	22	34	-	.03	-	-	10	-
9-10-73	-	6990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-25-74	6560	7100	2700	2800	117	-	.01	.00	.44	.00	.45	-	-	-	-	96	.05	.00	1	-	1900
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	.03	-	-	-
1- 9-75	6600	4610	2800	2900	120	-	.00	.00	.62	.00	-	6.0	2.0	-	-	-	.74	.02	0	-	870
3-11-75	6280	6870	2800	2900	150	.1	.00	.00	.79	.06	-	1.0	1.0	-	-	10	.08	.04	1	-	1100
5-24-75	6680	7070	2800	2900	118	-	.00	.00	.61	.08	-	1.0	1.0	-	-	20	.02	.01	0	-	620
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-16-75	6520	6890	2800	3000	116	0	.00	.00	.56	-	.29	-	4.0	-	-	-	.04	.03	1	1	1000
4-01-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-01-76	6880	-	2800	2900	92	0	.00	.00	.47	-	.37	1.0	1.0	-	-	-	.02	.02	1	2	430
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2 Micrograms per liter

Table 5. Chemical analyses, deep annulus monitor (concentrations in milligrams per liter, except as noted). (Continued.)

Date of Collection	Cadmium (Cd) Dissolved[2]	Cadmium (Cd) Total[2]	Chromium (Cr) Dissolved[2]	Chromium (Cr) Hexavalent[2]	Chromium (Cr) Total[2]	Cobalt (Co) Dissolved[2]	Cobalt (Co) Total[2]	Copper (Cu) Dissolved[2]	Copper (Cu) Total[2]	Iron (Fe) Dissolved[2]	Iron (Fe) Total[2]	Lead (Pb) Dissolved[2]	Lead (Pb) Total[2]	Lithium (Li) Dissolved[2]	Lithium (Li) Total[2]	Manganese (Mn) Dissolved[2]	Mercury (Hg) Dissolved[2]	Mercury (Hg) Total[2]	Molybdenum (Mo) Dissolved[2]	Molybdenum (Mo) Total[2]	Nickel (Ni) Dissolved[2]	Nickel (Ni) Total[2]	Zinc (Zn) Dissolved[2]	Zinc (Zn) Total[2]
10- 4-72	0	1.0	20	0	20	0	1	0	10	2400	3500	2	11	80	80	170	0.0	-	1	1	0	1	20	260
9-10-73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7-25-74	0	-	0	0	10	1	-	0	4	20	1900	1	1	79	-	170	0.0	-	-	-	5	-	20	20
9-30-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1- 9-75	0	-	1	1	20	0	-	1	0	160	900	4	7	82	-	91	0.0	0.0	-	-	5	-	6	6
3-11-75	1	-	0	0	40	0	-	0	4	10	1600	1	2	80	-	90	0.0	0.0	-	-	0	-	6	50
6-24-75	1	-	0	0	20	0	-	0	2	20	740	4	6	90	-	90	0.0	0.0	-	-	0	-	10	20
9-30-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-16-75	0	-	0	0	10	0	0	0	4	20	1000	2	14	70	-	40	0.0	0.0	-	-	0	-	0	50
7-01-76	0	-	0	0	40	0	-	0	12	180	850	0	10	80	-	40	0.2	0.5	-	-	0	-	10	20
11-04-76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2 Micrograms per liter

The Kaiser Plant at Mulberry produces sodium fluosilicate from the reaction of sodium chloride with fluosilicic acid, a byproduct of nearby phosphate-processing plants. Except for occasional interruptions, the plant and the injection well operate continuously.

The waste effluent is injected sometimes by a constant-head pump and sometimes by gravity flow. When the effluent is being pumped, the rate varies in order to maintain constant well-head pressure. Figure 2 shows the monthly volume of waste injected, as reported by Kaiser (written communication). From October 1975 through December 1976, injection rate averaged about 8.2 Mgal per month. The maximum monthly volume was 10.2 Mgal, in June 1976. The minimum value (1.52 Mgal) occurred in April 1976, when the plant was shut down for several weeks.

Figure 3 shows hydrographs for the two monitor wells in the grouted part of the injection-well annulus. The shallow annulus monitor well taps fresh water in the lower part of the Floridan aquifer and the deep one is open to a saline-water aquifer. The hydrographs indicate that the shallow well has a greater range of water-level fluctuation, reflecting seasonal variations in recharge and discharge of the Floridan aquifer, including pumping by wells in the area.

Figure 4 shows mean water levels taken every fifth day from a continuous recorder chart. A comparison with the graph of monthly injection rate (fig. 2) indicates that the water level in the satellite monitor well rises in response to increased injection rate and declines in response to decreased injection rate at the injection well.

Tables 2 through 5 present the results of chemical analyses of samples of the injected waste effluent and from the injection well, satellite monitor well, and annulus monitor wells. The chemical constituents show variations in concentration from time to time, but no overall changes. The relatively high and widely varying concentrations of iron in all well samples probably represent varying amounts of iron derived from the well casings. Variations in the chemical makeup of the waste effluent result from variations in plant processing and in the amount of dilution from rainwater in the storage pond.

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