Resource Conservation and Recovery Act

Post-Closure Care Permit Application

For U.S.D.O.E.-Rocky Flats Plant Hazardous & Radioactive Mixed Wastes

CO7890010526

5 October 1988

Volume VI

[redacted]

APPENDIX 4

- Laboratory Test Results
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  Buffer Zone
  April and May 1986

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  February 1988

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  August 14, 1987
  Lab No. E87-3918

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- 207-A and 207-C Solar Pond
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APPENDIX 4

LABORATORY TEST RESULTS
SOLAR PONDS 207-A AND 207-B NORTH
INTERCEPTOR TRENCH PUMP HOUSE
BUFFER ZONE
APRIL AND MAY 1986

TABLE 4-I

SUMMARY OF RADIOCHEMICAL ANALYSES
APRIL AND MAY 1986

COMPOUND	POND 207-A LIQUID (pCi/L)	POND 207-A SLUDGE (pCi/g)	POND 207-B NORTH LIQUID (pCi/L)
Gross Alpha	46,000±4,000 to 80,000±6,000	4,700±200 to 14,000±1,000	74±58 to 120±50
Gross Beta	35,000±2,000 to 40,000±2,000	160±20 to 1,400±100	56±32 to 100±92
Plutonium-239	56±16 to 660±50	1,000±100 to 3,700±100	ND[(a)]
Americium-241	ND to 45±14	1,400±200 to 4,400±100	ND
Uranium-233+234	14,000±1,000 to 20,000±1,000	71±10 to 570±30	50±2 to 53±2
Uranium-238	21,000±1,000 to 28,000±1,000	130±10 480±30	31±1 to 33±1
Tritium	240±180 to 930±260	1,300±500[(b)] to 12,000±1,000	1,200±300 to 1,300±300

(a) ND indicates levels below the detection error limits.
(b) Units for tritium in sludge = pCi/l

TABLE 4-II

SUMMARY OF METALS AND PHENOLS TESTING
APRIL AND MAY 1986

COMPOUND	POND 207-A LIQUID (ug/L)	POND 207-A SLUDGE (mg/kg)	POND 207-B NORTH LIQUID (ug/L)
Aluminum	2,310-2,640	11,000-11,900	ND[(a)]
Arsenic	150	ND	ND
Barium	ND	ND	ND-220
Beryllium	27-43	309-1,570	ND
Cadmium	70-150	1,110-10,500	ND
Calcium	ND	19,600-50,000	176,000-198,000
Chromium	13,700-16,700	1,010-19,700	ND
Cobalt	200-500	ND	ND
Copper	1,610-1,800	425-1,590	ND
Iron	1,500-8,000	3,590-6,900	ND
Lead	ND	65-455	ND
Magnesium	ND	6,110-21,000	66,400-72,600
Manganese	95-115	153-595	ND-15
Mercury	ND-0.2	7.5-25	ND
Nickel	1,900-2,000	124-1,320	ND-50
Potassium	13,200,000-14,300,000	50,000-65,300	56,100-62,700
Selenium	ND	ND	9
Silver	310-370	153-237	ND
Sodium	36,300,000-42,900,000	130,000-166,000	363,000-451,000
Tin	7,000-13,000	ND	ND
Vanadium	100-210	ND	ND
Zinc	620-780	227-595	ND-22
Phenols	13-35	ND-3.3	3-46

(a) ND indicates compound not detected above the detection limit.

INTRODUCTION

The results presented herein are for samples from Ponds 207-A and 207-B North, the interceptor trench pump house and the buffer zone collected in April and May 1986 and resampling of the interceptor trench pump house in August 1986.

The samples are generally designated by a three character code. The last character designates the analytical sample code as shown in Table A. The remaining portion of the codes are as follows:

Liquids

Pond 207-A liquid is designated by a prefix of 207A and a two character code. The first character is, A, B or C, indicates the location, north, center or south, respectively, that the sample was taken along the west side of the pond. The meaning of the second character is shown in Table A.

Pond 207-B North liquid is designed by a prefix 207B and a two character code. The first character of the code is the same as described for the Pond 207-A liquid samples. The meaning of the second character is shown in Table A.

TABLE A

ANALYTICAL SAMPLE CODE

Sample Type	Code	Designation
Water	1	Volatiles
	2	Semi-Volatiles
	3	Metals
	4	Cyanide
	5	Phenolics
	6	RCRA Waste Characterization
	7	Radiochemistry
	8	Tritium
Soil/Sediment	1	Volatiles
	2	Semi-Volatiles
	3	Metals and Cyanide
	4	RCRA Waste Characteristics
	5	Radiochemistry

For samples from the interceptor trench pump house, the first character, L, indicates a liquid sample. The liquid was sampled in triplicate, A,B or C, designated by the second character. A second character of 0 (zero) indicates a field blank sample. In the resampling, the sample code has a prefix of ITPH.

Soils and Sediment

Sediment from Pond 207-A is designated with a 207-A prefix and three character code. The first character, S, indicates a sediment sample. The second character, A, B or C, indicates the location, north, center or south, respectively, that the sample was taken along the west side of the pond. The meaning of the third character is shown in Table A.

For samples from the interceptor trench pump house, the first characters, S, indicates a sediment sample. The second character, A or B, indicates the initial or duplicate sample, respectively. In the resampling, the sample code has a prefix of ITPH. The meaning of the third character is shown in Table A.

Samples from the buffer zone are designated by a three character code. The first character of the code indicates the composite sample number, 1, 2 or 3. The second character, A, B or C, indicates the sample depth. A surface scrape is designated by A, a sample from 0 to 6 inches by B and a sample from 6 to 12 inches by C.

Solar Pond 207A liquor

VOLATILE COMPOUNDS

Compound ug/l	A1	B1	C1
		Sample Numbers	
Chloromethane	1000U	100U	NA
Bromomethane	1000U	100U	
Vinyl Chloride	1000U	100U	
Chloroethane	1000U	100U	
Methylene Chloride	500U	50U	
Acetone	*260J	*100J	
Carbon Disulfide	500U	50U	
1,1 Dichloroethene	500U	50U	
1,1 Dichloroethane	500U	50U	
Trans-1,2- Dichloroethene	500U	50U	
Chloroform	500U	50U	
1,2 Dichloroethane	500U	50U	
2-Butanone	1000U	100U	
1,1,1-Trichloroethane	500U	50U	
Carbon Tetrachloride	500U	50U	
Vinyl Acetate	1000U	100U	
Bromodichloromethane	500U	50U	
1,2 Dichloropropane	500U	50U	
Trans-1,3-Dichloropropene	500U	50U	
Trichloroethene	500U	50U	
Dibromochloromethane	500U	50U	
1,1,2-Trichloroethane	500U	50U	
Benzene	500U	50U	
cis-1,3-Dichloropropene	500U	50U	
2-Chloroethylvinylether	1000U	100U	
Bromoform	500U	50U	
4-Methyl-2-Pentanone	1000U	100U	
2-Hexanone	1000U	100U	
Tetrachloroethene	500U	50U	
1,1,2,2-Tetrachloroethane	500U	50U	
Toluene	500U	50U	
Chlorobenzene	500U	50U	
Ethylbenzene	500U	50U	
Styrene	500U	50U	
Total Xylenes	500U	50U	

U - indicates that compound was analyzed for but not detected. The number associated with the letter U is the minimum detection limit attainable for the sample.

J - indicates an estimated value.

Solar Pond 207A Sediments

VOLATILE COMPOUNDS

Compound ug/Kg	SA1	SB1	SC1
	Sample Number		
Chloromethane	3600U	36U	4000U
Bromomethane	3600U	36U	4000U
Vinyl Chloride	3600U	36U	4000U
Chloroethane	3600U	36U	4000U
Methylene Chloride	1800U	18U	2000U
Acetone	* 4680	* 5JB	*1600JB
Carbon Disulfide	1800U	18U	2000U
1,1 Dichloroethene	1800U	18U	2000U
1,1 Dichloroethane	1800U	18U	2000U
Trans-1,2- Dichloroethene	1800U	18U	2000U
Chloroform	1800U	18U	2000U
1,2 Dichloroethane	1800U	18U	2000U
2-Butanone	3600U	36U	4000U
1,1,1-Trichloroethane	1800U	18U	2000U
Carbon Tetrachloride	1800U	18U	2000U
Vinyl Acetate	3600U	36U	4000U
Bromodichloromethane	1800U	18U	2000U
1,2 Dichloropropane	1800U	18U	2000U
Trans-1,3-Dichloropropene	1800U	18U	2000U
Trichloroethene	1800U	18U	2000U
Dibromochloromethane	1800U	18U	2000U
1,1,2-Trichloroethane	1800U	18U	2000U
Benzene	1800U	18U	2000U
cis-1,3-Dichloropropene	1800U	18U	2000U
2-Chloroethylvinylether	3600U	36U	4000U
Bromoform	1800U	18U	2000U
4-Methyl-2-Pentanone	3600U	36U	4000U
2-Hexanone	3600U	36U	4000U
Tetrachloroethene	1800U	*200B	*1200JB
1,1,2,2-Tetrachloroethane	1800U	18U	2000U
Toluene	1800U	18U	2000U
Chlorobenzene	1800U	18U	2000U
Ethylbenzene	1800U	18U	2000U
Styrene	1800U	18U	2000U
Total Xylenes	1800U	18U	2000U

U - indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

J - indicates an estimated value.
B - analyte was found in blank as well as the sample; indicates possible blank contamination.

Solar Pond 207B liquor

VOLATILE COMPOUNDS

Compound	ug/l	Sample Numbers A1	B1	C1	01
Chloromethane		10U	10U	10U	10U
Bromomethane		10U	10U	10U	10U
Vinyl Chloride		10U	10U	10U	10U
Chloroethane		10U	10U	10U	10U
Methylene Chloride		*28B	*35B	*19B	*71B
Acetone		10U	10U	10U	10U
Carbon Disulfide		5U	5U	5U	5U
1,1 Dichloroethene		5U	5U	5U	5U
1,1 Dichloroethane		5U	5U	5U	5U
Trans-1,2- Dichloroethene		5U	5U	5U	5U
Chloroform		5U	5U	5U	5U
1,2 Dichloroethane		5U	5U	5U	5U
2-Butanone		10U	10U	10U	*20
1,1,1-Trichloroethane		5U	5U	5U	5U
Carbon Tetrachloride		5U	5U	5U	5U
Vinyl Acetate		10U	10U	10U	10U
Bromodichloromethane		5U	5U	5U	5U
1,2 Dichloropropane		5U	5U	5U	5U
Trans-1,3-Dichloropropene		5U	5U	5U	5U
Trichloroethene		5U	5U	5U	5U
Dibromochloromethane		5U	5U	5U	5U
1,1,2-Trichloroethane		5U	5U	5U	5U
Benzene		5U	5U	5U	5U
cis-1,3-Dichloropropene		5U	5U	5U	5U
2-Chloroethylvinylether		10U	10U	10U	10U
Bromoform		5U	5U	5U	5U
4-Methyl-2-Pentanone		10U	10U	10U	10U
2-Hexanone		10U	10U	10U	10U
Tetrachloroethene		5U	5U	5U	5U
1,1,2,2-Tetrachloroethane		5U	5U	5U	5U
Toluene		5U	5U	5U	5U
Chlorobenzene		5U	5U	5U	5U
Ethylbenzene		5U	5U	5U	5U
Styrene		5U	5U	5U	5U
Total Xylenes		5U	5U	5U	5U

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

B - Analyte was found in the blank as well as the sample; indicates possible blank contamination.

Interceptor Trench Pump House Water

VOLATILE COMPOUNDS

Sample Numbers

Compound ug/l	LA1	LB1	LC1	L01
Chloromethane	10U	10U	10U	10U
Bromomethane	10U	10U	10U	10U
Vinyl Chloride	10U	10U	10U	10U
Chloroethane	10U	10U	10U	10U
Methylene Chloride	*3BJ	*10B	*14B	*99B
Acetone	10U	10U	10U	10U
Carbon Disulfide	5U	5U	5U	5U
1,1 Dichloroethene	5U	5U	5U	5U
1,1 Dichloroethane	5U	5U	5U	5U
Trans-1,2- Dichloroethene	5U	5U	5U	5U
Chloroform	*3J	*6	5U	3J
1,2 Dichloroethane	5U	5U	5U	5U
2-Butanone	10U	10U	10U	*110
1,1,1-Trichloroethane	5U	5U	5U	5U
Carbon Tetrachloride	*7	*6	*7	5U
Vinyl Acetate	10U	10U	10U	10U
Bromodichloromethane	5U	5U	5U	5U
1,2 Dichloropropane	5U	5U	5U	5U
Trans-1,3-Dichloropropene	5U	5U	5U	5U
Trichloroethene	*7	*8U	*8	5U
Dibromochloromethane	5U	5U	5U	5U
1,1,2-Trichloroethane	5U	5U	5U	5U
Benzene	*1J	5U	5U	5U
cis-1,3-Dichloropropene	5U	5U	5U	5U
2-Chloroethylvinylether	10U	10U	10U	10U
Bromoform	5U	5U	5U	5U
4-Methyl-2-Pentanone	10U	10U	10U	10U
2-Hexanone	10U	10U	10U	10U
Tetrachloroethene	5U	5U	5U	5U
1,1,2,2-Tetrachloroethane	5U	5U	5U	5U
Toluene	5U	5U	5U	5U
Chlorobenzene	5U	5U	5U	5U
Ethylbenzene	5U	5U	5U	5U
Styrene	5U	5U	5U	5U
Total Xylenes	5U	5U	5U	5U

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

J - Indicates an estimated value.

B - Analyte was found in blank as well as the sample indicating possible blank contamination.

Interceptor Trench Pump House Sediments

VOLATILE COMPOUNDS

Compound ug/Kg	Sample Numbers SA1	SB1
Chloromethane	17U	16U
Bromomethane	17U	16U
Vinyl Chloride	17U	16U
Chloroethane	17U	16U
Methylene Chloride	*44B	*27B
Acetone	*23	*47
Carbon Disulfide	*3BJ	*5JB
1,1 Dichloroethene	8U	8U
1,1 Dichloroethane	8U	8U
Trans-1,2- Dichloroethene	8U	8U
Chloroform	8U	8U
1,2 Dichloroethane	8U	8U
2-Butanone	17U	16U
1,1,1-Trichloroethane	8U	8U
Carbon Tetrachloride	8U	8U
Vinyl Acetate	17U	16U
Bromodichloromethane	8U	8U
1,2 Dichloropropane	8U	8U
Trans-1,3-Dichloropropene	8U	8U
Trichloroethene	3J	*2J
Dibromochloromethane	8U	8U
1,1,2-Trichloroethane	8U	8U
Benzene	8U	8U
cis-1,3-Dichloropropene	8U	8U
2-Chloroethylvinylether	17U	16U
Bromoform	8U	8U
4-Methyl-2-Pentanone	17U	16U
2-Hexanone	17U	16U
Tetrachloroethene	8U	8U
1,1,2,2-Tetrachloroethane	8U	8U
Toluene	8U	*7J
Chlorobenzene	8U	8U
Ethylbenzene	8U	8U
Styrene	8U	8U
Total Xylenes	8U	8U

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum detection limit attainable for the sample.

J - Indicates as estimated value.

B - Analyte was found in the blank as well as the sample indicating possible blank contamination.

Buffer Zone Soils

VOLATILE COMPOUNDS

Composite 1 - Sample Numbers

Compound ug/Kg	surface scrape 1A1	0-6" 1B1	6-12" 1C1
Chloromethane	10U	13U	14U
Bromomethane	10U	13U	14U
Vinyl Chloride	10U	13U	14U
Chloroethane	10U	13U	14U
Methylene Chloride	5U	*46B	*39B
Acetone	10U	13U	*130
Carbon Disulfide	5U	*3BJ	*3BJ
1,1 Dichloroethene	5U	6U	7U
1,1 Dichloroethane	5U	6U	7U
Trans-1,2- Dichloroethene	5U	6U	7U
Chloroform	5U	6U	7U
1,2 Dichloroethane	5U	6U	7U
2-Butanone	10U	13U	*61
1,1,1-Trichloroethane	5U	6U	7U
Carbon Tetrachloride	5U	6U	7U
Vinyl Acetate	10U	13U	14U
Bromodichloromethane	5U	6U	7U
1,2 Dichloropropane	5U	6U	7U
Trans-1,3-Dichloropropene	5U	6U	7U
Trichloroethene	5U	6U	7U
Dibromochloromethane	5U	6U	7U
1,1,2-Trichloroethane	5U	6U	7U
Benzene	5U	6U	7U
cis-1,3-Dichloropropene	5U	6U	7U
2-Chloroethylvinylether	10U	13U	14U
Bromoform	5U	6U	7U
4-Methyl-2-Pentanone	10U	13U	14U
2-Hexanone	10U	13U	14U
Tetrachloroethene	5U	6U	7U
1,1,2,2-Tetrachloroethane	5U	6U	7U
Toluene	*1JB	6U	*3J
Chlorobenzene	5U	6U	7U
Ethylbenzene	5U	6U	7U
Styrene	5U	6U	7U
Total Xylenes	5U	6U	7U

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

J - Indicates an estimated value.

B - Analyte was found in blank as well as the sample indicating possible blank contamination.

VOLATILE COMPOUNDS

Compound	ug/Kg	Composite 2 - Sample Numbers surface scrape 2A1	0-6" 2B1	6-12" 2C1
Chloromethane		10U	13U	NA
Bromomethane		10U	13U	
Vinyl Chloride		10U	13U	
Chloroethane		10U	13U	
Methylene Chloride		5U	*32B	
Acetone		*10B	13U	
Carbon Disulfide		5U	*2BJ	
1,1 Dichloroethene		5U	6U	
1,1 Dichloroethane		5U	6U	
Trans-1,2- Dichloroethene		5U	6U	
Chloroform		5U	6U	
1,2 Dichloroethane		5U	6U	
2-Butanone		10U	13U	
1,1,1-Trichloroethane		5U	6U	
Carbon Tetrachloride		5U	6U	
Vinyl Acetate		10U	13U	
Bromodichloromethane		5U	6U	
1,2 Dichloropropane		5U	6U	
Trans-1,3-Dichloropropene		5U	6U	
Trichloroethene		5U	6U	
Dibromochloromethane		5U	6U	
1,1,2-Trichloroethane		5U	6U	
Benzene		5U	6U	
cis-1,3-Dichloropropene		5U	6U	
2-Chloroethylvinylether		10U	13U	
Bromoform		5U	6U	
4-Methyl-2-Pentanone		10U	13U	
2-Hexanone		10U	13U	
Tetrachloroethene		5U	6U	
1,1,2,2-Tetrachloroethane		5U	6U	
Toluene		*1JB	6U	
Chlorobenzene		5U	6U	
Ethylbenzene		5U	6U	
Styrene		5U	6U	
Total Xylenes		5U	6U	

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

J - Indicates an estimated value.

B - Analyte was found in blank as well as the sample indicating possible blank contamination.

Buffer Zone Soils

VOLATILE COMPOUNDS

composite 3 - Sample Numbers

Compound ug/Kg	surface scrape 3A1	0-6" 3B1	6-12" 3C1
Chloromethane	10U	13U	13U
Bromomethane	10U	13U	13U
Vinyl Chloride	10U	13U	13U
Chloroethane	10U	13U	13U
Methylene Chloride	5U	*32B	*28B
Acetone	*10B	13U	*71
Carbon Disulfide	5U	*2BJ	6U
1,1 Dichloroethene	5U	7U	6U
1,1 Dichloroethane	5U	7U	6U
Trans-1,2- Dichloroethene	5U	7U	6U
Chloroform	5U	7U	6U
1,2 Dichloroethane	5U	7U	6U
2-Butanone	10U	*20	*26
1,1,1-Trichloroethane	5U	7U	6U
Carbon Tetrachloride	5U	7U	6U
Vinyl Acetate	10U	13U	13U
Bromodichloromethane	5U	7U	6U
1,2 Dichloropropane	5U	7U	6U
Trans-1,3-Dichloropropene	5U	7U	6U
Trichloroethene	5U	7U	6U
Dibromochloromethane	5U	7U	6U
1,1,2-Trichloroethane	5U	7U	6U
Benzene	5U	7U	6U
cis-1,3-Dichloropropene	5U	7U	6U
2-Chloroethylvinylether	10U	13U	13U
Bromoform	5U	7U	6U
4-Methyl-2-Pentanone	10U	13U	13U
2-Hexanone	10U	13U	13U
Tetrachloroethene	5U	7U	6U
1,1,2,2-Tetrachloroethane	5U	7U	6U
Toluene	*1JB	7U	6U
Chlorobenzene	5U	7U	6U
Ethylbenzene	5U	7U	6U
Styrene	5U	7U	6U
Total Xylenes	5U	7U	6U

U - Indicates compound was analyzed for but not detected. The number associated with the letter U is the minimum attainable detection limit for the sample.

J - Indicates an estimated value.

B - Analyte was found in blank as well as the sample indicating possible blank contamination.

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

July 16, 1986

Mr. Mark Selman
Roy F. Weston
938 Quail Street
Denver, CO 80215

RE: 9299-21884-6
Date Samples Rec'd 5-7-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21884-6-5 207A-B7 Solar Pond Depth ≈ 4" 5-7-86	9299-21884-6-6 207A-B8 Solar Pond Depth ≈ 4" 5-7-86
Determination: pCi/L		
Gross Alpha, ± counting error*	80000 ± 6000	--
Gross Beta, ± counting error*	40000 ± 2000	--
Plutonium-239, ± counting error*	660 ± 50	--
Americium-241, ± counting error*	45 ± 14	--
Uranium-233 + 234, ± counting error*	14000 ± 1000	--
Uranium-238, ± counting error*	21000 ± 1000	--
Tritium, ± counting error*	--	930 ± 260

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
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July 17, 1986

Mr. Mark Selman
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RE: 9299-21856-6
Date Samples Rec'd 5-1-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21856-6-5 207A-A7 Solar Pond Northwest 5-1-86	9299-21856-6-6 207A-A8 Solar Pond Northwest 5-1-86
Determination: pCi/L		
Gross Alpha, dissolved, ± counting error*	46000 ± 4000	--
Gross Beta, dissolved, ± counting error*	37000 ± 2000	--
Plutonium-239, dissolved, ± counting error*	84 ± 16	--
Americium-241, dissolved, ± counting error*	-2.2 ± 3.6	--
Uranium-233 + 234, dissolved, ± counting error*	17000 ± 1000	--
Uranium-238, dissolved, ± counting error*	22000 ± 1000	--
Tritium, total, ± counting error*	--	610 ± 270

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 17, 1986

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RE: 9299-21870-8
Date Samples Rec'd 5-6-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation Determination: pCi/g (dry)	9299-21870-8-5 207A-SA7 Solar Pond NW Corner 5-5-86	9299-21870-8-6 207A-SA8 Solar Pond NW Corner 5-5-86	9299-21870-8-7 207A-SA9 Solar Pond NW Corner 5-5-86	9299-21870-8-8 207A-SA10 Solar Pond NW Corner 5-5-86
Gross Alpha, ± counting error*	14000 ± 1000	--	7400 ± 200	--
Gross Beta, ± counting error*	560 ± 50	--	160 ± 20	--
Plutonium-239, ± counting error*	3700 ± 100	--	1500 ± 100	--
Americium-241, ± counting error*	4400 ± 100	--	2800 ± 100	--
Uranium-233 + Uranium-234, ± counting error*	200 ± 20	--	570 ± 30	--
Uranium-238, ± counting error*	130 ± 10	--	280 ± 20	--
Tritium, ± counting error*, pCi/L	--	9300 ± 800	--	12000 ± 1000
Air Dry Loss, %	--	76.7	--	73.2

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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RE: 9299-21890-6
Date Samples Rec'd 5-8-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21890-6-5	9299-21890-6-6
Sponsor Designation	207A-SB7 Solar Pond Center West 5-8-86	207A-SB8 Solar Pond Center West 5-8-86
Determination: pCi/g (dry)		
Gross Alpha, ± counting error*	4700 ± 200	--
Gross Beta, ± counting error*	190 ± 40	--
Plutonium-239, ± counting error*	3400 ± 100	--
Americium-241, ± counting error*	1400 ± 200	--
Uranium-233 + 234, ± counting error*	180 ± 20	--
Uranium-238, ± counting error*	210 ± 20	--
Tritium, ± counting error*, pCi/L	--	2400 ± 600
Air Dry Loss, %	--	78.3

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 21, 1986

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RE: 9299-21907-6
Date Samples Rec'd 5-12-86
Project 2029-13-03-01

CORRECTED REPORT

REPORT OF ANALYSIS

ALR Designation	9299-21907-6-5	9299-21907-6-6
Sponsor Designation	207A-SC7 Solar Pond SW Corner 5-12-86	207A-SC8 Solar Pond SW Corner 5-12-86
Determination: pCi/g (dry)		
Gross Alpha, ± counting error*	12000 ± 1000	--
Gross Beta, ± counting error*	1400 ± 100	--
Plutonium-239, ± counting error*	1700 ± 100	--
Americium-241, ± counting error*	3500 ± 100	--
Uranium-233 + 234, ± counting error*	120 ± 20	--
Uranium-238, ± counting error*	480 ± 30	--
Tritium, ± counting error*, pCi/L	--	1300 ± 500
Air Dry Loss, %	75.7	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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RE: 9299-21907-6
Date Samples Rec'd 5-12-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21907-6-5	9299-21907-6-6
Sponsor Designation	207A-SC7 Solar Pond SW Corner 5-12-86	207A-SC8 Solar Pond SW Corner 5-12-86
Determination: pCi/g (dry)		
Gross Alpha, ± counting error*	12000 ± 1000	--
Gross Beta, ± counting error*	1400 ± 100	--
Plutonium-239, ± counting error*	1000 ± 100	--
Americium-241, ± counting error*	2100 ± 100	--
Uranium-233 + 234, ± counting error*	71 ± 10	--
Uranium-238, ± counting error*	280 ± 20	--
Tritium, ± counting error*, pCi/L	--	1500 ± 600
Air Dry Loss, %	58.8	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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RE: 9299-21943-11
Date Samples Rec'd 5-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21943-11-5 207A-C7 Solar Pond Southwest 5-15-86	9299-21943-11-6 207A-C8 Solar Pond Southwest 5-15-86	9299-21943-11-10 207A-07 Solar Pond Southwest 5-15-86	9299-21943-11-11 207A-08 Solar Pond Southwest 5-15-86
Determination: pCi/L				
Gross Alpha, ± counting error*	63000 ± 6000	--	32 ± 38	--
Gross Beta, ± counting error*	35000 ± 2000	--	-2 ± 83	--
Plutonium-239, ± counting error*	56 ± 16	--	2.9 ± 6.3	--
Americium-241, ± counting error*	11 ± 7	--	0.2 ± 5.2	--
Uranium-233 + Uranium-234, ± counting error*	20000 ± 1000	--	-2 ± 23	--
Uranium-238, ± counting error*	28000 ± 1000	--	4 ± 19	--
Tritium, ± counting error*, pCi/L	--	640 ± 190	--	240 ± 180

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 2, 1986

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RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21823-20-1	9299-21823-20-2	9299-21823-20-7	9299-21823-20-8	9299-21823-20-13
Sponsor Designation	LA7 (ITPH) Sample A	LA8 (ITPH) Sample A	LB7 (ITPH) Sample B	LB8 (ITPH) Sample B	LC7 (ITPH) Sample C
Determination: pCi/L					
Gross Alpha, dissolved, ± counting error*	120 ± 40	--	120 ± 40	--	100 ± 40
Gross Beta, dissolved, ± counting error*	120 ± 40	--	75 ± 25	--	100 ± 30
Plutonium-239, dissolved, ± counting error*	0.16 ± 0.10	--	0.05 ± 0.08	--	0.06 ± 0.06
Americium-241, dissolved, ± counting error*	-0.01 ± 0.03	--	0.00 ± 0.04	--	0.02 ± 0.05
Uranium-233 + Uranium-234, dissolved, ± counting error*	66 ± 2	--	62 ± 2	--	66 ± 2
Uranium-238, dissolved, ± counting error*	44 ± 2	--	41 ± 2	--	40 ± 2
Tritium, total, ± counting error*	--	2700 ± 300	--	3400 ± 300	--

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July 2, 1986

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RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21823-20-14 LC8 (ITPH) Sample C	9299-21823-20-19 L07 HPLC Distilled Water	9299-21823-20-20 L08 HPLC Distilled Water
Determination: pCi/L			
Gross Alpha, dissolved, ± counting error*	--	-1 ± 2	--
Gross Beta, dissolved, ± counting error*	--	-2 ± 4	--
Plutonium-239, dissolved, ± counting error*	--	0.01 ± 0.05	--
Americium-241, dissolved, ± counting error*	--	-0.01 ± 0.03	--
Uranium-233 + Uranium-234, dissolved, ± counting error*	--	0.05 ± 0.27	--
Uranium-238, dissolved, ± counting error*	--	-0.09 ± 0.24	--
Tritium, total, ± counting error*	3400 ± 300	--	40 ± 260

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 17, 1986

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RE: 9299-21843-6
Date Samples Rec'd 4-30-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21843-6-2 207B-B7 Solar Pond North (Central) 4-30-86	9299-21843-6-4 207B-C7 Solar Pond North (Central) 4-30-86	9299-21843-6-6 207B-07 Solar Pond North (Central) 4-30-86
Determination: pCi/L			
Gross Alpha, dissolved, ± counting error*	93 ± 60	74 ± 58	16 ± 41
Gross Beta, dissolved, ± counting error*	25 ± 89	100 ± 92	-21 ± 84
Plutonium-239, diss., ± counting error*	-0.02 ± 0.11	-0.03 ± 0.06	0.05 ± 0.07
Americium-241, diss., ± counting error*	0.08 ± 0.08	-0.02 ± 0.04	0.08 ± 0.22
Uranium-233 + 234, dissolved, ± counting error*	51 ± 2	53 ± 2	0.10 ± 0.24
Uranium-238, dissolved, ± counting error*	32 ± 1	33 ± 1	-0.10 ± 0.21

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 2, 1986

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RE: 9299-21833-18
Date Samples Rec'd 4-29-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation Determination: pCi/L	9299-21833-18-5 Solar Pond 207B-A7 North Northwest Corner 4-29-86	9299-21833-18-6 Solar Pond 207B-A8 North Northwest Corner 4-29-86	9299-21833-18-10 Solar Pond 207B-B8 North Central 4-29-86	9299-21833-18-14 Solar Pond 207B-C8 North Northeast 4-29-86	9299-21833-18-18 Solar Pond 207B-08 Field Blank 4-29-86
Gross Alpha, dissolved, ± counting error*	120 ± 50	--	--	--	--
Gross Beta, dissolved, ± counting error*	56 ± 32	--	--	--	--
Plutonium-239, dissolved, ± counting error*	0.01 ± 0.06	--	--	--	--
Americium-241, dissolved, ± counting error*	-0.02 ± 0.04	--	--	--	--
Uranium-233 + Uranium-234, dissolved, ± counting error*	50 ± 2	--	--	--	--
Uranium-238, dissolved, ± counting error*	31 ± 1	--	--	--	--
Tritium, total, ± counting error*	--	1200 ± 300	1200 ± 300	1300 ± 300	-40 ± 260

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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July 7, 1986

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RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21741-27-3 1B5 (BZ)	9299-21741-27-6 1C5 (BZ)	9299-21741-27-9 2B5 (BZ)	9299-21741-27-12 2C5 (BZ)	9299-21741-27-15 3B5 (BZ)
Determination: pCi/g (dry)					
Gross Alpha, ± counting error*	46 ± 15	18 ± 11	47 ± 15	36 ± 13	35 ± 13
Gross Beta, ± counting error*	34 ± 6	31 ± 6	40 ± 7	28 ± 5	30 ± 6
Plutonium-239, ± counting error*	0.01 ± 0.10	0.05 ± 0.21	0.07 ± 0.21	0.03 ± 0.21	0.09 ± 0.22
Americium-241, ± counting error*	0.28 ± 0.16	0.01 ± 0.07	0.02 ± 0.06	0.07 ± 0.10	0.00 ± 0.08
Uranium-233 + Uranium-234, ± counting error*	0.77 ± 0.17	0.67 ± 0.17	0.86 ± 0.17	0.67 ± 0.15	0.89 ± 0.19
Uranium-238, ± counting error*	0.66 ± 0.16	0.62 ± 0.17	0.92 ± 0.18	0.84 ± 0.17	0.75 ± 0.18
Tritium, ± counting error*, pCi/mL	-0.07 ± 0.22	0.13 ± 0.23	0.04 ± 0.23	0.08 ± 0.23	0.20 ± 0.23
Air Dry Loss, %	22.3	28.2	21.6	20.1	22.8

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July 7, 1986

Mr. Mark Selman
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RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21741-27-18 3C5 (BZ)	9299-21741-27-21 1D5 (BZ)	9299-21741-27-24 1E5 (BZ)	9299-21741-27-27 1F5 (BZ)
Determination: pCi/g (dry)				
Gross Alpha, ± counting error*	37 ± 14	52 ± 16	44 ± 15	21 ± 11
Gross Beta, ± counting error*	29 ± 6	40 ± 6	32 ± 6	29 ± 6
Plutonium-239, ± counting error*	0.05 ± 0.21	0.12 ± 0.21	0.07 ± 0.20	-0.08 ± 0.09
Americium-241, ± counting error*	-0.02 ± 0.03	0.01 ± 0.05	-0.02 ± 0.03	-0.02 ± 0.03
Uranium-233 + Uranium-234, ± counting error*	0.66 ± 0.16	1.1 ± 0.2	0.73 ± 0.17	0.59 ± 0.13
Uranium-238, ± counting error*	0.76 ± 0.18	1.2 ± 0.2	0.80 ± 0.18	0.61 ± 0.14
Tritium, ± counting error*, pCi/mL	0.28 ± 0.27	0.34 ± 0.23	0.34 ± 0.23	0.54 ± 0.24
Air Dry Loss, %	19.8	26.1	20.5	16.2

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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June 19, 1986

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RE: 9299-21732-9
Date Samples Rec'd 4-14-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21732-9-3 1A5 (BZ) Composite 1 Surface Scrape	9299-21732-9-6 2A5 (BZ) Composite 2 Surface Scrape	9299-21732-9-9 3A5 (BZ) Composite 3 Surface Scrape
Determination: pCi/g (dry)			
Gross Alpha, ± counting error*	67 ± 17	71 ± 18	75 ± 18
Gross Beta, ± counting error*	55 ± 7	50 ± 7	56 ± 7
Plutonium-239, ± counting error*	0.10 ± 0.20	0.02 ± 0.10	0.02 ± 0.21
Americium-241, ± counting error*	-0.02 ± 0.03	-0.02 ± 0.03	0.00 ± 0.05
Uranium-233 + 234, ± counting error*	1.1 ± 0.2	1.2 ± 0.2	1.4 ± 0.2
Uranium-238, ± counting error*	0.89 ± 0.20	1.2 ± 0.2	1.2 ± 0.2
Tritium, ± counting error*, pCi/ml	0.09 ± 0.23	0.02 ± 0.22	-0.05 ± 0.22
Air Dry Loss, %	24.8	21.9	22.5

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

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June 26, 1986

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RE: 9299-21884-6
Date Samples Rec'd 5-7-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21884-6-1	9299-21884-6-3
Sponsor Designation	207A-B3 Solar Pond Depth ≈ 4" 5-7-86	207A-B5 Solar Pond Depth ≈ 4" 5-7-86
Determination: µg/L		
Aluminum, total	2640	--
Antimony, total	600U	--
Arsenic, total	150	--
Barium, total	200U	--
Beryllium, total	43	--
Cadmium, total	70	--
Calcium, total	[880]	--
Chromium, total	16700	--
Cobalt, total	200	--
Copper, total	1800	--
Iron, total	1600	--
Lead, total	50U	--
Magnesium, total	[1650]	--
Manganese, total	115	--
Mercury, total	0.2	--
Nickel, total	1900	--
Potassium, total	14,300,000	--
Selenium, total	50U	--
Silver, total	370	--
Sodium, total	42,900,000	--
Thallium, total	100U	--
Tin, total	13000	--
Vanadium, total	100	--
Zinc, total	780	--
Phenols	--	35

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RE: 9299-21856-6
Date Samples Rec'd 5-1-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21856-6-1	9299-21856-6-3
Sponsor Designation	207A-A3 Solar Pond Northwest 5-1-86	207A-A5 Solar Pond Northwest 5-1-86
Determination: µg/L		
Aluminum, total	2420	--
Antimony, total	600U	--
Arsenic, total	150	--
Barium, total	200U	--
Beryllium, total	27	--
Cadmium, total	100	--
Calcium, total	[990]	--
Chromium, total	16300	--
Cobalt, total	200	--
Copper, total	1610	--
Iron, total	8000	--
Lead, total	50U	--
Magnesium, total	[1540]	--
Manganese, total	105	--
Mercury, total	0.2U	--
Nickel, total	1900	--
Potassium, total	13,200,000	--
Selenium, total	50U	--
Silver, total	310	--
Sodium, total	36,300,000	--
Thallium, total	100U	--
Tin, total	7000	--
Vanadium, total	120	--
Zinc, total	620	--
Phenols	--	13

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RE: 9299-21943-11
Date Samples Rec'd 5-15-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21943-11-1	9299-21943-11-3
Sponsor Designation	207A-C3 Solar Pond Southwest 5-15-86	207A-C5 Solar Pond Southwest 5-15-86
Determination: µg/L		
Aluminum, total	2310	--
Antimony, total	600U	--
Arsenic, total	1000U	--
Barium, total	200U	--
Beryllium, total	39	--
Cadmium, total	150	--
Calcium, total	[770]	--
Chromium, total	13700	--
Cobalt, total	500	--
Copper, total	1750	--
Iron, total	1500	--
Lead, total	50U	--
Magnesium, total	[1540]	--
Manganese, total	95	--
Mercury, total	0.2U	--
Nickel, total	2000	--
Potassium, total	14,300,000	--
Selenium, total	50U	--
Silver, total	350	--
Sodium, total	38,500,000	--
Thallium, total	100U	--
Tin, total	13000	--
Vanadium, total	210	--
Zinc, total	690	--
Phenols	--	14

June 26, 1986

Mr. Mark Selman
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RE: 9299-21943-11
Date Samples Rec'd 5-15-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21943-11-7 207A-03 Solar Pond Southwest 5-15-86	9299-21943-11-8 207A-05 Solar Pond Southwest 5-15-86
Determination: µg/L		
Aluminum, total	200U	--
Antimony, total	60U	--
Arsenic, total	10U	--
Barium, total	200U	--
Beryllium, total	5U	--
Cadmium, total	5U	--
Calcium, total	[440]	--
Chromium, total	5U	--
Cobalt, total	20U	--
Copper, total	[7]	--
Iron, total	[90]	--
Lead, total	11	--
Magnesium, total	[99]	--
Manganese, total	5U	--
Mercury, total	0.2U	--
Nickel, total	20U	--
Potassium, total	[1430]	--
Selenium, total	5U	--
Silver, total	5U	--
Sodium, total	15400	--
Thallium, total	10U	--
Tin, total	40U	--
Vanadium, total	5U	--
Zinc, total	57	--
Phenols	--	2

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RE: 9299-21870-8
Date Samples Rec'd 5-6-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21870-8-1 207A-SA3 Solar Pond NW Corner 5-5-86	9299-21870-8-3 207A-SA5 Solar Pond NW Corner 5-5-86
Determination: mg/kg dry wt.		
Aluminum, total	11300	--
Antimony, total	250U	--
Arsenic, total	42U	--
Barium, total	833U	--
Beryllium, total	309	--
Cadmium, total	1110	--
Calcium, total	24100	--
Chromium, total	1010	--
Cobalt, total	83U	--
Copper, total	425	--
Iron, total	3590	--
Lead, total	65	--
Magnesium, total	20400	--
Manganese, total	153	--
Mercury, total	7.5	--
Nickel, total	124	--
Potassium, total	59000	--
Selenium, total	21U	--
Silver, total	153	--
Sodium, total	154000	--
Thallium, total	42U	--
Tin, total	167U	--
Vanadium, total	208U	--
Zinc, total	248	--
Phenols, total	--	1.7U

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June 27, 1986

Mr. Mark Selman
Roy F. Weston
938 Quail Street
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RE: 9299-21890-6
Date Samples Rec'd 5-8-86
Project 2029-13-03-0001

REPORT OF ANALYSIS

ALR Designation	9299-21890-6-1	9299-21890-6-3
Sponsor Designation	207A-SB3 Solar Pond Center West 5-8-86	207A-SB5 Solar Pond Center West 5-8-86
Determination: mg/kg dry wt.		
Aluminum, total	11000	--
Antimony, total	273U	--
Arsenic, total	45U	--
Barium, total	909U	--
Beryllium, total	668	--
Cadmium, total	10500	--
Calcium, total	50000	--
Chromium, total	1500	--
Cobalt, total	91U	--
Copper, total	1590	--
Iron, total	5550	--
Lead, total	455	--
Magnesium, total	21000	--
Manganese, total	595	--
Mercury, total	25	--
Nickel, total	1320	--
Potassium, total	50000	--
Selenium, total	23U	--
Silver, total	191	--
Sodium, total	130000	--
Thallium, total	45U	--
Tin, total	182U	--
Vanadium, total	227U	--
Zinc, total	595	--
Phenols, total	--	1.8U

Cathy Cairns
Cathy Cairns
Water Laboratory
Supervisor

CC/dh
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June 30, 1986

Mr. Mark Selman
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RE: 9299-21907-6
Date Samples Rec'd 5-12-86
Project 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21907-6-1	9299-21907-6-3
Sponsor Designation	207A-SC3 Solar Pond SW Corner 5-12-86	207A-SC5 Solar Pond SW Corner 5-12-86
Determination: mg/kg dry wt.		
Aluminum, total	11900	--
Antimony, total	333U	--
Arsenic, total	56U	--
Barium, total	1110U	--
Beryllium, total	1570	--
Cadmium, total	1220	--
Calcium, total	19600	--
Chromium, total	19700	--
Cobalt, total	111U	--
Copper, total	879	--
Iron, total	6900	--
Lead, total	142	--
Magnesium, total	6110	--
Manganese, total	178	--
Mercury, total	10	--
Nickel, total	162	--
Potassium, total	65300	--
Selenium, total	28U	--
Silver, total	237	--
Sodium, total	166000	--
Thallium, total	56U	--
Tin, total	222U	--
Vanadium, total	278U	--
Zinc, total	227	--
Phenols, total	--	3.3

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June 11, 1986

Mr. Mark Selman
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RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project 2023-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21823-20-3 LB3 (ITPH) Sample B	9299-21823-20-5 LB5 (ITPH) Sample B	9299-21823-20-9 LC3 (ITPH) Sample C
Determination: µg/L			
Aluminum, total	200U	--	200U
Antimony, total	60U	--	60U
Arsenic, total	10U	--	10U
Barium, total	200U	--	220
Beryllium, total	5U	--	5U
Cadmium, total	5U	--	5U
Calcium, total	308000	--	319000
Chromium, total	[9]	--	[7]
Cobalt, total	20U	--	20U
Copper, total	5U	--	5U
Iron, total	20U	--	20U
Lead, total	5U	--	5U
Magnesium, total	76800	--	77400
Manganese, total	[12]	--	[13]
Mercury, total	0.5	--	0.4
Nickel, total	20U	--	20U
Potassium, total	73700	--	71500
Selenium, total	11	--	12
Silver, total	12	--	10
Sodium, total	451000	--	462000
Thallium, total	10U	--	10U
Tin, total	400U	--	400U
Vanadium, total	50U	--	50U
Zinc, total	24	--	30
Phenols, total	--	10	--

June 11, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project 2023-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21823-20-11 LC5 (ITPH) Sample C	9299-21823-20-15 L03 HPLC Distilled Water	9299-21823-20-17 L05 HPLC Distilled Water
Determination: µg/L			
Aluminum, total	--	200U	--
Antimony, total	--	60U	--
Arsenic, total	--	10U	--
Barium, total	--	200U	--
Beryllium, total	--	5U	--
Cadmium, total	--	5U	--
Calcium, total	--	[220]	--
Chromium, total	--	5U	--
Cobalt, total	--	20U	--
Copper, total	--	5U	--
Iron, total	--	[80]	--
Lead, total	--	5U	--
Magnesium, total	--	[66]	--
Manganese, total	--	5U	--
Mercury, total	--	0.2U	--
Nickel, total	--	20U	--
Potassium, total	--	[220]	--
Selenium, total	--	5U	--
Silver, total	--	5U	--
Sodium, total	--	[440]	--
Thallium, total	--	10U	--
Tin, total	--	40U	--
Vanadium, total	--	50U	--
Zinc, total	--	58	--
Phenols, total	2U	--	2

Erda Hergemeder for CC.
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June 12, 1986

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RE: 9299-21843-6
Date Samples Rec'd 4-30-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21843-6-1	9299-21843-6-3	9299-21843-6-5
Sponsor Designation	207B-B3 Solar Pond North (Center) 4-30-86	207B-C3 Solar Pond North (Center) 4-30-86	207B-03 Solar Pond North (Center) 4-30-86
Determination: µg/L			
Aluminum, total	200U	200U	200U
Antimony, total	60U	60U	60U
Arsenic, total	10U	10U	10U
Barium, total	200U	220	200U
Beryllium, total	5U	5U	5U
Cadmium, total	5U	5U	5U
Calcium, total	187000	176000	[990]
Chromium, total	5U	[9]	5U
Cobalt, total	20U	20U	20U
Copper, total	[6]	5U	5U
Iron, total	20U	20U	[20]
Lead, total	5U	5U	5U
Magnesium, total	67500	66400	[407]
Manganese, total	5U	5U	5U
Mercury, total	0.2U	0.2U	0.2U
Nickel, total	[30]	20U	20U
Potassium, total	62700	60500	[110]
Selenium, total	9	9	5U
Silver, total	[5]	[7]	5U
Sodium, total	374000	363000	[330]
Thallium, total	10U	10U	10U
Tin, total	400U	400U	40U
Vanadium, total	50U	50U	50U
Zinc, total	5U	5U	[11]

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June 26, 1986

Mr. Mark Selman
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RE: 9299-21833-18
Date Samples Rec'd 4-29-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21833-18-1 Solar Pond 207B-A3 North Northwest Corner 4-29-86	9299-21833-18-3 Solar Pond 207B-A5 North Northwest Corner 4-29-86	9299-21833-18-8 Solar Pond 207B-B5 North Central 4-29-86
Determination: µg/L			
Aluminum, total	200U	--	--
Antimony, total	60U	--	--
Arsenic, total	10U	--	--
Barium, total	200U	--	--
Beryllium, total	5U	--	--
Cadmium, total	5U	--	--
Calcium, total	198000	--	--
Chromium, total	5U	--	--
Cobalt, total	20U	--	--
Copper, total	[14]	--	--
Iron, total	[90]	--	--
Lead, total	5U	--	--
Magnesium, total	72600	--	--
Manganese, total	15	--	--
Mercury, total	0.2U	--	--
Nickel, total	50	--	--
Potassium, total	56100	--	--
Selenium, total	9	--	--
Silver, total	5U	--	--
Sodium, total	451000	--	--
Thallium, total	10U	--	--
Tin, total	400U	--	--
Vanadium, total	50U	--	--
Zinc, total	22	--	--
Phenols	--	3	46

June 26, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21833-18
Date Samples Rec'd 4-29-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21833-18-12	9299-21833-18-16
Sponsor Designation	Solar Pond 207B-C5 North (Northeast) 4-29-86	Solar Pond 207B-05 Field Blank 4-29-86
Determination: µg/L		
Aluminum, total	--	--
Antimony, total	--	--
Arsenic, total	--	--
Barium, total	--	--
Beryllium, total	--	--
Cadmium, total	--	--
Calcium, total	--	--
Chromium, total	--	--
Cobalt, total	--	--
Copper, total	--	--
Iron, total	--	--
Lead, total	--	--
Magnesium, total	--	--
Manganese, total	--	--
Mercury, total	--	--
Nickel, total	--	--
Potassium, total	--	--
Selenium, total	--	--
Silver, total	--	--
Sodium, total	--	--
Thallium, total	--	--
Tin, total	--	--
Vanadium, total	--	--
Zinc, total	--	--
Phenols	3	4

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May 30, 1986

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RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21741-27-1	9299-21741-27-4	9299-21741-27-7
Sponsor Designation	1B3 (BZ) Composite 1 0-6" depth	1C3 (BZ) Composite 1 6-12" depth	2B3 (BZ) Composite 2 0-6" depth
Determination: mg/kg, dry wt.			
Aluminum, total	8190	8640	6540
Antimony, total	38U	37U	38U
Arsenic, total	6.3U	10F	7.0
Barium, total	126U	123U	128U
Beryllium, total	3.2U	3.1U	3.2U
Cadmium, total	3.2U	3.1U	3.2U
Calcium, total	[1660]	[1100]	[1320]
Chromium, total	11	10	9.0
Cobalt, total	13U	[22]	[12]
Copper, total	[6.9]	[6.6]	[8.4]
Iron, total	9080	12400	9610
Lead, total	31	19	29
Magnesium, total	[1240]	[1030]	[997]
Manganese, total	274	293	247
Mercury, total	0.1U	0.1U	0.1U
Nickel, total	[13]	[16]	13U
Potassium, total	[1390]	[1100]	[1260]
Selenium, total	3.2U	3.1U	3.2U
Silver, total	3.2U	3.1U	3.2U
Sodium, total	63U	62U	64U
Thallium, total	6.3U	6.2U	6.4U
Tin, total	25U	25U	26U
Vanadium, total	32U	38	32U
Zinc, total	33	23	29
Phenols	0.3U	0.5	0.3U

Accu-Labs Research, Inc.

May 30, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21741-27-10	9299-21741-27-13	9299-21741-27-16
Sponsor Designation	2C3 (BZ) Composite 2 6-12" depth	3B3 (BZ) Composite 3 0-6" depth	3C3 (BZ) Composite 3 6-12" depth
Determination: mg/kg, dry wt.			
Aluminum, total	7640	6740	7200
Antimony, total	37U	38U	38U
Arsenic, total	6.1U	6.4	6.3U
Barium, total	122U	128U	125U
Beryllium, total	3.0U	3.2U	3.1U
Cadmium, total	3.0U	3.2U	3.1U
Calcium, total	[1440]	[1400]	[1020]
Chromium, total	9.6	5.7	5.6
Cobalt, total	12U	13U	25
Copper, total	[9.1]	[8.3]	[9.9]
Iron, total	10200	9580	10900
Lead, total	16	17	15
Magnesium, total	[1060]	[976]	[883]
Manganese, total	196	215	285
Mercury, total	0.1U	0.1U	0.1U
Nickel, total	[17]	[13]	13U
Potassium, total	[1250]	[1190]	[951]
Selenium, total	3.0U	3.2U	3.1U
Silver, total	3.0U	3.2U	3.1U
Sodium, total	61U	[68]	63U
Thallium, total	6.1U	6.4U	6.3U
Tin, total	24U	26U	25U
Vanadium, total	30U	32U	31U
Zinc, total	30	25	20
Phenols	0.2U	0.3U	0.3U

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RE: 9299-21732-9
Date Samples Rec'd 4-14-86
Project 2029-13-03

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21732-9-1 1A3 (BZ) Composite 1 Surface Scrape	9299-21732-9-4 2A3 (BZ) Composite 2 Surface Scrape	9299-21732-9-7 3A3 (BZ) Composite 3 Surface Scrape
Determination: mg/kg, dry wt.			
Aluminum, total	8770	9140	9050
Antimony, total	40U	41U	41U
Arsenic, total	6.7U	6.8	6.8U
Barium, total	133U	135U	135U
Beryllium, total	3.3U	3.4U	3.4U
Cadmium, total	3.3U	3.4U	3.4U
Calcium, total	[1840]	[1930]	[1960]
Chromium, total	10	10	13
Cobalt, total	13U	14U	14U
Copper, total	[9.6]	[9.7]	[10]
Iron, total	11000	11400	12300
Lead, total	38	48	42
Magnesium, total	[1360]	[1490]	[1350]
Manganese, total	272	337	286
Mercury, total	0.1U	0.1U	0.1U
Nickel, total	13U	[13]	14U
Potassium, total	[1700]	[1860]	[1750]
Selenium, total	3.3U	3.4U	3.4U
Silver, total	3.3U	3.4U	3.4U
Sodium, total	67U	[217]	[140]
Thallium, total	6.7U	6.8U	6.8U
Tin, total	27U	27U	27U
Vanadium, total	33U	34U	34U
Zinc, total	41	49	44
Phenols	0.3U	0.3U	0.3U

Lynda Hercenrecler for CC
Cathy Cairns
Project Manager

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July 21, 1986

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RE: 9299-21884-6
Date Samples Rec'd 5-7-86
Project No. 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21884-6-2	9299-21884-6-4
Sponsor Designation	207A-B6 Solar Pond 207A	207A-B6 Solar Pond 207A
Reactivity, mg/L:		
Cyanide	--	19
Sulfide	--	*
Corrosivity-pH	--	9.9
Ignitability, °C	--	>100
Total Cyanide, mg/L	9.4	--
Hexavalent Chromium, mg/L	--	<0.01

*Not analyzed due to insufficient sample.

Michel A. Herzog
RCRA Analysis

MAH/dh dh

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July 21, 1986

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RE: 9299-21856-6
Date Samples Rec'd 5-1-86
Project No. 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21856-6-2	9299-21856-6-4
Sponsor Designation	207A-A4 Solar Pond 207A Northwest	207A-A6 Solar Pond 207A Northwest
Reactivity, mg/L:		
Cyanide	--	*
Sulfide	--	**
Corrosivity-pH	--	9.8
Ignitability, °C	--	>100
Total Cyanide, mg/L	11	--
Hexavalent Chromium, mg/L	--	<0.01

*Not analyzed due to insufficient sample.
**Not calculated due to interferences.

Michel A. Herzog
Soils and Overburden
Supervisor

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23 1986

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July 23, 1986

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RE: 9299-21943-11
Date Samples Rec'd: 5-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation / Sponsor Designation	9299-21943-11-2 / 207A-C4	9299-21943-11-4 / 207A-C6	9299-21943-11-9 / 207A-06
Determination: mg/L			
Reactivity:			
Cyanide	--	*	*
Sulfide	--	*	<10
Corrosivity-pH	--	9.8	6.6
Ignitability, °C	--	>100	>100
Total Cyanide	17	--	--
Hexavalent Chromium	--	0.02	<0.01

*Not analyzed due to insufficient sample.

Michel A. Herzog
RCRA Analysis

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July 21, 1986

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RE: 9299-21907-6
Date Samples Rec'd 5-12-86
Project No. 2029-13-03-01

REPORT OF ANALYSIS

ALR Designation	9299-21907-6-2	9299-21907-6-4
Sponsor Designation	207A-SC4 Solar Pond 207A SW Corner Sediment C-Composite	207A-SC6 Solar Pond 207A SW Corner Sediment C-Composite
RCRA EP Toxicity, mg/L:		
Arsenic	--	0.04
Barium	--	<0.2
Cadmium	--	4.5
Chromium	--	0.86
Lead	--	0.11
Mercury	--	0.001
Selenium	--	<0.005
Silver	--	<0.02
Reactivity, µg/g:		
Cyanide	--	6.3
Sulfide	--	*
Corrosivity-pH	--	9.0
Ignitability, °C	--	>100
Hexavalent Chromium, mg/L	--	0.01
Total Cyanide, µg/g	6.5	--

*Not calculated due to interferences.

Michel A. Herzog
RCRA Analysis

MAH/dh

Accu-Labs Re[illegible]ch, Inc.

July 21, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21823-20-18
Sponsor Designation	LB6-LC6-LD6
	HPLC Distilled Water
Reactivity, mg/L:	
Cyanide	<0.05
Sulfide	<10
Corrosivity-pH	6.7
Ignitability, °C	>100
Total Cyanide, mg/L	--
Hexavalent Chromium, mg/L	<0.01

Michel A. Herzog
RCRA Analysis

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July 21, 1986

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RE: 9299-21823-20
Date Samples Rec'd 4-28-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21823-20-4 LB4 Interceptor Trench Pump House Sample B	9299-21823-20-6 LB6 Interceptor Trench Pump House Sample B	9299-21823-20-10 LC4 Interceptor Trench Pump House Sample C	9299-21823-20-12 LC6 Interceptor Trench Pump House Sample C	9299-21823-20-16 LD4 HPLC Distilled Water
Reactivity, mg/L:					
Cyanide	--	<0.05	--	<0.05	--
Sulfide	--	<10	--	<10	--
Corrosivity-pH	--	7.8	--	8.0	--
Ignitability, °C	--	>100	--	>100	--
Total Cyanide, mg/L	<0.05	--	<0.05	--	<0.05
Hexavalent Chromium, mg/L	--	<0.01	--	<0.01	--

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July 21, 1986

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RE: 9299-21833-18
Date Samples Rec'd 4-29-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21833-18-2 207B-A4 Solar Pond 207B N-NW Corner	9299-21833-18-4 207B-A6 Solar Pond 207B N-NW Corner	9299-21833-18-7 207B-B4 Solar Pond 207B North (Central)	9299-21833-18-9 207B-B6 Solar Pond 207B North (Central)	9299-21833-18-11 207B-C4 Solar Pond 207B North (Northeast)
Reactivity, mg/L:					
Cyanide	--	<0.05	--	<0.05	--
Sulfide	--	<10	--	<10	--
Corrosivity-pH	--	8.0	--	7.9	--
Ignitability, °C	--	>100	--	>100	--
Total Cyanide, mg/L	<0.05	--	<0.05	--	<0.05
Hexavalent Chromium, mg/L	--	<0.01	--	<0.01	--

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Accu-Labs Res[illegible]h, Inc.

July 21, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21833-18
Date Samples Rec'd 4-29-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21833-18-13 207B-C6 Solar Pond 207B North (Northeast)	9299-21833-18-15 207B-04 Solar Pond 207B Field Blank	9299-21833-18-17 207B-06 Solar Pond 207B Field Blank
Reactivity, mg/L:			
Cyanide	<0.05	--	<0.05
Sulfide	<10	--	<10
Corrosivity-pH	8.1	--	7.1
Ignitability, °C	>100	--	>100
Total Cyanide, mg/L	--	<0.05	--
Hexavalent Chromium, mg/L	<0.01	--	<0.01

Michel A. Herzog
RCRA Analysis

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May 16, 1986

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938 Quail St.
Denver, CO 80215

RE: 9299-21732-9
Date Samples Rec'd 4-14-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21732-9-1 1A3 (BZ) Composite 1 Surface Scrape	9299-21732-9-3 1A4 (BZ) Composite 1 Surface Scrape	9299-21732-9-4 2A3 (BZ) Composite 2 Surface Scrape	9299-21732-9-5 2A4 (BZ) Composite 2 Surface Scrape	9299-21732-9-7 3A3 (BZ) Composite 3 Surface Scrape
RCRA EP Toxicity, mg/L:					
Arsenic	--	<0.005	--	<0.005	--
Barium	--	<0.2	--	<0.2	--
Cadmium	--	<0.005	--	0.006	--
Chromium	--	<0.01	--	0.01	--
Lead	--	<0.05	--	<0.05	--
Mercury	--	0.001	--	<0.001	--
Selenium	--	<0.005	--	<0.005	--
Silver	--	<0.02	--	<0.02	--
Reactivity:					
Cyanide, µg/g	--	0.11	--	0.11	--
Sulfide, µg/g	--	<10	--	<10	--
Corrosivity-pH	--	5.7	--	5.6	--
Ignitability, °C	--	>100	--	>100	--
Hexavalent Chromium, mg/L	--	<0.01	--	<0.01	--
Total Cyanide, µg/g	0.17	--	0.16	--	0.10

Accu-Labs Re[illegible]ch, Inc.

May 16, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21732-9
Date Samples Rec'd 4-14-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation	9299-21732-9-8
Sponsor Designation	3A4 (BZ) Composite 3 Surface Scrape
RCRA EP Toxicity, mg/L:	
Arsenic	<0.005
Barium	<0.2
Cadmium	0.005
Chromium	0.02
Lead	<0.05
Mercury	<0.001
Selenium	<0.005
Silver	<0.02
Reactivity:	
Cyanide, µg/g	0.12
Sulfide, µg/g	<10
Corrosivity-pH	5.6
Ignitability, °C	>100
Hexavalent Chromium, mg/L	<0.01
Total Cyanide, µg/g	--

These samples are scheduled to be disposed of 45 days after the date of this report.

Michel A. Herzog
RCRA Analysis

MAH/dh

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

May 16, 1986

Mr. Mark Selman
Roy F. Weston
938 Quail St.
Denver, CO 80215

RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21741-27-1 1B3 (BZ) Composite 1 0"-6"	9299-21741-27-2 1B4 (BZ) Composite 1 0"-6"	9299-21741-27-4 1C3 (BZ) Composite 1 6"-12"	9299-21741-27-5 1C4 (BZ) Composite 1 6"-12"	9299-21741-27-7 2B3 (BZ) Composite 2 0"-6"
RCRA EP Toxicity, mg/L:					
Arsenic	--	<0.005	--	<0.005	--
Barium	--	<0.2	--	<0.2	--
Cadmium	--	<0.005	--	<0.005	--
Chromium	--	<0.01	--	<0.01	--
Lead	--	<0.05	--	<0.05	--
Mercury	--	<0.001	--	<0.001	--
Selenium	--	<0.005	--	<0.005	--
Silver	--	<0.02	--	<0.02	--
Reactivity:					
Cyanide, µg/g	--	0.12	--	0.05	--
Sulfide, µg/g	--	<10	--	<10	--
Corrosivity-pH	--	5.7	--	5.7	--
Ignitability, °C	--	>100	--	>100	--
Hexavalent Chromium, mg/L	--	<0.01	--	<0.01	--
Total Cyanide, µg/g	0.10	--	0.05	--	0.08

Accu-Labs Research, Inc.

May 16, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21741-27-8 2B4 (BZ) Composite 2 0"-6"	9299-21741-27-10 2C3 (BZ) Composite 2 6"-12"	9299-21741-27-11 2C4 (BZ) Composite 2 6"-12"	9299-21741-27-13 3B3 (BZ) Composite 3 0"-6"	9299-21741-27-14 3B4 (BZ) Composite 3 0"-6"
RCRA EP Toxicity, mg/L:					
Arsenic	<0.005	--	<0.005	--	<0.005
Barium	<0.2	--	<0.2	--	<0.2
Cadmium	<0.005	--	<0.005	--	0.005
Chromium	<0.01	--	<0.01	--	<0.01
Lead	<0.05	--	<0.05	--	<0.05
Mercury	<0.001	--	<0.001	--	<0.001
Selenium	<0.005	--	<0.005	--	<0.005
Silver	<0.02	--	<0.02	--	<0.02
Reactivity:					
Cyanide, µg/g	0.08	--	<0.05	--	0.06
Sulfide, µg/g	<10	--	<10	--	<10
Corrosivity-pH	5.7	--	5.5	--	5.7
Ignitability, °C	>100	--	>100	--	>100
Hexavalent Chromium, mg/L	<0.01	--	0.01	--	0.06
Total Cyanide, µg/g	--	0.05	--	0.09	--

Accu-Labs Res[illegible]ch, Inc.

May 16, 1986

Mr. Mark Selman
Roy F. Weston

RE: 9299-21741-27
Date Samples Rec'd 4-15-86
Project No. 2029-13-03

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9299-21741-27-16 3C3 (BZ) Composite 3 6"-12"	9299-21741-27-17 3C4 (BZ) Composite 3 6"-12"	9299-21741-27-19 1D3 Composite 1 Surface Scrape	9299-21741-27-20 1D4 Composite 1 Surface Scrape	9299-21741-27-22 1E3 Composite 1 0"-6" Core
RCRA EP Toxicity, mg/L:					
Arsenic	--	<0.005	--	<0.005	--
Barium	--	<0.2	--	<0.2	--
Cadmium	--	<0.005	--	<0.005	--
Chromium	--	<0.01	--	<0.01	--
Lead	--	<0.05	--	<0.05	--
Mercury	--	<0.001	--	<0.001	--
Selenium	--	<0.005	--	<0.005	--
Silver	--	<0.02	--	<0.02	--
Reactivity:					
Cyanide, µg/g	--	<0.05	--	0.13	--
Sulfide, µg/g	--	<10	--	<10	--
Corrosivity-pH	--	5.7	--	5.9	--
Ignitability, °C	--	>100	--	>100	--
Hexavalent Chromium, mg/L	--	0.02	--	0.02	--
Total Cyanide, µg/g	<0.05	--	0.13	--	0.07

WESTON

SEP 29 [redacted]

VOA ORGANIC ANALYTICAL DATA PACKAGE FOR ROCKY FLATS

DATE RECEIVED: August 21, 1986

SAMPLE DESCRIPTION	WESTON ID R.F.W. NUMBER	DATE COLLECTED	VOA ANALYSIS
ITPH-LAI	8608-682-0070	8/19/86	9/01/86
ITPH-SAI	8608-682-0080	8/19/86	9/01/86
ITPH-LB1	8608-682-0240	8/19/86	9/01/86
ITPH-LC1	8608-682-0250	8/19/86	9/01/86
ITPH-SB1	8608-682-0260	8/19/86	9/01/86

WESTON ANALYTICS
GC/MS DATA SUMMARY
VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

RFW Batch Number: 8608-682- Client: ROCKY FLATS

Sample Information	Cust ID:	ITPH-LAI	LAB DUP	MS	ITPH-SAI	ITPH-LBI	ITPH-LCI
	RFW#:	0070	0070	0070	0080	0240	0250
	Matrix:	Water	Water	Water	Water	Water	Water
	D.F.:	1	1	1	1	1	1
	Units:	ug/l fl	ug/l fl	ug/l fl	ug/l fl	ug/l fl	ug/l f
Chloromethane		1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane		1 U	1 U	1 U	1 U	1 U	1 U
Vinyl Chloride		1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane		1 U	1 U	1 U	1 U	1 U	1 U
Methylene Chloride		4 U	4 U	4 U	4 U	4 U	4 U
Acetone		2 U	2 U	2 U	2.5	2 U	2 U
Carbon Disulfide		1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene		1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane		1 U	1 U	1 U	1 U	1 U	1 U
Trans-1,2-Dichloroethene		1 U	1 U	1 U	1 U	1 U	1 U
Chloroform		1.2	1 U	89 %	6.9	1.4	1 U
1,2-Dichloroethane		1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone		1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane		1 U	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride		1 U	1 U	1 U	1 U	3.1	4.8
Bromodichloromethane		1 U	1 U	69 %	1 U	1.6	2.1
1,2-Dichloropropane		1 U	1 U	1 U	1 U	1 U	1 U
Trans-1,3-Dichloropropene		1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene		3.7	2.2	2.9	1 U	2.5	2.4
Dibromochloromethane		2 U	2 U	97 %	2 U	2 U	2 U
1,1,2-Trichloroethane		1 U	1 U	1 U	1 U	1 U	1 U
Benzene		1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene		1 U	1 U	1 U	1 U	1 U	1 U
2-Chloroethylvinylether		2 U	2 U	2 U	2 U	2 U	2 U
Bromoform		4 U	4 U	4 U	4 U	4 U	4 U
4-Methyl-2-pentanone		1 U	1 U	1 U	1 U	1 U	1 U

RFW Batch Number: 8608-682- Client: ROCKY FLATS Page:

Cust ID: / RFW#:	ITPH-LAI 0070	fl	LAB DUP 0070	fl	MS 0070	fl	ITPH-SAI 0080	fl	ITPH-LBI 0240	fl	ITPH-LCI 0250
Tetrachloroethene	1	U	1	U	1	U	1	U	1	U	1
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U	1	U	1	U	1
Toluene	1	U	1	U	1	U	1	U	1	U	1
Chlorobenzene	1	U	1	U	1	U	1	U	1	U	1
Ethylbenzene	1	U	1	U	1	U	1	U	1	U	1
Styrene	1	U	1	U	1	U	1	U	1	U	1
Total Xylenes	1	U	1	U	1	U	1	U	1	U	1
1,2-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1
1,3-Dichlorobenzene	1	U	1	U	1	U	1	U	1	U	1
1,4-Dichlenzenes	1	U	1	U	1	U	1	U	1	U	1
Trichlorofluoromethane	1	U	1	U	1	U	1	U	1	U	1
Dichlorodifluoromethane	1	U	1	U	1	U	1	U	1	U	1

U=Analyzed, not detected. B=Present in blank. NRP=Not Reported
J=Present at less than detection limit. NR=Not requested.

WEST NALYTICS
GC/MS D. A SUMMARY
VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

RFW Batch Number: 8608-682- Client: ROCKY FLATS Page:

Sample Information						
Cust ID:	ITPH-SB1		BLANK		BS	
RFW#:	0260		BLANK		BS	
Matrix:	Water		Water		Water	
D.F.:	1		1		1	
Units:	ug/l	fl	ug/l	fl	ug/l	fl
Chloromethane	1	U	1	U	1	U
Bromomethane	1	U	1	U	1	U
Vinyl Chloride	1	U	1	U	1	U
Chloroethane	1	U	1	U	1	U
Methylene Chloride	4	U	4	U	4	U
Acetone	2.2		2	U	2	U
Carbon Disulfide	1	U	1	U	1	U
1,1-Dichloroethene	1	U	1	U	1	U
1,1-Dichloroethane	1	U	1	U	1	U
Trans-1,2-Dichloroethene	1	U	1	U	1	U
Chloroform	1	U	1	U	1	U
1,2-Dichloroethane	1	U	1	U	1	U
2-Butanone	1	U	1	U	1	U
1,1,1-Trichloroethane	1	U	1	U	1	U
Carbon Tetrachloride	29		1	U	1	U
Bromodichloromethane	1	U	1	U	1	U
1,2-Dichloropropane	1	U	1	U	1	U
Trans-1,3-Dichloropropene	1	U	1	U	1	U
Trichloroethene	1	U	1	U	1	U
Dibromochloromethane	2	U	2	U	2	U
1,1,2-Trichloroethane	1	U	1	U	1	U
Benzene	1	U	1	U	113	%
cis-1,3-Dichloropropene	1	U	1	U	1	U
2-Chloroethylvinylether	2	U	2	U	2	U
Bromoform	4	U	4	U	4	U
4-Methyl-2-pentanone	1	U	1	U	1	U

RFW Batch Number: 8608-682-   Client: ROCKY FLATS   Pag 2

Cust ID:	ITPH-SB1		BLANK		BS	
RFW#:	0260	fl	BLANK	fl	BS	fl
Tetrachloroethene	1	U	1	U	1	U
1,1,2,2-Tetrachloroethane	1	U	1	U	1	U
Toluene	1	U	1	U	1	U
Chlorobenzene	1	U	1	U	1	U
Ethylbenzene	1	U	1	U	1	U
Styrene	1	U	1	U	1	U
Total Xylenes	1	U	1	U	114	%
1,2-Dichlorobenzene	1	U	1	U	1	U
1,3-Dichlorobenzene	1	U	1	U	1	U
1,4-Dichlenzenes	1	U	1	U	1	U
Trichlorofluoromethane	1	U	1	U	1	U
Dichlorodifluoromethane	1	U	1	U	1	U

U=Analyzed, not detected. B=Present in blank. NRP=Not Reported
J=Present at less than detection limit. NR=Not requested.

SLUDGE AND POND-CRETE
VOLATILE ORGANICS ANALYSIS
POND 207-A
FEBRUARY 1988

Files: FEB19A1

Sample Information					
	Sample ID:	06062	06062	06062	06063
	Sample Type:	FIELD BLANK	SPIKE	SPIKE DUP	TRIP BLANK
	Matrix:	WATER	WATER	WATER	WATER
	D.F.:	1.0	1.0	1.0	1.0
	Units:	UG/L	UG/L	UG/L	UG/L
	Collection Date:	2-2-88	2-2-88	2-2-88	2-2-88

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Surrogate Recovery (%)				
Toluene-d8	105	76	99	107
Bromofluorobenzene	85	66	87	92
1,2-Dichloroethane-d4	82	66	83	88

Analyte:				
Chloromethane	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U	5 U
Acetone	10 U	10 U	10 U	10 U
Carbon Disulfide	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	77 %	96 %	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U
1,2-Dichloroethene(Total)	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U
2-Butanone	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U	5 U
Trichloroethene	5 U	86 %	112 %	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U
Benzene	5 U	77 %	102 %	5 U
Trans-1,3-Dichloropropene	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U
Tetrachloroethene	5 U	5 U	5 U	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U
Toluene	5 U	85 %	111 %	5 U
Chlorobenzene	5 U	80 %	105 %	5 U
Ethylbenzene	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U	5 U

Modifiers: U=Analyzed, not detected.

Files: FEB16D E88-2124

Sample Information	Sample ID:	06060-19	06060-19	06060-19
	Sample Type:	01	DUPLICATE	SPIKE
	Matrix:	P-CRETE	P-CRETE	P-CRETE
	D.F.:	1.0	1.0	1.0
	Units:	UG/KG	UG/KG	UG/KG
	Collection Date:	2-2-88	2-2-88	2-2-88

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Surrogate Recovery (%)

Toluene-d8	62	70	56
Bromofluorobenzene	116	114	91
1,2-Dichloroethane-d4	94	96	79

Analyte:

Chloromethane	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U
Acetone	35	23	10 U
Carbon Disulfide	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	72 %
1,1-Dichloroethane	5 U	5 U	5 U
1,2-Dichloroethene(Total)	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U
2-Butanone	23	12	10 U
1,1,1-Trichloroethane	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U
Trichloroethene	5 U	5 U	89 %
Dibromochloromethane	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U
Benzene	5 U	5 U	93 %
Trans-1,3-Dichloropropene	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U
4-Methyl-2-pentanone	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U
Tetrachloroethene	17	5	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U
Toluene	5 U	5 U	54 %
Chlorobenzene	5 U	5 U	92 %
Ethylbenzene	5 U	5 U	5 U
Styrene	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U

Modifiers: U=Analyzed, not detected.

Files: FEB16C EBB-2124

Sample Information							
	Sample ID:	06060-13	06060-14	06060-15	06060-16	06060-17	06060-18
	Sample Type:	01	01	01	01	01	01
	Matrix:	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE
	D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
	Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
	Collection Date:	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88

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Surrogate Recovery (%)	06060-13	06060-14	06060-15	06060-16	06060-17	06060-18
Toluene-d8	84	108	72	108	108	74
Bromofluorobenzene	120	98	80	118	108	80
1,2-Dichloroethane-d4	102	100	96	98	104	96

Analyte:	06060-13	06060-14	06060-15	06060-16	06060-17	06060-18
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	10 U	15	37	31	10 U	33
Carbon Disulfide	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(Total)	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone	10 U	10 U	19	15	10 U	19
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Trans-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5 U	5 U	5 U	5 U	6	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U	5 U	5 U	5 U

Modifiers: U=Analyzed, not detected.

Files: FEB16B E88-2124

Sample Information						
Sample ID:	06060-7	06060-8	06060-9	06060-10	06060-11	06060-12
Sample Type:	01	01	01	01	01	01
Matrix:	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE
D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
Collection Date:	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88

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Surrogate Recovery (%)						
Toluene-d8	94	190	84	0	66	80
Bromofluorobenzene	94	104	108	0	78	90
1,2-Dichloroethane-d4	94	102	90	0	88	96
Analyte:						
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	11	18	11	10 U	29	25
Carbon Disulfide	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(Total)	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone	10 U	10 U	10 U	10 U	21	13 *
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Trans-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5 U	26	5 U	5 U	5 U	5
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U	5 U	5 U	5 U

Modifiers: U=Analyzed, not detected.

File: FEB16A E88-2124

Sample Information

Sample ID:	06060-1	06060-2	06060-3	06060-4	06060-5	06060-6
Sample Type:	01	01	01	01	01	01
Matrix:	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE	P-CRETE
D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
Collection Date:	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88	2-2-88

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Surrogate Recovery (%)

	06060-1	06060-2	06060-3	06060-4	06060-5	06060-6
Toluene-d8	84	100	86	88	0	94
Bromofluorobenzene	86	82	100	90	0	94
1,2-Dichloroethane-d4	102	104	96	108	0	104

Analyte:

	06060-1	06060-2	06060-3	06060-4	06060-5	06060-6
Chloromethane	10 U	10 U	10 U	10 U	10 U	10 U
Bromomethane	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Chloride	10 U	10 U	10 U	10 U	10 U	10 U
Chloroethane	10 U	10 U	10 U	10 U	10 U	10 U
Methylene Chloride	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	20	21	10 U	24	10 U	22
Carbon Disulfide	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
1,1-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethene(Total)	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
2-Butanone	10 U	10 U	10 U	14	10 U	14
1,1,1-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Tetrachloride	5 U	5 U	5 U	5 U	5 U	5 U
Vinyl Acetate	10 U	10 U	10 U	10 U	10 U	10 U
Bromodichloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dichloropropane	5 U	5 U	5 U	5 U	5 U	5 U
cis-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-Trichloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5 U	5 U	5 U	5 U	5 U	5 U
Trans-1,3-Dichloropropene	5 U	5 U	5 U	5 U	5 U	5 U
Bromoform	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	10 U	10 U	10 U	10 U	10 U	10 U
2-Hexanone	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	5 U	5 U	6	11	5 U	5 U
1,1,2,2-Tetrachloroethane	5 U	5 U	5 U	5 U	5 U	5 U
Toluene	5 U	5 U	5 U	5 U	5 U	5 U
Chlorobenzene	5 U	5 U	5 U	5 U	5 U	5 U
Ethylbenzene	5 U	5 U	5 U	5 U	5 U	5 U
Styrene	5 U	5 U	5 U	5 U	5 U	5 U
Total Xylenes	5 U	5 U	5 U	5 U	5 U	5 U

Modifiers: U=Analyzed, not detected.

File: MOREFEB26
Sample E#88-2124 Sample ID: 06061-190-C
Information
Sample Type: 01
Matrix: SOIL
D.F.: 1.0
Units: UG/KG
Extraction Date: 2/15/88

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2,4-Dinitrophenol(2)	1600 U
4-Nitrophenol(2)	1600 U
Dibenzofuran	330 U
2,4-Dinitrotoluene	330 U
2,6-Dinitrotoluene	330 U
Diethylphthalate	330 U
4-Chlorophenyl-phenylether	330 U
Fluorene	330 U
4-Nitroaniline(2)	1600 U
4,6-Dinitro-2-methylphenol(2)	1600 U
N-Nitrosodiphenylamine(1)	1600 U
4-Bromophenyl-phenylether	330 U
Hexachlorobenzene	330 U
Pentachlorophenol(2)	1600 U
Phenanthrene	330 U
Anthracene	330 U
di-n-Butyl Phthalate	330 U
Fluoranthene	481
Pyrene	330 U
Butyl Benzyl Phthalate	330 U
3,3'-Dichlorobenzidine(3)	660 U
Benzo(a)Anthracene	330 U
bis(2-Ethylhexyl)Phthalate	330 U
Chrysene	330 U
di-n-Octyl Phthalate	330 U
Benzo(b)Fluoranthene	330 U
Benzo(k)Fluoranthene	330 U
Benzo(a)Pyrene	330 U
Indeno(1,2,3-cd)Pyrene	330 U
Dibenz(a,h)Anthracene	330 U
Benzo(g,h,i)Perylene	330 U

Modifiers: U=Analyzed, not detected.

File:	MOREFEB26	
Sample	E#88-2124 Sample ID:	06061-190-C
Information	Sample Type:	01
	Matrix:	SOIL
	D.F.:	1.0
	Units:	UG/KG
	Extraction Date:	2/15/88

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Surrogate Recovery (%)

Nitrobenzene-d5	3
2-Fluorobiphenyl	12
Terphenyl-d14	0
Phenol-d5	7
2-Fluorophenol	0
2,4,6-Tribromophenol	3.5

Analyte:

Phenol	330 U
bis(2-Chloroethyl)Ether	330 U
2-Chlorophenol	330 U
1,3-Dichlorobenzene	330 U
1,4-Dichlorobenzene	330 U
Benzyl Alcohol	330 U
1,2-Dichlorobenzene	330 U
2-Methylphenol	330 U
bis(2-Chloroisopropyl)Ether	330 U
4-Methylphenol	330 U
N-Nitroso-di-n-propylamine	330 U
Hexachloroethane	330 U
Nitrobenzene	330 U
Isophorone	330 U
2-Nitrophenol	330 U
2,4-Dimethylphenol	330 U
Benzoic Acid(2)	1600 U
bis(2-Chloroethoxy)Methane	330 U
2,4-Dichlorophenol	330 U
1,2,4-Trichlorobenzene	330 U
Naphthalene	330 U
4-Chloroaniline	330 U
Hexachlororbutadiene	330 U
4-Chloro-3-methylphenol	330 U
2-Methylnaphthalene	330 U
Hexachlorocyclopentadiene	330 U
2,4,6-Trichlorophenol	330 U
2,4,5-Trichlorophenol(2)	1600 U
2-Chloronaphthalene	330 U
2-Nitroaniline(2)	1600 U
Dimethyl Phthalate	330 U
Acenaphthylene	330 U
3-Nitroaniline(2)	1600 U
Acenaphthene	330 U

Modifiers: U=Analyzed, not detected.

File:							SPIKE
Sample	EW88-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Information	Sample Type:	01	[illegible]	[illegible]	01	[illegible]	[illegible]
	Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	
	D.F.:	1.0	1.0	1.0	1.0	1.0	
	Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
	Extraction Date:	2/12/88	2/12/88	2/12/88	2/12/88	2/15/88	2/15/88
2,4-Dinitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Nitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Dibenzofuran		330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U	330 U
2,6-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U	330 U
Diethylphthalate		330 U	330 U	330 U	330 U	330 U	330 U
4-Chlorophenyl-phenylether		330 U	330 U	330 U	330 U	330 U	330 U
Fluorene		330 U	330 U	330 U	330 U	330 U	330 U
4-Nitroaniline(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4,6-Dinitro-2-methylphenol(21)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
N-Nitrosodiphenylamine(1)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Bromophenyl-phenylether		330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorobenzene		330 U	330 U	330 U	330 U	330 U	330 U
Pentachlorophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Phenanthrene		330 U	330 U	330 U	330 U	330 U	330 U
Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
Di-n-Butyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
Fluoranthene		249 J	252 J	252 J	195 J	425	360
Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Butyl Benzyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
3,3'-Dichlorobenzidine(3)		660 U	660 U	660 U	660 U	660 U	660 U
Benzo(a)Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Ethylhexyl)Phthalate		5110	330 U	330 U	330 U	330 U	330 U
Chrysene		330 U	330 U	330 U	330 U	330 U	330 U
Di-n-Octyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(b)Fluoranthene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(k)Fluoranthene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(a)Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Indeno(1,2,3-cd)Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Dibenz(a,h)Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(g,h,i)Perylene		330 U	330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

		06060-16	06060-17	06060-18	06060-19	SPIKE 06061-19D-A	06061-19D-B
File:	FE326						
Sample	E#88-2124 Sample ID:	06060-16	06060-17	06060-18	06060-19	06061-19D-A	06061-19D-B
Information	Sample Type:	01	01	01	01	01	01
	Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
	Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
	Extraction Date:	2/12/88	2/12/88	2/12/88	2/12/88	2/15/88	2/15/88

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Surrogate Recovery (%)

	06060-16	06060-17	06060-18	06060-19	06061-19D-A	06061-19D-B
Nitrobenzene-d5	43	43	12	8	24	10
2-Fluorobiphenyl	56	39	17	13	23	13
Terphenyl-d14	55	0	0	38	0	0
Phenol-d5	25	31	19	14	27	12
2-Fluorophenol	14.5	14	5	3	17	7
2,4,6-Tribromophenol	21.5	16	7	4	7	5

Analyte:

	06060-16	06060-17	06060-18	06060-19	06061-19D-A	06061-19D-B
Phenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroethyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
2-Chlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,3-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
1,4-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Benzyl Alcohol	330 U	330 U	330 U	330 U	330 U	330 U
1,2-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroisopropyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
4-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
N-Nitroso-di-n-propylamine	330 U	330 U	330 U	330 U	330 U	330 U
Hexachloroethane	330 U	330 U	330 U	330 U	330 U	330 U
Nitrobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Isophorone	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitrophenol	330 U	[illegible]	330 U	330 U	330 U	330 U
2,4-Dimethylphenol	330 U	330 U	330 U	330 U	330 U	330 U
Benzoic Acid (2)	1600 U	1600 U	1600 U	1600 U	[illegible]	1600 U
bis(2-Chloroethoxy)Methane	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,2,4-Trichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Naphthalene	330 U	330 U	330 U	330 U	330 U	330 U
4-Chloroaniline	330 U	330 U	330 U	[illegible]	330 U	330 U
Hexachlorobutadiene	330 U	330 U	330 U	330 U	330 U	330 U
4-Chloro-3-methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylnaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorocyclopentadiene	330 U	330 U	330 U	330 U	330 U	330 U
2,4,6-Trichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
2,4,5-Trichlorophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
2-Chloronaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Dimethyl Phthalate	330 U	330 U	330 U	330 U	330 U	330 U
Acenaphthylene	330 U	[illegible]	330 U	330 U	330 U	330 U
3-Nitroaniline(2)	1600 U	[illegible]	1600 U	[illegible]	[illegible]	[illegible]
Acenaphthene	330 U	330 U	330 U	[illegible]	[illegible]	[illegible]

Qualifiers: U=Analyzed, not detected.

FILE	MOREFEB88		
Sample	E#88-2124 Sample ID:	06060-14	06060-15
Information	Sample Type:	01	01
	Matrix:	SOIL	SOIL
	D.F.:	1.0	1.0
	Units:	UG/KG	UG/KG
	Extraction Date:	2/15/88	2/15/88

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2,4-Dinitrophenol(2)	1600 U	1600 U
4-Nitrophenol(2)	1600 U	1600 U
Dibenzofuran	330 U	330 U
2,4-Dinitrotoluene	330 U	330 U
2,6-Dinitrotoluene	330 U	330 U
Diethylphthalate	330 U	330 U
4-Chlorophenyl-phenylether	330 U	330 U
Fluorene	330 U	330 U
4-Nitroaniline(2)	1600 U	1600 U
4,6-Dinitro-2-methylphenol(2)	1600 U	1600 U
N-Nitrosodiphenylamine(1)	1600 U	1600 U
4-Bromophenyl-phenylether	330 U	330 U
Hexachlorobenzene	330 U	330 U
Pentachlorophenol(2)	1600 U	1600 U
Phenanthrene	330 U	330 U
Anthracene	330 U	330 U
di-n-Butyl Phthalate	330 U	590
Fluoranthene	253 J	164 J
Pyrene	330 U	131 J
Butyl Benzyl Phthalate	330 U	330 U
3,3-Dichlorobenzidine(3)	660 U	660 U
Benzo(a)Anthracene	330 U	330 U
bis(2-Ethylhexyl)Phthalate	330 U	5391
Chrysene	330 U	330 U
di-n-Octyl Phthalate	330 U	330 U
Benzo(b)Fluoranthene	330 U	330 U
Benzo(k)Fluoranthene	330 U	330 U
Benzo(a)Pyrene	330 U	330 U
Indeno(1,2,3-cd)Pyrene	330 U	330 U
Dibenz(a,h)Anthracene	330 U	330 U
Benzo(g,h,i)Perylene	330 U	330 U

Modifiers: U=Analyzed, not detected.

FILE	MOREFE323			
Sample	E#88-2124	Sample ID:	06060-14	06060-15
Information		Sample Type:	01	01
		Matrix:	SOIL	SOIL
		D.F.:	1.0	1.0
		Units:	UG/KG	UG/KG
		Extraction Date:	2/15/88	2/15/88

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Surrogate Recovery (%)

Nitrobenzene-d5	7	0
2-Fluorobiphenyl	14	6
Terphenyl-d14	0	15
Phenol-d5	40	11
2-Fluorophenol	28	2
2,4,6-Tribromophenol	16	3

Analyte:

Phenol	330 U	330 U
bis(2-Chloroethyl)Ether	330 U	330 U
2-Chlorophenol	330 U	330 U
1,3-Dichlorobenzene	330 U	330 U
1,4-Dichlorobenzene	330 U	330 U
Benzyl Alcohol	330 U	330 U
1,2-Dichlorobenzene	330 U	330 U
2-Methylphenol	330 U	330 U
bis(2-Chloroisopropyl)Ether	330 U	330 U
4-Methylphenol	330 U	330 U
N-Nitroso-di-n-propylamine	330 U	330 U
Hexachloroethane	330 U	330 U
Nitrobenzene	330 U	330 U
Isophorone	330 U	330 U
2-Nitrophenol	330 U	330 U
2,4-Dimethylphenol	330 U	330 U
Benzoic Acid(2)	1600 U	1600 U
bis(2-Chloroethoxy)Methane	330 U	330 U
2,4-Dichlorophenol	330 U	330 U
1,2,4-Trichlorobenzene	330 U	330 U
Naphthalene	330 U	330 U
4-Chloroaniline	330 U	330 U
Hexachlorobutadiene	330 U	330 U
4-Chloro-3-methylphenol	330 U	330 U
2-Methylnaphthalene	330 U	330 U
Hexachlorocyclopentadiene	330 U	330 U
2,4,6-Trichlorophenol	330 U	330 U
2,4,5-Trichlorophenol(2)	1600 U	1600 U
2-Chloronaphthalene	330 U	330 U
2-Nitroaniline(2)	1600 U	1600 U
Dimethyl Phthalate	330 U	330 U
Acenaphthylene	330 U	330 U
3-Nitroaniline(2)	1600 U	1600 U
Acenaphthene	330 U	330 U

Modifiers: U=Analyzed, not detected.

FILE FEB23

Sample Information	E#88-2124	06060-8	06060-9	06060-10	06060-11	06060-12	06060-13
	Sample ID:	06060-8	06060-9	06060-10	06060-11	06060-12	06060-13
	Sample Type:	01	01	01	01	01	01
	Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
	Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
	Extraction Date:	2/10/88	2/10/88	2/15/88	2/15/88	2/15/88	2/15/88
2,4-Dinitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Nitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Dibenzofuran		330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U	330 U
2,6-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U	330 U
Diethylphthalate		330 U	330 U	330 U	330 U	330 U	330 U
4-Chlorophenyl-phenylether		330 U	330 U	330 U	330 U	330 U	330 U
Fluorene		330 U	330 U	330 U	330 U	330 U	330 U
4-Nitroaniline(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4,6-Dinitro-2-methylphenol(21)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
N-Nitrosodiphenylamine(1)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Bromophenyl-phenylether		330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorobenzene		330 U	330 U	330 U	330 U	330 U	330 U
Pentachlorophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Phenanthrene		330 U	330 U	330 U	330 U	330 U	330 U
Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
di-n-Butyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
Fluoroanthene		639	574	1015	534	1683	374
Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Butyl Benzyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
3,3-Dichlorobenzidine(3)		660 U	660 U	660 U	660 U	660 U	660 U
Benzo(a)Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Ethylhexyl)Phthalate		330 U	5463	330 U	330 U	14947	330 U
Chrysene		330 U	330 U	330 U	330 U	330 U	330 U
di-n-Octyl Phthalate		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(b)Fluoranthene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(k)Fluoranthene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(a)Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Indeno(1,2,3-cd)Pyrene		330 U	330 U	330 U	330 U	330 U	330 U
Dibenz(a,h)Anthracene		330 U	330 U	330 U	330 U	330 U	330 U
Benzo(g,h,i)Perylene		330 U	330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

FILE [illegible]

Sample [illegible]	Sample ID:	[illegible]-8	[illegible]-9	[illegible]-10	[illegible]-11	[illegible]-12	[illegible]-13
[illegible]	Sample Type:	[illegible]	01	01	01	01	01
	Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	D.F.:	1.		[illegible]	1.0	[illegible]	1.0
	Units:	UG/KG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Extraction Date:	2/10/88	2/10/88	2/15/88	[illegible]		[illegible]

Surrogate Recovery (%)

Nitrobenzene-d5	27.00	26	11	16	44	32
2-Fluorobiphenyl	24.00	26	29	15	43	36
Terphenyl-d14	0.00	40	0	0	51	0
Phenol-d5	31.50	24	12	21	19	23
2-Fluorophenol	9.00	9	6	10	4	14
2,4,6-Tribromophenol	13.00	11	0	10	2	17

Analyte:

Phenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroethyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
2-Chlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,3-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
1,4-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Benzyl Alcohol	330 U	330 U	330 U	330 U	330 U	330 U
1,2-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroisopropyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
4-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
N-Nitroso-di-n-propylamine	330 U	330 U	330 U	330 U	330 U	330 U
Hexachloroethane	330 U	330 U	330 U	330 U	330 U	330 U
Nitrobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Isophorone	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitrophenol	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dimethylphenol	330 U	330 U	330 U	330 U	330 U	330 U
Benzoic Acid(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
bis(2-Chloroethoxy)Methane	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,2,4-Trichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Naphthalene	330 U	330 U	330 U	20 J	330 U	330 U
4-Chloroaniline	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorobutadiene	330 U	330 U	330 U	330 U	330 U	330 U
4-Chloro-3-methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylnaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorocyclopentadiene	330 U	330 U	330 U	330 U	330 U	330 U
2,4,6-Trichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
2,4,5-Trichlorophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
2-Chloronaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	970	1600 U
Dimethyl Phthalate	330 U	330 U	330 U	330 U	330 U	330 U
Acenaphthylene	330 U	330 U	330 U	330 U	330 U	330 U
3-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Acenaphthene	330 U	330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

File:	[illegible]					
Sample	E#88-2124 Sample ID:	06060-3	06060-4	06060-5	06060-6	06060-7
Information	Sample Type:	01	01	01	01	01
	Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL
	D.F.:	1.0	1.0	1.0	1.0	1.0
	Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
	Extraction Date:	2/10/88	2/10/88	2/10/88	2/10/88	2/10/88
2,4-Dinitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U
4-Nitrophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U
Dibenzofuran		330 U	330 U	330 U	330 U	330 U
2,4-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U
2,6-Dinitrotoluene		330 U	330 U	330 U	330 U	330 U
Diethylphthalate		330 U	330 U	330 U	330 U	330 U
4-Chlorophenyl-phenylether		330 U	330 U	330 U	330 U	330 U
Fluorene		330 U	330 U	330 U	330 U	330 U
4-Nitroaniline(2)		1600 U	1600 U	1600 U	1600 U	1600 U
4,6-Dinitro-2-methylphenol(21)		1600 U	1600 U	1600 U	1600 U	1600 U
N-Nitrosodiphenylamine(1)		1600 U	1600 U	1600 U	1600 U	1600 U
4-Bromophenyl-phenylether		330 U	330 U	330 U	330 U	330 U
Hexachlorobenzene		330 U	330 U	330 U	330 U	330 U
Pentachlorophenol(2)		1600 U	1600 U	1600 U	1600 U	1600 U
Phenanthrene		330 U	330 U	330 U	330 U	330 U
Anthracene		330 U	330 U	330 U	330 U	330 U
Di-n-Butyl Phthalate		330 U	161 J	330 U	330 U	330 U
Fluoranthene		215 J	161 J	271 J	80 J	285 J
Pyrene		330 U	330 U	330 U	330 U	330 U
Butyl Benzyl Phthalate		330 U	330 U	330 U	330 U	330 U
3,3'-Dichlorobenzidine(2)		660 U	660 U	660 U	660 U	660 U
Benzo(a)Anthracene		330 U	330 U	330 U	330 U	330 U
bis(2-Ethylhexyl)Phthalate		330 U	1857	4973	330 U	2745
Chrysene		330 U	330 U	330 U	330 U	330 U
Di-n-Octyl Phthalate		330 U	330 U	330 U	330 U	330 U
Benzo(b)Fluoranthene		330 U	330 U	330 U	330 U	330 U
Benzo(k)Fluoranthene		330 U	330 U	330 U	330 U	330 U
Benzo(a)Pyrene		330 U	330 U	330 U	330 U	330 U
Indeno(1,2,3-cd)Pyrene		330 U	330 U	330 U	330 U	330 U
Dibenz(a,h)Anthracene		330 U	330 U	330 U	330 U	330 U
Benzo(g,h,i)Perylene		330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

File:	FEE22						
Sample	E#66-2124	Sample ID:	06060-3	06060-4	06060-5	06060-6	06060-7
Information		Sample Type:	01	01	01	01	01
		Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL
		D.F.:	1.0	1.0	1.0	1.0	1.0
		Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
		Extraction Date:	2/10/88	2/10/88	2/10/88	2/10/88	2/10/88

=+=

Surrogate Recovery (%)

Nitrobenzene-d5	8	17	25	57	57
2-Fluorobiphenyl	11	23	28	32	34
Terphenyl-d14	22	38	53	[illegible]	52
Phenol-d5	7.5	4	1	53	60
2-Fluorophenol	6.5	4	0	12	12
2,4,6-Tribromophenol	0	0	0	16	55

Analyte:

Phenol	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroethyl)Ether	330 U	330 U	330 U	330 U	330 U
2-Chlorophenol	330 U	330 U	330 U	330 U	330 U
1,3-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U
1,4-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U
Benzyl Alcohol	330 U	330 U	330 U	330 U	330 U
1,2-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U
2-Methylphenol	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroisopropyl)Ether	330 U	330 U	330 U	330 U	330 U
4-Methylphenol	330 U	330 U	330 U	330 U	330 U
N-Nitroso-di-n-propylamine	330 U	330 U	330 U	330 U	330 U
Hexachloroethane	330 U	330 U	330 U	330 U	330 U
Nitrobenzene	330 U	330 U	330 U	330 U	330 U
Isophorone	330 U	330 U	330 U	330 U	330 U
2-Nitrophenol	330 U	330 U	330 U	330 U	330 U
2,4-Dimethylphenol	330 U	330 U	330 U	330 U	330 U
Benzoic Acid(2)	1600 U	1600 U	1600 U	1600 U	1600 U
bis(2-Chloroethoxy)Methane	330 U	330 U	330 U	330 U	330 U
2,4-Dichlorophenol	330 U	330 U	330 U	330 U	330 U
1,2,4-Trichlorobenzene	330 U	330 U	330 U	330 U	330 U
Naphthalene	330 U	330 U	330 U	330 U	330 U
4-Chloroaniline	330 U	330 U	330 U	330 U	330 U
Hexachlorobutadiene	330 U	330 U	330 U	330 U	330 U
4-Chloro-3-methylphenol	330 U	330 U	330 U	330 U	330 U
2-Methylnaphthalene	330 U	330 U	330 U	330 U	330 U
Hexachlorocyclopentadiene	330 U	330 U	330 U	330 U	330 U
2,4,6-Trichlorophenol	330 U	330 U	330 U	330 U	330 U
2,4,5-Trichlorophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U
2-Chloronaphthalene	330 U	330 U	330 U	330 U	330 U
2-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U
Dimethyl Phthalate	330 U	330 U	330 U	330 U	330 U
Acenaphthylene	330 U	330 U	330 U	330 U	330 U
3-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U
Acenaphthene	330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

File:	FEB88						
Sample	E#88-2124	Sample ID:	06060-1	06060-2	06060-3	06060-4	06060-5	06060-6
Information		Sample Type:	01	01	01	01	01	01
		Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
		D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
		Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
		Extraction Date:	2/10/88	2/10/88	2/10/88	2/10/88	2/10/88	2/10/88

Compound	06060-1	06060-2	06060-3	06060-4	06060-5	06060-6
2,4-Dinitrophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Nitrophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Dibenzofuran	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dinitrotoluene	330 U	330 U	330 U	330 U	330 U	330 U
2,6-Dinitrotoluene	330 U	330 U	330 U	330 U	330 U	330 U
Diethylphthalate	330 U	330 U	330 U	330 U	330 U	330 U
4-Chlorophenyl-phenylether	330 U	330 U	330 U	330 U	330 U	330 U
Fluorene	330 U	330 U	330 U	330 U	330 U	330 U
4-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4,6-Dinitro-2-methylphenol(21)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
N-Nitrosodiphenylamine(1)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
4-Bromophenyl-phenylether	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Pentachlorophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Phenanthrene	330 U	171 J	330 U	330 U	330 U	330 U
Anthracene	330 U	330 U	330 U	330 U	330 U	330 U
di-n-Butyl Phthalate	202 J	330 U	330 U	161 J	330 U	330 U
Fluoroanthene	330 U	214 J	216 J	161 J	271 J	508
Pyrene	330 U	330 U	330 U	330 U	330 U	330 U
Butyl Benzyl Phthalate	330 U	330 U	330 U	330 U	330 U	330 U
3,3-Dichlorobenzidine(3)	660 U	660 U	660 U	660 U	660 U	660 U
Benzo(a)Anthracene	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Ethylhexyl)Phthalate	330 U	2230	330 U	1357	4773	330 U
Chrysene	330 U	330 U	330 U	330 U	330 U	330 U
di-n-Octyl Phthalate	330 U	330 U	330 U	330 U	330 U	330 U
Benzo(b)Fluoranthene	330 U	330 U	330 U	330 U	[illegible]	330 U
Benzo(k)Fluoranthene	[illegible]	[illegible]	330 U	330 U	[illegible]	330 U
Benzo(a)Pyrene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	330 U
Indeno(1,2,3-cd)Pyrene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	330 U
Dibenz(a,h)Anthracene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	330 U	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] not detected.

File:	FE8E2						
Sample	E#88-2124	Sample ID:	06060-1	06060-2	06060-3	060[illegible]	[illegible]
Information		Sample Type:	01	01	01	01	[illegible]
		Matrix:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
		D.F.:	1.0	1.0	1.0	1.0	1.0	1.0
		Units:	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG
		Extraction Date:	2/10/89	2/10/89	2/10/89	2/10/89	2/10/89	2/10/89

Surrogate Recovery (%)

Nitrobenzene-d5	29	14	8	17	25	37
2-Fluorobiphenyl	44	15	11	33	28	32
Terphenyl-d14	127	33	22	38	53	0
Phenol-d5	5.5	12	7.5	4	1	53
2-Fluorophenol	5	9.5	6.5	4	0	12
2,4,6-Tribromophenol	13	4	0	0	0	16

Analyte:

Phenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroethyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
2-Chlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,3-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
1,4-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Benzyl Alcohol	330 U	330 U	330 U	330 U	330 U	330 U
1,2-Dichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
bis(2-Chloroisopropyl)Ether	330 U	330 U	330 U	330 U	330 U	330 U
4-Methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
N-Nitroso-di-n-propylamine	330 U	330 U	330 U	330 U	330 U	330 U
Hexachloroethane	330 U	330 U	330 U	330 U	330 U	330 U
Nitrobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Isophorone	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitrophenol	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dimethylphenol	330 U	330 U	330 U	330 U	330 U	330 U
Benzoic Acid(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
bis(2-Chloroethoxy)Methane	330 U	330 U	330 U	330 U	330 U	330 U
2,4-Dichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
1,2,4-Trichlorobenzene	330 U	330 U	330 U	330 U	330 U	330 U
Naphthalene	330 U	330 U	330 U	330 U	330 U	330 U
4-Chloroaniline	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorobutadiene	330 U	330 U	330 U	330 U	330 U	330 U
4-Chloro-3-methylphenol	330 U	330 U	330 U	330 U	330 U	330 U
2-Methylnaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
Hexachlorocyclopentadiene	330 U	330 U	330 U	330 U	330 U	330 U
2,4,6-Trichlorophenol	330 U	330 U	330 U	330 U	330 U	330 U
2,4,5-Trichlorophenol(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
2-Chloronaphthalene	330 U	330 U	330 U	330 U	330 U	330 U
2-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Dimethyl Phthalate	330 U	330 U	330 U	330 U	330 U	330 U
Acenaphthylene	330 U	330 U	330 U	330 U	330 U	330 U
3-Nitroaniline(2)	1600 U	1600 U	1600 U	1600 U	1600 U	1600 U
Acenaphthene	330 U	330 U	330 U	330 U	330 U	330 U

Modifiers: U=Analyzed, not detected.

File: FE52201BLANK

Sample	Sample ID:	REAGENTBLANK	FIELDBLANK	TRIPBLANK
Information	Sample Type:	01	01	01
	Matrix:	WATER	WATER	WATER
	D.F.:	1.0	1.0	1.0
	Units:	UG/L	UG/L	UG/L
	Extraction Date:	2/8/88	2/8/88	2/8/88
2,4-Dinitrophenol(2)		50 U	50 U	50 U
4-Nitrophenol(2)		50 U	50 U	50 U
Dibenzofuran		10 U	10 U	10 U
2,4-Dinitrotoluene		10 U	10 U	10 U
2,6-Dinitrotoluene		10 U	10 U	10 U
Diethylphthalate		10 U	10 U	10 U
4-Chlorophenyl-phenylether		10 U	10 U	10 U
Fluorene		10 U	10 U	10 U
4-Nitroaniline(2)		50 U	50 U	50 U
4,6-Dinitro-2-methylphenol(2)		50 U	50 U	50 U
N-Nitrosodiphenylamine(1)		10 U	10 U	10 U
4-Bromophenyl-phenylether		10 U	10 U	10 U
Hexachlorobenzene		10 U	10 U	10 U
Pentachlorophenol(2)		50 U	50 U	50 U
Phenanthrene		10 U	10 U	10 U
Anthracene		10 U	10 U	10 U
di-n-Butyl Phthalate		6 J	3 J	4 J
Fluoranthene		1 J	10 U	10 U
Pyrene		10 U	10 U	10 U
Butyl Benzyl Phthalate		10 U	10 U	10 U
3,3-Dichlorobenzidine(3)		20 U	20 U	20 U
Benzo(a)Anthracene		10 U	10 U	10 U
bis(2-Ethylhexyl)Phthalate		7 J	10 U	10 U
Chrysene		10 U	10 U	10 U
di-n-Octyl Phthalate		10 U	10 U	10 U
Benzo(b)Fluoranthene		10 U	10 U	10 U
Benzo(k)Fluoranthene		10 U	10 U	10 U
Benzo(a)Pyrene		10 U	10 U	10 U
Indeno(1,2,3-cd)Pyrene		10 U	10 U	10 U
Dibenz(a,h)Anthracene		10 U	10 U	10 U
Benzo(g,h,i)Perylene		10 U	10 U	10 U

Modifiers: U=Analyzed, not detected.

File: FE22201BLANK

Sample Information	Sample ID:	REAGENTBLANK	FIELDBLANK	TRIPBLANK
	Sample Type:	01	01	01
	Matrix:	WATER	WATER	WATER
	D.F.:	1.0	1.0	1.0
	Units:	UG/L	UG/L	UG/L
	Extraction Date:	2/8/88	2/8/88	2/8/88

=+=-

Surrogate Recovery (%)

Nitrobenzene-d5	0	6	31
2-Fluorobiphenyl	1	9	43
Teronenyl-di4	10	19	101
Phenol-d5	3	2	7
2-Fluorophenol	2.5	2	7
2,4,6-Tribromophenol	36.5	10	23

Analyte:

Phenol	10 U	10 U	10 U
bis(2-Chloroethyl)Ether	10 U	10 U	10 U
2-Chlorophenol	10 U	10 U	10 U
1,3-Dichlorobenzene	10 U	10 U	10 U
1,4-Dichlorobenzene	10 U	10 U	10 U
Benzyl Alcohol	10 U	10 U	10 U
1,2-Dichlorobenzene	10 U	10 U	10 U
2-Methylphenol	10 U	10 U	10 U
bis(2-Chloroisopropyl)Ether	10 U	10 U	10 U
4-Methylphenol	10 U	10 U	10 U
N-Nitroso-di-n-propylamine	10 U	10 U	10 U
Hexachloroethane	10 U	10 U	10 U
Nitrobenzene	10 U	10 U	10 U
Isophorone	10 U	10 U	10 U
2-Nitrophenol	10 U	10 U	10 U
2,4-Dimethylphenol	10 U	10 U	10 U
Benzoic Acid(2)	50 U	50 U	50 U
bis(2-Chloroethoxy)Methane	10 U	10 U	10 U
2,4-Dichlorophenol	10 U	10 U	10 U
1,2,4-Trichlorobenzene	10 U	10 U	10 U
Naphthalene	10 U	10 U	10 U
4-Chloroaniline	10 U	10 U	10 U
Hexachlorobutadiene	10 U	10 U	10 U
4-Chloro-3-methylphenol	10 U	10 U	10 U
2-Methylnaphthalene	10 U	10 U	10 U
Hexachlorocyclopentadiene	10 U	10 U	10 U
2,4,6-Trichlorophenol	10 U	10 U	10 U
2,4,5-Trichlorophenol(2)	50 U	50 U	50 U
2-Chloronaphthalene	10 U	10 U	10 U
2-Nitroaniline(2)	50 U	50 U	50 U
Dimethyl Phthalate	10 U	10 U	10 U
Acenaphthylene	10 U	10 U	10 U
3-Nitroaniline(2)	50 U	50 U	50 U
Acenaphthene	10 U	10 U	10 U

Modifiers: U=Analyzed, not detected.

207-B SOLAR POND
NORTH AND CENTER
QUARTERLY METALS ANALYSIS
AUGUST 14, 1987

LAB NO. E87-3918

LAB NO: E87-3918
DATE: AUGUST 14, 1987

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

CHARGE: 331

TO: R.L.HENRY
CC: FILE

BLDG: T452B
DEPT: ENV. ANALYSIS

SAMPLE DESCRIPTION:

207B SOLAR POND NORTH (QUARTERLY)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT	Mg/L	ELEMENT	Mg/L
Ag	<.0028	Mo	<.0028
Al	<.0028	Na *	820
As *	<.01	Nb	<.14
B	.14	Ni	<.028
Ba *	<1.0	P	<.14
Be *	<.05	Pb	<.0028
Bi	<.014	Rb	<.28
Ca *	96.0	Sb	<.028
Cd *	<.01	Se *	<.01
Ce	<2.8	Si *	2.1
Co	<.014	Sn	<.028
Cr *	<.05	Sr	.14
Cs	<.28	Ta	<.028
Cu	<.014	Te	<.28
Fe	.057	Th	<.028
Ge	<.014	Ti	<.014
Hg *	<.002	Tl	<.014
K *	89.0	U	<1.4
Li	1.7	V	<.028
Mg *	88	W	<1.4
Mn	<.0028	Zn	<.14
		Zr	<.028

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 2829

ANALYSIS BY: R2D,DLP

APPROVED BY R.A. Silver

PLATE NO: 3399

LAB NO: E87-3918
DATE: AUGUST 14, 1987

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: R.L.HENRY
CC: FILE

BLDG: T452B
DEPT: ENV. ANALYSIS

CHARGE: 331

SAMPLE DESCRIPTION:

207B SOLAR POND CENTER (QUARTERLY)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		<.0032	Mo		.019
Al		<.0032	Na	*	800.0
As	*	<.01	Nb		<.16
B		.13	Ni		<.032
Ba	*	<1.0	P		<.16
Be	*	<.05	Pb		<.0032
Bi		<.016	Rb		<.32
Ca	*	95.0	Sb		<.032
Cd	*	<.01	Se	*	<.01
Ce		<3.2	Si	*	1.4
Co		<.016	Sn		<.032
Cr	*	<.05	Sr		.16
Cs		<.32	Ta		<.032
Cu		<.016	Te		<.32
Fe		.13	Th		<.032
Ge		<.016	Ti		<.016
Hg	*	<.002	Tl		<.016
K	*	98.0	U		<1.6
Li		2.9	V		<.032
Mg	*	86.0	W		<1.6
Mn		<.0032	Zn		<.16
			Zr		<.032

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 3226

ANALYSIS BY: R2D,DLP

PLATE NO: 3399

APPROVED BY R. A. Silva

207-B SOLAR POND
NORTH AND CENTER
QUARTERLY METALS ANALYSIS
NOVEMBER 30, 1987

LAB NO. E87-4254

LAB NO: E87-4254
DATE: NOVEMBER 30, 1987

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: R.L.HENRY
CC: FILE

BLDG: T452B
DEPT: ENV. ANALYSIS

CHARGE: 331

SAMPLE DESCRIPTION:

207B NORTH (QUARTERLY)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT		Mg/L	ELEMENT		Mg/L
Ag		<.003	Mo		.003
Al		<.003	Na	*	770.0
As	*	<.01	Nb		<.15
B		.09	Ni		<.03
Ba	*	<1.0	P		<.15
Be	*	.06	Pb		<.003
Bi		<.015	Rb		<.3
Ca	*	180.0	Sb		<.03
Cd	*	.01	Se	*	.024
Ce		<3	Si	*	<.5
Co		<.015	Sn		<.03
Cr	*	<.05	Sr		.21
Cs		<.3	Ta		<.03
Cu		<.015	Te		<.3
Fe		<.03	Th		<.03
Ge		<.015	Ti		<.015
Hg	*	<.002	Tl		<.015
K	*	64.0	U		<1.5
Li		6	V		<.03
Mg	*	80.0	W		<1.5
Mn		<.003	Zn		<.15
			Zr		<.03

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 2996

ANALYSIS BY: R2D,CM

PLATE NO: 3443A

APPROVED BY R.C. Silva

LAB NO: E87-4254
DATE: NOVEMBER 30, 1987

ROCKWELL INTERNATIONAL
ENERGY SYSTEMS GROUP
ROCKY FLATS PLANT
881 GENERAL LABORATORY

ANALYSIS REPORT

TO: R.L.HENRY
CC: FILE

BLDG: T452B
DEPT: ENV. ANALYSIS

CHARGE: 331

SAMPLE DESCRIPTION:

207B CENTER (QUARTERLY)

EMISSION SPECTROGRAPHIC RESULTS

ELEMENT	Mg/L	ELEMENT	Mg/L
Ag	<.0035	Mo	.0035
Al	<.0035	Na *	650.0
As *	<.01	Nb	<.18
B	.071	Ni	<.035
Ba *	<1.0	P	.18
Be *	<.05	Pb	<.0035
Bi	<.018	Rb	<.35
Ca *	66.0	Sb	<.035
Cd *	.01	Se *	.019
Ce	<3.5	Si *	1.6
Co	<.018	Sn	<.035
Cr *	<.05	Sr	.14
Cs	.35	Ta	<.035
Cu	<.018	Te	<.35
Fe	<.035	Th	<.035
Ge	<.018	Ti	<.018
Hg *	<.002	Tl	<.018
K *	110.0	U	<1.8
Li	3.5	V	<.035
Mg *	91.0	W	<1.8
Mn	<.0035	Zn	<.18
		Zr	<.035

* ATOMIC ABSORPTION SPECTROPHOTOMETRIC RESULTS.
** NOT RUN

TOTAL SOLIDS: 3543

ANALYSIS BY: R2D,CM

PLATE NO: 3443A

APPROVED BY ..R. A. [signature]......

207-A AND 207-C SOLAR POND
QUARTERLY ANALYSIS RESULTS (LIQUID)
MARCH 1987 TO MARCH 1988

9

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. T. Illsley, HS&E T452B
R. L. Henry, HS&E T452B
File

LAB NUMBER: E87-3384
DATE: 7-22-87
ACCOUNT NO: 900458

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

207 C Solar Pond - Quarterly - Received: 3-27-87

ANALYSIS RESULTS

Analysis	Results
pH (S.U.)	10.8
NO_3^- as N (mg/L)	9650
T. D. S. (mg/L)	93850
CN^- (ppm)	*
Be (ug/ml)	*
Gross Alpha (pCi/L)	$(1.3 \pm 0.1) \times 10^4$
Gross Beta (pCi/L)	$(1.4 \pm 0.1) \times 10^4$
Pu-239 (pCi/L)	$(3.0 \pm 1.3) \times 10^2$
Am-241 (pCi/L)	$(1.9 \pm 1.5) \times 10^2$
U (pCi/L)	$(1.4 \pm 0.09) \times 10^4$

* Not requested.

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ANALYTICAL REPORT

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

T. C. Greengard, RCRA/CERCLA T452F
C. L. Sundblad, EM T452B
File

LAB NUMBER: E87-4150
DATE: 1-12-88
ACCOUNT NO: 900458

APPROVED: [signature]
J. A. Blair

SAMPLE DESCRIPTION

207 A & C Solar Pond - Quarterly - Received: 9-14-87

ANALYSIS RESULTS

Analysis	207A	207C
pH (S.U.)	10.1	10.6
NO_3^- as N (mg/L)	19,200	21,400
T. D. S. (mg/L)	127,000	146,400
CN^- (ppm)	0.1	0.5
Gross Alpha (pCi/L)	$(8.0 \pm 0.1) \times 10^4$	$(4.1 \pm 0.3) \times 10^4$
Gross Beta (pCi/L)	$(2.1 \pm 0.2) \times 10^3$	$(3.4 \pm 0.1) \times 10^3$
Be (ug/ml)	2.0	not available

*Plutonium, Uranium, and Americium were canceled per telephone conversation with C. L. Sundblad, 1-12-88.

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. L. Sundblad, HS&E T452B

File

LAB NUMBER: E87-4483
DATE: 3-14-88
ACCOUNT NO: 900458

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

207-C Solar Pond - Quarterly - Received: 12-07-87

ANALYSIS RESULTS

Analysis	Results
pH (S.U.)	10.5
NO_3^- as N (mg/L)	20,600
T. D. S. (mg/L)	162,400
Gross Alpha (pCi/L)	$(4.6 \pm 0.8) \times 10^4$
Gross Beta (pCi/L)	$(4.4 \pm 0.4) \times 10^4$
Pu-239 (pCi/L)	$(3.3 \pm 0.4) \times 10^3$
Am-241 (pCi/L)	$(0.0 \pm 2.7) \times 10^1$
U (pCi/L)	$(4.0 \pm 0.1) \times 10^4$

GENERAL LABORATORY | | BUILDING 881
03/28/88 | ANALYTICAL REPORT | 15:02

LAB'NO : 88.ENV.02326

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Aerospace Operations

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Golden, Colorado 80402

DISTRIBUTION
C.L. Sundblad HS&E T452B
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02326
Account No: 900458
APPROVED: ____________________
Judy A. Blair

SAMPLE DESCRIPTION

Pond 207-C; quarterly.
Sample Logged in: 03/14/88 15:17 Collection Date 03/14/88

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207				
Beryllium (HSL metals)	0.1	mg/L		
Gross Alpha	(4.6+0.6)*E+04	pCi/L	0.00000	40.00000
Gross Beta	(3.4+0.3)*E+04	pCi/L	0.00000	50.00000
pH	11.3	S.U.	6.00	9.00
Total Dissolved Solids	175,800	mg/L		
Nitrate as N	12,000	mg/L		
Cyanide by chem analysis	0.480	ppm		
Plutonium 239	(2.1+0.3)*E+03	pCi/L	2100	
Americium 241	(2.9+0.3)*E+03	pCi/L		
Uranium	(4.0+0.2)*E+04	pCi/L		

207-B SOLAR POND
WEEKLY ANALYSIS RESULTS
OCTOBER 1987 TO JUNE 1988

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

✓C. L. Sundblad, T452B EM
E. R. Naimon 374 Wste Ops
T. C. Greengard, 750 RCRA/CERCLA
File

LAB NUMBER: E87-4245
DATE: 10-30-87
ACCOUNT NO: 900458

APPROVED: [signature] for J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B
(Weekly Sample)

1) North 1) Center
Received: 10-12-87

Analysis	North	Center
pH (S.U.)	8.4	10.5
NO^-_3 as N (mg/L)	332	379
Gross Alpha (pCi/L)	99 ± 15	57 ± 21
Gross Beta (pCi/L)	67 ± 3	154 ± 21

ANALYTICAL REPORT

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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. L. Sundblad, T452B EM
E. R. Naimon 374 Wste Ops
T. C. Greengard, 750 RCRA/CERCLA
File

LAB NUMBER: E87-4288
DATE: 11-05-87
ACCOUNT NO: 900458

APPROVED: for J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B
(Weekly Sample)

1) North 1) Center
Received: 10-19-87

Analysis	North	Center
pH (S.U.)	8.5	10.5
NO_3^- as N (mg/L)	335	385
Gross Alpha (pCi/L)	133 ± 3	39 ± 3
Gross Beta (pCi/L)	97 ± 21	119 ± 56

ANALYTICAL REPORT

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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:	
✓C. L. Sundblad, T452B EM	LAB NUMBER: E87-4311
E. R. Naimon 374 Wste Ops	DATE: 10-30-87
T. C. Greengard, T452F RCRA/CERCLA	ACCOUNT NO: 900458
File	APPROVED: for J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B (Weekly Sample)

1) North 1) Center
Received: 10-26-87

Analysis	North	Center
pH (S.U.)	8.5	10.2
NO_3^- as N (mg/L)	334.2	346.4
Gross Alpha (pCi/L)	52 ± 20	105 ± 5
Gross Beta (pCi/L)	106 ± 32	72 ± 16

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
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GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. L. Sundblad, T452B EM
E. R. Naimon 374 Wste Ops
T. C. Greengard, 750 RCRA/CERCLA
File

LAB NUMBER: E87-4385
DATE: 11-13-87
ACCOUNT NO: 900458

APPROVED: for J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B
(Weekly Sample)

1) North 1) Center
Received: 11-09-87

Analysis	North	Center
pH (S.U.)	8.2	10.0
NO_3^- as N (mg/L)	363	401
Gross Alpha (pCi/L)	92 ± 7	52 ± 3
Gross Beta (pCi/L)	107 ± 3	114 ± 24

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

C. L. Sundblad, T452B EM
E. R. Naimon 374 Wste Ops
T. C. Greengard, 750 RCRA/CERCLA
File

LAB NUMBER: E87-4414
DATE: 11-24-87
ACCOUNT NO: 900458

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B
(Weekly Sample)

1) North 1) Center
Received: 11-16-87

Analysis	North	Center
pH (S.U.)	8.3	10.0
NO_3^- as N (mg/L)	350.4	378.0
Gross Alpha (pCi/L)	105 $\pm$ 32	55 $\pm$ 25
Gross Beta (pCi/L)	102 $\pm$ 51	92 $\pm$ 50

GENERAL LABORATORY	ANALYTICAL REPORT	BUILDING 881
11/30/87		15:54
		Page 1

LAB'NO : 87.ENV.04443

Rockwell International
North American Space Operations

P. O. Box 464
Golden, Colorado 80402

DISTRIBUTION
C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 7
File

Lab Number: 87.ENV.04443
Account No: 900458

APPROVED: for Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds, 207B North & Center
Sample Logged in: 11/23/87 13:36 Collection Date 11/23/87

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Nitrate as N	359.5	mg/L	.1999999	1000.000
Gross Alpha	90 (+/-) 29 *	pCi/L	0.00000	40.00000
Gross Beta	82 (+/-) 46 *	pCi/L	0.00000	50.00000
pH	8.1	S.U.	6.00	9.00
No preservation.				
Solar Pond 207-B Center				
Nitrate as N	404.5	mg/L	.1999999	1000.000
pH	9.9	S.U.	6.00	9.00
Gross Alpha	69 (+/-) 27 *	pCi/L	0.00000	40.00000
Gross Beta	105 (+/-) 47 *	pCi/L	0.00000	50.00000
No preservation.				

GENERAL LABORATORY		BUILDING 881
01/04/88	ANALYTICAL REPORT	15:52

LAB'NO : 87.ENV.04476

Rockwell International
North American Space Operations
P. O. Box 464
Golden, Colorado 80402

DISTRIBUTION
C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 7
File

Lab Number: 87.ENV.04476
Account No: 900458

APPROVED: for Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B
Sample Logged in: 12/07/87 13:52 Collection Date 12/07/87

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	86 (+/-) 30	pCi/L	0.00000	40.00000
Gross Beta	91 (+/-) 54	pCi/L	0.00000	50.00000
pH	8.3	S.U.	6.00	9.00
Nitrate as N	373	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
Gross Alpha	40 (+/-) 22	pCi/L	0.00000	40.00000
Gross Beta	79 (+/-) 45	pCi/L	0.00000	50.00000
pH	9.6	S.U.	6.00	9.00
Nitrate as N	388	mg/L	.1999999	1000.000

GENERAL LABORATORY		BUILDING 881
03/23/88	ANALYTICAL REPORT	12:34
		Page 1

LAB'NO : 88.ENV.02290

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Golden, Colorado 80402

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C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02290
Account No: 900458

APPROVED: ______________
Judy A. Blair

SAMPLE DESCRIPTION

Solar Pond 207-B North and Center
Sample Logged in: 03/07/88 13:55 Collection Date 03/07/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	128 (+/-) 54	pCi/L	0.00000	40.00000
Gross Beta	117 (+/-) 36	pCi/L	0.00000	50.00000
pH	8.2	S.U.	6.00	9.00
Nitrate as N	212	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
Gross Alpha	159 (+/-) 68	pCi/L	0.00000	40.00000
Gross Beta	183 (+/-) 43	pCi/L	0.00000	50.00000
pH	9.7	S.U.	6.00	9.00
Nitrate as N	580	mg/L	.1999999	1000.000

GENERAL LABORATORY		BUILDING 881
03/25/88	ANALYTICAL REPORT	09:41
		Page 1

LAB'NO : 88.ENV.02322

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DISTRIBUTION
C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02322
Account No: 900458

APPROVED: ______________
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 03/14/88 15:07 Collection Date 03/14/88

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	97 (+/-) 34	pCi/L	0.00000	40.00000
Gross Beta	(1.3±0.4)*E+02	pCi/L	0.00000	50.00000
[illegible]	8.2	S.U.	6.00	9.00
Nitrate as N	390	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
Gross Alpha	81 (+/-) 31	pCi/L	0.00000	40.00000
Gross Beta	(1.3±0.4)*E+02	pCi/L	0.00000	50.00000
pH	9.6	S.U.	6.00	9.00
Nitrate as N	370	mg/L	.1999999	1000.000

LAB'NO : 88.ENV.02356

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Aerospace Operations
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DISTRIBUTION
C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02356
Account No: 900458

APPROVED: [signature]
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B North and Center
Sample Logged in: 03/21/88 13:44 Collection Date 03/21/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	(9.9±4.3)*E+01	pCi/L	0.00000	40.00000
Gross Beta	(1.1±0.4)*E+02	pCi/L	0.00000	50.00000
pH	8.2	S.U.	6.00	9.00
Nitrate as N	436	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
Gross Alpha	(3.3±1.2)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(2.4±0.6)*E+02	pCi/L	0.00000	50.00000
pH	9.8	S.U.	6.00	9.00
Nitrate as N	481	mg/L	.1999999	1000.000

GENERAL LABORATORY		BUILDING 881
04/07/88	ANALYTICAL REPORT	08:15

LAB'NO : 88.ENV.02393

Rockwell International
Aerospace Operations

P. O. Box 464
Golden, Colorado 80402

DISTRIBUTION
C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02393
Account No: 900458

APPROVED: Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 03/28/88 14:08 Collection Date 03/28/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	(2.0+0.8)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(9.7+3.9)*E+01	pCi/L	0.00000	50.00000
pH	8.1	S.U.	6.00	9.00
Nitrate as N	378	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
Gross Alpha	(1.2+0.8)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(4.8+0.7)*E+02	pCi/L	0.00000	50.00000
pH	10.0	S.U.	6.00	9.00
Nitrate as N	599	mg/L	.1999999	1000.000

GENERAL LABORATORY	ANALYTICAL REPORT	BUILDING 881
04/11/88		08:05
		Page 1

LAB'NO : 88.ENV.02415

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DISTRIBUTION

C.L. Sundblad HS&E T452B
G.T. Hewitt Waste Ops 374
T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02415
Account No: 900458

APPROVED: Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 04/04/88 15:21 Collection Date 04/04/88

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
pH	8.0	S.U.	6.00	9.00
Nitrate as N	490	mg/L	.1999999	1000.000
Gross Alpha	(9.3+3.3)*E+01	pCi/L	0.00000	40.00000
Gross Beta	(1.1+0.4)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
pH	10.0	S.U.	6.00	9.00
Nitrate as N	756	mg/L	.1999999	1000.000
Gross Alpha	(9.7+4.0)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(6.2+0.8)*E+02	pCi/L	0.00000	50.00000

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File

Lab Number: 88.ENV.02446
Account No: 900458

APPROVED: Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B -- North and Center
Sample Logged in: 04/11/88 15:07 Collection Date 04/11/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Nitrate as N	507	mg/L	.1999999	1000.000
pH	8.2	S.U.	6.00	9.00
Gross Alpha	(1.0±0.5)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(1.0±0.4)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
Nitrate as N	819	mg/L	.1999999	1000.000
pH	10.1	S.U.	6.00	9.00
Gross Alpha	(1.1±0.3)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.1±0.2)*E+03	pCi/L	0.00000	50.00000

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Account No: 900458

APPROVED: Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B; North and Center
Sample Logged in: 04/22/88 13:13 Collection Date 04/18/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Gross Alpha	(1.1±0.4)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(7.2±5.5)*E+01	pCi/L	0.00000	50.00000
Nitrate as N	505	mg/L	.1999999	1000.000
pH	8~~4~~.0	S.U.	6.00	9.00
Solar Pond 207-B Center				
Gross Alpha	(9.8±2.5)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(8.4±1.4)*E+02	pCi/L	0.00000	50.00000
Nitrate as N	980	mg/L	.1999999	1000.000
pH	10.3	S.U.	6.00	9.00

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| GENERAL LABORATORY   BUILDING 881 |
| 05/02/88   ANALYTICAL REPORT   08:17 |
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- File

Lab Number: 88.ENV.02532
Account No: 900458

APPROVED: ______________
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B; North and Center
Sample Logged in: 04/25/88 13:15 Collection Date 04/25/88

ANALYSIS RESULTS

"*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
pH	8.2	S.U.	6.00	9.00
Nitrate as N	424	mg/L	.1999999	1000.000
Gross Alpha	(1.3±0.5)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(1.3±0.4)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
pH	10.2	S.U.	6.00	9.00
Nitrate as N	918	mg/L	.1999999	1000.000
Gross Alpha	(2.2±0.8)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.2±0.2)*E+03	pCi/L	0.00000	50.00000

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File

Lab Number: 88.ENV.02560
Account No: 900458

APPROVED: ____________
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 05/02/88 14:10 Collection Date 05/02/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
pH	8.7	S.U.	6.00	9.00
Nitrate as N	431	mg/L	.1999999	1000.000
Gross Alpha	(1.9+0.8)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(1.8+0.6)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
pH	10.3	S.U.	6.00	9.00
Nitrate as N	978	mg/L	.1999999	1000.000
Gross Alpha	(2.5+0.4)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.5+0.2)*E+03	pCi/L	0.00000	50.00000

ANALYTICAL REPORT

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E. R. Naimon 374 Wste Ops
T. C. Greengard, 750 RCRA/CERCLA
File

LAB NUMBER: E88-2610
DATE: 5-23-88
ACCOUNT NO: 900458

APPROVED: J. A. Blair

SAMPLE DESCRIPTION

Solar Evaporation Pond 207B
(Weekly Sample)

1) North 1) Center
Received: 5-09-88

Analysis	North	Center
pH (S.U.)	8.4	10.4
NO_3^- as N (mg/L)	433	1,125
Gross Alpha (pCi/L)	$(8.9 \pm 4.1) \times 10^1$	$(2.4 \pm 0.4) \times 10^3$
Gross Beta (pCi/L)	$(1.8 \pm 0.4) \times 10^2$	$(1.0 \pm 0.1) \times 10^3$

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Account No: 900458

APPROVED: Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North ~~and Center~~
Sample Logged in: 05/18/88 16:51 Collection Date 05/18/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
pH	8.5	S.U.	6.00	9.00
Gross Alpha	82 (+/-) 66	pCi/L	0.00000	40.00000
Gross Beta	(1.6+0.8)*E+02	pCi/L	0.00000	50.00000
Nitrate as N	503	mg/L	.1999999	1000.000
Solar Pond 207-B Center				
pH	10.3	S.U.	6.00	9.00
Gross Alpha	(2.4+0.4)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.3+0.2)*E+03	pCi/L	0.00000	50.00000
Nitrate as N	1204	mg/L	.1999999	1000.000

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File

Lab Number: 88.ENV.02710
Account No: 900458

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Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 05/25/88 14:36 Collection Date 05/25/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Nitrate as N	460	mg/L	.1999999	1000.000
Gross Alpha	(1.0±0.8)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(1.4±0.7)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
Nitrate as N	1221	mg/L	.1999999	1000.000
Gross Alpha	(1.9±0.3)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.3±0.2)*E+03	pCi/L	0.00000	50.00000

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Account No: 900458

APPROVED: [signature]
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 06/01/88 14:52 Collection Date 06/01/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Nitrate as N	416	mg/L	.1999999	1000.000
Gross Alpha	99 (+/-) 59	pCi/L	0.00000	40.00000
Gross Beta	91 (+/-) 69	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
Nitrate as N	977	mg/L	.1999999	1000.000
Gross Alpha	(2.4±0.4)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.1±0.1)*E+03	pCi/L	0.00000	50.00000

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T.C. Greengard RCRA/CERCLA 750
File

Lab Number: 88.ENV.02779
Account No: 900458

APPROVED:
Judy A. Blair

SAMPLE DESCRIPTION

Solar Ponds 207-B, North and Center
Sample Logged in: 06/08/88 14:52 Collection Date 06/08/88

ANALYSIS RESULTS "*" Indicates this analysis did not meet the control guide.

TEST	RESULT	UNITS	LOWER LIMIT	UPPER LIMIT
Solar Pond 207-B North				
Nitrate as N	319	mg/L	.1999999	1000.000
Gross Alpha	(1.6±0.8)*E+02	pCi/L	0.00000	40.00000
Gross Beta	(2.0±0.8)*E+02	pCi/L	0.00000	50.00000
Solar Pond 207-B Center				
Nitrate as N	1078	mg/L	.1999999	1000.000
Gross Alpha	(2.2±0.3)*E+03	pCi/L	0.00000	40.00000
Gross Beta	(1.5±0.2)*E+03	pCi/L	0.00000	50.00000

APPENDIX 5

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH

COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE PROGRAM

PHASE 2:
ROCKY FLATS PLANT
INSTALLATION GENERIC MONITORING PLAN
(Comprehensive Source and Plume Characterization Plan)

QUALITY ASSURANCE/QUALITY CONTROL PLAN

February 1987

DRAFT

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TABLES

FIGURES

QUALITY ASSURANCE/QUALITY CONTROL PLAN

1. INTRODUCTION

CEARP Phase 2 consists of CEARP Phase 2a, Monitoring Plan, and CEARP Phase 2b, Site Characterization (Remedial Investigation). This Quality Assurance/Quality Control (QA/QC) Plan is one component of the Monitoring Plan for Rocky Flats Plant. The Monitoring Plan typically consists of five parts: Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control Plan. Because of the Compliance Agreement made by the State of Colorado, Environmental Protection Agency, and the DOE, this Monitoring Plan also includes a Feasibility Study Plan. The Synopsis provides a discussion of the current situation and serves as an introduction to the other plans.

CEARP uses a three-tiered approach in preparing the monitoring plans: the CEARP Generic Monitoring Plan (CGMP) (DOE, 1986b), the Installation Generic Monitoring Plan (IGMP), and the Site-Specific Monitoring Plans (SSMPs). The CGMP Quality Assurance/Quality Control (QA/QC) Plan provides the generic guidelines and procedures that will be employed during CEARP Phase 2 site characterization (remedial investigation) to ensure the reliability of data collected at CEARP sites. It is intended to establish a general quality assurance/quality control policy and to provide the framework for more specific quality assurance/quality control requirements to be employed at each installation and at each site. This IGMP Quality Assurance/Quality Control Plan provides installation generic information and procedures, whereas the SSMPs will provide site-specific detail regarding locations, types and number of samples.

This IGMP is the Comprehensive Source and Plume Characterization Plan required by the Compliance Agreement. Therefore, the acronym used to refer to this plan is IGMP/CSPCP.

According to DOE policy, DOE activities shall maintain programs of quality assurance (DOE Order 5700.6B). In the area of environmental protection, quality assurance plans must be integrated with the DOE implementation of CERCLA (DOE Order 5480.14).

CEARP Phase 2b site characterizations (remedial investigations) will be implemented using procedures to assure that the precision, accuracy, completeness, and representativeness of data are known and documented. At a minimum, this will include adherence to the CEARP CGMP, IGMP/CSPCP, and SSMP Quality Assurance/Quality Control Plans, and may include preparation of written Quality Assurance/Quality Control Plans covering each aspect of the project performed.

This IGMP/CSPCP Quality Assurance/Quality Control Plan presents the organization, objectives, functional activities, and specific quality assurance and quality control activities associated with the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. The Quality Assurance/Quality Control Plan is designed to achieve specific data quality goals for CEARP Phase 2b site characterizations (remedial investigations). Appendix A includes the quality assurance protocols for all laboratory services to be provided under CEARP Phase 2b site characterizations (remedial investigations).

A brief description of the CEARP Phase 2b site characterization (remedial investigation) and background can be found in the Synopsis. For a more in-depth background description, see the CEARP Phase 1 report.

2. PROJECT ORGANIZATION AND RESPONSIBILITY

Project organization and responsibility are divided among DOE, Los Alamos National Laboratory, and Rockwell International as described below. Los Alamos National Laboratory has the primary responsibility to implement CEARP under the guidance of DOE-Albuquerque Operations Office. However, operational responsibilities have been assigned to Rockwell International at Rocky Flats Plant for the site characterizations (remedial investigations). The DOE-Rocky Flats Plant Area Office is responsible for the function of the Rocky Flats Plant. Because of this responsibility, the DOE-Rocky Flats Plant Area Office will provide additional guidance to its contractor, Rockwell International, in implementation of the CEARP Phase 2b site characterizations (remedial investigations).

Project organization is shown in Figure 2.1. The responsibilities of the various personnel can be divided into operational, laboratory, and quality assurance responsibilities, as follows.

2.1. OPERATIONAL RESPONSIBILITIES

Assistant Secretary for the Environment. The DOE Assistant Secretary for the Environment appoints Headquarters investigation boards and establishes the scope of Headquarters investigations (DOE Order 5484.1). DOE-wide Environmental Surveys and Audits originate from the Assistant Secretary.

Environmental Surveys and Audits. Headquarters Environmental Survey Teams have been directed to conduct one-time environmental surveys and sampling of DOE facilities. These surveys are independent of CEARP activities at Rocky Flats Plant, but data from survey team sampling will be utilized in the CEARP characterization of Rocky Flats Plant. A Headquarters environmental survey team visited the Rocky Flats Plant site in 1986. The results of the survey will be used as an internal management tool by the Secretary and Undersecretary of DOE.

Audits are a function of the Office of the Assistant Secretary for the Environment. Audit teams provide quality control for the implementation of environmental monitoring at DOE facilities. Although independent of CEARP, audit teams complement CEARP activities by providing additional quality assurance.

DOE-Albuquerque Operations Office Environmental Programs Branch. The DOE-Albuquerque Operations Office, Environmental Programs Branch, is responsible for overseeing all environmental programs within DOE-Albuquerque Operations and conducting special assessments such as CEARP.

DOE-Rocky Flats Area Office. The DOE Rocky Flats Area Office is responsible for the missions of the Rocky Flats Plant, including environmental protection. The DOE Rocky Flats Area Office oversees the integration of Rocky Flats Plant resources with CEARP activities at Rocky Flats Plant.

Rockwell International. Rockwell International, as prime contractor to DOE, provides support to DOE in accomplishing the mission of Rocky Flats Plant, including environmental protection. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant.

Los Alamos National Laboratory. Los Alamos National Laboratory manages the CEARP program, providing direction, oversight and review, and preparing final reports.

2.2. ANALYTICAL LABORATORY RESPONSIBILITIES

Analytical laboratory responsibilities include performing analytical services, and providing quality assurance. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. This IGMP/CSPCP provides guidance for quality assurance programs to be implemented by

- field laboratory operations
- analytical laboratories
- geotechnical laboratories
- radiological laboratories.

2.3. QA RESPONSIBILITY

Quality assurance responsibilities are to monitor and review the procedures used to perform all aspects of site characterizations (remedial investigations), including data collection, analytical services, data analysis, and report preparations. Primary responsibility for project quality rests with the Rockwell International CEARP Manager. Ultimate responsibility for project quality rests with DOE.

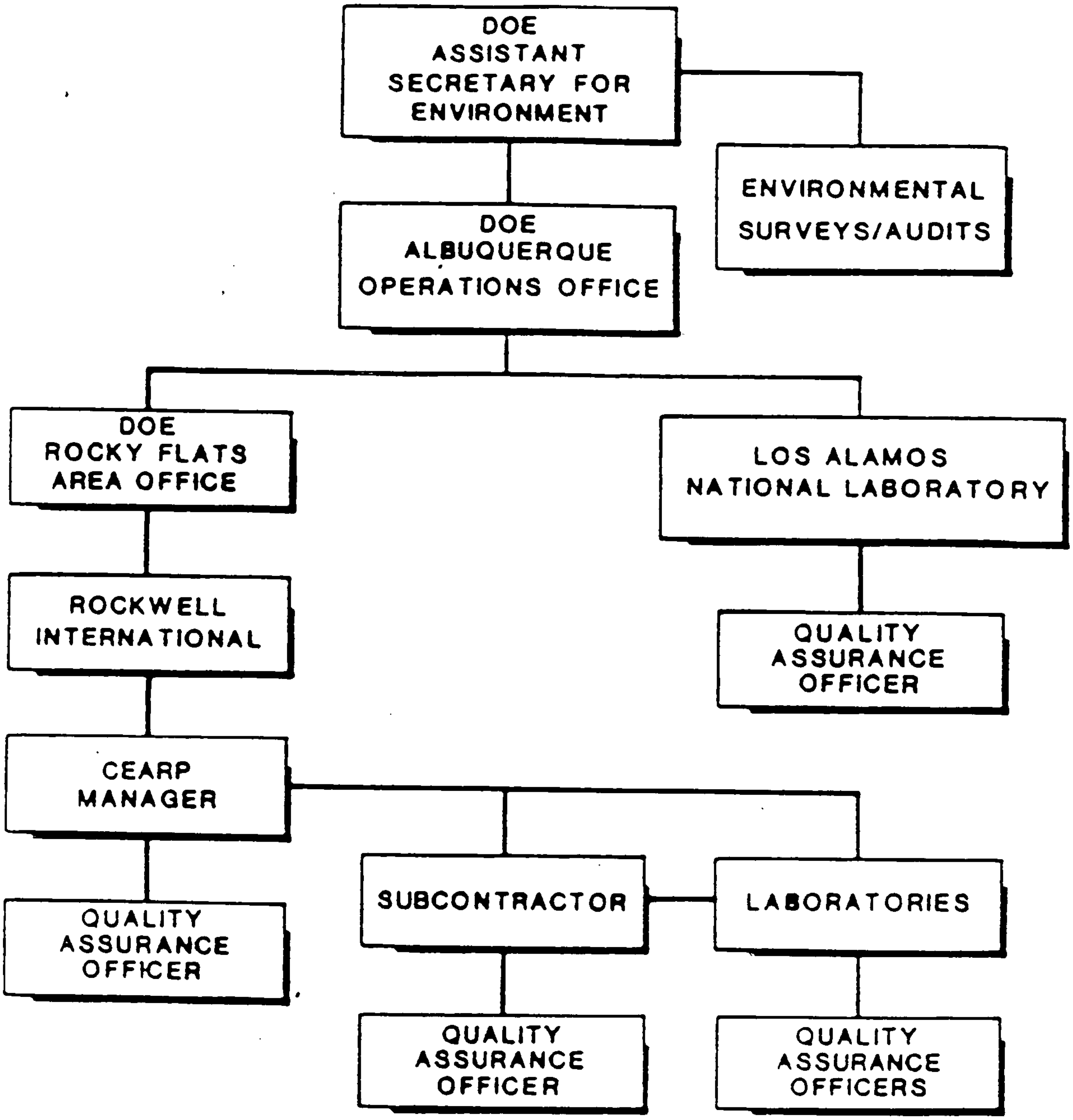

Figure 2.1. Quality Assurance/Quality Control Organization Chart.

3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall quality assurance objective is to develop and implement procedures for field sampling, field testing, chain of custody, laboratory analysis, and reporting that will assure quality as specified in DOE orders governing quality assurance and environmental protection. Specific procedures to be used for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this IGMP Quality Assurance/Quality Control Plan. The purpose of this section is to define quality assurance goals for accuracy; precision and sensitivity of analysis; and completeness, representativeness, and comparability of measurement data from all analytical laboratories. Quality assurance objectives for field measurements are also discussed.

For some field activities, samples will not be collected, but measurements will be taken where quality assurance concerns are appropriate (e.g., field measurements of pH, temperature, and elevations). The primary quality assurance objective in activities where samples are not collected is to obtain reproducible measurements to a degree of accuracy consistent with their intended use and to document measurement procedures.

3.1. REGULATORY AND LEGAL REQUIREMENTS

Data used to evaluate compliance with the National Interim Primary Drinking Water Standards, State of Colorado water-quality standards, or water-quality criteria for agricultural or industrial use will have method detection limits as specified by the analytical method used, as appropriate.

3.2. LEVEL OF QUALITY ASSURANCE EFFORT

Field duplicates, field blanks, and trip blanks will be taken and submitted to the analytical laboratories to provide a means to assess data quality resulting from field sampling. Duplicate samples will be analyzed to check for sampling reproducibility. Field and trip blanks will be analyzed to check for procedural contamination and/or ambient site conditions that are causing sample contamination. Trip blanks will be analyzed to check for contamination during packaging and shipment.

Because volatile organic compounds are a class of contaminants most likely to be introduced to the sample by the sample container, there will be one trip blank per batch of samples designated for volatile organic compound analysis (shipping container). There will be one duplicate and one field blank for every 10 investigative samples collected. For laboratory organic analysis, matrix spikes and matrix spike duplicates will be used. The general level of quality assurance effort for organic analysis will be one matrix spike and one matrix spike duplicate prepared for every 20 samples of similar concentration and/or similar sample matrix, whichever is greater. In addition to field check samples, water samples of known concentration traceable to either EPA or NBS standards will be prepared for inorganic and radiological analyses. The general level of quality assurance effort for inorganic analyses will be one duplicate known sample and one duplicate field sample for every 10 investigative samples to check analytical reproducibility.

Soil samples selected for geotechnical testing will include one field duplicate for each 20 analyses being performed, if possible, but will not include blanks.

The groundwater, surface water, and soil samples collected at Rocky Flats Plant during CEARP Phase 2 will be analyzed using the analytical methods specified in Tables 3.1, 3.2, 3.3, and 3.4. The level of laboratory quality assurance effort will correspond to the procedures outlined in Appendix A.

3.3. ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSES

The fundamental quality assurance objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the quality control acceptance criteria of the analytical protocols. Sensitivities required for analyses of radionuclides, organics, metals, and other inorganic compounds, in both aqueous and solid matrices will be the detection limits shown in Tables 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6. Achieving these detection limits depends on the sample matrix. Highly contaminated samples requiring dilution will have detection limits higher than those detected.

The accuracy of field laboratory measurements of groundwater and surface water pH will be assessed through pre-measurement calibrations and post-measurement verifications using at least two standard buffer solutions. The two measurements must each be within +0.05 standard units of buffer solution values. Precision will be assessed through replicate measurements of every tenth sample. The standard deviation of four replicate measurements must be less than or equal to 0.1 standard units. (The electrode will be withdrawn, deionized-rinsed and re-immersed between each replicate. The calibration and verification will be done before the first replicate and after the last replicate.) The instrument used will be capable of providing measurements to 0.01 standard units.

The geotechnical and field data will be considered accurate if the quality assurance criteria with respect to equipment, solutions, and calculations are met, and if adherence to appropriate methods can be documented during a systems audit.

3.4. COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The laboratories will provide data meeting quality control acceptance criteria as described in Appendix A. Laboratories will provide completely valid data (IGMP/CSPCP QA/QC Plan, Section 8); the reasons for any variances from 100 percent completeness will be documented in writing.

3.5. FIELD MEASUREMENTS

Measurement data will be generated in many field activities. These activities may include, but are not limited to, the following:

- using geophysical surveys
- documenting time and weather conditions
- locating and determining the elevation of sampling stations
- measuring pH, conductivity, and temperature of water samples
- qualitative organic vapor screening of solid samples using a photoionization detector (PID) or an organic vapor analyzer (OVA)
- measuring water levels in a borehole or well
- standard penetration testing
- calculating pumping rates
- verifying well-development and presampling purge volumes
- performing hydraulic conductivity tests

The general quality assurance objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data through the documented use of standardized procedures. Procedures for performing these activities and standardized formats for documenting them are presented in the CGMP and IGMP/CSPCP Sampling Plans. These procedures may be incorporated by reference (EPA methods) or included as appendices. Standardized formats for documenting data collection are included in the Technical Data Management Plan.

Table 3.1. Analysis Plan for Aqueous Samples*

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
HSL Volatile	Ref. 1	X[3]	40 ml vial (2) w/teflon lined silicone rubber septum	40 ml	Cold, 4°C[9]	14	ug/L
HSL Base/Neutral/Acid[1]	Ref. 2	X[3]	Amber G, 1L	1 L	Cold, 4°C[9]	7/40[7]	ug/L
HSL Pesticide/PCB	Ref. 3	X[3]	Amber G, 1L	1 L	Cold, 4°C[9]	7/40	ug/L
HSL Inorganic[2]	EPA 200.7[8]	X[3]	P, G, 1L	1 L	pH<2, w/HNO_3[9]	180	ug/L
Cyanide	EPA 335[8]	X[3]	P, G, 1L	0.5 L	pH>11, w/NaOH[9]	14	ug/L
pH[4]	EPA 150.1[8]	0.1 pH unit	P, G	N/A	None	Field Meas.	pH unit
Sp. Conductivity[4]	EPA 120.1[8]	1	P, G	N/A	None	Field Meas.	umho/cm
Temperature[4]	EPA 170.1[8]	0.1	P, G	N/A	None	Field Meas.	°C
Diss. Oxygen[4]	EPA 360.1[8]	0.5	G	N/A	None	Field Meas.	mg/l
TDS	EPA 160[8]	5	P, G 1L	0.1 L	Cold 4°C[9]	7	mg/l
TSS	EPA 160[8]	10	P, G 1L	0.1 L	Cold 4°C[9]	7	mg/l
Total Phosphate	EPA 365.4[8]	0.01	P, G 1L	1 L	Cold 4°C, pH<2[9] w/H_2SO_4	28	mg/l

Table 3.1. (Continued)

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
Chloride, Sulfate	EPA 352.2[8] 375.2[8]	5	P, G, 1L	1 L	Cold $4^{\circ}C$[9]	28	mg/l
Carbonate/Biocarbonate[5]	S.M. 403[6]	10	P, G, 1L	1 L	Cold $4^{\circ}C$[9]	14	mg/l
Nitrate	EPA 300.0[8]	5	P, G, 1L	1 L	Cold $4^{\circ}C$[9]	2	mg/l
Hexavalent Chromium	S.M. 312B[6]	0.01	P, G, 1L	1 L	Cold $4^{\circ}C$[9]	1	mg/l

[1] The HSL Base/Neutral/Acid fractions analytical parameters are the HSL semivolatiles.
[2] Includes Cesium, Molybdenum, Strontium which are non-HSL metals.
[3] See Tables 3.5 and 3.6.
[4] Field Measurements.
[5] These are reported as carbonate and biocarbonate alkalinity.
[6] Standard Methods for Examination of Water and Wastewater, 15th Edition.
[7] 7 days to extraction, analysis within 40 days of extraction.
[8] Methods for Chemical Analysis of Water and Wastes, 1983; EPA 600/4-79-020.
[9] All samples with the exception of VOA's will be filtered within 4 hours of sample collection, and preservatives added to the filtrate as specified. All samples will be kept at $4^{\circ}C$ until delivered to the laboratory.
*The SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

Method References

Ref. 1. Method 624 - "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984.

Ref. 2. Method 625 - "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984.

Ref. 3. Method 608 - "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4-82-057 plus additions, 1984.

Table 3.2. Analysis Plan for Soil/Sediment/Waste Samples*

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
HSL Volatile	Ref. 2	X[2]	40-ml vial (2) w/teflon lined silicon rubber septa	5	Cold, 4°C	14	ug/kg
HSL Base/Neutral/Acid	Ref. 3	X[2]	Amber G, 1 l	10-30	Cold, 4°C	7/40[3]	ug/kg
HSL Pesticide/PCB	Ref. 4	X[2]	Amber G, 1 L	10-30	Cold, 4°C	7/40[3]	ug/kg
HSL Inorganic[1]	Ref. 5	X[2]	P G, 1 L	200	Cold, 4°C	180	mg/kg
Reactivity	Ref. 6	Ref. 8	Amber G	...	Cold 4°C	N/A	ug/l
EP Toxicity	Ref. 7	Ref. 9	Amber G	100 g	Cold 4°C	N/A	ug/l in leachate
Chloride	EPA 300.0[5]	60 ug/g[6]	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Sulfate	EPA 300.0[5]	60 ug/g[6]	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Nitrate	EPA 300.0[5]	60 ug/g[6]	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Cyanide	Ref. 1	X[2]	G, 1 L	200	Cold, 4°C	14	mg/kg
Hexavalent Chromium	S. M. 312B[7]	1 ug/g[6]	G, 1 L	100	Cold 4°C	1	mg/kg

[1] Includes Cesium, Molybdenum, and Strontium which are non-HSL metals.
[2] See Tables 3.5 and 3.6.
[3] Extract within 7 days, analysis within 40 days of extraction.
[4] Reported as dry weight, % moisture reported separately.
[5] Soil/Sediments will be leached with Laboratory Reagent Water (20 g soil to 50 ml water) and water extract analyzed using referenced procedure. Procedure reference Methods for Chemical Analysis of Water and Wastes, 1983; EPA 600/4-79-020.

Table 3.2. (Continued)

[6] These are estimated detection limits.

[7] Soil/sediment will be leached with Laboratory Reagent Water (5 g soil and 100 ml of water) by shaking for 2 hours, and the water extract filtered and subsequently analyzed. This is in accordance with method 312B in Standard Methods for Examination of Water and Wastewater, 15th Edition.

*The SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

Method References

Ref. 1. Method 9010 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Ref. 2. Method 8240 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Ref. 3. Method 8270 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Ref. 4. Method 8080 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Ref. 5. Method 6010 or 7000 Series Methods - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revis April 1984.

Ref. 6. Method 9010, 9030 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Ref. 7. Method 1310 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Table 3.3. Analysis Plan for Radiological Analysis for Aqueous Samples

Analyte	Method*	Detection Limit**	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
Gross alpha/beta	1,2,3,4,6,7, 8,9	Gross a = 2pCi/L	P, 1 gal	0.2 L	HNO_3 to pH <2	180	pCi/L
Tritium	1,2,3,8	400 pCi/L	G, 100 ml	0.008 L	No preservation	NA	pCi/L
Pu-239	10,11	0.3 pCi/L	P, 1 gal	1.000 L	HNO_3 to pH <2	180	pCi/L
Am-241	11,12	0.4 pCi/L	P, 1 gal	1.000 L	HNO_3 to pH <2	180	pCi/L
Isotopic U	1,3,4,7,8,9	U-233 + 234 = 0.6 pCi/L U-238 = 0.6 pCi/L	P, 1 gal	0.500 L	HNO_3 to pH <2	180	pCi/L
Sr-90	1,3,4,8	1 pCi/L	P, 1 gal	1.000 L	HNO_3 to pH <2	180	pCi/L

*See Attachment 1

**See Attachment 2

ATTACHMENT 1

Method References

1. U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency.

2. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am. Public Health Association.

3. U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati U.S. Environmental Protection Agency.

4. Harley, J. H., ed., 1975, HASL Procedures Manual, HASL-300; Washington, D.C., U.S. Energy Research and Development Administration.

5. Misaqi, Fazlelleh L., Monitoring Radon-222 Content of Mine Waters Informational Report 1026, U.S. Department of Interior, Mining Enforcement and Safety Administration, Denver, CO, 1975.

6. "Radioassay Procedures for Environmental Samples," 1967, USDHEW, Section 7.2.3.

7. "Handbook of Analytical Procedures," USAEC, Grand Junction Lab. 1970, page 196.

8. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, Auguat 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

9. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S.G.S. Book 5, Chapter A5, 1977.

10. "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.

11. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium and Americium," by E. H. Essington and B. J. Drennon, Los Alamos National Laboratory, a private communication.

12. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.

ATTACHMENT 2

Lower Limits of Detection

The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$LLD = \frac{4.66 \left(\frac{BKG}{DUR}\right)^{1/2}}{(2.22)\,(Eff)\,(CR)\,(SR)\,(e\text{-}xt)\,(Aliq)},$$

Where

LLD	=	Lower Limit of Detection in pCi per sample unit
BKG	=	Instrument Background in counts per minute (cpm)
DUR	=	Duration of sample counting in minutes
Eff	=	Counting efficiency in cpm/disintegration per minute (dpm)
CR	=	Fractional radiochemical yield
SR	=	Fractional radiochemical yield of a known solution
x	=	The radioactive decay constant for the particular radionuclide
t	=	the elapsed time between sample collection and counting.

In that LLD is a function of many variables including sample matrix, sample volume, and other factors, the limits presented are only intended as guides to order-of-magnitude sensitivities and, in practice, can easily change by a factor of two or more even for the conditions specified.

Table 3.4. Analysis Plan for Radiological Analysis for Soils/Sediments

Analyte	Method*	Detection Limit**	Sample Container	Sample Size (g)	Preservations	Holding Time (days)	Reporting Units
Gross alpha/beta	1,2,3,4,6,7, 8,9	Gross a = 4 pCi/g Gross b = 10 pCi/g	G, 1 L	0.1	NA	NA	pCi/g
Pu-239	10,11	0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Am-241	11,12	0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Isotopic U	1,3,4,7,8,9	U-233 + 234 = 0.3 pCi/g U-238 = 0.3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Sr-90	1,3,4,8	1 pCi/g	G, 1 L	1	NA	NA	Pci/g

*See Attachment 1

**See Attachment 2

SOLAR EVAPORATION PONDS

HYDROGEOLOGIC CHARACTERIZATION REPORT

ROCKY FLATS PLANT

GOLDEN, COLORADO

JULY 1, 1988

Prepared for:

Rockwell International
Aerospace Operations
Rocky Flats Plant
Golden, Colorado 80401

Prepared by:

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215 Union Boulevard
Suite 600
Lakewood, Colorado 80228

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SECTION 1

CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

The hydrogeologic investigation of the Solar Evaporation Ponds has shown that the solar ponds are contaminating alluvial ground water migrating to the north into the North Walnut Creek drainage. The current French drain system does not appear completely effective in containing the contaminated ground-water flow, as contaminated ground water occurs directly downgradient of the system.

Surficial ground-water flow in the solar pond area is influenced by topography, the top of bedrock, and the effects of drainage installations. Ground water enters the solar pond area from the west and is recharged throughout the area by incident precipitation. Ground water flows north and east from the solar ponds following topography and the top of bedrock. Flow to the north is limited by the French drain system which in the process of collecting contaminated ground water appears to have produced extensive areas of unsaturated surficial materials. Unsaturated surficial materials are extensive and continuous to the east and south. The contaminants of the alluvial ground system are major ions, tritium, uranium, and nitrate. Total dissolved solids, sulfate, chloride, uranium and nitrate all occur above proposed ground water quality criteria. Contaminated ground water appears to recharge North Walnut Creek; however, containment of the water in the downgradient surface water management ponds results in reduction of contamination to acceptable levels by natural processes. Ground water in deep sandstones beneath the solar ponds does not appear impacted by the ponds. However, there are several subcropping sandstones at the solar ponds, and the extent of contamination, if any, of these units is unknown at this time but will be evaluated.

1.2 RECOMMENDATIONS

As discussed in Section 5, ground water contamination occurs downgradient of the French drain at wells 17-86 and 15-86. This may be due in part to the inability of the French drains to effectively remove large amounts of ground water during extended or intense periods of precipitation. To analyze the efficiency of the French drain system separately, it is necessary to characterize the three sources of water entering the system. Therefore the following recommendations are made to evaluate the performance of the French drain system. Implementation of these recommendations will be initiated within the next year:

1) Water entering the uppermost (east-west) intercept trench from the sump at Building 774 should be monitored monthly for flow rates and sampled monthly for the standard suite of analytes (Table 5-4). Monthly monitoring of flow rate may require the design and installation of a manhole along the western end of the interceptor trench but east of the 774 sump.

2) Water entering the uppermost (east-west) interceptor trench should be monitored monthly for flow rates and sampled monthly for the standard suite of analytes (Table 5-4). Monthly monitoring of flowrates may require the installation of equipment in the current manhole located on this trench.

3) Water pumped from the interceptor-trench pumphouse to Pond 207B-North should be continually monitored for flowrate and sampled monthly. A meter to measure and record the quantity of water pumped to Pond 207B North was installed in June 1988.

4) Flow rates and chemical data should be analyzed with respect to precipitation records collected at Building 774. This will allow predictions of future pumpage requirements and of future analyte concentrations.

To reduce the total amount of water currently being pumped from the interceptor trench pumphouse and to evaluate the effectiveness of the uppermost east-west intercept in capturing ground-water flow, the following are recommended:

1) Trenches 1 and 2 and Sumps 1 and 2 from the original trench and sump system will be reactivated to minimize the area impacted by seepage from the solar ponds. These reactivated units will return water directly to the solar ponds. The water which will be collected by these sumps is currently collected by the east-west lateral.

2) Sealing the surface of the uppermost (east-west) interceptor trench to the inflow of surface water should be evaluated. The gravel backfill of this interceptor trench surfaces and intercepts some component of surface run-off in the area. The expected quantity of surface run-off collected will first be evaluated before proceeding with sealing the surface. If the collected surface water run-off component is relatively small, the surface may not be sealed.

3) Depending upon the flow rates of the water collected at the manhole on the east-west interceptor trench, and based upon the capability of this trench to fulfill the needs of the final cap design, direct return of the water collected in this lateral to the Solar Ponds will be investigated. The existing manhole, or the manhole that may be installed for flow measurement, can be converted to a submersible pump station for direct return.

The following monitoring wells should be installed to further characterize bedrock hydrogeology at the Solar Evaporation Ponds:

1) A bedrock monitoring well will be installed near well 22-86. The well should encounter a subcropping sandstone approximately 11 feet below ground level and will be completed over the entire thickness (approximately seven feet). This well will provide additional bedrock ground-water quality data.

2) Another bedrock monitoring well should be installed adjacent to well 39-87BR to monitor ground-water quality in the subcropping sandstone at this location. This well should encounter a subcropping sandstone approximately five feet below ground surface and will be completed over the entire thickness of the sandstone (approximately twenty feet). Well 39-87BR is completed in a deeper sandstone unit.

3) A bedrock monitoring well will be installed 60 feet north of well 37-87 to monitor ground-water quality in the shallow sandstone at this location. This well should encounter a sandstone approximately 42 feet below ground surface. This sandstone subcrops at SP04-87 and is a

minimum of 2.5 feet thick. This new well will be completed over the entire sandstone interval.

The following activities will be implemented to further assess alluvial ground-water conditions:

1) An alluvial monitoring well will be installed at approximately N 37,200 and E 21,550 (Rocky Flats coordinates). This well will be approximately 17 feet deep and screened from three feet below ground surface to total depth. This well will help define potentiometric conditions in surficial materials south of the solar ponds and will provide additional water balance information for the solar pond area.

2) An alluvial monitor well will be installed east of Pond 207B-Center and west of well 29-86 to evaluate potentiometric conditions in surficial materials. This well will effectively replace existing well 4-60.

3) Slug tests will be conducted in all newly installed wells as well as wells 11-86, 12-86, 13-86, 15-86, 17-86 22-86, 26-86, 28-86, 30-86, 35-86, 36-86, 37-86, and 56-87. Results of these tests will be used to re-evaluate the anomalously low values of hydraulic conductivity currently available for surficial materials in the solar ponds area.

In addition to further evaluation of the French drain system and additional monitor well installation, the following activities will be conducted to minimize environmental impacts from the solar ponds. These activities will also provide leak detection capability for the ponds.

1) Attempt to identify, renovate, and reactivate the drain tiles under the 207-B ponds. These tiles are identified in the engineering drawings of the 207-B Ponds.

2) Monitor the leak detection unit under the 207-B flexible membrane liner for early leak detection.

3) Visually inspect the liner of each pond for possible leaks when all liquids are drained from them. If potential problem areas are identified, they will be repaired before liquid is transferred back into that pond.

Lastly, quarterly ground-water monitoring of wells completed in valley fill alluvium of North Walnut Creek will continue, and an assessment will be made as to whether corrective action beyond source control at the solar ponds is required. This assessment, and the design of any corrective action measures, would be conducted under the Low Priority Site Investigations if necessary.

SECTION 2

INTRODUCTION

This report presents a hydrogeologic and waste source characterization of the Solar Evaporation Ponds at Rocky Flats Plant. The solar ponds were first identified as a RCRA regulated unit in the summer of 1986. Shortly thereafter, an interim status closure plan for the Solar Evaporation Ponds was prepared in accordance with the Compliance Agreement. A closure plan for the interim status closure of the Solar Ponds is required pursuant to Part 265 of the Colorado State Hazardous Waste Regulations (6 CCR) and Title 40, Part 265 of the Code of Federal Regulations (40 CFR). The goal of the closure plan is to meet closure performance standards as follows:

- The owner or operator must close the facility in a manner that: a) minimizes the need for further maintenance; and b) controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere (6 CCR and 40 CCR 265.111).

- The owner or operator must provide a detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination necessary to satisfy the closure performance standard [6 CCR and 40 CFR 265.112 (b)(4)].

- The owner or operator must provide a detailed description of other activities necessary during partial closure period to ensure that all partial and final closure satisfy the closure performance standards, including, but not limited to, ground-water monitoring, leachate collection, and run-on and run-off control [6 CCR and 40 CFR 265.112(b)(5)].

- During the partial and final closure periods, all contaminated equipment, structures and soil must be properly disposed of, or decontaminated unless specified otherwise in 265.228 or 265.310 (6 CCR and 40 CFR 265.114).

- If the owner or operator does not remove all the impoundment materials (standing liquids, waste and waste residues, liners, underlying and surrounding contaminated soil), he must close the impoundment and provide post-closure care as for a landfill under Subpart G (6 CCR and 40 CFR 265.110 to 265.120 and 265.310; 6 CCR and 40 CFR 265.288 (a,b,c)).

- At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to provide long-term minimization of migration of liquids through the closed landfill; function with minimum maintenance; promote drainage and minimize erosion or abrasion of the cover; accommodate settling and subsidence so that the covers' integrity is maintained; and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present (6 CCR and 40 CFR 265.310).

A closure plan for the Solar Ponds was submitted on November 28, 1986, as part of the Post Closure Care Permit Application (Rockwell International, 1986a), and a revised Closure Plan was submitted on March 1, 1987 (Rockwell International, 1987a). Interpretations and conclusions incorporated in this document supersede those in the March 1, 1987, plan.

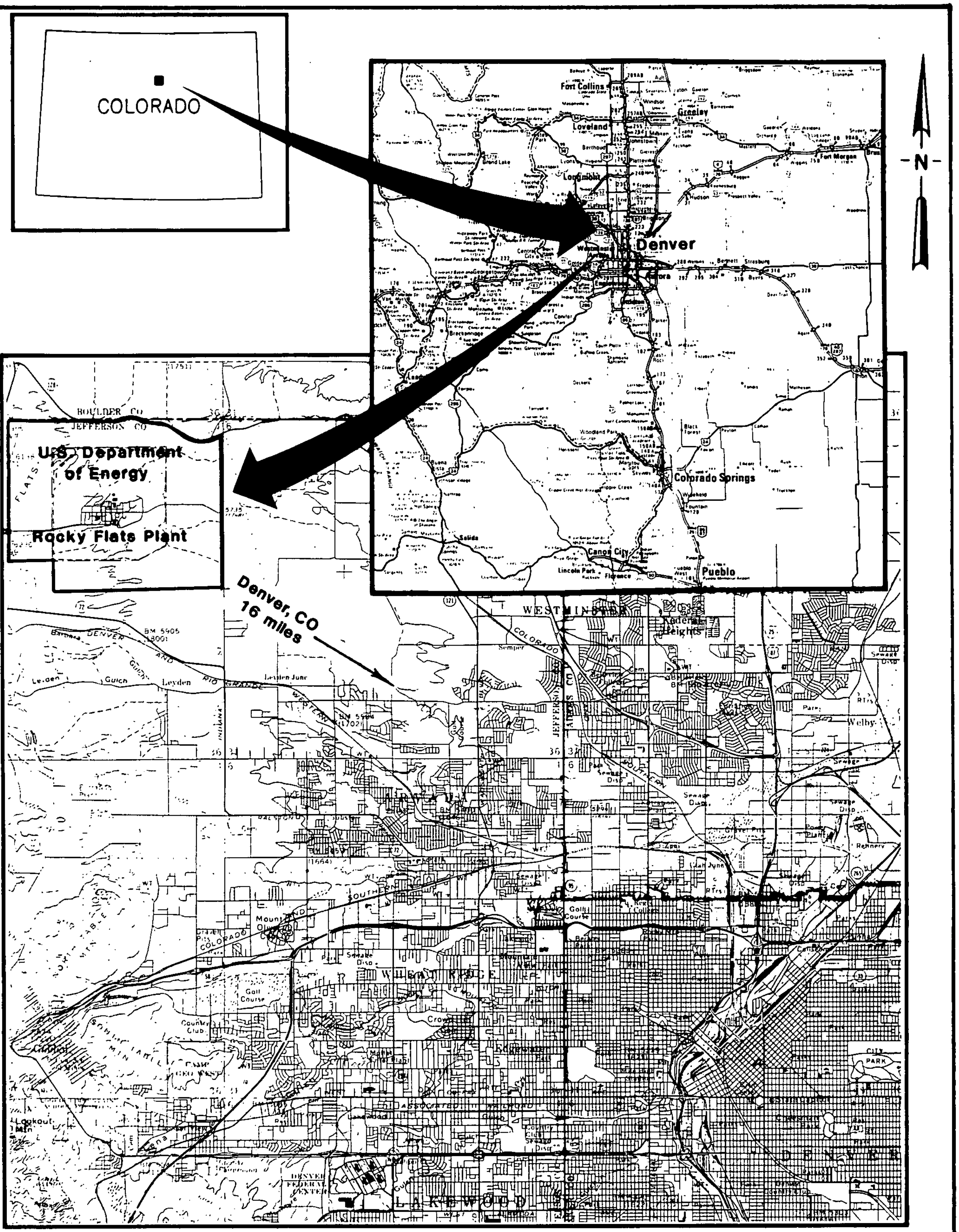
2.1 REPORT OVERVIEW

This report provides results of the 1986 and 1987 site characterization investigations performed at the Solar Evaporation Ponds. Results of previous investigations are also incorporated. The report begins with site background information. Presented in this introduction are site location and description, objectives of this study, and a summary of previous investigation results. The introduction is followed by a regional setting chapter (Section 3) which describes climatology, physiography, geology, ground-water hydrology, and surface water hydrology in the vicinity of Rocky Flats Plant. Section 4, Soils Characterization, provides a chemical characterization of the Solar Evaporation Pond sludges, liquids, liners, and surrounding soils; and Section 5, Site Hydrogeology, discusses geology, ground-water flow, and ground-water quality in the vicinity of the solar ponds. The hydrogeology and water quality of both surficial and bedrock flow systems are presented in Section 5 along with an evaluation of the French drain system north of the ponds. Surface water characterization, Section 6, discusses water flow and water quality data for North Walnut Creek, South Walnut Creek, Ponds A-1 through A-4, and Ponds B-1 through B-5.

Appendices A through E contain supporting data. The work plan for the 1987 field work is presented in Appendix A. Appendix B contains hydrogeologic data, and analytical data for soils, ground water, surface water, and sediments are found in Appendix C. Appendix D contains historical analytical data, and Appendix E consists of data collected during previous investigations.

2.2 SITE LOCATION AND DESCRIPTION

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 2-1). The Plant consists of approximately 6,550 acres of federally owned land in Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th Principal Meridian. Major buildings are located within the Plant security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,150 acres (Figure 2-2).



Not To Scale

Figure 2-1: Location of Rocky Flats Plant

This site characterization report addresses the 207 Solar Evaporation Ponds, located on the north side of the Perimeter Security Zone (PSZ) at the Rocky Flats Plant (Figure 2-2).

2.2.1. Construction History

The original solar evaporation pond consisted of a single clay-lined impoundment constructed in December 1953 in the vicinity of the existing Pond 207-C. Plate 2-1 shows the locations of the original and existing ponds. The clay-lined pond had two containments measuring 100 by 200 feet and 200 by 200 feet, respectively, and was operated with both one and two cells until 1956 when its regular use was discontinued. However, at least one of the two cells held liquids at least once since 1963. This pond was removed in 1970 (Colorado Aerial Photo Service 1968, 1970, 1972, 1974-1985; U.S. Geological Survey, 1971; Scharf and Associates 1986; Agricultural Stabilization and Conservation Service, 1969), when the existing 207-C pond was constructed.

Pond 207-A was placed in service in August 1956. The pond was originally lined with asphalt planking approximately one-half inch thick. Ponds 207-B North, Center, and South were placed in service in June 1960. These ponds were also lined with asphalt planking. Pond 207-C was placed in service in December 1970. The original lining is presumed to be the existing lining. Modifications to the ponds' linings have been made since the original construction because of cracking and slumping of the existing linings and leakage of pond contents. Pond 207-A and the three 207-B ponds have been relined at least one time each. No records were located which indicate Pond 207-C has been relined. Details of the specifications of the linings are presented in Section 1.2.1 of this Solar Evaporation Pond Closure Plan.

Six interceptor trenches and a "French drain" system (Rockwell, 1983a) have been constructed on the hillside north of the solar ponds to prevent natural seepage and pond leakage from entering North Walnut Creek. The six interceptor trenches were constructed north of the ponds in the 1970's. Trenches 1 and 2 were installed in October 1971, Trench 3 in September 1972, Trenches 4 and 5 in April 1974, and Trench 6 in July 1974 (DOE, 1985). The French drain system was installed in the hillside north of the Solar Evaporation Ponds sometime between June 1980 and April 1981 and is currently in use. This system replaced the interceptor trenches. The intercepted seepage was and is pumped back into Ponds 207-B North and Center (Hawes, 1986). Details of the past and current uses of the system are presented in Section 1.2.1 of this Solar Evaporation Pond Closure Plan.

2.3 OBJECTIVES

The objectives of this study are to characterize waste sources, site geology and hydrology, and the extent of ground-water and soils contamination. This information will support closure activities, post closure care, and monitoring programs. Specifically, it is the objective of this study to evaluate the effectiveness of the French drain system and to make recommendations for additional data collection as needed.

2.4 SUMMARY OF PREVIOUS INVESTIGATIONS

A series of investigations have been conducted at Rocky Flats Plant to characterize ground water, surface water, and soils. A summary of investigations performed at the Solar Evaporation Ponds is presented below.

Woodward-Clyde and Associates, 1970, conducted an investigation of a potential landslide area north of Solar Evaporation Ponds 207-A, B, and C. Test holes were drilled to assist in the determination of subsoil and ground-water conditions and evaluate landslide risk. Ten test holes were drilled and up to six feet of fill was encountered underlain by 5 to 21 feet of clay, clayey gravel and sand, and weathered claystone. Free water was encountered in all test holes. The study concluded that the hillside below the ponds is a high risk area for landsliding, particularly with the probable addition of subsurface water flows from the ponds. In addition, it was recommended that a drainage system to remove subsurface water be installed.

Engineering Science (1975) conducted an investigation concerning the problem of nitrate salts being transported from the area of 207 Solar Evaporation Ponds into North Walnut Creek. Ten holes were drilled along the north and east exterior of the Solar Evaporation Ponds and 21 additional test holes were drilled down the north slope of the ponds to determine the distribution of contaminated soil. These holes were terminated in bedrock and samples were collected for laboratory analysis. Findings from this study indicated that soils north and east of the solar ponds were contaminated with nitrate and that these nitrates would continue to leak from the contaminated soil and be transported to North Walnut Creek. A system comprised of a polyethylene-lined French drain and trenches to intercept surface water runoff and ground-water from entering North Walnut Creek was proposed.

Another geotechnical investigation was conducted in 1984 by Geotechnical and Materials. Two exploratory test borings were drilled southeast and east of Pond 207-C to describe the subsurface conditions and recommend suitable types and depths of foundations for proposed new structures. These borings terminated approximately 14 feet below the existing grade in overburden materials. This study concluded that the proposed structures could be founded on spread footings, ring-wall, or mat foundations bearing on the in situ soils.

Hydro-Search, Inc. (1985) presented a hydrogeologic characterization of the Rocky Flats Plant. This report describes the hydrogeologic and ground-water quality conditions at the Plant based on existing data at the time. The ground-water monitoring system was described and evaluated, and recommendations were made for a new monitoring program.

In 1986, R.L. Henry (Rockwell International) submitted a report summarizing trends observed in the surface water monitoring at Rocky Flats Plant. The report discusses the surface water control system (SWCS) completed in 1980, which is designed to divert flow around Plant site and collect surface runoff and store it temporarily for monitoring before discharge. Non-radioactive and radioactive trends in the surface water were also discussed.

Chen and Associates (Rockwell International, 1986a) prepared a closure plan for the Solar Evaporation Ponds. The plan describes the construction and operation procedures at the solar ponds including past usage and size and volume of impoundments, waste inventory, and treatment and disposal of wastes. This closure plan was revised in 1987 (Rockwell International, 1987a).

Twenty-one ground-water monitoring wells were installed in 1986. These wells were installed to characterize the hydrogeology in the solar ponds area and to evaluate if the solar ponds were an imminent threat to the public or the environment. The work plan for the 1986 field program is presented in Rockwell International (1986b), and Plate 2-1 presents monitor well locations at the Rocky Flats Facility.

Chen and Associates (Rockwell International, 1986c) also prepared a preliminary prioritization of sites at the Rocky Flats Plant. The prioritization of sites was based on review of previous investigations and historical aerial photographs. The Solar Evaporation Ponds were considered a priority site.

In 1987, 6 monitor wells and 14 boreholes were drilled for characterization of the solar pond area. Results of this drilling program are presented in Sections 4 and 5 of this report.

Rockwell International (1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986g, and 1987a) are annual environmental monitoring reports. These reports summarize annual monitoring, data collection, analysis, and evaluation occurring at the facility.

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document #000288

Titled: Plate 2-1: Monitor Well Locations

Fiche location: A-SW-M11

SECTION 3

REGIONAL SETTING

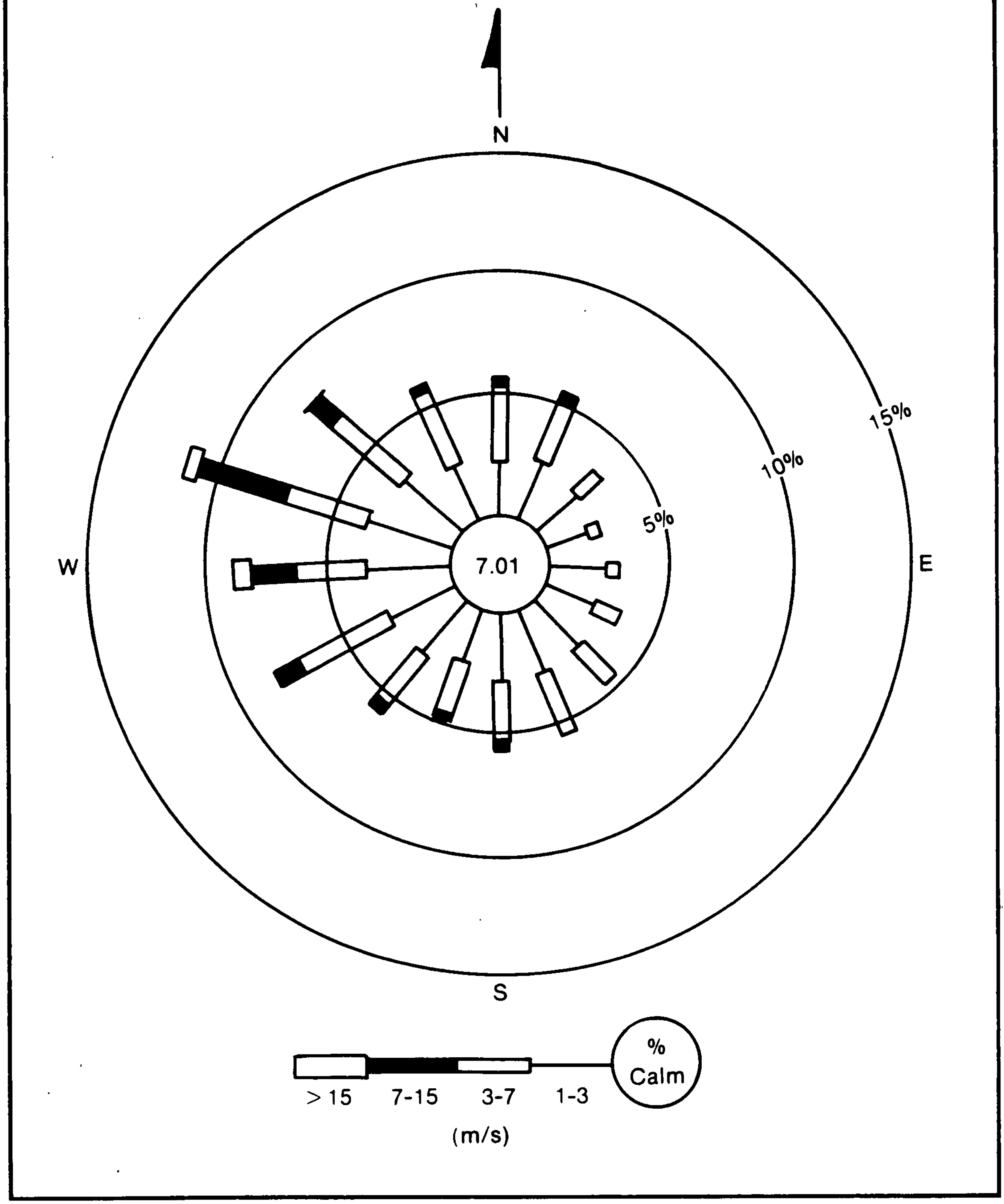
This section presents the regional setting of Rocky Flats Plant, including discussions of climatology, physiography, geology, ground-water hydrology, and surface water hydrology. Site-specific discussions of hydrogeology and surface water hydrology at the Solar Pond Area are presented in Sections 5.0 and 6.0, respectively.

3.1 CLIMATOLOGY

The area surrounding the Rocky Flats Plant has a semiarid climate typical of the Rocky Mountain region. However, the elevation of the Plant and the nearby slopes of the Front Range slightly modify the regional climate.

Winds at Rocky Flats Plant, although variable, are predominantly from the west-northwest. Stronger winds occur during the winter, and the area occasionally experiences Chinook winds with gusts up to 100 miles per hour because of its location near the Front Range (DOE, 1980). Figure 3-1 shows the wind direction, frequency, and average velocity for each direction as recorded in 1985.

Temperatures are moderate; extremely warm or cold weather is usually of short duration. On the average, daily summer temperatures range from 55 to 85 degrees Fahrenheit (F) and winter temperatures range from 20 to 45 degrees F. Temperature extremes recorded at the Plant have ranged from 102 degrees F on July 12, 1971 to -26 degrees F on January 12, 1963. The 24-year daily average maximum temperature for the period 1952 to 1976 was 76 degrees F, the daily average minimum



(after: Rockwell International, 1987a)

Figure 3-1:
1986 Annual Wind Rose for the Rocky Flats Plant

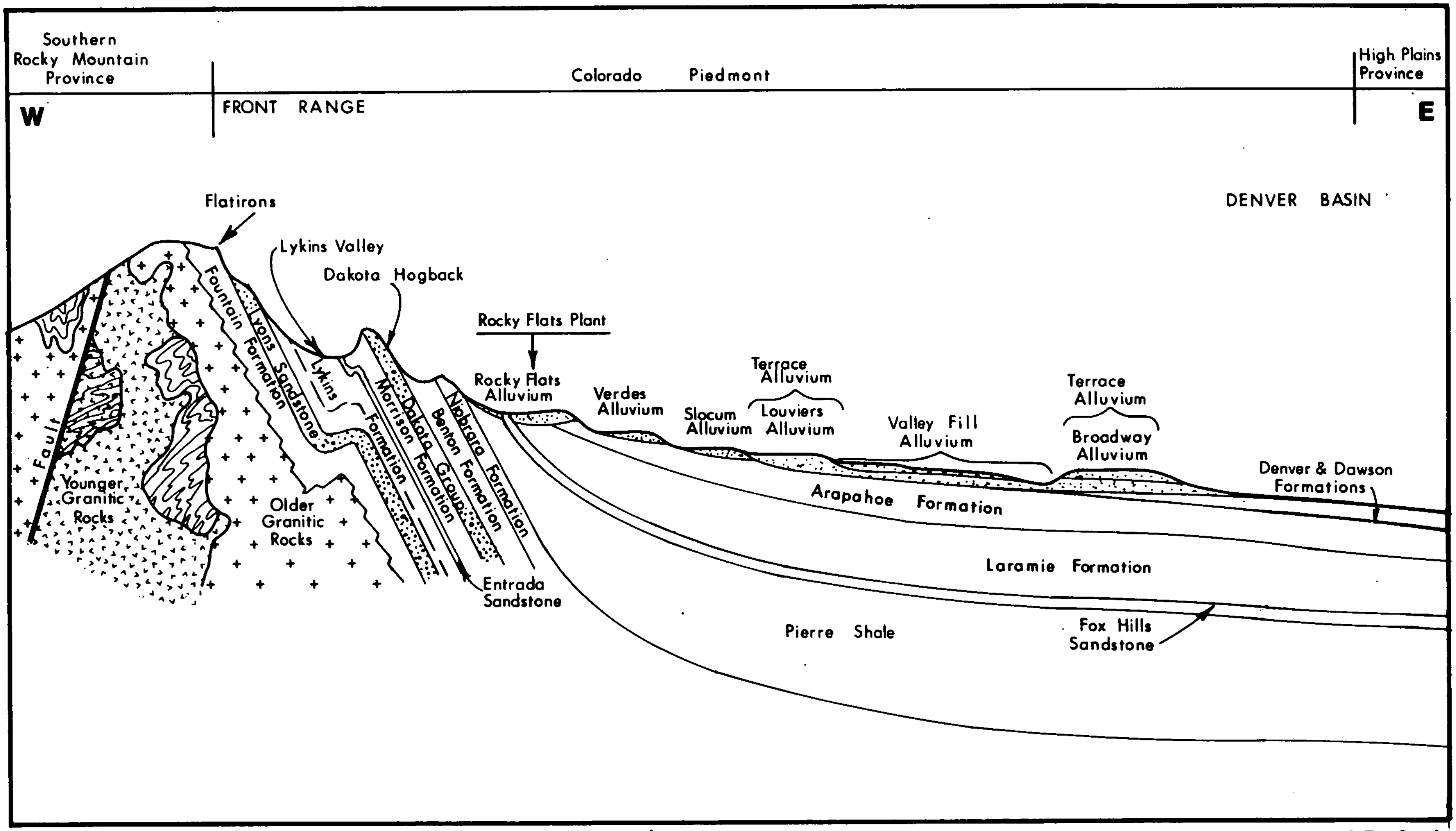
was 22 degrees F, and the average annual mean was 50 degrees F. Average relative humidity was 46 percent (DOE, 1980).

Average annual precipitation at the Plant is 15 inches. Approximately 40 percent of the precipitation falls during the spring season, much of it as snow. Thunderstorms from June to August account for an additional 30 percent of the precipitation. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Snowfall averages 85 inches per year, generally occurring between October and May (DOE, 1980).

3.2 PHYSIOGRAPHY

The Rocky Flats Plant is located at an elevation of approximately 6,000 feet above mean sea level. The site is on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Fenneman, 1931). The Colorado Piedmont ranges in elevation from 4,000 feet on the east to 7,000 feet on the west. The Piedmont merges to the east with the High Plains section of the Great Plains Province and is terminated abruptly on the west by the Front Range section of the Southern Rocky Mountain Province (Figure 3-2).

The Colorado Piedmont is an area of dissected topography and denudation where Tertiary strata underlying the High Plains have been almost completely removed. In a regional context, the piedmont represents an old erosional surface along the eastern margin of the Rocky Mountains. It is underlain by gently dipping sedimentary rocks (Paleozoic to Cenozoic in age), which are abruptly upturned at the Front Range to form hogback ridges parallel to the mountain front. The piedmont surface is broadly rolling and slopes gently to the east with a topographic relief of



(after: Boulder County Planning Commission, 1983 and Scott, 1960) **Not To Scale**

Figure 3-2:
Generalized East-West Cross Section
Front Range to Denver Basin

only several hundred feet. This relief is due both to resistant bedrock units that locally rise above the surrounding landscape and to the presence of incised stream valleys. Major stream valleys which transect the piedmont from west to east have their origin in the Front Range. Small local valleys have developed as tributaries to these major streams within the piedmont. In the area of the Plant, a series of Quaternary pediments have been eroded across this gently rolling surface (DOE, 1980).

The eastern margin of the Front Range a few miles west of the Plant is characterized by a narrow zone of hogback ridges and flatirons formed by steeply east-dipping Mesozoic strata (such as the Dakota Sandstone and the Fountain Formation). Less resistant sedimentary units were removed by erosion (Figure 3-2). The Front Range reaches elevations of 12,000 to 14,000 feet above mean sea level 15 miles farther west. The range itself is broad and underlain by resistant gneiss, schist and granitic rocks of Precambrian age. The resistant nature of these rocks has restricted stream erosion so that deep, narrow canyons have developed in the Front Range.

Several pediments have been eroded across both hard and soft bedrock in the area of the Plant during Quaternary time (Scott, 1963). The Rocky Flats pediment is the most extensive of these, forming a broad flat surface south of Coal Creek. The broad pediments and more narrow terraces are covered by thin alluvial deposits of ancient streams draining eastward into the Great Plains. The sequence of pediments reflects repetitive physical processes associated with cyclic changes in climate. Each erosional surface and stratigraphic sequence deposited on it probably represents a single glacial cycle. The oldest and highest pediment, the Subsummit Surface (Scott, 1960), truncates the hogback ridges of the Front Range. Three successively younger pediments, veneered by alluvial gravels, extend eastward from the mountain front. Erosion of valleys into the pediments followed each depositional cycle so that, near the mountain front, stratigraphically younger geologic units occur at topographically lower elevations as narrow terrace deposits along the streams. From oldest to youngest, the three pre-Wisconsin deposits are the Rocky Flats Alluvium, the Verdos Alluvium and the Slocum Alluvium (Scott, 1965). A series of Wisconsin and post-Wisconsin terrace deposits are present at lower elevations along streams that have incised the older pediments (east of the Plant). These alluvial deposits are described in Section 3.3.3, Surficial Geology.

The Rocky Flats Plant is located on a relatively flat surface of Rocky Flats Alluvium. The pediment surface and overlying alluvium (generally 10 to 50 feet thick, although the alluvium is as much as 100 feet thick west of the Plant) have been eroded by Walnut Creek on the north and Woman Creek on the south so that terraces along these streams range in height from 50 to 150 feet. The grade of the gently eastward-sloping, dissected Rocky Flats Alluvium surface varies from 0.7 percent at the Plant to approximately 2 percent just east of the Plant.

3.3 REGIONAL GEOLOGY

3.3.1 Geologic and Stratigraphic History

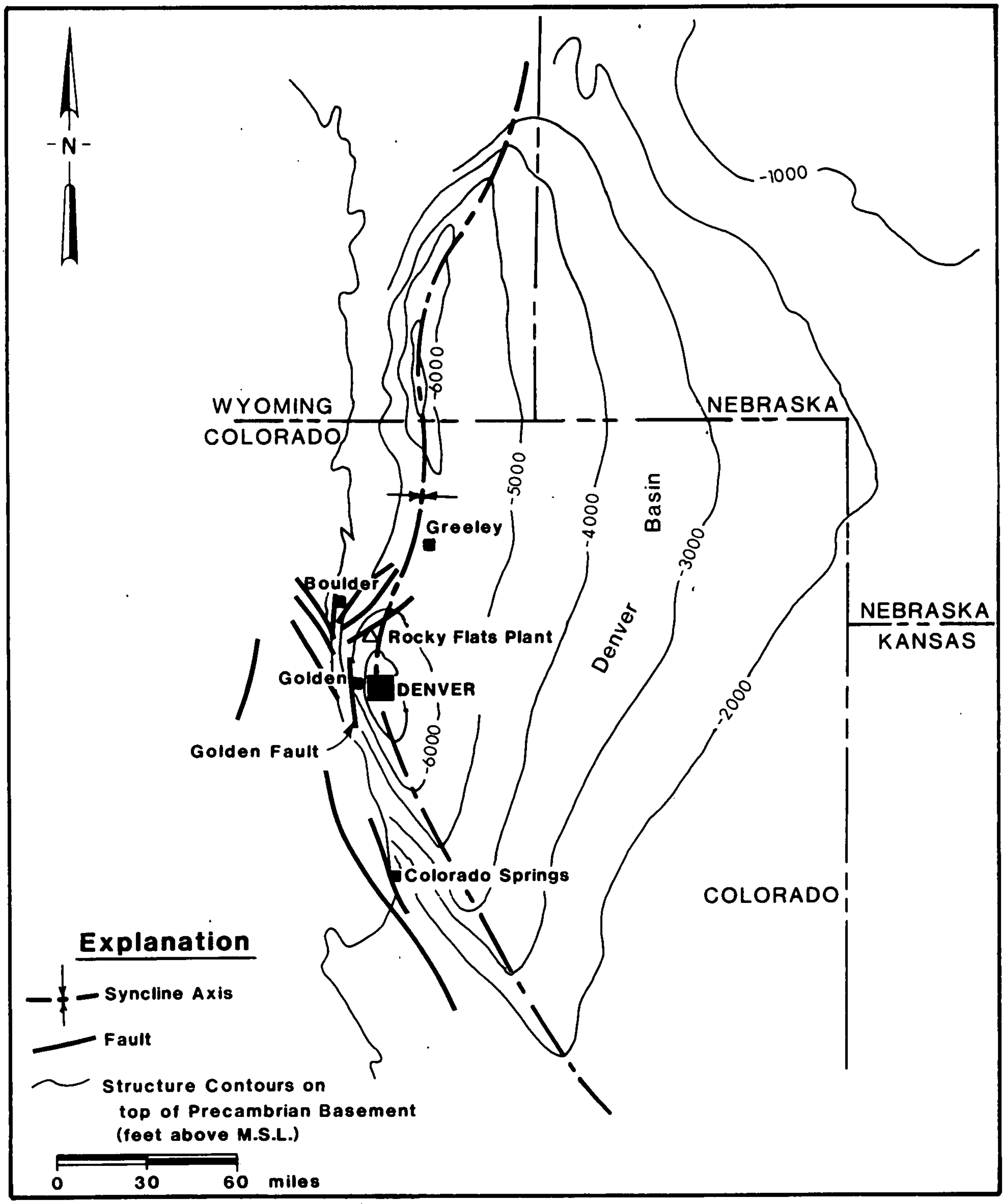
This section describes the regional geologic and stratigraphic history in the vicinity of the Plant, including the Denver Basin. Section 5.0 describes the site specific geology and stratigraphy of the Solar Pond Area.

The Rocky Flats Plant is located on the northwestern flank of the Denver Basin and is underlain by about 12,000 feet of Paleozoic and Mesozoic sedimentary rocks (Hurr, 1976). The Denver Basin is an asymmetric syncline that formed during the Late Cretaceous Laramide Orogeny. The western limb of the basin dips steeply to the east, and the eastern limb dips gently to the west (Figure 3-3).

The geologic history of northeastern Colorado involves several episodes of mountain building and oceanic transgression and regression, resulting in the deposition of thousands of feet of sedimentary rock on top of the Precambrian basement. This section describes the geologic history beginning with Precambrian time. Geologic descriptions of the various units are provided within this context. More detailed descriptions of the units present on site are provided in Section 5.0.

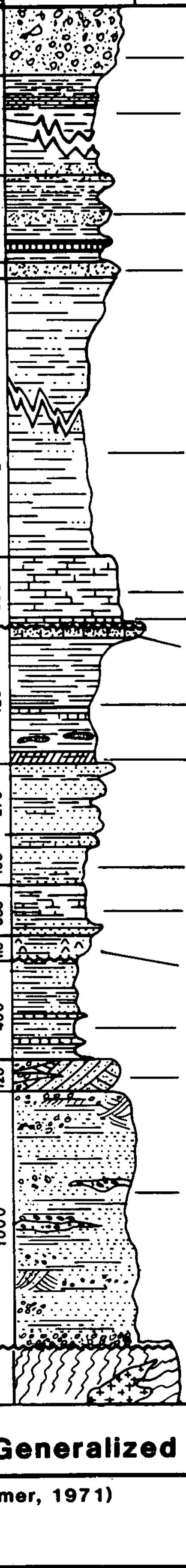
Early Precambrian tectonic, metamorphic, and plutonic igneous activity created a complex fabric in the basement rock of Colorado (Grose, 1972). The Precambrian units were covered by marine and continental sedimentation during the lower Paleozoic (carbonate and siliciclastic rock units were deposited unconformably on the Precambrian basement). Most of these units were later eroded by multiple Paleozoic diastrophisms, thus removing Cambrian to Mississippian rocks from the Denver Basin area (Kent, 1972).

Middle Pennsylvanian orogenic activity formed the Ancestral Rockies, and the Fountain Formation was deposited unconformably on the uplifted Precambrian basement (Figure 3-4). The Fountain Formation contains coarse clastics derived from the erosion of the Ancestral Rockies and deposited as alluvial fans along a continental margin (Martin, 1965). The result was nonmarine sedimentation that occurred in northeastern Colorado from the Triassic to early Cretaceous. This sedimentation deposited a sequence of aeolian, fluvial-deltaic, and lacustrine units



(after: Rockwell International, 1986a)

Figure 3-3: Structure of the Denver Basin



AGE	FORMATION	Thick. (feet)	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600'	Boulder conglomerate with occasional thin siltstone lenses
TERTIARY	Denver-Arapahoe	1200'	Tan sandy claystone and clayey sandstone; conglomerate at base; includes Table Mountain "flow" rocks to the north
UPPER CRETACEOUS	Laramie	500'	Gray, fine-to-medium-grained sandstone and silty clays; thin coal beds in lower part
UPPER CRETACEOUS	Fox Hills	50'	Tan, fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000'	Dark gray, silty shale and few thin, silty sandstones
UPPER CRETACEOUS	Niobrara	350'	Dark gray, very calcareous shale. "Foraminifers" abundant (Smoky Hills Member) Light gray, dense, fossiliferous limestone(Fort Hays Member)
UPPER CRETACEOUS	Benton	420'	Brown, sandy, fossiliferous limestone Dark gray shale with bentonite streaks; thin limestones in middle part; few cone-in-cone concretions in lower part Dark gray, brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So. Platte	270'	Light gray, fine-to-medium-grained sandstone, several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100'	Light gray, fine-to-coarse-grained, locally conglomeratic sandstone; frequent red and green siltstone interbeds
Jurassic	Morrison	365'	Gray to greenish-gray to red shale and siltstone; thin limestones in middle part; lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	110'	Light tan siltstone and light red; silty shale; gypsiferous; sandstone at base and locally conglomeratic
Tri-assic? / PERMIAN	Lykins	400'	Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120'	Grayish-white, fine-to-medium-grained cross-bedded sandstone; conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000'	Red, fine-to-coarse-grained sandstone and conglomerate; arkosic; thin, lenticular red siltstones frequent throughout
PRECAMBIAN			Gneiss, schist, and small granitic intrusions

Figure 3-4: Generalized Stratigraphic Section, Golden-Morrison Area

(after: LeRoy and Weimer, 1971)

known as the Lyons, Lykins, Ralston Creek, Morrison, and Dakota Formations (Figure 3-4) (Kent, 1972).

The Pierre Shale, consisting of more than 5,600 feet of shales and siltstones, was deposited in the final phases of oceanic sedimentation. The sedimentation resulted from the last oceanic transgression occurring 100 million years ago during the late Cretaceous. This transgression formed an epicontinental sea called the Cretaceous Seaway that covered the eastern portions of New Mexico, Colorado, and Wyoming.

Following deposition of the Pierre, the ocean began to regress and deposition of the Upper Cretaceous Fox Hills and Laramie Formations occurred. These formations contain sandstones, siltstones, claystones, and coals deposited in fluvial-deltaic and lacustrine environments (Weimer, 1973). Deposition of the Laramie was influenced and then stopped by the Laramide Orogeny, a major mountain building event that began in the late Cretaceous and caused uplift of the Colorado Front Range Mountains and the eastward tilting of the Denver Basin.

The Upper Cretaceous Arapahoe Formation was deposited on an erosional surface marking the end of deposition of the Laramie. Major uplift of the Front Range and downwarp of the Denver Basin continued during deposition of the Arapahoe Formation. Coarse pebble conglomerate lenses deposited in alluvial fans commonly occur in the Lower Arapahoe; however, conglomerate lenses have not been found at Rocky Flats Plant. Claystone and sandstone units flank and top the alluvial fan deposits (Weimer, 1973).

The Denver Formation was deposited above the Arapahoe and is over 600 feet thick. This formation contains a variety of lithologies including siltstones, arkoses, conglomerates, and basalt flows (near Golden, Colorado) (Robson, 1984).

The Dawson Formation was deposited above the Denver in a similar geologic environment during the late Cretaceous and early Tertiary. Robinson (1972) described the Dawson Formation as a stratigraphic equivalent to the Denver Formation in southern portions of the Denver Basin. However, Robson (1984) mapped the Dawson as a separate, younger (Tertiary) formation occurring above the Denver. The Dawson is up to 600 feet thick and consists of conglomerates, sandstones, and shales (Robson, 1984).

The Tertiary Green Mountain Conglomerate was deposited unconformably on the Denver Formation, and consists of conglomerates, sandstones, siltstones, and claystones deposited by a local fluvial system that occurred only in the Golden, Colorado, area. This unit is only found capping Green Mountain, approximately 15 miles south of Rocky Flats Plant (Costa and Bilodeau, 1982).

The Rocky Flats Alluvium was deposited on top of a major erosional surface that developed in late Tertiary time. Before deposition of the Rocky Flats Alluvium, both the Dawson and Denver Formations were completely removed by erosion. The Green Mountain Conglomerate may never have been deposited at the site, but if it was, it also was removed by erosion. The Rocky Flats Alluvium contains boulders, cobbles, gravels, sands, silts, and clays deposited in alluvial fans at the base of the Colorado Front Range Mountains (Hurr, 1976).

Following deposition of the Rocky Flats Alluvium, the material was partially removed by erosion and the resulting drainages repeatedly infilled with more recent sediments. The Verdos Alluvium and the younger Slocum Alluvium are the result of drainage infilling associated with glacial activity. Similar processes are occurring now with an active valley fill alluvium in the stream channels and a recent but stable terrace above the valley fill.

3.3.2 Plant Bedrock Geology

Bedrock units mapped at the Plant consist of the Laramie and Arapahoe Formations (Rockwell International, 1986a). These are shown in cross section in Figure 3-5. Because of the thickness (750 to 800 feet) and low permeability of the Upper Laramie, it is considered to be the base of the hydrologic system which could be affected by Plant operations (Hurr, 1976). The Upper Laramie and overlying Arapahoe Formations are described below.

Laramie Formation

The Laramie Formation is a fluvial sequence of sandstones, siltstones, claystones, and coals, which is subdivided into two major lithologic units: a lower sandstone unit and an upper claystone unit. The lower sandstone unit is exposed in clay pits west of the Plant, and the upper claystone unit was observed in outcrop and in cores of several 1986 monitor wells west of the Plant. The descriptions presented below are taken from Rockwell International (1986a).

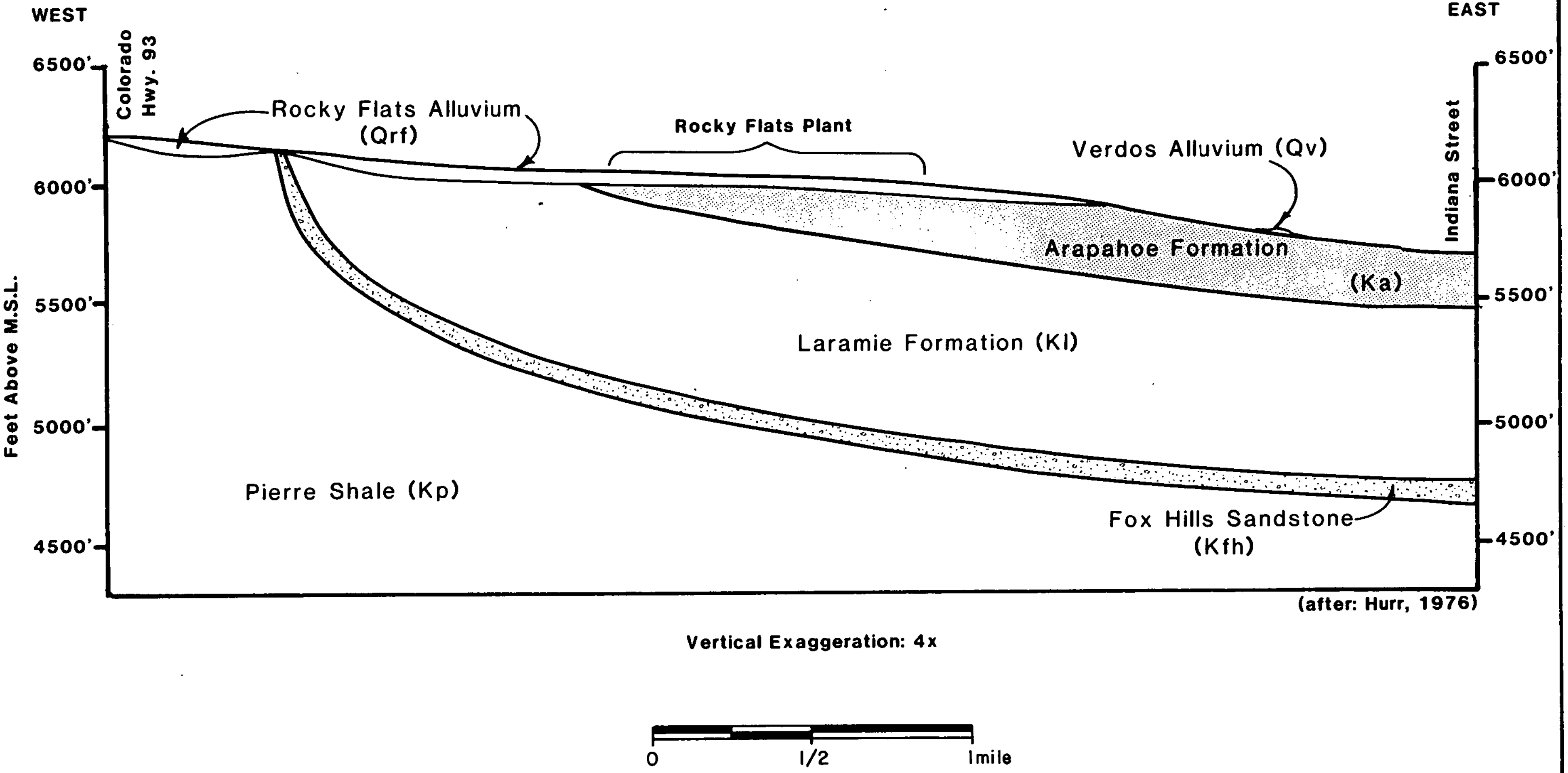


Figure 3-5: Generalized Cross Section of Rocky Flats Plant

Lower Sandstone Unit: The lower sandstone unit consists of light to medium gray, very fine- to medium-grained, well sorted, subrounded to subangular quartzose sand with up to 25% lithic fragments. Sandstones are typically fair to poorly indurated and cemented with silica. Individual sandstone beds are 5 to 15 feet thick and are interbedded with white to light gray claystones. The claystones are organic-rich and kaolinitic and have been mined from the clay pits west of the plant. Individual claystone beds are 10 to 15 feet thick. Sedimentary structures observed in outcrop include planar, angular, and trough crossbeds, load structures, fluid escape structures, and ripple marks. Plant fossil casts and molds of branches, stems, and leaves are concentrated along bedding planes. The contact between the lower sandstone unit and the upper claystone unit is gradational and was selected where thick sandstone beds and kaolinite-rich claystones are less abundant.

Upper Claystone Unit: The upper claystone unit consists primarily of dark olive gray (5 Y 2/1) (GSA Rock Color Chart), poorly indurated claystones. Upper Laramie claystones generally weather to a light olive gray (5 Y 4/1) and may have dark yellowish orange (10 YR 6/6) iron staining along bedding planes and secondary fractures. These claystones appear quite similar to Arapahoe claystones in outcrop.

Thin sandstone lenses (less than three feet thick) also occur in the upper Laramie. These sandstones are typically yellowish gray (5 Y 8/1), fine- to very fine-grained, well sorted, subangular, and calcareous. Core data (well 50-86) indicate that thin beds of white, kaolinite-rich claystone typical of the Lower Laramie occur in the Upper Laramie as well.

The contact between the Upper Laramie claystones and the Lower Arapahoe sandstones is gradational and was selected using core data. The contact was picked below the first Arapahoe sandstone greater than five feet thick (Rockwell International, 1986a). This is consistent with the stratigraphic horizon picked as the base of the Arapahoe Formation at Rocky Flats Plant by Hurr (1976, 1985).

Arapahoe Formation

The Arapahoe Formation consists of fluvial claystones with interbedded lenticular sandstones and siltstones. Contacts between these lithologies are both sharp and gradational. The claystones are olive gray (5 Y3/2) to dark gray (N 3/0), poorly indurated, silty, and contain up to 15 percent organic material. Weathering has penetrated from 10 to 40 feet into bedrock. The weathered claystone is light olive gray, blocky, slightly fractured, and has iron staining as mottles and along bedding planes and fractures (Rockwell International, 1986a).

Sandstones in the Arapahoe Formation are light gray (N 6/0) to yellowish gray (5 YR 8/1), very fine- to medium-grained, with approximately 15 percent silt and clay. The sandstones are lenticular, discontinuous, and stratigraphically complex. The sand grains are subangular to subrounded and are predominantly quartzose with 10 percent lithic fragments. The sandstones are poorly to moderately cemented and exhibit ripple marks, load casts, and planar, angular, and trough crossbedding. Arapahoe Formation siltstones exhibit the same coloration, constituents, bedding characteristics, and sedimentary structures as the sandstones; however, they consist predominantly of silt-sized particles (Rockwell International, 1986a).

3.3.3 Plant Surficial Geology

There are six distinct Quaternary unconsolidated units of surficial materials in the vicinity of the Plant: Rocky Flats Alluvium, Verdos Alluvium, Slocum Alluvium, terrace alluviums, valley fill alluvium, and colluvium (Figure 3-6).

The Rocky Flats Alluvium is topographically the highest and the oldest of the alluvial deposits. The alluvium unconformably overlies the Laramie and Arapahoe Formations in the vicinity of the Plant. The deposit is a series of laterally coalescing alluvial fans deposited by streams (Hurr, 1976). The fans were deposited on an erosional surface cut into the bedrock units, including channelization around the hogbacks of the lower Laramie.

The alluvium consists of sand, clay, silt, gravel, cobble, and occasional boulder deposits. Locally, the alluvium is cemented with calcium carbonate in the form of caliche. Color of the alluvium is pale to dark yellowish brown. The sands range from very fine-grained to medium-grained and poorly to moderately sorted. The thickness of the alluvium is variable due to deposition on an erosional surface and recent erosional processes. The alluvium is thickest to the west of the Plant, where less has been eroded, and thinnest to the east of the Plant (Rockwell International, 1986a).

Various alluvial deposits occur topographically below the Rocky Flats Alluvium in the drainages and include the Verdos, Slocum, terrace, and valley fill alluviums and colluvium (Figure 3-7). These deposits are primarily composed of reworked Rocky Flats Alluvium with the addition of some bedrock material. Each unit is described below.

YEARS before presen	EPOCH	GLACIAL SEQUENCE	DEPOSIT				
1000	HOLOCENE	Gannett Peak Stade	"Valley Fill"	post-Piney Creek Alluvium	young alluvial fan	colluvium and landslides	loess and eolian sand
2000		Interstade		(Soil) Piney Creek Alluvium			
3000		Temple Lake Stade					
5000		"Altithermal Interval"		(Soil) pre-Piney Creek Alluvium			
12,000	PLEISTOCENE	WISCONSIN: Pinedale Glaciation	Terrace Alluvium	(Soil) Broadway Alluvium	old alluvial fan		
60,000		WISCONSIN: Bull Lake Glaciation		Louviers Alluvium			
130,000							
250,000		Sangamon Interglaciation / ILLINOIAN		(Soil) Slocum Alluvium			
600,000		Yarmouth Interglaciation / KANSAN		(Soil) Verdos Alluvium			
1,000,000		Aftonian Interglaciation / NEBRASKAN		(Soil) Rocky Flats Alluvium			
1,500,000							
	Pleistocene or Pliocene			Pre-Rocky Flats Alluvium			

(after: Van Horn, 1976, and Scott, 1965)

Figure 3-6:

Surficial Alluvial Deposits in the Rocky Flats Area

The Verdos Alluvium occupies a topographic position about 0 to 100 feet below the adjacent top of the Rocky Flats Alluvium. The Verdos was deposited around the periphery of the present extent of the Rocky Flats Alluvium as fans and channel filling derived by erosion of the older Rocky Flats Alluvium. The maximum thickness is about 40 feet, occurring as terraces in valleys east of the Plant. The alluvium consists of unsorted gravels, sands, and clays similar to the Rocky Flats Alluvium, but the material is whitish gray in color (Rockwell International, 1986a).

The Slocum Alluvium is a poorly sorted gravel deposit containing much sand, silt, and clay derived from erosion of bedrock and the older gravel deposits. The formation has a maximum thickness in the vicinity of the Plant of about 20 feet, but is commonly 5 to 10 feet thick. It occupies a topographic position of about 150 to 300 feet below the top of the Rocky Flats Alluvium, and occurs downslope of the Verdos Alluvium in valleys east of the Plant site (Rockwell International, 1986a).

Locally, two Wisconsin-age terraces are associated with the present drainages. The terrace alluvium occurs 5 to 35 feet above recent valley floors. The alluvium is comprised of gravels, sands, and clays, derived from bedrock and reworking of older alluvial deposits. The terrace alluvium can rarely occur up to 30 feet in thickness; however, the thickness is usually around 5 feet. The alluvium occurs in valleys surrounding the Plant (Rockwell International, 1986a).

Valley fill alluvium occurs in the bottom of the present stream valleys around the Plant. The valley fill ranges from dark-brown, sandy, clayey silt to moderately sorted cobbles and small boulders, recently reworked from previously deposited alluviums. The valley fill along streams which head on the Rocky Flats Alluvium and have not yet cut through to bedrock tends to be coarse and have little or no fine

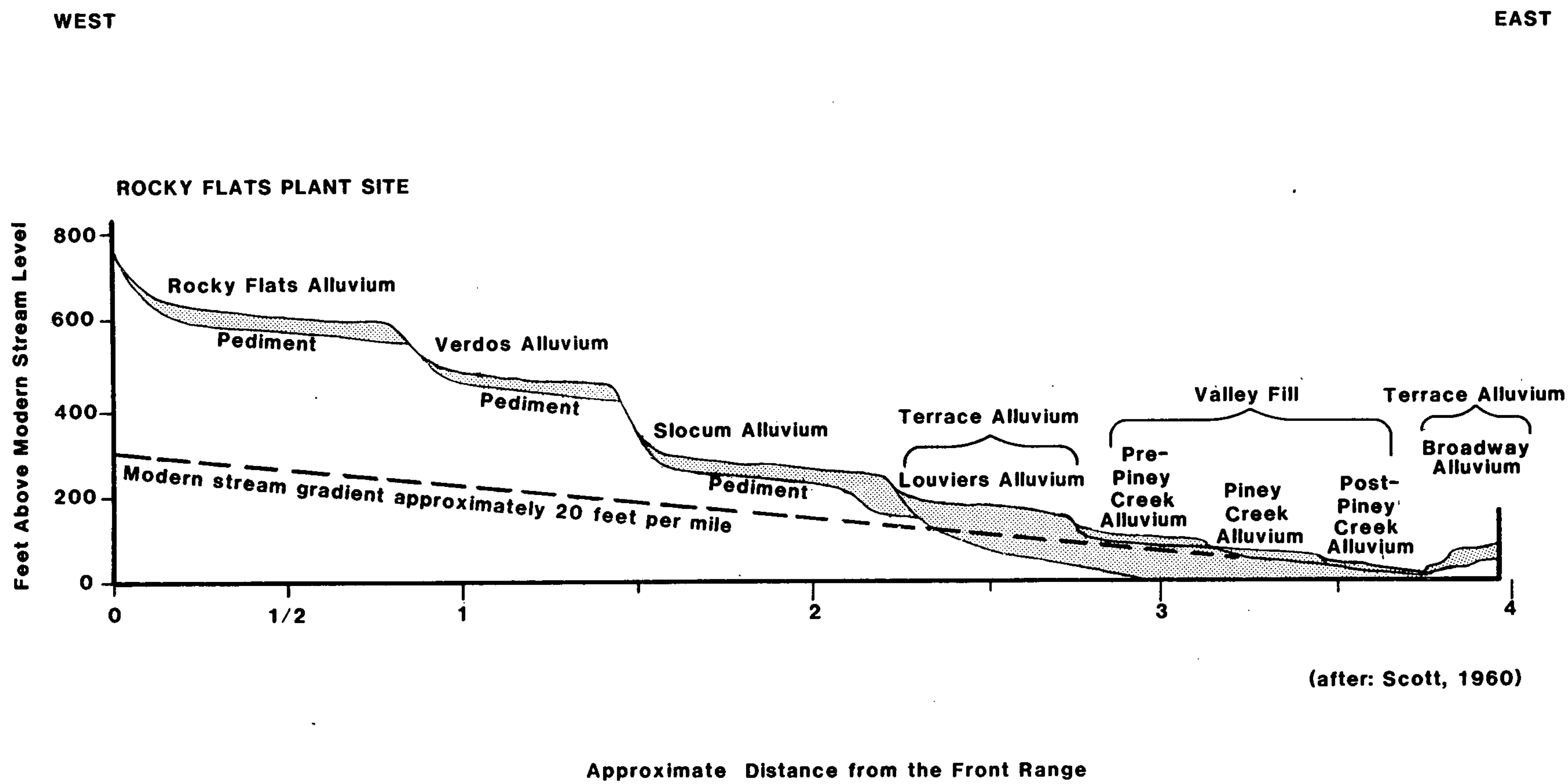


Figure 3-7:

Erosional Surfaces and Alluvial Deposits East of the Front Range, Colorado

material. However, where the valley fill is deposited on bedrock, 0.5 to 2 feet of cobbly sand and gravel commonly is overlain by several feet of sandy, clayey silt (Rockwell International, 1986a). Subsequent erosion and deposition locally may have added more sand, gravel and cobbles on top of the silt, or cut through the valley fill to expose bedrock along the channel bottom (Hurr, 1976).

Colluvium, produced by mass wasting and downslope creep, collects on the sides and at the base of hills and slopes. These deposits are poorly sorted mixtures of soil and debris from bedrock clay and sand mixed with gravel and cobbles derived from the older Rocky Flats Alluvium. The colluvium consists predominantly of clay with common occurrences of sandy clay and gravel. Color is yellowish brown to dusky brown and caliche is common locally. The thickness of the colluvium ranges from 3 to 22 feet (Rockwell International, 1986a).

3.3.4 Regional Bedrock Structure

The general geologic structure of the area is north-striking sedimentary beds with dips to the east away from the Front Range Monocline. Dips are quite steep west of the Plant in the Fox Hills Sandstone and Laramie Formation (on the order of 50 degrees or greater). These units are flanked on the west by Precambrian terrain of the Front Range Uplift and on the east by gently dipping sedimentary beds of the Denver Basin. However, because the axis of the monocline onto the Front Range appears to be inclined to the east, dips become rapidly more gentle, on the order of 7 to 15 degrees beneath the Plant itself (Rockwell International, 1986a). A major bounding fault between the Front Range and the Denver Basin, the Golden Fault, runs north-south several miles west of the Plant at the mountain front (Figure 3-7).

The majority of the displacement on the Golden Fault, the uplift of the Front Range and subsidence of the Denver Basin, occurred during the late Cretaceous to early Eocene Laramide Orogeny about 40 to 70 million years ago (Martin, 1965). Erosion during the Laramide Orogeny is believed to have kept pace with uplift and the Front Range probably never stood very high above the Denver Basin during the orogeny. By the late Eocene, an erosional surface of the low relief covered much of the Rocky Mountain Region.

The present rugged topography to the west of the Rocky Flats Plant is the result of Post-Laramide tectonics and erosion. About 5,000 to 10,000 feet of uplift has taken place in the Rocky Mountain Region since the early Miocene about 25 million years ago. Late Tertiary block faulting is believed to have accompanied the regional uplift as indicated by apparent displacements of the late Eocene erosional surface (Scott, 1975 and Epis and Chapin, 1975). There is some evidence that block faulting has continued into the Quaternary (Scott, 1970; Whitkind, 1976; and Kirkham and Rogers, 1981).

In 1981, extensive studies were done to evaluate the Quaternary history of the Golden Fault and other faults at the Rocky Flats Plant and vicinity (Dames and Moore, 1981). The Golden Fault studies did not produce any evidence of tectonic activity along the Golden Fault within the past 500,000 years, and the fault does not have surficial expressions characteristic of geologically young fault zones.

Hurr (1976) showed a fault crossing the eastern edge of the Plant, based on a series of bedding irregularities that appeared to be an extension of the previously mapped Eggleston Fault (northwest of the site). Further investigations of the feature (Dames and Moore, 1981) revealed that it is probably a penecontemporaneous growth fault attributed to slumping of the unconsolidated Arapahoe Formation before burial and lithification. The Denver Basin has been tectonically stable for about 28 million years with the exception of a series of earthquakes associated with waste injection at the Rocky Mountain Arsenal in the 1960s and possible surface rupture on the Golden Fault approximately 600,000 years ago (Kirkham and Rogers, 1981).

3.4 REGIONAL GROUND-WATER HYDROLOGY

There are two hydraulically connected ground-water systems at the Rocky Flats Plant. These systems occur in the surficial material (Rocky Flats Alluvium, colluvium, and valley fill material) and the underlying bedrock formations (Laramie-Fox Hills Aquifer and the Arapahoe Aquifer). These are discussed individually below.

3.4.1 Unconfined Surficial Flow Systems

Recharge/Discharge Conditions

The shallow ground-water flow system occurs in the Rocky Flats Alluvium and other surficial materials under unconfined conditions. The alluvium is recharged by infiltration of incident precipitation, irrigation, and surface water diversion canals (primarily through the Rocky Flats Alluvium). In addition, the retention ponds in the various drainages recharge the valley fill alluvium.

The shallow system appears to be quite dynamic, with large water level changes in response to seasonal and other stresses. Hurr (1976) describes the rapid response of water levels in wells completed in the Rocky Flats Alluvium to surface flows in the irrigation ditches. Similarly, between mid-April and September 1986, the water levels in wells 1-86 and 4-86 at the eastern property boundary (completed in most recent valley fill) dropped more than four to eight feet, respectively. These wells were dry in September, and there was no water exiting the Plant as ground-water flow in the valley fill alluvium in either Woman or Walnut Creek.

Ground-Water Flow Directions

Flow directions follow topography to the east and toward the drainages. In addition, flow directions are controlled by the configuration of the top of bedrock beneath surficial materials. The ground water in the drainages flows to the east in the valley fill materials and discharges as subsurface flow across the eastern Plant boundary during some portions of the year. In addition, water in all of the surficial materials recharges the bedrock.

3.4.2 Bedrock Flow Systems

The Denver ground-water basin underlies a 6,700 square mile area extending from the Front Range on the west to near Limon, Colorado on the east and from Greeley on the north to Colorado Springs on the south. The four major bedrock aquifers from deepest to shallowest are the Laramie-Fox Hills Aquifer, the Arapahoe Aquifer, the Denver Aquifer, and the Dawson Aquifer. The Pierre Shale underlies these units and is considered the base of the Denver Basin bedrock aquifer system due to its great thickness (up to 8000 feet) and its low permeability (Robson and others, 1981a).

Presented below are discussions of the two Denver Basin bedrock aquifers which occur beneath Rocky Flats Plant - the Laramie-Fox Hills Aquifer and the

Arapahoe Aquifer. The Denver and Dawson Aquifers do not occur in the immediate vicinity of Rocky Flats Plant.

Laramie-Fox Hills Aquifer

The Laramie-Fox Hills Aquifer is composed of the upper sandstone and siltstone units of the Fox Hills Formation and the lower sandstone units of the Laramie Formation. The thickness of the aquifer ranges from zero near the aquifer boundaries to 200 to 300 feet near the center of the basin. The upper Laramie coals and claystones separate the Laramie-Fox Hills Aquifer from the overlying Arapahoe Aquifer (Robson and others, 1981b).

On a regional scale ground-water in the Laramie-Fox Hills Aquifer flows from outcrop recharge areas toward the center of the basin and discharges to remote stream valleys. In addition, ground water discharges to pumping wells in the basin (Robson and others, 1981b). In the vicinity of Rocky Flats Plant ground-water flow is generally from the west to the east.

Arapahoe Aquifer

The Arapahoe Aquifer is defined as the saturated portion of the Arapahoe Formation by Robson and others (1981a). The Arapahoe Formation consists of a 400 to 700 foot thick sequence of interbedded claystones, siltstones, sandstones, and conglomerates with claystones and shale being more prominent in the northern third of the basin (Robson and others, 1981a). Individual sandstone beds are commonly lens shaped and range from a few inches to 30 to 40 feet in thickness (Robson and others, 1981a). Beneath the Plant the majority of ground-water flow in the Arapahoe is in the lenticular sandstones contained within the claystones (Rockwell International, 1986a).

There are two primary methods of recharge to the Arapahoe Aquifer. In outcrop and subcrop areas, it occurs from infiltration of incident precipitation and as infiltration of water from shallow alluvial aquifers. However, on a regional scale the primary recharge mechanism for the Arapahoe Aquifer is leakage from the overlying Denver Aquifer (Robson and others, 1981a).

Ground-water flow in the Arapahoe Aquifer is from recharge areas at the edges of the basin toward discharge areas along incised stream valleys. Ground-water is also discharged to pumping wells (Robson and others, 1981a). Ground-water flow in the vicinity of Rocky Flats Plant is from west to east toward the area of regional discharge along the South Platte River.

3.4.3 Ground-Water Use

Usable ground water occurs in both the Laramie-Fox Hills and Arapahoe Aquifers. The Laramie-Fox Hills subcrops west of the Plant but has little potential for use in the general area because of its great depth (approximately 750 to 800 feet deeper than the Arapahoe). Various sandstones in the Arapahoe Aquifer are used for irrigation, livestock watering, and domestic purposes east of the Plant.

3.5 SURFACE WATER HYDROLOGY

3.5.1 Natural Drainages

Three ephemeral streams drain the Rocky Flats Plant with flow generally from west to east (Figure 3-8). Rock Creek drains the northwestern corner and flows to the northeast in the buffer zone to its off-site confluence with Coal Creek.

A topographic divide bisects the Plant. The divide trends east-west and lies slightly south of Central Avenue (the approximate center line of the Plant site). An interceptor ditch lies between the Plant and the southern drainage Woman Creek. The South Interceptor Ditch is tributary to the "C" Ponds. Surface runoff downstream of the interceptor ditch is tributary to Woman Creek, which flows eastward to Standley Lake. An irrigation ditch headgate located in the northeast quarter of the northwest quarter diverts water from Woman Creek and conveys it to a small reservoir known as Mower Reservoir. North and South Walnut Creeks and an unnamed tributary drain the remainder of the Plant. These three forks of Walnut Creek join in the buffer zone (approximately 0.7 miles downstream of the eastern edge of the Plant security area) and flow to Great Western Reservoir approximately one mile east of the confluence of the forks.

3.5.2 Ditches and Diversions

The Church and McKay ditches cross the northern portion of the Plant. Both carry water diverted from Coal Creek to Great Western Reservoir. A diversion structure has been built in North Walnut Creek upstream of the Plant to divert McKay ditch out of the drainage. The ditches parallel each other north of the

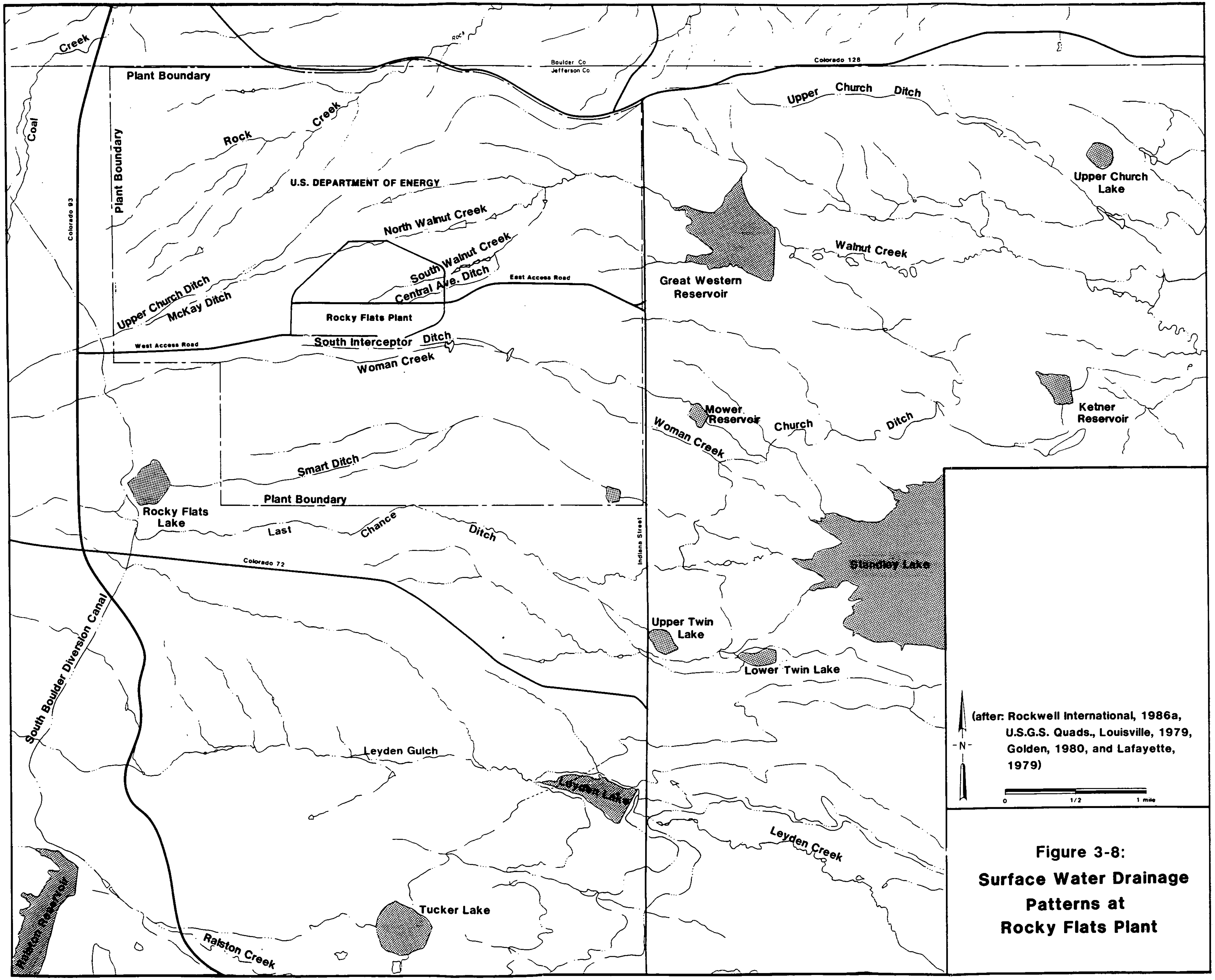


Figure 3-8: Surface Water Drainage Patterns at Rocky Flats Plant

Present Landfill and enter the Walnut Creek drainage downstream of the confluence of the north and south forks.

In addition to the natural flows, there are six ditches in the general vicinity of the Plant. The Church, McKay, and Kinnear Ditch and Reservoir Co. Ditches (diversions of Coal Creek) cross the Plant. Church Ditch delivers water to Upper Church Lake and Great Western Reservoir (City of Broomfield municipal water storage). McKay Ditch also supplies water to Great Western Reservoir. Kinnear Ditch and Reservoir Co. Ditch diverts water from Coal Creek and delivers it to Standley Lake (municipal water storage for the City of Westminster) via Woman Creek. Woman Creek also delivers water to Mower Reservoir. Last Chance Ditch flows south of the Plant and delivers water to Rocky Flats Lake and Twin Lakes. Smart Ditch takes water from Rocky Flats Lake and transports it out of the area to the east. The South Boulder Diversion Canal runs along the western upgradient edge of the Plant diverting water from South Boulder Creek and delivering it to Ralston Reservoir (City of Denver municipal water storage).

3.5.3 Retention Ponds and Plant Discharges

A series of dams, retention ponds, diversion structures, and ditches has been constructed at the Plant to control surface water and limit the potential for release of poor quality water.

The ponds are located in the drainages of Walnut and Woman Creeks and are designated the A, B, and C series ponds. Discharges from the downstream pond in each series are in accordance with the Plant's National Pollution Discharge Elimination System (NPDES) permit. Ponds A-1 and A-2 are used only for spill control, and North Walnut Creek stream flow is diverted around them through an underground pipe. Pond A-3 receives the North Walnut Creek stream flow and Plant runoff from the northern portion of the Plant. Pond A-4 is designed for surface water control and for additional storage capacity for overflow from pond A-3.

Five retention ponds are located along South Walnut Creek and are designated as B-1, B-2, B-3, B-4, and B-5, from west to east. Ponds B-1 and B-2 are reserved for spill control, whereas pond B-3 receives treated effluent from the sanitary sewage treatment plant. Ponds B-4 and B-5 receive surface runoff and occasionally collect discharge from pond B-3. Pond B-5 receives runoff from the central portion of the Plant and is used for surface water control in addition to collection of overflow from pond B-4.

The two C series ponds, C-1 and C-2, are located along Woman Creek, south and east of the Plant, respectively. Pond C-1 receives stream flow from Woman Creek. This flow is diverted around pond C-2 into the Woman Creek channel downstream. Pond C-2 receives surface runoff from the South Interceptor Ditch along the southern portion of the Plant. Water in pond C-2 is discharged to Woman Creek in accordance with the Plant NPDES permit.

There are many runoff control ditches in the generally vicinity of the Plant. The largest of these is the Central Avenue Ditch which runs eastward along Central Avenue and discharges to South Walnut Creek (Pond B-5). The other major runoff control ditch is the South Interceptor Ditch which prevents runoff from the south side of the Plant from entering Woman Creek. The ditch discharges to pond C-2, and Woman Creek is diverted around pond C-2 by a diversion structure just upstream of the pond.

Another retention pond is located on the unnamed northern tributary of Walnut Creek, downstream of the Present Landfill (see Section 2.1). Following water quality analyses, the water from the landfill pond is spray irrigated onto an area south of the landfill but upstream of the pond.

The permit requires monitoring of specific parameters at seven discharge points. The permitted discharges are:

Discharge	Location
001	Pond B-3
002	Pond A-3
003	Reverse Osmosis Pilot Plant
004	Reverse Osmosis Plant
005	Pond A-4
006	Pond B-5
007	Pond C-2

The discharges from the ponds are regularly monitored to document compliance with NPDES permit requirements. In addition to NPDES monitoring requirements, all discharges are monitored for plutonium, americium, uranium, and tritium concentrations.

SECTION 4

SOIL CHARACTERIZATION

This section presents soil chemistry data from historical and recent investigations at the Solar Evaporation Ponds. The purpose of this section is to characterize the nature and extent of soil contamination that resulted from pond leakage. The section begins with a summary of the characteristics of the solar pond contents as this material is the source of any contamination.

4.1 SOLAR POND WASTE CHARACTERISTICS

To characterize waste composition in the Solar Evaporation Ponds numerous analyses of pond liquids and sludge have been conducted. Summaries of the laboratory results are presented in Tables 4-1 and 4-2, and detailed laboratory data are presented in Appendices 3 and 4 of this Solar Evaporation Pond Closure Plan. As shown in the tables, liquids from Ponds 207-A and 207-C contain high concentrations of nitrate, metals, and radionuclides which are approximately two orders of magnitude higher than those in Ponds 207-B North and Center. This is expected because these ponds represent a mixture of ground water and Pond 207-A leakage collected by the French drain system. Pond 207-A liquid is characterized by high levels of the trace metals, aluminum, chromium, copper, iron, nickel, and tin, and high levels of the major cations potassium and sodium. Pond 207-A is generally more contaminated than Pond 207-C except for plutonium and americium which are approximately ten times higher in Pond 207-C. Ponds 207-B North and Center contain concentrations of metals near or below drinking water standards. Nitrate and gross

Table 4-1

LIQUID CHARACTERIZATION SUMMARY 1984 - 1988 "( )" - Test Result Reference Number

ANALYTE	*UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
pH		(1) 8.3 - 11.0 (9) 10.1	(2) 7.5 - 9.6 (10)8.0 - 8.5	(2) 7.3 - 11.3 (10)9.6 - 10.5	-----	(1) 7.7 - 12.5 (9) 10.5 - 11.3
Nitrate as Nitrogen	(mg/l)	(1) ND - 21,739 (9) 19,200	(2) 335 - 1,367 (10)212 - 507	(2) ND - 15.6 (10)346.4 - 1221	-----	(1) 8.4 - 18,841 (9) 9650 - 21,400
Total Disolved Solids	(mg/l)	(9) 127,000	-----	-----	-----	(9) 93,859 - 175,800
Cyanide	(mg/l)	(1) ND - 1.7 (9) 0.1	-----	-----	-----	(1) ND - 1.9 (9) 0.48 - 0.5
Gross Alpha	(pCi/l)	(1) 32(16) - 56,000(0.0) (4) 46,000(4,000) - 80,000(6,000) (9) 80,000(1,000)	(2) 13(50) - 323(33) (4) 74(58) - 120(50) (10)52(20) - 200(80)	(2) 4(0) - 59(23) (10)57(21) - 2,500(400)	-----	(1) 10,000(17,000) - 15,000(3,000) (9) 13,000(1,000) - 46,000(8,000)
Gross Beta	(pCi/l)	(1) 2(27) - 27,000(600) (4) 35,000(2,000) - 40,000(2,000) (9) 2,100(200)	(2) 5(25) - 163(25) (4) 56(32) - 100(92) (10)67(3) - 200(80)	(2) 8(11) - 73(0) (10)72(16) - 1,500(200)	-----	(1) 405(79) - 11,000(2,000) (9) 3,400(100) - 44,000(4,000)
Pu, Plutonium 239	(pCi/l)	(1) 0.0(420) -240(100) (4) 56(16) - 660(50)	(4) ND	-----	-----	(1) 210(320) - 1,400(300) (9) 300(130) - 2,100(300)
Am, Americum 241	(pCi/l)	(1) 0.0(1,000) - 200(120) (4) ND - 45(14)	(4) ND	-----	-----	(1) 12 - 13,000(1,000) (9) 0.0(27) - 2,900(300)
U, Uranium	(pCi/l)	(1) 0.69(0.79) - 26,000(2,000)	-----	-----	-----	(1) 1,800(300) - 15,000(1,000) (9) 1,400(900) - 40,000(2,000)
U, Uranium 233 + 234	(pCi/l)	(4) 14,000(1,000) - 20,000(1,000)	(4) 50(2) - 53(2)	-----	-----	-----
U, Uranium 238	(pCi/l)	(4) 21,000(1,000) - 28,000(1,000)	(4) 31(1) - 33(1)	-----	-----	-----
Tritium	(pCi/l)	(1) 620(230) - 3,000(800) (4) 240(180) - 930(260)	(4) 1,200(300) - 1,300(300)	-----	-----	(1) 0.0(0.0) - 6,400(600)
Al, Aluminum	(mg/l)	(5) 2.31 - 2.64	(3) 0.16 (3) 1 (5) ND (7) <.0028 (8) <.003	(3) 0.15 (3) 2. (7) <.0032 (8) <.0035	-----	-----
Sb, Antimony	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
As, Arsenic	(mg/l)	(5) 0.150	(5) ND (7) <.01 (8) <.01	(7) <.01 (8) <.01	-----	-----

Table 4-1 (cont'd.)

LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
Ba, Barium	(mg/l)	(5) ND	(5) ND - 0.220 (7) <1.0 (8) <1.0	(7) <1.0 (8) <1.0	-----	-----
Be, Beryllium	(mg/l)	(1) ND - 0.1 (5) 0.027 - 0.043 (9) .002	(5) ND (7) <.05 (8) .06	(7) <.05 (8) <.05	-----	(1) ND - 0.6 (9) 0.1
Bi, Bismuth	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
B, Boron	(mg/l)	-----	(3) 0.29 (3) 0.31 (7) .14 (8) .09	(3) 0.24 (3) 0.67 (7) 0.13 (8) .071	-----	-----
Cd, Cadmium	(mg/l)	(5) 0.070 - 0.150	(5) ND (7) <.01 (8) .01	(7) <.01 (8) .01	-----	-----
Ca, Calicum	(mg/l)	(5) ND	(3) 20.0 (3) 290 (5) 176 - 198 (7) 96.0 (8) 180.0	(3) 2.9 (3) 45.0 (7) 95.0 (8) 66.0	-----	-----
Ce, Cerium	(mg/l)	-----	(7) <2.8 (8) <3.	(7) <3.2 (8) <3.5	-----	-----
Cs, Cesium	(mg/l)	-----	(3) ND (3) ND (7) <.28 (8) <.3	(3) ND (3) 0.041 (7) <.32 (8) .35	-----	-----
Co, Cobalt	(mg/l)	(5) 0.200 - 0.500	(5) ND (7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
Cr, Chromuim	(mg/l)	(5) 13.7 - 16.7	(5) ND (7) <.05 (8) <.05	(7) <.05 (8) <.05	-----	-----
Cu, Copper	(mg/l)	(5) 1.61 - 1.80	(3) ND (3) ND (5) ND (7) <.014 (8) <.015	(3) 0.016 (3) 0.037 (7) <.016 (8) <.018	-----	-----

Table 4-1 (cont'd.)

LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
Ge, Germanium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.018 (8) <.018	-----	-----
Fe, Iron	(mg/l)	(5) 1.50 - 8.00	(3) 0.28 (3) 0.29 (5) ND (7) .057 (8) <.03	(3) 0.074 (3) 0.2 (7) 0.13 (8) <.035	-----	-----
Pb, Lead	(mg/l)	(5) ND	(3) ND (3) 0.0035 (5) ND (7) <.0028 (8) <.003	(3) ND (3) 0.002 (7) <.0032 (8) <.0035	-----	-----
Li, Lithium	(mg/l)	-----	(3) 0.37 (3) 3.5 (7) 1.7 (8) 6.	(3) 0.052 (3) 0.41 (7) 2.9 (8) 3.5	-----	-----
Mn, Manganese	(mg/l)	(5) 0.095 - 0.115	(3) ND (3) ND (5) ND - 0.015 (7) <.0028 (8) <.003	(3) 0.022 (3) 0.001 (7) <.0032 (8) <.0035	-----	-----
Mg, Magnesium	(mg/l)	(5) ND	(3) 87.0 (3) 120.0 (5) 66.4 - 72.6 (7) 88 (8) 80.0	(3) 3.9 (3) 13.0 (7) 86.0 (8) 91.0	-----	-----
Hg, Mercury	(mg/l)	(5) ND - 0.0002	(5) ND (7) <.002 (8) <.002	(7) <.002 (8) <.002	-----	-----
Mo, Molybdenum	(mg/l)	-----	(3) ND (3) 0.0069 (7) <.0028 (8) .003	(3) 0.016 (3) 0.037 (7) .019 (8) .0035	-----	-----
Ni, Nickel	(mg/l)	(5) 1.90 - 2.00	(3) ND (3) ND (5) ND - 0.050 (7) <.028 (8) <.03	(3) 0.015 (3) 0.018 (7) <.032 (8) <.035	-----	-----
Nb, Niobium	(mg/l)	-----	(7) <.14 (8) <.15	(7) <.16 (8) <.18	-----	-----

Table 4-1 (cont'd.)

LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
P, Phosphorous	(mg/l)	-----	(3) ND (3) ND (7) <.14 (8) <.15	(3) 0.074 (3) 0.2 (7) <.16 (8) 0.18	-----	-----
K, Potassium	(mg/l)	(5) 13,200 - 14,300	(3) 82.0 (3) 120 (5) 56.1 - 62.7 (7) 89.0 (8) 64.0	(3) 30.0 (3) 36.0 (7) 98.0 (8) 110.0	-----	-----
Rb, Rubidium	(mg/l)	-----	(7) <.28 (8) <.3	(7) <.32 (8) <.35	-----	-----
Se, Selinium	(mg/l)	(5) ND	(3) 0.01 (3) 0.02 (5) 0.009 (7) <.01 (8) .024	(3) ND (3) ND (7) <.01 (8) .019	-----	-----
Si, Silicon	(mg/l)	-----	(3) 2.1 (3) 5.6 (7) 2.1 (8) <.5	(3) 2.4 (3) 5.5 (7) 1.4 (8) 1.6	-----	-----
Ag, Silver	(mg/l)	-----	(3) ND (3) 0.082 (5) ND (7) <.0028 (8) <.003	(3) 0.0016 (3) 0.015 (7) <.0032 (8) <.0035	-----	-----
Na, Sodium	(mg/l)	(5) 36,300 - 42,900	(3) 370.0 (3) 620.0 (5) 363 - 451 (7) 820. (8) 770.0	(3) 67.0 (3) 250.0 (7) 800.0 (8) 650.0	-----	-----
Sr, Strontium	(mg/l)	-----	(3) 1.2 (3) 3.5 (7) 0.14 (8) .21	(3) 0.28 (3) 0.52 (7) .16 (8) .14	-----	-----
Ta, Tantalum	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Te, Tellurium	(mg/l)	-----	(7) <.28 (8) <.3	(7) <.32 (8) <.35	-----	-----

Table 4-1 (cont'd.)

LIQUID CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207 A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207 C
Tl, Thallium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
Th, Thorium	(mg/l)	-----	(7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Sn, Tin	(mg/l)	(5) 7.00 - 13 00	(5) ND (7) <.028 (8) <.03	(7) <.032 (8) <.035	-----	-----
Ti, Titanium	(mg/l)	-----	(7) <.014 (8) <.015	(7) <.016 (8) <.018	-----	-----
W, Tungsten	(mg/l)	-----	(7) <1.4 (8) <1.5	(7) <1.6 (8) <1.8	-----	-----
U, Uranium	(mg/l)	-----	(7) <1.4 (8) <1.5	(7) <1.6 (8) <1.8	-----	-----
V, Vanadium	(mg/l)	(5) 0.10 - 0 20	(3) ND (3) ND (5) ND (7) <.028 (8) <.03	(3) ND (3) 0.0081 (7) <.032 (8) <.035	-----	-----
Zn, Zinc	(mg/l)	(5) 0.62 - 0 78	(3) ND (3) ND (5) ND - 0.022 (7) <.14 (8) <.15	(3) 0.041 (3) ND (7) <.16 (8) <.18	-----	-----
Zr, Zirconium	(mg/l)	-----	(3) ND (3) ND (7) <.028 (8) <.03	(3) 0.0041 (3) ND (7) <.032 (8) <.035	----	-----
Tritium	(mg/l)	-----	(3) ND (3) 0.069	(3) 0.022 (3) 0.041	-----	-----
Phenols	(mg/l)	(5) 0.013 - 0.035	(5) 0.003 - 0.046	-----	-----	-----

Table 4-2

SLUDGE CHARACTERIZATION SUMMARY 1984 - 1988

"( )" - Test Result Reference Number

ANALYTE	UNITS	POND 207-A	POND 207-B NORTH	POND 207-B CENTER	POND 207-B SOUTH	POND 207-C
pH		(6) 9.5				
Nitrate as Nitrogen	(mg/l)	(6) 8,800				
Gross Alpha	(pCi/g)	(4) 4,700(200) - 14,000(1,000)				
	(pCi/l)*	(6) 860,000				
Gross Beta	(pCi/g)	(4) 160(20) - 1,400(100)				
Pu, Plutonium 239	(pCi/g)	(4) 1,000(100) - 3,700(100)				
Am, Americum 241	(pCi/g)	(4) 1,400(200) - 4,400(100)				
U, Uranium 233 + 234	(pCi/g)	(4) 70(10) - 570(30)				
U, Uranium 235	(pCi/l)*	(6) 28(19)				
U, Uranium 238	(pCi/g)	(4) 130(10) - 480(30)				
	(pCi/l)*	(6) 520(90)				
Tritium	(pCi/g)	(4) 1,300(500) - 12,000(1,000)				
Al, Aluminum	(mg/kg)	(5) 11,000 - 11,900				
As, Arsenic	(mg/kg)	(5) ND				
Ba, Barium	(mg/kg)	(5) ND				
Be, Beryllium	(mg/kg)	(5) 309 - 1,570				
		(6) 170				
Cd, Cadmium	(mg/kg)	(5) 1,110 - 10,500				
Ca, Calicum	(mg/kg)	(5) 19,600 - 50,000				
Co, Cobalt	(mg/kg)	(5) ND				
Cr, Chromuim (Total)	(mg/kg)	(5) 1,010 - 19,700				
Cr, Chromium (Hex.)	(mg/kg)	(6) <1.0				
Cu, Copper	(mg/kg)	(5) 425 - 1,590				
Fe, Iron	(mg/kg)	(5) 3,590 - 6,900				
Pb, Lead	(mg/kg)	(5) 65 - 455				
Mn, Manganese	(mg/kg)	(5) 153 - 595				
Mg, Magnesium	(mg/kg)	(5) 6,100 - 21,000				
Hg, Mercury	(mg/kg)	(5) 7.5 - 25				
Ni, Nickel	(mg/kg)	(5) 124 - 1,320				
K, Potassium	(mg/kg)	(5) 50,000 - 65,300				
Se, Sellnium	(mg/kg)	(5) ND				
Ag, Silver	(mg/kg)	(5) 153 - 237				
Na, Sodium	(mg/kg)	(5) 130,000 - 166,000				
Sn, Tin	(mg/kg)	(5) ND				
V, Vanadium	(mg/kg)	(5) ND				
Z, Zinc	(mg/kg)	(5) 227 - 595				
Phenols	(mg/kg)	(5) ND - 3.3				

EXPLANATION FOR TABLES 4-1 AND 4-2

ND = Not Detected

( )* = Units Shown on Data Provided for Sludge in Pond 207-A

( ) = Test Result Reference Ranging from 1 to 10, Described below:

1 Summary of Quarterly Sampling 1984 and 1985, Appendix 3, Table 3-1

2 Summary of Weekly Sampling for Ponds 207-B North and Center Liquids, Appendix 3, Table 3-II

3 Summary of Two Sets of Metals Analyses of Ponds 207-B North and Center Liquids, October 1984 and April 1985, Appendix 3, Table 3-III.

4 Summary of Radiochemical Analyses, April and May 1986, Appendix 4, Table 4-I

5 Summary of Metals and Phenols Testing April and May 1986, Appendix 4, Table 4-II

6 Summary of Parameters monitored in Pond 207-A Sludge in May 1985, Appendix 4, Table 4-III

7 207-B Solar Pond North and Center Quarterly Metals Analysis, August 14, 1987, Lab No. E87-3918, Appendix 4

8 207-B Solar Pond North and Center Quarterly Metals Analysis, November 30, 1987, Lab No. E87-4254, Appendix 4

9 207-A and 207-C Solar Pond Quarterly Analysis Results (Liquids), March 1987 to March 1988, Appendix 4

10 207-B Solar Pond Weekly Analysis Results (Liquids), October 1987 to June 1988.

alpha occur in the ponds at levels above drinking water standards. Plutonium and americium were not detected in Pond 207-B North.

4.2 SOIL CHEMISTRY

4.2.1 Background Soil Chemistry

Background metal and radionuclide concentrations in soils have been developed based on 1986 sampling and analysis in the west buffer zone (an area unaffected by waste disposal activities). The top one foot of soil (Rocky Flats Alluvium) west of the West Spray Field was sampled. Table 4-3 presents a summary of the background soils data. Sampling and analysis of soils from a single plot in the west buffer zone is not considered a complete characterization of background alluvial and bedrock materials; however, it serves as a basis for assessing potential contamination. At the present time the soils data presented in Table 4-3 are the only background soils data available. A plan is currently being developed to characterize background soils, surface water, and ground water at the Rocky Flats Plant.

4.2.2 Site Soil Chemistry

Soil samples were collected during the 1986 and 1987 field investigations conducted in the solar ponds area. The 1986 field investigation included split spoon sampling of alluvium, bedrock and the bedrock/alluvium contact in five boreholes. These five boreholes were later completed as wells 18-86, 20-86, 22-86, 25-86 and 27-86. The procedures followed during the 1986 sampling program are described in the Draft Work Plan, Geological and Hydrological Site Characterization (Rockwell International, 1986b). The 1987 field program included collection of soil samples

TABLE 4-3

METAL AND RADIONUCLIDE CONCENTRATIONS IN BACKGROUND SOIL

Metals	Concentration (mg/kg)
Aluminum	6,540 - 9,140
Antimony	41U
Arsenic	6.1U - 10
Barium	135U
Beryllium	3.4U
Calcium	2,500U
Cadmium	3.4U
Chromium (Total)	5.6 - 13
Cobalt	12U - 25
Copper	12U
Iron	9,080 - 12,400
Lead	15 - 48
Magnesium	2,500U
Manganese	196 -337
Mercury	0.1U
Nickel	20U
Potassium	2,500U
Selenium	3.4U
Silver	5U
Sodium	2,500U
Thallium	6.8U
Tin	41U
Vanadium	30U - 38
Zinc	20 -49

Radionuclides	Concentration (pCi/g)
Plutonium	0.01(0.10) - 0.10(0.20)
Americium	-0.02(0.03) - 0.28(0.16)
Uranium 233+234	0.66(0.16) - 1.4(0.20)
Uranium 238	0.62(0.16) - 1.2(0.2)
Tritium	-70(220 - 280(270)

NOTES:
(1) Background values based on nine composite samples collected from the top one foot of Rocky Flats Alluvium in the West Buffer Zone.
(2) "U" Indicates values less than detection limits.
(3) Values in parentheses indicate counting uncertainty.
(4) Tritium is in units of pCi/l of soil water.

16 boreholes, SP01-87 through SP16-87, two of which were completed as monitoring wells. Borehole SP08-87 was completed as well 39-87, and SP16-87 as well 56-87. The procedures followed during the 1987 field investigation are described in the Comprehensive Environmental Assessment and Response Program (CEARP), Phase 2, Rocky Flats Plant, Installation Generic Monitoring Plan (DOE, 1987).

Soils were analyzed for a comprehensive suite of metals, organics, radionuclides, and other inorganics (Table 4-4). As discussed herein, examination of the soil analyses from the solar pond area indicates that the metals calcium, beryllium, cadmium, antimony, thallium, and possibly chromium and nickel are soil contaminants of the solar pond area. Although sodium and potassium concentrations are high in the liquids and sludge analyses from the ponds, elevated sodium and potassium concentrations were not detected in the analyzed soil samples. Except for probable laboratory contamination of the samples, volatile organic compounds (VOC) were not detected in the 1987 borehole samples from the solar pond area; however, low levels of 1,1-dichloroethane (1,1-DCA), chloroform ($CHCl_3$), 1,1,1-trichloroethane (1,1,1-TCA), trichloroethene (TCE), and total xylenes were detected in 1986 core samples. Several soil samples also contained plutonium and to a lesser extent americium and uranium at levels above estimated background levels. Nitrates are elevated in several of the analyzed soil samples. These general conclusions, including a discussion of laboratory contamination, are specifically addressed in this section.

TABLE 4-4

SOIL SAMPLING PARAMETERS

Metals

Hazardous Substance List-Metals
Beryllium
Lithium
Strontium

Organics

Hazardous Substance List - Volatiles
Hazardous Substance List - Semi-Volatiles*
Oil and Grease*

Radionuclides

Gross Alpha
Gross Beta
Uranium 233, 234, and 238
Americium 241
Plutonium 239, 240
Strontium 90
Tritium*

Other

Pesticides*
PCB's*
Cyanide
Sulfide**
Nitrates, Nitrite, Nitrogen
Percent Solids
pH

NOTE: (1) Analytical methods are presented in the IGMP Work Plan for Rocky Flats Plant (DOE), 1986a.

(2) "*" Analyses not requested for 1987 borehole soil samples.

(3) "**" Analyses not requested for 1986 core samples.

Metals

Generally, metal concentrations in soil samples from the solar pond area were within two times estimated background levels as shown in Table 4-5. It is likely that natural variations in soil chemistry could explain variability in soil metal concentrations of a factor of two or even three. However, it becomes more likely that metal concentrations exceeding three times estimated background could be indicative of contamination. Concentrations of metals exceeding the upper limit of the background range by a factor of three are shown in Table 4-6.

Calcium exceeded three times the maximum background concentrations in a majority of the analyzed soil samples. Sludges in Pond 207-A contained calcium ranging from 20,000 to 50,000 milligrams per kilogram (mg/kg). Although a one time analysis of Pond 207-A liquids indicates calcium was not detected, this datum is considered erroneous considering the high calcium content of the sludges and the elevated calcium concentrations in Pond 207-B North which contains seepage/ground water from beneath Pond 207-A. Leaching of calcium from these sludges along with leakage of high calcium liquids from the solar ponds probably resulted in deposition of calcium in the soils beneath and hydraulically downgradient of the solar ponds. High calcium is pervasive throughout these soils.

As shown in Table 4-6, beryllium, cadmium, antimony, and thallium are at notably high concentrations and pervasive in the soils at borehole SP16-87 located south of Pond 207-C. This borehole is in an area where the original solar pond was located. This is the only borehole where several metals occur throughout the depth at concentrations ranging from 10 to 1000 times background. Therefore, it is likely that contaminated soils/waste from the original solar pond is the material encountered in this borehole.

TABLE 4-5a

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Al (9140)	As (10)	Ba (135u)	Ca (2500u)	Co (25)	Cr (13)	Cu (13u)	Fe (12,400)	Hg (0.1U)	K (2500)
SP01-87	SP018700FS	0.0-1.2	13,442	-	-	10,348*	-	21	-	15,797	-	-
	SP018704DH	4.0-5.0	14,499	-	-	8,663*	-	16	-	14,220	-	-
	SP018705DH	5.0-6.3	30,899*	-	-	14,409*	-	28	-	23,226	-	-
	SP018711DH	10.5-12.2	9,166	-	-	-	-	18	-	16,421	-	-
	SP018713DH	12.7-14.9	-	-	-	-	-	-	-	-	-	-
	SP018716BR (WT)	15.2-16.7	-	-	-	-	-	-	-	-	-	-
	SP018721DH	20.2-22.3	-	-	-	3,080	-	-	-	14,745	-	-
	SP018723DH	22.7-24.1	-	-	-	3,332	-	31	30	13,806	-	-
SP02-87	SP02870008	0.0-10.1	-	-	-	18,390*	-	-	-	15,043	-	-
	SP028708UC	7.1-10.1	-	-	-	126,076*	-	-	-	-	-	-
	SP028711CT	10.1-12.6	-	-	-	50,605*	-	-	-	-	-	-
	SP028713BR	12.6-15.1	-	-	-	26,297*	-	-	-	-	-	-
SP03-87	SP038702DH	2.0-3.5	NA	-	NA	NA	-	NA	NA	NA	-	NA
	SP038703FS	4.0-4.6	NA	NA	NA	NA	-	NA	NA	NA	-	NA
	SP038711DH	10.3-11.6	9,691	-	-	-	-	-	-	-	-	-
	SP038713CT	12.8-14.4	-	-	-	2,523	-	-	-	-	-	-
	SP038716BR	15.2-16.9	10,704	11	-	-	-	-	-	-	-	-
SP04-87	SP048702DH	2.0-3.7	-	-	-	-	-	-	-	-	-	-
	SP048704DH	4.0-5.8	18,764	-	174	119,858*	-	17	-	12,419	-	3,500
	SP0487004D	4.0-5.8	20,345	-	200	81,473*	-	22	-	13,052	-	5,200
	SP048707DH	7.0-8.7	9,576	NA	170	161,428*	-	-	-	-	-	-
	SP048710DH	9.5-10.1	NA	NA	NA	-	-	NA	NA	NA	-	NA
	SP048712DH (WT)	12.6-14.5	-	15	-	11,991*	-	-	21	23,702	-	-
	SP048715FS	14.5-17.0	-	-	-	-	-	-	-	-	-	-
	SP048717DH	17.0-19.5	10,908	18	-	3,578	-	-	17	-	-	-
	SP048720DH	19.5-22.0	-	-	-	3,097	-	-	-	-	-	-
	SP048722DH	22.0-24.0	-	-	-	-	-	-	-	-	-	-
	SP048725DH	24.5-27.0	-	-	-	3,640	-	-	19	-	-	-
	SP048727DH	27.0-29.5	-	-	119*	38,269*	-	-	-	-	-	-
	SP048730DH	29.5-32.0	-	-	-	2,583	-	-	-	-	-	-
	SP048732DH	32.0-34.0	-	27	-	-	-	-	-	-	-	-

TABLE 4-5b

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Mg (2500)	Mn (337)	Ni (20u)**	V (38)	Zn (49)	Be (3.4U)	Cd (3.4U)	Sb (41U)	Tl (6.8U)
SP01-87	SP018700FS	0.0-1.2	2,731	-	-	42	61	-	3.74	-	-
	SP018704DH	4.0-5.0	2,801	-	-	53	54	-	-	-	-
	SP018705DH	5.0-6.3	2,799	-	30	72	-	-	-	-	-
	SP018711DH	10.5-12.2	-	-	-	-	-	-	-	-	-
	SP018713DH	12.7-14.9	-	408	35	-	-	-	-	-	-
	SP018716BR (WT)	15.2-16.7	-	-	-	40	-	-	-	-	-
	SP018721DH	20.2-22.3	-	-	-	42	55	-	-	-	-
	SP018723DH	22.7-24.1	-	-	39	-	51	-	-	-	-
SP02-87	SP02870008	0.0-10.1	-	-	-	-	-	-	-	-	-
	SP028708UC	7.1-10.1	3,514	-	-	-	-	-	5.07	-	-
	SP028711CT	10.1-12.6	-	-	-	-	-	-	3.51	-	-
	SP028713BR	12.6-15.1	-	-	-	-	-	-	-	-	-
SP03-87	SP038702DH	2.0-3.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP038703FS	4.0-4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP038711DH	10.3-11.6	-	-	-	-	-	-	-	-	-
	SP038713CT	12.8-14.4	-	-	-	-	-	-	-	-	-
	SP038716BR	15.2-16.9	-	-	-	-	-	-	-	-	-
SP04-87	SP048702DH	2.0-3.7	-	-	-	-	-	-	51.10*	-	-
	SP048704DH	4.0-5.8	3,916	-	38	-	-	-	70.85*	-	-
	SP0487004D	4.0-5.8	3,681	-	59	-	-	-	119.14*	-	-
	SP048707DH	7.0-8.7	3,951	NA	-	-	-	-	7.41	-	-
	SP048710DH	9.5-10.1	NA	-	NA	-	-	NA	NA	NA	NA
	SP048712DH (WT)	12.6-14.5	-	-	-	50	80	-	-	-	-
	SP048715FS	14.5-17.0	-	-	-	-	54	3.75	-	-	-
	SP048717DH	17.0-19.5	2,598	-	-	-	-	-	-	-	-
	SP048720DH	19.5-22.0	-	-	-	-	-	-	-	-	-
	SP048722DH	22.0-24.0	-	-	-	-	-	-	-	-	-
	SP048725DH	24.5-27.0	-	-	-	-	-	-	-	-	-
	SP048727DH	27.0-29.5	-	-	-	-	-	-	-	-	-
	SP048730DH	29.5-32.0	-	-	30	-	50	-	-	-	-
	SP048732DH	32.0-34.0	-	-	-	-	-	-	-	-	-

TABLE 4-5a(Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Al (9140)	As (10)	Ba (135u)	Ca (2500u)	Co (25)	Cr (13)	Cu (13u)	Fe (12,400)	Hg (0.1U)	K (2500)
SP05-87	SP058700DH	0.0-0.4	NA	NA	NA	NA	-	NA	NA	NA	-	NA
	SP058702DH	2.0-3.3	10,142	30	166	-	-	14	58*	12,536	-	2,600
	SP058704DH	4.0-5.6	11,242	15	-	-	-	15	33	13,183	-	2,600
	SP058707DH	7.0-8.3	16,123	-	-	90,980*	-	15	-	19,069	-	2,700
	SP058710DH	9.5-10.1	9,276	-	202	48,641	-	780*	23	15,349	-	3,900
	SP058712DH (WT)	12.8-14.4	10,905	-	-	20,810	-	132*	22	14,482	-	3,800
	SP058716DH	15.3-17.3	-	-	-	7,403	-	11	15	-	-	3,400
SP06-87	SP068702FS	2.0-3.7	17,725	35*	152	109,942*	-	16	-	12,790	-	-
	SP068708DH	8.0-10.4	12,522	16	-	2,619	-	-	-	13,334	-	3,300
	SP068711DH	10.5-12.4	-	-	153	143,650*	-	-	-	-	-	-
	SP068713DH	13.0-14.3	-	11	-	8,907*	-	-	-	-	-	-
	SP068716DH	15.5-17.7	-	-	-	12,081*	-	-	-	-	-	-
	SP068718DH	18.0-20.5	11,479	-	-	48,271*	-	14	24	14,390	-	-
	SP068721DH	20.5-23.0	13,630	17	-	8,135*	-	17	18	-	-	-
	SP068724DH	23.2-25.7	11,921	29	-	2,725	-	40*	30	17,706	-	-
	SP068726DH	25.7-28.2	14,799	19	-	3,318	-	22	23	-	-	-
SP07-87	SP078700DH	0.0-1.8	24,579	-	-	48,884*	-	22	44*	17,302	-	-
	SP078702DH	2.0-3.8	16,435	-	-	10,644*	-	21	-	12,694	-	-
	SP078708FS	8.0-10.3	30,265*	12	163	44,679*	-	25	26	21,846	-	-
	SP078711DH	10.5-12.2	9,232	-	-	-	-	-	-	-	-	-
	SP078713DH	13.0-14.8	22,724	-	148	3,155	-	22	21	23,823	-	-
	SP078716DH	15.5-16.7	-	-	-	56,105*	-	586*	23	13,444	-	-
	SP078718WT (WT)	18.0-19.3	-	-	-	5,205	-	393*	20	13,996	-	-
	SP078721CT	20.5-23.0	12,140	29	-	-	-	92*	29	13,349	-	-
	SP078723BR	23.0-26.0	10,902	64*	-	4,183	-	15	21	-	-	-
	SP078726DH	26.0-28.5	14,759	55*	-	4,894	-	24	23	-	-	-
39-87/ SP08-87	SP088703UC	3.5-6.5	-	-	-	6,322	-	-	-	-	-	3,000
	SP088706CT	6.5-8.5	-	-	-	-	-	-	-	-	-	3,500
	SP088709BR	9.0-11.5	-	-	-	-	-	-	-	-	-	-
SP09-87	SP098703UC	3.0-5.1	10,308	-	-	39,908*	-	-	17	16,334	-	-
	SP098706CT	6.0-8.5	-	-	-	2,836	-	-	15	-	-	-
	SP098708BR	8.5-11.0	10,202	-	-	4,141	-	-	20	-	-	-

TABLE 4-5b (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Mg (2500)	Mn (337)	Ni (20u)**	V (38)	Zn (49)	Be (3.4U)	Cd (3.4U)	Sb (41U)	Tl (6.8U)
SP05-87	SP058700DH	0.0-0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP058702DH	2.0-3.3	-	-	-	47	-	-	16.45*	-	-
	SP058704DH	4.0-5.6	-	-	-	44	-	-	10.47*	-	-
	SP058707DH	7.0-8.3	3,110	509	-	-	-	-	83.68*	-	-
	SP058710DH	9.5-10.1	-	802	474*	-	-	-	21.97*	-	-
	SP058712DH (WT)	12.8-14.4	-	-	-	-	-	-	19.96*	-	-
	SP058716DH	15.3-17.3	-	-	-	-	-	-	7.30	-	-
SP06-87	SP068702FS	2.0-3.7	3,828	-	-	44	-	5.22	5.07	-	-
	SP068708DH	8.0-10.4	-	-	-	-	-	-	-	-	-
	SP068711DH	10.5-12.4	3,628	-	-	-	-	-	4.45	-	-
	SP068713DH	13.0-14.3	-	-	-	-	-	-	-	-	-
	SP068716DH	15.5-17.7	-	-	-	-	61	-	-	-	-
	SP068718DH	18.0-20.5	5,217	-	-	43	73	-	3.62	-	-
	SP068721DH	20.5-23.0	4,063	-	-	43	-	-	-	-	-
	SP068724DH	23.2-25.7	3,524	-	28	-	114	-	-	-	-
	SP068726DH	25.7-28.2	4,386	-	-	-	74	-	-	-	-
SP07-87	SP078700DH	0.0-1.8	3,397	-	29	50	51	-	8.01	-	-
	SP078702DH	2.0-3.8	-	-	-	47	-	-	-	-	-
	SP078708FS	8.0-10.3	3,587	-	58	41	52	-	-	-	-
	SP078711DH	10.5-12.2	-	-	-	-	-	-	-	-	-
	SP078713DH	13.0-14.8	-	-	49	49	68	-	-	-	-
	SP078716DH	15.5-16.7	2,518	-	514*	-	-	-	3.88	-	-
	SP078718WT (WT)	18.0-19.3	-	-	313*	-	-	-	-	-	-
	SP078721CT	20.5-23.0	3,030	-	94*	-	64	-	-	-	-
	SP078723BR	23.0-26.0	3,105	-	-	-	60	-	-	-	-
	SP078726DH	26.0-28.5	2,960	-	-	-	-	-	-	-	-
39-87/ SP08-87	SP088703UC	3.5-6.5	-	-	-	-	-	-	-	-	-
	SP088706CT	6.5-8.5	-	-	-	-	-	-	-	-	-
	SP088709BR	9.0-11.5	-	-	-	-	-	-	-	-	-
SP09-87	SP098703UC	3.0-5.1	2,951	-	-	-	50	-	-	-	-
	SP098706CT	6.0-8.5	-	-	-	-	-	4.48	-	-	-
	SP098708BR	8.5-11.0	2,542	-	-	-	-	-	-	-	-

TABLE 4-5a (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Al (9140)	As (10)	Ba (135u)	Ca (2500u)	Co (25)	Cr (13)	Cu (13u)	Fe (12,400)	Hg (0.1U)	K (2500)
SP10-87	SP108700DH	0.0-1.8	10,997	NA	-	17,391*	-	-	-	-	-	3,600
	SP108702DH	2.0-3.9	9,562	NA	166	39,224*	-	-	18	17,124	-	-
	SP108704BR	4.0-5.0	-	-	-	20,445*	-	-	22	35,795	-	-
	SP108705DH	5.0-7.0	-	-	-	13,618*	-	-	22	27,515	-	-
	SP108707DH	7.0-9.0	-	-	-	-	-	-	-	-	-	-
	SP108709DH	9.0-11.0	10,614	NA	-	NA	-	-	NA	-	-	NA
	SP108711DH	11.0-13.0	-	-	-	4,153	-	-	15	-	-	-
	SP108713DH	13.0-14.9	-	-	-	3,546	-	-	-	-	-	-
	SP108715DH	15.0-16.9	-	-	-	-	-	-	-	-	-	-
	SP108717DH	17.0-19.0	-	-	-	3,452	-	-	-	-	-	-
	SP1087017D	17.0-19.0	9,461	-	-	4 379	-	-	-	-	-	-
	SP108719DH	19.0-21.0	15,699	-	-	6,820	-	15	17	-	-	-
	SP108721WT (WT)	21.0-23.0	12,056	-	-	7,658	-	-	23	-	-	-
	SP108723DH	22.7-23.7	11,807	-	-	4,611	-	NA	-	-	-	-
	SP108724DH	23.7-25.7	10,210	-	-	4,461	-	NA	-	-	-	-
SP11-87	SP11870008	0.0-8.8	-	-	-	6,246	-	-	-	-	-	-
	SP118708DH	8.8-11.3	-	-	-	5,132	-	-	-	-	-	-
	SP118711DH	11.5-14.0	-	-	-	3,062	-	-	-	-	-	-
	SP118714DH	14.0-15.1	-	-	-	5,716	-	-	-	-	-	-
	SP118716DH	16.5-17.8	-	-	-	2,873	-	-	-	17,914	-	-
	SP118719DH	19.0-21.5	-	-	-	7,883*	-	-	-	-	-	-
	SP118721DH	21.5-24.0	-	-	-	-	-	-	-	-	-	-
	SP118724DH	24.0-26.5	-	-	-	-	-	-	-	-	-	-
	SP118726DH	26.5-29.0	-	-	-	4,192	-	-	17	-	-	-
	SP118729DH	29.0-31.5	9,892	-	-	6,571	-	612*	32	18,835	-	-
SP12-87	SP12870009	0.0-9.0	-	-	-	-	-	-	-	-	-	-
	SP12870916	9.0-16.5	-	-	-	3,025	-	-	-	-	-	-
	SP128716DH	16.5-19.0	17,771	-	143	17,225*	-	40*	19	12,600	-	-
	SP128719DH	19.0-21.5	16,308	-	171	7,228	-	36	20	17,912	-	-
	SP128721DH	21.5-24.0	-	-	-	1,974	-	-	-	-	-	3,000
	SP128724DH	24.0-25.2	-	-	-	-	-	-	-	-	-	-
	SP128726DH	26.5-29.0	-	-	-	4,336	-	-	15	-	-	-
	SP128729DH	29.0-31.5	-	-	-	2,514	-	-	14	-	-	-
	SP128731DH	31.5-32.2	11,755	-	-	7,658*	-	15	26	-	-	-
	SP128734DH	34.0-34.5	11,099	-	-	9,273*	-	-	23	16,856	-	-
	SP128739DH	39.0-41.5	-	-	-	3,293*	-	-	15	-	-	-
	SP128741DH	41.5-44.0	11,221	-	-	-	-	-	-	-	-	-

TABLE 4-5b (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Mg (2500)	Mn (337)	Ni (20u)**	V (38)	Zn (49)	Be (3.4U)	Cd (3.4U)	Sb (41U)	Tl (6.8U)
SP10-87	SP108700DH	0.0-1.8	-	-	-	-	-	-	4.04	-	-
	SP108702DH	2.0-3.9	2,670	-	-	-	53	4.44	-	-	-
	SP108704BR	4.0-5.0	-	509	-	-	68	-	-	-	-
	SP108705DH	5.0-7.0	-	-	-	-	66	-	-	-	-
	SP108707DH	7.0-9.0	-	-	-	-	-	-	-	-	-
	SP108709DH	9.0-11.0	NA	NA	NA	NA	NA	-	-	-	-
	SP108711DH	11.0-13.0	-	-	-	-	-	-	-	-	-
	SP108713DH	13.0-14.9	-	-	-	-	-	-	-	-	-
	SP108715DH	15.0-16.9	-	-	-	-	-	-	-	-	-
	SP108717DH	17.0-19.0	-	426	-	-	-	3.66	-	-	-
	SP1087017D	17.0-19.0	-	-	-	-	61	-	-	-	-
	SP108719DH	19.0-21.0	2,685	-	-	-	52	-	100.66*	-	-
	SP108721WT (WT)	21.0-23.0	-	-	-	-	51	-	-	-	-
	SP108723DH	22.7-23.7	-	-	-	-	-	-	-	-	-
	SP108724DH	23.7-25.7	-	-	-	-	56	-	-	-	-
SP11-87	SP11870008	0.0-8.8	-	-	-	-	-	-	-	-	-
	SP118708DH	8.8-11.3	-	-	-	-	-	-	3.42	-	-
	SP118711DH	11.5-14.0	-	-	-	-	-	-	-	-	-
	SP118714DH	14.0-15.1	-	-	29	-	50	-	-	-	-
	SP118716DH	16.5-17.8	-	-	-	-	-	-	-	-	-
	SP118719DH	19.0-21.5	-	-	-	-	-	-	-	-	-
	SP118721DH	21.5-24.0	-	-	-	-	-	-	-	-	-
	SP118724DH	24.0-26.5	-	-	-	-	-	-	-	-	-
	SP118726DH	26.5-29.0	-	-	-	-	49	-	-	-	-
	SP118729DH	29.0-31.5	3,330	-	366*	-	84	-	-	-	-
SP12-87	SP12870009	0.0-9.0	-	-	-	-	-	-	-	-	-
	SP12870916	9.0-16.5	-	-	-	-	-	-	3.50	-	-
	SP128716DH	16.5-19.0	2,809	-	-	-	50	-	-	-	-
	SP128719DH	19.0-21.5	2,803	-	-	46	66	-	-	-	-
	SP128721DH	21.5-24.0	-	-	-	-	-	-	-	-	-
	SP128724DH	24.0-25.2	-	-	-	-	-	-	-	-	-
	SP128726DH	26.5-29.0	-	-	-	-	-	-	-	-	-
	SP128729DH	29.0-31.5	-	-	-	-	-	-	-	-	-
	SP128731DH	31.5-32.2	-	-	-	-	91	-	-	-	-
	SP128734DH	34.0-34.5	2,784	-	32	-	116	-	-	-	-
	SP128739DH	39.0-41.5	-	-	-	-	69	-	-	-	-
	SP128741DH	41.5-44.0	-	-	-	-	66	-	-	-	-

TABLE 4-5a (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Al (9140)	As (10)	Ba (135u)	Ca (2500u)	Co (25)	Cr (13)	Cu (13u)	Fe (12,400)	Hg (0.1U)	K (2500)
SP13-87	SP138700UC	0.0-1.5	13,770	-	161	6,215	-	-	19	14,828	-	-
	SP138701CT	1.5-3.5	10,070	-	-	5,617	-	-	21	-	-	-
	SP138703BR	3.5-6.5	9,162	-	-	4,819	-	-	28	-	-	-
	SP138706DH	6.5-9.0	-	-	-	3,778	-	-	16	14,200	-	-
	SP13876DUP	6.5-9.0	-	-	-	-	-	-	-	-	-	-
	SP138709DH	9.0-11.5	-	-	-	-	-	-	-	-	-	-
	SP138711DH	11.5-14.0	-	-	-	-	-	-	-	-	-	-
SP14-87	SP148700UC	0.0-0.4	NA	NA	NA	-	-	NA	NA	NA	-	NA
	SP148702CT	2.0-4.0	10,810	-	-	5,515	-	-	19	NA	-	-
	SP148704BR	4.0-7.0	-	-	-	4,869	-	17	21	-	-	-
SP15-87	SP158702DH	2.0-2.8	12,674	-	182	6,420	-	24	18	26,993	-	-
	SP158704DH	4.0-4.4	12,020	-	140	7,205	-	18	19	20,517	-	-
	SP158708DH	8.0-10.0	10,159	-	-	2,639	-	-	-	14,666	-	-
	SP1587008D	8.0-10.0	20,546	-	242	4,789	-	21	23	29,505	-	-
	SP158710DH	10.0-12.0	11,604	-	179	3,134	-	503*	29	23,469	-	-
	SP158712WT (WT)	12.0-14.5	-	-	-	2,654	-	-	-	-	-	-
	SP158714CT	14.5-17.0	11,560	-	144	4,710	-	-	23	21,362	-	-
	SP158716BR	17.0-19.0	11,327	-	261	4,728	-	-	20	-	-	-
56-87/ SP16-87	SP168702FS	0.0-2.0	12,751	NA	-	-	-	21	17	16,363	-	NA
	SP168708UC	6.0-8.0	9,726	NA	-	63,857*	-	16	-	-	-	NA
	SP168710CT	10.0-11.2	9,673	NA	-	85,844*	-	18	-	-	-	NA
	SP168711BR	11.2-13.4	-	NA	345	16,274*	-	17	22	-	-	NA
18-86	C188608860	6.5-10.3	25,000	-	210	8,000*	-	24	-	22,000	-	3,270
	C188608861	13.0-14.0	11,700	-	-	7,160	-	-	-	-	-	-
	C188608862	35.0-38.0	9,440	-	-	19,200*	34	-	-	-	0.14	-

TABLE 4-5b (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Mg (2500)	Mn (337)	Ni (20u)**	V (38)	Zn (49)	Be (3.4U)	Cd (3.4U)	Sb (41U)	Tl (6.8U)
SP13-87	SP138700UC	0.0-1.5	-	-	-	-	62	-	-	-	-
	SP138701CT	1.5-3.5	-	-	-	-	-	-	-	-	-
	SP138703BR	3.5-6.5	-	-	-	-	63	-	-	-	-
	SP138706DH	6.5-9.0	-	-	-	-	126	-	-	-	-
	SP13876DUP	6.5-9.0	-	-	-	-	-	-	-	-	-
	SP138709DH	9.0-11.5	-	-	-	-	-	-	-	-	-
	SP138711DH	11.5-14.0	-	-	-	-	-	-	-	-	-
SP14-87	SP148700UC	0.0-0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP148702CT	2.0-4.0	-	-	-	-	68	-	-	-	-
	SP148704BR	4.0-7.0	-	-	-	-	-	-	-	-	-
SP15-87	SP158702DH	2.0-2.8	-	512	32	-	62	-	-	-	-
	SP158704DH	4.0-4.4	2,550	-	41	-	67	NA	NA	NA	NA
	SP158708DH	8.0-10.0	-	-	33	-	55	-	-	-	-
	SP1587008D	8.0-10.0	3,265	-	41	-	-	-	-	-	-
	SP158710DH	10.0-12.0	-	502	543*	-	-	-	-	-	-
	SP158712WT (WT)	12.0-14.5	-	-	-	-	-	-	-	-	-
	SP158714CT	14.5-17.0	2,867	-	-	-	75	-	-	-	-
	SP158716BR	17.0-19.0	2,801	-	-	-	85	-	-	-	-
56-87/ SP16-87	SP168702FS	0.0-2.0	-	-	-	-	103	103.13*	64.67*	16,362.67*	12,750.58*
	SP168708UC	6.0-8.0	-	-	-	-	-	24.29*	43.96*	8,943.78*	9,725.90*
	SP168710CT	10.0-11.2	-	-	-	-	-	24.15*	83.15*	10,297.33*	9,673.45*
	SP168711BR	11.2-13.4	-	1,258*	-	-	51	50.66*	345.06*	10,681.13*	6,670.45*
18-86	C188608860	6.5-10.3	6,730		-	-	70	-	-	-	-
	C188608861	13.0-14.0	2,650		-	-	62	-	-	-	-
	C188608862	35.0-38.0	-		-	-	93	-	-	-	-

TABLE 4-5a (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Al (9140)	As (10)	Ba (135u)	Ca (2500u)	Co (25)	Cr (13)	Cu (13u)	Fe (12,400)	Hg (0.1U)	K (2500)
20-86	C208609860	2.0-4.0	44,400*	-	160	4,050	-	33	-	34,700	-	8,020
	C208609861	13.0-14.70	11,900	-	-	6,500	-	-	-	13,000	-	-
	C208609862	20.4-22.0	15,000	-	-	9,160*	-	-	15	-	0.20	-
22-86	C228609860	FILL	11,900	-	-	6,500	-	-	-	13,000	-	-
	C228609861	CONTACT	-	-	-	-	-	-	-	-	-	-
	C228609862	BEDROCK	15,000	-	-	9,160*	-	-	15	-	0.20	-
25-86	C258608860	FILL	15,000	-	-	254,000*	-	-	-	-	0.16	-
	C258608861	12.5-14.5	16,200	-	550*	3,690	-	-	-	14,700	-	-
	C258608862	20.5-22.5	10,300	-	-	3,400	-	-	-	-	-	-
27-86	C278609860	5.7-8.0	10,600	-	-	10,400*	-	-	14	-	0.98*	-
	C278609861	12.0-13.8	14,400	-	-	5,750	-	-	17	-	-	-
	C278609862	20.5-22.5	11,500	-	-	5,280	-	-	-	-	2.8*	-

NOTES:
(1) "-" Value below upper background limit.
(2) Values in parentheses are the upper range of background values described in 881 Hillside RI Report, Rockwell International, 1988. "U" indicates detection limit.
(3) Values are rounded to the nearest integer. Lab reported values are listed in Appendix D.
(4) * Indicates value greater than 3 times the upper background value.
(5) (WT) indicates water table sample.
(6) "NA" indicates sample not analyzed.
(7) ** Nickel background is 20 U. The table does not include Solar Pond nickel values below detection limits of 27U.

TABLE 4-5b (Continued)

METAL CONCENTRATIONS IN SOILS ABOVE ESTIMATED BACKGROUND LEVELS (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Mg (2500)	Mn (337)	Ni (20u)**	V (38)	Zn (49)	Be (3.4U)	Cd (3.4U)	Sb (41U)	Tl (6.8U)
20-86	C208609860	2.0-4.0	4,380		-	53	65	-	-	-	-
	C208609861	13.0-14.70	2,860		41	-	59	-	-	-	-
	C208609862	20.4-22.0	2,840		-	-	81	-	-	-	-
22-86	C228609860	FILL	2,860		41	-	59	-	-	-	-
	C228609861	CONTACT	-		-	-	-	-	-	-	-
	C228609862	BEDROCK	2,840		-	-	-	-	-	-	-
25-86	C258608860	FILL	8,810		-	-	81	-	-	-	-
	C258608861	12.5-14.5	4,920		-	40	94	-	-	-	-
	C258608862	20.5-22.5	-		-	-	-	-	-	-	-
27-86	C278609860	5.7-8.0	-		42	-	51	-	-	-	-
	C278609861	12.0-13.8	3,700		-	-	84	-	-	-	-
	C278609862	20.5-22.5	-		-	-	-	-	-	-	-

NOTES:
(1) "-" Value below upper background limit.
(2) Values in parentheses are the upper range of background values described in 881 Hillside RI Report, Rockwell International, 1988. "U" indicates detection limit.
(3) Values are rounded to the nearest integer. Lab reported values are listed in Appendix D.
(4) * Indicates value greater than 3 times the upper background value.
(5) (WT) indicates water table sample.
(6) "NA" indicates sample not analyzed.
(7) ** Nickel background is 20 U. The table does not include Solar Pond nickel values below detection limits of 27U.

TABLE 4-6

METAL CONCENTRATIONS IN SOILS GREATER THAN THREE TIMES BACKGROUND (mg/kg)

Sample No.	Al (9140)	As (10)	Be (3.4u)	Cd (3.4u)	Cr (13)	Cu (13u)	Mn (337)	Ni (20u)	Sb (41u)	Tl (6.8u)
SP018700FS	30,899	--	--	--	--	--	--	--	--	--
SP048702DH	--	--	--	51	--	--	--	--	--	--
SP048704DH	--	--	--	71	--	--	--	--	--	--
SP0487004D	--	--	--	119	--	--	--	--	--	--
SP058702DH	--	--	--	16	--	58	--	--	--	--
SP058704DH	--	--	--	10	--	--	--	--	--	--
SP058707DH	--	--	--	84	--	--	--	--	--	--
SP058710DH	--	--	--	22	780	--	--	474	--	--
SP058712DH	--	--	--	20	132	--	--	--	--	--
SP068702FS	--	35	--	--	--	--	--	--	--	--
SP068724DH	--	--	--	--	40	--	--	--	--	--
SP078700DH	--	--	--	--	--	44	--	--	--	--
SP078708FS	30,265	--	--	--	--	--	--	--	--	--
SP078716DH	--	--	--	--	586	--	--	514	--	--
SP078718WT	--	--	--	--	393	--	--	313	--	--
SP078721CT	--	--	--	--	92	--	--	94	--	--
SP078723BR	--	64	--	--	--	--	--	--	--	--
SP078726DH	--	55	--	--	--	--	--	--	--	--
SP108719DH	--	--	--	101	--	--	--	--	--	--
SP118729DH	--	--	--	--	612	--	--	366	--	--
SP128716DH	--	--	--	--	40	--	--	--	--	--
SP158710DH	--	--	--	--	503	--	--	543	--	--
SP168702FS	--	--	103	65	--	--	--	--	16,363	12,751
SP168708UC	--	--	24	44	--	--	--	--	8,944	9,726
SP168710CT	--	--	24	83	--	--	--	--	10,297	9,673
SP168711BR	--	--	51	345	--	--	1,258	--	10,681	6,670

NOTES: (1) "--" Value below three times the upper background limit.
(2) Values in parentheses are the upper range of background values described in 881 Hillside RI Report, Rockwell International, 1988. "U" indicates detection limit.
(3) Values are rounded to the nearest integer. Lab reported values are listed in Appendix D.

Elevated cadmium concentrations occur in several soil samples from boreholes SP4-87 and SP5-87 adjacent to Pond 207-A (Table 4-6). Concentrations in some soil samples were over 10 times estimated background levels. Considering cadmium was elevated in the Pond 207-A liquids and sludge, it is likely the observed cadmium concentrations represent soil contamination originating from the solar ponds.

As shown in Table 4-6, elevated chromium and nickel almost always occur in the same samples. These samples appear to be randomly distributed areally and vertically. One of the highest concentrations of chromium occurred in bedrock at a depth of 29 feet northeast of the solar ponds and on the north side of the North Walnut Creek drainage (SP11-87). Hydraulically, it is difficult to explain the occurrence of these metals at this location if they originated from the solar ponds. Also, soil samples occurring above and below samples with high concentrations of chromium and nickel are an order of magnitude lower in concentration. Although chromium and nickel occurred at elevated concentrations in Pond 207-A liquid and sludges, the absence of any spatial trend to the soils data, and their "suspicious" co-occurrence in the same samples (a possible laboratory error), does not support the conclusion that these metals originated from the solar ponds. Furthermore, chromium is not a contaminant of the ground water, and nickel does not occur pervasively at elevated concentrations in ground water. This further suggests it is unlikely chromium and nickel migrated from the solar ponds to the remote locations where they occur at high concentrations. Given the above assessment, closure activities need not address these elements to meet the closure performance standard.

There are no background data for strontium in soils at the Rocky Flats Plant; however, inspection of all the data collected for the Remedial Investigation Reports for the 903 Pad, Mound, East Trenches; and 881 Hillside (Rockwell International, 1987b and 1988) show strontium concentrations to vary widely but randomly through the soils. Concentrations ranged from <20 mg/kg to 196 mg/kg, but were generally less than 50 mg/kg at the Plant. Lindsay (1979) presented a range of 50 to 1000 mg/kg and and average of 200 mg/kg for strontium in soils. Brown Hazardous Waste Land Treatment Manual (1983) also presents a range of typical strontium values between 50 and 1000 mg/kg, with an average of 200 mg/kg. Krauskopk (1979) presents and average strontium value for sand and sandstone of 20 mg/kg and an average strontium value for shales and recent clays of 400 mg/kg. Strontium concentrations in the soil samples from the solar pond area (and entire Plant area) were within these general ranges. Strontium concentrations in borehole samples from the solar pond area ranged from undetected to 250 mg/kg (sample SP068711DH). Although data do not exist for strontium in Ponds 207-A and 207-C, strontium is not considered a contaminant of soils in the solar ponds area. As postulated in the 881 Hillside RI (Rockwell, 1988), strontium above background levels in ground water may be due to a release of strontium from the soils by the liquid waste disposed (or in this case, leakage from the solar ponds).

Radionuclides

Radionuclides are analyzed by counting particles randomly emitted during radioactive decay. The rate of decay approaches some average rate for the material as the counting period increases. Because actual samples are counted for finite periods of time, there will always be uncertainty associated with any measured value. Radionuclide concentrations are thus reported as a measured value plus or minus a two standard deviation counting uncertainty (error term). This uncertainty is indicated in parentheses immediately following the measured value.

A determination that two radionuclide concentrations are different from each other requires a statistical analysis incorporating the uncertainty. However, radionuclide concentrations with error terms larger than their respective measured value are not considered statistically different from the background values shown in Table 4-7 because of the significant overlap of the probability distributions. If the measured value for a radionuclide falls within the background measured range, it is not considered to be above background levels regardless of the error term. This is the basis for stating within this report that radionuclide concentration is within background ranges. Similiarly, if the measured value minus the error term of a sample is greater than the measured value plus the error term for the upper limit of the background range, it can be considered to be statistically different from background. This leaves a range of measured values and error terms between these two extremes, where without a statistical analysis, it cannot be definitely stated whether the radionuclide concentration in the sample is different from background.

Uranium, plutonium and americium concentrations in soil and core samples from the solar pond borehole samples, generally met the above criteria for being below background concentrations. Background data are not available for strontium 90 or for cesium 137. Table 4-7 show those samples in which radionuclide concentrations are above background levels. Only two soil samples had uranium 233 + 234, and only five soil and three core samples had uranium 238 concentrations above estimated background levels. These concentrations were within a factor of three of the upper background concentrations. Plutonium 239 + 240 exceeded background in seven soil and one core sample and americium 241 in three soil samples. Notably high plutonium concentrations occur near the surface northeast and south of Pond 207-C (SP1-87 and SP16-87), west and east of Pond 207-B South (SP4-87

TABLE 4-7

RADIONUCLIDE CONCENTRATIONS IN SOILS ABOVE BACKGROUND LEVELS (pCi/g)

Well No. and/or Borehole No.	Sample No.		$U^{233+234}$	U^{238}	$Pu^{239+240}$	Am^{241}
Background Maximum		Interval (ft)	[1.4(0.2)]	[1.2(0.2)]	[0.1(0.20)]	[0.28(0.16)]
SP01-87	SP018700FS	0.0-1.2	4.0(0.6)	1.9(0.4)	18(1)	2.2(0.2)
	SP018704DH	4.0-5.0	-	2.1(0.5)	-	-
	SP018705DH	5.0-6.3	-	2.8(0.5)	-	-
SP04-87	SP048702DH	2.0-3.7	-	-	1.9(0.3)	-
SP05-87	SP058716DH	15.3-17.3	-	-	0.5(0.16)	1.2(0.2)
SP06-87	SP068702FS	2.0-3.7	-	-	0.52(0.16)	-
	SP068718DH	18.0-20.5	-	1.7(0.2)	-	-
SP07-87	SP078700DH	0.0-1.8	-	-	2.2(0.3)	-
SP10-87	SP108700DH	0.0-1.8	-	-	3.5(0.3)	-
	SP108702DH	2.0-3.9	3.7(0.4)	-	-	-
SP11-87	SP118716DH	16.5-17.8	-	1.7(0.2)	-	-
SP16-87	SP168702FS	0.0-2.0	-	-	9.0(0.6)	0.96(0.26)
20-86	C208609860	2.0-4.0	-	2.7(0.3)	-	-
	C208609862	20.4-28.0	-	2.1(0.4)	-	-
22-86	C228609861	Contact	-	1.8(0.4)	-	-
25-86	C258608860		-	-	0.42(0.05)	-

NOTE: (1) Values in parentheses indicate counting errors.

(2) "-" Indicates value below maximum background value or counting error is greater than its associated value.

(3) Maximum background is the upper range of background values described in the 881 Hillside RI Report, Rockwell International, 1988.

and SP7-87), and north of Pond 207-C (SP10-87). These concentrations range from 10 to over 100 times estimated background levels. The criteria listed in Table XII of this Solar Evaporation Pond Closure Plan define 20 picocuries per gram (pCi/gm) of transuranics as the limit above which soil removal is necessary. As shown in Table 4-7, only soils at borehole SP1-87 exceed the criterion of 20 pCi/g for the sum of plutonium 239+240 and americium 241.

Nitrate

Examination of the soil nitrate data (Table 4-8) indicates that significantly elevated concentrations of nitrate (>200 mg/kg) form a northeast trending "plume" from borehole SP3-87 to SP14-87 and enveloping all intermediate boreholes except SP13-87 (i.e., SP4-87, SP5-87, SP6-87, SP8-87, and SP9-87) This "plume" direction is generally what is expected based on ground water flow. The elevated concentrations occur at or beneath the water table or in the upper several feet of weathered bedrock. Although a water table was not identified during drilling of many of the boreholes into weathered bedrock, it is likely the weathered bedrock has been saturated with high nitrate water at times in the past. Where the water table was encountered, it can be shown that a significant fraction of the nitrate in the soil is actually nitrate in the ground water. The low concentrations of nitrate in the soils at SP13-87 may be due to its location on a bedrock high and within the French drain system. These two features have largely diverted nitrate laden ground water away from this location. The high concentration of nitrate in the soils at SP14-87, which is just downgradient from the French drain system, may be residual nitrate contamination from historical releases from the solar ponds and/or releases from the French drain system during periods of overflow.

TABLE 4-8

CONCENTRATION OF NITRATE
IN SOIL SAMPLES (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Nitrate as Nitrogen
SP01-87	SP018700FS	0.0-1.2	25.0
	SP018704DH	4.0-5.0	96.0
	SP018705DH	5.0-6.3	131.0
	SP018711DH	10.5-12.2	4.0
	SP018713DH	12.7-14.9	8.0
	SP018716BR (WT)	15.2-16.7	2.0U
	SP018721DH	20.2-22.3	2.0U
	SP018723DH	22.7-24.1	8.0
SP02-87	SP02870008	0.0-10.1	9.0
	SP028708UC	7.1-10.1	12.0
	SP028711CT	10.1-12.6	3.0
	SP028713BR	12.6-15.1	2.0U
SP03-87	SP038702DH	2.0-3.5	NA
	SP038703FS	4.0-4.6	NA
	SP038711DH	10.3-11.6	200.0
	SP038713CT	12.8-14.4	186.0
	SP038716BR	15.2-16.9	260.0
SP04-87	SP048702DH	2.0-3.7	2.0U
	SP048704DH	4.0-5.8	5.0
	SP0487004D	4.0-5.8	4.0
	SP048707DH	7.0-8.7	5.0
	SP048710DH	9.5-10.1	NA
	SP048712DH (WT)	12.6-14.5	361.0
	SP048715FS	14.5-17.0	142.0
	SP048717DH	17.0-19.5	14.0
	SP048720DH	19.5-22.0	101.0
	SP048722DH	22.0-24.0	79.0
	SP048725DH	24.5-27.0	13.0
	SP048727DH	27.0-29.5	2.0U
	SP048730DH	29.5-32.0	2.0
	SP048732DH	32.0-34.0	25.0
SP05-87	SP058700DH	0.0-0.4	NA
	SP058702DH	2.0-3.3	8.0
	SP058704DH	4.0-5.6	2.0U
	SP058707DH	7.0-8.3	9.0
	SP058710DH	9.5-10.1	345.0
	SP058712DH (WT)	12.8-14.4	705.0
	SP058716DH	15.3-17.3	1480.0
SP06-87	SP068702FS	2.0-3.7	307.0
	SP068708DH	8.0-10.4	22.0
	SP068711DH	10.5-12.4	2.0U
	SP068713DH	13.0-14.3	2.0U
	SP068716DH	15.5-17.7	2.0U
	SP068718DH	18.0-20.5	2.0U
	SP068721DH	20.5-23.0	2.0U
	SP068724DH	23.2-25.7	2.0U
	SP068726DH	25.7-28.2	4.0

TABLE 4-8 (Continued)

CONCENTRATION OF NITRATE
IN SOIL SAMPLES (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Nitrate as Nitrogen
SP07-87	SP078700DH	0.0-1.8	2.0U
	SP078702DH	2.0-3.8	2.0U
	SP078708FS	8.0-10.3	2.0
	SP078711DH	10.5-12.2	3.0
	SP078713DH	13.0-14.8	2.0U
	SP078716DH	15.5-16.7	150.0
	SP078718WT (WT)	18.0-19.3	480.0
	SP078721CT	20.5-23.0	656.0
	SP078723BR	23.0-26.0	58.0
	SP078726DH	26.0-28.5	2.0
39-87/ SP08-87	SP088703UC	3.5-6.5	511.0
	SP088706CT	6.5-8.5	396.0
	SP088709BR	9.0-11.5	638.0
SP09-87	SP098703UC	3.0-5.1	329.0
	SP098706CT	6.0-8.5	87.0
	SP098708BR	8.5-11.0	242.0
SP10-87	SP108700DH	0.0-1.8	4.0
	SP108702DH	2.0-3.9	15.0
	SP108704BR	4.0-5.0	10.0
	SP108705DH	5.0-7.0	11.0
	SP108707DH	7.0-9.0	10.0
	SP108709DH	9.0-11.0	14.0
	SP108711DH	11.0-13.0	12.0
	SP108713DH	13.0-14.9	14.0
	SP108715DH	15.0-16.9	26.0
	SP108717DH	17.0-19.0	16.0
	SP1087017D	17.0-19.0	23.0
	SP108719DH	19.0-21.0	12.0
	SP108721WT (WT)	21.0-23.0	11.0
	SP108723DH	22.7-23.7	10.0
	SP108724DH	23.7-25.7	13.0
SP11-87	SP11870008	0.0-8.8	9.0
	SP118708DH	8.8-11.3	2.0U
	SP118711DH	11.5-14.0	2.0U
	SP118714DH	14.0-15.1	2.0U
	SP118716DH	16.5-17.8	3.0
	SP118719DH	19.0-21.5	10.0
	SP118721DH	21.5-24.0	11.0
	SP118724DH	24.0-26.5	10.0
	SP118726DH	26.5-29.0	12.0
	SP118729DH	29.0-31.5	2.0U

TABLE 4-8 (Continued)

CONCENTRATION OF NITRATE IN SOIL SAMPLES (mg/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	Nitrate as Nitrogen
SP12-87	SP12870009	0.0-9.0	3.0
	SP12870916	9.0-16.5	3.0
	SP128716DH	16.5-19.0	3.0
	SP128719DH	19.0-21.5	2.0U
	SP128721DH	21.5-24.0	4.0
	SP128724DH	24.0-25.2	8.0
	SP128726DH	26.5-29.0	35.0
	SP128729DH	29.0-31.5	11.0
	SP128731DH	31.5-32.2	3.0
	SP128734DH	34.0-34.5	21.0
	SP128739DH	39.0-41.5	2.0U
	SP128741DH	41.5-44.0	3.0
SP13-87	SP138700UC	0.0-1.5	2.0U
	SP138701CT	1.5-3.5	2.0U
	SP138703BR	3.5-6.5	4.0
	SP138706DH	6.5-9.0	2.0U
	SP13876DUP	6.5-9.0	2.0U
	SP138709DH	9.0-11.5	21.0
	SP138711DH	11.5-14.0	2.0U
SP14-87	SP148700UC	0.0-0.4	NA
	SP148702CT	2.0-4.0	251.0
	SP148704BR	4.0-7.0	220.0
SP15-87	SP158702DH	2.0-2.8	20.0
	SP158704DH	4.0-4.4	NA
	SP158708DH	8.0-10.0	2.0
	SP1587008D	8.0-10.0	3.0
	SP158710DH	10.0-12.0	2.0U
	SP158712WT (WT)	12.0-14.5	2.0U
	SP158714CT	14.5-17.0	4.0
	SP158716BR	17.0-19.0	2.0U
56-87/ SP16-87	SP168702FS	0.0-2.0	11.0
	SP168708UC	6.0-8.0	12.0
	SP168710CT	10.0-11.2	3.0
	SP168711BR	11.2-13.4	2.0U

NOTES: (1) "U" Indicates detection limit.

(2) "E" with no result: Indicates that the sample contained a substance that interfered with the titration, masking the color change of the indicator, making the end point impossible to determine.

(3) "E" with a result: Indicates that the end point color change was a dark salmon color instead of peach, indicating possible interference. hundredth.

(4) "NA" Indicates that sample was not analyzed.

From a historical perspective, soil nitrate concentrations in the early 1970s were an order of magnitude higher and generally located near the surface (Engineering Science, 1975). It is conjectured that the French drain system has lowered the water table allowing flushing of the soils near the surface by precipitation, and that the current nitrate releases to ground water are less than in years past.

4.2.3 Organic Laboratory Contamination of Soil

The presence of Hazardous Substance List (HSL) organics in soil samples at concentrations above detection limits are indicative of contamination provided that these organics are not present in laboratory blanks associated with the samples. However, the presence of an HSL organic in a laboratory blank and sample does not necessarily imply laboratory artifact, if the concentration in the sample greatly exceeded the laboratory blank concentration. No analyses for laboratory blanks were included with the volatile organics analytical results for the 1987 boring soil samples (SP01-87 through SP16-87); therefore, it is not possible to evaluate whether the detected concentrations of methylene chloride, chloroform and 2-butanone are laboratory contaminants. However, inspection of the data in Table 4-9 indicates volatile organics are generally near or below detection limits. Analytical data for the core samples collected in 1986 indicated the presence of low concentrations of methylene chloride (MeCl), acetone, 1,1-DCA, $CHCl_3$, 2-butanone, 1,1,1-TCA, TCE, toluene, and total xylenes. In most cases, concentrations of these VOCs are at estimated concentrations below detection limits and/or are present in the laboratory blanks. Low concentrations of VOCs also occur infrequently in the ground water at the solar ponds area. It appears that organic contamination, although possible, is not of major significance at the solar ponds.

TABLE 4-9

VOLATILE ORGANIC CONCENTRATIONS DETECTED IN SOIL AND CORE SAMPLES (ug/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	MeCl	Acetone	1,1-DCA	$CHCl_3$	MEK	1,1,1-TCA	TCE	Toluene	Total Xylenes
SP01-87	SP018700FS	0.0-1.2	-	-	-	-	-	-	-	-	-
	SP018704DH	4.0-5.0	-	-	-	6J	-	-	-	-	-
	SP018705DH	5.0-6.3	-	-	-	-	-	-	-	-	-
	SP018711DH	10.5-12.2	-	-	-	-	-	-	-	-	-
	SP018713DH	12.7-14.9	-	-	-	6J	-	-	-	-	-
	SP018716BR (WT)	15.2-16.7	-	-	-	-	-	-	-	-	-
	SP018721DH	20.2-22.3	-	-	-	-	-	-	-	-	-
	SP018723DH	22.7-24.1	-	-	-	-	-	-	-	-	-
SP02-87	SP02870008	0.0-10.1	-	-	-	-	-	-	-	-	-
	SP028708UC	7.1-10.1	-	-	-	-	-	-	-	-	-
	SP028711CT	10.1-12.6	-	-	-	10J	-	-	-	-	-
	SP028713BR	12.6-15.1	-	-	-	6J	-	-	-	-	-
SP03-87	SP038702DH	2.0-3.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP038703FS	4.0-4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP038711DH	10.3-11.6	-	-	-	-	-	-	-	-	-
	SP038713CT	12.8-14.4	-	-	-	-	-	-	-	-	-
	SP038716BR	15.2-16.9	-	-	-	5J	-	-	-	-	-
SP04-87	SP048702DH	2.0-3.7	-	-	-	-	-	-	10J	-	-
	SP048704DH	4.0-5.8	-	-	-	-	-	-	-	-	-
	SP0487004D	4.0-5.8	-	-	-	-	-	-	-	-	-
	SP048707DH	7.0-8.7	-	-	-	-	-	-	-	-	-
	SP048710DH	9.5-10.1	-	-	-	11J	-	-	-	-	-
	SP048712DH (WT)	12.6-14.5	-	-	-	10J	-	-	-	-	-
	SP048715FS	14.5-17.0	-	-	-	-	-	-	-	-	-
	SP048717DH	17.0-19.5	-	-	-	-	-	-	-	-	-
	SP048720DH	19.5-22.0	-	-	-	-	-	-	-	-	-
	SP048722DH	22.0-24.0	-	-	-	-	-	-	-	-	-
	SP048725DH	24.5-27.0	-	-	-	-	-	-	-	-	-
	SP048727DH	27.0-29.5	-	-	-	-	-	-	-	-	-
	SP048730DH	29.5-32.0	-	-	-	-	-	-	-	-	-
	SP048732DH	32.0-34.0	-	-	-	-	-	-	-	-	-
SP05-87	SP058700DH	0.0-0.4	-	-	-	-	-	-	-	-	-
	SP058702DH	2.0-3.3	-	-	-	-	-	-	-	-	-
	SP058704DH	4.0-5.6	-	-	-	-	-	-	-	-	-
	SP058707DH	7.0-8.3	-	-	-	-	-	-	-	-	-
	SP058710DH	9.5-10.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP058712DH (WT)	12.8-14.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP058716DH	15.3-17.3	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9 (Continued)

VOLATILE ORGANIC CONCENTRATIONS DETECTED IN SOIL AND CORE SAMPLES (ug/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	MeCl	Acetone	1,1-DCA	$CHCl_3$	MEK	1,1,1-TCA	TCE	Toluene	Total Xylenes
SP06-87	SP068702FS	2.0-3.7	6.40J	-	-	-	-	-	-	-	-
	SP068708DH	8.0-10.4	52.0	-	-	-	-	-	-	-	-
	SP068711DH	10.5-12.4	-	-	-	-	-	-	-	-	-
	SP068713DH	13.0-14.3	-	-	-	-	-	-	-	-	-
	SP068716DH	15.5-17.7	-	-	-	-	-	-	-	-	-
	SP068718DH	18.0-20.5	6.80J	-	-	-	-	-	-	-	-
	SP068721DH	20.5-23.0	-	-	-	-	-	-	-	-	-
	SP068724DH	23.2-25.7	-	-	-	-	-	-	-	-	-
	SP068726DH	25.7-28.2	-	-	-	-	-	-	-	-	-
SP07-87	SP078700DH	0.0-1.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078702DH	2.0-3.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078708FS	8.0-10.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078711DH	10.5-12.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078713DH	13.0-14.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078716DH	15.5-16.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078718WT (WT)	18.0-19.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078721CT	20.5-23.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078723BR	23.0-26.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP078726DH	26.0-28.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
39-87/ SP08-87	SP088703UC	3.5-6.5	-	-	-	-	-	-	-	-	-
	SP088706CT	6.5-8.5	-	-	-	-	-	-	-	-	-
	SP088709BR	9.0-11.5	-	-	-	-	-	-	-	-	-
SP09-87	SP098703UC	3.0-5.1	-	-	-	10J	-	-	-	-	-
	SP098706CT	6.0-8.5	-	-	-	-	-	-	-	-	-
	SP098708BR	8.5-11.0	-	-	-	-	-	-	-	-	-
SP10-87	SP108700DH	0.0-1.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108702DH	2.0-3.9	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108704BR	4.0-5.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108705DH	5.0-7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108707DH	7.0-9.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108709DH	9.0-11.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108711DH	11.0-13.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108713DH	13.0-14.9	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108715DH	15.0-16.9	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9 (Continued)

VOLATILE ORGANIC CONCENTRATIONS DETECTED IN SOIL AND CORE SAMPLES (ug/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	MeCl	Acetone	1,1-DCA	$CHCl_3$	MEK	1,1,1-TCA	TCE	Toluene	Total Xylenes
SP10-87	SP108717DH	17.0-19.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP1087017D	17.0-19.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108719DH	19.0-21.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108721WT (WT)	21.0-23.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108723DH	22.7-23.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP108724DH	23.7-25.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
SP11-87	SP11870008	0.0-8.8	-	-	-	-	-	-	-	-	-
	SP118708DH	8.8-11.3	-	-	-	-	-	-	-	-	-
	SP118711DH	11.5-14.0	-	-	-	-	-	-	-	-	-
	SP118714DH	14.0-15.1	-	-	-	-	29.30	-	-	-	-
	SP118716DH	16.5-17.8	-	-	-	-	-	-	-	-	-
	SP118719DH	19.0-21.5	-	-	-	-	-	-	-	-	-
	SP118721DH	21.5-24.0	-	-	-	-	-	-	-	-	-
	SP118724DH	24.0-26.5	-	-	-	-	-	-	-	-	-
	SP118726DH	26.5-29.0	-	-	-	-	-	-	-	-	-
	SP118729DH	29.0-31.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
SP12-87	SP12870009	0.0-9.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP12870916	9.0-16.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128716DH	16.5-19.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128719DH	19.0-21.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128721DH	21.5-24.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128724DH	24.0-25.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128726DH	26.5-29.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128729DH	29.0-31.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128731DH	31.5-32.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128734DH	34.0-34.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128739DH	39.0-41.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP128741DH	41.5-44.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
SP13-87	SP138700UC	0.0-1.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP138701CT	1.5-3.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP138703BR	3.5-6.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP138706DH	6.5-9.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP13876DUP	6.5-9.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP138709DH	9.0-11.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP138711DH	11.5-14.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
SP14-87	SP148700UC	0.0-0.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP148702CT	2.0-4.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP148704BR	4.0-7.0	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-9 (Continued)

VOLATILE ORGANIC CONCENTRATIONS DETECTED IN SOIL AND CORE SAMPLES (ug/kg)

Well No. and/or Borehole No.	Sample No.	Interval (ft)	MeCl	Acetone	1,1-DCA	$CHCl_3$	MEK	1,1,1-TCA	TCE	Toluene	Total Xylenes
SP15-87	SP158702DH	2.0-2.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158704DH	4.0-4.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158708DH	8.0-10.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158700BD	8.0-10.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158710DH	10.0-12.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158712WT (WT)	12.0-14.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158714CT	14.5-17.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP158716BR	17.0-19.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
56-87/ SP16-87	SP168702FS	0.0-2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP168708UC	6.0-8.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP168710CT	10.0-11.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SP168711BR	11.2-13.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
18-86	C188608860	6.5-10.3	24	72	-	-	-	-	-	-	-
	C188608861	13.0-14.0	10	110	-	-	-	-	-	-	-
	C188608862	35.0-38.0	10	165B	-	-	-	2J	7J	2BJ	-
20-86	C208609860	2.0-4.0	2J	35B	4J	-	-	-	-	1J	-
	C208609861	13.0-14.70	2J	44B	6	-	13B	-	-	-	-
	C208609862	20.4-22.0	2J	45B	2J	-	-	-	-	-	-
22-86	C228609860	FILL	2J	31B	3J	-	-	21B	-	1J	4J
	C228609861	CONTACT	7J	39B	25	-	-	3J	-	2J	4J
	C228609862	BEDROCK	8J	124B	43	-	-	5J	-	2J	5J
25-86	C258608860	FILL	9	46B	42	21	-	-	-	8B	11
	C258608861	12.5-14.5	6J	89BJ	16	-	-	2J	-	1BJ	-
	C258608862	20.5-22.5	5J	30BJ	13	-	-	-	-	1BJ	-
27-86	C278609860	5.7-8.0	2J	49BJ	3J	-	-	-	-	-	-
	C278609861	12.0-13.8	12	41B	49	-	12	6J	-	2BJ	-
	C278609862	20.5-22.5	10	52B	35	-	-	4J	-	2BJ	2J

NOTES: (1) Abbreviations: MeCl = Methylene Chloride; 1,1-DCA = 1,1-Dichloroethane; $CHCl_3$ = Chloroform; MEK = 2-Butanone; 1,1,1-TCA = 1,1,1-Trichloroethane; TCE = Trichloroethene.
(2) "J" indicates that value is estimated below detection limit.
"-" indicates compound concentration below detection limit.
(3) "NA" indicates sample holding time exceeded; therefore, sample not analyzed.
(4) "B" indicates that the compound was present in the laboratory blank.

5.0 SITE HYDROGEOLOGY

5.1 SITE GEOLOGY

Presented below are hydrogeologic and ground-water quality data collected during site investigations at the Solar Evaporation Ponds in 1986 and 1987 as well as from previous investigations. The section begins with detailed descriptions of surficial (Section 5.1.1) and bedrock (Section 5.1.2) geology including lithologies, thicknesses, and extent of materials found in the solar ponds area. Ground-water hydrology and water quality data are discussed in Sections 5.2.1 and 5.2.2 for surficial and bedrock flow systems, respectively.

Information for these discussions was obtained from previous studies, aerial photographs, 28 monitor well boring logs, 16 shallow borings, and field mapping. Plate 2-1 shows the location of all monitoring wells at the Rocky Flats Plant, and Plate 5-2 presents monitor well locations at the Solar Evaporation Ponds. Geologic logs of all boreholes and wells at the Solar Evaporation Ponds along with well completion data sheets are located in Appendix B, and analytical data are presented in Appendices C (recent data) and D (historical data).

5.1.1 Surficial Geology

Surficial materials in the Solar Ponds area consist of the Rocky Flats Alluvium, colluvium, valley fill alluvium, and disturbed ground unconformably overlying bedrock (Plate 5-1). In addition, there are a few isolated exposures of claystone and sandstone bedrock located along slopes and the road cut directly east of the ponds.

The five solar ponds are located on a terrace which is capped by Rocky Flats Alluvium. Colluvium (slope wash) covers the hillsides of the terrace, and valley fill alluvium is present in the drainages of North and South Walnut Creeks. Much of the area surrounding the ponds is disturbed ground due to construction of the ponds, roads, the Perimeter Security Zone (PSZ) fence, nearby buildings, and the French drain system.

5.1.1.1 Rocky Flats Alluvium

The Quaternary Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit of the Rocky Flats Plant; it is Nebraskan in age (Scott, 1965). The Rocky Flats Alluvium occurs at an elevation of approximately 5,950 feet above mean sea level in the vicinity of the solar ponds. The Rocky Flats Alluvium is a series of coalescing alluvial fans deposited by braided streams (Hurr, 1976). The erosional surface (pediment) on which the alluvium was deposited slopes gently eastward truncating the Arapahoe Formation at the Solar Evaporation Ponds.

Following deposition of the Rocky Flats Alluvium, eastward flowing streams began dissecting the deposit by headward erosion and lateral planation. All of the alluvium was eroded in the drainages of North and South Walnut Creeks, and the terrace on which the ponds are located remained. Colluvium and valley fill alluvium were subsequently deposited along the slopes and in drainages, respectively. Rocky Flats Alluvium capped the terrace at the solar ponds prior to pond construction.

Much of the alluvium was removed and/or reworked during construction activities (Cross sections A-A', B-B', C-C', D-D', and E-E'; Plate 5-3).

The reworked Rocky Flats Alluvium in the solar ponds area is described as a generally poorly sorted, unconsolidated deposit of clay, silt, sand, and gravel. Colors range from light brown (5 YR 5/6) to gray brown (5 YR 3/2) with isolated horizons of olive gray (5 Y 3/2) to gray brown (5 YR 3/2). Color codes are adopted from GSA Color Chart. The grain size of the quartz and granitic sand ranges from fine- to coarse-grained (3.0 Ø - 1.0 Ø on the Wentworth Scale) with no single size taking predominance. Gravels range from 0.25 mm to 2.0 mm in size and are angular to subangular, indicative of materials transported short distances. The deposits are mildly calcareous and weakly cemented in places. Where undisturbed to the east of the ponds, the Rocky Flats Alluvium is 8.7 feet thick (well 29-86).

5.1.1.2 Colluvium

Colluvial materials are present on hill slopes to the northeast and southeast of the Solar Evaporation Ponds descending to North and South Walnut Creeks (Plate 5-1). However, much of the colluvium on the slope due north of the ponds was removed during construction of the PSZ fence and the French drain system. Colluvium was penetrated by wells 21-87 and 22-87 to depths of 9.5 and 12.8 feet, respectively.

Colluvium is described as consisting predominantly of clay with common occurrences of sandy clay and gravel layers. Colluvial clay is typically poorly consolidated and ranges in color from dark yellowish brown (10 YR 4/2) to light olive gray (5 Y 5/2) and light olive brown (5 Y 5/6). Occasional dark yellowish orange iron staining (10 YR 6/6) and stringers of brownish gray (5 YR 4/1) are present. Sand, when present, is very fine-grained to coarse-grained and poorly sorted.

Occasional cobbles occur within gravel layers, which are poorly sorted and unconsolidated (Cross Section F-F'; Plate 5-3).

5.1.1.3 Valley Fill Alluvium

The most recent alluvial deposit in the solar ponds area is valley fill alluvium found along the drainages of North and South Walnut Creeks (Cross Section G-G'; Plate 5-3). This alluvium is derived from reworked and redeposited older alluviums and bedrock material.

Valley fill alluvium was encountered in eight wells in the solar ponds area ranging from 5.5 feet (36-86) to 16.1 feet (34-86) in thickness. The unconsolidated valley fill alluvium consists of poorly sorted sand, gravel, and cobbles in a clay matrix. Colors range from olive gray (5 Y 3/2) with dark yellowish orange mottles (10 YR 6/6) to dark yellowish brown (10 YR 4/2). Gravels are subangular to subrounded and unsorted. Composition of the valley fill alluvium does not differ significantly between North and South Walnut Creeks based on lithologic descriptions from borings for wells 13-86, 14-86, 15-86, 16-86, and 17-86 drilled in the North Walnut Creek drainage and borings for wells 34-86, 35-86, and 36-86 drilled in the South Walnut Creek drainage.

5.1.1.4 Disturbed Ground

Plate 5-1 shows much of the area around the Solar Evaporation Ponds as disturbed ground. This includes the ponds, buildings, roadways, the PSZ fence, and the French drain system north of the ponds. A total of 15 wells and all 16 borings were drilled though disturbed materials (Plate 5-1). Areas of disturbed ground are also shown in cross section on Plate 5-3.

Disturbed ground is generally described as unconsolidated clay, silt, sand, gravel, and pebbles. The materials are very poorly sorted with fragments of claystone and cement rubble and display no bedding. A multitude of colors were encountered from olive to reddish brown (5 Y 5/6 - 10 R 5/4) to olive to yellow gray (5 Y 5/2 - 5 Y 8/4) and gray to yellow orange (10 YR 7/4 - 10 YR 6/6). Granitic and quartzite, angular to subangular gravels and pebbles are commonly found in areas of disturbed Rocky Flats Alluvium. Sand, when present, varied from fine- to coarse-grained and was very poorly sorted. Thickness of the fill material ranges from 0.8 feet at well 32-86 (north of pond 207A) to greater than 21 feet at boring SP07-87 (east of Pond 207-B South).

5.1.2 Bedrock Geology

The Cretaceous Arapahoe Formation underlies surficial deposits in the solar pond area. Ten wells were completed in various zones of the bedrock during the 1986 and 1987 drilling programs. The Arapahoe Formation beneath the Solar Evaporation Ponds consists primarily of claystone with interbedded sandstones and siltstones. The Arapahoe Formation was deposited by meandering streams flowing generally west to east off the Front Range. Sandstones were deposited as braided stream channel deposits and as overbank splays. Claystones were deposited in back swamp and floodplain areas. Leaf fossils, black organic matter, and wood fragments were encountered within the claystones during drilling at the solar ponds. Contacts between various lithologies are both gradational and sharp.

Plate 5-4 illustrates the top of the Arapahoe Formation beneath the Solar Ponds Areas. This plate shows three distinct ridges in the top of bedrock, one oriented north-south, one oriented southwest-northeast, and one oriented west-east.

These bedrock ridges correspond to the subcropping sandstone areas indicating the resistant nature of the sandstone units (Plate 5-2).

Between these ridges are two paleochannels. As discussed in Section 5.2.1, these channels aid in directing the alluvial ground-water flow toward the North Walnut Creek drainage.

5.1.2.1 Arapahoe Claystones

Claystones were the most frequently encountered lithology of the Arapahoe Formation immediately below the Quaternary/Cretaceous contact (Cross Sections A-A' through G-G'; Plate 5-3). Claystones are described as massive and blocky, containing occasional thin laminae and stringers of sands, silt, and coal.

Weathered bedrock was encountered directly beneath surficial materials in all of the monitor wells and borings. Weathering was noted to depths of 28.0 and 39.0 feet below ground surface in boring SP06-87 and monitor well 39-87BR, respectively. The weathered claystones generally range from pale yellowish brown (10 YR 6/2) to light olive gray (5 YR 5/6) in color and are moderately stained with iron oxide. Iron oxide stains also occurred as brown and red mottling. Calcium carbonate deposits along with iron oxide concretions are noted in the weathered zone. Fractures are noted between 6.0 and 26.0 feet below ground surface in wells 24-86, 27-86, 22-87, 29-86, 31-86, and 33-86 associated with the weathered zone. Calcareous pockets and ironstone concretions were observed along these fractures.

Unweathered claystone is typically dark gray (N 3/0) to yellowish gray (5 Y 7/2) and has little mottling. Vertical, subvertical, horizontal, and 45 degree fractures associated with unweathered claystone are found at varying depths between approximately 30 feet (34-86) to greater than 100 feet (23-86). Many of the shallower fractures (30-60 feet) are described as calcareous, limonitic, or iron stained implying water movement. However, the fractures cannot be correlated between holes. Both weathered and unweathered claystone contains laminae of very fine silt and sand. Typical silt or sand horizons range from brownish gray (5 YR 4/1) to dark yellowish orange (10 YR 6/6) in color.

5.1.2.2 Arapahoe Formation Sandstones

Bedrock wells 14-86, 16-86, 23-86, 25-86, 27-86, 31-86, 32-86, and 39-87BR in the solar ponds area are completed in Arapahoe Formation sandstones. In addition, boreholes SP01-87, SP04-87, SP11-87 and SP12-87 encountered near surface Arapahoe sandstones. These sandstones are generally composed of moderately to well sorted, subrounded to rounded, very fine- to medium-grained, consolidated quartz sand. The shallower (weathered) sandstones exhibited dark yellowish orange mottling (10YR 6/6), and cementation increased with depth due to a decrease in weathering. The thickness of individual sandstone layers ranged from 1.9 feet in wells 14-86 and 16-86 to a maximum of 19.8 feet in well 39-87BR. Most sandstones encountered contain thin beds or laminae of fine silt and clay. Bedding ranged from none apparent in well 32-86 to convoluted bedding in well 23-86. Color of the sandstone ranged from light gray (N 6/6) to dark greenish gray (5 GY 4/1) in well 25-86 to olive gray (N 7/0) in well 32-86.

Siltstones were also encountered in the Arapahoe Formation during drilling at the Solar Evaporation Ponds. Specifically, wells 14-86, 16-86, 23-86, and 25-86 encountered relatively homogeneous beds of unweathered siltstone. These beds ranged from less than one foot (well 14-86) to 30 feet in thickness (well 23-86). They are dark gray (N 3/0) to dark greenish gray (5 GY 4/1) in color, contain a trace of very fine-grained sand, are slightly calcareous, and contain some wood fragments.

As shown on cross sections A-A' through G-G' (Plate 5-3), sandstone/siltstone beds are present beneath the Solar Evaporation Ponds area. Some beds occur at depth and others subcrop at the Quaternary/Cretaceous boundary. Cross sections A-A' through G-G' depict the siltstone and sandstone units dipping gently eastward at approximately seven degrees.

Subcropping sandstones were encountered in the vicinity of the solar ponds in wells 39-87BR, 31-86, 32-86, 22-86 and borings SP01-87, SP02-87, SP11-87, and SP04-87 (Plate5-2). Subcropping sandstones vary in thickness from less than 3.0 feet at borehole SP04-87 to approximately 20.0 feet at well 39-87BR (Cross Sections A-A', B-B', C-C', D-D', and F-F'; Plate 5-3). In well 31-86, approximately 11.0 feet of sand described as soft and weakly consolidated (very weathered) underlies disturbed ground. In all other cases the sandstone is consolidated and firm.

The subcropping Arapahoe sandstones are generally described as a fine to coarse-grained (3.5 - 2.5 Ø), rounded to subrounded, weakly to moderately cemented, quartz sand. They occasionally contain small pebble horizons which are generally moderately to well sorted. The sandstone color ranges from light gray (N 6) to dark gray (N 4) grading into yellow gray (5 Y 2/2 - 5 Y 7/2) and pale olive (10 YR 6/2). Yellow orange iron oxide staining (10 YR 6/6) is noted in several wells with the frequency of occurrence increasing toward the surface as a result of weathering.

The subcropping sandstone is generally weathered, blocky, massive, and contains lignite fragments (SP11-87) and leaf imprints (32-86). Calcium carbonate and coal stringers are noted in borehole SP03-87. Fractures are noted in core from holes

32-85, 31-86, and 22-86 at depths of 5.0, 6.8, and 14.4 feet, respectively. The fractures at 6.8 feet in hole 31-86 are infilled with calcareous deposits.

The relative vertical and horizontal location of the subcropping sandstones and the physical descriptions of the same sandstones in the solar pond area suggest that many of the subcropping sandstones are interconnected. Approximate areal extents of subcropping sandstones are shown in plan view on Plate 5-2.

One occurrence of subcropping sandstone appears at well 39-87BR where approximately 20 feet of fine-grained sandstone subcrop. Sandstone subcrop was not encountered in any adjacent wells.

The second and third occurrences of subcropping sandstones include borehole SP04-87 where approximately 3.0 feet of sandstone is present and borehole SP11-87 where approximately 8.5 feet of subcropping sandstone underlies disturbed ground. In both cases, no adjacent wells contain subcropping sandstone, suggesting that these sandstone occurrences have limited lateral extent.

A fourth and extensive area of subcropping sandstone occurs in wells 31-86, 32-86, 22-86, and boreholes SP01-87 and SP02-87. Sandstone thicknesses range from 5.0 feet to 15.5 feet in boreholes SP03-87 and 32-86, respectively. The combination of these five holes outlines an oblong area underlying portions of Solar Evaporation Ponds 207-A and 207-C (Plate 5-2).

5.2 Ground-Water Hydrology

Ground water occurs in surficial materials (Rocky Flats Alluvium, colluvium, valley fill alluvium, and disturbed ground) and in Arapahoe sandstones and claystones at the Solar Pond Area. These two hydraulically connected flow systems are discussed separately below.

5.2.1 Ground-water System in Surficial Materials

Ground water is present in surficial materials at the Solar Evaporation Ponds under unconfined conditions. Portions of the surficial materials at the solar ponds are unsaturated.

5.2.1.1 Recharge/Discharge Conditions

Recharge to the water table occurs as infiltration of incident precipitation. In addition, ground water within surficial materials flows into the solar pond area from the west.

Discharge from the water table occurs as evapotranspiration and seepage into creeks, ditches, and the ground-water collection system (French drain system north of the solar ponds). In addition, ground water is discharged from the surficial ground-water system into the underlying bedrock ground-water system. Although this probably occurs to a limited extent throughout the solar pond area, it is more significant where sandstones of the Arapahoe Formation subcrop beneath the saturated surficial cover.

The surficial ground-water flow system is quite dynamic, with large water level changes occurring in response to precipitation events and to stream and ditch flow. Hurr (1976) describes the rapid response of water levels in wells completed in Rocky Flats Alluvium to surface flows in irrigation ditches.

There are also seasonal variations in the saturated thicknesses of surficial materials. Chronological variations in saturated thickness are shown in the hydrographs found in Appendix B. In general, water level data are available from September 1986 to April 1988 for the 1986 wells. Data are available from November 1987 to April, 1988 for 1987 wells. In view of the limited amount of data available for many wells, full analysis of seasonal variations in saturated thickness is not possible at this time.

Three wells completed in North Walnut Creek valley fill alluvium (13-86, 15-86, and 17-86) exhibit a near constant saturated thickness with the greatest saturated thickness in spring and the least saturated thickness in late summer. Only well 13-86 was dry for part of the year.

The saturated thickness is thin in the Rocky Flats Alluvium and disturbed ground. Of the ten wells screened in this interval, none has a saturated thickness in excess of six feet. Four wells have been dry whenever sampled, and three others are dry part of the year. In general, saturated thicknesses peak between January and April and then slowly decline for the rest of the year.

5.2.1.2 Ground-water Flow

Ground water flows toward the east and northeast in the solar pond area through the Rocky Flats Alluvium and disturbed ground. This flow is locally influenced by topography, the configuration of the top of bedrock (Plate 5-4), and various water collection systems around the solar ponds.

Ground water entering the solar pond area from the west is controlled by a bedrock high through the center of the area. Ground water is diverted north around this ridge, and much of the area south and east of the Solar Evaporation Ponds is unsaturated (Plates 5-5 through 5-10). Ground water moves downslope (northward) from the solar ponds toward North Walnut Creek through thin colluvial materials on the hillside. Large areas of unsaturated surficial materials also occur on this slope due to bedrock highs and the French drain system. The area of unsaturated materials is greatest during dry portions of the year (Plates 5-5 through 5-10).

The French drain system was installed in the hillside north of the Solar Evaporation Ponds sometime between JUNE 1980 and April 1981. Depths of the drains range from approximately 1 to 27 feet below ground surface with a typical depth of 4 to 16 feet (see Rockwell Drawing No. 26637-01 in Appendix 1 of this closure plan). The seepage intercepted by the French drain system flows by gravity into the interceptor trench pump house. The amount of pumpage from the pump house is estimated at four million gallons per year. Not all of this flow is ground-water seepage from the slope north of the solar ponds. Included is a yet unmeasured flow from the foundation drains in the 774 Building west of the solar pond area. The water collected in these foundation drains is piped to the interceptor trench pump house, where it and the ground water collected by the French drains are currently pumped to Pond 207-B North.

5.2.1.3 Hydraulic Conductivities

Hydraulic conductivity values were developed for surficial materials from drawdown-recovery and pump tests performed on 1986 wells. Drawdown-recovery tests were analyzed using the methods of Bouwer and Rice (1976). Results of these tests are summarized in Table 5-1. Test data and analyses are presented in Appendix B.

TABLE 5-1

RESULTS OF HYDRAULIC CONDUCTIVITY TESTS OF SURFICIAL MATERIALS

Well Number	Formation	Lithology Screened	Drawdown Recovery Test cm/s
17-86	Q_{VF}	Gravel	$4.8x10^{-6}$
22-86	Q_{RF}	Gravel	$8.7x10^{-6}$
26-86	Q_D	Gravel and Sand	$4x10^{-8}$

The hydraulic conductivity values calculated for surficial materials at the Solar Evaporation Ponds ranged from 4×10^{-8} centimeters per second (cm/s) to 9×10^{-6} cm/s. These values are low with respect to those at other locations at the Plant, and additional testing is needed to further characterize hydraulic conductivity values in the vicinity of the solar ponds.

The horizontal ground-water flow velocity for North Walnut Creek valley fill alluvium is estimated at 1.5 feet/year (ft/yr). This value is based on a hydraulic conductivity 4.8×10^{-6} cm/sec (4.6 ft/yr), and average horizontal gradient of 0.03, and an assumed effective porosity of 0.1.

5.2.1.4 Basis for Ground-water Quality Assessment

This section evaluates the impact of the Solar Evaporation Ponds on alluvial ground water. Because all of the alluvial wells in the solar ponds area are impacted, the immediate upgradient alluvial wells cannot be used as a basis for characterizing contamination of alluvial ground water in the vicinity of the solar ponds. Therefore, alluvial ground water quality in the solar ponds area is evaluated by comparing the water chemistry to Plant background water chemistry and to ground-water quality criteria. The justification and interpretation of the background water quality data are described in the 881 Hillside Remedial Investigation Report, March 1988 (Rockwell International, 1988). Table 5-2 provides the analyte concentration ranges for background alluvial ground water.

The background alluvial ground-water ranges, as described in the 881 Hillside Remedial Investigation Report, are only estimates as impacts from upgradient Solid Waste Management Units have not been statistically ruled out. However, they are

TABLE 5-2

BACKGROUND ALLUVIAL
GROUND-WATER QUALITY
AND GROUND-WATER QUALITY CRITERIA

	Element	Concentration Range (mg/l) Background*	Proposed Ground-water Quality Criteria
METALS			
	Aluminum		5.0
++	Antimony	.060U	NA**
+	Arsenic	.001U	0.05
+	Barium	.047-.190	1.0
++	Beryllium	5U	0.1
+	Cadmium	.005U	0.01
	Cesium	.1U	NA
+	Chromium	.002U-.027	0.05
	Cobalt	.05U	0.05
	Copper	.02U-.026	1.0
	Iron		0.3
+	Lead	.005U-.05	0.5
	Lithium		2.5
	Manganese	.01U-.547	0.05
	Mercury	.0002U	0.002
	Molybdenum	.1U	0.1
++	Nickel	.04U-.08	0.2
+	Selenium	.005U	0.01
+	Silver	.01U	0.05
	Strontium	0.02U-.20	NA
++	Thallium	.002U	NA
	Vanadium	.005U-.047	0.1
	Zinc	.005U-0.09	5.0
RADIONUCLIDES			
	Gross Alpha	Below MDA	15
	Gross Beta	Below MDA	50
	Uranium 233,234	Below MDA-3.5(.9)	40
	Uranium-235	Below MDA	40***
	Uranium-238	Below MDA-4(.9)	40***
	Plutonium 239,240	Below MDA	40***
	Americium 241	Below MDA	4
	Strontium 89,90	Below 9.3	8
	Tritium	Below 330	20,000

TABLE 5-2
(CONTINUED)
BACKGROUND ALLUVIAL
GROUND-WATER QUALITY
AND GROUND-WATER QUALITY CRITERIA

	Element	Concentration Range (mg/l) Background	Proposed Ground-water Quality Criteria
MAJOR IONS			
	Tritium	Below 330	20,000
	Calcium	12-36	NA
	Magnesium	2-8	NA
	Potassium	.010-5	NA
	Sodium	8-21	NA
	Bicarbonate	ND-130	NA
	Carbonate	ND-120	NA
	Chloride	.7-19	250
	Nitrate	ND-1.2	10
	Sulfate	3.5-31	250
	Total Dissolved Solids	115-269	400

* Plant background water quality conditions (Rockwell International, 1988)
** Not available
*** Total Uranium
\+ SDWA metal
++ Appendix VIII hazardous constituent that is not a SDWA metal

adequate to determine areas of potential ground-water contamination. Background alluvial ground-water chemistry will be reevaluated by additional well installation and ground-water sampling during 1988 field investigations.

The assessment provided here is qualitative in nature, its purpose being the identification of obvious impacts of the solar ponds on ground-water quality. The reader is referred to Section E of the Post Closure Care Permit Application for a discussion of proposed monitoring to achieve compliance with 40 CFR Subpart F. Although the current monitoring program at the landfill was not designed specifically to satisfy RCRA requirements, many of the analytes measured are those required for routine monitoring under 265.92(b) and assessment monitoring under 265.93(a). Parameters for routine monitoring included in the monitoring program are the Safe Drinking Water Act (SDWA) metals, chloride, iron, manganese, sodium, sulfate, pH, and specific conductance. Assessment monitoring parameters are Appendix VIII hazardous waste constituents expected in the unit. Many of the HSL volatiles are Appendix VIII hazardous waste constituents that could have been disposed of and released from the solar ponds. The radionuclides, although not Appendix VIII hazardous waste constituents, have been analyzed because they are constituents of the waste disposed at the solar ponds. Other parameters analyzed are for general inorganic characterization of the ground water.

A ground-water protection standard is not defined for interim status regulated units under 40 CFR 265; however, regulations at 40 CFR 264 Subpart F have been used as a framework to examine the ground-water quality at the solar ponds. The ground-water protection standard defined at 40 CFR 264.94 specifies background levels for hazardous constituents or SDWA drinking water standards for the SDWA metals (which are also hazardous constituents). The SDWA drinking water standards, as well as standards for other metals, inorganics, and radionuclides which are not hazardous constituents are shown in Table 5-4. The concentrations for major ions and non-SDWA metals are the Colorado Department of Health (CDH) ground-water standards for protection of human health (or protection of agriculture if human health standards are not available). The plutonium and americium concentrations are proposed drinking water standards (51 FR 34859). The uranium concentration is a CDH surface water standard [5 CCR 1002-8, Section 3.8.5(3)]. All other radionuclide standards are SDWA maximum contaminant levels. These analyte concentrations have been termed ground-water quality criteria and are used to preliminarily assess the public health significance of the ground-water quality.

This evaluation is based on solar pond alluvial ground-water data collected since 1986. The 1986 wells have six quarters of analytical results (the last quarter of 1986, four quarters of 1987, and the first quarter of 1988). Wells completed in 1987 have first quarter, 1988 analytical data only. Table 5-3 lists the analyses performed on ground-water samples, and Table 5-4 summarizes the availability of ground-water quality data used in this report. Tables 5-5, 5-6, and 5-7 compare solar pond ground-water analytical data to background concentrations. Only wells with ground-water concentrations exceeding background are listed in the comparison tables. All analytical data are presented in Appendix C.

During the 1986 drilling program, twelve alluvial wells were installed in the vicinity of the solar ponds to monitor ground-water chemical conditions. Six alluvial wells were placed downgradient of the solar pond area in the North Walnut Creek drainage (11-86, 12-86, 13-86, 15-86, 17-86, and 18-86). Two wells (35-86 and 36-86) were installed in the Valley Fill Alluvium of South Walnut Creek. Seven additional

TABLE 5-3

GROUND-WATER AND SURFACE WATER SAMPLING PARAMETERS

FIELD PARAMETERS
pH
Specific Conductance
Temperature
Dissolved Oxygen*

INDICATORS
Total Dissolved Solids
Total Suspended Solids*

METALS**
Hazardous Substances List - Metals
Molybdenum
Strontium
Chromium (hexavalent)
Lithium

ANIONS
Carbonate
Bicarbonate
Chloride
Sulfate
Nitrate

ORGANICS
Hazardous Substances List - Volatiles***
Oil and Grease

RADIONUCLIDES
Gross Alpha
Gross Beta
Uranium 233, 234, 235, and 238
Americium 241
Plutonium 239
Strontium 90
Cesium 137
Tritium

TABLE 5-3
(CONTINUED)
GROUND-WATER AND SURFACE WATER SAMPLING PARAMETERS
(CONTINUED)

* For surface water samples only
** Dissolved metals for ground-water samples, total and dissolved metals for surface water samples
*** Ground-water samples from the first, second, and third quarters of 1987, and all surface water samples were analyzed by the Rockwell 881 Laboratory for only 9 of the HSL volatiles. These volatiles are the chlorinated solvents historically detected in the ground water and are as follows: PCE, TCE, 1,1-DCE, 1,2-DCA, t-1,2-DCE, 1,1,1-TCA, 1,1,2-TCA, CCl_4 and $CHCl_3$. Ground-water samples from fourth quarter 1987 and first quarter 1988 were analyzed for HSL volatiles with the exception of 2-chloroethylvinyl ether.

Table 5-4

SOLAR PONDS ALLUVIAL WELLS

GROUND WATER SAMPLE INFORMATION

WELL NUMBER	SAMPLE INFORMATION: NUMBER	DATE	TYPE	FIELD PARAMETERS: pH	CONDUCT (umho/cm)	TEMP (deg C)	LABORATORY BATCH NUMBERS: VOLATILE ORGANICS	SEMI-VOL ORGANICS	PESTICIDES AND PCB'S	METALS	INORGANICS	RADIO-CHEMISTRY
0486	DRY	08/28/86										
0486	DRY	08/10/87										
1186	G118609860	09/18/86	Routine	7.20	710	15.0	8609-049-046	No Sample	No Sample	8609-049-047	I	Insufficient Sample
1186	11-86-05-04-87	05/04/87	Routine	7.00	870	9 0	0187-881-072	No Sample	No Sample	0187-881-072	0187-881-076	0187-881-076
1186	11 86-06-08-87	06/08/87	Routine	7.20	837	11.5	0287-881-035	No Sample	No Sample	0287-881-035	0287 881-039	0287-881-035
1186	11-86-07-31-87	07/31/87	Routine	6.90	957	18.5	0387-881-063	No Sample	No Sample	0387-881-070	0387-881-069	0387-881-012
1286	G128609860	09/11/86	Routine	6.90	880	15 0	8609-030-006	8609-040-001	8609-040 001	8609-030-007	8609-030-008	1000-000-248
1286	G128609862	09/11/86	Field Duplicate	6.89	880	15 0	8609-030-016	8609-040-002	8609-040-002	8609-030-017	8609-030-018	1000-000-250
1286	12-86-04-23-87	04/23/87	Routine	7.10	1230	12 0	0187-881-063	No Sample	No Sample	0187-881-063	0187-881-065	0187-881-065
1286	12-86-06-10-87	06/10/87	Routine	7.20	1276	11.2	0287-881-037	No Sample	No Sample	0287-881-037	0287-881 064	0287-881-037
1286	12-86-08-04-87	08/04/87	Routine	6.70	2090	17.5	0387-881-066	No Sample	No Sample	0387-881-072	0387-881-072	0387-881-049
1286	12-86D-08-04-87	08/04/87	Field Duplicate					No Sample	No Sample	0387-881-073		
1386	DRY	09/03/86										
1386	13-86-04-23-87	04/23/87	Routine	7.00	540	10.0	0187 881-121	No Sample	No Sample	Insufficient Sample	0187-881-065	Insufficient Sample
1386	13 86-06-11-87	06/11/87	Routine	7.70	656	13.8	0287-881-083	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
1386	13-86-08-04-87	08/04/87	Routine	7.00	944	15.0	0387-881 067	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
1386	13-86-03-14-88	03/14/88	Routine				0188-881 038	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
1586	G158609860	09/09/86	Routine	6.90	1200	13.0	8609-025-006	8609-034 001	8609 034 001	8609-025-007	8609-025 008	1000-000-254
1586	G158609862	09/09/86	Field Duplicate	7.00	1200	13.0	8609 025-016	8609-034-002	8609-034-002	8609-025-017	8609-025-018	1000-000-256
1586	15-86-04-22-87	04/22/87	Routine	6.60	1480	11.0	0187-881-060	No Sample	No Sample	0187-881-060	0187-881-062	0187-881-062
1586	15-86-06-10-87	06/10/87	Routine	6.60	1551	11 6	0287 881-040	No Sample	No Sample	0287-881-040	0287-881-043	0287-881-040
1586	15-86-08-06-87	08/06/87	Routine	6.40	1695	15 5	0387-881-069	No Sample	No Sample	0387-881-075	0387-881-074	0387-881-050
1586	15-86D-08-06-87	08/06/87	Field Duplicate				No Sample	No Sample	No Sample	0387-881 076	0387-881-075	0387-881-051
1586	15-86-12-08-87	12/08/87	Routine	7.20	1451	7.9	0487-881-052	No Sample	No Sample	0487-881-052	0487-881 038	0487-881-046
1586	15-86-03-14-88	03/14/88	Routine	6.80	1616	6.9	0188-881-023	No Sample	No Sample	0188-881-023	0188 881-023	0188-881-023
1786	G178609860	09/25/86	Routine	6.67	3800	14.5	8609-065-006	8609-068-002	8609-068-002	8609-065-007	8609-065-009	1000-000-258
1786	G178609862	09/25/86	Field Duplicate				8609-065-016	8609-068-004	8609-068-004	8609-065-017	8609-065-018	1000-000-260
1786	17-86-04-22 87	04/22/87	Routine	7 20	2090	11 0	0187-881-061	No Sample	No Sample	0187 881 061	0187 881-064	0187-881-064
1786	17-86-06 10 87	06/10/87	Routine	6.00	3690	10.8	0287-881-042	No Sample	No Sample	0287-881 042	0287 881-045	0287-881-042
1786	17 86 08 06-87	08/06/87	Routine	6.90	4210	17 0	0387-881 070	No Sample	No Sample	0387-881 077	0387-881-076	0387-881-052
1786	17-86-12-08-87	12/08/87	Routine	6.90	4860	9.1	0487-881-053	No Sample	No Sample	0487-881-044	0487-881-039	0487 881-047
1786	17-86-03-14 88	03/14/88	Routine	6.60	5430	5 8	0188-881-025	No Sample	No Sample	0188-881-025	0188 881-025	0188-881-025
1886	DRY	09/03/86										
1886	DRY	08/05/87										
1886	DRY	03/14/88										
2086	DRY	09/12/86										
2086	DRY	09/24/87										
2086	DRY	03/16/88										

Table 5-4 (cont'd.)

SOLAR PONDS ALLUVIAL WELLS

GROUND WATER SAMPLE INFORMATION

	SAMPLE INFORMATION			FIELD PARAMETERS			LABORATORY BATCH NUMBERS					
WELL NUMBER	NUMBER	DATE	TYPE	pH	CONDUCT (umho/cm)	TEMP (deg C)	VOLATILE ORGANICS	SEMI-VOL ORGANICS	PESTICIDES AND PCB'S	METALS	INORGANICS	RADIO-CHEMISTRY
2187	DRY	10/29/87										
2286	G2286098602	09/09/86	Routine	6.75	762	13.5	8609-051-006	8609-057-007	8609-057-007	8609-051-007	8609-051-008	1000-000-267
2286	G2286098602	09/19/86	Field Duplicate				8609-051-022	8609-057-008	8609-057 008	8609-051-022	8609-051-023	1000 000-269
2286	22-86-03-24-87	03/24/87	Routine	6.80	970	5.6	0187-881-033	No Sample	No Sample	0187-881-033	0187-881-034	0187-881-034
2286	22-86-06-24-87	06/24/87	Routine	7.50	811	17.3	0287-881-070	No Sample	No Sample	0287-881-070	0287-881-070	0287-881-070
2286	22-86-08-28-87	08/28/87	Routine	7.20	856	19.5	0387-881-103	No Sample	No Sample	0387-881-112	0387-881-107	0387-881-088
2286	22-860-08-28-87	08/28/87	Field Duplicate				No Sample	No Sample	No Sample	0387-881-113	No Sample	No Sample
2286	22-86-12-18-87	12/18/87	Routine	7.00	912	8.0	0487-881-076	No Sample	No Sample	0487-881-067	0487-881-063	0487-881-064
2286	22-86-03-16-88	03/16/88	Routine	7.30	824	5.4	Insufficient Sample	No Sample	No Sample	0188-881-026	0188-881-026	0188-881-026
2486	DRY	09/01/86										
2486	DRY	09/24/87										
2486	DRY	03/16/88										
2686	G2686098600	09/18/86	Routine	7.25	2500	19.5	8609-049-006	No Sample	No Sample	8609-049-007	8609-049-008	Insufficient Sample
2686	26-86-03-18-87	03/18/87	Routine	7.50	2200	10.0	0187-881-022	No Sample	No Sample	0187-881-022	0187-881-024	0187-881-022
2686	26-86-08-28-87	08/28/87	Routine	6.80	2450	19.7	0387-881-105	No Sample	No Sample	0387-881-115	0387-881-109	0387-881-090
2586	DRY	03/16/88										
2886	G2886098600	09/18/86	Routine	7.60	22000	20.0	8609-049-015	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
2886	28-86-03-19-87	03/19/87	Routine	7.00	7400	12.0	0187-881-028	No Sample	No Sample	0187-881-028	0187-881-028	0187-881-028
2886	28-86-06-24-87	06/24/87	Routine	6.90	16180	16.8	0287-881-067	No Sample	No Sample	0287-881-067	0287-881-073	0287-881-067
2886	28-86-09-08-87	09/08/87	Routine	6.90	17240	21.3	0387-881-108	No Sample	No Sample	Insufficient Sample	0387-881-125	Insufficient Sample
2886	28-86-03-16-88	03/16/88	Routine	7.40	10770	5.1	0188-881-029	No Sample	No Sample	0188-881-029	0188-881-029	0188-881-029
2986	DRY	09/12/86										
2986	DRY	09/24/87										
2986	DRY	03/16/88										
3787	37-87-03-16-88	03/16/88	Routine				0188-881-039	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
3687	DRY	03/16/88										
5687	56-87-03-16-88	03/16/88	Routine				0188-881-040	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample

Table 5-4 (cont'd.)

SOLAR PONDS BEDROCK WELLS

GROUND WATER SAMPLE INFORMATION

	SAMPLE INFORMATION			FIELD PARAMETERS			LABORATORY BATCH NUMBERS					
WELL NUMBER	NUMBER	DATE	TYPE	pH	CONDUCT (umho/cm)	TEMP (deg C)	VOLATILE ORGANICS	SEMI-VOL ORGANICS	PESTICIDES AND PCB'S	METALS	INORGANICS	RADIO-CHEMISTRY
1486	G148609860	09/18/86	Routine	7.50	1290	11.0	8609-049-026	8609-052-002	8609-052-003	8609-049-027	8609-049-028	1000-000-251
1486	G148609862	09/18/86	Field Duplicate	7.90	1170	12.0	8609-049-036	No Sample	No Sample	8609-049-037	8609-049-038	1000-000-253
1486	14-86-04-16-87	04/16/87	Routine	7.30	1670	15.0	0187-881-059	No Sample	No Sample	0187-881-057	0187-881-061	0187-881-061
1486	14-86-D-4-16-87	04/16/87	Field Duplicate	7.30	1670	15.0	0187-881-119	No Sample	No Sample	No Sample	No Sample	No Sample
1486	14-86-06-10-87	06/10/87	Routine	6.20	1628	13.5	0287-881-039	No Sample	No Sample	0287-881-039	0287-881-042	0287-881-039
1486	14-86-08-05-87	08/05/87	Routine	7.30	196	15.4	0387-881-068	No Sample	No Sample	0387-881-074	0387-881-073	0387-881-049
1486	14-86-12-08-87	12/08/87	Routine	7.40	1824	9.3	0487-881-051	No Sample	No Sample	0487-881-038	0487-881-037	0487-881-045
1486	14-86-03-14-88	03/14/88	Routine	7.10	2090	9.1	0188-881-022	No Sample	No Sample	0188-881-022	0188-881-022	0188-881-022
1686	G168609860	09/18/86	Routine	7.20	1620	12.0	8609-049-041	No Sample	No Sample	8609-049-042	8609-049-043	1000-000-257
1686	16-86-04-22-87	04/22/87	Routine	6.90	1440	11.0	0187-881-062	No Sample	No Sample	0187-881-062	0187-881-063	0187-881-063
1686	16-86-06-10-87	06/10/87	Routine	6.70	2390	11.6	0287-881-041	No Sample	No Sample	0287-881-041	0287-881-044	0287-881-041
1686	16-86-08-07-87	08/07/87	Routine	7.20	2020	14.7	0387-881-073	No Sample	No Sample	0387-881-080	0387-881-079	0387-881-058
1686	16-86-12-17-87	12/17/87	Routine	7.20	2010	10.0	0487-881-073	No Sample	No Sample	0487-881-063	0487-881-061	0487-881-061
1686	16-86-03-14-88	03/14/98	Routine	7.10	2180	10.4	0188-881-024	No Sample	No Sample	0188-881-024	0188-881-024	0188-881-024
2386	G238611860	11/25/86	Routine	7.50	1750	13.0	8612-002-061	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
2386	23-86-03-18-87	03/18/87	Routine	7.90	1250	15.0	0187-881-111	No Sample	No Sample	Insufficient Sample	0187-881-022	Insufficient Sample
2386	23-86-06-24-87	06/24/87	Routine	7.70	1533	14.5	0287-881-089	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
2386	23-86-09-23-87	09/23/87	Routine	7.60	1452	14.9	0387-881-121	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
2386	23-86-01-15-88	01/15/88	Routine	7.20	2050	12.6	0487-881-099	No Sample	No Sample	0487-881-119	0487-881-077	0487-881-079
2386	23-86-03-21-88	03/21/88	Routine	7.50	1528	14.3	0188-881-037	No Sample	No Sample	0188-881-037	0188-881-037	0188-881-037
2586	G258611860	11/07/86	Routine	7.20	3300	11.0	8611-014-031	No Sample	No Sample	8611-014-032	Insufficient Sample	Insufficient Sample
2586	25-86-03-18-87	03/18/87	Routine	7.00	2200	12.0	0187-881-021	No Sample	No Sample	0187-881-021	0187-881-023	0187-881-021
2586	25-86-06-24-87	06/24/87	Routine	6.90	2870	14.2	0287-881-066	No Sample	No Sample	0287-881-066	0287-881-071	0287-881-066
2586	25-86-08-28-87	08/28/87	Routine	7.40	2540	13.7	0387-881-104	No Sample	No Sample	0387-881-114	0387-881-108	0387-881-089
2586	25-86-01-15-88	01/15/88	Routine	7.10	3870	10.6	0487-881-100	No Sample	No Sample	0487-881-120	0487-881-078	0487-881-080
2586	25-86D-01-15-88	01/15/88	Field Duplicate				No Sample	No Sample	No Sample	0487-881-121	0487-881-082	0487-881-081
2586	25-86-03-21-88	03/21/88	Routine	6.70	2650	11.9	0188-881-033	No Sample	No Sample	0188-881-033	0188-881-033	0188-881-033
2786	G278611860	11/07/86	Routine	8.60	1450	11.5	8611-014-036	No Sample	No Sample	Insufficient Sample	Insufficient Sample	Insufficient Sample
2786	27-86-03-19-87	03/19/87	Routine	8.50	1200	14.0	0187-881-026	No Sample	No Sample	0187-881-026	0187-881-027	0187-881-026
2786	27-86-04-15-87	04/15/87	Routine	7.90	1350	15.0	0187-881-056	No Sample	No Sample	0187-881-056	0187-881-058	0187-881-058
2786	27-86-06-24-87	06/24/87	Routine	7.80	1244	13.3	0287-881-071	No Sample	No Sample	0287-881-071	0287-881-072	0287-881-071
2786	27-86-09-23-87	09/23/87	Routine	7.30	1249	13.6	0387-881-119	No Sample	No Sample	0387-881-127	0387-881-120	
2786	27-86-12-16-87	12/16/87	Routine	6.90	1268	9.7	0487-881-069	No Sample	No Sample	0487-881-057	0487-881-055	0487-881-059
2786	27-86-03-21-88	03/21/88	Routine	7.30	1410	12.5	0188-881-034	No Sample	No Sample	0188-881-034	0188-881-034	0188-881-034
3086	G308609860	09/19/86	Routine	6.85	14000	12.5	8609-051-016	No Sample	No Sample	8609-051-017	8609-051-018	Insufficient Sample
3086	30-86-03-23-87	03/23/87	Routine	6.10	7100	6.0	0187-881-030	No Sample	No Sample	0187-881-030	0187-881-031	0187-881-030
3086	30-86-04-15-87	04/15/87	Routine	7.30	4700	10.0	0187-881-055	No Sample	No Sample	0187-881-055	0187-881-057	0187-881-057
3086	30-86-06-24-87	06/24/87	Routine	6.50	12630	14.9	0287-881-078	No Sample	No Sample	0287-881-078	0287-881-074	0287-881-078
3086	30-86-09-24-87	09/24/87	Routine	7.30	12180	16.8	0387-881-123	No Sample	No Sample	0387-881-129	0387-881-122	0387-881-105
3086	30-86-01-15-88	01/15/88	Routine	6.90	24200	7.3	0487-881-101	No Sample	No Sample	0487-881-122	0487-881-079	0487-881-082
3086	30-86D-01-16-88	01/16/88	Field Duplicate				No Sample	No Sample	No Sample	0487-881-123	No Sample	No Sample

Table 5-4 (cont'd.)

SOLAR PONDS BEDROCK WELLS

GROUND WATER SAMPLE INFORMATION

	SAMPLE INFORMATION			FIELD PARAMETERS			LABORATORY BATCH NUMBERS					
WELL NUMBER	NUMBER	DATE	TYPE	pH	CONDUCT (umho/cm)	TEMP (deg C)	VOLATILE ORGANICS	SEMI-VOL ORGANICS	PESTICIDES AND PCB'S	METALS	INORGANICS	RADIO-CHEMISTRY
3086	30-86-03-16-88	03/16/88	Routine	6.90	9220	6.2	0188-881-032	No Sample	No Sample	0188-881-032	0188-881-032	0188 881-032
3186	DRY	09/12/86										
3186	DRY	09/24/87										
3186	DRY	03/16/88										
3286	G328611860	11/07/86	Routine	8.30	1250	12.0	8611-014-041	No Sample	No Sample	8611-014-042	8611-014-043	1000-000-271
3286	32-86-03-23-87	03/23/87	Routine	6.80	950	10.0	0187-881-031	No Sample	No Sample	0187-881-031	0187-881-032	0187-881-031
3286	32-86-04-15-87	04/15/87	Routine	7.50	920	14 0	0187-881-054	No Sample	No Sample	0187-881-054	0187-881-056	0187-881-056
3286	32-86-06-29-87	06/29/87	Routine	7.60	870	12 6	0287-881-073	No Sample	No Sample	0287-881-073	0287-881-090	0287 881-073
3286	32-86-09-23 87	09/23/87	Routine	7.60	816	14.0	0387-881-120	No Sample	No Sample	0387-881-126	0387 881 119	0387-881-106
3286	32-86-12 16-87	12/16/87	Routine	8.90	928	10.1	0487-881-070	No Sample	No Sample	0487-881-058	0487-881-056	0487-881-060
3286	32-86-03-21-88	03/21/88	Routine	7.70	890	13.6	0188-881-035	No Sample	No Sample	0188-881-035	0188-881-035	0188-881-035
3987	39-87-03-16-88	03/16/88	Routine	7.80	121	10.7	0188-881-027	No Sample	No Sample	0188-881-027	0188-881-027	0188-881-027

TABLE 5-5

METALS CONCENTRATIONS ABOVE BACKGROUND IN ALLUVIAL WELLS (mg/l)

Well No. Background	Date Sampled	Ba (0.190)	Ca (36)	Hg (0.0002)	K (5)	Mg (25)	Mn (0.547)	Mo (0.1)	Na (21)	Ni (0.07)	Sb (0.060)	Se (0.005)	Sr (0.20)	Th (0.01)	Zn (0.09)
15-86	09/09/86	-	324.0	-	-	61.5	-	0.190	88.0	-	-	-	1.70	0.024	-
	04/22/87	0.2264	193.892	-	-	49.7915	-	-	126.0598	-	-	-	1.4422	0.024	-
	06/10/87	0.2386	202.2351	-	-	43.7932	-	-	117.9158	-	-	-	1.4210	-	-
	08/06/87	0.2849	193.4261	-	-	43.1885	-	-	122.0968	-	-	-	1.3845	-	-
	03/14/88	0.4361	301.1928	-	-	-	-	-	-	-	-	-	-	-	-
17-86	09/25/86	-	193.0	-	8.0	142.0	-	-	322.0	-	-	-	3.950	0.120	-
	04/22/87	0.1933	391.9108	-	-	129.1388	-	-	299.9212	-	-	-	3.2177	-	-
	06/10/87	0.3333	430.7377	-	-	131.4248	-	-	219.4704	-	-	0.150	3.6146	-	0.957
	08/06/87	0.2893	498.0135	-	5.1	162.2504	-	-	263.3607	-	-	0.18	4.5343	-	-
	12/08/87	0.2634	574.3088	-	-	162.5240	-	-	265.8579	-	-	-	5.0306	-	-
	03/16/88	0.3887	826.6744	-	-	253.8005	-	-	369.0358	-	-	0.29	7.6571	-	-
22-86	09/09/86	-	57.0	0.00067	-	9.180	-	-	99.7	-	0.062	0.0076	0.320	-	-
	03/24/87	-	41.9695	-	6.0	-	-	-	185.2432	0.1097	-	-	0.2594	-	-
	06/24/87	0.1908	53.8322	-	8.2	-	-	-	145.6882	0.1054	-	-	0.2941	-	-
	08/28/87	0.2045	50.3961	-	10.6	9.7533	-	-	129.0079	0.0938	-	-	0.3537	-	-
	12/18/87	0.1972	49.3018	-	6.7	10.2115	-	-	79.2068	0.1973	-	-	0.4488	-	-
	03/16/87	-	63.0093	-	-	9.0908	-	-	87.0659	0.1695	-	-	0.3745	-	-
26-86	09/18/86	-	97.0	0.00026	-	106.0	-	-	388.0	-	-	-	2.130	0.044	-
	03/18/87	-	82.9436	-	-	109.4108	-	-	368.0944	-	-	-	2.435	-	-
	08/28/87	-	79.8956	-	-	127.7899	-	-	296.0713	-	-	0.18	2.5126	-	-
28-86	03/19/87	-	348.9810	-	260.0	84.911	-	-	1211.5603	0.087	-	-	2.7577	-	-
	06/27/87	-	812.6987	0.0003	250	243.2086	1.7085	-	2535.8950	0.2854	-	-	6.1852	-	-
	03/16/88	-	479.1007	-	-	151.2661	1.2420	-	1900.9309	0.1512	-	-	4.4360	-	-

TABLE 5-6

INORGANIC RESULTS CONCENTRATIONS ABOVE BACKGROUND IN ALLUVIAL WELLS (mg/l)

Well No. Background	Date Sampled	Chloride (20)	Nitrate Nitrite/Nitrogen (1.5)	Sulfate (31)	HCO_3 (130)	Cyanide (ND)	TDS (ND)
13-86	04/23/87	86.0	1-	490	417	-	1137
15-86	09/09/86	63	NR	170	NR	0.040	1000
	04/22/87	81	28.0	204	409	-	1125
	06/10/87	80.2	120	175	371	-	1153
	08/06/87	87.9	54	195	398	-	1117
	12/08/87	74.9	34.5	142	34.5	-	996
	03/14/88	76.3	44.0	125	44	-	1022
22-86	09/09/86	37	NR	75	-	-	750
	03/24/87	47.0	6.80	81.0	231	-	577
	06/24/87	48.1	2.30	60.5	317	-	477
	08/28/87	40.4	-	59.0	335	-	533
	12/18/87	28.5	1.32	70.0	308	-	478
	03/16/88	43.6	2.74	42.0	170	-	477
26-86	09/18/86	77	NR	500	NR	-	1800
	03/18/87	67.7	88	390	682	-	1814
	08/28/87	59.7	79	375	650	-	1760
28-86	03/19/87	259	1120	0	381	-	9033
	06/24/87	40.1	2200	390	636	-	16776
	03/16/88	336	1670	335	314	-	12052
17-86	09/25/86	140	NR	290	NR	-	3900
	04/22/87	97	145	208	322	-	1324
	06/10/87	105	305	270	333	-	2796
	08/06/87	12	465	290	296	-	3929
	12/08/87	123	516	282	274	-	1906
	03/14/88	130	540	240	146	-	4392

TABLE 5-7

RADIONUCLIDE CONCENTRATIONS ABOVE BACKGROUND IN ALLUVIAL WELLS (pci/l)

Well No.	Date Sampled	$U^{233+234}$	U^{235}	U^{238}	$Pu^{239+240}$	Am^{241}	H_3
Background		(3.5(0.9))	ND	(5.5(2.1))	ND	ND	ND
15-86	09/09/86	24(2)	NR	24(2)	-	-	0.28(0.22)*
	04/22/87	24(4)	2.1(1.0)	19(3)	-	-	-
	08/06/87	16.1(2.4)	0.9(0.5)	11(1.9)	-	-	-
	12/08/87	17(2)	0.99(0.28)	13(2)	-	-	-
	03/14/88	18(1)	0.69(0.14)	14(1)	-	-	240(100)
17-86	09/25/86	33(1)	NR	27(1)	-	-	0.69(0.24)*
	04/22/87	26(5)	1.3(1.0)	25(4)	-	-	380
	06/10/87	3.7(1.2)	-	-	-	-	-
	08/06/87	24.8(4.4)	0.9(0.7)	20.9(4.0)	-	-	-
	12/08/87	23(3)	1.3(0.4)	21(3)	-	-	730(100)
	03/14/88	28(2)	1.2(0.2)	15(1)	-	-	700(100)
22-86	09/09/86	24(3)	NR	21(3)	0.95(0.39)	-	(0.58/0.23)*
	03/24/87	9.2(2.4)	-	4.3(1.9)	4.6(2.3)	-	230
	06/24/87	9.1(18)	-	6.0(1.4)	-	-	-
	08/28/87	5.8(1.9)	0.6(0.5)	7.5(2.0)	-	-	723(318)
	12/18/87	5.6(0.5)	0.12(0.06)	-	-	-	260(80)
	03/16/87	6.3(0.6)	0.21(0.010)	-	-	-	340(100)
26-86	03/18/87	32(6)	4.5(117)	-	-	-	1300
	08/28/87	34.2(4.8)	1.3(0.7)	31.2(1.0)	-	-	1352(343)
28-86	03/19/87	211(25)	7.7(2.6)	142(20)	-	-	6300
	06/24/87	1000(300)	47(15)	750(200)	-	-	12000
	03/16/88	320(20)	12(1)	220(20)	-	-	9000(300)

* ( ) Denotes two standard deviation counting error

alluvial wells were placed around and adjacent to the solar ponds (20-86, 22-86, 24-86, 26-86, 28-86, 29-86, and 33-86).

In 1987, additional wells were installed to characterize the solar ponds area. Two alluvial wells were placed south of the solar ponds to monitor ground-water quality (56-87 and 38-87) in this area. Another well (37-87) was installed immediately east of the southernmost ponds (207B) and well 21-87 is located southeast of the ponds.

Eight alluvial wells were dry during the sampling efforts. Therefore, no analytical data are available for wells 20-86, 24-86, 29-86, 18-86, 31-86, 33-86, 21-87, and 38-87.

5.2.1.5 Alluvial Ground-water Chemistry

Overview

The alluvial ground-water system in the Solar Ponds area can be divided into five areas. The first area consists of the ground water at the upgradient wells, 22-86 and 56-87. The second area is the ground water at the alluvial well to the south of the solar ponds, 26-86. Alluvial ground water to the north at well 28-86 and the shallow unconfined bedrock well 30-86 compose the third area. The fourth area of wells is located downgradient along North Walnut Creek and includes wells 17-86, 15-86, and 13-86. The fifth area is further downgradient along the North Walnut Creek drainage at wells 12-86 and 11-86.

Upgradient Alluvial Ground-water Quality

Wells 56-87 and 22-86 contain contaminants which do not reflect the composition of the solar pond liquids or sludge. The pond sludge and liquids are characterized by high concentrations of nitrate, radionuclides, chromium (total), copper, potassium, sodium, nickel, arsenic, magnesium and zinc (discussed in Section 4.0, Tables 4-1 and 4-2). Volatiles were rarely detected in solar pond liquids and sludge. Ground water at well 22-86, located to the south of Pond 207-C and in the location of an original/buried solar evaporation pond is characterized by the consistent presence of chloroform ($CHCl_3$), carbon tetrachloride (CCl_4), and trichloroethene (TCE), and the occasional presence of 1,1,1-trichloroethane (1,1,1-TCA) and 1,2-dichloroethane (1,2-DCA). Detected concentrations are generally in the hundred to thousands ppb range. In addition to high concentrations of volatiles in the 22-86 ground-water samples, only sodium, sulfate, and bicarbonate significantly exceeded background values. This is in contrast to the ground-water quality north and east of the ponds, where other major ions, strontium, uranium, and nitrate are also significantly elevated. Also, plutonium is above background only at this well. Aside from the presence of organics, only total dissolved solids (TDS) exceeds the proposed ground-water quality criterion. The concentrations and types of contaminants from well 22-86 indicate that another source, possibly the original solar ponds, have impacted the ground water at this well.

Prior to installation of well 56-87, located east of Building 779, borehole samples were collected from SP16-87 to evaluate the soils within the screened interval. The borehole samples are discussed in detail in Section 4. In general, the soils are uniquely characterized by high concentrations of thallium, cadmium, antimony and beryllium. Except for cadmium, the solar ponds do not contain these metals. Ground water collected from well 56-87 also contained volatile organic compounds, specifically $CHCl_3$, 1,1,1-TCA, and TCE. Data do not exist for metals, major ions, and radionuclides. The presence of these organic compounds in ground water and the high concentrations of metals in the soils also suggest that a separate source of contamination has impacted ground water at well 56-87.

Well 24-86 is completed in Rocky Flats Alluvium from 2.95 to 7.45 feet in depth. This well, located to the south of Building 779 and southwest of Pond 207-A, has always been dry.

Ground-water Quality South of the Ponds

South of Ponds 207-A and 207-B South is the alluvial well 26-86. Well 26-86 is screened from 3.75 to 11.0 feet in the artificial fill associated with construction and regrading of the ponds. The samples collected in September, 1986 and March, 1987 contain 6 and 8 microgram per liter (mg/l) of TCE. Well 26-86 also contains above background concentrations of calcium, mercury, magnesium, sodium, selenium, strontium, thallium, chloride, nitrate, sulfate, bicarbonate and radionuclides. Of these analytes, magnesium, strontium, nitrate, and sulfate were an order of magnitude higher in concentration than observed for ground water at well 22-86. Sodium was at twice the concentration. However, compared to ground water at downgradient wells to the north and east, the concentrations of these metals and inorganics are significantly less. The potentiometric surface maps suggest that ground-water flow extends both to the north, and east from the ponds in the area of the solar ponds, with little or no flow to the south. It would appear the small flow component to the south travels through some portion of Pond 207-A leakage and in so doing picks up some contamination. Uranium, sulfate, nitrate, and TDS concentrations all exceed the proposed ground-water quality criteria at well 26-86.

Ground-water Quality of Wells to East and North

Second only to ground water at well 30-86, alluvial well 28-86, located to the east of Pond 207-B North, contains the highest concentrations of contaminants at the solar pond area. Above background concentrations of radionuclides, chlorides (40-336 milligrams per liter (mg/l), sulfate (290-335 mg/l), potassium (250-260 mg/l), calcium (349-813 mg/l), mercury (0.0003 mg/l), magnesium (84-243 mg/l), manganese (1.24-1.71 mg/l), sodium (1211-2536 mg/l), nickel (0.087-0.285 mg/l), strontium (2.76-6.19 mg/l), and nitrates as high as 2200 mg/l occur in ground water at well 28-86. Potassium, present in high concentrations in the pond liquids and sludge, is only significantly elevated in well 28-86, well 30-86, and the ground water collected by the French drain system. Background for potassium is less than 5 mg/l. Similarly, the concentration of strontium in background samples is 0.20 mg/l, and the samples from well 28-86 contain over an order of magnitude greater concentration. Radionuclides are elevated in the ground water in well 28-86 with uranium 233+234 as high as 1000 (300) picoCuries per liter (pCi/l), uranium 235 at 47 (15), uranium 238 at 750 (200) pCi/l, and tritium at 12000 pCi/l. Only traces of TCE and tetrachloroethene (PCE) were present in the ground water at well 28-86. Chloride, sulfate, nitrate, TDS, manganese, nickel, and uranium all exceeded the proposed ground-water quality criteria.

Well 30-86 is a bedrock well which is completed in the shallow weathered claystone immediately beneath the artificial fill/disturbed ground. The well, even though completed in claystone bedrock, is unconfined and in communication with the overlying surficial materials. Ground water in well 30-86 (see Tables 5-13 through 5-

16) contains consistently above background concentrations of barium (0.21-0.58 mg/l), potassium (39-146 mg/l), magnesium (136-310 mg/l), sodium (1063-1408 mg/l), selenium (<0.005-.017 mg/l), and strontium (6-14 mg/l). Radionuclides, specifically uranium and tritium are elevated above background. Uranium 233+234 ranges from 139.6(21.1) pCi/l to 370(250) pCi/l; uranium 235 from 5.2(1.4) pCi/l to 10(6) pCi/l; and uranium 238 93.1(14.7) pCi/l to 125(29) pCi/l. Tritium ranges from 6300(200) to 9800 pCi/l. Chlorides (179-430 mg/l), sulfates (100-340 mg/l), and nitrates (1410-2040 mg/l) are significantly above background. As previously mentioned, ground water at this well shows the most contamination anywhere in the Solar Pond Area. Chlorides, sulfates, nitrates, TDS, and uranium all exceed the proposed ground-water quality criteria.

Well 20-86 and 18-86 were dry during all sampling periods.

Ground-water Quality Adjacent to North Walnut Creek

Wells 17-86, 15-86 and 13-86, screened in valley fill alluvium adjacent to North Walnut Creek, contain variable concentrations of the contaminants associated with the solar ponds. Nitrate was not detected above background in well 13-86, the most downgradient well. However, at wells 17-86 and 15-86, nitrate ranges were 145-540 mg/l and 28-120 mg/l, respectively. Total uranium concentrations ranged from 43-600 pCi/l in well 17-86 to 27-48 pCi/l in well 15-86. (No data available for 13-86). TDS exceeded 4000 mg/l at well 17-86, and exceeded 1000 mg/l at both wells 15-86 and 13-86. TDS, uranium, and nitrate all exceed the ground-water quality criteria at wells 17-86 and 15-86. Ground water at well 17-86 also has elevated selenium concentrations (<0.002-0.29 mg/l) that exceed the ground-water quality criteria. Although selenium is also present in ground water at well 30-86 (<0.005-0.017 mg/l), concentrations are significantly lower. It appears the selenium at well 17-86 originates from another source upgradient.

In general, the ground-water quality improves downgradient from wells 17-86 to well 13-86. Ground water at well 17-86 has significantly higher calcium, magnesium, and sodium relative to well 15-86. (Metals data do not exist for well 13-86). The ground water also has higher strontium at well 17-86 compared to well 15-86, and a similar pattern exists for uranium and tritium (again, no data exist for well 13-86). Nitrate concentrations decrease in the ground water from approximately 500 mg/l at well 17-86, to less than 100 mg/l at well 15-86, to less than 1 mg/l at well 13-86. Dilution by ground water from the north in North Walnut Creek valley fill alluvium is one likely explanation for the reduction in metal and nitrate concentrations.

The source of the strontium, nitrate, sodium, potassium, tritium, and uranium at well 17-86 appears to be the solar ponds because all of these constituents are notably elevated at well 30-86. These constituents are all diluted by about a factor of 5 to 10 at well 17-86 relative to 30-86. The interceptor pump house water quality (metals data only) indicates concentrations of sodium and potassium intermediate to the range observed for wells 30-86 and 17-86 (see Appendix 4 of this closure plan). This is expected given the location of the French drain system. It is likely that contamination at 17-86 has arisen from the solar ponds because of the inability of the French drain system to capture all contaminated ground water exiting the solar ponds during periods of high precipitation.

Volatile organics are only present in well 13-86. It is possible that the culvert/drainage from the Triangle Area (a low priority SWMU site which will be investigated in 1989) is draining surface water containing contaminants from the area previously used for drum storage. Well 13-86 is located within 200 feet of the end of the drainage from the Triangle Area. Drums of organics and radionuclides were stored at the Triangle Area.

<u>Ground Water Quality Downgradient in North Walnut Creek</u>

Ground-water quality at wells 12-86 and 11-86 located farther downgradient in the North Walnut Creek drainage have similar inorganic chemistry to that observed for well 15-86. Calcium (78-205 mg/l), magnesium (25-65 mg/l), sodium (47-224 mg/l), sulfate (104-630 mg/l), and chloride (37-100 mg/l) are at concentrations typical of the ground water at 15-86. However, nitrate concentrations are low ranging from non detected to values generally less than 3 mg/l. This compares somewhat with the absence of nitrate at well 13-86. The only metal elevated in concentration in both wells is strontium ranging from 0.60-1.48 mg/l. Nickel is elevated only in well 11-86 (most downgradient well) at concentrations ranging from <0.037-0.167 mg/l. However, the absence of detectable concentrations of nickel at 2-86 and 15-86 suggest there is another contributing source. As for the radionuclides, only at well 12-86 was uranium significantly elevated. Uranium 233 + 234 and uranium 238 ranged from 11(3)-25(5) pCi/l, and 13(3)-20(3) pCi/l respectively. The elevated major ion and uranium concentrations suggest ground water at this location is impacted by the solar ponds. The reduced concentrations of nitrate may be a result of uptake by phreatophytes. Only TDS, sulfate, and uranium (one occasion only) exceed the ground water quality criteria. The downgradient extent of this "plume" is unknown but within the plant boundaries, as well 4-86 located at Indiana Street has always been dry.

Historical Alluvial Ground Water Data North of the Solar Ponds

Historical data (Appendix D) indicate gross alpha, gross beta, and nitrates have been elevated in the ground water north of the solar ponds since sampling and analysis began in 1975. The quality of the water in Sumps 1, 2, 3, and 6 represent the ground water extracted from intercept trenches 1, 2, 3, and 6. For the first six months of 1975, nitrates in Sumps 1, 2, and 3 were greater than 20,000 mg/l. From this point in time until February 1980 (end of record), nitrate concentrations were generally in the 2000-5000 mg/l range. Only in Sump 1 did nitrates suddenly decrease to <500 mg/l in JUNE 1978. Because Sump 1 is also connected to the leachate collection system of the 207B ponds, this decrease in nitrate concentration is probably due to the removal of process waste and cleaning of these ponds at that time. The Sump 1 gross alpha and beta data show this pattern as well. From 1975 through JUNE 1978, they were in the range of 1000-10,000 pCi/l, and subsequent to JUNE 1978 dropped to less than 100 pCi/l. Gross alpha for Sump 2 was always generally in the range of 1000-2000 pCi/l while gross beta was somewhat higher in 1975 and 1976 but generally on the order of 2000 pCi/l. In Sump 3, gross alpha and beta were each in the range 200-500 pCi/l from 1975-1977 and in subsequent years were in the range <100-200 pCi/l. Sump 6 had nitrate concentrations in 1979 on the order of 1000 mg/l. There is no gross alpha and beta data for Sump 6.

In 1975, Engineering Science drilled test holes and sampled ground water for subsequent nitrate analysis. Their data is similar to the Plant data showing nitrate concentrations just north of the ponds as high as 20,000 mg/l (Figure 5-1).

It is concluded that nitrates, gross alpha, and gross beta concentrations have decreased over the years to levels an order of magnitude less than they were in early

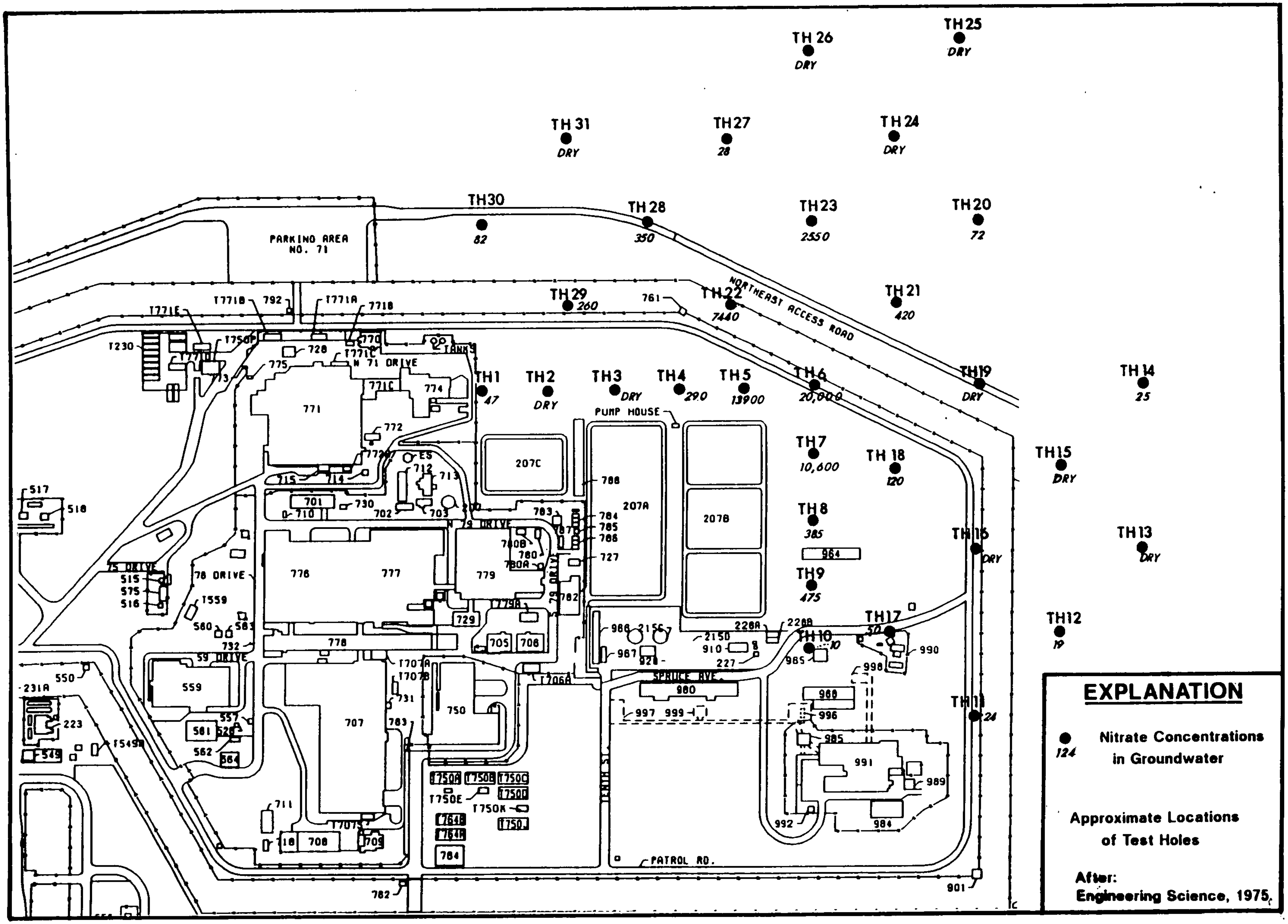


Figure 5-1: TEST HOLE LOCATIONS

1975. A significant decrease occurred in late 1975, and it would appear concentrations have dropped steadily since then. This may be due to decreases in nitrate concentrations in pond 207A (23,000 down to 240 mg/l) through the years 1975 to 1982. However, 1982 nitrate concentrations were up to 22,000 mg/l in the pond liquid, and a corresponding increase in nitrates in the ground water is not obvious.

A pond known as the 774 pond receives footing drain flow from buildings in the 700 area. The pond now discharges to the French drain system. The historical nitrate and tritium data for the pond indicate these constituents are elevated in the water. During the years 1980 and 1981, tritium concentrations ranged from 2000-10,000 pci/l. Nitrate concentrations ranged from 50-200 mg/l from 1976-1980. Although there are no other data to characterize this water, it is obvious that release of contaminants to ground water occurs west of the solar ponds and the contamination is likely to migrate downgradient through the North Walnut Creek drainage. Therefore, impacts to the ground water of the valley fill alluvium of North Walnut Creek cannot be entirely attributed to the solar ponds.

5.2.2 Bedrock Ground-water Flow System

Ground-water flow occurs in the Arapahoe Formation under unconfined and confined conditions.

Unconfined ground water occurs in the weathered claystones that subcrop beneath surficial materials in well 30-86. The borehole log (Appendix B) notes that the overlying 2 feet of artificial fill is wet, although recorded water levels from September 1986 through April 1988 indicate the water table has been within the Arapahoe claystone throughout this period.

Well 31-86 west of well 30-86 is completed in subcropping Arapahoe sandstone. This well is screened from 2.46 to 17.32 feet below ground surface and has been dry since its installation.

Confined ground-water flow occurs in sandstones within the Arapahoe Formation. Wells completed in sandstones include wells 14-86, 16-86, 23-86, 25-86, 27-86, 32-86, and 39-87BR. As shown in cross section E-E' on Plate 5-3, wells 27-86 and 39-87 are completed in the same sandstone.

5.2.2.1 Recharge Conditions

Recharge to the unconfined bedrock aquifer at 30-86 occurs from infiltration of incident precipitation through the overlying surficial materials. Overflow from Sump 2 which is located uphill from 30-86 also contributes to recharge of the unconfined flow system at this location.

Recharge to the Arapahoe sandstones occurs as infiltation to the sandstones at subcrops, and from downward leakage through the overlying claystones.

There is a variable downward gradient between ground water in surficial materials and bedrock. The presence of a downward gradient has been demonstrated previously at the Plant (Hurr, 1976 and Rockwell International, 1986a; Rockwell International, 1988). Table 5-8 presents vertical hydraulic gradients calculated for alluvial/bedrock well pairs in the solar ponds area. Calculated vertical gradients range from about 0.01 to 0.95. The well pair 24-86 and 23-86 (bedrock) does not yield a vertical gradient because 24-86 is always dry. No vertical gradient between upper and lower sands in the Arapahoe Formation can be calculated from well pair 31-86 (bedrock) and 32-86 (bedrock) because 31-86 is always dry.

TABLE 5-8
VERTICAL GRADIENTS

WELL	ELEVATION OF POTENTIOMETRIC SURFACE & DATE	WATER LEVEL DIFFERENCE (ft)	ELEVATION OF SCREENED INTERVAL	ELEVATION OF SATURATED INTERVAL MIDPOINT	SEPARATOR THICKNESS (ft)	DOWNWARD VERTICAL GRADIENT
14-86*	5836.61 (04/11/88)	4.62	5805.29-5789.35	5797.32	38.76	0.12
15-86	5841.23 (04/11/88)		5841.52-5830.92	5836.08		
16-86*	5861.00 (04/11/88)	0.35	5825.68-5819.68	5822.68	33.64	0.01
17-86	5861.35 (04/11/88)		5861.52-5851.28	5856.32		
21-87	5921.56 (04/18/88)	69.57	5924.33-5917.18	5919.37	73.60	0.95
22-87BR*	5851.99 (04/18/88)		5849.29-5842.24	5845.77		
25-86*	5935.85 (04/18/88)	30.24	5914.55-5892.45	5903.50	61.29	0.49
26-86	5966.09 (04/18/88)		5970.73-5963.48	5964.79		
27-86*	5863.96 (04/18/88)	94.11	5833.36-5828.86	5831.11	124.24	0.05
28-86	5958.07 (04/18/88)		5957.20-5952.63	5955.35		
34-86*	5890.88 (04/18/88)	13.66	5866.20-5854.19	5860.20	40.87	0.33
35-86	5904.54 (04/18/88)		5904.34-5897.60	5901.07		

* Completed in Bedrock
( ) Date of water level measurement

5.2.2.2 Ground-water flow Directions

Ground-water flow within individual sandstones is from west to east at an average gradient of 0.09 ft/ft based on wells completed in the same sandstones at the 903 Pad, Mound, and East Trenches Areas (Rockwell International, 1987b) and on regional data (Robson and others, 1981a).

5.2.2.3 Hydraulic Conductivities

Hydraulic conductivity values for Arapahoe sandstones were estimated from drawdown-recovery tests performed in 1986, slug tests performed in 1987, and packer tests performed in 1986 and 1987. Table 5-9 and 5-10 summarize the results of these tests. Data, analyses, and results of each test are provided in Appendix B.

The hydraulic conductivities calculated for sandstones vary from 1.12×10^{-8} cm/s to 3×10^{-6} cm/s with a geometric mean of 4.0×10^{-7} cm/s. This is in the range of the geometric mean of hydraulic conductivities calculated for siltstones (3.9×10^{-7} cm/s) and claystones (4.7×10^{-7} cm/s).

The horizontal ground-water flow velocity for sandstone is 0.3 ft/year. This is based upon a hydraulic conductivity of 4.0×10^{-7} cm/s (0.38 ft/year). The horizontal ground-water flow velocity for siltstones is 0.3 ft/year based upon a hydraulic conductivity of 3.9×10^{-7} cm/s (0.38 ft/year) and for claystones is 0.4 ft/year based upon a hydraulic conductivity of 4.7×10^{-7} cm/s (0.45 ft/year). All calculations are based upon an average horizontal gradient of 0.09 ft/ft, and an assumed effective porosity of 0.1.

TABLE 5-9

RESULTS OF PACKER TESTS IN ARAPAHOE FORMATION

Well Number	Interval (ft)	Lithology	1st P1/3 (cm/s)	P2/3 (cm/s)	2nd P1/3 (cm/s)	Geometric Mean (cm/s)
14-86	32.46-43.64	Claystone	7.8×10^{-7}	3.47×10^{-6}	8.8×10^{-7}	1.34×10^{-6}
	43.26-54.44	Sandstone	2.11×10^{-6}	7.34×10^{-6}	6.5×10^{-7}	2.16×10^{-6}
	53.91-65.09	Claystone/Siltstone				
16-86	28.68-38.68	Claystone	3.89×10^{-6}	7.10×10^{-6}	Aborted	5.26×10^{-6}
	34.43-44.42	Claystone/Siltstone/Sandstone				
	42.49-52.59	Claystone/Siltstone				
	52.43-62.43	Siltstone	4.0×10^{-7}	1.88×10^{-6}	3.0×10^{-7}	6.1×10^{-7}
23-86	37.25-48.43	Claystone	2.0×10^{-7}	Aborted	Aborted	2.0×10^{-7}
	44.68-52.35	Claystone	4.3×10^{-7}	1.41×10^{-6}	4.0×10^{-8}	2.9×10^{-7}
	52.35-63.55	Claystone/Siltstone				
	66.10-77.30	Siltstone/Claystone				
	67.80-79.00	Siltstone/Claystone				
	71.80-83.00	Siltstone/Claystone				
	78.00-79.00	Siltstone	3.08×10^{-6}	Aborted	Aborted	3.08×10^{-6}
	82.72-93.92	Siltstone	2.9×10^{-7}	Aborted	Aborted	2.9×10^{-7}
	84.05-95.25	Siltstone	3.6×10^{-7}	Aborted	Aborted	3.6×10^{-7}
	104.21-115.40	Sandstone/Siltstone				
		Geometric Mean for Claystone:				2.4×10^{-7}
		Geometric Mean for Siltstone:				6.9×10^{-7}
25-86	35.88-47.06	Claystone	7.8×10^{-7}	2.14×10^{-6}	6.3×10^{-7}	1.02×10^{-6}
	48.05-59.23	Claystone	1.0×10^{-8}	2.0×10^{-8}	Aborted	1.0×10^{-8}
	58.86-70.04	Claystone	2.0×10^{-8}	5.9×10^{-7}	3.3×10^{-7}	1.6×10^{-7}
	69.36-80.54	Sandstone*	2.0×10^{-8}	2.65×10^{-6}	7.7×10^{-7}	3.4×10^{-7}
	83.29-94.47	Test Interval in Excess of TD				
		Geometric Mean for Claystone:				1.2×10^{-7}
27-86	24.29-35.84	Claystone	2.00×10^{-6}	2.70×10^{-6}	Aborted	2.32×10^{-6}
	24.65-35.84	Claystone	2.04×10^{-6}	2.75×10^{-6}	Aborted	2.37×10^{-6}
	35.84-47.03	Claystone	4.7×10^{-7}	6.5×10^{-7}	$4. \times 10^{-8}$	2.3×10^{-7}
	42.58-53.77	Claystone	$1. \times 10^{-8}$	$1. \times 10^{-8}$	-	$1. \times 10^{-8}$
	70.96-82.15	Claystone	1.01×10^{-6}	2.98×10^{-6}	3.36×10^{-6}	2.16×10^{-6}
	82.15-93.34	Claystone	3.4×10^{-7}	3.84×10^{-6}	3.8×10^{-7}	7.9×10^{-7}
	96.43-107.62	Siltstone	3.1×10^{-7}	2.1×10^{-7}	$4. \times 10^{-8}$	1.4×10^{-7}
	107.62-118.81	Claystone/Siltstone				
	118.81-130.0	Claystone	$1. \times 10^{-8}$	1.1×10^{-7}	$2. \times 10^{-8}$	$3. \times 10^{-8}$
	130.00-141.19	Claystone/Sandstone				
	138.37-149.56	Claystone	$1. \times 10^{-8}$	$6. \times 10^{-8}$	-	$2. \times 10^{-8}$
		Geometric Mean for Claystone:				2.4×10^{-7}

TABLE 5-9 (Continued)

RESULTS OF PACKER TESTS IN ARAPAHOE FORMATION

Well Number	Interval (ft)	Lithology	1st P1/3 (cm/s)	P2/3 (cm/s)	2nd P1/3 (cm/s)	Geometric Mean (cm/s)
32-86	45.20-55.20	Claystone	5.6×10^{-7}	1.59×10^{-6}	2.8×10^{-7}	6.3×10^{-7}
	55.20-65.20	Claystone	2.8×10^{-7}	$6. \times 10^{-8}$	Aborted	1.3×10^{-7}
	65.20-75.20	Claystone	4.6×10^{-7}	6.4×10^{-7}	1.9×10^{-7}	3.8×10^{-7}
	75.20-85.20	Claystone	$8. \times 10^{-8}$	3.7×10^{-7}	$6. \times 10^{-8}$	1.2×10^{-7}
	85.20-95.20	Claystone/Sandstone				
	95.20-105.20	Claystone	3.7×10^{-7}	4.1×10^{-7}	7.0×10^{-8}	2.1×10^{-7}
	95.20-105.92	Claystone	3.5×10^{-7}	3.9×10^{-7}	$6. \times 10^{-8}$	2.0×10^{-7}
	105.20-115.20	Claystone	6.0×10^{-8}	4.6×10^{-7}	1.3×10^{-7}	1.5×10^{-7}
	116.08-126.08	Claystone/Sandstone				
		Geometric Mean for Claystone:				2.2×10^{-7}
34-86	46.01-56.00	Sandstone	1.73×10^{-6}	---	6.30×10^{-6}	3.30×10^{-6}
	55.01-65.00	Claystone	4.14×10^{-6}	5.73×10^{-6}	1.56×10^{-6}	3.33×10^{-6}
	76.71-86.70	Claystone	4.7×10^{-7}	---	---	4.7×10^{-7}
	85.10-95.09	Claystone	5.6×10^{-7}	4.28×10^{-6}	---	1.55×10^{-6}
		Geometric Mean for Claystone:				1.34×10^{-6}
39-87BR	50.10-59.75	Claystone	Aborted	$3. \times 10^{-8}$	Aborted	$3. \times 10^{-8}$
	59.75-69.40	Claystone	-	$6. \times 10^{-8}$	-	$6. \times 10^{-8}$
	69.40-79.05	Claystone	-	$4. \times 10^{-8}$	-	$4. \times 10^{-8}$
	79.05-88.70	Claystone/Siltstone/Sandstone				
	88.70-98.35	Siltstone/Sandstone				
	98.35-108.00	Claystone/Siltstone				
	108.00-117.65	Sandstone/Siltstone				
	115.65-125.00	Siltstone	Aborted	3.9×10^{-7}	Aborted	3.9×10^{-7}
	122.68-132.33	Sandstone	$2. \times 10^{-8}$	$4. \times 10^{-8}$	Aborted	$3. \times 10^{-8}$
		Geometric Mean for Claystone:				$4. \times 10^{-8}$

TABLE 5-10

RESULTS OF HYDRAULIC CONDUCTIVITY TESTS
IN ARAPAHOE FORMATION

Well	Lithology	Drawdown Recovery Test (cm/s)	Slug Test (cm/s)	Packer Test (cm/s)
14-86	Sandstone	$1.9x10^{-7}$		$2.2x10^{-6}$
	Claystone			$1.3x10^{-6}$
16-86	Siltstone & Sandstone*	$6x10^{-8}$		
	Siltstone			$6.1\ x10^{-7}$
	Claystone			$5.3x10^{-6}$
23-86	Sandstone		$1x10^{-8}$	
	Siltstone			$6.9\ x10^{-7}$
	Claystone			$2.4\ x10^{-7}$
25-86	Claystone & Sandstone*	$7x10^{-8}$		
	Sandstone			$3.4\ x10^{-7}$
	Claystone			$1.2\ x10^{-7}$
27-86	Sandstone	$1.9x10^{-7}$		
	Siltstone			$1.4\ x10^{-7}$
	Claystone			$2.4\ x10^{-7}$
32-86	Sandstone & Claystone*	$9x10^{-8}$		
	Claystone			$2.2\ x10^{-7}$
34-86	Sandstone	$3.1\ x10^{-6}$		$3.3\ x10^{-6}$
	Claystone			$1.3\ x10^{-6}$
	Geometric Mean (cm/s)			
	Sandstone:	$4.8\ x10^{-7}$	$1x10^{-8}$	$1.4\ x10^{-6}$
	Siltstone:			$3.9\ x10^{-7}$
	Claystone:			$5.4\ x10^{-7}$

* Mixed lithology tests not used in calculating geometric means.

5.2.2.4 Bedrock Ground-water Quality

This section describes the bedrock ground-water chemical conditions in the vicinity of the solar ponds. As discussed in Section 5.2.1, interpretation of the chemical conditions is compared to background bedrock ground-water quality west of the plant (Table 5-11) and ground-water quality criteria (Table 5-2).

Nine bedrock wells were installed in 1986 in the vicinity of the solar ponds to monitor bedrock ground-water quality. Two wells, 14-86 and 15-86 were installed in the North Walnut Creek drainage, one well (34-86) was placed in South Walnut Creek. The remaining six wells are located around the solar ponds.

In 1987, one additional bedrock ground-water monitoring well was installed. Well 39-87BR is located slightly northeast of pond 207B north. All analytical data is provided in Appendix C; however, chemical concentrations in bedrock ground water that are above estimated background levels are shown in Tables 5-13 through 5-16.

As shown in Table 5-12, with four exceptions, volatiles did not occur above detection limits. The only exceptions are the infrequent occurrences of concentrations (generally less than 15 mg/l) of methylene chloride, acetone, methyl ethyl ketone (MEK), CCl_4, TCE, toluene, and PCE. Because methylene chloride, acetone, and MEK are common laboratory contaminants, their presence may be laboratory artifact. The occurrence of other VOC's above detection limits, albeit infrequently and at low concentrations, may be indicative of organic contamination. However, in the unlikely event that VOC contamination is actually present in the bedrock ground-water, this contamination would have arisen from an area to the west of the solar ponds where the sandstone subcrops (if they subcrop).

TABLE 5-11

BACKGROUND ALLUVIAL GROUND-WATER QUALITY

METALS

Element	Concentration Range (mg/l)
Antimony	.06U
Arsenic	.001U
Barium	.04-.22
Beryllium	.005U
Cadmium	.005U
Cesium	.1U
Chromium	.002U-.015
Cobalt	.05U
Copper	.02U-.05
Lead	.005U-.030
Manganese	.01U-.23
Mercury	.0002U-.0003
Molybdenum	.1U
Nickel	.04U
Selenium	.002U
Silver	.01U
Strontium	.14-.87
Thallium	.002U
Vanadium	.005U-.05
Zinc	.005U-.09

RADIONUCLIDES

Plutonium, Americium, Uranium-235	Not detected
Uranium-234	Not detected - 6.6(1.8)
Uranium-238	Not detected - 7.5(1.7)

MAJOR IONS

Ion	Concentration Range (mg/l)
Calcium	7-110
Magnesium	1-25
Potassium	1-8
Sodium	22-47
Bicarbonate	9-318
Carbonate	ND-257
Chloride	1-24
Nitrate	ND
Sulfate	ND-66

TABLE 5-12

VOLATILE ORGANIC RESULTS FOR BEDROCK WELLS
(ug/l)

Well No.	Date Sampled	MeCL	Acetone	MEK	CCL_4	TCE	Toluene	PCE
Detection Limit		(5)	(10)	(10)	(4-5)	(4-5)	(5)	(4-5)
23-86	01/15/88	13	-	-	7	-	-	-
23-86	03/21/88	16	-	-	-	-	-	-
25-86	11/07/86	-	21B	15	-	-	-	-
25-86	01/15/88	-	-	-	7	-	2J	-
25-86	03/21/88	-	17	-	-	-	-	-
27-86	11/07/86	2J	7JB	-	-	1J	-	-
27-86	12/16/87	13	-	-	-	-	-	-
27-86	03/21/88	17	-	-	-	-	-	-
30-86	09/19/86	-	-	-	-	-	-	2J
30-86	04/15/87	-	-	-	-	5	-	-
30-86	06/24/87	-	-	-	-	-	-	16
30-86	03/16/88	14	-	-	-	-	-	-
32-86	11/07/86	-	-	9J	-	-	-	-
39-86	03/16/88	13	-	-	-	-	-	-

Notes:
(1) "-" Indicates that value is undetected
(2) "J" Indicates value is estimated below detection
(3) "B" indicates that analyte was present in the laboratory blank
(4) Analyte abbreviations:
MeCL = Methylene Chloride;
MEK = Methyl Ethyl Ketone
CCL_4 = carbon tetrachloride;
TCE = trichloroethene;
PCE = tetrachloroethene

TABLE 5-13

METALS CONCENTRATIONS ABOVE BACKGROUND IN BEDROCK WELLS

Well No. Background	Date Sampled	Ag (0.01)	As (0.001)	Ba (0.22)	Ca (36)	Co (0.005)	Cd (0.005)	Hg (0.0003)	K (5)	Mg (8)	Mo (0.1)	Na (21)	Ni (0.07)	Sb (0.060)	Se (0.002)	Sr (0.87)	Th (0.01)	Zn (0.09)	Pb (0.30)
14-86	09/18/86	-	-	-	-	-	-	-	-	29	-	267	-	-	-	1.37	-	-	-
	04/16/87	-	-	-	141	-	-	-	-	41	-	251	-	-	-	2.04	-	0.09	-
	06/10/87	-	-	-	155	-	-	-	-	41	-	250	0.0476	-	-	2.10	-	0.13	-
	08/05/87	-	-	-	140	-	-	-	-	41	-	253	-	-	0.004J	2.07	-	-	-
	12/08/87	-	-	-	138	-	-	-	8.2	39	-	237	-	-	-	2.09	-	-	-
	03/14/88	-	-	-	154	-	-	-	-	47	-	266	-	-	-	2.42	-	-	-
16-86	09/18/86	-	-	-	142	-	-	0.0003	-	45	-	297	-	-	0.0045	1.88	-	-	-
	04/22/87	-	-	-	169	-	-	-	-	49	-	291	0.1672	-	-	2.22	-	-	-
	06/10/87	-	-	-	166	0.072	0.0006J	-	-	45	-	271	0.2061	-	-	2.12	-	-	-
	08/07/87	-	-	-	161	0.054	-	-	-	49	-	287	0.0891	-	-	2.10	-	-	-
	12/17/87	-	-	-	148	-	-	-	8.7	45	-	272	0.0464	-	0.005	2.03	-	-	-
	03/14/88	-	0.002J	-	421	-	-	-	-	-	-	-	-	-	0.003J	6.16	-	0.11	-
23-86	01/15/88	-	0.005	-	-	-	-	-	14.0	-	-	182	-	-	0.007	1.18	-	-	-
	03/21/88	-	-	-	-	-	-	-	11.0	26	-	180	-	-	-	1.28	-	0.18	-
	11/07/88	-	-	-	224	-	-	-	35.0	80	0.013	33	0.965	-	-	2.85	-	0.10	-
25-86	03/18/87	-	-	-	192	-	-	-	25.0	76	-	247	0.1249	-	-	2.56	-	-	-
	06/24/87	-	-	-	268	-	-	-	17	-	-	306	0.2102	-	-	3.21	-	-	-
	08/28/87	-	-	-	209	-	-	-	18.0	101	-	280	0.1005	-	-	3.11	-	-	-
	01/15/88	-	0.019	-	233	-	-	-	15.5	100	-	282	0.1057	-	-	3.14	-	-	-
	03/21/88	-	-	-	206	-	-	-	15	85	-	259	-	-	-	3.04	-	-	-
27-86	03/19/87	-	-	-	-	-	-	-	9.0	-	-	259	0.1271	-	-	-	-	-	-
	04/15/87	-	-	-	-	-	-	-	-	-	-	247	0.1869	-	-	-	-	0.3	-
	06/29/87	-	-	-	-	-	-	-	-	-	-	219	0.1158	-		-	-	-	-
	09/23/87	-	-	-	-	-	-	-	-	-	-	200	0.0993	-	0.005	-	-	-	-
	12/16/87	-	-	-	-	-	-	-	-	-	-	205	0.0622	-	0.006	-	-	-	-
	03/21/88	-	-	-	-	-	-	-	-	-	-	201	0.0415	-	-	-	-	-	-
30-86	09/19/86	0.030	-	0.58	-	-	-	0.0011	38.60	165	-	1440	-	-	-	21.5	0.544	-	-
	01/16/87	-	-	-	1031	-	-	-	-	264	-	1266	0.0580	-	-	9.68	-	-	-
	03/23/87	0.010	-	-	681	-	-	-	132.0	135	-	1062	-	-	-	5.69	-	-	-
	04/15/87	0.013	-	0.31	1270	-	-	-	82.0	215	-	1145	-	-	0.007	11.78	-	-	-
	06/24/87	-	-	0.31	1692	-	-	-	74	308	-	1407	-	-	-	14.21	-	-	-
	09/24/87	-	-	0.35	1172	-	-	-	125	309	-	1284	-	-	-	12.25	-	-	-
	01/15/88	-	0.011	0.22	1130	-	-	-	146	274	-	1390	0.0689	-	-	10.22	-	-	-
	03/16/88	-	0.002J	0.23	845	-	-	-	146	229	-	1263	0.0433	-	0.005	7.75	-	-	-
32-86	11/07/86	-	-	-	-	-	-	-	8.35	-	-	118	-	-	-	-	-	-	0.12
	03/23/87	-	-	-	-	-	-	-	10.0	-	0.0329	152	-	-	-	-	-	-	-
	04/15/87	-	-	-	-	-	-	-	-	-	0.0312	152	-	-	-	-	-	-	-
	06/29/87	-	-	-	-	-	-	-	-	-	0.412	-	0.622	-	-	-	-	-	0.004
	09/23/87	-	-	-	-	-	-	-	-	-	-	127	-	-	0.004J	-	-	0.98	-
	12/16/87	-	0.005	-	-	-	-	-	-	-	-	132	-	-	0.005	-	-	-	-
	03/21/88	-	-	-	-	-	-	-	-	-	-	121	-	-	-	-	-	-	-
34-87	03/16/88	-	-	-	-	-	-	-	-	-	-	-	-	-	0.003J	0.08	-	-	-

TABLE 5-14
OTHER INORGANICS ABOVE BACKGROUND IN BEDROCK WELLS (mg/l)

Well No. Background	Date Sampled	Chloride (24)	Nitrate/ Nitrite/Nitrogen (ND)	Sulfate (66)	HCO_3 (318)	TDS ( )
14-86	09/18/86	160	NR	310	NR	1100
	04/16/87	79	0.60	550	368	1303
	06/10/87	81	0.20U	570	348	1331
	08/05/87	83	0.20U	148	364	1292
	12/17/87	78	0.04	562	381	1358
	03/14/87	80	0.20U	480	-	1367
16-86	09/18/86	220	NR	510	NR	1400
	04/16/87	242	0.60	179	340	2489
	06/10/87	202	0.20U	175	332	1470
	08/07/87	201	0.29	495	347	1442
	12/17/87	180	0.09	420	384	1459
	03/14/88	208	0.06	430	-	1462
23-86	03/18/87	190	NR	340	NR	NR
	01/15/88	172	0.02	321	190	962
	03/21/88	172	0.07	290	114	1040
25-86	03/18/87	52	0.28	1100	410	2322
	06/24/87	40	0.20U	400	390	2242
	08/28/87	42	0.45	1060	407	2265
	01/15/88	44	0.10	1030	437	2297
	03/21/88	43	0.12	1050	104	2293
27-86	03/19/87	144	42.0	245	-	793
	04/15/87	167	0.20U	260	-	756
	06/24/87	160	0.20U	188	-	812
	09/23/87	166	0.20U	340	-	842
	12/16/87	141	0.40	219	-	823
	03/21/87	163	0.43	220	-	818
30-86	09/19/86	430	NR	100	NR	NA
	03/23/87	179	1440	215	NA	8085
	04/15/87	215	8.40	340	334	9430
	06/24/87	288	2040	280	-	13740
	09/24/87	318	1520	301	-	14019
	01/15/88	276	1457	282	-	13682
	03/16/88	210	1410	205	-	10571
32-86	11/07/86	122	NR	101	-	616
	03/23/87	107	6.90	92	-	523
	04/15/87	107	1.88	92	-	575
	06/29/87	146	0.40	57	-	512
	09/23/87	121	0.46	66	-	547
	12/16/87	109	0.19	75	-	507
	03/21/88	121	0.04	65	-	501
39-87	03/16/88	7	0.10	134	NR	

Notes: (1) "-" Indicates value is below background concentrations
(2) "NR" Indicates sample not requested; "NA" indicates sample not analyzed

TABLE 5-15

RADIONUCLIDE CONCENTRATIONS ABOVE BACKGROUND IN BEDROCK WELLS (pCi/l)

Well No.	Date Sampled	$U^{233+234}$	U^{235}	U^{238}	$Pu^{239+240}$	Am^{241}	H_3
Background		(6.6(1.8))	ND	(7.5(1.7))	ND	ND	ND
14-86	09/18/86	7.4(0.7)	-	-	1.2(0.9)	-	-
	06/10/87	13(2)	-	14(2)	-	-	-
16-86	08/07/87	-	1.3(1.2)	-	-	-	-
25-86	03/18/87	9.1(2.6)	-	-	-	-	210
	01/15/88	6.6(1.1)	-	-	-	-	-
30-86	03/23/87	-	10(6)	125(29)	-	-	6400
	04/15/87	370(250)	-	-	-	-	8500
	06/24/87	150(50)	-	97(34)	-	-	9800
	09/24/87	139.6(21.1)	6.5(2.0)	93.1(14.7)	-	-	8611(825)
	01/15/88	160(34)	5.2(1.4)	100(22)	-	-	7900(200)
	03/16/88	NR	NR	NR	-	-	6300(200)
32-86	11/07/86	13(3)	NR	10(2)	-	-	-
	03/21/88	-	0.14(0.10)	-	-	-	-

With few exceptions, radionuclide concentrations are below estimated background levels (Table 5-15). Uranium 233 + 234, and uranium 238 occasionally exceeded background in wells 14-86, 25-86, and 32-86, however, the concentrations were within a factor of two of background. There was a one time occurrence at well 14-86 of plutonium at the low concentration of 1.2(0.9) pCi/l. It is likely these concentrations reflect natural variability in radionuclide concentrations.

As with the radionuclides, trace metal concentrations were infrequently detected at levels above background. (Table 5-13). Trace metals occurring above background at low concentrations, infrequently and seemingly at random include arsenic, cobalt, cadmium, mercury, molybdenum, selenium, zinc, and lead. In contrast, nickel often occurred above estimated background levels, however concentrations were generally within a factor of 2-3 of background. The data appear to indicate bedrock ground water is not contaminated with trace metals.

Inorganic Chemistry

As a group, the upper and lower deep sandstones encountered during drilling of many of the bedrock wells each have a unique chemistry. Wells 25-86, 14-86, and 16-86 are all completed in upper deep sandstones whereas wells 23-86, 27-86, 32-86, and 39-87 are all completed in lower deep sandstones. Ground water in the upper sandstones is a calcium/magnesium bicarbonate water, although sodium, chlorides, and sulfate also occur above background. Strontium also occurs an order of magnitude above background. Strontium is an element that should coexist with and behave similarly to calcium and magnesium. In contrast, ground water in the lower sandstones was low (generally within background ranges) of calcium, magnesium, strontium, and bicarbonate. This water is only elevated in sodium, chloride, and sulfate.

Summary of Bedrock Ground-Water Chemistry

Nitrate, the most prominent indicator of contamination arising from the solar ponds, is with few exceptions below 0.5 mg/l in bedrock ground water. The exceptions are the occurrence of 42 mg/l in well 27-86 (otherwise <0.5 mg/l at this well) and the occurrence of 6.9 and 1.9 mg/l on two sampling events of well 32-86 (otherwise <0.5 mg/l). These wells are both completed on the lower deep sandstone contamination of which by the solar ponds is a remote possibility. These nitrate concentrations appear to be outliers.

The nitrate, trace metal, and radionuclide data tend to support that the deep bedrock ground water is not impacted by the solar ponds or other unidentified solid waste management unit that may be upgradient. The high salt concentrations relative to background is likely due to dissolution of minerals in the bedrock system that does not occur in bedrock west of the plant. Indeed, the bedrock wells west of the plant are completed in the Laramie Formation which could be geochemically different from the Arapahoe Formation. The sporadic occurrence at low concentrations of VOC's in bedrock ground water does not provide convincing support to a hypothesis of VOC contamination of bedrock ground water.

It is concluded that the deep bedrock sandstone ground water is not impacted by the solar ponds or other possible upgradient SWMUs. The subcropping sandstone at wells 22-86 and 31-86 is partially dry (at well 31-86). The extent of bedrock ground water contamination in this unit, and the vertical extent of this unit, (although presumably not extensive), is unknown. The vertical extent of the subcropping sandstones at well 39-87 and borehole SP04-87, and the extent of any bedrock contamination is unknown at this time. Further investigation is required to fully characterize the nature and extent of potential contamination in these subcropping sandstones.

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-1 Solar Ponds Area Surficial Geology Map

Fiche location: A-SW-M 11

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-2 Solar Ponds Area, Cross Section Location Lines and Subcropping Sandstone (Plain View) Map

Fiche location: A-SW-M11

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-3 Solar Ponds Area, Cross Sections A-A', B-B', C-C', D-D', E-E', F-F', & G-G'

Fiche location: A-SW-M 11

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-4 Solar Ponds Area, Top of Bedrock Elevation Beneath Rocky Flats Alluvium

Fiche location: A-SW-M 11

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-5 Water Table Elevations AT The Solar Ponds for November 1986

Fiche location: A-SW-M11

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-6 : Water Table Elevations at the Solar Ponds for APRIL 1987

Fiche location: A-SW-M12

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This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-7: Water Table Elevations at the Solar Ponds for June 1987

Fiche location: A-SW-M12

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-8: Water Table Elevations at the Solar Ponds for August 1987

Fiche location: A-SW-M12

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-9: Water Table Elevations at the Solar Ponds for November 1987

Fiche location: A-SW-M12

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 5-10: Water Table Elevations at the Solar Ponds for APRIL 1988

Fiche location: A-SW-M12

SOLAR EVAPORATION PONDS

HYDROGEOLOGIC CHARACTERIZATION REPORT

ROCKY FLATS PLANT

GOLDEN, COLORADO

JULY 1, 1988

Prepared for:

Rockwell International
Aerospace Operations
Rocky Flats Plant
Golden, Colorado 80401

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SECTION 6

SURFACE WATER CHARACTERIZATION

Surface water drainage from the Solar Ponds Area is toward North Walnut and South Walnut Creeks (Figure 6-1). A series of retention ponds known as the A series ponds are located on North Walnut Creek, and a series of retention ponds known as the B series ponds are located on South Walnut Creek. South Walnut Creek joins North Walnut Creek and an unnamed tributary, coming from the landfill area, approximately 0.7 miles downstream of the eastern edge of the Plant security area within the buffer zone. The Walnut Creeks then flow eastward approximately one mile to Great Western Reservoir. For this characterization, surface water quality data from August 1986, and July and November 1987 will be discussed as will other historical data from the solar ponds area.

Background surface water quality at the Rocky Flats Plant has not been thoroughly characterized; however, for the purpose of characterizing surface water downgradient of the solar ponds, the chemistry of the surface water quality is compared to local alluvial ground-water quality and health based water quality criteria. A plan for background soils, ground-water and surface water characterization is currently being prepared for Rocky Flats Plant. The water quality criteria examined are The Safe Drinking Water Act (SDWA), Maximum Contaminant Levels (MCLs), and the Colorado Department of Health (CDH) in-stream standards for tributaries to Great Western Reservoir. These surface water quality criteria are presented in Table 6-1. Where an MCL and an in-stream standard both

TABLE 6-1

SURFACE WATER QUALITY CRITERIA

METALS Analyte	CDH Water Quality Limited Standard (mg/l)	SDWA MCL (mg/l)	Water Quality Criteria (to be applied to Rocky Flats Plant site)
Aluminum	0.95		0.95 mg/l
Antimony			NS
Arsenic	0.05	0.05	0.05 mg/l
Barium	1.0	1.0	1.0 mg/l
Beryllium	0.1		0.1 mg/l
Cadmium	0.01	0.01	0.01 mg/l
Chromium III	0.05		0.05 mg/l
Chromium VI	0.05	0.05	0.05 mg/l
Cobalt			
Copper	1.0		1.0 mg/l
Lead	0.05	0.05	0.005 mg/l
Iron	0.3		0.3 mg/l
Manganese	0.05		0.05 mg/l
Mercury	0.002	0.002	0.002 mg/l
Molybdenum			NS
Nickel	0.05		0.05 mg/l
Selenium	0.01	0.01	0.01 mg/l
Silver	0.05	0.05	0.05 mg/l
Strontium			NS
Thallium	0.015		0.015 mg/l
Vanadium			NS
Zinc	5.0		5.0 mg/l

TABLE 6-1
(CONTINUED)

SURFACE WATER STANDARDS AND CRITERIA

RADIONUCLIDES Analyte	CDH Water Quality Limited Standard (mg/l)	SDWA MCL (mg/l)	Water Quality Criteria (to be applied to Rocky Flats Plant site)
Gross Alpha		15 pCi/l	15 pCi/l
Gross Beta		50 pCi/l	50 pCi/l
$Pu^{238,\ 239,\ 240}$ *		40 pCi/l	40 pCi/l
Am^{241} *		4 pCi/l	4 pCi/l
H^{3}		20000 pCi/l	20000 pCi/l
Sr^{90}		8 pCi/l	8 pCi/l
Cs^{134}		100000 pCi/l	100000 pCi/l
Cs^{137}		100 pCi/l	100 pCi/l
$Radium^{226}$		5 pCi/l	5 pCi/l
$Radium^{228}$		5 pCi/l	5 pCi/l
$Thorium^{230,\ 232}$			
$Uranium^{total}$		40^{**} pCi/l	
Major Ions			
pH	6.5-9.0		6.5-9.0
Nitrate	10.0		10.0 mg/l
Nitrite	0.5		0.5 mg/l
Chloride	250		250 mg/l
Sulfate	250		250 mg/l
Sulfides	0.002		0.002 mg/l
Cyanide (total)	0.200		0.200 mg/l
TDS		500^{***}	500^{***} mg/l

TABLE 6-1
(CONTINUED)

SURFACE WATER STANDARDS AND CRITERIA

VOLATILE ORGANICS Analyte	CDH Water Quality Limited Standard (mg/l)	SDWA MCL (mg/l)	Water Quality Criteria (to be applied to Rocky Flats Plant site)
CCl_4		0.005	0.005 mg/l
Chloroform		0.100	0.100 mg/l
1,2-DCA		0.005	0.005 mg/l
1,1-DCE		0.007	0.007 mg/l
trans-1,2-DCE			NS
Tetrachloroethene			NS
Toluene			NS
1,1,1-TCA		0.200	0.200 mg/l
1,1,2-TCA			NS
TCE		0.005	0.005 mg/l
Acetone			NS
Methylene Chloride			NS

* Proposed value in drinking water yielding a risk equal to that from a dose rate of 4 mrem/yr. September 30, 1986 (51FR34859).

** CDH Water Quality Standard for Surface Water [5CCR 1002-8, Section 3.8.5(3)]

*** SDWA Secondary Maximum Concentration Limit (SMCL)

NS = No standard

exist for an analyte, it is noted that they are equivalent. It is further noted that a discharge to the drainage is necessary for these criteria to be considered enforceable. They are presented here merely to provide perspective for the water quality observed at the Rocky Flats Plant.

6.1 NORTH WALNUT CREEK

North Walnut Creek is an eastward flowing stream located north of the solar ponds area. Surface runoff patterns (Figure 6-1) indicate flow entering the drainage from the solar ponds area, the 700 building complex, 300 building complex, and general surface runoff from the north and west sides of the Plant. Due to the surface drainage pattern any releases from the 700 and 300 areas would flow into North Walnut Creek above the retention ponds in the drainage located north of Pond 207-C. Potentiometric surface maps indicate flow to the northeast from the Solar Evaporation Ponds Area toward the Walnut Creek drainage. The water table in valley fill alluvium is slightly above or at stream elevation in the drainage, as evidenced by all water level measurements taken in wells 17-86 and 15-86.

The A series ponds on North Walnut Creek are designated A-1, A-2, A-3, and A-4, from west to east. Ponds A-1 and A-2 are used only for spill control, and North Walnut Creek stream flow is diverted around them through an underground pipe. Until 1980, Ponds A-1 and A-2 were used for storage and evaporation of laundry water. Pond A-3 receives the North Walnut Creek stream flow and runoff from the northern portion of the Plant. Pond A-4 is designed for surface water control and for additional storage capacity for overflow from Pond A-3. Discharges from Pond A-4 (discharge point 005) and Pond A-3 (discharge point 002) are in accordance with the NPDES permit.

The discharges from the ponds are regularly monitored to document compliance with NPDES permit requirements. In addition to NPDES monitoring requirements, all discharges are monitored for plutonium, americium, uranium, and tritium concentrations.

6.1.1 Surface Water Flow--North Walnut Creek

As part of the initial site characterization, during August 1986 (Rockwell International, 1986a), flow rates were measured in all of the site natural drainages and ditches using a portable cut-throat flume and the Parshall flumes used for NPDES monitoring. The results of flow rate measurements for North Walnut Creek are presented in Table 6-2 and discussed below. Flow rates were not measured during 1987 surface water sampling. Flow in North Walnut Creek is dependent upon water control management, surface water runoff, and influx from ground water.

Of the seven surface water stations (Plate 6-1) along the North Walnut Creek drainage, only SW-17 (upstream of Pond A-1) and SW-18 (371 tributary) had measurable flow rates of 4.6 gallons per minute (gpm) and 1.6 gpm, respectively, in August 1986 . Stations SW-7, SW-8, SW-9, and SW-11 (in upper Walnut Creek) and SW-16 (downstream of Pond A-4) were not flowing in August 1986. The increased flow at SW-17 is probably due to additional influx of ground water and footing drain flows associated with the Solar Evaporation Ponds. The flow rate at SW-3 (below North and South Walnut Creek confluence) was 138 gpm. This flow rate is due to a retention pond discharge along the Walnut Creek drainage system.

TABLE 6-2

SURFACE WATER FLOW RATES
AUGUST 1986

Station Number	Measurement Date	Flow Rate (cfs)	Flow Rate (gpm)
SW-7	8-11-86	0.0000	0.0
SW-8	8-11-86	0.0000	0.0
SW-9	8-11-86	0.0000	0.0
SW-11	8-11-86	0.0000	0.0
SW-18	8-12-86	0.0036	1.6
SW-17	8-12-86	0.0102	4.6
SW-16	8-12-86	0.0000	0.0
SW-3	8-20-86	0.3074	138

6.1.2 Water Quality--North Walnut Creek

Surface water samples collected in August 1986 and July and November 1987, were analyzed for HSL volatile organics, semi-volatiles, pesticide/PCB's, major inorganic ions, metals and radionuclides (Table 6-3). Those analytes exceeding detection limits are presented in Tables 6-4 through 6-7. The tables indicate detection limits for the analytes as well as the surface water quality criteria for comparative purposes.

In general, for the ponds and surface water stations where water was present, HSL volatile organics are either not detectable, at estimated values below detection limits, or suspect because of laboratory blank contamination. Methylene chloride was present at SW-18 at 22 ug/l, but the significance of this observation cannot be determined without further data. Additionally, no pesticide/PCB compounds were above laboratory detection limits, and, with the exception of N-Nitrosodiphenylamine, semivolatiles were not above detection limits. N-Nitrosodiphenylamine was detected at 300 ug/l in 1986 samples collected from Ponds A-1 (SW-A1) and A-4 (SW-A4). The occurrence of this compound cannot be related to ground water or soils in the area and appears to reflect laboratory contamination. The major ions, chloride and sulfate, did not exceed surface water quality criteria, nor did radionuclide concentrations.

SW-18, located in the 371 tributary, was the farthest upstream station that had flow in 1986. SW-18 flows into North Walnut Creek north of the Solar Pond area. Radionuclide concentrations exceed laboratory detection limits but did not exceed surface water quality criteria. However, iron (2.17 mg/l) and manganese (0.41 mg/l)

TABLE 6-3

SURFACE WATER SAMPLE INFORMATION
SOLAR POND SURFACE WATER SAMPLES

SAMPLE INFORMATION						LABORATORY BATCH NUMBERS					
Station Number	Number	Date	pH	Conduct (umho/cm)	Temp. (deg C)	Volatile Organics	Semi-Volatile Organics	Pesticides and PCB's	Metals	Inorganics	Radiochemistry
SW03	SW03088600	08/20/86	6.80	350	20.0	8608-044-021	8608-044-004	8608-044-004	8608-044-022	8608-044-023	1000-000-369
SW16	DRY	08/12/86									
SW17	SW17088600	08/12/86	6.00	700	17.0	8608-024-001	No Sample	8608-672-007	8608-024-003	8608-024-004	1000-000-371
SW18	SW18088600	08/22/86	7.40	28	19.0	8606-056-006	8608-056-002	8608-056-002	8608-056-007	8608-056-008	1000-000-373
SWA1	SWA1088600	08/14/86	8.30	827	22.0	8608-029-001	8608-055-001	8608-055-001	8608-029-003	8608-029-004	1000-000-391
SWA2	SWA2088600	08/14/86	8.50	1500	22.0	8608-029-007	8608-055-002	8608-055-002	8608-029-009	8608-029-010	1000-000-393
SWA3	SWA3088600	08/14/86	6.90	816	25.0	8608-029-013	8608-055-003	8608-055-003	8608-028-015	8608-028-016	1000-000-394
SWA4	SWA4088600	08/14/86	7.00	318	22.0	8608-029-019	8608-055-004	8608-055-004	8608-029-021	8608-029-022	1000-000-395
SWB1	SWB1088600	08/16/86	8.40	3498	21.0	8608-033-001	8608-057-006	8608-053-006	8608-033-002	8608-033-003	1000-000-396
SWB2	SWB2088600	08/15/86	9.50	475	26.0	8608-033-006	8608-057-001	8608=053-001	8608-033-007	8608-033-008	1000-000-398
SWB3	SWB3088600	08/15/86	6.90	370	23.0	8608-033-011	8608-057-002	8608-053-002	8608-033-012	8608-033-013	1000-000-399
SWB4	SWB4088600	08/15/86	7.00	550	24.0	8608-033-016	8608-057-003	8608-053-003	8608-033-017	8608-033-018	1000-000-400
SWB5	SWB5088600	08/18/86	8.00	367	28.0	8608-036-037	8608-058-002	8608-058-002	8608-036-039	8608-036-040	1000-000-401

TABLE 6-4

VOLATILE ORGANIC CONCENTRATIONS IN SURFACE WATER
(ug/l)

Station	1,1-DCE	t1,2-DCE	$CHCl_3$	1,2-DCA	1,1,1-TCA	CCl_4	TCE	1,1,2-TCA	PCE	Acetone	MeCl
Water Quality Criteria[1]		NS	100	5	200	5	5	NS	NS	NS	NS
SW-18	<5U	<5U	<5U	<5U	<5U	<5U	2**	<5U	<5U	5[b]	22
SW-17	<5U	3**	<5U	<5U	<5U	<5U	1**	<5U	<5U	<10	<5
A-1	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	3[b]	1**
A-2	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	3[b]	2**
A-3	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	4[b]	4**
A-4	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	7[b]	<5
SW-3	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<5U	<10	<5

1 Water Quality Criteria presented in Section 6.0, Table 6-1.

U Signifies the detection limit.

** Estimated value, detected but below detection limit.

b Compound also detected in the blank.

TABLE 6-5

MAJOR ION CONCENTRATIONS AND OTHER PARAMETERS FOR SURFACE WATER (mg/l)

STATION	Ca	K	Mg	Na	NO_3	HCO_3	CO_3	Cl	CN	PO_4	SO_4	TDS
Water Quality Criteria[1]					10			250	0.200		250	500
SW-18	130	3.1	29	37	<5U	12	290	29	<0.005U	1.7	58	439
SW-17	85.5	26.4	24.2	53.2	17.2	NA	NA	51	<0.001U	NA	94	530
A-1	26.9	36.9	10.8	104	<5U	NA	NA	82	<0.001U	NA	53	534
A-2	86.1	72.7	20.3	193	<5U	NA	NA	156	<0.0013U	NA	212	1070
A-3	27.4	47.1	14.6	67.1	<5U	NA	NA	69	<0.0013U	NA	152	507
A-4	16.4	15.5	4.55	14.8	<5U	NA	NA	21	<0.001U	NA	30	279
SW-03	47.5	<0.100	6.0	23.2	<5U	NA	NA	15	<0.005U	NA	39	180

U Signifies the detection limit. NA = Not Analyzed

[1] Water Quality Criteria presented in Section 6.0, Table 6-1

TABLE 6-6

METAL CONCENTRATIONS IN SURFACE WATER
(mg/l)

STATION	Al	As	Ba	Be	Cr	Cu	Fe	Hg	Mn	Mo	Pb	Se	Sr	Tl	V	Zn
Water Quality Criteria [1]	0.95	.05	1.0	.1	.05	1.0	.3	.002	.05	NS	.05	.01	NS	.015	NS	5.0
SW-18	<0.100U	<0.100U	<0.100U	<0.005U	<0.010U	<0.020U	2.17	<0.0002U	0.41	<0.10U	<0.005U	<0.005U	0.64	<0.010U	<0.050U	<0.020U
SW-17	<0.100U	<0.001U	0.340	<0.005U	<0.005U	<0.020U	<0.030U	0.0008	0.660	<0.10U	<0.005U	0.0016	0.76	0.029	<0.050U	0.090
A-1	0.150	0.002U	0.150	<0.005U	0.009	<0.020U	0.080	<0.0002U	<0.010U	<0.10U	<0.005U	<0.002U	0.20	<0.010U	<0.050U	4.21
A-2	0.580	0.002	0.170	<0.005U	0.022	<0.020U	0.240	0.0014	0.080	<0.10U	<0.005U	<0.002U	0.36	0.015	<0.005U	4.2
A-3	<0.100U	<0.001U	0.150	<0.005U	0.0091	<0.020U	<0.030U	0.00081	0.240	<0.10U	0.006	<0.002U	0.34	<0.010U	<0.050U	0.040
A-4	<0.100U	<0.001U	0.120	<0.005U	0.010	<0.020U	<0.030U	<0.0002U	0.020	<0.10U	0.008	<0.002U	0.15	<0.010U	<0.050U	0.040
SW-3	<0.100U	<0.002U	<0.100U	0.090	<0.010U	0.030	<0.075U	<0.0002U	0.020	0.300	<0.010U	<0.002U	0.36	<0.010U	0.313	0.300

U signifies the detection limit.
The following metals were not detected: Ag(0.010U), Cd (0.005U), Co (0.050U), Cs (0.100U), Ni (0.040U), and Sb (0.020U).

[1] Water Quality Criteria presented in Section 6.0, Table 6-1.

TABLE 6-7

RADIONUCLIDE CONCENTRATIONS IN SURFACE WATER
(pCi/l)

STATION	GROSS ALPHA	GROSS BETA	PLUTONIUM	AMERICIUM	U^{234}	U^{238}	TRITIUM
Water Quality Criteria[1]	15	50	40	4	40	40	20000
SW-18	4(5)	2(4)	1.9(0.5)	1.4(0.5)	-0.03(0.05)	0.04(0.04)	0.07(0.21)
SW-17	6(10)	4(5)	0.0(0.03)	0.0(0.02)	3.3(0.4)	2.9(0.4)	0.19(0.22)
A-1	10(9)	12(5)	0.24(0.14)	0.02(0.03)	1.4(0.3)	1.3(0.2)	0.16(0.22)
A-2	7(14)	23(8)	0.17(0.06)	0.05(0.04)	6.4(0.7)	5.8(0.7)	0.09(0.22)
A-3	18(10)	14(5)	0.03(0.06)	0.01(0.02)	3.0(0.4)	2.1(0.3)	0.03(0.22)
A-4	2(2)	5(2)	0.0(0.07)	0.05(0.04)	0.81(0.19)	0.49(0.16)	0.10(0.22)
SW-03	2(3)	3(3)	-0.04(0.17)	0.02(0.03)	0.63(0.22)	0.60(0.20)	-0.09(0.24)

* Units pCi/l
Parentheses indicate 2 standard deviation error

1 Water Quality Criteria presented in Section 6.0, Table 6-1

did exceed surface water quality criteria. SW-18 is not impacted by the Solar Evaporation Ponds but may impact downgradient surface water stations.

SW-17, located due north of the Solar Evaporation Ponds in Woman Creek, had metal and total dissolved solid (TDS) concentrations that were elevated with respect to surface water quality criteria. The TDS concentration was 530 mg/l, with dominant ions of calcium, sodium, chloride, and sulfate. Manganese and thallium were the metals exceeding their respective water quality criteria. Radionuclides did not exceed surface water quality criteria.

The major differences between surface water quality at SW-18 and SW-17 are noted by elevated concentrations of potassium, sodium, sulfate, chloride, nitrate, barium, thallium, and uranium at SW-17 relative to SW-18. These analytes are elevated in alluvial ground water in the vicinity of SW-17, suggesting this reach of North Walnut Creek is recharged to some extent by ground water. Furthermore, the potentiometric surface maps indicate ground-water flow toward the drainage and the water table is at or near the stream elevation.

As mentioned, Pond A-1 and Pond A-2 are downgradient of SW-17 but are isolated from the main flow of the drainage. These ponds are zero discharge spill control units. TDS exceeds the water quality criteria in both Pond A-1 (534 mg/l) and Pond A-2 (1070 mg/l). Manganese (0.080 mg/l) in Pond A-2 also exceeded the water quality criteria. In general, the elevated concentrations of potassium, sodium, chloride, and sulfate (Pond A-2 only) suggest recharge of these ponds by alluvial ground water. Also, the potentiometric surface of alluvial ground water is at or near the pond's water elevations. However, nitrate is conspicuously absent in the ponds and zinc is significantly elevated (4.2 mg/l in both ponds) relative to alluvial groundwater.

The absence of nitrate may be due to uptake by plants and algae in the ponds, and the elevated zinc may be characteristic of the laundry effluent historically discharged to the ponds. The extent to which there is ground-water influx to Ponds A-1 and A-2 is unknown.

Pond A-3 (SW-A3) receives Walnut Creek flow and possible ground-water influx from the northeast, as indicated by the potentiometric surface of the ground water. As expected, water quality at Pond A-3 is very similar to that at SW-17. TDS (507 mg/l) and manganese (0.240 mg/l) are the only analytes exceeding the water quality criteria. Again, the absence of nitrate may be due to nitrate uptake by plants and algae. However, maximum nitrate concentrations from the NPDES monitoring data (1980-1985, NPDES discharge point #002) exceeded the water quality criteria. Maximum concentrations were 16, 11, and 11 mg/l for the years 1980, 1984, and 1985, respectively. It is noted, however, that the average nitrate concentrations over the same period range from 4 to 8 mg/l falling below the 10 mg/l water quality criteria. This is in compliance with NPDES Permit Requirements. The nitrate values are likely reflective of influence of upgradient alluvial ground water flowing to the north-northeast from the Solar Evaporation Ponds into the North Walnut Creek drainage as discussed in Section 5.2.1.2.

Pond A-4 receives overflow from Pond A-3. In general, concentrations found in A-4 are less than respective compound concentrations in A-3. Concentrations of all analytes were below the water quality criteria. Pond A-4 discharges are also in accordance with the Plant's NPDES permit. Historical data from NPDES permit sampling show a slight increase in nitrate for the period 1982 (2.5 mg/l) to 1985 (4.5 mg/l). These concentrations probably reflect elevated nitrate discharges to Pond A-4 from Pond A-3. Lower analyte concentrations in Pond A-4 relative to Pond A-3 may be due to dilution of the discharges to Pond A-4 by local runoff.

The farthest downstream surface water station on Plant site that had flow in August 1986 is SW-3 at Indiana Street. Major ions, metals, and radionuclides (Table 6-8) were all below surface water quality criteria. The trace metal vanadium was detected at 0.313 mg/l. The absence of detectable vanadium upstream renders this data point a possible outlier.

6.1.3 Summary

Analytes exceeding water quality criteria in North Walnut Creek include manganese, thallium, iron and TDS. Manganese exceeded water quality criteria at SW-18 and SW-17 and Ponds A-2 and A-3; thallium exceeded criteria at SW-17 and iron at SW-18. TDS exceeded the water quality criterion at SW-17 and Ponds A-1, A-2, and A-3. The highest concentration of each of these analytes occurs in Pond A-2 and may reflect residual contaminants from past usage to store laundry effluents. Ponds A-1 and A-2 are currently used for spill control and do not discharge to the North Walnut Creek drainage. Water loss from the ponds is through natural evaporation which is enhanced by spraying water through fog nozzles over the surface of the ponds. At Pond A-3, TDS and manganese exceeded the water quality criteria. However, discharges from this pond are in compliance with the Plant's NPDES Permit. Furthermore, at the most downgradient station (SW-3 at Indiana Street), all analyte concentrations are below the water quality criteria.

TABLE 6-8

PLUTONIUM, URANIUM, AMERICIUM, AND TRITIUM CONCENTRATIONS

SW-3, WALNUT CREEK AT INDIANA

Radionuclides	1976	1977 (54)	1987	1979	1980	1981	1982	1983	1984	1985	1986	1987
Plutonium												
C_{MIN}	0.105	<0.1			<0.008	0.00±0.01	0.03±0.03	0.02±0.01	0.02±0.01	0.01±0.05	0.01±0.02	
C_{MAX}	1.603	3.8			<0.1	0.07±0.04	0.07±0.04	0.06±0.04	0.05±0.02	0.08±0.01	0.05±0.01	
C_{AVG}	0.529	<0.3			<0.03	0.020±0.004	0.013±0.003	0.014±0.007	0.015±0.003	0.018±0.020	0.013±0.001	
Uranium**												
C_{MIN}	1.523	0.2			<1.0	1.2±0.1	0.3±0.13	0.04±0.03	0.01±0.07	0.3±0.15	0.0±0.1	
C_{MAX}	7.087	8.1			14±3	11.9±0.3	11.1±0.93	0.6±0.2	7.8±0.8	8.3±0.85	11±1	
C_{AVG}	3.754	1.5			<6.0	7.6±0.1	5.0±0.13	4.0±0.1	4.10±0.06	3.96±0.07	5.6±0.12	
Americium												
C_{MIN}	0.007	<0.1			<0.002	-0.01±0.01	-0.05±0.05	0.04±0.05	-0.063±00.003	-0.05±0.05	0.01±0.02	
C_{MAX}	0.742	0.8			<0.1	0.08±0.07	0.08±0.07	0.06±0.09	0.14±0.04	0.05±0.06	0.04±0.06	
C_{AVG}	0.197	<0.1			<0.03	0.011±0.004	0.011±0.005	0.007±0.004	0.010±0.003	0.013±0.003	0.007±0.004	
Tritium			(52)									
C_{MIN}	<500	526	<500		<400	-300±500	-400±600	-900±900	-400±400	900±1100	300±400	
C_{MAX}	2160	1873	1400		1300±600	1000±500	900±500	1100±700	800±7001	700±700	700±4002	
C_{AVG}	<1098	919	<900		<700	-100±100	-100±100	200±100	200±100	100±100	200±1002	

** Total uranium

Ref. Rockwell International, 1977, 1978, 1979, 1980, 1981a, 1982a, 1983a, 1984a, 1985, 1986g, 1987a

It is concluded that degradation of surface water quality in North Walnut Creek is due, in part, to recharge by alluvial ground water in the vicinity of the solar ponds, particularly at SW-17. However, containment of the flow by Pond A-3 and Pond A-4 with attendant reduction in analyte concentrations by natural processes, renders the quality of the water leaving the Plant site acceptable with respect to the water quality criteria established here.

6.2 SOUTH WALNUT CREEK

South Walnut Creek is an eastward flowing stream located to the east of the Solar Pond Area. South Walnut Creek receives surface water run-off from the central portion of the Plant site. The Plant surface water drainage pattern (Figure 6-1) indicates surface water drainage from the area south and southeast of the 207B Ponds flowing in a southeasterly direction toward South Walnut Creek. However, the drainage pattern also indicates runoff from the Mound and 903 Pad Areas located to the south of the Solar Evaporation Ponds would contribute significantly to flow in South Walnut Creek.

The potentiometric surface maps (Plates 5-5 to 5-10) indicate some component of ground-water flow in a south, southeast direction from Pond 207-B toward the South Walnut Creek drainage. However, this is not continuous as wells to the southeast of the 207-B Ponds are frequently dry. The discussion in the 903 Pad, Mound, and East Trenches Areas Remedial Investigation Report (Rockwell International, 1987b) attributes most of the surface water contamination in South Walnut Creek to the Mound and 903 Pad Areas. For the above reasons, it is not felt that the Solar Evaporation Ponds are contributing to South Walnut Creek contamination.

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000288

Titled: Plate 6-1: Surface Water and Sediment Monitoring Locations

Fiche location: A-SW-M12

SECTION 7

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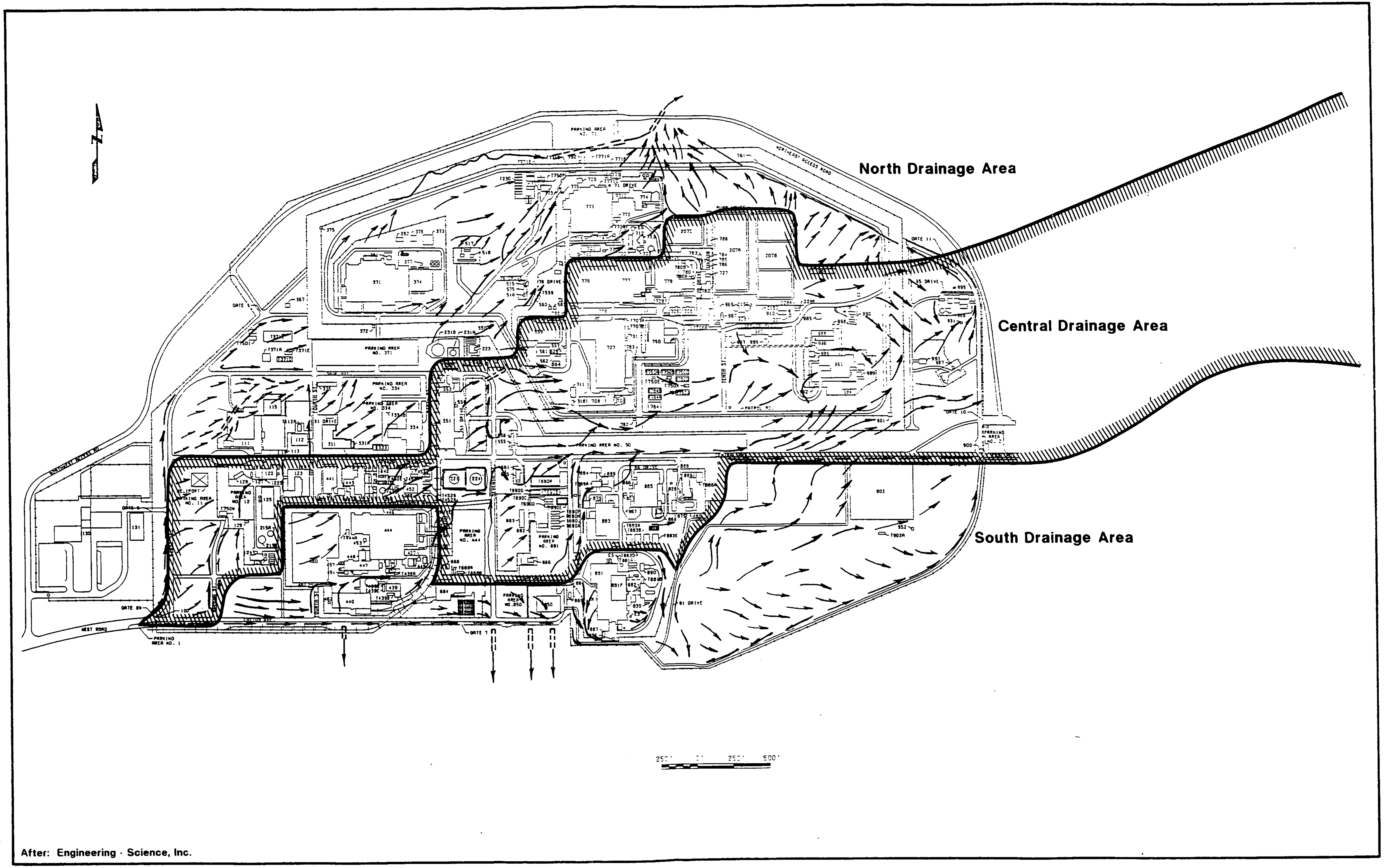

Figure 6-1: PLANT SURFACE RUNOFF DRAINAGE PATTERN

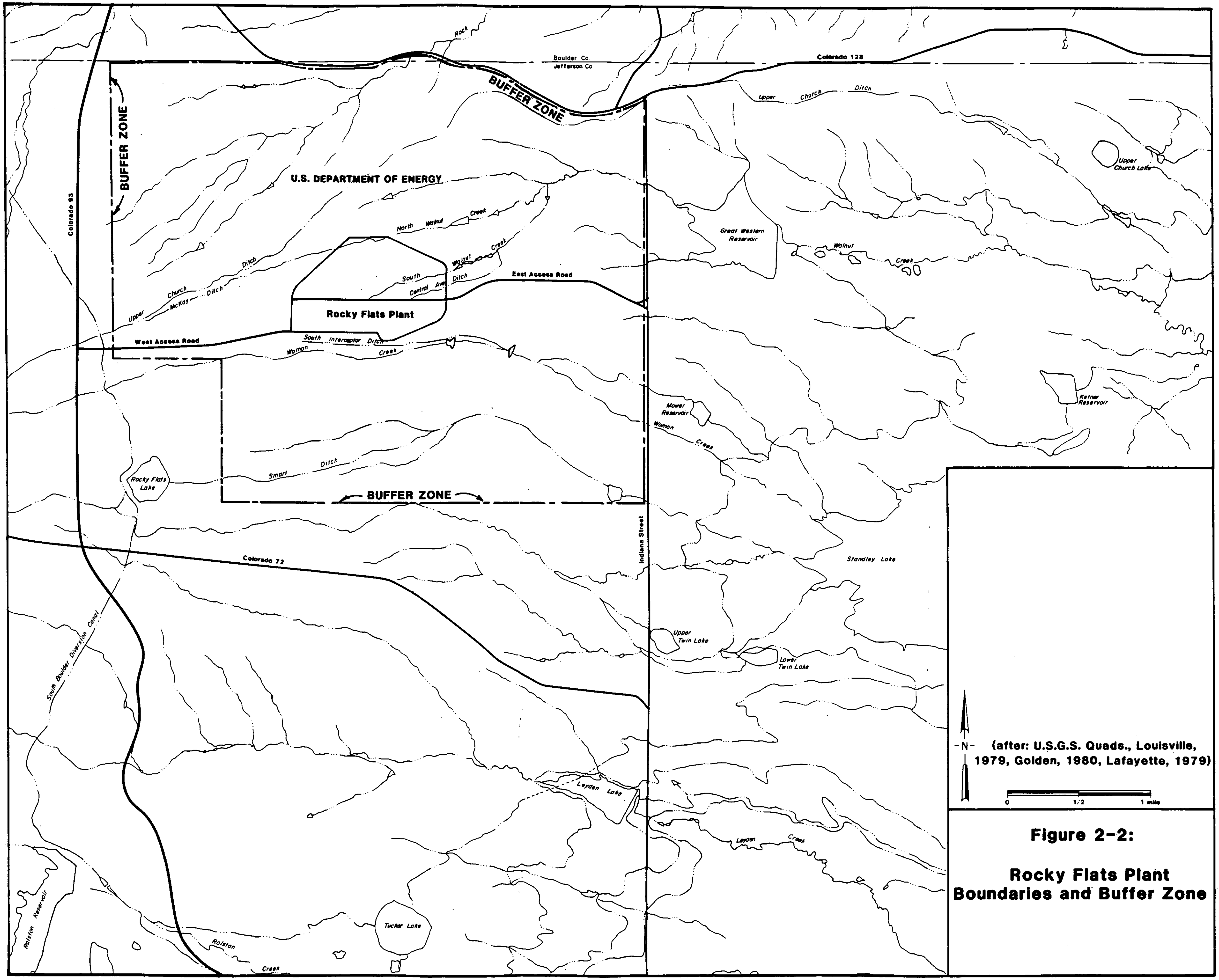

Figure 2-2:

Rocky Flats Plant Boundaries and Buffer Zone