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NAS FORT WORTH
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FINAL REMEDIAL ACTION PLAN FOR RISK BASED REMEDIATION OF SITE SOLID WASTE MANAGEMENT UNIT 64, 67, 68 AND AREA OF CONCERN 7 VOLUME 2 OF 2 NAS FORT WORTH TX

7/1/1997

PARSONS ENGINEERING

File: 17G
A.F.

332 0

NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 332

File:
A.F. 17A-39

332 332 1

FINAL

REMEDIAL ACTION PLAN
FOR THE RISK-BASED REMEDIATION OF SITE ST14(SWMU 68)
LPST ID 104819;
THE FORMER BASE REFUELING AREA (AOC7);
THE FRENCH UNDERDRAIN SYSTEM (SWMU 64);
AND THE NORTH OIL/WATER SEPARATOR (SWMU67).

VOLUME II: APPENDICES

CARSWELL AIR FORCE BASE
NAVAL AIR STATION FORT WORTH JOINT RESERVE BASE
TEXAS

JULY 1997

Prepared for

Air Force Center for Environmental Excellence
Brooks Air Force Base
San Antonio, Texas

and

Carswell Air Force Base/Naval Air Station Fort Worth Joint Reserve Base, Texas

Prepared by
Parsons Engineering Science, Inc.
Denver and Austin (CAS #RCAS00101B)

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APPENDIX A

ANALYTICAL RESULTS FOR 1994/1995 SAMPLING EVENTS,

1995/1996 GROUNDWATER MONITORING SUMMARY (DETECTS),

1997 GROUNDWATER MONITORING SUMMARY (DETECTS),

1997 SURFACEWATER MONITOIRNG RESULTS

ANALYTICAL RESULTS FOR 1994/1995 SAMPLING EVENT

TABLE A.1
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW05	25-Mar-94	1.00 - 3.00	Petroleum Hydrocarbons	90		mg/kg	E418.1
			Toluene	0.0008		mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW05	25-Mar-94	3.00 - 5.00	Petroleum Hydrocarbons	2500		mg/kg	E418.1
			Toluene	0.0005	U	mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW05	25-Mar-94	5.00 - 7.00	Petroleum Hydrocarbons	110		mg/kg	E418.1
			Toluene	0.0005	U	mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW05	25-Mar-94	7.00 - 9.00	Petroleum Hydrocarbons	40		mg/kg	E418.1
			Toluene	0.0012		mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW06	24-Mar-94	0.00 - 2.00	Petroleum Hydrocarbons	440		mg/kg	E418.1
			Toluene	0.0017	U	mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW06	24-Mar-94	6.00 - 8.00	Petroleum Hydrocarbons	670		mg/kg	E418.1
			Toluene	0.013		mg/kg	SW8020
			Ethylbenzene	0.036		mg/kg	SW8020
			Xylenes (Total)	0.052		mg/kg	SW8020
SD13-MW07	24-Mar-94	2.00 - 4.00	Petroleum Hydrocarbons	54		mg/kg	E418.1
			Toluene	0.0032		mg/kg	SW8020
			Ethylbenzene	0.0005	U	mg/kg	SW8020
			Xylenes (Total)	0.001	U	mg/kg	SW8020
SD13-MW07	24-Mar-94	8.00 - 10.00	Petroleum Hydrocarbons	8800		mg/kg	E418.1
			Toluene	2.5	U	mg/kg	SW8020
			Ethylbenzene	30		mg/kg	SW8020
			Xylenes (Total)	29		mg/kg	SW8020
SD13-PT1	9-Mar-95	7.50 - 9.50	Benzene	0.44	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	1.4	J	µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Method
SD13-PT1 (Cont)	9-Mar-95	7.50 - 9.50	Xylenes (Total)	6.9		µg/kg	SW802
			1,3,5-Trimethylbenzene	4.1	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	0.5	J	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	13		µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
SD13-PT1	10-Mar-95	7.50 - 9.50	Total Extractable Hydrocarbons	140		mg/kg	SW801
SD13-PT10	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11.4	U	mg/kg	SW801
			Benzene	0.44	U	µg/kg	SW802
			Toluene	4.4	U	µg/kg	SW802
			Ethylbenzene	4.4	U	µg/kg	SW802
			Xylenes (Total)	4.4	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.4	U	µg/kg	[illegible]
			Chlorobenzene	4.4	U	µg/kg	[illegible]
SD13-PT2	9-Mar-95	6.50 - 8.50	Benzene	0.48	U	µg/kg	SW802
			Toluene	4.8	U	µg/kg	SW802
			Ethylbenzene	4.8	U	µg/kg	SW802
			Xylenes (Total)	4.8	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.8	U	µg/kg	SW802
			Chlorobenzene	4.8	U	µg/kg	SW802
SD13-PT2	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11	U	mg/kg	SW801
SD13-PT3	9-Mar-95	6.50 - 8.50	Benzene	0.47	U	µg/kg	SW802
			Toluene	4.7	U	µg/kg	SW802
			Ethylbenzene	4.7	U	µg/kg	SW802
			Xylenes (Total)	4.7	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.7	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.7	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.7	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.7	U	µg/kg	SW802
			Chlorobenzene	4.7	U	µg/kg	SW802
SD13-PT3	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11	U	mg/kg	[illegible]

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
SD13-PT4	9-Mar-95	6.50 - 8.50	Benzene	0.44	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	4.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	1.3	J	µg/kg	SW8020
			Chlorobenzene	4.4	U	µg/kg	SW8020
SD13-PT4	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11.6	U	mg/kg	SW8015
SD13-PT8	9-Mar-95	6.50 - 8.50	Benzene	0.49	U	µg/kg	SW8020
			Toluene	4.9	U	µg/kg	SW8020
			Ethylbenzene	4.9	U	µg/kg	SW8020
			Xylenes (Total)	4.9	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.9	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.9	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.9	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.9	U	µg/kg	SW8020
			Chlorobenzene	4.9	U	µg/kg	SW8020
SD13-PT8	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	83		mg/kg	SW8015
SD13-PT13	9-Mar-95	6.50 - 8.50	Benzene	2.2	U	µg/kg	SW8020
			Toluene	22	U	µg/kg	SW8020
			Ethylbenzene	22	U	µg/kg	SW8020
			Xylenes (Total)	22	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	22	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	22	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	22	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	22	U	µg/kg	SW8020
			Chlorobenzene	22	U	µg/kg	SW8020
SD13-PT13	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11	U	mg/kg	SW8015
SD13-PT5	9-Mar-95	6.50 - 8.50	Benzene	0.44	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	4.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
SD13-PT5 (Cont)	9-Mar-95	6.50 - 8.50	1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	0.9	J	µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
SD13-PT5	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11.1	U	mg/kg	SW801
SD13-PT6	9-Mar-95	6.50 - 8.50	Benzene	0.46	U	µg/kg	SW802
			Toluene	4.6	U	µg/kg	SW802
			Ethylbenzene	4.6	U	µg/kg	SW802
			Xylenes (Total)	4.6	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.6	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.6	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.6	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.6	U	µg/kg	SW802
			Chlorobenzene	4.6	U	µg/kg	SW802
SD13-PT6	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	12.2	U	mg/kg	SW801
SD13-PT7	9-Mar-95	6.50 - 8.50	Benzene	0.44	U	µg/kg	SW802
			Toluene	4.4	U	µg/kg	SW802
			Ethylbenzene	4.4	U	µg/kg	SW802
			Xylenes (Total)	4.4	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.4	U	µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
SD13-PT7	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11.1	U	mg/kg	SW801
SD13-PT11	10-Mar-95	7.50 - 9.50	Total Extractable Hydrocarbons	10.9	U	mg/kg	SW801
			Benzene	2.2	U	µg/kg	SW802
			Toluene	22	U	µg/kg	SW802
			Ethylbenzene	22	U	µg/kg	SW802
			Xylenes (Total)	22	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	22	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	22	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	22	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	22	U	µg/kg	SW802
			Chlorobenzene	22	U	µg/kg	SW802
SD13-PT12	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11.4	U	mg/kg	SW801
			Benzene	0.45	U	µg/kg	SW802

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
SD13-PT12 (Cont)	10-Mar-95	6.50 - 8.50	Toluene	4.5	U	µg/kg	SW8020
			Ethylbenzene	4.5	U	µg/kg	SW8020
			Xylenes (Total)	4.5	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.5	U	µg/kg	SW8020
			Chlorobenzene	4.5	U	µg/kg	SW8020
SD13-PT14	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	10.9	U	mg/kg	SW8015
			Benzene	0.44	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	4.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.4	U	µg/kg	SW8020
			Chlorobenzene	4.4	U	µg/kg	SW8020
SD13-PT9	10-Mar-95	6.50 - 8.50	Total Extractable Hydrocarbons	11	U	mg/kg	SW8015
			Benzene	0.43	U	µg/kg	SW8020
			Toluene	4.3	U	µg/kg	SW8020
			Ethylbenzene	4.3	U	µg/kg	SW8020
			Xylenes (Total)	4.3	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.3	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.3	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.3	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.3	U	µg/kg	SW8020
			Chlorobenzene	4.3	U	µg/kg	SW8020
ST14-MPA	25-May-93	9.00 - 10.00	Petroleum Hydrocarbons	2500		mg/kg	E418.1
			Benzene	1800		µg/kg	SW8020
			Toluene	3700		µg/kg	SW8020
			Ethylbenzene	5300		µg/kg	SW8020
			Xylenes (Total)	36000		µg/kg	SW8020
ST14-VW1	25-May-93	5.00 - 6.00	Petroleum Hydrocarbons	890		mg/kg	E418.1
			Benzene	410		µg/kg	SW8020
			Toluene	580		µg/kg	SW8020
			Ethylbenzene	790		µg/kg	SW8020
			Xylenes (Total)	4200		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-VW1	25-May-93	10.00 - 11.00	Petroleum Hydrocarbons	1500		mg/kg	E418.1
			Benzene	270		µg/kg	SW802
			Toluene	530		µg/kg	SW802
			Ethylbenzene	1400		µg/kg	SW802
			Xylenes (Total)	8800		µg/kg	SW802
ST14-MPC	26-May-93	6.00 - 7.00	Petroleum Hydrocarbons	1100		mg/kg	E418.1
			Benzene	500	U	µg/kg	SW802
			Toluene	2000		µg/kg	SW802
			Ethylbenzene	3700		µg/kg	SW802
			Xylenes (Total)	24000		µg/kg	SW802
ST14-MPC	26-May-93	10.00 - 11.00	Petroleum Hydrocarbons	1500		mg/kg	E418.1
			Benzene	200	U	µg/kg	SW802
			Toluene	10000		µg/kg	SW802
			Ethylbenzene	2600		µg/kg	SW802
			Xylenes (Total)	17000		µg/kg	SW802
ST14-SB1	26-May-93	10.00 - 11.00	Petroleum Hydrocarbons	9300		mg/kg	E418.1
			Benzene	67000		µg/kg	SW802
			Toluene	5000	U	µg/kg	SW802
			Ethylbenzene	14000		µg/kg	SW802
			Xylenes (Total)	7700		µg/kg	SW802
ST14-MPBG2	15-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	47	J	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	SW802
			Ethylbenzene	2	U	µg/kg	SW802
			Xylenes (Total)	2	U	µg/kg	SW802
ST14-VW3	16-Jun-93	7.00 - 8.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	SW802
			Ethylbenzene	2	U	µg/kg	SW802
			Xylenes (Total)	4.1		µg/kg	SW802
ST14-VW3	16-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	4500		mg/kg	E418.1
			Benzene	1000		µg/kg	SW802
			Toluene	12000		µg/kg	SW802
			Ethylbenzene	3600		µg/kg	SW802
			Xylenes (Total)	18000		µg/kg	SW802

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW4	16-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	1900		mg/kg	E418.1
			Benzene	160		µg/kg	SW8020
			Toluene	570		µg/kg	SW8020
			Ethylbenzene	1500		µg/kg	SW8020
			Xylenes (Total)	6900		µg/kg	SW8020
ST14-VW7	17-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	5700		mg/kg	E418.1
			Benzene	1000	U	µg/kg	SW8020
			Toluene	19000		µg/kg	SW8020
			Ethylbenzene	3600		µg/kg	SW8020
			Xylenes (Total)	4800		µg/kg	SW8020
ST14-VW8	17-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	1900		mg/kg	E418.1
			Benzene	2000		µg/kg	SW8020
			Toluene	2600		µg/kg	SW8020
			Ethylbenzene	1200		µg/kg	SW8020
			Xylenes (Total)	5000		µg/kg	SW8020
ST14-SB2	18-Jun-93	7.00 - 8.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	3.6		µg/kg	SW8020
			Toluene	4.8		µg/kg	SW8020
			Ethylbenzene	7.4		µg/kg	SW8020
			Xylenes (Total)	40		µg/kg	SW8020
ST14-SB2	18-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	5100		mg/kg	E418.1
			Benzene	53		µg/kg	SW8020
			Toluene	600		µg/kg	SW8020
			Ethylbenzene	10	U	µg/kg	SW8020
			Xylenes (Total)	2000		µg/kg	SW8020
ST14-SB2	31-Mar-95	7.60 - 7.80	Benzene	4.4	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	44	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	2	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.4	U	µg/kg	SW8020
			Chlorobenzene	4.4	U	µg/kg	SW8020
ST14-VW9	18-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	1200		mg/kg	E418.1
			Benzene	200		µg/kg	SW8020
			Toluene	3600		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-VW9 (Cont)	18-Jun-93	9.00 - 10.00	Ethylbenzene	910		µg/kg	SW802
			Xylenes (Total)	4800		µg/kg	SW802
ST14-SB3	21-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	1400		mg/kg	E418.1
			Benzene	5400		µg/kg	SW802
			Toluene	15000		µg/kg	SW802
			Ethylbenzene	4100		µg/kg	SW802
			Xylenes (Total)	24000		µg/kg	SW802
ST14-SB4	21-Jun-93	7.00 - 8.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	SW802
			Ethylbenzene	2	U	µg/kg	SW802
			Xylenes (Total)	2	U	µg/kg	SW802
ST14-SB4	21-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	02
			Ethylbenzene	2	U	µg/kg	802
			Xylenes (Total)	2	U	µg/kg	SW802
ST14-SB5	21-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	SW802
			Ethylbenzene	2	U	µg/kg	SW802
			Xylenes (Total)	2	U	µg/kg	SW802
ST14-SB6	22-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	34		mg/kg	E418.1
			Benzene	2	U	µg/kg	SW802
			Toluene	2	U	µg/kg	SW802
			Ethylbenzene	2	U	µg/kg	SW802
			Xylenes (Total)	2	U	µg/kg	SW802
ST14-VW12	22-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	2900		mg/kg	E418.1
			Benzene	3800		µg/kg	SW802
			Toluene	2600		µg/kg	SW802
			Ethylbenzene	2700		µg/kg	SW802
			Xylenes (Total)	5900		µg/kg	SW802
ST14-VW13	22-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	1400		mg/kg	E418.1
			Benzene	2000	U	µg/kg	SW802
			Toluene	54000		µg/kg	SW802
			Ethylbenzene	17000		µg/kg	02

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW13 (Cont)	22-Jun-93	9.00 - 10.00	Xylenes (Total)	52000		µg/kg	SW8020
ST14-VW14	23-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	350		mg/kg	E418.1
			Benzene	890		µg/kg	SW8020
			Toluene	2900		µg/kg	SW8020
			Ethylbenzene	1500		µg/kg	SW8020
			Xylenes (Total)	7100		µg/kg	SW8020
ST14-VW15	23-Jun-93	11.00 - 12.00	Petroleum Hydrocarbons	3600		mg/kg	E418.1
			Benzene	1000	U	µg/kg	SW8020
			Toluene	10000		µg/kg	SW8020
			Ethylbenzene	3400		µg/kg	SW8020
			Xylenes (Total)	14000		µg/kg	SW8020
ST14-VW16	23-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	2600		mg/kg	E418.1
			Benzene	2800		µg/kg	SW8020
			Toluene	11000		µg/kg	SW8020
			Ethylbenzene	6600		µg/kg	SW8020
			Xylenes (Total)	32000		µg/kg	SW8020
ST14-SB7	24-Jun-93	11.00 - 12.00	Petroleum Hydrocarbons	10	U	mg/kg	E418.1
			Benzene	2	U	µg/kg	SW8020
			Toluene	2	U	µg/kg	SW8020
			Ethylbenzene	2	U	µg/kg	SW8020
			Xylenes (Total)	2	U	µg/kg	SW8020
ST14-MPB	26-May-93	9.00 - 10.00	Petroleum Hydrocarbons	2500		mg/kg	E418.1
			Benzene	2800		µg/kg	SW8020
			Toluene	4100		µg/kg	SW8020
			Ethylbenzene	7000		µg/kg	SW8020
			Xylenes (Total)	26000		µg/kg	SW8020
ST14-VW10	21-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	1500		mg/kg	E418.1
			Benzene	470		µg/kg	SW8020
			Toluene	740		µg/kg	SW8020
			Ethylbenzene	1100		µg/kg	SW8020
			Xylenes (Total)	5200		µg/kg	SW8020
ST14-VW2	15-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	6500		mg/kg	E418.1
			Benzene	200	U	µg/kg	SW8020
			Toluene	19000		µg/kg	SW8020
			Ethylbenzene	5200		µg/kg	SW8020
			Xylenes (Total)	25000		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Methoc
ST14-VW5	16-Jun-93	7.00 - 8.00	Petroleum Hydrocarbons	420		mg/kg	E418.1
			Benzene	10	U	µg/kg	SW802(
			Toluene	380		µg/kg	SW802(
			Ethylbenzene	120		µg/kg	SW802(
			Xylenes (Total)	410		µg/kg	SW802(
ST14-VW5	16-Jun-93	10.00 - 11.00	Petroleum Hydrocarbons	2600		mg/kg	E418.1
			Benzene	10	U	µg/kg	SW802(
			Toluene	440		µg/kg	SW802(
			Ethylbenzene	10	U	µg/kg	SW802(
			Xylenes (Total)	1200		µg/kg	SW802(
ST14-VW6	17-Jun-93	9.00 - 10.00	Petroleum Hydrocarbons	3800		mg/kg	E418.1
			Benzene	950		µg/kg	SW802(
			Toluene	310		µg/kg	SW802(
			Ethylbenzene	980		µg/kg	SW802(
			Xylenes (Total)	1800		µg/kg	02(
ST14-MW07	9-Aug-94	13.60 - 14.00	Benzene	0.51	U	µg/kg	SW802(
			Toluene	5.1	U	µg/kg	SW802(
			Ethylbenzene	5.1	U	µg/kg	SW802(
			Xylenes (Total)	5.1	U	µg/kg	SW802(
			1,3,5-Trimethylbenzene	5.1	U	µg/kg	SW802(
			1,2,4-Trimethylbenzene	5.1	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	5.1	U	µg/kg	SW802(
			Chlorobenzene	5.1	U	µg/kg	SW802(
ST14-MW10	9-Aug-94	7.50 - 7.70	Benzene	0.53	U	µg/kg	SW802(
			Toluene	5.3	U	µg/kg	SW802(
			Ethylbenzene	5.3	U	µg/kg	SW802(
			Xylenes (Total)	5.3	U	µg/kg	SW802(
			1,3,5-Trimethylbenzene	5.3	U	µg/kg	SW802(
			1,2,4-Trimethylbenzene	5.3	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	5.3	U	µg/kg	SW802(
			Chlorobenzene	5.3	U	µg/kg	SW802(
ST14-MW10	9-Aug-94	13.80 - 14.00	Total Extractable Hydrocarbons	230		mg/kg	SW801:
			Benzene	2.7	U	µg/kg	SW802(
			Toluene	27	U	µg/kg	SW802(
			Ethylbenzene	4.7	J	µg/kg	SW802(
			Xylenes (Total)	25	J	µg/kg	[illegible]02(
			1,3,5-Trimethylbenzene	35		µg/kg	[illegible]02(

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW10 (Cont)	9-Aug-94	13.80 - 14.00	1,2,4-Trimethylbenzene	23	J	µg/kg	SW8020
			1,2,3-Trimethylbenzene	53		µg/kg	SW8020
			Chlorobenzene	3.3	J	µg/kg	SW8020
ST14-MW13	10-Aug-94	13.90 - 14.10	Benzene	2.4	U	µg/kg	SW8020
			Toluene	790		µg/kg	SW8020
			Ethylbenzene	310		µg/kg	SW8020
			Xylenes (Total)	1200		µg/kg	SW8020
			1,3,5-Trimethylbenzene	280		µg/kg	SW8020
			1,2,4-Trimethylbenzene	620		µg/kg	SW8020
			1,2,3-Trimethylbenzene	110		µg/kg	SW8020
			Chlorobenzene	50		µg/kg	SW8020
ST14-MW14	12-Aug-94	11.50 - 11.70	Benzene	2.6	U	µg/kg	SW8020
			Toluene	330	J	µg/kg	SW8020
			Ethylbenzene	1500		µg/kg	SW8020
			Xylenes (Total)	680		µg/kg	SW8020
			1,3,5-Trimethylbenzene	690		µg/kg	SW8020
			1,2,4-Trimethylbenzene	430		µg/kg	SW8020
			1,2,3-Trimethylbenzene	26	U	µg/kg	SW8020
			Chlorobenzene	2200		µg/kg	SW8020
ST14-MW15	12-Aug-94	11.70 - 11.70	Benzene	0.43	U	µg/kg	SW8020
			Toluene	4.3	U	µg/kg	SW8020
			Ethylbenzene	4.3	U	µg/kg	SW8020
			Xylenes (Total)	4.3	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.3	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.3	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.3	U	µg/kg	SW8020
			Chlorobenzene	4.3	U	µg/kg	SW8020
ST14-MW16	22-Aug-94	3.00 - 3.20	Benzene	2.1	J	µg/kg	SW8020
			Toluene	13		µg/kg	SW8020
			Ethylbenzene	7.1		µg/kg	SW8020
			Xylenes (Total)	16		µg/kg	SW8020
			1,3,5-Trimethylbenzene	2.5	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	8.2		µg/kg	SW8020
			1,2,3-Trimethylbenzene	5.2		µg/kg	SW8020
			Chlorobenzene	2	J	µg/kg	SW8020
ST14-MW16	22-Aug-94	9.30 - 9.50	Benzene	0.46	U	µg/kg	SW8020
			Toluene	1.4	J	µg/kg	SW8020
			Ethylbenzene	7.2		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-MW16 (Cont)	22-Aug-94	9.30 - 9.50	Xylenes (Total)	11		µg/kg	SW802
			1,3,5-Trimethylbenzene	2.7	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	15		µg/kg	SW802
			1,2,3-Trimethylbenzene	4.6	U	µg/kg	SW802
			Chlorobenzene	8.1		µg/kg	SW802
ST14-MW18	22-Aug-94	8.80 - 9.00	Benzene	2.6	U	µg/kg	SW802
			Toluene	480	J	µg/kg	SW802
			Ethylbenzene	490		µg/kg	SW802
			Xylenes (Total)	4400		µg/kg	SW802
			1,3,5-Trimethylbenzene	750		µg/kg	SW802
			1,2,4-Trimethylbenzene	590		µg/kg	SW802
			1,2,3-Trimethylbenzene	550		µg/kg	SW802
			Chlorobenzene	230		µg/kg	SW802
ST14-MW23	23-Aug-94	7.50 - 7.70	Total Extractable Hydrocarbons	17		mg/kg	SW801
			Benzene	0.48	U	µg/kg	SW802
			Toluene	4.8	U	µg/kg	02
			Ethylbenzene	4.8	U	µg/kg	SW802
			Xylenes (Total)	4.8	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.8	U	µg/kg	SW802
			Chlorobenzene	4.8	U	µg/kg	SW802
ST14-MW06	24-Aug-94	10.50 - 10.70	Benzene	0.53	U	µg/kg	SW802
			Toluene	0.7	J	µg/kg	SW802
			Ethylbenzene	5.3	U	µg/kg	SW802
			Xylenes (Total)	5.3	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	5.3	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	5.3	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	5.3	U	µg/kg	SW802
			Chlorobenzene	5.3	U	µg/kg	SW802
ST14-MW08	24-Aug-94	19.40 - 19.60	Benzene	0.48	U	µg/kg	SW802
			Toluene	4.8	U	µg/kg	SW802
			Ethylbenzene	4.8	U	µg/kg	SW802
			Xylenes (Total)	4.8	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.8	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.8	U	µg/kg	SW802
			Chlorobenzene	4.8	U	µg/kg	SW802

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW17	24-Aug-94	1.00 - 1.20	Benzene	2.4	J	µg/kg	SW8020
			Toluene	4.1	J	µg/kg	SW8020
			Ethylbenzene	4.6	J	µg/kg	SW8020
			Xylenes (Total)	14		µg/kg	SW8020
			1,3,5-Trimethylbenzene	6.6		µg/kg	SW8020
			1,2,4-Trimethylbenzene	9.3		µg/kg	SW8020
			1,2,3-Trimethylbenzene	3.2	J	µg/kg	SW8020
			Chlorobenzene	0.5	J	µg/kg	SW8020
ST14-VW17	24-Aug-94	5.30 - 5.80	Total Extractable Hydrocarbons	1600		mg/kg	SW8015
			Benzene	70	U	µg/kg	SW8020
			Toluene	2500		µg/kg	SW8020
			Ethylbenzene	4200		µg/kg	SW8020
			Xylenes (Total)	27000		µg/kg	SW8020
			1,3,5-Trimethylbenzene	5700		µg/kg	SW8020
			1,2,4-Trimethylbenzene	3400		µg/kg	SW8020
			1,2,3-Trimethylbenzene	5500		µg/kg	SW8020
			Chlorobenzene	820		µg/kg	SW8020
ST14-VW18	24-Aug-94	1.00 - 1.20	Benzene	2.4	U	µg/kg	SW8020
			Toluene	5.9	J	µg/kg	SW8020
			Ethylbenzene	5.9	J	µg/kg	SW8020
			Xylenes (Total)	20	J	µg/kg	SW8020
			1,3,5-Trimethylbenzene	7.7	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	5.9	J	µg/kg	SW8020
			1,2,3-Trimethylbenzene	3	J	µg/kg	SW8020
			Chlorobenzene	24	U	µg/kg	SW8020
ST14-VW18	24-Aug-94	5.00 - 5.20	Benzene	68	U	µg/kg	SW8020
			Toluene	680	U	µg/kg	SW8020
			Ethylbenzene	9100		µg/kg	SW8020
			Xylenes (Total)	56000		µg/kg	SW8020
			1,3,5-Trimethylbenzene	7400		µg/kg	SW8020
			1,2,4-Trimethylbenzene	10000		µg/kg	SW8020
			1,2,3-Trimethylbenzene	3200		µg/kg	SW8020
			Chlorobenzene	2100		µg/kg	SW8020
ST14-VW22	25-Aug-94	1.00 - 1.20	Total Extractable Hydrocarbons	2100		mg/kg	SW8015
			Benzene	60	U	µg/kg	SW8020
			Toluene	2000		µg/kg	SW8020
			Ethylbenzene	3100		µg/kg	SW8020
			Xylenes (Total)	20000		µg/kg	SW8020
			1,3,5-Trimethylbenzene	3800		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Method
ST14-VW22 (Cont)	25-Aug-94	1.00 - 1.20	1,2,4-Trimethylbenzene	5500		µg/kg	SW802(
			1,2,3-Trimethylbenzene	2000		µg/kg	SW802(
			Chlorobenzene	640		µg/kg	SW802(
ST14-VW22	25-Aug-94	5.90 - 6.50	Total Extractable Hydrocarbons	2000		mg/kg	SW801:
			Benzene	66	U	µg/kg	SW802(
			Toluene	3600		µg/kg	SW802(
			Ethylbenzene	5100		µg/kg	SW802(
			Xylenes (Total)	32000		µg/kg	SW802(
			1,3,5-Trimethylbenzene	4600		µg/kg	SW802(
			1,2,4-Trimethylbenzene	2900		µg/kg	SW802(
			1,2,3-Trimethylbenzene	1600		µg/kg	SW802(
			Chlorobenzene	1100		µg/kg	SW802(
ST14-VW23	25-Aug-94	1.00 - 1.20	Benzene	0.5	U	µg/kg	SW802(
			Toluene	5.8		µg/kg	SW802(
			Ethylbenzene	21		µg/kg	SW802(
			Xylenes (Total)	48		µg/kg	[illegible]
			1,3,5-Trimethylbenzene	36		µg/kg	[illegible]
			1,2,4-Trimethylbenzene	50		µg/kg	SW802(
			1,2,3-Trimethylbenzene	64		µg/kg	SW802(
			Chlorobenzene	5.2		µg/kg	SW802(
ST14-VW23	25-Aug-94	6.20 - 6.40	Benzene	2.6	U	µg/kg	SW802(
			Toluene	26	U	µg/kg	SW802(
			Ethylbenzene	290		µg/kg	SW802(
			Xylenes (Total)	1800		µg/kg	SW802(
			1,3,5-Trimethylbenzene	730		µg/kg	SW802(
			1,2,4-Trimethylbenzene	780		µg/kg	SW802(
			1,2,3-Trimethylbenzene	1300		µg/kg	SW802(
			Chlorobenzene	85		µg/kg	SW802(
ST14-VW24	25-Aug-94	6.90 - 7.10	Benzene	0.53	U	µg/kg	SW802(
			Toluene	5.3	U	µg/kg	SW802(
			Ethylbenzene	5.3	U	µg/kg	SW802(
			Xylenes (Total)	5.3	U	µg/kg	SW802(
			1,3,5-Trimethylbenzene	5.3	U	µg/kg	SW802(
			1,2,4-Trimethylbenzene	5.3	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	5.3	U	µg/kg	SW802(
			Chlorobenzene	5.3	U	µg/kg	SW802(
ST14-VW25	25-Aug-94	1.00 - 1.20	Benzene	0.5	U	µg/kg	[illegible]
			Toluene	5.9		µg/kg	[illegible]

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW25 (Cont)	25-Aug-94	1.00 - 1.20	Ethylbenzene	0.6	J	µg/kg	SW8020
			Xylenes (Total)	3.1	J	µg/kg	SW8020
			1,3,5-Trimethylbenzene	1.8	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	2.6	J	µg/kg	SW8020
			1,2,3-Trimethylbenzene	2.9	J	µg/kg	SW8020
			Chlorobenzene	5	U	µg/kg	SW8020
ST14-VW25	25-Aug-94	6.70 - 6.90	Benzene	0.53	U	µg/kg	SW8020
			Toluene	1.7	J	µg/kg	SW8020
			Ethylbenzene	5.3	U	µg/kg	SW8020
			Xylenes (Total)	5.3	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	5.3	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	5.3	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	5.3	U	µg/kg	SW8020
			Chlorobenzene	5.3	U	µg/kg	SW8020
ST14-VW26	25-Aug-94	1.00 - 1.20	Benzene	61	U	µg/kg	SW8020
			Toluene	540	J	µg/kg	SW8020
			Ethylbenzene	2500		µg/kg	SW8020
			Xylenes (Total)	4900		µg/kg	SW8020
			1,3,5-Trimethylbenzene	4800		µg/kg	SW8020
			1,2,4-Trimethylbenzene	15000		µg/kg	SW8020
			1,2,3-Trimethylbenzene	9600		µg/kg	SW8020
			Chlorobenzene	230	J	µg/kg	SW8020
ST14-VW26	25-Aug-94	5.20 - 6.10	Total Extractable Hydrocarbons	2200		mg/kg	SW8015
			Benzene	68	U	µg/kg	SW8020
			Toluene	1600		µg/kg	SW8020
			Ethylbenzene	3500		µg/kg	SW8020
			Xylenes (Total)	11000		µg/kg	SW8020
			1,3,5-Trimethylbenzene	5400		µg/kg	SW8020
			1,2,4-Trimethylbenzene	3700		µg/kg	SW8020
			1,2,3-Trimethylbenzene	7000		µg/kg	SW8020
			Chlorobenzene	600	J	µg/kg	SW8020
ST14-MPD	26-Aug-94	3.00 - 3.20	Total Extractable Hydrocarbons	260		mg/kg	SW8015
			Benzene	0.51	U	µg/kg	SW8020
			Toluene	0.6	J	µg/kg	SW8020
			Ethylbenzene	3.7	J	µg/kg	SW8020
			Xylenes (Total)	34		µg/kg	SW8020
			1,3,5-Trimethylbenzene	71		µg/kg	SW8020
			1,2,4-Trimethylbenzene	180		µg/kg	SW8020
			1,2,3-Trimethylbenzene	93		µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-MPD (Cont)	26-Aug-94	3.00 - 3.20	Chlorobenzene	0.8	J	µg/kg	SW802
ST14-MPE	26-Aug-94	3.50 - 3.70	Total Extractable Hydrocarbons	12	U	mg/kg	SW801
			Benzene	0.5	U	µg/kg	SW802
			Toluene	5	U	µg/kg	SW802
			Ethylbenzene	5	U	µg/kg	SW802
			Xylenes (Total)	5	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	0.6	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	5	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	5	U	µg/kg	SW802
			Chlorobenzene	5	U	µg/kg	SW802
ST14-VW19	26-Aug-94	5.20 - 5.40	Benzene	0.55	U	µg/kg	SW802
			Toluene	1.5	J	µg/kg	SW802
			Ethylbenzene	5.5	U	µg/kg	SW802
			Xylenes (Total)	0.7	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	0.7	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	1	J	µg/kg	[illegible]302
			1,2,3-Trimethylbenzene	5.5	U	µg/kg	[illegible]802
			Chlorobenzene	5.5	U	µg/kg	SW802
ST14-VW20	26-Aug-94	5.00 - 5.60	Total Extractable Hydrocarbons	30		mg/kg	SW801
			Benzene	0.5	U	µg/kg	SW802
			Toluene	0.8	J	µg/kg	SW802
			Ethylbenzene	5	U	µg/kg	SW802
			Xylenes (Total)	0.8	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	5	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	5	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	5	U	µg/kg	SW802
			Chlorobenzene	5	U	µg/kg	SW802
ST14-VW21	26-Aug-94	3.40 - 4.40	Total Extractable Hydrocarbons	13	U	mg/kg	SW801
			Benzene	0.53	U	µg/kg	SW802
			Toluene	5.3	U	µg/kg	SW802
			Ethylbenzene	5.3	U	µg/kg	SW802
			Xylenes (Total)	5.3	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	5.3	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	5.3	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	5.3	U	µg/kg	SW802
			Chlorobenzene	5.3	U	µg/kg	SW802
ST14-VW27	26-Aug-94	7.20 - 7.40	Benzene	66	U	µg/kg	[illegible]802
			Toluene	1200		µg/kg	[illegible]02

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW27 (Cont)	26-Aug-94	7.20 - 7.40	Ethylbenzene	3600		µg/kg	SW8020
			Xylenes (Total)	11000		µg/kg	SW8020
			1,3,5-Trimethylbenzene	6100		µg/kg	SW8020
			1,2,4-Trimethylbenzene	2700		µg/kg	SW8020
			1,2,3-Trimethylbenzene	7700		µg/kg	SW8020
			Chlorobenzene	790		µg/kg	SW8020
ST14-MW05	9-Aug-94	8.40 - 9.10	Total Extractable Hydrocarbons	56		mg/kg	SW8015
			Benzene	0.44	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	4.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW8020
			Chlorobenzene	4.4	U	µg/kg	SW8020
ST14-MW09	9-Aug-94	9.60 - 9.80	Benzene	0.54	U	µg/kg	SW8020
			Toluene	5.4	U	µg/kg	SW8020
			Ethylbenzene	5.4	U	µg/kg	SW8020
			Xylenes (Total)	5.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	5.4	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	5.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	5.4	U	µg/kg	SW8020
			Chlorobenzene	5.4	U	µg/kg	SW8020
ST14-MW11	10-Aug-94	14.30 - 14.50	Benzene	2.8	U	µg/kg	SW8020
			Toluene	28	U	µg/kg	SW8020
			Ethylbenzene	180		µg/kg	SW8020
			Xylenes (Total)	110		µg/kg	SW8020
			1,3,5-Trimethylbenzene	140		µg/kg	SW8020
			1,2,4-Trimethylbenzene	95		µg/kg	SW8020
			1,2,3-Trimethylbenzene	140		µg/kg	SW8020
			Chlorobenzene	310		µg/kg	SW8020
ST14-MW12	10-Aug-94	9.50 - 9.70	Benzene	0.55	U	µg/kg	SW8020
			Toluene	5.5	U	µg/kg	SW8020
			Ethylbenzene	1.7	J	µg/kg	SW8020
			Xylenes (Total)	5.5	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	0.7	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	5.5	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	5.5	U	µg/kg	SW8020
			Chlorobenzene	2.6	J	µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-MW12	10-Aug-94	14.50 - 14.70	Benzene	2.4	U	µg/kg	SW802
			Toluene	390		µg/kg	SW802
			Ethylbenzene	1500		µg/kg	SW802
			Xylenes (Total)	1700		µg/kg	SW802
			1,3,5-Trimethylbenzene	860		µg/kg	SW802
			1,2,4-Trimethylbenzene	670		µg/kg	SW802
			1,2,3-Trimethylbenzene	24	U	µg/kg	SW802
			Chlorobenzene	2400		µg/kg	SW802
ST14-MW19	23-Aug-94	13.50 - 14.00	Total Extractable Hydrocarbons	1900		mg/kg	SW801
			Benzene	58	U	µg/kg	SW802
			Toluene	3800		µg/kg	SW802
			Ethylbenzene	7300		µg/kg	SW802
			Xylenes (Total)	28000		µg/kg	SW802
			1,3,5-Trimethylbenzene	14000		µg/kg	SW802
			1,2,4-Trimethylbenzene	28000		µg/kg	SW802
			1,2,3-Trimethylbenzene	8600		µg/kg	02
			Chlorobenzene	1100		µg/kg	602
ST14-MW20	22-Aug-94	7.10 - 7.30	Benzene	0.47	U	µg/kg	SW802
			Toluene	0.8	J	µg/kg	SW802
			Ethylbenzene	4.7	U	µg/kg	SW802
			Xylenes (Total)	2.6	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	0.6	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	0.8	J	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.7	U	µg/kg	SW802
			Chlorobenzene	4.7	U	µg/kg	SW802
ST14-MW20	22-Aug-94	10.00 - 10.20	Benzene	0.45	U	µg/kg	SW802
			Toluene	2.1	J	µg/kg	SW802
			Ethylbenzene	0.8	J	µg/kg	SW802
			Xylenes (Total)	4.5	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.5	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.5	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.5	U	µg/kg	SW802
			Chlorobenzene	4.5	U	µg/kg	SW802
ST14-MW21	12-Aug-94	10.50 - 10.70	Benzene	0.48	U	µg/kg	SW802
			Toluene	4.8	U	µg/kg	SW802
			Ethylbenzene	4.8	U	µg/kg	SW802
			Xylenes (Total)	4.8	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.8	U	µg/kg	02

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW21 (Cont)	12-Aug-94	10.50 - 10.70	1,2,4-Trimethylbenzene	4.8	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.8	U	µg/kg	SW8020
			Chlorobenzene	4.8	U	µg/kg	SW8020
ST14-MW22	23-Aug-94	11.00 - 11.20	Benzene	0.42	U	µg/kg	SW8020
			Toluene	4.2	U	µg/kg	SW8020
			Ethylbenzene	4.2	U	µg/kg	SW8020
			Xylenes (Total)	4.2	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.2	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.2	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.2	U	µg/kg	SW8020
			Chlorobenzene	4.2	U	µg/kg	SW8020
1190-PT3	9-Mar-95	3.50 - 5.50	Benzene	0.47	U	µg/kg	SW8020
			Toluene	4.7	U	µg/kg	SW8020
			Ethylbenzene	4.7	U	µg/kg	SW8020
			Xylenes (Total)	4.7	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.7	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.7	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.7	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.7	U	µg/kg	SW8020
			Chlorobenzene	4.7	U	µg/kg	SW8020
1190-PT3	10-Mar-95	3.50 - 5.50	Total Extractable Hydrocarbons	11.9	U	mg/kg	SW8015
1190-PT5	9-Mar-95	6.00 - 8.00	Benzene	0.45	U	µg/kg	SW8020
			Toluene	4.5	U	µg/kg	SW8020
			Ethylbenzene	4.5	U	µg/kg	SW8020
			Xylenes (Total)	4.5	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.5	U	µg/kg	SW8020
			Chlorobenzene	4.5	U	µg/kg	SW8020
1190-PT5	10-Mar-95	6.00 - 8.00	Total Extractable Hydrocarbons	11.4	U	mg/kg	SW8015
ST14-MW28	29-Mar-95	9.20 - 9.40	Benzene	4.7	U	µg/kg	SW8020
			Toluene	4.7	U	µg/kg	SW8020
			Ethylbenzene	4.7	U	µg/kg	SW8020
			Xylenes (Total)	4.7	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	1.7	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.7	U	µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic: Method
ST14-MW28 (Cont)	29-Mar-95	9.20 - 9.40	1,2,3-Trimethylbenzene	4.7	U	µg/kg	SW802(
			1,2,3,4-Tetramethylbenzene	1.9	J	µg/kg	SW802(
			Chlorobenzene	4.7	U	µg/kg	SW802(
ST14-VW28	31-Mar-95	5.00 - 5.20	Benzene	4.7	U	µg/kg	SW802(
			Toluene	4.7	U	µg/kg	SW802(
			Ethylbenzene	4.7	U	µg/kg	SW802(
			Xylenes (Total)	4.7	U	µg/kg	SW802(
			1,3,5-Trimethylbenzene	5.4	J	µg/kg	SW802(
			1,2,4-Trimethylbenzene	4.7	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	4.7	U	µg/kg	SW802(
			1,2,3,4-Tetramethylbenzene	1	J	µg/kg	SW802(
			Chlorobenzene	4.7	U	µg/kg	SW8020
ST14-VW28	31-Mar-95	7.50 - 8.30	Benzene	4.6	U	µg/kg	SW802(
			Toluene	4.6	U	µg/kg	SW802(
			Ethylbenzene	4.6	U	µg/kg	SW802(
			Xylenes (Total)	4.6	U	µg/kg	S 2(
			1,3,5-Trimethylbenzene	3	J	µg/kg	S 02(
			1,2,4-Trimethylbenzene	4.6	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	4.6	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	2.3	J	µg/kg	SW802(
			Chlorobenzene	4.6	U	µg/kg	SW802(
ST14-VW29	31-Mar-95	4.20 - 4.50	Benzene	0.46	U	µg/kg	SW802(
			Toluene	4.6	U	µg/kg	SW802(
			Ethylbenzene	1.3	J	µg/kg	SW802(
			Xylenes (Total)	46		µg/kg	SW802(
			1,3,5-Trimethylbenzene	5.1	J	µg/kg	SW802(
			1,2,4-Trimethylbenzene	3.3	J	µg/kg	SW802(
			1,2,3-Trimethylbenzene	4.6	U	µg/kg	SW802(
			1,2,3,4-Tetramethylbenzene	18	J	µg/kg	SW802(
			Chlorobenzene	4.6	U	µg/kg	SW802(
ST14-VW29	31-Mar-95	8.60 - 9.20	Benzene	4.3	U	µg/kg	SW802(
			Toluene	4.3	U	µg/kg	SW802(
			Ethylbenzene	4.3	U	µg/kg	SW802(
			Xylenes (Total)	4.3	U	µg/kg	SW802(
			1,3,5-Trimethylbenzene	4.3	U	µg/kg	SW802(
			1,2,4-Trimethylbenzene	4.3	U	µg/kg	SW802(
			1,2,3-Trimethylbenzene	4.3	U	µg/kg	SW802(
			1,2,3,4-Tetramethylbenzene	0.9	J	µg/kg	SW 02(
			Chlorobenzene	4.3	U	µg/kg	S 2(

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW29 (Cont)	31-Mar-95	8.60 - 9.20	Benzene	0.5	U	µg/kg	SW8240
			Toluene	5	U	µg/kg	SW8240
			Ethylbenzene	5	U	µg/kg	SW8240
			Xylenes (Total)	5	U	µg/kg	SW8240
			1,3,5-Trimethylbenzene	5	U	µg/kg	SW8240
			1,2,4-Trimethylbenzene	5	U	µg/kg	SW8240
			1,2,3-Trimethylbenzene	5	U	µg/kg	SW8240
			1,2,3,4-Tetramethylbenzene	3	J	µg/kg	SW8240
			Chlorobenzene	5	U	µg/kg	SW8240
			Styrene	5	U	µg/kg	SW8240
ST14-VW30	31-Mar-95	4.50 - 4.70	Benzene	4.5	U	µg/kg	SW8020
			Toluene	4.5	U	µg/kg	SW8020
			Ethylbenzene	4.5	U	µg/kg	SW8020
			Xylenes (Total)	4.5	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	3.8	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.5	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	1.8	J	µg/kg	SW8020
			Chlorobenzene	4.5	U	µg/kg	SW8020
ST14-VW30	31-Mar-95	8.40 - 9.00	Benzene	4.4	U	µg/kg	SW8020
			Toluene	4.4	U	µg/kg	SW8020
			Ethylbenzene	4.4	U	µg/kg	SW8020
			Xylenes (Total)	4.4	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	3.7	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	2.3	J	µg/kg	SW8020
			Chlorobenzene	4.4	U	µg/kg	SW8020
ST14-VW31	31-Mar-95	4.00 - 4.20	Benzene	4.3	U	µg/kg	SW8020
			Toluene	3.9	J	µg/kg	SW8020
			Ethylbenzene	18	J	µg/kg	SW8020
			Xylenes (Total)	80		µg/kg	SW8020
			1,3,5-Trimethylbenzene	22	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	21	J	µg/kg	SW8020
			1,2,3-Trimethylbenzene	17	J	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	49		µg/kg	SW8020
			Chlorobenzene	4.3	U	µg/kg	SW8020
ST14-VW31	31-Mar-95	10.20 - 10.70	Benzene	4.4	U	µg/kg	SW8020
			Toluene	3.3	J	µg/kg	SW8020

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytic Metho
ST14-VW31 (Cont)	31-Mar-95	10.20 - 10.70	Ethylbenzene	10	J	µg/kg	SW802
			Xylenes (Total)	17	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	13	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	7.1	J	µg/kg	SW802
			1,2,3-Trimethylbenzene	15	J	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	19	J	µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
ST14-VW32	3-Apr-95	4.10 - 4.30	Benzene	4.4	U	µg/kg	SW802
			Toluene	4.4	U	µg/kg	SW802
			Ethylbenzene	4.4	U	µg/kg	SW802
			Xylenes (Total)	0.7	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	5.3	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	0.8	J	µg/kg	SW802
			1,2,3-Trimethylbenzene	7.4	J	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	21	J	µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
ST14-VW32	3-Apr-95	9.50 - 10.50	Total Extractable Hydrocarbons	110		mg/kg	...6015
			Benzene	21	U	µg/kg	SW802
			Toluene	21	U	µg/kg	SW802
			Ethylbenzene	21	U	µg/kg	SW802
			Xylenes (Total)	9.6	J	µg/kg	SW802
			1,3,5-Trimethylbenzene	36	J	µg/kg	SW802
			1,2,4-Trimethylbenzene	39	J	µg/kg	SW802
			1,2,3-Trimethylbenzene	68	J	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	190	J	µg/kg	SW802
			Chlorobenzene	21	U	µg/kg	SW802
ST14-VW33	3-Apr-95	8.70 - 8.90	Benzene	4.4	U	µg/kg	SW802
			Toluene	4.4	U	µg/kg	SW802
			Ethylbenzene	4.4	U	µg/kg	SW802
			Xylenes (Total)	44	U	µg/kg	SW802
			1,3,5-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,4-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3-Trimethylbenzene	4.4	U	µg/kg	SW802
			1,2,3,4-Tetramethylbenzene	4.4	U	µg/kg	SW802
			Chlorobenzene	4.4	U	µg/kg	SW802
ST14-MW29	28-Mar-95	9.50 - 9.70	Benzene	58.4	U	µg/kg	SW802
			Toluene	584	U	µg/kg	SW802
			Ethylbenzene	6000		µg/kg	SW802
			Xylenes (Total)	29000		µg/kg	302

TABLE A.1 (Continued)
SOIL DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW29 (Cont)	28-Mar-95	9.50 - 9.70	1,3,5-Trimethylbenzene	3800		µg/kg	SW8020
			1,2,4-Trimethylbenzene	3900		µg/kg	SW8020
			1,2,3-Trimethylbenzene	584	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	19000		µg/kg	SW8020
			Chlorobenzene	980		µg/kg	SW8020
ST14-MW30	29-Mar-95	7.00 - 7.20	Benzene	4.9	U	µg/kg	SW8020
			Toluene	49	U	µg/kg	SW8020
			Ethylbenzene	4.9	U	µg/kg	SW8020
			Xylenes (Total)	1.3	J	µg/kg	SW8020
			1,3,5-Trimethylbenzene	0.5	J	µg/kg	SW8020
			1,2,4-Trimethylbenzene	4.9	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	4.9	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	4.9	U	µg/kg	SW8020
			Chlorobenzene	4.9	U	µg/kg	SW8020
ST14-MW25	28-Mar-95	5.00 - 5.50	Total Extractable Hydrocarbons	12	U	mg/kg	M8015
			Benzene	0.6	J	µg/kg	SW8020
			Toluene	1.8	J	µg/kg	SW8020
			Ethylbenzene	2.3	J	µg/kg	SW8020
			Xylenes (Total)	5	U	µg/kg	SW8020
			1,3,5-Trimethylbenzene	5	U	µg/kg	SW8020
			1,2,4-Trimethylbenzene	5	U	µg/kg	SW8020
			1,2,3-Trimethylbenzene	5	U	µg/kg	SW8020
			1,2,3,4-Tetramethylbenzene	5	U	µg/kg	SW8020
			Chlorobenzene	5	U	µg/kg	SW8020

TABLE A.2
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW10	9-Aug-94	13.80 - 14.00	Naphthalene	450	U	µg/kg	SW8270
ST14-MW23	23-Aug-94	7.50 - 7.70	Naphthalene	400	U	µg/kg	SW8270
ST14-VW17	24-Aug-94	5.30 - 5.80	Naphthalene	2900		µg/kg	SW8270
ST14-VW22	25-Aug-94	1.00 - 1.20	Naphthalene	2600		µg/kg	SW8270
ST14-VW26	25-Aug-94	5.20 - 6.10	Naphthalene	1800		µg/kg	SW8270
ST14-VW21	26-Aug-94	3.40 - 4.40	Naphthalene	450	U	µg/kg	SW8270
ST14-MW05	9-Aug-94	8.40 - 9.10	Naphthalene	350	U	µg/kg	SW8270
ST14-MW19	23-Aug-94	13.50 - 14.00	Naphthalene	990		µg/kg	SW8270
ST14-VW28	31-Mar-95	7.50 - 8.30	bis(2-Chloroethyl)ether	390	U	µg/kg	SW8270
			1,3-Dichlorobenzene	390	U	µg/kg	SW8270
			1,4-Dichlorobenzene	390	U	µg/kg	SW8270
			1,2-Dichlorobenzene	390	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	390	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	390	U	µg/kg	SW8270
			Hexachloroethane	390	U	µg/kg	SW8270
			Nitrobenzene	390	U	µg/kg	SW8270
			Isophorone	390	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	390	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	390	U	µg/kg	SW8270
			Naphthalene	390	U	µg/kg	SW8270
			4-Chloroaniline	390	U	µg/kg	SW8270
			Hexachlorobutadiene	390	U	µg/kg	SW8270
			2-Methylnaphthalene	100	J	µg/kg	SW8270
			Hexachlorocyclopentadiene	390	U	µg/kg	SW8270
			2-Chloronaphthalene	390	U	µg/kg	SW8270
			2-Nitroaniline	390	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW28 (Cont)	31-Mar-95	7.50 - 8.30	Dimethylphthalate	390	U	µg/kg	SW8270
			2,6-Dinitrotoluene	390	U	µg/kg	SW8270
			Acenaphthylene	390	U	µg/kg	SW8270
			3-Nitroaniline	390	U	µg/kg	SW8270
			Acenaphthene	390	U	µg/kg	SW8270
			Dibenzofuran	390	U	µg/kg	SW8270
			2,4-Dinitrotoluene	390	U	µg/kg	SW8270
			Diethylphthalate	390	U	µg/kg	SW8270
			4-Chlorophenyl-phenylether	390	U	µg/kg	SW8270
			Fluorene	390	U	µg/kg	SW8270
			4-Nitroaniline	1900	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	390	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	390	U	µg/kg	SW8270
			Hexachlorobenzene	390	U	µg/kg	SW[illegible]
			Phenanthrene	390	U	µg/kg	SW8270
			Anthracene	390	U	µg/kg	SW8270
			Di-n-butylphthalate	390	U	µg/kg	SW8270
			Fluoranthene	390	U	µg/kg	SW8270
			Pyrene	390	U	µg/kg	SW8270
			Butylbenzylphthalate	390	U	µg/kg	SW8270
			3,3'-Dichlorobenzidine	770	U	µg/kg	SW8270
			Benzo(a)anthracene	390	U	µg/kg	SW8270
			bis(2-Ethylhexyl)phthalate	390	U	µg/kg	SW8270
			Chrysene	390	U	µg/kg	SW8270
			Di-n-octylphthalate	390	U	µg/kg	SW8270
			Benzo(b)fluoranthene	390	U	µg/kg	SW8270
			Benzo(k)fluoranthene	390	U	µg/kg	SW8270
			Benzo(a)pyrene	390	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	390	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	390	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	390	U	µg/kg	SW8270
			Phenol	390	U	µg/kg	SW8270
			2-Chlorophenol	390	U	µg/kg	SW8270
			Benzyl Alcohol	390	U	µg/kg	SW[illegible]

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW28 (Cont)	31-Mar-95	7.50 - 8.30	2-Methylphenol(o-Cresol)	390	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	390	U	µg/kg	SW8270
			2-Nitrophenol	390	U	µg/kg	SW8270
			2,4-Dimethylphenol	390	U	µg/kg	SW8270
			Benzoic Acid	1900	U	µg/kg	SW8270
			2,4-Dichlorophenol	390	U	µg/kg	SW8270
			4-Chloro-3-methylphenol	390	U	µg/kg	SW8270
			2,4,6-Trichlorophenol	390	U	µg/kg	SW8270
			2,4-Dinitrophenol	1900	U	µg/kg	SW8270
			4-Nitrophenol	1900	U	µg/kg	SW8270
			4,6-Dinitro-2-methylphenol	1900	U	µg/kg	SW8270
			Pentachlorophenol	1900	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	390	U	µg/kg	SW8270
ST14-VW29	31-Mar-95	8.60 - 9.20	bis(2-Chloroethyl)ether	360	U	µg/kg	SW8270
			1,3-Dichlorobenzene	360	U	µg/kg	SW8270
			1,4-Dichlorobenzene	53	J	µg/kg	SW8270
			1,2-Dichlorobenzene	360	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	360	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	54	J	µg/kg	SW8270
			Hexachloroethane	360	U	µg/kg	SW8270
			Nitrobenzene	360	U	µg/kg	SW8270
			Isophorone	360	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	360	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	53	J	µg/kg	SW8270
			Naphthalene	66	J	µg/kg	SW8270
			4-Chloroaniline	360	U	µg/kg	SW8270
			Hexachlorobutadiene	360	U	µg/kg	SW8270
			2-Methylnaphthalene	46	J	µg/kg	SW8270
			Hexachlorocyclopentadiene	360	U	µg/kg	SW8270
			2-Chloronaphthalene	360	U	µg/kg	SW8270
			2-Nitroaniline	360	U	µg/kg	SW8270
			Dimethylphthalate	360	U	µg/kg	SW8270
			2,6-Dinitrotoluene	360	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW29 (Cont)	31-Mar-95	8.60 - 9.20	Acenaphthylene	360	U	µg/kg	SW8270
			3-Nitroaniline	360	U	µg/kg	SW8270
			Acenaphthene	59	J	µg/kg	SW8270
			Dibenzofuran	360	U	µg/kg	SW8270
			2,4-Dinitrotoluene	360	U	µg/kg	SW8270
			Diethylphthalate	360	U	µg/kg	SW8270
			4-Chlorophenyl-phenylether	360	U	µg/kg	SW8270
			Fluorene	360	U	µg/kg	SW8270
			4-Nitroaniline	1800	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	360	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	360	U	µg/kg	SW8270
			Hexachlorobenzene	360	U	µg/kg	SW8270
			Phenanthrene	360	U	µg/kg	SW8270
			Anthracene	360	U	µg/kg	SW[illegible]0
			Di-n-butylphthalate	68	J	µg/kg	SW8270
			Fluoranthene	360	U	µg/kg	SW8270
			Pyrene	49	J	µg/kg	SW8270
			Butylbenzylphthalate	360	U	µg/kg	SW8270
			3,3'-Dichlorobenzidine	720	U	µg/kg	SW8270
			Benzo(a)anthracene	360	U	µg/kg	SW8270
			bis(2-Ethylhexyl)phthalate	360	U	µg/kg	SW8270
			Chrysene	360	U	µg/kg	SW8270
			Di-n-octylphthalate	360	U	µg/kg	SW8270
			Benzo(b)fluoranthene	360	U	µg/kg	SW8270
			Benzo(k)fluoranthene	360	U	µg/kg	SW8270
			Benzo(a)pyrene	360	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	360	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	360	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	360	U	µg/kg	SW8270
			Phenol	120	J	µg/kg	SW8270
			2-Chlorophenol	100	J	µg/kg	SW8270
			Benzyl Alcohol	360	U	µg/kg	SW8270
			2-Methylphenol(o-Cresol)	360	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	360	U	µg/kg	SW[illegible]0

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW29 (Cont)	31-Mar-95	8.60 - 9.20	2-Nitrophenol	360	U	µg/kg	SW8270
			2,4-Dimethylphenol	360	U	µg/kg	SW8270
			Benzoic Acid	1800	U	µg/kg	SW8270
			2,4-Dichlorophenol	360	U	µg/kg	SW8270
			4-Chloro-3-methylphenol	98	J	µg/kg	SW8270
			2,4,6-Trichlorophenol	360	U	µg/kg	SW8270
			2,4-Dinitrophenol	1800	U	µg/kg	SW8270
			4-Nitrophenol	1800	U	µg/kg	SW8270
			4,6-Dinitro-2-methylphenol	1800	U	µg/kg	SW8270
			Pentachlorophenol	1800	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	360	U	µg/kg	SW8270
ST14-VW30	31-Mar-95	8.40 - 9.00	bis(2-Chloroethyl)ether	360	U	µg/kg	SW8270
			1,3-Dichlorobenzene	360	U	µg/kg	SW8270
			1,4-Dichlorobenzene	360	U	µg/kg	SW8270
			1,2-Dichlorobenzene	360	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	360	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	360	U	µg/kg	SW8270
			Hexachloroethane	360	U	µg/kg	SW8270
			Nitrobenzene	360	U	µg/kg	SW8270
			Isophorone	360	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	360	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	360	U	µg/kg	SW8270
			Naphthalene	360	U	µg/kg	SW8270
			4-Chloroaniline	360	U	µg/kg	SW8270
			Hexachlorobutadiene	360	U	µg/kg	SW8270
			2-Methylnaphthalene	360	U	µg/kg	SW8270
			Hexachlorocyclopentadiene	360	U	µg/kg	SW8270
			2-Chloronaphthalene	360	U	µg/kg	SW8270
			2-Nitroaniline	360	U	µg/kg	SW8270
			Dimethylphthalate	360	U	µg/kg	SW8270
			2,6-Dinitrotoluene	360	U	µg/kg	SW8270
			Acenaphthylene	360	U	µg/kg	SW8270
			3-Nitroaniline	360	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW30 (Cont)	31-Mar-95	8.40 - 9.00	Acenaphthene	360	U	µg/kg	SW8270
			Dibenzofuran	360	U	µg/kg	SW8270
			2,4-Dinitrotoluene	360	U	µg/kg	SW8270
			Diethylphthalate	360	U	µg/kg	SW8270
			4-Chlorophenyl-phenylether	360	U	µg/kg	SW8270
			Fluorene	360	U	µg/kg	SW8270
			4-Nitroaniline	1800	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	360	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	360	U	µg/kg	SW8270
			Hexachlorobenzene	360	U	µg/kg	SW8270
			Phenanthrene	360	U	µg/kg	SW8270
			Anthracene	360	U	µg/kg	SW8270
			Di-n-butylphthalate	360	U	µg/kg	SW8270
			Fluoranthene	360	U	µg/kg	SW)
			Pyrene	360	U	µg/kg	SW8270
			Butylbenzylphthalate	360	U	µg/kg	SW8270
			3,3'-Dichlorobenzidine	730	U	µg/kg	SW8270
			Benzo(a)anthracene	360	U	µg/kg	SW8270
			bis(2-Ethylhexyl)phthalate	360	U	µg/kg	SW8270
			Chrysene	360	U	µg/kg	SW8270
			Di-n-octylphthalate	360	U	µg/kg	SW8270
			Benzo(b)fluoranthene	360	U	µg/kg	SW8270
			Benzo(k)fluoranthene	360	U	µg/kg	SW8270
			Benzo(a)pyrene	360	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	360	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	360	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	360	U	µg/kg	SW8270
			Phenol	360	U	µg/kg	SW8270
			2-Chlorophenol	360	U	µg/kg	SW8270
			Benzyl Alcohol	360	U	µg/kg	SW8270
			2-Methylphenol(o-Cresol)	360	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	360	U	µg/kg	SW8270
			2-Nitrophenol	360	U	µg/kg	SW8270
			2,4-Dimethylphenol	360	U	µg/kg	SW)

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW30 (Cont)	31-Mar-95	8.40 - 9.00	Benzoic Acid	1800	U	µg/kg	SW8270
			2,4-Dichlorophenol	360	U	µg/kg	SW8270
			4-Chloro-3-methylphenol	360	U	µg/kg	SW8270
			2,4,6-Trichlorophenol	360	U	µg/kg	SW8270
			2,4-Dinitrophenol	1800	U	µg/kg	SW8270
			4-Nitrophenol	1800	U	µg/kg	SW8270
			4,6-Dinitro-2-methylphenol	1800	U	µg/kg	SW8270
			Pentachlorophenol	1800	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	360	U	µg/kg	SW8270
ST14-VW31	31-Mar-95	10.20 - 10.70	bis(2-Chloroethyl)ether	360	U	µg/kg	SW8270
			1,3-Dichlorobenzene	360	U	µg/kg	SW8270
			1,4-Dichlorobenzene	360	U	µg/kg	SW8270
			1,2-Dichlorobenzene	360	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	360	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	360	U	µg/kg	SW8270
			Hexachloroethane	360	U	µg/kg	SW8270
			Nitrobenzene	360	U	µg/kg	SW8270
			Isophorone	360	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	360	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	360	U	µg/kg	SW8270
			Naphthalene	360	U	µg/kg	SW8270
			4-Chloroaniline	360	U	µg/kg	SW8270
			Hexachlorobutadiene	360	U	µg/kg	SW8270
			2-Methylnaphthalene	360	U	µg/kg	SW8270
			Hexachlorocyclopentadiene	360	U	µg/kg	SW8270
			2-Chloronaphthalene	360	U	µg/kg	SW8270
			2-Nitroaniline	360	U	µg/kg	SW8270
			Dimethylphthalate	360	U	µg/kg	SW8270
			2,6-Dinitrotoluene	360	U	µg/kg	SW8270
			Acenaphthylene	360	U	µg/kg	SW8270
			3-Nitroaniline	360	U	µg/kg	SW8270
			Acenaphthene	360	U	µg/kg	SW8270
			Dibenzofuran	360	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW31 (Cont)	31-Mar-95	10.20 - 10.70	2,4-Dinitrotoluene	360	U	µg/kg	SW8270
			Diethylphthalate	360	U	µg/kg	SW8270
			4-Chlorophenyl-phenylether	360	U	µg/kg	SW8270
			Fluorene	360	U	µg/kg	SW8270
			4-Nitroaniline	1800	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	360	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	360	U	µg/kg	SW8270
			Hexachlorobenzene	360	U	µg/kg	SW8270
			Phenanthrene	360	U	µg/kg	SW8270
			Anthracene	360	U	µg/kg	SW8270
			Di-n-butylphthalate	360	U	µg/kg	SW8270
			Fluoranthene	360	U	µg/kg	SW8270
			Pyrene	360	U	µg/kg	SW8270
			Butylbenzylphthalate	360	U	µg/kg	SW[illegible]
			3,3'-Dichlorobenzidine	720	U	µg/kg	SW8270
			Benzo(a)anthracene	360	U	µg/kg	SW8270
			bis(2-Ethylhexyl)phthalate	360	U	µg/kg	SW8270
			Chrysene	360	U	µg/kg	SW8270
			Di-n-octylphthalate	360	U	µg/kg	SW8270
			Benzo(b)fluoranthene	360	U	µg/kg	SW8270
			Benzo(k)fluoranthene	360	U	µg/kg	SW8270
			Benzo(a)pyrene	360	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	360	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	360	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	360	U	µg/kg	SW8270
			Phenol	360	U	µg/kg	SW8270
			2-Chlorophenol	360	U	µg/kg	SW8270
			Benzyl Alcohol	360	U	µg/kg	SW8270
			2-Methylphenol(o-Cresol)	360	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	360	U	µg/kg	SW8270
			2-Nitrophenol	360	U	µg/kg	SW8270
			2,4-Dimethylphenol	360	U	µg/kg	SW8270
			Benzoic Acid	1800	U	µg/kg	SW8270
			2,4-Dichlorophenol	360	U	µg/kg	SW[illegible]

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW31 (Cont)	31-Mar-95	10.20 - 10.70	4-Chloro-3-methylphenol	360	U	µg/kg	SW8270
			2,4,6-Trichlorophenol	360	U	µg/kg	SW8270
			2,4-Dinitrophenol	1800	U	µg/kg	SW8270
			4-Nitrophenol	1800	U	µg/kg	SW8270
			4,6-Dinitro-2-methylphenol	1800	U	µg/kg	SW8270
			Pentachlorophenol	1800	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	360	U	µg/kg	SW8270
ST14-VW32	3-Apr-95	9.50 - 10.50	bis(2-Chloroethyl)ether	350	U	µg/kg	SW8270
			1,3-Dichlorobenzene	350	U	µg/kg	SW8270
			1,4-Dichlorobenzene	350	U	µg/kg	SW8270
			1,2-Dichlorobenzene	350	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	350	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	350	U	µg/kg	SW8270
			Hexachloroethane	350	U	µg/kg	SW8270
			Nitrobenzene	350	U	µg/kg	SW8270
			Isophorone	350	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	350	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	350	U	µg/kg	SW8270
			Naphthalene	350	U	µg/kg	SW8270
			4-Chloroaniline	350	U	µg/kg	SW8270
			Hexachlorobutadiene	350	U	µg/kg	SW8270
			2-Methylnaphthalene	460		µg/kg	SW8270
			Hexachlorocyclopentadiene	350	U	µg/kg	SW8270
			2-Chloronaphthalene	350	U	µg/kg	SW8270
			2-Nitroaniline	350	U	µg/kg	SW8270
			Dimethylphthalate	350	U	µg/kg	SW8270
			2,6-Dinitrotoluene	350	U	µg/kg	SW8270
			Acenaphthylene	350	U	µg/kg	SW8270
			3-Nitroaniline	350	U	µg/kg	SW8270
			Acenaphthene	350	U	µg/kg	SW8270
			Dibenzofuran	350	U	µg/kg	SW8270
			2,4-Dinitrotoluene	350	U	µg/kg	SW8270
			Diethylphthalate	350	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW32 (Cont)	3-Apr-95	9.50 - 10.50	4-Chlorophenyl-phenylether	350	U	µg/kg	SW8270
			Fluorene	25	J	µg/kg	SW8270
			4-Nitroaniline	1800	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	350	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	350	U	µg/kg	SW8270
			Hexachlorobenzene	460		µg/kg	SW8270
			Phenanthrene	350	U	µg/kg	SW8270
			Anthracene	350	U	µg/kg	SW8270
			Di-n-butylphthalate	350	U	µg/kg	SW8270
			Fluoranthene	350	U	µg/kg	SW8270
			Pyrene	350	U	µg/kg	SW8270
			Butylbenzylphthalate	350	U	µg/kg	SW8270
			3,3'-Dichlorobenzidine	700	U	µg/kg	SW8270
			Benzo(a)anthracene	350	U	µg/kg	SW[illegible]
			bis(2-Ethylhexyl)phthalate	350	U	µg/kg	SW8270
			Chrysene	350	U	µg/kg	SW8270
			Di-n-octylphthalate	350	U	µg/kg	SW8270
			Benzo(b)fluoranthene	350	U	µg/kg	SW8270
			Benzo(k)fluoranthene	350	U	µg/kg	SW8270
			Benzo(a)pyrene	350	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	350	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	350	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	350	U	µg/kg	SW8270
			Phenol	350	U	µg/kg	SW8270
			2-Chlorophenol	350	U	µg/kg	SW8270
			Benzyl Alcohol	350	U	µg/kg	SW8270
			2-Methylphenol(o-Cresol)	350	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	350	U	µg/kg	SW8270
			2-Nitrophenol	350	U	µg/kg	SW8270
			2,4-Dimethylphenol	350	U	µg/kg	SW8270
			Benzoic Acid	1800	U	µg/kg	SW8270
			2,4-Dichlorophenol	350	U	µg/kg	SW8270
			4-Chloro-3-methylphenol	350	U	µg/kg	SW8270
			2,4,6-Trichlorophenol	350	U	µg/kg	SW[illegible]

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW32 (Cont)	3-Apr-95	9.50 - 10.50	2,4-Dinitrophenol	1800	U	µg/kg	SW8270
			4-Nitrophenol	1800	U	µg/kg	SW8270
			4,6-Dinitro-2-methylphenol	1800	U	µg/kg	SW8270
			Pentachlorophenol	1800	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	350	U	µg/kg	SW8270
ST14-MW25	28-Mar-95	5.00 - 5.50	bis(2-Chloroethyl)ether	370	U	µg/kg	SW8270
			1,3-Dichlorobenzene	370	U	µg/kg	SW8270
			1,4-Dichlorobenzene	370	U	µg/kg	SW8270
			1,2-Dichlorobenzene	370	U	µg/kg	SW8270
			bis(2-Chloroisopropyl)ether	370	U	µg/kg	SW8270
			N-Nitroso-di-n-propylamine	370	U	µg/kg	SW8270
			Hexachloroethane	370	U	µg/kg	SW8270
			Nitrobenzene	370	U	µg/kg	SW8270
			Isophorone	370	U	µg/kg	SW8270
			bis(2-Chloroethoxy)methane	370	U	µg/kg	SW8270
			1,2,4-Trichlorobenzene	370	U	µg/kg	SW8270
			Naphthalene	370	U	µg/kg	SW8270
			4-Chloroaniline	370	U	µg/kg	SW8270
			Hexachlorobutadiene	370	U	µg/kg	SW8270
			2-Methylnaphthalene	370	U	µg/kg	SW8270
			Hexachlorocyclopentadiene	370	U	µg/kg	SW8270
			2-Chloronaphthalene	370	U	µg/kg	SW8270
			2-Nitroaniline	370	U	µg/kg	SW8270
			Dimethylphthalate	370	U	µg/kg	SW8270
			2,6-Dinitrotoluene	370	U	µg/kg	SW8270
			Acenaphthylene	370	U	µg/kg	SW8270
			3-Nitroaniline	370	U	µg/kg	SW8270
			Acenaphthene	370	U	µg/kg	SW8270
			Dibenzofuran	370	U	µg/kg	SW8270
			2,4-Dinitrotoluene	370	U	µg/kg	SW8270
			Diethylphthalate	370	U	µg/kg	SW8270
			4-Chlorophenyl-phenylether	370	U	µg/kg	SW8270
			Fluorene	370	U	µg/kg	SW8270

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW25 (Cont)	28-Mar-95	5.00 - 5.50	4-Nitroaniline	1800	U	µg/kg	SW8270
			N-Nitrosodiphenylamine	370	U	µg/kg	SW8270
			4-Bromophenyl-phenylether	370	U	µg/kg	SW8270
			Hexachlorobenzene	370	U	µg/kg	SW8270
			Phenanthrene	370	U	µg/kg	SW8270
			Anthracene	370	U	µg/kg	SW8270
			Di-n-butylphthalate	370	U	µg/kg	SW8270
			Fluoranthene	370	U	µg/kg	SW8270
			Pyrene	370	U	µg/kg	SW8270
			Butylbenzylphthalate	370	U	µg/kg	SW8270
			3,3'-Dichlorobenzidine	740	U	µg/kg	SW8270
			Benzo(a)anthracene	370	U	µg/kg	SW8270
			bis(2-Ethylhexyl)phthalate	370	U	µg/kg	SW8270
			Chrysene	370	U	µg/kg	SW)
			Di-n-octylphthalate	370	U	µg/kg	SW8270
			Benzo(b)fluoranthene	370	U	µg/kg	SW8270
			Benzo(k)fluoranthene	370	U	µg/kg	SW8270
			Benzo(a)pyrene	370	U	µg/kg	SW8270
			Indeno(1,2,3-cd)pyrene	370	U	µg/kg	SW8270
			Dibenz(a,h)anthracene	370	U	µg/kg	SW8270
			Benzo(g,h,i)perylene	370	U	µg/kg	SW8270
			Phenol	370	U	µg/kg	SW8270
			2-Chlorophenol	370	U	µg/kg	SW8270
			Benzyl Alcohol	370	U	µg/kg	SW8270
			2-Methylphenol(o-Cresol)	370	U	µg/kg	SW8270
			4-Methylphenol(p-Cresol)	370	U	µg/kg	SW8270
			2-Nitrophenol	370	U	µg/kg	SW8270
			2,4-Dimethylphenol	370	U	µg/kg	SW8270
			Benzoic Acid	1800	U	µg/kg	SW8270
			2,4-Dichlorophenol	370	U	µg/kg	SW8270
			4-Chloro-3-methylphenol	370	U	µg/kg	SW8270
			2,4,6-Trichlorophenol	370	U	µg/kg	SW8270
			2,4-Dinitrophenol	370	U	µg/kg	SW8270
			4-Nitrophenol	370	U	µg/kg	SW

TABLE A.2 (Continued)
SOIL DATA FOR SEMIVOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW25 (Cont)	28-Mar-95	5.00 - 5.50	4,6-Dinitro-2-methylphenol	1800	U	µg/kg	SW8270
			Pentachlorophenol	370	U	µg/kg	SW8270
			2,4,5-Trichlorophenol	370	U	µg/kg	SW8270

TABLE A.3
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MPA	25-May-93	9.00 - 10.00	Moisture, Percent	25.3		%	D2216
			Gravel	0.1	U	%	D422
			Sand	7.5		%	D422
			Silt	65.8		%	D422
			Clay	26.8		%	D422
			Phosphorus, Total Orthophosphate	114		mg/kg	E300
			Alkalinity, Carbonate	350		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	280		mg/kg	E351.3
			pH	8.6		pH units	SW9045
ST14-VW1	25-May-93	5.00 - 6.00	Moisture, Percent	18.6		%	D2216
ST14-VW1	25-May-93	10.00 - 11.00	Moisture, Percent	15.3		%	D2216
			Gravel	0.1	U	%	D422
			Sand	20.5		%	D422
			Silt	60.6		%	D422
			Clay	18.9		%	D422
			Phosphorus, Total Orthophosphate	97.2		mg/kg	E300
			Alkalinity, Carbonate	350		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	350		mg/kg	E351.3
			pH	8.9		pH units	SW9045
ST14-MPC	26-May-93	6.00 - 7.00	Moisture, Percent	21.1		%	D2216
ST14-MPC	26-May-93	10.00 - 11.00	Moisture, Percent	16.3		%	D2216
			Gravel	0.1	U	%	D422
			Sand	38.6		%	D422
			Silt	49.5		%	D422
			Clay	11.9		%	D422
			Phosphorus, Total Orthophosphate	73.1		mg/kg	E300
			Alkalinity, Carbonate	250		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	420		mg/kg	E351.3
			pH	8.9		pH units	SW9045
ST14-SB1	26-May-93	10.00 - 11.00	Moisture, Percent	14.9		%	D2216
ST14-MPBG	15-Jun-93	10.00 - 11.00	Moisture, Percent	15.7		%	D2216
			Gravel	0.1	U	%	D422
			Sand	24.5		%	D422
			Silt	57		%	D422
			Clay	18.5		%	D422
			Phosphorus, Total Orthophosphate	85.8		mg/kg	E300

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MPBG (Cont)	15-Jun-93	10.00 - 11.00	Alkalinity, Carbonate	1550		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	238		mg/kg	E351.3
			pH	8.3		pH units	SW9045
ST14-VW3	16-Jun-93	7.00 - 8.00	Moisture, Percent	12.7		%	D2216
			Gravel	0.1	U	%	D422
			Sand	9.7		%	D422
			Silt	57.6		%	D422
			Clay	32.7		%	D422
			Phosphorus, Total Orthophosphate	133		mg/kg	E300
			Alkalinity, Carbonate	412		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	462		mg/kg	E351.3
			pH	8.2		pH units	SW9045
ST14-VW3	16-Jun-93	10.00 - 11.00	Moisture, Percent	12.4		%	D2216
ST14-VW4	16-Jun-93	10.00 - 11.00	Moisture, Percent	15		%	D2216
			Gravel	0.1	U	%	D422
			Sand	13.9		%	[illegible]
			Silt	61.4		%	[illegible]
			Clay	24.7		%	D422
			Phosphorus, Total Orthophosphate	89		mg/kg	E300
			Alkalinity, Carbonate	515		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	336		mg/kg	E351.3
			pH	8.4		pH units	SW9045
ST14-VW7	17-Jun-93	9.00 - 10.00	Moisture, Percent	14.5		%	D2216
			Gravel	0.1	U	%	D422
			Sand	52.1		%	D422
			Silt	35.6		%	D422
			Clay	12.3		%	D422
			Phosphorus, Total Orthophosphate	67.7		mg/kg	E300
			Alkalinity, Carbonate	206		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	420		mg/kg	E351.3
			pH	9.5		pH units	SW9045
ST14-VW8	17-Jun-93	9.00 - 10.00	Moisture, Percent	22.1		%	D2216
			Gravel	0.1	U	%	D422
			Sand	9.9		%	D422
			Silt	63.1		%	D422
			Clay	27		%	D422
			Phosphorus, Total Orthophosphate	96.6		mg/kg	E300
			Alkalinity, Carbonate	361		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	504		mg/kg	[illegible]
			pH	8.5		pH units	[illegible]

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SB2	18-Jun-93	7.00 - 8.00	Moisture, Percent	14.9		%	D2216
ST14-SB2	18-Jun-93	10.00 - 11.00	Moisture, Percent	16.6		%	D2216
ST14-VW9	18-Jun-93	9.00 - 10.00	Moisture, Percent	21.7		%	D2216
			Gravel	0.1	U	%	D422
			Sand	13.8		%	D422
			Silt	53.7		%	D422
			Clay	32.5		%	D422
			Phosphorus, Total Orthophosphate	98.4		mg/kg	E300
			Alkalinity, Carbonate	309		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	392		mg/kg	E351.3
			pH	8.6		pH units	SW9045
ST14-SB3	21-Jun-93	9.00 - 10.00	Moisture, Percent	17.4		%	D2216
ST14-SB4	21-Jun-93	7.00 - 8.00	Moisture, Percent	15.7		%	D2216
ST14-SB4	21-Jun-93	10.00 - 11.00	Moisture, Percent	12.3		%	D2216
ST14-SB5	21-Jun-93	10.00 - 11.00	Moisture, Percent	15.5		%	D2216
ST14-SB6	22-Jun-93	9.00 - 10.00	Moisture, Percent	25.1		%	D2216
ST14-VW12	22-Jun-93	10.00 - 11.00	Moisture, Percent	14		%	D2216
			Gravel	0.1	U	%	D422
			Sand	31.8		%	D422
			Silt	51.4		%	D422
			Clay	16.9		%	D422
			Phosphorus, Total Orthophosphate	76.9		mg/kg	E300
			Alkalinity, Carbonate	1310		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	280		mg/kg	E351.3
			pH	9		pH units	SW9045
ST14-VW13	22-Jun-93	9.00 - 10.00	Moisture, Percent	16.2		%	D2216
			Gravel	0.1	U	%	D422
			Sand	81		%	D422
			Silt	14.2		%	D422
			Clay	4.8		%	D422
			Phosphorus, Total Orthophosphate	73.5		mg/kg	E300
			Alkalinity, Carbonate	1350		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	140		mg/kg	E351.3
			pH	8.8		pH units	SW9045

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytica Method
ST14-VW14	23-Jun-93	9.00 - 10.00	Moisture, Percent	19.8		%	D2216
			Gravel	0.1	U	%	D422
			Sand	4.6		%	D422
			Silt	67.4		%	D422
			Clay	28		%	D422
			Phosphorus, Total Orthophosphate	90.9		mg/kg	E300
			Alkalinity, Carbonate	490		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	350		mg/kg	E351.3
			pH	8.9		pH units	SW9045
ST14-VW15	23-Jun-93	11.00 - 12.00	Moisture, Percent	13.4		%	D2216
			Gravel	0.1	U	%	D422
			Sand	49.3		%	D422
			Silt	38.5		%	D422
			Clay	12.1		%	D422
			Phosphorus, Total Orthophosphate	118		mg/kg	E300
			Alkalinity, Carbonate	1260		mg/kg	E 1
			Nitrogen, Total Kjeldahl	252		mg/kg	E351.3
			pH	9.1		pH units	SW9045
ST14-VW16	23-Jun-93	9.00 - 10.00	Moisture, Percent	14		%	D2216
			Gravel	0.1	U	%	D422
			Sand	55.4		%	D422
			Silt	35.3		%	D422
			Clay	9.3		%	D422
			Phosphorus, Total Orthophosphate	105		mg/kg	E300
			Alkalinity, Carbonate	1360		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	280		mg/kg	E351.3
			pH	8.6		pH units	SW9045
ST14-SB7	24-Jun-93	11.00 - 12.00	Moisture, Percent	11.6		%	D2216
ST14-MPB	26-May-93	9.00 - 10.00	Moisture, Percent	23		%	D2216
			Gravel	0.1	U	%	D422
			Sand	6		%	D422
			Silt	60.4		%	D422
			Clay	33.6		%	D422
			Phosphorus, Total Orthophosphate	96.2		mg/kg	E300
			Alkalinity, Carbonate	450		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	224		mg/kg	E351.3
			pH	9		pH units	SW[illegible]45

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW10	21-Jun-93	10.00 - 11.00	Moisture, Percent	23.7		%	D2216
			Gravel	0.1	U	%	D422
			Sand	6.8		%	D422
			Silt	65.1		%	D422
			Clay	28.1		%	D422
			Phosphorus, Total Orthophosphate	88.3		mg/kg	E300
			Alkalinity, Carbonate	790		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	294		mg/kg	E351.3
			pH	8.8		pH units	SW9045
ST14-VW2	15-Jun-93	10.00 - 11.00	Moisture, Percent	8.2		%	D2216
			Gravel	0.1	U	%	D422
			Sand	37.9		%	D422
			Silt	48.5		%	D422
			Clay	13.6		%	D422
			Phosphorus, Total Orthophosphate	62.4		mg/kg	E300
			Alkalinity, Carbonate	206		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	224		mg/kg	E351.3
			pH	8.6		pH units	SW9045
ST14-VW5	16-Jun-93	7.00 - 8.00	Moisture, Percent	18.8		%	D2216
			Gravel	0.1	U	%	D422
			Sand	17.6		%	D422
			Silt	52.8		%	D422
			Clay	29.6		%	D422
			Phosphorus, Total Orthophosphate	211		mg/kg	E300
			Alkalinity, Carbonate	515		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	714		mg/kg	E351.3
			pH	8.5		pH units	SW9045
ST14-VW5	16-Jun-93	10.00 - 11.00	Moisture, Percent	14.3		%	D2216
ST14-VW6	17-Jun-93	9.00 - 10.00	Moisture, Percent	15.4		%	D2216
			Gravel	0.1	U	%	D422
			Sand	66.2		%	D422
			Silt	24.9		%	D422
			Clay	8.9		%	D422
			Phosphorus, Total Orthophosphate	81.4		mg/kg	E300
			Alkalinity, Carbonate	464		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	308		mg/kg	E351.3
			pH	8.6		pH units	SW9045

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytica Method
ST14-MW23	23-Aug-94	7.50 - 7.70	Moisture, Percent	17.2		%	SW846
ST14-VW17	24-Aug-94	5.30 - 5.80	Moisture, Percent	28.2		%	SW846
ST14-VW22	25-Aug-94	5.90 - 6.50	Percent Passing #10 Sieve	98.33		%	D422
			Percent Passing #14 Sieve	97.12		%	D422
			Percent Passing #20 Sieve	95.41		%	D422
			Percent Passing #28 Sieve	93.46		%	D422
			Percent Passing #35 Sieve	92.51		%	D422
			Percent Passing #48 Sieve	88.13		%	D422
			Percent Passing #65 Sieve	86.08		%	D422
			Percent Passing #100 Sieve	83.77		%	D422
			Percent Passing #150 Sieve	80.94		%	D422
			Percent Passing #200 Sieve	78.06		%	D422
			Percent Passing #270 Sieve	73.55		%	D422
			Percent Passing #325 Sieve	70.21		%	D422
			Percent Passing #400 Sieve	68.54		%	D422
			Phosphorus, Total Orthophosphate	3.3	U	mg/kg	)
			Nitrogen, Total Kjeldahl	119		mg/kg	E351.3
			Moisture, Percent	24.6		%	SW846
			Total Organic Carbon	1.14		mg/kg	SW9060
			Total Organic Carbon	0.86		%	SW9060
ST14-VW26	25-Aug-94	5.20 - 6.10	Percent Passing #10 Sieve	97.78		%	D422
			Percent Passing #14 Sieve	95.34		%	D422
			Percent Passing #20 Sieve	91.41		%	D422
			Percent Passing #28 Sieve	86.94		%	D422
			Percent Passing #35 Sieve	84.93		%	D422
			Percent Passing #48 Sieve	76.86		%	D422
			Percent Passing #65 Sieve	73.64		%	D422
			Percent Passing #100 Sieve	70.38		%	D422
			Percent Passing #150 Sieve	66.88		%	D422
			Percent Passing #200 Sieve	63.8		%	D422
			Percent Passing #270 Sieve	60.3		%	D422
			Percent Passing #325 Sieve	58.41		%	D422
			Percent Passing #400 Sieve	57.32		%	D422
			Phosphorus, Total Orthophosphate	3.42	U	mg/kg	E300
			Nitrogen, Total Kjeldahl	6.84	U	mg/kg	E351.3
			Moisture, Percent	26.9		%	SW846
			Total Organic Carbon	0.73		mg/kg	SW9060
			Total Organic Carbon	0.53		%	SW9060

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW20	26-Aug-94	5.00 - 5.60	Percent Passing #10 Sieve	98.34		%	D422
			Percent Passing #14 Sieve	97.51		%	D422
			Percent Passing #20 Sieve	96.54		%	D422
			Percent Passing #28 Sieve	95.37		%	D422
			Percent Passing #35 Sieve	94.74		%	D422
			Percent Passing #48 Sieve	90.66		%	D422
			Percent Passing #65 Sieve	87.48		%	D422
			Percent Passing #100 Sieve	83.99		%	D422
			Percent Passing #150 Sieve	80.04		%	D422
			Percent Passing #200 Sieve	75.77		%	D422
			Percent Passing #270 Sieve	68.81		%	D422
			Percent Passing #325 Sieve	64.39		%	D422
			Percent Passing #400 Sieve	62.53		%	D422
			Phosphorus, Total Orthophosphate	3.14	U	mg/kg	E300
			Nitrogen, Total Kjeldahl	19.6		mg/kg	E351.3
			Moisture, Percent	20.5		%	SW846
			Total Organic Carbon	0.63	U	mg/kg	SW9060
			Total Organic Carbon	0.05	U	%	SW9060
ST14-VW21	26-Aug-94	3.40 - 4.40	Percent Passing #10 Sieve	93.02		%	D422
			Percent Passing #14 Sieve	86.32		%	D422
			Percent Passing #20 Sieve	79.54		%	D422
			Percent Passing #28 Sieve	73.36		%	D422
			Percent Passing #35 Sieve	70.98		%	D422
			Percent Passing #48 Sieve	61.68		%	D422
			Percent Passing #65 Sieve	58.18		%	D422
			Percent Passing #100 Sieve	57.88		%	D422
			Percent Passing #150 Sieve	51.63		%	D422
			Percent Passing #200 Sieve	48.88		%	D422
			Percent Passing #270 Sieve	45.9		%	D422
			Percent Passing #325 Sieve	44.32		%	D422
			Percent Passing #400 Sieve	43.45		%	D422
			Phosphorus, Total Orthophosphate	6.32		mg/kg	E300
			Nitrogen, Total Kjeldahl	6.67	U	mg/kg	E351.3
			Moisture, Percent	24.9		%	SW846
			Total Organic Carbon	0.2		mg/kg	SW9060
			Total Organic Carbon	0.15		%	SW9060
ST14-MW05	9-Aug-94	8.40 - 9.10	Phosphorus, Total Orthophosphate	2.64	U	mg/kg	E300
			Nitrogen, Total Kjeldahl	5.28	U	mg/kg	E351.3
			Total Organic Carbon	2800		mg/kg	SW9060
ST14-MW19	23-Aug-94	13.50 - 14.00	Moisture, Percent	14.2		%	SW846

TABLE A.3 (Continued)
SOIL DATA FOR OTHER ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW28	31-Mar-95	7.50 - 8.30	Moisture, Percent	13.8		%	%MOIST
			Total Organic Carbon	0.01	J	%	C02 CO
			Phosphourus, dissolved	2.88	U	mg/kg	E300.0
			Alkalinity, Total (as CACO3)	210		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	5.75	U	mg/kg	E351.2
			Iron, Total	2200		mg/kg	SW6010
			pH	8.89		pH units	SW9045
ST14-VW29	31-Mar-95	8.60 - 9.20	Moisture, Percent	7.85		%	%MOIST
			Total Organic Carbon	0.52		%	C02 CO
			Alkalinity, Total (as CACO3)	127		mg/kg	E.310.
			Phosphourus, dissolved	2.73	U	mg/kg	E300.0
			Nitrogen, Total Kjeldahl	5.38	U	mg/kg	E351.2
			Iron, Total	2100		mg/kg	SW6010
			pH	9.05		pH units	SW9045
ST14-VW30	31-Mar-95	8.40 - 9.00	Moisture, Percent	8.36		%	% ST
			Total Organic Carbon	0.15		%	C02 CO
			Phosphourus, dissolved	2.73	U	mg/kg	E300.0
			Alkalinity, Total (as CACO3)	186		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	5.4	U	mg/kg	E351.2
			Iron, Total	870		mg/kg	SW6010
			pH	9.03		pH units	SW9045
ST14-VW31	31-Mar-95	10.20 - 10.70	Moisture, Percent	8.3		%	%MOIST
			Total Organic Carbon	0.62		%	C02 CO
			Phosphorus, Total Orthophosphate	2.7	U	mg/kg	E300.0
			Alkalinity, Total (as CACO3)	268		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	5.43	U	mg/kg	E351.2
			Iron, Total	5300		mg/kg	SW6010
			pH	8.54		pH units	SW9045
ST14-VW32	3-Apr-95	9.50 - 10.50	Moisture, Percent	6.3		%	%MOIST
			Total Organic Carbon	0.16		%	CO2 CO
			Phosphourus, dissolved	2.65	U	mg/kg	E300.0
			Alkalinity, Total (as CACO3)	121		mg/kg	E310.1
			Nitrogen, Total Kjeldahl	5.29	U	mg/kg	E351.2
			Iron, Total	1200		mg/kg	SW6010
ST14-MW29	28-Mar-95	9.50 - 9.70	Total Organic Carbon	0.55		%	C02 CO
ST14-MW25	28-Mar-95	5.00 - 5.50	Total Organic Carbon	0.45		%	C[illegible]O

TABLE A.4
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW01	28-Jul-94	4.50 - 5.00	Carbon Dioxide	17		%	FCO2
			Petroleum Hydrocarbons	600		PPM	FIELD
			Oxygen	0.1		%	FO
SD13-MW04	28-Jul-94	4.50 - 5.00	Carbon Dioxide	11		%	FCO2
			Petroleum Hydrocarbons	5000		PPM	FIELD
			Oxygen	1.5		%	FO
SD13-PT1	8-Mar-95	8.00 - 8.50	Carbon Dioxide	5.5		%	FCO2
			Oxygen	8.5		%	FO
			Total Volatile Hydrocarbons	10000	>	PPM	FTPH
SD13-PT10	8-Mar-95	7.50 - 8.00	Carbon Dioxide	6.1		%	FCO2
			Oxygen	0.5	J	%	FO
			Total Volatile Hydrocarbons	2000		PPM	FTPH
SD13-PT2	8-Mar-95	8.00 - 8.50	Carbon Dioxide	5		%	FCO2
			Oxygen	9		%	FO
			Total Volatile Hydrocarbons	10000	>	PPM	FTPH
SD13-PT3	8-Mar-95	6.00 - 6.50	Carbon Dioxide	5		%	FCO2
			Oxygen	2		%	FO
			Total Volatile Hydrocarbons	4400		PPM	FTPH
SD13-PT4	8-Mar-95	5.00 - 5.50	Carbon Dioxide	5.5		%	FCO2
			Oxygen	4.5		%	FO
			Total Volatile Hydrocarbons	10000		PPM	FTPH
SD13-PT8	8-Mar-95	7.00 - 7.50	Carbon Dioxide	6.5		%	FCO2
			Oxygen	4.5		%	FO
			Total Volatile Hydrocarbons	350		PPM	FTPH
SD13-PT5	8-Mar-95	6.00 - 6.50	Carbon Dioxide	4.7		%	FCO2
			Oxygen	6		%	FO
			Total Volatile Hydrocarbons	10000	>	PPM	FTPH
SD13-PT6	8-Mar-95	6.50 - 7.00	Carbon Dioxide	7.1		%	FCO2
			Oxygen	1		%	FO
			Total Volatile Hydrocarbons	3000		PPM	FTPH

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
SD13-PT7	8-Mar-95	6.50 - 7.00	Carbon Dioxide	6.2		%	FCO2
			Oxygen	8		%	FO
			Total Volatile Hydrocarbons	460		PPM	FTPH
SD13-PT11	8-Mar-95	7.50 - 8.00	Carbon Dioxide	6.8		%	FCO2
			Oxygen	6.1		%	FO
			Total Volatile Hydrocarbons	5400		PPM	FTPH
SD13-PT12	8-Mar-95	8.00 - 8.50	Carbon Dioxide	4.5		%	FCO2
			Oxygen	10.8		%	FO
			Total Volatile Hydrocarbons	360		PPM	FTPH
SD13-PT9	8-Mar-95	7.00 - 7.50	Carbon Dioxide	6.1		%	FCO2
			Oxygen	0.5	J	%	FO
			Total Volatile Hydrocarbons	2000		PPM	FTPH
ST14-MPA	9-Jun-93	4.00 - 4.50	Benzene	3.4	U	µg/L	TO3
			Toluene	4	U	µg/L	TO3
			Ethylbenzene	19		µg/L	TO3
			Xylenes (Total)	47		µg/L	TO3
			Petroleum Hydrocarbons	130000		µg/L	TO3
ST14-MPA	28-Jul-94	4.50 - 5.00	Carbon Dioxide	2.5		%	FCO2
			Petroleum Hydrocarbons	300	>	PPM	FIELD
			Oxygen	16		%	FO
ST14-VW1	9-Jun-93	5.00 - 5.50	Benzene	6.6	U	µg/L	TO3
			Toluene	7.7	U	µg/L	TO3
			Ethylbenzene	27		µg/L	TO3
			Xylenes (Total)	81		µg/L	TO3
			Petroleum Hydrocarbons	140000		µg/L	TO3
ST14-MPC	9-Jun-93	7.00 - 7.50	Benzene	3.4	U	µg/L	TO3
			Toluene	4	U	µg/L	TO3
			Ethylbenzene	33		µg/L	TO3
			Xylenes (Total)	89		µg/L	TO3
			Petroleum Hydrocarbons	170000		µg/L	TO3
ST14-VW3	28-Jul-94	0.00 - 0.00	Benzene	120		µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	79		µg/L	TO3
			Xylenes (Total)	180		µg/L	TO3
			Petroleum Hydrocarbons	97000		µg/L	TO3

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW3	28-Jul-94	4.50 - 5.00	Carbon Dioxide	22		%	FCO2
			Petroleum Hydrocarbons	10000	>	PPM	FIELD
			Oxygen	0.2		%	FO
ST14-VW4	28-Jul-94	4.50 - 5.00	Carbon Dioxide	25	>	%	FCO2
			Petroleum Hydrocarbons	800		PPM	FIELD
			Oxygen	1		%	FO
ST14-VW7	28-Jul-94	4.50 - 5.00	Carbon Dioxide	17		%	FCO2
			Petroleum Hydrocarbons	1100		PPM	FIELD
			Oxygen	3		%	FO
ST14-VW8	28-Jul-94	4.50 - 5.00	Carbon Dioxide	17		%	FCO2
			Petroleum Hydrocarbons	1500		PPM	FIELD
			Oxygen	2		%	FO
ST14-VW9	28-Jul-94	4.50 - 5.00	Carbon Dioxide	9.1		%	FCO2
			Petroleum Hydrocarbons	5000		PPM	FIELD
			Oxygen	1		%	FO
ST14-VW12	28-Jul-94	4.50 - 5.00	Carbon Dioxide	16		%	FCO2
			Petroleum Hydrocarbons	500		PPM	FIELD
			Oxygen	1		%	FO
ST14-VW13	28-Jul-94	4.50 - 5.00	Carbon Dioxide	16		%	FCO2
			Petroleum Hydrocarbons	3800		PPM	FIELD
			Oxygen	3.2		%	FO
ST14-VW14	28-Jul-94	4.50 - 5.00	Carbon Dioxide	18		%	FCO2
			Petroleum Hydrocarbons	2000		PPM	FIELD
			Oxygen	2.5		%	FO
ST14-VW15	28-Jul-94	4.50 - 5.00	Carbon Dioxide	15		%	FCO2
			Petroleum Hydrocarbons	8000		PPM	FIELD
			Oxygen	5.8		%	FO
ST14-VW16	28-Jul-94	4.50 - 5.00	Carbon Dioxide	19		%	FCO2
			Petroleum Hydrocarbons	250		PPM	FIELD
			Oxygen	1		%	FO
ST14-MPB	28-Jul-94	4.00 - 4.50	Carbon Dioxide	0.8		%	FCO2
			Oxygen	7		%	FO

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MPB	28-Jul-94	7.00 - 7.50	Carbon Dioxide	7		%	FCO2
			Petroleum Hydrocarbons	2000		PPM	FIELD
			Oxygen	0.1		%	FO
ST14-MW01	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	3.9		µg/L	TO3
			Xylenes (Total)	9.7		µg/L	TO3
			Petroleum Hydrocarbons	2300		µg/L	TO3
ST14-MW01	28-Jul-94	4.50 - 5.00	Carbon Dioxide	7		%	FCO2
			Petroleum Hydrocarbons	96		PPM	FIELD
			Oxygen	4.5		%	FO
ST14-MW04	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	18		µg/L	TO3
			Xylenes (Total)	39		µg/L	TO3
			Petroleum Hydrocarbons	7100		µg/L	TO3
ST14-MW04	28-Jul-94	4.50 - 5.00	Carbon Dioxide	15		%	FCO2
			Petroleum Hydrocarbons	880		PPM	FIELD
			Oxygen	1.5		%	FO
ST14-MW17J	28-Jul-94	4.50 - 5.00	Carbon Dioxide	9		%	FCO2
			Petroleum Hydrocarbons	6400		PPM	FIELD
			Oxygen	1	U	%	FO
T14-MW17	28-Jul-94	4.50 - 5.00	Carbon Dioxide	2		%	FCO2
			Petroleum Hydrocarbons	40		PPM	FIELD
			Oxygen	19		%	FO
ST14-SG10B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	6.8		%	FCO2
			Petroleum Hydrocarbons	9400		PPM	FIELD
			Oxygen	1		%	FO
ST14-SG11B	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	84		µg/L	TO3
			Xylenes (Total)	210		µg/L	TO3
			Petroleum Hydrocarbons	65000		µg/L	TO3

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SG11B	28-Jul-94	1.00 - 1.50	Carbon Dioxide	7		%	FCO2
			Petroleum Hydrocarbons	10000	>	PPM	FIELD
			Oxygen	5		%	FO
ST14-SG11B	28-Jul-94	3.00 - 3.50	Carbon Dioxide	2		%	FCO2
			Petroleum Hydrocarbons	760		PPM	FIELD
			Oxygen	20		%	FO
ST14-SG12B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	11.9		%	FCO2
			Petroleum Hydrocarbons	3700		PPM	FIELD
			Oxygen	3.5		%	FO
ST14-SG13B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	2.1		%	FCO2
			Petroleum Hydrocarbons	40		PPM	FIELD
			Oxygen	19		%	FO
ST14-SG14B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	4		%	FCO2
			Petroleum Hydrocarbons	59		PPM	FIELD
			Oxygen	18		%	FO
ST14-SG15B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	4.1		%	FCO2
			Petroleum Hydrocarbons	200		PPM	FIELD
			Oxygen	12		%	FO
ST14-SG16B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	3.5		%	FCO2
			Petroleum Hydrocarbons	5200		PPM	FIELD
			Oxygen	14		%	FO
ST14-SG17B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	5.1		%	FCO2
			Petroleum Hydrocarbons	4400		PPM	FIELD
			Oxygen	13		%	FO
ST14-SG18B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	11.2		%	FCO2
			Petroleum Hydrocarbons	2200		PPM	FIELD
			Oxygen	3		%	FO
ST14-SG19B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	2.5		%	FCO2
			Petroleum Hydrocarbons	7		PPM	FIELD
			Oxygen	19.5		%	FO

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SG1B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	1.25		%	FCO2
			Petroleum Hydrocarbons	24		PPM	FIELD
			Oxygen	17		%	FO
ST14-SG20B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	3.2		%	FCO2
			Petroleum Hydrocarbons	9.2		PPM	FIELD
			Oxygen	19.3		%	FO
ST14-SG21B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	1.75		%	FCO2
			Petroleum Hydrocarbons	150		PPM	FIELD
			Oxygen	19.5		%	FO
ST14-SG22B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	1		%	FCO2
			Petroleum Hydrocarbons	200	U	PPM	FIELD
			Oxygen	10		%	FO
ST14-SG23B	28-Jul-94	3.00 - 3.50	Carbon Dioxide	2.8		%	FCO2
			Petroleum Hydrocarbons	7.6		PPM	FIELD
			Oxygen	19		%	FO
ST14-SG24B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	0.8		%	FCO2
			Petroleum Hydrocarbons	160		PPM	FIELD
			Oxygen	20		%	FO
ST14-SG25B	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	0.009	J	µg/L	TO3
			Xylenes (Total)	0.071		µg/L	TO3
			Petroleum Hydrocarbons	19		µg/L	TO3
ST14-SG25B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	6		%	FCO2
			Petroleum Hydrocarbons	200	U	PPM	FIELD
			Oxygen	16		%	FO
ST14-SG26B	28-Jul-94	5.00 - 5.50	Carbon Dioxide	2.6		%	FCO2
			Petroleum Hydrocarbons	61		PPM	FIELD
			Oxygen	18		%	FO
ST14-SG2B	28-Jul-94	3.00 - 3.50	Carbon Dioxide	7.75		%	FCO2
			Petroleum Hydrocarbons	620		PPM	FIELD
			Oxygen	6.5		%	FO

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SG3B	28-Jul-94	3.00 - 3.50	Carbon Dioxide	2.7		%	FCO2
			Petroleum Hydrocarbons	5		PPM	FIELD
			Oxygen	17		%	FO
ST14-SG4A	28-Jul-94	5.00 - 5.50	Carbon Dioxide	1.7		%	FCO2
			Petroleum Hydrocarbons	200		PPM	FIELD
			Oxygen	14		%	FO
ST14-SG4B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	3.9		%	FCO2
			Petroleum Hydrocarbons	40		PPM	FIELD
			Oxygen	15		%	FO
ST14-SG5B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	7.5		%	FCO2
			Petroleum Hydrocarbons	10000	>	PPM	FIELD
			Oxygen	3		%	FO
ST14-SG6A	28-Jul-94	3.00 - 3.50	Carbon Dioxide	0.2		%	FCO2
			Oxygen	21		%	FO
ST14-SG6B	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	75		µg/L	TO3
			Xylenes (Total)	210		µg/L	TO3
			Petroleum Hydrocarbons	65000		µg/L	TO3
ST14-SG6B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	15		%	FCO2
			Petroleum Hydrocarbons	2400		PPM	FIELD
ST14-SG7B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	13		%	FCO2
			Petroleum Hydrocarbons	5600		PPM	FIELD
			Oxygen	11.5		%	FO
ST14-SG8B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	10		%	FCO2
			Petroleum Hydrocarbons	60		PPM	FIELD
			Oxygen	3		%	FO
ST14-SG9B	28-Jul-94	4.00 - 4.50	Carbon Dioxide	3.5		%	FCO2
			Petroleum Hydrocarbons	240		PPM	FIELD
			Oxygen	18.5		%	FO
ST14-VW10	28-Jul-94	4.50 - 5.00	Carbon Dioxide	18		%	FCO2
			Petroleum Hydrocarbons	2000		PPM	FIELD
			Oxygen	1.2		%	FO

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-VW11	28-Jul-94	4.50 - 5.00	Carbon Dioxide	16		%	FCO2
			Petroleum Hydrocarbons	10000	>	PPM	FIELD
			Oxygen	0.5		%	FO
ST14-VW2	28-Jul-94	4.50 - 5.00	Carbon Dioxide	13		%	FCO2
			Petroleum Hydrocarbons	10000	>	PPM	FIELD
			Oxygen	5		%	FO
ST14-VW5	28-Jul-94	4.50 - 5.00	Carbon Dioxide	17		%	FCO2
			Petroleum Hydrocarbons	2000		PPM	FIELD
			Oxygen	2		%	FO
ST14-VW6	28-Jul-94	4.50 - 5.00	Carbon Dioxide	17.5		%	FCO2
			Petroleum Hydrocarbons	1000		PPM	FIELD
			Oxygen	1.5		%	FO
ST14-MW23	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	0.044		µg/L	TO3
			Xylenes (Total)	0.39		µg/L	TO3
			Petroleum Hydrocarbons	38		µg/L	TO3
ST14-MW23	28-Jul-94	4.50 - 5.00	Carbon Dioxide	4.5		%	FCO2
			Petroleum Hydrocarbons	460		PPM	FIELD
			Oxygen	17		%	FO
ST14-MW17I	28-Jul-94	0.00 - 0.00	Benzene	0.007	U	µg/L	TO3
			Toluene	0.008	U	µg/L	TO3
			Ethylbenzene	1.6		µg/L	TO3
			Xylenes (Total)	3.8		µg/L	TO3
			Petroleum Hydrocarbons	1400		µg/L	TO3
ST14-MW17I	28-Jul-94	4.50 - 5.00	Carbon Dioxide	6.7		%	FCO2
			Petroleum Hydrocarbons	52		PPM	FIELD
			Oxygen	13		%	FO
ST14-MW17	28-Jul-94	4.50 - 5.00	Carbon Dioxide	9		%	FCO2
			Petroleum Hydrocarbons	45		PPM	FIELD
			Oxygen	4.5		%	FO

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW02	28-Jul-94	4.50 - 5.00	Carbon Dioxide	0.1		%	FCO2
			Petroleum Hydrocarbons	300		PPM	FIELD
			Oxygen	21		%	FO
T14-MW17	28-Jul-94	4.50 - 5.00	Carbon Dioxide	0.5		%	FCO2
			Petroleum Hydrocarbons	50		PPM	FIELD
			Oxygen	21		%	FO
1190-PT1	7-Mar-95	4.50 - 5.00	Carbon Dioxide	4		%	FCO2
			Oxygen	17.5		%	FO
			Total Volatile Hydrocarbons	300		PPM	FTPH
1190-PT11	7-Mar-95	3.50 - 4.00	Carbon Dioxide	0.5	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	400		PPM	FTPH
1190-PT12	7-Mar-95	2.50 - 3.00	Carbon Dioxide	0.5	J	%	FCO2
			Oxygen	20.25		%	FO
			Total Volatile Hydrocarbons	500		PPM	FTPH
1190-PT14	7-Mar-95	4.50 - 5.00	Carbon Dioxide	6.1		%	FCO2
			Oxygen	8		%	FO
			Total Volatile Hydrocarbons	450		PPM	FTPH
1190-PT6	7-Mar-95	3.00 - 3.50	Carbon Dioxide	0.5	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	16		PPM	FTPH
1190-PT7	7-Mar-95	2.00 - 2.50	Carbon Dioxide	0.3	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	3		PPM	FTPH
1190-PT8	7-Mar-95	3.00 - 3.50	Carbon Dioxide	0.25	J	%	FCO2
			Oxygen	20.5		%	FO
			Total Volatile Hydrocarbons	35		PPM	FTPH
1190-PT9	7-Mar-95	3.50 - 4.00	Carbon Dioxide	0.25	J	%	FCO2
			Oxygen	20.5		%	FO
			Total Volatile Hydrocarbons	160		PPM	FTPH
1190-PT10	8-Mar-95	8.50 - 9.00	Carbon Dioxide	0.5	J	%	FCO2
			Oxygen	20.2		%	FO
			Total Volatile Hydrocarbons	160		PPM	FTPH

TABLE A.4 (Continued)
SOIL GAS DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Interval (ft bgs: begin-end)	Analyte	Result	Data Qual	Units	Analytical Method
1190-PT2	8-Mar-95	3.00 - 3.50	Carbon Dioxide	2		%	FCO2
			Oxygen	17		%	FO
1190-PT4	8-Mar-95	4.50 - 5.00	Carbon Dioxide	3.5		%	FCO2
			Oxygen	17.2		%	FO
			Total Volatile Hydrocarbons	250		PPM	FTPH
1190-PT15	9-Mar-95	6.00 - 6.50	Carbon Dioxide	0.7	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	150		PPM	FTPH
1190-PT17	9-Mar-95	3.50 - 4.00	Carbon Dioxide	0.7	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	160		PPM	FTPH
1190-PT18	9-Mar-95	6.00 - 6.50	Carbon Dioxide	0.7	J	%	FCO2
			Oxygen	20		%	FO
			Total Volatile Hydrocarbons	400		PPM	FTPH
1190-PT3	8-Mar-95	4.50 - 5.00	Carbon Dioxide	8.5		%	FCO2
			Oxygen	3.5		%	FO
			Total Volatile Hydrocarbons	7400		PPM	FTPH
1190-PT5	8-Mar-95	8.50 - 9.00	Carbon Dioxide	3.9		%	FCO2
			Oxygen	8		%	FO
			Total Volatile Hydrocarbons	290		PPM	FTPH

TABLE A.5
UNADJUSTED SOIL FLUX DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-FLX1	28-Jul-94	Benzene	0.007	U	µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.01	U	µg/L	TO3
		Petroleum Hydrocarbons	4.6		µg/L	TO3
ST14-FLX2	28-Jul-94	Benzene	0.007	U	µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.01	U	µg/L	TO3
		Petroleum Hydrocarbons	2.1		µg/L	TO3
ST14-FLX3	28-Jul-94	Benzene	0.007	U	µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.01	U	µg/L	TO3
		Petroleum Hydrocarbons	1.7		µg/L	TO3
ST14-FLX4	28-Jul-94	Benzene	0.013		µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.62		µg/L	TO3
		Petroleum Hydrocarbons	8.4		µg/L	TO3
ST14-FLX5	28-Jul-94	Benzene	0.007	U	µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.01	U	µg/L	TO3
		Petroleum Hydrocarbons	1.9		µg/L	TO3
ST14-FLX6	28-Jul-94	Benzene	0.007	U	µg/L	TO3
		Toluene	0.008	U	µg/L	TO3
		Ethylbenzene	0.01	U	µg/L	TO3
		Xylenes (Total)	0.01	U	µg/L	TO3
		Petroleum Hydrocarbons	3.4		µg/L	TO3

CARSWELL
FLUX CHAMBER CALCULATIONS

FLUX 1

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	80.50	79.60			
benzene	0.007	0	0.164	5	0.213414634	26.94	26.44	1.067159024	0.227747	MDL USED TO CALC. EMISSIONS
toluene	0.008	0	0.164	5	0.243902439				0.260283	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.325353	MDL USED TO CALC. EMISSIONS
xylenes	0.01	0	0.164	5	0.304878049				0.325353	MDL USED TO CALC. EMISSIONS
tph	4.6	1	0.164	5	140.2439024				149.6625	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

FLUX 2

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	79.50	78.50			
benzene	0.007	0	0.164	5	0.213414634	26.39	25.83	1.074894183	0.229398	MDL USED TO CALC. EMISSIONS
toluene	0.008	0	0.164	5	0.243902439				0.262169	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.327712	MDL USED TO CALC. EMISSIONS
xylenes	0.01	0	0.164	5	0.304878049				0.327712	MDL USED TO CALC. EMISSIONS
tph	2.1	1	0.164	5	64.02439024				68.81944	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

FLUX 3

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	92.50	89.70			
benzene	0.007	0	0.164	5	0.213414634	33.61	32.06	1.224120005	0.261245	MDL USED TO CALC. EMISSIONS
toluene	0.008	0	0.164	5	0.243902439				0.298566	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.373207	MDL USED TO CALC. EMISSIONS
xylenes	0.01	0	0.164	5	0.304878049				0.373207	MDL USED TO CALC. EMISSIONS
tph	1.7	1	0.164	5	51.82926829				63.44524	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

FLUX 4

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	98.00	92.80			
benzene	0.013	1	0.164	5	0.396341463	36.67	33.78	1.455799968	0.576994	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS
toluene	0.009	0	0.164	5	0.274390244				0.399457	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.443841	MDL USED TO CALC. EMISSIONS
xylenes	0.62	1	0.164	5	18.90243902				27.51817	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS
tph	8.4	1	0.164	5	256.097561				372.8268	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

FLUX 5

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	98.00	92.80			
benzene	0.007	0	0.164	5	0.213414634	36.67	33.78	1.455799968	0.310689	MDL USED TO CALC. EMISSIONS
toluene	0.008	0	0.164	5	0.243902439				0.355073	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.443841	MDL USED TO CALC. EMISSIONS
xylenes	0.01	0	0.164	5	0.304878049				0.443841	MDL USED TO CALC. EMISSIONS
tph	1.9	1	0.164	5	57.92682927				84.32988	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

FLUX 6

ANALYTE	MEAS. CONC.		AREA	FLOWRATE	Erate(uncor.)	temp(c)	temp(a)	C factor	Erate	
	µg/L		m^2	L/min	µg/min m^2	98.00	92.80			
benzene	0.007	0	0.164	5	0.213414634	36.67	33.78	1.455799968	0.310689	MDL USED TO CALC. EMISSIONS
toluene	0.009	0	0.164	5	0.274390244				0.399457	MDL USED TO CALC. EMISSIONS
ethylbenzene	0.01	0	0.164	5	0.304878049				0.443841	MDL USED TO CALC. EMISSIONS
xylenes	0.01	0	0.164	5	0.304878049				0.443841	MDL USED TO CALC. EMISSIONS
tph	3.4	1	0.164	5	103.6585366				150.9061	DETECTED ANALYTE CONC. USED TO CALC. EMISSIONS

TABLE A.6
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
SD13-MW05	30-Mar-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	0.5	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
SD13-MW05	23-Jun-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW05	7-Sep-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	2	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW05	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
SD13-MW03	27-Mar-94	Petroleum Hydrocarbons	1.2		mg/L	E418.1
SD13-MW03	29-Mar-94	Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	3.5	J	µg/L	SW8020
		Xylenes (Total)	4.7	J	µg/L	SW8020
SD13-MW03	21-Jun-94	Petroleum Hydrocarbons	3.5		mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW03	7-Sep-94	Petroleum Hydrocarbons	3.1		mg/L	E418.1
		Toluene	2	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW03	11-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	4	U	µg/L	E602
		Xylenes (Total)	4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	21		µg/L	E602
		Chlorobenzene	0.7	J	µg/L	E602
		Total Extractable Hydrocarbons	0.7		mg/L	M8015

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
SD13-MW06	30-Mar-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	2.4		µg/L	SW8020
		Xylenes (Total)	2.5		µg/L	SW8020
SD13-MW06	24-Jun-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW06	8-Sep-94	Petroleum Hydrocarbons	1.1	U	mg/L	E418.1
		Toluene	4.8		µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW01	27-Mar-94	Petroleum Hydrocarbons	1.2		mg/L	E418.1
SD13-MW01	29-Mar-94	Petroleum Hydrocarbons	5.2		mg/L	E418.1
		Toluene	2.5	U	µg/L	SW8020
		Ethylbenzene	4.89		µg/L	SW8020
		Xylenes (Total)	5	U	µg/L	SW8020
SD13-MW01	21-Jun-94	Petroleum Hydrocarbons	3.2	J	mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW01	7-Sep-94	Petroleum Hydrocarbons	2.5		mg/L	E418.1
		Toluene	3.4		µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW01	9-Sep-94	Benzene	0.8	J	µg/L	SW8020
		Toluene	8.7		µg/L	SW8020
		Ethylbenzene	3.9	J	µg/L	SW8020
		Xylenes (Total)	28		µg/L	SW8020
		1,3,5-Trimethylbenzene	4.2		µg/L	SW8020
		1,2,4-Trimethylbenzene	17		µg/L	SW8020
		1,2,3-Trimethylbenzene	2.1	J	µg/L	SW8020
		Chlorobenzene	2.4	J	µg/L	SW8020
SD13-MW07	30-Mar-94	Petroleum Hydrocarbons	1.9		mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	3.7		µg/L	SW8020
		Xylenes (Total)	3.4		µg/L	SW8020
SD13-MW07	22-Jun-94	Petroleum Hydrocarbons	1.6		mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
SD13-MW07	7-Sep-94	Petroleum Hydrocarbons	4.2		mg/L	E418.1
		Toluene	2	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW07	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	7.5		µg/L	SW8020
		Ethylbenzene	6.5		µg/L	SW8020
		Xylenes (Total)	41		µg/L	SW8020
		1,3,5-Trimethylbenzene	10		µg/L	SW8020
		1,2,4-Trimethylbenzene	13		µg/L	SW8020
		1,2,3-Trimethylbenzene	6		µg/L	SW8020
		Chlorobenzene	2.5	J	µg/L	SW8020
SD13-MW04	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	0.7	J	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	1.1	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	0.4	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	1.2	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
SD13-MW02	27-Mar-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
SD13-MW02	29-Mar-94	Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	0.5	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
SD13-MW02	21-Jun-94	Petroleum Hydrocarbons	1.1	U	mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW02	8-Sep-94	Petroleum Hydrocarbons	1.1	U	mg/L	E418.1
		Toluene	2	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
SD13-MW02	11-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
SD13-MW02 (Cont.)	11-Apr-95	1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
		Total Extractable Hydrocarbons	0.5	U	mg/L	M8015
A100	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	5		µg/L	SW8020
		Ethylbenzene	31		µg/L	SW8020
		Xylenes (Total)	37		µg/L	SW8020
A400	13-Apr-94	Petroleum Hydrocarbons	5500		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	5500		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	5		µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	5		µg/L	SW8020
A700	13-Apr-94	Petroleum Hydrocarbons	1900		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	1900		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
A900	13-Apr-94	Petroleum Hydrocarbons	100	J	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
B100	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
B1000	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	42		µg/L	SW8020
		Toluene	12		µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	7		µg/L	SW8020
B200	13-Apr-94	Petroleum Hydrocarbons	3600		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	3600		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	5		µg/L	SW8020
		Ethylbenzene	409		µg/L	SW8020
		Xylenes (Total)	1089		µg/L	SW8020
B500	13-Apr-94	Petroleum Hydrocarbons	5000		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	5000		mg/L	SW8015
		Benzene	47		µg/L	SW8020
		Toluene	22		µg/L	SW8020
		Ethylbenzene	18		µg/L	SW8020
		Xylenes (Total)	77		µg/L	SW8020
B800	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	1600		mg/L	SW8015
		Benzene	3		ug/L	SW8020
		Toluene	5		µg/L	SW8020
		Ethylbenzene	9		µg/L	SW8020
		Xylenes (Total)	25		µg/L	SW8020
C000	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
C100	13-Apr-94	Petroleum Hydrocarbons	2400		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	2400		mg/L	SW8015
		Benzene	2		µg/L	SW8020
		Toluene	2		µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
C200	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
C500	13-Apr-94	Petroleum Hydrocarbons	4600		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	4600		mg/L	SW8015
		Benzene	15		µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	24		µg/L	SW8020
C800	13-Apr-94	Petroleum Hydrocarbons	111000		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	111000		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	14		µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	44		µg/L	SW8020
D200	13-Apr-94	Petroleum Hydrocarbons	3600		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	3600		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	4		µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	28		µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
D700	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	12600		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	2		µg/L	SW8020
		Ethylbenzene	5		µg/L	SW8020
		Xylenes (Total)	24		µg/L	SW8020
E0+10	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
E1+10	13-Apr-94	Petroleum Hydrocarbons	200	U	mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
E210	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
E400	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	184000		mg/L	SW8015
		Benzene	59		µg/L	SW8020
		Toluene	69		µg/L	SW8020
		Ethylbenzene	74		µg/L	SW8020
		Xylenes (Total)	62		µg/L	SW8020
E600	13-Apr-94	Petroleum Hydrocarbons	1300		mg/L	SW8015
		Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	1300		mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
F300	13-Apr-94	Total Extractable Hydrocarbons	100	U	mg/L	SW8015
		Total Volatile Hydrocarbons	100	U	mg/L	SW8015
		Benzene	1	U	µg/L	SW8020
		Toluene	1	U	µg/L	SW8020
		Ethylbenzene	1	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
ST14-MW01	9-Sep-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW04	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	25		µg/L	SW8020
		Xylenes (Total)	110		µg/L	SW8020
		1,3,5-Trimethylbenzene	52		µg/L	SW8020
		1,2,4-Trimethylbenzene	44		µg/L	SW8020
		1,2,3-Trimethylbenzene	28		µg/L	SW8020
		Chlorobenzene	7.6		µg/L	SW8020
ST14-MW17J	8-Sep-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	µg/L	SW8020
		Toluene	0.4	J	µg/L	SW8020
		Ethylbenzene	1.8	J	µg/L	SW8020
		Xylenes (Total)	1.3	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	4		µg/L	SW8020
		1,2,4-Trimethylbenzene	3.8	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	5.9		µg/L	SW8020
ST14-MW17K	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW07	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	0.8	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	0.7	J	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW10	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	0.4	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW13	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	0.5	J	µg/L	SW8020
		Xylenes (Total)	1.1	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	7.2		µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW14	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	1.8	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW15	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW16	8-Sep-94	Benzene	110		µg/L	SW8020
		Toluene	2.9	J	µg/L	SW8020
		Ethylbenzene	16		µg/L	SW8020
		Xylenes (Total)	20		µg/L	SW8020
		1,3,5-Trimethylbenzene	9.2		µg/L	SW8020
		1,2,4-Trimethylbenzene	10		µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	14		µg/L	SW8020
ST14-MW18	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	3.6	J	µg/L	SW8020
		Ethylbenzene	1.9	J	µg/L	SW8020
		Xylenes (Total)	2.1	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	0.8	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	0.6	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	0.8	J	µg/L	SW8020
		Chlorobenzene	1	J	µg/L	SW8020
ST14-MW23	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
ST14-MW06	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW08	7-Sep-94	Benzene	2.5	J	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	9.5		µg/L	SW8020
		Xylenes (Total)	3	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	1.4	J	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW08 (Cont.)	7-Sep-94	1,2,4-Trimethylbenzene	19		µg/L	SW8020
		1,2,3-Trimethylbenzene	0.8	J	µg/L	SW8020
		Chlorobenzene	2.8	J	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
ST14-SW3	5-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	4	U	µg/L	E602
		Ethylbenzene	4	U	µg/L	E602
		Xylenes (Total)	4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.7	J	µg/L	E602
		1,2,4-Trimethylbenzene	4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	33.3		µg/L	E602
		Chlorobenzene	0.9	J	µg/L	E602
ST14-SW4	5-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
ST14-MW05	7-Sep-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
ST14-MW09	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW11	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW12	7-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
OT12-MW15B	30-Mar-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	0.5	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
OT12-MW15B	22-Jun-94	Petroleum Hydrocarbons	1.1	U	mg/L	E418.1
		Trichloroethene	0.85		µg/L	SW8240
OT12-MW15B	8-Sep-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Trichloroethene	1.4		µg/L	SW8240
ST14-MW17I	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	3	J	µg/L	SW8020
		Ethylbenzene	1.2	J	µg/L	SW8020
		Xylenes (Total)	3.5	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	0.7	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	0.5	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	0.6	J	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW17L	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	0.5	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	3.7	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW19	8-Sep-94	Benzene	45		µg/L	SW8020
		Toluene	5.3		µg/L	SW8020
		Ethylbenzene	17		µg/L	SW8020
		Xylenes (Total)	15		µg/L	SW8020
		1,3,5-Trimethylbenzene	14		µg/L	SW8020
		1,2,4-Trimethylbenzene	33		µg/L	SW8020
		1,2,3-Trimethylbenzene	13		µg/L	SW8020
		Chlorobenzene	1.5	J	µg/L	SW8020
ST14-MW20	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	0.7	J	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	0.4	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	9.9		µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW21	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	0.6	J	µg/L	SW8020
		Ethylbenzene	0.5	J	µg/L	SW8020
		Xylenes (Total)	2.6	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	1.2	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW22	8-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
OT12-MW15C	29-Mar-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Ethylbenzene	0.5	U	µg/L	SW8020
		Xylenes (Total)	1	U	µg/L	SW8020
OT12-MW15C	22-Jun-94	Petroleum Hydrocarbons	1.2	U	mg/L	E418.1
		Trichloroethene	5	U	µg/L	SW8240
OT12-MW15C	8-Sep-94	Petroleum Hydrocarbons	1	U	mg/L	E418.1
		Toluene	0.5	U	µg/L	SW8020
		Trichloroethene	5	U	µg/L	SW8240
OT12-MW15C	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	4	U	µg/L	SW8020
		Xylenes (Total)	4	U	µg/L	SW8020
		1,3,5-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,4-Trimethylbenzene	4	U	µg/L	SW8020
		1,2,3-Trimethylbenzene	4	U	µg/L	SW8020
		Chlorobenzene	4	U	µg/L	SW8020
ST14-MW02	9-Sep-94	Benzene	7.6		µg/L	SW8020
		Toluene	8.9		µg/L	SW8020
		Ethylbenzene	18		µg/L	SW8020
		Xylenes (Total)	50		µg/L	SW8020
		1,3,5-Trimethylbenzene	36		µg/L	SW8020
		1,2,4-Trimethylbenzene	71		µg/L	SW8020
		1,2,3-Trimethylbenzene	62		µg/L	SW8020
		Chlorobenzene	9.7		µg/L	SW8020
ST14-MW03	9-Sep-94	Benzene	0.4	U	µg/L	SW8020
		Toluene	4	U	µg/L	SW8020
		Ethylbenzene	0.7	J	µg/L	SW8020
		Xylenes (Total)	1.3	J	µg/L	SW8020
		1,3,5-Trimethylbenzene	0.9	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	6		µg/L	SW8020
		1,2,3-Trimethylbenzene	1.3	J	µg/L	SW8020
		Chlorobenzene	0.5	J	µg/L	SW8020

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW17M	9-Sep-94	Total Extractable Hydrocarbons	25		mg/L	SW8015
		Benzene	2	U	µg/L	SW8020
		Toluene	9.5	J	µg/L	SW8020
		Ethylbenzene	6.5	J	µg/L	SW8020
		Xylenes (Total)	46		µg/L	SW8020
		1,3,5-Trimethylbenzene	9	J	µg/L	SW8020
		1,2,4-Trimethylbenzene	16	J	µg/L	SW8020
		1,2,3-Trimethylbenzene	6	J	µg/L	SW8020
		Chlorobenzene	2.5	J	µg/L	SW8020
ST14-MW28	11-Apr-95	Benzene	1.8	J	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	38		µg/L	E602
		Xylenes (Total)	4	U	µg/L	E602
		1,3,5-Trimethylbenzene	2.4	J	µg/L	E602
		1,2,4-Trimethylbenzene	40		µg/L	E602
		1,2,3-Trimethylbenzene	3.6	J	µg/L	E602
		1,2,3,4-Tetramethylbenzene	51		µg/L	E602
		Chlorobenzene	1	J	µg/L	E602
ST14-MW24	10-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
ST14-MW26	10-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW27	10-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
		Benzene	0.5	U	µg/L	SW8240
		Toluene	5	U	µg/L	SW8240
		Ethylbenzene	5	U	µg/L	SW8240
		Xylenes (Total)	5	U	µg/L	SW8240
		1,3,5-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,4-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3,4-Tetramethylbenzene	5	U	µg/L	SW8240
		Chlorobenzene	5	U	µg/L	SW8240
		Styrene	5	U	µg/L	SW8240
ST14-MW29	11-Apr-95	Benzene	4	U	µg/L	E602
		Toluene	40	U	µg/L	E602
		Ethylbenzene	6.2	J	µg/L	E602
		Xylenes (Total)	40	U	µg/L	E602
		1,3,5-Trimethylbenzene	7.1	J	µg/L	E602
		1,2,4-Trimethylbenzene	9	J	µg/L	E602
		1,2,3-Trimethylbenzene	2.2	J	µg/L	E602
		1,2,3,4-Tetramethylbenzene	58		µg/L	E602
		Chlorobenzene	1.4	J	µg/L	E602
		Total Extractable Hydrocarbons	8.5		mg/L	M8015
ST14-MW30	11-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW31	11-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
ST14-MW32	11-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
		Total Extractable Hydrocarbons	0.5	U	mg/L	M8015
		Benzene	5	U	µg/L	SW8240
		Toluene	50	U	µg/L	SW8240
		Ethylbenzene	5	U	µg/L	SW8240
		Xylenes (Total)	5	U	µg/L	SW8240
		1,3,5-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,4-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3,4-Tetramethylbenzene	5	U	µg/L	SW8240
		Chlorobenzene	5	U	µg/L	SW8240
		Styrene	5	U	µg/L	SW8240
ST14-MW25	10-Apr-95	Benzene	0.4	U	µg/L	E602
		Toluene	0.4	U	µg/L	E602
		Ethylbenzene	0.4	U	µg/L	E602
		Xylenes (Total)	0.4	U	µg/L	E602
		1,3,5-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,4-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3-Trimethylbenzene	0.4	U	µg/L	E602
		1,2,3,4-Tetramethylbenzene	0.4	U	µg/L	E602
		Chlorobenzene	0.4	U	µg/L	E602
		Total Extractable Hydrocarbons	0.5	U	mg/L	M8015
		Benzene	5	U	µg/L	SW8240
		Toluene	5	U	µg/L	SW8240

TABLE A.6 (Continued)
GROUNDWATER DATA FOR VOLATILE ORGANIC COMPOUNDS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Date Qual	Units	Analytical Method
ST14-MW25 (Cont.)	10-Apr-95	Ethylbenzene	5	U	µg/L	SW8240
		Xylenes (Total)	5	U	µg/L	SW8240
		1,3,5-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,4-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3-Trimethylbenzene	5	U	µg/L	SW8240
		1,2,3,4-Tetramethylbenzene	5	U	µg/L	SW8240
		Chlorobenzene	5	U	µg/L	SW8240
		Styrene	5	U	µg/L	SW8240

TABLE A.7
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW03	11-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	5	J	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	8	J	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	1	J	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW03 (Cont)	11-Apr-95	Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
SD13-MW02	11-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	10	U	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW02 (Cont)	11-Apr-95	Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
SD13-MW02 (Cont)	11-Apr-95	Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
ST14-MW01	9-Sep-94	Naphthalene	10	U	µg/L	SW8270
ST14-MW17J	8-Sep-94	Naphthalene	10	U	µg/L	SW8270
ST14-SW3	5-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	4	J	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW3 (Cont)	5-Apr-95	Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
ST14-SW4	5-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW4 (Cont)	5-Apr-95	Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	10	U	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW4 (Cont)	5-Apr-95	Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
ST14-MW05	7-Sep-94	Naphthalene	10	U	µg/L	SW8270
ST14-MW17M	9-Sep-94	Naphthalene	53		µg/L	SW8270
ST14-MW31	11-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	10	U	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW31 (Cont)	11-Apr-95	N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
ST14-MW32	11-Apr-95	1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW32 (Cont)	11-Apr-95	Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	10	U	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270
		Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW32 (Cont)	11-Apr-95	2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270
ST14-MW25	10-Apr-95	bis(2-Chloroethyl)ether	10	U	µg/L	SW8270
		1,3-Dichlorobenzene	10	U	µg/L	SW8270
		1,4-Dichlorobenzene	10	U	µg/L	SW8270
		1,2-Dichlorobenzene	10	U	µg/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	µg/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	µg/L	SW8270
		Hexachloroethane	10	U	µg/L	SW8270
		Nitrobenzene	10	U	µg/L	SW8270
		Isophorone	10	U	µg/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	µg/L	SW8270
		1,2,4-Trichlorobenzene	10	U	µg/L	SW8270
		Naphthalene	10	U	µg/L	SW8270
		4-Chloroaniline	10	U	µg/L	SW8270
		Hexachlorobutadiene	10	U	µg/L	SW8270
		2-Methylnaphthalene	10	U	µg/L	SW8270
		Hexachlorocyclopentadiene	10	U	µg/L	SW8270
		2-Chloronaphthalene	10	U	µg/L	SW8270
		2-Nitroaniline	10	U	µg/L	SW8270
		Dimethylphthalate	10	U	µg/L	SW8270
		2,6-Dinitrotoluene	10	U	µg/L	SW8270
		Acenaphthylene	10	U	µg/L	SW8270
		3-Nitroaniline	10	U	µg/L	SW8270
		Acenaphthene	10	U	µg/L	SW8270
		Dibenzofuran	10	U	µg/L	SW8270
		2,4-Dinitrotoluene	10	U	µg/L	SW8270
		Diethylphthalate	10	U	µg/L	SW8270
		4-Chlorophenyl-phenylether	10	U	µg/L	SW8270

TABLE A.7 (Continued)
GROUNDWATER DATA FOR SEMIVOLATILE ORGANIC COMPOUND
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-MW25 (Cont)	10-Apr-95	Fluorene	10	U	µg/L	SW8270
		4-Nitroaniline	50	U	µg/L	SW8270
		N-Nitrosodiphenylamine	10	U	µg/L	SW8270
		4-Bromophenyl-phenylether	10	U	µg/L	SW8270
		Hexachlorobenzene	10	U	µg/L	SW8270
		Phenanthrene	10	U	µg/L	SW8270
		Anthracene	10	U	µg/L	SW8270
		Di-n-butylphthalate	10	U	µg/L	SW8270
		Fluoranthene	10	U	µg/L	SW8270
		Pyrene	10	U	µg/L	SW8270
		Butylbenzylphthalate	10	U	µg/L	SW8270
		3,3'-Dichlorobenzidine	20	U	µg/L	SW8270
		Benzo(a)anthracene	10	U	µg/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	µg/L	SW8270
		Chrysene	10	U	µg/L	SW8270
		Di-n-octylphthalate	10	U	µg/L	SW8270
		Benzo(b)fluoranthene	10	U	µg/L	SW8270
		Benzo(k)fluoranthene	10	U	µg/L	SW8270
		Benzo(a)pyrene	10	U	µg/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	µg/L	SW8270
		Dibenz(a,h)anthracene	10	U	µg/L	SW8270
		Benzo(g,h,i)perylene	10	U	µg/L	SW8270
		Phenol	10	U	µg/L	SW8270
		2-Chlorophenol	10	U	µg/L	SW8270
		Benzyl Alcohol	10	U	µg/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	µg/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	µg/L	SW8270
		2-Nitrophenol	10	U	µg/L	SW8270
		2,4-Dimethylphenol	10	U	µg/L	SW8270
		Benzoic Acid	50	U	µg/L	SW8270
		2,4-Dichlorophenol	10	U	µg/L	SW8270
		4-Chloro-3-methylphenol	10	U	µg/L	SW8270
		2,4,6-Trichlorophenol	10	U	µg/L	SW8270
		2,4-Dinitrophenol	50	U	µg/L	SW8270
		4-Nitrophenol	50	U	µg/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	µg/L	SW8270
		Pentachlorophenol	50	U	µg/L	SW8270
		2,4,5-Trichlorophenol	10	U	µg/L	SW8270

TABLE A.8
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
SD13-MW05	9-Sep-94	Dissolved Oxygen	1.17		mg/L	FDO
		Iron, Total	0.06		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.005		mg/L	H8040
		Sulfate	50.38		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.01	U	mg/L	H8146
		Carbon Dioxide	40		mg/L	H8223
SD13-MW03	10-Apr-95	Dissolved Oxygen	0.65	J	mg/L	FDO
		Iron, Total	13.2		mg/L	H8008
		Nitrate	3.9		mg/L	H8039
		Nitrite	0.004		mg/L	H8040
		Sulfate	35.9		mg/L	H8051
		Sulfide	0.011		mg/L	H8131
		Iron, Ferrous	8.2		mg/L	H8146
		Manganese	0.2		mg/L	HMANG
SD13-MW03	11-Apr-95	Carbon Dioxide	356		mg/L	CO2
		Methane	4.41		mg/L	RSKSOP
SD13-MW01	9-Sep-94	Dissolved Oxygen	0.4		mg/L	FDO
		Iron, Total	10.12		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	7.2		mg/L	H8051
		Sulfide	0.01		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	7.26		mg/L	H8146
		Carbon Dioxide	55		mg/L	H8223
SD13-MW07	9-Sep-94	Dissolved Oxygen	0.39		mg/L	FDO
		Iron, Total	6.52		mg/L	H8008
		Nitrate	1.9		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	2.49		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	5.28		mg/L	H8146
		Carbon Dioxide	95		mg/L	H8223
		Methane	0.39		mg/L	RSK175

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
SD13-MW04	9-Sep-94	Dissolved Oxygen	0.29		mg/L	FDO
		Iron, Total	17.7		mg/L	H8008
		Nitrate	0.9		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	5.36		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	10		mg/L	H8146
		Carbon Dioxide	65		mg/L	H8223
SD13-MW02	10-Apr-95	Dissolved Oxygen	0.8	J	mg/L	FDO
		Iron, Total	0.18		mg/L	H8008
		Nitrate	0.5		mg/L	H8039
		Nitrite	0.006		mg/L	H8040
		Sulfate	11.29		mg/L	H8051
		Sulfide	0.018		mg/L	H8131
		Iron, Ferrous	0.09		mg/L	H8146
		Manganese	0.3		mg/L	HMANG
SD13-MW02	11-Apr-95	Carbon Dioxide	352		mg/L	CO2
		Methane	0.004	U	mg/L	RSKSOP
A100	13-Apr-94	Dissolved Oxygen	0.4		mg/L	FDO
		Iron, Total	0.63		mg/L	H8008
		Nitrite	0.072		mg/L	H8040
		Lead	12		µg/L	SW7421
A400	13-Apr-94	Dissolved Oxygen	2		mg/L	FDO
		Iron, Total	1.49		mg/L	H8008
		Nitrate	0.5		mg/L	H8039
		Nitrite	0.013		mg/L	H8040
		Lead	60		µg/L	SW7421
A700	13-Apr-94	Dissolved Oxygen	1.8		mg/L	FDO
		Iron, Total	3.89		mg/L	H8008
		Nitrate	0.5		mg/L	H8039
		Nitrite	0.01		mg/L	H8040
		Lead	10		µg/L	SW7421

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
A900	13-Apr-94	Dissolved Oxygen	1.2		mg/L	FDO
		Nitrate	0.4		mg/L	H8039
		Nitrite	0.005		mg/L	H8040
		Lead	30		µg/L	SW7421
B100	13-Apr-94	Dissolved Oxygen	1.8		mg/L	FDO
		Iron, Total	0.06		mg/L	H8008
		Nitrate	0.4		mg/L	H8039
		Nitrite	0.023		mg/L	H8040
		Lead	5	U	µg/L	SW7421
B1000	13-Apr-94	Dissolved Oxygen	0.8		mg/L	FDO
		Iron, Total	8.1		mg/L	H8008
		Nitrate	8.15		mg/L	H8039
		Nitrite	0.001		mg/L	H8040
		Lead	66		µg/L	SW7421
B200	13-Apr-94	Dissolved Oxygen	0.4		mg/L	FDO
		Iron, Total	6.49		mg/L	H8008
		Nitrate	4.85		mg/L	H8039
		Nitrite	0.015		mg/L	H8040
		Lead	5	U	µg/L	SW7421
B500	13-Apr-94	Dissolved Oxygen	1.1		mg/L	FDO
		Iron, Total	3.45		mg/L	H8008
		Nitrate	10.6		mg/L	H8039
		Lead	35		µg/L	SW7421
B800	13-Apr-94	Dissolved Oxygen	1.2		mg/L	FDO
		Iron, Total	4.88		mg/L	H8008
		Nitrate	6.8		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Lead	54		µg/L	SW7421
C000	13-Apr-94	Dissolved Oxygen	2.4		mg/L	FDO
		Iron, Total	0.18		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.017		mg/L	H8040
		Lead	5	U	µg/L	SW7421

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
C100	13-Apr-94	Dissolved Oxygen	1.4		mg/L	FDO
		Iron, Total	0.045		mg/L	H8008
		Nitrate	0.9		mg/L	H8039
		Nitrite	0.049		mg/L	H8040
		Lead	5	U	µg/L	SW7421
C200	13-Apr-94	Dissolved Oxygen	1.4		mg/L	FDO
		Iron, Total	0.79		mg/L	H8008
		Nitrate	0.75		mg/L	H8039
		Nitrite	0.073		mg/L	H8040
		Lead	5	U	µg/L	SW7421
C500	13-Apr-94	Dissolved Oxygen	1		mg/L	FDO
		Iron, Total	8.2		mg/L	H8008
		Nitrate	14.05		mg/L	H8039
		Nitrite	0.005		mg/L	H8040
		Lead	65		µg/L	SW7421
C800	13-Apr-94	Dissolved Oxygen	2.2		mg/L	FDO
		Iron, Total	4		mg/L	H8008
		Nitrate	1.8		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Lead	88		µg/L	SW7421
D200	13-Apr-94	Dissolved Oxygen	1.8		mg/L	FDO
		Lead	5	U	µg/L	SW7421
D700	13-Apr-94	Dissolved Oxygen	0.4		mg/L	FDO
		Iron, Total	6.05		mg/L	H8008
		Nitrate	5.6		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Lead	75		µg/L	SW7421
E0+10	13-Apr-94	Dissolved Oxygen	1.4		mg/L	FDO
		Iron, Total	0.895		mg/L	H8008
		Nitrate	0.6		mg/L	H8039
		Nitrite	0.048		mg/L	H8040
		Lead	50		µg/L	SW7421
E1+10	13-Apr-94	Dissolved Oxygen	0.8		mg/L	FDO
		Iron, Total	0.28		mg/L	H8008
		Nitrite	0.056		mg/L	H8040
		Lead	5	U	µg/L	SW7421

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
E210	13-Apr-94	Dissolved Oxygen	1.6		mg/L	FDO
		Iron, Total	1.52		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.087		mg/L	H8040
		Lead	40		µg/L	SW7421
E400	13-Apr-94	Iron, Total	8.1		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Lead	90		µg/L	SW7421
E600	13-Apr-94	Dissolved Oxygen	0.7		mg/L	FDO
		Iron, Total	1.05		mg/L	H8008
		Lead	45		µg/L	SW7421
F300	13-Apr-94	Dissolved Oxygen	0.6		mg/L	FDO
		Iron, Total	4.265		mg/L	H8008
		Nitrate	0.5		mg/L	H8039
		Nitrite	0.009		mg/L	H8040
		Lead	30		µg/L	SW7421
ST14-MW01	9-Sep-94	Dissolved Oxygen	0.8		mg/L	FDO
		Iron, Total	8.76		mg/L	H8008
		Nitrate	5		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	68.4		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	4.66		mg/L	H8146
		Carbon Dioxide	98		mg/L	H8223
		Methane	0.254		mg/L	RSK175
ST14-MW04	9-Sep-94	Dissolved Oxygen	0.29		mg/L	FDO
		Iron, Total	4.94		mg/L	H8008
		Nitrate	0.9		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	33.5		mg/L	H8051
		Sulfide	0.01		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	4.18		mg/L	H8146
		Carbon Dioxide	96		mg/L	H8223

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW17J	8-Sep-94	Carbon Dioxide	384		mg/L	COU-02
		Dissolved Oxygen	0.2		mg/L	FDO
		Iron, Total	0.48		mg/L	H8008
		Nitrate	0.6		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	112		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.42		mg/L	H8146
		Carbon Dioxide	60		mg/L	H8223
		Methane	0.57		mg/L	RSK175
ST14-MW17K	8-Sep-94	Dissolved Oxygen	2.22		mg/L	FDO
		Iron, Total	0.08		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.001		mg/L	H8040
		Sulfate	28.04		mg/L	H8051
		Sulfide	0.01		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.01	U	mg/L	H8146
		Carbon Dioxide	56		mg/L	H8223
ST14-MW07	7-Sep-94	Dissolved Oxygen	1.8		mg/L	FDO
		Iron, Total	0.2		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	31		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Carbon Dioxide	50		mg/L	H8223
ST14-MW10	7-Sep-94	Carbon Dioxide	367		mg/L	COU-02
		Dissolved Oxygen	0.41		mg/L	FDO
		Iron, Total	0.27		mg/L	H8008
		Nitrate	3.7		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	76.84		mg/L	H8051
		Sulfide	12.5		mg/L	H8131
		Hydrogen Sulfide	5		mg/L	H8131
		Iron, Ferrous	0.12		mg/L	H8146
		Carbon Dioxide	75		mg/L	H8223
		Methane	0.004	J	mg/L	RSK175

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW13	7-Sep-94	Carbon Dioxide	400		mg/L	COU-02
		Dissolved Oxygen	0.13		mg/L	FDO
		Iron, Total	3.99		mg/L	H8008
		Nitrate	2.3		mg/L	H8039
		Nitrite	0.003		mg/L	H8040
		Sulfate	7.7		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	3.6		mg/L	H8146
		Carbon Dioxide	96		mg/L	H8223
		Methane	0.64		mg/L	RSK175
ST14-MW14	8-Sep-94	Carbon Dioxide	335		mg/L	COU-02
		Dissolved Oxygen	0.53		mg/L	FDO
		Iron, Total	1.79		mg/L	H8008
		Nitrate	0.3		mg/L	H8039
		Nitrite	0.001		mg/L	H8040
		Sulfate	1.53		mg/L	H8051
		Sulfide	0.03		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	1.76		mg/L	H8146
		Carbon Dioxide	66		mg/L	H8223
		Methane	0.09		mg/L	RSK175
ST14-MW15	8-Sep-94	Carbon Dioxide	394		mg/L	COU-02
		Dissolved Oxygen	1.47		mg/L	FDO
		Iron, Total	1.57		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	107.2		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	1.4		mg/L	H8146
		Carbon Dioxide	75		mg/L	H8223
		Methane	0.57		mg/L	RSK175
ST14-MW16	8-Sep-94	Dissolved Oxygen	0.06		mg/L	FDO
		Iron, Total	4.67		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	28		mg/L	H8051
		Sulfide	0.12		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW16 (Cont)	8-Sep-94	Iron, Ferrous	4.3		mg/L	H8146
		Carbon Dioxide	95		mg/L	H8223
ST14-MW18	8-Sep-94	Carbon Dioxide	473		mg/L	COU-02
		Dissolved Oxygen	0.38		mg/L	FDO
		Iron, Total	8.83		mg/L	H8008
		Nitrate	1.8		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	2.56		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	7.82		mg/L	H8146
		Carbon Dioxide	113		mg/L	H8223
		Methane	3.04		mg/L	RSK175
ST14-MW23	8-Sep-94	Dissolved Oxygen	4.1		mg/L	FDO
		Iron, Total	0.03		mg/L	H8008
		Nitrate	0.9		mg/L	H8039
		Nitrite	0.002		mg/L	H8040
		Sulfate	16.89		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.002	J	mg/L	H8146
		Carbon Dioxide	46		mg/L	H8223
ST14-MW06	7-Sep-94	Carbon Dioxide	345		mg/L	COU-02
		Dissolved Oxygen	0.23		mg/L	FDO
		Iron, Total	0.79		mg/L	H8008
		Nitrate	2.9		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	29		mg/L	H8051
		Sulfide	0.07		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.61		mg/L	H8146
		Carbon Dioxide	100		mg/L	H8223
ST14-MW08	7-Sep-94	Carbon Dioxide	440		mg/L	COU-02
		Dissolved Oxygen	0.67		mg/L	FDO
		Iron, Total	0.38		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	79.4		mg/L	H8051
		Sulfide	0.02		mg/L	H8131

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW08 (Cont)	7-Sep-94	Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.17		mg/L	H8146
		Carbon Dioxide	90		mg/L	H8223
		Methane	0.092		mg/L	RSK175
ST14-MW05	7-Sep-94	Carbon Dioxide	378		mg/L	COU-02
		Dissolved Oxygen	0.23		mg/L	FDO
		Iron, Total	0.15		mg/L	H8008
		Nitrate	1.4		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	31.67		mg/L	H8051
		Sulfide	0.22		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.08		mg/L	H8146
		Carbon Dioxide	125		mg/L	H8223
		Methane	0.052		mg/L	RSK175
ST14-MW09	7-Sep-94	Carbon Dioxide	407		mg/L	COU-02
		Dissolved Oxygen	0.64		mg/L	FDO
		Iron, Total	0.31		mg/L	H8008
		Nitrate	0.1	U	mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	66.42		mg/L	H8051
		Sulfide	0.05		mg/L	H8131
		Hydrogen Sulfide	0.1		mg/L	H8131
		Iron, Ferrous	0.26		mg/L	H8146
		Carbon Dioxide	70		mg/L	H8223
		Methane	0.001	U	mg/L	RSK175
ST14-MW11	7-Sep-94	Dissolved Oxygen	0.48		mg/L	FDO
		Iron, Total	2.84		mg/L	H8008
		Nitrate	0.1		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	120.6		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	2.7		mg/L	H8146
		Carbon Dioxide	90		mg/L	H8223

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW12	7-Sep-94	Dissolved Oxygen	1.82		mg/L	FDO
		Iron, Total	0.69		mg/L	H8008
		Nitrate	1.4		mg/L	H8039
		Nitrite	0.013		mg/L	H8040
		Sulfate	97.1		mg/L	H8051
		Sulfide	0.13		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.034		mg/L	H8146
		Carbon Dioxide	65		mg/L	H8223
ST14-MW17I	8-Sep-94	Carbon Dioxide	376		mg/L	COU-02
		Dissolved Oxygen	0.31		mg/L	FDO
		Iron, Total	1.06		mg/L	H8008
		Nitrate	0.6		mg/L	H8039
		Nitrite	0.004		mg/L	H8040
		Sulfate	0.77		mg/L	H8051
		Sulfide	0.03		mg/L	H8131
		Hydrogen Sulfide	0.1		mg/L	H8131
		Iron, Ferrous	0.7		mg/L	H8146
		Carbon Dioxide	60		mg/L	H8223
		Methane	2.15		mg/L	RSK175
ST14-MW17L	8-Sep-94	Dissolved Oxygen	0.5		mg/L	FDO
		Iron, Total	0.41		mg/L	H8008
		Nitrate	0.7		mg/L	H8039
		Nitrite	0.006		mg/L	H8040
		Sulfate	17.44		mg/L	H8051
		Sulfide	0.04		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.32		mg/L	H8146
		Carbon Dioxide	68		mg/L	H8223
ST14-MW19	8-Sep-94	Dissolved Oxygen	0.18		mg/L	FDO
		Iron, Total	2.56		mg/L	H8008
		Nitrate	1.7		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	81.3		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	2.28		mg/L	H8146
		Carbon Dioxide	65		mg/L	H8223

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW20	8-Sep-94	Dissolved Oxygen	0.1		mg/L	FDO
		Iron, Total	4.57		mg/L	H8008
		Nitrate	4.1		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	4.8		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	4.1		mg/L	H8146
		Carbon Dioxide	84		mg/L	H8223
ST14-MW21	8-Sep-94	Carbon Dioxide	418		mg/L	COU-02
		Dissolved Oxygen	1.6		mg/L	FDO
		Iron, Total	5.05		mg/L	H8008
		Nitrate	1.9		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	0.5		mg/L	H8051
		Sulfide	0.01		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	4.86		mg/L	H8146
		Carbon Dioxide	110		mg/L	H8223
		Methane	0.81		mg/L	RSK175
ST14-MW22	8-Sep-94	Carbon Dioxide	372		mg/L	COU-02
		Dissolved Oxygen	4.21		mg/L	FDO
		Iron, Total	0.09		mg/L	H8008
		Nitrate	0.6		mg/L	H8039
		Nitrite	0.003		mg/L	H8040
		Sulfate	43.45		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Iron, Ferrous	0.01	U	mg/L	H8146
		Carbon Dioxide	180		mg/L	H8223
		Methane	0.001	U	mg/L	RSK175
OT12-MW15C	9-Sep-94	Dissolved Oxygen	0.45		mg/L	FDO
		Iron, Total	0.69		mg/L	H8008
		Nitrate	0.8		mg/L	H8039
		Nitrite	0.028		mg/L	H8040
		Sulfate	43.33		mg/L	H8051
		Sulfide	0.02		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	0.1		mg/L	H8146
		Carbon Dioxide	50		mg/L	H8223
		Methane	4	U	mg/L	RSK175

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW02	9-Sep-94	Dissolved Oxygen	0.19		mg/L	FDO
		Iron, Total	518		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	92.8		mg/L	H8051
		Sulfide	0.03		mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	296		mg/L	H8146
		Carbon Dioxide	80		mg/L	H8223
ST14-MW03	9-Sep-94	Dissolved Oxygen	0.12		mg/L	FDO
		Iron, Total	770		mg/L	H8008
		Nitrate	0.3		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	14.4		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	680		mg/L	H8146
		Carbon Dioxide	120		mg/L	H8223
ST14-MW17M	9-Sep-94	Carbon Dioxide	413		mg/L	COU-02
		Dissolved Oxygen	0.12		mg/L	FDO
		Iron, Total	9.46		mg/L	H8008
		Nitrate	1.1		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	27.3		mg/L	H8051
		Sulfide	0.01	U	mg/L	H8131
		Hydrogen Sulfide	0.1	U	mg/L	H8131
		Iron, Ferrous	7.12		mg/L	H8146
		Carbon Dioxide	85		mg/L	H8223
		Methane	2		mg/L	RSK175
ST14-MW28	10-Apr-95	Dissolved Oxygen	1.7		mg/L	FDO
		Iron, Total	20.7		mg/L	H8008
		Nitrate	19.5		mg/L	H8039
		Nitrite	0.002		mg/L	H8040
		Sulfate	1.44		mg/L	H8051
		Sulfide	0.03		mg/L	H8131
		Iron, Ferrous	11.4		mg/L	H8146
		Manganese	0.5		mg/L	HMANG
ST14-MW28	11-Apr-95	Methane	5.3		mg/L	RSKSOP

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW24	10-Apr-95	Dissolved Oxygen	1.04		mg/L	FDO
		Iron, Total	0.07		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.095		mg/L	H8040
		Sulfate	48.47		mg/L	H8051
		Sulfide	0.117		mg/L	H8131
		Iron, Ferrous	0.05		mg/L	H8146
		Manganese	0.2		mg/L	HMANG
ST14-MW26	10-Apr-95	Carbon Dioxide	411		mg/L	CO2
		Dissolved Oxygen	0.8	J	mg/L	FDO
		Iron, Total	0.24		mg/L	H8008
		Nitrate	0.5		mg/L	H8039
		Nitrite	0.078		mg/L	H8040
		Sulfate	31.96		mg/L	H8051
		Sulfide	0.051		mg/L	H8131
		Iron, Ferrous	0.19		mg/L	H8146
		Manganese	0.1		mg/L	HMANG
		Methane	0.004	U	mg/L	RSKSOP
ST14-MW27	10-Apr-95	Methane	0.035		mg/L	RSKSO
		Dissolved Oxygen	1.62		mg/L	FDO
		Iron, Total	0.1		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.002		mg/L	H8040
		Sulfate	53.88		mg/L	H8051
		Sulfide	0.034		mg/L	H8131
		Iron, Ferrous	0.08		mg/L	H8146
		Manganese	0.1		mg/L	HMANG
ST14-MW29	10-Apr-95	Dissolved Oxygen	2		mg/L	FDO
		Iron, Total	5.2		mg/L	H8008
		Nitrate	2.1		mg/L	H8039
		Nitrite	0.004		mg/L	H8040
		Sulfate	0.57		mg/L	H8051
		Sulfide	0.013		mg/L	H8131
		Iron, Ferrous	4.56		mg/L	H8146
		Manganese	0.2		mg/L	HMANG
ST14-MW29	11-Apr-95	Carbon Dioxide	477		mg/L	CO2
		Methane	2.48		mg/L	RSKSOP

TABLE A.8 (Continued)
GROUNDWATER DATA FOR GEOCHEMICAL INDICATORS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qaul	Units	Analytical Method
ST14-MW30	10-Apr-95	Dissolved Oxygen	1.6		mg/L	FDO
		Iron, Total	3.33		mg/L	H8008
		Nitrate	0.2		mg/L	H8039
		Nitrite	0.004		mg/L	H8040
		Sulfate	24.64		mg/L	H8051
		Sulfide	0.016		mg/L	H8131
		Iron, Ferrous	2.95		mg/L	H8146
		Manganese	0.2		mg/L	HMANG
ST14-MW31	10-Apr-95	Dissolved Oxygen	1.8		mg/L	FDO
		Iron, Total	0.03		mg/L	H8008
		Nitrate	0.3		mg/L	H8039
		Nitrite	0.001	U	mg/L	H8040
		Sulfate	38.71		mg/L	H8051
		Sulfide	0.016		mg/L	H8131
		Iron, Ferrous	0.02		mg/L	H8146
		Manganese	0.05	U	mg/L	HMANG
ST14-MW31	11-Apr-95	Carbon Dioxide	367		mg/L	CO2
ST14-MW32	10-Apr-95	Dissolved Oxygen	0.39	J	mg/L	FDO
		Iron, Total	1.17		mg/L	H8008
		Nitrate	0.3		mg/L	H8039
		Nitrite	0.005		mg/L	H8040
		Sulfate	3.45		mg/L	H8051
		Sulfide	0.017		mg/L	H8131
		Iron, Ferrous	0.86		mg/L	H8146
		Manganese	0.2		mg/L	HMANG
ST14-MW32	11-Apr-95	Carbon Dioxide	367		mg/L	CO2
		Methane	0.87		mg/L	RSKSOP
ST14-MW25	10-Apr-95	Carbon Dioxide	444		mg/L	CO2
		Dissolved Oxygen	0.8	J	mg/L	FDO
		Iron, Total	0.04		mg/L	H8008
		Nitrate	0.1		mg/L	H8039
		Nitrite	0.01		mg/L	H8040
		Sulfate	8.23		mg/L	H8051
		Sulfide	0.025		mg/L	H8131
		Iron, Ferrous	0.02		mg/L	H8146
		Manganese	0.4		mg/L	HMANG
		Methane	0.02		mg/L	RSKSOP

TABLE A.9
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
SD13-MW05	9-Sep-94	Electrical Conductivity	729	mmhos/cm	FCOND
		pH	6.7	pH units	FPH
		Redox potential	7.5051	pE units	FREDOX
		Temperature	26.6	°C	FTEMP
		Alkalinity, Carbonate	280	mg/L	H8221
SD13-MW03	10-Apr-95	Electrical Conductivity	8.84	mmhos/cm	FCOND
		pH	7.06	pH units	FPH
		Redox potential	6.5078	pE units	FREDOX
		Temperature	19	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
SD13-MW01	9-Sep-94	Electrical Conductivity	668	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Redox potential	2.6826	pE units	FREDOX
		Temperature	25.9	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
SD13-MW07	9-Sep-94	Electrical Conductivity	833	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	3.2522	pE units	FREDOX
		Temperature	19.1	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
SD13-MW04	9-Sep-94	Electrical Conductivity	683	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	2.6454	pE units	FREDOX
		Temperature	26.2	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
SD13-MW02	10-Apr-95	Electrical Conductivity	8.18	mmhos/cm	FCOND
		pH	7.06	pH units	FPH
		Redox potential	3.7948	pE units	FREDOX
		Temperature	18.6	°C	FTEMP
		Alkalinity, Carbonate	340	mg/L	H8221
A100	13-Apr-94	Electrical Conductivity	740	mmhos/cm	FCOND
		pH	7.38	pH units	FPH
		Redox potential	2.096	pE units	FREDOX
		Temperature	76.9	°C	FTEMP

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
A400	13-Apr-94	Electrical Conductivity	720	mmhos/cm	FCOND
		pH	6.94	pH units	FPH
		Redox potential	1.4097	pE units	FREDOX
		Temperature	67.7	°C	FTEMP
A700	13-Apr-94	Electrical Conductivity	780	mmhos/cm	FCOND
		pH	6.84	pH units	FPH
		Redox potential	2.5609	pE units	FREDOX
		Temperature	63.4	°C	FTEMP
A900	13-Apr-94	Electrical Conductivity	8500	mmhos/cm	FCOND
		pH	7.25	pH units	FPH
		Redox potential	2.2667	pE units	FREDOX
		Temperature	74.9	°C	FTEMP
B100	13-Apr-94	Electrical Conductivity	640	mmhos/cm	FCOND
		pH	7.16	pH units	FPH
		Redox potential	4.7989	pE units	FREDOX
		Temperature	75.9	°C	FTEMP
B1000	13-Apr-94	Electrical Conductivity	860	mmhos/cm	FCOND
		pH	7	pH units	FPH
		Redox potential	2.2414	pE units	FREDOX
		Temperature	70.5	°C	FTEMP
B200	13-Apr-94	Electrical Conductivity	1130	mmhos/cm	FCOND
		pH	6.57	pH units	FPH
		Redox potential	4.215	pE units	FREDOX
		Temperature	70.8	°C	FTEMP
B500	13-Apr-94	Electrical Conductivity	1140	mmhos/cm	FCOND
		pH	6.77	pH units	FPH
		Redox potential	2.7671	pE units	FREDOX
		Temperature	75.7	°C	FTEMP
B800	13-Apr-94	Electrical Conductivity	1010	mmhos/cm	FCOND
		pH	6.86	pH units	FPH
		Redox potential	2.4138	pE units	FREDOX
		Temperature	70.5	°C	FTEMP

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
C000	13-Apr-94	Electrical Conductivity	480	mmhos/cm	FCOND
		pH	6.64	pH units	FPH
		Redox potential	5.7877	pE units	FREDOX
		Temperature	69.9	°C	FTEMP
C100	13-Apr-94	Electrical Conductivity	710	mmhos/cm	FCOND
		pH	7.2	pH units	FPH
		Redox potential	6.1427	pE units	FREDOX
		Temperature	78.5	°C	FTEMP
C200	13-Apr-94	Electrical Conductivity	900	mmhos/cm	FCOND
		pH	7.11	pH units	FPH
		Redox potential	4.4878	pE units	FREDOX
		Temperature	81.1	°C	FTEMP
C500	13-Apr-94	Electrical Conductivity	1110	mmhos/cm	FCOND
		pH	6.81	pH units	FPH
		Redox potential	2.6944	pE units	FREDOX
		Temperature	71.1	°C	FTEMP
C800	13-Apr-94	Electrical Conductivity	1080	mmhos/cm	FCOND
		pH	6.84	pH units	FPH
		Redox potential	2.8465	pE units	FREDOX
		Temperature	81.7	°C	FTEMP
D200	13-Apr-94	Electrical Conductivity	1240	mmhos/cm	FCOND
		pH	6.74	pH units	FPH
		Redox potential	2.5592	pE units	FREDOX
		Temperature	75.3	°C	FTEMP
D700	13-Apr-94	Electrical Conductivity	880	mmhos/cm	FCOND
		pH	6.44	pH units	FPH
		Redox potential	2.3124	pE units	FREDOX
		Temperature	75.1	°C	FTEMP
E0+10	13-Apr-94	Electrical Conductivity	930	mmhos/cm	FCOND
		pH	7.02	pH units	FPH
		Redox potential	3.859	pE units	FREDOX
		Temperature	77.3	°C	FTEMP

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
E1+10	13-Apr-94	Electrical Conductivity	910	mmhos/cm	FCOND
		pH	6.98	pH units	FPH
		Redox potential	5.1048	pE units	FREDOX
		Temperature	77.9	°C	FTEMP
E210	13-Apr-94	Electrical Conductivity	840	mmhos/cm	FCOND
		pH	7.14	pH units	FPH
		Redox potential	4.4287	pE units	FREDOX
		Temperature	72	°C	FTEMP
E400	13-Apr-94	Electrical Conductivity	700	mmhos/cm	FCOND
		pH	6.45	pH units	FPH
		Redox potential	2.5423	pE units	FREDOX
		Temperature	69.8	°C	FTEMP
E600	13-Apr-94	Electrical Conductivity	940	mmhos/cm	FCOND
		pH	7.03	pH units	FPH
		Redox potential	1.9861	pE units	FREDOX
		Temperature	77	°C	FTEMP
F300	13-Apr-94	Electrical Conductivity	940	mmhos/cm	FCOND
		pH	7.01	pH units	FPH
		Redox potential	2.3191	pE units	FREDOX
		Temperature	74.5	°C	FTEMP
ST14-MW01	9-Sep-94	Electrical Conductivity	708	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Redox potential	4.1312	pE units	FREDOX
		Temperature	22.5	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW04	9-Sep-94	Electrical Conductivity	677	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Redox potential	2.7772	pE units	FREDOX
		Temperature	24.2	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
ST14-MW17J	8-Sep-94	Electrical Conductivity	730	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	2.9057	pE units	FREDOX
		Temperature	22.9	°C	FTEMP
		Alkalinity, Carbonate	320	mg/L	H8221

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
ST14-MW17K	8-Sep-94	Electrical Conductivity	623	mmhos/cm	FCOND
		pH	7	pH units	FPH
		Redox potential	6.3641	pE units	FREDOX
		Temperature	21.5	°C	FTEMP
		Alkalinity, Carbonate	320	mg/L	H8221
ST14-MW07	7-Sep-94	Electrical Conductivity	695	mmhos/cm	FCOND
		pH	6.972	pH units	FPH
		Redox potential	7.5085	pE units	FREDOX
		Temperature	27.2	°C	FTEMP
ST14-MW10	7-Sep-94	Electrical Conductivity	711	mmhos/cm	FCOND
		pH	6.791	pH units	FPH
		Redox potential	-1.7072	pE units	FREDOX
		Temperature	23.8	°C	FTEMP
ST14-MW13	7-Sep-94	Electrical Conductivity	745	mmhos/cm	FCOND
		pH	6.93	pH units	FPH
		Redox potential	0.6085	pE units	FREDOX
		Temperature	21.1	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW14	8-Sep-94	Electrical Conductivity	593	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Temperature	25.7	°C	FTEMP
		Alkalinity, Carbonate	250	mg/L	H8221
ST14-MW15	8-Sep-94	Electrical Conductivity	723	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	5.7336	pE units	FREDOX
		Temperature	24.9	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
ST14-MW16	8-Sep-94	Electrical Conductivity	707	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	1.5551	pE units	FREDOX
		Temperature	23.2	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
ST14-MW18	8-Sep-94	Electrical Conductivity	792	mmhos/cm	FCOND
		pH	6.6	pH units	FPH
		Redox potential	1.8729	pE units	FREDOX
		Temperature	26.6	°C	FTEMP
		Alkalinity, Carbonate	430	mg/L	H8221
ST14-MW23	8-Sep-94	Electrical Conductivity	610	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Temperature	23.9	°C	FTEMP
		Alkalinity, Carbonate	260	mg/L	H8221
ST14-MW06	7-Sep-94	Electrical Conductivity	640	mmhos/cm	FCOND
		pH	6.94	pH units	FPH
		Redox potential	5.7184	pE units	FREDOX
		Temperature	22.5	°C	FTEMP
		Alkalinity, Carbonate	340	mg/L	H8221
ST14-MW08	7-Sep-94	Electrical Conductivity	7100	mmhos/cm	FCOND
		pH	6.97	pH units	FPH
		Redox potential	5.4632	pE units	FREDOX
		Temperature	22.2	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW05	7-Sep-94	Electrical Conductivity	674	mmhos/cm	FCOND
		pH	6.862	pH units	FPH
		Redox potential	7.26	pE units	FREDOX
		Temperature	23.2	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW09	7-Sep-94	Electrical Conductivity	727	mmhos/cm	FCOND
		pH	6.95	pH units	FPH
		Redox potential	6.0734	pE units	FREDOX
		Temperature	24.5	°C	FTEMP
ST14-MW11	7-Sep-94	Electrical Conductivity	798	mmhos/cm	FCOND
		pH	6.87	pH units	FPH
		Redox potential	1.3134	pE units	FREDOX
		Temperature	23.4	°C	FTEMP
		Alkalinity, Carbonate	340	mg/L	H8221

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
ST14-MW12	7-Sep-94	Electrical Conductivity	744	mmhos/cm	FCOND
		pH	6.89	pH units	FPH
		Redox potential	4.6062	pE units	FREDOX
		Temperature	24	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
ST14-MW17I	8-Sep-94	Electrical Conductivity	640	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	5.5764	pE units	FREDOX
		Temperature	23.6	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
ST14-MW17L	8-Sep-94	Electrical Conductivity	697	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	0.3229	pE units	FREDOX
		Temperature	21.9	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW19	8-Sep-94	Electrical Conductivity	703	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	1.7326	pE units	FREDOX
		Temperature	24.7	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW20	8-Sep-94	Electrical Conductivity	642	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Redox potential	2.3732	pE units	FREDOX
		Temperature	24.9	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW21	8-Sep-94	Electrical Conductivity	685	mmhos/cm	FCOND
		pH	6.7	pH units	FPH
		Redox potential	3.5531	pE units	FREDOX
		Temperature	24	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW22	8-Sep-94	Electrical Conductivity	734	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	5.431	pE units	FREDOX
		Temperature	25.3	°C	FTEMP
		Alkalinity, Carbonate	340	mg/L	H8221

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
OT12-MW15C	9-Sep-94	Electrical Conductivity	723	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	7.3242	pE units	FREDOX
		Temperature	21.4	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW02	9-Sep-94	Electrical Conductivity	710	mmhos/cm	FCOND
		pH	6.8	pH units	FPH
		Redox potential	3.783	pE units	FREDOX
		Temperature	22.8	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW03	9-Sep-94	Electrical Conductivity	816	mmhos/cm	FCOND
		pH	6.9	pH units	FPH
		Redox potential	3.4297	pE units	FREDOX
		Temperature	23.2	°C	FTEMP
		Alkalinity, Carbonate	420	mg/L	H8221
ST14-MW17M	9-Sep-94	Electrical Conductivity	701	mmhos/cm	FCOND
		pH	7	pH units	FPH
		Redox potential	2.8059	pE units	FREDOX
		Temperature	23.4	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW28	10-Apr-95	Electrical Conductivity	8.1	mmhos/cm	FCOND
		pH	6.91	pH units	FPH
		Redox potential	6.9473	pE units	FREDOX
		Temperature	20.6	°C	FTEMP
		Alkalinity, Carbonate	500	mg/L	H8221
ST14-MW24	10-Apr-95	Electrical Conductivity	9.33	mmhos/cm	FCOND
		pH	7.15	pH units	FPH
		Redox potential	3.6883	pE units	FREDOX
		Temperature	18.4	°C	FTEMP
		Alkalinity, Carbonate	380	mg/L	H8221
ST14-MW26	10-Apr-95	Electrical Conductivity	9.17	mmhos/cm	FCOND
		pH	7.23	pH units	FPH
		Redox potential	3.215	pE units	FREDOX
		Temperature	17.8	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221

TABLE A.9 (Continued)
FIELD MEASUREMENTS ON GROUNDWATER
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
ST14-MW27	10-Apr-95	Electrical Conductivity	7.45	mmhos/cm	FCOND
		pH	7.14	pH units	FPH
		Redox potential	3.5159	pE units	FREDOX
		Temperature	17.4	°C	FTEMP
		Alkalinity, Carbonate	300	mg/L	H8221
ST14-MW29	10-Apr-95	Electrical Conductivity	9.43	mmhos/cm	FCOND
		pH	5.62	pH units	FPH
		Redox potential	5.3229	pE units	FREDOX
		Temperature	17.5	°C	FTEMP
		Alkalinity, Carbonate	420	mg/L	H8221
ST14-MW30	10-Apr-95	Electrical Conductivity	11.06	mmhos/cm	FCOND
		pH	5.9	pH units	FPH
		Redox potential	4.6062	pE units	FREDOX
		Temperature	15.1	°C	FTEMP
		Alkalinity, Carbonate	400	mg/L	H8221
ST14-MW31	10-Apr-95	Electrical Conductivity	8.62	mmhos/cm	FCOND
		pH	6.57	pH units	FPH
		Redox potential	3.8117	pE units	FREDOX
		Temperature	18.5	°C	FTEMP
		Alkalinity, Carbonate	340	mg/L	H8221
ST14-MW32	10-Apr-95	Electrical Conductivity	8.04	mmhos/cm	FCOND
		pH	7.31	pH units	FPH
		Redox potential	7.7147	pE units	FREDOX
		Temperature	18.4	°C	FTEMP
		Alkalinity, Carbonate	360	mg/L	H8221
ST14-MW25	10-Apr-95	Electrical Conductivity	9	mmhos/cm	FCOND
		pH	6.87	pH units	FPH
		Redox potential	3.5869	pE units	FREDOX
		Temperature	16.8	°C	FTEMP
		Alkalinity, Carbonate	440	mg/L	H8221

TABLE A.10
DATA FROM FREE PRODUCT ANALYSIS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Units	Analytical Method
ST14-MW17M	9-Sep-94	Total Extractable Hydrocarbons	540000	mg/L	SW8015

TABLE A.11
SURFACE WATER DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW1	31-Aug-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	4	U	ug/L	SW8020
		Ethylbenzene	4	U	ug/L	SW8020
		Xylenes (Total)	4	U	ug/L	SW8020
		1,3,5-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,4-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,3-Trimethylbenzene	4	U	ug/L	SW8020
		Chlorobenzene	4	U	ug/L	SW8020
		Naphthalene	10	U	ug/L	SW8270
		Total Organic Carbon	27.5		mg/L	SW9060
ST14-SW2	31-Aug-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	4	U	ug/L	SW8020
		Ethylbenzene	4	U	ug/L	SW8020
		Xylenes (Total)	4	U	ug/L	SW8020
		1,3,5-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,4-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,3-Trimethylbenzene	4	U	ug/L	SW8020
		Chlorobenzene	4	U	ug/L	SW8020
		Naphthalene	10	U	ug/L	SW8270
		Total Organic Carbon	58.2		mg/L	SW9060
ST14-SW3	31-Aug-94	Total Extractable Hydrocarbons	0.5		mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	1.5	J	ug/L	SW8020
		Ethylbenzene	0.5	J	ug/L	SW8020
		Xylenes (Total)	1.2	J	ug/L	SW8020
		1,3,5-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,4-Trimethylbenzene	2.1	J	ug/L	SW8020
		1,2,3-Trimethylbenzene	4	U	ug/L	SW8020
		Chlorobenzene	4	U	ug/L	SW8020
		Naphthalene	10	U	ug/L	SW8270
		Total Organic Carbon	76.6		mg/L	SW9060
ST14-SW3	05-Apr-95	Benzene	0.4	U	ug/L	E602
		Toluene	2.7	U	ug/L	E602
		Ethylbenzene	0.7	U	ug/L	E602
		Xylenes (Total)	2.3	U	ug/L	E602
		1,3,5-Trimethylbenzene	0.7	J	ug/L	E602
		1,2,4-Trimethylbenzene	3.9	U	ug/L	E602
		1,2,3-Trimethylbenzene	0.4	U	ug/L	E602

TABLE A.11 (Continued)
SURFACE WATER DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW3	05-Apr-95	1,2,3,4-Tetramethylbenzene	33.3		ug/L	E602
(Continued)		Chlorobenzene	0.9	J	ug/L	E602
		bis(2-Chloroethyl)ether	10	U	ug/L	SW8270
		1,3-Dichlorobenzene	10	U	ug/L	SW8270
		1,4-Dichlorobenzene	10	U	ug/L	SW8270
		1,2-Dichlorobenzene	10	U	ug/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	ug/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	ug/L	SW8270
		Hexachloroethane	10	U	ug/L	SW8270
		Nitrobenzene	10	U	ug/L	SW8270
		Isophorone	10	U	ug/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	ug/L	SW8270
		1,2,4-Trichlorobenzene	10	U	ug/L	SW8270
		Naphthalene	10	U	ug/L	SW8270
		4-Chloroaniline	10	U	ug/L	SW8270
		Hexachlorobutadiene	10	U	ug/L	SW8270
		2-Methylnaphthalene	4	J	ug/L	SW8270
		Hexachlorocyclopentadiene	10	U	ug/L	SW8270
		2-Chloronaphthalene	10	U	ug/L	SW8270
		2-Nitroaniline	10	U	ug/L	SW8270
		Dimethylphthalate	10	U	ug/L	SW8270
		2,6-Dinitrotoluene	10	U	ug/L	SW8270
		Acenaphthylene	10	U	ug/L	SW8270
		3-Nitroaniline	10	U	ug/L	SW8270
		Acenaphthene	10	U	ug/L	SW8270
		Dibenzofuran	10	U	ug/L	SW8270
		2,4-Dinitrotoluene	10	U	ug/L	SW8270
		Diethylphthalate	10	U	ug/L	SW8270
		4-Chlorophenyl-phenylether	10	U	ug/L	SW8270
		Fluorene	10	U	ug/L	SW8270
		4-Nitroaniline	50	U	ug/L	SW8270
		N-Nitrosodiphenylamine	10	U	ug/L	SW8270
		4-Bromophenyl-phenylether	10	U	ug/L	SW8270
		Hexachlorobenzene	10	U	ug/L	SW8270
		Phenanthrene	10	U	ug/L	SW8270
		Anthracene	10	U	ug/L	SW8270
		Di-n-butylphthalate	10	U	ug/L	SW8270
		Fluoranthene	10	U	ug/L	SW8270
		Pyrene	10	U	ug/L	SW8270
		Butylbenzylphthalate	10	U	ug/L	SW8270
		3,3'-Dichlorobenzidine	20	U	ug/L	SW8270
		Benzo(a)anthracene	10	U	ug/L	SW8270
		bis(2-Ethylhexyl)phthalate	10	U	ug/L	SW8270

TABLE A.11 (Continued)
SURFACE WATER DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

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Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW3 (Continued)	05-Apr-95	Chrysene	10	U	ug/L	SW8270
		Di-n-octylphthalate	10	U	ug/L	SW8270
		Benzo(b)fluoranthene	10	U	ug/L	SW8270
		Benzo(k)fluoranthene	10	U	ug/L	SW8270
		Benzo(a)pyrene	10	U	ug/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	ug/L	SW8270
		Dibenz(a,h)anthracene	10	U	ug/L	SW8270
		Benzo(g,h,i)perylene	10	U	ug/L	SW8270
		Phenol	10	U	ug/L	SW8270
		2-Chlorophenol	10	U	ug/L	SW8270
		Benzyl Alcohol	10	U	ug/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	ug/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	ug/L	SW8270
		2-Nitrophenol	10	U	ug/L	SW8270
		2,4-Dimethylphenol	10	U	ug/L	SW8270
		Benzoic Acid	50	U	ug/L	SW8270
		2,4-Dichlorophenol	10	U	ug/L	SW8270
		4-Chloro-3-methylphenol	10	U	ug/L	SW8270
		2,4,6-Trichlorophenol	10	U	ug/L	SW8270
		2,4-Dinitrophenol	50	U	ug/L	SW8270
		4-Nitrophenol	50	U	ug/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	ug/L	SW8270
		Pentachlorophenol	50	U	ug/L	SW8270
		2,4,5-Trichlorophenol	10	U	ug/L	SW8270
ST14-SW4	31-Aug-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	4	U	ug/L	SW8020
		Ethylbenzene	4	U	ug/L	SW8020
		Xylenes (Total)	4	U	ug/L	SW8020
		1,3,5-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,4-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,3-Trimethylbenzene	4	U	ug/L	SW8020
		Chlorobenzene	4	U	ug/L	SW8020
		Naphthalene	10	U	ug/L	SW8270
		Total Organic Carbon	77.9		mg/L	SW9060
ST14-SW4	05-Apr-95	Benzene	0.4	U	ug/L	E602
		Toluene	0.4	U	ug/L	E602
		Ethylbenzene	0.4	U	ug/L	E602
		Xylenes (Total)	0.4	U	ug/L	E602
		1,3,5-Trimethylbenzene	0.4	U	ug/L	E602
		1,2,4-Trimethylbenzene	0.4	U	ug/L	E602

TABLE A.11 (Continued)
SURFACE WATER DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

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Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW4	05-Apr-95	1,2,3-Trimethylbenzene	0.4	U	ug/L	E602
(Continued)		1,2,3,4-Tetramethylbenzene	2.1	U	ug/L	E602
		Chlorobenzene	0.4	U	ug/L	E602
		bis(2-Chloroethyl)ether	10	U	ug/L	SW8270
		1,3-Dichlorobenzene	10	U	ug/L	SW8270
		1,4-Dichlorobenzene	10	U	ug/L	SW8270
		1,2-Dichlorobenzene	10	U	ug/L	SW8270
		bis(2-Chloroisopropyl)ether	10	U	ug/L	SW8270
		N-Nitroso-di-n-propylamine	10	U	ug/L	SW8270
		Hexachloroethane	10	U	ug/L	SW8270
		Nitrobenzene	10	U	ug/L	SW8270
		Isophorone	10	U	ug/L	SW8270
		bis(2-Chloroethoxy)methane	10	U	ug/L	SW8270
		1,2,4-Trichlorobenzene	10	U	ug/L	SW8270
		Naphthalene	10	U	ug/L	SW8270
		4-Chloroaniline	10	U	ug/L	SW8270
		Hexachlorobutadiene	10	U	ug/L	SW8270
		2-Methylnaphthalene	10	U	ug/L	SW8270
		Hexachlorocyclopentadiene	10	U	ug/L	SW8270
		2-Chloronaphthalene	10	U	ug/L	SW8270
		2-Nitroaniline	10	U	ug/L	SW8270
		Dimethylphthalate	10	U	ug/L	SW8270
		2,6-Dinitrotoluene	10	U	ug/L	SW8270
		Acenaphthylene	10	U	ug/L	SW8270
		3-Nitroaniline	10	U	ug/L	SW8270
		Acenaphthene	10	U	ug/L	SW8270
		Dibenzofuran	10	U	ug/L	SW8270
		2,4-Dinitrotoluene	10	U	ug/L	SW8270
		Diethylphthalate	10	U	ug/L	SW8270
		4-Chlorophenyl-phenylether	10	U	ug/L	SW8270
		Fluorene	10	U	ug/L	SW8270
		4-Nitroaniline	50	U	ug/L	SW8270
		N-Nitrosodiphenylamine	10	U	ug/L	SW8270
		4-Bromophenyl-phenylether	10	U	ug/L	SW8270
		Hexachlorobenzene	10	U	ug/L	SW8270
		Phenanthrene	10	U	ug/L	SW8270
		Anthracene	10	U	ug/L	SW8270
		Di-n-butylphthalate	10	U	ug/L	SW8270
		Fluoranthene	10	U	ug/L	SW8270
		Pyrene	10	U	ug/L	SW8270
		Butylbenzylphthalate	10	U	ug/L	SW8270
		3,3'-Dichlorobenzidine	20	U	ug/L	SW8270
		Benzo(a)anthracene	10	U	ug/L	SW8270

TABLE A.11 (Continued)
SURFACE WATER DATA
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Analyte	Result	Data Qual	Units	Analytical Method
ST14-SW4	05-Apr-95	bis(2-Ethylhexyl)phthalate	10	U	ug/L	SW8270
(Continued)		Chrysene	10	U	ug/L	SW8270
		Di-n-octylphthalate	10	U	ug/L	SW8270
		Benzo(b)fluoranthene	10	U	ug/L	SW8270
		Benzo(k)fluoranthene	10	U	ug/L	SW8270
		Benzo(a)pyrene	10	U	ug/L	SW8270
		Indeno(1,2,3-cd)pyrene	10	U	ug/L	SW8270
		Dibenz(a,h)anthracene	10	U	ug/L	SW8270
		Benzo(g,h,i)perylene	10	U	ug/L	SW8270
		Phenol	10	U	ug/L	SW8270
		2-Chlorophenol	10	U	ug/L	SW8270
		Benzyl Alcohol	10	U	ug/L	SW8270
		2-Methylphenol(o-Cresol)	10	U	ug/L	SW8270
		4-Methylphenol(p-Cresol)	10	U	ug/L	SW8270
		2-Nitrophenol	10	U	ug/L	SW8270
		2,4-Dimethylphenol	10	U	ug/L	SW8270
		Benzoic Acid	50	U	ug/L	SW8270
		2,4-Dichlorophenol	10	U	ug/L	SW8270
		4-Chloro-3-methylphenol	10	U	ug/L	SW8270
		2,4,6-Trichlorophenol	10	U	ug/L	SW8270
		2,4-Dinitrophenol	50	U	ug/L	SW8270
		4-Nitrophenol	50	U	ug/L	SW8270
		4,6-Dinitro-2-methylphenol	50	U	ug/L	SW8270
		Pentachlorophenol	50	U	ug/L	SW8270
		2,4,5-Trichlorophenol	10	U	ug/L	SW8270
ST14-SW5	31-Aug-94	Total Extractable Hydrocarbons	0.5	U	mg/L	SW8015
		Benzene	0.4	U	ug/L	SW8020
		Toluene	4	U	ug/L	SW8020
		Ethylbenzene	4	U	ug/L	SW8020
		Xylenes (Total)	4	U	ug/L	SW8020
		1,3,5-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,4-Trimethylbenzene	4	U	ug/L	SW8020
		1,2,3-Trimethylbenzene	4	U	ug/L	SW8020
		Chlorobenzene	4	U	ug/L	SW8020
		Naphthalene	10	U	ug/L	SW8270
		Total Organic Carbon	43.8		mg/L	SW9060

TABLE A.12
DETECTED COMPOUNDS IN QC SAMPLES
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Field Blank	Blank Date	Analyte	Blank Concentration	Sample Location	Sample Date	Sample Matrix	Sample Depth
EB1	10-Aug-94	1,2,4-Trimethylbenzene	1	ST14-MW13	10-Aug-94	SOIL	13.90-14.10
				ST14-MW11	10-Aug-94	SOIL	14.30-14.50
				ST14-MW12	10-Aug-94	SOIL	9.50-9.70
				ST14-MW12	10-Aug-94	SOIL	14.50-14.70
EB1	10-Aug-94	Toluene	0.8	ST14-VW32	3-Apr-95	SOIL	4.10-4.30
				ST14-VW32	3-Apr-95	SOIL	9.50-10.50
				ST14-VW33	3-Apr-95	SOIL	8.70-8.90
EB1	12-Aug-94	Xylenes (Total)	0.6	ST14-VW22	25-Aug-94	SOIL	1.00-1.20
				ST14-VW22	25-Aug-94	SOIL	5.90-6.50
				ST14-VW23	25-Aug-94	SOIL	1.00-1.20
				ST14-VW23	25-Aug-94	SOIL	6.20-6.40
				ST14-VW24	25-Aug-94	SOIL	6.90-7.10
				ST14-VW25	25-Aug-94	SOIL	1.00-1.20
				ST14-VW25	25-Aug-94	SOIL	6.70-6.90
				ST14-VW26	25-Aug-94	SOIL	1.00-1.20
				ST14-VW26	25-Aug-94	SOIL	5.20-6.10
EB1	25-Aug-94	1,2,3-Trimethylbenzene	0.4	ST14-VW22	25-Aug-94	SOIL	1.00-1.20
				ST14-VW22	25-Aug-94	SOIL	5.90-6.50
				ST14-VW23	25-Aug-94	SOIL	1.00-1.20
				ST14-VW23	25-Aug-94	SOIL	6.20-6.40
				ST14-VW24	25-Aug-94	SOIL	6.90-7.10
				ST14-VW25	25-Aug-94	SOIL	1.00-1.20
				ST14-VW25	25-Aug-94	SOIL	6.70-6.90
				ST14-VW26	25-Aug-94	SOIL	1.00-1.20
				ST14-VW26	25-Aug-94	SOIL	5.20-6.10
RB1	4-Apr-95	1,2,3,4-Tetramethylbenzene	2.2	SD13-MW03	11-Apr-95	GW	0.00-0.00
				SD13-MW02	11-Apr-95	GW	0.00-0.00
				ST14-MW28	11-Apr-95	GW	0.00-0.00
				ST14-MW24	10-Apr-95	GW	0.00-0.00
				ST14-MW26	10-Apr-95	GW	0.00-0.00
				ST14-MW27	10-Apr-95	GW	0.00-0.00
				ST14-MW29	11-Apr-95	GW	0.00-0.00
				ST14-MW30	11-Apr-95	GW	0.00-0.00
				ST14-MW31	11-Apr-95	GW	0.00-0.00
				ST14-MW32	11-Apr-95	GW	0.00-0.00
				ST14-MW25	10-Apr-95	GW	0.00-0.00
				ST14-SW3	5-Apr-95	SW	0.00-0.00
				ST14-SW4	5-Apr-95	SW	0.00-0.00

TABLE A.12 (Continued)
DETECTED COMPOUNDS IN QC SAMPLES
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Field Blank	Blank Date	Analyte	Blank Concentration	Sample Location	Sample Date	Sample Matrix	Sample Depth
RB1	4-Apr-95	1,2,4-Trimethylbenzene	1.6	SD13-MW03	11-Apr-95	GW	0.00-0.00
				SD13-MW02	11-Apr-95	GW	0.00-0.00
				ST14-MW28	11-Apr-95	GW	0.00-0.00
				ST14-MW24	10-Apr-95	GW	0.00-0.00
				ST14-MW26	10-Apr-95	GW	0.00-0.00
				ST14-MW27	10-Apr-95	GW	0.00-0.00
				ST14-MW29	11-Apr-95	GW	0.00-0.00
				ST14-MW30	11-Apr-95	GW	0.00-0.00
				ST14-MW31	11-Apr-95	GW	0.00-0.00
				ST14-MW32	11-Apr-95	GW	0.00-0.00
				ST14-MW25	10-Apr-95	GW	0.00-0.00
				ST14-SW3	5-Apr-95	SW	0.00-0.00
				ST14-SW4	5-Apr-95	SW	0.00-0.00
RB1	4-Apr-95	Ethylbenzene	0.5	SD13-MW03	11-Apr-95	GW	0.00-0.00
				SD13-MW02	11-Apr-95	GW	0.00-0.00
				ST14-MW28	11-Apr-95	GW	0.00-0.00
				ST14-MW24	10-Apr-95	GW	0.00-0.00
				ST14-MW26	10-Apr-95	GW	0.00-0
				ST14-MW27	10-Apr-95	GW	0.00-0.00
				ST14-MW29	11-Apr-95	GW	0.00-0.00
				ST14-MW30	11-Apr-95	GW	0.00-0.00
				ST14-MW31	11-Apr-95	GW	0.00-0.00
				ST14-MW32	11-Apr-95	GW	0.00-0.00
				ST14-MW25	10-Apr-95	GW	0.00-0.00
				ST14-SW3	5-Apr-95	SW	0.00-0.00
				ST14-SW4	5-Apr-95	SW	0.00-0.00
RB1	4-Apr-95	Toluene	1.3	SD13-MW03	11-Apr-95	GW	0.00-0.00
				SD13-MW02	11-Apr-95	GW	0.00-0.00
				ST14-MW28	11-Apr-95	GW	0.00-0.00
				ST14-MW24	10-Apr-95	GW	0.00-0.00
				ST14-MW26	10-Apr-95	GW	0.00-0.00
				ST14-MW27	10-Apr-95	GW	0.00-0.00
				ST14-MW29	11-Apr-95	GW	0.00-0.00
				ST14-MW30	11-Apr-95	GW	0.00-0.00
				ST14-MW31	11-Apr-95	GW	0.00-0.00
				ST14-MW32	11-Apr-95	GW	0.00-0.00
				ST14-MW25	10-Apr-95	GW	0.00-0.00
				ST14-SW3	5-Apr-95	SW	0.00-0.00
				ST14-SW4	5-Apr-95	SW	0.00-0.00

TABLE A.12 (Continued)
DETECTED COMPOUNDS IN QC SAMPLES
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Field Blank	Blank Date	Analyte	Blank Concentration	Sample Location	Sample Date	Sample Matrix	Sample Depth
RB1	4-Apr-95	Xylenes (Total)	16	SD13-MW03	11-Apr-95	GW	0.00-0.00
				SD13-MW02	11-Apr-95	GW	0.00-0.00
				ST14-MW28	11-Apr-95	GW	0.00-0.00
				ST14-MW24	10-Apr-95	GW	0.00-0.00
				ST14-MW26	10-Apr-95	GW	0.00-0.00
				ST14-MW27	10-Apr-95	GW	0.00-0.00
				ST14-MW29	11-Apr-95	GW	0.00-0.00
				ST14-MW30	11-Apr-95	GW	0.00-0.00
				ST14-MW31	11-Apr-95	GW	0.00-0.00
				ST14-MW32	11-Apr-95	GW	0.00-0.00
				ST14-MW25	10-Apr-95	GW	0.00-0.00
				ST14-SW3	5-Apr-95	SW	0.00-0.00
				ST14-SW4	5-Apr-95	SW	0.00-0.00

TABLE A.13
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
SD13-PT1	9-Mar-95	7.50-9.50	SOIL	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
SD13-PT4	9-Mar-95	6.50-8.50	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
SD13-PT5	9-Mar-95	6.50-8.50	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
SD13-PT12	10-Mar-95	6.50-8.50	SOIL	SW8020	1,3,5-Trimethylbenzene	=		U			U
ST14-MPBG2	15-Jun-93	10.00-11.00	SOIL	E418.1	Petroleum Hydrocarbons	=			J		J
ST14-SB2	31-Mar-95	7.60-7.80	SOIL	SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=		U			U
ST14-MW07	9-Aug-94	13.60-14.00	SOIL	SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U
ST14-MW10	9-Aug-94	7.50-7.70	SOIL	SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=			J		J
ST14-MW14	12-Aug-94	11.50-11.70	SOIL	SW8020	Toluene	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW15	12-Aug-94	11.70-11.70	SOIL	SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U
ST14-MW16	22-Aug-94	3.00-3.20	SOIL	SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Benzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
ST14-MW18	22-Aug-94	8.80-9.00	SOIL	SW8020	Toluene	=			J		J
ST14-MW06	24-Aug-94	10.50-10.70	SOIL	SW8020	Toluene	=			J		J
ST14-VW17	24-Aug-94	1.00-1.20	SOIL	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	Benzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
ST14-VW18	24-Aug-94	1.00-1.20	SOIL	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-VW25	25-Aug-94	1.00-1.20	SOIL	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=				U	U
ST14-VW26	25-Aug-94	1.00-1.20	SOIL	SW8020	Chlorobenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Chlorobenzene	=			J		J
ST14-MPD	26-Aug-94	3.00-3.20	SOIL	SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
ST14-MPE	26-Aug-94	3.50-3.70	SOIL	SW8020	1,3,5-Trimethylbenzene	=			J		J
ST14-VW19	26-Aug-94	5.20-5.40	SOIL	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-VW20	26-Aug-94	5.00-5.60	SOIL	SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW05	9-Aug-94	8.40-9.10	SOIL	SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW09	9-Aug-94	9.60-9.80	SOIL	SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U
ST14-MW12	10-Aug-94	9.50-9.70	SOIL	SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=		U			U
ST14-MW20	22-Aug-94	7.10-7.30	SOIL	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
ST14-MW21	12-Aug-94	10.50-10.70	SOIL	SW8020	Toluene	=		U			U
ST14-MW28	29-Mar-95	9.20-9.40	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
ST14-VW28	31-Mar-95	5.00-5.20	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				C02 CO	Total Organic Carbon	=			J		J
				SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8270	2-Methylnaphthalene	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-VW29	31-Mar-95	4.20-4.50	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8240	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8270	1,2,4-Trichlorobenzene	=			J		J
				SW8270	1,4-Dichlorobenzene	=			J		J
				SW8270	2-Chlorophenol	=			J		J
				SW8270	2-Methylnaphthalene	=			J		J
				SW8270	4-Chloro-3-methylphenol	=			J		J
				SW8270	Acenaphthene	=			J		J
				SW8270	Di-n-butylphthalate	=			J		J
				SW8270	N-Nitroso-di-n-propylamine	=			J		J
				SW8270	Naphthalene	=			J		J
				SW8270	Phenol	=			J		J
				SW8270	Pyrene	=			J		J
ST14-VW30	31-Mar-95	4.50-4.70	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-VW31	31-Mar-95	4.00-4.20	SOIL	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-VW32	3-Apr-95	4.10-4.30	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
				SW8020	1,2,3,4-Tetramethylbenzene	=			J		J
				SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
				SW8270	Fluorene	=			J		J
ST14-VW33	3-Apr-95	8.70-8.90	SOIL	SW8020	Xylenes (Total)	=		U			U

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW30	29-Mar-95	7.00-7.20	SOIL	SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Toluene	=		U			U
				SW8020	Xylenes (Total)	=			J		J
ST14-MW25	28-Mar-95	5.00-5.50	SOIL	SW8020	Benzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
SD13-PT10	8-Mar-95	7.50-8.00	SOIL GAS	FO	Oxygen	=			J		J
SD13-PT9	8-Mar-95	7.00-7.50	SOIL GAS	FO	Oxygen	=			J		J
ST14-SG25B	28-Jul-94	0.00-0.00	SOIL GAS	TO3	Ethylbenzene	=			J		J
1190-PT11	7-Mar-95	3.50-4.00	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT12	7-Mar-95	2.50-3.00	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT6	7-Mar-95	3.00-3.50	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT7	7-Mar-95	2.00-2.50	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT8	7-Mar-95	3.00-3.50	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT9	7-Mar-95	3.50-4.00	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT10	8-Mar-95	8.50-9.00	SOIL GAS	FCO2	Carbon Dioxide	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
1190-PT15	9-Mar-95	6.00-6.50	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT17	9-Mar-95	3.50-4.00	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
1190-PT18	9-Mar-95	6.00-6.50	SOIL GAS	FCO2	Carbon Dioxide	=			J		J
SD13-MW03	11-Apr-95	0.00-0.00	GW	E602	1,2,4-Trimethylbenzene	=			J	U	U
				E602	Chlorobenzene	=			J		J
				E602	Ethylbenzene	=			J	U	U
				E602	Xylenes (Total)	=			J	U	U
				FDO	Dissolved Oxygen	=			J		J
				SW8270	2-Methylnaphthalene	=			J		J
				SW8270	Dibenzofuran	=			J		J
				SW8270	Naphthalene	=			J		J
				SW8270	bis(2-Ethylhexyl)phthalate	=		U			U
SD13-MW01	9-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	Benzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
SD13-MW07	9-Sep-94	0.00-0.00	GW	SW8020	Chlorobenzene	=			J		J
SD13-MW04	9-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
SD13-MW02	10-Apr-95	0.00-0.00	GW	FDO	Dissolved Oxygen	=			J		J
				SW8270	bis(2-Ethylhexyl)phthalate	=		U			U
A900	13-Apr-94	0.00-0.00	GW	SW8015	Petroleum Hydrocarbons	=			J		J
ST14-MW17J	8-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW07	7-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
ST14-MW10	7-Sep-94	0.00-0.00	GW	RSK175	Methane	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
ST14-MW13	7-Sep-94	0.00-0.00	GW	SW8020	Ethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW14	8-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
ST14-MW16	8-Sep-94	0.00-0.00	GW	SW8020	Toluene	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW18	8-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW23	8-Sep-94	0.00-0.00	GW	H8146	Iron, Ferrous	=			J		J
ST14-MW08	7-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Benzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW17I	8-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW17L	8-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW19	8-Sep-94	0.00-0.00	GW	SW8020	Chlorobenzene	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW20	8-Sep-94	0.00-0.00	GW	SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW21	8-Sep-94	0.00-0.00	GW	SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW03	9-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
ST14-MW17M	9-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	=			J		J
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	1,3,5-Trimethylbenzene	=			J		J
				SW8020	Chlorobenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
ST14-MW28	11-Apr-95	0.00-0.00	GW	E602	1,2,3-Trimethylbenzene	=			J		J
				E602	1,3,5-Trimethylbenzene	=			J		J
				E602	Benzene	=			J		J
				E602	Chlorobenzene	=			J		J
				E602	Xylenes (Total)	=				U	U
ST14-MW26	10-Apr-95	0.00-0.00	GW	FDO	Dissolved Oxygen	=			J		J

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-MW27	10-Apr-95	0.00-0.00	GW	E602	1,2,4-Trimethylbenzene	=			J	U	U
ST14-MW29	11-Apr-95	0.00-0.00	GW	E602	1,2,3-Trimethylbenzene	=			J		J
				E602	1,2,4-Trimethylbenzene	=			J		J
				E602	1,3,5-Trimethylbenzene	=			J		J
				E602	Chlorobenzene	=			J		J
				E602	Ethylbenzene	=			J		J
				E602	Toluene	=			J	U	U
				E602	Xylenes (Total)	=			J	U	U
ST14-MW30	11-Apr-95	0.00-0.00	GW	E602	1,2,3,4-Tetramethylbenzene	=			J	U	U
				E602	1,2,4-Trimethylbenzene	=			J	U	U
				E602	Toluene	=			J	U	U
ST14-MW31	11-Apr-95	0.00-0.00	GW	SW8270	bis(2-Ethylhexyl)phthalate	=		U			U
ST14-MW32	11-Apr-95	0.00-0.00	GW	E602	1,2,4-Trimethylbenzene	=			J	U	U
				FDO	Dissolved Oxygen	=			J		J
				SW8240	Toluene	=			J	U	U
				SW8270	bis(2-Ethylhexyl)phthalate	=		U			U
ST14-MW25	10-Apr-95	0.00-0.00	GW	FDO	Dissolved Oxygen	=			J		J
				SW8270	bis(2-Ethylhexyl)phthalate	=		U			U

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TABLE A.13 (Continued)
SUMMARY OF DATA QUALIFIERS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Laboratory Flag	Holding Time Flag	Method Blank Flag	PQL Flag	Field Flag	Final Report
ST14-SW3	5-Apr-95	0.00-0.00	SW	E602	1,2,4-Trimethylbenzene	=			J	U	U
				E602	1,3,5-Trimethylbenzene	=			J		J
				E602	Chlorobenzene	=			J		J
				E602	Ethylbenzene	=			J	U	U
				E602	Toluene	=			J	U	U
				E602	Xylenes (Total)	=			J	U	U
				SW8020	1,2,4-Trimethylbenzene	=			J		J
				SW8020	Ethylbenzene	=			J		J
				SW8020	Toluene	=			J		J
				SW8020	Xylenes (Total)	=			J		J
				SW8270	2-Methylnaphthalene	=			J		J
ST14-SW4	5-Apr-95	0.00-0.00	SW	E602	1,2,3,4-Tetramethylbenzene	=			J	U	U
				E602	Xylenes (Total)	=			J	U	U

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TABLE A.14
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
SD13-MW05	25-Mar-94	5.00-7.00	SOIL	SW8020	Ethylbenzene	0.001	U	0.001	U	mg/kg	
				SW8020	Toluene	0.001	U	0.001	U	mg/kg	
				SW8020	Xylenes (Total)	0.001	U	0.001	U	mg/kg	
				SW8240	Acetone	0.023		0.022		mg/kg	1.11
				SW8240	Methylene Chloride	0.014		0.009		mg/kg	10.34
				E418.1	Petroleum Hydrocarbons	110		210		mg/kg	15.63
ST14-VW8	17-Jun-93	9.00-10.00	SOIL	SW8020	Benzene	2000		1900		µg/kg	1.28
				SW8020	Ethylbenzene	1200		1300		µg/kg	2
				SW8020	Toluene	2600		3400		µg/kg	6.67
				SW8020	Xylenes (Total)	5000		6100		µg/kg	4.95
				E418.1	Petroleum Hydrocarbons	1900		2300		mg/kg	4.76
				D2216	Moisture, Percent	22.1		21.1		Percent	1.16
				D422	Clay	27		29.1		Percent	1.87
				D422	Gravel	0.1	U	0.1	U	Percent	
				D422	Sand	9.9		9.5		Percent	1.03
				D422	Silt	63.1		61.4		Percent	0.68
				E310.1	Alkalinity, Carbonate	361		412		mg/kg	3.3
				E351.3	Nitrogen, Total Kjeldahl	504		378		mg/kg	7.14
				SW6010	Phosphorus, Total Orthophosphate			97.7			50
				SW9045	pH	8.5		8.7		pH Units	0.58
ST14-SB4	21-Jun-93	10.00-11.0	SOIL	SW8020	Benzene	2	U	2	U	µg/kg	
				SW8020	Ethylbenzene	2	U	2	U	µg/kg	
				SW8020	Toluene	2	U	2	U	µg/kg	
				SW8020	Xylenes (Total)	2	U	2	U	µg/kg	
				E418.1	Petroleum Hydrocarbons	10	U	10	U	mg/kg	
				D2216	Moisture, Percent	12.3		12.3		Percent	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-MW07	9-Aug-94	13.60-14.0	SOIL	SW8020	1,2,3-Trimethylbenzene	5.1	U	5.1	U	µg/kg	
				SW8020	1,2,4-Trimethylbenzene	5.1	U	5.1	U	µg/kg	
				SW8020	1,3,5-Trimethylbenzene	5.1	U	5.1	U	µg/kg	
				SW8020	Benzene	0.51	U	0.51	U	µg/kg	
				SW8020	Chlorobenzene	5.1	U	5.1	U	µg/kg	
				SW8020	Ethylbenzene	5.1	U	5.1	U	µg/kg	
				SW8020	Toluene	5.1	U	5.1	U	µg/kg	
				SW8020	Xylenes (Total)	5.1	U	5.1	U	µg/kg	
ST14-MW18	22-Aug-94	8.80-9.00	SOIL	SW8020	1,2,3-Trimethylbenzene	550		5900		µg/kg	41.47
				SW8020	1,2,4-Trimethylbenzene	590		5900		µg/kg	40.91
				SW8020	1,3,5-Trimethylbenzene	750		5800		µg/kg	38.55
				SW8020	Benzene	2.6	U	67	U	µg/kg	
				SW8020	Chlorobenzene	230		1600		µg/kg	37.43
				SW8020	Ethylbenzene	490		5600		µg/kg	41.95
				SW8020	Toluene	480	J	3600		µg/kg	38.24
				SW8020	Xylenes (Total)	4400		17000		µg/kg	29.44
ST14-VW25	25-Aug-94	6.70-6.90	SOIL	SW8020	1,2,3-Trimethylbenzene	5.3	U	5.3	U	µg/kg	
				SW8020	1,2,4-Trimethylbenzene	5.3	U	0.7	J	µg/kg	
				SW8020	1,3,5-Trimethylbenzene	5.3	U	5.3	U	µg/kg	
				SW8020	Benzene	0.53	U	0.53	U	µg/kg	
				SW8020	Chlorobenzene	5.3	U	5.3	U	µg/kg	
				SW8020	Ethylbenzene	5.3	U	5.3	U	µg/kg	
				SW8020	Toluene	1.7	J	1.3	J	µg/kg	6.
				SW8020	Xylenes (Total)	5.3	U	5.3	U	µg/kg	
ST14-VW21	26-Aug-94	3.40-4.40	SOIL	SW8020	1,2,3-Trimethylbenzene	5.3	U	5.4	U	µg/kg	
				SW8020	1,2,4-Trimethylbenzene	5.3	U	5.4	U	µg/kg	
				SW8020	1,3,5-Trimethylbenzene	5.3	U	5.4	U	µg/kg	
				SW8020	Benzene	0.53	U	0.54	U	µg/kg	
				SW8020	Chlorot ıe	5.3	U	5.4	U	µg	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-VW21 (Cont)	26-Aug-94	3.40-4.40	SOIL	SW8020	Ethylbenzene	5.3	U	5.4	U	µg/kg	
				SW8020	Toluene	5.3	U	5.4	U	µg/kg	
				SW8020	Xylenes (Total)	5.3	U	5.4	U	µg/kg	
				SW8270	Naphthalene	450	U	440	U	µg/kg	
				SW8015	Total Extractable Hydrocarbons	13	U	13	U	mg/kg	
ST14-MW19	23-Aug-94	13.50-14.0	SOIL	SW8020	1,2,3-Trimethylbenzene	8600		7600		µg/kg	3.09
				SW8020	1,2,4-Trimethylbenzene	28000		24000		µg/kg	3.85
				SW8020	1,3,5-Trimethylbenzene	14000		11000		µg/kg	6
				SW8020	Benzene	58	U	58	U	µg/kg	
				SW8020	Chlorobenzene	1100		680		µg/kg	11.8
				SW8020	Ethylbenzene	7300		4400		µg/kg	12.39
				SW8020	Toluene	3800		1900		µg/kg	16.67
				SW8020	Xylenes (Total)	28000		21000		µg/kg	7.14
				SW8270	Naphthalene	990		3800		µg/kg	29.33
				SW8015	Total Extractable Hydrocarbons	1900		1700		mg/kg	2.78
				SW846	Moisture, Percent	14.2		13.8		Percent	0.71
ST14-VW29	31-Mar-95	4.20-4.50	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	18	J	7.1	J	µg/kg	21.71
				SW8020	1,2,3-Trimethylbenzene	4.6	U	4.4	U	µg/kg	
				SW8020	1,2,4-Trimethylbenzene	3.3	J	4.4	U	µg/kg	
				SW8020	1,3,5-Trimethylbenzene	5.1	J	2.5	J	µg/kg	17.11
				SW8020	Benzene	0.46	U	4.4	U	µg/kg	
				SW8020	Chlorobenzene	4.6	U	4.4	U	µg/kg	
				SW8020	Ethylbenzene	1.3	J	4.4	U	µg/kg	
				SW8020	Toluene	4.6	U	4.4	U	µg/kg	
				SW8020	Xylenes (Total)	46		0.5	J	µg/kg	48.92
ST14-VW32	3-Apr-95	9.50-10.50	SOIL	SW8020	1,2,3,4-Tetramethylbenzene	190	J	71		µg/kg	22.[illegible]
				SW8020	1,2,3-Trimethylbenzene	68	J	9.8	J	µg/kg	37.[illegible]
				SW8020	1,2,4-Trimethylbenzene	39	J	1.8	J	µg/kg	45.[illegible]
				SW8020	1,3,5-Trimethylbenzene	36	J	4.2	U	µg/kg	

TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-VW32 (Cont)	3-Apr-95	9.50-10.50	SOIL	SW8020	Benzene	21	U	4.2	U	µg/kg	
				SW8020	Chlorobenzene	21	U	4.2	U	µg/kg	
				SW8020	Ethylbenzene	21	U	4.2	U	µg/kg	
				SW8020	Toluene	21	U	4.2	U	µg/kg	
				SW8020	Xylenes (Total)	9.6	J	42	U	µg/kg	
				SW8270	1,2,4-Trichlorobenzene	350	U	330	U	µg/kg	
				SW8270	1,2-Dichlorobenzene	350	U	330	U	µg/kg	
				SW8270	1,3-Dichlorobenzene	350	U	330	U	µg/kg	
				SW8270	1,4-Dichlorobenzene	350	U	330	U	µg/kg	
				SW8270	2,4,5-Trichlorophenol	350	U	330	U	µg/kg	
				SW8270	2,4,6-Trichlorophenol	350	U	330	U	µg/kg	
				SW8270	2,4-Dichlorophenol	350	U	330	U	µg/kg	
				SW8270	2,4-Dimethylphenol	350	U	330	U	µg/kg	
				SW8270	2,4-Dinitrophenol	1800	U	1700	U	µg/kg	
				SW8270	2,4-Dinitrotoluene	350	U	330	U	µg/kg	
				SW8270	2,6-Dinitrotoluene	350	U	330	U	µg/kg	
				SW8270	2-Chloronaphthalene	350	U	330	U	µg/kg	
				SW8270	2-Chlorophenol	350	U	330	U	µg/kg	
				SW8270	2-Methylnaphthalene	460		350	J	µg/kg	6.79
				SW8270	2-Methylphenol(o-Cresol)	350	U	330	U	µg/kg	
				SW8270	2-Nitroaniline	350	U	330	U	µg/kg	
				SW8270	2-Nitrophenol	350	U	330	U	µg/kg	
				SW8270	3,3'-Dichlorobenzidine	700	U	660	U	µg/kg	
				SW8270	3-Nitroaniline	350	U	330	U	µg/kg	
				SW8270	4,6-Dinitro-2-methylphenol	1800	U	1700	U	µg/kg	
				SW8270	4-Bromophenyl-phenylether	350	U	330	U	µg/kg	
				SW8270	4-Chloro-3-methylphenol	350	U	330	U	µg/kg	
				SW8270	4-Chloroaniline	350	U	330	U	µg/kg	
				SW8270	4-Chlorophenyl-phenylether	350	U	330	U	µg/kg	
				SW8270	4-Methylphenol(p-Cresol)	350	U	330	U	µg/kg	
				SW8270	4-Nitroaniline	1800	U	1700	U	µg/kg	
				SW8270	4-Nitro[illegible]l	1800	U	1700	U	µg	

TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-VW32 (Cont)	3-Apr-95	9.50-10.50	SOIL	SW8270	Acenaphthene	350	U	330	U	µg/kg	
				SW8270	Acenaphthylene	350	U	330	U	µg/kg	
				SW8270	Anthracene	350	U	330	U	µg/kg	
				SW8270	Benzo(a)anthracene	350	U	330	U	µg/kg	
				SW8270	Benzo(a)pyrene	350	U	330	U	µg/kg	
				SW8270	Benzo(b)fluoranthene	350	U	330	U	µg/kg	
				SW8270	Benzo(g,h,i)perylene	350	U	330	U	µg/kg	
				SW8270	Benzo(k)fluoranthene	350	U	330	U	µg/kg	
				SW8270	Benzoic Acid	1800	U	1700	U	µg/kg	
				SW8270	Benzyl Alcohol	350	U	330	U	µg/kg	
				SW8270	Butylbenzylphthalate	350	U	330	U	µg/kg	
				SW8270	Chrysene	350	U	330	U	µg/kg	
				SW8270	Di-n-butylphthalate	350	U	330	U	µg/kg	
				SW8270	Di-n-octylphthalate	350	U	330	U	µg/kg	
				SW8270	Dibenz(a,h)anthracene	350	U	330	U	µg/kg	
				SW8270	Dibenzofuran	350	U	330	U	µg/kg	
				SW8270	Diethylphthalate	350	U	330	U	µg/kg	
				SW8270	Dimethylphthalate	350	U	330	U	µg/kg	
				SW8270	Fluoranthene	350	U	330	U	µg/kg	
				SW8270	Fluorene	25	J	330	U	µg/kg	
				SW8270	Hexachlorobenzene	460		330	U	µg/kg	
				SW8270	Hexachlorobutadiene	350	U	330	U	µg/kg	
				SW8270	Hexachlorocyclopentadiene	350	U	330	U	µg/kg	
				SW8270	Hexachloroethane	350	U	330	U	µg/kg	
				SW8270	Indeno(1,2,3-cd)pyrene	350	U	330	U	µg/kg	
				SW8270	Isophorone	350	U	330	U	µg/kg	
				SW8270	N-Nitroso-di-n-propylamine	350	U	330	U	µg/kg	
				SW8270	N-Nitrosodiphenylamine	350	U	330	U	µg/kg	
				SW8270	Naphthalene	350	U	330	U	µg/kg	
				SW8270	Nitrobenzene	350	U	330	U	µg/kg	
				SW8270	Pentachlorophenol	1800	U	1700	U	µg/kg	
				SW8270	Phenanthrene	350	U	330	U	µg/kg	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-VW32 (Cont)	3-Apr-95	9.50-10.50	SOIL	SW8270	Phenol	350	U	330	U	µg/kg	
				SW8270	Pyrene	350	U	330	U	µg/kg	
				SW8270	bis(2-Chloroethoxy)methane	350	U	330	U	µg/kg	
				SW8270	bis(2-Chloroethyl)ether	350	U	330	U	µg/kg	
				SW8270	bis(2-Chloroisopropyl)ether	350	U	330	U	µg/kg	
				SW8270	bis(2-Ethylhexyl)phthalate	350	U	330	U	µg/kg	
				SW6010	Iron	1200		1600		mg/kg	7.14
				M8015	Total Extractable Hydrocarbons	110		150		mg/kg	7.69
				%MOIST	Moisture, Percent	6.3		5.2		Percent	4.78
				CO2 CO	Total Organic Carbon	0.16		0.6		Percent	28.95
				E300.0	Phosphourus, dissolved	2.65	U	2.58	U	mg/kg	
				E310.1	Alkalinity, Total (as CACO3)	121		119		mg/kg	0.42
				E351.2	Nitrogen, Total Kjeldahl	5.29	U	5.2	U	mg/kg	
ST14-MW04	28-Jul-94	0.00-0.00	SOIL GAS	TO3	Benzene	0.007	U	0.007	U	µg/kg	
				TO3	Ethylbenzene	18		17		µg/kg	1.43
				TO3	Toluene	0.008	U	0.008	U	µg/kg	
				TO3	Xylenes (Total)	39		23		µg/kg	12.9
				TO3	Petroleum Hydrocarbons	7100		6200		µg/kg	3.38
ST14-SG25B	28-Jul-94	0.00-0.00	SOIL GAS	TO3	Benzene	0.007	U	0.007	U	µg/kg	
				TO3	Ethylbenzene	0.009	J	0.009	J	µg/kg	0
				TO3	Toluene	0.008	U	0.008	U	µg/kg	
				TO3	Xylenes (Total)	0.071		0.057		µg/kg	.47
				TO3	Petroleum Hydrocarbons	19		14		µg/kg	.58
ST14-FLX2	28-Jul-94	0.00-0.00	FLUX GAS	TO3	Benzene	0.007	U	0.007	U	µg/kg	
				TO3	Ethylbenzene	0.01	U	0.01	U	µg/kg	
				TO3	Toluene	0.008	U	0.008	U	µg/kg	
				TO3	Xylenes (Total)	0.01	U	0.01	U	µg/kg	
				TO3	Petroleum Hydrocarbons	2.1		1.4		µg/kg	10

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
SD13-MW05	30-Mar-94	0.00-0.00	GW	SW8020	Ethylbenzene	0.5	U	0.5	U	µg/L	
				SW8020	Toluene	0.5	U	0.5	U	µg/L	
				SW8020	Xylenes (Total)	1	U	1	U	µg/L	
				SW8240	Tetrachloroethene	5	U	5	U	µg/L	
				E418.1	Petroleum Hydrocarbons	1	U	1	U	mg/L	
SD13-MW01	27-Mar-94	0.00-0.00	GW	SW8240	Methylene Chloride	5	U	6.5	J	µg/L	
				E418.1	Petroleum Hydrocarbons	1.2		1	U	mg/L	
SD13-MW01	7-Sep-94	0.00-0.00	GW	SW8020	Toluene	3.4		2.4		µg/L	8.62
				SW8020	Xylene-m,p	4.2		1	U	µg/L	
				SW8240	Bromodichloromethane	5	U	5	U	µg/L	
				SW8240	Chloroform	5	U	5	U	µg/L	
				SW8240	Methylene Chloride	4	J	2.6	J	µg/L	10.61
				SW8240	Tetrachloroethene	5	U	5	U	µg/L	
				SW8240	Trichloroethene	5	U	5	U	µg/L	
				E418.1	Petroleum Hydrocarbons	2.5		3.2		mg/L	6.14
SD13-MW07	22-Jun-94	0.00-0.00	GW	SW8240	Bromodichloromethane	1	U	1	U	µg/L	
				SW8240	Chloroform	5	U	5	U	µg/L	
				SW8240	Dibromochloromethane	5	U	5	U	µg/L	
				SW8240	Methylene Chloride	7.9	J	7.1	J	µg/L	2.67
				SW8240	Tetrachloroethene	5	U	5	U	µg/L	
				SW8240	Trichloroethene	5	U	5	U	µg/L	
				E418.1	Petroleum Hydrocarbons	1.6		1.9		mg/L	4.29
SD13-MW04	9-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	4	U	3	J	µg/L	
				SW8020	1,2,4-Trimethylbenzene	1.2	J	4.2		µg/L	2[illegible]78
				SW8020	1,3,5-Trimethylbenzene	0.4	J	7		µg/L	4[illegible]9
				SW8020	Benzene	0.4	U	0.4	J	µg/L	
				SW8020	Chlorobenzene	4	U	2.5	J	µg/L	
				SW8020	Ethylbenzene	4	U	5.2		µg/L	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
SD13-MW04 (Cont)	9-Sep-94	0.00-0.00	GW	SW8020	Toluene	0.7	J	8.4		µg/L	42.31
				SW8020	Xylenes (Total)	1.1	J	34		µg/L	46.87
B200	13-Apr-94	0.00-0.00	GW	SW7421	Lead	5	U	5	U	µg/L	
B800	13-Apr-94	0.00-0.00	GW	SW8020	Benzene	3		2		µg/L	10
				SW8020	Ethylbenzene	9		9		µg/L	0
				SW8020	Toluene	5		6		µg/L	4.55
				SW8020	Xylenes (Total)	25		20		µg/L	5.56
				SW7421	Lead	54		58		µg/L	1.79
				SW8015	Total Extractable Hydrocarbons	100	U	100	U	MG/L	
				SW8015	Total Volatile Hydrocarbons	1600		2300		MG/L	8.97
ST14-MW16	8-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	4	U	4	U	µg/L	
				SW8020	1,2,4-Trimethylbenzene	10		6.6		µg/L	10.24
				SW8020	1,3,5-Trimethylbenzene	9.2		2.2	J	µg/L	30.7
				SW8020	Benzene	110		110		µg/L	0
				SW8020	Chlorobenzene	14		9.2		µg/L	10.34
				SW8020	Ethylbenzene	16		11		µg/L	9.26
				SW8020	Toluene	2.9	J	2.3	J	µg/L	5.77
				SW8020	Xylenes (Total)	20		13		µg/L	10.61
ST14-MW23	8-Sep-94	0.00-0.00	GW	SW8240	Trichloroethene	5	U	5	U	µg/L	
ST14-MW17I	8-Sep-94	0.00-0.00	GW	SW8020	1,2,3-Trimethylbenzene	4	U	4	U	µg/L	
				SW8020	1,2,4-Trimethylbenzene	0.5	J	1.3	J	µg/L	22.22
				SW8020	1,3,5-Trimethylbenzene	0.7	J	4	U	µg/L	
				SW8020	Benzene	0.4	U	0.4	U	µg/L	
				SW8020	Chlorobenzene	0.6	J	4	U	µg/L	
				SW8020	Ethylbenzene	1.2	J	0.6	J	µg/L	16.67
				SW8020	Toluene	3	J	1.5	J	µg/L	16.67
				SW8020	Xylene tal)	3.5	J	3.1	J	µ	3.03

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-MW17I (Cont)	8-Sep-94	0.00-0.00	GW	RSK175	Methane	2.15		2.26		MG/L	1.25
				COU-02	Carbon Dioxide	376		373		MG/L	0.2
ST14-MW17M	9-Sep-94	0.00-0.00	GW	SW8270	Naphthalene	53		82		µg/L	10.74
ST14-MW30	11-Apr-95	0.00-0.00	GW	E602	1,2,3,4-Tetramethylbenzene	4	U	0.4	U	µg/L	
				E602	1,2,3-Trimethylbenzene	0.4	U	0.4	U	µg/L	
				E602	1,2,4-Trimethylbenzene	4	U	4	U	µg/L	
				E602	1,3,5-Trimethylbenzene	0.4	U	0.4	U	µg/L	
				E602	Benzene	0.4	U	0.4	U	µg/L	
				E602	Chlorobenzene	0.4	U	0.4	U	µg/L	
				E602	Ethylbenzene	0.4	U	0.4	U	µg/L	
				E602	Toluene	4	U	4	U	µg/L	
				E602	Xylenes (Total)	0.4	U	4	U	µg/L	
ST14-MW32	11-Apr-95	0.00-0.00	GW	E602	1,2,3,4-Tetramethylbenzene	0.4	U	0.4	U	µg/L	
				E602	1,2,3-Trimethylbenzene	0.4	U	0.4	U	µg/L	
				E602	1,2,4-Trimethylbenzene	4	U	4	U	µg/L	
				E602	1,3,5-Trimethylbenzene	0.4	U	0.4	U	µg/L	
				E602	Benzene	0.4	U	0.4	U	µg/L	
				E602	Chlorobenzene	0.4	U	0.4	U	µg/L	
				E602	Ethylbenzene	0.4	U	0.4	U	µg/L	
				E602	Toluene	0.4	U	4	U	µg/L	
				E602	Xylenes (Total)	0.4	U	0.4	U	µg/L	
				SW8240	1,2,3,4-Tetramethylbenzene	5	U	5	U	µg/L	
				SW8240	1,2,3-Trimethylbenzene	5	U	5	U	µg/L	
				SW8240	1,2,4-Trimethylbenzene	5	U	5	U	µg/L	
				SW8240	1,3,5-Trimethylbenzene	5	U	5	U	µg/L	
				SW8240	Benzene	5	U	5	U	µg/L	
				SW8240	Chlorobenzene	5	U	5	U	µg/L	
				SW8240	Ethylbenzene	5	U	5	U	µg/L	
				SW8240	Styrene	5	U	5	U	µg/L	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-MW32 (Cont)	11-Apr-95	0.00-0.00	GW	SW8240	Toluene	50	U	5	U	µg/L	
				SW8240	Xylenes (Total)	5	U	5	U	µg/L	
				SW8270	1,2,4-Trichlorobenzene	10	U	10	U	µg/L	
				SW8270	1,2-Dichlorobenzene	10	U	10	U	µg/L	
				SW8270	1,3-Dichlorobenzene	10	U	10	U	µg/L	
				SW8270	1,4-Dichlorobenzene	10	U	10	U	µg/L	
				SW8270	2,4,5-Trichlorophenol	10	U	10	U	µg/L	
				SW8270	2,4,6-Trichlorophenol	10	U	10	U	µg/L	
				SW8270	2,4-Dichlorophenol	10	U	10	U	µg/L	
				SW8270	2,4-Dimethylphenol	10	U	10	U	µg/L	
				SW8270	2,4-Dinitrophenol	50	U	50	U	µg/L	
				SW8270	2,4-Dinitrotoluene	10	U	10	U	µg/L	
				SW8270	2,6-Dinitrotoluene	10	U	10	U	µg/L	
				SW8270	2-Chloronaphthalene	10	U	10	U	µg/L	
				SW8270	2-Chlorophenol	10	U	10	U	µg/L	
				SW8270	2-Methylnaphthalene	10	U	10	U	µg/L	
				SW8270	2-Methylphenol(o-Cresol)	10	U	10	U	µg/L	
				SW8270	2-Nitroaniline	10	U	10	U	µg/L	
				SW8270	2-Nitrophenol	10	U	10	U	µg/L	
				SW8270	3,3'-Dichlorobenzidine	20	U	20	U	µg/L	
				SW8270	3-Nitroaniline	10	U	10	U	µg/L	
				SW8270	4,6-Dinitro-2-methylphenol	50	U	50	U	µg/L	
				SW8270	4-Bromophenyl-phenylether	10	U	10	U	µg/L	
				SW8270	4-Chloro-3-methylphenol	10	U	10	U	µg/L	
				SW8270	4-Chloroaniline	10	U	10	U	µg/L	
				SW8270	4-Chlorophenyl-phenylether	10	U	10	U	µg/L	
				SW8270	4-Methylphenol(p-Cresol)	10	U	10	U	µg/L	
				SW8270	4-Nitroaniline	50	U	50	U	µg/L	
				SW8270	4-Nitrophenol	50	U	50	U	µg/L	
				SW8270	Acenaphthene	10	U	10	U	µg/L	
				SW8270	Acenaphthylene	10	U	10	U	µg/L	
				SW8270	Anthra(	10	U	10	U	µ(	

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TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-MW32 (Cont)	11-Apr-95	0.00-0.00	GW	SW8270	Benzo(a)anthracene	10	U	10	U	µg/L	
				SW8270	Benzo(a)pyrene	10	U	10	U	µg/L	
				SW8270	Benzo(b)fluoranthene	10	U	10	U	µg/L	
				SW8270	Benzo(g,h,i)perylene	10	U	10	U	µg/L	
				SW8270	Benzo(k)fluoranthene	10	U	10	U	µg/L	
				SW8270	Benzoic Acid	50	U	50	U	µg/L	
				SW8270	Benzyl Alcohol	10	U	10	U	µg/L	
				SW8270	Butylbenzylphthalate	10	U	10	U	µg/L	
				SW8270	Chrysene	10	U	10	U	µg/L	
				SW8270	Di-n-butylphthalate	10	U	10	U	µg/L	
				SW8270	Di-n-octylphthalate	10	U	10	U	µg/L	
				SW8270	Dibenz(a,h)anthracene	10	U	10	U	µg/L	
				SW8270	Dibenzofuran	10	U	10	U	µg/L	
				SW8270	Diethylphthalate	10	U	10	U	µg/L	
				SW8270	Dimethylphthalate	10	U	10	U	µg/L	
				SW8270	Fluoranthene	10	U	10	U	µg/L	
				SW8270	Fluorene	10	U	10	U	µg/L	
				SW8270	Hexachlorobenzene	10	U	10	U	µg/L	
				SW8270	Hexachlorobutadiene	10	U	10	U	µg/L	
				SW8270	Hexachlorocyclopentadiene	10	U	10	U	µg/L	
				SW8270	Hexachloroethane	10	U	10	U	µg/L	
				SW8270	Indeno(1,2,3-cd)pyrene	10	U	10	U	µg/L	
				SW8270	Isophorone	10	U	10	U	µg/L	
				SW8270	N-Nitroso-di-n-propylamine	10	U	10	U	µg/L	
				SW8270	N-Nitrosodiphenylamine	10	U	10	U	µg/L	
				SW8270	Naphthalene	10	U	10	U	µg/L	
				SW8270	Nitrobenzene	10	U	10	U	µg/L	
				SW8270	Pentachlorophenol	50	U	50	U	µg/L	
				SW8270	Phenanthrene	10	U	10	U	µg/L	
				SW8270	Phenol	10	U	10	U	µg/L	
				SW8270	Pyrene	10	U	10	U	µg/L	
				SW8270	bis(2-Chloroethoxy)methane	10	U	10	U	µg/L	

TABLE A.14 (Continued)
COMPARISON OF PRIMARY RESULTS TO DUPLICATE RESULTS
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Sample Location	Sample Date	Sample Depth	Matrix	Analytical Method	Analyte	Primary Sample Result		Duplicate Sample Result		Units	RPD
ST14-MW32 (Cont)	11-Apr-95	0.00-0.00	GW	SW8270	bis(2-Chloroethyl)ether			10	U		
				SW8270	bis(2-Chloroisopropyl)ether	10	U	10	U	µg/L	
				SW8270	bis(2-Ethylhexyl)phthalate	10	U	10	U	µg/L	
				M8015	Total Extractable Hydrocarbons	0.5	U	0.5	U	mg/L	
				RSKSOP	Methane	0.87		1.23		mg/L	8.57
				CO2	Carbon Dioxide	367		370		mg/L	0.2
ST14-SW3	31-Aug-94	0.00-0.00	SW	SW8020	1,2,3-Trimethylbenzene	4	U	4	U	µg/L	
				SW8020	1,2,4-Trimethylbenzene	2.1	J	2.1	J	µg/L	0
				SW8020	1,3,5-Trimethylbenzene	4	U	4	U	µg/L	
				SW8020	Benzene	0.4	U	0.4	U	µg/L	
				SW8020	Chlorobenzene	4	U	4	U	µg/L	
				SW8020	Ethylbenzene	0.5	J	0.5	J	µg/L	0
				SW8020	Toluene	1.5	J	1.4	J	µg/L	1.72
				SW8020	Xylenes (Total)	1.2	J	1.2	J	µg/L	0
				SW8270	Naphthalene	10	U	10	U	µg/L	
				SW8015	Total Extractable Hydrocarbons	0.5		0.5		MG/L	0
				SW9060	Total Organic Carbon	76.6		85.2		MG/L	2.66

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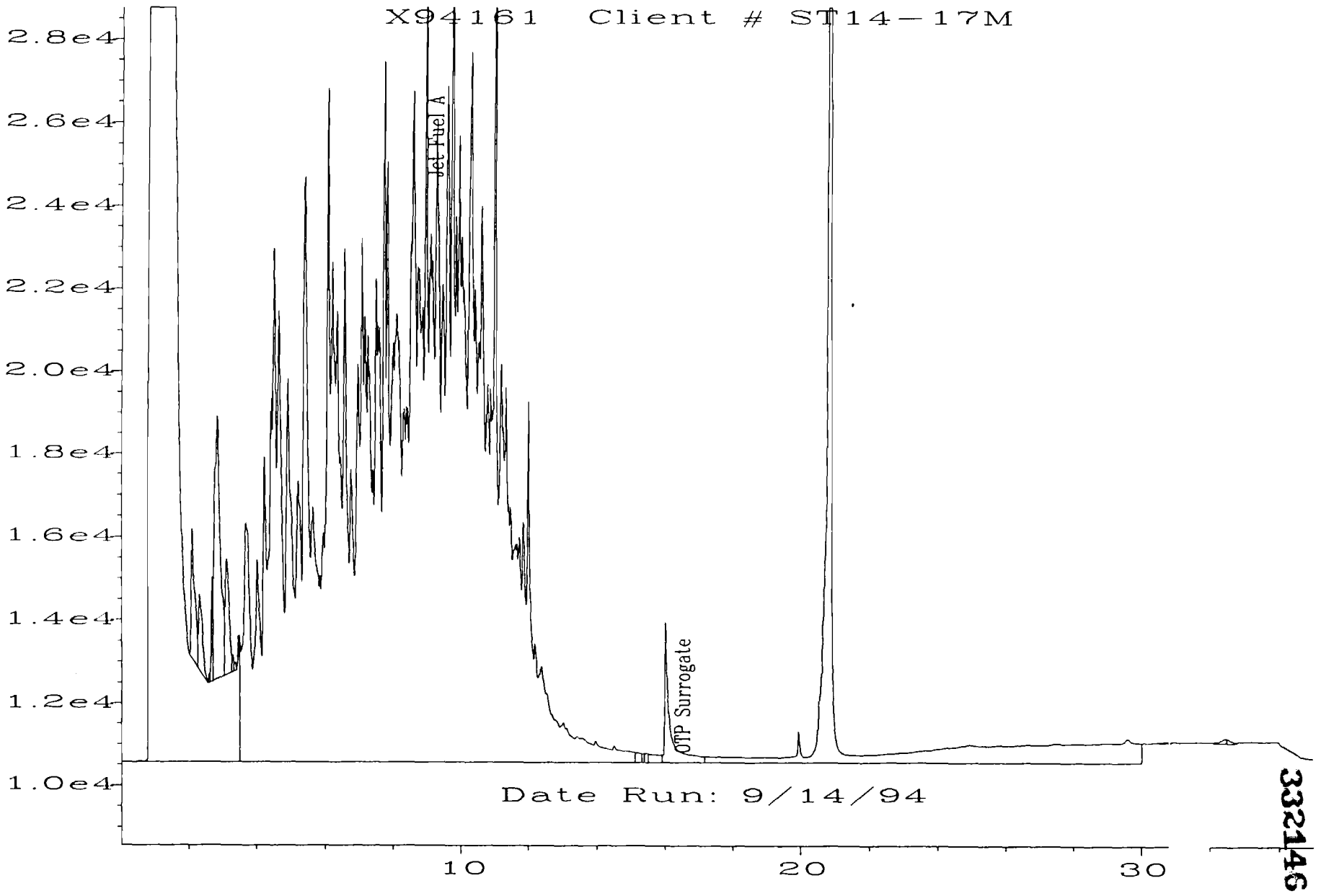

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1995/1996 GROUNDWATER MONITORING SUMMARY (DETECTS)

1995/1996 GROUNDWATER MONITORING - SITE SD13 332148
ANALYSIS BY SAMPLING LOCATION

LOCATION	METHOD
OT-15C	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8080
	SW8260
	SW8270
SD13-01	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270
SD13-02	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270
SD13-03	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8240
	SW8260
	SW8270
SD13-05	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270

LOCATION	METHOD
SD13-06	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270
SD13-07	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8240
	SW8260
	SW8270
ST14-W22	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270
ST14-W23	SW6010
	SW7060
	SW7421
	SW7470
	SW7740
	SW7841
	SW8260
	SW8270

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
OT-15C	08-Apr-95	ALUMINUM	3200	SW6010
OT-15C	08-Apr-95	ALUMINUM	4100	SW6010
OT-15C	08-Apr-95	BARIUM	170	SW6010
OT-15C	08-Apr-95	BARIUM	190	SW6010
OT-15C	08-Apr-95	CALCIUM	170000	SW6010
OT-15C	08-Apr-95	CALCIUM	180000	SW6010
OT-15C	08-Apr-95	IRON	2600	SW6010
OT-15C	08-Apr-95	IRON	3300	SW6010
OT-15C	08-Apr-95	MAGNESIUM	5100	SW6010
OT-15C	08-Apr-95	MAGNESIUM	5300	SW6010
OT-15C	08-Apr-95	MANGANESE	220	SW6010
OT-15C	08-Apr-95	MANGANESE	330	SW6010
OT-15C	08-Apr-95	POTASSIUM	2700	SW6010
OT-15C	08-Apr-95	POTASSIUM	2700	SW6010
OT-15C	08-Apr-95	SODIUM	25000	SW6010
OT-15C	08-Apr-95	SODIUM	25000	SW6010
OT-15C	08-Apr-95	TETRACHLOROETHYLENE(PCE)	2.3	SW8260
OT-15C	08-Apr-95	TETRACHLOROETHYLENE(PCE)	2.4	SW8260
OT-15C	08-Apr-95	ZINC	12	SW6010
SD13-01	08-Apr-95	METHYLENE CHLORIDE	4.3	SW8260
SD13-02	08-Apr-95	ALUMINUM	680	SW6010
SD13-02	08-Apr-95	BARIUM	180	SW6010
SD13-02	08-Apr-95	CALCIUM	170000	SW6010
SD13-02	08-Apr-95	IRON	4700	SW6010
SD13-02	08-Apr-95	MAGNESIUM	6500	SW6010
SD13-02	08-Apr-95	MANGANESE	480	SW6010
SD13-02	08-Apr-95	METHYLENE CHLORIDE	3	SW8260
SD13-02	08-Apr-95	POTASSIUM	2000	SW6010
SD13-02	08-Apr-95	SODIUM	19000	SW6010
SD13-02	08-Apr-95	ZINC	15	SW6010
SD13-03	08-Apr-95	ALUMINUM	4200	SW6010
SD13-03	08-Apr-95	ARSENIC	31	SW7060
SD13-03	08-Apr-95	BARIUM	320	SW6010
SD13-03	08-Apr-95	CALCIUM	210000	SW6010
SD13-03	08-Apr-95	IRON	24000	SW6010
SD13-03	08-Apr-95	LEAD	18	SW7421
SD13-03	08-Apr-95	MAGNESIUM	7900	SW6010
SD13-03	08-Apr-95	MANGANESE	300	SW6010
SD13-03	08-Apr-95	METHYLENE CHLORIDE	11	SW8240
SD13-03	08-Apr-95	POTASSIUM	1800	SW6010
SD13-03	08-Apr-95	SODIUM	23000	SW6010
SD13-03	08-Apr-95	ZINC	35	SW6010
SD13-06	08-Apr-95	ALUMINUM	720	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-06	08-Apr-95	BARIUM	240	SW6010
SD13-06	08-Apr-95	CALCIUM	200000	SW6010
SD13-06	08-Apr-95	IRON	1200	SW6010
SD13-06	08-Apr-95	MAGNESIUM	12000	SW6010
SD13-06	08-Apr-95	MANGANESE	330	SW6010
SD13-06	08-Apr-95	METHYLENE CHLORIDE	2.4	SW8260
SD13-06	08-Apr-95	POTASSIUM	950	SW6010
SD13-06	08-Apr-95	SODIUM	28000	SW6010
SD13-06	08-Apr-95	ZINC	25	SW6010
SD13-07	08-Apr-95	2-METHYLNAPHTHALENE	22	SW8270
SD13-07	08-Apr-95	BARIUM	170	SW6010
SD13-07	08-Apr-95	CALCIUM	150000	SW6010
SD13-07	08-Apr-95	IRON	5300	SW6010
SD13-07	08-Apr-95	LEAD	5.6	SW7421
SD13-07	08-Apr-95	MAGNESIUM	7300	SW6010
SD13-07	08-Apr-95	MANGANESE	530	SW6010
SD13-07	08-Apr-95	METHYLENE CHLORIDE	14	SW8240
SD13-07	08-Apr-95	POTASSIUM	1400	SW6010
SD13-07	08-Apr-95	SODIUM	42000	SW6010
ST14-W22	08-Apr-95	ALUMINUM	4700	SW6010
ST14-W22	08-Apr-95	BARIUM	140	SW6010
ST14-W22	08-Apr-95	CALCIUM	210000	SW6010
ST14-W22	08-Apr-95	IRON	13000	SW6010
ST14-W22	08-Apr-95	LEAD	7.3	SW7421
ST14-W22	08-Apr-95	MAGNESIUM	9800	SW6010
ST14-W22	08-Apr-95	MANGANESE	210	SW6010
ST14-W22	08-Apr-95	METHYLENE CHLORIDE	2.4	SW8260
ST14-W22	08-Apr-95	POTASSIUM	3300	SW6010
ST14-W22	08-Apr-95	SODIUM	20000	SW6010
ST14-W22	08-Apr-95	TETRACHLOROETHYLENE(PCE)	1.3	SW8260
ST14-W22	08-Apr-95	ZINC	46	SW6010
SD13-05	10-Apr-95	ALUMINUM	570	SW6010
SD13-05	10-Apr-95	ALUMINUM	770	SW6010
SD13-05	10-Apr-95	BARIUM	200	SW6010
SD13-05	10-Apr-95	BARIUM	210	SW6010
SD13-05	10-Apr-95	CALCIUM	150000	SW6010
SD13-05	10-Apr-95	CALCIUM	150000	SW6010
SD13-05	10-Apr-95	IRON	1000	SW6010
SD13-05	10-Apr-95	IRON	1300	SW6010
SD13-05	10-Apr-95	MAGNESIUM	4600	SW6010
SD13-05	10-Apr-95	MAGNESIUM	4700	SW6010
SD13-05	10-Apr-95	MANGANESE	81	SW6010
SD13-05	10-Apr-95	MANGANESE	83	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-05	10-Apr-95	POTASSIUM	1800	SW6010
SD13-05	10-Apr-95	POTASSIUM	1900	SW6010
SD13-05	10-Apr-95	SODIUM	32000	SW6010
SD13-05	10-Apr-95	SODIUM	33000	SW6010
SD13-05	10-Apr-95	ZINC	50	SW6010
SD13-05	10-Apr-95	ZINC	74	SW6010
ST14-W23	10-Apr-95	ALUMINUM	4100	SW6010
ST14-W23	10-Apr-95	BARIUM	110	SW6010
ST14-W23	10-Apr-95	CALCIUM	170000	SW6010
ST14-W23	10-Apr-95	IRON	4100	SW6010
ST14-W23	10-Apr-95	MAGNESIUM	4700	SW6010
ST14-W23	10-Apr-95	MANGANESE	140	SW6010
ST14-W23	10-Apr-95	POTASSIUM	2000	SW6010
ST14-W23	10-Apr-95	SODIUM	15000	SW6010
ST14-W23	10-Apr-95	ZINC	87	SW6010
SD13-01	13-Apr-95	2-METHYLNAPHTHALENE	16	SW8270
SD13-01	13-Apr-95	ALUMINUM	2100	SW6010
SD13-01	13-Apr-95	ARSENIC	37	SW7060
SD13-01	13-Apr-95	BARIUM	210	SW6010
SD13-01	13-Apr-95	CALCIUM	150000	SW6010
SD13-01	13-Apr-95	IRON	18000	SW6010
SD13-01	13-Apr-95	MAGNESIUM	6100	SW6010
SD13-01	13-Apr-95	MANGANESE	180	SW6010
SD13-01	13-Apr-95	POTASSIUM	1300	SW6010
SD13-01	13-Apr-95	SODIUM	25000	SW6010
SD13-01	13-Apr-95	ZINC	18	SW6010
SD13-03	13-Apr-95	2-METHYLNAPHTHALENE	12	SW8270
SD13-03	13-Apr-95	ALUMINUM	9500	SW6010
SD13-03	13-Apr-95	ARSENIC	22	SW7060
SD13-03	13-Apr-95	BARIUM	340	SW6010
SD13-03	13-Apr-95	CALCIUM	270000	SW6010
SD13-03	13-Apr-95	IRON	34000	SW6010
SD13-03	13-Apr-95	LEAD	22	SW7421
SD13-03	13-Apr-95	MAGNESIUM	10000	SW6010
SD13-03	13-Apr-95	MANGANESE	440	SW6010
SD13-03	13-Apr-95	POTASSIUM	2900	SW6010
SD13-03	13-Apr-95	SODIUM	24000	SW6010
SD13-03	13-Apr-95	ZINC	61	SW6010
ST14-W23	12-Jul-95	ALUMINUM	11000	SW6010
ST14-W23	12-Jul-95	BARIUM	176	SW6010
ST14-W23	12-Jul-95	CALCIUM	302000	SW6010
ST14-W23	12-Jul-95	IRON	8310	SW6010
ST14-W23	12-Jul-95	LEAD	5.28	SW7421

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
ST14-W23	12-Jul-95	MAGNESIUM	6590	SW6010
ST14-W23	12-Jul-95	MANGANESE	322	SW6010
ST14-W23	12-Jul-95	POTASSIUM	3260	SW6010
ST14-W23	12-Jul-95	SODIUM	18600	SW6010
ST14-W23	12-Jul-95	ZINC	31	SW6010
SD13-01	14-Jul-95	2-METHYLNAPHTHALENE	15.8	SW8270
SD13-01	14-Jul-95	ALUMINUM	3260	SW6010
SD13-01	14-Jul-95	ARSENIC	36.8	SW7060
SD13-01	14-Jul-95	BARIUM	255	SW6010
SD13-01	14-Jul-95	BENZYL BUTYL PHTHALATE	41.9	SW8270
SD13-01	14-Jul-95	CALCIUM	195000	SW6010
SD13-01	14-Jul-95	IRON	26500	SW6010
SD13-01	14-Jul-95	LEAD	14.4	SW7421
SD13-01	14-Jul-95	MAGNESIUM	6400	SW6010
SD13-01	14-Jul-95	MANGANESE	348	SW6010
SD13-01	14-Jul-95	POTASSIUM	1660	SW6010
SD13-01	14-Jul-95	SODIUM	21800	SW6010
SD13-01	14-Jul-95	ZINC	28	SW6010
SD13-02	14-Jul-95	ARSENIC	15.1	SW7060
SD13-02	14-Jul-95	BARIUM	183	SW6010
SD13-02	14-Jul-95	CALCIUM	130000	SW6010
SD13-02	14-Jul-95	IRON	2670	SW6010
SD13-02	14-Jul-95	MAGNESIUM	5960	SW6010
SD13-02	14-Jul-95	MANGANESE	422	SW6010
SD13-02	14-Jul-95	METHYLENE CHLORIDE	6.18	SW8260
SD13-02	14-Jul-95	POTASSIUM	1900	SW6010
SD13-02	14-Jul-95	SODIUM	18600	SW6010
SD13-03	14-Jul-95	2-METHYLNAPHTHALENE	16.1	SW8270
SD13-03	14-Jul-95	ALUMINUM	2540	SW6010
SD13-03	14-Jul-95	ARSENIC	37.7	SW7060
SD13-03	14-Jul-95	BARIUM	304	SW6010
SD13-03	14-Jul-95	CALCIUM	182000	SW6010
SD13-03	14-Jul-95	IRON	20700	SW6010
SD13-03	14-Jul-95	LEAD	8.02	SW7421
SD13-03	14-Jul-95	MAGNESIUM	7360	SW6010
SD13-03	14-Jul-95	MANGANESE	285	SW6010
SD13-03	14-Jul-95	POTASSIUM	1550	SW6010
SD13-03	14-Jul-95	SODIUM	22600	SW6010
SD13-03	14-Jul-95	ZINC	16	SW6010
ST14-W22	14-Jul-95	BARIUM	121	SW6010
ST14-W22	14-Jul-95	CALCIUM	151000	SW6010
ST14-W22	14-Jul-95	IRON	1170	SW6010
ST14-W22	14-Jul-95	MAGNESIUM	7100	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
ST14-W22	14-Jul-95	MANGANESE	109	SW6010
ST14-W22	14-Jul-95	POTASSIUM	2460	SW6010
ST14-W22	14-Jul-95	SODIUM	19800	SW6010
ST14-W22	14-Jul-95	TETRACHLOROETHYLENE(PCE)	0.94	SW8260
SD13-06	15-Jul-95	ALUMINUM	664	SW6010
SD13-06	15-Jul-95	BARIUM	266	SW6010
SD13-06	15-Jul-95	CALCIUM	206000	SW6010
SD13-06	15-Jul-95	IRON	3740	SW6010
SD13-06	15-Jul-95	MAGNESIUM	12200	SW6010
SD13-06	15-Jul-95	MANGANESE	459	SW6010
SD13-06	15-Jul-95	POTASSIUM	1240	SW6010
SD13-06	15-Jul-95	SODIUM	27400	SW6010
SD13-06	15-Jul-95	ZINC	30	SW6010
OT-15C	16-Jul-95	BARIUM	168	SW6010
OT-15C	16-Jul-95	BARIUM	167	SW6010
OT-15C	16-Jul-95	BENZENE	0.625	SW8260
OT-15C	16-Jul-95	BENZENE	0.777	SW8260
OT-15C	16-Jul-95	BENZYL BUTYL PHTHALATE	53	SW8270
OT-15C	16-Jul-95	BENZYL BUTYL PHTHALATE	53.3	SW8270
OT-15C	16-Jul-95	CALCIUM	132000	SW6010
OT-15C	16-Jul-95	CALCIUM	131000	SW6010
OT-15C	16-Jul-95	CIS-1,2-DICHLOROETHYLENE	0.925	SW8260
OT-15C	16-Jul-95	ETHYLBENZENE	0.539	SW8260
OT-15C	16-Jul-95	ETHYLBENZENE	0.673	SW8260
OT-15C	16-Jul-95	MAGNESIUM	4150	SW6010
OT-15C	16-Jul-95	MAGNESIUM	4150	SW6010
OT-15C	16-Jul-95	MANGANESE	222	SW6010
OT-15C	16-Jul-95	MANGANESE	223	SW6010
OT-15C	16-Jul-95	POTASSIUM	2530	SW6010
OT-15C	16-Jul-95	POTASSIUM	2530	SW6010
OT-15C	16-Jul-95	SODIUM	27100	SW6010
OT-15C	16-Jul-95	SODIUM	27200	SW6010
OT-15C	16-Jul-95	TETRACHLOROETHYLENE(PCE)	0.668	SW8260
OT-15C	16-Jul-95	TETRACHLOROETHYLENE(PCE)	0.747	SW8260
OT-15C	16-Jul-95	TOLUENE	5.11	SW8260
OT-15C	16-Jul-95	TOLUENE	6.44	SW8260
OT-15C	16-Jul-95	TRICHLOROETHYLENE (TCE)	1.53	SW8260
OT-15C	16-Jul-95	TRICHLOROETHYLENE (TCE)	3.64	SW8260
OT-15C	16-Jul-95	XYLENES, O & M	2.69	SW8260
OT-15C	16-Jul-95	XYLENES, O & M	3.61	SW8260
SD13-05	16-Jul-95	BARIUM	230	SW6010
SD13-05	16-Jul-95	BARIUM	208	SW6010
SD13-05	16-Jul-95	CALCIUM	140000	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-05	16-Jul-95	CALCIUM	139000	SW6010
SD13-05	16-Jul-95	MAGNESIUM	4590	SW6010
SD13-05	16-Jul-95	MAGNESIUM	4560	SW6010
SD13-05	16-Jul-95	MANGANESE	106	SW6010
SD13-05	16-Jul-95	MANGANESE	105	SW6010
SD13-05	16-Jul-95	POTASSIUM	2140	SW6010
SD13-05	16-Jul-95	POTASSIUM	2090	SW6010
SD13-05	16-Jul-95	SODIUM	31300	SW6010
SD13-05	16-Jul-95	SODIUM	30700	SW6010
SD13-07	16-Jul-95	2-METHYLNAPHTHALENE	57	SW8270
SD13-07	16-Jul-95	BARIUM	186	SW6010
SD13-07	16-Jul-95	IRON	6410	SW6010
SD13-07	16-Jul-95	LEAD	8.12	SW7421
SD13-07	16-Jul-95	MAGNESIUM	6510	SW6010
SD13-07	16-Jul-95	MANGANESE	625	SW6010
SD13-07	16-Jul-95	POTASSIUM	1210	SW6010
SD13-07	16-Jul-95	SODIUM	25900	SW6010
SD13-02	17-Oct-95	ACETONE	5.67	SW8260
SD13-02	17-Oct-95	ARSENIC	6.95	SW7060
SD13-02	17-Oct-95	BARIUM	182	SW6010
SD13-02	17-Oct-95	CALCIUM	128000	SW6010
SD13-02	17-Oct-95	IRON	1930	SW6010
SD13-02	17-Oct-95	MAGNESIUM	5950	SW6010
SD13-02	17-Oct-95	MANGANESE	396	SW6010
SD13-02	17-Oct-95	POTASSIUM	2010	SW6010
SD13-02	17-Oct-95	SODIUM	20600	SW6010
SD13-07	17-Oct-95	ALUMINUM	2090	SW6010
SD13-07	17-Oct-95	BARIUM	219	SW6010
SD13-07	17-Oct-95	CALCIUM	180000	SW6010
SD13-07	17-Oct-95	IRON	8360	SW6010
SD13-07	17-Oct-95	LEAD	161	SW7421
SD13-07	17-Oct-95	MAGNESIUM	6940	SW6010
SD13-07	17-Oct-95	MANGANESE	675	SW6010
SD13-07	17-Oct-95	POTASSIUM	1620	SW6010
SD13-07	17-Oct-95	SODIUM	26500	SW6010
ST14-W23	17-Oct-95	ALUMINUM	14500	SW6010
ST14-W23	17-Oct-95	BARIUM	153	SW6010
ST14-W23	17-Oct-95	CALCIUM	309000	SW6010
ST14-W23	17-Oct-95	IRON	10100	SW6010
ST14-W23	17-Oct-95	MAGNESIUM	6830	SW6010
ST14-W23	17-Oct-95	MANGANESE	364	SW6010
ST14-W23	17-Oct-95	POTASSIUM	3520	SW6010
ST14-W23	17-Oct-95	SODIUM	17000	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
ST14-W23	17-Oct-95	ZINC	32	SW6010
SD13-06	18-Oct-95	ARSENIC	8.28	SW7060
SD13-06	18-Oct-95	BARIUM	202	SW6010
SD13-06	18-Oct-95	CALCIUM	164000	SW6010
SD13-06	18-Oct-95	IRON	8750	SW6010
SD13-06	18-Oct-95	MAGNESIUM	10800	SW6010
SD13-06	18-Oct-95	MANGANESE	270	SW6010
SD13-06	18-Oct-95	POTASSIUM	1050	SW6010
SD13-06	18-Oct-95	SODIUM	23500	SW6010
OT-15C	21-Oct-95	ALUMINUM	4240	SW6010
OT-15C	21-Oct-95	ALUMINUM	5310	SW6010
OT-15C	21-Oct-95	BARIUM	221	SW6010
OT-15C	21-Oct-95	BARIUM	200	SW6010
OT-15C	21-Oct-95	CALCIUM	184000	SW6010
OT-15C	21-Oct-95	CALCIUM	185000	SW6010
OT-15C	21-Oct-95	IRON	3820	SW6010
OT-15C	21-Oct-95	IRON	4540	SW6010
OT-15C	21-Oct-95	MAGNESIUM	5140	SW6010
OT-15C	21-Oct-95	MAGNESIUM	5210	SW6010
OT-15C	21-Oct-95	MANGANESE	489	SW6010
OT-15C	21-Oct-95	MANGANESE	444	SW6010
OT-15C	21-Oct-95	POTASSIUM	3600	SW6010
OT-15C	21-Oct-95	POTASSIUM	3160	SW6010
OT-15C	21-Oct-95	SODIUM	28000	SW6010
OT-15C	21-Oct-95	SODIUM	27100	SW6010
OT-15C	21-Oct-95	ZINC	11	SW6010
OT-15C	21-Oct-95	ZINC	11	SW6010
SD13-01	21-Oct-95	2-METHYLNAPHTHALENE	19.8	SW8270
SD13-01	21-Oct-95	ALUMINUM	1320	SW6010
SD13-01	21-Oct-95	ARSENIC	45.9	SW7060
SD13-01	21-Oct-95	BARIUM	198	SW6010
SD13-01	21-Oct-95	BENZYL BUTYL PHTHALATE	22.3	SW8270
SD13-01	21-Oct-95	CALCIUM	148000	SW6010
SD13-01	21-Oct-95	IRON	17400	SW6010
SD13-01	21-Oct-95	LEAD	7.55	SW7421
SD13-01	21-Oct-95	MAGNESIUM	5510	SW6010
SD13-01	21-Oct-95	MANGANESE	176	SW6010
SD13-01	21-Oct-95	POTASSIUM	1130	SW6010
SD13-01	21-Oct-95	SODIUM	22500	SW6010
SD13-01	21-Oct-95	ZINC	14	SW6010
SD13-03	21-Oct-95	2-METHYLNAPHTHALENE	13.5	SW8270
SD13-03	21-Oct-95	ALUMINUM	1230	SW6010
SD13-03	21-Oct-95	ARSENIC	39.2	SW7060

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-03	21-Oct-95	BARIUM	287	SW6010
SD13-03	21-Oct-95	CALCIUM	157000	SW6010
SD13-03	21-Oct-95	IRON	16000	SW6010
SD13-03	21-Oct-95	MAGNESIUM	6660	SW6010
SD13-03	21-Oct-95	MANGANESE	178	SW6010
SD13-03	21-Oct-95	POTASSIUM	1320	SW6010
SD13-03	21-Oct-95	SODIUM	23300	SW6010
SD13-03	21-Oct-95	ZINC	10	SW6010
ST14-W22	21-Oct-95	ALUMINUM	3790	SW6010
ST14-W22	21-Oct-95	BARIUM	171	SW6010
ST14-W22	21-Oct-95	BENZYL BUTYL PHTHALATE	35	SW8270
ST14-W22	21-Oct-95	CALCIUM	204000	SW6010
ST14-W22	21-Oct-95	IRON	10100	SW6010
ST14-W22	21-Oct-95	LEAD	6.02	SW7421
ST14-W22	21-Oct-95	MAGNESIUM	8660	SW6010
ST14-W22	21-Oct-95	MANGANESE	223	SW6010
ST14-W22	21-Oct-95	POTASSIUM	3980	SW6010
ST14-W22	21-Oct-95	SODIUM	23500	SW6010
ST14-W22	21-Oct-95	TETRACHLOROETHYLENE(PCE)	3.51	SW8260
ST14-W22	21-Oct-95	ZINC	27	SW6010
SD13-05	23-Oct-95	BARIUM	202	SW6010
SD13-05	23-Oct-95	BARIUM	189	SW6010
SD13-05	23-Oct-95	CALCIUM	133000	SW6010
SD13-05	23-Oct-95	CALCIUM	128000	SW6010
SD13-05	23-Oct-95	IRON	151	SW6010
SD13-05	23-Oct-95	IRON	431	SW6010
SD13-05	23-Oct-95	MAGNESIUM	4400	SW6010
SD13-05	23-Oct-95	MAGNESIUM	4170	SW6010
SD13-05	23-Oct-95	MANGANESE	102	SW6010
SD13-05	23-Oct-95	MANGANESE	98	SW6010
SD13-05	23-Oct-95	POTASSIUM	2550	SW6010
SD13-05	23-Oct-95	POTASSIUM	2420	SW6010
SD13-05	23-Oct-95	SODIUM	23700	SW6010
SD13-05	23-Oct-95	SODIUM	22900	SW6010
SD13-05	23-Oct-95	ZINC	19	SW6010
SD13-05	23-Oct-95	ZINC	26	SW6010
SD13-02	11-Jan-96	ARSENIC	24.5	SW7060
SD13-02	11-Jan-96	BARIUM	187	SW6010
SD13-02	11-Jan-96	CALCIUM	146000	SW6010
SD13-02	11-Jan-96	IRON	3360	SW6010
SD13-02	11-Jan-96	MAGNESIUM	6070	SW6010
SD13-02	11-Jan-96	MANGANESE	438	SW6010
SD13-02	11-Jan-96	POTASSIUM	1960	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-02	11-Jan-96	SODIUM	21600	SW6010
SD13-03	11-Jan-96	ARSENIC	25	SW7060
SD13-03	11-Jan-96	BARIUM	414	SW6010
SD13-03	11-Jan-96	BENZYL BUTYL PHTHALATE	15.3	SW8270
SD13-03	11-Jan-96	CALCIUM	544000	SW6010
SD13-03	11-Jan-96	COPPER	70	SW6010
SD13-03	11-Jan-96	IRON	63600	SW6010
SD13-03	11-Jan-96	ISOPHORONE	12.9	SW8270
SD13-03	11-Jan-96	LEAD	69.3	SW7421
SD13-03	11-Jan-96	MAGNESIUM	11900	SW6010
SD13-03	11-Jan-96	MANGANESE	790	SW6010
SD13-03	11-Jan-96	MOLYBDENUM	25600	SW6010
SD13-03	11-Jan-96	POTASSIUM	4650	SW6010
SD13-03	11-Jan-96	ZINC	108	SW6010
ST14-W23	11-Jan-96	ALUMINUM	13700	SW6010
ST14-W23	11-Jan-96	BARIUM	173	SW6010
ST14-W23	11-Jan-96	CALCIUM	318000	SW6010
ST14-W23	11-Jan-96	COPPER	50	SW6010
ST14-W23	11-Jan-96	IRON	11300	SW6010
ST14-W23	11-Jan-96	LEAD	8.34	SW7421
ST14-W23	11-Jan-96	MAGNESIUM	7290	SW6010
ST14-W23	11-Jan-96	MANGANESE	381	SW6010
ST14-W23	11-Jan-96	POTASSIUM	3460	SW6010
ST14-W23	11-Jan-96	SODIUM	20400	SW6010
ST14-W23	11-Jan-96	ZINC	45	SW6010
OT-15C	12-Jan-96	ALUMINUM	49600	SW6010
OT-15C	12-Jan-96	BARIUM	4560	SW6010
OT-15C	12-Jan-96	BENZYL BUTYL PHTHALATE	15.4	SW8270
OT-15C	12-Jan-96	BERYLLIUM	4	SW6010
OT-15C	12-Jan-96	CALCIUM	846000	SW6010
OT-15C	12-Jan-96	CHROMIUM, TOTAL	65	SW6010
OT-15C	12-Jan-96	COPPER	62	SW6010
OT-15C	12-Jan-96	IRON	44300	SW6010
OT-15C	12-Jan-96	LEAD	49.9	SW7421
OT-15C	12-Jan-96	MAGNESIUM	16200	SW6010
OT-15C	12-Jan-96	MANGANESE	1860	SW6010
OT-15C	12-Jan-96	POTASSIUM	8610	SW6010
OT-15C	12-Jan-96	SODIUM	28400	SW6010
OT-15C	12-Jan-96	VANADIUM	102	SW6010
OT-15C	12-Jan-96	ZINC	98	SW6010
SD13-05	12-Jan-96	ALUMINUM	554	SW6010
SD13-05	12-Jan-96	BARIUM	183	SW6010
SD13-05	12-Jan-96	BARIUM	171	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-05	12-Jan-96	CALCIUM	125000	SW6010
SD13-05	12-Jan-96	CALCIUM	133000	SW6010
SD13-05	12-Jan-96	IRON	688	SW6010
SD13-05	12-Jan-96	IRON	1190	SW6010
SD13-05	12-Jan-96	MAGNESIUM	4100	SW6010
SD13-05	12-Jan-96	MAGNESIUM	4240	SW6010
SD13-05	12-Jan-96	MANGANESE	118	SW6010
SD13-05	12-Jan-96	MANGANESE	141	SW6010
SD13-05	12-Jan-96	POTASSIUM	1680	SW6010
SD13-05	12-Jan-96	POTASSIUM	1770	SW6010
SD13-05	12-Jan-96	SODIUM	21300	SW6010
SD13-05	12-Jan-96	SODIUM	21700	SW6010
SD13-05	12-Jan-96	ZINC	19	SW6010
SD13-05	12-Jan-96	ZINC	26	SW6010
SD13-06	12-Jan-96	BARIUM	204	SW6010
SD13-06	12-Jan-96	CALCIUM	136000	SW6010
SD13-06	12-Jan-96	IRON	3190	SW6010
SD13-06	12-Jan-96	MAGNESIUM	9410	SW6010
SD13-06	12-Jan-96	MANGANESE	255	SW6010
SD13-06	12-Jan-96	POTASSIUM	804	SW6010
SD13-06	12-Jan-96	SODIUM	23400	SW6010
ST14-W22	12-Jan-96	ALUMINUM	10300	SW6010
ST14-W22	12-Jan-96	BARIUM	203	SW6010
ST14-W22	12-Jan-96	BENZYL BUTYL PHTHALATE	12	SW8270
ST14-W22	12-Jan-96	CALCIUM	292000	SW6010
ST14-W22	12-Jan-96	IRON	24100	SW6010
ST14-W22	12-Jan-96	LEAD	14.9	SW7421
ST14-W22	12-Jan-96	MAGNESIUM	10300	SW6010
ST14-W22	12-Jan-96	MANGANESE	395	SW6010
ST14-W22	12-Jan-96	POTASSIUM	4880	SW6010
ST14-W22	12-Jan-96	SODIUM	23900	SW6010
ST14-W22	12-Jan-96	TETRACHLOROETHYLENE(PCE)	6.13	SW8260
ST14-W22	12-Jan-96	VANADIUM	50	SW6010
ST14-W22	12-Jan-96	ZINC	51	SW6010
SD13-01	15-Jan-96	2-METHYLNAPHTHALENE	13.3	SW8270
SD13-01	15-Jan-96	ALUMINUM	3790	SW6010
SD13-01	15-Jan-96	ARSENIC	32.3	SW7060
SD13-01	15-Jan-96	BARIUM	223	SW6010
SD13-01	15-Jan-96	CALCIUM	202000	SW6010
SD13-01	15-Jan-96	IRON	28100	SW6010
SD13-01	15-Jan-96	LEAD	17.9	SW7421
SD13-01	15-Jan-96	MAGNESIUM	6540	SW6010
SD13-01	15-Jan-96	MANGANESE	299	SW6010

APPENDIX
1995/1996 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

LOCID	LOGDATE	PARNAME (ANALYTE)	PAR VALUE (ug/L)	ANMCODE
SD13-01	15-Jan-96	POTASSIUM	1740	SW6010
SD13-01	15-Jan-96	SODIUM	23800	SW6010
SD13-01	15-Jan-96	ZINC	30	SW6010

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1997 GROUNDWATER MONITORING SUMMARY (DETECTS)

1997 GROUNDWATER MONITORING - SITE SD13
ANALYSIS BY SAMPLING LOCATION

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Location	Method
OT-15C	SW6010A
	SW7421
	SW7470A
	SW8260A
SD13-01	EPA310.1
	SM6211M
	SW8020A
	SW9056
	SW9060
SD13-02	EPA310.1
	SM6211M
	SW8020A
	SW9056
	SW9060
ST14-28	EPA310.1
	SM6211M
	SW8020A
	SW9056
	SW9060
ST14-29	EPA310.1
	SM6211M
	SW8020A
	SW9056
	SW9060
ST14-W31	EPA310.1
	SM6211M
	SW8020A
	SW9056
	SW9060

APPENDIX
1997 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

Location	Sample Date	Analyte	Result	Units	Method
OT-15C	25-Jan-97	Aluminum	87.89	UG/L	SW6010A
OT-15C	25-Jan-97	Barium	163.64	UG/L	SW6010A
OT-15C	25-Jan-97	Calcium	136200	UG/L	SW6010A
OT-15C	25-Jan-97	Copper	10.84	UG/L	SW6010A
OT-15C	25-Jan-97	Iron	120.33	UG/L	SW6010A
OT-15C	25-Jan-97	Magnesium	4551.19	UG/L	SW6010A
OT-15C	25-Jan-97	Manganese	67.45	UG/L	SW6010A
OT-15C	25-Jan-97	Nickel	7.82	UG/L	SW6010A
OT-15C	25-Jan-97	Potassium	1890.26	UG/L	SW6010A
OT-15C	25-Jan-97	Sodium	19839	UG/L	SW6010A
SD13-01	28-Jan-97	ALKALINITY	341	MG/L	EPA310.1
SD13-01	28-Jan-97	ALKALINITY	343	MG/L	EPA310.1
SD13-01	28-Jan-97	CHLORIDE	30.3	MG/L	SW9056
SD13-01	28-Jan-97	CHLORIDE	30.6	MG/L	SW9056
SD13-01	28-Jan-97	ethylbenzene	3.54	UG/L	SW8020A
SD13-01	28-Jan-97	ethylbenzene	4.88	UG/L	SW8020A
SD13-01	28-Jan-97	m,p-Xylene	7.1	UG/L	SW8020A
SD13-01	28-Jan-97	m,p-Xylene	10.7	UG/L	SW8020A
SD13-01	28-Jan-97	Methane	8840		SM6211M
SD13-01	28-Jan-97	Methane	10800		SM6211M
SD13-01	28-Jan-97	o-xylene	5.2	UG/L	SW8020A
SD13-01	28-Jan-97	o-xylene	7.75	UG/L	SW8020A
SD13-01	28-Jan-97	SULFATE	0.09	MG/L	SW9056
SD13-01	28-Jan-97	TOC	1.28	MG/L	SW9060
SD13-02	28-Jan-97	ALKALINITY	338	MG/L	EPA310.1
SD13-02	28-Jan-97	Benzene	0.87	UG/L	SW8020A
SD13-02	28-Jan-97	CHLORIDE	35.1	MG/L	SW9056
SD13-02	28-Jan-97	ethylbenzene	0.61	UG/L	SW8020A
SD13-02	28-Jan-97	m,p-Xylene	1.28	UG/L	SW8020A
SD13-02	28-Jan-97	Methane	4760		SM6211M
SD13-02	28-Jan-97	o-xylene	0.77	UG/L	SW8020A
SD13-02	28-Jan-97	SULFATE	0.08	MG/L	SW9056
SD13-02	28-Jan-97	Toluene	0.75	UG/L	SW8020A
ST14-28	28-Jan-97	ALKALINITY	445	MG/L	EPA310.1
ST14-28	28-Jan-97	CHLORIDE	36.2	MG/L	SW9056
ST14-28	28-Jan-97	ethylbenzene	7.16	UG/L	SW8020A
ST14-28	28-Jan-97	m,p-Xylene	11.8	UG/L	SW8020A
ST14-28	28-Jan-97	Methane	9040		SM6211M
ST14-28	28-Jan-97	SULFATE	0.11	MG/L	SW9056
ST14-28	28-Jan-97	TOC	13.18	MG/L	SW9060
ST14-29	29-Jan-97	ALKALINITY	450	MG/L	EPA310.1
ST14-29	29-Jan-97	CHLORIDE	11	MG/L	SW9056
ST14-29	29-Jan-97	ethylbenzene	7.39	UG/L	SW8020A
ST14-29	29-Jan-97	m,p-Xylene	10.9	UG/L	SW8020A

APPENDIX
1997 GROUNDWATER MONITORING - SITE SD13
RESULTS SUMMARY - DETECTIONS

Location	Sample Date	Analyte	Result	Units	Method
ST14-29	29-Jan-97	Methane	6430		SM6211M
ST14-29	29-Jan-97	o-xylene	9.79	UG/L	SW8020A
ST14-29	29-Jan-97	SULFATE	1.29	MG/L	SW9056
ST14-29	29-Jan-97	TOC	2.38	MG/L	SW9060
ST14-W31	30-Jan-97	ALKALINITY	231	MG/L	EPA310.1
ST14-W31	31-Jan-97	Benzene	0.1	UG/L	SW8020A
ST14-W31	02-Feb-97	CHLORIDE	24.2	MG/L	SW9056
ST14-W31	03-Feb-97	ethylbenzene	0.45	UG/L	SW8020A
ST14-W31	04-Feb-97	m,p-Xylene	3.31	UG/L	SW8020A
ST14-W31	05-Feb-97	Methane	0.33		SM6211M
ST14-W31	06-Feb-97	NITRATE	2.42	MG/L	SW9056
ST14-W31	07-Feb-97	o-xylene	1.46	UG/L	SW8020A
ST14-W31	08-Feb-97	SULFATE	21.3	MG/L	SW9056
ST14-W31	09-Feb-97	TOC	0.99	MG/L	SW9060
ST14-W31	10-Feb-97	Toluene	2.22	UG/L	SW8020A

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1997 SURFACEWATER MONITORING RESULTS

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1997 SURFACEWATER ANALYSIS RESULTS
SITE SD13

Location	Analyte	Result	Units	LabFlag	Sample Date	Method
UNSTRMDOWN	Aluminum	32.65	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Aluminum	33.27	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Antimony	10	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Arsenic	20	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Barium	101.57	UG/L		30-Jan-97	SW6010A
UNSTRMDOWN	Barium	102.99	UG/L		30-Jan-97	SW6010A
UNSTRMDOWN	Berylium	0.3	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Cadmium	1	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Calcium	107430	UG/L	B	30-Jan-97	SW6010A
UNSTRMDOWN	Calcium	108080	UG/L	B	30-Jan-97	SW6010A
UNSTRMDOWN	Chromium	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Cobalt	1	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Copper	4	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Iron	18	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Lead	1.5	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Lead	1.5	UG/L	U	30-Jan-97	SW7421
UNSTRMDOWN	Magnesium	8129.7	UG/L		30-Jan-97	SW6010A
UNSTRMDOWN	Magnesium	8144.2	UG/L		30-Jan-97	SW6010A
UNSTRMDOWN	Manganese	13.19	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Manganese	13.53	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Mercury	0.06	UG/L	U	30-Jan-97	SW7470A
UNSTRMDOWN	Nickel	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Potassium	2706.2	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Potassium	2711.2	UG/L	F	30-Jan-97	SW6010A
UNSTRMDOWN	Selenium	20	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Silver	3	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Sodium	34800	UG/L	B	30-Jan-97	SW6010A
UNSTRMDOWN	Sodium	40300	UG/L	B	30-Jan-97	SW6010A
UNSTRMDOWN	Thallium	20	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	TOC	0.99	MG/L	U	30-Jan-97	SW9060
UNSTRMDOWN	Vanadium	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMDOWN	Zinc	16	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Aluminum	107.43	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Antimony	10.42	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Arsenic	20	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Barium	97.49	UG/L		30-Jan-97	SW6010A
UNSTRMUP	Berylium	0.37	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Cadmium	1	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Calcium	109420	UG/L	B	30-Jan-97	SW6010A
UNSTRMUP	Chromium	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Cobalt	1.05	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Copper	4.4	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Iron	30.41	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Lead	2.59	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Lead	3.41	UG/L	F	30-Jan-97	SW7421
UNSTRMUP	Magnesium	8064.9	UG/L		30-Jan-97	SW6010A
UNSTRMUP	Manganese	9.28	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Mercury	0.06	UG/L	U	30-Jan-97	SW7470A
UNSTRMUP	Nickel	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Potassium	2593.1	UG/L	F	30-Jan-97	SW6010A
UNSTRMUP	Selenium	20	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Silver	3	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Sodium	34900	UG/L	B	30-Jan-97	SW6010A
UNSTRMUP	Thallium	20	UG/L	U	30-Jan-97	SW6010A

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1997 SURFACEWATER ANALYSIS RESULTS
SITE SD13

Location	Analyte	Result	Units	LabFlag	Sample Date	Method
UNSTRMUP	TOC	0.99	MG/L	U	30-Jan-97	SW9060
UNSTRMUP	Vanadium	2	UG/L	U	30-Jan-97	SW6010A
UNSTRMUP	Zinc	16	UG/L	U	30-Jan-97	SW6010A

APPENDIX B

BORING LOGS, WELL CONSTRUCTION DIAGRAMS, AND WELL DEVELOPMENT REPORTS

Geologic Borehole and Well Completion Log

CARSWELL AFB

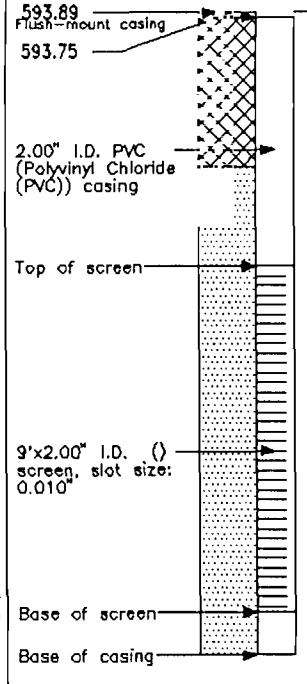
Date	09/07/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400314.37 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023318.28 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	16.60 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW05**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD — SED — SMCODE — REC%

8.40–9.10	SS	

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System, ASTMCODE)	Lithologic Symbols & Codes	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
ML		SOIL, DRY, CRUMBLY, MINOR GRAVEL, MINOR CALICHE, ROOTS. –LB	
CL		SILTY SAND, VERY PALE BROWN (10YR8/3), DAMP TO DRY, MINOR CALICHE PEBBLES, WELL SORTED. –LB	
ML		SANDY GRAVEL, PALE YELLOW (2.5Y7/4) 20% GRAVEL, 30% SILT, CALICHE, DRY, CRUMBLY. –LB	
CH		CLAY, DARK BROWN (10YR3/3), MOIST, PLASTIC, SOFT. –LB	
SWSM		SILTY SAND, BROWNISH YELLOW (10YR6/6), MOIST, WELL SORTED, VERY FINE, SOFT. –LB	
GM		GRAVEL, MINOR SAND AND SILT, BROWNISH YELLOW (10YR6/6), POORLY SORTED, WET AT 9.3'	
GM		SANDY GRAVEL, VERY PALE BROWN (10YR7/4), MINOR SILT, WET. –LB	
NACM		LIMESTONE, LIGHT GRAY (2.5Y7/2), BRITTLE, MUDDY. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather	Time / Equipment / Water Level –Initials
1.00' Borehole diameter 9" –LB	
Water level at 00:01 10/05/94 8.99' (Elev. 584.90')	

CRSWL ST14-MW05 TD 16.60' 1"=5.00' 1:60.00 950526 1303 Sheet 1 o

ST14-MW05
Geologic Borehole and Well Completion Log

ENGINEERING-SCIENCE, INC.
Denver, Colorado

332168

ST14-MW06
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/24/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400392.35 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023556.13 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	27.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW06**	LOCID

Completion

Elevation feet MSL

581.59 Flush-mount casing
581.33
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing
Top of screen
19'x2.00" I.D. () screen, slot size: 0.010"

Sampling

Instrument Reading Penetration — SBD, SMCODE, SED, REC%

10.50–10.70 SS

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
CL		SILTY CLAYEY SOIL, BLACK (5Y2.5/1), CRUMBLY, DRY, NONPLASTIC, MINOR ROOTS. –LB	
CL		SILTY CLAY, GRADATIONAL COLOR TO BROWN (10YR5/3), CRUMBLY, DRY, NONPLASTIC. –LB	
GPGM		SILTY GRAVEL, BROWN (10YR5/3), DRY. –LB	
CL		SILTY CLAY, LIGHT YELLOWISH BROWN (10YR7/3), CRUMBLY, POWDERY, DRY. –LB	
SWSM		SILT AND SAND, VERY PALE BROWN (10YR7/3), VERY FINE GRAINED, POWDERY, WELL SORTED, DRY. –LB	
SWSM		SAA, WET. –LB	
SW		SAA, WET, GRADING TO A SAND, VERY FINE GRAINED. (ZONE NOT CORED DUE TO GRAVEL AT TOP OF BEDROCK) –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 13.04' (Elev. 568.55')

CRSWL ST14-MW06 TD 27.10' 1"=5.00' 1:60.00 950526 1304 Sheet 1 of 2

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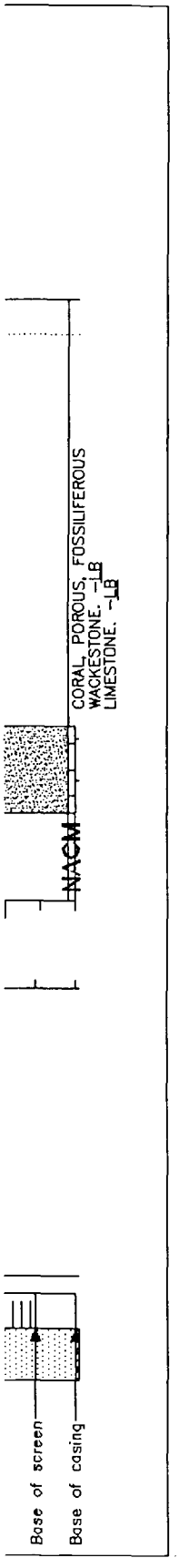
Denver, Colorado

332163



CRSWL ST14-MW06 TD 27.10' 1"=5.00' 1:60.00 950526 1304 Sheet 2 of

ST14-MW06

Geologic Borehole and Well Completion Log *(continued)*

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/09/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400199.79 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023617.16 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	26.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW07**	LOCID

Completion

Elevation feet MSL

580.05 Flush-mount casing

579.98

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

19'x2.00" I.D. () screen, slot size: 0.010"

Base of screen

Sampling

Instrument Reading Penetration | SBD | SMCODE | REC% | SED

13.60 — 14.00 SS

Depth

feet

Ground Surface

5

10

15

20

25

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
NA		SOIL AND FILL MATERIAL, GRAVELY, SANDY SOIL WITH PIECES OF GLASS. OLD ROAD BED. –LB	
CL		SILTY CLAY, VERY DARK GREY (10YR3/1), MOIST, CRUMBLY, NONPLASTIC. –LB	
CL		SILTY CLAY, MINOR SAND, DARK GRAYISH BROWN (10YR4/2), MINOR CALICHE NODULES, MOIST, NONPLASTIC, HARD. –LB	
SM		SILTY SAND, MOIST TO WET, VERY PALE BROWN (10YR7/3), FINE GRAINED. –LB	
CH		CLAY, MINOR SILT AND SAND, VERY PALE BROWN (10YR7/3), EXTREMELY WET. –LB	
GM		GRAVEL, MINOR SILT AND SAND, POORLY SORTED 1–3MM ASSORTMENT, WET. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 14.44' (Elev. 565.61')

CRSWL ST14-MW07 TD 26.00' 1"=5.00' 1:60.00 950526 1304 Sheet 1 of 2

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Denver, Colorado

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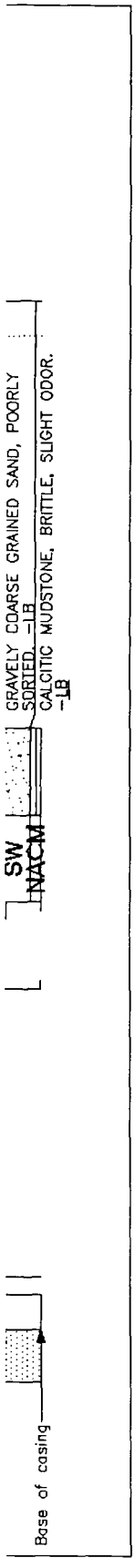
ST14-MW07
Geologic Borehole and Well Completion Log

332171

332172



CRSWL ST14-MW07 TD 26.00' 1"=5.00' 1:60.00 950526 1304 Sheet 2 o

ST14-MW07

Geologic Borehole and Well Completion Log *(continued)*

ST14-MW08
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	09/07/94 ESTDATE	Establishing Company	ESCI ESCCODE	**CARSWELL AIR FORCE BASE**	
Northing	400908.19 ft. NCOORD	Drilling Company	RONE DRLCODE	Air Force Installation	CRSWL AFIID
Easting	2023710.16 ft. ECOORD	Drill Rig Type	HSA DRLEQP	Location Identification	**ST14-MW08** LOCID
Borehole Total Depth	26.10 ft. DEPTH	Construction Method	HS CMCCODE		

Completion

Elevation feet MSL

580.73 Flush-mount casing
580.43
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing
Top of screen
17'x2.00" I.D. screen, slot size: 0.010"
Base of screen

Sampling

Instrument Reading Penetration — SBD, SMCODE, SED, REC%

19.40
19.60 SS

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVELY FILL. -LB	
CL		CLAY, BLACK (5Y2.5/1), MOD. HARD, DAMP, NONPLASTIC, SLT. CRUMBLY. -LB	
CL		SAA, GRADATIONAL COLOR TO DARK BROWN (10YR3/3), HARD, DAMP, NONPLASTIC. -LB	
CH		SILTY CLAY, BROWN (10YR4/3), CRUMBLY, DAMP, MINOR SHELLS, MOD. PLASTIC. -LB	
CH		SILTY CLAY, YELLOWISH BROWN (10YR5/4), MOD. PLASTIC, CRUMBLY, MOIST, MINOR GREY AND TAN MOTTLING. -LB	
CH		SILTY CLAY, GRAY (10YR5/1), MOIST, CRUMBLY, MOD. PLASTIC, MINOR SHELLS. -LB	
CH		SAA, CRUMBLY, FISSILE BREAKING, SHEAN TO CORE AT 17.5'. -LB	
SM		SAA GRADING TO A SILTY SAND, LIGHT GRAY, WET (2.5YN7/). -LB	
SM		SILTY SAND, LIGHT GRAY (2.5YN7/), WET. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather	Time / Equipment / Water Level -Initials
1.00' Borehole diameter 9" -LB	
Water level at 00:01 10/05/94 12.55' (Elev. 568.18')	

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CRSWL ST14-MW08 TD 26.10' 1"=5.00' 1:60.00 950525 1305 Sheet 1 of 2

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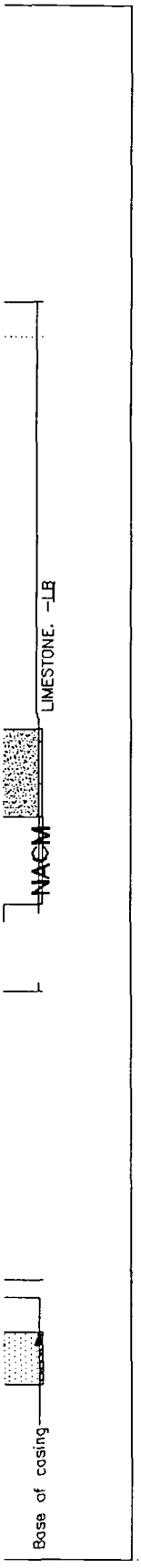
332174



CRSWL ST14-MW08 TD 26.10' 1"=5.00' 1:60.00 950526 1305 Sheet 2 o

ST14-MW08
Geologic Borehole and Well Completion Log *(continued)*

ST14-MW09
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	09/07/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400055.14 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023711.94 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	22.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW09**	LOCID

Completion

Elevation feet MSL

575.78 Flush-mount casing
575.51
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing
Top of screen
14'x2.00" I.D. screen, slot size: 0.010"
Base of screen
Base of casing

Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC%

9.60
9.80 SS

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) / ASTMCODE	Lithologic Symbols & Codes / LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
OL		SOIL, OM, GRASS, DRY AND CRUMBLY -LB	
CL		CLAY, BLACK (5Y2.5/1), BRITTLE, DRY, NONPLASTIC, HARD, MINOR GRAVEL FROM 0.8 TO 1.2 OF LIMESTONE/CALICHE, MINOR ROOTS. -LB	
CL		SAA, GRADING IN COLOR TO DARK GRAYISH BROWN (2.5Y4/2). -LB	
SM		SILTY SAND, VERY PALE BROWN (10YR7/4), DAMP. -LB	
SM		SAA, MOIST TO WET. -LB	
CH		SANDY, SILTY CLAY, VERY PALE BROWN (10YR7/4), MOIST TO WET. -LB	
CH		SAA, WET. -LB	
SM		SILTY SAND, OLIVE GRAY (5Y4/2), MOIST. -LB	
NACM		LIMESTONE. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 10.64' (Elev. 565.14')

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CRSWL ST14-MW09 TD 22.00' 1"=5.00' 1.60.00 950525 1311 Sheet 1 of 1

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Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	09/07/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400536.38 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023807.86 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	21.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW10**	LOCID

Completion

Elevation feet MSL

575.37 — Surface casing

575.33

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

14'x2.00" I.D. screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

7.50 – 7.70

13.80 – 14.00

Depth (feet)

Ground Surface

5

10

15

20

Lithology

USCS (Unified Soil Classification System) / ASTMCODE	Lithologic Symbols & Codes	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
OL		SOIL, O.M., GRASS, MINOR GRAVEL, CRUMBLY, AND DRY. –LB	
CL		SILTY CLAY, BLACK (5Y2.5/1), CRUMBLY, DRY NONPLASTIC, HARD. –LB	
SC		CLAYEY SILTY SAND, PALE BROWN (10YR6/3), VERY FINE GRAINED, DRY. CRUMBLY, SOFT. –LB	
SC		SAA, GRADING TO MOIST. –LB	
SC		SAA, WET. (FUEL ON THE OUTSIDE OF CORE FROM 10' TO 15', LIGHT ORANGE SHEEN/SMEAR), 13.5' TO 13.10' FUEL IN CORE. –LB	
CH		CLAY, GRAY (10YR5/1), WET PLASTIC, SOFT. –LB	
SW		SAND, GRAY (10YR5/1), MINOR ORANGE STAINING, VERY FINE GRAINED, WELL SORTED, WET. –LB	
SP		SAND, YELLOWISH BROWN (10YR5/8), FINE GRAINED, WET, GRADING TO GRAVEL. –LB	
NACM		SANDSTONE. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 9.04' (Elev. 566.29')

CRSWL ST14-MW10 TD 21.10' 1"=5.00' 1:60.00 950525 1312 Sheet 1

ST14-MW10 Geologic Borehole and Well Completion Log

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Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/10/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400711.01 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023886.57 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	21.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW11**	LOCID

Completion

Elevation feet MSL

576.30 Flush-mount casing

576.21

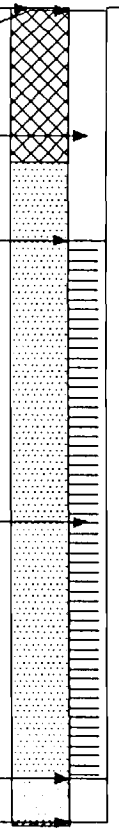
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

14'x2.00" I.D. screen, slot size: 0.010"

Base of screen

Base of casing



Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

14.30–14.50 SS

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System, ASTMCODE)	Lithologic Symbols & Codes (LITHCODE)	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
CL		SILTY CLAY, VERY DARD GREY (10YR3/1), ROOTS, MINOR CALICHE NODULES, NONPLASTIC, DRY, CRUMBLY. –LB	
CL		SILTY CLAY, DARK GRAYISH BROWN (10YR4/2), DRY TO DAMP, NONPLASTIC, CRUMBLY, GRADING INTO MOIST. –LB	
CH		SILTY CLAY, SOME SAND, VERY PALE BROWN (10YR7/3), MOIST, CRUMBLY, VERY FINE SAND, PLASTIC. –LB	
CH		SILTY, SANDY CLAY, GRAY (10YR6/1), VERY FINE GRAINED SAND, SOFT, PLASTIC, WET. –LB	
CH		SAA, MOIST. –LB	
SM		SILTY SAND, FINE GRAINED, WELL SORTED, WET. –LB	
NACM		SANDSTONE –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 9.72' (Elev. 566.58')

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CRSWL ST14-MW11 TD 21.10' 1"=5.00' 1.60.00 950525 1312 Sheet 1 of 1

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ST14-MW11
Geologic Borehole and Well Completion Log

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ST14-MW12
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/10/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400530.97 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023956.77 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	19.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW12**	LOCID

Completion

Elevation feet MSL

573.97 Flush-mount casing
573.80
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing
Top of screen
12'x2.00" I.D. screen, slot size: 0.010"
Base of screen
Base of casing

Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC% (10 0)

9.50 – 9.70 SS
14.50 – 14.70 SS

Depth

feet — Ground Surface

5
10
15

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
OL		SOIL, SILTY CLAY, BLACK (5Y2.5/1), O.M., ROOTS, MINOR CALICHE NODULES, DRY, CRUMBLY, HARD. GRADATIONAL TO 2.7'. –LB	
OL		SAA, GRAYISH BROWN (2.5Y5/2), DRY, CRUMBLY, HARD. –LB	
CH		SILTY CLAY, LIGHT BROWNISH GRAY (2.5Y6/2), MOIST, PLASTIC, SOFT. –LB	
CH		SAA, MOIST TO WET. –LB	
SW		SAND, FINE GRAINED, WELL SORTED, WET. –LB	
SW		SAA, BUT YELLOWISH BROWN (10YR5/8). –LB	
SP		SAND, COARSE GRAINED, POORLY SORTED, WET. –LB	
NACM		WEATHERED SHALE / LIMESTONE. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather — Time, Equipment, Water Level, –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 8.48' (Elev. 565.49')

CRSWL ST14-MW12 TD 19.10' 1"=5.00' 1:60.00 950525 1313 Sheet 1 of

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Denver, Colorado
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Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/10/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400276.33 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024000.51 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	19.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW13**	LOCID

Completion

Elevation feet MSL

574.51 Flush-mount casing

574.35

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

12'x2.00" I.D. screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

13.90 SS 14.10

Depth

feet

Ground Surface

5

10

15

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
OL	SOIL, SILTY CLAY, DARK REDDISH BROWN (5YR3/2), O.M., ROOTS, DRY, CRUMBLY, HARD	
OL	SAA, BUT BLACK (5YR2.5/1). –LB	
CL	SILTY CLAY, MINOR SAND, MINOR SHELLS (1 TO 2MM), YELLOWISH BROWN (10YR5/4), DAMP, CRUMBLY, NONPLASTIC, "LIGHT & AIRY". –LB	
CL	SAA, MOIST, ODOR AND MINOR STAINING IN CORE. –LB	
SM	SILTY SAND, GRAY (10YR5/1), MOIST, VERY FINE GRAINED. –LB	
SM	SAA, WET. –LB	
GP	GRAVELY SAND AND GRAVEL, POORLY SORTED, WET	
NACM	LIMESTONE. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 10.44' (Elev. 564.07')

CRSWL ST14-MW13 TD 19.10' 1"=5.00' 1:60.00 950525 1313 Sheet 1 of

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ST14-MW13
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/12/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400891.95 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023964.96 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	22.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW14**	LOCID

Completion

Elevation feet MSL

576.10 Flush-mount casing

575.50

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

14'x2.00" I.D. screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — SED — REC%

11.50
11.70

Depth

feet

Ground Surface

5

10

15

20

Lithology

USCS (Unified Soil Classification System) / ASTMCODE	Lithologic Symbols & Codes	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
NA		ASPHALT –LB	
CL		CLAY, MINOR SILT, BLACK (2.5YN2/), NONPLASTIC, DAMP, CRUMBLY. –LB	
CL		SILTY CLAY, VERY DARK GRAY (10YR3/1) GRADING TO DARK GREY (10YR4/1), MINOR CALICHE, DRY TO MOIST, CRUMBLY, MOD HARD, NONPLASTIC. –LB	
CH		SANDY CLAY, DARK GREY (10YR3/1), MOIST, CRUMBLY, MOD. PLASTIC. –LB	
CH		SANDY CLAY, DARK GREY (10YR4/1), WET, MINOR GRAVEL SOFT. –LB	
CH		SANDY CLAY GRADING FROM SAA TO GREY (10YR5/1), MOIST, CRUMBLY, MOD. PLASTIC. –LB	
SM		SILTY SAND, OLIVE GRAY (5Y5/2), WET, WELL SORTED, VERY FINE GRAINED. –LB	
GPGM		SAA, GRADING TO VERY COARSE GRAINED SAND TO GRAVEL AND MINOR SHELLS WITH CLAY	
NACM		MUDDY LIMESTONE, FISSILE, DARK GRAY (2.5YN4/). –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 9.38' (Elev. 566.72')

CRSWL ST14-MW14 TD 22.10' 1"=5.00' 1:60.00 950525 1314 Sheet 1

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ST14-MW14
Geologic Borehole and Well Completion Log

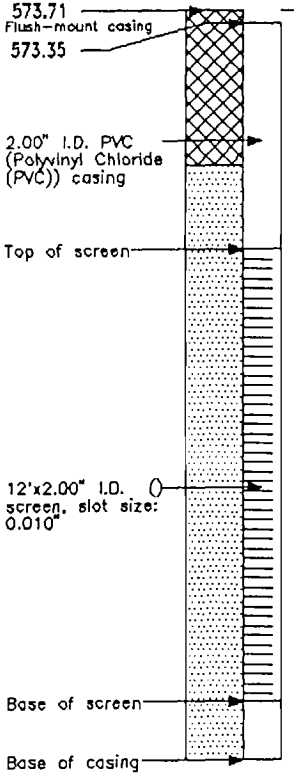
Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/12/94 ESTDATE	Establishing Company	ESCI ESCCODE	**CARSWELL AIR FORCE BASE**	
Northing	399895.29 ft. NCOORD	Drilling Company	RONE DRLCODE	Air Force Installation	CRSWL AFIID
Easting	2024143.27 ft. ECOORD	Drill Rig Type	HSA DRLEQP	Location Identification	**ST14-MW15** LOCID
Borehole Total Depth	19.40 ft. DEPTH	Construction Method	HS CMCCODE		

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SED, SMCODE, REC%

11.70 — SS

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
NA		ASPHALT. –LB	
NA		GRAVELY FILL MATERIAL –LB	
CL		SILTY CLAY, VERY DARK GRAY (5Y3/1), DRY, CRUMBLY, MINOR FE STAINING IN "JOINTS", HARD, NONPLASTIC. –LB	
CL		SILTY CLAY, GRADATIONAL COLOR TO DARK GRAYISH BROWN (10YR4/2), MOIST, MINOR SHELLS (1MM), NONPLASTIC, CRUMBLY. –LB	
CL		SAA, GRADING TO SANDY CLAY. –LB	
SW		SAND, BROWNISH YELLOW (10YR6/6), VERY FINE GRAINED, WELL SORTED, WET. –LB	
GPGM		GRAVEL, POORLY SORTED. –LB	
NACM		LIMESTONE. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather	Time / Equipment / Water Level –Initials
1.00' Borehole diameter 9" –LB	
Water level at 00:01 10/05/94 11.50' (Elev. 562.21')	

CRSWL ST14-MW15 TD 19.40' 1"=5.00' 1:60.00 950525 1314 Sheet 1 of 1

ST14-MW15
Geologic Borehole and Well Completion Log

ENGINEERING-SCIENCE, INC.
Denver, Colorado

333218

332182

ST14-MW16
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/22/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400642.17 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024356.10 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	20.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW16**	LOCID

Completion

Elevation feet MSL

573.83 Flush-mount casing
573.46
2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing
Top of screen
12'x2.00" I.D. screen, slot size: 0.010"
Base of screen
Base of casing

Sampling

Instrument Reading / Penetration — SBD / SED — SMCODE — REC%

3.00–3.20 SS
9.30–9.50 SS

Depth

feet — Ground Surface

5, 10, 15, 20

Lithology

USCS (Unified Soil Classification System) / ASTMCODE	Lithologic Symbols & Codes / LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
NA		ASPHALT. -LB	
NA		SANDY FILL MATERIAL. -LB	
CL		CLAY, BLACK (5YR2.5/1), DRY, HARD, NONPLASTIC. -LB	
CL		SAA, BUT GRADATIONAL TO SANDY CLAY. -LB	
CL		SANDY CLAY, MINOR SILT, GRAY (10YR5/1), CRUMBLY, DAMP, NONPLASTIC, CALICHE GRANUALS. -LB	
SC		CLAYEY SAND, GRAYISH BROWN (2.5Y5/2), MOIST, VERY FINE GRAINED, WELL SORTED, SOFT	
SW		SAND, GRAYISH BROWN (2.5Y5/2), WET, VERY FINE GRAINED. -LB	
GPGM		GRAVEL, PODRLY SORTED (NO RECOVERY). -LB	
NACM		LIMESTONE. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level / -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 9.75' (Elev. 564.08')

CRSWL ST14-MW16 TD 20.10' 1"=5.00' 1:60.00 950525 1315 Sheet 1 of

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	09/08/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400484.05 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024388.69 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	17.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW18**	LOCID

Completion

Elevation feet MSL

573.92 Flush-mount casing

573.66

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

12'x2.00" I.D. screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC% (100, 50)

8.80
9.00

Depth

feet — Ground Surface

5

10

15

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
NA		ASPHALT. -LB	
NA		SANDY FILL MATERIAL. -LB	
CL		CLAY, BLACK (5YR2.5/1), DAMP TO DRY, CRUMBLY, HARD, NONPLASTIC. -LB	
CL		SILTY CLAY, GRAYISH BROWN (2.5Y5/2), DAMP TO MOIST, SOLID, NONPLASTIC, MOD. HARD. CRUMBLY ZONE AT 9.2'. -LB	
CL		SAA GRADING TO SANDY CLAY. -LB	
SW		SAND, GRAY (10YR5/1), WELL SORTED, FINE GRAINED, WET. -LB	
GPGM		GRAVEL, POORLY SORTED -LB	
NACM		LIMESTONE. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 10.49' (Elev. 563.43')

CRSWL ST14-MW18 TD 17.10' 1"=5.00' 1:60.00 950525 1315 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ST14-MW18

Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	01/01/90	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400276.64 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024427.83 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	17.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW19**	LOCID

Completion

Elevation feet MSL

573.88 Flush-mount casing

573.11

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

9'x2.00" I.D. () screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

13.50 – 14.00 SS

Depth

feet

Ground Surface

5

10

15

Lithology

USCS Unified Soil Classification System (ASTMCODE)	Lithologic Symbols & Codes (LITHCODE)	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
		ASPHALT. –LB	
NA		ROCK AND GRAVEL FILL. –LB	
CL		SILTY CLAY, OLIVE (5Y5/3), DAMP, HARD, NONPLASTIC, MINOR CALICHE AND SHELLS. –LB	
CH		SILTY CLAY, OLIVE GRAY (5Y5/2), MOIST, CRUMBLY, MINOR SHELLS. –LB	
CH		SAA, HARD, NONCRUMBLY. –LB	
CH		SILTY CLAY, OLIVE GRAY (5Y5/2), MOIST, SOFT, PLASTIC. –LB	
SW		SAND, OLIVE GRAY (5Y5/2), WET, WELL SORTED, FINE GRAINED GRADING TO MED. GRAINED. –LB	
GPGM		GRAVEL, POORLY SORTED. –LB	
NACM		LIMESTONE. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

Water level at 00:01 10/05/94 10.62' (Elev. 563.26')

CRSWL ST14-MW19 TD 17.10' 1"=5.00' 1:60.00 950525 1316 Sheet 1 of

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

ST14-MW19
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/22/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400585.08 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024502.63 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	17.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW20**	LOCID

Completion

Elevation feet MSL

573.76 Flush-mount casing

573.44

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

9'x2.00" I.D. () screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

7.10 / 7.30 SS

10.00 / 10.20 SS

Depth

feet

Ground Surface

5

10

15

Lithology

USCS Unified Soil Classification System (ASTMCODE)	Lithologic Symbols & Codes (LITHCODE)	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVEL, ROAD FILL. -LB	
CL		CLAY, BLACK (2.5YN2/), MINOR GRAVEL AT TOP, HARD, NONPLASTIC, VERY MINOR SHELLS. -LB	
CH		SILTY CLAY, OLIVE (5Y5/3), CRUMBLY, MOIST, MOD. SOFT. -LB	
CH		SAA, GRADATIONAL TO PALE OLIVE (5Y6/3). -LB	
SW		SAND, OLIVE (5Y5/3), GRADING FROM MOIST TO WET AT 12', FINE GRAINED, WELL SORTED. -LB	
GPGM		GRAVEL, POORLY SORTED -LB	
NACM		LIMESTONE. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 10.24' (Elev. 563.52')

CRSWL ST14-MW20 TD 17.10' 1"=5.00' 1.60.00 950525 1316 Sheet 1 of

ST14-MW20

Geologic Borehole and Well Completion Log

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/12/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	399994.13 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024463.12 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	18.10 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW21**	LOCID

Completion

Elevation feet MSL

572.91 Flush-mount casing

572.76

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

9'x2.00" I.D. () screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

10.50 SS
10.70

Depth

feet

Ground Surface

5

10

15

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
OL		SILTY, SANDY SOIL, DARK BROWN (7.5YR4/2), CRUMBLY. -LB	
NA		RAILROAD BED GRAVEL. -LB	
CL		SILTY CLAY, VERY DARK GRAY (10YR3/1), DRY, CRUMBLY, NONPLASTIC, HARD. -LB	
CL		SILTY CLAY, BROWN (10YR5/3) GRADING TO GRAY (10YR5/1), HARD, NONPLASTIC, FE STAINING IN "JOINTS", CRUMBLY. -LB	
SM		SILTY SAND, GRAY (10YR5/1), UNIFORM, VERY FINE GRAINED, FROM DAMP TO WET. -LB	
GPGM		GRAVEL, POORLY SORTED, WET. -LB	
NACM		LIMESTONE. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 11.37' (Elev. 561.54')

CRSWL ST14-MW21 TD 18.10' 1"=5.00' 1:60.00 950525 1316 Sheet 1 of

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

ST14-MW21
Geologic Borehole and Well Completion Log

332186

332202

ST14-VW18
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

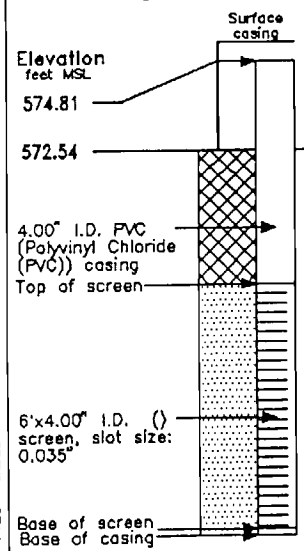
CARSWELL AFB

Date	08/24/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400274.46 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023753.58 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW18**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBO — SMCODE — RECX — SED

1.00 – 1.20 SS

5.00 – 5.20 SS

Depth

feet

Ground Surface

5

10

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVEL COVERING. -LB	
CL		SILTY CLAY, BROWN (7.5YR5/2), CRUMBLY, DRY, MINOR CALICHE GRAVEL, HEAVY ODOR. -LB	
ML		SILTY SAND, PINKISH WHITE (7.5YR8/2), MOIST, POWDERY, VERY FINE GRAINED SAND. WET AT 4.3'. -LB	
CH		SILTY CLAY, PINKISH GRAY (7.5YR7/2), WET, SOFT, PLASTIC. -LB	
CH		SILTY CLAY, PALE BROWN (10YR6/3), CRUMBLY, MINOR SHELLS. THIN ZONES OF HEAVY ODORED SILTY CLAY, DARK BROWN (10YR3/3) AT 8.0' AND 8.5'. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather — Time, Equipment, Water Level -Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-VW18 TD 10.00' 1"=5.00' 1:60.00 950526 0749

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

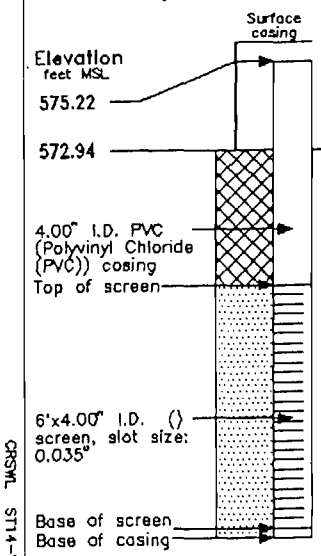
CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400264.53 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023647.87 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW19**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

5.20
5.40

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW	GRAVEL COVER. -LB	
CL	SILTY, SANDY CLAY, DARK BROWN (10YR9/3), FILL MATERIAL, MINOR GRAVEL, DRY CRUMBLY, NONPLASTIC. -LB	
ML	SANDY, CLAYEY SILT, VERY PALE BROWN (10YR7/3), VERY FINE GRAINED SAND, POWDERY, DAMP. WET AT 5.5'. -LB	
CH	SILTY CLAY, YELLOWISH BROWN (10YR5/4), CRUMBLY, WET TO MOIST, MINOR SHELLS. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-VW19 TD 10.00' 1"=5.00' 1.60.00 950526 0749 Sheet 1 of 1

ST14-VW19

Geologic Borehole and Well Completion Log

ENGINEERING-SCIENCE, INC.
Denver, Colorado
ES

Geologic Borehole and Well Completion Log

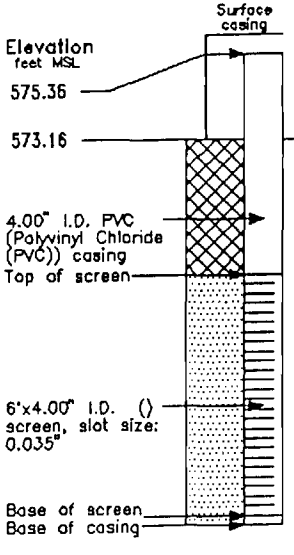
CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400375.45 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023625.74 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW20**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBO / SED	SMCODE	REC%
5.00–5.60	SS	

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
GW		GRAVEL COVER. –LB	
CL		SILTY CLAY, MINOR COARSE SAND, OLIVE BROWN (2.5Y4/3), MINOR CALICHE GRAVEL. DRY, CRUMBLY, NONPLASTIC. –LB	
ML		SANDY, CLAYEY SILT, PALE YELLOW (2.5Y7/4). DRY TO DAMP, CRUMBLY, POWDERY SILT, SAND, VERY FINE GRAINED. IRON STAINED ZONE 0.1" THICK AT 3.6'. –LB	
CH		SILTY SANDY CLAY, PALE YELLOW (2.5Y7/4), MOIST, GRADING TO WET AT 5.8'. –LB	
CH		SAA, MOIST. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW20 TD 10.00' 1"=5.00' 1:60.00 950526 0749

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ST14-VW20
Geologic Borehole and Well Completion Log

3322

Geologic Borehole and Well Completion Log

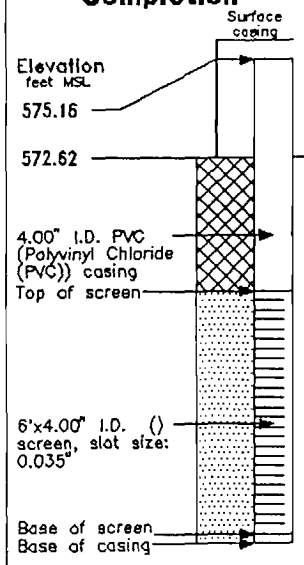
CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400393.50 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023728.19 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW21**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD — SMCODE — RECX — SED

3.40 – 4.40 SS

Depth

feet

Ground Surface

5

10

Lithology

USCS — Unified Soil Classification System — ASTMCODE

ASTMCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)
GW	GRAVEL COVER. -LB
CL	SILTY CLAY, MINOR COARSE SAND AND GRAVEL FILL, LIGHT OLIVE BROWN (2.5Y5/3), DRY, CRUMBLY, NONPLASTIC. -LB
ML	SANDY CLAYEY SILT, PALE YELLOW (2.5Y7/3), CRUMBLY, POWDERY, DRY TO DAMP, GRADING TO WET AT 4.8'. -LB
ML	SAA, WITH INCREASING CLAY. -LB
CH	SILTY CLAY, LIGHT OLIVE BROWN (2.5Y5/4), WET, CRUMBLY, MINOR SHELLS, MOD. PLASTIC. -LB

STRATORDER

Remarks

Depth — Borehole Diameter — Drilling Problems — Weather — Time — Equipment — Water Level — -Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-VW21 TD 10.00' 1"=5.00' 1:60.00 950526 0750 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

ST14-VW21
Geologic Borehole and Well Completion Log

332204

ST14-VW20

Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

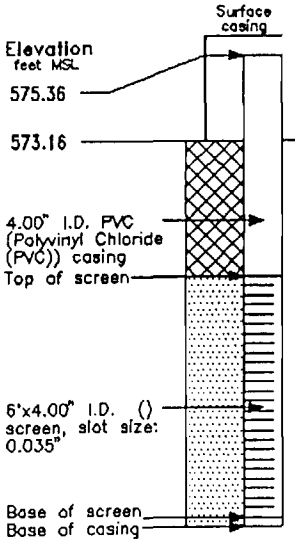
CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400375.45 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023625.74 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW20**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD / SED	SMCODE	REC%
5.00–5.60	SS	

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
GW		GRAVEL COVER. –LB	
CL		SILTY CLAY, MINOR COARSE SAND, OLIVE BROWN (2.5Y4/3), MINOR CALICHE GRAVEL. DRY, CRUMBLY, NONPLASTIC. –LB	
ML		SANDY, CLAYEY SILT, PALE YELLOW (2.5Y7/4), DRY TO DAMP, CRUMBLY, POWDERY SILT, SAND, VERY FINE GRAINED. IRON STAINED ZONE 0.1" THICK AT 3.6'. –LB	
CH		SILTY SANDY CLAY, PALE YELLOW (2.5Y7/4), MOIST, GRADING TO WET AT 5.8'. –LB	
CH		SAA, MOIST. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW20 TD 10.00' 1"=5.00' 1:60.00 950526 0749

ENGINEERING-SCIENCE, INC.
Denver, Colorado

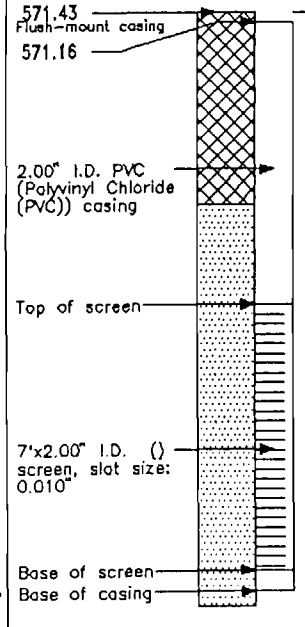
Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	01/01/90 ESTDATE	Establishing Company	ESCI ESCCODE	**CARSWELL AIR FORCE BASE**	
Northing	400218.03 ft. NCOORD	Drilling Company	RONE DRLCODE	Air Force Installation	CRSWL AFIID
Easting	2025240.12 ft. ECOORD	Drill Rig Type	HSA DRLEQP	Location Identification	**ST14-MW22** LOCID
Borehole Total Depth	15.10 ft. DEPTH	Construction Method	HS CMCCODE		

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, SED, REC%

11.00
11.20 SS

Depth

feet — Ground Surface

5
10
15

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description — SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials	STRATORDER
NA		ASPHALT. -LB	
NA		SANDY, GRAVELY FILL. -LB	
CL		SILTY CLAY, DARK BROWN (7.5YR4/4), HARD, DAMP, NONPLASTIC, MINOR SHELLS. -LB	
CL		SILTY CLAY, BROWN (10YR5/3), DAMP, CRUMBLY, NONPLASTIC. -LB	
SWSM		GRADATIONAL TO CLAYEY SILTY SAND, LIGHT YELLOWIGH BROWN (2.5Y6/3), FINE GRAINED, WELL SORTED, DAMP. -LB	
SW		SAND, LIGHT YELLOWISH BROWN (10YR6/4), WELL SORTED, FINE GRAINED, DAMP. -LB	
SP		SAND, LIGHT YELLOWISH BROWN (10YR6/4), MEDIUM TO COARSE GRAINED SAND, POORLY SORTED, WET. -LB	
GPGM		GRAVEL, POORLY SORTED. -LB	
NACM		LIMESTONE -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 10.64' (Elev. 560.79')

CRSWL ST14-MW22 TD 15.10' 1"=5.00' 1:60.00 950525 1317 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

ST14-MW23
Geologic Borehole and Well Completion Log

332188

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	09/08/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	399523.51 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2024628.13 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.60 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW23**	LOCID

Completion

Elevation feet MSL

565.11 Flush-mount casing

564.97

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

4'x2.00" I.D. () screen, slot size: 0.010"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration | SBD | SED | SMCODE | REC% | 8 | g

4.50–5.00 SS

7.50–7.70 SS

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System / ASTMCODE)	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
CL	CLAY, BLACK (5YR2.5/1), DAMP, CRUMBLY, HARD, NONPLASTIC. -LB	
CL	SILTY CLAY, GRADATIONAL COLOR TO GRAYISH BROWN (2.5Y5/2), CALICHE NODULES, HARD, DRY, NONPLASTIC. -LB	
CH	SILTY CLAY, OLIVE YELLOW (2.5Y6/6), MOIST, MOD. PLASTIC, SOFT. -LB	
SM	GRADATIONAL TO SILTY CLAYEY SAND, OLIVE YELLOW (2.5Y6/6), WET. -LB	
GPGM NACM	GRAVEL, COARSE, POORLY SORTED, WET. WEATHERED SHALEY MUDSTONE, OLIVE YELLOW (2.5Y6/6). -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather | Time / Equipment / Water Level -Initials

1.00' Borehole diameter 9" -LB

Water level at 00:01 10/05/94 7.58' (Elev. 557.53')

CRSWL ST14-MW23 TD 10.60' 1"=5.00' 1:60.00 950526 1237 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

CARSWELL AFB

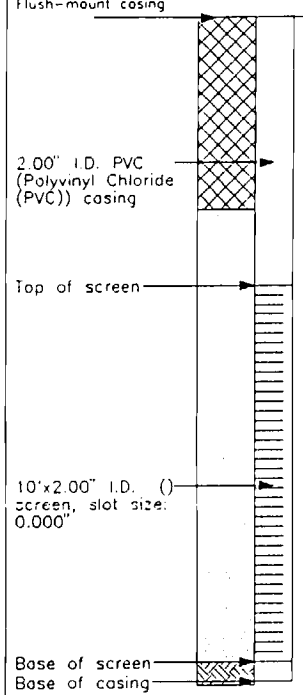
Date	03/28/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	17.30 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW24**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC% — Ground Surface

Depth

feet

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
ML		SOIL, CRUMBLY SANDY, SILTY WITH MINOR LARGE GRAVEL, POORLY SORTED. YELLOWISH BROWN (10YR5/4). -LB	
CH		CLAY, MINOR SILT, YELLOWISH BROWN (10YR5/4), BROWN AND WHITE MOTTLING. -LB	
NA		CONSOLIDATED BRECCIA LOOKING CONCRETE. -LB	
CL		CLAY, MINOR GRAVEL, LIGHT GRAY (10YR7/1), WHITE AND TAN MOTTLING, INCREASING GRAVEL CONTENT WITH DEPTH. -LB	
GM		SANDY GRAVEL, MINOR CLAY, WET, YELLOW (10YR7/8). SANDSTONE AT BOTTOM OF BARREL, CONTINUE DRILLING WITHOUT SAMPLER. -LB	
GM		NO RECOVERY. INTERMITTENT SANDSTONE LENSES. -LB	
NACM		COMPETENT LIMESTONE. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

5, 10, 15

CRSWL ST14-MW24 TD 17.30' 1"=5.00' 1:60.00 950705 0649 Sheet 1 of 1

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ST14-MW24
Geologic Borehole and Well Completion Log

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ST14-MW25

Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

CARSWELL AFB

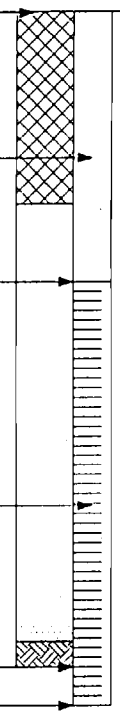
Date	03/28/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	17.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW25**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, REC%, SED

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
CL		GRAVELY CLAY, DARK GRAYISH BROWN (10YR4/2) ORANGE AND WHITE MOTTLING, STRUCTURELESS, MOD SOFT, PLASTIC. -LB	
CH		SAA WITH DECREASING GRAVEL, SOFT CLAY. -LB	
SP		GRAVELY SAND, WET, POORLY SORTED, LARGE GRAVEL FILL, UP TO 0.1FT. -LB	
SM		GRAVELY SAND, WET, VERY PALE BROWN (10YR7/3). -LB	
SC		SAA, WITH INCREASING CLAY CONTENT TO CLAY, OLIVE BROWN (2.5Y4/3), HARD, WHITE SHELL FRAGMENTS, DAMP. -LB	
NACM		LIMESTONE LAYER AT 10FT. (CONTINUE DRILLING WITHOUT SAMPLING) INTERMITTENT SANDSTONE LENSES. -LB	
NACM		COMPETENT BEDROCK. -LB	

Depth: 5, 10, 15

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, -Initials

CRSWL ST14-MW25 TD 17.00' 1"=5.00' 1:60.00 950705 0701 Sheet 1 of

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Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	04/04/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	28.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW26**	LOCID

Completion

Elevation feet MSL

Flush-mount casing

2.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

5'x2.00" I.D () screen, slot size: 0.000"

Base of screen

Sampling

Instrument Reading Penetration

SBD — SMCODE — REC%

SED

Depth

feet

Ground Surface

5

10

15

20

25

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials) STRATORDER
NA		ASPHALT AND BASE FILL. -LB
CL		SILTY CLAY, VERY DARK BROWN (10YR2/2), DAMP, MOD. SOFT, MOD PLASTIC. -LB
CL		SAA WITH INCREASING SILT, BROWN (10YR5/3), MINOR SHELLS AND FRAGMENTS -LB
CL		SILTY SANDY CLAY, BROWN (10YR5/2), MINOR SHELLS, WET. -LB
CL		SILTY CLAY, GRAYISH BROWN (10YR5/2), MINOR SHELLS, WET. -LB
CL		SILTY CLAY, BROWN (10YR5/3), DAMP TO WET, MINOR SHELLS, CRUMBLY SOFT, MOD PLASTIC. -LB
CH		SANDY CLAY, YELLOWISH BROWN (10YR5/4), DAMP TO WET, FINE GRAINED, SOFT PLASTIC. -LB
SM		SILTY SAND, WET, FINE GRAINED, WELL SORTED. -LB
SW		SAND, MOD WELL SORTED, MEDIUM GRAINED, WET -LB
		NO RECOVERY. -LB

Remarks

Depth
Borehole Diameter
Drilling Problems
Weather

Time
Equipment
Water Level
-Initials

CRSWL ST14-MW26 TD 28.00' 1"=5.00' 1:60.00 950705 0702 Sheet 1 of 2

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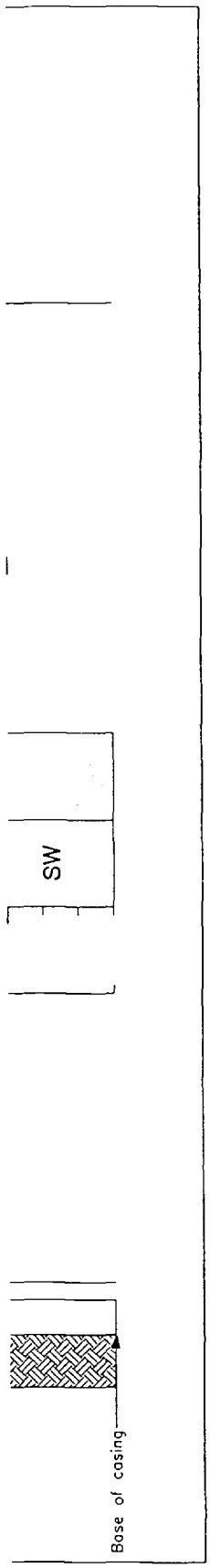
ST14-MW26
Geologic Borehole and Well Completion Log



CRSWL ST14-MW26 TD 28.00' 1"=5.00' 1:60.00 950705 0702 Sh 2 of

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ST14-MW26

Geologic Borehole and Well Completion Log *(continued)*

Geologic Borehole and Well Completion Log

CARSWELL AFB

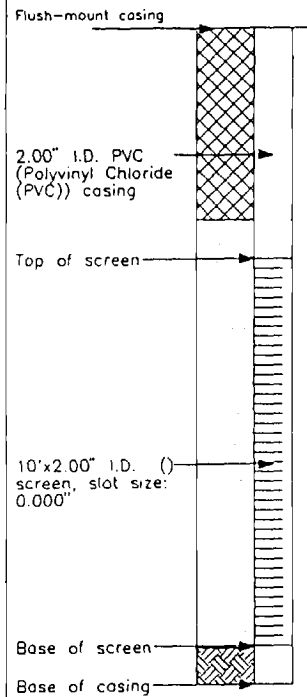
Date	03/28/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	17.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW27**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD — SMCODE — REC% — SED

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	Depth
NA		SANDY SILTY FILL MATERIAL, MINOR GRAVEL/ GRAVEL AT BOTTOM. -LB	
CL		CLAY, MINOR SILT, VERY DARK GRAYISH BROWN (10YR3/2), MOD SOFT, MOD PLASTIC, DAMP TO DRY, GRADING TO A LIGHTER CLAY BELOW. -LB	
CL		SAA, DARK BROWN (10YR4/3) INCREASING SILT, MINOR ROOTS. -LB	
CL		SILTY CLAY, INCREASING SILT CONTENT WITH DEPTH, LIGHT BROWNISH GRAY (10YR6/2) LIGHTENS WITH DEPTH, CRUMBLY, SOFT, DAMP, NONPLASTIC. -LB	5
SC		CLAYEY SAND, FINE GRAINED, BROWN (10YR5/3), WELL SORTED, WET. -LB	10
SW		SAND, GRAY (10YR5/1), FINE GRAINED, WELL SORTED, WET. -LB	
CP		INCREASING GRAVEL, POORLY SORTED. -LB	15
NACM		BEDROCK. -LB	

STRATORDER

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level — -Initials

CRSWL ST14-MW27 TD 17.00' 1"=5.00' 1:60.00 950705 0702 Sheet 1 of 1

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

ST14-MW27
Geologic Borehole and Well Completion Log

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Geologic Borehole and Well Completion Log

CARSWELL AFB

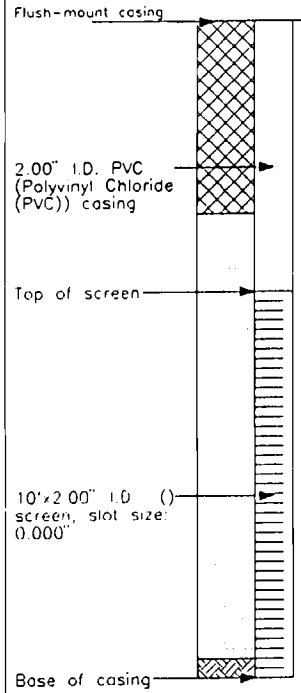
Date	03/29/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	17.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW28**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC%

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	Depth
CH		SOIL, SILTY, SANDY CLAY, WITH MINOR GRAVEL, VERY DARK GRAYISH BROWN (2.5Y3/2). CLAY IS PLASTIC, MOIST, SOFT, MOD OM. -LB	
CL		CLAY, MINOR SILT, BLACK (5Y2.5/1). O.M., HARD, MOD PLASTIC, BLOCKY STRUCTURE.-LB	
CL		SAA. GRADATIONAL COLOR FORM LIGHT OLIVE BROWN (2.5Y6/2) TO LIGHT BROWNISH GREY (2.5Y6/2). CRUMBLY, DAMP. -LB	5
CL		SAA, MOIST, INCREASING SAND CONTENT. -LB	
SM		SAND, MEDIUM GRAINED, WET, POORLY SORTED. -LB	10
GM		NO RECOVERY. SAND AND GRAVEL MIX -LB	
SP		SAND, WET, MEDIUM GRAINED, MOD SORTED, GRADING TO BELOW. -LB	15
GP		POORLY SORTED GRAVEL, LARGE PEBBLES, 0.1FT INCLUDED, VERY STRONG FUEL ODOR. -LB	
NACM		LIMESTONE SHALE, BRITTLE. -LB	

STRATORDER

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

CRSWL ST14-MW28 TD 17.00' 1"=5.00' 1:60.00 950705 0703 Sheet 1 of

ST14-MW28

Geologic Borehole and Well Completion Log

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PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado (303) 831-8100

Geologic Borehole and Well Completion Log

CARSWELL AFB

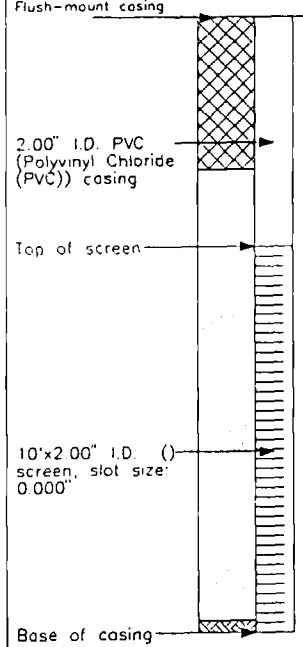
Date	03/28/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	16.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW29**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD — SMCODE — REC% — SED

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing -Initials)	Depth
NA		SOIL, OM FILL MATERIAL (GRAVEL) VERY DARK GREY (10YR3/2). -LB	
CH		CLAY, MINOR GRAVEL, OM, VERY DARK GREYISH BROWN (10YR3/2), MOD SOFT, PLASTIC, DAMP. -LB	
CL		SILTY CLAY, VERY MINOR GRAVEL, DARK GRAYISH BROWN (10YR4/2), MOD PLASTIC, CRUMBLY, MOD HARD, DAMP. -LB	
CL		SILTY CLAY, SHELL FRAGMENTS, YELLOWISH BROWNISH BROWN (10YR5/4), CRUMBLY, NON PLASTIC, SLT ODOR. -LB	5
CL		SILTY CLAY, INCREASING SAND, LIGHT OLIVE BROWN (2.5Y5/3), MOD PLASTIC, DAMP, MINOR CALICHE PEBBLES. -LB	
CL		SANDY CLAY TO SAND, LIGHT OLIVE BROWN (2.5Y5/3). -LB	
SW		SAND, LIGHT BROWNISH GREY (2.5Y6/2), BROWN (2.5Y5/3). -LB	
SW		SAND, LIGHT OLIVE BROWN (2.5Y5/3), FINE GRAINED, DAMP, WELL SORTED, LIGHT OLIVE FINE GRAINED, WET, GRADING TO COARSE GRAVEL MIX, SHEEN ON WATER. -LB	10
NA		NO RECOVERY. GRAVEL POORLY SORTED -LB	
NACM		BEDROCK. -LB	15

STRATORDER

Remarks

Depth
Borehole Diameter
Drilling Problems
Weather

Time
Equipment
Water Level
-Initials

CRSWL ST14-MW29 TD 16.00' 1"=5.00' 1:60.00 950705 0703 Sheet 1 of 1

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ST14-MW29
Geologic Borehole and Well Completion Log

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Geologic Borehole and Well Completion Log

CARSWELL AFB

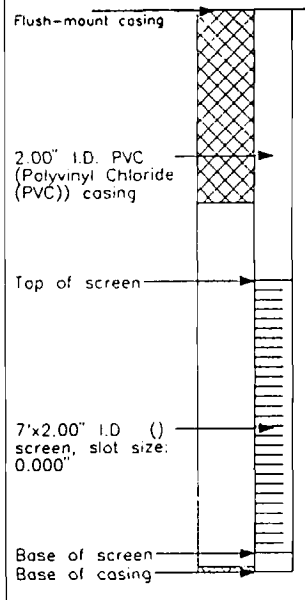
Date	03/28/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	14.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW30**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SED — SMCODE — REC% — 8" — 8"

Depth

feet — Ground Surface

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
CH		SOIL, HIGH CLAY CONTENT, MINOR GRAVEL, DARK YELLOWISH BROWN (10YR4/4). -LB	
CH		CLAY, MINOR SILT AND OM, DARK BROWN (10YR3/3), HARD, DAMP, CRUMBLY, MOD PLASTIC, GRADING TO A BROWN (10YR5/3) WITH CALICHE PEBBLES. -LB	
CL		SILTY CLAY, MINOR SAND CONTENT INCREASING TO SANDY CLAY AT DEPTH, BROWNISH YELLOW (10YR6/6), DAMP TO MOIST, INCREASING TO MOIST AT DEPTH. -LB	
SP		SANDY GRAVEL, GRAY (10YR5/1), VERY POORLY SORTED, CLAY FILLING/HARD, WET. -LB	
GPGM		GRAVEL, POORLY SORTED,WET. -LB	
NACM		NO RECOVERY, BEDROCK, BRITTLE LIMESTONE. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather — Time, Equipment, Water Level -Initials

CRSWL ST14-MW30 TD 14.50' 1"=5.00' 1:60.00 950705 0930 Sher of

ST14-MW30

Geologic Borehole and Well Completion Log

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado (303) 831-8100

Geologic Borehole and Well Completion Log

CARSWELL AFB

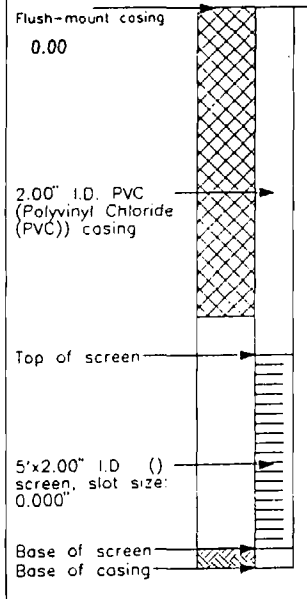
Date	03/29/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	14.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW31**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD / SED — SMCODE — REC% — 50 — 55

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	Depth
NA		ASPHALT. -LB	
		BASE FILL. -LB	
CL		SILTY CLAY, DARK BROWN, (7.5YR3/3). HARD, NONPLASTIC, MINOR SMALL PEBBLES, BLOCKY STRUCTURE, MOD CRUMBLY, DAMP TO DRY, MINOR OM, GRADATIONAL COLOR YELLOWISH BROWN (10YR4/4) TO DARK. -LB	
CL		SAA, GRADATIONAL WITH INCREASING SILT -LB	5
ML		SANDY SILT, VERY FINE GRAINED SAND, GRADATIONAL TO SAND, DAMP. -LB	
SP		SAND, MINOR SILT, POORLY SORTED MEDIUM GRAINED, YELLOWISH BROWN (10YR5/6), DAMP. -LB	
SP		SAA, INCREASING WATER WITH DEPTH. -LB	10
GP		COARSE GRAINED GRAVEL MIX, WET, POORLY SORTED, INCREASING COARSE WITH DEPTH -LB	
NACM		BEDROCK, SOLID HARD LIMESTONE. -LB	

STRATORDER

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

CRSWL ST14-MW31 TD 14.50' 1"=5.00' 1:60.00 950705 0931 Sheet 1 of 1

ST14-MW31

Geologic Borehole and Well Completion Log

332197

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado (303) 831-8100

Geologic Borehole and Well Completion Log

CARSWELL AFB

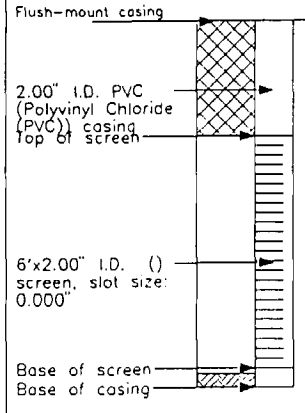
Date	03/29/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	9.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MW32**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
OL		SOIL, SILTY CLAY WITH GRAVEL, OM ROOTS, DARK REDDISH BROWN (5YR3/2). -LB	
CL		SILTY CLAY, INCREASING SAND, VERY DARK GRAY (5YR3/1), PLASTIC, SOFT, MOIST TO WET, INCREASING SAND, SLIGHT ODOR TO CORE. -LB	
GP		SANDY GRAVEL, COARSE GRAINED LARGEST GRAVEL 0.01FT, GRADATIONAL TO LARGER GRAVEL, SLIGHT ODOR TO CORE. -LB	
GPGM		COARSE, POORLY SORTED GRAVEL, PEBBLES TO 0.03FT, RIVER ALLUVIUM DEPOSITS. -LB	
NACM		BEDROCK, HARD LIMESTONE. -LB	

5

Remarks

Depth
Borehole Diameter
Drilling Problems
Weather

Time
Equipment
Water Level
-Initials

CRSWL ST14-MW32 TD 9.50' 1"=5.00' 1:60.00 950705 D704 Sheet 1 o

PARSONS ENGINEERING SCIENCE, Inc.
Denver, Colorado (303) 831-8100

Geologic Borehole and Well Completion Log
ST14-MW32

3331188

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400353.38 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023738.15 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	6.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MPD**	LOCID

Completion

Elevation feet MSL: 572.64

Sampling

Instrument Reading Penetration — SBO, SED — SMCODE — REC%

3.00 – 3.20 SS

Depth

feet — Ground Surface

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVEL COVERING. -LB	
CL		SILTY CLAY, GRAYISH BROWN (2.5Y5/2) MINOR GRAVEL, SAND, FILL MATERIAL. -LB	
ML		SANDY CLAYEY SILT, PALE YELLOW (2.5Y7/4), CRUMBLY, POWDERY, DAMP. -LB	
ML		SAA, MOIST. -LB	
CH		SILTY CLAY, LIGHT BROWNISH GRAY (10YR6/2), MOIST, CRUMBLY, MOD. PLASTIC. -LB	

5

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather — Time, Equipment, Water Level -Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-MPD TD 6.00' 1"=5.00' 1:60.00 950526 1408 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

ST14-MPD
Geologic Borehole and Well Completion Log

332199

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400372.09 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023734.91 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	8.30 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-MPE**	LOCID

Completion	Sampling	Depth (feet)	Lithology: USCS / ASTMCODE	Lithologic Symbols & Codes	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER	Remarks (Depth, Borehole Diameter, Drilling Problems, Weather; Time, Equipment, Water Level -Initials)
Elevation feet MSL: 572.71	Instrument Reading, Penetration; SBD, SED; SMCODE; REC%	Ground Surface	GW		GRAVEL COVERING. -LB		
			CL		SILTY CLAY, MINOR GRAVEL/SAND FILL, LIGHT OLIVE BROWN (2.5Y5/3), CRUMBLY DRY, NONPLASTIC. -LB		1.00' Borehole diameter 9" -LB
	3.50 SS 3.70		ML		SANDY, CLAYEY SILT, PALE YELLOW (2.5Y8/3), DAMP. -LB		
		5	ML		SAA, WET AT 5.3'. -LB		
			CL		SILTY CLAY, GRAYISH BROWN (10YR5/2), MOIST, NONPLASTIC, CRUMBLY. -LB		

CRSWL ST14-MPE TD 8.30' 1"=5.00' 1:60.00 950526 1408 S

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ST14-MPE
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

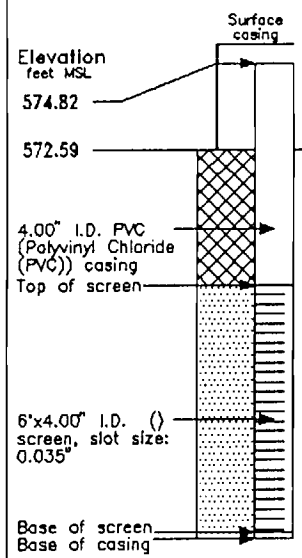
CARSWELL AFB

Date	08/25/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400306.88 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023855.11 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW22**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD / SED	SMCODE	REC%
1.00–1.20	SS	
5.90–6.50	SS	

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
GW		GRAVEL COVERING. –LB	
CL		SILTY SANDY CLAY, MINOR GRAVEL, DARK GRAY (5Y4/1), CRUMBLY, DRY, SLT. ODOR TO CORE, MINOR SHELLS. –LB	
ML		SANDY SILT, PALE OLIVE (5Y6/3), POWDERY VERY FINE SAND, DAMP. –LB	
CH	1.00	SILTY SANDY CLAY, OLIVE (5Y6/3), CRUMBLY, VERY FINE SAND, DAMP TO MOIST. –LB	
CH		SILTY SANDY CLAY, DARK GRAY (5Y4/1), WET, MINOR SHELLS, CRUMBLY. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW22 TD 10.00' 1"=5.00' 1:60.00 950526 0750

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ST14-VW22
Geologic Borehole and Well Completion Log

9322306

Geologic Borehole and Well Completion Log

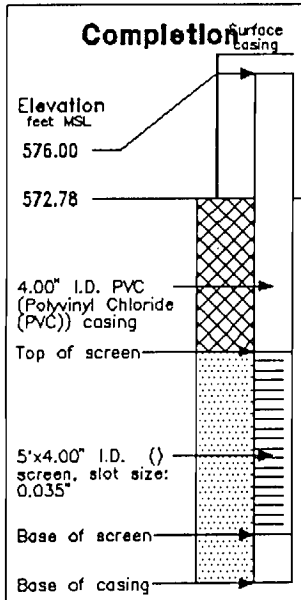
CARSWELL AFB

Date	08/25/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400359.64 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023933.72 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW23**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

1.00 – 1.20 SS

6.20 – 6.40 SS

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVEL COVERING. -LB	
CL		SILTY CLAY, MINOR SAND, VERY DARK GRAY (10YR3/2), COARSE GRAINED SAND, CRUMBLY, DRY, NONPLASTIC. -LB	
ML		SANDY CLAYEY SILT, VERY PALE BROWN (10YR7/3), VERY FINE GRAINED, DRY, CRUMBLY, MINOR SHELLS. -LB	
CH		SILTY SANDY CLAY, LIGHT OLIVE BROWN (2.5Y5/3), MINOR SHELLS, MOIST, CRUMBLY, FISSILE. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, -Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-VW23 TD 10.00' 1"=5.00' 1:60.00 950526 0750 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

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ST14-VW23
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

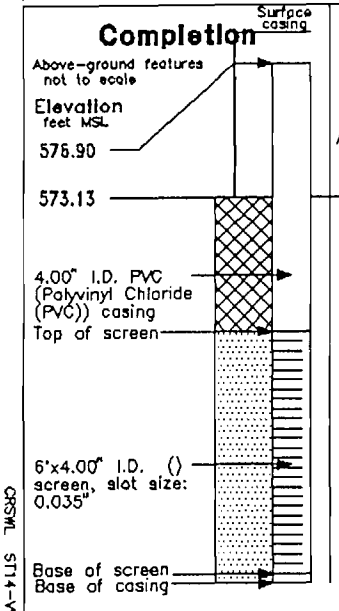
CARSWELL AFB

Date	08/25/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400442.19 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023927.00 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW24**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD — SMCODE — REC% — SED

6.90 — 7.10

Depth

feet

Ground Surface

5

10

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description *SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials*	STRATORDER
GW		GRAVEL COVER. –LB	
CL		SILTY CLAY, MINOR GRAVEL, VERY DARK GREY (10YR3/1), MINOR COARSE GRAINED SAND, DRY, CRUMBLY, NONPLATIC. –LB	
ML		GRADATIONAL TO SANDY CLAYEY SILT, DARK GRAY (10YR4/1), VERY FINE GRAINED, CRUMBLY, POWDERY, DRY. –LB	
SM		GRADATIONAL TO SILTY, CLAYEY SAND, BROWN (10YR5/3), CRUMBLY, POWDERY, MOIST. –LB	
CH		SILTY CLAY, BROWN (10YR5/3), WET, MINOR SHELLS, FISSILE. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW24 TD 10.00' 1"=5.00' 1:60.00 950526 0751 St

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ST14-VW24
Geologic Borehole and Well Completion Log

8223

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	08/25/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400455.73 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023834.48 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW25**	LOCID

Completion

Surface casing

Elevation feet MSL

576.51

573.27

4.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

6'x4.00" I.D. () screen, slot size: 0.035"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration

SBD

SMCODE

REC%

SED

1.00
1.20

6.70
6.90

Depth

feet

Ground Surface

5

10

Lithology

USCS Unified Soil Classification System ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
GW		GRAVEL COVERING. -LB	
CL		SILTY CLAY, MINOR COARSE SAND, VERY DARK GRAY (5YR3/1), DRY, HARD, NONPLASTIC. -LB	
ML		SANDY CLAYEY SILT, PALE YELLOW (2.5Y7/4), VERY FINE GRAINED, POWDERY, CRUMBLY, DRY, MINOR SHELLS. -LB	
ML		SAA, INCREASING CLAY. -LB	
CH		SILTY SANDY CLAY, PALE YELLOW (2.5Y7/3), CRUMBLY, WET. -LB	

Remarks

Depth
Borehole Diameter
Drilling Problems
Weather

Time
Equipment
Water Level
-Initials

1.00' Borehole diameter 9" -LB

CRSWL ST14-VW25 TD 10.00' 1"=5.00' 1:60.00 950526 0751 Sheet 1 of 1

ENGINEERING-SCIENCE, INC.
Denver, Colorado

ES

ST14-VW25
Geologic Borehole and Well Completion Log

Geologic Borehole and Well Completion Log

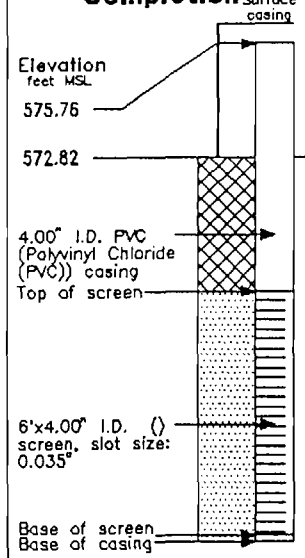
CARSWELL AFB

Date	08/25/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400381.18 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023834.92 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW26**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD / SED	SMCODE	REC%
1.00–1.20	SS	
5.20–6.10	SS	

Depth

feet

Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
GW		GRAVEL COVERING. –LB	
CL		SILTY CLAY, MINOR COARSE SAND, DARK OLIVE GRAY (5Y3/2), DRY, CRUMBLY, NONPLASTIC. –LB	
ML		SANDY CLAYEY SILT, PALE YELLOW (5Y8/3), VERY FINE GRAINED, DRY, POWDERY, CRUMBLY, MINOR SHELLS. –LB	
CH		SAA, GRADATIONAL TO SILTY SANDY CLAY. –LB	
CH		SAA, MOIST TO WET –LB	
CH		SAA, SILTY SANDY CLAY, LIGHT YELLOWISH BROWN (2.5Y6/3), WET. –LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather / Time / Equipment / Water Level –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW26 TD 10.00' 1"=5.00' 1:60.00 950526 0752

ST14-VW26

Geologic Borehole and Well Completion Log

0122210

ENGINEERING-SCIENCE, INC.
Denver, Colorado

Geologic Borehole and Well Completion Log

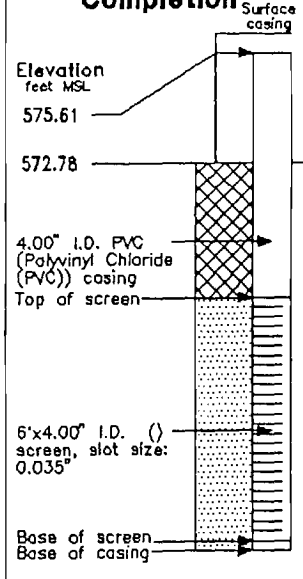
CARSWELL AFB

Date	08/26/94	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	400275.91 ft.	NCOORD	Drilling Company	RONE	DRLCODE
Easting	2023919.56 ft.	ECOORD	Drill Rig Type	HSA	DRLEQP
Borehole Total Depth	10.00 ft.	DEPTH	Construction Method	HS	CMCCODE

CARSWELL AIR FORCE BASE

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW27**	LOCID

Completion



Sampling

Instrument Reading Penetration

SBD — SMCODE — RECX — SED

7.20–7.40 SS

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. –Initials)	STRATORDER
GW		GRAVEL COVERING. –LB	
CL		SILTY CLAY, MINOR COARSE SAND/GRAVEL, VERY DARK GRAY (10YR3/1), DRY, CRUMBLY, NONPLASTIC. –LB	
ML		SANDY CLAYEY SILT, DARK GRAY (5Y4/1), POWDERY FINE SAND AND SILT, DRY, CRUMBLY. WET AT 5.2. –LB	
CH		SILTY CLAY, MINOR SHELLS, GRAYISH BROWN (10YR5/2). CRUMBLY, WET TO MOIST. –LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather — Time, Equipment, Water Level –Initials

1.00' Borehole diameter 9" –LB

CRSWL ST14-VW27 TD 10.00' 1"=5.00' 1:60.00 950526 0752 Sheet 1 of 1

ST14-VW27

Geologic Borehole and Well Completion Log

ENGINEERING-SCIENCE, INC.
Denver, Colorado
ES

Geologic Borehole and Well Completion Log

CARSWELL AFB

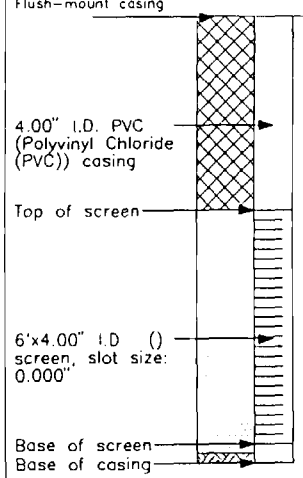
Date	03/31/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	11.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW28**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, REC%, SED

Depth

feet — Ground Surface

Lithology

Depth (feet)	USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
	CL		CLAY, MINOR OM, VERY DARK GREY (5YR3/1), NONPLASTIC, HARD, DAMP. -LB	
	CL		SILTY CLAY, LIGHT OLIVE BROWN (2.5Y5/3), CRUMBLY, DRY. -LB	
5	CL		SAA, WITH INCREASING SAND. -LB	
	SC		SILTY CLAYEY SAND, GRAYISH BROWN (2.5Y5/2), DAMP, FINE GRAINED, WELL SORTED, POWDERY SILT. -LB	
	SP		SAND, MINOR SILT, LIGHT YELLOWISH BROWN (10YR6/4), COARSE GRAINED MIX, POORLY SORTED, WET. -LB	
10	SP		SAA, WITH INCREASING GRAVEL, WET. -LB	
	SC		CLAYEY SAND, GREY (2.5YN5/), SOFT PLASTIC, WET. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

CRSWL ST14-VW28 TD 11.50' 1"=5.00' 1:60.00 950705 0705 Sheet 1 of 1

ST14-VW28

Geologic Borehole and Well Completion Log

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

33212

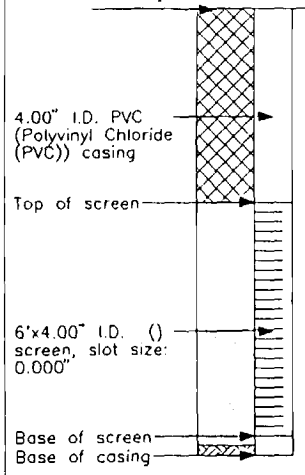
Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	03/31/95 ESTDATE	Establishing Company	ESCI ESCCODE	**Carswell Air Force Base**	
Northing	0.00 ft. NCOORD	Drilling Company	DRLCODE	Air Force Installation	CRSWL AFIID
Easting	0.00 ft. ECOORD	Drill Rig Type	DRLEQP	Location Identification	**ST14-VW29** LOCID
Borehole Total Depth	11.50 ft. DEPTH	Construction Method	HS CMCCODE		

Completion

Elevation feet MSL



Sampling

Instrument Reading / Penetration — SBD / SED — SMCODE — REC.%

Depth feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
SC		CLAY, MINOR SILT, VERY DARK GREY (2.5YN3/), DRY, CRUMBLY, NONPLASTIC -LB	
CL		SAA, WITH INCREASING SILT. -LB	
CL		CLAYEY SILT, MINOR SAND, INCREASING WITH DEPTH, GREYISH BROWN (2.5Y5/2), DRY, POWDERY SILT. -LB	
SM		SILTY SAND, GREYISH BROWN (2.5Y5/2), DAMP SOFT POWDERY SILT, SAND MEDIUM GRAINED, WELL SORTED. -LB	
SP		SAND, MOIST TO WET, COARSE GRAINED, POORLY SORTED, COARSE GRADING TO SANDY GRAVEL. -LB	
GP		SANDY GRAVEL, WET. -LB	

Remarks

Depth / Borehole Diameter / Drilling Problems / Weather — Time / Equipment / Water Level -Initials

CRSWL ST14-VW29 TD 11.50' 1"=5.00' 1:60.00 950705 0705 Sheet 1 of

ST14-VW29

Geologic Borehole and Well Completion Log

PARSONS ENGINEERING SCIENCE, IN

Denver, Colorado (303) 831-8100

33221.3

Geologic Borehole and Well Completion Log

CARSWELL AFB

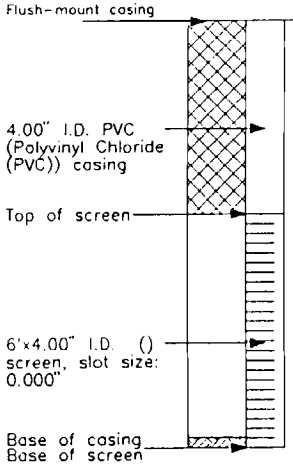
Date	03/31/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	11.00 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW30**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, SED, REC%

Depth

feet — Ground Surface

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
CL		SILTY CLAY, DARK GRAYISH BROWN (2.5Y4/2), HARD, DRY, NONPLASTIC, MINOR ROOTS, OM -LB	
CL		INCREASING SILT, GRAYISH BROWN (2.5Y5/2), MINOR CLAICHE PEBBLES, NONPLASTIC ORANGE AND GREY MOTTLING, MINOR ODOR. -LB	
CL		SAA, INCREASING SAND CONTENT, VERY FINE GRAINED SAND AND SILT. -LB	
SW		SAND, COARSE GRAINED, WELL SORTED, DRY TO DAMP. -LB	
SP		SAND, POORLY SORTED, WET. -LB	
SPGM		GRAVEL, POORLY SORTED, RANGE TO 0.02FT, WET. -LB	
NACM		COMPETENT LAYER. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

ST14-VW30

Geologic Borehole and Well Completion Log

CRSWL ST14-VW30 TD 11.00' 1"=5.00' 1:60.00 950705 0705 Sheet 1 of 1

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 331-8100

332214

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	03/31/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	12.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW31**	LOCID

Completion

Elevation feet MSL

Flush-mount casing

4.00" I.D. PVC (Polyvinyl Chloride (PVC)) casing

Top of screen

7'x4.00" I.D. () screen, slot size: 0.000"

Base of screen

Base of casing

Sampling

Instrument Reading Penetration — SBD, SMCODE, SED — RECOVERY

Depth

feet

Ground Surface

5

10

Lithology

USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
NA		ASPHALT AND FILL MIX. -LB	
NA		CLAYEY MUDDY FILL MATERIAL, LARGE GRAVEL, SILTY SAND. -LB	
NA		FILL MATERIAL. -LB	
		TARPAPER, WET, HEAVY ODOR. -LB	
NA		FILL MATERIAL.WET AT 11.7FT. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

CRSWL ST14-VW31 TD 12.50' 1"=5.00' 1:60.00 950705 0706 Sheet 1 of 1

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

ST14-VW31
Geologic Borehole and Well Completion Log

332215

Geologic Borehole and Well Completion Log

CARSWELL AFB

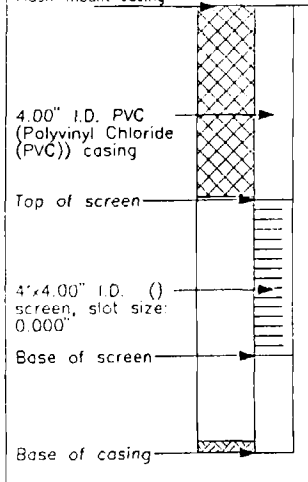
Date	04/03/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	11.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-VW32**	LOCID

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, SED, REC%

Depth

feet — Ground Surface

Lithology

Depth (feet)	USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER
	NA		ASPHALT AND BASE GRAVEL. -LB	
	CL		SILTY CLAY, BLACK (10YR2/1), HARD, NONPLASTIC, BLOCK STRUCTURE, DRY. -LB	
	CL		SAA, WITH INCREASING CALICHE CONTENT AND SILT. SILTY CLAY, GRAYISH BROWN (10YR5/2), CRUMBLY, DRY, HARD, NON-PLASTIC, DAMP. -LB	
5	CL		SAA, WITH INCREASING SAND. -LB	
	CL		SANDY SILTY CLAY, OLIVE GRAY (5Y5/2), DRY. -LB	
	SM		SILTY SAND, MINOR GRAVEL, POWDERY SILT, PALE OLIVE (5Y6/30), MED GRAINED, WELL TO MODERATELY SORTED. -LB	
10	SW		SAND, MEDIUM GRAINED, MINOR SMALL PEBBLES, DAMP, WELL TO MOD SORTED. -LB	
	SW		SAA, GRADING DOWN TO A SANDY GRAVEL, WET. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level -Initials

CRSWL ST14-VW32 TD 11.50' 1"=5.00' 1:60.00 950705 2706 Sheet 1 of 1

ST14-VW32

Geologic Borehole and Well Completion Log

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

332216

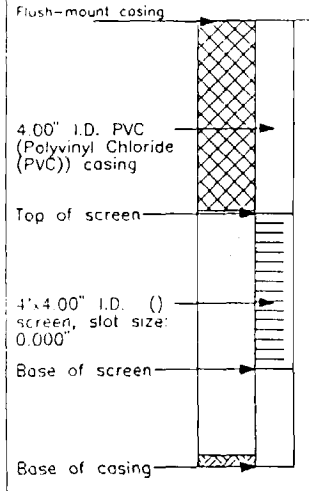
Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	04/03/95 ESTDATE	Establishing Company	ESCI ESCCODE	**Carswell Air Force Base**	
Northing	0.00 ft. NCOORD	Drilling Company	DRLCODE	Air Force Installation	CRSWL AFIID
Easting	0.00 ft. ECOORD	Drill Rig Type	DRLEQP	Location Identification	**ST14-VW33** LOCID
Borehole Total Depth	11.50 ft. DEPTH	Construction Method	HS CMCCODE		

Completion

Elevation feet MSL



Sampling

Instrument Reading Penetration — SBD, SMCODE, SED — REC% (8 / 5)

Depth

feet — Ground Surface

Lithology

Depth (feet)	USCS (Unified Soil Classification System) / ASTMCODE	Lithologic Symbols & Codes / LITHCODE	Description (SOIL/ROCK TYPE, modifiers, grain size, sorting, color, cement/lithification, moisture content, porosity, permeability, fracturing. -Initials)	STRATORDER
	NA		ASPHALT AND BASE FILL. -LB	
	CH		SILTY SANDY CLAY, LIGHT OLIVE BROWN (2.5Y5/3), LITTLE TO NO ODOR. -LB	
5	SC		SILTY CLAYEY SAND GRADING TO A SAND, LIGHT OLIVE BROWN (2.5Y5/3), DAMP, MEDIUM GRAINED, MINOR PEBBLES. -LB	
	SW		SAND, MEDIUM GRAINED, MOD TO POORLY SORTED, DRY. -LB	
	SW		GRAVELY SAND, POORLY SORTED, DRY, SLIGHT ODOR. -LB	
10	GPGM		GRAVEL, POORLY SORTED, WET, HEAVY ODOR TO WET ZONE. -LB	

Remarks

Depth, Borehole Diameter, Drilling Problems, Weather, Time, Equipment, Water Level, -Initials

CRSWL ST14-VW33 TD 11.50' 1"=5.00' 1.60.00 950705 07CE Sheet 1 of

ST14-VW33

Geologic Borehole and Well Completion Log

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

332217

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	03/31/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	11.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-SB1**	LOCID

Completion	Sampling	Depth (feet)	Lithology: USCS (Unified Soil Classification System) ASTMCODE	Lithologic Symbols & Codes LITHCODE	Description (SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials)	STRATORDER	Remarks: Depth, Borehole Diameter, Drilling Problems, Weather	Remarks: Time, Equipment, Water Level -Initials
Elevation feet MSL	Instrument, Reading, Penetration; SBD, SMCODE, REC%, SED	Ground Surface						
0.00			NA		ASPHALT -LB			
			NA		BASE FILL. -LB			
			CL		CLAY, DARK BROWN (7.5Y3/2), HARD, NONPLASTIC, DAMP, MINOR GRAVEL. -LB			
			CL		SILTY CLAY, MINOR SHELLS, HARD, NONPLASTIC, FLAKEY CALICHE, LIGHT OLIVE BROWN (2.5Y5/3). -LB			
		5	CL		SAA, INCREASING SAND, MINOR GRAVEL TO SILTY SANDY CLAY, BROWNISH YELLOW (10YR6/6). -LB			
			SC		GRADATIONAL SAND TO CLAYEY SILTY SAND -LB			
			SW		SAND, FINE GRAINED, WELL SORTED, DRY -LB			
		10	SW		SAA, WITH INCREASING GRAVEL CONTENT WET AT 11.2. -LB			

CRSWL ST14-SB1 TD 11.50' 1"=5.00' 1:60.00 950706 0722 Sheet 1 of 1

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

ST14-SB1
Geologic Borehole and Well Completion Log

332218

Geologic Borehole and Well Completion Log

CARSWELL AFB

Date	03/31/95	ESTDATE	Establishing Company	ESCI	ESCCODE
Northing	0.00 ft.	NCOORD	Drilling Company		DRLCODE
Easting	0.00 ft.	ECOORD	Drill Rig Type		DRLEQP
Borehole Total Depth	11.50 ft.	DEPTH	Construction Method	HS	CMCCODE

Carswell Air Force Base

Air Force Installation	CRSWL	AFIID
Location Identification	**ST14-SB2**	LOCID

Completion	Sampling	Depth	Lithology			Remarks
Elevation feet MSL	Instrument Reading / Penetration; SBD, SED, SMCODE, REC%	feet; Ground Surface	USCS Unified Soil Classification System (ASTMCODE); Lithologic Symbols & Codes (LITHCODE)	Description: SOIL/ROCK TYPE, modifiers/grain size, sorting, color, cement/lithification, moisture content, porosity, permeability/fracturing. -Initials	STRATORDER	Depth, Borehole Diameter, Drilling Problems, Weather; Time, Equipment, Water Level -Initials
0.00			NA	ASPHALT. -LB		
			CL	SILTY CLAY, HARD, NONPLASTIC, DAMP TO DRY, BLACK (10YR2/1). -LB		
		5	CL	SILTY CLAY, CALICHE PEBBLES, DARK GRAYISH BROWN (10YR4/2), DRY, NONPLASTIC, CRUMBLY. -LB		
			SM	SILTY SAND, MED GRAINED, GRAYISH BROWN (10YR5/2), WELL SORTED WITH SHELL FRAGMENTS. -LB		
			SM	SAND, BROWNISH YELLOW (10YR6/6), POORLY SORTED WITH SHELL FRAGMENTS-LB		
		10	SP	SAA, WITH INCREASING GRAVEL CONTENT. WET AT 11.2FT. -LB		

CRSWL ST14-SB2 TD 11.50' 1"=5.00' 1:60.00 965706 0723 Sheet 1 of 1

PARSONS ENGINEERING SCIENCE, INC
Denver, Colorado (303) 831-8100

ST14-SB2
Geologic Borehole and Well Completion Log

332219

APPENDIX C

WELL SURVEY REPORT

332221

GEOSOURCE INCORPORATED

ENVIRONMENTAL DATA, RESEARCH & MAPPING SERVICES

WATER WELL REVIEW

SITE:

NAS FT WORTH JRB
FT WORTH, TEXAS
PROJECT# 725520.04000

CLIENT:

PARSONS ENGINEERING & SCIENCE

Geosource Incorporated · 1000 West Ave., Suite A · Austin, Texas 78701 · ph (512)474-6721 fax (512)474-5428

332222

Geosource Incorporated

September 8, 1995 Project# 725520.04000

Leigh Benson
Parsons Engineering & Science
1700 Broadway, Suite 900
Denver, Colorado 80290

In re: Water well search for a site in Tarrant County: NAS Ft Worth JRB, Ft Worth, Texas.

Dear Ms. Benson,

Geosource Incorporated (GI) has performed a water well search for a site in Tarrant County. GI utilized the following steps for this project:

1. Locate all located and plotted water wells on TWDB (Texas Water Development Board) County highway maps onto a map provided by GI within the area of review (AOR).

   Locate all located water wells on TWDB USGS (United States Geological Survey) 7.5 minute topo maps onto the map provided by GI.

2. Research well schedules of located and plotted wells found on the TWDB water well maps at the TNRCC (Texas Natural Resources Conservation Commission) central records.

3. Research well schedules of partially numbered water wells within the plotted water well files at the TNRCC central records within the AOR.

Note: A set of files named "unplotted wells" exist for every county. Within these files are well logs which have no location information. The TWDB does not assign a state id. no. to these wells considering that location information is not available. These files date back to 1966. GI did not search through these files due to the fact that many of the logs have little or no location information. if you feel that these files should be examined, GI will search the files per your request.

GI has enclosed the map and well records for your review. The following is a brief explanation of terms:

Plotted water wells - wells whose location has been taken from water well drillers logs. Since June of 1986 the TWDB has stopped locating these wells on their county highway maps. The accuracy of the location for these wells was dependent on the driller. Drillers logs that are currently being processed are given a partial well number where by the well is identified within a 2.5 minute quadrangle (within a 7.5 minute topo). There are also wells which have duplicate well numbers. These wells are supposedly in or around the original well location. (Examples; of a plotted well number is 10-10-5A, of a partial well number 10-10-4)

1000 WEST AVENUE · SUITE A · AUSTIN, TEXAS 78701-2019
512-474-6721 · FAX: 512-474-5428

Located water wells - wells whose location has been verified on site by a TWDB or USGS staff member. Often times when a well is located on the ground it ends up being a plotted well. In such cases the plotted water well becomes located well. (Example of a located well number is 12-34-654)

GI identified no wells within the area of review.

GI's research of water wells within the AOR was a search of the maps at the TWDB and the records within the TNRCC central records files at the time of the search. GI may not be able to account for logs not within the files of the TNRCC central records files. Also, due to the fact that some water well logs are not submitted by drillers and the unaccountability of privately drilled water wells, GI is unable to provide 100% of the data in the AOR.

If you have any questions concerning this project or need additional information, please call me at 512 474 6721.

Sincerely,

Eloy Del Bosque
Enclosures

LEGEND

- ● WELL LOCATION
- ★ SITE LOCATION

APPROXIMATE LOCATIONS ONLY

WATER WELL LOCATION MAP
WELLS WITHIN A 1/2 MILE RADIUS

NAS FT. WORTH JRB
TARRANT CO., TEXAS

USGS 7.5 MINUTE QUADRANGLE

LAKE WORTH (1982)

Geosource, Inc.
ENVIRONMENTAL DATA and RESEARCH

1000 WEST AVE., SUITE A
AUSTIN, TEXAS 78701
512-474-6721 FAX: 512-474-5428

332225

NOTE: THE FOLLOWING WELL LOGS ARE FOR YOUR REVIEW. THEY DO NOT APPEAR ON YOUR LOCATION MAP OR WITHIN YOUR REPORT. THE WELL LOGS HAVE INCOMPLETE LOCATION INFORMATION.

T.D.M. WELL

Please use black ink.
Send original copy by certified mail to the Texas Water Commission P.O. Box 13087 Austin, Texas 78711

State of Texas
WATER WELL REPORT
ATTENTION OWNER: *Confidentiality Privilege Notice on Reverse Side*

Texas Water Well Drillers Board
P.O. Box 13087
Austin, Texas 78711

332226

1) OWNER LAWRENCE BROWN (Name) Address 1701 GLENWICK FORT WORTH, TEX 76114 (Street or RFD) (City) (State) (Zip)

2) LOCATION OF WELL: County TARRANT 1 miles in NORTH (N.E., S.W., etc.) direction from C.H. IN RIVER OAKS (Town)

Driller must complete the legal description to the right with distance and direction from two intersecting section or survey lines, or he must locate and identify the well on an official Quarter- or Half-Scale Texas County General Highway Map and attach the map to this form.

☐ Legal description:
Section No. _____ Block No. _____ Township _____
Abstract No. _____ Survey Name _____
Distance and direction from two intersecting section or survey lines _____

☒ See attached map.

3) TYPE OF WORK (Check): ☒ New Well ☐ Deepening ☐ Reconditioning ☐ Plugging

4) PROPOSED USE (Check): ☒ Domestic ☐ Industrial ☐ Monitor ☐ Public Supply ☒ Irrigation ☐ Test Well ☐ Injection ☐ Other _____

5) DRILLING METHOD (Check): ☐ Driven ☒ Mud Rotary ☐ Air Hammer ☐ Jetted ☐ Bored ☐ Air Rotary ☐ Cable Tool ☐ Other _____

6) WELL LOG:
Date Drilling:
Started MAR 25 19 87
Completed MAR 26 19 87

DIAMETER OF HOLE Dia. (in.)	From (ft.)	To (ft.)
	Surface	
7 7/8		265

7) BOREHOLE COMPLETION: ☐ Open Hole ☐ Straight Wall ☐ Underreamed ☒ Gravel Packed ☐ Other _____
If Gravel Packed give interval . . . from 265 ft. to 210 ft.

From (ft.)	To (ft.)	Description and color of formation material
0	8	TOPSOIL
8	14	RED CLAY
14	30	YELLOW CLAY
30	42	LIME ROCK
42	61	LIME - SHALE STREAKS
61	66	SHALE HARD - LIME
66	77	LIME
77	84	SHALE
84	111	LIME
111	121	SANDY SHALE
121	161	LIME
161	173	SHALE
173	190	BROKEN SAND
190	210	SHALE
210	222	SAND STREAKS - SHALE
222	265	SAND

(Use reverse side if necessary)

RECEIVED MAY 11 87 Texas Water Commission

8) CASING, BLANK PIPE, AND WELL SCREEN DATA:

Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mgf., if commercial	Setting (ft.) From	Setting (ft.) To	Gage Casing Screen
4½	N	SCH 40 P.V.C.	0	265	
4½	N	SCH 40 P.V.C. PERFS	265	225	
		1/8" X 3"			

9) CEMENTING DATA [Rule 319.44(b)]
Cemented from 210 ft. to 170 ft. No. of Sacks Used 7½
17 ft. to SURF ft. No. of Sacks Used 3½
Method used PRESSURE CEMENTED - TREMI PIPE
Cemented by SCOTT THURMAN

10) SURFACE COMPLETION
☐ Specified Surface Slab Installed [Rule 319.44(c)]
☐ Pitless Adapter Used [Rule 319.44(d)]
☒ Approved Alternative Procedure Used [Rule 319.71]

11) WATER LEVEL:
Static level 190 ft. below land surface Date _____
Artesian flow _____ gpm. Date _____

12) PACKERS: Type Depth

13) TYPE PUMP: ☐ Turbine ☐ Jet ☒ Submersible ☐ Cylinder ☐ Other _____
Depth to pump bowls, cylinder, jet, etc., 250 ft.

14) WELL TESTS:
Type Test: ☒ Pump ☐ Bailer ☐ Jetted ☐ Estimated
Yield: 14 gpm with 20 ft. drawdown after 3 hrs.

15) WATER QUALITY:
Did you knowingly penetrate any strata which contained undesirable water? ☐ Yes ☒ No
If yes, submit "REPORT OF UNDESIRABLE WATER"
Type of water? _____ Depth of strata _____
Was a chemical analysis made? ☐ Yes ☒ No

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief. I understand that failure to complete items 1 thru 12 will result in the log(s) being returned for completion and resubmittal.

COMPANY NAME THURMAN WATER WELL SERVICE, INC Water Well Driller's License No. 2326 (Type or Print)

ADDRESS 3311 NO COMMERCE FORT WORTH, TEXAS 76106 (Street or RFD) (City) (State) (Zip)

(Signed) Scott Thurman (Licensed Water Well Driller) (Signed) Shawn Mayne (Registered Driller Trainee)

For TWC use only
Well No. 32-13-9
Located on map _____

Please attach electric log, chemical analysis, and other pertinent information, if available.

TWC-0392 (Rev. 06-10-85) TEXAS WATER COMMISSION COPY

332227

APPENDIX D

AQUIFER TEST DATA, STREAM FLOW CALCULATIONS, TRACER TEST RESULTS, AND GROUNDWATER ELEVATION MEASUREMENTS

332228

AQUIFER TEST DATA AND ANALYSIS

332229

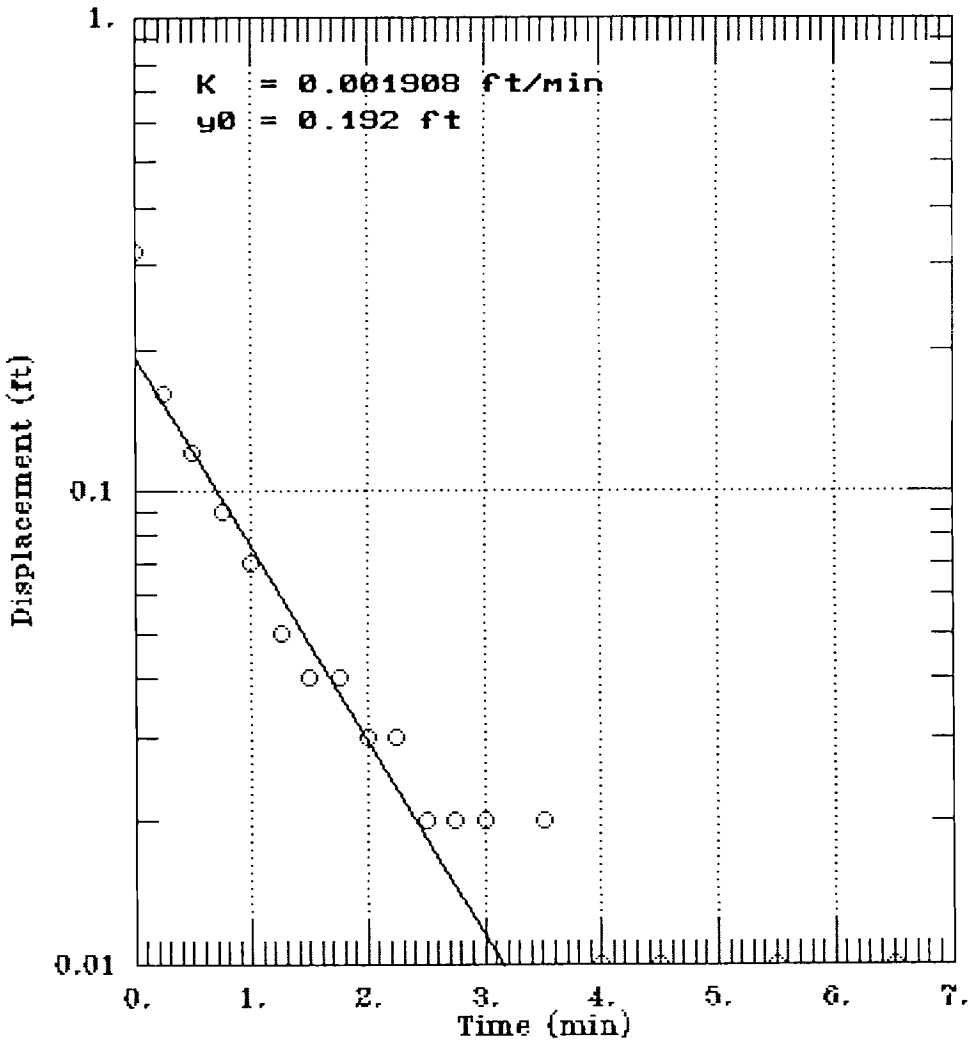
Summary of Slug test data

Well	Test Type	Result	Comments
SD13-MW02	Rising head	1.91 E-3 (ft/min)	
ST14-MW05	Rising	7.73 E-3	good Only 3 data points
ST14-MW14	Rising	1.29 E-3	screened in sandy clay and silty sand
ST14-MW14	falling	4.37 E-2	" "
ST14-MW15	Rising	5.25 E-4	screened predom. in sand (very fine)
ST14-MW20	Rising	2.97 E-3	screened in fine sand
T14-MW23	Rising	1.54 E-3	screened in silty clayey sand

$$\frac{cm}{s} \left| \frac{ft}{30.48\,cm} \right| \frac{60\,s}{min} = \frac{ft}{min}$$

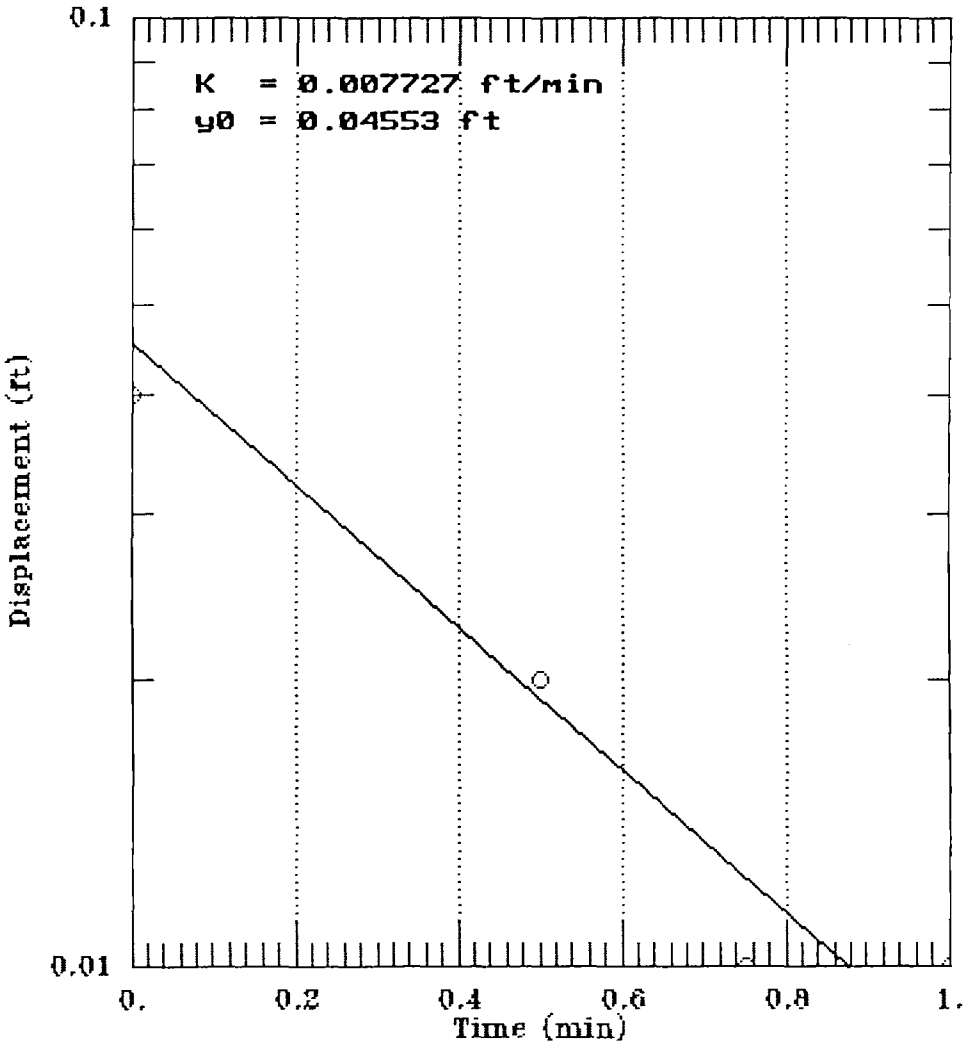
$$\frac{ft}{m} = 1.9685$$

RISING HEAD SLUG TEST SD13-02



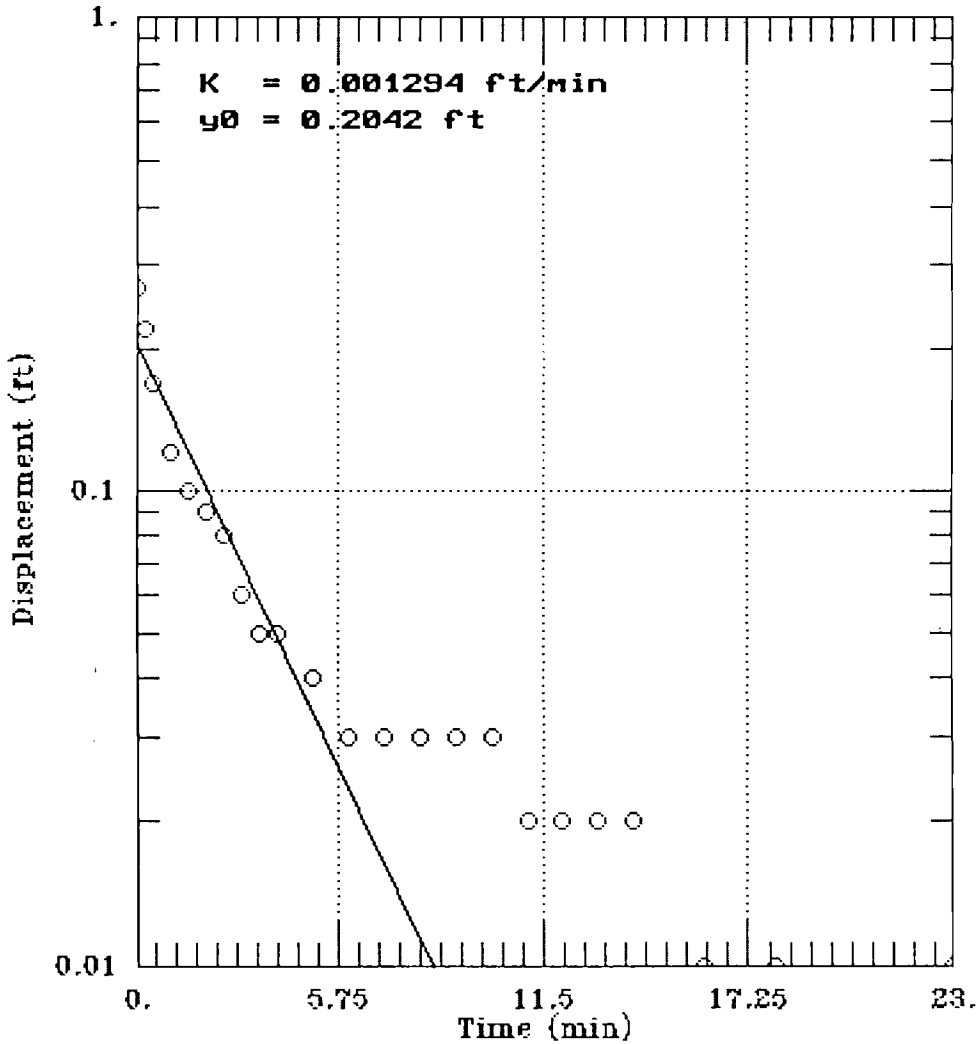
332230

RISING HEAD SLUG TEST ST14W05



33223

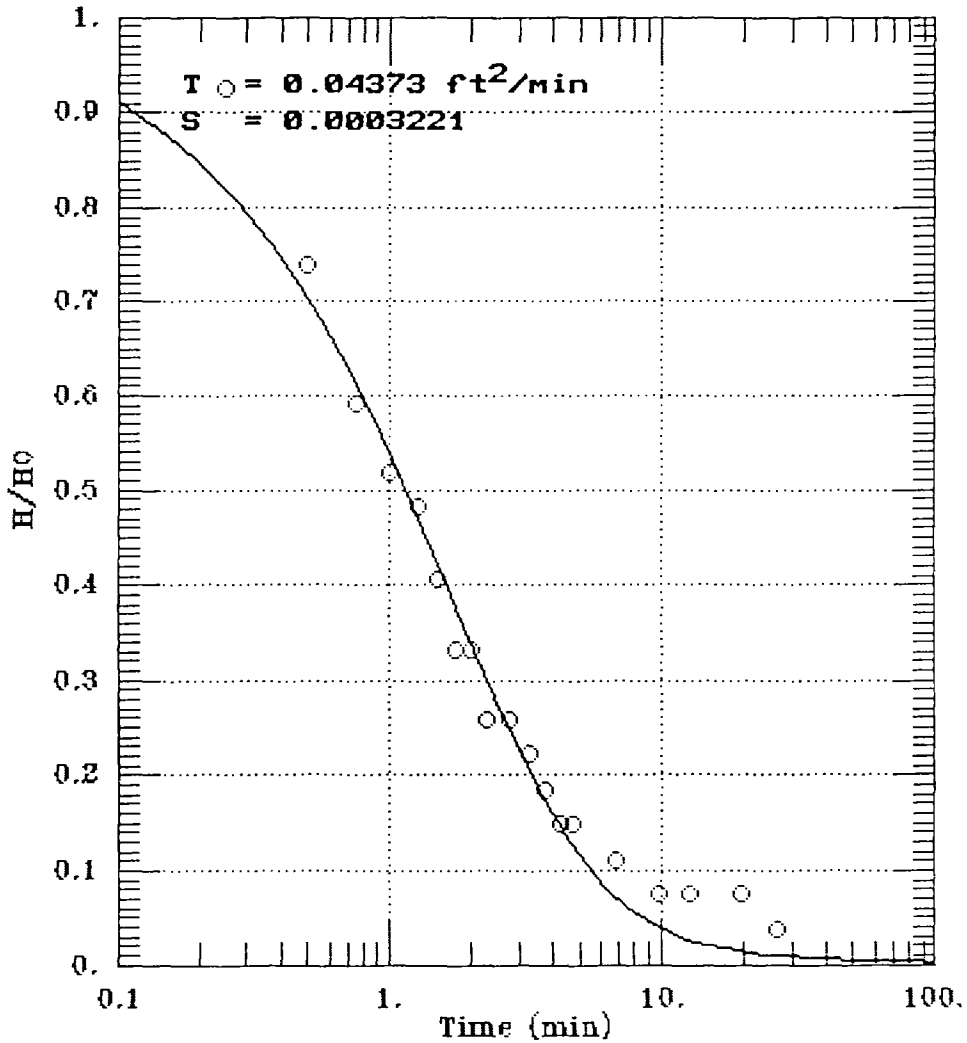
RISING HEAD SLUG TEST ST14-W14



332232

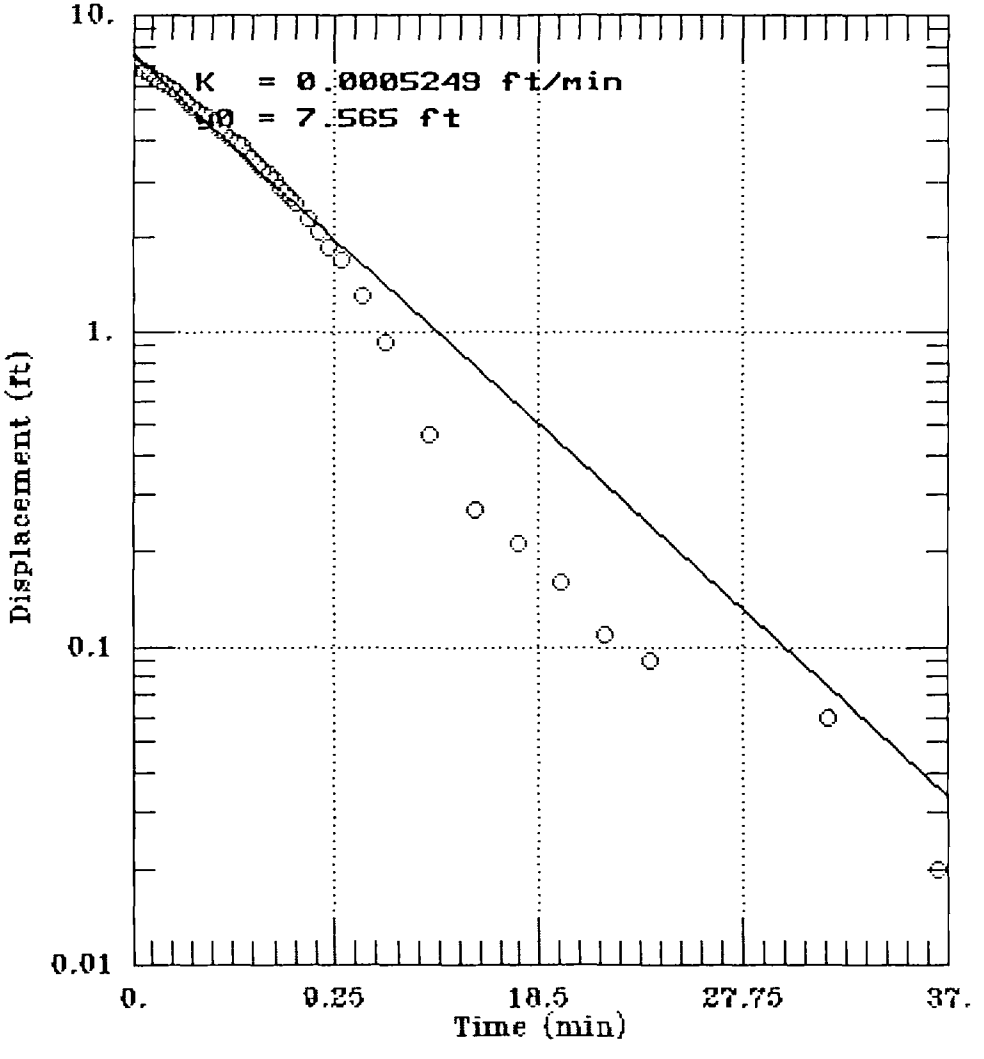
*rB

FALLING HEAD SLUG TEST ST14-W14



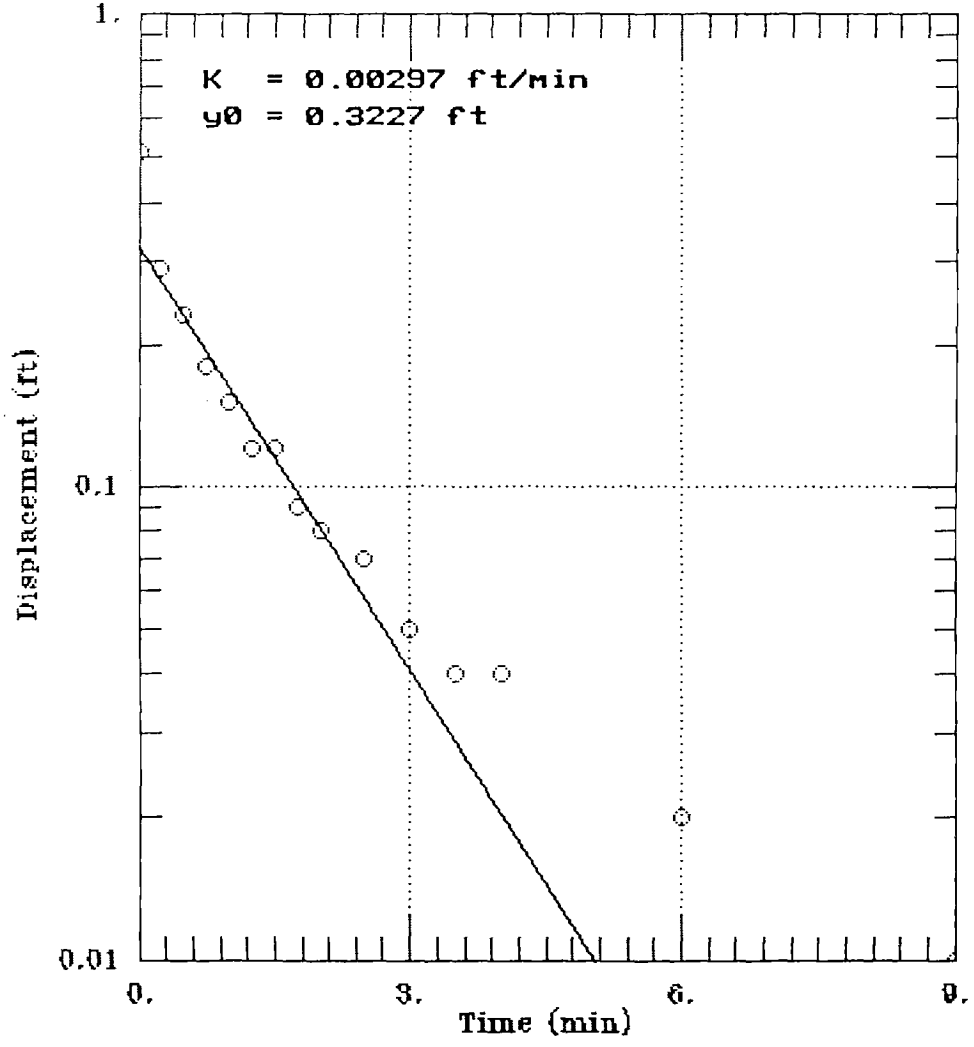
332233

RISING HEAD SLUG TEST ST14W15

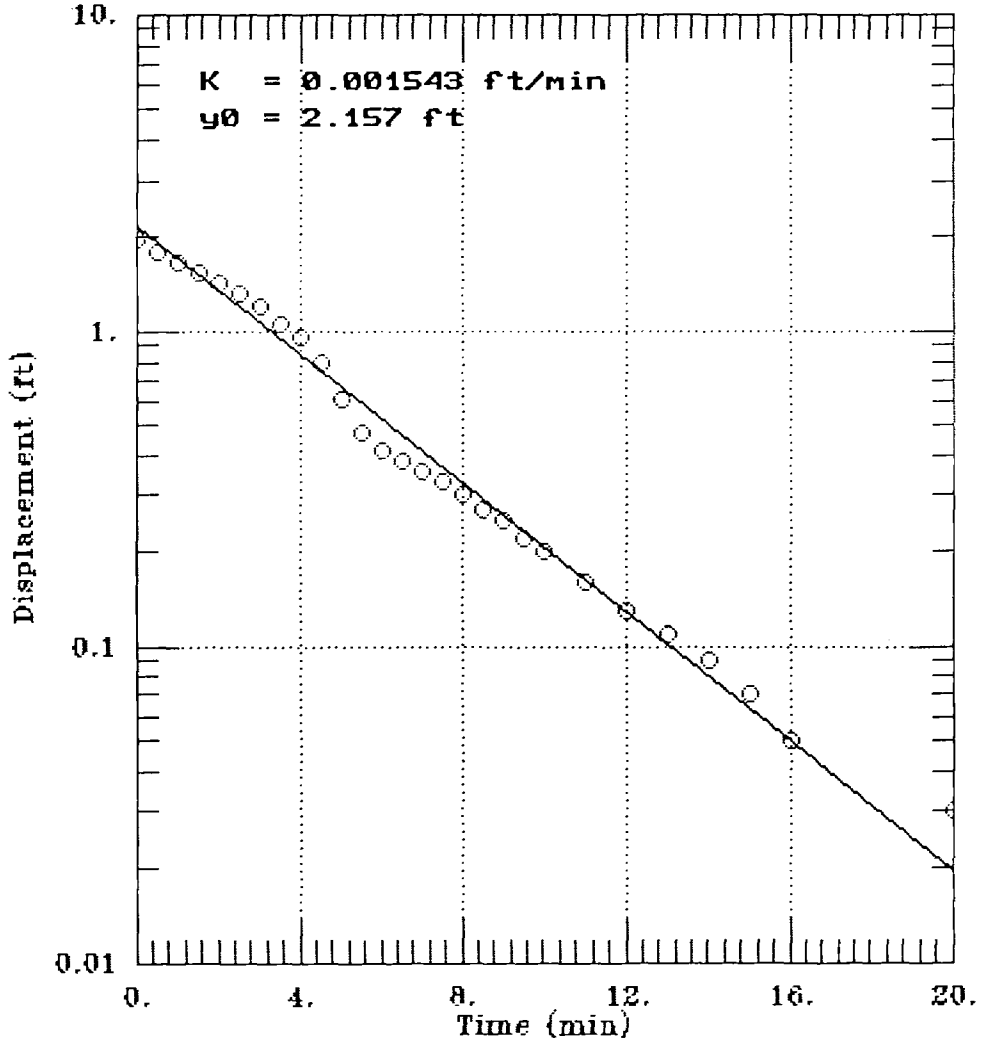


332234

RISING HEAD SLUG TEST ST14W20



RISING HEAD SLUG TEST ST14W23



332236

332237

STREAM FLOW CALCULATIONS

332238

M E M O R A N D U M

March 2, 1995

To: Brian V.

From: Kent Duran

Subject: Flow Measurements at Carswell Air Force Base

CALCULATIONS FOR FLOW RATES FOLLOWS:

Float Method:

Calculate the average velocity by averaging all the test runs. Surface velocity multiplied by 0.85 converts it to mean vertical velocity. Flow rate equals area times velocity. Find the area of the steam channel by adding the smaller segments into one large area. Multiply by velocity to calculate flow rate.

Volumetric Measurement:

Change quarts/second by unit conversion to cubic feet per second.

Flow Meter Method:

Calculate flow rate of each segment of the stream bed, and add for total flow rate. This is done by calculating the area, width times depth for each segment. Then find the velocity by averaging both depth velocities (.2 and .8), then take the average for the mean vertical velocity. (When only one depth is used (.6), take this value as the mean vertical velocity). Multiply vertical velocity by area to calculate discharge of the segment. Add the segments together for total discharge (in cubic feet per second).

Instructions for calculations can be found in the copied material enclosed. It is from USGS Water-Supply Paper 2175. Title, Measurement and Computation of Streamflow: Vol. 1. Measurement of Stage and Discharge.

method, observations of width, depth, and velocity are taken at intervals in a cross section of the stream, while the hydrographer is wading or supported by a cableway, bridge, ice cover, or boat. A current meter is used to measure velocity. This chapter describes the conventional current-meter method.

GENERAL DESCRIPTION OF A CONVENTIONAL CURRENT-METER MEASUREMENT OF DISCHARGE

A current-meter measurement is the summation of the products of the subsection areas of the stream cross section and their respective average velocities. The formula

$$Q = \Sigma(a\ v) \tag{9}$$

represents the computation, where Q is total discharge, a is an individual subsection area, and v is the corresponding mean velocity of the flow normal to the subsection.

In the midsection method of computing a current-meter measurement, it is assumed that the velocity sample at each vertical represents the mean velocity in a rectangular subsection. The subsection area extends laterally from half the distance from the preceding observation vertical to half the distance to the next, and vertically from the water surface to the sounded depth. (See fig. 41.)

The cross section is defined by depths at verticals 1, 2, 3, 4, . . . n. At each vertical the velocities are sampled by current meter to obtain the mean velocity for each subsection. The subsection discharge is then computed for any subsection at vertical x by use of the equation,

$$q_x = v_x \left[\frac{(b_x - b_{(x-1)})}{2} + \frac{(b_{(x+1)} - b_x)}{2}\right] d_x$$

$$= v_x \left[\frac{b_{(x+1)} - b_{(x-1)}}{2}\right] d_x \tag{10}$$

where

q_x = discharge through subsection x,
v_x = mean velocity at vertical x,
b_x = distance from initial point to vertical x,
$b_{(x-1)}$ = distance from initial point to preceding vertical,
$b_{(x+1)}$ = distance from initial point to next vertical, and
d_x = depth of water at vertical x.

Thus, for example, the discharge through subsection 4 (heavily outlined in fig. 41) is

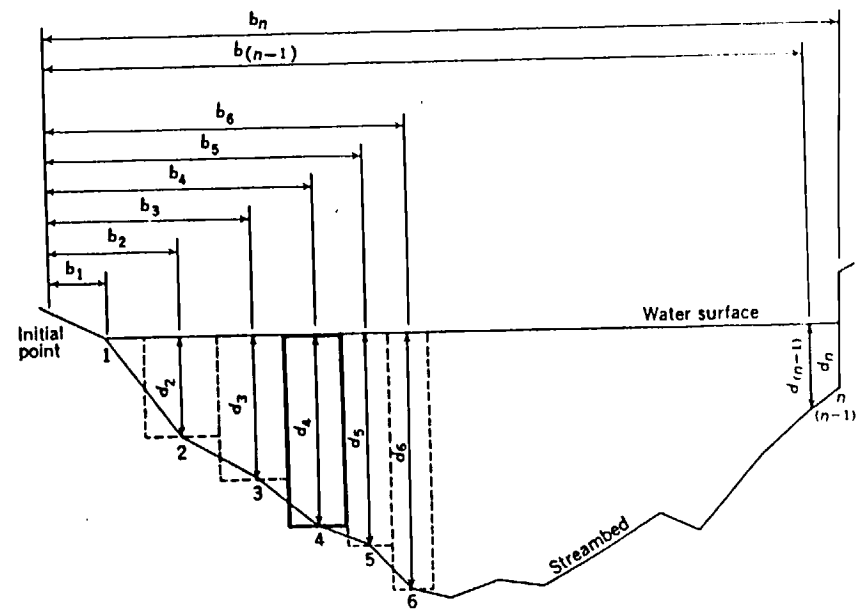
$$q_4 = v_4 \left[\frac{b_5 - b_3}{2}\right] d_4.$$

The procedure is similar when x is at an end section. The "preceding vertical" at the beginning of the cross section is considered coincident with vertical 1; the "next vertical" at the end of the cross section is considered coincident with vertical n. Thus,

$$q_1 = v_1 \left[\frac{b_2 - b_1}{2}\right] d_1$$

and

$$q_n = v_n \left[\frac{b_n - b_{(n-1)}}{2}\right] d_n.$$



EXPLANATION

1, 2, 3 . . . . . n	Observation verticals
$b_1, b_2, b_3, \ldots b_n$	Distance, in feet or meters, from the initial point to the observation vertical
$d_1, d_2, d_3, \ldots d_n$	Depth of water, in feet or meters, at the observation vertical
Dashed lines	Boundaries of subsections; one heavily outlined is discussed in text

332239

FIGURE 41.—Definition sketch of midsection method of computing cross-section area for discharge measurements.

For the example shown in figure 41, q_1 is zero because the depth at observation point 1 is zero. However, when the cross-section boundary is a vertical line at the edge of the water as at vertical n, the depth is not zero and velocity at the end vertical may or may not be zero. The formula for q_1 or q_n is used whenever there is water only on one side of an observation vertical such as at piers, abutments, and islands. It is necessary to estimate the velocity at an end vertical, usually as some percentage of the adjacent vertical, because it is impossible to measure the velocity accurately with the current meter close to a boundary. There is also the possibility of damage to the equipment if the flow is turbulent. Laboratory data suggest that the mean vertical velocity in the vicinity of a smooth sidewall of a rectangular channel can be related to the mean vertical velocity at a distance from the wall equal to the depth. The tabulation below gives values that define the relation.

Distance from wall, as a ratio of the depth	*Mean vertical velocity, as related to V_n*
0.00	$0.65V_n$
.25	$.90V_n$
.50	$.95V_n$
1.00	$1.00V_n$

NOTE—V_n is the mean vertical velocity at a distance from the vertical wall equal to the depth.

The summation of the discharges for all the subsections—usually 25 to 30 in number—is the total discharge of the stream. An example of the measurement notes used by the U.S. Geological Survey is shown in figure 42.

The mean-section method, used by the U.S. Geological Survey prior to 1950, differs from the midsection method, described above, in computation procedure. In the older method discharges are computed for subsections between successive observation verticals. The velocities and depths at successive verticals are each averaged, and each subsection extends laterally from one observation vertical to the next. Subsection discharge is the product of the average of two mean velocities, the average of two depths, and the distance between observation verticals. In both methods total discharge is the sum of the subsection discharges. A study by Young (1950) concluded that the midsection method is simpler to compute and is a slightly more accurate procedure than the mean-section method.

Current-meter meaurements are usually classified in terms of the means used to cross the stream during the measurement, such as wading, cableway, bridge, boat, or ice cover.

INSTRUMENTS AND EQUIPMENT

Current meters, timers, and a means of counting meter revolutions are needed for the measurement of discharge, along with additional

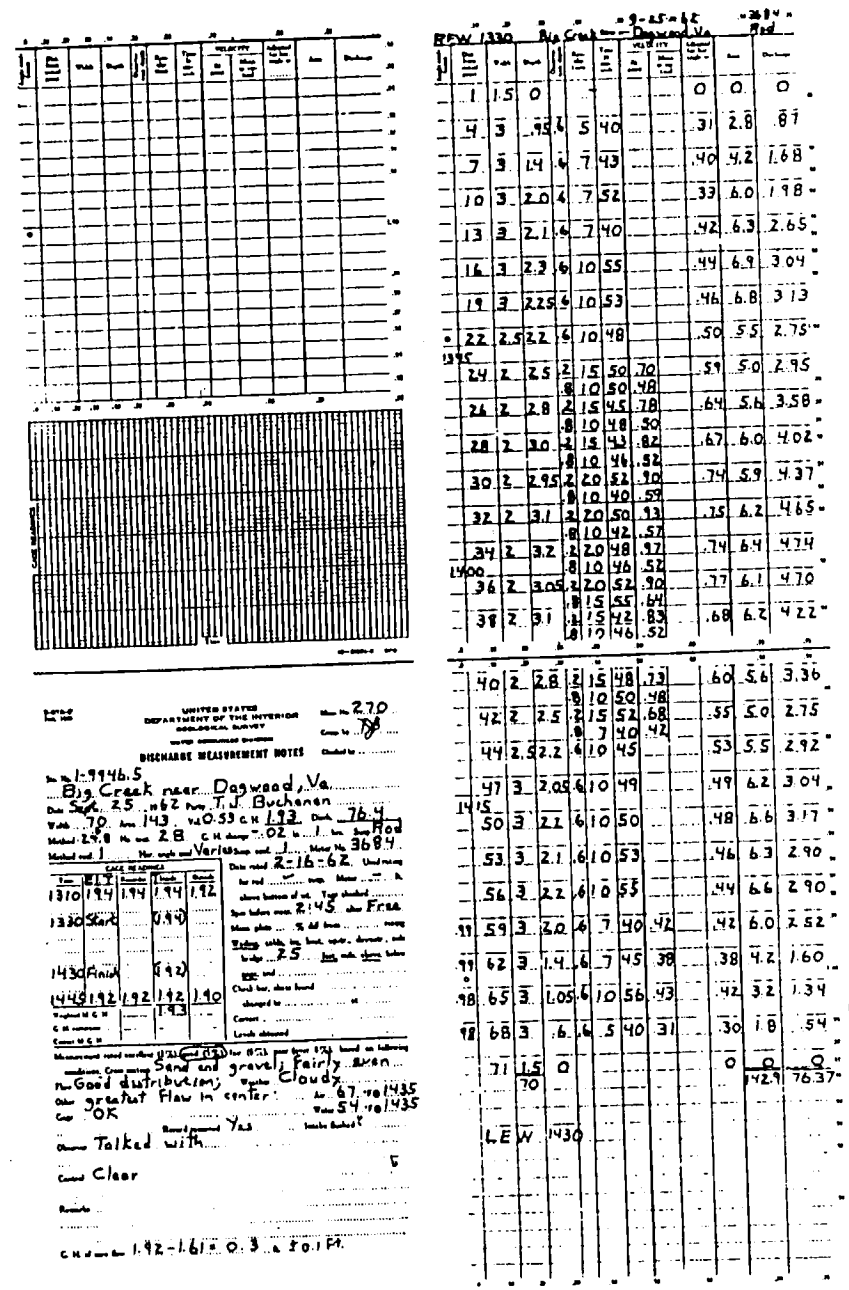


FIGURE 42.—Computation notes of a current-meter measurement by the midsection method.

[redacted]332241

FLOATS

Floats are seldom used in stream gaging but are useful in an emergency for measuring high discharges under the following circumstances:

1. No conventional or optical current meter is available.
2. A current meter is available but the measurement structure—bridge or cableway—has been destroyed, and equipment for measuring from a boat is unavailable.
3. A conventional current meter is available, but floating ice or drift make it impossible to use the meter.

Surface floats are used in those situations, and they may be almost any distinguishable article that floats, such as wooden disks; bottles partly filled with either water, soil, or stones; or oranges. Floating ice cakes or distinguishable pieces of drift may be used if they are present in the stream.

Two cross sections are selected along a reach of straight channel for a float measurement. The cross sections should be far enough apart so that the time the float takes to pass from one cross section to the other can be measured accurately. A traveltime of at least 20 s is recommended, but a shorter time may be used for streams with such high velocities that it is not possible to find a straight reach of channel having adequate length. The water-surface elevation should be referenced to stakes along the bank at each cross section and at one or more intermediate sites. Those elevations will be used at a later date, when conditions permit, to survey cross sections of the measurement reach, and the end stakes will be used to obtain the length of the reach. The surveyed cross sections will then be used to derive an average cross section for the reach.

In making a float measurement a number of floats are distributed uniformly across the stream width, and the position of each with respect to distance from the bank is noted. The floats should be introduced a short distance upstream from the upstream cross section so that they will be traveling at the speed of the current when they reach the upstream section. A stopwatch is used to time their travel between the end cross sections of the reach. The estimated position of each float with respect to the bank is also noted at the downstream cross section.

If there is no bridge or cableway from which to introduce the floats in the stream, the floats will have to be tossed in from the streambank. If that is the situation that exists at a wide stream, it may be impossible to position any floats in the central core of the stream where most of the flow occurs. A float measurement of discharge made under those conditions would be meaningless. However, the difficulty of introducing floats at intervals across the entire width

of a wide stream can be overcome if a boat can be obtained for the purpose.

The velocity of a float is equal to the distance between the end cross sections divided by the time of travel. The mean velocity in the vertical is equal to the float velocity multiplied by a coefficient whose value is dependent on the shape of the vertical-velocity profile of the stream and on the depth of immersion of the float with respect to stream depth. A coefficient of 0.85 is commonly used to convert the velocity of a surface float to mean velocity in the vertical.

The procedure for computing the discharge is similar to that used in computing the discharge for a conventional current-meter measurement. (See chapter 5.) The discharge in each subsection of the average cross section is computed by multiplying the area of the subsection by the mean vertical velocity for that subsection. The total discharge is equal to the sum of the discharges for all subsections.

Float measurements of discharge that are carefully made under favorable conditions may be accurate to within ±10 percent. Wind may adversely affect the accuracy of the computed discharge by its effect on the velocity of the floats. If a nonuniform reach is selected and few floats are used in the cross section, measurement results may be in error by as much as 25 percent.

VOLUMETRIC MEASUREMENT

The volumetric measurement of discharge is only applicable to small discharges, but it is the most accurate method of measuring such flows. In that method the hydrographer observes the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume. The only equipment required, other than the calibrated container, is a stopwatch.

The container is calibrated in either of two ways. In the first method, water is added to the container by known increments of volume, and the depth of water in the container is noted after the addition of each increment. In the second method, the empty container is placed on a weighing scales, and its weight is noted. Water is added to the container in increments, and after each addition the total weight of container and water is noted, along with the depth of water in the container. The equation used to determine the volume corresponding to a depth that was read is

$$V = \frac{W_2 - W_1}{w}, \qquad (42)$$

where

V = volume of water in container, in cubic feet or cubic meters,
W_2 = weight of water and container, in pounds or kilograms,

W_1 = weight of empty container, in pounds or kilograms, and
w = unit weight of water, 62.4 lb/ft^3 or 1,000 kg/m^3.

Volumetric measurements are usually made where the flow is concentrated in a narrow stream, or can be so concentrated, so that all the flow may be diverted into a container. Examples of sites presenting the opportunity for volumetric measurement of discharge are a V-notch weir; an artificial control where all the flow is confined to a notch or to a narrow width of catenary-shaped weir crest; and a cross section of natural channel where a temporary earth dam can be built over a pipe of small diameter, through which the entire flow is directed. Sometimes it is necessary to place a trough against the artificial control to carry the water from the control to the calibrated container. If a small temporary dam is built, the stage behind the dam should be allowed to stabilize before the measurement is begun. The measurement is made three or four times to be certain no errors have been made and to be sure the results are consistent.

Volumetric measurements have also been made under particular circumstances when no other type of measurement was feasible. One such circumstance involved a small stream that was in actuality a series of deep pools behind broad-crested weirs that acted as drop structures to dissipate the energy of the stream. At low flows the depth of water on the weir crest was too shallow to be measured by current meter, and the velocity in the pools was too slow for such measurement. To measure the discharge a large container of known volume was placed on a raft held close to the downstream weir face by ropes operated from the banks. A sharp-edged rectangular spout of known width was held so that one end butted tightly against the downstream face of the weir, the base of the spout being held just below the weir crest. The other end of the spout led to the container of known volume. Timed samples of the flow, sufficient to fill the container, were taken at a number of locations along the downstream face of the weir, the raft being moved laterally across the stream, from location to location, by the ropes. The procedure was analogous to making a conventional current-meter discharge measurement. Instead of measuring depth and velocity at a series of observation sites in the cross section, as is done in a current-meter measurement, the discharge per width of spout opening was measured at a series of observation sites. The discharge measured at each site was multiplied by the ratio of subsection width to spout width to obtain the discharge for the subsection. The total discharge of the stream was the summation of the discharges computed for each subsection.

332242

PORTABLE WEIR PLATE

A portable weir plate is a useful device for determining discharge

8-31-94 Stream Gaging

Joe Bauer
Andrew Gulyane

7:10 Arrive at base with Brian Vanderglas.

Brian showed us the creeks and the sampling locations

We purchased some ice and collected the sample bottles and equipment from the ES Staging area.

0840 Arrive at Farmers Branch to gage and sample

Weather: partly cloudy hot 80's-90's calm

Checked location for sample #2. We will collect it when we sample #1

0934 Calibrate pH, cond., & temp. meter

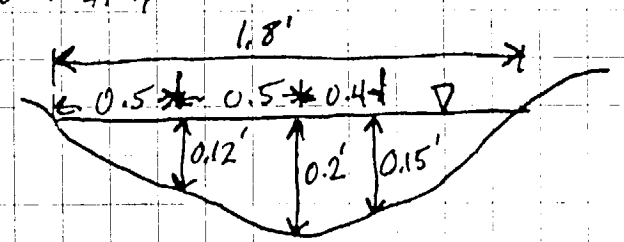
cond. 80° 1413 µS/cm
(solution is 1413 µS/cm)

pH 7 solution
reading 7.00

10 solution
reading 9.97

0950 gaging station #4
Due to low flows we gaged ~ 150 down stream of the confluence of the unnamed creek and Farmers Branch

station #4



ES ENGINEERING-SCIENCE, INC.

332244

Client _____ Job No. _____ Sheet ___ of ___

Subject [illegible] #4 By _____ Date _____

Checked _____ Rev. _____

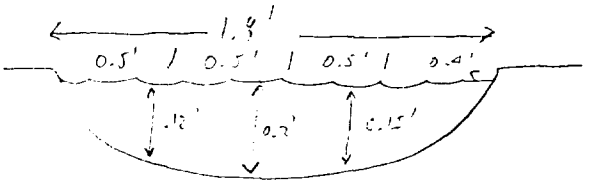
Trial 1 [illegible] Time (sec) Station # 4

2 [illegible]

3 [illegible] (time at [illegible])

4 [illegible]

5 [illegible]



(drawn not to scale)

[illegible] Velocity = Distance/time

Avg time [illegible] seconds

V = 3/6.64

= .45 FT/sec

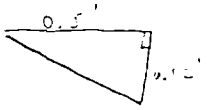
Multiply velocity of a surface float by 0.85 to convert to mean vertical velocity

$Vel_{vert} = .45\ FT/sec\ (0.85)$

$= .38\ FT/sec.$

Q = AV Q = Flow Rate A = Area V = Velocity

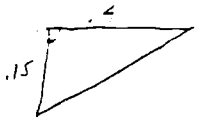
Area = Each section of the stream bed added to equal the whole bed



Area = ½ bh
= ½ (.12')(.5)
= .03 FT²

Area = depth × width
= 0.2' × 0.5'
= 0.1 FT²

A = depth × width
= 0.2 × 0.4
= 0.08 FT²



Area = ½ bh
= ½ (.15')(.4')
= .03 FT²

Total Area = .24 FT²
(sum of slices)

Q = A V
= (.24 FT²) (.38 FT/sec)
= .09 FT³/sec

(32)

8-30-94

We will use the float method to measure velocity due to low flows

3 foot run

1st 6.33 seconds
2nd 6.62 seconds
3rd 10.12 seconds
4th 6.28 seconds
5th 7.33 seconds

1010 Collected Sample #4
ST14-SW4

6.78 µS/cm
79.9 °F
7.40 pH

2 VOA for BTEX
1 TOC
1 TPH
1 Naphthalene

(33)

JB 8/31/94

1100 Gage ST14-SW3

Used a bucket to gage

Vol	Time
7 Quarts	9.54 sec.
8.5 Quarts	9.26 sec.
9 Quarts	9.89 sec
8.5 Quarts	9.81 sec

1115 Collect ST14-SW3 and ST14-SW3 dup.

Collect same bottles as SW4

Temp 79.7 °F
cond 710 µS/cm
pH 6.4

11:35 Picked up more bottles
11:45 Break for Lunch
2:30 Back from lunch

332245

ES ENGINEERING-SCIENCE, INC.

Client _____ Job No. _____ Sheet _____ of

Subject ST14-SW3 By _____ 332246

Volumetric Measurement Checked _____ Rev.

Volume	TIME (sec.)	Q (flow rate FT³/sec)
7 Qts	9.54	.025
8.5 Qts	9.26	.031
9 Qts	9.89	.030
8.5 Qts	9.81	.029

$$\frac{qts}{sec} \times \frac{.9463 \text{ liters}}{1 qt} \times \frac{1000 \text{ cm}^3}{1 \text{ liter}} \times \frac{0.061 \text{ inch}^3}{1 \text{ cm}^3} \times \frac{1 \text{ ft}^3}{1728 \text{ inch}^3} = \text{cubic FT/second}$$

Avg. Q = .029 FT³/sec

(34)

8-31-94

Unable to find a suitable location to measure streamflow ~~for~~ for ST14-SW5

We will just sample the surface water

There are several groundwater seeps or springs about 50 feet down stream of sample location.

1300 Sample ST14-SW5
Same bottles as above

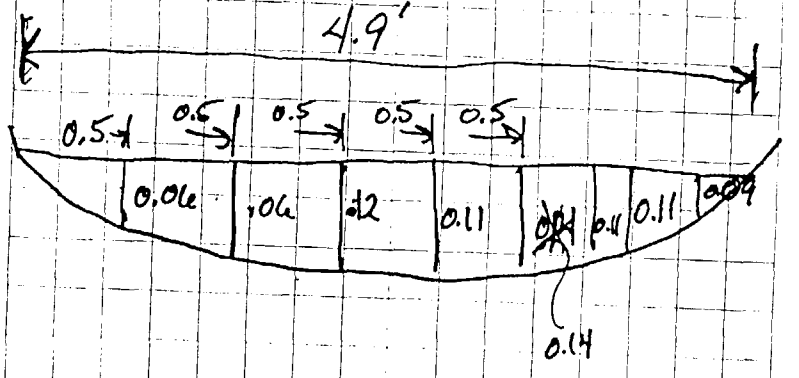
temp 90.2°
Cond. ~~530~~ 485 µS/cm
pH 9.1

After further investigation low seeps appear to be a storm water outfall of some kind.

(35)

8/31/94

1340 Set up to gage ST14-SW22
We will gage upstream of the confluence with main creek
We will sample downstream of confluence.



Velocity measurement

Distance	4.9'
#1	6.44 seconds
#2	8.08 seconds
#3	5.90 seconds
#4	5.76 seconds

ES ENGINEERING-SCIENCE, INC.

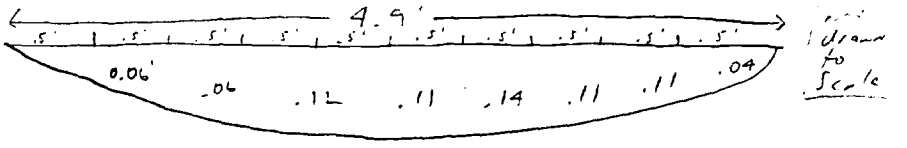
Client _____ Job No. 332248 Sheet ___ of ___

Subject ST 14 - SW 2 By _____ Date 8/31/94

Checked _____ Rev. _____

Test	Time (sec)
1	6.44
2	8.03
3	5.40
4	5.76

test run = 3'



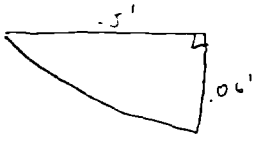
Avg running time 6.55 seconds

Velocity = Distance / time
= 3 FT / 6.55 sec
= .46 FT/sec.

Multiply surface velocity by coefficient to achieve vertical velocity

V = (.46)(.85)
= .39 FT/sec.

Q = AV Q = flow Rate A = Area V = Velocity



A = ½ bh
= ½ (.06') (.5')
= .02 FT²

A = depth × width
= .06' × .5'
= .03 FT²

A = .06' × .5'
= .03 FT²

A = .12' × .5'
= .06 FT²

A = .12' × .5'
= .06 FT²

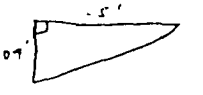
A = .11' × .5
= .05 FT²

A = .14' × .5'
= .07 FT²

A = .11' × .5'
= .05 FT²

A = .11' × .5'
= .05 FT²

A = ½ bh
= ½ .04' × .5'



A = .01 FT²

Total Area = .43 FT²
(sum of slices)

Q = A V
= (.43 FT²) (.39 FT/sec)

= .17 FT³/sec

(36)
31 Aug 94

1350 Security stopped us to check why we were wandering around down the Creek.

1405 Sample Creek
ST14-SW2

Temp. 82°
Cond 514 µS/cm
pH 8.2

1430 We are at ST14-SW1
Due to the low flow and a very rocky stream bed the location is unsuitable for gaging.
We will go ahead and sample

Temp. 88.8
Cond. 440 µS/cm
pH 7.8

(37)
31 Aug 94

1445 Collected Field blank by pouring distilled water into VOA bottles.
2 VOA's were filled.

page 4-16 of Brook Work Plan for map of approx locations.

~~1700~~ BRV

1600 Samples packed in coolers
1830 Dropped samples at FedEx for shipment to Evergreen Lab.

Brian Vanfo

332249

Carswell AFB — Tracer test — 11/10/94

probe. The sytem is set so that the channels are 1) Oil/Water Separator: Temp.
2) Oil/Water seperator: Conductivity
3) SD1306: Temperature
4) SD1306: Conductivity

The parameters were input as such

Temp
Linearity = 0
Scale = 10 (for Celsius)
Offset = 0 (for Celsius)
Delay = 100 m Sec

Conductivity
Linearity = 0
Scale = 20,000 for uS/cm
Offset = 0
Delay = ~~100~~ 15,000 m Sec

Extent of Memory
Number of data points = 7873
# of Days the test can run = 55

Set Test to start.
Joe Bower arrives to help w/ stream survey.

Stream Gaging — 11/10/94

1445 Begin doing stream surface flow measurements.

(1) Location is at O/W separator outflow

time to fill up bucket 5.73 seconds

5 second intervals of filling

time is seconds: 6.5 quarts
7 quarts
6.75 quarts
7 quarts
7 quarts

total of 5 runs of test.

Note: not location of SW3 during the round of soil sampling. That location is at the small culvert located above the outfall to the stream. The survey location was wrong.

So this ~~survey~~ streamgaging was done as at SW3 last time.

1 was collected with a bucket. Location is shown on map on pg. 142.

ES ENGINEERING-SCIENCE, INC.

Client _____ Job No. 332251 Sheet ___ of ___

Subject Volumetric Measurement Oil/Water Separator By _____ Date _____

Checked _____ Rev. _____

Volume (gts)	Time (sec)	Q (FT³/sec)
6.5	5	.043
7	5	.047
6.75	5	.045
7	5	.047
7	5	.047

gts/sec × .0334 = FT³/sec (see SW3 for details)

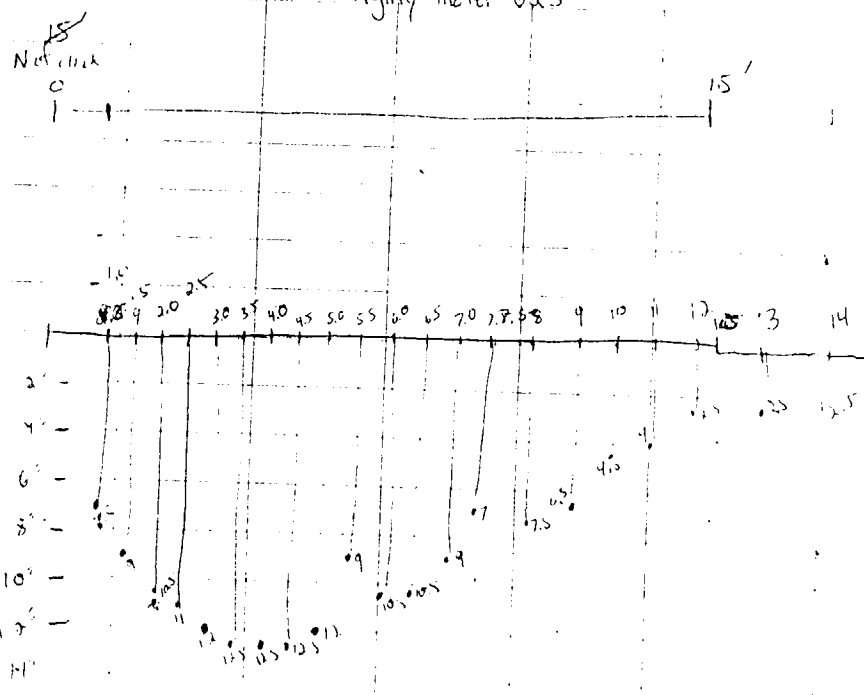
Avg Q = .046 FT³/sec

(141)

Caswell AFB 11/10/94

1524 Get ready to do the flow measurements for the unnamed creek downstream of the outflow. Location is past SW 5

use flow meter - Teledyne Gurley
- Pigmy meter 625



(ft/sec)

% from bottom of creek

%	over 1' (6.5)		1.5'	2' 0.9	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
0.2	NA		0.4 (ft/sec)		1.0	1.0	0.7	0.9	0.8	0.9	0.9	0.8	0.6
0.6													
0.8			0.3	0.8	1.2	1.2	0.9	1.0	1.2	1.0	0.9	0.9	0.7

%	7.0	7.5	8.0	9.0	10.0	11	12	13	14
0.2	0.4								
0.6		0.4	0.4	0.2	0.2	0.1	0.1	0.1	0.1
0.8	0.6								

took one measurement only used it across flow flow

1618 complete flow measurement

1648 Look at SW location for stream flow gaging. Will use the pigmy meter for this location also.
Set up is on next page.

LIS

C32252

Figure 6.2 Discharge Measurem Form (USGS form 9-275)

9-275D
(Mar. 1972)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Meas. No. .....
Comp. by .....
Checked by .....

FORM NO.
TWO

DISCHARGE MEASUREMENT NOTES

Sta. No. SW5 (outflow)

Date 10-NOV, 1994 Party .....

Width 1.5' Area ..... Vel. ..... G. H. ..... Disch. .....

Method 2.6.8 No. secs. 20 G. H. change ..... in ..... hrs. Susp. .....

Method coef. ..... Hor. angle coef. ..... Susp. coef. ..... Meter No. .....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter Price AA

Date rated ..... for rod, other.

Meter ..... ft. above bottom of weight.

Spin before meas. 10-10 after Free

Meas. plots .... % diff. from rating .....

(Wading), cable, ice, boat, upstr., (downstr.), side bridge ..... feet, mile, above, (below) gage, and downstream of outflow

Check-bar, found .....

changed to ..... at .....

Correct .....

Levels obtained on strong sections

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section .....

Flow ..... Weather .....

Other ..... Air .....°F@ .....

Gage ..... Water .....°F@ .....

..... Record removed ..... Intake flushed U .....

Observer .....

Control .....

Remarks .....

G. H. of zero flow ..... ft.

GPO : 1974 O - 541-885

Date 10-NOV 19 94 DISCHARGE MEASUREMENT NOTES

UNAMED River, at CARSWELL AFB

Dist. from initial point	Angle coefficient	Depth (inches)	Depth of observation	Revolutions	Time in seconds	Velocity ft/sec: At point	Velocity ft/sec: Mean in vertical	Velocity ft/sec: Mean in section	Area (Ft²)	Mean Depth	Width FT	Discharge
1.5'		7.5"	.2			.4	.35		.31		.5	.11
			.8			.3						
2.0'		9"	.2			.9	.85		.38		.5	.32
			.8			.8						
2.5'		11"	.2			1.0	1.1		.46		.5	.55
			.8			1.2						
3.0'		12"	.2			1.0	1.1		.5		.5	.55
			.8			1.2						
3.5'		12.5"	.2			.7	.8		.52		.5	.42
			.8			.9						
4.0'		12.5"	.2			.9	.95		.52		.5	.49
			.8			1.0						
4.5'		13"	.2			.8	1.0		.54		.5	.54
			.8			1.2						
5.0'		12"	.2			.9	.95		.50		.5	.48
			.8			1.0						
5.5'		9"	.2			.9	.9		.38		.5	.34
			.8			.9						
6.0'		10.5"	.2			.8	.85		.44		.5	.37
			.8			.9						
6.5'		10.5"	.2			.6	.65		.44		.5	.29
			.8			.7						
7.0'		9"	.2			.4	.5		.38		.5	.19
			.8			.6						

332253

Final

Figure 6.2 Discharge Measurem' 's Form (USGS form 9-275)

9-275D
(Mar. 1972)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. .....
Comp. by .....
Checked by .....

FORM NO.
TWO

Sta. No. .....

Date ....., 19..... Party .....

Width ..... Area ..... Vel. ..... G. H. ..... Disch. .....

Method ..... No. secs. ..... G. H. change ..... in ..... hrs. Susp. .....

Method coef. ..... Hor. angle coef. ..... Susp. coef. ..... Meter No. .....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter .....

Date rated ..... for rod, other.

Meter ..... ft. above bottom of weight.

Spin before meas. ..... after .....

Meas. plots .... % diff. from rating .....

Wading, cable, ice, boat, upstr., downstr., side bridge ..... feet, mile, above, below gage, and .....

Check-bar, found .....

changed to ..... at .....

Correct .....

Levels obtained .....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section .....

Flow ..... Weather .....

Other ..... Air .....°F@ .....

Gage ..... Water .....°F@ .....

..... Record removed ..... Intake flushed U L .....

Observer .....

.....

Control .....

.....

Remarks .....

.....

.....

G. H. of zero flow ..... ft.

GPO : 1974 O - 541-805

Date 12 NOV 19 94 DISCHARGE MEASUREMENT NOTES

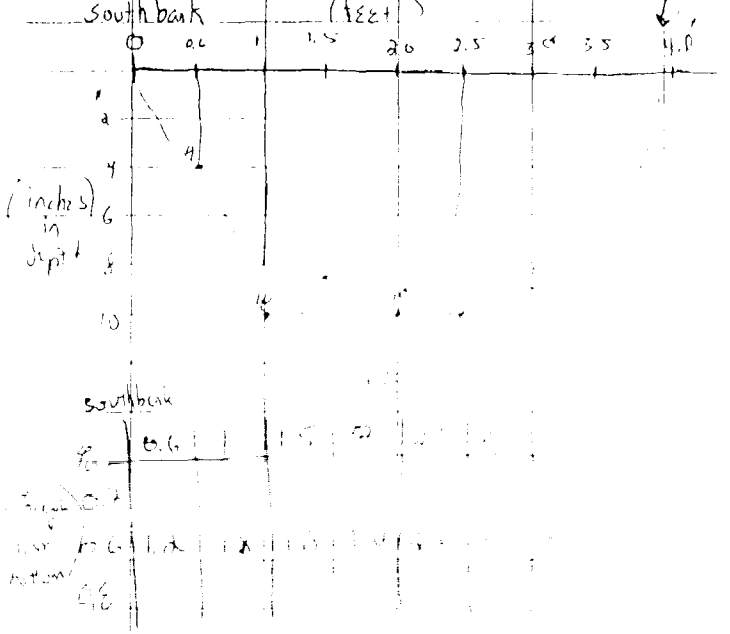
UNAMED River, at CARSWELL AFB

Dist. from initial point	Angle coefficient	Depth inches	Depth of observation	Revolutions	Time in seconds	VELOCITY Ft/sec At point	Mean in vertical	Mean in section	Area FT²	Mean Depth	Width FT	Discharge
7.5'		7"	.6			.4	.4		.29		.5	.12
8'		7.5"	.6			.4	.4		.31		.5	.12
9'		6.5"	.6			.2	.2		.27		.5	.05
10'		4.5"	.6			.2	.2		.19		.5	.04
11'		4"	.6			.1	.1		.17		.5	.02
12'		2.5"	.6			.1	.1		.10		.5	.01
13'		2.5"	.6			.1	.1		.10		.5	.01
14'		2.5"	.6			.1	.1		.10		.5	.01
												5.03

total discharge FT³/sec

Stream flow

Stream gaging west of entrance road to the golf course at the location on the map



1782 Set up for gaging at the creek running behind the [illegible] house behind the community house.

Stream flow

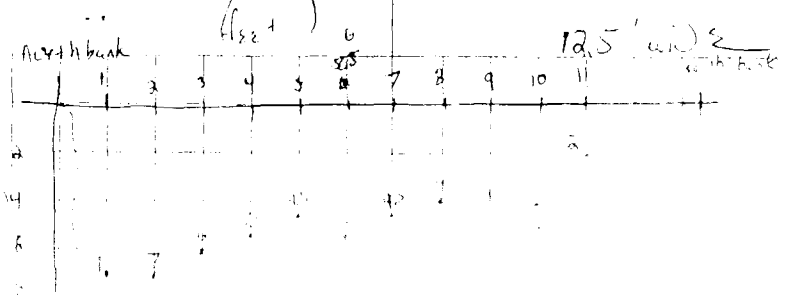


Figure 6.2 Discharge Measureme Form (USGS form 9-275)

9-275A
(Mar. 1972)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. .....
Comp. by .....
Checked by .....

FORM NO.
TWO

Sta. No. Golf Course

Date 10 NOV 1994 Party .....

Width 4 FT Area ..... Vel. ..... G. H. ..... Disch. .....

Method ..... No. secs. ..... G. H. change ..... in ..... hrs. Susp. .....

Method coef. ..... Hor. angle coef. ..... Susp. coef. ..... Meter No. .....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter PRICE AA

Date rated ..... for rod, other.

Meter ..... ft. above bottom of weight.

Spin before meas. ..... after .....

Meas. plots .... % diff. from rating .....

Wading, cable, ice, boat, upstr., downstr., side bridge ..... feet, mile, above, below gage, and .....

Check-bar, found .....

changed to ..... at .....

Correct .....

Levels obtained .....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section .....

Flow ..... Weather .....

Other ..... Air .....°F@ .....

Gage ..... Water .....°F@ .....

..... Record removed ..... Intake flushed U L .....

Observer .....

Control .....

Remarks .....

G. H. of zero flow ..... ft.

GPO : 1974 O - 661-005

Date 10 NOV 19 94 DISCHARGE MEASUREMENT NOTES

Golf Course River, at CARSWELL AFB

Dist. from initial point	Angle coefficient	Depth (inches)	Depth of observation	Revolutions	Time in seconds	Velocity At point	Velocity Mean in vertical	Velocity Mean in section	Area (sq. ft.)	Mean Depth	Width (ft)	Discharge (ft³/sec)
IP		0				NA			0			0
.6		4	.6			1.2	1.2		.17		.5	.20
1.0		10	.6			1.8	1.8		.38		.45	.68
1.5		9.5	.6			1.3	1.3		.40		.5	.52
2.0		10	.6			1.0	1.0		.42		.5	.42
2.5		10	.6			.8	.8		.42		.5	.34
3.0		9	.6			.3	.3		.38		.5	.11
3.5		8	.6			.1	.1		.33		.5	.03
4.0		0				NA						0
												2.3 ft³/sec

332256

Final

Figure 6.2 Discharge Measurem Form (USGS form 9-275)

9-275A
(Mar. 1972)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Meas. No. .....
Comp. by .....
Checked by .....

FORM NO.
TWO

DISCHARGE MEASUREMENT NOTES

Sta. No. C. Creek
behind abandoned house

Date 10 Nov 1994 Party .....

Width 12.5' Area ..... Vel. ..... G. H. ..... Disch. .....

Method ..... No. secs. ..... G. H. change ..... in ..... hrs. Susp. .....

Method coef. ..... Hor. angle coef. ..... Susp. coef. ..... Meter No. .....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Type of meter PRICE AA

Date rated ..... for rod, other.

Meter ..... ft. above bottom of weight.

Spin before meas. ..... after .....

Meas. plots .... % diff. from rating .....

Wading, cable, ice, boat, upstr., downstr., side bridge ..... feet, mile, above, below gage, and .....

Check-bar, found .....
changed to ..... at .....

Correct .....

Levels obtained .....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section .....

Flow ..... Weather .....

Other ..... Air .....°F@ .....

Gage ..... Water .....°F@ .....

..... Record removed ..... Intake flushed U/L .....

Observer .....

.....

Control .....

.....

Remarks .....

.....

.....

G. H. of zero flow ..... ft.

GPO : 1974 O - 541-885

Date 10 Nov 19 94 DISCHARGE MEASUREMENT NOTES

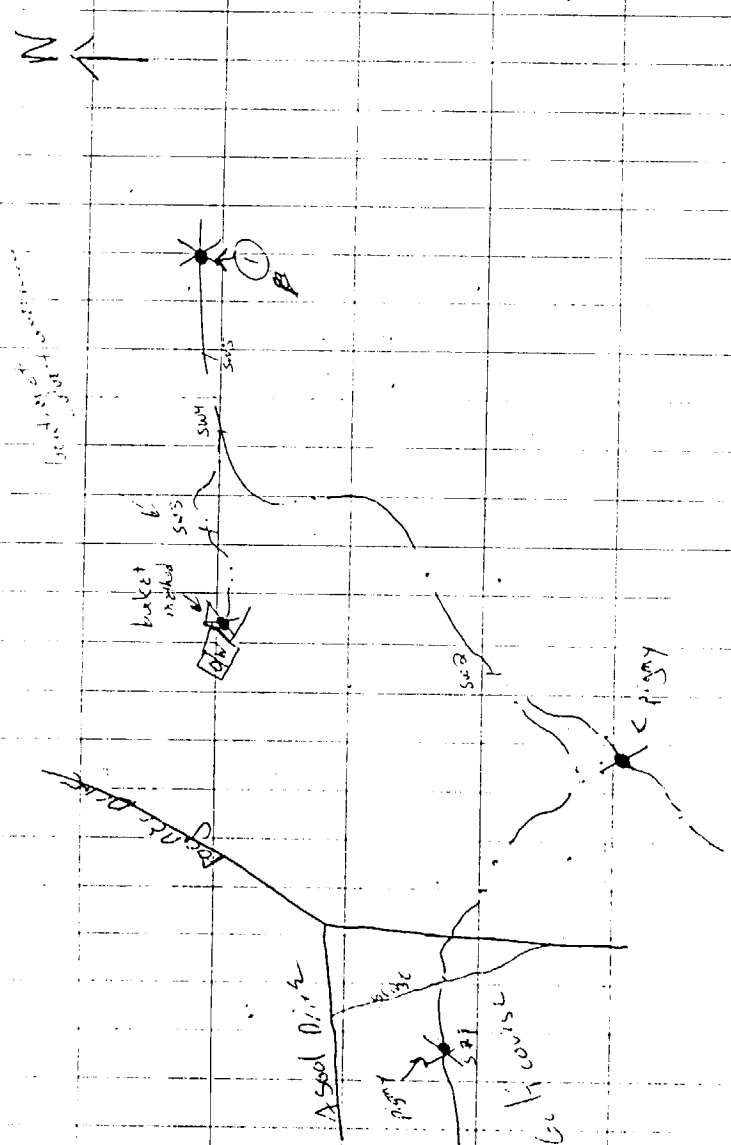
A.R.D. House River, at CARSWELL AFB

Dist. from initial point	Angle coefficient	Depth (inches)	Depth of observation	Revolutions	Time in seconds	VELOCITY At point ft/sec	VELOCITY Mean in vertical	VELOCITY Mean in section	Area sq. ft	Mean Depth	Width (ft)	Discharge ft³/sec
IP		0	.6			NA			0		1	
1'		7	.6			0.1	0.1		.58		1	.06
2'		7	.6			0.3	0.3		.58		1.	.17
3'		6	.6			0.3	0.3		.50		1	.15
4'		5.5	.6			0.4	0.4		.46		1	.18
5'		4.5	.6			0.5	0.5		.38		1	.19
6'		5.5	.6			0.4	0.4		.46		1	.18
7'		4.5	.6			0.5	0.5		.38		1	.19
8'		4	.6			.4	.4		.33		1	.13
9'		4.5	.6			.6	.6		.38		1	.23
10'		5	.6			0.3	0.3		.42		1	.13
11'		2	.6			0.2	0.2		.17		1	.04
12'		0	.6			—					1	—
												1.65 ft³/sec

332257

CAFB

Stream Flow Survey Locations 11/10/94


N
1
Swy
Swy
Swy
Swy
basket method
Swy
Swy
Swy
Swy

TRACER TEST DATA

332260

11/11/94

pulled up and down to mix the salt in the well.

1300 Leave AFB for Airport.

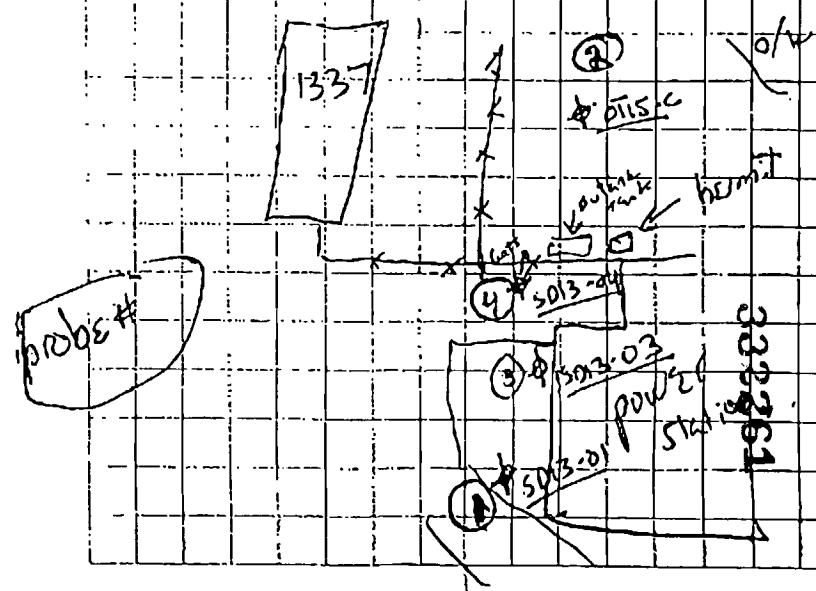
LB

Tracer test 2 12/19/94, 152

1330 Arrive at base. Talk with Alan Flolo. Discuss 2nd tracer test.

1407 Stop test 1. Pull out Probes. Info for the radio for insitue. For 1st test
Probe 1 = 9443002
ch 1:2
Probe 2 = 9443001
ch 3:4

1449 Begin to set up new test.



o/w

323361

Tracer Test #2 12/19/94

Probe 1 (200'), placed in SD13-01
ch 1:2 Lin=0 | Lin Scale=40 Offset=0
S/N 9443001 Scale=40
CTS-200 offset=0

Probe 2 (200'), placed in OT15C
ch 3:4 15CTEMP
S/N = 9443002 SAA
CTS-200

Probe 3 (50'), placed in SD13-03
ch 5:6
S/N 9444003 SAA

Probe 4 (50'), placed in SD13-04
ch 7:8
S/N 9444004 SAA

settings for T = Lin=0
Scale=40
Offset=0
settings for Cond = Lin=0
Scale=20000
Offset=0.00

Tracer Test #2 12/19/94

Channels

1) SD13-01 Temp - 13:01 Temp
2) SD13-01 Cond - 13:01 Cond
3) OT15C Temp - 15CTEMP
4) OT15C Cond - 15CCOND
5) SD13-03 Temp - 13:03 Temp
6) SD13-03 Cond - 13:03 Cond
7) SD13-04 Temp - 13:04 Temp
8) SD13-04 Cond - 13:04 Cond

1640 Begin Test. Test is setup to collect sample every 60 minutes.
1700 Leave site. End of Day

LS

(155)

SD13-01 SLUG TEST 12/23/94
CURT BURDORF (CAB)
0845 SUNNY, 35°F, LIGHT WIND
PICK UP ALAN'S KEY (ON DESK)
0915 RETRIEVE DATA FROM HERMIT
ELAPSED TIME 5280 MINUTES
CONDUCTIVITY IN SD13-01 = 784.30 µS/cm
0920 PULL TRANSDUCER FROM SD13-01
WATER LEVEL SD13-01 12.50 feet
BELOW TOP OF CASING (BTOC)
(INNER CASING, NORTH SIDE)
BOTTOM DEPTH 17.42 feet BTOC
WATER COLUMN 4.92 feet
BAIL 500 mL - SAMPLE COND
WITH HACH = 750 µS/cm
0930 CALCULATE MASS NaBr TO
RAISE MOLARITY X 0.3 NaBr
SEE EQUATION PAGE 149.
MUST ADD 93.81 grams NaBr
TO WELL SD13-01.
0935 RETRIEVE HERMIT DATA
5340 MIN.
COND SD13-01 = 783.79
IN AIR, OUTSIDE WELL.
CAB

(156)

CONT'D 12/23/94
1010 ADD 94 grams NaBr crystal
TO 500 ml OF SD13-01 WATER
IN JAR. MIX IN JAR.
POUR INTO SD13-01.
MIX WITH BAILER.
DRAIN BAILER.
COLLECT 500 ML SAMPLE COND = XX
PEGGED OUT THE METER.
TDS = 11.08 g/L
1020 PLACE TRANSDUCER & BAILER
INTO SD13-01 AT SAME DEPTH.
1040 RETRIEVE HERMIT DATA
COND SD13-01 = 5368.50 µS/cm
1140 RETRIEVE HERMIT DATA
COND SD13-01 = 1805.75 µS/cm
1210 REPLACE KEYS, LOCK UP.
DEPART BASE.
REMAINING DATA
COLLECTED, BUT NOT ENTERED
IN FIELD BOOK - WILL BE
IN AUSTIN OFFICE.
CAB
CAB

332253

332264

CARSWELL SD13-01 TRACER TEST (1)
12/23/94

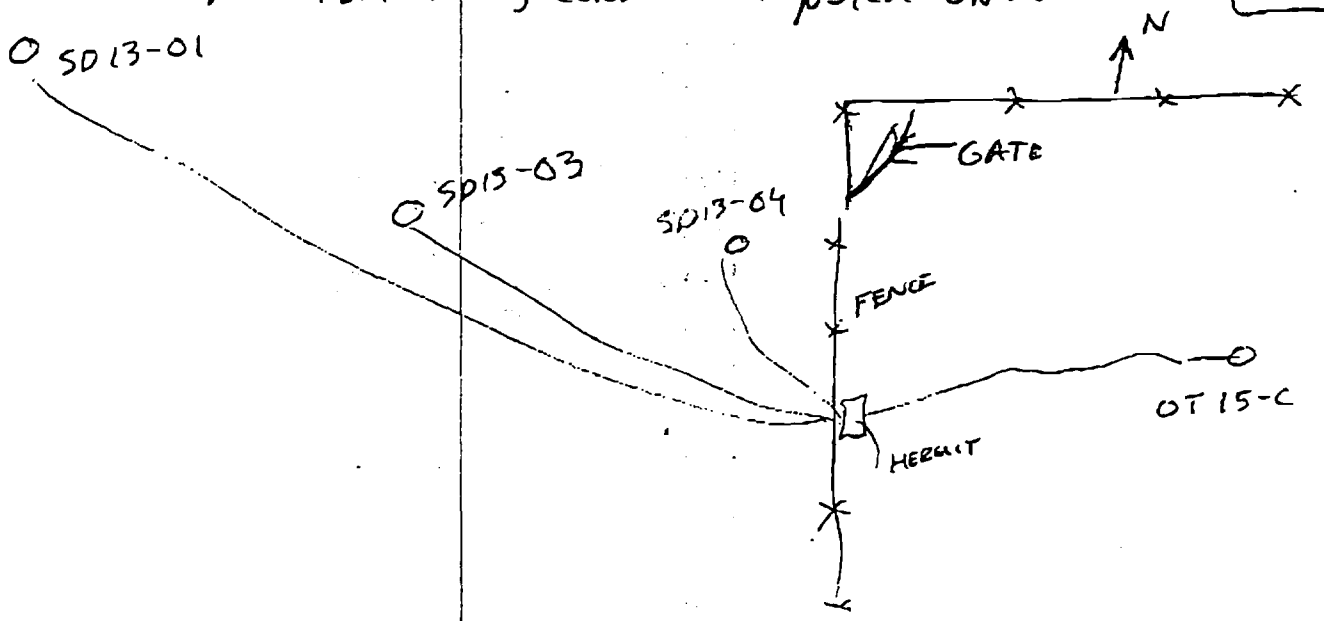
0845 Sunny, 35°F, light wind
Pick up key from Alan F. (ON DESK)
Curt Burdorf (CAB)

0915 RETRIEVE DATA FROM HERMIT
READING 1 TIME ON HERMIT 9:15 12/23 → CORRECT
ELAPSED TIME 5280 MINUTES

INPUT 1	1301	TEMP	21.685 °C	~~COND~~
2	1301	COND	784.300	µS/cm
3	15-C	TEMP	19.878	
4	15-C	COND	765.130	
5	1303	TEMP	21.080	
6	1303	COND	655.212	
7	1304	TEMP	20.39	
8	1304	COND	589.478	

*ALL TEMP IN °C, CONDUCTIVITY µS/cm UNLESS NOTED.

B1337



0920 PULL TRANSDUCER FROM SD13-01
WATER LEVEL IN SD13-01 12.50 ft BTOC (INNER CASING, N)
BOTTOM DEPTH 17.42' BTOC (" " ")
WATER COLUMN 4.92 ft

BAIL 500 ml, SAMPLE COND w/ HACH 0.75 mS/cm 750µS/cm
CALIBRATED 12/22/94 TO 1000µS/cm.

CAB

CARSWELL SD13-01 CONT'D 332265 (2)
12/23/94

09:30 CALCULATE MASS NaBr TO ADD TO RAISE MOLARITY TO 0.3 NaBr IN WELL, USING LAURA BROCKS CALCULATIONS FROM COMMUNICATION w/ LEIGH BENSON.

VOL. H_2O IN SD13-01 = 4.92 ft × 0.1632 gal/ft casing
= 0.8029 gal (3.785 l/gal)

$Vol\ H_2O = 3.04\ l$

$$\text{MOLARITY} = \frac{\text{MOLES SOLUTE}}{\text{LITERS SOLUTION}}$$

$$0.3\ M\ NaBr = \frac{X\ \text{MOLES NaBr}}{3.04\ l\ H_2O}$$

Moles NaBr = 0.9117

Na = 22.99
Br = 79.90

M.W. NaBr = 102.89 g

$$\frac{1\ \text{mole}}{102.89\ g\ NaBr} = \frac{0.9117\ \text{moles}}{X}$$

X = 93.81 grams NaBr to Add to WELL

0950 CONDUCTIVITY D.I. WATER = 0.05 mS/cm

0955 HERMIT READING 2

ELAPSED TIME 5340 MIN

INPUT 1	1301	TEMP	12.226	
2	1301	COND	-83.796	(IN AIR)
3	15-C	TEMP	19.724	
4	15-C	COND	871.931	
5	1303	TEMP	21.085	
6	1303	COND	611.389	
7	1304	TEMP	20.017	
8	1304	COND	597.694	

CAB

332266

CARSWELL SD13-01 CONT'D (3)
12/23/94

1010 ADD ~94 grams NaBr crystals to 500 ml of SD13-01 WELL WATER IN BAR. MIX, ~~MEASURE~~ POUR INTO SD13-01. MIX WITH BAILER. DRAIN BAILER, PULL SAMPLE COND - PEGGED OUT. TDS = 11.02 g/L

1020 PLACE TRANSDUCER & DEDICATED BAILER INTO SD13-01 AT SAME DEPTH.

10:40 READING 3 ON HERMIT ELAPSED TIME 5400 MIN

INPUT 1	1301	T	20.929
2	1301	COND	5368.50 ← SLUG MIX IN SD13-01
3	15-C	T	20.02
4	15-C	COND	830.854
5	1303	T	20.948
6	1303	COND	688.080
7	1304	T	20.148
8	1304	COND	611.389

CONDUCTIVITY FROM 784.3 µS/cm TO 5368.50 µS/cm.
INCREASE 6.84 TIMES CONCENTRATION PRE-SLUG.

11:40 READING 4 ELAPSED TIME 5460 MIN.

1	1301	T	21.57
2	1301	COND	1805.75
3	15C	T	19.598
4	15C	COND	806.730
5	1303	T	21.118
6	1303	COND	707.253
7	1304	T	20.105
8	1304	COND	597.694

1210 DEPART, KEYS IN ORIGINAL LOCATIONS

CAB

332267

CAB 12/23/94

NaBr TO ADD:

VOL. $H_2O_{SD13-01}$ = 4.92 ft × 0.16 gal/ft casing

= 0.8029 gal H_2O (3.785 liters/gal)

= 3.039 liters

Vol = 3.04 liters

USING LAURA BROCK'S CALC.

TO RAISE MOLARITY TO 0.3 NaBr in WELL

Molarity = MOLES SOLUTE / LITERS SOLUTION

0.3 M NaBr = X MOLES NaBr / 3.04 liters H_2O in well

Moles NaBr = 0.9117

M.W. of NaBr = 102.89 Na = 22.99, Br = 79.90

1 mole / 102.89 g NaBr = 0.9117 moles / X

X = 93.81 grams NaBr to ADD

---

500 gm NaBr Bottle 16 oz JAR ½ FULL w/ 500 gm (ie. 8 oz = 500 gm)

LAURA USED ~ 1/5 OF 1ST BOTTLE 400 gm Remain

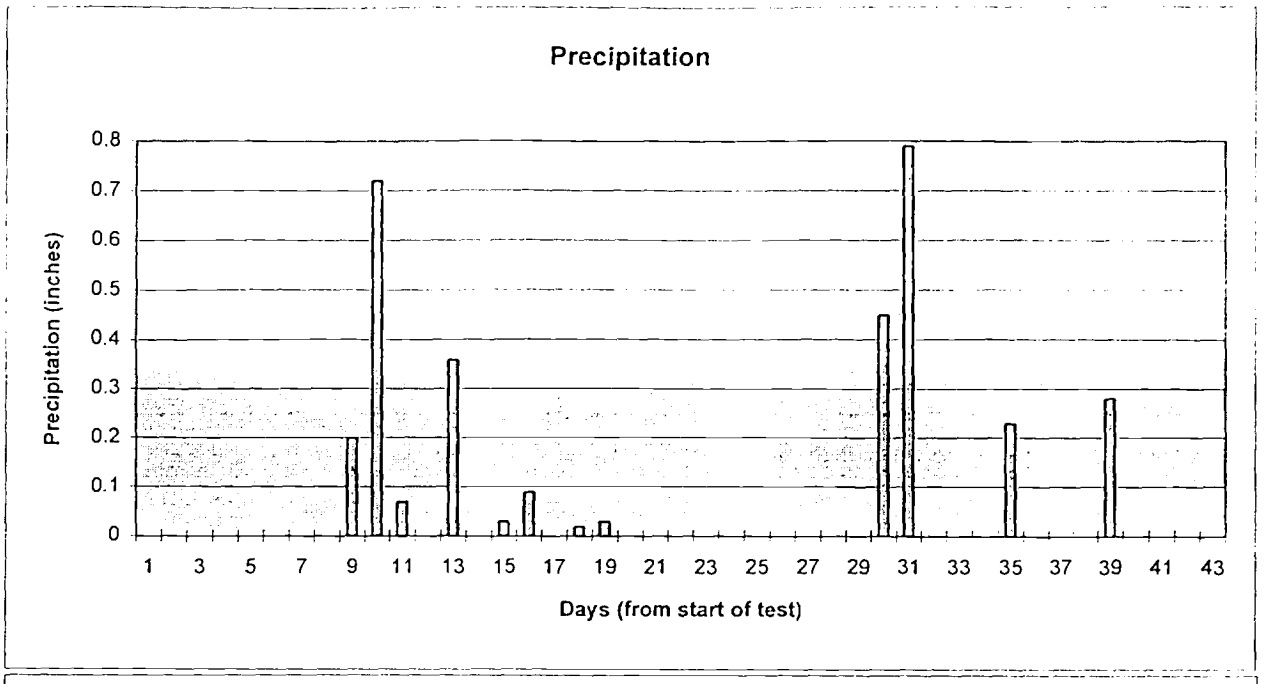
9:50 CONDUCTIVITY METER CAL. TO 1000 µS/cm 12/22/94

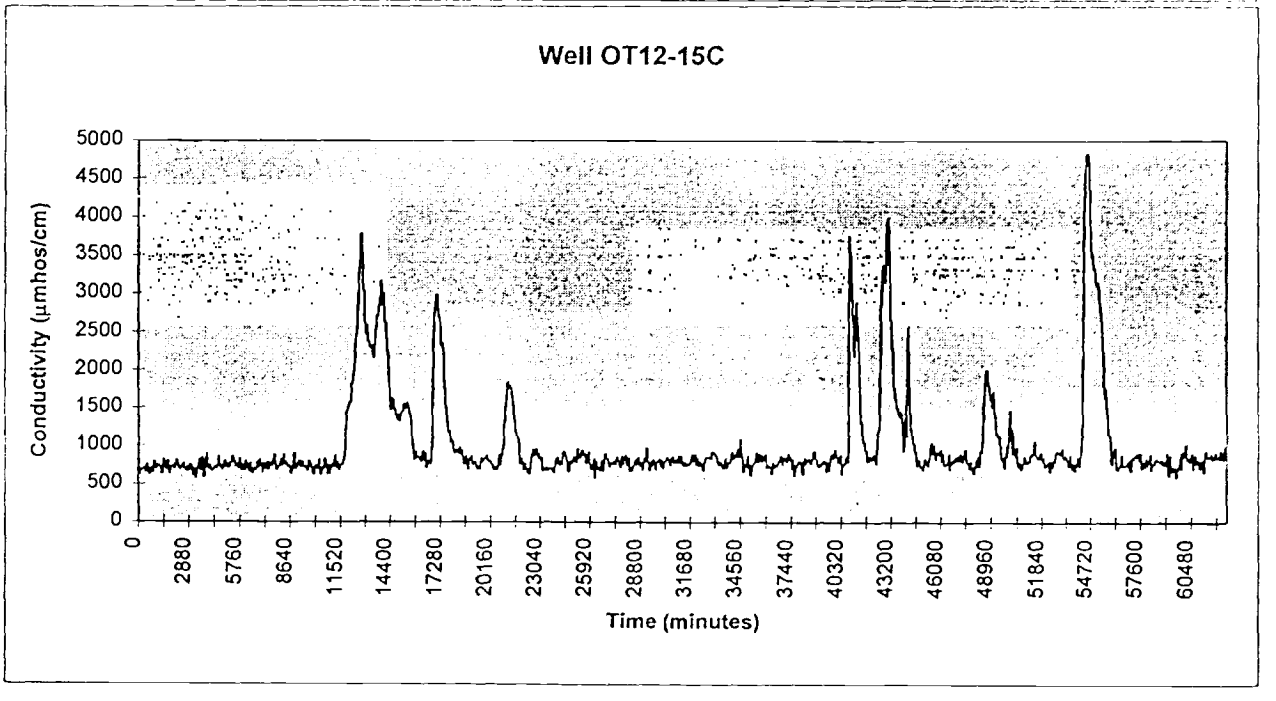
D.I. WATER 0.05 µS/cm = 50 µS/cm

TWO NAVY GUYS ON SITE

9:55 CHECK HERMIT COND IN SD01 ~83...

CORRECT PROBE/WELL.


Precipitation
Precipitation (inches)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43
Days (from start of test)


Well OT12-15C
Conductivity (µmhos/cm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0 2880 5760 8640 11520 14400 17280 20160 23040 25920 28800 31680 34560 37440 40320 43200 46080 48960 51840 54720 57600 60480
Time (minutes)

332269

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
0	21.8	1175.9	20.611	825.377	21.326	846.939	20.198	2315.01
60	21.723	874.669	20.365	625.468	21.189	751.076	20.307	633.301
120	21.685	781.561	20.244	666.545	21.326	767.51	20.373	592.217
180	21.521	808.946	20.442	693.93	21.452	729.164	20.68	589.478
240	21.909	778.823	20.277	696.668	21.304	745.598	20.346	553.871
300	21.751	765.13	20.299	707.622	21.26	704.514	20.362	616.867
360	21.663	767.869	20.173	696.668	21.277	657.951	20.505	581.261
420	21.844	767.869	20.108	650.114	21.381	800.377	20.614	559.349
480	21.603	762.392	20.294	756.915	21.381	709.992	20.225	578.522
540	21.849	589.868	20.234	751.438	21.233	844.2	20.296	614.128
600	21.74	611.776	20.146	636.422	21.408	682.602	20.269	671.646
660	21.482	745.961	20.255	622.73	21.2	729.164	20.313	496.353
720	21.92	625.468	20.217	715.838	21.392	649.735	20.187	578.522
780	21.789	715.838	20.217	715.838	21.282	693.558	20.302	537.438
840	21.608	696.668	20.058	639.16	21.222	688.08	20.329	594.956
900	21.811	650.114	20.042	803.469	21.282	644.257	20.318	696.297
960	21.816	781.561	20.157	765.13	21.266	759.293	20.274	740.12
1020	21.674	789.777	20.113	691.191	21.14	690.819	20.263	679.863
1080	21.553	718.576	20.113	745.961	21.2	789.421	20.422	688.08
1140	21.915	691.191	19.834	759.653	21.43	696.297	20.477	693.558
1200	21.773	633.684	20.168	732.269	21.058	709.992	20.395	696.297
1260	21.784	680.238	20.327	729.53	21.195	625.084	20.044	734.642
1320	21.745	650.114	20.113	699.407	21.348	715.469	20.253	770.248
1380	21.575	718.576	20.113	628.207	21.184	822.289	20.269	885.284
1440	21.559	765.13	19.954	836.331	20.926	800.377	20.274	668.907
1500	21.805	762.392	20.179	754.176	21.31	805.855	20.225	627.823
1560	21.822	652.853	19.998	754.176	20.724	655.212	20.307	594.956
1620	21.543	699.407	20.294	682.976	21.173	704.514	20.236	531.96
1680	21.762	740.484	20.217	817.161	21.321	767.51	20.225	570.305
1740	21.553	674.761	20.053	718.576	21.315	586.739	20.57	608.65
1800	21.647	713.099	20.349	630.945	21.463	709.992	20.17	521.004
1860	21.685	628.207	20.113	702.145	21.299	701.775	20.291	589.478
1920	21.838	562.483	20.124	754.176	21.26	666.168	20.231	482.658
1980	21.712	688.453	19.883	751.438	21.129	704.514	20.318	575.783
2040	21.488	652.853	20.206	737.746	21.189	718.208	20.225	542.915
2100	21.614	650.114	20.206	691.191	21.151	696.297	20.198	570.305
2160	21.751	557.006	19.993	817.161	21.222	685.341	20.253	529.221
2220	21.597	735.007	20.058	792.515	21.118	699.036	20.17	515.526
2280	21.532	641.899	20.009	754.176	21.091	682.602	20.263	540.176
2340	21.564	808.946	19.949	702.145	21.233	699.036	20.269	633.301
2400	21.499	762.392	19.971	682.976	21.184	704.514	20.263	603.172
2460	21.816	880.146	19.888	743.222	21.2	819.55	20.263	646.996
2520	21.433	806.207	20.053	729.53	21.392	701.775	20.137	737.381
2580	21.641	808.946	20.036	778.823	21.134	616.867	20.209	630.562
2640	21.575	784.3	19.905	699.407	21.206	742.859	20.203	622.345
2700	21.482	754.176	20.08	674.761	21.48	685.341	20.291	611.389
2760	21.499	765.13	20.08	677.499	21.2	652.474	20.258	636.04
2820	21.658	751.438	19.905	743.222	21.14	674.385	20.236	838.722
2880	21.641	688.453	19.686	661.068	21.036	896.24	20.285	896.24
2940	21.471	702.145	19.96	765.13	21.222	655.212	20.335	540.176
3000	21.816	795.253	20.042	713.099	20.987	630.562	20.066	455.269
3060	21.69	647.376	20.097	748.699	21.381	709.992	20.291	518.265
3120	21.663	814.423	19.872	600.822	21.529	685.341	20.072	485.397
3180	21.564	704.884	20.004	699.407	21.129	657.951	20.137	584
3240	21.723	721.315	19.91	707.622	21.113	638.779	20.116	485.397
3300	21.882	661.068	20.004	573.437	21.217	655.212	20.022	501.831

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
3360	21.548	611.776	20.135	699.407	21.118	644.257	20.192	534.699
3420	21.608	677.499	19.987	784.3	21.118	636.04	20.099	490.875
3480	21.778	784.3	19.806	833.592	21.255	671.646	20.05	490.875
3540	21.384	691.191	20.157	666.545	21.2	753.815	20.302	425.14
3600	21.734	767.869	19.927	858.238	21.14	674.385	19.847	477.181
3660	21.46	622.73	19.905	828.115	21.063	630.562	20.181	482.658
3720	21.745	732.269	20.004	600.822	21.195	666.168	20.263	523.743
3780	21.482	863.715	20.086	589.868	21.206	671.646	20.192	646.996
3840	21.751	745.961	20.064	811.684	21.156	778.465	20.209	581.261
3900	21.767	784.3	19.856	896.577	21.107	762.032	20.137	646.996
3960	21.553	860.977	19.872	732.269	21.145	715.469	20.099	586.739
4020	21.614	860.977	19.993	680.238	21.326	794.899	20.044	622.345
4080	21.784	828.115	19.686	759.653	21.14	559.349	20.307	677.124
4140	21.455	696.668	20.14	674.761	20.987	600.433	20.083	693.558
4200	21.63	743.222	19.823	669.284	21.08	627.823	20.225	584
4260	21.499	680.238	19.817	693.93	21.167	767.51	20.214	551.132
4320	21.614	819.9	19.993	688.453	21.124	559.349	20.176	630.562
4380	21.499	674.761	19.85	740.484	21.019	660.69	20.05	458.008
4440	21.619	833.592	19.899	693.93	20.756	630.562	20.105	468.964
4500	21.729	663.807	19.713	732.269	21.096	682.602	20.127	458.008
4560	21.564	767.869	19.976	869.192	21.08	671.646	20.346	510.048
4620	21.619	595.345	20.009	773.346	20.828	696.297	20.066	441.574
4680	21.614	672.022	20.031	724.053	21.102	663.429	20.077	521.004
4740	21.521	781.561	20.201	688.453	21.096	699.036	20.072	403.229
4800	21.51	682.976	20.234	688.453	21.107	660.69	20.137	447.052
4860	21.614	677.499	19.801	773.346	21.124	699.036	20.094	436.096
4920	21.482	885.623	19.872	814.423	21.447	649.735	20.105	395.012
4980	21.603	784.3	19.883	707.622	21.134	622.345	20.028	425.14
5040	21.734	735.007	19.899	784.3	21.145	589.478	20.033	452.53
5100	21.794	691.191	19.708	737.746	21.085	644.257	20.083	425.14
5160	21.559	661.068	19.757	710.361	21.063	696.297	20.017	436.096
5220	21.718	828.115	19.637	781.561	21.052	737.381	20.066	630.562
5280	21.685	784.3	19.878	765.13	21.08	655.212	20.039	589.478
5340	12.226	-83.796	19.724	871.931	21.085	611.389	20.017	597.694
5400	20.929	5368.5	20.02	830.854	20.948	688.08	20.148	611.389
5460	21.57	1805.75	19.598	800.73	21.118	707.253	20.105	597.694
5520	21.258	973.254	19.719	715.838	21.041	682.602	20.039	551.132
5580	21.422	923.962	19.834	762.392	21.041	723.686	20.258	644.257
5640	21.581	795.253	19.702	759.653	20.943	723.686	20.094	696.297
5700	21.438	808.946	19.779	691.191	21.047	709.992	20.088	496.353
5760	21.176	855.5	19.812	839.069	21.096	701.775	20.121	655.212
5820	21.537	806.207	19.845	721.315	20.992	510.048	20.001	438.835
5880	21.532	748.699	19.85	663.807	21.041	619.606	19.929	433.357
5940	21.4	860.977	19.773	767.869	21.162	720.947	19.979	427.879
6000	21.422	797.992	19.554	754.176	20.987	737.381	19.973	460.747
6060	21.351	655.591	19.675	663.807	21.365	649.735	19.858	411.446
6120	21.307	732.269	19.899	808.946	21.003	709.992	19.979	389.534
6180	21.395	792.515	19.522	704.884	21.025	638.779	20.006	493.614
6240	21.46	737.746	19.773	767.869	20.74	762.032	19.929	436.096
6300	21.307	609.037	19.691	647.376	20.943	638.779	19.891	438.835
6360	21.417	726.792	19.719	784.3	20.893	704.514	19.979	425.14
6420	21.307	628.207	19.626	724.053	21.041	663.429	19.957	408.707
6480	21.4	702.145	19.899	636.422	20.91	682.602	19.76	433.357
6540	21.367	748.699	19.806	658.33	21.014	682.602	19.962	400.49
6600	21.521	691.191	19.757	715.838	20.926	611.389	19.973	422.402
6660	21.417	792.515	19.735	674.761	20.976	685.341	20.001	468.964

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
6720	21.477	915.746	19.708	699.407	20.981	759.293	19.979	463.486
6780	21.488	904.792	19.773	797.992	20.91	699.036	19.94	636.04
6840	21.543	789.777	19.615	699.407	20.97	677.124	19.984	605.911
6900	21.411	913.008	19.801	828.115	20.992	693.558	19.781	468.964
6960	21.313	932.177	19.697	751.438	21.233	709.992	19.907	589.478
7020	21.515	945.87	19.653	745.961	21.008	726.425	19.765	526.482
7080	21.794	792.515	19.779	644.637	20.981	581.261	19.968	526.482
7140	21.466	902.054	19.626	792.515	21.08	611.389	20.017	499.092
7200	21.477	784.3	19.713	688.453	20.981	671.646	19.962	553.871
7260	21.499	693.93	19.812	787.038	20.91	625.084	19.913	403.229
7320	21.307	800.73	19.691	674.761	20.877	663.429	19.858	353.928
7380	21.553	691.191	19.522	792.515	21.145	668.907	19.929	395.012
7440	21.258	874.669	19.735	674.761	20.998	688.08	20.039	441.574
7500	21.488	847.285	19.68	787.038	20.992	720.947	19.902	414.185
7560	21.466	644.637	19.746	762.392	20.926	660.69	20.001	397.751
7620	21.34	792.515	19.549	724.053	20.882	679.863	19.913	373.1
7680	21.548	759.653	19.697	811.684	20.937	652.474	19.869	397.751
7740	21.197	652.853	19.773	891.1	20.921	709.992	19.869	364.884
7800	21.384	847.285	19.626	836.331	20.998	718.208	19.913	364.884
7860	21.367	713.099	19.648	677.499	21.052	699.036	19.913	408.707
7920	21.433	751.438	19.779	693.93	20.987	767.51	19.864	411.446
7980	21.597	839.069	19.763	735.007	20.882	638.779	19.836	460.747
8040	21.488	797.992	19.642	715.838	20.954	685.341	19.853	373.1
8100	21.395	888.362	19.669	833.592	20.893	729.164	19.968	559.349
8160	21.395	828.115	19.626	737.746	21.019	814.072	19.853	542.915
8220	21.099	661.068	19.713	743.222	20.839	622.345	19.886	523.743
8280	21.263	814.423	19.401	893.839	20.674	690.819	19.913	641.518
8340	21.208	970.516	19.697	748.699	21.047	674.385	19.76	460.747
8400	21.482	797.992	19.39	800.73	20.861	570.305	19.705	474.442
8460	21.247	880.146	19.56	765.13	20.915	551.132	19.677	638.779
8520	21.449	781.561	19.598	729.53	20.91	485.397	19.88	611.389
8580	21.269	926.7	19.527	713.099	20.915	682.602	19.732	570.305
8640	21.581	767.869	19.609	756.915	20.866	652.474	19.836	526.482
8700	21.307	767.869	19.516	630.945	20.899	584	19.929	386.795
8760	21.247	784.3	19.549	677.499	21.069	657.951	19.858	397.751
8820	21.4	713.099	19.642	702.145	20.91	636.04	19.727	411.446
8880	21.4	751.438	19.609	913.008	20.855	605.911	19.798	326.538
8940	21.471	729.53	19.571	748.699	20.844	677.124	19.88	419.663
9000	21.411	724.053	19.472	688.453	20.861	663.429	19.814	351.189
9060	21.291	822.638	19.516	767.869	20.926	652.474	19.76	458.008
9120	21.515	888.362	19.554	776.084	20.828	715.469	19.913	416.924
9180	21.356	844.546	19.68	814.423	20.976	666.168	19.875	364.884
9240	21.356	806.207	19.505	710.361	20.915	649.735	19.847	433.357
9300	21.225	735.007	19.511	754.176	20.806	636.04	19.853	386.795
9360	21.395	639.16	19.385	800.73	20.85	652.474	19.716	419.663
9420	21.219	817.161	19.68	710.361	20.872	594.956	19.814	386.795
9480	21.4	800.73	19.719	724.053	20.855	657.951	19.836	441.574
9540	21.384	877.408	19.549	737.746	20.855	693.558	19.787	518.265
9600	21.559	841.808	19.39	707.622	20.789	666.168	19.765	542.915
9660	21.203	762.392	19.73	666.545	20.899	734.642	19.836	425.14
9720	21.241	828.115	19.752	808.946	20.647	707.253	19.666	564.827
9780	21.526	918.485	19.571	767.869	20.713	501.831	19.929	408.707
9840	21.367	871.931	19.669	767.869	20.948	633.301	19.831	531.96
9900	21.329	803.469	19.401	707.622	20.669	685.341	19.688	540.176
9960	21.351	882.885	19.686	652.853	20.899	627.823	19.94	488.136
10020	21.438	748.699	19.56	622.73	20.57	493.614	19.617	559.349

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
10080	21.285	828.115	19.587	762.392	20.751	619.606	19.792	521.004
10140	21.181	765.13	19.571	726.792	20.806	578.522	19.787	416.924
10200	21.23	808.946	19.571	688.453	20.674	564.827	20.006	405.968
10260	21.132	680.238	19.428	710.361	20.861	578.522	19.403	359.406
10320	21.4	778.823	19.412	830.854	20.85	616.867	19.765	397.751
10380	21.367	776.084	19.483	622.73	20.959	690.819	19.825	351.189
10440	21.411	789.777	19.604	641.899	20.877	646.996	19.77	351.189
10500	21.252	762.392	19.281	726.792	20.784	666.168	19.727	400.49
10560	21.362	663.807	19.505	674.761	20.822	699.036	19.727	403.229
10620	21.296	850.023	19.423	841.808	20.811	666.168	19.781	403.229
10680	21.367	743.222	19.538	795.253	20.833	652.474	19.76	405.968
10740	21.28	696.668	19.527	759.653	20.658	641.518	19.847	359.406
10800	21.132	732.269	19.292	614.514	20.773	644.257	19.705	351.189
10860	21.269	740.484	19.5	756.915	20.767	630.562	19.727	370.361
10920	21.334	806.207	19.489	625.468	20.822	622.345	19.732	370.361
10980	21.488	797.992	19.324	718.576	20.784	589.478	19.743	512.787
11040	21.23	696.668	19.417	770.607	20.587	720.947	19.803	521.004
11100	21.307	795.253	19.543	710.361	20.784	636.04	19.787	537.438
11160	21.411	877.408	19.385	784.3	21.041	723.686	19.683	556.61
11220	21.258	850.023	19.428	877.408	20.74	594.956	19.929	586.739
11280	20.978	745.961	19.593	699.407	20.57	531.96	19.727	463.486
11340	21.34	773.346	19.604	797.992	20.74	619.606	19.677	600.433
11400	21.23	882.885	19.292	767.869	20.713	709.992	19.65	556.61
11460	21.241	860.977	19.39	672.022	20.696	740.12	19.732	594.956
11520	21.203	803.469	19.275	759.653	20.477	822.289	19.727	537.438
11580	21.252	713.099	19.237	743.222	20.789	718.208	19.677	307.366
11640	21.274	680.238	19.352	756.915	20.85	674.385	19.579	373.1
11700	21.241	688.453	19.149	800.73	20.718	616.867	19.655	438.835
11760	21.329	995.162	19.664	891.1	20.751	619.606	19.623	392.273
11820	21.34	814.423	19.412	1206.02	21.129	679.863	19.65	370.361
11880	21.197	1030.76	19.407	1449.74	20.751	723.686	19.672	279.976
11940	21.356	926.7	19.445	1455.22	20.778	682.602	19.579	370.361
12000	21.154	1148.51	19.489	1537.38	20.636	715.469	19.666	433.357
12060	21.214	1082.79	19.428	1581.19	20.669	690.819	19.584	427.879
12120	21.34	1208.76	19.242	1553.81	20.806	737.381	19.754	482.658
12180	21.197	1216.97	19.516	1822.18	20.718	748.337	19.787	447.052
12240	21.039	1219.71	19.396	1822.18	20.713	660.69	19.634	482.658
12300	21.34	1260.79	19.368	2008.39	21.113	764.771	19.535	381.317
12360	21.077	1444.27	19.308	2098.76	20.811	811.333	19.842	493.614
12420	21.148	1471.65	19.324	2397.26	20.702	934.586	19.59	1701.49
12480	21.203	1597.62	19.385	2509.53	20.735	841.461	19.891	1183.83
12540	21.296	1616.79	19.412	2723.13	21.102	805.855	19.65	603.172
12600	21.252	1709.9	19.27	3281.78	20.735	1192.04	19.601	594.956
12660	21.17	1898.85	19.472	3492.65	20.74	1109.87	19.655	630.562
12720	21.17	2008.39	19.522	3788.4	20.735	1205.74	19.644	597.694
12780	21.247	1994.7	19.461	3741.85	20.762	1164.65	19.546	783.943
12840	21.263	1803.01	19.352	3054.49	20.707	964.714	19.655	1003.05
12900	21.296	1660.61	19.308	3005.2	20.773	992.104	19.617	868.851
12960	21.197	1553.81	19.417	2536.92	20.822	874.329	19.699	649.735
13020	21.285	1178.64	19.357	2457.5	20.488	896.24	19.42	425.14
13080	21.28	1479.87	19.379	2594.43	20.735	877.068	19.606	430.618
13140	21.093	1551.07	19.33	2358.92	20.521	844.2	19.803	378.578
13200	21.181	1482.61	19.511	2372.61	20.68	866.112	19.453	518.265
13260	21.247	1468.91	19.412	2284.98	20.532	882.546	19.518	490.875
13320	21.061	1392.24	19.275	2326.06	20.696	868.851	19.595	416.924
13380	21.187	1436.05	19.231	2309.63	20.68	871.59	19.288	411.446

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
13440	21.285	1468.91	19.341	2150.79	21.151	786.682	19.699	334.755
13500	21.269	1337.47	19.341	2211.04	20.685	827.766	19.546	422.402
13560	21.187	1559.28	19.182	2460.24	20.767	877.068	19.486	422.402
13620	21.11	1586.67	19.231	2610.86	20.691	1022.23	19.518	416.924
13680	21.351	1589.41	19.368	2701.23	20.641	912.674	19.508	400.49
13740	21.028	1594.88	19.078	2728.61	20.674	1022.23	19.792	373.1
13800	21.176	1718.11	19.176	2955.91	20.702	1044.14	19.634	433.357
13860	21.055	1819.44	19.324	2871.01	20.844	1038.66	19.491	586.739
13920	21.154	1803.01	19.346	3174.98	20.735	1164.65	19.491	477.181
13980	21.126	1627.75	19.231	2832.67	20.428	997.582	19.557	521.004
14040	21.077	1687.99	19.374	3018.89	20.57	1038.66	19.54	652.474
14100	21.247	1567.5	19.297	2679.32	20.614	994.843	19.518	594.956
14160	21.258	1518.21	19.253	2599.9	20.57	1008.53	19.573	603.172
14220	21.115	1353.9	19.138	2427.38	20.4	888.023	19.628	619.606
14280	21.154	1537.38	19.176	2227.47	20.729	767.51	19.436	553.871
14340	21.373	1277.22	19.067	1981.01	20.609	704.514	19.261	490.875
14400	20.885	1301.87	19.176	1718.11	20.554	723.686	19.497	589.478
14460	20.995	1126.6	19.22	1457.96	20.74	778.465	19.201	373.1
14520	21.022	1156.73	19.122	1627.75	20.614	808.594	19.414	378.578
14580	20.956	1104.7	19.116	1616.79	20.663	789.421	19.469	345.711
14640	20.924	1225.19	19.16	1504.51	20.472	797.638	19.584	375.839
14700	21.121	1036.23	19.242	1474.39	20.62	704.514	19.409	392.273
14760	20.907	1071.83	19.16	1422.36	20.784	652.474	19.486	400.49
14820	21.225	1093.74	19.012	1331.99	20.696	608.65	19.447	381.317
14880	20.891	1143.04	18.908	1411.41	20.592	627.823	19.612	419.663
14940	21.296	1156.73	19.253	1315.56	20.565	688.08	19.842	364.884
15000	21.28	1167.68	19.16	1386.76	20.729	644.257	19.497	381.317
15060	21.088	1189.59	19.281	1433.31	20.554	646.996	19.464	364.884
15120	21.006	1121.13	19.122	1433.31	20.587	704.514	19.151	304.627
15180	20.995	962.3	19.007	1463.44	20.587	712.73	19.497	356.667
15240	21.028	1318.3	19.144	1564.76	20.543	674.385	19.31	389.534
15300	20.896	1143.04	19.133	1474.39	20.581	709.992	19.486	474.442
15360	20.874	1170.42	19.193	1564.76	20.532	737.381	19.535	436.096
15420	20.935	1219.71	19.259	1556.54	20.614	688.08	19.343	482.658
15480	21.028	1017.07	19.111	1507.25	20.291	625.084	19.59	600.433
15540	20.984	959.562	18.99	1438.79	20.515	646.996	19.371	545.654
15600	20.869	910.269	19.094	1315.56	20.68	570.305	19.508	488.136
15660	20.913	978.731	19.27	1126.6	20.625	545.654	19.54	553.871
15720	20.924	937.654	19.105	986.947	20.313	726.425	19.403	477.181
15780	20.852	740.484	19.407	814.423	20.702	652.474	19.475	510.048
15840	21.093	921.223	19.127	934.916	20.515	636.04	19.217	515.526
15900	21.159	713.099	19.231	907.531	20.576	605.911	19.398	304.627
15960	20.995	784.3	19.105	833.592	20.62	693.558	19.299	321.06
16020	21.115	850.023	19.105	866.454	20.576	657.951	19.513	414.185
16080	21.104	735.007	19.072	860.977	20.609	614.128	19.228	323.799
16140	20.918	874.669	19.27	814.423	20.707	616.867	19.382	332.016
16200	21.181	841.808	19.215	778.823	20.307	611.389	19.277	395.012
16260	21.072	795.253	19.029	932.177	20.494	625.084	19.376	386.795
16320	20.962	797.992	19.226	904.792	20.756	652.474	19.442	356.667
16380	20.77	808.946	18.968	784.3	20.488	630.562	19.371	362.145
16440	21.165	860.977	18.946	910.269	20.505	619.606	19.414	345.711
16500	21.176	748.699	19.061	702.145	20.565	605.911	19.245	310.104
16560	20.94	825.377	19.166	819.9	20.603	633.301	19.392	370.361
16620	21.263	825.377	19.083	792.515	20.532	641.518	19.508	315.582
16680	20.929	825.377	19.078	756.915	20.609	709.992	19.409	345.711
16740	21.044	954.085	18.886	759.653	20.581	630.562	19.343	433.357

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
16800	21.033	967.777	19.04	984.208	20.548	567.566	19.338	510.048
16860	20.836	1219.71	19.105	1597.62	20.587	622.345	19.294	482.658
16920	21.077	1572.98	19.029	2435.6	20.477	707.253	19.349	589.478
16980	20.984	1572.98	19.122	2766.95	20.505	742.859	19.453	559.349
17040	20.989	1715.38	18.848	2966.86	20.269	816.811	19.425	479.92
17100	20.88	1819.44	19.105	2988.77	20.548	753.815	19.617	627.823
17160	20.885	1786.58	18.93	2860.06	20.461	814.072	19.672	594.956
17220	21.061	1860.52	18.919	2706.7	20.433	989.365	19.086	477.181
17280	20.962	1731.81	18.93	2660.15	20.472	666.168	19.31	540.176
17340	21.072	1545.59	19.023	2306.89	20.85	792.16	19.573	378.578
17400	21.061	1696.21	18.711	2353.44	20.494	811.333	19.442	419.663
17460	21.099	1715.38	19.264	2353.44	20.433	693.558	19.327	460.747
17520	20.666	1405.93	18.919	2022.09	20.4	641.518	19.245	392.273
17580	20.924	1326.51	19.209	1556.54	20.494	712.73	19.195	362.145
17640	20.913	1091	18.985	1509.99	20.34	663.429	19.283	403.229
17700	20.896	1164.94	19.023	1296.39	20.461	603.172	19.321	362.145
17760	21.044	1003.37	19.111	1178.64	20.521	677.124	19.299	362.145
17820	21.247	945.87	19.001	1200.54	20.537	611.389	19.365	386.795
17880	21.011	874.669	19.012	1030.76	20.466	677.124	19.075	345.711
17940	21.033	940.393	19.1	1063.62	20.428	575.783	19.239	364.884
18000	21.033	945.87	18.815	1058.14	20.477	622.345	19.349	285.454
18060	20.94	710.361	18.936	899.316	20.488	649.735	19.469	364.884
18120	21.055	877.408	19.007	910.269	20.483	567.566	19.371	307.366
18180	20.841	959.562	18.957	904.792	20.17	729.164	19.491	564.827
18240	20.978	1000.63	19.007	956.823	20.422	707.253	19.349	518.265
18300	20.891	893.839	19.023	891.1	20.483	652.474	18.878	526.482
18360	20.984	776.084	18.963	986.947	20.389	688.08	19.256	504.57
18420	20.962	778.823	18.968	978.731	20.411	663.429	19.316	540.176
18480	20.891	880.146	19.023	871.931	20.45	633.301	19.338	515.526
18540	20.82	825.377	18.919	948.608	20.472	660.69	19.316	395.012
18600	21	743.222	18.755	781.561	20.395	668.907	19.436	540.176
18660	20.814	871.931	18.886	754.176	20.532	655.212	19.447	449.791
18720	20.885	778.823	18.946	787.038	20.499	783.943	19.382	575.783
18780	20.781	803.469	18.914	877.408	20.384	652.474	19.277	504.57
18840	21.055	691.191	18.87	737.746	20.636	586.739	19.036	364.884
18900	20.77	825.377	18.755	688.453	20.379	556.61	19.272	364.884
18960	20.907	800.73	19.051	839.069	20.34	668.907	19.206	337.494
19020	20.841	792.515	18.87	841.808	20.4	608.65	19.277	304.627
19080	21.093	781.561	18.722	874.669	20.411	649.735	19.266	329.277
19140	21.011	830.854	18.946	745.961	20.406	630.562	19.239	389.534
19200	20.978	803.469	18.853	792.515	20.389	619.606	19.157	351.189
19260	20.787	770.607	19.001	778.823	20.439	616.867	19.245	359.406
19320	20.683	707.622	18.892	797.992	20.543	674.385	19.316	359.406
19380	20.776	833.592	18.974	704.884	20.411	556.61	19.31	271.759
19440	20.798	699.407	19.012	696.668	20.789	521.004	19.277	340.233
19500	20.918	828.115	18.831	737.746	20.428	548.393	19.316	315.582
19560	20.951	633.684	18.81	691.191	20.417	529.221	19.146	351.189
19620	21.05	830.854	18.974	850.023	20.329	737.381	19.25	542.915
19680	20.787	713.099	18.782	773.346	20.428	677.124	19.371	666.168
19740	20.705	836.331	18.837	822.638	20.324	630.562	19.261	515.526
19800	21.132	770.607	18.886	822.638	20.515	521.004	19.31	482.658
19860	21.214	896.577	19.023	839.069	20.291	720.947	19.223	466.225
19920	20.989	918.485	18.886	877.408	20.192	682.602	19.25	510.048
19980	20.82	836.331	18.837	839.069	20.225	641.518	19.288	468.964
20040	20.633	871.931	18.722	789.777	20.346	655.212	19.266	479.92
20100	21.022	797.992	18.711	806.207	20.34	589.478	19.124	507.309

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
20160	20.918	784.3	18.881	787.038	20.439	573.044	19.124	381.317
20220	21.072	735.007	18.985	759.653	20.411	592.217	19.228	342.972
20280	20.847	787.038	18.957	756.915	20.357	570.305	19.201	405.968
20340	20.655	866.454	18.678	707.622	20.291	584	19.36	285.454
20400	20.891	808.946	18.612	682.976	20.581	548.393	19.321	345.711
20460	20.907	685.715	18.81	726.792	20.313	578.522	19.19	315.582
20520	20.721	641.899	18.87	682.976	20.318	646.996	19.195	310.104
20580	20.831	781.561	18.853	732.269	20.313	633.301	19.097	236.153
20640	20.54	806.207	18.831	893.839	20.324	548.393	19.343	318.321
20700	20.885	1017.07	18.629	745.961	20.362	570.305	19.529	329.277
20760	21.006	902.054	18.952	778.823	20.346	559.349	19.173	315.582
20820	20.803	956.823	18.957	923.962	20.351	553.871	19.228	318.321
20880	20.792	989.685	18.733	975.993	20.274	537.438	19.223	271.759
20940	20.787	992.424	18.793	1269.01	20.269	594.956	19.141	255.325
21000	20.847	1025.28	18.755	1381.28	20.269	627.823	19.513	345.711
21060	20.661	1186.85	18.82	1592.15	20.351	657.951	19.332	871.59
21120	20.726	1222.45	18.684	1772.88	20.296	737.381	19.173	1413.9
21180	20.809	1167.68	18.837	1849.56	20.296	652.474	18.927	1947.99
21240	20.765	1148.51	18.853	1797.53	20.313	622.345	19.261	427.879
21300	20.902	1151.25	18.87	1792.05	20.17	748.337	18.927	2350.62
21360	20.847	1123.87	18.941	1729.07	20.318	770.248	19.053	1969.91
21420	20.962	1060.88	18.766	1614.05	20.253	729.164	19.217	2131.5
21480	21.077	1238.88	18.601	1556.54	20.302	715.469	19.086	1578.23
21540	20.885	965.039	18.946	1356.64	20.362	830.505	19.223	1287.91
21600	20.759	1063.62	18.853	1230.67	20.291	740.12	19.228	1679.58
21660	20.913	773.346	18.76	1112.91	20.368	720.947	18.993	1186.56
21720	20.776	1008.85	18.771	1118.39	20.324	564.827	19.004	271.759
21780	20.863	962.3	18.738	1074.57	20.214	660.69	19.217	395.012
21840	20.776	880.146	18.607	751.438	20.302	627.823	19.135	411.446
21900	20.913	773.346	18.782	803.469	20.28	581.261	19.097	416.924
21960	20.579	702.145	18.87	841.808	20.274	633.301	19.119	359.406
22020	20.776	784.3	18.7	773.346	20.231	592.217	18.965	312.843
22080	21.033	699.407	18.793	682.976	20.368	564.827	19.201	277.237
22140	20.737	707.622	18.64	781.561	20.379	534.699	19.108	271.759
22200	20.776	721.315	18.957	721.315	20.214	578.522	19.168	321.06
22260	20.896	855.5	18.788	724.053	20.22	507.309	19.184	334.755
22320	20.726	830.854	18.716	644.637	20.411	553.871	19.119	340.233
22380	20.721	655.591	18.826	647.376	20.285	600.433	19.036	332.016
22440	20.831	724.053	18.673	628.207	20.242	584	19.108	266.281
22500	20.781	891.1	18.59	797.992	20.165	772.987	19.162	2197.24
22560	20.759	874.669	18.7	885.623	20.159	729.164	19.069	1457.72
22620	20.896	926.7	18.711	962.3	20.231	729.164	19.047	1871.3
22680	20.661	932.177	18.623	860.977	20.247	731.903	19.02	2931.28
22740	20.694	904.792	18.864	915.746	20.307	723.686	19.119	2032.9
22800	21.022	1060.88	18.695	973.254	20.132	756.554	19.009	2506.74
22860	20.825	896.577	18.711	913.008	20.296	690.819	19.08	1854.87
22920	20.814	1014.33	18.662	830.854	19.935	608.65	19.102	2643.69
22980	20.765	1126.6	18.875	910.269	20.225	638.779	19.053	2701.21
23040	20.94	1014.33	18.727	817.161	20.329	638.779	19.004	2851.85
23100	20.852	934.916	18.81	860.977	20.17	685.341	19.064	2914.84
23160	20.568	636.422	18.448	718.576	20.313	540.176	19.206	323.799
23220	20.491	704.884	18.749	666.545	20.209	614.128	19.195	397.751
23280	20.71	680.238	18.514	702.145	20.263	559.349	19.184	288.193
23340	20.721	721.315	18.563	699.407	20.072	545.654	18.976	315.582
23400	20.688	773.346	18.569	732.269	20.247	573.044	19.075	255.325
23460	20.831	762.392	18.563	669.284	20.17	573.044	19.135	299.149

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
23520	20.869	754.176	18.645	702.145	20.236	545.654	19.13	271.759
23580	20.967	663.807	18.519	702.145	20.159	592.217	19.069	301.888
23640	20.343	735.007	18.766	715.838	20.154	597.694	19.075	359.406
23700	20.699	869.192	18.689	707.622	20.236	559.349	19.069	364.884
23760	20.606	685.715	18.58	704.884	20.132	614.128	19.075	340.233
23820	20.918	702.145	18.722	655.591	20.389	600.433	19.091	288.193
23880	20.924	797.992	18.662	652.853	19.918	600.433	18.943	290.932
23940	20.584	825.377	18.53	822.638	20.291	677.124	19.157	504.57
24000	20.699	937.654	18.623	822.638	20.236	636.04	19.124	419.663
24060	20.562	825.377	18.497	855.5	20.105	655.212	19.097	477.181
24120	20.852	850.023	18.448	754.176	20.17	581.261	19.217	597.694
24180	20.611	910.269	18.503	743.222	20.231	660.69	19.256	548.393
24240	20.59	902.054	18.596	808.946	20.148	625.084	19.015	479.92
24300	20.803	737.746	18.612	754.176	20.033	641.518	19.086	444.313
24360	20.759	948.608	18.716	929.439	20.094	630.562	19.042	625.084
24420	20.732	844.546	18.716	923.962	20.143	652.474	18.971	2950.45
24480	20.82	1017.07	18.634	871.931	20.072	770.248	18.905	2553.3
24540	20.502	940.393	18.788	880.146	20.121	638.779	19.058	2493.05
24600	20.781	721.315	18.53	770.607	20.148	608.65	19.069	310.104
24660	20.644	839.069	18.596	663.807	20.077	608.65	18.669	312.843
24720	20.469	819.9	18.541	680.238	20.231	638.779	19.075	288.193
24780	20.606	858.238	18.36	819.9	20.225	655.212	19.064	422.402
24840	20.666	913.008	18.421	787.038	20.181	641.518	18.982	362.145
24900	20.628	825.377	18.508	767.869	20.159	578.522	18.73	301.888
24960	20.721	915.746	18.574	839.069	20.121	518.265	18.949	266.281
25020	20.579	915.746	18.492	863.715	20.11	537.438	19.036	310.104
25080	20.831	877.408	18.585	814.423	19.984	493.614	19.009	269.02
25140	20.787	869.192	18.443	773.346	20.088	526.482	19.009	269.02
25200	20.584	833.592	18.569	962.3	20.127	564.827	18.899	329.277
25260	20.787	806.207	18.514	844.546	20.154	584	19.042	274.498
25320	20.617	945.87	18.289	836.331	20.176	545.654	19.058	288.193
25380	20.705	1030.76	18.552	866.454	20.083	564.827	19.031	419.663
25440	20.59	888.362	18.273	951.347	20.094	592.217	19.058	537.438
25500	20.595	800.73	18.569	913.008	20.055	573.044	18.801	389.534
25560	20.381	839.069	18.41	863.715	20.346	630.562	18.921	370.361
25620	20.579	756.915	18.3	915.746	20.022	586.739	19.031	389.534
25680	20.557	981.47	18.486	773.346	20.137	523.743	19.069	526.482
25740	20.54	830.854	18.475	773.346	20.061	540.176	19.168	392.273
25800	20.677	776.084	18.421	855.5	20.274	474.442	18.905	482.658
25860	20.524	819.9	18.47	926.7	20.11	537.438	18.987	444.313
25920	20.518	858.238	18.47	751.438	20.127	605.911	18.79	378.578
25980	20.54	893.839	18.541	724.053	20.105	715.469	18.697	321.06
26040	20.6	762.392	18.47	688.453	20.066	581.261	18.993	263.542
26100	20.748	669.284	18.339	707.622	20.105	573.044	18.889	277.237
26160	20.529	724.053	18.432	841.808	20.198	586.739	18.889	332.016
26220	20.513	729.53	18.344	576.176	20.137	559.349	18.938	269.02
26280	20.661	724.053	18.459	814.423	20.181	594.956	19.119	345.711
26340	20.661	811.684	18.267	702.145	20.083	600.433	18.932	293.671
26400	20.513	691.191	18.514	702.145	20.121	562.088	19.02	315.582
26460	20.759	789.777	18.415	745.961	20.417	619.606	18.927	307.366
26520	20.721	636.422	18.393	674.761	20.055	605.911	18.883	310.104
26580	20.568	888.362	18.41	808.946	19.951	540.176	18.943	378.578
26640	20.606	808.946	18.41	814.423	20.061	619.606	19.031	329.277
26700	20.321	871.931	18.426	666.545	19.716	518.265	18.91	342.972
26760	20.376	795.253	18.585	860.977	20.083	652.474	18.954	356.667
26820	20.655	877.408	18.492	904.792	20.11	688.08	18.839	438.835

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
26880	20.557	877.408	18.415	825.377	20.033	641.518	18.845	501.831
26940	20.628	863.715	18.459	839.069	20.017	586.739	18.932	537.438
27000	20.458	830.854	18.601	776.084	20.154	657.951	18.916	496.353
27060	20.732	893.839	18.547	721.315	20.099	636.04	18.921	326.538
27120	20.458	844.546	18.371	787.038	19.968	581.261	18.839	493.614
27180	20.42	885.623	18.382	776.084	20.159	625.084	18.938	427.879
27240	20.836	787.038	18.3	759.653	20.181	600.433	18.834	348.45
27300	20.765	778.823	18.59	811.684	20.044	655.212	18.839	427.879
27360	20.496	822.638	18.404	751.438	20.132	584	18.867	468.964
27420	20.524	866.454	18.377	841.808	20.061	699.036	18.938	438.835
27480	20.622	923.962	18.497	860.977	20.094	594.956	18.965	386.795
27540	20.524	770.607	18.119	795.253	20.05	512.787	18.938	507.309
27600	20.409	907.531	18.267	792.515	20.083	666.168	18.889	482.658
27660	20.491	880.146	18.421	715.838	20.022	597.694	18.921	471.703
27720	20.475	871.931	18.234	880.146	20.077	573.044	18.839	460.747
27780	20.633	956.823	18.322	751.438	20.001	594.956	18.899	490.875
27840	20.491	844.546	18.481	833.592	20.061	581.261	18.845	447.052
27900	20.442	778.823	18.382	850.023	20.017	531.96	18.943	441.574
27960	20.518	680.238	18.366	891.1	20.077	570.305	18.812	515.526
28020	20.502	806.207	18.306	745.961	20.033	666.168	18.784	433.357
28080	20.42	836.331	18.191	756.915	20.001	540.176	19.064	531.96
28140	20.54	858.238	18.322	858.238	20.335	584	18.79	468.964
28200	20.414	735.007	18.3	663.807	20.083	690.819	18.954	408.707
28260	20.562	729.53	18.24	729.53	20.05	605.911	18.856	419.663
28320	20.65	762.392	18.432	677.499	19.968	586.739	18.921	395.012
28380	20.683	860.977	18.421	748.699	20.083	600.433	18.889	458.008
28440	20.579	907.531	18.185	759.653	20.143	677.124	18.894	600.433
28500	20.535	828.115	18.355	825.377	20.039	734.642	18.763	436.096
28560	20.716	836.331	18.371	743.222	19.858	674.385	18.878	367.622
28620	20.398	765.13	18.432	811.684	19.562	597.694	18.697	458.008
28680	20.568	871.931	18.213	858.238	19.946	578.522	18.889	562.088
28740	20.234	721.315	18.306	756.915	20.072	562.088	18.445	493.614
28800	20.628	792.515	17.966	729.53	19.962	608.65	18.467	592.217
28860	20.644	732.269	18.234	797.992	20.006	578.522	18.927	504.57
28920	20.31	858.238	18.224	680.238	19.957	594.956	18.85	370.361
28980	20.644	767.869	18.333	729.53	19.984	564.827	18.894	471.703
29040	20.535	781.561	18.262	850.023	19.99	573.044	18.839	373.1
29100	20.507	833.592	18.196	776.084	19.907	696.297	18.806	531.96
29160	20.464	748.699	18.169	986.947	20.017	605.911	18.795	518.265
29220	20.475	754.176	18.174	800.73	20.055	630.562	18.768	542.915
29280	20.376	822.638	18.169	787.038	20.389	608.65	18.839	427.879
29340	20.557	880.146	18.311	677.499	20.329	625.084	18.85	463.486
29400	20.414	959.562	18.207	800.73	19.918	619.606	18.757	408.707
29460	20.683	874.669	18.147	726.792	19.924	649.735	18.795	523.743
29520	20.573	724.053	18.366	833.592	19.973	597.694	18.856	370.361
29580	20.639	743.222	18.207	803.469	19.984	636.04	18.828	482.658
29640	20.535	874.669	18.207	787.038	19.875	633.301	18.73	452.53
29700	20.529	740.484	18.306	691.191	19.929	630.562	18.938	460.747
29760	20.568	1011.59	18.108	789.777	19.902	660.69	18.773	438.835
29820	20.398	880.146	18.191	803.469	19.951	578.522	19.004	488.136
29880	20.327	819.9	18.333	833.592	19.995	521.004	18.839	488.136
29940	20.639	869.192	18.306	825.377	19.809	542.915	18.406	260.803
30000	20.469	808.946	18.207	729.53	19.71	649.735	18.806	496.353
30060	20.469	795.253	17.977	825.377	19.935	644.257	18.735	403.229
30120	20.611	874.669	18.163	710.361	19.82	660.69	18.878	441.574
30180	20.672	803.469	18.256	800.73	19.907	693.558	18.724	556.61

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
30240	20.244	795.253	18.114	795.253	19.798	709.992	18.593	556.61
30300	20.37	735.007	18.229	800.73	19.787	671.646	18.817	460.747
30360	20.321	735.007	18.191	860.977	19.634	636.04	18.396	408.707
30420	20.672	743.222	18.087	808.946	20.143	603.172	18.763	504.57
30480	20.442	904.792	18.229	830.854	19.891	589.478	18.719	425.14
30540	20.321	869.192	18.065	743.222	19.814	578.522	18.856	397.751
30600	20.518	828.115	17.988	819.9	19.875	608.65	18.379	521.004
30660	20.403	836.331	18.18	866.454	20.011	655.212	18.954	321.06
30720	20.37	745.961	18.114	800.73	19.918	542.915	18.932	329.277
30780	20.436	874.669	18.311	765.13	19.869	611.389	18.691	422.402
30840	20.403	778.823	18.01	830.854	19.721	600.433	18.741	458.008
30900	20.223	948.608	18.218	773.346	19.825	611.389	18.735	441.574
30960	20.475	751.438	17.917	800.73	19.946	597.694	18.631	403.229
31020	20.469	880.146	18.076	880.146	19.918	518.265	18.626	397.751
31080	20.436	937.654	18.185	767.869	19.924	564.827	18.686	534.699
31140	20.36	860.977	18.136	882.885	19.924	619.606	18.62	564.827
31200	20.507	841.808	18.103	825.377	19.825	564.827	18.658	542.915
31260	20.48	896.577	18.202	770.607	19.875	597.694	18.374	441.574
31320	20.442	784.3	18.13	740.484	19.924	510.048	18.806	373.1
31380	20.48	850.023	18.136	803.469	19.453	638.779	18.647	395.012
31440	20.464	762.392	18.103	748.699	19.957	627.823	18.483	436.096
31500	20.48	806.207	17.862	751.438	20.094	644.257	18.768	312.843
31560	20.568	770.607	17.829	767.869	19.628	666.168	18.527	501.831
31620	20.283	817.161	17.9	756.915	19.929	679.863	18.812	529.221
31680	20.557	904.792	18.108	781.561	19.836	671.646	18.554	422.402
31740	20.469	847.285	17.972	817.161	19.518	729.164	18.68	348.45
31800	20.513	795.253	18.054	902.054	19.661	603.172	18.878	342.972
31860	20.381	707.622	17.939	795.253	19.601	625.084	18.434	493.614
31920	20.277	721.315	18.043	882.885	19.913	559.349	18.702	329.277
31980	20.491	817.161	18.043	899.316	19.814	556.61	18.467	496.353
32040	20.453	850.023	17.868	745.961	19.655	575.783	18.675	458.008
32100	20.37	787.038	17.993	841.808	19.847	657.951	18.757	430.618
32160	20.135	767.869	17.917	732.269	19.891	521.004	18.878	252.586
32220	20.069	732.269	18.125	776.084	19.831	594.956	18.56	274.498
32280	20.573	726.792	17.944	800.73	19.814	556.61	18.604	285.454
32340	20.42	808.946	17.84	735.007	19.836	589.478	18.39	279.976
32400	20.31	866.454	17.911	778.823	19.524	564.827	18.5	236.153
32460	20.376	726.792	18.119	672.022	19.672	534.699	18.576	310.104
32520	20.376	852.761	17.906	781.561	19.798	510.048	18.598	255.325
32580	20.524	1049.93	17.961	847.285	19.787	633.301	18.308	1134.52
32640	20.447	921.223	17.829	850.023	19.743	668.907	18.505	1055.1
32700	20.283	986.947	18.081	855.5	19.76	540.176	18.604	983.887
32760	20.502	863.715	18.087	841.808	19.946	570.305	18.554	1422.11
32820	20.42	932.177	18.191	852.761	19.858	646.996	18.396	1753.53
32880	20.579	915.746	18.108	828.115	19.891	668.907	18.527	2279.41
32940	20.436	934.916	18.119	934.916	19.683	589.478	18.565	1679.58
33000	20.162	806.207	18.048	910.269	19.962	671.646	18.445	2134.24
33060	20.398	841.808	18.092	913.008	19.836	690.819	18.456	2249.28
33120	20.398	850.023	17.78	893.839	19.562	641.518	18.483	1876.78
33180	20.223	869.192	17.939	877.408	19.727	660.69	18.483	1528.93
33240	20.294	754.176	17.988	828.115	19.694	553.871	18.483	345.711
33300	20.25	893.839	18.114	759.653	19.858	611.389	18.489	266.281
33360	20.244	797.992	17.906	756.915	19.836	463.486	18.379	304.627
33420	20.365	841.808	17.955	806.207	19.803	488.136	18.28	359.406
33480	20.425	693.93	17.889	770.607	19.683	619.606	18.363	296.41
33540	20.332	729.53	18.125	732.269	19.82	573.044	18.658	304.627

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
33600	20.458	841.808	17.939	702.145	19.803	581.261	18.39	326.538
33660	20.212	808.946	17.873	789.777	19.787	559.349	18.456	340.233
33720	20.217	806.207	17.731	850.023	19.721	600.433	18.45	233.414
33780	20.294	748.699	17.807	704.884	19.491	496.353	18.231	238.892
33840	20.431	759.653	17.813	740.484	19.732	548.393	18.554	337.494
33900	20.398	737.746	17.785	795.253	19.754	523.743	18.615	288.193
33960	20.354	715.838	17.807	770.607	19.76	531.96	18.582	282.715
34020	20.414	882.885	17.818	830.854	19.77	548.393	18.768	416.924
34080	20.327	795.253	18.065	926.7	19.628	537.438	18.532	386.795
34140	20.338	921.223	17.676	817.161	19.831	521.004	18.56	326.538
34200	20.042	860.977	17.9	869.192	19.754	696.297	18.489	2271.19
34260	20.294	910.269	17.862	899.316	19.688	575.783	18.554	622.345
34320	20.239	975.993	17.709	844.546	19.754	504.57	18.171	1989.08
34380	20.162	965.039	17.873	970.516	19.754	671.646	18.264	1797.35
34440	20.387	918.485	17.988	847.285	19.94	630.562	18.406	1665.88
34500	20.535	989.685	17.851	860.977	19.71	627.823	18.385	1783.66
34560	20.151	945.87	18.174	1096.48	19.655	663.429	18.308	1786.4
34620	20.157	795.253	17.747	869.192	19.732	584	18.341	395.012
34680	20.277	828.115	17.857	858.238	19.798	540.176	18.423	173.157
34740	20.403	833.592	17.928	655.591	19.792	586.739	18.27	312.843
34800	20.162	877.408	17.648	776.084	19.749	646.996	18.439	312.843
34860	20.064	825.377	18.026	724.053	19.716	493.614	18.631	299.149
34920	20.223	803.469	17.906	773.346	19.36	603.172	18.428	296.41
34980	20.321	858.238	17.928	882.885	19.864	551.132	18.439	299.149
35040	20.146	685.715	17.769	693.93	19.71	627.823	18.702	337.494
35100	20.234	674.761	17.895	781.561	19.71	493.614	18.467	304.627
35160	20.228	724.053	17.933	614.514	19.639	575.783	18.752	310.104
35220	20.184	781.561	17.824	713.099	19.749	493.614	18.401	279.976
35280	20.097	795.253	17.939	767.869	19.573	526.482	18.543	290.932
35340	20.223	800.73	17.742	781.561	19.617	518.265	18.406	290.932
35400	20.08	1006.11	17.851	803.469	19.628	589.478	18.5	1545.37
35460	20.239	850.023	17.911	926.7	19.524	556.61	18.341	909.935
35520	20.37	926.7	17.829	858.238	19.661	633.301	18.374	2065.77
35580	19.954	904.792	17.829	778.823	19.409	682.602	18.423	2136.98
35640	20.239	1000.63	17.72	882.885	19.705	575.783	18.396	471.703
35700	20.129	850.023	17.95	899.316	19.617	668.907	18.341	2501.26
35760	20.173	869.192	17.61	822.638	19.606	625.084	18.193	1898.69
35820	20.157	918.485	17.878	787.038	19.562	723.686	18.472	2309.54
35880	20.42	943.131	18.032	880.146	19.551	762.032	18.428	1830.22
35940	20.277	981.47	17.84	825.377	19.743	668.907	18.489	871.59
36000	20.025	822.638	18.015	902.054	19.475	526.482	18.198	1619.32
36060	20.102	688.453	17.944	707.622	19.924	611.389	18.259	323.799
36120	20.365	748.699	17.676	770.607	19.634	559.349	18.374	156.723
36180	20.08	710.361	17.84	732.269	19.595	627.823	18.396	293.671
36240	20.25	776.084	17.594	726.792	19.508	551.132	18.28	277.237
36300	20.239	710.361	17.692	740.484	19.612	545.654	18.264	255.325
36360	20.354	732.269	17.599	633.684	19.661	575.783	18.691	290.932
36420	20.053	819.9	17.763	795.253	19.677	586.739	18.27	260.803
36480	20.108	672.022	17.692	710.361	19.54	515.526	18.291	340.233
36540	20.288	751.438	17.807	765.13	19.338	510.048	18.28	252.586
36600	20.201	765.13	17.725	732.269	19.957	600.433	18.631	304.627
36660	20.212	751.438	17.774	743.222	19.606	564.827	17.996	296.41
36720	20.064	696.668	17.72	811.684	19.644	553.871	18.242	348.45
36780	20.129	800.73	17.621	795.253	19.453	592.217	18.73	296.41
36840	20.157	945.87	17.665	880.146	19.869	720.947	17.924	2021.95
36900	20.234	959.562	17.988	869.192	19.568	663.429	18.122	1780.92

Time (Mins)	Temp SD13-01 °C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C °C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 °C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 °C	Conductivity SD13-04 (µmhos/cm)
36960	20.327	915.746	17.698	754.176	19.606	630.562	17.919	3035.36
37020	20.277	986.947	17.736	847.285	19.414	718.208	18.165	1096.18
37080	20.097	981.47	17.758	855.5	19.612	589.478	18.089	523.743
37140	20.102	880.146	17.736	841.808	19.601	570.305	18.094	1441.29
37200	20.212	836.331	17.632	787.038	19.595	556.61	18.034	2156.15
37260	20.047	885.623	17.659	902.054	19.628	627.823	18.226	1865.82
37320	20.146	962.3	17.676	885.623	19.365	589.478	18.434	1685.05
37380	20.08	896.577	17.714	811.684	19.217	564.827	18.237	1931.56
37440	20.173	954.085	17.818	855.5	19.584	540.176	18.187	1775.44
37500	20.261	735.007	17.758	691.191	19.743	553.871	18.368	359.406
37560	20.162	776.084	17.774	836.331	19.562	466.225	18.215	362.145
37620	20.119	921.223	17.621	669.284	19.579	570.305	18.302	260.803
37680	20.217	836.331	17.911	600.822	19.568	575.783	18.401	271.759
37740	20.327	751.438	17.555	770.607	19.486	616.867	18.264	307.366
37800	20.266	789.777	17.627	713.099	19.491	570.305	18.368	252.586
37860	20.053	713.099	17.698	787.038	19.535	589.478	18.308	279.976
37920	19.993	811.684	17.61	808.946	19.634	545.654	18.401	282.715
37980	20.113	740.484	17.714	765.13	19.738	567.566	18.308	271.759
38040	20.135	765.13	17.802	806.207	19.584	529.221	18.171	315.582
38100	20.069	729.53	17.687	658.33	19.573	556.61	18.182	296.41
38160	19.943	756.915	17.676	622.73	19.557	603.172	18.406	288.193
38220	20.151	765.13	17.709	858.238	19.382	512.787	18.346	323.799
38280	20.283	704.884	17.67	762.392	19.88	540.176	18.346	521.004
38340	20.064	756.915	17.709	789.777	19.502	485.397	18.412	345.711
38400	20.217	951.347	17.791	828.115	19.54	611.389	18.215	2008.25
38460	20.327	907.531	17.665	830.854	19.551	652.474	18.111	2224.63
38520	19.883	951.347	17.692	839.069	19.42	833.244	17.957	2095.9
38580	20.042	891.1	17.731	765.13	19.469	734.642	18.176	1950.73
38640	20.031	913.008	17.544	800.73	19.573	589.478	18.467	1898.69
38700	19.91	844.546	17.774	855.5	19.365	720.947	18.357	1942.52
38760	20.14	841.808	17.484	943.131	19.343	646.996	18.335	397.751
38820	20.025	965.039	17.621	913.008	19.529	526.482	18.379	2043.86
38880	20.031	915.746	17.709	836.331	19.535	630.562	18.259	1643.97
38940	20.184	682.976	17.67	833.592	19.371	584	18.001	258.064
39000	20.047	776.084	17.627	735.007	19.447	548.393	18.198	304.627
39060	20.086	776.084	17.462	732.269	19.568	540.176	18.127	304.627
39120	20.168	704.884	17.572	740.484	19.886	534.699	18.297	290.932
39180	20.025	554.268	17.687	743.222	19.141	501.831	18.439	274.498
39240	19.905	680.238	17.632	784.3	19.475	578.522	18.308	310.104
39300	19.976	710.361	17.495	814.423	19.672	548.393	18.324	290.932
39360	19.932	877.408	17.758	762.392	19.332	490.875	18.187	356.667
39420	20.069	713.099	17.731	819.9	19.508	575.783	18.215	255.325
39480	20.168	611.776	17.539	655.591	19.447	542.915	17.87	290.932
39540	20.036	828.115	17.835	781.561	19.518	526.482	18.357	293.671
39600	20.135	696.668	17.55	787.038	19.392	534.699	18.598	348.45
39660	19.845	735.007	17.72	666.545	19.447	581.261	18.291	274.498
39720	20.217	825.377	17.605	877.408	19.431	551.132	18.154	1550.85
39780	20.464	956.823	17.709	888.362	19.502	578.522	18.05	2035.64
39840	20.069	882.885	17.78	899.316	19.382	641.518	18.313	2301.32
39900	19.982	1006.11	17.747	822.638	19.277	666.168	18.193	762.032
39960	20.277	956.823	17.544	959.562	19.36	696.297	18.061	2112.33
40020	20.266	967.777	17.38	877.408	19.414	619.606	18.231	1895.95
40080	20.053	882.885	17.528	860.977	19.518	616.867	18.116	1915.13
40140	20.146	866.454	17.566	776.084	19.332	649.735	18.061	1213.95
40200	19.949	970.516	17.616	803.469	19.699	723.686	18.264	1063.31
40260	20.064	915.746	17.637	885.623	19.442	619.606	18.264	2112.33

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
40320	20.086	885.623	17.747	877.408	19.409	625.084	17.826	2180.8
40380	20.288	743.222	17.528	628.207	19.464	633.301	18.209	279.976
40440	20.299	710.361	17.703	759.653	19.677	392.273	18.149	318.321
40500	19.987	797.992	17.583	765.13	19.431	608.65	18.187	255.325
40560	20.124	754.176	17.501	765.13	19.639	518.265	18.193	310.104
40620	20.146	732.269	17.665	874.669	19.513	614.128	18.291	310.104
40680	20.376	765.13	17.566	852.761	19.623	584	18.259	321.06
40740	19.976	737.746	17.402	784.3	19.469	575.783	18.176	255.325
40800	20.119	2128.89	17.818	3747.32	19.48	1129.05	18.363	356.667
40860	20.025	1923.5	17.566	3520.03	19.502	972.931	18.226	260.803
40920	20.212	1882.42	17.479	3358.46	19.502	890.762	18.259	416.924
40980	19.949	1671.56	17.555	2865.54	19.475	981.148	18.16	310.104
41040	20.053	1321.04	17.511	2342.49	19.469	803.116	18.111	321.06
41100	20.064	1351.16	17.457	2169.96	19.617	764.771	18.144	296.41
41160	20.091	1509.99	17.648	2610.86	19.464	879.807	18.439	1512.5
41220	20.162	1583.93	17.473	2895.66	19.392	904.457	17.974	1208.48
41280	20.332	1419.62	17.621	2536.92	19.354	789.421	18.176	1734.36
41340	19.965	1323.77	17.654	2347.96	19.338	833.244	18.341	961.975
41400	19.976	1123.87	17.758	2024.82	19.436	814.072	18.215	1824.74
41460	20.086	1033.5	17.511	1348.42	19.349	704.514	18.406	2054.81
41520	20.031	913.008	17.681	1258.05	19.376	644.257	17.99	1759.01
41580	19.943	975.993	17.654	1044.45	19.327	693.558	18.089	2353.36
41640	20.168	943.131	17.528	1058.14	19.299	666.168	18.028	2383.49
41700	20.244	841.808	17.709	945.87	19.338	759.293	18.149	1756.27
41760	20.064	828.115	17.616	951.347	19.256	649.735	18.039	1539.89
41820	20.255	745.961	17.517	806.207	19.338	545.654	18.078	238.892
41880	19.982	732.269	17.55	795.253	19.371	578.522	17.985	288.193
41940	19.993	915.746	17.533	871.931	19.398	597.694	17.892	269.02
42000	20.042	907.531	17.517	830.854	19.382	466.225	18.522	293.671
42060	20.069	951.347	17.599	817.161	19.398	594.956	18.226	269.02
42120	20.091	880.146	17.347	817.161	19.425	562.088	18.324	285.454
42180	20.036	852.761	17.369	893.839	19.387	523.743	18.538	247.109
42240	19.982	965.039	17.676	880.146	19.272	540.176	18.094	238.892
42300	19.998	1038.97	17.627	811.684	19.869	526.482	18.154	249.848
42360	19.888	874.669	17.271	759.653	19.431	523.743	18.259	263.542
42420	20.025	1181.37	17.457	1162.2	19.403	510.048	18.302	416.924
42480	20.184	1192.33	17.479	1184.11	19.425	627.823	18.176	233.414
42540	20.031	1219.71	17.621	1274.48	19.743	570.305	18.308	230.675
42600	20.305	1416.88	17.637	2041.25	18.894	701.775	18.204	512.787
42660	19.899	1644.18	17.533	2983.29	19.294	863.373	18.286	392.273
42720	19.932	1876.95	17.588	3306.43	19.42	885.284	18.39	386.795
42780	20.162	1731.81	17.643	3383.11	19.387	1005.79	18.176	463.486
42840	20.206	1627.75	17.588	3139.38	19.256	915.413	18.587	449.791
42900	19.888	1682.51	17.681	3155.81	19.42	866.112	17.903	548.393
42960	20.069	2035.78	17.55	3903.42	19.688	1008.53	18.22	496.353
43020	20.014	1882.42	17.533	3936.28	19.108	1008.53	18.259	460.747
43080	19.91	2148.06	17.544	3996.53	19.425	1153.7	18.253	551.132
43140	20.124	1551.07	17.44	3142.12	19.239	1156.44	18.215	318.321
43200	20.179	1351.16	17.687	2698.49	19.316	989.365	18.248	619.606
43260	20.009	1304.61	17.67	2342.49	19.305	866.112	18.067	323.799
43320	19.965	1389.5	17.468	2126.15	19.321	877.068	18.352	326.538
43380	20.223	1326.51	17.72	1803.01	19.398	792.16	18.171	342.972
43440	19.949	1277.22	17.446	1641.44	19.365	688.08	18.116	348.45
43500	19.949	1216.97	17.511	1592.15	19.365	734.642	18.176	296.41
43560	19.801	1233.4	17.752	1493.56	19.272	715.469	18.149	342.972
43620	20.031	1000.63	17.577	1482.61	19.245	570.305	18.532	282.715

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Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (μmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (μmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (μmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (μmhos/cm)
43680	20.042	1055.4	17.605	1373.07	19.283	660.69	18.116	337.494
43740	19.845	1126.6	17.402	1449.74	19.338	625.084	18.105	378.578
43800	19.976	1077.31	17.484	1447.01	19.332	666.168	18.193	225.197
43860	20.266	1085.53	17.566	1181.37	19.283	578.522	18.385	299.149
43920	20.129	959.562	17.44	926.7	19.25	556.61	18.16	334.755
43980	19.971	995.162	17.281	1077.31	19.332	504.57	17.892	260.803
44040	19.976	1222.45	17.55	1545.59	19.288	666.168	18.187	1956.21
44100	20.004	1178.64	17.731	1123.87	19.36	709.992	18.138	1471.42
44160	19.861	1701.68	17.544	2230.21	19.283	737.381	18.034	1493.33
44220	20.129	1334.73	17.522	2572.52	19.42	981.148	18.105	1969.91
44280	19.79	1129.34	17.588	1668.82	19.518	751.076	18.182	2243.8
44340	19.965	1014.33	17.61	1244.36	19.015	657.951	18.012	2090.42
44400	19.938	937.654	17.583	1192.33	18.998	644.257	18.105	2120.55
44460	19.987	830.854	17.506	1038.97	19.179	663.429	18.248	1583.71
44520	19.752	882.885	17.364	1025.28	19.327	540.176	18.16	1923.34
44580	20.031	907.531	17.632	921.223	19.283	726.425	18.193	2405.4
44640	20.02	962.3	17.599	929.439	19.42	660.69	18.154	2276.67
44700	19.943	781.561	17.435	729.53	19.036	559.349	18.302	208.763
44760	19.976	844.546	17.473	787.038	19.299	564.827	18.631	249.848
44820	20.217	841.808	17.479	836.331	19.387	575.783	18.237	285.454
44880	19.894	866.454	17.528	765.13	19.228	542.915	18.22	307.366
44940	19.993	869.192	17.621	713.099	19.25	622.345	18.248	337.494
45000	19.899	765.13	17.473	737.746	19.584	633.301	18.264	293.671
45060	19.949	844.546	17.517	682.976	19.277	548.393	18.417	296.41
45120	20.047	1019.8	17.468	765.13	19.469	537.438	18.023	282.715
45180	19.888	877.408	17.391	847.285	19.31	477.181	18.439	337.494
45240	19.96	803.469	17.407	784.3	19.25	542.915	18.28	318.321
45300	20.305	839.069	17.331	770.607	19.195	529.221	18.198	247.109
45360	20.036	759.653	17.61	735.007	19.212	597.694	18.056	290.932
45420	19.894	926.7	17.435	825.377	19.19	499.092	18.27	241.631
45480	19.96	965.039	17.621	984.208	19.212	564.827	18.22	967.453
45540	20.02	1041.71	17.616	1055.4	19.261	729.164	18.111	1983.6
45600	19.998	1121.13	17.594	891.1	19.562	603.172	18.198	1553.58
45660	20.02	1006.11	17.506	1028.02	19.179	641.518	18.165	2123.29
45720	19.943	1003.37	17.687	981.47	19.201	685.341	18.231	1893.21
45780	19.867	995.162	17.451	822.638	19.277	512.787	18.313	2495.78
45840	20.146	1025.28	17.643	907.531	19.13	797.638	18.401	2016.47
45900	19.987	877.408	17.457	934.916	19.13	592.217	17.87	3459.9
45960	19.905	921.223	17.468	904.792	19.338	614.128	17.93	2030.16
46020	20.004	954.085	17.457	880.146	19.13	657.951	18.111	2986.06
46080	19.921	973.254	17.413	967.777	19.266	537.438	17.952	1797.35
46140	20.053	740.484	17.533	789.777	19.223	510.048	18.045	219.719
46200	20.064	992.424	17.462	915.746	19.272	668.907	18.034	2468.39
46260	19.801	869.192	17.501	773.346	19.184	688.08	18.417	1975.38
46320	20.009	839.069	17.413	737.746	19.256	540.176	18.204	312.843
46380	19.697	860.977	17.528	762.392	19.316	570.305	18.089	279.976
46440	19.905	819.9	17.511	756.915	19.228	551.132	18.171	274.498
46500	19.954	869.192	17.271	776.084	19.343	553.871	17.782	304.627
46560	19.998	817.161	17.451	904.792	19.179	537.438	18.357	290.932
46620	19.927	825.377	17.616	688.453	19.19	551.132	18.182	279.976
46680	19.713	1028.02	17.698	814.423	19.151	559.349	18.22	307.366
46740	19.702	729.53	17.424	756.915	18.998	534.699	17.979	334.755
46800	19.779	882.885	17.353	830.854	19.162	545.654	18.018	321.06
46860	19.905	800.73	17.561	781.561	19.091	485.397	18.319	301.888
46920	20.009	896.577	17.473	860.977	18.998	600.433	18.286	1783.66
46980	19.883	1137.56	17.511	860.977	19.245	586.739	18.626	1969.91

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
47040	19.91	1060.88	17.303	803.469	19.195	627.823	18.067	2057.55
47100	19.878	836.331	17.402	885.623	19.119	589.478	18.028	2295.84
47160	19.878	902.054	17.418	797.992	19.403	548.393	18.149	1235.87
47220	19.779	830.854	17.533	910.269	19.212	603.172	18.237	2660.12
47280	19.932	781.561	17.49	814.423	19.108	693.558	18.089	1548.11
47340	19.993	836.331	17.522	784.3	19.59	644.257	17.952	2468.39
47400	19.905	970.516	17.605	891.1	19.184	649.735	18.231	2673.82
47460	19.708	814.423	17.473	877.408	19.168	553.871	18.231	2079.46
47520	19.932	962.3	17.555	967.777	19.135	636.04	18.001	2147.94
47580	19.861	814.423	17.55	776.084	19.305	625.084	18.16	312.843
47640	19.828	735.007	17.457	792.515	19.162	564.827	18.264	282.715
47700	20.053	789.777	17.511	773.346	19.179	540.176	18.149	279.976
47760	19.686	787.038	17.637	696.668	19.173	573.044	18.05	337.494
47820	19.916	756.915	17.424	814.423	19.223	529.221	18.122	321.06
47880	19.768	800.73	17.703	688.453	19.184	578.522	18.034	293.671
47940	19.713	729.53	17.369	729.53	19.113	570.305	18.089	266.281
48000	19.795	756.915	17.353	630.945	19.102	567.566	18.165	323.799
48060	19.949	691.191	17.353	713.099	19.113	573.044	18.187	301.888
48120	19.888	765.13	17.32	828.115	19.151	553.871	18.319	301.888
48180	19.773	781.561	17.265	724.053	19.075	559.349	18.018	332.016
48240	19.834	871.931	17.265	877.408	19.19	578.522	18.215	332.016
48300	20.108	663.807	17.424	721.315	19.157	570.305	18.127	299.149
48360	19.878	850.023	17.386	943.131	19.256	652.474	17.881	2966.88
48420	19.839	932.177	17.364	910.269	19.135	679.863	17.53	2983.32
48480	19.752	1216.97	17.561	1077.31	19.086	608.65	17.853	504.57
48540	19.713	1244.36	17.369	1394.97	19.141	584	17.908	551.132
48600	19.823	1455.22	17.446	1712.64	19.365	693.558	17.793	529.221
48660	19.768	1375.81	17.402	1942.67	18.839	726.425	18.445	534.699
48720	19.784	1397.71	17.38	2013.87	19.064	740.12	18.352	655.212
48780	19.834	1299.13	17.303	1991.96	19.086	704.514	18.127	742.859
48840	19.965	1337.47	17.435	1781.1	19.212	718.208	18.122	934.586
48900	19.845	1159.47	17.276	1605.84	19.157	688.08	18.275	479.92
48960	19.96	1107.44	17.407	1660.61	19.091	630.562	18.193	1397.46
49020	19.795	1214.24	17.386	1504.51	19.13	600.433	18.154	271.759
49080	19.658	1216.97	17.303	1723.59	19.31	646.996	18.187	288.193
49140	19.79	1186.85	17.292	1537.38	19.069	619.606	18.105	315.582
49200	19.806	1038.97	17.451	1367.59	19.113	605.911	18.209	359.406
49260	19.658	1041.71	17.254	1140.3	19.058	584	18.22	312.843
49320	19.752	1101.96	17.303	1184.11	19.069	594.956	18.018	301.888
49380	19.795	954.085	17.309	1033.5	19.075	496.353	18.094	299.149
49440	19.888	975.993	17.44	1148.51	19.217	551.132	18.22	329.277
49500	19.894	975.993	17.32	874.669	19.009	564.827	18.286	269.02
49560	19.653	776.084	17.364	817.161	19.184	534.699	17.946	307.366
49620	19.763	871.931	17.314	863.715	19.371	597.694	18.494	321.06
49680	19.888	729.53	17.402	718.576	19.113	573.044	18.253	285.454
49740	19.806	888.362	17.413	713.099	19.058	553.871	18.187	351.189
49800	19.856	1036.23	17.517	1025.28	19.102	726.425	18.259	2906.63
49860	19.784	1022.54	17.49	858.238	19.097	660.69	17.798	3062.75
49920	19.637	1162.2	17.539	1184.11	19.009	630.562	18.445	1800.09
49980	19.741	951.347	17.271	1321.04	19.091	638.779	17.886	805.855
50040	19.845	1044.45	17.221	1471.65	19.042	688.08	18.072	835.983
50100	19.752	1028.02	17.517	880.146	18.867	723.686	18.007	2353.36
50160	19.795	973.254	17.473	1227.93	18.954	674.385	18.001	2487.57
50220	19.543	962.3	17.38	984.208	19.025	619.606	18.357	1739.83
50280	19.773	855.5	17.303	899.316	19.409	668.907	18.083	2035.64
50340	19.691	1038.97	17.375	852.761	18.867	663.429	18.182	2068.51

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Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
50400	19.708	913.008	17.325	997.901	19.075	759.293	17.744	2627.25
50460	19.686	765.13	17.632	729.53	18.927	504.57	18.111	310.104
50520	19.697	704.884	17.309	737.746	19.025	477.181	18.385	233.414
50580	19.658	929.439	17.254	795.253	19.13	592.217	18.067	312.843
50640	19.686	836.331	17.309	693.93	19.02	575.783	18.182	293.671
50700	19.686	866.454	17.227	743.222	19.075	573.044	18.007	323.799
50760	19.938	869.192	17.424	759.653	19.025	614.128	18.133	315.582
50820	19.626	874.669	17.435	871.931	19.135	564.827	18.1	249.848
50880	19.631	850.023	17.243	852.761	19.108	540.176	18.007	359.406
50940	19.812	787.038	17.314	778.823	19.004	584	17.705	285.454
51000	19.68	792.515	17.271	776.084	19.223	534.699	17.886	285.454
51060	19.675	751.438	17.44	814.423	18.987	592.217	18.028	337.494
51120	19.664	806.207	17.238	792.515	18.971	540.176	18.105	247.109
51180	19.549	847.285	17.605	882.885	18.993	545.654	18.028	288.193
51240	19.867	1011.59	17.572	913.008	19.036	663.429	17.623	2306.8
51300	19.883	967.777	17.314	904.792	19.015	622.345	17.661	2027.42
51360	19.845	1162.2	17.276	880.146	18.735	605.911	18.1	1797.35
51420	19.779	866.454	17.353	1071.83	19.025	657.951	18.313	1772.7
51480	19.861	860.977	17.232	877.408	19.091	649.735	18.22	2942.23
51540	19.784	951.347	17.358	871.931	18.993	644.257	18.133	3432.51
51600	19.741	989.685	17.331	847.285	18.998	570.305	18.144	2238.32
51660	19.878	888.362	17.123	833.592	19.009	573.044	18.105	1824.74
51720	19.916	877.408	17.188	863.715	19.376	855.156	17.831	2424.57
51780	19.845	860.977	17.194	926.7	18.626	652.474	18.133	2065.77
51840	19.943	951.347	17.15	852.761	18.883	584	18.05	1203
51900	19.752	745.961	17.386	797.992	19.069	655.212	18.056	373.1
51960	19.68	751.438	17.325	866.454	19.053	575.783	18.478	373.1
52020	19.604	773.346	17.276	726.792	19.031	551.132	17.957	208.763
52080	19.741	797.992	17.172	765.13	19.13	600.433	18.05	315.582
52140	19.702	726.792	17.369	756.915	18.96	559.349	17.996	290.932
52200	19.56	789.777	17.347	748.699	19.042	570.305	18.357	348.45
52260	19.664	784.3	17.227	817.161	18.746	616.867	18.28	337.494
52320	19.735	625.468	17.199	661.068	19.025	542.915	18.072	307.366
52380	19.516	650.114	17.413	811.684	18.965	641.518	18.072	247.109
52440	19.615	726.792	17.298	721.315	19.031	534.699	18.28	296.41
52500	19.763	767.869	17.298	745.961	19.02	575.783	18.111	219.719
52560	19.669	672.022	17.353	841.808	18.965	575.783	18.012	271.759
52620	19.708	776.084	17.276	789.777	19.058	526.482	18.209	285.454
52680	20.08	863.715	17.32	943.131	18.949	674.385	17.924	2169.85
52740	19.878	866.454	17.309	923.962	18.954	644.257	17.798	3101.09
52800	19.713	970.516	17.309	943.131	18.987	592.217	17.815	2493.05
52860	19.746	866.454	17.216	893.839	18.938	636.04	17.552	2780.64
52920	19.894	891.1	17.145	896.577	18.889	682.602	17.99	1679.58
52980	19.85	929.439	17.303	915.746	19.146	638.779	18.302	2997.01
53040	19.938	1047.19	17.292	986.947	18.795	548.393	17.99	3128.48
53100	19.867	932.177	17.325	858.238	18.894	652.474	17.946	3027.14
53160	19.642	918.485	17.303	836.331	18.795	562.088	17.661	2509.48
53220	19.631	880.146	17.26	880.146	19.217	690.819	17.618	2556.04
53280	19.615	918.485	17.309	852.761	19.064	636.04	18.001	2514.96
53340	19.713	721.315	17.199	806.207	18.982	441.574	18.1	315.582
53400	19.658	806.207	17.265	751.438	18.861	586.739	18.127	329.277
53460	19.828	707.622	17.183	726.792	19.058	542.915	18.111	263.542
53520	19.801	792.515	17.238	888.362	19.25	594.956	18.023	269.02
53580	19.576	795.253	17.123	767.869	19.031	616.867	17.968	299.149
53640	19.675	735.007	17.117	691.191	18.626	526.482	17.93	249.848
53700	19.795	759.653	17.166	784.3	19.015	510.048	17.979	263.542

Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
53760	19.691	707.622	17.139	699.407	18.965	521.004	17.946	301.888
53820	19.746	776.084	17.26	674.761	18.943	573.044	17.771	334.755
53880	19.648	710.361	17.26	789.777	19.069	597.694	17.913	326.538
53940	19.516	945.87	17.205	869.192	18.927	600.433	18.05	282.715
54000	19.554	915.746	17.249	830.854	18.899	515.526	17.974	260.803
54060	19.741	808.946	17.375	732.269	19.064	553.871	18.039	304.627
54120	19.56	811.684	17.046	844.546	18.91	540.176	17.903	548.393
54180	19.609	992.424	17.309	1044.45	18.883	625.084	17.913	2739.55
54240	19.587	1318.3	17.358	1148.51	19.113	627.823	17.875	1638.49
54300	19.609	1334.73	17.145	1901.59	18.982	748.337	18.028	551.132
54360	19.62	1915.29	17.21	3971.88	18.856	1356.38	18.028	652.474
54420	19.768	1855.04	17.216	4574.34	18.812	1328.99	18.089	614.128
54480	19.773	2120.67	17.413	4766.04	18.949	1312.56	18.133	786.682
54540	19.576	2202.82	17.26	4839.98	18.899	1307.08	17.804	822.289
54600	19.724	2323.32	17.112	4823.54	18.921	1252.3	17.985	707.253
54660	19.576	2219.26	17.26	4656.5	18.752	1079.75	18.018	1337.21
54720	19.604	1989.22	17.249	4051.3	18.878	1129.05	17.87	1454.98
54780	19.828	2104.24	17.216	3583.02	18.921	1120.83	17.946	370.361
54840	19.872	2038.52	17.254	3443.35	18.965	948.28	17.93	321.06
54900	19.746	2120.67	17.101	3374.89	18.631	942.803	17.689	277.237
54960	19.839	2016.61	17.101	3306.43	18.669	967.453	18.007	290.932
55020	19.741	2022.09	17.013	3295.48	18.971	923.63	18.089	370.361
55080	19.757	1901.59	17.183	3084.61	18.741	893.501	17.979	337.494
55140	19.735	2011.13	17.314	3153.08	18.653	874.329	17.979	299.149
55200	19.867	2002.92	17.117	3079.14	18.779	838.722	17.87	362.145
55260	19.576	1959.1	17.062	2914.83	18.91	786.682	18.522	381.317
55320	19.861	1838.61	17.062	2824.46	18.845	775.726	17.952	304.627
55380	19.609	1731.81	16.997	2671.1	18.839	737.381	17.897	364.884
55440	19.516	1687.99	17.073	2378.09	18.653	731.903	17.924	293.671
55500	19.604	1652.39	17.325	2156.27	18.85	712.73	17.897	340.233
55560	19.598	1307.34	16.997	1619.53	18.867	630.562	17.957	277.237
55620	19.779	1225.19	17.188	1764.67	18.927	709.992	18.007	1233.13
55680	19.516	1088.27	17.128	1542.85	18.85	625.084	18.023	1531.67
55740	19.565	945.87	17.106	1342.94	18.664	660.69	18.193	1696.01
55800	19.702	770.607	17.134	1153.99	18.604	633.301	18.078	2131.5
55860	19.56	940.393	17.04	1123.87	18.812	567.566	17.853	2950.45
55920	19.691	839.069	17.123	836.331	18.708	762.032	18.072	1172.87
55980	19.828	866.454	17.396	759.653	18.773	825.028	17.974	646.996
56040	19.609	855.5	16.882	934.916	18.96	644.257	17.842	1643.97
56100	19.39	762.392	17.035	954.085	18.768	573.044	17.842	2745.03
56160	19.56	880.146	17.314	989.685	18.773	627.823	17.76	2000.03
56220	19.823	743.222	17.04	756.915	18.697	657.951	17.979	211.502
56280	19.549	751.438	16.975	693.93	18.845	578.522	17.815	252.586
56340	19.604	811.684	17.101	715.838	18.752	542.915	17.924	348.45
56400	19.527	795.253	17.134	748.699	18.91	605.911	17.881	269.02
56460	19.746	715.838	17.008	735.007	18.883	540.176	18.231	249.848
56520	19.763	674.761	17.079	899.316	18.932	567.566	17.892	315.582
56580	19.675	795.253	17.09	740.484	18.916	518.265	17.99	271.759
56640	19.527	899.316	17.09	751.438	19.206	584	17.842	277.237
56700	19.642	740.484	16.975	754.176	18.795	521.004	18.007	301.888
56760	19.374	814.423	17.188	770.607	18.801	622.345	17.771	252.586
56820	19.653	702.145	17.051	737.746	19.195	510.048	17.974	279.976
56880	19.483	691.191	17.101	806.207	18.817	564.827	17.935	367.622
56940	19.806	745.961	16.936	724.053	18.757	551.132	17.941	241.631
57000	19.702	685.715	17.09	830.854	18.686	578.522	17.886	392.273
57060	19.675	787.038	17.216	666.545	18.757	575.783	17.76	430.618

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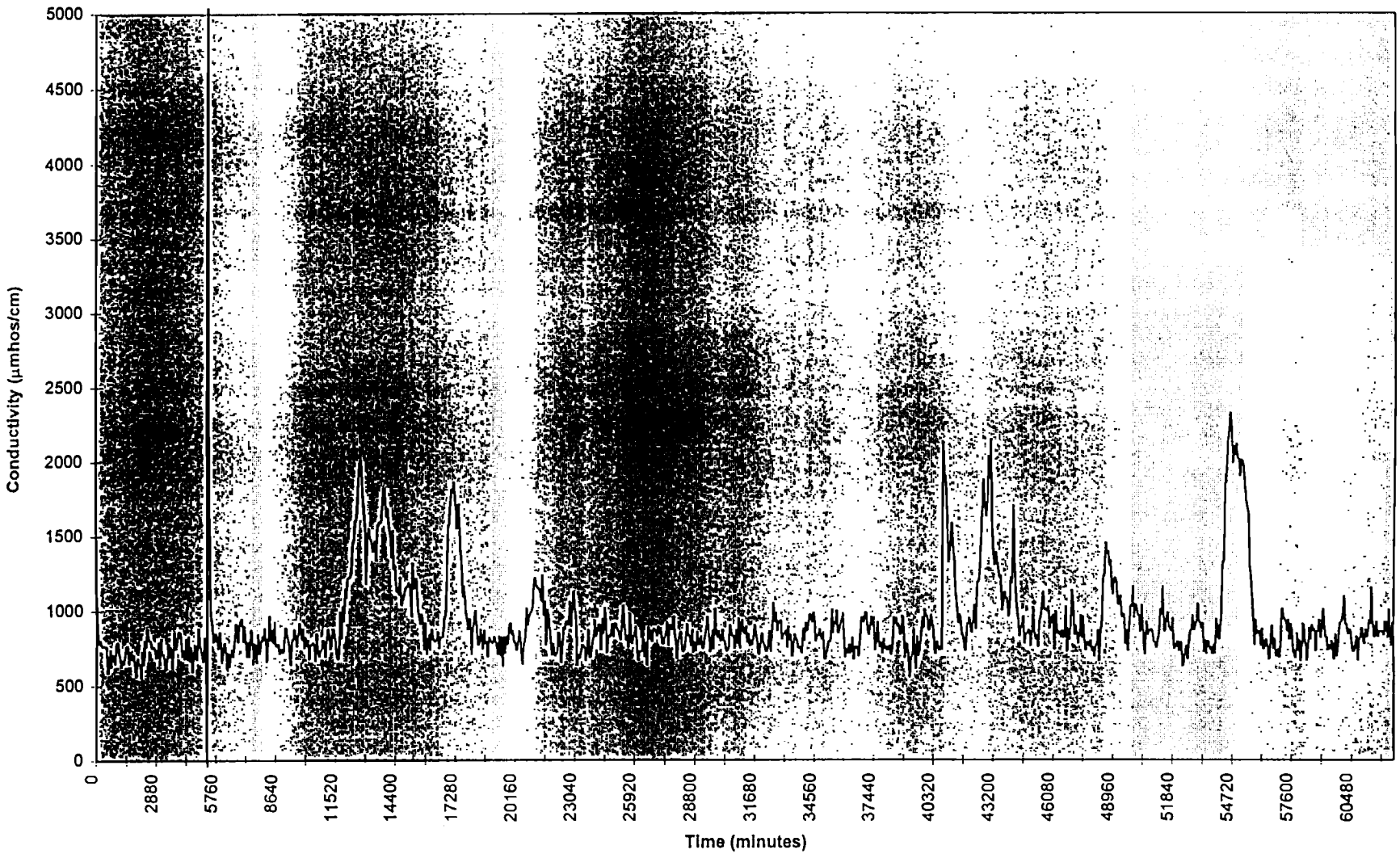
Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
57120	19.428	1014.33	17.238	871.931	18.374	655.212	17.919	1019.49
57180	19.812	965.039	17.155	819.9	18.905	611.389	17.875	1756.27
57240	19.374	937.654	16.991	874.669	18.828	693.558	17.892	1865.82
57300	19.598	932.177	16.975	866.454	19.031	600.433	17.93	1408.42
57360	19.642	860.977	17.188	904.792	18.817	709.992	17.952	2380.75
57420	19.73	940.393	17.177	847.285	18.691	608.65	17.968	2369.79
57480	19.527	803.469	17.123	923.962	18.773	657.951	17.557	1879.52
57540	19.631	913.008	17.221	803.469	18.664	734.642	18.034	2408.14
57600	19.724	874.669	16.936	918.485	18.812	644.257	17.76	2180.8
57660	19.801	726.792	17.101	704.884	18.845	586.739	17.689	241.631
57720	19.505	713.099	17.095	789.777	18.987	559.349	17.963	211.502
57780	19.571	682.976	16.969	800.73	18.795	584	17.881	282.715
57840	19.505	850.023	16.98	724.053	18.856	589.478	17.793	282.715
57900	19.516	726.792	16.778	855.5	18.828	570.305	17.831	277.237
57960	19.363	808.946	17.046	737.746	18.773	581.261	17.886	329.277
58020	19.522	663.807	17.101	795.253	18.839	551.132	18.204	337.494
58080	19.593	710.361	16.893	773.346	19.004	559.349	17.651	260.803
58140	19.648	910.269	16.936	907.531	18.719	518.265	18.193	252.586
58200	19.461	866.454	17.101	685.715	18.834	485.397	18.22	238.892
58260	19.746	754.176	16.986	759.653	18.834	553.871	18.072	312.843
58320	19.472	666.545	17.035	759.653	18.779	562.088	17.76	285.454
58380	19.708	740.484	17.024	781.561	18.971	589.478	17.645	318.321
58440	19.576	885.623	17.008	844.546	18.741	592.217	17.793	2476.61
58500	19.604	803.469	16.882	817.161	19.173	679.863	17.514	2580.69
58560	19.642	902.054	16.958	808.946	18.735	657.951	17.831	1693.27
58620	19.522	866.454	17.013	814.423	18.784	622.345	17.7	2682.03
58680	19.631	880.146	17.101	792.515	18.708	685.341	18.226	2183.54
58740	19.741	729.53	16.986	778.823	18.817	657.951	17.777	2213.67
58800	19.522	866.454	17.09	833.592	18.795	586.739	17.886	2186.28
58860	19.691	855.5	17.15	748.699	19.015	657.951	17.727	1819.26
58920	19.522	943.131	17.035	811.684	18.801	668.907	17.853	1972.64
58980	19.511	819.9	17.046	784.3	18.735	679.863	18.198	841.461
59040	19.489	860.977	17.019	740.484	18.856	789.421	17.82	1728.88
59100	19.461	1014.33	17.013	913.008	18.779	531.96	17.711	252.586
59160	19.582	929.439	17.095	718.576	18.647	556.61	17.404	301.888
59220	19.56	822.638	17.161	606.299	18.839	499.092	18.007	277.237
59280	19.494	825.377	17.145	888.362	18.801	570.305	18.007	277.237
59340	19.434	735.007	17.062	765.13	18.735	529.221	18.028	293.671
59400	19.478	773.346	16.958	658.33	18.834	597.694	17.601	307.366
59460	19.713	737.746	17.046	724.053	18.801	562.088	18.116	233.414
59520	19.543	800.73	17.013	732.269	18.763	594.956	17.672	332.016
59580	19.582	726.792	16.778	740.484	18.691	548.393	17.552	225.197
59640	19.686	674.761	16.969	584.391	18.894	545.654	17.656	318.321
59700	19.516	841.808	16.876	704.884	18.653	485.397	17.612	271.759
59760	19.669	693.93	16.975	699.407	18.686	512.787	17.766	279.976
59820	19.259	743.222	16.969	787.038	18.85	542.915	17.853	274.498
59880	19.461	880.146	16.958	923.962	18.609	605.911	17.815	2849.11
59940	19.456	921.223	17.04	693.93	18.631	564.827	18.061	1507.02
60000	19.478	921.223	16.936	943.131	18.806	638.779	17.618	2577.95
60060	19.697	989.685	17.046	855.5	18.795	633.301	17.782	2120.55
60120	19.598	1096.48	17.073	965.039	18.352	584	17.661	2104.11
60180	19.615	915.746	16.975	1033.5	18.719	655.212	17.798	3177.78
60240	19.62	902.054	17.084	800.73	18.817	688.08	17.618	1813.78
60300	19.763	841.808	16.893	858.238	18.609	652.474	17.897	1657.66
60360	19.543	877.408	16.893	784.3	18.768	638.779	17.831	1501.54
60420	19.423	866.454	16.997	806.207	18.752	704.514	17.612	2084.94

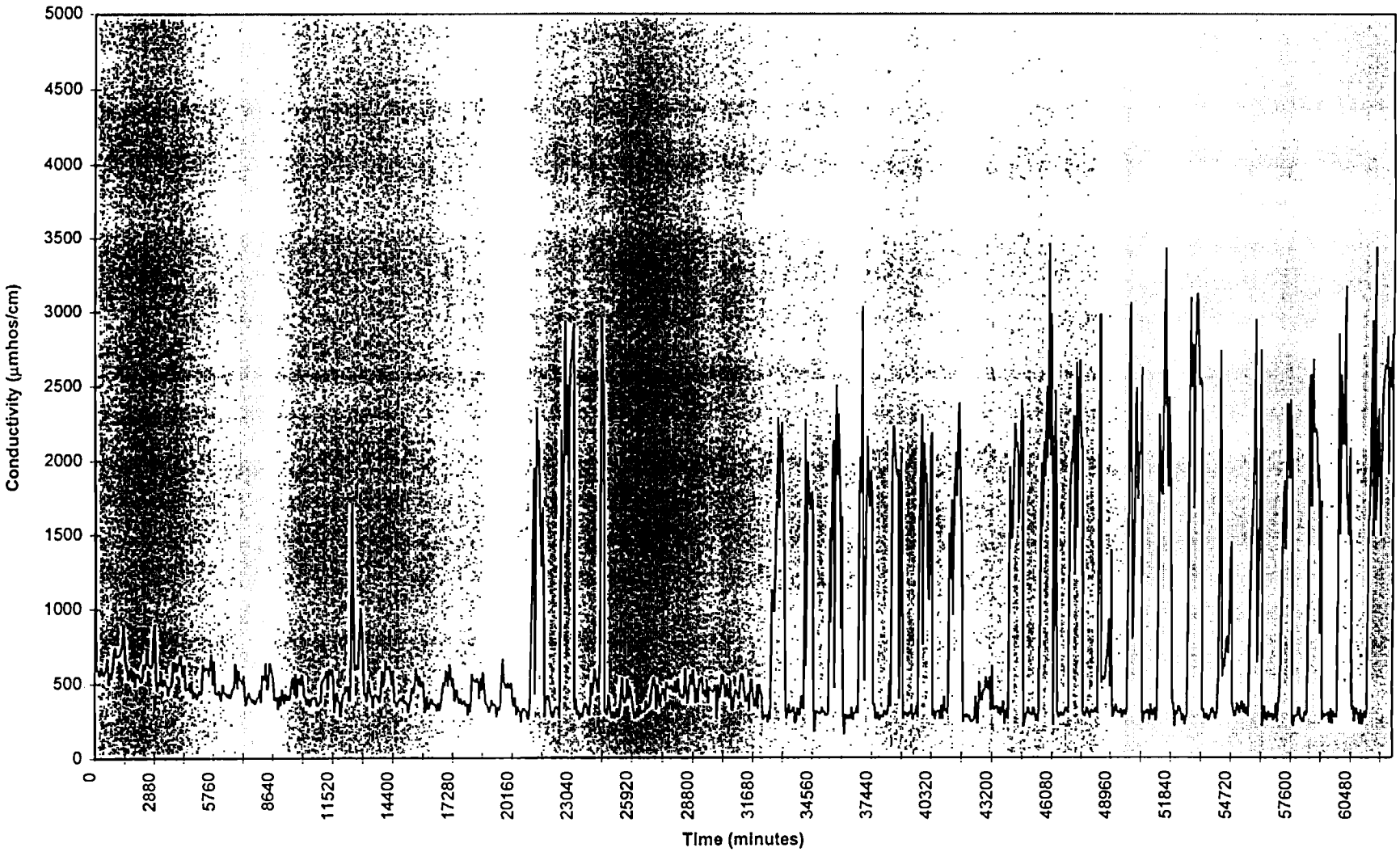
Time (Mins)	Temp SD13-01 ° C	Conductivity SD13-01 (µmhos/cm)	Temp OT12-15C ° C	Conductivity OT12-15C (µmhos/cm)	Temp SD13-03 ° C	Conductivity SD13-03 (µmhos/cm)	Temp SD13-04 ° C	Conductivity SD13-04 (µmhos/cm)
60480	19.494	773.346	16.925	902.054	18.724	646.996	17.705	1197.52
60540	19.68	729.53	16.931	910.269	18.795	690.819	17.771	326.538
60600	19.45	726.792	16.947	693.93	18.713	608.65	17.859	348.45
60660	19.549	792.515	17.035	841.808	18.768	477.181	17.82	241.631
60720	19.543	830.854	16.799	888.362	18.363	471.703	17.733	337.494
60780	19.467	666.545	16.936	773.346	18.741	559.349	17.853	321.06
60840	19.62	800.73	16.947	759.653	18.806	501.831	17.892	285.454
60900	19.379	833.592	16.936	825.377	18.642	515.526	17.607	225.197
60960	19.5	885.623	16.986	699.407	18.686	542.915	17.897	323.799
61020	19.511	817.161	17.145	745.961	18.609	570.305	18.127	219.719
61080	19.522	778.823	16.838	814.423	18.664	556.61	17.766	244.37
61140	19.489	877.408	16.942	808.946	18.686	507.309	18.171	315.582
61200	19.56	819.9	17.15	647.376	18.779	512.787	17.837	266.281
61260	19.45	855.5	17.019	852.761	18.768	499.092	17.678	307.366
61320	19.626	940.393	17.046	943.131	18.675	666.168	17.607	1586.45
61380	19.439	910.269	17.019	847.285	18.697	649.735	17.755	1654.93
61440	19.439	1156.73	16.915	860.977	18.664	578.522	17.481	2142.46
61500	19.664	937.654	16.92	874.669	18.609	646.996	17.596	2942.23
61560	19.62	825.377	16.849	836.331	18.697	649.735	17.782	1498.81
61620	19.439	830.854	16.947	910.269	18.653	668.907	17.831	3440.72
61680	19.834	929.439	17.062	819.9	18.823	573.044	17.634	1600.15
61740	19.489	822.638	17.035	852.761	18.73	655.212	17.661	1849.39
61800	19.45	858.238	16.986	822.638	18.516	603.172	17.574	2347.88
61860	19.428	860.977	17.112	921.223	18.752	679.863	17.892	1975.38
61920	19.428	863.715	16.849	874.669	18.571	529.221	17.705	1498.81
61980	19.543	860.977	17.172	855.5	18.385	816.811	17.563	2235.58
62040	19.691	833.592	16.646	822.638	18.439	592.217	17.705	2514.96
62100	19.637	926.7	16.887	841.808	18.828	630.562	17.59	2646.43
62160	19.543	921.223	17.008	948.608	18.587	622.345	17.678	2616.3
62220	19.45	817.161	17.035	817.161	18.965	636.04	17.793	2832.68
62280	19.297	1008.85	16.849	863.715	18.713	688.08	17.678	1912.39
62340	19.401	850.023	16.871	808.946	18.604	616.867	17.941	2632.73
62400	19.532	765.13	16.986	992.424	18.335	690.819	17.76	2493.05
62460	19.631	921.223	17.013	910.269	18.346	715.469	17.634	2849.11
62520	19.56	904.792	16.843	819.9	18.62	578.522	17.755	2101.37

Well SD13-01



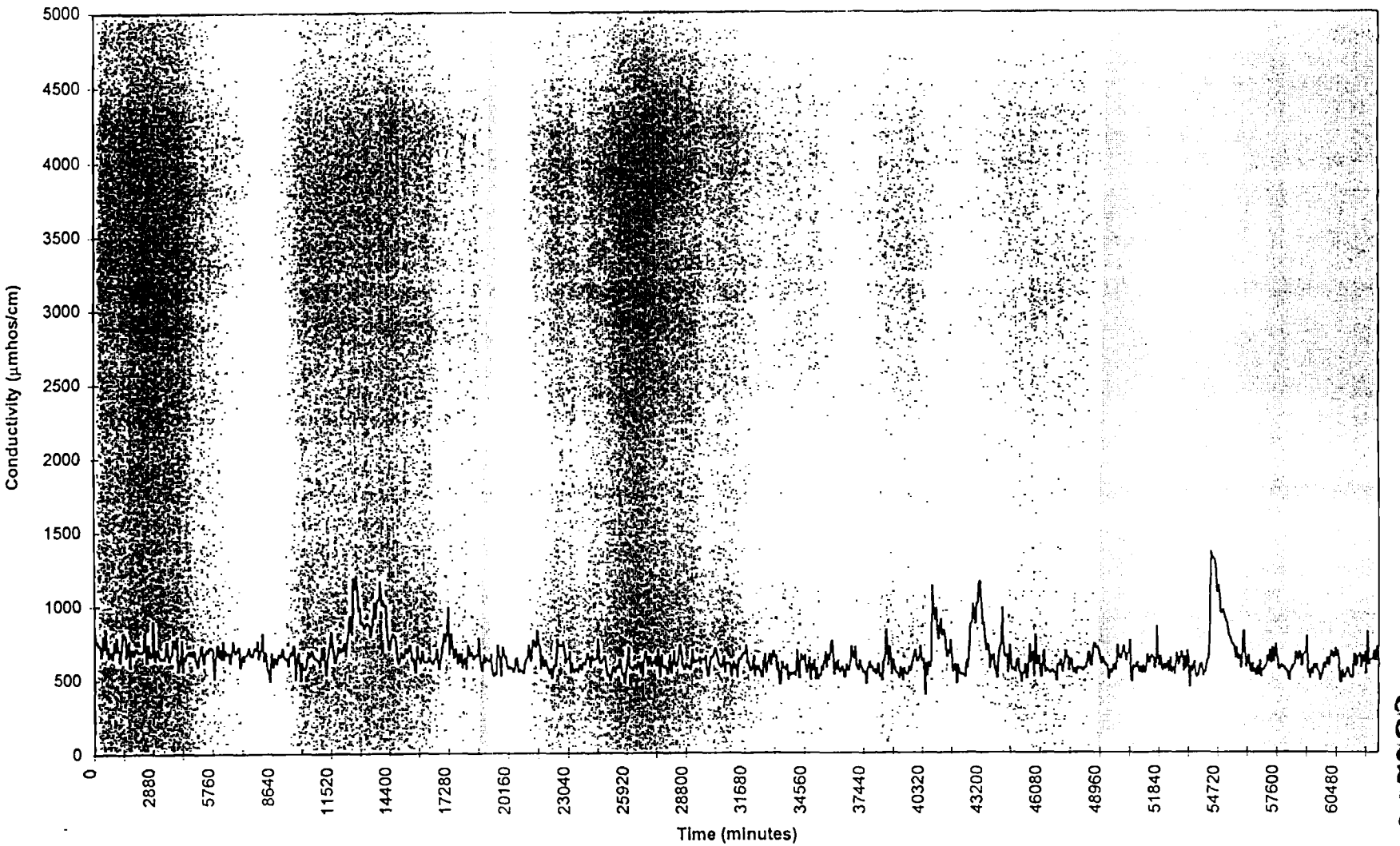
332288

Well SD13-04



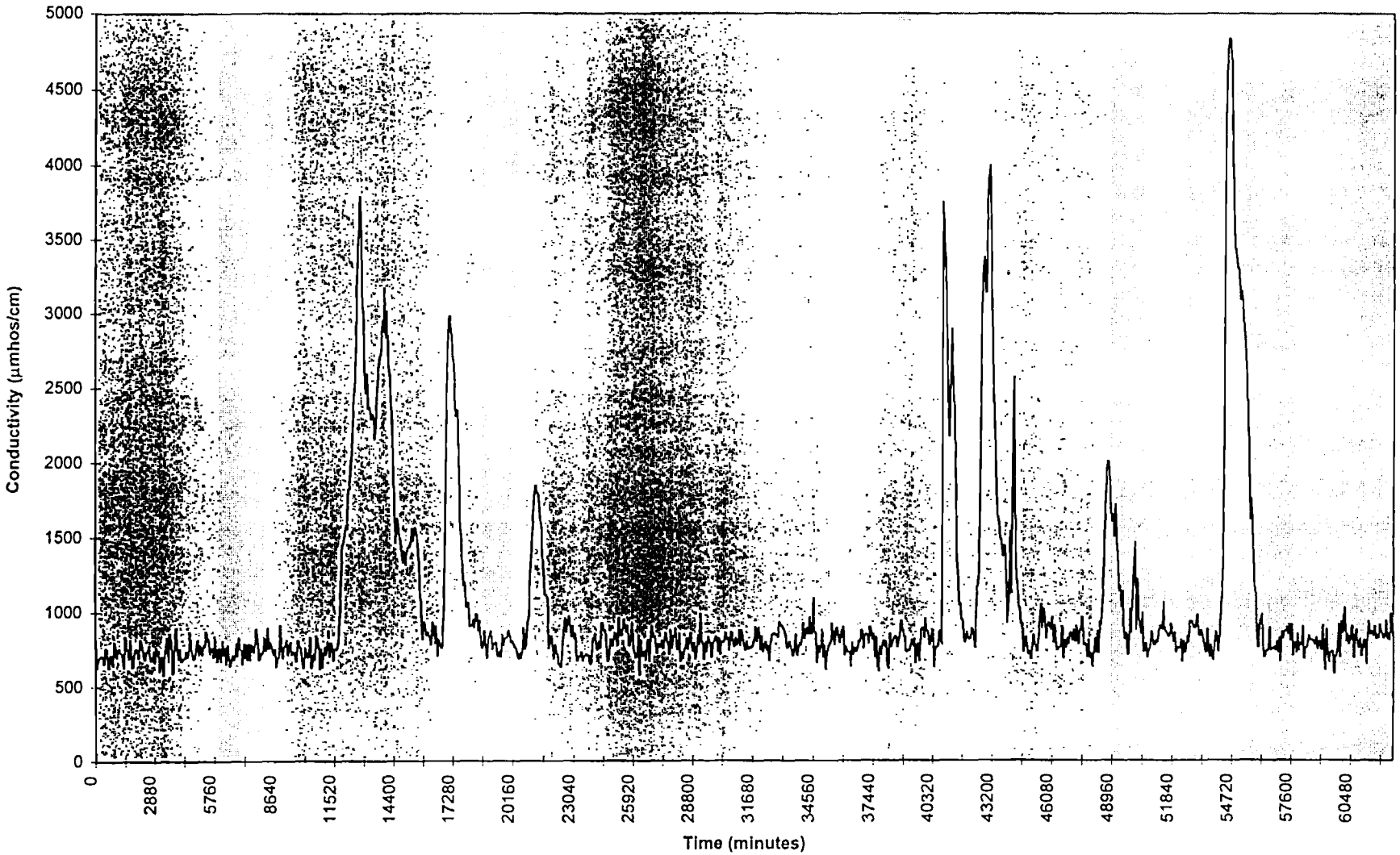
332289

Well SD13-03



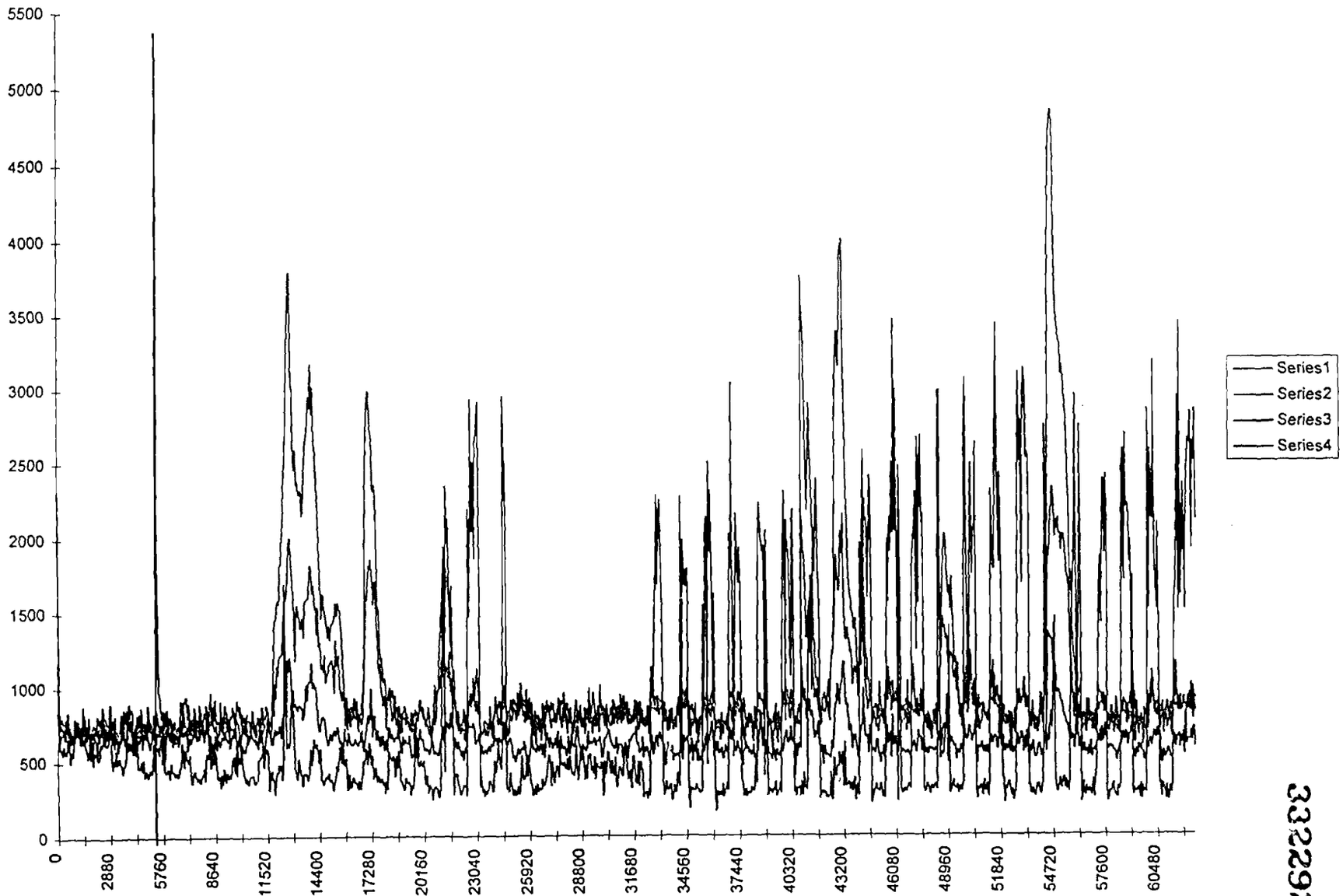
3322290

Well OT12-15C



332291

Sheet6 Chart 1



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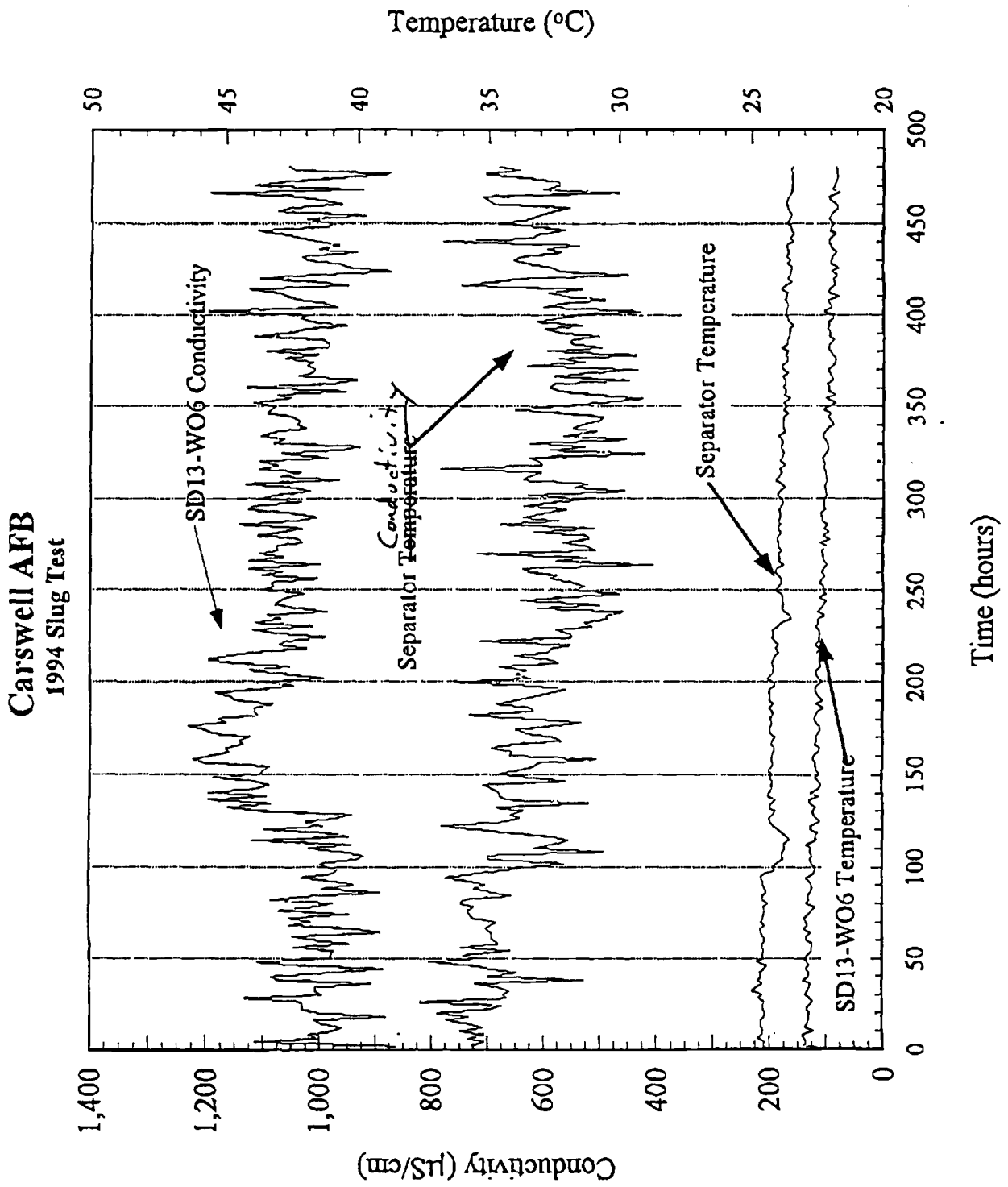
332293


Carswell AFB
1994 Slug Test
SD13-WO6 Conductivity
Separator Temperature
Conductivity
Separator Temperature
SD13-WO6 Temperature
Temperature (°C)
Conductivity (µS/cm)
Time (hours)
1,400
1,200
1,000
800
600
400
200
0
50
45
40
35
30
25
20
0
50
100
150
200
250
300
350
400
450
500

332294

6600	23.668	581.652	22.676	943.131	110
6720	23.744	554.268	22.868	1118.39	112
6840	23.525	587.129	22.501	948.608	114
6960	23.629	655.591	22.572	978.731	116
7080	23.799	713.099	22.468	1096.48	118
7200	23.969	781.561	22.726	992.424	120
7320	24.133	669.284	22.731	1022.54	122
7440	24.254	641.899	22.37	970.516	124
7560	24.286	658.33	22.496	943.131	126
7680	24.15	636.422	22.643	1099.22	128
7800	24.084	682.976	22.682	1162.2	130
7920	24.303	518.668	22.545	1085.53	132
8040	24.215	666.545	22.753	1195.07	134
8160	24.051	677.499	22.802	1093.74	136
8280	24.341	677.499	22.424	1195.07	138
8400	24.297	688.453	22.758	1115.65	140
8520	24.182	707.622	22.397	1088.27	142
8640	24.215	559.745	22.348	1112.91	144
8760	24.166	619.991	22.408	1186.85	146
8880	24.27	682.976	22.556	1104.7	148
9000	24.155	644.637	22.386	1099.22	150
9120	24.319	614.514	22.496	1088.27	152
9240	24.177	611.776	22.55	1203.28	154
9360	24.161	504.975	22.534	1222.45	156
9480	24.221	661.068	22.654	1186.85	158
9600	24.199	655.591	22.616	1159.47	160
9720	24.117	693.93	22.446	1164.94	162
9840	24.1	647.376	22.386	1134.82	164
9960	24.204	567.96	22.589	1143.04	166
10080	24.193	584.391	22.49	1123.87	168
10200	24.084	630.945	22.534	1189.59	170
10320	24.259	650.114	22.479	1203.28	172
10440	24.27	584.391	22.337	1230.67	174
10560	24.226	532.36	22.408	1164.94	176
10680	24.171	628.207	22.534	1178.64	178
10800	24.276	732.269	22.589	1110.17	180
10920	24.166	617.253	22.523	1115.65	182
11040	24.177	622.73	22.463	1115.65	184
11160	24.314	685.715	22.249	1082.79	186
11280	24.128	647.376	22.539	1151.25	188
11400	24.297	619.991	22.293	1156.73	190
11520	24.276	584.391	22.419	1184.11	192
11640	24.286	559.745	22.534	1101.96	194
11760	24.292	625.468	22.589	1044.45	196
11880	24.089	759.653	22.501	1101.96	198
12000	24.128	622.73	22.32	992.424	200
12120	24.363	650.114	22.43	1060.88	202
12240	24.199	630.945	22.545	1123.87	204
12360	24.182	680.238	22.567	1052.67	206
12480	24.155	573.437	22.381	1151.25	208
12600	24.215	587.129	22.397	1195.07	210
12720	24.15	652.853	22.408	1159.47	212
12840	24.073	589.868	22.364	1110.17	214
12960	23.947	587.129	22.506	1022.54	216
13080	24.062	551.529	22.408	1071.83	218
13200	23.969	713.099	22.55	1058.14	220

332295

minutes	temp	cond	temp2	cond2	hours
0	24.363	729.53	22.035	863.715	0
120	24.538	704.884	22.983	1115.65	2
240	24.473	735.007	22.879	1003.37	4
360	24.73	704.884	22.994	1019.8	6
480	24.577	748.699	23.016	978.731	8
600	24.506	707.622	22.621	959.562	10
720	24.56	735.007	22.917	995.162	12
840	24.599	773.346	22.813	1008.85	14
960	24.588	732.269	22.797	880.146	16
1080	24.44	789.777	22.808	1000.63	18
1200	24.44	699.407	22.742	1030.76	20
1320	24.506	674.761	22.884	1028.02	22
1440	24.533	819.9	22.764	1030.76	24
1560	24.473	663.807	22.643	1132.08	26
1680	24.681	672.022	22.764	995.162	28
1800	24.555	661.068	22.934	1006.11	30
1920	24.944	680.238	22.846	1006.11	32
2040	24.719	721.315	22.758	907.531	34
2160	24.538	526.883	22.731	1071.83	36
2280	24.692	699.407	22.999	1085.53	38
2400	24.604	647.376	22.802	986.947	40
2520	24.653	696.668	22.775	885.623	42
2640	24.489	724.053	22.906	1030.76	44
2760	24.385	803.469	22.802	1110.17	46
2880	24.747	707.622	22.857	978.731	48
3000	24.511	743.222	22.945	978.731	50
3120	24.538	658.33	22.808	973.254	52
3240	24.456	745.961	22.682	1044.45	54
3360	24.538	680.238	22.704	945.87	56
3480	24.344	688.453	22.643	1008.85	58
3600	24.412	693.93	22.862	1047.19	60
3720	24.611	691.191	22.879	891.1	62
3840	24.577	702.145	22.72	934.916	64
3960	24.61	693.93	22.961	1052.67	66
4080	24.451	682.976	22.824	1014.33	68
4200	24.577	726.792	22.89	1052.67	70
4320	24.586	729.53	22.977	945.87	72
4440	24.495	735.007	22.78	1071.83	74
4560	24.423	721.315	22.682	1008.85	76
4680	24.506	748.699	22.539	975.993	78
4800	24.336	743.222	22.884	1085.53	80
4920	24.527	655.591	22.797	1008.85	82
5040	24.56	688.453	22.824	891.1	84
5160	24.38	724.053	22.731	995.162	86
5280	24.451	702.145	22.665	937.654	88
5400	24.5	729.53	22.682	970.516	90
5520	24.511	773.346	22.742	1030.76	92
5640	24.593	724.053	22.884	975.993	94
5760	24.495	674.761	22.572	967.777	96
5880	24.051	628.207	22.534	986.947	98
6000	24.199	562.483	22.578	997.901	100
6120	23.996	699.407	22.682	934.916	102
6240	23.755	699.407	22.742	921.223	104
6360	23.799	491.283	22.649	959.562	106
6480	23.761	614.514	22.78	1017.07	108

332296

13320	24.089	548.791	22.43	989.685	222
13440	24.21	551.529	22.446	1074.57	224
13560	24.139	578.914	22.391	1118.39	226
13680	24.188	513.191	22.435	1011.59	228
13800	23.991	526.883	22.528	1115.65	230
13920	23.859	485.806	22.43	1069.1	232
14040	23.498	488.544	22.452	1093.74	234
14160	23.525	458.421	22.205	986.947	236
14280	23.75	611.776	22.479	1044.45	238
14400	23.815	499.498	22.342	1080.05	240
14520	23.772	641.899	22.244	1069.1	242
14640	23.837	551.529	22.178	1052.67	244
14760	23.805	463.898	22.441	1028.02	246
14880	23.887	546.052	22.172	1099.22	248
15000	24.089	526.883	22.298	1082.79	250
15120	23.963	546.052	22.244	1085.53	252
15240	23.832	587.129	22.419	1003.37	254
15360	23.87	576.176	22.309	1101.96	256
15480	23.969	625.468	22.211	1066.36	258
15600	24.073	639.16	22.32	1126.6	260
15720	24.056	406.39	22.287	997.901	262
15840	23.772	578.914	22.134	1126.6	264
15960	23.963	521.406	22.249	1063.62	266
16080	23.925	718.576	22.287	1107.44	268
16200	23.98	507.714	22.293	1074.57	270
16320	23.821	524.145	22.32	1077.31	272
16440	23.98	565.222	22.145	1030.76	274
16560	23.947	518.668	22.391	1036.23	276
16680	24.04	521.406	22.019	1110.17	278
16800	23.952	617.253	22.276	1066.36	280
16920	23.887	510.452	22.079	1030.76	282
17040	24.013	677.499	22.244	1143.04	284
17160	23.892	573.437	22.134	1041.71	286
17280	23.985	636.422	22.32	1006.11	288
17400	23.898	603.56	22.276	1044.45	290
17520	23.903	559.745	22.397	1126.6	292
17640	23.936	636.422	22.216	1118.39	294
17760	23.887	581.652	22.271	1033.5	296
17880	23.805	524.145	22.255	1107.44	298
18000	23.891	628.207	22.238	1077.31	300
18120	23.996	455.683	22.15	1017.07	302
18240	23.93	546.052	22.161	1047.19	304
18360	23.7	521.406	22.227	1132.08	306
18480	23.837	636.422	22.189	965.039	308
18600	24.051	628.207	22.112	1069.1	310
18720	23.952	603.56	22.172	1033.5	312
18840	23.821	784.3	22.14	1107.44	314
18960	23.925	603.56	22.244	1074.57	316
19080	23.706	609.037	22.216	1107.44	318
19200	23.903	625.468	22.265	986.947	320
19320	23.848	420.082	22.315	1069.1	322
19440	23.772	589.868	22.183	967.777	324
19560	23.821	526.883	22.107	929.439	326
19680	23.892	625.468	22.074	1082.79	328
19800	23.81	452.944	22.123	1063.62	330
19920	23.821	565.222	22.189	1104.7	332

332297

20040	23.974	504.975	22.326	1077.31	334
20160	23.711	548.791	22.178	1025.28	336
20280	23.799	532.36	22.129	1041.71	338
20400	23.805	502.237	21.888	1036.23	340
20520	23.81	494.021	21.981	1049.93	342
20640	23.766	565.222	22.085	1093.74	344
20760	23.607	652.853	21.986	1088.27	346
20880	23.798	581.652	22.26	1080.05	348
21000	23.662	499.498	22.063	1118.39	350
21120	23.777	425.559	21.805	1052.67	352
21240	23.547	504.975	22.189	1077.31	354
21360	23.777	573.437	21.827	956.823	356
21480	23.657	589.868	22.096	1132.08	358
21600	23.783	581.652	22.03	986.947	360
21720	23.733	447.467	22.15	934.916	362
21840	23.728	581.652	21.915	1038.97	364
21960	23.805	524.145	21.948	1014.33	366
22080	23.618	433.775	22.041	1008.85	368
22200	23.805	630.945	22.079	1022.54	370
22320	23.859	526.883	21.904	1014.33	372
22440	23.679	573.437	21.833	1063.62	374
22560	23.635	436.513	21.789	1003.37	376
22680	23.733	595.345	21.926	1096.48	378
22800	23.618	496.76	22.008	986.947	380
22920	23.87	551.529	22.118	984.208	382
23040	23.607	551.529	22.014	997.901	384
23160	23.651	502.237	21.866	1118.39	386
23280	23.596	573.437	22.041	1052.67	388
23400	23.553	598.083	21.986	1028.02	390
23520	23.58	532.36	22.101	954.085	392
23640	23.427	614.514	22.041	1014.33	394
23760	23.58	573.437	22.074	1036.23	396
23880	23.629	537.837	21.899	1022.54	398
24000	23.689	428.298	21.904	1197.8	400
24120	23.689	600.822	22.255	970.516	402
24240	23.624	567.96	21.942	992.424	404
24360	23.629	491.283	22.025	1036.23	406
24480	23.733	559.745	22.085	1060.88	408
24600	23.7	592.606	21.707	1071.83	410
24720	23.651	532.36	22.068	1126.6	412
24840	23.87	748.699	22.041	951.347	414
24960	23.722	693.93	21.86	1000.63	416
25080	23.476	641.899	21.86	1107.44	418
25200	23.629	450.206	21.882	1019.8	420
25320	23.536	573.437	21.734	874.669	422
25440	23.509	587.129	21.953	951.347	424
25560	23.459	628.207	21.696	967.777	426
25680	23.64	655.591	22.008	1025.28	428
25800	23.547	641.899	21.964	1033.5	430
25920	23.662	570.699	21.931	937.654	432
26040	23.564	595.345	21.767	1003.37	434
26160	23.651	537.837	21.909	967.777	436
26280	23.662	781.561	21.992	1003.37	438
26400	23.41	622.73	22.063	1033.5	440
26520	23.536	611.776	21.992	1069.1	442
26640	23.388	562.483	21.794	1112.91	444

332298

26760	23.492	609.037	22.025	989.685	446
26880	23.509	682.976	21.97	981.47	448
27000	23.679	628.207	21.888	1025.28	450
27120	23.58	609.037	22.041	921.223	452
27240	23.47	584.391	21.981	1077.31	454
27360	23.58	554.268	21.86	1052.67	456
27480	23.629	691.191	21.707	962.3	458
27600	23.684	699.407	21.8	992.424	460
27720	23.673	710.361	21.981	1041.71	462
27840	23.58	466.637	22.068	1195.07	464
27960	23.536	603.56	21.685	926.7	466
28080	23.459	573.437	21.926	1118.39	468
28200	23.514	573.437	21.833	1071.83	470
28320	23.438	636.422	21.8	965.039	472
28440	23.498	704.884	21.739	877.408	474
28560	23.438	644.637	21.756	1047.19	476
28680	23.503	682.976	21.718	1058.14	478
28800	23.416	644.637	21.827	1085.53	480

332299

Hours	Con1	Initial1	Con2	Initial2	Slug	ConR1	ConR2	Slug1
0	729.53	729	863.7	940	15000	100.0727	91.88298	4.863533
4	735	729	1003.4	940	15000	100.823	106.7447	4.9
8	748.7	729	978.7	940	15000	102.7023	104.117	4.991333
12	735	729	995.2	940	15000	100.823	105.8723	4.9
16	732.3	729	880.1	940	15000	100.4527	93.62766	4.882
20	699.4	729	1030.7	940	15000	95.93964	109.6489	4.662667
24	819	729	1030.7	940	15000	112.3457	109.6489	5.46
28	672	729	995.1	940	15000	92.18107	105.8617	4.48
32	680.3	729	1006.1	940	15000	93.31962	107.0319	4.535333
36	526.8	729	1071.8	940	15000	72.26337	114.0213	3.512
40	647.4	729	986.9	940	15000	88.80658	104.9894	4.316
44	724	729	1030.7	940	15000	99.31413	109.6489	4.826667
48	707.6	729	978.7	940	15000	97.06447	104.117	4.717333
52	658	729	973	940	15000	90.26063	103.5106	4.386667
56	680.3	729	945.8	940	15000	93.31962	100.617	4.535333
60	693.9	729	1047.2	940	15000	95.18519	111.4043	4.626
64	702.1	729	934.9	940	15000	96.31001	99.45745	4.680667
68	682.9	729	1014.3	940	15000	93.67627	107.9043	4.552667
72	729.5	729	945.8	940	15000	100.0686	100.617	4.863333
76	721.3	729	1008.8	940	15000	98.94376	107.3191	4.808667
80	743.2	729	1085.5	940	15000	101.9479	115.4787	4.954667
84	688.4	729	891.1	940	15000	94.43073	94.79787	4.589333
88	702.1	729	937.6	940	15000	96.31001	99.74468	4.680667
92	773.3	729	1030.7	940	15000	106.0768	109.6489	5.155333
96	674.7	729	967.8	940	15000	92.55144	102.9574	4.498
100	562.5	729	997.9	940	15000	77.16049	106.1596	3.75
104	699.4	729	921.2	940	15000	95.93964	98	4.662667
108	614.5	729	1017.1	940	15000	84.29355	108.2021	4.096667
112	554.3	729	1118.4	940	15000	76.03567	118.9787	3.695333
116	655.6	729	978.7	940	15000	89.93141	104.117	4.370667
120	781.5	729	992.4	940	15000	107.2016	105.5745	5.21
124	641.9	729	970.5	940	15000	88.05213	103.2447	4.279333
128	636.4	729	1099.2	940	15000	87.29767	116.9362	4.242667
132	518.6	729	1085.5	940	15000	71.13855	115.4787	3.457333
136	677.5	729	1093.7	940	15000	92.93553	116.3511	4.516667
140	688.4	729	1115.6	940	15000	94.43073	118.6809	4.589333
144	559.7	729	1112.9	940	15000	76.77641	118.3936	3.731333
148	682.9	729	1104.7	940	15000	93.67627	117.5213	4.552667
152	614.5	729	1088.3	940	15000	84.29355	115.7766	4.096667
156	504.9	729	1222.4	940	15000	69.25926	130.0426	3.366
160	655.6	729	1159.5	940	15000	89.93141	123.3511	4.370667
164	647.4	729	1134.8	940	15000	88.80658	120.7234	4.316
168	584.4	729	1123.8	940	15000	80.16461	119.5532	3.896
172	650.1	729	1203.3	940	15000	89.17695	128.0106	4.334
176	532.4	729	1164.9	940	15000	73.03155	123.9255	3.549333
180	732.3	729	1110.2	940	15000	100.4527	118.1064	4.882
184	622.7	729	1115.6	940	15000	85.41838	118.6809	4.151333

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188	647.4	729	1151.2	940	15000	88.80658	122.4681	4.316
192	584.4	729	1184.1	940	15000	80.16461	125.9681	3.896
196	625.5	729	1044.4	940	15000	85.80247	111.1064	4.17
200	622.7	729	992.4	940	15000	85.41838	105.5745	4.151333
204	630.9	729	1123.8	940	15000	86.54321	119.5532	4.206
208	573.4	729	1151.2	940	15000	78.65569	122.4681	3.822667
212	652.8	729	1159.5	940	15000	89.54733	123.3511	4.352
216	587.1	729	1022.5	940	15000	80.53498	108.7766	3.914
220	713.1	729	1058.1	940	15000	97.81893	112.5638	4.754
224	551.5	729	1074.6	940	15000	75.65158	114.3191	3.676667
228	513.2	729	1011.6	940	15000	70.39781	107.617	3.421333
232	485.8	729	1069.1	940	15000	66.63923	113.734	3.238667
236	458.4	729	986.9	940	15000	62.88066	104.9894	3.056
240	499.5	729	1080	940	15000	68.51852	114.8936	3.33
244	551.5	729	1052.7	940	15000	75.65158	111.9894	3.676667
248	546	729	1099.2	940	15000	74.89712	116.9362	3.64
252	546	729	1085.5	940	15000	74.89712	115.4787	3.64
256	576.2	729	1101.9	940	15000	79.03978	117.2234	3.841333
260	639.2	729	1126.6	940	15000	87.68176	119.8511	4.261333
264	578.9	729	1126.6	940	15000	79.41015	119.8511	3.859333
268	718.6	729	1107.4	940	15000	98.57339	117.8085	4.790667
272	524.1	729	1077.3	940	15000	71.893	114.6064	3.494
276	518.7	729	1036.2	940	15000	71.15226	110.234	3.458
280	617.2	729	1066.3	940	15000	84.66392	113.4362	4.114667
284	677.5	729	1143	940	15000	92.93553	121.5957	4.516667
288	636.4	729	1006.1	940	15000	87.29767	107.0319	4.242667
292	559.7	729	1126.6	940	15000	76.77641	119.8511	3.731333
296	581.6	729	1033.5	940	15000	79.78052	109.9468	3.877333
300	628.2	729	1077.3	940	15000	86.17284	114.6064	4.188
304	546.1	729	1047.2	940	15000	74.91084	111.4043	3.640667
308	636.4	729	965	940	15000	87.29767	102.6596	4.242667
312	603.5	729	1033.5	940	15000	82.78464	109.9468	4.023333
316	603.5	729	1074.6	940	15000	82.78464	114.3191	4.023333
320	625.5	729	986.9	940	15000	85.80247	104.9894	4.17
324	589.9	729	967.8	940	15000	80.91907	102.9574	3.932667
328	625.5	729	1082.8	940	15000	85.80247	115.1915	4.17
332	565.2	729	1104.7	940	15000	77.53086	117.5213	3.768
336	548.8	729	1025.3	940	15000	75.28121	109.0745	3.658667
340	502.2	729	1036.2	940	15000	68.88889	110.234	3.348
344	565.2	729	1049.9	940	15000	77.53086	111.6915	3.768
348	581.6	729	1080	940	15000	79.78052	114.8936	3.877333
352	425.6	729	1052.6	940	15000	58.38134	111.9787	2.837333
356	573.4	729	936.8	940	15000	78.65569	99.65957	3.822667
360	581.6	729	986.9	940	15000	79.78052	104.9894	3.877333
364	581.6	729	1038.9	940	15000	79.78052	110.5213	3.877333
368	433.8	729	1008.9	940	15000	59.50617	107.3298	2.892
372	526.8	729	1014.3	940	15000	72.26337	107.9043	3.512
376	436.5	729	1003.4	940	15000	59.87654	106.7447	2.91
380	496.7	729	986.9	940	15000	68.13443	104.9894	3.311333

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384	551.5	729	997.9	940	15000	75.65158	106.1596	3.676667
388	573.4	729	1052.7	940	15000	78.65569	111.9894	3.822667
392	532.4	729	954	940	15000	73.03155	101.4894	3.549333
396	573.5	729	1036.2	940	15000	78.66941	110.234	3.823333
400	428.3	729	1197.8	940	15000	58.75171	127.4255	2.855333
404	567.9	729	992.4	940	15000	77.90123	105.5745	3.786
408	559.7	729	1060.9	940	15000	76.77641	112.8617	3.731333
412	532.4	729	1126.6	940	15000	73.03155	119.8511	3.549333
416	693.9	729	1000.6	940	15000	95.18519	106.4468	4.626
420	450.2	729	1019.8	940	15000	61.75583	108.4894	3.001333
424	597.1	729	951.3	940	15000	81.90672	101.2021	3.980667
428	655.6	729	1025.3	940	15000	89.93141	109.0745	4.370667
432	570.7	729	937.6	940	15000	78.28532	99.74468	3.804667
436	537.8	729	967.8	940	15000	73.77229	102.9574	3.585333
440	622.73	729	1033.5	940	15000	85.4225	109.9468	4.151533
444	562.5	729	1112.9	940	15000	77.16049	118.3936	3.75
448	682.9	729	981.5	940	15000	93.67627	104.4149	4.552667
452	609.1	729	921.2	940	15000	83.55281	98	4.060667
456	554.3	729	1052.7	940	15000	76.03567	111.9894	3.695333
460	699.4	729	992.4	940	15000	95.93964	105.5745	4.662667
464	466.6	729	1195.1	940	15000	64.00549	127.1383	3.110667
468	573.4	729	1118.4	940	15000	78.65569	118.9787	3.822667
472	636.4	729	965.1	940	15000	87.29767	102.6702	4.242667
476	644.6	729	1047.2	940	15000	88.4225	111.4043	4.297333
480	644.6	729	1085.5	940	15000	88.4225	115.4787	4.297333

332302

Slug2
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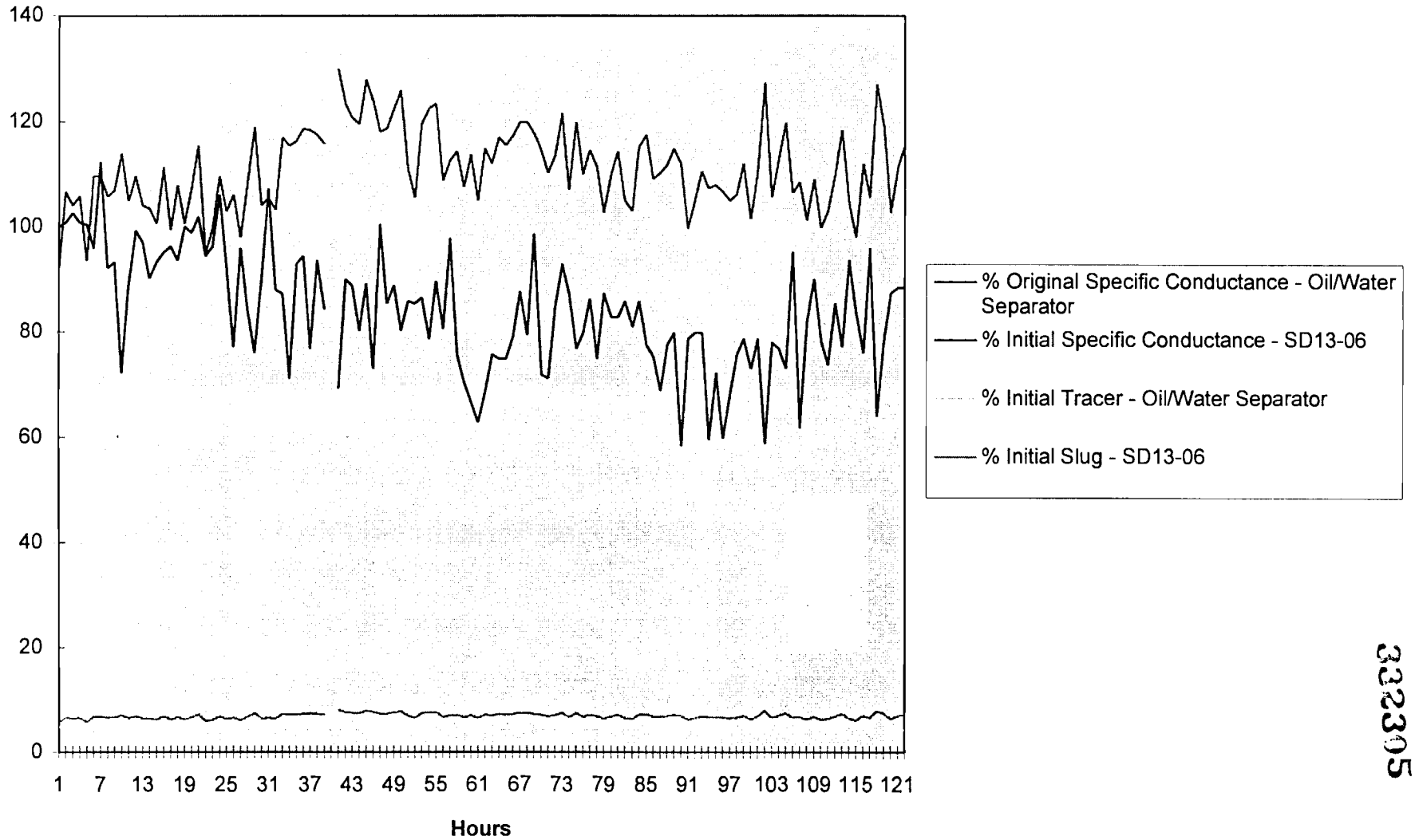
Carswell - Tracer Test



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GROUNDWATER ELEVATION MEASUREMENTS

TABLE B-2
GROUNDWATER ELEVATIONS IN SITE ST14/SITE SD13 WELLS FOLLOWING FRENCH UNDERDRAIN SYSTEM ABANDONMENT
RISK-BASED APPROACH TO REMEDIATION
SITE ST14/ SITE SD13
NAS FW JRB, TEXAS

Well ID	Top of Casing Elevation	Date Measured								
		9/6/94	6/19/96	6/20/96*	6/24/96	6/25/96	6/26/96	6/27/96	6/28/96	8/7/96
SD13-MW01	573.19	560.04	559.72	559.74	559.85	559.82	559.82	559.75	559.75	559.99
SD13-MW02	573.33	557.94	558.81	558.93	559.18	559.17	559.07	559.06	559.01	559.33
SD13-MW03	571.49	559.39	559.22	559.24	559.37	559.36	559.40	559.36	559.31	559.52
SD13-MW04	569.18	558.79	558.51	558.81	558.86	558.85	NA	NA	NA	NA
SD13-MW06	557.95	546.12	546.53	546.60	546.32	546.26	546.23	546.09	546.04	545.91
SD13-MW07	556.52	538.58	539.80	539.73	537.49	537.44	537.48	537.45	537.30	537.59
ST14-MW04	575.74	562.92	NA	NA	NA	NA	NA	NA	NA	562.02
ST14-MW21	572.91	562.47	NA	NA	NA	NA	NA	NA	NA	562.34
ST14-MW22	571.43	561.05	NA	NA	NA	NA	NA	NA	NA	560.73
ST14-MW23	565.11	558.15	NA	NA	NA	NA	NA	NA	NA	557.66
ST14-MW28	574.75	562.45	NA	NA	NA	NA	NA	561.89	561.89	NA
ST14-MW29	571.89	561.56	NA	NA	NA	NA	NA	561.14	561.13	561.35
ST14-MW30	NS	560.55	NA	NA	NA	NA	NA	NA	NA	560.39
ST14-MW31	571.51	560.33	560.12	559.15	560.11	560.07	560.14	560.14	560.10	560.15
ST14-MW32	564.15	558.7	558.90	558.81	558.82	558.83	558.85	558.69	558.83	559.04
OT12-MW15C	567.98	558.98	558.78	558.78	558.81	558.81	558.75	558.75	558.74	558.84
NOTES:			Creek Flowing	Creek Flowing	Creek Not Flowing	Creek Not Flowing	Creek Not Flowing	Creek Not Flowing	Creek Not Flowing	Creek Not Flowing

NS - Location not surveyed

NA - Data not available

* - Date that abandonment activities were completed

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TABLE 1
BIOPLUME II MODEL INPUT PARAMETERS
SITES ST14 AND SD13
RISK-BASED APPROACH TO REMEDIATION
CARSWELL NASJRB, TEXAS

			Model Runs	
Parameter	Description	Calibrated Model Setup	CARA_BEN	CARB_BEN
NTIM	Maximum number of time steps in a pumping period	1	1	1
NPMP	Number of Pumping Periods	2	21	21
NX	Number of nodes in the X direction	20	20	20
NY	Number of nodes in the Y direction	30	30	30
NPMAX	Maximum number of Particles NPMAX=(NX-2)(NY-2)(NPTPND) + (Ns[a])(NPTPND) + 250	5119	5119	5119
NPNT	Time step interval for printing data	1	1	1
NITP	Number of iteration parameters	7	7	7
NUMOBS	Number of observation points	0	0	0
ITMAX	Maximum allowable number of iterations in ADIP [b]	200	200	200
NREC	Number of pumping or injection wells	6	6	6
NPTPND	Initial number of particles per node	9	9	9
NCODES	Number of node identification codes	1	1	1
NPNTMV	Particle movement interval (IMOV)	0	0	0
NPNTVL	Option for printing computed velocities	1	1	1
NPNTD	Option to print computed dispersion equation coefficients	0	0	0
NPDELC	Option to print computed changes in concentration	0	0	0
NPNCHV	Option to punch velocity data	0	0	0
NREACT	Option for biodegradation, retardation and decay	1	1	1
PINT	Pumping period (years)	1@20	1@20, 20@1	1@20, 20@1
TOL	Convergence criteria in ADIP	0.001	0.001	0.001
POROS	Effective porosity	0.30	0.30	0.30
BETA	Characteristic length (long. dispersivity; feet)	90	90	90
S	Storage Coefficient	0 (Steady-State)	0	0
TIMX	Time increment multiplier for transient flow	-	-	-
TINIT	Size of initial time step (seconds)	-	-	-
XDEL	Width of finite difference cell in the x direction (feet)	80	80	80
YDEL	Width of finite difference cell in the y direction (feet)	80	80	80
DLTRAT	Ratio of transverse to longitudinal dispersivity	0.1	0.1	0.1
CELDIS	Maximum cell distance per particle move	0.5	0.5	0.5
ANFCTR	Ratio of Tyy to Txx (1 = isotropic)	1	1	1
DK	Distribution coefficient	0.351	0.351	0.351
RHOB	Bulk density of the solid (grams/cubic centimeter)	1.65	1.65	1.65
THALF	Half-life of the solute	-	-	-
DEC1	Anaerobic decay coefficient (day^{-1})	-	-	-
DEC2	Reaeration coefficient (day^{-1})	0.00141	0.00141	0.0041
F	Stoichiometric Ratio of Hydrocarbons to Oxygen	3.14	3.14	3.14

[a] Ns = Number of nodes that represent fluid sources (wells or constant head cells)
[b] ADIP = Alternating-direction implicit procedure (subroutine for solving groundwater flow equation)
[c] Identical to model CARA_BEN with the exception that bioventing and biosparging units were simulated.

TABLE 2
CALCULATION OF RETARDATION COEFFICIENTS
SITES ST14 AND SD13
RISK-BASED APPROACH TO REMEDIATION
CARSWELL AFB/NAS, TEXAS

Compound	K_{oc} [a/] (L/kg)	Fraction Organic Carbon [b/]	Distribution Coefficient K_d (L/kg) Average [c/]	Bulk Density [d/] (kg/L)	Effective Porosity [e/]	Coefficient of Retardation Average	Approximate Groundwater Velocity [f/] (ft/day)	Contaminant Velocity (ft/day)
Benzene	78	0.0045	0.351	1.65	0.30	2.93	0.2000	0.06825
Toluene	132	0.0045	0.593	1.65	0.30	4.26	0.2000	0.04693
Ethylbenzene	157	0.0045	0.705	1.65	0.30	4.88	0.2000	0.04100
m-xylene	1585	0.0045	7.132	1.65	0.30	40.23	0.2000	0.00497
o-xylene	129	0.0045	0.580	1.65	0.30	4.19	0.2000	0.04776
p-xylene	204	0.0045	0.919	1.65	0.30	6.05	0.2000	0.03304

NOTES:

[a/] From the Groundwater Chemical Desk Reference (Mongomery and Welkom, 1990).

[b/] From site data.

[c/] K_d = Average Fraction Organic Carbon x K_{oc}.

[d/] Literature values.

[e/] Estimated effective porosity based on gravelly SAND (Section 3).

[f/] Estimated groundwater velocity (Section 3).

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FIGURE 5
PLOT OF TOTAL BTEX VS. DISTANCE ALONG PLUME CENTERLINE WITH VARYING TRANSMISSIVITY
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas

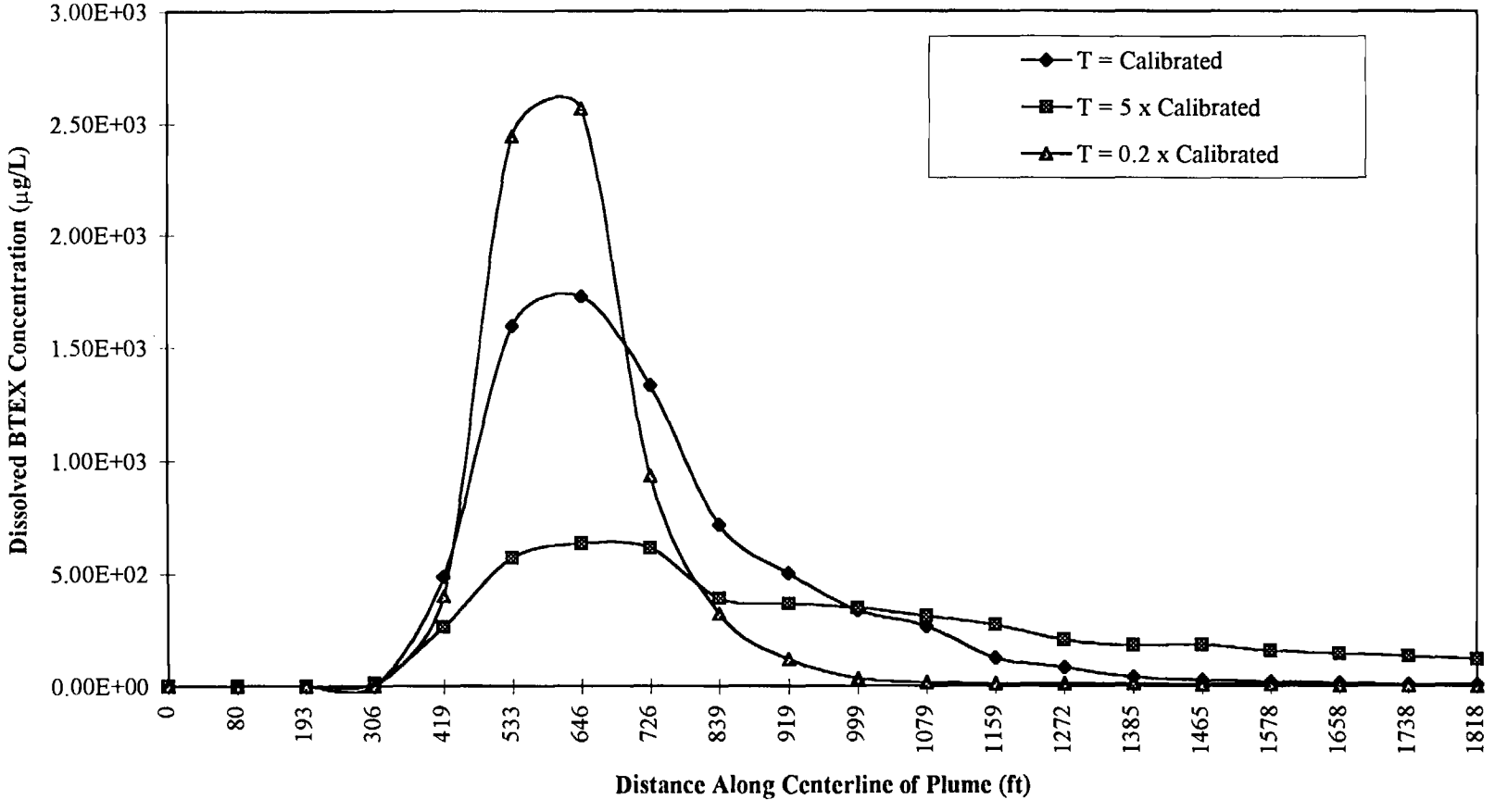

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FIGURE 6
PLOT OF TOTAL BTEX VS. DISTANCE ALONG PLUME CENTERLINE WITH VARYING BIODEGRADATION RATES
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas

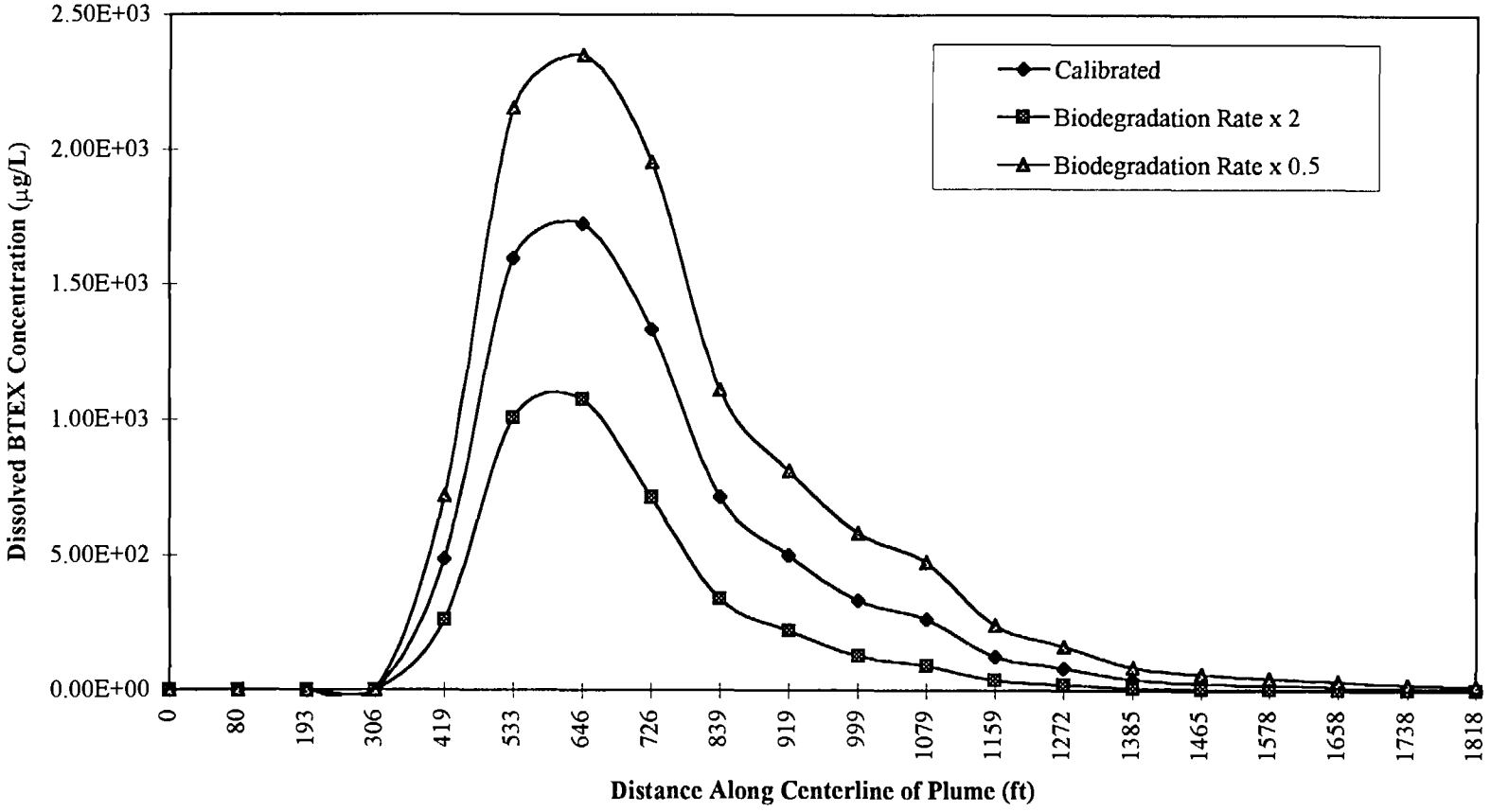

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FIGURE 7
PLOT OF TOTAL BTEX VS. DISTANCE ALONG PLUME CENTERLINE WITH VARYING RETARDATION (SORPTION)
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas

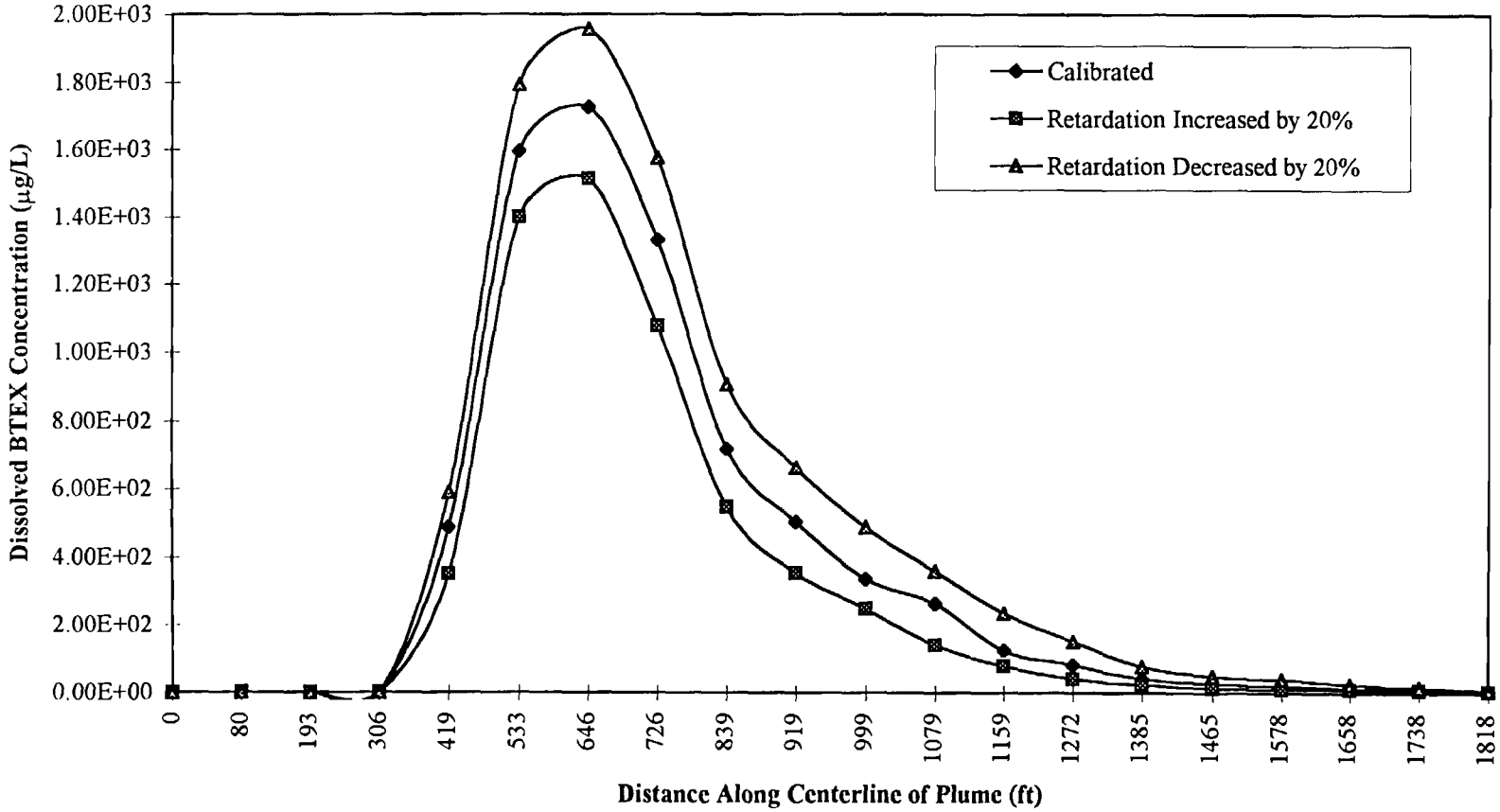

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FIGURE 8
PLOT OF TOTAL BTEX VS. DISTANCE ALONG PLUME CENTERLINE WITH VARYING DISPERSIVITY
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas

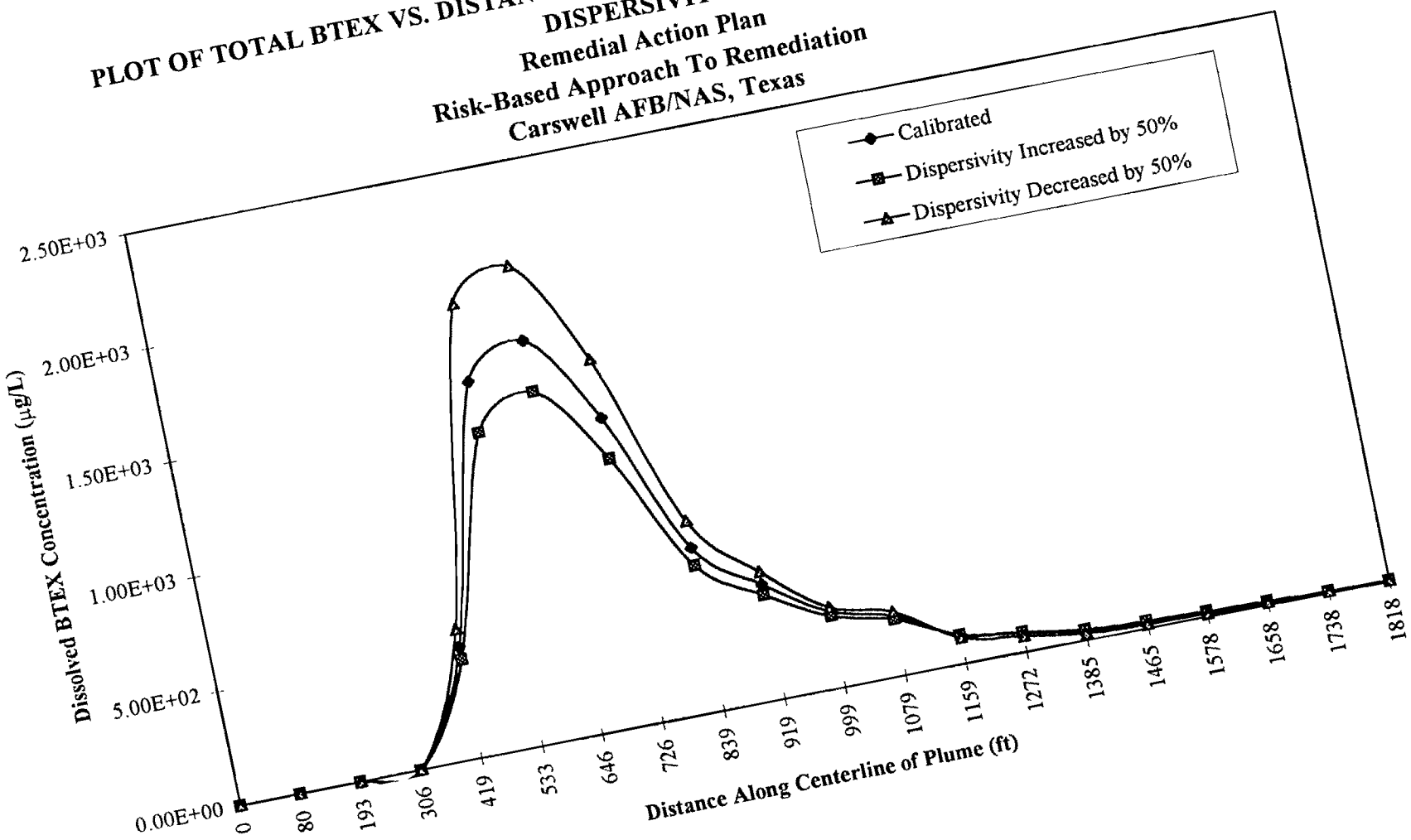

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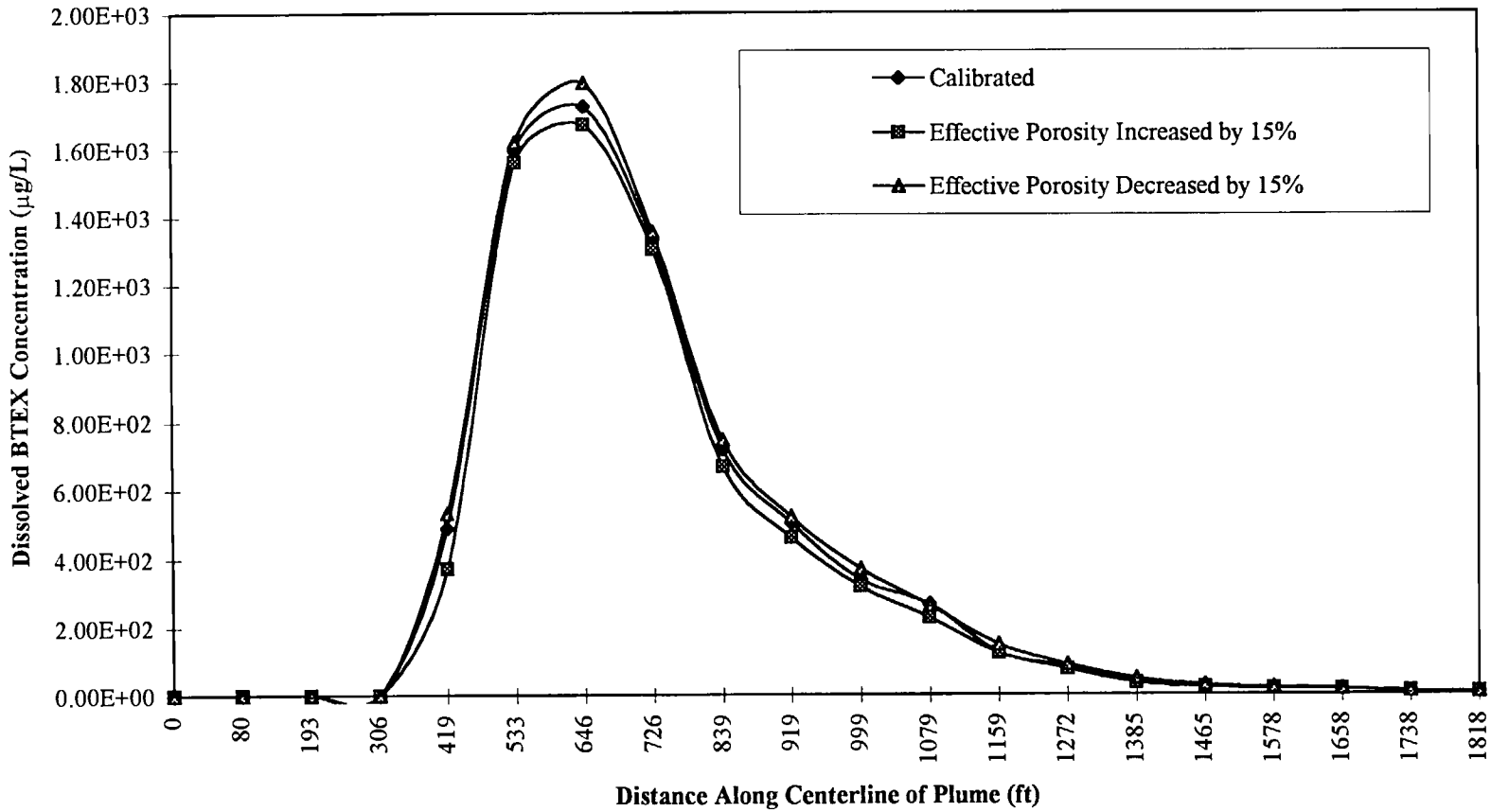
FIGURE 9
PLOT OF TOTAL BTEX VS. DISTANCE ALONG PLUME CENTERLINE WITH VARYING EFFECTIVE POROSITY
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas



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Mean Error, Mean Average Error, and Root-Mean-Square Error for the Calibrated Flow Model
Remedial Action Plan
Risk-Based Approach To Remediation
Carswell AFB/NAS, Texas

Location	Actual Water Level (h_m)[a/]	Calibrated Water Level (h_s)[a/]	h_m-h_s	abs(h_m-h_s)	(h_m-h_s)^2
ST14-MW11	569.3	570.1	0.77	0.77	0.59
ST14-MW3	567.4	568.8	1.37	1.37	1.88
ST14-MW20	564.6	564.3	-0.29	0.29	0.08
ST14-MW28	562.5	563.2	0.75	0.75	0.56
ST14-MW22	561.1	558.3	-2.75	2.75	7.56
ST14-MW32	558.7	553.0	-5.70	5.70	32.49
ST14-MW01	560.0	560.1	0.01	0.01	0.00
ST14-MW21	562.5	562.8	0.33	0.33	0.11
ST14-MW02	563.4	565.0	1.59	1.59	2.53
ST14-MW17H	565.5	568.0	2.50	2.50	6.25
ST14-MW7	570.0	573.0	2.99	2.99	8.94
ST14-MW17L	566.7	569.4	2.69	2.69	7.24
ST14-MW19	563.5	563.9	0.43	0.43	0.18
ST14-MW29	561.6	562.4	0.84	0.84	0.71
Total:	7896.68	7902.21	5.53	23.01	69.12
			ME[b/] =	0.39	
			MAE[c/] =	1.64	
			RMS[d/] =	2.22	

[a/] Water levels are in feet mean-sea-level.

[b/] ME = Mean Error =1/n x (h_m-h_s).

[c/] MAE = Mean Average Error = 1/n x |(h_m-h_s)|.

[d/] RMS = Root-Mean-Square (RMS) Error = (1/n x (h_m-h_s)^2)$^{0.5}$.

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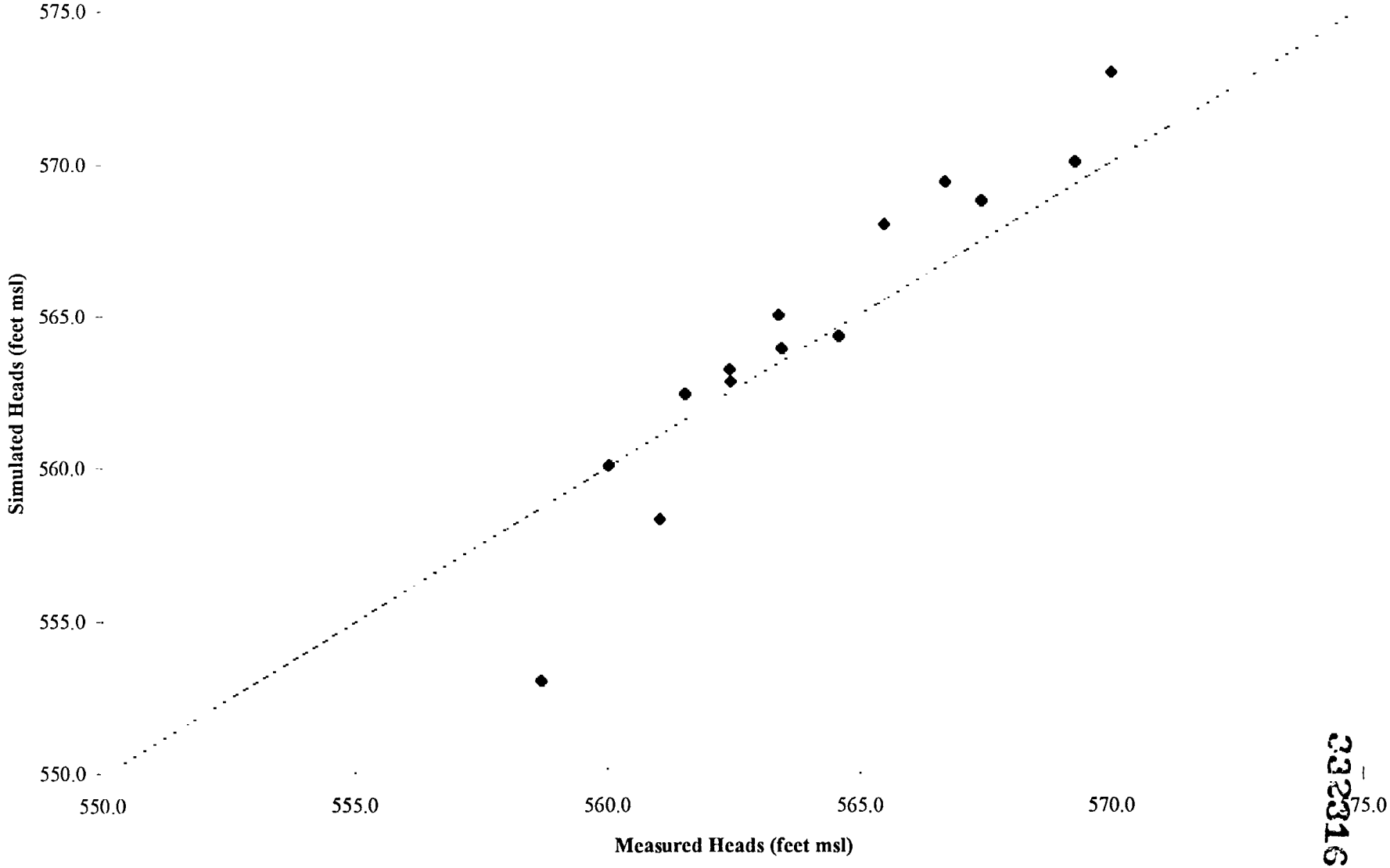
Measured Heads vs. Simulated Heads
Carswell AFB/NAS, Texas



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APPENDIX E

FATE AND TRANSPORT MODEL CALCULATIONS

THERMODYNAMIC REACTIONS

Remedial Action Plan
Risk-Based Approach to Remediation
Site ST14, Carswell AFB/NAS Fort Worth JRB, TX

Electron Donor and Electron Acceptor Half Cell Reactions

HALF-CELL REACTIONS	ΔG°_r (kcal/equiv)*	ΔG°_r (kJ/equiv)*	E° (V)	Eh (V)	pe	Conditions for Eh and pe §
ELECTRON-ACCEPTOR (REDUCTION) HALF CELL REACTIONS						
$5e^- + 6H^+ + NO_3^- \Rightarrow 0.5N_2 + 3H_2O$ *Denitrification*	-28.7	-120.	+1.24	+0.708	+12.0	pH = 7 $\Sigma[N]=10^{-3}$
$4e^- + 4H^+ + O_2 \Rightarrow 2H_2O$ *Aerobic Respiration*	-28.3	-119.	+1.23	+0.805	+13.6	pH = 7 $P_{O_2}=0.21$ atm
$2e^- + 4H^+ + \underline{MnO_2} \Rightarrow Mn^{2+} + 2H_2O$ *Pyrolusite Dissolution/Reduction*	-28.3	-119	+1.23	+0.550	+9.27	pH = 7 $\Sigma[Mn]=10^{-5}$
$CO_2 + e^- + H^+ + \underline{MnOOH} \Rightarrow MnCO_3 + H_2O$ *a Manganite Carbonation/Reduction*	-23.1	-96.8	+1.00	+0.408	+6.90	pH = 8 $P_{CO_2}=10^{-2}$
$e^- + H^+ + MnO_2 \Rightarrow \underline{MnOOH}$ *Pyrolusite Hydrolysis/Reduction*	-22.1	-92.5	+0.959	+0.545	+9.21	pH = 7
$e^- + 3H^+ + \underline{Fe(OH)_{3,amph.}} \Rightarrow Fe^{2+} + 2H_2O$ *Amorphous "Goethite" Dissolution/Reduction*	-21.5	-89.9	+0.932	+0.163	+2.75	pH = 6 $\Sigma[Fe]=10^{-5}$
$8e^- + 10H^+ + NO^-_3 \Rightarrow NH^+_4 + 3H_2O$ *Nitrate Reduction*	-20.3	-84.9	+0.879	+0.362	+6.12	pH = 7
$2e^- + 2H^+ + NO^-_3 \Rightarrow NO^-_2 + H_2O$ *Nitrate Reduction*	-18.9	-78.9	+0.819	+0.404	+6.82	pH = 7
$e^- + 3H^+ + \underline{FeOOH} \Rightarrow Fe^{2+} + 2H_2O$ *"Ferric oxyhydroxide" Dissolution/Reduction*	-15.0	-62.9	+0.652	-0.118	-1.99	pH = 6 Σ [Fe]$=10^{-5}$
$e^- + 3H^+ + \underline{Fe(OH)_{3,xline.}} \Rightarrow Fe^{2+} + 3H_2O$ *Crystallized "Goethite" Dissolution/Reduction*	-11.8	-49.2	+0.510	-0.259	-4.38	pH = 6 Σ [Fe]$=10^{-5}$
$e^- + H^+ + CO_{2,g} + \underline{Fe(OH)_{3,amph.}} \Rightarrow \underline{FeCO_3} + 2H_2O$ *Amorphous "Goethite" Carbonation/Reduction*	-11.0	-46.2	+0.479	-0.113	-1.90	pH = 8 $P_{CO_2}=10^{-2}$ atm
$8e^- + 9H^+ + SO^{2-}_4 \Rightarrow HS^- + 4H_2O$ *Sulfate Reduction*	-5.74	-24.0	+0.249	-0.278	-4.70	pH = 8
$8e^- + 10H^+ + SO^{2-}_4 \Rightarrow H_2S^0 + 4H_2O$ *Sulfate Reduction*	-6.93	-28.9	+0.301	-0.143	-2.42	pH = 6
$C_2Cl_4 + H^+ + 2e^- \Rightarrow C_2HCl_3 + Cl^-$ *PCE Reductive Dechlorination*	-14.79	-61.9	+0.642	+0.553	+9.35	pH = 7 $[Cl^-]=10^{-4}$
$C_2HCl_3 + H^+ + 2e^- \Rightarrow C_2H_2Cl_2 + Cl^-$ *TCE Reductive Dechlorination*	-14.50	-60.7	+0.629	+0.540	+9.13	pH = 7 $[Cl^-]=10^{-4}$
$C_2H_2Cl_2 + H^+ + 2e^- \Rightarrow C_2H_3Cl + Cl^-$ *c-DCE Reductive Dechlorination*	-12.12	-50.7	+0.526	+0.437	+7.39	pH = 7 $[Cl^-]=10^{-4}$
$C_2H_3Cl + H^+ + 2e^- \Rightarrow C_2H_4 + Cl^-$ *VC Reductive Dechlorination*	-13.73	-57.4	+0.595	+0.506	+8.55	pH = 7 $[Cl^-]=10^{-4}$
$8e^- + 8H^+ + CO_{2,g} \Rightarrow CH_{4,g} + 2H_2O$ *Methanogenesis*	-3.91	-16.4	+0.169	-0.259	-4.39	pH = 7 $P_{CO_2}=10^{-2}$ $P_{CH_4}=10^0$

HALF-CELL REACTIONS	$\Delta G°_r$ (kcal/ equiv)*	$\Delta G°_r$ (kJ/ equiv)*	E° (V)	Eh (V)	pe	Conditions for Eh and pe §
ELECTRON-DONOR (OXIDATION) HALF CELL REACTIONS						
$12H_2O + C_6H_6 \Rightarrow 6CO_2 + 30H^+ + 30e^-$ *Benzene Oxidation*	+2.83	+11.8	-0.122	+0.316	+5.34	pH = 7 $P_{CO_2}=10^{-2}$
$14H_2O + C_6H_5CH_3 \Rightarrow 7CO_2 + 36H^+ + 36e^-$ *Toluene Oxidation*	+2.96	+12.4	-0.128	+0.309	+5.22	pH = 7 $P_{CO_2}=10^{-2}$
$16H_2O + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42H^+ + 42e^-$ *Ethylbenzene Oxidation*	+2.96	+12.4	-0.128	+0.309	+5.21	pH = 7 $P_{CO_2}=10^{-2}$
$20H_2O + C_{10}H_8 \Rightarrow 10CO_2 + 48H^+ + 48e^-$ *Naphthalene Oxidation*	+2.98	+12.5	-0.130[a]	+0.309	+5.22	pH = 7 $P_{CO_2}=10^{-2}$
$18H_2O + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 48H^+ + 48e^-$ *1,3,5-Trimethylbenzene Oxidation*	+3.07	+12.8	-0.133[a]	+0.303	+5.12	pH = 7 $P_{CO_2}=10^{-2}$
$18H_2O + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 48H^+ + 48e^-$ *1,2,4-Trimethylbenzene Oxidation*	+3.07	+12.9	-0.134[a]	+0.302	+5.11	pH = 7 $P_{CO_2}=10^{-2}$
$4H_2O + C_2H_3Cl \Rightarrow 2CO_2 + 11H^+ + 10e^- + Cl^-$ *Vinyl Chloride Oxidation*	-0.55	-2.30	+0.024[a]	-0.455	-7.69	pH = 7 $P_{CO_2}=10^{-2}$
$12H_2O + C_6H_5Cl \Rightarrow 6CO_2 + 29H^+ + 28e^- + Cl^-$ *Chlorobenzene Oxidation*	+2.21	+9.26	-0.096[a]	+0.358	+6.05	pH = 7 $P_{CO_2}=10^{-2}$

NOTES:

* = $\Delta G°_r$ for half cell reaction as shown divided by the number of electrons involved in reaction.

§ = Conditions assumed for the calculation of Eh and pe (pe = Eh/0.05916). Where two dissolved species are involved, other than those mentioned in this column, their activities are taken as equal. Note, this does not affect the free energy values listed.

[a] = E^0 calculated using the following equation; $E^0 = \Delta G°_r$ (J/nF) * 1.0365×10^{-5} (VF/J) from Stumm and Morgan, 1981

Coupled Oxidation Reactions

Coupled Benzene Oxidation Reactions	ΔG°_r (kcal/mole Benzene)	ΔG°_r (kJ/mole Benzene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$7.5O_2 + C_6H_6 \Rightarrow 6CO_{2,g} + 3H_2O$ *Benzene oxidation /aerobic respiration*	-765.34	-3202	3.07:1
$6NO_3^- + 6H^+ + C_6H_6 \Rightarrow 6CO_{2,g} + 6H_2O + 3N_{2,g}$ *Benzene oxidation / denitrification*	-775.75	-3245	4.77:1
$30H^+ + 15\underline{MnO_2} + C_6H_6 \Rightarrow 6CO_{2,g} + 15Mn^{2+} + 18H_2O$ *Benzene oxidation / manganese reduction*	-765.45	-3202	10.56:1
$3.75\ NO_3^- + C_6H_6 + 7.5\ H^+ + 0.75\ H_2O \Rightarrow 6\ CO_2 + 3.75\ NH_4^+$ *Benzene oxidation / nitrate reduction*	-524.1	-2193	2.98:1
$60H^+ + 30\underline{Fe(OH)_{3,a}} + C_6H_6 \Rightarrow 6CO_2 + 30Fe^{2+} + 78H_2O$ *Benzene oxidation / iron reduction*	-560.10	-2343	21.5:1
$7.5H^+ + 3.75SO_4^{2-} + C_6H_6 \Rightarrow 6CO_{2,g} + 3.75H_2S^o + 3H_2O$ *Benzene oxidation / sulfate reduction*	-122.93	-514.3	4.61:1
$4.5H_2O + C_6H_6 \Rightarrow 2.25CO_{2,g} + 3.75CH_4$ *Benzene oxidation / methanogenesis*	-32.40	-135.6	0.77:1
$15C_2Cl_4 + 12H_2O + C_6H_6 \Rightarrow 15C_2HCl_3 + 6CO_2 + 15H^+ + 15Cl^-$ *Benzene oxidation/ Tetrachloroethylene reductive dehalogenation*	-358.59	-1500	31.8:1
$15C_2HCl_3 + 12H_2O + C_6H_6 \Rightarrow 15C_2H_2Cl_2 + 6CO_2 + 15H^+ + 15Cl^-$ *Benzene oxidation/ Trichloroethylene reductive dehalogenation*	-350.04	-1465	25.2:1
$15C_2H_2Cl_2 + 12H_2O + C_6H_6 \Rightarrow 15C_2H_3Cl + 6CO_2 + 15H^+ + 15Cl^-$ *Benzene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-278.64	-1166	18.6:1
$15C_2H_3Cl + 12H_2O + C_6H_6 \Rightarrow 15C_2H_4 + 6CO_2 + 15H^+ + 15Cl^-$ *Benzene oxidation/ Vinyl chloride reductive dehalogenation*	-327.37	-1370	11.9:1

Coupled Toluene Oxidation Reactions	ΔG°_r (kcal/mole Toluene)	ΔG°_r (kJ/mole Toluene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$9O_2 + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4H_2O$ *Toluene oxidation /aerobic respiration*	-913.76	-3823	3.13:1
$7.2NO_3^- + 7.2H^+ + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 7.6H_2O + 3.6N_{2,g}$ *Toluene oxidation / denitrification*	-926.31	-3875	4.85:1
$36H^+ + 18\underline{MnO_2} + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 18Mn^{2+} + 22H_2O$ *Toluene oxidation / manganese reduction*	-913.89	-3824	10.74:1
$72H^+ + 36\underline{Fe(OH)_{3,a}} + C_6H_5CH_3 \Rightarrow 7CO_2 + 36Fe^{2+} + 94H_2O$ *Toluene oxidation / iron reduction*	-667.21	-2792	21.86:1
$9H^+ + 4.5SO_4^{2-} + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4.5H_2S^a + 4H_2O$ *Toluene oxidation / sulfate reduction*	-142.86	-597.7	4.7:1
$5H_2O + C_6H_5CH_3 \Rightarrow 2.5CO_{2,g} + 4.5CH_4$ *Toluene oxidation / methanogenesis*	-34.08	-142.6	0.78:1
$18C_2Cl_4 + 14H_2O + C_6H_5CH_3 \Rightarrow 18C_2HCl_3 + 7CO_2 + 18H^+ + 18Cl^-$ *Toluene oxidation/ Tetrachloroethylene reductive dehalogenation*	-425.66	-1781	32.4:1
$18C_2HCl_3 + 14H_2O + C_6H_5CH_3 \Rightarrow 18C_2H_2Cl_2 + 7CO_2 + 18H^+ + 18Cl^-$ *Toluene oxidation/ Trichloroethylene reductive dehalogenation*	-415.40	-1738	25.7:1
$18C_2H_2Cl_2 + 14H_2O + C_6H_5CH_3 \Rightarrow 18C_2H_3Cl + 7CO_2 + 18H^+ + 18Cl^-$ *Toluene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-329.72	-1380	18.9:1
$18C_2H_3Cl + 14H_2O + C_6H_5CH_3 \Rightarrow 18C_2H_4 + 7CO_2 + 18H^+ + 18Cl^-$ *Toluene oxidation/ Vinyl chloride reductive dehalogenation*	-388.22	-1624	12.1:1

Coupled Ethylbenzene Oxidation reactions	ΔG°_r kcal/mole Ethylbenzene	ΔG°_r kJ/mole Ethylbenzene	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$10.5O_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5H_2O$ *Ethylbenzene oxidation /aerobic respiration*	-1066.13	-4461	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *Ethylbenzene oxidation / denitrification*	-1080.76	-4522	4.92:1
$46H^+ + 22\underline{MnO_2} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 22Mn^{2+} + 28H_2O$ *Ethylbenzene oxidation / manganese reduction*	-1066.27	-4461	11.39:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *Ethylbenzene oxidation / iron reduction*	-778.48	-3257	22.0:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *Ethylbenzene oxidation / sulfate reduction*	-166.75	-697.7	4.75:1
$5.5H_2O + C_6H_5C_2H_5 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *Ethylbenzene oxidation / methanogenesis*	-39.83	-166.7	0.79:1
$21C_2Cl_4 + 16H_2O + C_6H_5C_2H_5 \Rightarrow 21C_2HCl_3 + 8CO_2 + 21H^+ + 21Cl^-$ *Ethylbenzene oxidation/ Tetrachloroethylene reductive dehalogenation*	-496.67	-2078	32.8:1
$21C_2HCl_3 + 16H_2O + C_6H_5C_2H_5 \Rightarrow 21C_2H_2Cl_2 + 8CO_2 + 21H^+ + 21Cl^-$ *Ethylbenzene oxidation/ Trichloroethylene reductive dehalogenation*	-484.70	-2028	26.0:1
$21C_2H_2Cl_2 + 16H_2O + C_6H_5C_2H_5 \Rightarrow 21C_2H_3Cl + 8CO_2 + 21H^+ + 21Cl^-$ *Ethylbenzene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-384.74	-1610	19.2:1
$21C_2H_3Cl + 16H_2O + C_6H_5C_2H_5 \Rightarrow 21C_2H_4 + 8CO_2 + 21H^+ + 21Cl^-$ *Ethylbenzene oxidation/ Vinyl chloride reductive dehalogenation*	-452.99	-1895	12.3:1

Coupled m-Xylene Oxidation Reactions	ΔG°_r (kcal/mole *m*-xylene)	ΔG°_r (kJ/mole *m*-xylene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$10.5O_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5H_2O$ *m-Xylene oxidation /aerobic respiration*	-1063.25	-4448	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *m-Xylene oxidation / denitrification*	-1077.81	-4509	4.92:1
$46H^+ + 22\underline{MnO_2} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 22Mn^{2+} + 28H_2O$ *m-Xylene oxidation / manganese reduction*	-1063.39	-4449	11.39:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *m-Xylene oxidation / iron reduction*	-775.61	-3245	22:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *m-Xylene oxidation / sulfate reduction*	-163.87	-685.6	4.75:1
$5.5H_2O + C_6H_4(CH_3)_2 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *m-Xylene oxidation / methanogenesis*	-36.95	-154.6	0.79:1 [a]
$21C_2Cl_4 + 16H_2O + C_6H_4(CH_3)_2 \Rightarrow 21C_2HCl_3 + 8CO_2 + 21H^+ + 21Cl^-$ *m-Xylene oxidation/ Tetrachloroethylene reductive dehalogenation*	-493.79	-2066	32.8:1
$21C_2HCl_3 + 16H_2O + C_6H_4(CH_3)_2 \Rightarrow 21C_2H_2Cl_2 + 8CO_2 + 21H^+ + 21Cl^-$ *m-Xylene oxidation/ Trichloroethylene reductive dehalogenation*	-481.82	-2016	26.0:1
$21C_2H_2Cl_2 + 16H_2O + C_6H_4(CH_3)_2 \Rightarrow 21C_2H_3Cl + 8CO_2 + 21H^+ + 21Cl^-$ *m-Xylene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-381.86	-1598	19.2:1
$21C_2H_3Cl + 16H_2O + C_6H_4(CH_3)_2 \Rightarrow 21C_2H_4 + 8CO_2 + 21H^+ + 21Cl^-$ *m-Xylene oxidation/ Vinyl chloride reductive dehalogenation*	-450.11	-1883	12.3:1

Coupled Naphthalene Oxidation Reactions	ΔG°_r (kcal/mole naphthalene)	ΔG°_r (kJ/mole naphthalene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$12O_2 + C_{10}H_8 \Rightarrow 10CO_2 + 4H_2O$ *Naphthalene oxidation /aerobic respiration*	-1217.40	-5094	3.00:1
$9.6NO_3^- + 9.6H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 8.8H_2O + 4.8N_{2,g}$ *Naphthalene oxidation / denitrification*	-1234.04	-5163	4.65:1
$24MnO_2 + 48H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 24Mn^{2+} + 28H_2O$ *Naphthalene oxidation / manganese reduction*	-1217.57	-5094	16.31:1
$48Fe(OH)_{3,a} + 96H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 48Fe^{2+} + 124H_2O$ *Naphthalene oxidation / iron reduction*	-932.64	-3902	40.13:1
$6SO_4^{2-} + 12H^+ + C_{10}H_8 \Rightarrow 10CO_2 + 6H_2S^o + 4H_2O$ *Naphthalene oxidation / sulfate reduction*	-196.98	-824.2	4.50:1
$8H_2O + C_{10}H_8 \Rightarrow 4CO_2 + 6CH_4$ *Naphthalene oxidation / methanogenesis*	-44.49	-186.1	1.13:1
$24C_2Cl_4 + 20H_2O + C_{10}H_8 \Rightarrow 24C_2HCl_3 + 10CO_2 + 24H^+ + 24Cl^-$ *Naphthalene oxidation/ Tetrachloroethylene reductive dehalogenation*	-566.59	-2371	31.1:1
$24C_2HCl_3 + 20H_2O + C_{10}H_8 \Rightarrow 24C_2H_2Cl_2 + 10CO_2 + 24H^+ + 24Cl^-$ *Naphthalene oxidation/ Trichloroethylene reductive dehalogenation*	-552.91	-2313	24.6:1
$24C_2H_2Cl_2 + 20H_2O + C_{10}H_8 \Rightarrow 24C_2H_3Cl + 10CO_2 + 24H^+ + 24Cl^-$ *Naphthalene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-438.67	-1835	18.2:1
$24C_2H_3Cl + 20H_2O + C_{10}H_8 \Rightarrow 24C_2H_4 + 10CO_2 + 24H^+ + 24Cl^-$ *Naphthalene oxidation/ Vinyl chloride reductive dehalogenation*	-516.67	-2162	11.6:1

Coupled 1,3,5-Trimethylbenzene Oxidation Reactions	ΔG°_r (kcal/mole 1,3,5-TMB)	ΔG°_r (kJ/mole 1,3,5-TMB)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$12O_2 + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 6H_2O$ *1,3,5-Trimethylbenzene oxidation /aerobic respiration*	-1213.29	-5076	3.20:1
$9.6NO_3^- + 9.6H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 10.8H_2O + 4.8N_{2,g}$ *1,3,5-Trimethylbenzene oxidation / denitrification*	-1229.93	-5146	4.96:1
$24MnO_2 + 48H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 30H_2O + 24Mn^{2+}$ *1,3,5-Trimethylbenzene oxidation / manganese reduction*	-1213.46	-5077	17.40:1
$48Fe(OH)_{3,a} + 96H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 48Fe^{2+} + 126H_2O$ *1,3,5-Trimethylbenzene oxidation / iron reduction*	-928.53	-3885	42.80:1
$6SO_4^{2-} + 12H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 6H_2O + 6H_2S^o$ *1,3,5-Trimethylbenzene oxidation / sulfate reduction*	-192.87	-807.0	4.80:1
$6H_2O + C_6H_3(CH_3)_3 \Rightarrow 3CO_2 + 6CH_4$ *1,3,5-Trimethylbenzene oxidation / methanogenesis*	-40.39	-169.0	0.90:1
$24C_2Cl_4 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2HCl_3 + 9CO_2 + 24H^+ + 24Cl^-$ *1,3,5-Trimethylbenzene oxidation/ Tetrachloroethylene reductive dehalogenation*	-562.48	-2353	33.2:1
$24C_2HCl_3 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_2Cl_2 + 9CO_2 + 24H^+ + 24Cl^-$ *1,3,5-Trimethylbenzene oxidation/ Trichloroethylene reductive dehalogenation*	-548.80	-2296	26.3:1
$24C_2H_2Cl_2 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_3Cl + 9CO_2 + 24H^+ + 24Cl^-$ *1,3,5-Trimethylbenzene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-434.56	-1818	19.4:1
$24C_2H_3Cl + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_4 + 9CO_2 + 24H^+ + 24Cl^-$ *1,3,5-Trimethylbenzene oxidation/ Vinyl chloride reductive dehalogenation*	-512.56	-2145	12.4:1

Coupled 1,2,4-Trimethylbenzene Oxidation Reactions	ΔG°_r (kcal/mole 1,2,4-TMB)	ΔG°_r (kJ/mole 1,2,4-TMB)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$12O_2 + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 6H_2O$ *1,2,4-Trimethylbenzene oxidation /aerobic respiration*	-1212.92	-5075	3.20:1
$9.6NO_3^- + 9.6H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 10.8H_2O + 4.8N_{2,g}$ *1,2,4-Trimethylbenzene oxidation / denitrification*	-1229.56	-5144	4.96:1
$24\underline{MnO_2} + 48H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 30H_2O + 24Mn^{2+}$ *1,2,4-Trimethylbenzene oxidation / manganese reduction*	-1213.09	-5076	17.4:1
$48\underline{Fe(OH)}_{3,a} + 96H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 48Fe^{2+} + 126H_2O$ *1,2,4-Trimethylbenzene oxidation / iron reduction*	-928.16	-3883	42.8:1
$6SO_4^{2-} + 12H^+ + C_6H_3(CH_3)_3 \Rightarrow 9CO_2 + 6H_2O + 6H_2S^o$ *1,2,4-Trimethylbenzene oxidation / sulfate reduction*	-192.50	-805.4	4.80:1
$6H_2O + C_6H_3(CH_3)_3 \Rightarrow 3CO_2 + 6CH_4$ *1,2,4-Trimethylbenzene oxidation / methanogenesis*	-40.02	-167.4	0.90:1
$24C_2Cl_4 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2HCl_3 + 9CO_2 + 24H^+ + 24Cl^-$ *1,2,4-Trimethylbenzene oxidation/ Tetrachloroethylene reductive dehalogenation*	-562.11	-2352	33.2:1
$24C_2HCl_3 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_2Cl_2 + 9CO_2 + 24H^+ + 24Cl^-$ *1,2,4-Trimethylbenzene oxidation/ Trichloroethylene reductive dehalogenation*	-548.43	-2295	26.3:1
$24C_2H_2Cl_2 + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_3Cl + 9CO_2 + 24H^+ + 24Cl^-$ *1,2,4-Trimethylbenzene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-434.19	-1817	19.4:1
$24C_2H_3Cl + 18H_2O + C_6H_3(CH_3)_3 \Rightarrow 24C_2H_4 + 9CO_2 + 24H^+ + 24Cl^-$ *1,2,4-Trimethylbenzene oxidation/ Vinyl chloride reductive dehalogenation*	-512.19	-2143	12.4:1

Coupled Chlorobenzene Oxidation Reactions	ΔG°_r (kcal/mole Chlorobenzene)	ΔG°_r (kJ/mole Chlorobenzene)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$7O_2 + C_6H_5Cl \Rightarrow 6CO_2 + H^+ + 2H_2O + Cl^-$ *Chlorobenzene oxidation /aerobic respiration*	-731.62	-3061	2.00:1
$5.6NO_3^- + 4.6H^+ + C_6H_5Cl \Rightarrow 6CO_2 + 4.8H_2O + 2.8N_{2,g} + Cl^-$ *Chlorobenzene oxidation / denitrification*	-741.33	-3102	3.10:1
$14\underline{MnO_2} + 27H^+ + C_6H_5Cl \Rightarrow 6CO_2 + 16H_2O + 14Mn^{2+} + Cl^-$ *Chlorobenzene oxidation / manganese reduction*	-731.72	-3062	10.9:1
$28\underline{Fe(OH)}_{3,a} + 55H^+ + C_6H_5Cl \Rightarrow 6CO_2 + 72H_2O + 28Fe^{2+} + Cl^-$ *Chlorobenzene oxidation / iron reduction*	-565.51	-2366	26.8:1
$3.5SO_4^{2-} + 6H^+ + C_6H_5Cl \Rightarrow 6CO_2 + 2H_2O + 3.5H_2S^o + Cl^-$ *Chlorobenzene oxidation / sulfate reduction*	-136.38	-570.6	3.00:1
$5H_2O + C_6H_5Cl \Rightarrow 2.5CO_2 + 3.5CH_4 + H^+ + Cl^-$ *Chlorobenzene oxidation / methanogenesis*	-47.43	-198.4	0.80:1
$14C_2Cl_4 + 12H_2O + C_6H_5Cl \Rightarrow 14C_2HCl_3 + 6CO_2 + 15H^+ + 15Cl^-$ *Chlorobenzene oxidation/ Tetrachloroethylene reductive dehalogenation*	-351.99	-1473	20.7:1
$14C_2HCl_3 + 12H_2O + C_6H_5Cl \Rightarrow 14C_2H_2Cl_2 + 6CO_2 + 15H^+ + 15Cl^-$ *Chlorobenzene oxidation/ Trichloroethylene reductive dehalogenation*	-344.01	-1439	16.4:1
$14C_2H_2Cl_2 + 12H_2O + C_6H_5Cl \Rightarrow 14C_2H_3Cl + 6CO_2 + 15H^+ + 15Cl^-$ *Chlorobenzene oxidation/ cis-Dichloroethylene reductive dehalogenation*	-277.37	-1161	12.1:1
$14C_2H_3Cl + 12H_2O + C_6H_5Cl \Rightarrow 14C_2H_4 + 6CO_2 + 15H^+ + 15Cl^-$ *Chlorobenzene oxidation/ Vinyl chloride reductive dehalogenation*	-322.87	-1351	7.75:1

Coupled Vinyl Chloride Oxidation Reactions	ΔG°_r (kcal/mole vinyl chloride)	ΔG°_r (kJ/mole vinyl chloride)	Stoichiometric Mass Ratio of Electron Acceptor to Compound
$2.5O_2 + C_2H_3Cl \Rightarrow 2CO_2 + H_2O + H^+ + Cl^-$ *Vinyl Chloride oxidation /aerobic respiration*	-288.98	-1209	1.29:1
$2NO_3^- + H^+ C_2H_3Cl \Rightarrow 2CO_2 + 2H_2O + Cl^- + N_{2,g}$ *Vinyl Chloride oxidation / denitrification*	-292.44	-1224	2.00:1
$5\underline{MnO_2} + 9H^+ + C_2H_3Cl \Rightarrow 2CO_2 + 6H_2O + 5Mn^{2+} + Cl^-$ *Vinyl Chloride oxidation / manganese reduction*	-289.01	-1209	7.02:1
$10\underline{Fe(OH)_{3,a}} + 19H^+ + C_6H_3(CH_3)_3 \Rightarrow 2CO_2 + 10Fe^{2+} + 26H_2O + Cl^-$ *Vinyl Chloride oxidation / iron reduction*	-229.65	-960.9	17.3:1
$1.25SO_4^{2-} + 1.5H^+ + C_2H_3Cl \Rightarrow 2CO_2 + H_2O + 1.25H_2S^o + Cl^-$ *Vinyl Chloride oxidation / sulfate reduction*	-76.40	-319.7	1.94:1
$1.5H_2O + C_2H_3Cl \Rightarrow .75CO_2 + 1.25CH_4 + H^+ + Cl^-$ *Vinyl Chloride oxidation / methanogenesis*	-44.62	-186.7	0.44:1
$5C_2Cl_4 + 4H_2O + C_2H_3Cl \Rightarrow 5C_2HCl_3 + 2CO_2 + 6H^+ + 6Cl^-$ *Vinyl Chloride oxidation/ Tetrachloroethylene reductive dehalogenation*	-153.39	-641.8	13.4:1
$5C_2HCl_3 + 4H_2O + C_2H_3Cl \Rightarrow 5C_2H_2Cl_2 + 2CO_2 + 6H^+ + 6Cl^-$ *Vinyl Chloride oxidation/ Trichloroethylene reductive dehalogenation*	-150.54	-629.9	10.6:1
$5C_2H_2Cl_2 + 4H_2O + C_2H_3Cl \Rightarrow 5C_2H_3Cl + 2CO_2 + 6H^+ + 6Cl^-$ *Vinyl Chloride oxidation/ cis-Dichloroethylene reductive dehalogenation*	-126.74	-530.3	7.82:1

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Gibbs Free Energy of Formation for Species used in Half-Cell reactions and Coupled Oxidation-Reduction Reactions

Species	State	$\Delta G^{o}_{f,298.15}$ (kcal/mole)	Source
e^-	i	0	std
H^+	i	0	std
O_2	g	0	std
H_2O	l	-56.687	Dean (1972)
Carbon Species			
CO_2	g	-94.26	Dean (1972)
CH_2O, formalydehyde	aq	-31.02	Dean (1972)
C_6H_6, benzene	l	+29.72	Dean (1972)
CH_4, methane	g	-12.15	Dean (1972)
$C_6H_5CH_3$, toluene	l	+27.19	Dean (1972)
$C_6H_5C_2H_5$, ethylbenzene	l	+28.61	Dean (1972)
$C_6H_4(CH_3)_2$, o-xylene	l	+26.37	Dean (1972)
$C_6H_4(CH_3)_2$, m-xylene	l	+25.73	Dean (1972)
$C_6H_4(CH_3)_2$, p-xylene	l	+26.31	Dean (1972)
C_2Cl_4, PCE	l	+1.1	CRC Handbook (1990)
C_2HCl_3, TCE	l	+2.9	CRC Handbook (1990)
$C_2H_2Cl_2$, c-DCE	l	+5.27	CRC Handbook (1990)
C_2H_4, ethene	g	+16.28	CRC Handbook (1990)
$C_{10}H_8$, naphthalene	l	+48.05	Dean (1972)
$C_6H_3(CH_3)_3$, 1,3,5-TMB	l	+24.83	Dean (1972)
$C_6H_3(CH_3)_3$, 1,2,4-TMB	l	+24.46	Dean (1972)
C_2H_3Cl, vinyl chloride	g	+12.4	Dean (1972)
C_6H_5Cl, chlorobenzene	l	+21.32	Dean (1972)
$C_{14}H_{10}$, phenanthrene	l	+64.12	Dean (1972)
Nitrogen Species			
NO_3^-	i	-26.61	Dean (1972)
N_2	g	0	std
NO_2^-	i	-7.7	Dean (1972)
NH_4^+	aq	-18.97	Dean (1972)
Sulfur Species			
SO_4^{2-}	i	-177.97	Dean (1972)
H_2S	aq	-6.66	Dean (1972)
H_2S	g	-7.9	Dean (1972)
HS^-	i	+2.88	Dean (1972)
Iron Species			
Fe^{2+}	i	-18.85	Dean (1972)
Fe^{3+}	i	-1.1	Dean (1972)
Fe_2O_3, hematite	c	-177.4	Dean (1972)
FeOOH, ferric oxyhydroxide	c	-117.2	Naumov *et al.* (1974)
$Fe(OH)_3$, goethite	a	-167.416	Langmuir and Whittemore (1971)
$Fe(OH)_3$, goethite	c	-177.148	Langmuir and Whittemore (1971)
$FeCO_3$, siderite	c	-159.35	Dean (1972)
Manganese Species			
Mn^{2+}	i	-54.5	Dean (1972)
MnO_2, pyrolusite	c	-111.18	Stumm and Morgan (1981)
MnOOH, manganite	c	-133.29	Stumm and Morgan (1981)
$MnCO_3$, rhodochrosite	p	-194	Dean (1972)
Chloride Species			
Cl^-	aq	-31.37	Dean (1972)

NOTES:

c = crystallized solid
a = amorphous solid (may be partially crystallized - dependent on methods of preparation)
p = freshly precipitated solid
i = dissociated, aqueous ionic species (concentration = 1 m)
aq = undissociated aqueous species
g = gaseous
l = liquid
std = accepted by convention
Wherever possible multiple sources were consulted to eliminate the possibility of typographical error.

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BIOPLUME MODEL SETUP AND RESULTS

Overview and Model Description

To help estimate how dissolved benzene compounds will migrate in groundwater at Sites ST14 and SD13 under the influence of natural chemical attenuation processes, Parsons ES used a quantitative numerical groundwater flow and contaminant transport model that provides for *in situ* degradation of contaminant mass. The modeling effort was conducted as part of the risk-based remedial evaluation process to identify the contaminant mass and concentration that would be expected to persist in impacted media over time and to assess whether potential exposure pathways involving groundwater could be completed. The numerical model was developed using site-specific data and conservative assumptions about governing physical and chemical processes.

The Bioplume II code was used to estimate the nature and extent of benzene migration in groundwater at Sites ST14 and SD13 accounting for the effects of natural chemical attenuation mechanisms on benzene mass, concentration, mobility, persistence, and toxicity. The Bioplume II model incorporates advection, dispersion, sorption, and biodegradation to simulate contaminant plume migration and degradation. The model is based upon the USGS Method of Characteristics (MOC) two-dimensional (2-D) solute transport model of Konikow and Bredehoeft (1978). The model was modified by researchers at Rice University to include a biodegradation component that can be activated by a superimposed dissolved oxygen (DO) plume. Based on the work of Borden and Bedient (1986), the model assumes a reaction between DO and contaminant mass that is instantaneous relative to the advective groundwater velocity. Bioplume II solves the USGS 2-D solute transport equation twice, once for contaminant concentrations in the aquifer and once for a DO plume. The two plumes are combined using superposition at every particle move to simulate the instantaneous, biologically-mediated reaction between benzene and DO.

It has become apparent that anaerobic processes such as denitrification or nitrate reduction, manganese reduction, ferric iron reduction, sulfate reduction, and methanogenesis can be important benzene degradation mechanisms (Grbic´-Galic´, 1990;

Beller *et al.*, 1992; Edwards *et al.*, 1992; Edwards and Grbic′-Galic′, 1992; Grbic′-Galic′ and Vogel, 1987; Lovley *et al.*, 1989; Hutchins, 1991). Reliance on DO-activated degradation in the numerical model may severely underestimate the effects of natural chemical attenuation processes on contaminant mass, concentration, and mobility over time. To account for these substantial destructive chemical attenuation processes in model simulations, it also is possible to simulate both anaerobic and aerobic contaminant degradation in Bioplume II using a site-specific decay constant. This was the modeling approach pursued for Sites ST14 and SD13 because the site-specific geochemical evidence discussed in Section 5 suggests that anaerobic biodegradation of benzene compounds is occurring at the site via aerobic biodegradation, nitrate reduction, ferric iron reduction, sulfate reduction, and methanogenesis. By basing the decay constant on site-specific data and observed chemical attenuation at the field scale, the numerical model accounts for the limiting effects of mass transfer, mixing, and degradation kinetics on contaminant mass loss estimates. The following subsections discuss this approach and other model input parameters, model assumptions, model calibration, and the simulation results in further detail.

Conceptual Model Design and Assumptions

Prior to developing a groundwater model, it is important to determine if sufficient data are available to provide a reasonable estimate of aquifer conditions. In addition, it is important to ensure that any limiting assumptions can be justified. As discussed previously, the combined effect of aerobic and anaerobic processes are incorporated into the model through use of a site-specific decay constant.

Based on the data presented in Section 3, the shallow saturated zone was conceptualized and modeled as a shallow unconfined aquifer composed of fine sands and gravel with intermittent, overlying layers of silty to clayey sands (Figures 3.4 to 3.6). The saturated thickness of the aquifer is estimated to vary from below 3 feet to greater than 17 feet (northwest of Site ST14), although the highest saturated thickness in the source area at Site ST14 is approximately 14 feet in thickness. Saturated thickness varies significantly

over the site as a result of variable Goodland Formation topography. Figure 3.8 illustrates the variable saturated thickness at Sites ST14 and SD13. As seen by the sharpening of isocontours at Site ST14, the Goodland Formation forms a paleochannel running to the southeast from Site ST14 to SD14. In addition to the Goodland Formation topography, the thinned saturated thickness toward the north and south of Site ST14 are suspected to be influenced by occasional layers of relatively dense silty and clayey sands that cause semi-confined flow conditions. Based on the estimated potentiometric surface at the site (Figure 3.7), groundwater appears to flow southeasterly over both Sites ST14 and SD13. However, the effect of paleochanneling and localized, confined-flow conditions suggest that groundwater may temporarily travel southward at ST14 before turning southeastward toward SD13. These physical influences explain why contaminants appear to flow to the south, away from the suspected source area at Site ST14, and then turn southeastward toward SD13. Figure 4.7 and 4.8 illustrate the particular migration pathways taken by BTEX and benzene compounds.

The use of a 2-D model is appropriate at Sites ST14 and SD13 because the saturated interval is thin, and the local flow system, as defined by groundwater elevation data and the underlying Goodland Formation, will likely prevent significant downward vertical migration of dissolved benzene contamination. The identified source of JP-4 contamination at Site ST14 is located adjacent to the refueling strip east of Building 1217. Contaminated soils at Site ST14 have not been fully remediated and residual LNAPL contamination still exists. Pockets of mobile fuel hydrocarbon contamination may also exist, but were not included as a potential source to groundwater because the presence of observed LNAPL has been infrequent (Section 4). The suspected source area of residual LNAPL contamination at Site SD13 is located in the proximity of monitoring well ST14-MW29. This source area coincides with the suspected location of buried USTs that were formerly used at a gas station closed in the early 1970s. To develop conservative model predictions, a continuing source factor from residual LNAPL was incorporated into the Bioplume II model for both Sites ST14 and SD13 to account for the possible additional dissolution of benzene into groundwater over time. The calculations used to derive the

source term for this model are summarized in Section 5, and fully presented elsewhere in this appendix.

Initial Model Setup

Where possible, the initial setup for this model was based on site-specific data. Where site-specific data were not available (e.g., effective porosity), reasonable assumptions for the types of materials comprising the shallow aquifer were made based on widely-accepted literature values. The following sections describe the basic model setup.

Grid Design and Boundary Conditions

The maximum grid size for the Bioplume II model is limited to 20 columns by 30 rows. The dimension of each column and row can range from 0.1 to 999.9 feet. A 20- by 30-cell grid was used to model Sites ST14 and SD13. Each grid cell was 80 feet long by 80 feet wide. The grid was oriented so that the longest dimension was parallel to the overall direction of groundwater flow. The grid encompasses the existing benzene plumes with sufficient space between all model boundaries to avoid significant numerical errors caused by contact between the boundary and the benzene plume. The model grid covers an area of 3,840,000 square feet, or approximately 88 acres. The full extent of the model grid is indicated on Figure 1.

Model boundaries are mathematical statements that represent hydrogeologic boundaries, such as areas of specified head (i.e., surface water bodies or contour lines of constant hydraulic head) or specified flux. Hydrogeologic boundaries are represented by three mathematical statements that describe the hydraulic head at the model boundaries. These include:

- Specified-head boundaries (Dirichlet condition) for which the head is determined as a function of location and time only. Surface water bodies exhibit constant head conditions. Specified-head boundaries are expressed mathematically as:

$$Head = f(x, y, z, t)$$

where f is the function symbol, x, y, and z are position coordinates, and t is time.

- Specified-flow boundaries (Neumann conditions) for which the mathematical description of the flux across the boundary is given. The flux is defined as a volumetric flow rate per unit area (i.e., $ft^3/ft^2/day$). No-flow boundaries are a special type of specified flow boundary and are set by specifying the flux to be zero. Examples of no-flow boundaries include groundwater divides and impermeable hydrostratigraphic units. Specified-flux boundaries are expressed mathematically as:

$$Flux = f(x, y, z, t)$$

- 3) Head-dependent flow boundaries (Cauchy or mixed-boundary conditions) where the flux across the boundary is calculated from a given boundary head value. This type of flow boundary is sometimes referred to as a mixed-boundary condition because it is a combination of a specified-head boundary and a specified-flow boundary. Head-dependent flow boundaries are used to model leakage across semipermeable boundaries. Head-dependent flow boundaries are expressed mathematically as (Bear, 1979):

$$Flux = \frac{(H_0 - H)K'}{B'}$$

Where: H = Head in the zone being modeled (generally the zone containing the contaminant plume)

H_0 = Head in external zone (separated from plume by semipermeable layer)

K' = Hydraulic conductivity of semipermeable layer

B' = Thickness of semipermeable layer.

Natural hydraulic boundaries are modeled using a combination of the three types of model boundary conditions listed above. When possible, hydrologic boundaries such as surface water bodies, groundwater divides, contour lines, or hydrologic barriers should coincide with the perimeter of the model. In areas lacking obvious hydrologic boundaries, specified-head or specified-flux boundaries can be specified at the model perimeter if the boundaries are far enough removed from the contaminant plume that transport calculations are not affected. Bioplume II requires the entire model domain to be bounded

by zero-flux cells (also known as no-flow cells), with other boundary conditions established within the subdomain specified by the no-flow cells.

Specified-head boundaries for the model were set on the southeast and northwest perimeter of the model grid to simulate general groundwater flow direction to the southeast as observed at the site. The head of the northwest model boundary (a minimum of 240 feet west and northwest of the source) was estimated to be between 577 and 568 feet above msl. The heads at the southeast boundary, which was partially aligned with Farmers Branch Creek, was estimated to vary from 538 to 555 ft msl.

The northeast and southwest model boundaries were configured as no-flow (specified-flux) boundaries. In this case, the flux through these boundaries is assumed to be zero because flow is generally parallel to these boundaries. The base or lower boundary of the model is also assumed to be no-flow, and is typically defined by the upper surface of the Goodland Formation. On the basis of aquifer thickness and benzene data (Sections 3 and 4), the saturated thickness of the aquifer was assumed to vary from 3 to 14 feet to the confining layer in the vicinity of Sites ST14 and SD13. Flow hydraulics were matched in the model by varying transmissivities (and therefore hydraulic conductivity) through variable saturated thickness and hydraulic conductivity. The upper model boundary is defined by the simulated water table surface.

Groundwater Elevation and Gradient

The water table elevation map presented in Figure 3.7 was used to define the starting heads input into the Bioplume II model. Groundwater flow in the vicinity of Sites ST14 and SD13 is generally southeast at a maximum estimated gradient in the modeled area of approximately 0.011 ft/ft near ST14 and increases to approximately 0.12 near SD13. Gradients appear to increase toward Farmers Branch Creek as groundwater discharges into this area.

Limited data exist to document if seasonal precipitation rates significantly vary groundwater flow direction. Considering the deposits of silty and clayey sands overlying the aquifer and the depth to groundwater (approximately 10 to 15 feet bgs) , it was

assumed that precipitation reaching the water table causes minimal groundwater fluctuations, and that the observed water levels were representative of steady-state conditions. As described in later sections, the model was calibrated to the observed water table.

Benzene Concentrations

The benzene concentrations obtained from laboratory analytical results for each well location were used for model development. Benzene data collected during the August 1994 sampling events and the March through April, 1995 sampling event were used to calibrate the model. Appendix A presents dissolved benzene data from these sampling event. Figure 4.7 presents the probable extent of benzene in groundwater based on these data. As described in Section 5, this model was calibrated using existing contaminant data and current site conditions to predict how dissolved contaminants would migrate in the future.

Contaminant Decay Coefficient

The discussion presented in Section 5 suggests that oxygen, nitrate, sulfate, ferric iron, and carbon dioxide are being used as electron acceptors during fuel hydrocarbon biodegradation at Sites ST14 and SD13. The modeling strategy pursued at this site involved using a site-specific benzene decay coefficient that accounted for both aerobic and anaerobic processes.

The site-specific decay coefficient was calculated using a simple regression technique developed by Buscheck and Alcantar (1995). The decay coefficient is determined by coupling the regression of concentration versus distance for a dissolved plume assumed to be under steady-state conditions. This technique provides an analytical method to use site data to distinguish contaminant mass losses due to nondestructive chemical attenuation processes from contaminant mass losses due to destructive attenuation processes. Figure 2 illustrates how site-specific data are used to derive a first-order regression to be used in determining a decay coefficient for benzene at Sites ST14 and SD13. The derivation of

the site-specific decay coefficient using the results of this regression is summarized in Section 5.3.3 and Table 5.1. The decay coefficient determined for benzene and applied to both Sites ST14 and SD13 is 0.00141 day^{-1}, which compares favorably to the saturated soil and groundwater degradation rates for benzene found in the technical literature.

This regression technique defines a site-specific decay coefficient that accounts for the limiting effects of mixing, mass transfer, and kinetics that are operating at Sites ST14 and SD13. This is an important conservative assumption in the Bioplume II model. When using a DO-activated biodegradation rate, the model assumes that the total mass of DO is available to participate in benzene degradation in accordance with mass stoichiometric relationships. As described in Section 5, only a fraction of the assimilative capacity of the saturated media, as calculated by mass stoichiometric relationships, is apparently used to biodegrade fuel hydrocarbons. Thus, if the model relied on electron mass, the effects of chemical destructive attenuation processes on chemical mass, concentration, and mobility over time may be overestimated. In contrast, use of the site-specific decay coefficient ensures that biodegradation effects as calculated from field scale evidence are incorporated into the model. Additionally, the fastest contaminant velocities that could be observed at this site were used to derive the site-specific decay coefficient. This also is an important assumption, because decay will become less effective in reducing contaminant mass as a function of distance as contaminant velocities increase. This means that the site-specific decay coefficients are conservative.

Model Calibration

Model calibration is an important component in the development of any numerical groundwater model. Calibration of the flow model demonstrates that the model is capable of matching hydraulic conditions observed at the site; calibration of a contaminant transport model superimposed upon the calibrated flow model helps verify that contaminant loading and transport conditions are being appropriately simulated. The numerical flow model developed for Sites ST14 and SD13 was calibrated by altering transmissivity in a trial-and-error fashion until simulated heads approximated observed

field values within a prescribed accuracy. After calibration of the flow model, the numerical transport model was calibrated by altering transport parameters in a trial-and-error fashion until the simulated benzene plume approximated observed field values. Table 1 lists input parameters used for the modeling effort.

Water Table Calibration

The shallow water table at Sites ST14 and SD13 was assumed to only be influenced by continuous recharge and discharge at the constant-head cells established at the upgradient and downgradient model boundaries. The initial water levels at the constant-head cells were varied to calibrate the water table surface. Transmissivities were also varied in the model because of heterogeneous sands and gravels, of possible localized, semi-confined conditions caused by overlying silty and clayey sand, and of variable topography of the Goodland Formation. The transmissivities were varied in accordance to the range of hydraulic conductivity estimates derived from slug test data and saturated thickness estimates. The model was calibrated under steady-state conditions.

Hydraulic conductivity is an important aquifer characteristic that determines the ability of the water-bearing strata to transmit groundwater. Transmissivity is the product of the hydraulic conductivity and the thickness of the aquifer. An accurate estimate of hydraulic conductivity is important to help quantify advective groundwater flow velocities and to define the flushing potential of the aquifer. According to the work of Rifai et al. (1988), the Bioplume II model is particularly sensitive to variations in hydraulic conductivity. Lower values of hydraulic conductivity result in slower-moving contaminants. These slower-moving contaminants will be simulated to degrade more rapidly than faster moving contaminants by using a constant decay coefficient. As discussed earlier, chemical decay will becomes more effective in reducing contaminant mass as a function of distance as contaminant velocities decrease. Higher values of hydraulic conductivity result in a faster-moving plume, which will not decay as effectively over distance as a slower-moving plume. The Bioplume II model for this site was calibrated using the highest hydraulic conductivities observed at the site. This is a critical conservative assumption in the Bioplume II model, which will serve to overestimate the

extent of contaminant migration and underestimate the type of contaminant mass destruction over time at the site.

Estimated saturated thickness data were used in conjunction with estimates of the hydraulic conductivity to create an initial transmissivity grid for the entire model. Figure 3 shows the calibrated water table. Calibrated model hydraulic conductivities ranged from 1.13 x 10^{-3} foot per second (ft/sec) to 2.04 x 10^{-6} ft/sec (6.78 x 10^{-2} ft/min to 1.22 x 10^{-4} ft/min), which are estimated values of hydraulic conductivity for the site based on the range of slug test data (Section 3).

Water level elevation data from 14 monitoring well locations were used to compare measured and simulated heads for flow calibration. The 14 selected monitoring well locations were: ST14-MW01, ST14-MW02, ST14-MW3, ST14-MW7, ST14-MW11, ST14-MW17H, ST14-MW17L, ST14-MW19, ST14-MW20, ST14-MW21, ST14-MW22, ST14-MW28, ST14-MW29, and ST14-MW32.

The root mean square (RMS) error is commonly used to express the average difference between simulated and measured heads. RMS error is the average of the squared differences between measured and simulated heads, and can be expressed as:

$$\mathrm{RMS} = \left[\frac{1}{n} \sum_{i=1}^{n} \left(h_m - h_s \right)_i^2 \right]^{0.5}$$

Where: n = the number of points where heads are being compared
h_m = measured head value
h_s = simulated head value.

The RMS error between observed and calibrated values at the 14 comparison points was 2.22 feet, which corresponds to a calibration error of 5.5 percent (water levels dropped approximately 34 feet over the length of the model grid). RMS error calculations are summarized at the end of this appendix. A plot of measured versus calibrated heads shows a distribution of points around a straight line, as shown at the end of this appendix. The points suggest that calibrated groundwater elevations in the vicinity of ST14 are slightly higher than those observed, which ultimately results in a conservative model prediction because calibrated groundwater gradients and velocities were slightly higher

than observed. Deviation of points from a straight line should be randomly distributed in such a plot of results from computer simulations (Anderson and Woessner, 1992).

In solving the groundwater flow equation, Bioplume II establishes the water table surface and calculates an overall hydraulic balance that accounts for the numerical difference between flux into and out of the system. The hydraulic mass balance for the calibrated model was excellent, with greater than 99.9 percent of the water flux into and out of the system being numerically accounted for (i.e., less than a 0.1-percent error). According to Anderson and Woessner (1992), a mass balance error of around 1 percent is acceptable.

Benzene Plume Calibration

Model input parameters affecting the distribution and concentration of the simulated benzene plume were not modified to match model predictions with dissolved benzene concentrations collected from August 1994 and March/April 1995 data (Section 4). Physical, chemical, and biological parameters estimated for the site, with the exception of transmissivity, were set to produce a calibrated model. The simulated plume is in reasonable agreement with the dissolved plume developed from the two data sets. Figure 5.10 compares the observed benzene plume in 1994/1995 to the simulated 1994/1995 benzene plume. The general geometry of the simulated plume resembles that of the observed plume, although the actual mass of contaminants in the groundwater in 1994/1995 as simulated by the Bioplume II model is more than the mass observed during the 1994/1995 field effort. Despite a greater width of the calibrated benzene plume, the downgradient extent of benzene and the maximum benzene concentrations in the suspected source area are comparable.

Because pockets of residual and/or mobile LNAPL could still act as a significant contaminant source at the site (i.e., variable levels of LNAPL have been encountered at the site during site investigations), Parsons ES opted to include model injection wells to simulate partitioning of benzene compounds from the LNAPL source into the groundwater. Mobile LNAPL in site monitoring wells has been observed infrequently,

and the potential contribution of mobile LNAPL contamination was considered minimal compared to residual LNAPL sources. Hence, the major transport pathway of contaminants from JP-4 to groundwater is through precipitation recharge that has migrated through contaminated soils. The locations of the injection wells are shown on Figure 4. Five injection wells for Site ST14 and one injection well for Site SD13 were placed to produce a benzene plumes representative of 1994/1995 conditions. Although residual LNAPL contamination potentially extends over areas larger than those predicted by the placement of the injection wells, it became apparent during the model calibration that the selected placement of injection wells accounted for a reasonable calibrations of the shape of the groundwater plume. The five injection wells for Site ST14 were placed in model grid cells (14,6), (14,7), (13,7), (13,8), and (12,8). The single injection well for Site SD13 was placed at (11,17).

While the term "injection well" suggests contaminants are being introduced at a point, Bioplume II assumes that contamination introduced at a well instantly equilibrates throughout the entire cell in which the well is located. The injection rate for the cells was set at 1.157×10^{-5} cubic foot per second (ft^3/sec), a value low enough that the flow calibration in the source area was not affected. After converting the predicted dissolution rate of benzene contamination from LNAPL at the site (discussed in the following paragraphs), relatively high benzene concentrations were needed in injection wells because of the low volumetric injection rates.

Benzene concentrations used in injection wells to simulate existing plume conditions were obtained from the SESOIL calculations described in Section 5. Continuing dissolution of benzene compounds into precipitation recharge, coupled with potential volatilization losses, were predicted to slowly reduce, or weather, benzene mass from the residual LNAPL. Therefore, the rate of benzene dissolution into groundwater in the model was continuously reduced in the model to simulate weathering. Estimated weathering rates were determined by the rate at which benzene could dissolve into precipitation recharge, which in turn was dependent on the continuously decreasing soil concentrations of residual benzene. Diminishing benzene mass (as a result of weathering)

in the residual LNAPL cause smaller concentration gradients, which in turn decreased the progressive magnitude of the weathering of the LNAPL. As a result, weathering rates and dissolution rates of benzene decrease at the site and in the model over time. Complete loss of benzene mass and the elimination of a source term in the model occurred after 12 years.

The objective of the contaminant calibration step was to obtain a modeled plume that equaled or exceeded the existing plume in terms of downgradient extent. The simulated 1994 plume closely resembles the observed plume in 1994 (Figure 5.10). The model predicts that benzene concentrations are currently stabilized and should not increase or migrate further downgradient as long as future fuel spills are prevented. Calibrated and observed migration distances of benzene for 1994 are both comparable (Figure 5.10). The maximum concentration of benzene in the observed and calibrated source area at ST14 are approximately 110 μg/L and 117 μg/L, respectively. Similarly at Site SD13, the maximum concentration of benzene in the observed and calibrated source area are approximately 59 μg/L and 66 μg/L, respectively. Hence, benzene plume calibrations is conservative with respect to the benzene concentrations observed at the site. The results of the different model scenarios are fully described in Sections 5 and 8.

Discussion of Important Plume Calibration Parameters

Few transport parameters were varied during plume calibration because of the sufficient amount of available site-specific data. Hence, it was not necessary to vary the modeling parameters of dispersivity, retardation, and contaminant decay to achieve a model calibration. Only transmissivity values in the model domain and range were varied to achieve the model calibration. However, the impact on the size and shape of the simulated plume and the estimation method used for the model parameters dispersivity, retardation, and contaminant decay rate is discussed below.

Dispersivity

Much controversy surrounds the concepts of dispersion and dispersivity. Longitudinal dispersivity values for sediments similar to those found at the site range from 0.1 to 200 feet (Walton, 1988). Longitudinal dispersivity was estimated as 90 feet, using one-tenth (0.1) of the estimated length of the BTEX plume at site ST14. Transverse dispersivity values generally are estimated as one-tenth (0.1) of the longitudinal dispersivity values (Domenico and Schwartz, 1990).

During plume calibration, longitudinal dispersivity was maintained at 90 feet. The use of a dispersivity value of 90 feet was a good estimate considering the scale of the site and the sandy and gravelly stratigraphy predominant in the saturated interval. Similarly, the ratio of transverse dispersivity to longitudinal dispersivity was maintained at 0.1 to help reproduce the plume width observed at the site.

Coefficient of Retardation

Retardation of the benzene compounds relative to the advective velocity of the groundwater occurs when benzene molecules are sorbed to the aquifer matrix. The coefficients of retardation for the benzene compounds were calculated based on measured total organic carbon (TOC) concentrations in the soils in and near the saturated zone at the site (Section 3), an assumed bulk density of 1.65 grams/cubic centimeter (Freeze and Cherry, 1979), and published values of the soil sorption coefficient (K_{oc}) for the benzene compounds, as listed by Wiedemeier *et al.* (1995). The results of these calculations are summarized in Table 2. A final value of 2.93 for the retardation coefficient was used for the benzene compounds. This value is relatively high, but is consistent with TOC values taken at the site which suggest that a great deal of organic matter exists in the soils. As with dispersivity and the reaeration coefficient, this variable was not adjusted in the model calibration.

Contaminant Decay Coefficient

The contaminant decay coefficient is a first-order rate constant that can be used in Bioplume II to simulate aerobic and anaerobic contaminant removal. The contaminant decay coefficient (or biodegradation coefficient) is estimated with an analytical solution of the general one-dimensional transport equation modified by Buscheck and Alcantar (1995). A contaminant decay coefficient of 0.00141 day^{-1} is derived by the above method. As with dispersivity and retardation, this site-specific value was not varied in the model calibration process.

Sensitivity Analysis

The purpose of the sensitivity analyses is to determine the effect of varying model input parameters on model output. Based on the work of Rifai *et al.* (1988), the Bioplume II model is most sensitive to changes in the contaminant decay coefficient and the hydraulic conductivity of the media, and is less sensitive to changes in the retardation factor, porosity, and dispersivity. The effect of aerobic and anaerobic processes on benzene mass are included together in the overall contaminant decay coefficient. The sensitivity analysis was conducted by varying the transmissivity, the contaminant decay coefficient, and the coefficient of retardation, the dispersivity, and the effective porosity.

To perform the sensitivity analyses, the calibrated model was adjusted by systematically changing the aforementioned parameters individually, and then comparing the new model runs to the original calibrated model. The sensitivity models were run for a 3-year period so that the independent effect of each variable could be assessed at predicted 1998 BTEX concentrations. BTEX concentrations were used in place of benzene concentrations in the sensitivity analysis to obtain a broader view affected contaminant mass as a result of changing model parameters over the downgradient length of the aquifer. As a result, 10 sensitivity runs of the calibrated model were made, with the following variations:

1) Transmissivity uniformly increased by a factor of 5;
2) Transmissivity uniformly decreased by a factor of 5;

3) Coefficient of contaminant decay increased by 2;
4) Coefficient of contaminant decay decreased by 2;
5) Coefficient of retardation increased by 20 percent;
6) Coefficient of retardation decreased by 20 percent;
7) Dispersivity uniformly increased by 50 percent;
8) Dispersivity uniformly decreased by 50 percent;
9) Effective porosity uniformly increased by 15 percent; and,
10) Effective porosity uniformly decreased by 15 percent.

The results of the sensitivity analyses are shown graphically in Figures 5 through 9. These figures show the results of the model simulations in BTEX concentrations versus distance along the estimated centerline of the plume. This manner of displaying data is useful because benzene concentrations are highest along the centerline, and the plume extends the farthest downgradient from the source of contamination. These figures allow easy visualization of the changes in BTEX concentration caused by varying model input parameters.

The effects of varying transmissivity are shown by Figure 5. Uniformly increasing the transmissivity by a factor of 5 altered the plume shape such that the maximum observed concentrations in the source cell area were 620 μg/L, compared to the calibrated BTEX maximum of 1,670 μg/L. In this case, the benzene plume extended farther downgradient and off the model grid. Lower BTEX concentrations in the center of the plume are a result of an increased advective velocity that reduced the residence time of groundwater below the source area. Thus, less BTEX contamination was able to dissolve into the groundwater from LNAPL. Increased groundwater velocity also caused BTEX contamination to migrate farther downgradient before being effectively biodegraded.

In contrast, decreasing the transmissivity by a factor of 5 slowed overall plume migration, which shortened the plume by approximately 400 feet. This, in turn, caused an increase in maximum BTEX levels. Increased BTEX concentrations in the plume area are caused by a reduction in the plume travel rate, thereby allowing greater BTEX

concentrations to dissolve into groundwater in the source area before being biodegraded downgradient.

The effects of varying the contaminant decay coefficient are illustrated by Figure 6. Increasing this parameter by 2 results in a dramatic reduction of the maximum BTEX concentrations by 690 μg/L. In addition, the front of the plume recedes approximately 160 feet. This is a result of increased biodegradation. Conversely, decreasing this coefficient by 2 decreases biodegradation and increases the maximum length of the plume by at least 240 feet (plume migrates beyond model grid). The corresponding increase in the computed maximum BTEX concentrations in the plume center was approximately 600 μg/L.

The effects of varying the coefficient of retardation (R) are shown on Figure 7. Increasing R by 20 percent had a modest effect with either BTEX concentrations in the source area or with the downgradient extent. The BTEX mass in the source area increased as a result of increased retardation. Decreasing R by 20 percent slightly accelerated plume migration because less contaminants were sorbed to soil particles and created a faster moving BTEX plume.

The effects of varying dispersivity are shown on Figure 8. Dispersivity had a similarly modest affect on BTEX concentrations, as did the coefficient of retardation. However, when the dispersivity was varied up to 20 percent, the BTEX migration distance was not noticeably changed in the model. The effects of varying effective porosity uniformly over the site are shown on Figure 9. Variations in effective porosity by up to 15 percent had negligible effects on the fate and transport of BTEX compounds.

The results of the sensitivity analyses suggest that the calibrated model parameters used for this Bioplume II model match observed conditions well (see Figure 5.10). The calibrated model is very sensitive to transmissivity and the contaminant decay coefficient, moderately sensitive to retardation coefficient and dispersivity, an insensitive to effective porosity. Increasing transmissivities or the decay coefficient reduced the predicted BTEX concentrations and/or reduced the predicted plume length. Lowering transmissivity increased source concentrations and reduced plume length. Lowering the reaeration

coefficient and the coefficient of retardation tended to lengthen the plume beyond calibrated conditions.

Simulating Bioventing and Biosparging

Bioventing

The effect of source reduction at ST14 through bioventing was evaluated with the Bioplume II model (Alternative 2). Conceptually, bioventing units are placed at the source of contamination to maximize both LNAPL removal and potential oxygen delivery in zones of highest contamination. Bioventing in the source area causes a reduction in LNAPL volumes and a reduction in dissolution rates of benzene (and BTEX). Bioventing was simulated in the Bioplume II model by reducing the source strength of benzene in model injection wells over time. A complete discussion of contaminant loss rates through bioventing at ST14 are discussed in Section 5. Bioventing was assumed to have removed all recoverable benzene in LNAPL from the source area at the end of 12 years. After the bioventing reductions, the benzene LNAPL source was assumed to be zero.

Biosparging

The effect of benzene reduction through biosparging was also evaluated with Bioplume II in Alternative 2. Biosparging was only simulated in the source area at Site SD13 near monitoring well ST14-MW29. Biosparging units are a means of mechanically introducing atmospheric oxygen into groundwater via existing monitoring or newly constructed monitoring wells at a site. The introduction of fresh oxygen sources to groundwater thereby enhances the potential for the aerobic biodegradation of contaminants. Estimates on the potential mass transfer rates of oxygen to groundwater, based on an adjacent site data (Air Force Plant 4), were used to simulate biosparging operations in Alternative 2. Section 5 discusses the results of these tests in greater detail.

Although field tests indicate that biosparging units would be capable of maintaining dissolved oxygen concentrations in groundwater above 1 mg/L, the actual simulation of biospargers in the Bioplume II model assumed that 1 mg/L of dissolved oxygen would be sustained in groundwater as a conservative estimate. Furthermore, since benzene

contamination is only one of four primary dissolved fuel hydrocarbons emanating from fuel contamination (as BTEX), only 13 percent of the 1 mg/L of oxygen was actually applied to benzene biodegradation. This benzene to BTEX ratio was derived from contaminant ratios in total BTEX observed in monitoring well ST14-MW16. As a result, biosparging units in the source area at SD13 were simulated to deliver enough oxygen to maintain dissolved oxygen levels at 0.13 mg/L for the duration of the model simulation.

332348

LEGEND

BUILDING

BUILDING NUMBER

FENCE

SOIL BOREHOLE/GEOPROBE

GROUNDWATER MONITORING WELL

APPROXIMATE LOCATION OF FRENCH DRAIN

APPROXIMATE LOCATION OF OIL/WATER SEPARATOR

GROUNDWATER FLOW DIRECTION ARROW

0 100 200 400
FEET

FIGURE 1

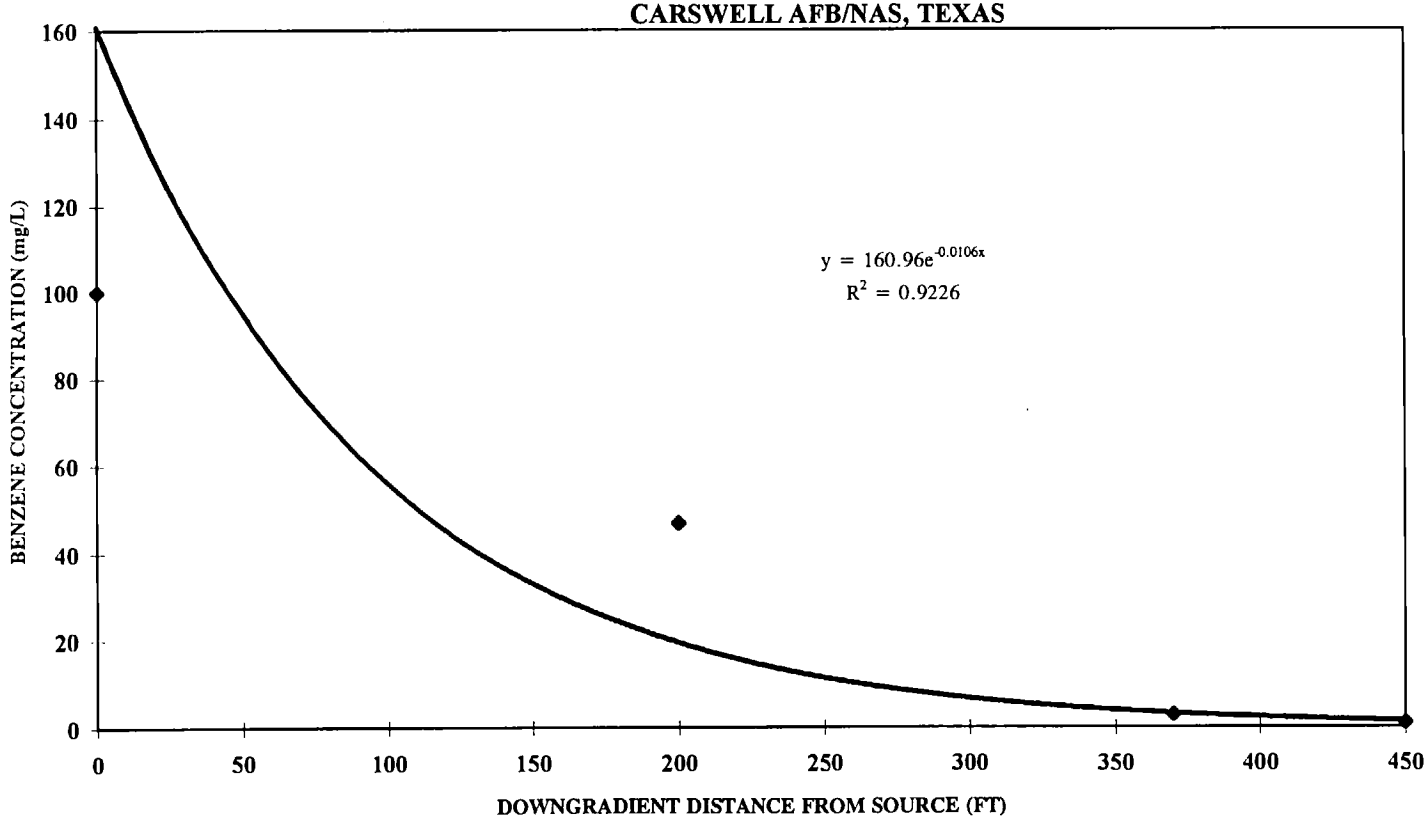
MODEL GRID

Sites ST14 and SD13
Remedial Action Plan
Risk-Based Approach to Remediation
Carswell NASJRB, Texas

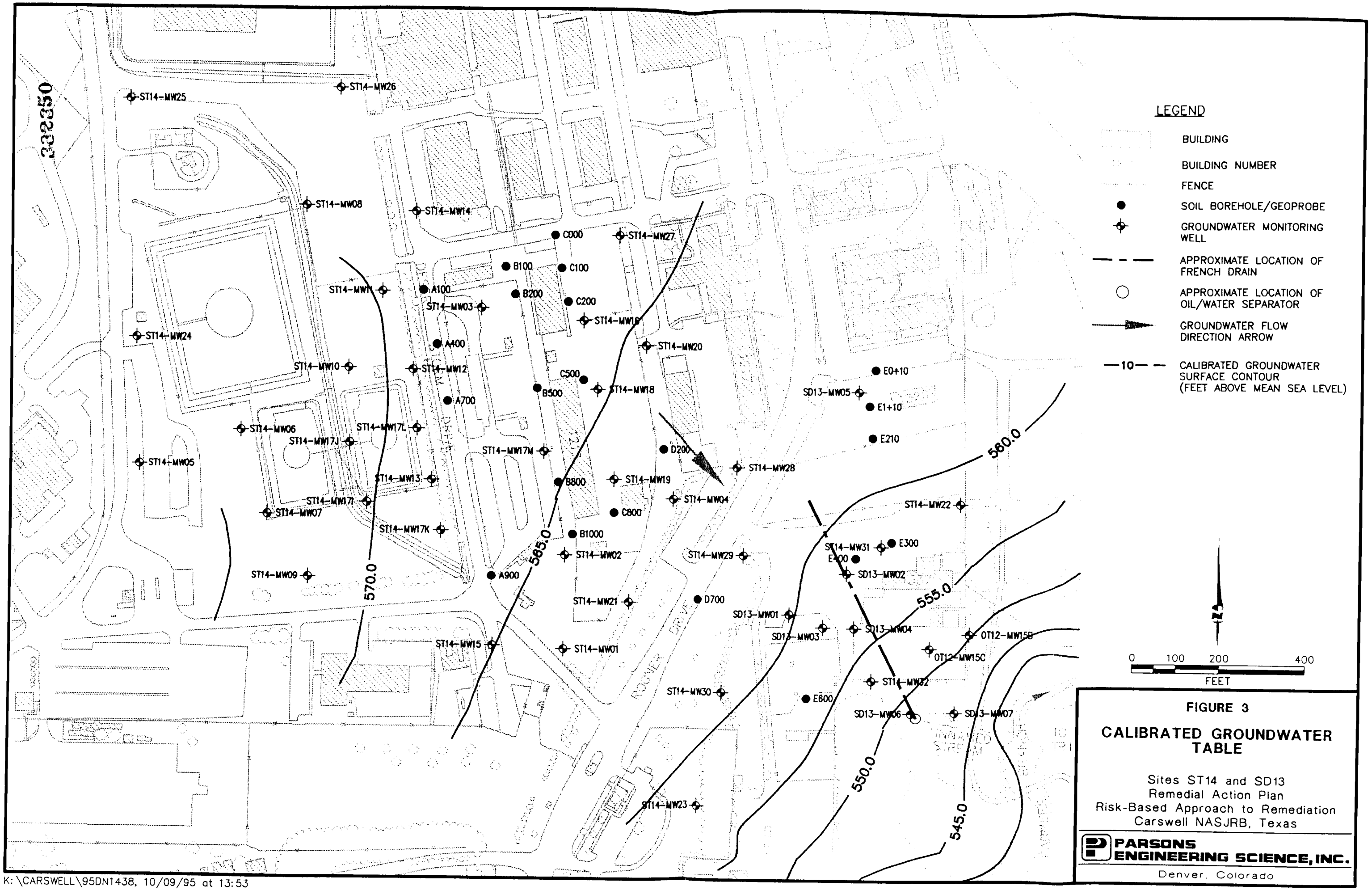
PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

K:\CARSWELL\95DN1440, 10/09/95 at 14:08

FIGURE 2
1ST-ORDER REGRESSION OF BENZENE CONCENTRATION VS DISTANCE FOR USE IN BUSCHEK AND ALCANTAR METHOD OF ESTIMATING BIODEGRADATION RATES
CARSWELL AFB/NAS, TEXAS



332349



K:\CARSWELL\95DN1438, 10/09/95 at 13:53

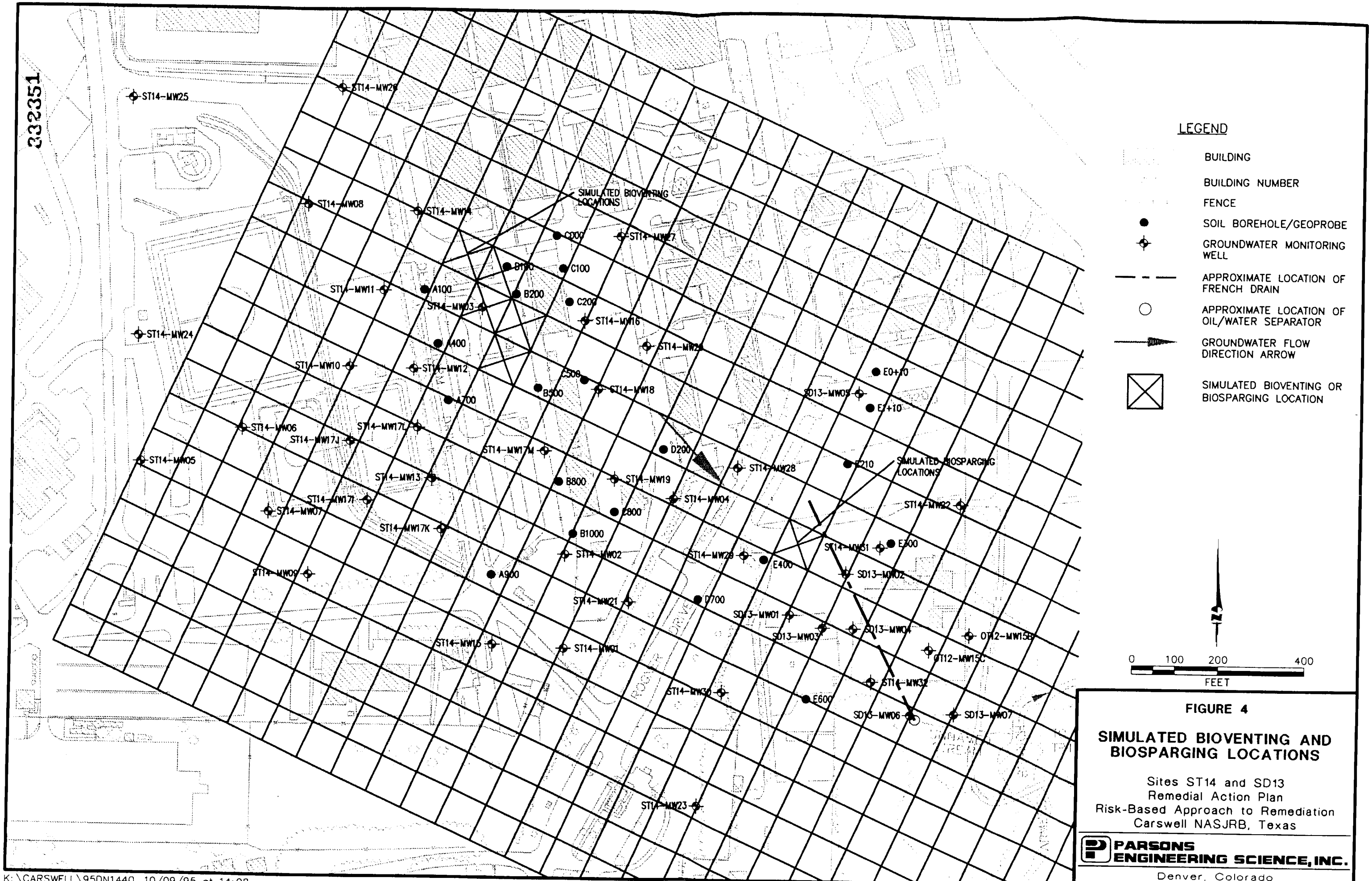
FIGURE 3

CALIBRATED GROUNDWATER TABLE

Sites ST14 and SD13
Remedial Action Plan
Risk-Based Approach to Remediation
Carswell NASJRB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

332351



K:\CARSWELL\95DN1440, 10/09/95 at 14:08

FIGURE 4

SIMULATED BIOVENTING AND BIOSPARGING LOCATIONS

Sites ST14 and SD13
Remedial Action Plan
Risk-Based Approach to Remediation
Carswell NASJRB, Texas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

332352

SESOIL MODEL SETUP AND RESULTS

332353

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/001
17 Jan 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR DECEMBER 1994

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF DECEMBER 1994

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	63	30	47	0	18	150/07KT	180/19KT	0.00	0.00	0
2	55	47	51	0	14	150/09KT	170/20KT	0.01	0.00	0
3	66	53	60	0	5	140/09KT	130/11KT	0.02	0.00	0
4	72	57	65	0	0	160/08KT	160/17KT	TRACE	0.00	0
5	58	47	53	0	12	230/06KT	360/14KT	0.00	0.00	0
6	72	45	58	0	7	130/09KT	270/16KT	0.00	0.00	0
7	56	44	50	0	15	140/09KT	360/21KT	0.00	0.00	0
8	51	39	45	0	20	250/08KT	330/20KT	0.27	0.00	1
9	38	35	37	0	28	330/12KT	350/23KT	1.02	0.00	0
10	50	35	43	0	22	330/13KT	340/24KT	0.00	0.00	0
11	46	30	38	0	27	160/07KT	120/17KT	0.00	0.00	0
12	54	30	42	0	23	230/07KT	270/16KT	0.00	0.00	0
13	58	39	49	0	16	100/05KT	060/10KT	0.03	0.00	0
14	50	42	46	0	19	060/05KT	140/12KT	0.09	0.00	0
15	50	45	48	0	17	050/07KT	030/14KT	0.06	0.00	0
16	53	48	51	0	14	300/06KT	350/17KT	0.04	0.00	0

332354

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR DECEMBER

	17	61	35	48	0	17	210/04KT	350/09KT	0.00	0.00	0
	18	61	36	49	0	16	220/04KT	060/12KT	0.00	0.00	0
01	19	62	37	50	0	15	160/09KT	170/23KT	0.00	0.00	0
1 2	20	64	43	54	0	11	230/07KT	170/17KT	0.00	0.00	0
2 3	21	66	37	52	0	13	290/07KT	330/17KT	0.00	0.00	0
3 4	22	58	38	48	0	17	290/08KT	010/19KT	0.00	0.00	0
4 5	23	57	37	47	0	18	310/07KT	300/14KT	0.00	0.00	0
5 6	24	52	35	44	0	21	160/06KT	040/14KT	0.00	0.00	0
6 7	25	60	32	46	0	19	280/04KT	310/10KT	0.00	0.00	0
7 8	26	64	30	47	0	18	170/04KT	100/11KT	0.00	0.00	0
8 9	27	61	38	50	0	15	190/04KT	260/15KT	0.20	0.00	0
9 10	28	50	45	53	0	12	190/07KT	350/13KT	0.72	0.00	0
10 11	29	53	41	47	0	18	330/08KT	350/16KT	0.07	0.00	0
11 12	30	56	43	50	0	15	150/05KT	130/10KT	0.00	0.00	0
11 13	31	58	42	50	0	15	200/08KT	310/28KT	0.36	0.00	0
		AVG	AVG	AVG	TOTAL	TOTAL	AVG	AVG	TOTAL	TOTAL	TOTAL
		57	40	49	0	517	210/07KT	220/16KT	2.53	0.00	1

MAXIMUM TEMPERATURE: 72

MINIMUM TEMPERATURE: 30

NUMBER OF DAYS WITH PRECIPITATION: 12

AVERAGE PRECIPITATION PER DAY: 0.21

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

D J Finney, A1

D. J. FINNEY
By direction

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NTMOD Dallas
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332355

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/003
02 Mar 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR FEBRUARY 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF JANUARY 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	76	38	55	0	10	170/05KT	200/14KT	0.00	0.00	0
2	84	42	63	0	2	180/07KT	220/17KT	0.00	0.00	0
3	64	46	56	0	9	330/13KT	320/30KT	0.00	0.00	0
4	70	35	52	0	13	240/07KT	250/19KT	0.00	0.00	0
5	58	43	51	0	14	170/09KT	020/23KT	0.00	0.00	0
6	64	37	51	0	14	200/05KT	200/16KT	0.00	0.00	0
7	49	38	44	0	21	190/10KT	020/26KT	0.00	0.00	0
8	52	28	42	0	23	200/06KT	130/16KT	0.00	0.00	0
9	68	47	54	0	11	180/13KT	180/23KT	0.00	0.00	0
10	74	48	58	0	7	260/10KT	280/22KT	0.00	0.00	0
11	49	32	37	0	28	040/13KT	020/24KT	0.22	TRACE	0
12	43	28	36	0	29	090/09KT	200/12KT	0.01	0.00	1
13	39	32	35	0	30	090/09KT	090/18KT	0.15	0.00	0
14	51	34	43	0	22	140/10KT	160/20KT	0.03	0.00	0
15	68	43	56	0	09	190/10KT	330/24KT	TRACE	0.00	0
16	44	39	41	0	24	260/12KT	350/23KT	0.07	0.00	0
17	63	32	47	0	18	270/08KT	360/17KT	0.00	0.00	0
18	66	32	49	0	16	190/06KT	180/16KT	0.00	0.00	0
19	70	41	54	0	11	310/05KT	350/24KT	0.00	0.00	0

332356

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR FEBRUARY

20	78	38	58	0	7	300/07KT	260/19KT	0.00	0.00	0
21	74	46	60	0	5	210/05KT	140/17KT	0.00	0.00	0
22	72	46	59	0	6	160/10KT	170/25KT	0.00	0.00	0
23	80	56	68	3	0	180/07KT	040/15KT	0.00	0.00	0
24	66	50	58	0	7	100/07KT	060/17KT	TRACE	0.00	1
25	63	45	54	0	11	170/09KT	170/17KT	0.01	0.00	0
26	74	55	63	0	2	180/11KT	200/25KT	0.00	0.00	0
27	71	56	63	0	2	230/09KT	260/19KT	0.00	0.00	0
28	55	39	44	0	21	260/15KT	360/25KT	0.02	0.00	0
	AVG 64	AVG 41	AVG 52	TOTAL 3	TOTAL 372	AVG 200/09KT	AVG 200/20KT	TOTAL 0.51	TOTAL TRACE	TOTAL 1

MAXIMUM TEMPERATURE: 84

MINIMUM TEMPERATURE: 28

NUMBER OF DAYS WITH PRECIPITATION: 9

AVERAGE PRECIPITATION PER DAY: 0.06

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

AG1

D. J. FINNEY
By direction

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NTMOD Dallas
ECA

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL

# of pages ▶ 2

To Alan Flolo	From AG1 Finney
Dept./Agency AFBCA	Phone # 782-7068
Fax # 817-731-8137	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE 33235
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/005
5 Apr 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR MARCH 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF MARCH 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	38	31	35	0	30	280/13KT	010/21KT	0.12	TRACE	0
2	33	29	31	0	34	310/09KT	010/19KT	0.08	TRACE	0
3	41	29	35	0	30	220/06KT	340/15KT	0.01	TRACE	0
4	47	39	43	0	22	140/10KT	140/19KT	0.16	0.00	0
5	58	45	53	0	12	110/07KT	170/18KT	0.00	0.00	0
6	71	45	59	0	6	150/09KT	180/23KT	0.03	0.00	1
7	61	32	36	0	29	340/20KT	320/38KT	0.09	0.00	2
8	51	23	38	0	27	210/08KT	350/19KT	0.00	0.00	0
9	61	28	46	0	19	160/07KT	160/21KT	0.00	0.00	0
10	65	39	52	0	13	160/10KT	180/24KT	0.00	0.00	0
11	69	46	55	0	10	160/13KT	180/27KT	0.00	0.00	0
12	72	56	65	0	0	150/12KT	160/26KT	0.24	0.00	2
13	65	48	57	0	8	230/08KT	290/23KT	1.57	0.00	2
14	61	50	56	0	9	210/08KT	270/19KT	0.28	0.00	0
15	62	52	56	0	9	200/09KT	020/21KT	0.07	0.00	0
16	73	52	62	0	3	220/09KT	020/23KT	TRACE	0.00	0
17	82	51	64	0	1	220/05KT	350/16KT	0.00	0.00	0
18	75	48	62	0	3	210/05KT	220/14KT	0.00	0.00	0
19	84	56	70	5	0	180/13KT	180/26KT	0.00	0.00	0

332358

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR MARCH

20	80	52	68	3	0	220/10KT	350/23KT	0.00	0.00	0
21	80	49	66	1	0	170/10KT	160/24KT	0.00	0.00	0
22	96	62	76	11	0	210/09KT	200/21KT	0.00	0.00	0
23	84	57	69	4	0	210/07KT	020/19KT	0.00	0.00	0
24	76	56	67	2	0	170/10KT	120/28KT	0.00	0.00	0
25	71	63	69	4	0	130/09KT	110/21KT	0.40	0.00	4
26	69	47	58	0	7	250/07KT	280/30KT	1.28	0.00	2
27	68	44	56	0	9	170/10KT	050/20KT	0.00	0.00	0
28	55	47	51	0	14	040/09KT	030/24KT	0.03	0.00	1
29	62	46	53	0	12	020/09KT	030/24KT	TRACE	0.00	0
30	66	44	55	0	10	120/08KT	050/19KT	0.00	0.00	0
31	61	46	53	0	12	190/09KT	020/19KT	TRACE	0.00	0
	AVG 66	AVG 46	AVG 55	TOTAL 30	TOTAL 329	AVG 190/09KT	AVG 160/22KT	TOTAL 4.36	TOTAL TRACE	TOTAL 14

MAXIMUM TEMPERATURE: 96

MINIMUM TEMPERATURE: 23

NUMBER OF DAYS WITH PRECIPITATION: 16

AVERAGE PRECIPITATION PER DAY: 0.14

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

M. A. Kaloz, AG2

M. A. KALOZ
By direction

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NTMOD Dallas
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332359

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/006
1 MAY 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR APRIL 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF APRIL 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	73	39	58	0	7	230/07KT	290/20KT	0.00	0.00	0
2	75	45	63	0	2	170/10KT	180/28KT	0.00	0.00	0
3	72	53	62	0	3	150/10KT	030/24KT	0.24	0.00	2
4	64	55	59	0	6	070/09KT	040/17KT	0.13	0.00	0
5	57	52	55	0	10	090/07KT	100/17KT	1.04	0.00	0
6	71	51	61	0	4	160/06KT	130/14KT	0.00	0.00	0
7	79	55	66	1	0	160/11KT	180/23KT	0.00	0.00	0
8	86	58	72	7	0	180/14KT	180/25KT	0.00	0.00	0
9	85	63	72	7	0	170/16KT	160/29KT	0.00	0.00	0
10	72	47	60	0	5	250/15KT	310/30KT	0.73	0.00	4
11	61	39	50	0	15	270/11KT	320/32KT	0.00	0.00	0
12	75	45	58	0	7	210/08KT	210/29KT	0.00	0.00	0
13	79	45	62	0	3	180/05KT	180/15KT	0.00	0.00	0
14	81	55	68	3	0	170/12KT	160/26KT	0.00	0.00	0
15	84	63	74	9	0	170/11KT	170/23KT	0.00	0.00	0
16	80	71	74	9	0	160/12KT	190/22KT	0.00	0.00	0
17	82	62	73	8	0	170/14KT	280/36KT	0.50	0.00	2
18	75	56	66	1	0	270/07KT	270/20KT	0.00	0.00	0
19	65	51	60	0	5	100/06KT	210/23KT	0.34	TRACE	2

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR APRIL 332360

20	77	57	70	5	0	230/09KT	250/20KT	0.00	0.00	0
21	78	52	65	0	0	180/09KT	170/22KT	0.00	0.00	0
22	63	49	56	0	9	360/13KT	320/23KT	0.04	0.00	0
23	60	44	52	0	13	310/12KT	340/25KT	0.01	0.00	0
24	63	43	56	0	9	190/04KT	070/17KT	0.00	0.00	0
25	73	47	60	0	5	170/09KT	160/19KT	0.00	0.00	0
26	78	55	67	2	0	190/15KT	170/28KT	0.04	0.00	2
27	73	50	60	0	5	020/10KT	010/21KT	0.00	0.00	0
28	78	57	67	2	0	170/10KT	160/21KT	0.00	0.00	0
29	87	66	77	12	0	170/10KT	040/25KT	TRACE	0.00	1
30	84	61	73	8	0	100/08KT	210/21KT	0.03	0.00	0
	AVG 75	AVG 53	AVG 64	TOTAL 74	TOTAL 108	AVG 180/10KT	AVG 180/23KT	TOTAL 3.10	TOTAL TRACE	TOTAL 11

MAXIMUM TEMPERATURE: 87

MINIMUM TEMPERATURE: 39

NUMBER OF DAYS WITH PRECIPITATION: 11

AVERAGE PRECIPITATION PER DAY: 0.10

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

M. A. Kaloz, AG2

M. A. KALOZ
By direction

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332361

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/007
1 JUN 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR MAY 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF MAY 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	75	54	66	1	0	250/13KT	340/26KT	0.00	0.00	0
2	65	49	58	0	7	100/07KT	120/15KT	TRACE	0.00	0
3	67	56	62	0	3	120/11KT	130/26KT	0.69	0.00	2.5
4	78	61	67	2	0	030/08KT	040/15KT	0.02	0.00	0
5	78	61	68	3	0	090/11KT	070/24KT	2.14	0.00	5.0
6	83	62	73	8	0	140/10KT	150/24KT	0.06	0.00	0.5
7	81	62	74	9	0	190/15KT	320/34KT	1.28	0.00	5.0
8	81	59	68	3	0	170/12KT	170/24KT	1.11	0.00	4.5
9	85	64	73	8	0	230/11KT	260/24KT	0.00	0.00	0
10	77	60	68	3	0	330/08KT	350/18KT	0.00	0.00	0
11	75	55	64	0	1	160/06KT	070/17KT	0.00	0.00	0
12	80	60	72	7	0	160/11KT	160/25KT	0.00	0.00	0
13	97	77	85	20	0	190/11KT	160/24KT	0.00	0.00	0
14	95	78	85	20	0	180/08KT	190/20KT	0.00	0.00	0
15	92	76	82	17	0	150/09KT	200/18KT	0.00	0.00	0
16	87	73	80	15	0	170/13KT	170/24KT	TRACE	0.00	0
17	89	72	80	15	0	190/13KT	210/26KT	0.02	0.00	0
18	74	61	67	2	0	310/10KT	330/26KT	0.00	0.00	0
19	82	54	67	2	0	240/06KT	330/16KT	0.00	0.00	0

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR MAY 332362

20	83	57	70	5	0	150/07KT	140/16KT	0.00	0.00	0
21	87	64	76	11	0	140/08KT	160/20KT	0.00	0.00	0
22	88	68	78	13	0	160/12KT	150/23KT	0.00	0.00	0
23	87	69	77	12	0	170/13KT	290/29KT	0.01	0.00	3.0
24	82	70	75	10	0	230/08KT	220/38KT	0.27	0.00	0
25	76	65	69	4	0	030/07KT	010/18KT	0.09	0.00	0
26	89	68	78	13	0	180/11KT	180/24KT	0.00	0.00	1.0
27	93	66	78	13	0	190/12KT	180/32KT	0.06	0.00	1.0
28	91	69	77	12	0	250/08KT	310/18KT	TRACE	0.00	0
29	86	64	63	0	2	020/09KT	020/22KT	0.01	0.00	1.5
30	87	65	75	10	0	230/06KT	110/24KT	0.06	0.00	0
31	84	63	70	5	0	220/06KT	270/33KT	0.61	0.00	4.5
	AVG 83	AVG 64	AVG 72	TOTAL 243	TOTAL 13	AVG 170/10KT	AVG 190/23KT	TOTAL 6.43	TOTAL 0.00	TOTAL 28.5

MAXIMUM TEMPERATURE: 91

MINIMUM TEMPERATURE: 49

NUMBER OF DAYS WITH PRECIPITATION: 17

AVERAGE PRECIPITATION PER DAY: 0.21

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

M. A. Kaloz

M. A. KALOZ
By direction

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NTMOD Dallas
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332363

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/008
2 JUL 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR JUN 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF JUN 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	89	61	75	10	0	170/04KT	320/09KT	0.00	0.00	0
2	92	71	82	17	0	200/10KT	160/20KT	0.00	0.00	0
3	89	74	80	15	0	160/13KT	150/24KT	0.01	0.00	1.0
4	88	71	79	14	0	160/09KT	330/24KT	TRACE	0.00	1.0
5	92	65	78	13	0	170/09KT	170/29KT	0.13	0.00	2.0
6	93	70	82	17	0	180/12KT	180/24KT	0.00	0.00	0
7	92	75	84	19	0	170/11KT	170/24KT	0.00	0.00	0
8	92	76	83	18	0	160/13KT	170/23KT	0.00	0.00	0
9	95	78	85	20	0	160/12KT	190/25KT	0.00	0.00	0
10	72	66	75	10	0	130/10KT	040/32KT	1.51	0.00	6.0
11	77	60	67	2	0	320/13KT	310/28KT	0.33	0.00	1.0
12	81	57	69	4	0	230/06KT	020/20KT	0.00	0.00	0
13	84	61	73	8	0	180/05KT	170/13KT	0.00	0.00	0
14	83	65	77	13	0	180/11KT	170/22KT	0.00	0.00	0
15	88	63	73	9	0	160/10KT	180/22KT	0.00	0.00	0
16	88	63	77	12	0	150/09KT	180/19KT	0.00	0.00	0
17	89	69	79	14	0	120/08KT	130/18KT	0.00	0.00	0
18	90	68	78	13	0	110/06KT	120/18KT	0.00	0.00	0
19	90	65	76	11	0	150/05KT	130/13KT	0.00	0.00	0

33236

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR JUN

20	93	65	79	14	0	140/05KT	130/12KT	0.00	0.00	0
21	89	68	79	14	0	180/05KT	130/11KT	0.00	0.00	0
22	93	65	81	16	0	160/05KT	250/14KT	0.00	0.00	0
23	95	73	83	18	0	170/05KT	220/16KT	0.00	0.00	0
24	95	74	83	18	0	300/06KT	340/14KT	0.00	0.00	0
25	88	69	77	12	0	320/10KT	330/21KT	0.00	0.00	0
26	96	69	82	17	0	250/06KT	300/15KT	0.00	0.00	0
27	86	65	73	8	0	180/05KT	200/17KT	0.32	0.00	1.5
28	94	68	80	15	0	160/07KT	180/19KT	0.00	0.00	0
29	86	70	78	13	0	150/05KT	120/17KT	TRACE	0.00	1.0
30	84	68	75	10	0	270/09KT	330/18KT	0.00	0.00	0
	AVG	AVG	AVG	TOTAL	TOTAL	AVG	AVG	TOTAL	TOTAL	TOTAL
	89	68	78	394	0	180/08KT	190/19KT	2.30	0.00	13.5

MAXIMUM TEMPERATURE: 96

MINIMUM TEMPERATURE: 57

NUMBER OF DAYS WITH PRECIPITATION: 7

AVERAGE PRECIPITATION PER DAY: 0.08

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

M. A. Kaloz, A62

M. A. KALOZ

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OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▶ 2

To Alan Flolo	From AG1 Finney
Dept./Agency AFBCA	Phone # 782-7065
Fax # 817-731-8137	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

332365

DEPARTMENT OF THE NAVY
NAVAL AIR STATION FORT WORTH JRB WEATHER OFFICE
1st STREET BLDG 1425
FORT WORTH, TX 76127

3148
Ser 00/009
2 Aug 95

From: Officer in Charge, Naval Training Meteorology and Oceanography Detachment, Dallas
To: Public Works Officer, Naval Air Station Fort Worth

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR JULY 1995

1. The following is submitted as requested:

MONTHLY CLIMATOLOGICAL SUMMARY
FOR THE MONTH OF JULY 1995

DATE	MAX TEMP	MIN TEMP	AVG TEMP	COOLING DEG DAYS	HEATING DEG DAYS	AVG WIND	MAX WIND	LIQUID PRECIP	FROZEN PRECIP	TSTM
1	90	64	75	10	0	200/06KT	360/14KT	0.00	0.00	0
2	91	70	80	15	0	170/07KT	140/19KT	TRACE	0.00	1
3	94	70	83	18	0	190/13KT	160/26KT	0.01	0.00	1
4	94	70	83	18	0	160/12KT	340/34KT	0.05	0.00	1
5	93	63	78	13	0	160/07KT	160/27KT	1.97	TRACE	9
6	94	68	81	16	0	160/06KT	150/21KT	0.00	0.00	0
7	96	71	84	19	0	180/05KT	180/15KT	0.00	0.00	0
8	96	71	85	20	0	180/06KT	270/15KT	0.00	0.00	0
9	99	74	85	20	0	220/08KT	250/21KT	0.00	0.00	0
10	100	73	87	22	0	270/05KT	260/17KT	0.00	0.00	0
11	101	79	90	25	0	250/04KT	280/13KT	0.00	0.00	0
12	103	79	91	26	0	190/05KT	130/12KT	0.00	0.00	0
13	97	80	89	24	0	150/06KT	140/18KT	0.00	0.00	0
14	95	78	86	21	0	140/07KT	120/16KT	0.00	0.00	0
15	95	76	83	18	0	150/06KT	090/22KT	0.01	0.00	2
16	96	75	82	17	0	160/06KT	300/17KT	0.00	0.00	1

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▶ 2

To ALAN FLOLC	From AG3 BYRLEY
Dept./Agency AFBCA	Phone # 782-7068
Fax # (817) 731-8137	Fax # 782-7963

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

332366

Subj: MONTHLY CLIMATOLOGICAL SUMMARY FOR JULY 1995

17	96	75	88	23	0	170/05KT	020/17KT	0.00	0.00	0
18	97	77	84	19	0	120/05KT	240/22KT	TRACE	0.00	0
19	97	73	84	19	0	200/05KT	140/16KT	0.00	0.00	0
20	103	75	89	24	0	180/08KT	160/17KT	TRACE	0.00	0
21	102	80	91	26	0	180/09KT	190/19KT	0.00	0.00	0
22	99	80	89	24	0	190/10KT	240/21KT	0.00	0.00	0
23	98	75	86	21	0	180/10KT	230/21KT	0.63	0.00	2
24	99	76	87	22	0	150/11KT	250/25KT	TRACE	0.00	0
25	99	78	88	23	0	170/09KT	210/19KT	0.00	0.00	0
26	102	80	90	25	0	160/09KT	170/19KT	0.00	0.00	0
27	104	80	92	27	0	180/10KT	170/18KT	0.00	0.00	0
28	107	79	93	28	0	180/06KT	220/15KT	0.00	0.00	0
29	100	81	91	26	0	120/08KT	110/20KT	0.00	0.00	0
30	96	76	85	20	0	090/08KT	150/20KT	0.00	0.00	0
31	79	75	76	11	0	060/11KT	080/27KT	2.13	0.00	1
	AVG 97	AVG 75	AVG 86	TOTAL 640	TOTAL 0	AVG 170/08KT	AVG 190/19KT	TOTAL 4.80	TOTAL TRACE	TOTAL 18HR

MAXIMUM TEMPERATURE: 107

MINIMUM TEMPERATURE: 63

NUMBER OF DAYS WITH PRECIPITATION: 10

AVERAGE PRECIPITATION PER DAY: 0.15

NOTE: FROZEN PRECIPITATION IS CONVERTED TO LIQUID BY USING 1-10 RATIO.

M. A. Kaloz

M.A. KALOZ

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carswell SESOIL input data

SESOIL-84 : SEASONAL CYCLES OF WATER, SEDIMENT, AND POLLUTANTS IN SOIL ENVIRONMENTS *****

***** *****

***** DEVELOPERS: M. BONAZOUNTAS,ARTHUR D. LITTLE INC. ,(617)864-5770,X5871 *****

***** J. WAGNER ,DIS/ADLPIPE, INC. ,(617)492-1991,X5820 *****

***** *****

***** MODIFIED EXTENSIVELY BY: *****

***** D.M. HETRICK *****

***** OAK RIDGE NATIONAL LABORATORY *****

***** (615) 576-7556 *****

***** VERSION : OCTOBER, 1993 *****

***** *****

****

****** MONTHLY SESOIL MODEL OPERATION ******

MONTHLY SITE SPECIFIC SIMULATION

REGION : (1) CARSWELL NASJRB, SITE ST14

SOIL TYPE : (1) SAND

COMPOUND : (1) TOTAL BTEX

WASHLOAD DATA : (0)

APPLICATION AREA: (1) CARSWELL APPLIC DATA

GENERAL INPUT PARAMETERS 332368

==========

-- SOIL INPUT PARAMETERS --

SOIL DENSITY (G/CM**3): 1.86

INTRINSIC PERMEABILITY (CM**2): .000E+00

DISCONNECTEDNESS INDEX (-): 6.00

POROSITY (-): .300

ORGANIC CARBON CONTENT (%): .450

CATION EXCHANGE CAPACITY (MILLI EQ./100G DRY SOIL): .000E+00

FREUNDLICH EXPONENT (-): 1.00

-- CHEMICAL INPUT PARAMETERS --

SOLUBILITY (UG/ML): .175E+04

DIFFUSION COEFFICIENT IN AIR (CM**2/SEC): .100E-01

HENRYS LAW CONSTANT (M**3-ATM/MOLE): 70.0

ADSORPTION COEFFICIENT ON ORGANIC CARBON(KOC): 550.

ADSORPTION COEFFICIENT ON SOIL (K): .000E+00

MOLECULAR WEIGHT (G/MOL): 106.

VALENCE (-): .000E+00

NEUTRAL HYDROLYSIS CONSTANT (/DAY): .000E+00

BASE HYDROLYSIS CONSTANT (L/MOL-DAY): .000E+00

ACID HYDROLYSIS CONSTANT (L/MOL-DAY): .000E+00

DEGRADATION RATE IN MOISTURE (/DAY): .000E+00

DEGRADATION RATE ON SOIL (/DAY): .000E+00

LIGAND-POLLUTANT STABILITY CONSTANT (-): .000E+00

NO. MOLES LIGAND/MOLE POLLUTANT (-): .000E+00

LIGAND MOLECULAR WEIGHT (G/MOL): .000E+00

-- APPLICATION INPUT PARAMETERS --

NUMBER OF SOIL LAYERS: 2

YEARS TO BE SIMULATED: 4

AREA (CM**2): 0.100E+05

APPLICATION AREA LATITUDE (DEG.): 33.0

SPILL (1) OR STEADY APPLICATION (0): 1

MODIFIED SUMMERS MODEL USED (1) OR NOT (0) FOR GWR. CONC.:
1

INITIAL CHEMICAL CONCENTRATIONS GIVEN (1) OR NOT GIVEN (0) 1

DEPTHS (CM): 15. 0.29E+03

NUMBER OF SUBLAYERS/LAYER 1 1

PH (CM): 7.0 7.0

INTRINSIC PERMEABILITIES (CM**2): 0.50E-02 0.10E-10

KDEL RATIOS (-): 1.0

KDES RATIOS (-): 1.0

OC RATIOS (-): 1.0

CEC RATIOS (-): 1.0

FRN RATIOS(-): 1.0

ADS RATIOS(-): 1.0

1

YEAR - 1 MONTHLY INPUT PARAMETERS

========= ==========

-- CLIMATIC INPUT PARAMETERS --

OCT NOV DEC JAN FEB MAR APR
MAY JUN JUL AUG SEP

TEMP. (DEG C) 33.500 30.250 26.950 26.400 28.660 30.250 35.200 39.600 42.950 47.330 41.280 38.500

CLOUD CVR (FRAC.) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

REL. HUM.(FRAC.) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

ALBEDO (-) 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

EVAPOT. (CM/DAY) 0.020 0.020 0.020 0.010 0.020 0.030 0.020 0.020 0.020 0.020 0.020 0.020

PRECIP. (CM) 7.610 7.110 6.420 4.870 1.290 10.070 7.870 13.330 5.840 12.190 10.770 8.100

M.TIME RAIN(DAYS) 0.080 0.080 0.080 0.080 0.080 0.080 0.080 0.080 0.080 0.080 0.080 0.080

M. STORM NO. (-) 10.000 10.000 12.000 11.000 10.000 16.000 11.000 17.000 7.000 10.000 8.000 9.000

M. SEASON (DAYS) 30.400 30.400 30.400 30.400 30.400 30.400 30.400 30.400 30.400 30.400 30.400 30.400

-- HYDROLOGIC CYCLE COMPONENTS --

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MOIS. IN L1 (%)	26.859	26.889	27.219	27.159	26.019	27.429	27.069	27.579	26.289	26.499	26.199	26.439
MOIS. BELOW L1 (%)	26.859	26.889	27.219	27.159	26.019	27.429	27.069	27.579	26.289	26.499	26.199	26.439
PRECIPATION (CM)	7.610	7.116	6.415	4.890	1.301	9.986	7.890	13.485	5.870	12.259	10.708	8.080
NET INFILT. (CM)	1.841	1.771	1.847	1.701	1.108	2.347	1.941	2.601	1.640	2.197	1.796	1.939
EVAPOTRANS. (CM)	0.608	0.608	0.608	0.304	0.608	0.912	0.608	0.608	0.608	0.608	0.608	0.608
MOIS. RETEN (CM)	-0.030	0.008	0.084	-0.015	-0.290	0.358	-0.091	0.130	-0.328	0.053	-0.076	0.061

SUR. RUNOFF (CM) 5.770 5.346 4.568 3.189 0.193 7.640 5.949 10.884 4.231 10.062 8.912 6.141

GRW. RUNOFF (CM) 1.263 1.155 1.155 1.412 0.790 1.076 1.424 1.863 1.359 1.535 1.264 1.270

YIELD (CM) 7.033 6.501 5.723 4.602 0.983 8.716 7.373 12.747 5.590 11.597 10.176 7.411

PAU/MPA (GZU) 1.000 1.001 0.999 1.004 1.009 0.992 1.003 1.012 1.005 1.006 0.994 0.998

PA/MPA (GZ) 1.000 1.001 0.999 1.004 1.009 0.992 1.003 1.012 1.005 1.006 0.994 0.998

-- POLLUTANT MASS INPUT TO COLUMN (UG) - INCLUDES INITIAL POLLUTANT CONCENTRATIONS --

---
--

OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP

PRECIP. 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01

LOAD UPPER 9.978E+07 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01

LOAD LOWER 1.417E+08 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01

TOTAL INPUT 2.415E+08 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01 0.000E-01

0 -- POLLUTANT MASS DISTRIBUTION IN COLUMN (UG) -- NOTE: IF COMPONENT IS ZERO EACH MONTH, IT IS NOT PRINTED

----- UPPER SOIL ZONE:

SUBLAYER 1

LOWER SOIL ZONE:

SUBLAYER 1 332372

IN SOIL MOI 7.073E+05 7.072E+05 7.875E+05 7.481E+05 5.223E+05 8.364E+05 7.664E+05 9.467E+05 6.097E+05 6.509E+05 5.859E+05 6.246E+05

ADS ON SOIL 1.212E+07 1.211E+07 1.332E+07 1.268E+07 9.240E+06 1.404E+07 1.303E+07 1.580E+07 1.068E+07 1.131E+07 1.029E+07 1.087E+07

IN SOIL AIR 2.287E+08 2.287E+08 2.274E+08 2.280E+08 2.317E+08 2.265E+08 2.276E+08 2.245E+08 2.300E+08 2.293E+08 2.304E+08 2.297E+08

GWR. RUNOFF 8.230E+03 1.049E+04 1.154E+04 1.343E+04 5.475E+03 1.134E+04 1.392E+04 2.209E+04 1.089E+04 1.302E+04 9.764E+03 1.036E+04

-- POLLUTANT CONCENTRATIONS (UG/ML) OR (UG/G) -- NOTE: IF CONCENTRATIONS ARE ZERO FOR EACH MONTH, THEY ARE NOT

Year 2:

SOIL MOISTURE (UG/ML) 1.811E+00

ADSORBED SOIL (UG/G) 4.481E+00

SOIL AIR (UG/ML) 5.028E+03

MAX. POLL. DEPTH (M) 3.048E+00

AVE. CONTAMINANT CONCENTRATION IN GROUNDWATER (UG/ML) 1.811E+00

YEAR - 3 MONTHLY RESULTS (OUTPUT)

SOIL MOISTURE (UG/ML) 2.714E+00

ADSORBED SOIL (UG/G) 6.716E+00

SOIL AIR (UG/ML) 7.536E+03

MAX. POLL. DEPTH (M) 3.048E+00

AVE. CONTAMINANT CONCENTRATION IN GROUNDWATER (UG/ML) 2.714E+00

Year 4:

TOTAL IN GROUNDWATER RUNOFF 5.668E+05

332373

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REGRESSION TECHNIQUES AND ANALYTICAL SOLUTIONS TO DEMONSTRATE INTRINSIC BIOREMEDIATION

Timothy E. Buscheck and Celia M. Alcantar
Chevron Research and Technology Company
Richmond, CA

ABSTRACT

It is now generally recognized that a major factor responsible for the attenuation and mass reduction of benzene, toluene, ethylbenzene, and xylenes (BTEX) in groundwater plumes is hydrocarbon biodegradation by indigenous microorganisms in aquifer material. Our objective is to apply well-known regression techniques and analytical solutions to estimate the contribution of advection, dispersion, sorption, and biodecay to the overall attenuation of petroleum hydrocarbons. These calculations yield an apparent biodecay rate based on field data. This biodecay rate is a significant portion of the overall attenuation in stable, dissolved hydrocarbon plumes.

INTRODUCTION

"Intrinsic bioremediation" is the degradation of organic compounds by indigenous microbes without artificial enhancement. Advection, dispersion, sorption, and decay each contribute to the overall attenuation of a dissolved hydrocarbon plume. The effect of advection is to transport dissolved contaminants at the same rate as the groundwater velocity. The effect of dispersion is to spread contaminant mass beyond the volume it would occupy due to advection alone, and reduce contaminant concentrations. The effect of sorption is to retard contaminant migration. These factors affect the configuration of dissolved hydrocarbon plumes. Overall attenuation can cause a plume to shrink over time, create a stable plume, or reduce the rate of plume migration. Two of the conditions for which intrinsic bioremediation is likely to contribute to the configuration of a contaminant plume are a shrinking plume and a stable plume. The configuration of a migrating plume can also be affected by intrinsic bioremediation. Under the conditions of a shrinking plume, degradation mechanisms are necessarily present. Intrinsic bioremediation also is likely to contribute to a stable plume, particularly if the source persists in residually contaminated soils at the water table. In this paper we couple the regression of concentration versus distance for stable plumes to an analytical solution for one-dimensional, steady-state, contaminant transport. The analytical solution includes advection, dispersion, sorption, and decay.

Biological transformation is the process that likely contributes most to the decay of compounds such as BTEX. Several studies suggest the concurrent loss of electron acceptors from groundwater as an indicator of biodegradation (McAllister and Chiang 1994, Salanitro 1993). The mechanism of biodegradation is complex, and the rate is most likely controlled by the mixing of the contaminant and electron acceptors in a three-dimensional, heterogeneous aquifer. The assumption of a first-order decay is a useful approximation of this complex phenomenon. Evaluation of site data suggests apparent first-order attenuation rates occur in the range of 0.1 to 1.0 % per day (Buscheck et al. 1993).

The objective of this paper is to provide tools to assist in documenting the loss of contaminants. The regression techniques and analytical solution described are intended to distinguish those mechanisms that contribute to contaminant loss.

PLUME CHARACTERISTICS

Shrinking Plume

Dissolved hydrocarbon plumes may decrease in size, as observed by declining contaminant concentrations in monitoring wells. Exponential regression methods can be used to evaluate whether concentration versus time data fit a first-order decay observed for petroleum hydrocarbons under certain conditions. The solution to the first-order decay is:

$$C(t) = C_i e^{-(kt)} \tag{1}$$

Where C(t) (M/L^3) is concentration as a function of time, t (T), C_i is the initial concentration at t = 0, and k is the first-order attenuation rate, T^{-1}. Equation (1) may be used to evaluate contaminant concentration versus time data for individual monitoring wells.

Stable Plume

A stable plume is characterized by dissolved contaminant concentrations remaining constant over time in individual monitoring wells. Short-term variations in monitoring well concentrations due to water table fluctuation, variability in groundwater flow direction, sampling variability, and analytical uncertainty should be distinguished from statistically significant concentration changes. In order for a plume to reach stable conditions, the rate of natural attenuation must be equal to the rate of contaminant addition to the aquifer from the source (McAllister and Chiang 1994). The contaminant source or influx rate is limited by the compound's effective solubility and the flow rate of water through the source area (infiltration, fluctuating water table, etc.).

Kemblowski et al. (1987) recast equation (1) for concentration as a function of distance:

$$C(x) = C_o e^{-(k\frac{x}{v_x})} \tag{2}$$

Where C_o (M/L^3) is the concentration at the source. The transformation of the exponential terms in equations (1) and (2) is achieved by substituting time, t, with distance traveled, x (L) divided by the linear groundwater velocity, v_x (L/T). The term "x/v_x" is the residence time for pore water to move some distance, x, from the source. The concentration versus distance regression is based on equation (2). The groundwater flow direction is defined based on multiple monitoring events covering the hydrologic cycle. Six monitoring wells were selected along the groundwater flow path (see inset of Figure 1). A minimum of three monitoring wells are required for this analysis. In this case, contaminant concentrations declined with downgradient distance. Figure 1 plots benzene concentration versus distance for a terminal in Fairfax, Virginia. From the exponent of equation (2), the slope of the line in Figure 1 is k/v_x (L^{-1}), the reciprocal of the attenuation distance. If this slope is multiplied by groundwater velocity (L/T), we obtain

k (T^{-1}). In the absence of a reliable estimate of groundwater velocity, the k/v_x term is useful, particularly for estimating the downgradient extent of contaminant migration and selecting downgradient monitoring well locations.

ANALYTICAL SOLUTION FOR A STABLE PLUME

The general one-dimensional transport equation, with first-order decay of the contaminant, is given by the following equation:

$$\frac{\delta C}{\delta t} = \frac{1}{R_f} \left[D_x \frac{\delta^2 C}{\delta x^2} - v_x \frac{\delta C}{\delta x} \right] - \lambda C \tag{3}$$

Where D_x (L^2/T) is the dispersion coefficient, v_x (L/T) is the linear groundwater velocity, R_f (-) is the retardation coefficient, and λ (T^{-1}) is the total decay rate. The form of equation (3) assumes D_x is constant and independent of distance, x. While the terms in brackets describe the mass transport by dispersion and advection, respectively, the retardation coefficient characterizes the contribution of sorption. The form of this equation assumes degradation occurs in the aqueous and sorbed phases at the same rate. If biological transformation of BTEX compounds occurs primarily in the aqueous phase, the term "λC" would appear inside the brackets.

Dispersion and advection are related by the longitudinal dispersivity, α_x (L), which has been described by empirical expressions (Fetter 1993).

$$D_x = \alpha_x v_x \tag{4}$$

The retardation coefficient (R_f) accounts for contaminant partitioning between the solid and aqueous phases. R_f describes the relationship between the linear groundwater velocity, and contaminant velocity, v_c (L/T):

$$R_f = \frac{v_x}{v_c} \tag{5}$$

Chiang et al. (1989) demonstrated that the contribution of volatilization to the dissolved contaminant attenuation was only 5% at one site. Except in the case of very shallow groundwater, volatilization is not expected to contribute significantly to the overall attenuation. Therefore, volatilization is neglected and the decay rate is assumed to be a measure of biodegradation of BTEX compounds.

Bear (1979) solved equation (3) for concentration. The steady-state solution is given as:

$$C(x) = C_o \exp\left[\left(\frac{x}{2\alpha_x}\right) \left[1 - \left(1 + \frac{4\lambda\alpha_x}{v_c}\right)^{\frac{1}{2}}\right]\right] \tag{6}$$

For the case in which decay occurs only in the aqueous phase, the contaminant velocity, v_c, is replaced by the linear groundwater velocity, v_x, in equation (6). As the decay rate (λ) increases with respect to the other transport mechanisms, the concentration away from the source ($x > 0$), approaches zero because the material is decaying at a greater rate than it is being transported through the medium. Similarly, as the contaminant velocity increases, the decay becomes less effective in reducing concentrations as a function

of distance. Retarded contaminants therefore have a greater opportunity to decay because retarded transport velocities favor biodegradation kinetics over transport (Domenico and Schwartz 1990).

The exponential regression for concentration versus distance yields the reciprocal of the attenuation distance, k/v_x (L^{-1}), previously shown in equation (2). Equations (2) and (6) are of the same form:

$$C(x) = C_o \exp(mx) \tag{7}$$

The slope of the log-linear data is given by m. The one-dimensional, steady-state transport solution also describes the slope, m, of the log-linear data:

$$m = \left(\frac{1}{2\alpha_x}\right) \left[1-\left(1+\frac{4\lambda\alpha_x}{v_c}\right)^{\frac{1}{2}}\right] \tag{8}$$

Therefore, the term k/v_x and equation (8) both describe the slope of the log-linear data and can be equated to solve for the total decay rate, λ, a measure of intrinsic bioremediation. Dispersivity (α), contaminant velocity (v_c), and k/v_x are input to the following equation to calculate the decay rate.

$$\lambda = \left(\frac{v_c}{4\alpha_x}\right) \left(\left[1+2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right) \tag{9}$$

For the case in which decay occurs only in the aqueous phase, v_c is replaced by v_x in equation (9).

RESULTS

The results of equating the spatial regression with the steady-state analytical solution for the Fairfax Terminal are presented in Table 1. The values for source concentration (C_o) and k/v_x were regressed using the data plotted in Figure 1. Table 1 includes k and the ratio, λ/k, the contribution of biodecay to the overall attenuation rate (expressed as %). In Case 1, groundwater velocity was 0.06 m/day, based on aquifer pump tests. Retardation was estimated as 2 and dispersivity was estimated as 7.5 m, approximately 5% of the flow field (distance separating the two furthest wells). In Case 1, λ = 0.30%/day (0.0030 $days^{-1}$); λ is 75% of k for this case. The next four cases were performed to evaluate the sensitivity of changing various input parameters. In each of these cases C_o and k/v_x remain constant. In Case 2, the groundwater velocity is reduced by a factor of two (v = 0.03 m/day), which reduces the decay rate by the same factor (λ = 0.15%/day). In this case, only half the decay rate is required to maintain the Case 1 concentration decline with distance; as in Case 1, λ is 75% of k in Case 2. In Case 3, the dispersivity is increased by a factor of two (α = 15 m) and λ = 0.40%/day. More decay is required with a larger dispersivity because more spreading of the contaminant occurs in the direction of groundwater flow; λ is equivalent to k in Case 3.

Cases 4 and 5 were performed to calculate λ assuming biodecay occurs only in the aqueous phase. This is accomplished by replacing v_c with v_x in equation (9) for λ (R = 1 in Table 1 for Cases 4 and 5). Given this revised formulation, the decay rate, λ, is independent of retardation. By limiting decay to the aqueous phase in Case 4, λ = 0.60%/day, twice the decay rate in Case 1. In Case 4, λ is 150% of k. Case 5 is similar to Case 4, but dispersivity is reduced to 0.3 m. In Case 5, λ = 0.40%/day. Less decay is required with a smaller dispersivity because less spreading of the contaminant plume occurs in the

direction of groundwater flow; λ and k are identical in Case 5.

SUMMARY

Contaminant decay is the primary process contributing to a stable configuration of a dissolved contaminant plume. Given a constant source, sorption and dispersion alone are not likely to account for a stable plume. Sorption only retards contaminant velocity, whereas dispersion results in further spreading of the contaminant, reducing concentrations. Decay (biodegradation of BTEX compounds) is the most significant mechanism that accounts for mass loss in a dissolved contaminant plume. The analytical solution for steady-state contaminant transport can be equated to a regression of concentration versus distance (expressed as k/v_x) to solve for the decay rate, λ. The decay rate is a measure of intrinsic bioremediation of petroleum hydrocarbons and can be used in more sophisticated models.

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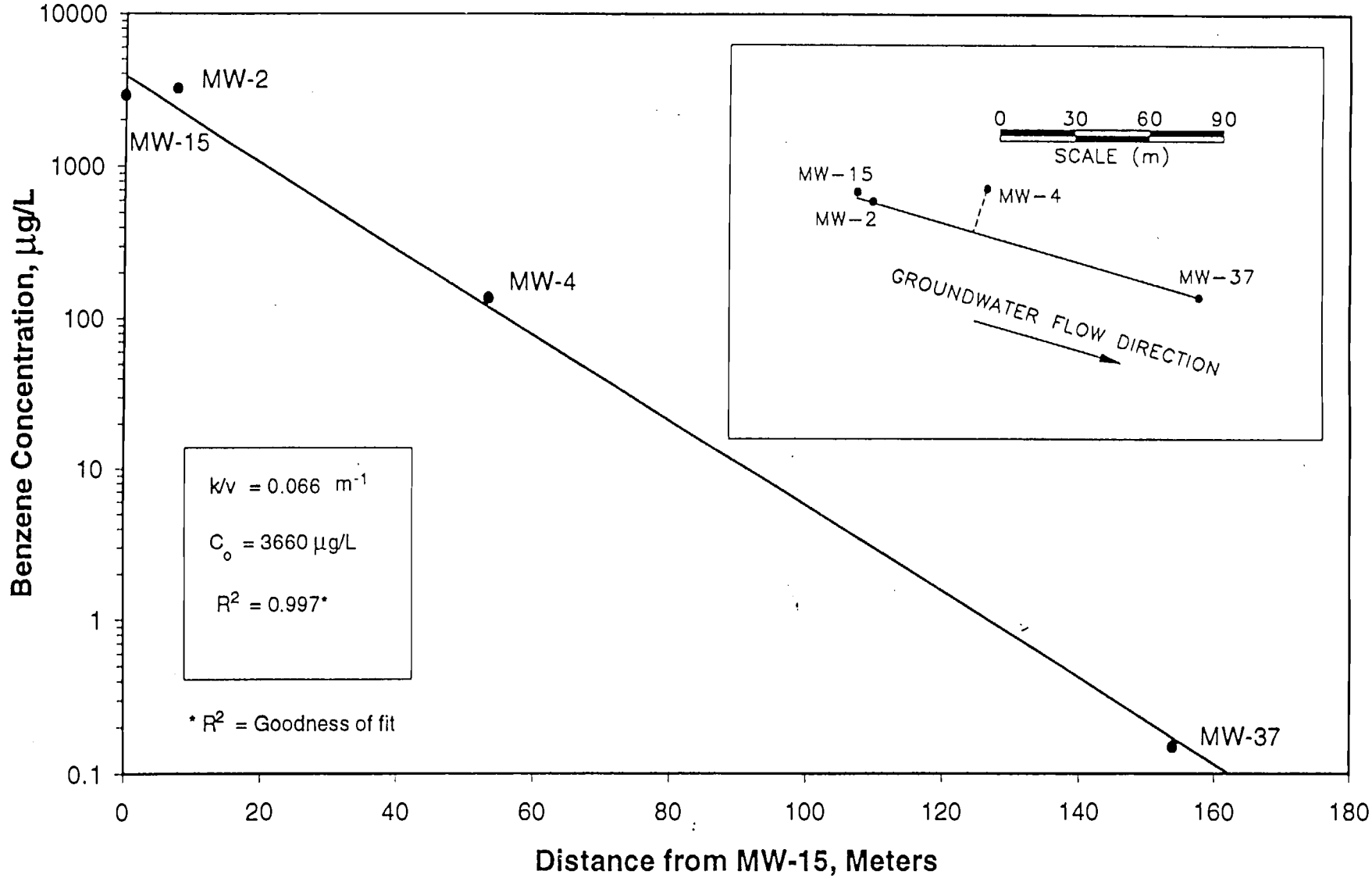

FIGURE 1. Exponential regression of concentration versus distance for Fairfax Terminal.

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TABLE 1. Decay rates based on steady-state analytical solution, C_o = 3,660 μg/L, k/v_x = 0.066 m^{-1}. (sensitivity on bold input values)

Case	groundwater velocity, v_x (m/day)	retardation coefficient, R_f	contaminant velocity, v_c (m/day)	dispersivity, α (m)	attenuation rate, k (%/day)	decay rate, λ (%/day)	λ/k (%)
Case 1	0.06	2	0.03	7.5	0.40	0.30	75
Case 2	**0.03**	2	0.015	7.5	0.20	0.15	75
Case 3	0.06	2	0.03	**15**	0.40	0.40	100
Case 4	0.06	1(1)	0.06	7.5	0.40	0.60	150
Case 5	0.06	1(1)	0.06	**0.3**	0.40	0.40	100

Note: (1) Calculation of λ independent of v_c.

APPENDIX F

PLAN A TARGET CONCENTRATION DERIVATIONS, PLAN B LIMITED RISK ASSESSMENT, AND PLAN B TARGET CONCENTRATION DERIVATIONS

PLAN A TARGET CONCENTRATIONS

APPENDIX F
PLAN A TARGET CONCENTRATIONS FOR SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	Current/Future Onsite Worker

Groundwater Protective Soil Concentrations - Beneficial Use II Groundwater

$C_T = C_L (\beta Kd + \phi w + (\phi a)H')/\beta$

where,

C_T = Bulk soil concentration (mg/kg dry weight)
C_L = Leachate concentration (mg/L)
β = Dry soil bulk density (kg/L) (default: 1.8)
ϕw = Water filled porosity (L/L) (default: 10% or 0.1)
Kd = Soil water partition coefficient (kg/kg/kg/L) (Koc x foc)
Koc = Organic carbon partition coefficient (chemical-specific)
foc = Soil organic carbon fraction (default: 0.02)
ϕa = Air filled soil porosity ($\phi - \phi w$) (0.221)
Total soil porosity ($\phi = 1-\beta/Pb$; Pb = particle density (default Pb = 2.65 kg/L)
H' = Henry's Law Constant (unitless); H' = H/RT where, H = Henry's Law Constant, R = Universal Gas Constant (8.21E-05 atm-m^3/mole-°K); T = Absolute temperature of soil, 273°K + °C.

Health-Based Soil Concentrations

Noncarcinogenic = 102/((5E-05/RfDo)+(1/RfDi) x ((20/VF) +(6.9E-10))

Carcinogenic = (TR x 286.2)/((5E-05 x SFo)+(SFi x ((20/VF) +(6.9E-10)))

where,

RfDo = Oral reference dose (mg/kg-day)
SFo = Oral slope factor $(mg/kg\text{-}day)^{-1}$
RfDi = Inhalation reference dose (mg/m^3)
SFi = Inhalation slope factor (mg/m^3)
VF = Volatilization factor (m^3/kg)
TR = Target risk (1E-06)

Chemical	RfDo	RfDi	SFo	SFi	Henry's Law Constant (unitless)	Kd	Groundwater Protective Soil Concentrations (mg/kg)	Health-Based Soil Noncarcinogenic (mg/kg)	Health-Based Soil Carcinogenic (mg/kg)	Target Concentration (mg/kg)
1,2,3,4-Tetramethylbenzene	-	-	-	-	-	-	-	-	-	-
1,2,3-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-
1,2,4-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-
1,3,5-Trimethylbenzene	-	-	-	-	-	-	-	-	-	-
Acetone	0.1	-	-	-	0.000856	0.044	2.20E+01 a/	2.36E+04 a/	-	2.20E+01
Benzene	-	-	0.029	0.029	0.232376	1.66	7.40E-01 a/	-	1.00E+01 a/	7.40E-01
Chlorobenzene	0.02	0.02	-	-	0.15464	0.957	1.24E+01 b/	4.47E+02 b/	-	1.24E+01
Ethylbenzene	0.1	1	-	-	0.267295	22	8.35E+02 a/	3.36E+03 a/	-	8.35E+02
Methylene Chloride	0.06	-	0.008	0.002	-	0.174	3.04E+01 b/	1.22E+05 b/	7.63E+02 b/	3.04E+01
Toluene	0.2	0.4	-	-	0.264801	6	5.03E+02 a/	3.26E+03 a/	-	5.03E+02
Xylenes (Total)	2	-	-	-	0.292653	4.8	9.68E+02 a/	9.68E+02 a/	-	9.68E+02

APPENDIX F (Continued)
PLAN A TARGET CONCENTRATIONS FOR SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	RfDo	RfDi	SFo	SFi	Henry's Law Constant (unitless)	Kd	Groundwater Protective Soil Concentrations (mg/kg)	Health-Based Soil Noncarcinogenic (mg/kg)	Health-Based Soil Carcinogenic (mg/kg)	Target Concentration (mg.kg)
1,2,4-Trichlorobenzene	0.01	0.2	-	-	0.096027	10.02	3.90E+01 b/	1.28E+04 b/	-	3.90E+01
1,4-Dichlorobenzene	-	-	0.024	-	0.120137	34	1.23E+02 a/	-	6.66E+02 a/	1.23E+02
2-Chlorophenol	0.005	-	-	-	3.44E-04	7.26	1.43E+01 b/	1.02E+04 b/	-	1.43E+01
2-Methylnaphthalene	-	-	-	-	-	170.2	-	-	-	-
4-Chloro-3-methylphenol	-	-	-	-	-	1	-	-	-	-
Acenaphthene	0.06	-	-	-	0.003824	92	3.14E+02 a/	3.14E+02 a/	-	3.14E+02
Di-n-butylphthalate	0.1	-	-	-	0.002619	27.6	1.03E+03 b/	2.04E+05 b/	-	1.03E+03
Fluorene	0.04	-	-	-	0.002669	146	2.47E+02 a/	2.47E+02 a/	-	2.47E+02
Hexachlorobenzene	8E-04	-	1.6	1.61	0.028309	77.8	4.17E-02 b/	1.63E+03 b/	3.61E-01 b/	4.17E-02
N-Nitroso-di-n-propylamine	-	-	7	-	-	0.2	-	-	8.18E-01 b/	8.18E-01
Naphthalene	0.04	-	-	-	-	26	3.89E+02 a/	7.82E+02 a/	-	3.89E+02
ıol	0.6	-	-	-	1.89E-05	0.54	2.40E+02 b/	1.22E+06 b/	-	2.40E+02
Pyrene	0.03	-	-	-	2.10E-04	760	9.90E+01 a/	9.90E+01 a/	-	9.90E+01
Aluminum	-	-	-	-	-	-	-	-	-	-
Arsenic	3E-04	-	1.75	15.05	-	-	-	6.12E+02 b/	3.27E+00 b/	3.27E+00
Barium	0.07	-	-	-	-	-	-	1.43E+05 b/	-	1.43E+05
Beryllium	0.005	-	4.3	8.4	-	-	-	1.02E+04 b/	-	1.02E+04
Cadmium	5E-04	-	-	6.3	-	-	-	1.02E+03 b/	-	1.02E+03
Calcium	-	-	-	-	-	-	-	-	-	-
Chromium	0.005	-	-	42	-	-	-	1.02E+04 b/	-	1.02E+04
Cobalt	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-	-	-	-
Manganese	0.005	-	-	0.175	-	-	-	1.02E+04 b/	-	1.02E+04
Nickel	0.02	-	-	-	-	-	-	4.08E+04 b/	-	4.08E+04
Potassium	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-
Vanadium	0.007	-	-	-	-	-	-	1.43E+04 b/	-	1.43E+04
Zinc	0.3	-	-	-	-	-	-	6.12E+05 b/	-	6.12E+05
ɔleum Hydrocarbons	-	-	-	-	-	-	-	-	-	-
.al Extractable Hydrocarbons	-	-	-	-	-	-	-	-	-	-

APPENDIX F (Continued)
PLAN A TARGET CONCENTRATIONS FOR SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	RfDo	RfDi	SFo	SFi	Henry's Law Constant (unitless)	Kd	Groundwater Protective Soil Concentrations (mg/kg)	Health-Based Soil Noncarcinogenic (mg/kg)	Health-Based Soil Carcinogenic (mg/kg)	Target Concentration (mg/kg)
Alkalinity, Carbonate	-	-	-	-	-	-	-	-	-	-
Alkalinity, Total (as CACO3)	-	-	-	-	-	-	-	-	-	-
Nitrogen, Total Kjeldahl	-	-	-	-	-	-	-	-	-	-
Phosphorus, Total Orthophosphat	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-

[a/] = Value from Plan A target concentration table in the TNRCC (1994) guidance.

[b/] = Value calculated using TNRCC (1994) guidance for Plan A target concentration algorithms.

APPENDIX F
PLAN A TARGET CONCENTRATIONS FOR GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	Current/Future Onsite Worker

Target Groundwater Concentrations - Beneficial Use II Groundwater

Noncarcinogenic = C = 36.5 x RfDo — RfDo = Oral reference dose (mg/kg-day)

Carcinogenic = C = (TR x 85.17)/SFo — TR = Target risk (1E-06)
SFo = Oral slope factor $(mg/kg\text{-}day)^{-1}$

Chemical	RfDo	SFo	Target Groundwater Concentrations Noncarcinogenic (mg/L)		Target Groundwater Concentrations Carcinogenic (mg/L)		Target Concentration (mg/L)
1,2,3,4-Tetramethylbenzene	-	-	-		-		-
1,2,3-Trimethylbenzene	-	-	-		-		-
1,2,4-Trimethylbenzene	-	-	-		-		-
1, rimethylbenzene	-	-	-		-		-
Benzene	-	0.029	-		2.94E-02	a/	2.94E-02
Bromodichloromethane	0.02	0.062	7.30E-01	b/	1.37E-03	b/	1.37E-03
Chlorobenzene	0.02	-	7.30E-01	b/	-		7.30E-01
Chloroform	0.01	0.0061	3.65E-01	b/	1.40E-02	b/	1.40E-02
Dibromochloromethane	0.02	0.084	7.30E-01	b/	1.01E-03	b/	1.01E-03
Ethylbenzene	0.1	-	3.65E+00	a/	-		3.65E+00
Methylene Chloride	0.06	0.0075	2.19E+00	b/	1.14E-02	b/	1.14E-02
Tetrachloroethene	0.01	-	3.65E-01	b/	-		3.65E-01
Toluene	0.2	-	7.30E+00	a/	-		7.30E+00
Trichloroethene	-	-	-		-		-
Xylenes (Total)	2	-	7.30E+01	a/	-		7.30E+01
2-Methylnaphthalene	-	-	-		-		-
Dibenzofuran	-	-	-		-		-
Naphthalene	0.04	-	1.46E+00	a/	-		1.46E+00
Aluminum	-	-	-		-		-
Arsenic	0.0003	1.75	1.10E-02	b/	4.87E-05	b/	4.87E-05
Barium	0.07	-	2.56E+00	b/	-		2.56E+00
Cadmium	0.0005	-	1.83E-02	b/	-		1.83E-02
C' ium	0.005	-	1.83E-01	b/	-		1.83E-01

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APPENDIX F
PLAN A TARGET CONCENTRATIONS FOR SURFACE WATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

xposure Assumptions	
eceptor	Current/Future Onsite Worker

ealth-Based Soil Concentrations

oncarcinogenic = 7.8E-04 x RfDo

arcinogenic = (TR x 6.4E+05)/SFo

RfDo = Oral reference dose (mg/kg-day)
SFo = Oral slope factor $(mg/kg\text{-}day)^{-1}$
RfDi = Inhalation reference dose (mg/m^3)
SFi = Inhalation slope factor (mg/m^3)
TR = Target risk (1E-06)

hemical	RfDo	RfDi	SFo	SFi	Residential Health-Based SW Noncarcinogenic (mg/kg)	Residential Health-Based SW Carcinogenic (mg/kg)	Target Concentration
2,3,4-Tetramethylbenzene	-	-	-	-	-	-	-
2,4-Trimethylbenzene	-	-	-	-	-	-	-
3,5-Trimethylbenzene	-	-	-	-	-	-	-
lorobenzene	0.02	0.02	-	-	1.56E+03	-	1560
hylbenzene	0.1	1	-	-	7.80E+03	-	7800
luene	0.2	0.4	-	-	1.56E+04	-	15600
lenes (Total)	2	-	-	-	1.56E+05	-	156000
Methylnaphthalene	-	-	-	-	-	-	-
tal Extractable Hydrocarb	-	-	-	-	-	-	-
tal Organic Carbon	-	-	-	-	-	-	-

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PLAN B LIMITED RISK ASSESSMENT

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	RME ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Ingestion Rate (IR)	480 mg/day
Fraction Ingested (FI)	1 unitless
Exposure frequency (EF)	250 days/yr
Exposure duration (ED)	1 yrs
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion Factor (CF)	0.000001 kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)
Noncarcinogenic Intake Factor (NIF)
= 4.70E-06 kg/kg-day
Carcinogenic Intake Factor (CIF)
= 6.71E-08 kg/kg-day
RfD = Reference Dose
SF = Slope Factor

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)
Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	8.92E-05	1.27E-06	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	4.04E-05	5.77E-07	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.32E-04	1.88E-06	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	6.58E-05	9.39E-07	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.60E-07	2.28E-09	1.00E-01	--	1.60E-06	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.15E-04	4.50E-06	--	2.90E-02	--	--	1.30E-07	64%
Chlorobenzene	108-90-7	2.20E+00	1.03E-05	1.48E-07	2.00E-02	--	5.17E-04	9%	--	--
Ethylbenzene	100-41-4	1.70E+01	7.98E-05	1.14E-06	1.00E-01	--	7.98E-04	14%	--	--
Methylene Chloride	75-09-2	1.60E-02	7.51E-08	1.07E-09	6.00E-02	7.50E-03	1.25E-06	< 1%	8.05E-12	< 1%
Toluene	108-88-3	5.40E+01	2.54E-04	3.62E-06	2.00E-01	--	1.27E-03	22%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.44E-04	3.49E-06	2.00E+00	--	1.22E-04	2%	--	--
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	2.49E-07	3.56E-09	1.00E-02	--	2.49E-05	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	2.49E-07	3.56E-09	--	2.40E-02	--	--	8.53E-11	< 1%
2-Chlorophenol	95-57-8	1.00E-01	4.70E-07	6.71E-09	5.00E-03	--	9.39E-05	2%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	1.45E-06	2.07E-08	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	4.60E-07	6.58E-09	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	2.77E-07	3.96E-09	6.00E-02	--	4.62E-06	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.19E-07	4.56E-09	1.00E-01	--	3.19E-06	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.17E-07	1.68E-09	4.00E-02	--	2.94E-06	< 1%	--	--

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APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Hexachlorobenzene	118-74-1	4.60E-01	2.16E-06	3.09E-08	8.00E-04	1.60E+00	2.70E-03	47%	4.94E-08	24%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	2.54E-07	3.62E-09	--	7.00E+00	--	--	2.54E-08	12%
Naphthalene	91-20-3	1.18E+00	5.54E-06	7.92E-08	4.00E-02	--	1.39E-04	2%	--	--
Phenol	108-95-2	1.20E-01	5.64E-07	8.05E-09	6.00E-01	--	9.39E-07	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.30E-07	3.29E-09	3.00E-02	--	7.67E-06	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.69E-03	2.05E-07

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APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CT ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Ingestion Rate (IR)	50	mg/day
Fraction Ingested (FI)	1	unitless
Exposure frequency (EF)	234	days/yr
Exposure duration (ED)	1	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)
Noncarcinogenic Intake Factor (NIF)
= 4.58E-07 kg/kg-day
Carcinogenic Intake Factor (CIF)
= 6.54E-09 kg/kg-day
RfD = Reference Dose
SF = Slope Factor

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)
Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	8.70E-06	1.24E-07	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	3.94E-06	5.63E-08	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.28E-05	1.83E-07	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	6.41E-06	9.16E-08	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.56E-08	2.22E-10	1.00E-01	--	1.56E-07	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.07E-05	4.38E-07	--	2.90E-02	--	--	1.27E-08	64%
Chlorobenzene	108-90-7	2.20E+00	1.01E-06	1.44E-08	2.00E-02	--	5.04E-05	9%	--	--
Ethylbenzene	100-41-4	1.70E+01	7.78E-06	1.11E-07	1.00E-01	--	7.78E-05	14%	--	--
Methylene Chloride	75-09-2	1.60E-02	7.33E-09	1.05E-10	6.00E-02	7.50E-03	1.22E-07	< 1%	7.85E-13	< 1%
Toluene	108-88-3	5.40E+01	2.47E-05	3.53E-07	2.00E-01	--	1.24E-04	22%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.38E-05	3.40E-07	2.00E+00	--	1.19E-05	2%	--	--
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	2.43E-08	3.47E-10	1.00E-02	--	2.43E-06	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	2.43E-08	3.47E-10	--	2.40E-02	--	--	8.32E-12	< 1%
2-Chlorophenol	95-57-8	1.00E-01	4.58E-08	6.54E-10	5.00E-03	--	9.16E-06	2%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	1.41E-07	2.02E-09	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	4.49E-08	6.41E-10	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	2.70E-08	3.86E-10	6.00E-02	--	4.50E-07	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.11E-08	4.45E-10	1.00E-01	--	3.11E-07	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.14E-08	1.64E-10	4.00E-02	--	2.86E-07	< 1%	--	--

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APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Hexachlorobenzene	118-74-1	4.60E-01	2.11E-07	3.01E-09	8.00E-04	1.60E+00	2.63E-04	47%	4.81E-09	24%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	2.47E-08	3.53E-10	--	7.00E+00	--	--	2.47E-09	12%
Naphthalene	91-20-3	1.18E+00	5.40E-07	7.72E-09	4.00E-02	--	1.35E-05	2%	--	--
Phenol	108-95-2	1.20E-01	5.50E-08	7.85E-10	6.00E-01	--	9.16E-08	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.24E-08	3.21E-10	3.00E-02	--	7.48E-07	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.54E-04	2.00E-08

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APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Absorption factor (ABS)	chem-spec	unitless
Soil-skin adherance (AF)	1	mg/cm²/day
Skin surface area (SA)	5800	cm²
Exposure frequency (EF)	250	days/yr
Exposure duration (ED)	1	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 5.68E-05 kg/kg-days

Carcinogenic Intake Factor (CIF)
= 8.11E-07 kg/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)
Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	1.08E-03	1.54E-05	2.50E-01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	4.88E-04	6.97E-06	2.50E-01	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.59E-03	2.27E-05	2.50E-01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	7.95E-04	1.14E-05	2.50E-01	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.93E-06	2.76E-08	2.50E-01	9.00E-02	--	5.36E-06	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.80E-03	5.43E-05	2.50E-01	--	3.05E-02	--	--	4.15E-07	48%
Chlorobenzene	108-90-7	2.20E+00	1.25E-04	1.78E-06	2.50E-01	6.00E-03	--	5.20E-03	17%	--	--
Ethylbenzene	100-41-4	1.70E+01	9.65E-04	1.38E-05	2.50E-01	8.50E-02	--	2.84E-03	9%	--	--
Methylene Chloride	75-09-2	1.60E-02	9.08E-07	1.30E-08	2.50E-01	5.88E-02	7.65E-03	3.86E-06	< 1%	2.48E-11	< 1%
Toluene	108-88-3	5.40E+01	3.06E-03	4.38E-05	2.50E-01	1.80E-01	--	4.26E-03	14%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.95E-03	4.22E-05	2.50E-01	1.80E+00	--	4.10E-04	1%	--	--
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	3.01E-06	4.30E-08	1.00E-01	2.00E-03	--	1.50E-04	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	3.01E-06	4.30E-08	1.00E-01	--	2.40E-02	--	--	1.03E-10	< 1%
2-Chlorophenol	95-57-8	1.00E-01	5.68E-06	8.11E-08	1.00E-01	4.50E-03	--	1.26E-04	< 1%	--	--

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APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
2-Methylnaphthalene	91-57-6	3.09E-01	1.75E-05	2.51E-07	1.00E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	5.56E-06	7.95E-08	1.00E-01	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	3.35E-06	4.78E-08	1.00E-01	1.20E-02	--	2.79E-05	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.86E-06	5.51E-08	1.00E-01	9.00E-02	--	4.29E-06	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.42E-06	2.03E-08	1.00E-01	8.00E-03	--	1.77E-05	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	2.61E-05	3.73E-07	1.00E-01	1.60E-04	8.00E+00	1.63E-02	54%	2.98E-07	34%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	3.06E-06	4.38E-08	1.00E-01	--	3.50E+01	--	--	1.53E-07	18%
Naphthalene	91-20-3	1.18E+00	6.70E-05	9.57E-07	1.00E-01	8.00E-03	--	8.37E-04	3%	--	--
Phenol	108-95-2	1.20E-01	6.81E-06	9.73E-08	1.00E-01	5.40E-01	--	1.26E-06	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.78E-06	3.97E-08	1.00E-01	6.00E-03	--	4.63E-05	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	3.02E-02	8.66E-07

332393

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations
Receptor	CT ONSITE INTRUSIVE WORKER		Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)
Chemical concentration	chem-spec	mg/kg	
Absorption factor (ABS)	chem-spec	unitless	Noncarcinogenic Intake Factor (NIF)
Soil-skin adherance (AF)	0.2	mg/cm²/day	= 9.16E-06 kg/kg-days
Skin surface area (SA)	5000	cm²	Carcinogenic Intake Factor (CIF)
Exposure frequency (EF)	234	days/yr	= 1.31E-07 kg/kg-days
Exposure duration (ED)	1	yrs	RfD = Reference Concentration
Body weight (BW)	70	kg	SF = Slope Factor
Avging time, noncar (ATN)	365	days	DABS = Dermal Absorption Percentages
Avging time, carcin (ATC)	25550	days	Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)
Conversion factor (CF)	0.000001	kg/mg	Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	1.74E-04	2.49E-06	2.50E-01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	7.88E-05	1.13E-06	2.50E-01	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	2.56E-04	3.66E-06	2.50E-01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	1.28E-04	1.83E-06	2.50E-01	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	3.11E-07	4.45E-09	2.50E-01	9.00E-02	--	8.65E-07	< 1%	--	--
Benzene	71-43-2	6.70E+01	6.14E-04	8.77E-06	2.50E-01	--	3.05E-02	--	--	6.69E-08	48%
Chlorobenzene	108-90-7	2.20E+00	2.01E-05	2.88E-07	2.50E-01	6.00E-03	--	8.40E-04	17%	--	--
Ethylbenzene	100-41-4	1.70E+01	1.56E-04	2.22E-06	2.50E-01	8.50E-02	--	4.58E-04	9%	--	--
Methylene Chloride	75-09-2	1.60E-02	1.47E-07	2.09E-09	2.50E-01	5.88E-02	7.65E-03	6.23E-07	< 1%	4.01E-12	< 1%
Toluene	108-88-3	5.40E+01	4.95E-04	7.07E-06	2.50E-01	1.80E-01	--	6.87E-04	14%	--	--
Xylenes (total)	1330-20-7	5.20E+01	4.76E-04	6.80E-06	2.50E-01	1.80E+00	--	6.61E-05	1%	--	--
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	4.85E-07	6.93E-09	1.00E-01	2.00E-03	--	2.43E-05	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	4.85E-07	6.93E-09	1.00E-01	--	2.40E-02	--	--	1.66E-11	< 1%
2-Chlorophenol	95-57-8	1.00E-01	9.16E-07	1.31E-08	1.00E-01	4.50E-03	--	2.04E-05	< 1%	--	--

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APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
2-Methylnaphthalene	91-57-6	3.09E-01	2.83E-06	4.04E-08	1.00E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	8.98E-07	1.28E-08	1.00E-01	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	5.40E-07	7.72E-09	1.00E-01	1.20E-02	--	4.50E-06	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	6.23E-07	8.90E-09	1.00E-01	9.00E-02	--	6.92E-07	< 1%	--	--
Fluorene	86-73-7	2.50E-02	2.29E-07	3.27E-09	1.00E-01	8.00E-03	--	2.86E-06	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	4.21E-06	6.02E-08	1.00E-01	1.60E-04	8.00E+00	2.63E-03	54%	4.81E-08	34%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	4.95E-07	7.07E-09	1.00E-01	--	3.50E+01	--	--	2.47E-08	18%
Naphthalene	91-20-3	1.18E+00	1.08E-05	1.54E-07	1.00E-01	8.00E-03	--	1.35E-04	3%	--	--
Phenol	108-95-2	1.20E-01	1.10E-06	1.57E-08	1.00E-01	5.40E-01	--	2.04E-07	< 1%	--	--
Pyrene	129-00-0	4.90E-02	4.49E-07	6.41E-09	1.00E-01	6.00E-03	--	7.48E-06	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	4.88E-03	1.40E-07

332395

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF FUGITIVE DUSTS
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	RME ONSITE INTRUSIVE WORKER	Intake Factor = (IR × ED × EF × ET)/(BW × AT)
Chemical concentration	chem-spec mg/m^3	Noncarcinogenic Intake Factor (NIF)
Inhalation rate (IR)	2.5 m^3/hr	= 1.96E-01 m^3/kg-day
Exposure frequency (EF)	250 days/yr	Carcinogenic Intake Factor (CIF)
Exposure duration (ED)	1 yrs	= 2.80E-03 m^3/kg-day
Exposure time (ET)	8 hrs/day	RfC = Reference Concentration
Body weight (BW)	70 kg	IUR = Inhalation Unit Risk
Avging time, noncar (ATN)	365 days	Hazard Quotient = (Conc × NIF) ÷ (RfC × 2/7)
Avging time, carcin (ATC)	25550 days	Cancer Risk = (Conc × CIF × IUR × 3500)

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	RfC (mg/m^3)	IUR (m^3/ug)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER										
Semivolatile Organic Compounds (mg/m^3)							--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	1.33E-05	2.60E-06	3.72E-08	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	1.32E-05	2.58E-06	3.69E-08	8.00E-01	--	1.13E-05	100%	--	--
2-Chlorophenol	95-57-8	1.27E-05	2.49E-06	3.55E-08	--	--	--	--	--	--
2-Methylnaphthalene	91-57-6	2.18E-05	4.27E-06	6.09E-08	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	1.25E-05	2.45E-06	3.49E-08	--	--	--	--	--	--
Acenaphthene	83-32-9	1.31E-05	2.56E-06	3.66E-08	--	--	--	--	--	--
Di-n-butylphthalate	84-74-2	1.31E-05	2.56E-06	3.66E-08	--	--	--	--	--	--
Fluorene	86-73-7	1.37E-05	2.68E-06	3.83E-08	--	--	--	--	--	--
Hexachlorobenzene	118-74-1	2.09E-05	4.09E-06	5.84E-08	--	4.60E-04	--	--	9.41E-08	100%
N-Nitroso-di-n-propylamine	621-64-7	1.31E-05	2.56E-06	3.66E-08	--	--	--	--	--	--
Naphthalene	91-20-3	1.18E-04	2.31E-05	3.30E-07	--	--	--	--	--	--
Phenol	108-95-2	1.26E-05	2.47E-06	3.52E-08	--	--	--	--	--	--
Pyrene	129-00-0	1.33E-05	2.60E-06	3.72E-08	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	1.13E-05	9.41E-08

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF FUGITIVE DUSTS
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/m^3
Inhalation rate (IR)	1.4 m^3/hr
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Exposure time (ET)	8 hrs/day
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)

= 1.03E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)

= 1.47E-03 m^3/kg-day

RfC = Reference Concentration

IUR = Inhalation Unit Risk

Hazard Quotient = (Conc × NIF) ÷ (RfC × 2/7)

Cancer Risk = (Conc × CIF × IUR × 3500)

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	RfC (mg/m^3)	IUR (m^3/ug)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER										
Semivolatile Organic Compounds (mg/m^3)										
1,2,4-Trichlorobenzene	120-82-1	1.33E-05	1.36E-06	1.95E-08	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	1.32E-05	1.35E-06	1.93E-08	8.00E-01	--	--	--	--	--
2-Chlorophenol	95-57-8	1.27E-05	1.30E-06	1.86E-08	--	--	5.92E-06	100%	--	--
2-Methylnaphthalene	91-57-6	2.18E-05	2.24E-06	3.19E-08	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	1.25E-05	1.28E-06	1.83E-08	--	--	--	--	--	--
Acenaphthene	83-32-9	1.31E-05	1.34E-06	1.92E-08	--	--	--	--	--	--
Di-n-butylphthalate	84-74-2	1.31E-05	1.34E-06	1.92E-08	--	--	--	--	--	--
Fluorene	86-73-7	1.37E-05	1.41E-06	2.01E-08	--	--	--	--	--	--
Hexachlorobenzene	118-74-1	2.09E-05	2.14E-06	3.06E-08	--	4.60E-04	--	--	4.93E-08	100%
N-Nitroso-di-n-propylamine	621-64-7	1.31E-05	1.34E-06	1.92E-08	--	--	--	--	--	--
Naphthalene	91-20-3	1.18E-04	1.21E-05	1.73E-07	--	--	--	--	--	--
Phenol	108-95-2	1.26E-05	1.29E-06	1.85E-08	--	--	--	--	--	--
Pyrene	129-00-0	1.33E-05	1.36E-06	1.95E-08	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.92E-06	4.93E-08

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	RME ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5800 cm^2
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	250 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 4.54E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 6.49E-03 L/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
1,2,3,4-Tetramethylbenzene	488-23-3	2.43E-02	1.10E-02	1.58E-04	--	--	--	--	--	--	--
1,2,3-Trimethybenzene	526-73-8	5.41E-03	2.46E-03	3.51E-05	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	1.55E-02	7.04E-03	1.01E-04	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.14E-03	3.24E-03	4.63E-05	--	--	--	--	--	--	--
Benzene	71-43-2	1.10E-01	4.99E-02	7.13E-04	2.10E-02	--	3.05E-02	--	--	4.57E-07	99%
Bromodichloromethane	75-27-4	2.06E-03	9.35E-04	1.34E-05	4.20E-03	2.00E-02	6.53E-02	1.96E-04	< 1%	3.66E-09	< 1%
Chlorobenzene	108-90-7	3.44E-03	1.56E-03	2.23E-05	1.38E-02	6.00E-03	--	3.59E-03	5%	--	--
Chloroform	67-66-3	2.80E-03	1.27E-03	1.82E-05	8.90E-03	1.00E-02	6.10E-03	1.13E-03	2%	9.86E-10	< 1%
Dibromochloromethane	124-48-1	4.70E-04	2.13E-04	3.05E-06	3.10E-03	1.50E-02	1.12E-01	4.41E-05	< 1%	1.06E-09	< 1%
Ethylbenzene	100-41-4	1.02E-02	4.63E-03	6.62E-05	7.40E-02	8.50E-02	--	4.03E-03	6%	--	--
Methylene Chloride	75-09-2	5.53E-03	2.51E-03	3.59E-05	--	5.88E-02	7.70E-03	--	--	--	--
Tetrachloroethene	127-08-4	4.39E-03	1.99E-03	2.85E-05	4.79E-02	9.00E-03	--	1.06E-02	15%	--	--
Toluene	108-88-3	5.31E-03	2.41E-03	3.44E-05	4.27E-02	1.80E-01	--	5.72E-04	< 1%	--	--
Trichloroethene	79-01-6	1.40E-03	6.36E-04	9.08E-06	1.26E-02	--	--	--	--	--	--
Xylenes (total)	1330-20-7	2.97E-02	1.35E-02	1.93E-04	7.08E-02	1.80E+00	--	5.30E-04	< 1%	--	--

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APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Semivolatile Organic Compounds (mg/L)											
2-Methylnaphthalene	91-57-6	6.88E-03	3.12E-03	4.46E-05	1.42E-01	--	--	--	--	--	--
Dibenzofuran	132-64-9	1.00E-03	4.54E-04	6.49E-06	1.51E-02	--	--	--	--	--	--
Naphthalene	91-20-3	2.03E-02	9.22E-03	1.32E-04	4.37E-02	8.00E-03	--	5.03E-02	71%	--	--

Pathway Sums:	Hazard Index	Cancer Risk
	7.11E-02	4.63E-07

332399

APPENDIX F
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5000 cm^2
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 3.66E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 5.23E-03 L/kg-days

RfD = Reference Concentration

SF = Slope Factor

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)

Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
1,2,3,4-Tetramethylbenzene	488-23-3	2.43E-02	8.90E-03	1.27E-04	--	--	--	--	--	--	--
1,2,3-Trimethybenzene	526-73-8	5.41E-03	1.98E-03	2.83E-05	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	1.55E-02	5.68E-03	8.11E-05	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.14E-03	2.62E-03	3.74E-05	--	--	--	--	--	--	--
Benzene	71-43-2	1.10E-01	4.03E-02	5.76E-04	2.10E-02	--	3.05E-02	--	--	3.69E-07	99%
Bromodichloromethane	75-27-4	2.06E-03	7.55E-04	1.08E-05	4.20E-03	2.00E-02	6.53E-02	1.58E-04	< 1%	2.96E-09	< 1%
Chlorobenzene	108-90-7	3.44E-03	1.26E-03	1.80E-05	1.38E-02	6.00E-03	--	2.90E-03	5%	--	--
Chloroform	67-66-3	2.80E-03	1.03E-03	1.47E-05	8.90E-03	1.00E-02	6.10E-03	9.13E-04	2%	7.96E-10	< 1%
Dibromochloromethane	124-48-1	4.70E-04	1.72E-04	2.46E-06	3.10E-03	1.50E-02	1.12E-01	3.56E-05	< 1%	8.54E-10	< 1%
Ethylbenzene	100-41-4	1.02E-02	3.74E-03	5.34E-05	7.40E-02	8.50E-02	--	3.25E-03	6%	--	--
Methylene Chloride	75-09-2	5.53E-03	2.03E-03	2.89E-05	--	5.88E-02	7.70E-03	--	--	--	--
Tetrachloroethene	127-08-4	4.39E-03	1.61E-03	2.30E-05	4.79E-02	9.00E-03	--	8.56E-03	15%	--	--
Toluene	108-88-3	5.31E-03	1.95E-03	2.78E-05	4.27E-02	1.80E-01	--	4.61E-04	< 1%	--	--
Trichloroethene	79-01-6	1.40E-03	5.13E-04	7.33E-06	1.26E-02	--	--	--	--	--	--
Xylenes (total)	1330-20-7	2.97E-02	1.09E-02	1.55E-04	7.08E-02	1.80E+00	--	4.28E-04	< 1%	--	--

APPENDIX F (Continued)
CURRENT ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Semivolatile Organic Compounds (mg/L)											
2-Methylnaphthalene	91-57-6	6.88E-03	2.52E-03	3.60E-05	1.42E-01	--	--	--	--	--	--
Dibenzofuran	132-64-9	1.00E-03	3.66E-04	5.23E-06	1.51E-02	--	--	--	--	--	--
Naphthalene	91-20-3	2.03E-02	7.44E-03	1.06E-04	4.37E-02	8.00E-03	--	4.06E-02	71%	--	--

Pathway Sums:	Hazard Index	Cancer Risk
	5.73E-02	3.73E-07

332401

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	RME ONSITE NONINTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Ingestion Rate (IR)	50 mg/day
Fraction Ingested (FI)	1 unitless
Exposure frequency (EF)	250 days/yr
Exposure duration (ED)	25 yrs
Body weight (BW)	70 kg
Avging time, noncar (ATN)	9125 days
Avging time, carcin (ATC)	25550 days
Conversion Factor (CF)	0.000001 kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)
Noncarcinogenic Intake Factor (NIF)
= 4.89E-07 kg/kg-day
Carcinogenic Intake Factor (CIF)
= 1.75E-07 kg/kg-day
RfD = Reference Dose
SF = Slope Factor

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)
Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE NONINTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	9.30E-06	3.32E-06	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	4.21E-06	1.50E-06	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.37E-05	4.89E-06	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	6.85E-06	2.45E-06	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.66E-08	5.94E-09	1.00E-01	--	1.66E-07	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.28E-05	1.17E-05	--	2.90E-02	--	--	3.39E-07	64%
Chlorobenzene	108-90-7	2.20E+00	1.08E-06	3.84E-07	2.00E-02	--	5.38E-05	9%	--	--
Ethylbenzene	100-41-4	1.70E+01	8.32E-06	2.97E-06	1.00E-01	--	8.32E-05	14%	--	--
Methylene Chloride	75-09-2	1.60E-02	7.83E-09	2.80E-09	6.00E-02	7.50E-03	1.30E-07	< 1%	2.10E-11	< 1%
Toluene	108-88-3	5.40E+01	2.64E-05	9.44E-06	2.00E-01	--	1.32E-04	22%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.54E-05	9.09E-06	2.00E+00	--	1.27E-05	2%	--	--
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	2.59E-08	9.26E-09	1.00E-02	--	2.59E-06	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	2.59E-08	9.26E-09	--	2.40E-02	--	--	2.22E-10	< 1%
2-Chlorophenol	95-57-8	1.00E-01	4.89E-08	1.75E-08	5.00E-03	--	9.78E-06	2%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	1.51E-07	5.40E-08	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	4.79E-08	1.71E-08	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	2.89E-08	1.03E-08	6.00E-02	--	4.81E-07	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.33E-08	1.19E-08	1.00E-01	--	3.33E-07	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.22E-08	4.37E-09	4.00E-02	--	3.06E-07	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	2.25E-07	8.04E-08	8.00E-04	1.60E+00	2.81E-04	47%	1.29E-07	24%

332402

APPENDIX F (Continued)
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	2.64E-08	9.44E-09	--	7.00E+00	--	--	6.60E-08	12%
Naphthalene	91-20-3	1.18E+00	5.77E-07	2.06E-07	4.00E-02	--	1.44E-05	2%	--	--
Phenol	108-95-2	1.20E-01	5.87E-08	2.10E-08	6.00E-01	--	9.78E-08	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.40E-08	8.56E-09	3.00E-02	--	7.99E-07	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.92E-04	5.34E-07

332403

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CT ONSITE NONINTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Ingestion Rate (IR)	50	mg/day
Fraction Ingested (FI)	1	unitless
Exposure frequency (EF)	234	days/yr
Exposure duration (ED)	10	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	3650	days
Avging time, carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 4.58E-07 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 6.54E-08 kg/kg-day

RfD = Reference Dose

SF = Slope Factor

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)

Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE NONINTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	8.70E-06	1.24E-06	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	3.94E-06	5.63E-07	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.28E-05	1.83E-06	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	6.41E-06	9.16E-07	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.56E-08	2.22E-09	1.00E-01	--	1.56E-07	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.07E-05	4.38E-06	--	2.90E-02	--	--	1.27E-07	64%
Chlorobenzene	108-90-7	2.20E+00	1.01E-06	1.44E-07	2.00E-02	--	5.04E-05	9%	--	--
Ethylbenzene	100-41-4	1.70E+01	7.78E-06	1.11E-06	1.00E-01	--	7.78E-05	14%	--	--
Methylene Chloride	75-09-2	1.60E-02	7.33E-09	1.05E-09	6.00E-02	7.50E-03	1.22E-07	< 1%	7.85E-12	< 1%
Toluene	108-88-3	5.40E+01	2.47E-05	3.53E-06	2.00E-01	--	1.24E-04	22%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.38E-05	3.40E-06	2.00E+00	--	1.19E-05	2%	--	--
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	2.43E-08	3.47E-09	1.00E-02	--	2.43E-06	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	2.43E-08	3.47E-09	--	2.40E-02	--	--	8.32E-11	< 1%
2-Chlorophenol	95-57-8	1.00E-01	4.58E-08	6.54E-09	5.00E-03	--	9.16E-06	2%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	1.41E-07	2.02E-08	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	4.49E-08	6.41E-09	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	2.70E-08	3.86E-09	6.00E-02	--	4.50E-07	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.11E-08	4.45E-09	1.00E-01	--	3.11E-07	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.14E-08	1.64E-09	4.00E-02	--	2.86E-07	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	2.11E-07	3.01E-08	8.00E-04	1.60E+00	2.63E-04	47%	4.81E-08	24%

332404

APPENDIX F (Continued)
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	2.47E-08	3.53E-09	--	7.00E+00	--	--	2.47E-08	12%
Naphthalene	91-20-3	1.18E+00	5.40E-07	7.72E-08	4.00E-02	--	1.35E-05	2%	--	--
Phenol	108-95-2	1.20E-01	5.50E-08	7.85E-09	6.00E-01	--	9.16E-08	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.24E-08	3.21E-09	3.00E-02	--	7.48E-07	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.54E-04	2.00E-07

332405

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE NONINTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Absorption factor (ABS)	chem-spec	unitless
Soil-skin adherance (AF)	1	mg/cm²/day
Skin surface area (SA)	5800	cm²
Exposure frequency (EF)	250	days/yr
Exposure duration (ED)	25	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	9125	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 5.68E-05 kg/kg-days

Carcinogenic Intake Factor (CIF)
= 2.03E-05 kg/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)
Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE NONINTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	1.08E-03	3.85E-04	2.50E-01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	4.88E-04	1.74E-04	2.50E-01	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	1.59E-03	5.68E-04	2.50E-01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	7.95E-04	2.84E-04	2.50E-01	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	1.93E-06	6.89E-07	2.50E-01	9.00E-02	--	5.36E-06	< 1%	--	--
Benzene	71-43-2	6.70E+01	3.80E-03	1.36E-03	2.50E-01	--	3.05E-02	--	--	1.04E-05	48%
Chlorobenzene	108-90-7	2.20E+00	1.25E-04	4.46E-05	2.50E-01	6.00E-03	--	5.20E-03	17%	--	--
Ethylbenzene	100-41-4	1.70E+01	9.65E-04	3.45E-04	2.50E-01	8.50E-02	--	2.84E-03	9%	--	--
Methylene Chloride	75-09-2	1.60E-02	9.08E-07	3.24E-07	2.50E-01	5.88E-02	7.65E-03	3.86E-06	< 1%	6.20E-10	< 1%
Toluene	108-88-3	5.40E+01	3.06E-03	1.09E-03	2.50E-01	1.80E-01	--	4.26E-03	14%	--	--
Xylenes (total)	1330-20-7	5.20E+01	2.95E-03	1.05E-03	2.50E-01	1.80E+00	--	4.10E-04	1%	--	--
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	3.01E-06	1.07E-06	1.00E-01	2.00E-03	--	1.50E-04	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	3.01E-06	1.07E-06	1.00E-01	--	2.40E-02	--	--	2.58E-09	< 1%

332406

APPENDIX F (Continued)
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
2-Chlorophenol	95-57-8	1.00E-01	5.68E-06	2.03E-06	1.00E-01	4.50E-03	--	1.26E-04	< 1%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	1.75E-05	6.26E-06	1.00E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	5.56E-06	1.99E-06	1.00E-01	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	3.35E-06	1.20E-06	1.00E-01	1.20E-02	--	2.79E-05	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	3.86E-06	1.38E-06	1.00E-01	9.00E-02	--	4.29E-06	< 1%	--	--
Fluorene	86-73-7	2.50E-02	1.42E-06	5.07E-07	1.00E-01	8.00E-03	--	1.77E-05	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	2.61E-05	9.32E-06	1.00E-01	1.60E-04	8.00E+00	1.63E-02	54%	7.46E-06	34%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	3.06E-06	1.09E-06	1.00E-01	--	3.50E+01	--	--	3.83E-06	18%
Naphthalene	91-20-3	1.18E+00	6.70E-05	2.39E-05	1.00E-01	8.00E-03	--	8.37E-04	3%	--	--
Phenol	108-95-2	1.20E-01	6.81E-06	2.43E-06	1.00E-01	5.40E-01	--	1.26E-06	< 1%	--	--
Pyrene	129-00-0	4.90E-02	2.78E-06	9.93E-07	1.00E-01	6.00E-03	--	4.63E-05	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	3.02E-02	2.17E-05

332407

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations
Receptor	CT ONSITE NONINTRUSIVE WORKER		Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)
Chemical concentration	chem-spec	mg/kg	
Absorption factor (ABS)	chem-spec	unitless	Noncarcinogenic Intake Factor (NIF)
Soil-skin adherance (AF)	0.2	mg/cm²/day	= 9.16E-06 kg/kg-days
Skin surface area (SA)	5000	cm²	Carcinogenic Intake Factor (CIF)
Exposure frequency (EF)	234	days/yr	= 1.31E-06 kg/kg-days
Exposure duration (ED)	10	yrs	RfD = Reference Concentration
Body weight (BW)	70	kg	SF = Slope Factor
Avging time, noncar (ATN)	3650	days	DABS = Dermal Absorption Percentages
Avging time, carcin (ATC)	25550	days	Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)
Conversion factor (CF)	0.000001	kg/mg	Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE NONINTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
1,2,3,4-Tetramethylbenzene	488-23-3	1.90E+01	1.74E-04	2.49E-05	2.50E-01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	526-73-8	8.60E+00	7.88E-05	1.13E-05	2.50E-01	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.80E+01	2.56E-04	3.66E-05	2.50E-01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	1.40E+01	1.28E-04	1.83E-05	2.50E-01	--	--	--	--	--	--
Acetone	67-64-1	3.40E-02	3.11E-07	4.45E-08	2.50E-01	9.00E-02	--	8.65E-07	< 1%	--	--
Benzene	71-43-2	6.70E+01	6.14E-04	8.77E-05	2.50E-01	--	3.05E-02	--	--	6.69E-07	48%
Chlorobenzene	108-90-7	2.20E+00	2.01E-05	2.88E-06	2.50E-01	6.00E-03	--	8.40E-04	17%	--	--
Ethylbenzene	100-41-4	1.70E+01	1.56E-04	2.22E-05	2.50E-01	8.50E-02	--	4.58E-04	9%	--	--
Methylene Chloride	75-09-2	1.60E-02	1.47E-07	2.09E-08	2.50E-01	5.88E-02	7.65E-03	6.23E-07	< 1%	4.01E-11	< 1%
Toluene	108-88-3	5.40E+01	4.95E-04	7.07E-05	2.50E-01	1.80E-01	--	6.87E-04	14%	--	--
Xylenes (total)	1330-20-7	5.20E+01	4.76E-04	6.80E-05	2.50E-01	1.80E+00	--	6.61E-05	1%	--	--
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	5.30E-02	4.85E-07	6.93E-08	1.00E-01	2.00E-03	--	2.43E-05	< 1%	--	--
1,4-Dichlorobenzene	106-46-7	5.30E-02	4.85E-07	6.93E-08	1.00E-01	--	2.40E-02	--	--	1.66E-10	< 1%

APPENDIX F (Continued)
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
2-Chlorophenol	95-57-8	1.00E-01	9.16E-07	1.31E-07	1.00E-01	4.50E-03	--	2.04E-05	< 1%	--	--
2-Methylnaphthalene	91-57-6	3.09E-01	2.83E-06	4.04E-07	1.00E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	9.80E-02	8.98E-07	1.28E-07	1.00E-01	--	--	--	--	--	--
Acenaphthene	83-32-9	5.90E-02	5.40E-07	7.72E-08	1.00E-01	1.20E-02	--	4.50E-06	< 1%	--	--
Di-n-butylphthalate	84-74-2	6.80E-02	6.23E-07	8.90E-08	1.00E-01	9.00E-02	--	6.92E-07	< 1%	--	--
Fluorene	86-73-7	2.50E-02	2.29E-07	3.27E-08	1.00E-01	8.00E-03	--	2.86E-06	< 1%	--	--
Hexachlorobenzene	118-74-1	4.60E-01	4.21E-06	6.02E-07	1.00E-01	1.60E-04	8.00E+00	2.63E-03	54%	4.81E-07	34%
N-Nitroso-di-n-propylamine	621-64-7	5.40E-02	4.95E-07	7.07E-08	1.00E-01	--	3.50E+01	--	--	2.47E-07	18%
Naphthalene	91-20-3	1.18E+00	1.08E-05	1.54E-06	1.00E-01	8.00E-03	--	1.35E-04	3%	--	--
Phenol	108-95-2	1.20E-01	1.10E-06	1.57E-07	1.00E-01	5.40E-01	--	2.04E-07	< 1%	--	--
Pyrene	129-00-0	4.90E-02	4.49E-07	6.41E-08	1.00E-01	6.00E-03	--	7.48E-06	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	4.88E-03	1.40E-06

332409

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE WATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE NONINTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/L
Ingestion Rate (IR)	0.05	L/hr
Exposure time (ET)	2.6	hrs/event
Exposure frequency (EF)	175	events/yr
Exposure duration (ED)	25	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	9125	days
Avging time, carcin (ATC)	25550	days
Conversion Factor (CF)	1	L/L

Intake Equations

Intake Factor = (IR × EF × ED x ET × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 8.90E-04 L/kg-days

Carcinogenic Intake Factor (CIF)
= 3.18E-04 L/kg-days

RfD = Oral value

SF = Oral value

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)

Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE NONINTRUSIVE WORKER										
Volatile Organic Compounds (mg/L)										
1,2,3,4-Tetramethylbenzene	488-23-3	3.33E-02	2.97E-05	1.06E-05	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.05E-03	1.83E-06	6.52E-07	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.00E-04	6.23E-07	2.23E-07	--	--	--	--	--	--
Chlorobenzene	108-90-7	9.00E-04	8.01E-07	2.86E-07	2.00E-02	--	4.01E-05	77%	--	--
Ethylbenzene	100-41-4	5.00E-04	4.45E-07	1.59E-07	1.00E-01	--	4.45E-06	9%	--	--
Toluene	108-88-3	1.50E-03	1.34E-06	4.77E-07	2.00E-01	--	6.68E-06	13%	--	--
Xylenes (total)	1330-20-7	1.20E-03	1.07E-06	3.82E-07	2.00E+00	--	5.34E-07	1%	--	--
Semivolatile Organic Compounds (mg/L)										
2-Methylnaphthalene	91-57-6	4.00E-03	3.56E-06	1.27E-06	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	5.17E-05	--

332410

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE WATER
REMEDIAL ACTION PLAN
SUPPLEMENTAL REMEDIAL INVESTIGATION/FEASIBILITY STUDY
LOWRY AIR FORCE BASE, COLORADO

Exposure Assumptions		Intake Equations
Receptor	CT ONSITE NONINTRUSIVE WORKER	Intake Factor = (IR × EF × ED x ET × CF)/(BW x AT)
Chemical concentration	chem-spec mg/L	
Ingestion Rate (IR)	0.05 L/hr	Noncarcinogenic Intake Factor (NIF)
Exposure time (ET)	2.6 hrs/event	= 3.31E-04 L/kg-days
Exposure frequency (EF)	65 events/yr	Carcinogenic Intake Factor (CIF)
Exposure duration (ED)	10 yrs	= 4.72E-05 L/kg-days
Body weight (BW)	70 kg	RfD = Oral value
Avging time, noncar (ATN)	3650 days	SF = Oral value
Avging time, carcin (ATC)	25550 days	Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)
Conversion Factor (CF)	1 L/L	Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE NONINTRUSIVE WORKER										
Volatile Organic Compounds (mg/L)										
1,2,3,4-Tetramethylbenzene	488-23-3	3.33E-02	1.10E-05	1.57E-06	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.05E-03	6.78E-07	9.69E-08	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.00E-04	2.32E-07	3.31E-08	--	--	--	--	--	--
Chlorobenzene	108-90-7	9.00E-04	2.98E-07	4.25E-08	2.00E-02	--	1.49E-05	77%	--	--
Ethylbenzene	100-41-4	5.00E-04	1.65E-07	2.36E-08	1.00E-01	--	1.65E-06	9%	--	--
Toluene	108-88-3	1.50E-03	4.96E-07	7.09E-08	2.00E-01	--	2.48E-06	13%	--	--
Xylenes (total)	1330-20-7	1.20E-03	3.97E-07	5.67E-08	2.00E+00	--	1.98E-07	1%	--	--
Semivolatile Organic Compounds (mg/L)							--	--	--	--
2-Methylnaphthalene	91-57-6	4.00E-03	1.32E-06	1.89E-07	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	1.92E-05	--

322411

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE WATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	RME ONSITE NONINTRUSIVE WORKER
Chemical concentration	chem-spec mg/L
Permeability constant (PC)	chem-spec cm/hour
Skin surface area (SA)	8680 cm^2
Exposure frequency (EF)	150 days/yr
Exposure duration (ED)	25 yrs
Exposure time (ET)	1 hrs/day
Body weight (BW)	70 kg
Avging time, noncar (ATN)	9125 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm^3

Intake Equations

Intake Factor = (SA × EF × ED × ET × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 5.10E-02 L-hr/cm-kg-days

Carcinogenic Intake Factor (CIF)
= 1.82E-02 L-hr/cm-kg-days

RfD = Dermal value -- Absorbed dose
SF = Dermal value -- Absorbed dose
PC = Dermal Permeability Values
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE NONINTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
1,2,3,4-Tetramethylbenzene	488-23-3	3.33E-02	1.70E-03	6.06E-04	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.05E-03	1.04E-04	3.73E-05	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.00E-04	3.57E-05	1.27E-05	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	9.00E-04	4.59E-05	1.64E-05	1.38E-02	6.00E-03	--	1.05E-04	71%	--	--
Ethylbenzene	100-41-4	5.00E-04	2.55E-05	9.10E-06	7.40E-02	8.50E-02	--	2.22E-05	15%	--	--
Toluene	108-88-3	1.50E-03	7.64E-05	2.73E-05	4.27E-02	1.80E-01	--	1.81E-05	12%	--	--
Xylenes (total)	1330-20-7	1.20E-03	6.12E-05	2.18E-05	7.08E-02	1.80E+00	--	2.41E-06	2%	--	--
Semivolatile Organic Compounds (mg/L)											
2-Methylnaphthalene	91-57-6	4.00E-03	2.04E-04	7.28E-05	1.42E-01	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	1.48E-04	--

332412

APPENDIX F
CURRENT ONSITE NONINTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE WATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CT ONSITE NONINTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/L
Permeability constant (PC)	chem-spec	cm/hour
Skin surface area (SA)	6360	cm^2
Exposure frequency (EF)	65	days/yr
Exposure duration (ED)	10	yrs
Exposure time (ET)	2.6	hrs/day
Body weight (BW)	70	kg
Avging time, noncar (ATN)	3650	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.001	L/cm^3

Intake Equations

Intake Factor = (SA × EF × ED × ET × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 4.21E-02 L-hr/cm-kg-days

Carcinogenic Intake Factor (CIF)
= 6.01E-03 L-hr/cm-kg-days

RfD = Dermal value -- Absorbed dose
SF = Dermal value -- Absorbed dose
PC = Dermal Permeability Values
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE NONINTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
1,2,3,4-Tetramethylbenzene	488-23-3	3.33E-02	1.40E-03	2.00E-04	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	2.05E-03	8.62E-05	1.23E-05	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	7.00E-04	2.94E-05	4.21E-06	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	9.00E-04	3.79E-05	5.41E-06	1.38E-02	6.00E-03	--	8.71E-05	76%	--	--
Ethylbenzene	100-41-4	5.00E-04	2.10E-05	3.00E-06	4.39E-02	8.50E-02	--	1.09E-05	9%	--	--
Toluene	108-88-3	1.50E-03	6.31E-05	9.01E-06	4.27E-02	1.80E-01	--	1.50E-05	13%	--	--
Xylenes (total)	1330-20-7	1.20E-03	5.05E-05	7.21E-06	7.08E-02	1.80E+00	--	1.99E-06	2%	--	--
Semivolatile Organic Compounds (mg/L)											
2-Methylnaphthalene	91-57-6	4.00E-03	1.68E-04	2.40E-05	1.42E-01	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	1.15E-04	--

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	RME ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5800 cm^2
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	250 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 4.54E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 6.49E-03 L/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	1.01E-01	4.59E-02	6.56E-04	2.10E-02	--	3.05E-02	--	--	4.20E-07	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	4.20E-07

332414

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5000 cm²
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 3.66E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 5.23E-03 L/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	1.01E-01	3.70E-02	5.29E-04	2.10E-02	--	3.05E-02	--	--	3.39E-07	100%

Pathway Sums:	Hazard Index	Cancer Risk
	0.00E+00	3.39E-07

332415

APPENDIX F
BIOVENTING/BIOSPARGING FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions

Receptor	RME ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5800 cm^2
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	250 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 4.54E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 6.49E-03 L/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	6.04E-02	2.74E-02	3.92E-04	2.10E-02	--	3.05E-02	--	--	2.51E-07	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	2.51E-07

332416

APPENDIX F
BIOVENTING/BIOSPARGING FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions

Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Skin surface area (SA)	5000 cm²
Dermal Permeability Constant (PC)	chem-spec cm/hr
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Exposure Time (ET)	8 hr/dy
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.001 L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 3.66E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 5.23E-03 L/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)
Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	6.04E-02	2.21E-02	3.16E-04	2.10E-02	--	3.05E-02	--	--	2.03E-07	100%

Pathway Sums:	Hazard Index	Cancer Risk
	0.00E+00	2.03E-07

322417

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE SD13, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Absorption factor (ABS)	chem-spec	unitless
Skin surface area (SA)	5800	cm^2
Dermal Permeability Constant (PC)	chem-spec	cm/hr
Exposure frequency (EF)	250	days/yr
Exposure duration (ED)	1	yrs
Exposure Time (ET)	8	hr/dy
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.001	L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 4.54E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 6.49E-03 L/kg-days

RfD = Reference Concentration

SF = Slope Factor

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)

Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	1.80E-02	8.17E-03	1.17E-04	2.10E-02	--	3.05E-02	--	--	7.48E-08	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	7.48E-08

033418

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE SD13, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CT ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Absorption factor (ABS)	chem-spec	unitless
Skin surface area (SA)	5000	cm^2
Dermal Permeability Constant (PC)	chem-spec	cm/hr
Exposure frequency (EF)	234	days/yr
Exposure duration (ED)	1	yrs
Exposure Time (ET)	8	hr/dy
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.001	L/cm3

Intake Equations

Intake Factor = (SA x ET x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 3.66E-01 L/kg-days

Carcinogenic Intake Factor (CIF)
= 5.23E-03 L/kg-days

RfD = Reference Concentration

SF = Slope Factor

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc × NIF × PC) ÷ (RfD)

Cancer Risk = Conc × CIF × PC × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	PC (cm/hr)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/L)											
Benzene	71-43-2	1.80E-02	6.59E-03	9.42E-05	2.10E-02	--	3.05E-02	--	--	6.03E-08	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	6.03E-08

322419

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations	
Receptor	RME ONSITE INTRUSIVE WORKER		Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)	
Chemical concentration	chem-spec	mg/kg	Noncarcinogenic Intake Factor (NIF)	
Ingestion Rate (IR)	480	mg/day	= 4.70E-06	kg/kg-day
Fraction Ingested (FI)	1	unitless	Carcinogenic Intake Factor (CIF)	
Exposure frequency (EF)	250	days/yr	= 6.71E-08	kg/kg-day
Exposure duration (ED)	1	yrs	RfD = Reference Dose	
Body weight (BW)	70	kg	SF = Slope Factor	
Avging time, noncar (ATN)	365	days		
Avging time, carcin (ATC)	25550	days	Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)	
Conversion Factor (CF)	0.000001	kg/mg	Cancer Risk = Chem Conc × CIF × SF	

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
Benzene	71-43-2	4.96E+01	2.33E-04	3.33E-06	--	2.90E-02	--	--	9.65E-08	79%
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
Hexachlorobenzene	118-74-1	2.39E-01	1.12E-06	1.60E-08	8.00E-04	1.60E+00	1.40E-03	100%	2.57E-08	21%

	Hazard Index	Cancer Risk
Pathway Sums:	1.40E-03	1.22E-07

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - INCIDENTAL INGESTION OF SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CT ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Ingestion Rate (IR)	50	mg/day
Fraction Ingested (FI)	1	unitless
Exposure frequency (EF)	234	days/yr
Exposure duration (ED)	1	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 4.58E-07 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 6.54E-09 kg/kg-day

RfD = Reference Dose

SF = Slope Factor

Hazard Quotient = (Chem Conc × NIF) ÷ (RfD)

Cancer Risk = Chem Conc × CIF × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER										
Volatile Organic Compounds (mg/kg)										
Benzene	71-43-2	4.96E+01	2.27E-05	3.24E-07	--	2.90E-02	--	--	9.41E-09	79%
Semivolatile Organic Compounds (mg/kg)							--	--	--	--
Hexachlorobenzene	118-74-1	2.39E-01	1.09E-07	1.56E-09	8.00E-04	1.60E+00	1.37E-04	100%	2.50E-09	21%

	Hazard Index	Cancer Risk
Pathway Sums:	1.37E-04	1.19E-08

332421

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/kg
Absorption factor (ABS)	chem-spec	unitless
Soil-skin adherance (AF)	1	mg/cm²/day
Skin surface area (SA)	5800	cm²
Exposure frequency (EF)	250	days/yr
Exposure duration (ED)	1	yrs
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days
Conversion factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 5.68E-05 kg/kg-days

Carcinogenic Intake Factor (CIF)
= 8.11E-07 kg/kg-days

RfD = Reference Concentration

SF = Slope Factor

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)

Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
Benzene	71-43-2	4.96E+01	2.81E-03	4.02E-05	2.50E-01	--	3.05E-02	--	--	3.07E-07	66%
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
Hexachlorobenzene	118-74-1	2.39E-01	1.36E-05	1.94E-07	1.00E-01	1.60E-04	8.00E+00	8.48E-03	100%	1.55E-07	34%

	Hazard Index	Cancer Risk
Pathway Sums:	8.48E-03	4.62E-07

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISKS - DERMAL EXPOSURE TO SOIL
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/kg
Absorption factor (ABS)	chem-spec unitless
Soil-skin adherance (AF)	0.2 mg/cm²/day
Skin surface area (SA)	5000 cm²
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days
Conversion factor (CF)	0.000001 kg/mg

Intake Equations

Intake Factor = (SA × AF x EF × ED × CF)/(BW x AT)

Noncarcinogenic Intake Factor (NIF)
= 9.16E-06 kg/kg-days

Carcinogenic Intake Factor (CIF)
= 1.31E-07 kg/kg-days

RfD = Reference Concentration
SF = Slope Factor
DABS = Dermal Absorption Percentages
Hazard Quotient = (Conc × NIF × DABS) ÷ (RfD)
Cancer Risk = Conc × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	DABS	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER											
Volatile Organic Compounds (mg/kg)											
Benzene	71-43-2	6.70E+01	6.14E-04	8.77E-06	2.50E-01	--	3.05E-02	--	--	6.69E-08	66%
Semivolatile Organic Compounds (mg/kg)								--	--	--	--
Hexachlorobenzene	118-74-1	3.23E-01	2.96E-06	4.23E-08	1.00E-01	1.60E-04	8.00E+00	1.85E-03	100%	3.38E-08	34%

	Hazard Index	Cancer Risk
Pathway Sums:	1.85E-03	1.01E-07

3324223

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - RME SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF FUGITIVE DUSTS
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	RME ONSITE INTRUSIVE WORKER	
Chemical concentration	chem-spec	mg/m^3
Inhalation rate (IR)	2.5	m^3/hr
Exposure frequency (EF)	250	days/yr
Exposure duration (ED)	1	yrs
Exposure time (ET)	8	hrs/day
Body weight (BW)	70	kg
Avging time, noncar (ATN)	365	days
Avging time, carcin (ATC)	25550	days

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)

= 1.96E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)

= 2.80E-03 m^3/kg-day

RfC = Reference Concentration

IUR = Inhalation Unit Risk

Hazard Quotient = (Conc × NIF) ÷ (RfC × 2/7)

Cancer Risk = (Conc × CIF × IUR × 3500)

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	RfC (mg/m^3)	IUR (m^3/ug)	Hazard Quotient	% of Total	Cancer Risk	% of Total
RME ONSITE INTRUSIVE WORKER										
Semivolatile Organic Compounds (mg/m^3)										
Hexachlorobenzene	118-74-1	1.59E-05	3.11E-06	4.45E-08	--	4.60E-04	--	--	7.16E-08	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	7.16E-08

332424

APPENDIX F
NATURAL CHEMICAL ATTENUATION FOR YEAR 1998
FUTURE ONSITE INTRUSIVE WORKER - CT SCENARIO
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF FUGITIVE DUSTS
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CT ONSITE INTRUSIVE WORKER
Chemical concentration	chem-spec mg/m^3
Inhalation rate (IR)	1.4 m^3/hr
Exposure frequency (EF)	234 days/yr
Exposure duration (ED)	1 yrs
Exposure time (ET)	8 hrs/day
Body weight (BW)	70 kg
Avging time, noncar (ATN)	365 days
Avging time, carcin (ATC)	25550 days

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)

= 1.03E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)

= 1.47E-03 m^3/kg-day

RfC = Reference Concentration

IUR = Inhalation Unit Risk

Hazard Quotient = (Conc × NIF) ÷ (RfC × 2/7)

Cancer Risk = (Conc × CIF × IUR × 3500)

Chemical	CAS No.	Exposure Conc.	INTAKE-NC (mg/kg-d)	INTAKE-C (mg/kg-d)	RfC (mg/m^3)	IUR (m^3/ug)	Hazard Quotient	% of Total	Cancer Risk	% of Total
CT ONSITE INTRUSIVE WORKER										
Semivolatile Organic Compounds (mg/m^3)										
Hexachlorobenzene	118-74-1	1.59E-05	1.63E-06	2.33E-08	--	4.60E-04	--	--	3.75E-08	100%

	Hazard Index	Cancer Risk
Pathway Sums:	--	3.75E-08

332423

CHEMICAL PROFILES FOR COPCs

BENZENE

CAS NUMBER

71-43-2

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,791 mg/L [1]
Vapor Pressure: 95.19 mm Hg at 25°C [1]
Henry's Law Constant: 5.43 x 10^{-3} atm-m^3/mole (temperature not given) [1]
Specific Gravity: 0.879 at 15/5°C [2]
Organic Carbon Partition Coefficient: 31 - 143 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 16 days [3]
Air: 2.09 - 20.9 days [3]
Surface Water: 5 - 16 days [3]
Groundwater: 10 days to 2 years [3]

NATURAL SOURCES

Crude oil, volcanoes, forest fires, plants [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, chemical industry, coke ovens, mining, manufacturing, cigarette smoke [1].

FATE AND TRANSPORT

Benzene will rapidly volatilize from surface soil and water. That which does not volatilize from permeable surface and subsurface soils will be highly to very highly mobile, and can be expected to leach to nearby groundwater which is not protected by a confining layer. It is fairly soluble, and will be carried with the groundwater to discharge points. It may be subject to biodegradation in soils, shallow groundwater, and surface water. Benzene will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms, or hydrolyze. Photodegradation may be a

significant removal mechanism in surface waters which are not conducive to microbial degradation. Benzene will undergo significant photodegradation in air, but may be washed out with rain [1].

HUMAN TOXICITY

General. Benzene is absorbed into the body following ingestion, inhalation, and dermal contact, and must undergo metabolic transformation to exert its toxic effects. Metabolism occurs primarily in the liver, and to a lesser extent in the bone marrow [4]. The primary targets of benzene toxicity are the central nervous system and the blood [4,5]. Benzene is genotoxic to humans and the USEPA has placed it in weight-of-evidence cancer Group A, indicating that it is a human carcinogen [6].

Oral Exposure. A chronic oral RfD for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following oral exposure. The lowest reported fatal dose in humans is 50 mg/kg [5]. Acute oral LD_{50} values in animals include 930 to 5600 mg/kg in rats, 2000 mg/kg in dogs and 4700 mg/kg in mice [4,5]. Data regarding the ingestion of benzene in humans are limited to acute overexposure. Ingestion of 2 ml (29 mg/kg) has resulted in depression of the central nervous system, while ingestion of 10 ml (143 mg/kg) has been fatal [5]. The cause of death was usually respiratory arrest, central nervous system depression or cardiac collapse [4]. In animals, longer-term oral exposure has resulted in toxic effects on the blood (cytopenia: decrease in various cellular elements of the blood) and the immunological system (decreased white blood cells) [4]. There is no evidence that oral exposure to benzene causes effects on reproduction and development, but studies in animals suggest that benzene may affect fetal development [4]. There is no information regarding carcinogenic effects in humans following oral exposure to benzene, but studies in animals indicate that benzene ingestion causes cancer in various regions of the body [4]. An oral Slope Factor of 0.029 $(mg/kg/day)^{-1}$ is based on an increase in the incidence of leukemia in occupationally-exposed workers [6]. The oral Slope Factor was extrapolated from the inhalation data.

Inhalation Exposure. A chronic inhalation RfC for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following inhalation exposure. The lowest reported fatal concentration in humans is 6380 mg/m^3 for a 5 minute exposure [5]. Acute inhalation LC_{50} values in rats ranged from 10,000 ppm for 7 hours to 13,700 ppm for 4 hours [4,5]. Most of the available data regarding benzene exposure involve workers exposed in the workplace. The acute effects of benzene exposure involve the central nervous system. Brief exposure to concentrations of 700 to 3000 ppm can cause drowsiness, dizziness, headaches and unconsciousness, and exposure to

concentrations of 10,000 to 20,000 ppm can result in death [4]. In most cases, the effects will end when exposure ceases. The hematopoietic system is the primary target of toxicity following long-term exposure: exposure for several months to years results in pancytopenia (reduction in red blood cells, platelets and white blood cells), while continued exposure for many years results in anemia or leukemia. The lowest concentration resulting in the hematological effects is approximately 10 to 50 ppm [5]. Benzene has been shown to cause chromosomal aberrations in bone marrow and lymphocytes in workers exposed to concentrations > 100 ppm [5]. Chromosomal damage has been found in animals at concentrations as low as 1 ppm [5]. Benzene is not known to be teratogenic (cause birth defects) in humans, but has been found to cause various problems in the developing fetus of animals (low birth weight, delayed bone formation) [4,5]. Occupational exposure to benzene has resulted in leukemia in exposed workers [4,5]. An inhalation Unit Risk of 8.3×10^{-6} $(ug/m^3)^{-1}$ is based on the incidence of leukemia in occupationally-exposed workers [6].

Dermal Exposure. Dermal exposure to benzene may cause redness and dermatitis [4,5]. Systemic effects have not been reported following dermal exposure to benzene.

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3. Howard, P.H., R.S. Boethling, W.F. Jarvis, W.M. Meylan, and E.M. Michalenko, 1991. Handbook of Environmental Degradation Rates. Lewis Publishers. Chelsea, Michigan.
4. ATSDR, 1991. Toxicological Profile for Benzene (Draft). Agency for Toxic Substances and Disease Registry. USPHS/USEPA. October 1991.
5. Arthur D. Little, Inc., 1989. The Installation Restoration Program Toxicology Guide. Volume 2. Cambridge, MA. July 1989.
6. USEPA, 1994. Integrated Risk Information System (IRIS). Data base. Online. February, 1994.

HEXACHLOROBENZENE

CAS NUMBER

118-74-1

COMMON SYNONYMS

Hexachlorobenzol; Perchlorobenzene; HCB; Amatin.

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.006 mg/l at 20°C [1]
Vapor Pressure: 1.089 x 10^{-5} Hg at 20°C [1]
Henry's Law Constant: 6.8 x 10^{-4} atm-m^3/mole [1]
Specific Gravity: 1.5691 [2]
Organic Carbon Partition Coefficient: ND [1]

FATE DATA: HALF-LIVES

Soil: 3 to 6 years [1]
Air: ND
Surface Water: 30-300 days [1]
Groundwater: ND

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Not currently manufactured commercially. Produced as a by-product during the manufacture of chemicals used as solvents, other chlorine-containing compounds and pesticides. Hexachlorobenzene was used as a pesticide until 1985. [1]

FATE AND TRANSPORT

Hexachlorobenzene is among the most persistent environmental pollutants, and it bioaccumulates in the environment, in animals, and humans. Low levels of

hexachlorobenzene have been found in almost all people tested, most likely through consumption of the contaminated food.

In the environment, most hexachlorobenzene exists tightly bound to soil. Due to its very low solubility in water, presence of hexachlorobenzene in surface water or groundwater is likely to be low. Also, because it is practically nonvolatile, it has not been detected in significant amounts in air.

The principal release of hexachlorobenzene into the water in the past has been through the direct discharge from chemical solvent manufacturing facilities. Hexachlorobenzene from soil is not considered a serious problem for its strong affinity to soil and removal mechanism from soils by biodegradation process.

HUMAN TOXICITY

General. Hexachlorobenzene is absorbed into the body following ingestion of contaminated foods and soils, inhalation of particles in the air, or dermal contact. Following intake, hexachlorobenzene will be rapidly deposited to many tissues in the body, especially to fat, and remain there for many years. A large portion of hexachlorobenzene in fat may be transferred in human milk. The USEPA has placed it in weight-of-evidence cancer group B-2, indicating that it is a probable human carcinogen [1].

Oral Exposure. Hexachlorobenzene is rapidly absorbed following oral exposure. Evidence of human lethality following oral exposure to hexachlorobenzene is derived from the case of people consuming bread prepared from grain treated with hexachlorobenzene at 2 kg/1,000 kg wheat in Turkey in the 1950's. There was an extremely high rate of mortality in children of lactating mothers known to have consumed this bread [1]. Acute oral LD_{50} values for animals range from 1,700 mg/kg in cats to 10,000 mg/kg in rates [2]. In humans, there is epidemiological evidence that hexachlorobenzene is toxic to young children; offspring nursing from hexachlorobenzene exposed mothers are exposed through the milk. In animals, long-term oral exposure has resulted in toxic effects on liver, immune system, kidneys, blood and reproductive system [1]. There is no information regarding carcinogenic effects in humans following oral exposure to hexachlorobenzene, but studies in animals indicate hexachlorobenzene ingestion causes cancers of the liver and thyroid. The oral slope factor for hexachlorobenzene is 1.6 $(mg/kg\text{-}day)^{-1}$ [3].

Inhalation Exposure. A USEPA lists 0.00046 ug/m^3 as the current inhalation unit risk for hexachlorobenzene [3]. No inhalation RfC value for this compound is available. Recent estimates of exposure by inhalation are an average of 2 ug/m^3 of air breathed. This is approximately 1,000 times less than exposure estimated by ingestion, making inhalation, a route of lesser concern. [1]

Dermal Exposure. No information.

REFERENCES

1. ATSDR, 1990. Toxicological Profile for Hexachlorobenzene. Agency for Toxic Substances and Disease Registry. USPHS/USEPA. December 1990.

2. USEPA, 1985. Drinking Water Criteria Document for Hexachlorobenzene, NTIS No. PB86-117777.

3. USEPA, 1992. Integrated Risk Information System (IRIS). Data base. Online. August 3, 1992.

1,2,4-TRIMETHYLBENZENE

332433

CAS NUMBER

95-63-6

COMMON SYNONYMS

Pseudocumene.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble
Vapor Pressure: NA
Henry's Law Constant: 5×10^{-3} atm-m^3/mole [1]
Specific Gravity: 0.8761 at 20°C [1]
Organic Carbon Partition Coefficient: 2150 [1]

FATE DATA: HALF-LIVES

Soil: NA
Air: NA
Surface Water: NA
Groundwater: NA

NATURAL SOURCES

Naturally occurring in coal tar and petroleum products [1].

ARTIFICIAL SOURCES

Used in the manufacture of dyes, perfumes, and resins; used as a solvent and paint thinner [1].

FATE AND TRANSPORT

No information was found regarding the fate and transport of 1,2,4-trimethylbenzene (1,2,4-TMB).

HUMAN TOXICITY

General. The relevant routes of exposure to 1,2,4-TMB are via inhalation and potentially dermal contact. The CNS, respiratory system, and the liver are the primary targets of 1,2,4-TMB toxicity [1].

Oral Exposure. A chronic RfD for 1,2,4-TMB is currently not available from the USEPA [1]. Information regarding toxic effects in humans or animals following oral exposure to 1,2,4-TMB are not available [1].

Inhalation Exposure. A chronic inhalation RfC for 1,2,4-TMB is currently not available from the USEPA [1]. Information regarding toxic effects in humans or animals following inhalation exposure to 1,2,4-TMB are not available [1].

Dermal Exposure. 1,2,4-TMB is a known skin irritant [1]. No other information was located regarding dermal exposure to 1,2,4-TMB in humans or animals [1].

REFERENCES

1. USEPA, 1996. Hazardous Substance Data Base (HSDB). Online. Database.

1,3,5-TRIMETHYLBENZENE

CAS NUMBER

108-67-8

COMMON SYNONYMS

Mesitylene.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble
Vapor Pressure: 1.86 mm Hg at 20°C [1]
Henry's Law Constant: 5 x 10^{-3} atm-m^3/mole [1]
Specific Gravity: 0.8637 at 20°C [1]
Organic Carbon Partition Coefficient: 2150 [1]

FATE DATA: HALF-LIVES

Soil: NA
Air: NA
Surface Water: NA
Groundwater: NA

NATURAL SOURCES

Naturally occurring in coal tar and petroleum crudes [1].

ARTIFICIAL SOURCES

Used as a dyestuff intermediate, solvent, and paint thinner [1].

FATE AND TRANSPORT

No information was found regarding the fate and transport of 1,3,5-trimethylbenzene (1,3,5-TMB).

HUMAN TOXICITY

General. The relevant routes of exposure to 1,3,5-TMB are via inhalation and potentially dermal contact. The skin and lungs are the primary targets of 1,3,5-TMB toxicity [1].

Oral Exposure. A chronic RfD for 1,3,5-TMB is currently not available from the USEPA [1]. Information regarding toxic effects in humans and animals following oral exposure to 1,3,5-TMB are not available [1].

Inhalation Exposure. A chronic RfC for 1,3,5-TMB is currently not available from the USEPA [1]. Information regarding toxic effects in humans or animals following inhalation exposure to 1,3,5-TMB are not available [1].

Dermal Exposure. 1,3,5-TMB is a known skin irritant [1]. No other information was located regarding dermal exposure to 1,3,5-TMB in humans or animals [1].

REFERENCES

1. USEPA, 1996. Hazardous Substance Data Base (HSDB). Online. Database.

PLAN B TARGET CONCENTRATIONS

APPENDIX F

PLAN B TARGET CONCENTRATIONS FOR SOIL - HEALTH-PROTECTIVE INTRUSIVE WORKERS

REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions: Onsite Intrusive Workers

Parameters	RME	CT
ABS = Absorption Factor (unitless)	chem-spec	chem-spec
AF = Soil-Skin Adherance Factor ($mg/cm^2/dy$)	1	0.2
ATc = Averaging Time for Carcinogens (dys)	25550	25550
ATn = Averaging Time for Noncarcinogens (dys)	365	365
BW = Body Weight (kg)	70	70
ED = Exposure Duration (yr)	1	1
EF = Exposure Frequency (dys/yr)	250	234
ET = Exposure Time (hrs/dy)	8	8
FI = Fraction Ingested (unitless)	1	1
HQ = Target Hazard Quotient	1	1
IRa = Air Inhalation Rate (m^3/hr)	2.5	1.4
IRw = Workday Soil Ingestion Rate (mg/dy)	480	50
IUR = Inhalation Unit Risk (m^3/ug)	chem-spec	chem-spec
RfC = Reference Concentration (mg/m^3)	chem-spec	chem-spec
RfDd = Dermal Reference Dose (mg/kg-dy)	chem-spec	chem-spec
RfDo = Oral Reference Dose (mg/kg-dy)	chem-spec	chem-spec
SA = Skin Surface Area (cm^2)	5800	5000
SFd = Dermal Slope Factor (kg-day/mg)	chem-spec	chem-spec
SFo = Oral Slope Factor (kg-dy/mg)	chem-spec	chem-spec
TR = Target risk	1.00E-06	1.00E-06

Calculations

VF = ((LS*V*DH/A)*((3.14*(Dei*ϕ/(ϕ+Ps*(1-ϕ)/Kas)*T)^0.5)/(2*Dei*ϕ*Kas*10-3kg/g)

where:

LS = Length of Contaminated Area (m)	200
V = Wind Speed (m/s)	5.1
DH = Diffusion Height (m)	2
A = Area of Contamination (cm^2)	7.20E+05
ϕ = soil porosity (unitless)	0.35
Dei = Effective Diffusivity (cm^2/s)	chem-spec
Ps = Soil Density (g/cm^3)	2.65
Kas = Soil/Air Partition Coefficient (g soil/cm^3 air)	chem-spec
T = Exposure Interval (sec)	7.90E+08

PEF = ((LS*V*DH*3600s/hr)/A)*(1000g/kg/(0.036*(1-G)(Um/Ut)^3*Fx))

where:

G = Fraction of Vegetative Cover (unitless)	0.2
Um = Mean Annual Wind Speed (m/s)	4.112
Ut = Threshold of Wind (m/s)	12.8
Fx = Function Dependent on Um/Ut (unitless)	0.0497

PEF = 2.15E+12

Carcinogenic Chemicals:

C = (TR * BW * ATc)/(ED * EF *((SFo*10-6kg/mg*IRw*FI)+(IUR*3500 kg-dy/m3*IRa*ET*(1/PEF+1/VF))+(SA*10-6kg/mg*AF*ABS*SFd))

Noncarcinogenic Chemicals:

C = (HQ * BW * ATn)/(ED * EF *((10-6kg/mg*IRw*FI/RfDo)+(7/2 *IRa*ET*(1/PEF+1/VF)/RfC)+(SA*10-6kg/mg*AF*ABS/RfDd))

Soil COPC	Henry's Law Constant (unitless)	Dei (cm^2/sec)	Koc (L/kg)	Kd (g/cm^3)	Kas (g/cm^3)	VF (m^3/kg)	ABS (unitless)	IUR (m^3/ug)	SFd (kg-dy/mg)	SFo (kg-dy/mg)	RfC (mg/m^3)	RfDo (mg/kg-dy)	RfDd (mg/kg-dy)
Benzene	2.32E-01	0.0231	78	0.351	27.1	44965.7	2.50E-01	8.30E-06	3.05E-02	2.90E-02	-	-	-
Hexachlorobenzene	2.83E-02	0.0124	502	2.259	502.0	3582.2	1.00E-01	4.60E-04	8.00E+00	1.60E+00	-	8.00E-04	1.60E-04

Soil COPC	Noncarcinogenic Plan B Target Concentration RME (mg/kg)	Noncarcinogenic Plan B Target Concentration CT (mg/kg)	Carcinogenic Plan B Target Concentration RME (mg/kg)	Carcinogenic Plan B Target Concentration CT (mg/kg)
Benzene	-	-	1.01E+02	4.69E+02
Hexachlorobenzene	2.42E+01	1.59E+02	4.97E-01	1.29E+00

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APPENDIX F

PLAN B TARGET CONCENTRATIONS FOR SOIL - HEALTH-PROTECTIVE NONINTRUSIVE WORKERS

REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions: Onsite Nonintrusive Workers

Parameters	RME	CT
ABS = Absorption Factor (unitless)	chem-spec	chem-spec
AF = Soil-Skin Adherance Factor ($mg/cm^2/dy$)	1	0.2
ATc = Averaging Time for Carcinogens (dys)	25550	25550
ATn = Averaging Time for Noncarcinogens (dys)	9125	9125
BW = Body Weight (kg)	70	70
ED = Exposure Duration (yr)	25	10
EF = Exposure Frequency (dys/yr)	250	234
FI = Fraction Ingested (unitless)	1	1
HQ = Target Hazard Quotient	1	1
IRw = Workday Soil Ingestion Rate (mg/dy)	50	50
RfDd = Dermal Reference Dose (mg/kg-dy)	chem-spec	chem-spec
RfDo = Oral Reference Dose (mg/kg-dy)	chem-spec	chem-spec
SA = Skin Surface Area (cm^2)	5800	5000
SFd = Dermal Slope Factor (kg-day/mg)	chem-spec	chem-spec
SFo = Oral Slope Factor (kg-dy/mg)	chem-spec	chem-spec
TR = Target risk	1.00E-06	1.00E-06

Calculations

Carcinogenic Chemicals:

C = (TR * BW * ATc)/(ED * EF *((SFo*10-6kg/mg*IRw*FI)+(SA*10-6kg/mg*AF*ABS*SFd))

Noncarcinogenic Chemicals:

C = (HQ * BW * ATn)/(ED * EF *((10-6kg/mg*IRw*FI/RfDo)+(SA*10-6kg/mg*AF*ABS/RfDd))

Soil COPC	ABS (unitless)	SFd (kg-dy/mg)	SFo (kg-dy/mg)	RfDo (mg/kg-dy)	RfDd (mg/kg-dy)	Noncarcinogenic Plan B Target Concentration RME (mg/kg)	Noncarcinogenic Plan B Target Concentration CT (mg/kg)	Carcinogenic Plan B Target Concentration RME (mg/kg)	Carcinogenic Plan B Target Concentration CT (mg/kg)
Benzene	2.50E-01	3.05E-02	2.90E-02	-	-	-	-	6.27E+00	8.42E+01
Hexachlorobenzene	1.00E-01	8.00E+00	1.60E+00	8.00E-04	1.60E-04	2.77E+01	3.97E+02	6.06E-02	8.69E-01

APPENDIX F
PLAN B TARGET CONCENTRATIONS FOR GROUNDWATER
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions: Onsite Intrusive Workers

Parameters	RME	CT
ATc = Averaging Time for Carcinogens (dys)	25550	25550
ATn = Averaging Time for Noncarcinogens (dys)	365	365
BW = Body Weight (kg)	70	70
ED = Exposure Duration (yr)	1	1
EF = Exposure Frequency (dys/yr)	250	234
ET = Exposure Time (hrs/dy)	8	8
HQ = Target Hazard Quotient	1	1
PC = Permeability Constant (cm/hr)	chem-spec	chem-spec
RfDd = Dermal Reference Dose (mg/kg-dy)	chem-spec	chem-spec
SA = Skin Surface Area (cm^2)	5800	5000
SFd = Dermal Slope Factor (kg-day/mg)	chem-spec	chem-spec
TR = Target risk	1.00E-06	1.00E-06

Calculations

Carcinogenic Chemicals:

C = (TR * BW * ATc)/(ED * EF *(SA*10-3 L/cm3*ET*PC*SFd))

Noncarcinogenic Chemicals:

C = (HQ * BW * ATn*RfDd)/(ED * EF *SA*10-3 L/mc3*ET*PC)

Soil COPC	PC (cm/hr)	SFd (kg-dy/mg)	RfDd (mg/kg-dy)	Noncarcinogenic Plan B Target Concentration RME (mg/L)	Noncarcinogenic Plan B Target Concentration CT (mg/L)	Carcinogenic Plan B Target Concentration RME (mg/L)	Carcinogenic Plan B Target Concentration CT (mg/L)
Benzene	2.10E-02	3.05E-02	-	-	-	2.41E-01	2.98E-01
Hexachlorobenzene	2.10E-01	8.00E+00	1.60E-04	1.68E-03	2.08E-03	9.18E-05	1.14E-04

232440

APPENDIX F
PLAN B TARGET CONCENTRATIONS FOR SOIL PROTECTIVE OF UNDERLYING GROUNDWATER QUALITY
REMEDIAL ACTION PLAN
RISK-BASED APPROACH TO REMEDIATION
SITE ST14, CARSWELL NASJRB, TEXAS

Exposure Assumptions

Receptor: Onsite Intrusive/Nonintrusive Workers

Groundwater Protective Soil Concentrations - Protective to Target B Concentrations

$C_T = C_L (\beta Kd + \phi w + (\phi a)H')/\beta$

where,

C_T = Bulk soil concentration (mg/kg dry weight)
C_L = Leachate concentration (mg/L) = Plan B target groundwater concentration * 100 (assumed CRF)
β = Dry soil bulk density (kg/L) (default: 1.8)
ϕw = Water filled porosity (L/L) (default: 10% or 0.1)
Kd = Soil water partition coefficient (kg/kg/kg/L) (Koc x foc)
Koc = Organic carbon partition coefficient (chemical-specific)
foc = Soil organic carbon fraction (Site-specific: 0.0045)
ϕa = Air filled soil porosity ($\phi - \phi w$) (Site-specific: 0.321)
ϕ = Total soil porosity ($\phi = 1-\beta/Pb$; Pb = particle density (default Pb = 2.65 kg/L)
H' = Henry's Law Constant (unitless); H' = H/RT where,
H = Henry's Law Constant, R = Universal Gas Constant (8.21E-05 atm-m^3/mole-°K); T = Absolute temperature of soil, 273°K + °C.

Chemical	Henry's Law Constant (unitless)	Koc (L/kg)	Kd	Plan B Health-Based Groundwater Concentration (mg/L)		Plan B Groundwater Protective Soil Concentrations (mg/kg)	
				Intrusive		Intrusive	
				RME	CT	RME	CT
Benzene	0.232376	78	0.351	2.41E-01	2.98E-01	1.08E+01	1.34E+01
Hexachlorobenzene	0.028309	502	2.259	9.18E-05	1.14E-04	2.13E-02	2.64E-02

322441

FUGITIVE DUST MODELING

SUSPENDED PARTICLE CONCENTRATIONS (FUGITIVE DUST)

Human receptors could be exposed to contaminants found in soil as a result of contaminated soil particles suspended in air (fugitive dust). Even though particles with a diameter of 10 microns (PM_{10}) are inhalable by a human receptor (EPA, 1988), the actual particle size of interest is 2.5 microns and smaller. The reasoning for this is that particle sizes greater than 2.5 microns will be mechanically cleared from the lungs and removed from the body (refer to Section 4.5 for a discussion on the importance of particulate size as it relates to deposition in the lung). The model equations that are used to estimate the fugitive dust emissions were developed to include all soil particulates that are equal to or less than 10 microns in size. Because the soil particle size of interest for human health risks due to the inhalation exposure route is 2.5 microns and smaller, the basic equations were adjusted to limit the mass of fugitive dust to the smaller particulate sizes. This was accomplished by using a respirable fraction (RF) variable which limits the amount of fugitive dust to particulate sizes 2.5 microns or less. The respirable concentration of fugitive dust was distinguished as a subset of all fugitive dust. This subset was used to estimate exposure. Fugitive dust particles can be generated from soils and remain suspended in air where human receptors may be exposed to them via inhalation.

The formation and distribution of suspended particles is a two-step process:

- Fugitive dust is emitted from underlying soil, and
- The emitted fugitive dust is dispersed into the atmosphere.

Fugitive dust could originate from soils with a limited reservoir of erodible material, such as soils surrounding established commercial and residential neighborhoods, or from soils with an unlimited reservoir of erodible material, such as sites where extensive land development is occurring. The emitted fugitive dust disperses in the atmosphere and will achieve mixed equilibrium concentrations, depending on site activities and climatological factors. If these particles contain contaminants, they could pose a health risk to humans.

The Gillette model (Gillette, 1981; EPA, 1985) was used to calculate emissions for sites with high a degree of erodibility. This model was used to address the construction worker scenario. The Near-Field Box model was intended for use in estimating resultant concentrations of fugitive dust in the atmosphere from soil emissions of fugitive dust from any kind of soil, regardless of the degree of erodibility.

Two receptors were evaluated for potential exposure to fugitive dusts associated with soils at Sites ST14 and SD13, the maintenance worker, and the future construction worker. Because future scenarios assume complete mixing of soils from 0- to 12-feet in depth, both of these hypothetical receptors are assumed to be exposed to the same chemical concentrations, regardless of the soil depths typically associated with each receptor. Note however, the maintenance worker scenarios are based on a low-erodibility assumption (more stable soils due to vegetative cover), whereas the future construction worker is assumed to work in a high-erodibility environment (i.e., uncovered/unvegetated soils that are more likely to be suspended as fugitive dust during construction and excavation activities). This high-degree-of-erodibility scenario was

anticipated to occur at the sites only when future construction workers were potentially exposed to high levels of fugitive dust emissions associated with construction soil disturbances.

Gillette Model

Gillette used field measurements to develop a predictive relationship concerning emissions from highly erodible soils. EPA (1985) recommends the use of this model to estimate PM_{10} emissions from wind erosion of surfaces with an unlimited reservoir of erodible particles. Within the EPA guidance (1985) there are two versions of the Gillette Model equation. One is a less conservative approach that is based on a mathematical factor, F(x), and the other is used to estimate the worst case 6-hour emissions. The worst case 6-hour emission equation is used for this modeling as the other form of Gillette's model shows a high degree of variability with a small change in wind speed. The cause of this variability is unclear, and it is unacceptable to perform an estimate using an equation that can vary 15 orders of magnitude or more with a 0.1 meter/sec change in wind speed. Such variability introduces a high degree of uncertainty, and so the 6 hour worst case equation is used. As before, this model has been amended to simulate emissions of particulates with a diameter of 2.5 microns or less. This fraction of the PM_{10} reservoir can be inhaled and reside in the lungs for a sufficient amount of time to induce potential adverse health effects.

The worst case emission factor was calculated using the following simplified equation (EPA, 1985):

$$Q = 0.036 \times (1-V) \times [u_{6hr}]^3 \qquad \text{(F-11)}$$

where V is the fraction of contaminated surface vegetative cover and $[u_{6hr}]$ is the expected maximum 6-hour mean wind speed during the year. Q is the calculated emission factor for the target sized particulates. This value will be lower than the u^+ values. The $[u_{6hr}]$ is based on the mean of the fastest mile wind speed value, 22 m/sec (EPA, 1985). The following relationship is proposed by (WMO, 1961; EPA, 1985):

$$[u_{6hr}] = [u^+] - 2 \qquad \text{(F-12)}$$

where all terms are in units of m/sec.

Near-Field Box Model

The Near-Field Box model was used to predict the air concentrations of fugitive dust on sites adjacent to a release point. The model requires little input information. For example, the contaminant release rate per unit surface area at the release point and the wind speed may be used in conjunction with the mixing height to estimate fugitive dust concentration in the air in the vicinity of the release, as represented by:

$$C = J / (H_b \times W_b \times u_m) \qquad \text{(F-13)}$$

where:

C = Concentration of fugitive dust in ambient air on site (kg/m^3)

J	=	Calculated emission rate (kg/sec)
H_b	=	Downwind exposure height (m)
W_b	=	Width of crosswind dimension of contaminated area (m)
u_m	=	Average wind speed (m/sec)

and

$$J = Q \times SA_c \qquad \text{(F-14)}$$

where:

Q	=	Calculated emission factor for target-sized particles (kg/m^2-sec)
SA_c	=	Contaminated area (m^2)

Probabilistic Modeling Approach

A probabilistic modeling approach was employed to develop exposure-point concentrations in the atmosphere as a result of fugitive dust generation at the site. The probabilistic model platform Crystal Ball was used in the Gillette and Near-Field Box models. Crystal Ball was used to complete a Monte Carlo simulation within each of the models to generate model input parameters based on their statistical characteristics. Input parameters used in the models were derived from a statistical distribution that describes the value in question.

For example, if Crystal Ball is used to conduct a Monte Carlo simulation on the input parameter F (number of soil disturbances per month), assumptions about which theoretical statistical distribution best fits actual data must be made. Once the governing characteristics of any one model input parameter have been described (i.e., best fit theoretical model distribution, mean, and standard deviation), Crystal Ball can be used to calculate a range of model results based on the probability that any one single-point input parameter is likely to occur. The inherent strength in the Monte Carlo approach is the ability to factor the likelihood that any single-point value used to estimate potential exposure may be representative of actual exposures occurring at the site into the modeled simulations. A Monte Carlo simulation results in a range of predictive forecasts based on their probability of occurring. The predictive forecasts for the Coal Storage Yard (West) are presented at the end of the appendix.

A sensitivity analysis on each of the models used in the Monte Carlo simulations was completed to identify which input parameters were most critical to the result. The goal of a sensitivity analysis is to verify that the selected model input parameters are a good approximation of actual conditions. This step can provide valuable information about the acceptable ranges of input parameters and when the model results may not be reasonable or useable. Results from the sensitivity analysis were used to characterize the uncertainty inherent in using these specific models to estimate exposure-point concentrations.

This appendix presents the sensitivity analysis and emission factor summary information (forecast reports) that were generated as a part of the Monte Carlo analysis for the fugitive dust emissions. The sensitivity analysis charts provided show the parameters within the model that contribute to the variance and therefore, the uncertainty of the model. The forecast reports show the frequency distribution function for the emission parameter for each model and any accompanying summary and statistical information that was generated.

For the Gillette model, the fastest mile wind speed, depicted as 'u' on the charts, is the largest contributor to the model variance (greater than 70 percent). The sensitivity analysis shows that wind speed is the parameter that interjects the most uncertainty in the modeling results. In many cases, wind speed will be insufficient to act as a release mechanism; the wind speed will not cause suspension of dust particulates, as threshold friction velocity is not attained.

Gillette Construction Worker Model
Shallow Soils

332447

For the prediction of the emission air concentrations of contaminants at Carswell AFB			
This model uses the Gillette Unlimited Erosion model and the NearField Box Model.			
The Worst Case Gillette Model is E=0.036*(1-V)*u6^3*0.01			
The NearField Box Model is C=Q/(H*w*ua)			
u (m/sec)	2.2E+01		
u6hr (m/s) [u-2]	19.90		
V_cw, vegatative cover	0.15		
Length of Site {l} (m)	518		
Width of Site {w} (m)	341		
Area of Site (m^2)	176638		
E_CW(g/m^2-hr)	2.41		
Q_CW (kg/sec)	1.2E-01		
H (m)	1.7E+00		
ua (m/sec)	4.9E+00		
C_CW (kg/m^3)	4.1E-05		
Contaminant Soil Concentrations and Dust Emissions			
Chemical	Mean Con (mg/kg)	Air Concentration (mg/m^3)	
1,2,4-Trichlorobenzene	0.161	6.53E-06	
1,4-Dichlorobenzene	0.161	6.53E-06	
2-Chlorophenol	0.169	6.85E-06	
2-Methylnaphthalene	0.192	7.78E-06	
4-Chloro-3-methylphenol	0.169	6.85E-06	
Acenaphthene	0.162	6.57E-06	
Di-n-butylphthalate	0.164	6.65E-06	
Fluorene	0.158	6.41E-06	
Hexachlorobenzene	0.17	6.89E-06	
N-Nitroso-di-n-propylamine	0.162	6.57E-06	
Naphthalene	0.721	2.92E-05	
Phenol	0.172	6.97E-06	
Pyrene	0.161	6.53E-06	

Forecast: Dust Concentration for CW Surface **Cell: B15**

Summary:

Display Range is from 0.0E+0 to 9.0E-5 kg/m^3
Entire Range is from 8.8E-6 to 1.1E-4 kg/m^3
After 2,500 Trials, the Std. Error of the Mean is 3.0E-7

Statistics:	Value
Trials	2500
Mean	4.2E-05
Median (approx.)	4.0E-05
Mode (approx.)	3.6E-05
Standard Deviation	1.5E-05
Variance	2.2E-10
Skewness	0.71
Kurtosis	3.62
Coeff. of Variability	0.35
Range Minimum	8.8E-06
Range Maximum	1.1E-04
Range Width	1.0E-04
Mean Std. Error	2.97E-07

Percentiles:

Percentile	kg/m^3 (approx.)
0%	8.8E-06
5%	2.2E-05
25%	3.2E-05
50%	4.0E-05
75%	5.1E-05
95%	7.0E-05
100%	1.1E-04

End of Forecast

332449

Crystal Ball Report
Simulation started on 9/12/95 at 9:41:30
Simulation stopped on 9/12/95 at 9:44:41

Forecast: 1,2,4-Trichlorobenzene G CW Soil **Cell: C19**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	-7.21E-07
5%	2.39E-06
25%	4.39E-06
50%	6.29E-06
75%	8.69E-06
95%	1.33E-05
100%	2.16E-05

End of Forecast

Forecast: 1,4-Dichlorobenzene G CW Soil **Cell: C20**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	-9.45E-07
5%	2.36E-06
25%	4.46E-06
50%	6.28E-06
75%	8.57E-06
95%	1.32E-05
100%	2.44E-05

End of Forecast

Forecast: 2-Chlorophenol G CW Soil **Cell: C21**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	1.31E-06
5%	3.22E-06
25%	5.02E-06
50%	6.66E-06
75%	8.86E-06
95%	1.27E-05
100%	2.30E-05

End of Forecast

339450

Forecast: 2-Methylnaphthalene G CW Soil **Cell: C22**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	3.06E-08
5%	1.29E-06
25%	4.62E-06
50%	7.78E-06
75%	1.25E-05
95%	2.18E-05
100%	4.00E-05

End of Forecast

Forecast: 4-Chloro-3-methylphenol G CW Soil **Cell: C23**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	1.31E-06
5%	3.20E-06
25%	4.98E-06
50%	6.68E-06
75%	8.85E-06
95%	1.25E-05
100%	2.19E-05

End of Forecast

Forecast: Acenaphthalene G CW Soil **Cell: C24**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	-1.60E-06
5%	2.56E-06
25%	4.42E-06
50%	6.32E-06
75%	8.63E-06
95%	1.31E-05
100%	2.63E-05

End of Forecast

332451

Forecast: Di-n-butylphthalate G CW Soil **Cell: C25**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	5.96E-07
5%	2.68E-06
25%	4.68E-06
50%	6.35E-06
75%	8.67E-06
95%	1.31E-05
100%	2.44E-05

End of Forecast

Forecast: Fluorene G CW Soil **Cell: C26**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	6.88E-08
5%	1.84E-06
25%	4.08E-06
50%	6.13E-06
75%	8.79E-06
95%	1.37E-05
100%	2.68E-05

End of Forecast

Forecast: Hexachlorobenzene G CW Soil **Cell: C27**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	2.01E-08
5%	2.21E-06
25%	5.71E-06
50%	9.03E-06
75%	1.33E-05
95%	2.09E-05
100%	4.27E-05

End of Forecast

332452

Forecast: N-Nitroso-di-n-propylamine G CW Soil **Cell: C28**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	-3.18E-07
5%	2.38E-06
25%	4.45E-06
50%	6.36E-06
75%	8.74E-06
95%	1.31E-05
100%	2.83E-05

End of Forecast

Forecast: Naphthalene G CW Soil **Cell: C29**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	7.45E-09
5%	4.54E-06
25%	1.97E-05
50%	3.93E-05
75%	6.55E-05
95%	1.18E-04
100%	3.60E-04

End of Forecast

Forecast: Phenol G CW Soil **Cell: C30**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	1.69E-06
5%	3.48E-06
25%	5.28E-06
50%	6.86E-06
75%	8.89E-06
95%	1.26E-05
100%	1.94E-05

End of Forecast

Forecast: Pyrene G CW Soil **Cell: C31**

Percentiles:

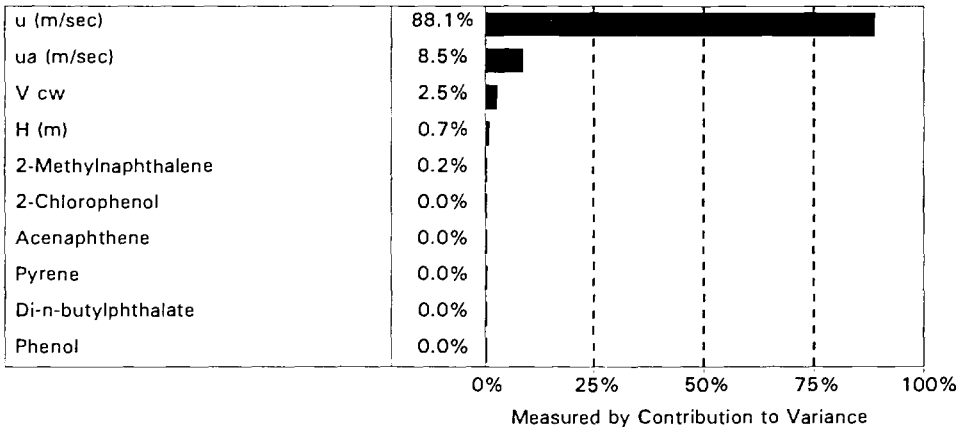
Percentile	mg/m^3 (approx.)
0%	2.34E-08
5%	2.33E-06
25%	4.30E-06
50%	6.31E-06
75%	8.76E-06
95%	1.33E-05
100%	2.43E-05

End of Forecast

Crystal Ball Report
Simulation started on 9/12/95 at 9:41:30
Simulation stopped on 9/12/95 at 9:44:41

Sensitivity Chart

Target Forecast: Dust Concentration for CW Surface



332455

Update Crystal Ball Report
Simulation started on 9/29/95 at 10:31:47
Simulation stopped on 9/29/95 at 10:34:53

Forecast: Hexachlorobenzene G CW Soil **Cell: C27**

Percentiles:

Percentile	mg/m^3 (approx.)
0%	1.79E-08
5%	1.63E-06
25%	4.36E-06
50%	6.54E-06
75%	9.74E-06
95%	1.59E-05
100%	3.19E-05

End of Forecast

Update Assumption

332453

Assumption: Hexachlorobenzene **Cell: B27**

Normal distribution with parameters:

Mean	0.17
Standard Dev.	0.08

Selected range is from 0.00 to +Infinity
Mean value in simulation was 0.17

End of Assumptions

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APPENDIX G

BASEWIDE BACKGROUND STUDY RESULTS, AND

DEVELOPMENT OF UPPER THRESHOLD LIMITS (UTL)

Tolerance Limits

Statistical tolerance limits are a "not-to-exceed" number developed from a data set for comparing future individual observations. The purpose of using upper tolerance limits (UTLs) in environmental site assessments is to define a concentration range from background (uncontaminated) data, within which a large proportion of the site data should fall with high probability. If they fall outside the interval then this is evidence of *potential* contamination. Each individual site data is compared to the UTL to identify unusually high site measurement that warrant further consideration. This is only one approach to comparing site and background data.

A UTL establishes a concentration limit that contains a specified proportion of the population with a specified level of *confidence*. The proportion of the population included is referred to as the *coverage*. The confidence level specifies the probability with which the tolerance interval includes a proportion of the population. A background UTL with 95% coverage and 95% confidence provides reasonable control of false-positive rates and adequate statistical power when the sample size is large enough.

When constructing tolerance intervals, distributional assumptions need to be checked. A parametric tolerance interval assumes that the data follow a known theoretical distribution (e.g., normally, lognormal, Poisson, etc.). When these assumptions cannot be justified, especially when a significant portion of the samples are nondetect, one should use the non-parametric tolerance interval.

Caution should be used when applying parametric UTLs when the sample size is small (e.g., 15 or less). These UTLs have low statistical *power* (i.e., ability to find contamination when it exists), and could therefore miss differences between site and background unless they were large. Non-parametric tolerance limits requires more samples than parametric tolerance limits to obtain the same coverage. For nonparametric UTLs, the percent coverage is prescribed by the sample size of the data set and the desired confidence level. The equation shown below shows the relationship between the false positive rate (α), the coverage proportion (P), and sample size (n).

$$n = \frac{\ln(\alpha)}{\ln(P)}$$

For a non-parametric tolerance limit to achieve 95% coverage with 95% confidence, at least 59 measurements are required. With 95% confidence, where α = 1- 0.95 = 0.05 and a sample size, n = 12, only 78% coverage can be achieved. High population coverage is desirable because fewer measurements are expected to exceed the UTL by chance alone. Subsequently, less exceedances need to be evaluated to distinguish an exceedance due to contamination from a naturally-occurring high background value. Consideration of further site-specific knowledge should be used to resolve this difficulty. This "extra weight of evidence" step is crucial in drawing conclusions from the statistical results and for deciding how to proceed with further analysis.

References

Gibbons, Robert D. 1994. *Statistical Methods for Groundwater Monitoring.* John Wiley & Sons, Inc. New York.

Hines, William W. and Montgomery, Douglas C., *Probability and Statistics in Engineering and Management Science*, 1990.

Parsons ES. 1997. *Draft Human Health Risk Assessment for Avawatz Valley Disposal Site (FTIR-08) and Avawatz Dry Lake Ordnance Burning/Ordnance Disposal Site (FTIR-25E).* February 14.

USEPA, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Interim Final Guidance, April 1989.

USEPA, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Addendum to Interim Final Guidance, July 1992.

TABLE ES-1
Summary of Background UTLs by Matrix
Naval Air Station Fort Worth

332460

Analyte	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Low-Stress Procedure Groundwater (mg/L)	Bailer Sampled Groundwater (mg/L)	Surface Water (mg/L)	Stream Sediment (mg/kg)
Aluminum	22035	17180	1.332	11.07	0.2716	28767
Antimony	0.56	0.712	ND at 0.002	0.0024	0.0031	0.33
Arsenic	5.855	5.533	ND at 0.0049	0.0067	ND at 0.0049	7.018
Barium	233.0	128.1	0.587	1.133	0.151	180.4
Beryllium	1.0200	0.957	0.0003	0.0019	ND at 0.0003	1.189
Calcium	167788	272000	266.3	2438	133.7	337544
Cadmium	0.5562	0.5891	ND at 0.0005	0.0016	ND at 0.0005	0.5071
Chromium	21.056	16.31	0.006	0.0136	0.0078	17.0
Cobalt	11.050	6.191	ND at 0.0089	0.01	ND at 0.0089	6.651
Copper	17.373	13.72	0.0028	0.0101	0.0101	22.18
Iron	17717	15224	0.2239	7.234	0.9208	10696
Lead	30.97	12.66	ND at 0.0016	ND at 0.0016	ND at 0.0016	104.1
Magnesium	3003	2420	37.80	68.78	9.353	2772
Manganese	849.1	351.7	0.175	10.57	0.4193	491.3
Mercury	0.14	ND at 0.035	ND at 0.0001	ND at 0.0001	0.0001	0.0360
Molybdenum	1.460	1.930	ND at 0.0144	ND at 0.0144	ND at 0.0144	9.693
Nickel	14.6	19.76	0.0204	0.0364	0.0178	19.76
Potassium	2895	1717	15.03	3.9	6.347	3227
Selenium	0.9072	0.3130	0.0077	0.0072	0.0115	0.214
Silver	0.213	0.1277	0.0002	0.0003	0.0003	0.144
Sodium	25800	53200	167.2	176.2	45.46	6.07
Thallium	63.9	65.4	ND at 0.0632	ND at 0.0632	ND at 0.0632	69.74
Vanadium	46.26	37.39	0.0123	0.0653	0.0159	32.26
Zinc	38.8	31.27	0.1180	0.0682	0.0122	101.3

Notes:

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
ND = not detected
UTL = upper tolerance limit

4.0 BACKGROUND CHARACTERIZATION

To assess whether site activities at NAS Fort Worth have affected the concentrations of inorganic constituents in site groundwater, surface water, sediment, and soils, it is necessary to compare the concentrations inorganic constituents in site media with their concentrations in background samples. The TI method was used to estimate reasonable background concentrations. According to the TI method (EPA 1989, 1992), the concentration of a given constituent in a given media is expressed as an appropriate UTL of the distribution of the constituent in the background data population. A UTL is generally expressed in terms of confidence and coverage levels, so that it can be said with a specified level of confidence that the UTL indicates the concentration of the constituent below which a specified proportion of the background data distribution will occur. Thus, a UTL with 95 percent confidence and 95 percent coverage ($UTL_{95,95}$) is the value that we can say, with 95 percent confidence, will exceed 95 percent of the background data. Any site value greater than the UTL has only a 5 percent probability of being drawn from the background data population, and thus may indicate the presence of site-related constituents.

UTLs (and other statistical properties) were determined for a total of 24 inorganic constituents in each of six background populations. The populations consisted of surface and subsurface soil; groundwater sampled via a low-stress technique (to approximate filtered samples), groundwater sampled with a bailer (unfiltered samples), surface water, and sediment within the surface water drainages.

A total of 30 surface soil, 30 subsurface soil, 12 groundwater samples (one low-stress and one bailer sample per well), 8 surface water, and 8 stream sediment samples were collected to characterize these media for background concentrations.

4.1 STATISTICAL PARAMETERS OF BACKGROUND DATA SETS

The following statistical parameters are to be defined for each constituent:

- Frequency of Detection – The frequency of detection is reported.
- Range – Minimum and maximum observed values are reported.
- Mean – The arithmetic mean is reported.
- Standard Deviation – The sample standard deviation is reported.
- Upper Tolerance Limit (UTL) – The UTL 95 percent confidence, 95 percent coverage value ($UTL_{95,95}$) is reported.
- Outlier Identification – Potential outlier values are identified but not removed from the data set unless rejected by the data validation process.

The statistical analyses applied were drawn from the following references:

- *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance*. (EPA 1989); and
- *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance* (EPA 1992).

4.2 PROCEDURES

The data for a given constituent were analyzed according to the procedure outlined in Figure 4-1. The frequency of nondetects in the data set was calculated first. Unless the frequency of nondetects exceeded 50 percent, lognormality and normality of the data set were tested using graphical and formal calculation tests. Various statistical parameters were then calculated using formulas appropriate for the apparent distribution of the data set. In particular the $UTL_{95,95}$ was calculated as the value that we can say, with 95 percent confidence, will exceed 95 percent of the background data. If the frequency of nondetects exceeded 50 percent, or the distribution of the data set could not be demonstrated to be either normal or lognormal, then nonparametric estimates of the UTL were determined (typically the highest value in the data set). If the frequency of nondetects was between 15 and 50 percent,

FIGURE 4-1
Naval Air Station Fort Worth Background Study
Flowchart of Data Analyses

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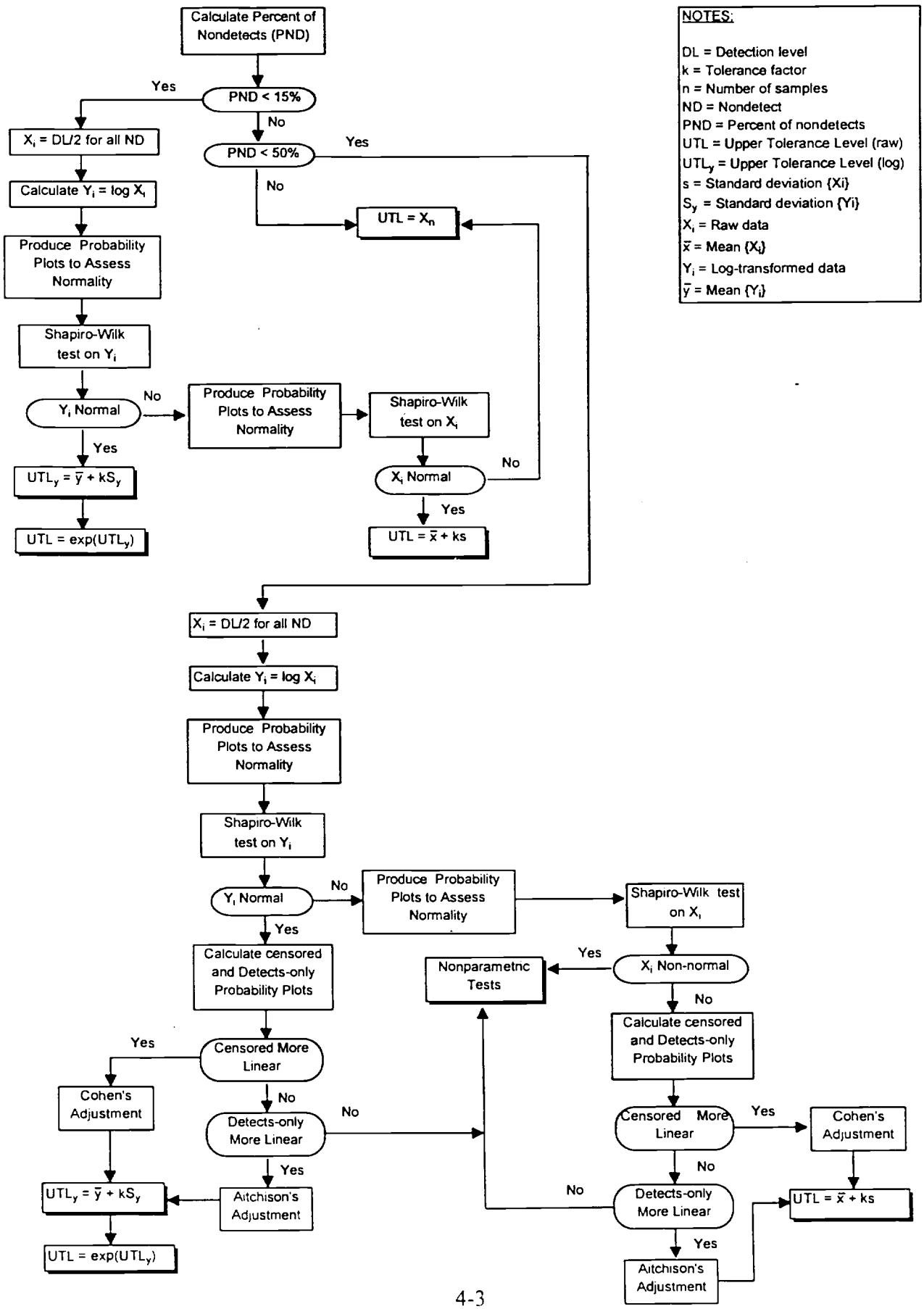

NOTES:

DL = Detection level
k = Tolerance factor
n = Number of samples
ND = Nondetect
PND = Percent of nondetects
UTL = Upper Tolerance Level (raw)
UTL_y = Upper Tolerance Level (log)
s = Standard deviation {Xi}
S_y = Standard deviation {Yi}
X_i = Raw data
$\bar{x}$ = Mean {X_i}
Y_i = Log-transformed data
$\bar{y}$ = Mean {Y_i}

appropriate adjustments to the calculated statistical parameters were used to account for the nondetects. For groundwater, a criteria of 17 percent as the minimum percentage of nondetects rather than the 15 percent recommended in the references was used based on the small sample size of 12 where each sample represents 8.33 percent of the total. This change allowed for analytes with only one or two nondetects out of 12 analyses to be handled by the simple substitution of one-half the detection limit and the subsequent calculation of a $UTL_{95,95}$.

The following sections discuss in greater detail the methods used to calculate UTLs and other statistical properties of background data sets.

4.2.1 Nondetects

Data that were reported at less than a detection level (i.e., nondetects) were treated differently depending on the frequency of nondetects. If the frequency of nondetects was less than 15 percent (17 percent for groundwater), the nondetects were replaced by one-half of the analytical method detection limit (EPA 1989, 1992), statistics were calculated, and statistical tests conducted using the data set with these replacement values. If the frequency of nondetects exceeded 50 percent, but was less than 100 percent, the nonparametric UTL was selected as the highest value in the data set (EPA 1989, 1992). In cases where the highest value was identified as a potential outlier, the second highest value was chosen as the UTL. If the frequency of nondetects was 100 percent, then the UTL was designated as the nondetect with the highest detection limit.

If the frequency of nondetects was between 15 and 50 percent, then the calculated statistics were adjusted for the presence of nondetects. Two adjustments are possible, depending on whether it appeared that the nondetects more likely represent zero values (i.e., the constituent is not present in the sample), or represent the presence of the constituent but at values less than the detection level. These adjustments are discussed further in Section 4.2.4.

4.2.2 Normality

The calculation of statistical parameters, and in particular the UTL, is affected significantly by the population distribution of the data set. Both formal and graphical statistical tests have been applied to assess normality. The general process is outlined in Figure 4-1.

To assess the population distribution of the data sets, each set was first addressed using a formal test for normality. Probability plots of the raw and log-transformed data were generated for some analytes to provide a graphical indication of whether the data distribution was normal or lognormal.

For the calculated statistical test of normality, it was first assumed that the data were lognormally distributed (EPA 1989, 1992). This assumption is based on the observation that environmental data are commonly distributed lognormally (i.e., logarithms of the observed data are distributed normally). This may be because environmental data are bounded by zero (i.e., negative constituent concentrations are not possible), so the data sets are often skewed to the right, which is characteristic of a lognormal distribution. Consequently, logarithms of the data were calculated before the tests for normality were performed.

Let x_i represent the raw data, and let $y_i = ln(x_i)$, where ln is the natural or Naperian logarithm. Let n be the statistical sample size (i.e., the number of data in the data set). If $n \leq 50$, then normality of the distribution of y_i was tested by the Shapiro-Wilk test (EPA 1989, 1992). If $n \geq 50$, then the alternate Shapiro-Francia test was applied (EPA 1992). In each case for the NAS Forth Worth AFB background groundwater data sets, the statistical sample size n was less than 50, and the Shapiro-Wilk test of normality was applied.

The Shapiro-Wilk test is described in EPA (1992). To test for normality of the data, a test statistic W is calculated as:

$$W = \left[\frac{b}{s\sqrt{n-1}} \right]^2$$

where:

$$b = \sum_{i=1}^{k} a_{n-i+1}(x_{(n-i+1)} - x_{(i)}) = \sum_{i=1}^{k} b_i$$

and x_i is the ith smallest ordered value;

a_i is a coefficient dependent on the sample size (n);

s is the standard deviation;

n is the number of samples; and

k is the greatest integer less than or equal to $\frac{n}{2}$

The null hypothesis of normality of the logs of the data was rejected if W was less than the appropriate critical value (dependent on n) (Appendix A, EPA 1992). If normality of the natural logs of the data was rejected, the test was repeated using the raw data x_i and the standard deviation s of the raw data. If the null hypothesis of normality was also rejected for the raw data, then probability plots of the raw and log-transformed data were examined to determine whether the data distribution was more nearly normal or lognormal. When a reasonable choice between normality and lognormality could still not be made, then a nonparametric test is recommended to compare site data with background data, rather than comparing site data to a background a single UTL.

4.2.3 Statistical Parameters

The following statistical parameters were calculated:

- frequency of detection;
- range;

- mean;
- standard deviation;
- UTL; and
- potential outlier statistic.

The calculation of these various parameters depends in part on whether the data set has been judged to be normally or lognormally distributed.

The frequency of detection is a simple ratio of the number of values greater than the MDL to the total number of samples in the data set. The range of the background data set for a given constituent is reported as the minimum and maximum observed values in the data set. These values do not depend on the shape of the distribution.

The mean $\bar{x}$ was calculated as the arithmetic mean of the data set

$$\bar{x} = (\Sigma_i x_i)/ n.$$

The standard deviation s was calculated as the sample standard deviation of the data set

$$s = \{[n \Sigma_i x_i^2 - (\Sigma_i x_i)^2]/[n (n - 1)]\}^{1/2}.$$

The $UTL_{95,95}$ was calculated as

$$UTL_{95,95} = \bar{x} + k s.$$

where k is the tolerance factor for a one-sided normal (or lognormal) tolerance interval with a minimum of 95 percent coverage, a 95 percent probability, and n background observations.

For distributions that were determined to be lognormal rather than normal, the UTL was calculated in the same fashion except that $\bar{x}$ was replaced by $\bar{y}$ (the mean of the

logarithms of the x_i) and s was replaced by S_y (the standard deviation of the logarithms of the x_i). The resultant value of the UTL (designated UTLy) is the UTL of the log-transformed data. The UTL for the raw data was then calculated as the exponential function of the UTLy of the log-transformed data; i.e., UTL = exp(UTLy).

4.2.4 Adjustment for Nondetects

If the frequency of nondetects for a given data set was between 15 (17 for groundwater) and 50 percent, appropriate adjustments to the calculated statistical parameters were used to account for the nondetects. Either Cohen's adjustment or Aitchison's adjustment was used, as outlined in EPA (1992) and excerpted below:

> Cohen's adjustment ... assumes that all the data (detects and nondetects) come from the same Normal or Lognormal population, but that nondetect values have been "censored" at their detection limits. This implies that the [constituent] of concern is present in nondetect samples, but the analytical equipment is not sensitive to concentrations lower than the detection limit. Aitchison's adjustment ... is constructed on the assumption that nondetect samples are free of contamination, so that all nondetects may be regarded as zero concentrations...
>
> To decide which approach is more appropriate ..., two separate Probability Plots can be constructed. In [the first] method, the combined set of detects and nondetects is ordered (with nondetects being given arbitrary but distinct ranks). ...Normal quantiles ... are then computed for the data set ... However, only the detected values and their associated Normal quantiles are actually plotted. If the shape of the Censored Probability Plot is reasonably linear, then Cohen's assumption that nondetects have been "censored" at their detection limit is probably

> acceptable ... If the Censored Probability Plot has significant bends and curves ..., one might consider Aitchison's procedure instead.
>
> To test the assumptions of Aitchison's method, a Detects-Only Probability Plot may be constructed. [N]ondetects are completely ignored and a standard Probability Plot is constructed using only the detected measurements. ... Thus, ... Normal quantiles are computed only for the ordered detected values. ... If the Detects-Only Probability Plot is reasonably linear, then the assumptions underlying Aitchison's adjustment (i.e., that "nondetects" represent zero concentrations ...) are probably reasonable.

Cohen's Adjustment. If it was determined that Cohen's adjustment was appropriate, the sample mean $\bar{x}_d$ and sample variance s_d^2 for only the data greater than the detection limit were first calculated. Then two parameters h and γ were computed as

$$h = (n - l)/n$$

and

$$\gamma = s_d^2 /(\bar{x}_d - MDL)^2,$$

where l is the number of observations greater than the detection level, and MDL is the method detection limit. Based on the values of h and γ, a value λ was determined from a table in Appendix B of EPA (1989), and corrected values of the mean $\bar{x}$ and standard deviation s were calculated by

$$\bar{x} = \bar{x}_d - \lambda (\bar{x}_d - MDL)$$

and

$$s =[s_d^2 + \lambda (\bar{x}_d - MDL)^2]^{1/2}.$$

If the distribution appeared to be lognormal rather than normal, the adjustment was made using the mean and standard deviation of the logarithms of the detected values, rather than $\bar{x}_d$ and s_d^2.

Aitchison's Adjustment. If it was determined that Aitchison's adjustment is appropriate, the sample mean $\bar{x}_d$ and sample variance s_d^2 for only the data greater than the method detection limit were first calculated. Let $d = n - l$ be the number of nondetects. Then the adjusted mean $\bar{x}$ and standard deviation s are given by

$$\bar{x} = (1 - d/n)\ \bar{x}_d$$

and

$$s = \{[n - (d + 1)]\ s_d^2 /(n - 1) + [d(n - d)\ \bar{x}_d^2]/[n(n - 1)]\}^{1/2}.$$

If the distribution appeared to be lognormal rather than normal, then the adjustment was made using the mean and standard deviation of the logarithms of the detected values, rather than $\bar{x}_d$ and s_d^2.

4.2.5 Outlier Identification

The highest value (x_n) in each data set with a frequency of detection greater than 50 percent was subjected to a formal test as an outlier (EPA 1989). The mean $\bar{x}$ and standard deviation s of the entire data set were first calculated. A test statistic T_n was then calculated

$$T_n = (x_n - \bar{x})/s.$$

T_n was then compared to a critical value (dependent on n) (Appendix B, EPA 1989). If T_n was greater than the tabulated critical value, this provided evidence that x_n was a statistical outlier and not truly a member of the background data set. However, x_n was not rejected, modified, or otherwise excluded from the data set solely on this basis. Only if the data validation process or other review of the data indicated some problem

with the datum (such as a transcription error or failure to account for dilution) was any change made to the data set. The test for outliers merely identified those data that might be outliers and for which additional data review was warranted.

4.3 BACKGROUND CONCENTRATIONS

Results of the background study, including percent of samples below the detection limit, number of detects, minimum, maximum, mean, standard deviation, UTL, and outlier identification, are listed in Tables 4-1 through 4-6. Additionally, the tables identify the results of the Shapiro-Wilk test for normality, indicating the sample-size dependent critical value (W(crit)) and the calculated test result for the log-transformed (W(log)), and untransformed (W(raw)) data. The following sections briefly explain the process by which background values were calculated for each media based on the Figure 4-1 flowchart for each analyte.

4.3.1 Soils

The Horizon A and Horizon B soils were evaluated separately.

4.3.1.1 Horizon A Soils

The following paragraphs briefly describe the process used to calculate each UTL. The analytes are grouped according to how the UTL was derived, based on the frequency of detection and the distribution of the data.

Calcium, Chromium, Cobalt, and Potassium. Calcium, chromium, cobalt, and potassium were detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for each analyte (Table 4-1). The mean and standard deviation listed in Table 4-1 are for the

TABLE 4-1
Summary of Background Values for Surface Soil
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects / Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.896 Reject	0.960 Accept	1790	19900	10775	5072	22035	No
Antimony	80.0%	6 / 30	-----	----- -----	----- -----	< 0.215	0.56	nc	nc	0.56	-----
Arsenic	0.0%	30 / 30	0.927	0.851 Reject	0.959 Accept	1.23	5.88	3.504	1.059	5.855	No
Barium	0.0%	30 / 30	0.927	0.810 Reject	0.281 Reject	24.9	1980	145.3	349.3	233.0	Yes
Beryllium	0.0%	30 / 30	0.927	0.808 Reject	0.911 Reject	0.164	1.02	0.6552	0.2432	1.0200	No
Calcium	0.0%	30 / 30	0.927	0.969 Accept	0.687 Reject	418	111000	20991	28270	167788	No
Cadmium	6.7%	28 / 30	0.927	0.928 Accept	0.809 Reject	0.054	0.625	0.2118	0.1119	0.5562	No
Chromium	0.0%	30 / 30	0.927	0.952 Accept	0.965 Accept	5.06	20.1	11.73	4.203	21.056	No
Cobalt	0.0%	30 / 30	0.927	0.961 Accept	0.953 Accept	1.54	10.2	4.751	1.851	11.050	No
Copper	0.0%	30 / 30	0.927	0.909 Reject	0.964 Accept	4.44	16.7	10.77	2.974	17.373	No
Iron	0.0%	30 / 30	0.927	0.879 Reject	0.946 Accept	3460	15500	10199	3386	17717	No
Lead	0.0%	30 / 30	0.927	0.927 Reject	0.750 Reject	6.08	40.5	14.59	6.628	30.97	Yes
Magnesium	0.0%	30 / 30	0.927	0.830 Reject	0.968 Accept	112	2830	1369	736	3003	No
Manganese	0.0%	30 / 30	0.927	0.923 Reject	0.624 Reject	132	1420	336.8	237.9	849.1	Yes
Mercury	93.3%	2 / 30	-----	----- -----	----- -----	< 0.031	0.14	nc	nc	0.14	-----
Molybdenum	80.0%	6 / 30	-----	----- -----	----- -----	< 0.657	1.460	nc	nc	1.460	-----
Nickel	0.0%	30 / 30	0.927	0.856 Reject	0.918 Reject	3.74	14.6	9.746	3.276	14.6	No
Potassium	0.0%	30 / 30	0.927	0.963 Accept	0.950 Accept	434	2790	1253	489.1	2895	No
Selenium	40.0%	18 / 30	0.927	0.857 Reject	0.840 Reject	0.059	0.637	0.212	0.1606	0.9072	No
Silver	3.3%	29 / 30	0.927	0.918 Reject	0.821 Reject	<0.025	0.213	0.0701	0.0352	0.213	No
Sodium	3.3%	29 / 30	0.927	0.723 Reject	0.467 Reject	<2.57	37300	3482	8804	25800	Yes
Thallium	16.7%	25 / 30	0.927	0.683 Reject	0.857 Reject	0.555	107	35.54	24.89	63.9	Yes
Vanadium	0.0%	30 / 30	0.927	0.884 Reject	0.966 Accept	5.82	48.5	23.89	10.08	46.26	No
Zinc	0.0%	30 / 30	0.927	0.819 Reject	0.488 Reject	13.3	124	29.30	18.96	38.8	Yes

Notes:

All units are in milligrams per kilogram (mg/kg).

----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

TABLE 4-2
Summary of Background Values for Subsurface Soil
Naval Air Station Fort Worth

Analyte	% Non detects	Detects / Total	W (crit)	W (log)	W (raw)	Minimum	Maximum	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.960 Accept	0.955 Accept	3780	17700	9905	3277	17180	No
Antimony	80.0%	6 / 30	0.927	----- -----	----- -----	< 0.21	0.712	nc	nc	0.712	-----
Arsenic	0.0%	30 / 30	0.927	0.963 Accept	0.942 Accept	1.42	5.31	3.0317	1.1266	5.533	No
Barium	0.0%	30 / 30	0.927	0.922 Reject	0.974 Accept	16.4	127	65.83	28.03	128.1	No
Beryllium	0.0%	30 / 30	0.927	0.966 Accept	0.969 Accept	0.208	1.07	0.5629	0.1776	0.957	No
Calcium	0.0%	30 / 30	0.927	0.733 Reject	0.853 Reject	751	347000	91395	76216	272000	Yes
Cadmium	33.3%	20 / 30	0.927	0.829 Reject	0.390 Reject	0.055	1.48	0.1754	0.2540	0.5891	Yes
Chromium	0.0%	30 / 30	0.927	0.937 Accept	0.847 Reject	5.77	17.90	9.494	2.766	16.31	No
Cobalt	10.0%	27 / 30	0.927	0.762 Reject	0.954 Accept	0.4395	5.5	3.181	1.356	6.191	No
Copper	0.0%	30 / 30	0.927	0.848 Reject	0.952 Accept	2.61	13.30	8.119	2.524	13.72	No
Iron	0.0%	30 / 30	0.927	0.936 Accept	0.941 Accept	3840	16900	9185	2720	15224	No
Lead	6.7%	28 / 30	0.927	0.746 Reject	0.949 Accept	0.073	14.3	5.280	3.325	12.66	No
Magnesium	0.0%	30 / 30	0.927	0.697 Reject	0.843 Reject	292	2420	1569	582.1	2420	No
Manganese	0.0%	30 / 30	0.927	0.904 Reject	0.964 Accept	28.7	317	169.6	82.03	351.7	No
Mercury	100.0%	0 / 30	0.927	----- -----	----- -----	< 0.03	< 0.035	nc	nc	ND at 0.035	-----
Molybdenum	80.0%	6 / 30	0.927	----- -----	----- -----	< 0.638	1.930	nc	nc	1.930	-----
Nickel	0.0%	30 / 30	0.927	0.959 Accept	0.837 Reject	4.17	22.1	9.166	3.862	19.76	No
Potassium	0.0%	30 / 30	0.927	0.909 Reject	0.977 Accept	271	1900	1000	322.8	1717	No
Selenium	80.0%	6 / 30	0.927	----- -----	----- -----	< 0.12	0.3130	nc	nc	0.3130	-----
Silver	33.3%	20 / 30	0.927	0.862 Reject	0.847 Reject	<0.021	0.0928	0.0354	0.0273	0.1277	No
Sodium	10.0%	27 / 30	0.927	0.898 Reject	0.426 Reject	1.1	53200	4225	11762	53200	No
Thallium	13.3%	26 / 30	0.927	0.630 Reject	0.858 Reject	0.575	65.4	34.74	19.84	65.4	No
Vanadium	0.0%	30 / 30	0.927	0.980 Accept	0.926 Reject	9.7	37.8	20.33	6.245	37.39	No
Zinc	0.0%	30 / 30	0.927	0.851 Reject	0.963 Accept	5.9	31	18.70	5.663	31.27	No

Notes:

All units are in milligrams per kilogram (mg/kg).

----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

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TABLE 4-3
Summary of Background Values for Low-Stress Groundwater Samples
Naval Air Station Fort Worth

Analyte	% Non detects	Detects / Total	W (crit)	W (log)	W (raw)	Minimum	Maximum	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	25.0%	9 / 12	0.859	0.930 Accept	0.505 Reject	0.052	0.472	0.0754	0.1910	1.332	No
Antimony	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.002	< 0.002	nc	nc	ND at 0.002	-----
Arsenic	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0049	< 0.0049	nc	nc	ND at 0.0049	-----
Barium	0.0%	12 / 12	0.859	0.887 Accept	0.647 Reject	0.052	0.472	0.135	0.114	0.587	Yes
Beryllium	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0003	0.0003	nc	nc	0.0003	-----
Calcium	0.0%	12 / 12	0.859	0.855 Reject	0.905 Accept	56.5	193	141.7	45.5	266.3	No
Cadmium	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0005	< 0.0005	nc	nc	ND at 0.0005	-----
Chromium	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0053	0.0064	nc	nc	0.006	-----
Cobalt	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0089	< 0.0089	nc	nc	ND at 0.0089	-----
Copper	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0008	0.0028	nc	nc	0.0028	-----
Iron	0.0%	12 / 12	0.859	0.874 Accept	0.872 Accept	0.0049	0.072	0.0253	0.0194	0.2239	No
Lead	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0016	< 0.0016	nc	nc	ND at 0.0016	-----
Magnesium	0.0%	12 / 12	0.859	0.839 Reject	0.639 Reject	2.76	37.8	10.32	10.49	37.80	No
Manganese	0.0%	12 / 12	0.859	0.820 Reject	0.376 Reject	0.0019	2.86	0.2713	0.8177	0.175	Yes
Mercury	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0001	< 0.0001	nc	nc	ND at 0.0001	-----
Molybdenum	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0144	< 0.0144	nc	nc	ND at 0.0144	-----
Nickel	75.0%	3 / 12	0.859	----- -----	----- -----	< 0.002	0.0204	nc	nc	0.0204	-----
Potassium	33.3%	8 / 12	0.859	0.890 Accept	0.665 Reject	0.233	5.55	1.277	2.079	15.03	No
Selenium	25.0%	9 / 12	0.859	0.823 Reject	0.882 Accept	0.00055	0.0046	0.0021	0.0012	0.0077	No
Silver	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0002	0.0002	nc	nc	0.0002	-----
Sodium	0.0%	12 / 12	0.859	0.885 Accept	0.519 Reject	6.17	144	28.76	37.05	167.2	Yes
Thallium	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0632	< 0.0632	nc	nc	ND at 0.0632	-----
Vanadium	18.2%	9 / 11	0.859	0.893 Accept	0.863 Accept	< 0.0029	0.0074	0.0034	0.0018	0.0123	No
Zinc	36.4%	7 / 11	0.859	0.877 Accept	0.622 Reject	0.00195	0.0487	0.0101	0.0170	0.1180	No

Notes:

All units are in milligrams per liter (mg/L).

----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level - (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

TABLE 4-4
Summary of Background Values for Unfiltered Groundwater Samples
Naval Air Station Fort Worth

Analyte	% Non detects	Detects / Total	W (crit)	W (log)	W (raw)	Minimum	Maximum	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	0.0%	12 / 12	0.859	0.950 Accept	0.779 Reject	0.0699	2.45	0.8072	0.8586	11.07	No
Antimony	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.002	0.0024	nc	nc	0.0024	-----
Arsenic	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0049	0.0067	nc	nc	0.0067	-----
Barium	0.0%	12 / 12	0.859	0.982 Accept	0.882 Accept	0.0358	0.513	0.1931	0.1362	1.133	No
Beryllium	66.7%	4 / 12	0.859	----- -----	----- -----	< 0.0003	0.0019	nc	nc	0.0019	-----
Calcium	0.0%	12 / 12	0.859	0.916 Accept	0.806 Reject	102	881	406.6	300.8	2438	No
Cadmium	66.7%	4 / 12	0.859	----- -----	----- -----	< 0.0005	0.0016	nc	nc	0.0016	-----
Chromium	58.3%	5 / 12	0.859	----- -----	----- -----	< 0.0053	0.0136	nc	nc	0.0136	-----
Cobalt	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0089	0.01	nc	nc	0.01	-----
Copper	50.0%	6 / 12	0.859	----- -----	----- -----	< 0.0008	0.0101	nc	nc	0.0101	-----
Iron	0.0%	12 / 12	0.859	0.984 Accept	0.828 Reject	0.0768	2.64	0.7838	0.7026	7.234	No
Lead	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0016	< 0.0016	nc	nc	ND at 0.0016	-----
Magnesium	0.0%	12 / 12	0.859	0.905 Accept	0.735 Reject	3.79	35.6	11.91	10.65	68.78	No
Manganese	0.0%	12 / 12	0.859	0.958 Accept	0.863 Accept	0.0393	2.17	0.7055	0.6592	10.57	No
Mercury	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0001	< 0.0001	nc	nc	ND at 0.0001	-----
Molybdenum	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0144	< 0.0144	nc	nc	ND at 0.0144	-----
Nickel	0.0%	12 / 12	0.859	0.92 Accept	0.78 Reject	0.0022	0.0203	0.0068	0.0055	0.0364	No
Potassium	50.0%	6 / 12	0.859	----- -----	----- -----	< 0.466	3.9	nc	nc	3.9	-----
Selenium	16.7%	10 / 12	0.859	0.891 Accept	0.851 Reject	< 0.0011	0.0042	0.0018	0.0009	0.0072	No
Silver	91.7%	1 / 12	0.859	----- -----	----- -----	< 0.0002	0.0003	nc	nc	0.0003	-----
Sodium	0.0%	12 / 12	0.859	0.960 Accept	0.630 Reject	1.96	91.5	20.24	23.68	176.2	No
Thallium	100.0%	0 / 12	0.859	----- -----	----- -----	< 0.0632	< 0.0632	nc	nc	ND at 0.0632	-----
Vanadium	9.1%	10 / 11	0.859	0.943 Accept	0.920 Accept	0.00145	0.0247	0.0093	0.0066	0.0653	No
Zinc	9.1%	10 / 11	0.859	0.964 Accept	0.874 Accept	0.00195	0.0307	0.0107	0.0082	0.0682	No

Notes:

All units are in milligrams per liter (mg/L).

----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level- (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

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TABLE 4-5
Summary of Background Statistics for Surface Water
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects / Total	W (crit)	W (log)		W (raw)		Minimum	Maximum	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.848	Accept	0.729	Reject	0.0509	0.178	0.0842	0.0410	0.2716	Yes
Antimony	75.0%	2 / 8	0.818	-----	-----	-----	-----	< 0.002	0.0031	nc	nc	0.0031	-----
Arsenic	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0049	< 0.0049	nc	nc	ND at 0.0049	-----
Barium	0.0%	8 / 8	0.818	0.957	Accept	0.928	Accept	0.0759	0.124	0.0953	0.0146	0.151	No
Beryllium	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0003	< 0.0003	nc	nc	ND at 0.0003	-----
Calcium	0.0%	8 / 8	0.818	0.908	Accept	0.879	Accept	84.1	118	96.01	10.61	133.7	No
Cadmium	87.5%	1 / 8	0.818	-----	-----	-----	-----	< 0.0005	0.0005	nc	nc	ND at 0.0005	-----
Chromium	62.5%	3 / 8	0.818	-----	-----	-----	-----	< 0.0053	0.0078	nc	nc	0.0078	-----
Cobalt	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0089	< 0.0089	nc	nc	ND at 0.0089	-----
Copper	25.0%	6 / 8	0.818	0.566	Reject	0.566	Reject	< 0.0004	0.0101	0.0077	0.0045	0.0101	No
Iron	0.0%	8 / 8	0.818	0.930	Accept	0.989	Accept	0.0221	0.223	0.1128	0.0633	0.9208	No
Lead	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0016	< 0.0016	nc	nc	ND at 0.0016	-----
Magnesium	0.0%	8 / 8	0.818	0.993	Accept	0.976	Accept	2.07	5.52	3.58	1.114	9.353	No
Manganese	0.0%	8 / 8	0.818	0.937	Accept	0.864	Accept	0.0038	0.0716	0.0251	0.0218	0.4193	No
Mercury	87.5%	1 / 8	0.818	-----	-----	-----	-----	< 0.0001	0.0001	nc	nc	0.0001	-----
Molybdenum	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0144	< 0.0144	nc	nc	ND at 0.0144	-----
Nickel	87.5%	1 / 8	0.818	-----	-----	-----	-----	<0.002	0.0178	nc	nc	0.0178	-----
Potassium	0.0%	8 / 8	0.818	0.893	Accept	0.924	Accept	2.06	3.93	3.001	0.6836	6.347	No
Selenium	25.0%	6 / 8	0.818	0.689	Reject	0.779	Reject	0.00055	0.0025	0.0018	0.0008	0.0115	No
Silver	75.0%	2 / 8	0.818	-----	-----	-----	-----	< 0.0002	0.0003	nc	nc	0.0003	-----
Sodium	0.0%	8 / 8	0.818	0.959	Accept	0.943	Accept	19.3	32.9	25.74	4.752	45.46	No
Thallium	100.0%	0 / 8	0.818	-----	-----	-----	-----	< 0.0632	< 0.0632	nc	nc	ND at 0.0632	-----
Vanadium	25.0%	6 / 8	0.818	0.882	Accept	0.941	Accept	< 0.0029	0.0058	nc	nc	0.0159	-----
Zinc	75.0%	2 / 8	0.818	-----	-----	-----	-----	<0.0039	0.0122	nc	nc	0.0122	No

Notes:

All units are in milligrams per liter (mg/L).

----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

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TABLE 4-6
Summary of Background Values for Stream Sediment Samples
Naval Air Station Fort Worth

Analyte	% Non detects	Detects / Total	W (crit)	W (log)	W (raw)	Minimum	Maximum	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.892 Accept	0.924 Accept	2280	9240	5540	2679	28767	No
Antimony	87.5%	1 / 8	0.818	----- -----	----- -----	< 0.244	0.33	nc	nc	0.33	-----
Arsenic	0.0%	8 / 8	0.818	0.951 Accept	0.925 Accept	2.85	5.27	3.7488	0.7848	7.018	No
Barium	0.0%	8 / 8	0.818	0.920 Accept	0.918 Accept	21.9	76.8	48.03	19.60	180.4	No
Beryllium	0.0%	8 / 8	0.818	0.912 Accept	0.912 Accept	0.194	0.557	0.3734	0.1336	1.189	No
Calcium	0.0%	8 / 8	0.818	0.877 Accept	0.928 Accept	75100	189000	139888	35825	337544	No
Cadmium	0.0%	8 / 8	0.818	0.859 Accept	0.866 Accept	0.152	0.292	0.2164	0.0588	0.5071	No
Chromium	0.0%	8 / 8	0.818	0.869 Accept	0.885 Accept	4.81	9.59	7.546	1.840	17.0	No
Cobalt	0.0%	8 / 8	0.818	0.882 Accept	0.872 Accept	1.59	3.43	2.51	0.7757	6.651	No
Copper	0.0%	8 / 8	0.818	0.961 Accept	0.953 Accept	4.28	11.7	7.428	2.627	22.18	No
Iron	0.0%	8 / 8	0.818	0.807 Reject	0.832 Accept	5030	8080	6923	1184	10696	No
Lead	0.0%	8 / 8	0.818	0.956 Accept	0.818 Reject	2.21	26.9	9.1	8.330	104.1	No
Magnesium	0.0%	8 / 8	0.818	0.912 Accept	0.938 Accept	1450	2140	1876	221.7	2772	No
Manganese	0.0%	8 / 8	0.818	0.840 Accept	0.743 Reject	143	362	198.4	71.16	491.3	Yes
Mercury	87.5%	1 / 8	0.818	----- -----	----- -----	< 0.037	0.0360	nc	nc	0.0360	-----
Molybdenum	12.5%	7 / 8	0.818	0.894 Accept	0.963 Accept	0.4355	2.68	1.659	0.7692	9.693	No
Nickel	0.0%	8 / 8	0.818	0.937 Accept	0.958 Accept	5.55	12	9.0475	2.147	19.76	No
Potassium	0.0%	8 / 8	0.818	0.904 Accept	0.929 Accept	386	1300	788.4	340	3227	No
Selenium	87.5%	1 / 8	0.818	----- -----	----- -----	< 0.134	0.214	nc	nc	0.214	-----
Silver	0.0%	8 / 8	0.818	0.965 Accept	0.888 Accept	0.0311	0.0929	0.0532	0.0188	0.144	No
Sodium	75.0%	2 / 8	0.818	----- -----	----- -----	< 2.44	6.07	nc	nc	6.07	-----
Thallium	0.0%	8 / 8	0.818	0.912 Accept	0.936 Accept	22.2	43.4	33.41	7.443	69.74	No
Vanadium	0.0%	8 / 8	0.818	0.902 Accept	0.896 Accept	15.4	24.1	19.26	3.206	32.26	No
Zinc	0.0%	8 / 8	0.818	0.971 Accept	0.853 Accept	11.3	53.9	25.48	13.11	101.3	No

Notes:
All units are in milligrams per kilogram (mg/kg)
----- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)

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raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exputlyUTLy). No outliers were identified based on the formal test of the log-transformed data.

Lead and Manganese. Lead and manganese were detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for the log-transformed data for each analyte (Table 4-1). However, because the calculated W was equal to W(crit) (W 0.927 = W(crit) 0.927) for lead, and was very close (W 0.923 < W(crit) 0.927) for manganese, the data sets were considered to be lognormally distributed. The mean and standard deviation listed in Table 4-1 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). The highest concentration for both lead and manganese was identified as a potential outlier based on the formal test of the log-transformed data.

Aluminum, Arsenic, Copper, Iron, Magnesium, and Vanadium. Aluminum, arsenic, copper, iron, magnesium, and vanadium were detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for the log-transformed data but accepted for the raw data for these analytes (Table 4-1). The mean, standard deviation, and UTL listed in Table 4-1 are for the raw data. No outliers were identified based on the formal test of the log-transformed data.

Cadmium. Cadmium was detected in 28 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for cadmium (Table 4-1). The mean and standard deviation listed in Table 4-1 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and

the UTL was calculated as exp(UTLy). No outliers were identified based on the formal test of the log-transformed data.

Antimony, Mercury, and Molybdenum. Antimony, mercury, and molybdenum were not detected in a large percentage of samples. Antimony and molybdenum were not detected in 80 percent of the samples, and mercury was not detected in 93.3 percent of samples. For these three analytes the minimum value is a nondetect at the lowest detection limit and the maximum value is the maximum detected value. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Beryllium Nickel, and Silver. Beryllium and nickel were detected in 30 of 30 samples, and silver was detected in 29 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-1). The mean and standard deviation listed in Table 4-1 are for the raw data. The UTL was established as the highest detected value. No outliers were identified based on the formal test of the log-transformed data.

Barium, Sodium, and Zinc. Barium and zinc were detected in 30 of 30 samples, and sodium was detected in 29 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-1). The mean and standard deviation listed in Table 4-1 are for the raw data. The UTL, which would normally be established as the highest detected value in this case, was found to be a potential outlier. The second highest value was therefore established as the UTL.

Selenium. Selenium was detected in 18 of 30 samples, so the frequency of nondetects was 40 percent. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-1). The mean and standard deviation listed in Table 4-1 are for the raw data. Review of the data

suggested that either the raw data or log-transformed data might be reasonably normal under Cohen's assumption that nondetects represent the presence of these analytes at levels too small to be quantified by the laboratory. Consequently, the censored and detects-only probability plots were prepared for both the raw data and log-transformed data. The most linear of the probability plots was the censored data plot for log-transformed data. Therefore, Cohen's adjustment was applied to the log-transformed data.

Based on Cohen's adjustment, estimates were calculated for the mean, $\bar{y}$, and standard deviation, sy, of the log-transformed data. The UTLy was then calculated from these values, and the UTL was calculated as UTL = exp(UTLy).

Because Cohen's adjustment was applied to the log-transformed data, we only have estimates of the mean and standard deviation of the log-transformed data. To obtain reliable estimates of the mean and standard deviation of the raw data set, estimates provided by Gilbert (1987) were applied. Thus, the mean $\bar{x}$ is estimated by

$$\bar{x} = \exp(\bar{y} + s_y^2/2),$$

and the standard deviation s is estimated by

$$s = \bar{x}\,[\exp(s_y^2) - 1]^{1/2}.$$

No outliers were identified using the formal test for outliers using the mean and standard deviation from the Cohen adjustment for log-transformed data.

<u>Thallium</u>. Thallium was detected in 25 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and raw data. Because the distribution of the data is bimodal with a potential outlier, Cohen's Adjustment results in a UTL almost 10 times greater than the highest value.

The UTL was therefore established as the second highest value. (Note: the bimodal nature of the data may be due to variability in the test method by the laboratory.)

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for antimony, barium, beryllium, lead, manganese, molybdenum, nickel, silver, sodium, thallium, and zinc.

4.3.1.2 Horizon B Soils

Aluminum, Arsenic, Beryllium, Chromium, Iron, Nickel, and Vanadium. Aluminum, arsenic, beryllium, chromium, iron, nickel, and vanadium were detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for all seven analytes (Table 4-2). The mean and standard deviation listed in Table 4-2 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). No outliers were identified based on the formal test of the log-transformed data.

Barium, Copper, Manganese, Potassium, and Zinc. Barium, copper, manganese, potassium, and zinc were detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for the log-transformed data but accepted for the raw data for these analytes (Table 4-2). The mean, standard deviation, and UTL listed in Table 4-2 are for the raw data. No outliers were identified based on the formal test of the log-transformed data.

Calcium. Calcium was detected in 30 of 30 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and raw

data (Table 4-2). The UTL, which would have been chosen as the highest value, was chosen as the second highest value because the highest value was identified as a potential outlier.

Cobalt and Lead. Cobalt and lead were detected in 27 and 28 of 30 samples, respectively. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for the log-transformed data but accepted for the raw data for these analytes (Table 4-2). The mean, standard deviation, and UTL listed in Table 4-2 are for the raw data. No outliers were identified based on the formal test of the log-transformed data.

Magnesium, Sodium, and Thallium. Magnesium, sodium, and thallium were detected in 30, 27, and 26 of 30 samples, respectively. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-2). The mean and standard deviation listed in Table 4-2 are for the raw data.

The UTL was established as the highest detected value. No outliers were identified based on the formal test of the log-transformed data.

Antimony, Molybdenum, and Selenium. Antimony, molybdenum, and selenium were detected in six of 30 samples, for a frequency of nondetects of 80 percent. For these three analytes the minimum value is a nondetect at the lowest detection limit and the maximum value is the maximum detected value. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Mercury. Mercury was not detected in any of the 30 background samples. Therefore, the minimum and maximum values in Table 4-2 are reported as less than the minimum and maximum detection limits, respectively. Mean and standard deviation

were not calculated for these analytes. As outlined in the flowchart (Figure 4-1), the UTL for analytes with greater than 90 percent nondetects is defined as the highest ranked value, or in this case nondetects at a given detection limit. Because none of these analytes were detected, no test for outliers was performed.

Cadmium and Silver. Cadmium and silver were detected in 20 of 30 samples for a frequency of nondetection of 33 percent. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-2). The mean and standard deviation listed in Table 4-2 are for the raw data. Review of the data suggested that either the raw data or log-transformed data might be reasonably normal under Cohen's assumption that nondetects represent the presence of these analytes at levels too small to be quantified by the laboratory. Consequently, the censored and detects-only probability plots were prepared for both the raw data and log-transformed data. The most linear of the probability plots for both analytes was the censored data plot for log-transformed data. Therefore, Cohen's adjustment was applied to the log-transformed data.

Based on Cohen's adjustment, estimates were calculated for the mean, $\bar{y}$, and standard deviation, sy, of the log-transformed data. The UTLy was then calculated from these values, and the UTL was calculated as UTL = exp(UTLy).

Because Cohen's adjustment was applied to the log-transformed data. estimates of the mean and standard deviation of the log-transformed data were obtained by the Gilbert (1987) method described in Section 4.3.1.1 above.

Based on the formal test for outliers using the mean and standard deviation from the Cohen adjustment for log-transformed data, the highest cadmium concentration was identified as a potential outlier.

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were

not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for antimony, calcium, magnesium, molybdenum, selenium, sodium, and thallium.

4.3.2 Groundwater

Groundwater collected by the low-stress method and by the bailing technique were evaluated separately.

4.3.2.1 Metals in Groundwater Sampled by the Low-Stress Procedure

Barium, Iron, and Sodium. Barium, iron, and sodium were detected in 12 of 12 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for all three analytes (Table 4-3). The mean and standard deviation listed in Table 4-3 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). The formal test for outliers of the log-transformed data indicated that the highest concentration detected for barium and sodium were potential outliers.

Calcium. Calcium also was detected in 12 of 12 samples. The Shapiro-Wilk test rejected the null hypothesis of normality for the log-transformed data but accepted the hypothesis for the raw data for these analytes (Table 4-3). The mean, standard deviation, and UTL listed in Table 4-3 are for the raw data. No outliers were identified based on the formal test of the log-transformed data.

Antimony, Arsenic, Cadmium, Cobalt, Lead, Mercury, Molybdenum, and Thallium. Antimony, arsenic, cadmium, cobalt, lead, mercury, molybdenum, and thallium were not detected in any of the background samples. Therefore, the minimum and maximum values in Table 4-3 are reported as less than the minimum and maximum detection limits, respectively. Additionally, the minimum and maximum values are the same because all of the detection limits for each analyte were the same. Mean and standard deviations were not calculated for these analytes. As outlined in the flowchart (Figure 4-1), the UTL for analytes with greater than 50 percent nondetects is defined as the highest ranked value, or in this case, nondetects at a given detection limit.

Beryllium, Chromium, Copper, Nickel, and Silver. Beryllium, chromium, copper, and silver were each detected in one of 12 samples, while nickel was detected in three of 12 samples. For these five analytes the minimum value is a nondetect at the lowest detection limit and the maximum value is the highest detected value. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Aluminum, Potassium, Selenium, and Zinc. Aluminum and selenium were detected in nine of 12 samples, and potassium and zinc were detected in eight of 12 and seven of 11 samples, respectively. One of the zinc results was rejected during the data-validation process. Review of the data suggested that either the raw data or log-transformed data might be reasonably normal under Cohen's assumption that nondetects represent the presence of these analytes at levels too small to be quantified by the laboratory. Consequently, the censored and detects-only probability plots were prepared for both the raw data and log-transformed data. The most linear of the probability plots was the censored data plot for log-transformed data. Therefore, Cohen's adjustment was applied to these data.

Based on Cohen's adjustment, estimates were calculated for the mean, $\bar{y}$, and standard deviation, sy, of the log-transformed data. The UTLy was then calculated as UTL = exp(UTLy).

Because Cohen's adjustment was applied to the log-transformed data, we only have estimates of the mean and standard deviation of the log-transformed data. To obtain reliable estimates of the mean and standard deviation of the raw data set, estimates provided by Gilbert (1987) were applied.

No outliers were identified using the formal test for outliers using the mean and standard deviation from the Cohen adjustment of log-transformed data.

Magnesium and Manganese. Magnesium and manganese were detected in 12 of 12 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for both the log-transformed and the raw data (Table 4-3). The mean and standard deviation listed in Table 4-3 are for the raw data. The UTL for magnesium was established as the highest detected value. The UTL for manganese was established as the second highest value, because the highest value was determined to be a potential outlier.

Vanadium. Vanadium was detected in nine of 11 samples. One of the vanadium analytical results was rejected during the data-validation process. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data (Table 4-3). The mean and standard deviation listed in Table 4-3 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). No outliers were identified by the formal test of the log-transformed data.

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were

not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for magnesium, manganese, and nickel.

4.3.2.2 Total Metals in Groundwater

Aluminum, Barium, Calcium, Iron, Magnesium, Manganese, Nickel, and Sodium. Aluminum, barium, calcium, iron, magnesium, manganese, nickel, and sodium were detected in 12 of 12 samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for all analytes (Table 4-4). The mean and standard deviation listed in Table 4-4 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy was calculated using the mean and standard deviation of the log-transformed data, and the UTL was calculated as exp(UTLy). No outliers were identified by the formal test of the log-transformed data.

Selenium, Vanadium, and Zinc. Selenium was detected in 10 of 12 samples, and vanadium and zinc were detected in 10 of 11 samples. One vanadium and one zinc result was rejected during the validation process. The Shapiro-Wilk test, accepted the null hypothesis of normality for the log-transformed data for all three analytes (Table 4-4). The mean and standard deviation listed in Table 4-4 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy was calculated using the mean and standard deviation of the log-transformed data, and the UTL was calculated as exp(UTLy). No outliers were identified based on the formal test of the log-transformed data.

Beryllium, Cadmium, Chromium, Copper, and Potassium. Beryllium and cadmium were detected in four of 12 samples, chromium was detected in five of 12 samples,

and copper and potassium were each detected in six of 12 samples. The minimum value is a nondetect at the lowest detection limit and the maximum value is the maximum detected value. The UTL was estimated as the highest detected value. No test for outliers was performed.

Antimony, Arsenic, Cobalt, and Silver. Antimony, arsenic, cobalt, and silver were detected in one of 12 samples. For these four analytes the minimum value is a nondetect at the lowest detection limit and the maximum value is the only detected value. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Lead, Mercury, Molybdenum, and Thallium. Lead, mercury, molybdenum, and thallium were not detected in any of the background samples. Therefore, the minimum and maximum values in Table 4-4 are reported as less than the minimum and maximum detection limits, respectively. Additionally, the minimum and maximum values are the same because all of the detection limits for a each analyte were the same. The UTL for these analytes is defined as the highest ranked value, or in this case nondetects at a the highest method detection limit.

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for beryllium, cadmium, chromium, copper, and potassium.

4.3.3 Surface Water

Aluminum, Barium, Calcium, Iron, Magnesium, Manganese, Potassium, and Sodium. Aluminum, barium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in eight of eight samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for these analytes (Table 4-5). The mean and standard deviation listed in Table 4-5 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). The highest value detected for aluminum was the only result identified as a potential outlier based on the formal test of the log-transformed data.

Copper. Copper was detected in six of eight samples. The null hypothesis of normality was rejected for both the log-transformed and raw data. The minimum value is a nondetect at the lowest detection limit and the maximum is the maximum detected concentration. The UTL was established as the highest detected value. No outliers were identified by the formal test.

Vanadium. Vanadium was detected in six of eight samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the log-transformed data for these analytes (Table 4-5). The minimum value is a nondetect at the lowest detection limit and the maximum is the maximum detected concentration. Because the null hypothesis of log-normality was accepted, a UTLy based on the mean and standard deviation of the log-transformed data was calculated, and the UTL was calculated as exp(UTLy). No outliers were identified by the formal test.

Arsenic, Beryllium, Cobalt, Lead, and Molybdenum, and Thallium. Arsenic, beryllium, cobalt, lead, molybdenum, and thallium were not detected in any of the background samples. Therefore, the minimum and maximum values in Table 4-5 are reported as less than the minimum and maximum detection limits, respectively.

Additionally, the minimum and maximum values are the same because all of the detection limits for a each analyte were the same. Mean and standard deviation were not calculated for these analytes. The UTL for these analytes is defined as the highest ranked value, or in this case nondetects at a given detection limit. No test for outliers was performed.

Antimony, Cadmium, Chromium, Mercury, Nickel, Silver, and Zinc. Cadmium, mercury, and nickel were detected in one of eight samples; antimony, silver, and zinc were detected in two of eight samples and chromium was detected in three of eight. For these seven analytes the minimum value is a nondetect at the lowest detection limit and the maximum value is the maximum detected concentration. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for antimony, cadmium, chromium, copper, mercury, nickel, silver, and zinc.

4.3.4 Stream Sediments

Aluminum, Arsenic, Barium, Beryllium, Calcium, Cadmium, Chromium, Cobalt, Copper, Lead, Magnesium, Manganese, Nickel, Potassium, Silver, Thallium, Vanadium, and Zinc. All of these metals were detected in eight of eight samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was accepted for the

log-transformed data for these analytes (Table 4-6). The mean and standard deviation listed in Table 4-6 are for the raw data. Because the null hypothesis of log-normality was accepted, a UTLy was calculated on the mean and standard deviation of the log-transformed data, and the UTL was calculated as exp(UTLy). The highest value detected for manganese was the only result identified as a potential outlier by the formal test of the log-transformed data.

Molybdenum. Molybdenum was detected in seven of eight samples. The Shapiro-Wilk test accepted the null hypothesis of normality for the log-transformed data for these analytes (Table 4-6). The mean and standard deviation listed in Table 4-6 are for the raw data, and the UTL was estimated from the mean and standard deviation of the log-transformed data and calculated as exp(UTLy). The highest value detected for molybdenum was not identified as a potential outlier based on the formal test of the log-transformed data.

Iron. Iron was detected in eight of eight samples. Based on the Shapiro-Wilk test, the null hypothesis of normality was rejected for the log-transformed data but accepted for the raw data for these analytes (Table 4-6). The mean, standard deviation, and UTL listed in Table 4-6 are for the raw data. No outliers were identified based on the formal test of the raw data.

Mercury, Selenium, and Sodium. Mercury and selenium were detected in one of eight samples, and sodium was detected in two of eight samples. For these three analytes, the minimum value is a nondetect at the lowest detection limit and the maximum value is the maximum detected value. Mean and standard deviation were not calculated because data were insufficient. The UTL was established as the highest detected value. No test for outliers was performed because of the high number of nondetects.

Recommendations for Nonparametric Tests. The UTL was established as the highest or second highest value for several constituents either because the distributions were

not clearly normal or lognormal, or because the percent of nondetects was between 50 and 90 percent. Although UTLs have been calculated for all such constituents, it is recommended that site-specific comparisons against UTLs for some constituents be supplemented by nonparametric tests such as the Wilcoxon rank-sum test or the Kruskal-Wallis test (Gilbert 1987; EPA 1992). Supplemental nonparametric tests are recommended for antimony, mercury, selenium, and sodium.

4.4 ORGANICS IN BACKGROUND SAMPLES

Background samples were collected from locations believed to be unaffected by operations at NAS Fort Worth. However, all of the samples were collected from locations on or near the base, and are thus potentially affected by previous base operations, or by operations at Plant 4. To help verify that the background locations were in fact unaffected by previous activities, the results of analyses for organic constituents were reviewed.

Each background sample was analyzed for volatile and semivolatile organic compounds, in addition to the inorganic constituents noted previously. Only a limited number of organic constituents were detected (Table 4-7).

The following paragraphs discuss the VOCs and SVOCs detected in each sample matrix.

4.4.1 Surface Soil

Twenty-seven positive detections of organic chemicals from 21 individual samples were recorded. Of the organics detected, the phthalates and methylene chloride are common laboratory contaminants. Eight of 10 methylene chloride detections were qualified during the data validation process as nondetected because these chemicals

TABLE 4-7
Organic Analytes Detected in Background Samples
Naval Air Station Fort Worth

MATRIX	SAMPLE_ID	LOCATION	VALUE	LAB_QUAL	JEG_QUAL	UNITS	NAME	DETECT	PQUANT	DILUTION
SURFACE SOIL	BJETA508-A	BJETA508	365.0000	F		MG/KG	BENZYL BUTYL PHTHALATE	256.0000	883.0000	1.00
SURFACE SOIL	BJETA530-A	BJETA530	219.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	105.0000	753.0000	1.00
SURFACE SOIL	BJETA514-A	BJETA514	2660.0000			MG/KG	DI-N-BUTYL PHTHALATE	134.0000	844.0000	1.00
SURFACE SOIL	BJETA511-A	BJETA511	702.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	135.0000	854.0000	1.00
SURFACE SOIL	BJETA512-A	BJETA512	389.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	138.0000	871.0000	1.00
SURFACE SOIL	BJETA530-A	BJETA530	175.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	119.0000	753.0000	1.00
SURFACE SOIL	BJETA534-A	BJETA534	161.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	132.0000	833.0000	1.00
SURFACE SOIL	BJETA532-A	BJETA532	147.0000	F		MG/KG	FLUORANTHENE	115.0000	781.0000	1.00
SURFACE SOIL	BJETA517-ARS	BJETA517	6.6500			µG/KG	METHYLENE CHLORIDE	3.0400	6.1100	1.00
SURFACE SOIL	BJETA527-A	BJETA527	6.4900			µG/KG	METHYLENE CHLORIDE	2.8500	5.7200	1.00
SURFACE SOIL	BJETA523-A	BJETA523	6.4500		e	µG/KG	METHYLENE CHLORIDE	3.1000	6.2300	1.00
SURFACE SOIL	BJETA524-A	BJETA524	5.1500	F	e	µG/KG	METHYLENE CHLORIDE	3.1600	6.3400	1.00
SURFACE SOIL	BJETA518-A	BJETA518	3.7700	F	e	µG/KG	METHYLENE CHLORIDE	2.9300	5.8800	1.00
SURFACE SOIL	BJETA509-A	BJETA509	3.7200	F	be	µG/KG	METHYLENE CHLORIDE	3.1400	6.3000	1.00
SURFACE SOIL	BJETA522-A	BJETA522	3.6500	F	e	µG/KG	METHYLENE CHLORIDE	2.9100	5.8400	1.00
SURFACE SOIL	BJETA519-A	BJETA519	3.2100	F	e	µG/KG	METHYLENE CHLORIDE	2.7800	5.5900	1.00
SURFACE SOIL	BJETA508-A	BJETA508	3.2000	F	be	µG/KG	METHYLENE CHLORIDE	3.0900	6.2100	1.00
SURFACE SOIL	BJETA504-A	BJETA504	3.1000	F	be	µG/KG	METHYLENE CHLORIDE	3.0600	6.1400	1.00
SURFACE SOIL	BJETA508-A	BJETA508	1.6000	F		µG/KG	TOLUENE	0.5020	6.2100	1.00
SURFACE SOIL	BJETA508-A	BJETA508	1.0900	F		µG/KG	TOLUENE	0.5020	6.2100	1.00
SURFACE SOIL	BJETA506-A	BJETA506	0.9510	F		µG/KG	TOLUENE	0.5030	6.2300	1.00
SURFACE SOIL	BJETA502-A	BJETA502	0.8020	F		µG/KG	TOLUENE	0.5180	6.4100	1.00
SURFACE SOIL	BJETA503-A	BJETA503	0.7830	F		µG/KG	TOLUENE	0.4980	6.1700	1.00
SURFACE SOIL	BJETA509-A	BJETA509	0.6980	F		µG/KG	TOLUENE	0.5090	6.3000	1.00
SURFACE SOIL	BJETA506-A	BJETA506	0.6850	F		µG/KG	TOLUENE	0.5030	6.2300	1.00
SURFACE SOIL	BJETA501-A	BJETA501	0.6540	F		µG/KG	TOLUENE	0.5070	6.2700	1.00
SURFACE SOIL	BJETA510-A	BJETA510	0.6520	F		µG/KG	TOLUENE	0.4920	6.0900	1.00
SUBSURFACE SOIL	BJETA503-B	BJETA503	8.3000	F		µG/KG	ACETONE	4.7600	106.0000	1.00
SUBSURFACE SOIL	BJETA526-B	BJETA526	8.0600	F		µG/KG	ACETONE	4.9600	111.0000	1.00
SUBSURFACE SOIL	BJETA521-B	BJETA521	6.3400	F		µG/KG	ACETONE	5.0900	114.0000	1.00
SUBSURFACE SOIL	BJETA510-B	BJETA510	6.0900	F		µG/KG	ACETONE	5.1700	115.0000	1.00
SUBSURFACE SOIL	BJETA525-B	BJETA525	5.7500	F		µG/KG	ACETONE	4.9500	110.0000	1.00
SUBSURFACE SOIL	BJETA518-B	BJETA518	5.1900	F		µG/KG	ACETONE	5.0500	113.0000	1.00
SUBSURFACE SOIL	BJETA513-B	BJETA513	2170.0000			MG/KG	DI-N-BUTYL PHTHALATE	126.0000	796.0000	1.00

TABLE 4-7
Organic Analytes Detected in Background Samples
Naval Air Station Fort Worth

MATRIX	SAMPLE_ID	LOCATION	VALUE	LAB_QUAL	JEG_QUAL	UNITS	NAME	DETECT	PQUANT	DILUTION
SUBSURFACE SOIL	BJETA510-B	BJETA510	1070.0000			MG/KG	DI-N-BUTYL PHTHALATE	126.0000	796.0000	1.00
SUBSURFACE SOIL	BJETA511-B	BJETA511	427.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	131.0000	824.0000	1.00
SUBSURFACE SOIL	BJETA512-B	BJETA512	381.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	122.0000	772.0000	1.00
SUBSURFACE SOIL	BJETA514-B	BJETA514	338.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	121.0000	766.0000	1.00
SUBSURFACE SOIL	BJETA532-B	BJETA532	130.0000	F		MG/KG	DI-N-BUTYL PHTHALATE	123.0000	779.0000	1.00
SUBSURFACE SOIL	BJETA503-B	BJETA503	3.3700	F		µG/KG	METHYL ETHYL KETONE (2-BUTANONE)	2.4000	106.0000	1.00
SUBSURFACE SOIL	BJETA525-B	BJETA525	6.0600		e	µG/KG	METHYLENE CHLORIDE	2.7500	5.5200	1.00
SUBSURFACE SOIL	BJETA526-B	BJETA526	5.9300		e	µG/KG	METHYLENE CHLORIDE	2.7600	5.5400	1.00
SUBSURFACE SOIL	BJETA523-B	BJETA523	5.6200	F	e	µG/KG	METHYLENE CHLORIDE	2.8400	5.7100	1.00
SUBSURFACE SOIL	BJETA524-B	BJETA524	5.4200	F	e	µG/KG	METHYLENE CHLORIDE	2.7900	5.6100	1.00
SUBSURFACE SOIL	BJETA522-B	BJETA522	3.6200	F	e	µG/KG	METHYLENE CHLORIDE	2.6700	5.3600	1.00
SUBSURFACE SOIL	BJETA519-B	BJETA519	3.2800	F	e	µG/KG	METHYLENE CHLORIDE	2.9100	5.8500	1.00
SUBSURFACE SOIL	BJETA518-B	BJETA518	3.1400	F	e	µG/KG	METHYLENE CHLORIDE	2.8000	5.6300	1.00
SUBSURFACE SOIL	BJETA521-B	BJETA521	2.8400	F	e	µG/KG	METHYLENE CHLORIDE	2.8300	5.6800	1.00
GROUNDWATER	LF044A-01	LF04-4A	16.8000			µG/L	BIS(2-ETHYLHEXYL) PHTHALATE	4.2000	10.0000	1.00
GROUNDWATER	WJETA531	WJETA531	5.9400	F	e	µG/L	BIS(2-ETHYLHEXYL) PHTHALATE	4.2000	10.0000	1.00
GROUNDWATER	HM127-01	HM-127	4.9600	F		µG/L	BIS(2-ETHYLHEXYL) PHTHALATE	4.2000	10.0000	1.00
GROUNDWATER	WJETA530-01	WJETA530	4.3600	F	bea	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	MWMTAC001-01	MWMTAC-001	4.3000	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	LF033D-01	LF03-3D	3.9400	F	e	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	WJETA531	WJETA531	3.6900	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	WJETA535-01	WJETA535	2.5600	F	bea	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	LF044B-01	LF04-4B	2.2600	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	USGS01T	USGS01T	1.8100	F	b	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	HM127-01	HM-127	1.7800	F	b	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
GROUNDWATER	HM120-01	HM-120	1.6600	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
SURFACE WATER	JEFB008-SW	JEFB008	2.9300	F		µG/L	BENZYL BUTYL PHTHALATE	2.8000	10.0000	1.00
SURFACE WATER	JEFB001-SW	JEFB001	60.1000			µG/L	DI-N-BUTYL PHTHALATE	5.4000	10.0000	1.00
SURFACE WATER	JEFB006-SW	JEFB006	38.5000			µG/L	DI-N-BUTYL PHTHALATE	5.4000	10.0000	1.00
SURFACE WATER	JEFB008-SW	JEFB008	35.3000			µG/L	DI-N-BUTYL PHTHALATE	5.4000	10.0000	1.00
SURFACE WATER	JEFB003-SW	JEFB003	3.2900	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
SURFACE WATER	JEFB008-SW	JEFB008	3.0600	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
SURFACE WATER	JEFB007-SW	JEFB007	2.2000	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00
SURFACE WATER	JEFB001-SW	JEFB001	1.8900	F	be	µG/L	METHYLENE CHLORIDE	0.7710	5.0000	1.00

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TABLE 4-7
Organic Analytes Detected in Background Samples
Naval Air Station Fort Worth

MATRIX	SAMPLE_ID	LOCATION	VALUE	LAB_QUAL	JEG_QUAL	UNITS	NAME	DETECT	PQUANT	DILUTION
SEDIMENT	JEFB004-SE	JEFB004	146.0000	F		MG/KG	BENZO(B)FLUORANTHENE	144.0000	943.0000	1.00
SEDIMENT	JEFB002-SE	JEFB002	207.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	124.0000	884.0000	1.00
SEDIMENT	JEFB007-SE	JEFB007	179.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	138.0000	985.0000	1.00
SEDIMENT	JEFB003-SE	JEFB003	175.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	140.0000	1000.0000	1.00
SEDIMENT	JEFB005-SE	JEFB005	157.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	138.0000	989.0000	1.00
SEDIMENT	JEFB004-SE	JEFB004	138.0000	F		MG/KG	BIS(2-ETHYLHEXYL) PHTHALATE	132.0000	943.0000	1.00
SEDIMENT	JEFB001-SE	JEFB001	207.0000	F		MG/KG	FLUORANTHENE	126.0000	854.0000	1.00
SEDIMENT	JEFB004-SE	JEFB004	174.0000	F		MG/KG	FLUORANTHENE	139.0000	943.0000	1.00
SEDIMENT	JEFB001-SE	JEFB001	131.0000	F		MG/KG	PYRENE	117.0000	854.0000	1.00

Notes:

a = detection less than five times the ambient blank value
b = detection less than five times the trip blank value
e = detection less than five times the equipment blank value
F = detection greater than the detection limit (DETECT), but less than the practical quantitation limit (PQUANT)
Lab_qual = laboratory qualifier
JEG_qual = Jacobs qualifier

were also present in associated blank samples. Toluene was detected nine times in seven individual samples, and fluoranthene was detected in a single sample. All of the toluene and fluoranthene detections were "F" qualified by the laboratory as a value above the detection limit, but below the practical quantitation limit.

4.4.2 Subsurface Soil

Twenty-one positive detections of organic chemicals from 15 individual samples were recorded. All of the organics detected—acetone, di-n-butyl phthalate, 2-butanone, and methylene chloride—are common laboratory contaminants. All of the methylene chloride detections were qualified during the data validation process as nondetected because these chemicals were also present in associated blank samples.

4.4.3 Groundwater

Twelve positive detections of organic chemicals from 10 individual samples were recorded. Both bis(2-ethylhexyl) phthalate and methylene chloride are common laboratory contaminants. All of the methylene chloride detections and one of the bis(2-ethylhexyl) phthalate detections were qualified during the data validation process as nondetected because these chemicals were also present in associated blank samples.

4.4.4 Surface Water

Eight positive detections of organic chemicals from five individual samples were recorded. The organics detected—benzyl butyl phthalate, di-n-butyl phthalate, and methylene chloride—are common laboratory contaminants. All four of the methylene chloride detections were qualified during the data validation process as nondetected because these chemicals were also present in associated blank samples

4.4.5 Sediment

Nine positive detections of organic chemicals from six individual samples were recorded. Of the organics detected, bis(2-ethylhexyl) phthalate is a common laboratory contaminant. Benzo(b)fluoranthene and pyrene were detected once, and fluoranthene was detected twice. All of the detections were "F" qualified by the laboratory as a value above the detection limit, but below the practical quantitation limit.

(intentionally blank)

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APPENDIX H

RISK REDUCTION STANDARD NUMBER 2 DERIVATIONS AND

HUMAN HEALTH RISK ASSESSMENT

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HUMAN HEALTH RISK ASSESSMENT

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	Intake Factor = (SA × EF × ED)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec mg/cm3	Noncarcinogenic Intake Factor (NIF)
Absorption Factor	chem-spec unitless	= 5.68E+01 kg/kg-day
Skin Surface Area	5,800 cm2	Carcinogenic Intake Factor (CIF)
Dermal Permeability constant	chem-spec cm/hr	= 8.11E-01 kg/kg-day
Exposure Frequency (EF)	250 days/yr	RfDd = Dermal Reference Dose value
Exposure Duration (ED)	1 yrs	SFd = Dermal Slope Factor value
Exposure Time (ET)	4 hr/day	Hazard Quotient = (NIF × DA) ÷ (RfDd)
Body Weight (BW)	70 kg	Cancer Risk = CIF ×DA × SFd
Avging Time, Noncar (ATN)	365 days	
Avging Time, Carcin (ATC)	25550 days	
Conversion Factor (CF)	0.001 L/cm3	

Chemical	CAS No.	Exposure Conc. (mg/cm3)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds										
1,2,3,4-Tetramethylbenzene	488233	--	--	--	4.00E+00	--	--	--	--	--
1,2,3-Trimethylbenzene	562738	--	--	--	4.00E+00	--	--	--	--	--
1,2,4-Trimethylbenzene	95636	--	--	--	4.00E+00	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	--	--	--	4.00E+00	--	--	--	--	--
Benzene	71432	8.70E-07	--	3.05E-02	4.00E+00	8.19E-08	--	--	2.03E-09	< 1%
Bromodichloromethane	75274	--	1.90E-02	6.53E-02	4.00E+00	--	--	--	--	--
Chlorobenzene	108907	--	6.00E-03	--	4.00E+00	--	--	--	--	--
Chloroform	67663	3.60E-07	1.00E-02	6.10E-03	4.00E+00	1.58E-08	8.95E-05	< 1%	7.80E-11	< 1%
1,2-Dichloroethylene (cis) (1)	156592	9.00E-07	9.00E-03	--	4.00E+00	3.57E-08	2.25E-04	< 1%	--	--
Dibromochloromethane	124481	--	1.50E-02	1.12E-01	4.00E+00	--	--	--	--	--
Ethylbenzene	100414	7.40E-06	8.50E-02	--	4.00E+00	3.32E-05	2.21E-02	1%	--	--
Methylene chloride	75092	1.40E-05	5.88E-02	7.65E-03	4.00E+00	2.88E-07	2.78E-04	< 1%	1.79E-09	< 1%
Tetrachloroethylene	127184	6.10E-06	1.00E-02	5.78E-02	4.00E+00	1.18E-05	6.72E-02	4%	5.54E-07	8%
Toluene	108883	6.44E-06	1.80E-01	--	4.00E+00	2.90E-05	9.14E-03	< 1%	--	--
Trichloroethene	79016	3.60E-06	--	1.22E-02	4.00E+00	4.19E-06	--	--	4.15E-08	< 1%
Xylenes (Total) (2)	1330207	3.60E-06	1.80E+00	--	4.00E+00	1.28E-06	4.03E-05	< 1%	--	--
Semivolatile Organic Compounds										
2-Methylnaphthalene	91576	4.93E-04	--	--	4.00E+00	3.12E-04	--	--	--	--
Acenaphthene	83329	2.50E-06	1.20E-02	--	4.00E+00	1.63E-06	7.69E-03	< 1%	--	--
Benz[a]anthracene	56553	1.20E-06	--	1.83E+00	4.00E+00	1.18E-08	--	--	1.75E-08	< 1%
Benzyl butyl phthalate	85687	5.30E-05	1.00E-01	--	4.00E+00	1.18E-04	6.72E-02	4%	--	--
Bis(2-ethylhexyl)phthalate	117817	1.07E-05	1.00E-02	2.80E-02	4.00E+00	6.34E-06	3.60E-02	2%	1.44E-07	2%
Di-N-Butylphthalate	84742	1.64E-06	9.00E-02	--	4.00E+00	4.66E-06	2.94E-03	< 1%	--	--
Dibenzofuran	132649	3.07E-06	--	--	4.00E+00	2.47E-06	--	--	--	--

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	Intake Factor = (SA × EF × ED)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec mg/cm3	Noncarcinogenic Intake Factor (NIF)
Absorption Factor	chem-spec unitless	= 5.68E+01 kg/kg-day
Skin Surface Area	5,800 cm2	Carcinogenic Intake Factor (CIF)
Dermal Permeability constant	chem-spec cm/hr	= 8.11E-01 kg/kg-day
Exposure Frequency (EF)	250 days/yr	RfDd = Dermal Reference Dose value
Exposure Duration (ED)	1 yrs	SFd = Dermal Slope Factor value
Exposure Time (ET)	4 hr/day	Hazard Quotient = (NIF × DA) ÷ (RfDd)
Body Weight (BW)	70 kg	Cancer Risk = CIF ×DA × SFd
Avging Time, Noncar (ATN)	365 days	
Avging Time, Carcin (ATC)	25550 days	
Conversion Factor (CF)	0.001 L/cm3	

Chemical	CAS No.	Exposure Conc. (mg/cm3)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Fluorene	86737	1.73E-06	8.00E-03	--	4.00E+00	1.41E-06	1.00E-02	< 1%	--	--
Isophorone	78591	1.29E-05	1.86E-01	1.02E-03	4.00E+00	2.82E-07	8.62E-05	< 1%	2.34E-10	< 1%
Naphthalene	91203	7.20E-06	--	--	4.00E+00	2.36E-06	--	--	--	--
Phenol	108952	9.30E-06	5.40E-01	--	4.00E+00	3.55E-07	3.73E-05	< 1%	--	--
Pyrene	129000	1.10E-06	1.20E-02	--	4.00E+00	2.42E-06	1.14E-02	< 1%	--	--
Metals										
Aluminum	7429905	4.96E-02	--	--	4.00E+00	1.98E-04	--	--	--	--
Arsenic	7440382	4.60E-05	2.40E-04	1.88E+00	4.00E+00	1.84E-07	4.35E-02	3%	2.80E-07	4%
Barium	7440393	4.56E-03	3.50E-03	--	4.00E+00	1.82E-05	2.96E-01	19%	--	--
Beryllium	7440417	4.00E-06	5.00E-05	4.30E+02	4.00E+00	1.60E-08	1.82E-02	1%	5.58E-06	84%
Cadmium	7440439	--	1.00E-05	--	4.00E+00	--	--	--	--	--
Chromium	16065831	6.50E-05	2.00E-02	--	4.00E+00	2.60E-07	7.38E-04	< 1%	--	--
Cobalt	7440484	--	--	--	4.00E+00	--	--	--	--	--
Copper	7440508	7.00E-05	--	--	4.00E+00	2.80E-07	--	--	--	--
Lead	7439921	1.61E-04	--	--	4.00E+00	6.44E-07	--	--	--	--
Manganese	7439965	1.86E-03	6.90E-04	--	4.00E+00	7.44E-06	6.12E-01	40%	--	--
Nickel	7440020	7.82E-06	8.00E-04	--	4.00E+00	3.13E-08	2.22E-03	< 1%	--	--
Silver	7440224	--	1.00E-03	--	4.00E+00	--	--	--	--	--
Vanadium	7440622	1.02E-04	7.00E-05	--	4.00E+00	4.08E-07	3.31E-01	22%	--	--
Zinc	7440666	1.08E-04	7.50E-02	--	4.00E+00	4.32E-07	3.27E-04	< 1%	--	--

(1) Kp for tran[illegible]2-dichloroethylene used
(2) constar[illegible] m-xylene used

	Hazard Index	Ca[illegible] Risk
Pathway Sum:	1.54E+00	[illegible]6

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APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations	
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT		Intake Factor = (SA × EF × ED)/(BW × AT)	
Chemical Concentration$_{soil}$	chem-spec	mg/cm3	Noncarcinogenic Intake Factor (NIF)	
Absorption Factor	chem-spec	unitless	= 5.31E+01	kg/kg-day
Skin Surface Area	5,800	cm2	Carcinogenic Intake Factor (CIF)	
Dermal Permeability constant	chem-spec	cm/hr	= 7.59E-01	kg/kg-day
Exposure Frequency (EF)	234	days/yr	RfDd = Dermal Reference Dose value	
Exposure Duration (ED)	1	yrs	SFd = Dermal Slope Factor value	
Exposure Time (ET)	2	hr/day	Hazard Quotient = (NIF × DA) ÷ (RfDd)	
Body Weight (BW)	70	kg	Cancer Risk = CIF ×DA × SFd	
Avging Time, Noncar (ATN)	365	days		
Avging Time, Carcin (ATC)	25550	days		
Conversion Factor (CF)	0.001	L/cm3		

Chemical		CAS No.	Exposure Conc. (mg/cm3)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds											
1,2,3,4-Tetramethylbenzene		488233	--	--	--	2.00E+00	--	--	--	--	--
1,2,3-Trimethylbenzene		562738	--	--	--	2.00E+00	--	--	--	--	--
1,2,4-Trimethylbenzene		95636	--	--	--	2.00E+00	--	--	--	--	--
1,3,5-Trimethylbenzene		108678	--	--	--	2.00E+00	--	--	--	--	--
Benzene		71432	8.70E-07	--	3.05E-02	2.00E+00	4.58E-08	--	--	1.06E-09	< 1%
Bromodichloromethane		75274	--	1.90E-02	6.53E-02	2.00E+00	--	--	--	--	--
Chlorobenzene		108907	--	6.00E-03	--	2.00E+00	--	--	--	--	--
Chloroform		67663	3.60E-07	1.00E-02	6.10E-03	2.00E+00	9.42E-09	5.00E-05	< 1%	4.36E-11	< 1%
1,2-Dichloroethylene (cis)	(1)	156592	9.00E-07	9.00E-03	--	2.00E+00	1.79E-08	1.05E-04	< 1%	--	--
Dibromochloromethane		124481	--	1.50E-02	1.12E-01	2.00E+00	--	--	--	--	--
Ethylbenzene		100414	7.40E-06	8.50E-02	--	2.00E+00	2.02E-05	1.26E-02	2%	--	--
Methylene chloride		75092	1.40E-05	5.88E-02	7.65E-03	2.00E+00	1.62E-07	1.47E-04	< 1%	9.43E-10	< 1%
Tetrachloroethylene		127184	6.10E-06	1.00E-02	5.78E-02	2.00E+00	8.37E-06	4.45E-02	6%	3.67E-07	57%
Toluene		108883	6.44E-06	1.80E-01	--	2.00E+00	1.68E-05	4.95E-03	< 1%	--	--
Trichloroethene		79016	3.60E-06	--	1.22E-02	2.00E+00	2.57E-06	--	--	2.38E-08	4%
Xylenes (Total)	(2)	1330207	3.60E-06	1.80E+00	--	2.00E+00	7.83E-07	2.31E-05	< 1%	--	--
Semivolatile Organic Compounds											
2-Methylnaphthalene		91576	4.93E-04	--	--	2.00E+00	2.20E-04	--	--	--	--
Acenaphthene		83329	2.50E-06	1.20E-02	--	2.00E+00	1.15E-06	5.09E-03	< 1%	--	--
Benz[a]anthracene		56553	1.20E-06	--	1.83E+00	2.00E+00	8.35E-09	--	--	1.16E-08	2%
Benzyl butyl phthalate		85687	5.30E-05	1.00E-01	--	2.00E+00	1.18E-04	6.24E-02	8%	--	--
Bis(2-ethylhexyl)phthalate		117817	1.07E-05	1.00E-02	2.80E-02	2.00E+00	4.48E-06	2.38E-02	3%	9.53E-08	15%
Di-N-Butylphthalate		84742	1.64E-06	9.00E-02	--	2.00E+00	4.62E-06	2.72E-03	< 1%	--	--
Dibenzofuran		132649	3.07E-06	--	--	2.00E+00	1.75E-06	--	--	--	--

332503

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL CONTACT WITH GROUNDWATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations	
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT		Intake Factor = (SA × EF × ED)/(BW × AT)	
Chemical Concentration$_{soil}$	chem-spec	mg/cm3	Noncarcinogenic Intake Factor (NIF)	
Absorption Factor	chem-spec	unitless	= 5.31E+01	kg/kg-day
Skin Surface Area	5,800	cm2	Carcinogenic Intake Factor (CIF)	
Dermal Permeability constant	chem-spec	cm/hr	= 7.59E-01	kg/kg-day
Exposure Frequency (EF)	234	days/yr	RfDd = Dermal Reference Dose value	
Exposure Duration (ED)	1	yrs	SFd = Dermal Slope Factor value	
Exposure Time (ET)	2	hr/day	Hazard Quotient = (NIF × DA) ÷ (RfDd)	
Body Weight (BW)	70	kg	Cancer Risk = CIF ×DA × SFd	
Avging Time, Noncar (ATN)	365	days		
Avging Time, Carcin (ATC)	25550	days		
Conversion Factor (CF)	0.001	L/cm3		

Chemical	CAS No.	Exposure Conc. (mg/cm3)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Fluorene	86737	1.73E-06	8.00E-03	--	2.00E+00	1.00E-06	6.64E-03	< 1%	--	--
Isophorone	78591	1.29E-05	1.86E-01	1.02E-03	2.00E+00	1.75E-07	4.99E-05	< 1%	1.35E-10	< 1%
Naphthalene	91203	7.20E-06	--	--	2.00E+00	1.53E-06	--	--	--	--
Phenol	108952	9.30E-06	5.40E-01	--	2.00E+00	2.03E-07	1.99E-05	< 1%	--	--
Pyrene	129000	1.10E-06	1.20E-02	--	2.00E+00	1.71E-06	7.57E-03	< 1%	--	--
Metals										
Aluminum	7429905	4.96E-02	--	--	2.00E+00	9.92E-05	--	--	--	--
Arsenic	7440382	4.60E-05	2.40E-04	1.88E+00	2.00E+00	9.20E-08	2.04E-02	3%	1.31E-07	20%
Barium	7440393	4.56E-03	3.50E-03	--	2.00E+00	9.12E-06	1.38E-01	18%	--	--
Beryllium	7440417	4.00E-06	5.00E-05	1.90E+00	2.00E+00	8.00E-09	8.50E-03	1%	1.15E-08	2%
Cadmium	7440439	--	1.00E-05	--	2.00E+00	--	--	--	--	--
Chromium	16065831	6.50E-05	2.00E-02	--	2.00E+00	1.30E-07	3.45E-04	< 1%	--	--
Cobalt	7440484	--	--	--	2.00E+00	--	--	--	--	--
Copper	7440508	7.00E-05	--	--	2.00E+00	1.40E-07	--	--	--	--
Lead	7439921	1.61E-04	--	--	2.00E+00	3.22E-07	--	--	--	--
Manganese	7439965	1.86E-03	6.90E-04	--	2.00E+00	3.72E-06	2.86E-01	37%	--	--
Nickel	7440020	7.82E-06	8.00E-04	--	2.00E+00	1.56E-08	1.04E-03	< 1%	--	--
Silver	7440224	--	1.00E-03	--	2.00E+00	--	--	--	--	--
Vanadium	7440622	1.02E-04	7.00E-05	--	2.00E+00	2.04E-07	1.55E-01	20%	--	--
Zinc	7440666	1.08E-04	7.50E-02	--	2.00E+00	2.16E-07	1.53E-04	< 1%	--	--

(1)Pc for trans 1,2-dichloroethylene used
(2) const: r m-xylene used

	Hazard Index	Cancer Risk
Pathway Sum:	7.81E-01	17

002504

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec mg/kg	Noncarcinogenic Intake Factor (NIF)
Ingestion Rate (IR)	480 mg/day	= 4.70E-06 kg/kg-day
Fraction Ingested (FI)	1 unitless	Carcinogenic Intake Factor (CIF)
Exposure Frequency (EF)	250 days/yr	= 6.71E-08 kg/kg-day
Exposure Duration (ED)	1 yrs	RfD = Oral Reference Dose value
Body Weight (BW)	70 kg	SF = Oral Slope Factor value
Avging Time, Noncar (ATN)	365 days	Hazard Quotient = (Conc$_{soil}$ × NIF) ÷ (RfD)
Avging Time, Carcin (ATC)	25550 days	Cancer Risk = Conc$_{soil}$ × CIF × SF
Conversion Factor (CF)	0.000001 kg/mg	

Chemical	CAS No.	Exposure Conc. (mg/kg)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds								
1,2,3,4-Tetramethylbenzene	488233	1.90E+01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	562738	9.60E+00	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95636	2.80E+01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	1.40E+01	--	--	--	--	--	--
Acetone	67641	3.40E-02	1.00E-01	--	1.60E-06	< 1%	--	--
Benzene	71432	2.40E-03	--	2.90E-02	--	--	4.67E-12	< 1%
Chlorobenzene	108907	2.40E+00	2.00E-02	--	5.64E-04	< 1%	--	--
Ethylbenzene	100414	3.00E+01	1.00E-01	--	1.41E-03	< 1%	--	--
Methylene chloride	75092	1.60E-02	6.00E-02	7.50E-03	1.25E-06	< 1%	8.05E-12	< 1%
Toluene	108883	2.50E+00	2.00E-01	--	5.87E-05	< 1%	--	--
Xylenes (Total)	1330207	5.60E+01	2.00E+00	--	1.32E-04	< 1%	--	--
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	120821	5.30E-02	1.00E-02	--	2.49E-05	< 1%	--	--
1,4-Dichlorobenzene	106467	5.30E-02	--	2.40E-02	--	--	8.53E-11	< 1%
2-Chlorophenol	95578	1.00E-01	5.00E-03	--	9.39E-05	< 1%	--	--
2-Methylnaphthalene	91576	4.60E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59507	9.80E-02	--	--	--	--	--	--
Acenaphthene	83329	5.90E-02	6.00E-02	--	4.62E-06	< 1%	--	--
Di-n-butylphthalate	84742	6.80E-02	1.00E-01	--	3.19E-06	< 1%	--	--
Fluorene	86737	2.50E-02	4.00E-02	--	2.94E-06	< 1%	--	--
Hexachlorobenzene	118741	4.60E-01	8.00E-04	1.60E+00	2.70E-03	< 1%	4.94E-08	4%
N-Nitroso-di-n-propylamine	621647	5.40E-02	--	7.00E+00	--	--	2.54E-08	2%
Naphthalene	91203	2.90E+00	--	--	--	--	--	--
Phenol	108952	1.20E-01	6.00E-01	--	9.39E-07	< 1%	--	--
Pyrene	129000	4.90E-02	3.00E-02	--	7.67E-06	< 1%	--	--
Metals								
Arsenic	7440382	1.20E+01	3.00E-04	1.50E+00	1.88E-01	65%	1.21E-06	94%

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	
Chemical Concentration$_{soil}$	chem-spec	mg/kg
Ingestion Rate (IR)	480	mg/day
Fraction Ingested (FI)	1	unitless
Exposure Frequency (EF)	250	days/yr
Exposure Duration (ED)	1	yrs
Body Weight (BW)	70	kg
Avging Time, Noncar (ATN)	365	days
Avging Time, Carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 4.70E-06 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 6.71E-08 kg/kg-day

RfD = Oral Reference Dose value

SF = Oral Slope Factor value

Hazard Quotient = (Conc$_{soil}$ × NIF) ÷ (RfD)

Cancer Risk = Conc$_{soil}$ × CIF × SF

Chemical	CAS No.	Exposure Conc. (mg/kg)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Barium	7440393	1.30E+02	7.00E-02	--	8.72E-03	3%	--	--
Cadmium	7440439	1.50E+00	5.00E-04	--	1.41E-02	5%	--	--
Copper	7440508	6.60E+01	--	--	--	--	--	--
Lead	7439921	3.60E+01	--	--	--	--	--	--
Manganese	7439965	3.60E+02	2.30E-02	--	7.35E-02	25%	--	--
Zinc	7440666	3.30E+01	3.00E-01	--	5.17E-04	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	2.90E-01	1.28E-06

332505

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT	Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec mg/kg	Noncarcinogenic Intake Factor (NIF)
Ingestion Rate (IR)	50 mg/day	= 4.58E-07 kg/kg-day
Fraction Ingested (FI)	1 unitless	Carcinogenic Intake Factor (CIF)
Exposure Frequency (EF)	234 days/yr	= 6.54E-09 kg/kg-day
Exposure Duration (ED)	1 yrs	RfD = Oral Reference Dose value
Body Weight (BW)	70 kg	SF = Oral Slope Factor value
Avging Time, Noncar (ATN)	365 days	Hazard Quotient = (Conc$_{soil}$ × NIF) ÷ (RfD)
Avging Time, Carcin (ATC)	25550 days	Cancer Risk = Conc$_{soil}$ × CIF × SF
Conversion Factor (CF)	0.000001 kg/mg	USEPA RAGS, 1989

Chemical	CAS No.	Exposure Conc. (mg/kg)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
ORGANICS								
1,2,3,4-Tetramethylbenzene	488233	1.90E+01	--	--	--	--	--	--
1,2,3-Trimethylbenzene	562738	9.60E+00	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95636	2.80E+01	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	1.40E+01	--	--	--	--	--	--
Acetone	67641	3.40E-02	1.00E-01	--	1.56E-07	< 1%	--	--
Benzene	71432	2.40E-03	--	2.90E-02	--	--	4.55E-13	< 1%
Chlorobenzene	108907	2.40E+00	2.00E-02	--	5.50E-05	< 1%	--	--
Ethylbenzene	100414	3.00E+01	1.00E-01	--	1.37E-04	< 1%	--	--
Methylene chloride	75092	1.60E-02	6.00E-02	7.50E-03	1.22E-07	< 1%	7.85E-13	< 1%
Toluene	108883	2.50E+00	2.00E-01	--	5.72E-06	< 1%	--	--
Xylenes (Total)	1330207	5.60E+01	2.00E+00	--	1.28E-05	< 1%	--	--
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	120821	5.30E-02	1.00E-02	--	2.43E-06	< 1%	--	--
1,4-Dichlorobenzene	106467	5.30E-02	--	2.40E-02	--	--	8.32E-12	< 1%
2-Chlorophenol	95578	1.00E-01	5.00E-03	--	9.16E-06	< 1%	--	--
2-Methylnaphthalene	91576	4.60E-01	--	--	--	--	--	--
4-Chloro-3-methylphenol	59507	9.80E-02	--	--	--	--	--	--
Acenaphthene	83329	5.90E-02	6.00E-02	--	4.50E-07	< 1%	--	--
Di-n-butylphthalate	84742	6.80E-02	1.00E-01	--	3.11E-07	< 1%	--	--
Fluorene	86737	2.50E-02	4.00E-02	--	2.86E-07	< 1%	--	--
Hexachlorobenzene	118741	4.60E-01	8.00E-04	1.60E+00	2.63E-04	< 1%	4.81E-09	4%
N-Nitroso-di-n-propylamine	621647	5.40E-02	--	7.00E+00	--	--	2.47E-09	2%
Naphthalene	91203	2.90E+00	--	--	--	--	--	--
Phenol	108952	1.20E-01	6.00E-01	--	9.16E-08	< 1%	--	--
Pyrene	129000	4.90E-02	3.00E-02	--	7.48E-07	< 1%	--	--
Metals								
Arsenic	7440382	1.20E+01	3.00E-04	1.50E+00	1.83E-02	65%	1.18E-07	94%

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- INGESTION OF SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT	
Chemical Concentration$_{soil}$	chem-spec	mg/kg
Ingestion Rate (IR)	50	mg/day
Fraction Ingested (FI)	1	unitless
Exposure Frequency (EF)	234	days/yr
Exposure Duration (ED)	1	yrs
Body Weight (BW)	70	kg
Avging Time, Noncar (ATN)	365	days
Avging Time, Carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (IR × FI × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 4.58E-07 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 6.54E-09 kg/kg-day

RfD = Oral Reference Dose value

SF = Oral Slope Factor value

Hazard Quotient = (Conc$_{soil}$ × NIF) ÷ (RfD)

Cancer Risk = Conc$_{soil}$ × CIF × SF

USEPA RAGS, 1989

Chemical	CAS No.	Exposure Conc. (mg/kg)	Oral RfD (mg/kg-d)	Oral SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Barium	7440393	1.30E+02	7.00E-02	--	8.50E-04	3%	--	--
Cadmium	7440439	1.50E+00	5.00E-04	--	1.37E-03	5%	--	--
Copper	7440508	6.60E+01	--	--	--	--	--	--
Lead	7439921	3.60E+01	--	--	--	--	--	--
Manganese	7439965	3.60E+02	2.30E-02	--	7.17E-03	25%	--	--
Zinc	7440666	3.30E+01	3.00E-01	--	5.04E-05	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	2.82E-02	1.25E-07

Toxicity data are presented in this appendix. A dashed line (--) indicates toxicity data are unavailable.

332503

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
Chemical Concentration$_{soil}$	chem-spec mg/kg
Dermal Absorption Factor (DABS)	chem-spec unitless
Soil-skin Adherance (AF)	1.0 mg/cm²-day
Skin Surface Area (SA)	5800 cm²
Exposure Frequency (EF)	250 days/yr
Exposure Duration (ED)	1 yrs
Body Weight (BW)	70 kg
Avging Time, Noncar (ATN)	365 days
Avging Time, Carcin (ATC)	25550 days
Conversion Factor (CF)	0.000001 kg/mg

Intake Equations

Intake Factor = (SA × AF × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 5.68E-05 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 8.11E-07 kg/kg-day

RfD = Dermal Reference Dose -- Absorbed dose

SF = Dermal Slope Factor -- Absorbed dose

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc$_{soil}$ × NIF × DABS) ÷ (RfD)

Cancer Risk = Conc$_{soil}$ × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc. (mg/kg)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	DABS	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds									
1,2,3,4-Tetramethylbenzene	488233	1.90E+01	--	--	0.250	--	--	--	--
1,2,3-Trimethylbenzene	562738	9.60E+00	--	--	0.250	--	--	--	--
1,2,4-Trimethylbenzene	95636	2.80E+01	--	--	0.250	--	--	--	--
1,3,5-Trimethylbenzene	108678	1.40E+01	--	--	0.250	--	--	--	--
Acetone	67641	3.40E-02	9.00E-02	--	0.250	5.36E-06	< 1%	--	--
Benzene	71432	2.40E-03	--	3.05E-02	0.250	--	--	1.48E-11	< 1%
Chlorobenzene	108907	2.40E+00	6.00E-03	--	0.250	5.68E-03	1%	--	--
Ethylbenzene	100414	3.00E+01	8.50E-02	--	0.250	5.01E-03	1%	--	--
Methylene chloride	75092	1.60E-02	5.88E-02	7.65E-03	0.250	3.86E-06	< 1%	2.48E-11	< 1%
Toluene	108883	2.50E+00	1.80E-01	--	0.250	1.97E-04	< 1%	--	--
Xylenes (Total)	1330207	5.60E+01	1.80E+00	--	0.250	4.41E-04	< 1%	--	--
Semivolatile Organic Compounds									
1,2,4-Trichlorobenzene	120821	5.30E-02	2.00E-03	--	0.100	1.50E-04	< 1%	--	--
1,4-Dichlorobenzene	106467	5.30E-02	--	2.40E-02	0.100	--	--	1.03E-10	< 1%
2-Chlorophenol	95578	1.00E-01	1.00E-03	--	0.100	5.68E-04	< 1%	--	--
2-Methylnaphthalene	91576	4.60E-01	--	--	0.150	--	--	--	--
4-Chloro-3-methylphenol	59507	9.80E-02	--	--	0.100	--	--	--	--
Acenaphthene	83329	5.90E-02	1.20E-02	--	0.150	4.19E-05	< 1%	--	--
Di-n-butylphthalate	84742	6.80E-02	9.00E-02	--	0.100	4.29E-06	< 1%	--	--
Fluorene	86737	2.50E-02	8.00E-03	--	0.100	1.77E-05	< 1%	--	--
Hexachlorobenzene	118741	4.60E-01	1.60E-04	8.00E+00	0.100	1.63E-02	4%	2.98E-07	30%
N-Nitroso-di-n-propylamine	621647	5.40E-02	--	3.50E+01	0.100	--	--	1.53E-07	15%
Naphthalene	91203	2.90E+00	--	--	0.150	--	--	--	--
Phenol	108952	1.20E-01	5.40E-01	--	0.100	1.26E-06	< 1%	--	--
Pyrene	129000	4.90E-02	1.20E-02	--	0.150	3.48E-05	< 1%	--	--
Metals									
Arsenic	7440382	1.20E+01	2.40E-04	1.88E+00	0.030	8.51E-02	19%	5.47E-07	55%

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions

Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	
Chemical Concentration$_{soil}$	chem-spec	mg/kg
Dermal Absorption Factor (DABS)	chem-spec	unitless
Soil-skin Adherance (AF)	1.0	mg/cm²-day
Skin Surface Area (SA)	5800	cm²
Exposure Frequency (EF)	250	days/yr
Exposure Duration (ED)	1	yrs
Body Weight (BW)	70	kg
Avging Time, Noncar (ATN)	365	days
Avging Time, Carcin (ATC)	25550	days
Conversion Factor (CF)	0.000001	kg/mg

Intake Equations

Intake Factor = (SA × AF × EF × ED × CF)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)

= 5.68E-05 kg/kg-day

Carcinogenic Intake Factor (CIF)

= 8.11E-07 kg/kg-day

RfD = Dermal Reference Dose – Absorbed dose

SF = Dermal Slope Factor – Absorbed dose

DABS = Dermal Absorption Percentages

Hazard Quotient = (Conc$_{soil}$ × NIF × DABS) ÷ (RfD)

Cancer Risk = Conc$_{soil}$ × CIF × DABS × SF

Chemical	CAS No.	Exposure Conc. (mg/kg)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	DABS	Hazard Quotient	% of Total	Cancer Risk	% of Total
Barium	7440393	1.30E+02	3.50E-03	--	0.010	2.11E-02	5%	--	--
Cadmium	7440439	1.50E+00	1.00E-05	--	0.001	8.51E-03	2%	--	--
Copper	7440508	6.60E+01	--	--	0.010	--	--	--	--
Lead	7439921	3.60E+01	--	--	0.100	--	--	--	--
Manganese	7439965	3.60E+02	6.90E-04	--	0.010	2.96E-01	67%	--	--
Zinc	7440666	3.30E+01	7.50E-02	--	0.010	2.50E-04	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	4.39E-01	9.99E-07

332510

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT	Intake Factor = (SA × AF × EF × ED × CF)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec mg/kg	Noncarcinogenic Intake Factor (NIF)
Dermal Absorption Factor (DABS)	chem-spec unitless	= 9.16E-06 kg/kg-day
Soil-skin Adherance (AF)	0.20 mg/cm²-day	Carcinogenic Intake Factor (CIF)
Skin Surface Area (SA)	5000 cm²	= 1.31E-07 kg/kg-day
Exposure Frequency (EF)	234 days/yr	RfD = Dermal Reference Dose -- Absorbed dose
Exposure Duration (ED)	1 yrs	SF = Dermal Slope Factor -- Absorbed dose
Body Weight (BW)	70 kg	DABS = Dermal Absorption Percentages
Avging Time, Noncar (ATN)	365 days	Hazard Quotient = (Conc$_{soil}$ × NIF × DABS) ÷ (RfD)
Avging Time, Carcin (ATC)	25550 days	Cancer Risk = Conc$_{soil}$ × CIF × DABS × SF
Conversion Factor (CF)	0.000001 kg/mg	

Chemical	CAS No.	Exposure Conc. (mg/kg)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	DABS	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds									
1,2,3,4-Tetramethylbenzene	488233	1.90E+01	--	--	0.250	--	--	--	--
1,2,3-Trimethylbenzene	562738	9.60E+00	--	--	0.250	--	--	--	--
1,2,4-Trimethylbenzene	95636	2.80E+01	--	--	0.250	--	--	--	--
1,3,5-Trimethylbenzene	108678	1.40E+01	--	--	0.250	--	--	--	--
Acetone	67641	3.40E-02	9.00E-02	--	0.250	8.65E-07	< 1%	--	--
Benzene	71432	2.40E-03	--	3.05E-02	0.250	--	--	2.40E-12	< 1%
Chlorobenzene	108907	2.40E+00	6.00E-03	--	0.250	9.16E-04	1%	--	--
Ethylbenzene	100414	3.00E+01	8.50E-02	--	0.250	8.08E-04	1%	--	--
Methylene chloride	75092	1.60E-02	5.88E-02	7.65E-03	0.250	6.23E-07	< 1%	4.01E-12	< 1%
Toluene	108883	2.50E+00	1.80E-01	--	0.250	3.18E-05	< 1%	--	--
Xylenes (Total)	1330207	5.60E+01	1.80E+00	--	0.250	7.12E-05	< 1%	--	--
Semivolatile Organic Compounds									
1,2,4-Trichlorobenzene	120821	5.30E-02	2.00E-03	--	0.100	2.43E-05	< 1%	--	
1,4-Dichlorobenzene	106467	5.30E-02	--	2.40E-02	0.100	--	--	1.66E-11	< 1%
2-Chlorophenol	95578	1.00E-01	1.00E-03	--	0.100	9.16E-05	< 1%	--	--
2-Methylnaphthalene	91576	4.60E-01	--	--	0.150	--	--	--	--
4-Chloro-3-methylphenol	59507	9.80E-02	--	--	0.100	--	--	--	--
Acenaphthene	83329	5.90E-02	1.20E-02	--	0.150	6.75E-06	< 1%	--	--
Di-n-butylphthalate	84742	6.80E-02	9.00E-02	--	0.100	6.92E-07	< 1%	--	--
Fluorene	86737	2.50E-02	8.00E-03	--	0.100	2.86E-06	< 1%	--	--
Hexachlorobenzene	118741	4.60E-01	1.60E-04	8.00E+00	0.100	2.63E-03	4%	4.81E-08	30%
N-Nitroso-di-n-propylamine	621647	5.40E-02	--	3.50E+01	0.100	--	--	2.47E-08	15%
Naphthalene	91203	2.90E+00	--	--	0.150	--	--	--	--
Phenol	108952	1.20E-01	5.40E-01	--	0.100	2.04E-07	< 1%	--	--
Pyrene	129000	4.90E-02	1.20E-02	--	0.150	5.61E-06	< 1%	--	--
Metals									< 1%

332511

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- DERMAL EXPOSURE TO SURFACE/SUBSURFACE SOIL
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT		Intake Factor = (SA × AF × EF × ED × CF)/(BW × AT)
Chemical Concentration$_{soil}$	chem-spec	mg/kg	Noncarcinogenic Intake Factor (NIF)
Dermal Absorption Factor (DABS)	chem-spec	unitless	= 9.16E-06 kg/kg-day
Soil-skin Adherance (AF)	0.20	mg/cm²-day	Carcinogenic Intake Factor (CIF)
Skin Surface Area (SA)	5000	cm²	= 1.31E-07 kg/kg-day
Exposure Frequency (EF)	234	days/yr	RfD = Dermal Reference Dose -- Absorbed dose
Exposure Duration (ED)	1	yrs	SF = Dermal Slope Factor -- Absorbed dose
Body Weight (BW)	70	kg	DABS = Dermal Absorption Percentages
Avging Time, Noncar (ATN)	365	days	Hazard Quotient = (Conc$_{soil}$ × NIF × DABS) ÷ (RfD)
Avging Time, Carcin (ATC)	25550	days	Cancer Risk = Conc$_{soil}$ × CIF × DABS × SF
Conversion Factor (CF)	0.000001	kg/mg	

Chemical	CAS No.	Exposure Conc. (mg/kg)	Derm RfD (mg/kg-d)	Derm SF (kg-d/mg)	DABS	Hazard Quotient	% of Total	Cancer Risk	% of Total
Arsenic	7440382	1.20E+01	2.40E-04	1.88E+00	0.030	1.37E-02	19%	8.83E-08	55%
Barium	7440393	1.30E+02	3.50E-03	--	0.010	3.40E-03	5%	--	--
Cadmium	7440439	1.50E+00	1.00E-05	--	0.001	1.37E-03	2%	--	--
Copper	7440508	6.60E+01	--	--	0.010	--	--	--	--
Lead	7439921	3.60E+01	--	--	0.100	--	--	--	--
Manganese	7439965	3.60E+02	6.90E-04	--	0.010	4.78E-02	67%	--	--
Zinc	7440666	3.30E+01	7.50E-02	--	0.010	4.03E-05	< 1%	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	7.09E-02	1.61E-07

322512

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF PARTICULATES
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		Intake Equations
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME	Intake Factor = (IR × ED × EF × ET)/(BW × AT)
Chemical Concentration$_{air}$	chem-spec conc. in soil (mg/kg) ÷ PEF (m3/kg)	Noncarcinogenic Intake Factor (NIF)
Inhalation Rate (IR)	2.5 m³/HR	= 1.96E-01 m^3/kg-day
Exposure Frequency (EF)	250 days/yr	Carcinogenic Intake Factor (CIF)
Exposure Duration (ED)	1 yrs	= 2.80E-03 m^3/kg-day
Exposure Time (ET)	8 hrs/day	RfDi = Inhalation Reference Dose
Body Weight (BW)	70 kg	SFi = Inhalation Slope Factor
Avging Time, Noncar (ATN)	365 days	Hazard Quotient = (Conc$_{air}$ × NIF) ÷ (RfDi)
Avging Time, Carcin (ATC)	25550 days	Cancer Risk = (Conc$_{air}$ × CIF × SFi)
Particulate Emission Factor (PEF)	5.74E+08 m3/kg	

Chemical	CAS No.	Exposure Conc.(mg/m^3)	Inhalation RfD (mg/kg-day)	Inhalation SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	120821	9.23E-11	5.71e-02	--	3.16E-10	< 1%	--	--
1,4-Dichlorobenzene	106467	9.23E-11	2.29E-01	--	7.89E-11	< 1%	--	--
2-Chlorophenol	95578	1.74E-10	--	--	--	--	--	--
2-Methylnaphthalene	91576	8.01E-10	5.00E-02	--	3.14E-09	< 1%	--	--
4-Chloro-3-methylphenol	59507	1.71E-10	--	7.30E-03	--	--	3.48E-15	< 1%
Acenaphthene	83329	1.03E-10	--	--	--	--	--	--
Di-n-butylphthalate	84742	1.18E-10	1.00E-02	--	2.32E-09	< 1%	--	--
Fluorene	86737	4.36E-11	--	--	--	--	--	--
Hexachlorobenzene	118741	8.01E-10	--	1.61E+00	--	--	3.61E-12	< 1%
N-Nitroso-di-n-propylamine	621647	9.41E-11	--	--	--	--	--	--
Naphthalene	91203	5.05E-09	--	--	--	--	--	--
Phenol	108952	2.09E-10	--	--	--	--	--	--
Pyrene	129000	8.54E-11	--	--	--	--	--	--
Metals								
Arsenic	7440382	2.09E-08	--	1.51E+01	--	--	8.83E-10	95%
Barium	7440393	2.26E-07	1.43E-04	--	3.10E-04	3%	--	--
Cadmium	7440439	2.61E-09	5.71E-05	6.30E+00	8.96E-06	< 1%	4.60E-11	5%
Copper	7440508	1.15E-07	--	--	--	--	--	--
Lead	7439921	6.27E-08	--	--	--	--	--	--
Manganese	7439965	6.27E-07	1.43e-05	--	8.58E-03	96%	--	--
Zinc	7440666	5.75E-08	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	8.90E-03	9.32E-10

232513

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF PARTICULATES
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
Chemical Concentration$_{air}$	chem-spec conc. in soil (mg/kg) x PM_{10} (kg/m^3)
Inhalation Rate (IR)	1.4 m^3/HR
Exposure Frequency (EF)	234 days/yr
Exposure Duration (ED)	1 yrs
Exposure Time (ET)	8 hrs/day
Body Weight (BW)	70 kg
Avging Time, Noncar (ATN)	365 days
Avging Time, Carcin (ATC)	25550 days
Particulate Emission Factor (PEF)	6E+08 m3/kg

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)

= 1.03E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)

= 1.47E-03 m^3/kg-day

RfDi = Inhalation Reference Dose

SFi = Inhalation Slope Factor

Hazard Quotient = (Conc$_{air}$ × NIF) ÷ (RfDi)

Cancer Risk = (Conc$_{air}$ × CIF × SFi)

Chemical	CAS No.	Exposure Conc.(mg/m^3)	Inhalation RfD (mg/kg-day)	Inhalation SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	120821	9.23E-11	5.71e-02	--	1.66E-10	< 1%	--	--
1,4-Dichlorobenzene	106467	9.23E-11	2.29E-01	--	4.14E-11	< 1%	--	--
2-Chlorophenol	95578	1.74E-10	--	--	--	--	--	--
2-Methylnaphthalene	91576	8.01E-10	5.00E-02	--	1.64E-09	< 1%	--	--
4-Chloro-3-methylphenol	59507	1.71E-10	--	7.30E-03	--	--	1.83E-15	< 1%
Acenaphthene	83329	1.03E-10	--	--	--	--	--	--
Di-n-butylphthalate	84742	1.18E-10	1.00E-02	--	1.22E-09	< 1%	--	--
Fluorene	86737	4.36E-11	--	--	--	--	--	--
Hexachlorobenzene	118741	8.01E-10	--	1.61E+00	--	--	1.89E-12	< 1%
N-Nitroso-di-n-propylamine	621647	9.41E-11	--	--	--	--	--	--
Naphthalene	91203	5.05E-09	--	--	--	--	--	--
Phenol	108952	2.09E-10	--	--	--	--	--	--
Pyrene	129000	8.54E-11	--	--	--	--	--	--
Metals								
Arsenic	7440382	2.09E-08	--	1.51E+01	--	--	4.63E-10	95%
Barium	7440393	2.26E-07	1.43E-04	--	1.62E-04	3%	--	--
Cadmium	7440439	2.61E-09	5.71E-05	6.30E+00	4.69E-06	< 1%	2.41E-11	5%
Copper	7440508	1.15E-07	--	--	--	--	--	--
Lead	7439921	6.27E-08	--	--	--	--	--	--
Manganese	7439965	6.27E-07	1.43e-05	--	4.50E-03	96%	--	--
Zinc	7440666	5.75E-08	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	4.67E-03	4.[illegible]0

325514

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF SOIL VOLATILES
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions	
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - RME
Chemical Concentration$_{air}$	chem-spec conc. in soil (mg/kg) ÷ VF (m3/kg)
Inhalation Rate (IR)	2.5 m³/hr
Exposure Frequency (EF)	250 days/yr
Exposure Duration (ED)	1 yrs
Exposure Time (ET)	8 hrs/day
Body Weight (BW)	70 kg
Avging Time, Noncar (ATN)	365 days
Avging Time, Carcin (ATC)	25550 days
Volatilization Factor (VF)	chem-spec m^3/kg

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 1.96E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)
= 2.80E-03 m^3/kg-day

RfC = Reference Concentration
IUR = Inhalation Unit Risk
Hazard Quotient = (Conc$_{air}$ × NIF) ÷ (RfD)
Cancer Risk = (Conc$_{air}$ × CIF × SF)

Chemical	CAS No.	Exposure Conc.(mg/m^3)	VF (m^3/kg)	Inhalation RfD (mg/kg-day)	Inhalation SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds									
1,2,3,4-Tetramethylbenzene	488233	--	--	--	--	--	--	--	--
1,2,3-Trimethylbenzene	562738	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95636	--	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	--	--	--	--	--	--	--	--
Acetone	67641	1.79E-06	1.90E+04	--	--	--	--	--	--
Benzene	71432	3.58E-07	6.70E+03	1.71E-03	2.90E-02	4.10E-05	< 1%	2.90E-11	1%
Chlorobenzene	108907	1.14E-04	2.10E+04	5.71E-03	--	3.92E-03	64%	--	--
Ethylbenzene	100414	2.73E-03	1.10E+04	2.86E-01	--	1.87E-03	30%	--	--
Methylene chloride	75092	4.85E-06	3.30E+03	8.57E-01	1.64E-03	1.11E-06	< 1%	2.22E-11	1%
Toluene	108883	1.92E-04	1.30E+04	1.14E-01	--	3.30E-04	5%	--	--
Xylenes (Total)	1330207	1.37E-03	4.10E+04	--	--	--	--	--	--
1,2,4-Trichlorobenzene	120821	3.53E-07	1.50E+05	5.71e-02	--	1.21E-06	< 1%	--	--
1,4-Dichlorobenzene	106467	1.20E-06	4.40E+04	2.29E-01	--	1.03E-06	< 1%	--	--
Acenaphthene	83329	4.21E-07	1.40E+05	--	--	--	--	--	--
Di-n-butylphthalate	84742	7.12E-08	9.55E+05	1.00E-01	--	1.39E-07	< 1%	--	--
Fluorene	86737	3.29E-08	7.60E+05	--	--	--	--	--	--
Hexachlorobenzene	118741	4.82E-07	9.55E+05	--	1.61E+00	--	--	2.17E-09	98%
Naphthalene	91203	4.08E-05	7.10E+04	--	--	--	--	--	--
Pyrene	129000	--	--	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	6.16E-03	2.22E-09

032515

APPENDIX
CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT
CARCINOGENIC AND NONCARCINOGENIC RISK -- INHALATION OF SOIL VOLATILES
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CURRENT/FUTURE ONSITE INTRUSIVE WORKER - CT	
Chemical Concentration$_{air}$	chem-spec conc. in soil (mg/kg) ÷ VF (m^3/kg)	
Inhalation Rate (IR)	1.4	m^3/hr
Exposure Frequency (EF)	234	days/yr
Exposure Duration (ED)	1	yrs
Exposure Time (ET)	8	hrs/day
Body Weight (BW)	70	kg
Avging Time, Noncar (ATN)	365	days
Avging Time, Carcin (ATC)	25550	days
Volatilization Factor (VF)	chem-spec	m^3/kg

Intake Equations

Intake Factor = (IR × ED × EF × ET)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 1.03E-01 m^3/kg-day

Carcinogenic Intake Factor (CIF)
= 1.47E-03 m^3/kg-day

RfC = Reference Concentration

IUR = Inhalation Unit Risk

Hazard Quotient = (Conc$_{air}$ × NIF) ÷ (RfD)

Cancer Risk = (Conc$_{air}$ × CIF × SF)

Chemical	CAS No.	Exposure Conc.(mg/m^3)	VF (m^3/kg)	Inhalation RfD (mg/kg-day)	Inhalation SF (kg-d/mg)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds									
1,2,3,4-Tetramethylbenzene	488233	--	--	--	--	--	--	--	--
1,2,3-Trimethylbenzene	562738	--	--	--	--	--	--	--	--
1,2,4-Trimethylbenzene	95636	--	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	--	--	--	--	--	--	--	--
Acetone	67641	1.79E-06	1.90E+04	--	--	--	--	--	--
Benzene	71432	3.58E-07	6.70E+03	1.71E-03	2.90E-02	2.15E-05	< 1%	1.52E-11	1%
Chlorobenzene	108907	1.14E-04	2.10E+04	5.71E-03	--	2.05E-03	64%	--	--
Ethylbenzene	100414	2.73E-03	1.10E+04	2.86E-01	--	9.78E-04	30%	--	--
Methylene chloride	75092	4.85E-06	3.30E+03	8.57E-01	1.64E-03	5.80E-07	< 1%	1.17E-11	1%
Toluene	108883	1.92E-04	1.30E+04	1.14E-01	--	1.73E-04	5%	--	--
Xylenes (Total)	1330207	1.37E-03	4.10E+04	--	--	--	--	--	--
1,2,4-Trichlorobenzene	120821	3.53E-07	1.50E+05	5.71e-02	--	6.35E-07	< 1%	--	--
1,4-Dichlorobenzene	106467	1.20E-06	4.40E+04	2.29E-01	--	5.40E-07	< 1%	--	--
Acenaphthene	83329	4.21E-07	1.40E+05	--	--	--	--	--	--
Di-n-butylphthalate	84742	7.12E-08	9.55E+05	1.00E-01	--	7.30E-08	< 1%	--	--
Fluorene	86737	3.29E-08	7.60E+05	--	--	--	--	--	--
Hexachlorobenzene	118741	4.82E-07	9.55E+05	--	1.61E+00	--	--	1.14E-09	98%
Naphthalene	91203	4.08E-05	7.10E+04	--	--	--	--	--	--
Pyrene	129000	--	--	--	--	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	3.23E-03	1.16E-09

032516

APPENDIX
CURRENT TRESSPASSER/FUTURE RECREATOR CHILD - RME
CARCINOGENIC AND NONCARCINOGENIC RISK
INCIDENTAL DERMAL EXPOSURE AND INCIDENTAL INGESTION FOR SURFACE WATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions

Receptor	CURRENT TRESSPASSER/FUTURE RECREATOR CHILD - RME	
Chemical Concentration	chem-spec	mg/L
Oral Absorption Factor (OAF)	chem-specific	unitless
Skin Surface Area (SA)	3434	cm2
Exposure Time (ET)	2.60	hrs/day
Exposure Frequency (EF)	90	days/yr
Exposure Duration (ED)	6	yrs
Body Weight (BW)	15	kg
Dermal Permeability Constant (PC)	chem-spec	cm/hr
Ingestion Rate (IR)	0.05	L/hr
Avging Time, Noncar (ATN)	2190	days
Avging Time, Carcin (ATC)	25550	days

Intake Equations

Intake Factor = (EF × ED)/(BW × AT)
Noncarcinogenic Intake Factor (NIF)
= 1.64E-02 kg/kg-day
Carcinogenic Intake Factor (CIF)
= 1.41E-03 kg/kg-day
RfDo = Oral Reference Dose value
RfDd = Dermal Reference Dose value (Rfdo x oral abs factor)
SFo = Oral Slope Factor value
SFd = Dermal Slope Factor value (SFo x oral abs factor)
CONCo= oral exposure concentration
Hazard Quotient = (NIF × [(CONCo × ET × IR / RfDo) + (SA × DA / RfDd)])
Cancer Risk = (CIF × [(CONCo × ET × IR × SFo) + (SA × DA × SFd)])

Chemical	CAS No.	Oral Exposure Conc. (mg/L)	Dermal Exposure Conc. (mg/cm3)	Oral RfD[a/] (mg/kg-d)	Oral SF[a/] (kg-d/mg)	Oral Abs. Factor	Dermal RfD (mg/kg-d)	Dermal SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds														
1,2,3,4-Tetramethylbenzene	488233	3.33E-02	3.33E-05	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
1,2,4-Trimethylbenzene	562738	2.10E-03	2.10E-06	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	7.00E-04	7.00E-07	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
Chlorobenzene	108907	9.00E-04	9.00E-07	2.00E-02	--	0.300	6.00E-03	--	2.60E+00	1.26E-07	1.28E-03	33%	--	--
Ethylbenzene	100414	5.00E-04	5.00E-07	1.00E-01	--	0.850	8.50E-02	--	2.60E+00	1.63E-06	1.09E-03	28%	--	--
Toluene	108883	1.50E-03	1.50E-06	2.00E-01	--	0.900	1.80E-01	--	2.60E+00	4.76E-06	1.51E-03	39%	--	--
Xylenes (Total)	1330207	1.20E-03	1.20E-06	2.00E+00	--	0.900	1.80E+00	--	2.60E+00	3.11E-07	1.10E-05	< 1%	--	--
Semivolatile Organic Compounds														
2-Methylnaphthalene	91576	4.00E-03	4.00E-06	--	--	0.200	--	--	2.60E+00	2.04E-06	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	3.89E-03	--

APPENDIX
CURRENT TRESSPASSER/FUTURE RECREATOR CHILD- CT
CARCINOGENIC AND NONCARCINOGENIC RISK --
INCIDENTAL DERMAL EXPOSURE AND INCIDENTAL INGESTION FOR SURFACE WATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CURRENT TRESSPASSER/FUTURE RECREATOR CHILD- CT	
Chemical Concentration	chem-spec	mg/L
Oral Absorption Factor (OAF)	chem-specific	unitless
Skin Surface Area (SA)	3434	cm2
Exposure Time (ET)	1.00	hrs/day
Exposure Frequency (EF)	40	days/yr
Exposure Duration (ED)	6	yrs
Body Weight (BW)	15	kg
Dermal Permeability Constant (PC)	chem-spec	cm/hr
Ingestion Rate (IR)	0.05	L/hr
Avging Time, Noncar (ATN)	2190	days
Avging Time, Carcin (ATC)	25550	days

Intake Equations

Intake Factor = (EF × ED)/(BW × AT)

Noncarcinogenic Intake Factor (NIF)
= 7.31E-03 kg/kg-day

Carcinogenic Intake Factor (CIF)
= 6.26E-04 kg/kg-day

RfDo = Oral Reference Dose value

RfDd = Dermal Reference Dose value (Rfdo x oral abs factor)

SFo = Oral Slope Factor value

SFd = Dermal Slope Factor value (SFo x oral abs factor)

CONCo= oral exposure concentration

Hazard Quotient = (NIF × [(CONCo × ET × IR / RfDo) + (SA × DA / RfDd)])

Cancer Risk = (CIF × [(CONCo × ET × IR × SFo) + (SA × DA × SFd)])

Chemical	CAS No.	Oral Exposure Conc. (mg/L)	Dermal Exposure Conc. (mg/cm3)	Oral RfD[a/] (mg/kg-d)	Oral SF[a/] (kg-d/mg)	Oral Abs. Factor	Dermal RfD (mg/kg-d)	Dermal SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds														
1,2,3,4-Tetramethylbenzene	488233	3.33E-02	3.33E-05	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
1,2,4-Trimethylbenzene	562738	2.10E-03	2.10E-06	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	7.00E-04	7.00E-07	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
Chlorobenzene	108907	9.00E-04	9.00E-07	2.00E-02	--	0.300	6.00E-03	--	1.00E+00	7.03E-08	3.11E-04	33%	--	--
Ethylbenzene	100414	5.00E-04	5.00E-07	1.00E-01	--	0.850	8.50E-02	--	1.00E+00	9.24E-07	2.75E-04	29%	--	--
Toluene	108883	1.50E-03	1.50E-06	2.00E-01	--	0.900	1.80E-01	--	1.00E+00	2.48E-06	3.49E-04	37%	--	--
Xylenes (Total)	1330207	1.20E-03	1.20E-06	2.00E+00	--	0.900	1.80E+00	--	1.00E+00	1.78E-07	2.70E-06	< 1%	--	--
Semivolatile Organic Compounds														
2-Methylnaphthalene	91576	4.00E-03	4.00E-06	--	-	0.200	--	--	1.00E+00	1.26E-06	--	--	--	--
					Pathway Sums:						Hazard Index 9.37E-04		Cancer Risk --	

322518

APPENDIX
CURRENT TRESSPASSER/FUTURE RECREATOR ADULT- RME
CARCINOGENIC AND NONCARCINOGENIC RISK --
INCIDENTAL DERMAL EXPOSURE AND INCIDENTAL INGESTION FOR SURFACE WATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions			Intake Equations
Receptor	CURRENT TRESSPASSER/FUTURE RECREATOR ADULT- RME		Intake Factor = (EF × ED)/(BW × AT)
Chemical Concentration	chem-spec	mg/L	Noncarcinogenic Intake Factor (NIF)
Oral Absorption Factor (OAF)	chem-specific	unitless	= 3.52E-03 kg/kg-day
Skin Surface Area (SA)	6000	cm2	Carcinogenic Intake Factor (CIF)
Exposure Time (ET)	2.60	hrs/day	= 1.51E-03 kg/kg-day
Exposure Frequency (EF)	90	days/yr	RfDo = Oral Reference Dose value
Exposure Duration (ED)	30	yrs	RfDd = Dermal Reference Dose value (Rfdo x oral abs factor)
Body Weight (BW)	70	kg	SFo = Oral Slope Factor value
Dermal Permeability Constant (PC)	chem-spec	cm/hr	SFd = Dermal Slope Factor value (SFo x oral abs factor)
Ingestion Rate (IR)	0.05	L/hr	CONCo= oral exposure concentration
Avging Time, Noncar (ATN)	10950	days	Hazard Quotient = (NIF × [(CONCo × ET × IR / RfDo) + (SA × DA / RfDd)])
Avging Time, Carcin (ATC)	25550	days	Cancer Risk = (CIF × [(CONCo × ET × IR × SFo) + (SA × DA × SFd)])

Chemical	CAS No.	Oral Exposure Conc. (mg/L)	Dermal Exposure Conc. (mg/cm3)	Oral RfD[a/] (mg/kg-d)	Oral SF[a/] (kg-d/mg)	Oral Abs. Factor	Dermal RfD (mg/kg-d)	Dermal SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds														
1,2,3,4-Tetramethylbenzene	488233	3.33E-02	3.33E-05	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
1,2,4-Trimethylbenzene	562738	2.10E-03	2.10E-06	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	7.00E-04	7.00E-07	--	--	0.900	--	--	2.60E+00	--	--	--	--	--
Chlorobenzene	108907	9.00E-04	9.00E-07	2.00E-02	--	0.300	6.00E-03	--	2.60E+00	1.26E-07	4.63E-04	32%	--	--
Ethylbenzene	100414	5.00E-04	5.00E-07	1.00E-01	--	0.850	8.50E-02	--	2.60E+00	1.63E-06	4.07E-04	28%	--	--
Toluene	108883	1.50E-03	1.50E-06	2.00E-01	--	0.900	1.80E-01	--	2.60E+00	4.76E-06	5.62E-04	39%	--	--
Xylenes (Total)	1330207	1.20E-03	1.20E-06	2.00E+00	--	0.900	1.80E+00	--	2.60E+00	3.11E-07	3.92E-06	< 1%	--	--
Semivolatile Organic Compounds														
2-Methylnaphthalene	91576	4.00E-03	4.00E-06	--	--	0.200	--	--	2.60E+00	2.04E-06	--	--	--	--

	Hazard Index	Cancer Risk
Pathway Sums:	1.44E-03	--

322549

APPENDIX
CURRENT TRESSPASSER/FUTURE RECREATOR ADULT- CT
CARCINOGENIC AND NONCARCINOGENIC RISK --
INCIDENTAL DERMAL EXPOSURE AND INCIDENTAL INGESTION FOR SURFACE WATER
REMEDIAL ACTION PLAN
SITE SD13 RISK ASSESSMENT
CARSWELL NASJRB, TEXAS

Exposure Assumptions		
Receptor	CURRENT TRESSPASSER/FUTURE RECREATOR ADULT- CT	
Chemical Concentration	chem-spec	mg/L
Oral Absorption Factor (OAF)	chem-specific	unitless
Skin Surface Area (SA)	6000	cm2
Exposure Time (ET)	1.00	hrs/day
Exposure Frequency (EF)	40	days/yr
Exposure Duration (ED)	30	yrs
Body Weight (BW)	70	kg
Dermal Permeability Constant (PC)	chem-spec	cm/hr
Ingestion Rate (IR)	0.05	L/hr
Avging Time, Noncar (ATN)	10950	days
Avging Time, Carcin (ATC)	25550	days

Intake Equations

Intake Factor = (EF × ED)/(BW × AT)
Noncarcinogenic Intake Factor (NIF)
= 1.57E-03 kg/kg-day
Carcinogenic Intake Factor (CIF)
= 6.71E-04 kg/kg-day
RfDo = Oral Reference Dose value
RfDd = Dermal Reference Dose value (Rfdo x oral abs factor)
SFo = Oral Slope Factor value
SFd = Dermal Slope Factor value (SFo x oral abs factor)
CONCo= oral exposure concentration
Hazard Quotient = (NIF × [(CONCo × ET × IR / RfDo) + (SA × DA / RfDd)])
Cancer Risk = (CIF × [(CONCo × ET × IR × SFo) + (SA × DA × SFd)])

Chemical	CAS No.	Oral Exposure Conc. (mg/L)	Dermal Exposure Conc. (mg/cm3)	Oral RfD[a/] (mg/kg-d)	Oral SF[a/] (kg-d/mg)	Oral Abs. Factor	Dermal RfD (mg/kg-d)	Dermal SF (kg-d/mg)	ET (hr/event)	DA (mg/cm2-event)	Hazard Quotient	% of Total	Cancer Risk	% of Total
Volatile Organic Compounds														
1,2,3,4-Tetramethylbenzene	488233	3.33E-02	3.33E-05	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
1,2,4-Trimethylbenzene	562738	2.10E-03	2.10E-06	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
1,3,5-Trimethylbenzene	108678	7.00E-04	7.00E-07	--	--	0.900	--	--	1.00E+00	--	--	--	--	--
Chlorobenzene	108907	9.00E-04	9.00E-07	2.00E-02	--	0.300	6.00E-03	--	1.00E+00	7.03E-08	1.14E-04	33%	--	--
Ethylbenzene	100414	5.00E-04	5.00E-07	1.00E-01	--	0.850	8.50E-02	--	1.00E+00	9.24E-07	1.03E-04	30%	--	--
Toluene	108883	1.50E-03	1.50E-06	2.00E-01	--	0.900	1.80E-01	--	1.00E+00	2.48E-06	1.30E-04	37%	--	--
Xylenes (Total)	1330207	1.20E-03	1.20E-06	2.00E+00	--	0.900	1.80E+00	--	1.00E+00	1.78E-07	9.77E-07	< 1%	--	--
Semivolatile Organic Compounds														
2-Methylnaphthalene	91576	4.00E-03	4.00E-06	--	--	0.200	--	--	1.00E+00	1.26E-06	--	--	--	

Pathway Sums:	Hazard Index	Cancer Risk
	3.47E-04	--

3325520

RISK REDUCTION STANDARD NUMBER 2 DERIVATIONS

Carswell AFB 7/1/97 ~~972522~~

Method for determining MSCs

Risk Reduction Standard Number 2

Surface Water

(1) use Texas Surface Water Quality Standards per 30 TAC chapter 307 if available for specific chemical

(2) use MCL per SDWA if available

(3) calc. MSC for residential groundwater use:

Table in App II 30 TAC 335.568

or calc. per 30 TAC 335.567 App I

GW Ingestion carcinogenic (residential)

$$MSC = \frac{85.16\,(1 \times 10^{-6})}{SF_{oral}}$$

GW Ingestion non carcinogenic (residential)

$$MSC = 36.5 \times RFD_{oral}$$

Final MSC is lower of the two.

SF_{oral} and RFD_{oral} from IRIS or Heast (if not available in Iris)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Ground Water

① use MCLs per SDWA if available

② calc. MSC for residential groundwater:

GW ingestion carcinogenic (residential)

$$MSC = \frac{85.16 \times (1 \times 10^{-6})}{SF_{oral}}$$

GW ingestion non-carcinogenic (residential)

$$MSC = 36.5 \times RFD_{oral}$$

Final MSC is lower of the two values.

Toxicity values from IRIS or HEAST (if no value in IRIS).

Soil

① calc. human health standards for soil ingestion / inhalation of particles / inhalation of volatile per 30TAC 335.567 App I

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

332524

Carswell AFB
Methodology for MSC Development

For carcinogenic effects (residential)

$$MSC = \frac{5110 \times (1 \times 10^{-6})}{\left[(7.98 \times 10^{-3}) \times SF_{oral}\right] + \left(SF_{inhal.} \times \left[\left(\frac{450}{VF}\right) + (9.72 \times 10^{-8})\right]\right)}$$

For non-carcinogenic effects (residential)

$$MSC = \frac{2190}{\left[(7.98 \times 10^{-3}) / RFD_{oral}\right] + \left[\frac{1}{RFD_{inhal.}} \times \left(\left(\frac{450}{VF}\right) + (9.72 \times 10^{-8})\right)\right]}$$

lower of the two values used for target level

Soil - Groundwater protective MSC

MSC = 100 x GW ingestion MSC

Target concentration is lower of Soil (human health) and soil (GW protective)

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PARSONS ENGINEERING SCIENCE, INC.

Client: Carswell AFB | Job No. 725520 | Sheet 1 of 1

Subject: Calculation of PEF | By: David Steffen | Date

Checked | Rev.

per EPA Soil Screening guidance (1996) pg 32

$$PEF\ (m^3/kg) = Q/C \times \frac{3{,}600\ s/h}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

$Q/C = 79.25$ (for Houston) per SSG

V = Fraction of vegetation = 0 (assumed for construction)

U_m = mean annual windspeed = 4.69 (EPA default)

U_t = equivalent threshhold value of windspeed = 11.32 (EPA default)

$F(x)$ = 0.194 (EPA default)

$$PEF = 79.25 \times \frac{3{,}600}{0.036 \times (1-0) \times (4.69/11.32)^3 \times 0.194}$$

$$= 79.25 \times \frac{3{,}600}{4.97 \times 10^{-4}}$$

$$PEF = 5.74 \times 10^8$$

Hexachlorobenzene

Client Carswell
Job No. 725520
By DS Date 7/2/97
Checked JWK Date 7/2/97

$D_i = 5.42 \in -2$
$D_w = 5.91 \in -6$
$H' = .0017$
$K_d = 208$

$$D_A = \frac{\left[\left[(.0144)(5.42\times10^{-2})(.0017) + (.00179)(5.91\times10^{-6})\right]^{1/2} / 0.188\right]}{1.5(208) + 0.15 + 0.28(.0017)}$$

$= 7.11 \in -6 / 3.12 \in 2$

$= 2.28 \in -8$

$$VF = 79.25 \times \frac{(3.14 \times 2.28\times10^{-8} \times 9.5\times10^{5})^{1/2}}{2 \times 1.5 \times 2.28\times10^{-8}} \times 10^{-4}$$

$$79.25 \times \frac{8.247}{6.84\times10^{-8}} \times 10^{-4}$$

$= 9.55 \times 10^{5}$

PARSONS ENGINEERING SCIENCE, INC.

Client Carswell AFB
Subject Calc of VF of hexachlorobenzene & Dinbutylphthalate

Job No. 333527
By
Checked

Sheet 2 of 3
Date 7/2/97
Rev.

VF calc. Dinbutylphthalate

Client Carswell
Proj. No. 725520
By DS Date 7/2/97
Chkd. JGK Date 7/2/97
Revision

$D_i = 4.38 \times 10^{-2}$
$H' = 6.3 \times 10^{-5}$
$D_w = 7.86 \times 10^{-6}$
$K_d = 8.28$ $\quad K_d = K_{oc} \times .006$
~~θ_a~~

$$D_A = \frac{\left[\left[(.0144)(4.38\times10^{-2})(6.3\times10^{-5}) + (.00179)(7.86\times10^{-6})\right]\right]/0.188}{1.5(8.28) + 0.15 + 0.28(6.3\times10^{-5})}$$

$$(3.97\times10^{-8} + 1.41\times10^{-8})/0.188 = 2.86\times10^{-7}$$

$$12.57$$

$$= 2.28\times10^{-8}$$

$$VF = 79.25 \times \frac{(3.14 \times 2.28\times10^{-8} \times 9.5\times10^{8})^{\frac{1}{2}}}{2 \times 1.5 \times 2.28\times10^{-8}} \times 10^{-4}$$

$$= 79.25 \times \frac{8.247}{6.84\times10^{-9}} \times 10^{-4}$$

$$79.25 \times 1.2057\times10^{8} \times 10^{-4}$$

$$= 9.55\times10^{5}$$

PARSONS ENGINEERING SCIENCE, INC.

332528 3 3

Client: Carswell AFB | Job No. | Sheet 3 of 3

Subject: Calc. of VF for Hexachlorobenzene & Dinbutylphthalate | By | Date 7/2/97

Checked | Rev.

$$VF = \frac{Q/C \times (3.14 \times D_A \times T)^{\frac{1}{2}}}{(2 \times \rho_b \times D_A)} \times 10^{-4}$$

pg 23 Soil Screening Guidance

Q/C = Houston 0.5 Acre source 79.25

D_A

$T = 9.5 \times 10^8$

$\rho_b = 1.5$

$$D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

$\theta_a = 0.28$ $\theta_a^{10/3} = .0144$

$\theta_w = 0.15$ $\theta_w^{10/3} = .00179$

$n = 1 - (\rho_b / \rho_s) = 0.434$ $n^2 = 0.188$

$\rho_s = 2.65$

chemical	D_i	H'	D_w	$K_d = K_{oc} \times .006$				
~~1,2,3,4 Tetramethylb~~								
~~1 2 3 Trimb~~								
~~1 2 4 Trmb~~								
~~1 3 5 Trmb~~								
Di-n-butylphthalate	4.35E-2	6.3E-5	7.86E-06 ~~0.49x10^-5 cm²/sec~~	log 3.14	K_{oc} = 1,380.4	Kd 8.28		
Hexachlorobenzene	5.43E-2	.0017	~~0.55x10^-5 cm²/sec~~ 5.91E-6	4.54	K_{oc} = 34674	208		

BENZENE

CAS NUMBER

71-43-2

COMMON SYNONYMS

None.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,791 mg/L [1]
Vapor Pressure: 95.19 mm Hg at 25°C [1]
Henry's Law Constant: 5.43 x 10^{-3} atm-m^3/mole (temperature not given) [1]
Specific Gravity: 0.879 at 15/5°C [2]
Organic Carbon Partition Coefficient: 31 - 143 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 16 days [3]
Air: 2.09 - 20.9 days [3]
Surface Water: 5 - 16 days [3]
Groundwater: 10 days to 2 years [3]

NATURAL SOURCES

Crude oil, volcanoes, forest fires, plants [1].

ARTIFICIAL SOURCES

Gasoline, fuel oils, chemical industry, coke ovens, mining, manufacturing, cigarette smoke [1].

FATE AND TRANSPORT

Benzene will rapidly volatilize from surface soil and water. That which does not volatilize from permeable surface and subsurface soils will be highly to very highly mobile, and can be expected to leach to nearby groundwater which is not protected by a confining layer. It is fairly soluble, and will be carried with the groundwater to discharge points. It may be subject to biodegradation in soils, shallow groundwater, and surface water. Benzene will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms, or hydrolyze. Photodegradation may be a

significant removal mechanism in surface waters which are not conducive to microbial degradation. Benzene will undergo significant photodegradation in air, but may be washed out with rain [1].

HUMAN TOXICITY

General. Benzene is absorbed into the body following ingestion, inhalation, and dermal contact, and must undergo metabolic transformation to exert its toxic effects. Metabolism occurs primarily in the liver, and to a lesser extent in the bone marrow [4]. The primary targets of benzene toxicity are the central nervous system and the blood [4,5]. Benzene is genotoxic to humans and the USEPA has placed it in weight-of-evidence cancer Group A, indicating that it is a human carcinogen [6].

Oral Exposure. A chronic oral RfD for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following oral exposure. The lowest reported fatal dose in humans is 50 mg/kg [5]. Acute oral LD_{50} values in animals include 930 to 5600 mg/kg in rats, 2000 mg/kg in dogs and 4700 mg/kg in mice [4,5]. Data regarding the ingestion of benzene in humans are limited to acute overexposure. Ingestion of 2 ml (29 mg/kg) has resulted in depression of the central nervous system, while ingestion of 10 ml (143 mg/kg) has been fatal [5]. The cause of death was usually respiratory arrest, central nervous system depression or cardiac collapse [4]. In animals, longer-term oral exposure has resulted in toxic effects on the blood (cytopenia: decrease in various cellular elements of the blood) and the immunological system (decreased white blood cells) [4]. There is no evidence that oral exposure to benzene causes effects on reproduction and development, but studies in animals suggest that benzene may affect fetal development [4]. There is no information regarding carcinogenic effects in humans following oral exposure to benzene, but studies in animals indicate that benzene ingestion causes cancer in various regions of the body [4]. An oral Slope Factor of 0.029 $(mg/kg/day)^{-1}$ is based on an increase in the incidence of leukemia in occupationally-exposed workers [6]. The oral Slope Factor was extrapolated from the inhalation data.

Inhalation Exposure. A chronic inhalation RfC for benzene is currently under review by the USEPA [6]. Benzene is readily absorbed following inhalation exposure. The lowest reported fatal concentration in humans is 6380 mg/m^3 for a 5 minute exposure [5]. Acute inhalation LC_{50} values in rats ranged from 10,000 ppm for 7 hours to 13,700 ppm for 4 hours [4,5]. Most of the available data regarding benzene exposure involve workers exposed in the workplace. The acute effects of benzene exposure involve the central nervous system. Brief exposure to concentrations of 700 to 3000 ppm can cause drowsiness, dizziness, headaches and unconsciousness, and exposure to

concentrations of 10,000 to 20,000 ppm can result in death [4]. In most cases, the effects will end when exposure ceases. The hematopoietic system is the primary target of toxicity following long-term exposure: exposure for several months to years results in pancytopenia (reduction in red blood cells, platelets and white blood cells), while continued exposure for many years results in anemia or leukemia. The lowest concentration resulting in the hematological effects is approximately 10 to 50 ppm [5]. Benzene has been shown to cause chromosomal aberrations in bone marrow and lymphocytes in workers exposed to concentrations > 100 ppm [5]. Chromosomal damage has been found in animals at concentrations as low as 1 ppm [5]. Benzene is not known to be teratogenic (cause birth defects) in humans, but has been found to cause various problems in the developing fetus of animals (low birth weight, delayed bone formation) [4,5]. Occupational exposure to benzene has resulted in leukemia in exposed workers [4,5]. An inhalation Unit Risk of 8.3×10^{-6} $(ug/m^3)^{-1}$ is based on the incidence of leukemia in occupationally-exposed workers [6].

Dermal Exposure. Dermal exposure to benzene may cause redness and dermatitis [4,5]. Systemic effects have not been reported following dermal exposure to benzene.

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HEXACHLOROBENZENE

CAS NUMBER

118-74-1

COMMON SYNONYMS

Hexachlorobenzol; Perchlorobenzene; HCB; Amatin.

ANALYTICAL CLASSIFICATION

Semivolatile Organic

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.006 mg/l at 20°C [1]
Vapor Pressure: 1.089 x 10^{-5} Hg at 20°C [1]
Henry's Law Constant: 6.8 x 10^{-4} atm-m^3/mole [1]
Specific Gravity: 1.5691 [2]
Organic Carbon Partition Coefficient: ND [1]

FATE DATA: HALF-LIVES

Soil: 3 to 6 years [1]
Air: ND
Surface Water: 30-300 days [1]
Groundwater: ND

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Not currently manufactured commercially. Produced as a by-product during the manufacture of chemicals used as solvents, other chlorine-containing compounds and pesticides. Hexachlorobenzene was used as a pesticide until 1985. [1]

FATE AND TRANSPORT

Hexachlorobenzene is among the most persistent environmental pollutants, and it bioaccumulates in the environment, in animals, and humans. Low levels of

hexachlorobenzene have been found in almost all people tested, most likely through consumption of the contaminated food.

In the environment, most hexachlorobenzene exists tightly bound to soil. Due to its very low solubility in water, presence of hexachlorobenzene in surface water or groundwater is likely to be low. Also, because it is practically nonvolatile, it has not been detected in significant amounts in air.

The principal release of hexachlorobenzene into the water in the past has been through the direct discharge from chemical solvent manufacturing facilities. Hexachlorobenzene from soil is not considered a serious problem for its strong affinity to soil and removal mechanism from soils by biodegradation process.

HUMAN TOXICITY

General. Hexachlorobenzene is absorbed into the body following ingestion of contaminated foods and soils, inhalation of particles in the air, or dermal contact. Following intake, hexachlorobenzene will be rapidly deposited to many tissues in the body, especially to fat, and remain there for many years. A large portion of hexachlorobenzene in fat may be transferred in human milk. The USEPA has placed it in weight-of-evidence cancer group B-2, indicating that it is a probable human carcinogen [1].

Oral Exposure. Hexachlorobenzene is rapidly absorbed following oral exposure. Evidence of human lethality following oral exposure to hexachlorobenzene is derived from the case of people consuming bread prepared from grain treated with hexachlorobenzene at 2 kg/1,000 kg wheat in Turkey in the 1950's. There was an extremely high rate of mortality in children of lactating mothers known to have consumed this bread [1]. Acute oral LD_{50} values for animals range from 1,700 mg/kg in cats to 10,000 mg/kg in rates [2]. In humans, there is epidemiological evidence that hexachlorobenzene is toxic to young children; offspring nursing from hexachlorobenzene exposed mothers are exposed through the milk. In animals, long-term oral exposure has resulted in toxic effects on liver, immune system, kidneys, blood and reproductive system [1]. There is no information regarding carcinogenic effects in humans following oral exposure to hexachlorobenzene, but studies in animals indicate hexachlorobenzene ingestion causes cancers of the liver and thyroid. The oral slope factor for hexachlorobenzene is 1.6 $(mg/kg\text{-}day)^{-1}$ [3].

Inhalation Exposure. A USEPA lists 0.00046 ug/m^3 as the current inhalation unit risk for hexachlorobenzene [3]. No inhalation RfC value for this compound is available. Recent estimates of exposure by inhalation are an average of 2 ug/m^3 of air breathed. This is approximately 1,000 times less than exposure estimated by ingestion, making inhalation, a route of lesser concern. [1]

Dermal Exposure. No information.

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BIS(2-ETHYLHEXYL)PHTHALATE

CAS NUMBER

117-81-7

COMMON SYNONYMS

1,2-Benzenedicarboxylic acid bis(2-ethylhexyl)ester; di(2-ethylhexyl) phthalate; dioctylphthalate.

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 0.3 mg/L at 25°C [1]
Vapor Pressure: 6.45 x 10^{-6} mm Hg at 25°C [1]
Henry's Law Constant: 1.1 x 10^{-5} atm-m^3/mole [1]
Specific Gravity: 0.99 at 20/20°C [2]
Organic Carbon Partition Coefficient: 10,000 - 100,000 [1]

FATE DATA: HALF-LIVES

Soil: 5 - 23 days [3]
Air: 2.9 - 29 hours [3]
Surface Water: 5 - 23 days [3]
Groundwater: 10 - 389 days [3]

NATURAL SOURCES

Possible product of animal and/or plant life.

ARTIFICIAL SOURCES

Plasticizer for polyvinylchloride and other polymers; and from disposal/incineration of plastic(s)/polymer(s) [1].

FATE AND TRANSPORT

Bis(2-ethylhexyl)phthalate (BEHP) has a strong tendency to adsorb to soils and sediments, suggesting low likelihood of leaching to groundwaters. Given the very low vapor pressure and Henry's Law constant of BEHP, volatilization from soil and water is very unlikely. This compound does show a tendency to bioconcentrate in aquatic organisms. Hydrolysis (from aquatic systems), photolysis (in the water and atmosphere), and photooxidation (in atmospheric systems) are not predicted to be important removal processes. In aquatic environments, aerobic biodegradation occurs

rapidly following acclimation; no anaerobic biodegradation occurs. Some slight biodegradation in soils is expected. In the atmosphere, the primary removal mechanism is via rainfall washout [1].

HUMAN TOXICITY

General. There is currently no evidence that BEHP causes adverse effects in humans, but animal studies indicate that the liver, kidneys, and testes are targets of oral exposure [4]. Information regarding the genotoxicity of BEHP are equivocal but indicate that BEHP may act as a co-carcinogen in rodents [4]. The USEPA has placed BEHP in weight-of-evidence cancer group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. A chronic oral RfD of 0.02 mg/kg-day is based on a LOAEL of 19 mg/kg-day for increased relative liver weight in a chronic oral study in guinea pigs [5]. BEHP is readily absorbed following oral exposure. Acute oral LD_{50} values of 30,600 mg/kg and 33,900 mg/kg have been defined for rats and rabbits, respectively [4]. BEHP has not been found to be fatal to humans at doses up to 143 mg/kg; mild abdominal pain and diarrhea were the only effects reported at this dose [4]. Oral studies in animals reported effects on the liver (morphological changes, nodules, and tumors), kidneys (effects on kidney cells), thyroid and pancreas (changes in the acinar cells of both organs), and testes (atrophy and degeneration). Animal studies indicated that monkeys are less susceptible to the toxic effects of BEHP than are mice and rats [4]. The relative susceptibility of humans is not known. Effects on fetal development (reduced survival and malformations) were reported in rodents following oral exposure [4]. There is no evidence that BEHP causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [4]. An oral slope factor of 0.014 $(mg/kg\text{-}day)^{-1}$ is based on the incidence of liver tumors in mice [5].

Inhalation Exposure. An inhalation RfC is not available for BEHP [5]. Information regarding the toxicity of inhaled BEHP in humans are not available and data in animals are limited to one developmental study [4]. In the developmental study, no adverse effects were reported in rats following exposure to up to 300 mg/m^3 during gestation [4]. There is no evidence that inhaled BEHP causes cancer in humans or animals, therefore, an inhalation unit risk for cancer is not available for BEHP [5].

Dermal Exposure. An acute dermal LD_{50} value of 24,750 mg/kg was reported for rabbits [4]. Dermal exposure of both humans and animals indicate that BEHP is neither an irritant nor a sensitizer [4].

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METHYLENE CHLORIDE

CAS NUMBER

75-09-2

COMMON SYNONYMS

Dichloromethane.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 13,000 mg/L at 25°C [1]
Vapor Pressure: 434.9 mm Hg at 25°C [1]
Henry's Law Constant: 2.68 x 10^{-3} atm-m^3/mole [1]
Specific Gravity: 1.3255 at 20/4°C [2]
Organic Carbon Partition Coefficient: 47.86 [1]

FATE DATA: HALF-LIVES

Soil: 1 - 4 weeks [3]
Air: 19.1 - 191 days [3]
Surface Water: 1 - 4 weeks [3]
Groundwater: 2 - 8 weeks [3]

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Aerosol propellant; paint remover; metal degreaser; urethane foam blowing agent; paint/ink industries; aluminum forming; coal mining; photographic equipment; pharmaceutical, organic chemicals/plastics, and rubber processing industries; foundries; and laundries [1,2].

FATE AND TRANSPORT

Methylene chloride released to soil will evaporate quickly from near-surface soils, given its high vapor pressure. That which does not volatilize can be expected to leach through soils to groundwater not protected by a confining layer. Under normal environmental conditions, hydrolysis in soil and/or groundwater is not predicted. Aerobic biodegredation of methylene chloride is reported to be complete (within 6 hours to 7 days), and anaerobic biodegradation will proceed after a variable-length acclimation period. The primary removal process of methylene chloride from surface water is volatilization. Biodegredation of methylene chloride is possible in natural waters, but will be a slow process relative to volatilization. Hydrolysis in surface

water, under normal environmental conditions, is not to be expected. The greater portion of atmospheric methylene chloride will degrade by reaction with hydroxyl radicals; photolysis is not expected. A small portion of the methylene chloride will diffuse to the stratosphere and will subsequently undergo rapid photolytic degradation and reaction with chlorine radicals. The moderate solubility of methylene chloride suggests the probability of atmospheric washout via rainfall.

Given its low, estimated bioconcentration factor of 5 (calculated from the octanol/water partition coefficient), methylene chloride is not expected to bioconcentrate in aquatic biota.

HUMAN TOXICITY

General. The major targets of methylene chloride toxicity are the CNS, the liver, and the kidneys [4]. Information regarding the mutagenicity of methylene chloride are equivocal. The USEPA has placed methylene chloride in weight-of-evidence cancer group B2, indicating that it is a probable human carcinogen [5].

Oral Exposure. The chronic oral RfD of 0.06 mg/kg-day is based on a NOAEL of 6 mg/kg-day for liver toxicity in a chronic oral study in rats [5]. Methylene chloride is readily absorbed following oral exposure. An acute oral LD_{50} of 2100 mg/kg was reported for rats [4]. Human fatalities resulting from oral exposure to methylene chloride have not been reported. Limited animal data indicates that effects on the liver and kidneys occur at doses above 55 mg/kg-day [4]. There is no evidence to suggest that methylene chloride affects reproduction or development. There is no evidence that methylene chloride causes cancer in humans, but studies in animals suggest that oral exposure results in liver cancer [4]. An oral slope factor of 7.5×10^{-3} $(mg/kg\text{-}day)^{-1}$ was derived based on the incidence of liver cancer in mice [5].

Inhalation Exposure. A chronic inhalation RfC of 3 mg/m^3 is based on a NOAEL of 694.8 mg/m^3 for liver toxicity in a chronic study in rats [6]. Methylene chloride is readily absorbed following inhalation exposure. An acute LC_{50} of 16,189 ppm was reported for mice [4]. The odor threshold is approximately 200 ppm. Case studies have demonstrated that inhaled methylene chloride can be fatal to humans, but exposure levels were not reported [4]. Acute (3-4 hours) exposure to concentrations of 300 ppm or greater resulted in adverse effects on vision and hearing, while exposure to 800 ppm or greater resulted in impairment of psychomotor performance (reaction time, hand precision, steadiness) [4]. In most cases, effects will disappear when exposure ceases. Animal studies indicate that exposure to higher concentrations (1000 ppm) resulted in unconsciousness or death [4]. Animal studies indicate that methylene chloride is not likely to produce adverse effects on reproduction or development in humans [4]. There is no evidence that methylene chloride causes cancer in humans, but studies in animals suggest that inhalation exposure results in liver cancer [4]. An inhalation unit risk of 4.7×10^{-7} $(\mu g/m^3)^{-1}$ was derived based on the incidence of liver cancer in mice [5].

Dermal Exposure. No information is available regarding the effects of dermal exposure to methylene chloride in humans. Limited animal studies report adverse effects on the eye of rabbits following exposure. The effects were reversed within a few days [4].

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POLYCYCLIC AROMATIC HYDROCARBONS

GENERAL

Polycyclic aromatic hydrocarbons (PAHs) are a large group of chemicals formed during the incomplete combustion of organic materials. There are over one hundred PAHs, and they are found throughout the environment in air, water, and soil. Seven of the 15 PAHs addressed in this profile are classified as probable human carcinogens [1,2].

CAS NUMBERS

Acenaphthene	83-32-9	Chrysene	218-01-9
Acenaphthylene	208-96-8	Dibenzo(a,h)anthracene	53-70-3
Anthracene	120-12-7	Fluoranthene	206-44-0
Benzo(a)anthracene	56-55-3	Fluorene	86-73-7
Benzo(a)pyrene	50-32-8	Indeno(1,2,3-cd)pyrene	193-39-5
Benzo(b)fluoranthene	205-99-2	Phenanthrene	85-01-8
Benzo(g,h,i)perylene	191-24-2	Pyrene	129-00-00
Benzo(k)fluoranthene	207-08-9		

COMMON SYNONYMS

Polynuclear aromatic hydrocarbons, PNAs, PAHs.

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: insoluble to 3.93 mg/L [1]
Vapor Pressure: negligible to very low at 25°C [1]
Henry's Law Constant: 6.95×10^{-8} to 1.45×10^{-3} atm-m^3/mole [1]
Specific Gravity: approximately 0.9 to 1.4 at 0 to 27°C [1]
Organic Carbon Partition Coefficient (K_{oc}): 2.5×10^3 to 5.5×10^6 [1]

FATE DATA: HALF-LIVES

Soil: 12.3 days to 5.86 years [3]
Air: 0.191 hours to 2.8 days [3]
Surface Water: 0.37 hours to 1.78 years [3]
Groundwater: 24.6 days to 10.4 years [3]

NATURAL SOURCES

Volcanoes, forest fires, crude oil, and oil shale [1].

ARTIFICIAL SOURCES

Motor vehicles and other petroleum fuel engines, wood-burning stoves and fireplaces, furnaces, cigarette smoke, industrial smoke or soot, and charcoal-broiled foods [1].

FATE AND TRANSPORT

Because the physical and chemical properties of PAHs vary substantially depending on the specific compounds in question, the fate and transport characteristics vary. Thus, the following discussion is presented in very general terms. Some fate characteristics are roughly correlated with molecular weight; so the compounds are grouped as follows [1]:

- Low molecular weight: acenaphthene, acenaphthylene, anthracene, fluorene, and phenanthrene;
- Medium molecular weight: fluoranthene and pyrene; and
- High molecular weight: benzo(a)anthracene, benzo(b)fluoranthene, benzo-(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo-(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

PAHs are present in the atmosphere in the gaseous phase and sorbed to particulates. They may be transported great distances, and are subject to photodegradation as well as wet or dry deposition [1].

PAHs in surface water are removed by volatilization, binding to particulates and sediments, bioaccumulation, and sorption onto aquatic biota. The low molecular weight PAHs have Henry's Law constants in the range of 10^{-3} to 10^{-5} atm-m^3/mole, and would therefore be expected to undergo significant volatilization; medium molecular weight PAHs have constants in the 10^{-6} range; and high molecular weight PAHs have constants in the range of 10^{-5} to 10^{-8}. Half-lives for volatilization of benzo(a)anthracene and benzo(a)pyrene from water have been estimated to be greater than 100 hours. It has been reported that lower molecular weight PAHs could be substantially removed by volatilization under conditions of high temperature, shallow depth, and high wind. For example, anthracene was found to have a half-life for volatilization of 18 hours in a stream with moderate current and wind. In an estuary, volatilization and adsorption are the primary removal mechanisms for medium and high molecular weight PAHs, whereas volatilization and biodegradation are the major mechanisms for low molecular weight compounds. PAHs can bioaccumulate in plants and animals, but are subject to extensive metabolism by high-trophic-level consumers, indicating that biomagnification is not significant [1].

Potential mobility in soil is related to the organic carbon partition coefficient (K_{oc}). The low molecular weight PAHs have K_{oc} values in the range of 10^3 to 10^4, which indicates a moderate potential to be adsorbed to organic material. Medium molecular weight compounds have values on the order of 10^4, while high molecular weight compounds have values in the 10^5 to 10^6 range. The latter compounds, then, have a much greater tendency to adsorb and resist movement through soil. Volatilization of the lower molecular weight compounds from soil may be substantial. However, some

portion of PAHs in soil may be transported to groundwater, and then move laterally in the aquifer, depending on soil/water conditions [1].

HUMAN TOXICITY

General. Ingestion of, inhalation of, or dermal contact with PAHs by laboratory animals has been shown to produce tumors. Reports in humans show that individuals exposed by inhalation or dermal contact for long periods of time to mixtures of PAHs and other compounds can also develop cancer. However, the relationship of exposure to any individual PAH with the onset of cancer in humans is not clear [1]. The available RfDs and weight-of-evidence groups for the PAHs addressed in this profile are presented in Table 1. The available slope factors are presented below. No other toxicity values were available [2,4].

Oral Exposure. Indirect evidence suggests that benzo(a)pyrene may not be readily absorbed following oral exposure in humans. On the other hand, absorption in rats appears to be rapid and efficient. Whether or not there is actually a significant difference between humans and rats in the capacity to absorb benzo(a)pyrene is questionable. It should be noted that the degree of uptake is highly dependent on the vehicle of administration. A NOAEL of 150 mg/kg-day was determined for gastrointestinal, hepatic, and renal effects in rats following acute oral exposure to benzo(a)pyrene or benzo(a)anthracene. LOAELs in the range of 40 to 160 mg/kg-day were determined for developmental and reproductive effects in mice following acute oral exposure to benzo(a)pyrene [1]. An oral slope factor of 7.3 $(mg/kg\text{-}day)^{-1}$ for benzo(a)pyrene is based on tumors detected in the forestomachs of rats and mice in various diet studies [2].

Inhalation Exposure. The USEPA does not currently provide inhalation RfCs for any of the PAHs [2,4]. Pure PAH aerosols appear to be well absorbed from the lungs of animals. However, PAHs adsorbed to various particles appear to be poorly absorbed, if at all. The latter are most likely to be removed from the lungs by mucociliary clearance and subsequent ingestion. Lung cancer in humans has been strongly associated with long-term inhalation of coke-oven emissions, roofing-tar emissions, and cigarette smoke, all of which contain mixtures of carcinogenic PAHs. It has been estimated that the 8-hour time-weighted average exposure to PAHs in older coke plants was approximately 22 to 33 $\mu g/m^3$ [1]. An inhalation slope factor of 6.1 $(mg/kg\text{-}day)^{-1}$ for benzo(a)pyrene is based on tumors detected in the respiratory tracts of hamsters in a chronic intermittent inhalation study [4].

Dermal Exposure. Limited *in-vivo* evidence exists that PAHs are at least partially absorbed by human skin. An *in-vitro* study with human skin indicated that 3% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. Studies in mice indicated that at least 40% of an applied dose of benzo(a)pyrene was absorbed after 24 hours. The carcinogenic PAHs as a group cause various noncancerous skin disorders in humans and animals. Substances containing mixtures of PAHs have been linked to skin cancers in humans. Studies in laboratory animals have demonstrated the ability of benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene to induce skin tumors [1].

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TETRACHLOROETHENE

CAS NUMBER

127-18-4

COMMON SYNONYMS

Tetrachloroethylene, perchloroethylene, PCE.

ANALYTICAL CLASSIFICATION

Volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1,503 mg/L at 25°C [1]
Vapor Pressure: 18.49 mm Hg at 25°C [1]
Henry's Law Constant: 1.49 x 10^{-2} atm-m^3/mole [1]
Specific Gravity: 1.6311 at 15/4°C [2]
Organic Carbon Partition Coefficient: 209 to 238 [1]

FATE DATA: HALF-LIVES

Soil: 0.5 - 1 year [3]
Air: 16 - 160 days [3]
Surface Water: 0.5 - 1 year [3]
Groundwater: 1 - 2 years [3]

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Dry cleaning industry, metal finishing, and organic chemical/plastics manufacturing [1].

FATE AND TRANSPORT

Tetrachloroethene (PCE) released to surface soil will be subject to evaporation into the atmosphere and leaching to the groundwater. It is weakly adsorbed to soil organic material. Since it is only somewhat soluble in water and substantially denser, when it occurs as a separate phase it tends to sink to the bottom of the aquifer. Biodegradation of PCE occurs in soils and, to a lesser extent, in some types of groundwater. PCE released to surface water will be subject to rapid volatilization; it will not be expected to significantly biodegrade, bioconcentrate in aquatic organisms, or adsorb to sediment. Photooxidation degrades PCE in the atmosphere, although some may be washed out in rain before this occurs [1].

HUMAN TOXICITY

General. The primary targets of PCE toxicity are the CNS, the liver, and the kidneys [4,5]. PCE is not considered to be mutagenic. The USEPA has not adopted a final position on the weight-of-evidence cancer classification for PCE, but an oral slope factor and inhalation unit risk have been derived [7].

Oral Exposure. A chronic oral RfD of 0.01 mg/kg-day is based on a NOAEL of 14 mg/kg-day for hepatotoxicity in mice and weight gain in rats following subchronic administration of PCE [6]. PCE is readily absorbed following oral exposure. Acute oral LD_{50} values ranged from 3000 to 8850 mg/kg in rats and 5000 to 8100 mg/kg in mice [4,5]. The fatal oral dose to humans is not known. Inebriation was the only reported side effect following treatment of intestinal parasites with doses of 2.8 to 4.0 ml (40-57 mg/kg) PCE [5]. No other data regarding toxic effects in humans following oral exposure are available. PCE has been found to cause liver tumors in mice following both oral and inhalation exposure [4]. An oral slope factor of 0.052 $(mg/kg\text{-}day)^{-1}$ is based on the incidence of liver cancer in mice [7].

Inhalation Exposure. An inhalation RfC for PCE is not currently available [6]. PCE is rapidly absorbed following inhalation exposure [4]. Acute inhalation LC_{50} values of 5200 ppm (4-hour) and 5040 ppm (8-hour) were identified for mice and rats, respectively [5]. Acute exposure of humans to concentrations of PCE in air above 200 ppm has resulted in depression of the central nervous system characterized by dizziness, impaired memory, confusion, irritability, "inebriation-like" symptoms, tremors, and numbness. Long-term exposure of humans to PCE (concentration not reported) has resulted in toxic effects on the liver, including hepatitis, cirrhosis, liver-cell necrosis, and enlarged liver. Chronic kidney disease has also been noted [5]. There is no evidence that PCE causes effects on human development or reproduction [4,5]. PCE has been found to cause liver tumors in mice following both oral and inhalation exposure [4]. An inhalation unit risk of 5.8×10^{-7} $(ug/m^3)^{-1}$ was derived based on the incidence of liver cancer in mice [7].

Dermal Exposure. A 10-day dermal LD_{50} value of 64,680 mg/kg was defined for mice [5]. Skin contact with PCE causes dryness, irritation, blistering, and burns. Mild liver and kidney damage may also occur. The exposure levels that result in these effects are not known.

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N-NITROSODIPROPYLAMINE

CAS NUMBER

621-64-7

COMMON SYNONYMS

N-Nitrosodi-N-propylamine.

ANALYTICAL CLASSIFICATION

Semivolatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 1% in water [1]
Vapor Pressure: 0.086 mm Hg at 20°C [1]
Henry's Law Constant: NA
Specific Gravity: 0.916 at 20/4°C [1]
Organic Carbon Partition Coefficient: 131 [1]

FATE DATA: HALF-LIVES

Soil: 21 days to 6 months [2]
Air: 0.17 to 1 hour [2]
Surface Water: 0.17 to 1 hour [2]
Groundwater: 42 days to 12 months [2]

NATURAL SOURCES

No known natural source.

ARTIFICIAL SOURCES

N-nitrosamines are primarily formed from the nitrosation of secondary amines. N-nitrosodipropylamine has been found as an impurity in the herbicide trifluralin. N-nitrosodipropylamine is used primarily as a research chemical, and not a commercial chemical [1].

FATE AND TRANSPORT

In soil, n-nitrosodipropylamine will rapidly volatilize. The low K_{OC} value indicates that it is not likely to adsorb to soil and, therefore, will be mobile in soil. Hydrolysis is not considered to be an important process for n-nitrosodipropylamine in soils [1].

In water, n-nitrosodipropylamine will have a slight tendency to adsorb to sediments and suspended matter. Volatilization should only be important in shallow waters. The most important degradative process for n-nitrosodipropylamine in water will be photolysis. Biodegradation may also be an important degradative process [1].

In air, n-nitrosodipropylamine will rapidly photolyze, with the major product of photolysis being n-propylamine [1].

HUMAN TOXICITY

General. N-nitrosodipropylamine is considered a group B2, probable human carcinogen, by the USEPA [3]. n-nitrosodipropylamine is considered to be mutagenic. Short-term exposure to n-nitrosodipropylamine causes effects on the liver and excessive bleeding [1]. n-nitrosamines have been reported to be potent teratogens when administered during late in pregnancy [1].

Oral Exposure. A chronic oral RfD is not available for n-nitrosodipropylamine [3,4]. The potential lethal dose in humans is 1.8 grams in adults (26 mg/kg) and 0.3 grams in children (30 mg/kg). In chronic cancer bioassays in rodents, an increase in the incidence of carcinoma of the liver and tumors of the esophagus and nose was observed [3]. Given this information, USEPA derived an oral slope factor of 7.0 $(mg/kg\text{-}day)^{-1}$ [3].

Inhalation Exposure. A chronic inhalation RfC is not available for n-nitrosodipropylamine [3,4]. Information regarding the teratogenicity or carcinogenicity of inhaled n-nitrosodipropylamine is not available [3,4].

Dermal Exposure. Information regarding potential dermal effects of n-nitrosodipropylamine has not been located.

REFERENCES

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4. USEPA, 1994. Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response. OHEA ECAO-CIN-909. March 1994.

1,4-DICHLOROBENZENE

CAS NUMBER

106-46-7

COMMON SYNONYMS

p-Dichlorobenzene.

ANALYTICAL CLASSIFICATION

Semi-volatile organic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: 74-87 mg/L at 25°C [1]
Vapor Pressure: 1.76 mm Hg at 25°C [1]
Henry's Law Constant: 1.5 x 10^{-3} atm-m^3/mole at 20°C [1]
Specific Gravity: 1.306 @ 20/4°C (ortho form) [2]
Organic Carbon Partition Coefficient: 273-1833 [1]

FATE DATA: HALF-LIVES

Soil: 1 - 6 months [3]
Air: 8.4 - 83.6 days [3]
Surface Water: 1 - 6 months [3]
Groundwater: 2 months - 1 year [3]

NATURAL SOURCES

None noted.

ARTIFICIAL SOURCES

Chemical manufacture/disposal; "area" deodorants; moth fumigants; and polyphenylene sulfide resin production intermediate [1,2].

FATE AND TRANSPORT

Volatilization of 1,4-dichlorobenzene (1,4-DCB) is an important mechanism for transport in soil, as well as being the dominant mechanism for removal in water. Tight adsorption of 1,4-DCB to soils and sediments attenuates volatilization. 1,4-DCB will undergo aerobic biodegradation in soils and waters, but is not expected to hydrolyze, photolyze, oxidize, or anaerobically biodegrade. If released to the air, 1,4-DCB exists predominantly in the vapor phase, and will react with photochemically produced

hydroxyl radicals; atmospheric washout, via rainfall, is possible. Significant bioconcentration of 1,4-DCB in aquatic organisms is not predicted [1].

HUMAN TOXICITY

General. 1,4-DCB is an eye, nose, throat, and skin irritant, but is not considered a major health hazard [4]. 1,4-DCB is not considered to be mutagenic [4,5]. USEPA placed 1,4-DCB in weight-of-evidence cancer group C, indicating that it is a possible human carcinogen [6].

Oral Exposure. A chronic oral RfD for 1,4-DCB is not available [7]. 1,4-DCB is readily absorbed through the gastrointestinal tract following oral exposure. Acute LD_{50} values in animals ranges from 500 mg/kg in rats to 2950 mg/kg in mice [4]. The lowest reported fatal dose in humans is 857 mg/kg [4]. Hematological effects (anemia) and skin blotches have been reported in individuals that have ingested 1,4-DCB over a period of time [5]. The dose resulting in these effects is not known. There is no evidence that 1,4-DCB causes birth defects or affects reproduction in animals or humans. There is no evidence that 1,4-DCB causes cancer in humans, but studies in animals suggest that oral exposure results in liver and kidney cancer [5]. An oral slope factor of 0.024 $(mg/kg/day)^{-1}$ is based on the incidence of liver tumors in a chronic oral study in mice [6].

Inhalation Exposure. A chronic inhalation RfC of 0.8 mg/m^3 is based on a NOAEL of 75 mg/m^3 for increased liver weights in male offspring in a multigenerational study in rats [7]. Approximately 20% of an inhaled concentration of 1,4-DCB will be absorbed into the blood through the respiratory tract [5]. Air concentrations fatal to humans or animals have not been reported. In humans, concentrations between 50 and 160 ppm have been reported to be painful and irritating to the eyes and nose [4]. There is no evidence that inhaled 1,4-DCB causes birth defects or cancer in animals or humans. An inhalation unit risk has not been derived by USEPA [7].

Dermal Exposure. The dermal LD_{50} for 1,4-DCB in rats is greater than 6,000 mg/kg [5]. No useful information was located regarding the toxicity of 1,4-DCB following dermal exposure [5].

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ALUMINUM

CAS NUMBER

7429-90-5

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 2.70 [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Aluminum is a naturally-occurring element. The concentration of aluminum in minimally disturbed soils varies. A collection of 1,247 soil samples from across the conterminous U.S. determined that 79 percent were less than 70,000 ppm, with a geometric mean of 47,000 ppm and a maximum value of 100,000 ppm [2]. In water, aluminum concentrations are dependent upon the pH of the water: significant concentrations occur only when the pH is less than 5. In waters with a high humic-derived acid content, aluminum may be present even at a more neutral pH [1]. In surface water, aluminum was detected at concentrations ranging from 0.001 to 2.760 mg/L with a mean concentration of 0.074 mg/L in 456/1577 samples [1].

FATE AND TRANSPORT

The mobility of aluminum in the environment will be dependent upon the solubility of the aluminum compound and upon the pH of the environmental medium. Soluble compounds will tend to be more mobile in the environment and a lowering of the pH of the soil generally results in an increase in mobility for monomeric forms of aluminum. Consequently, acid rain may mobilize aluminum in the environment. Terrestrial plants take up aluminum, but it is not likely to bioconcentrate [1].

HUMAN TOXICITY

General. Aluminum is a major component of the earth's crust. People may be exposed to aluminum through its use in cooking utensils, antacids, and antiperspirants. Aluminum in these forms has not been reported to be harmful, although excess exposure to aluminum is not beneficial and may be harmful to some people. Excess

aluminum has been associated with neurodegenerative diseases, although the link between the two is tenuous. The primary targets of aluminum toxicity are the CNS, skeletal system, respiratory system, and the developing fetus [1]. Aluminum is not known to cause cancer in humans or animals, and has not been placed in a USEPA weight-of-evidence cancer group [3].

Oral Exposure. A chronic oral RfD is not available for aluminum [3,4]. Oral LD_{50} values of 261 mg/mg body weight in rats (nitrate form) and 770 mg/kg in mice (chloride form) have been reported. In humans, aluminum has been associated with neurodegenerative diseases, such as Alzheimer's disease. A causal relationship, however, has not been shown between aluminum exposure and the progression of neurodegenerative disease. Neurodegenerative diseases have also developed in individuals who have been on renal dialysis for a number of years. Aluminum is present in the dialysis fluid and is given to control hyperphosphatemia. A softening of the bones, resulting in increased spontaneous fractures and pain, has been reported in dialysis patients. In infants given renal dialysis containing aluminum, aluminum accumulation and encephalopathy has been noted. The effects of aluminum on the developing fetus of animals have been controversial: a decrease in pup growth and neurological development have been observed in some studies, but not others [1].

Inhalation Exposure. An inhalation RfC is not available for aluminum [3,4]. Inhalation of aluminum results in irritive effects on the respiratory system, including asthma, cough, lung fibrosis and decreased pulmonary function [1].

Dermal Exposure. Dermal exposure to aluminum is primarily the result of the use of aluminum-containing antiperspirants. In sensitive individuals, aluminum may cause a skin rash [1].

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ANTIMONY

CAS NUMBER

7440-36-0

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble (elemental) [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: Density: 6.68 at 20/4°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATION

Pure antimony is a silver-white, lustrous, hard, brittle metal. Antimony was detected (in measurable quantities) in 66 of 354 soils samples from across the conterminous United States [2]. The concentration of antimony in minimally disturbed soils shows limited variations, with a range from <1 ppm up to a maximum of 8.8 ppm, and an overall geometric mean of 0.48. Of the samples collected, 81 percent showed antimony concentrations to be less than 1 ppm [2].

FATE AND TRANSPORT

Elemental antimony is relatively short-lived in the natural environment undergoing oxidation reactions to form antimony oxides and trihalides. Although not demonstrated, antimony may undergo biological methylation (forming organometals) as do those compounds surrounding it in the periodic table. Antimony oxides and trihalides are expected to volatilize readily, with $SbCl_3$ releasing HCl gas to the atmosphere when in the presence of moisture [1]. Antimony oxides are also expected to undergo photoreduction in aqueous environments. Organic antimony compounds are relatively mobile in all environments, while inorganic antimony compounds tend to be only slightly soluble or decompose in water [1]. Antimony, is not expected to bioconcentrate appreciably in fish or aquatic organisms [1].

HUMAN TOXICITY

General. The major targets of antimony toxicity are the respiratory system, heart, gastrointestinal system, and the skin [1]. Antimony exposure, however, has beneficial as well as adverse effects. Antimony is currently used to treat two parasitic diseases, schistosomiasis and leishmaniasis. Side effects following treatment include altered

EKG, anemia, vomiting, diarrhea, joint and/or muscle pain, and even death [1]. Information regarding the genotoxicity of antimony is equivocal. Metallic antimony has not been placed in a weight-of-evidence cancer group by the USEPA [3].

Oral Exposure. A chronic oral RfD of 0.0004 mg/kg-day is based on a LOAEL of 0.35 mg/kg-day for longevity, decreased blood glucose levels, and altered cholesterol levels in a chronic oral study in rats [3]. Antimony is poorly absorbed following oral exposure (<10%) [1]. Ingested antimony has not been reported to be fatal to humans, and acute oral LD_{50} values in animals are not available [1]. In humans, gastrointestinal effects have been reported following exposure to oral doses of 0.53 mg/kg-day [1]. In animals, long-term oral exposure to >0.07 mg/kg-day resulted in effects similar to those reported in humans [1]. There is no evidence that ingested antimony results in developmental or reproductive effects, or cancer in humans or animals [1]. An oral slope factor for cancer is not available for antimony [3].

Inhalation Exposure. An inhalation RfC for antimony is not available [3]. Antimony is absorbed following inhalation exposure, but the extent of absorption in humans is not known [1]. Inhaled antimony has not been reported to be fatal to humans, and acute inhalation LC_{50} values in animals are not available [1]. The effects of antimony in occupationally exposed workers include pneumoconiosis, altered EKG readings, increased blood pressure, abdominal distress, ulcers, dermatosis, and eye irritation [1]. These effects were generally observed following the inhalation of >2 mg/m^3 [3]. In animals, long-term inhalation exposure to concentrations >0.05 mg/m^3 resulted in effects similar to those reported in humans [1]. There is no conclusive evidence that inhaled antimony effects human reproduction or development, but problems with fertility were observed in animals exposed to high levels (209 mg/m^3) of antimony for 9 weeks [1]. Information regarding the carcinogenicity of inhaled antimony in humans is not available, but studies in animals indicate that inhaled antimony may cause lung cancer [1]. An inhalation unit risk for cancer is not available for antimony [3].

Dermal Exposure. Dermal exposure to antimony has not been reported to be fatal to humans, and acute dermal LD_{50} values in animals are not available [1]. Antimony is not a skin sensitizer in humans, but animal studies have shown that antimony is a skin and eye irritant [1].

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ARSENIC

CAS NUMBER

7440-38-2

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 5.727 at 25/5°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Arsenic is a naturally-occurring element. The concentration of arsenic in minimally disturbed soils varies tremendously. A collection of 1,257 soil samples from across the conterminous U.S. determined that 90 percent were less than or equal to 10 ppm, with a geometric mean of 5.2 ppm, but with a maximum value as high as 100 ppm.

FATE AND TRANSPORT

Elemental arsenic is extremely persistent in both water and soil. Environmental fate processes may transform one arsenic compound to another; however, arsenic itself is not degraded. Soluble forms of arsenic tend to be quite mobile in water, while less soluble species adsorb to clay or soil particles. Microorganisms in soils, sediments, and water can reduce and methylate arsenic to yield methyl arsines, which volatilize and enter the atmosphere. These forms then undergo oxidation to become methyl arsonic acids and are ultimately transformed back to inorganic arsenic [1].

Bioconcentration of arsenic occurs in aquatic organisms, primarily in algae and lower invertebrates. Biomagnification in aquatic food chains does not appear to be significant, although some fish and invertebrates contain high levels of arsenic compounds which are relatively inert toxicologically. Plants may accumulate arsenic, subject to various factors including soil arsenic concentration, plant type, and soil characteristics [1].

HUMAN TOXICITY

General. Arsenic is a long-recognized human poison capable of producing a lethal reaction and cancer. The major targets of arsenic toxicity are the respiratory system, gastrointestinal system, nervous system, hematological system, and skin [1]. Studies in animals suggest that low levels of arsenic may be necessary to maintain good health, but this has not been shown in humans [1]. Arsenic is considered a weak mutagen and has been placed in weight-of-evidence cancer group A, indicating that it is a human carcinogen [3].

Oral Exposure. A chronic oral RfD of 0.0003 mg/kg-day is based on a NOAEL of 0.0008 mg/kg-day for hyperpigmentation, keratosis, and possible vascular complications in a chronic oral study in humans [3]. Arsenic is readily absorbed following oral exposure. Acute oral LD_{50} values of 26 mg/kg for mice and 15 to 110 mg/kg for rats are reported [1]. The fatal dose in humans is estimated to be 2 mg/kg [1]. Low-level oral exposure (>0.01 mg/kg-day) may cause irritation of the digestive tract, pain, nausea, vomiting, diarrhea, skin abnormalities, decreased production of blood cells, abnormal heart function, blood-vessel damage, liver damage, kidney damage, and impaired nerve function ("pins and needles" sensation). In animal studies, high doses of arsenic (>14 mg/kg-day) have resulted in effects on the developing fetus. These effects have not been observed in humans [1]. In humans, chronic, oral exposure to low doses of arsenic (>0.01 mg/kg-day) has been shown to cause cancer of the skin, liver, bladder, and lung. The most characteristic effect of long-term oral exposure to arsenic is a darkening of the torso and the appearance of small "corns" or "warts" on the palms, soles, and torso. These "corns" or "warts" may develop into skin cancer [1]. An oral unit risk of 0.00005 $(\mu g/L)^{-1}$ [1.75 $(mg/kg\text{-}day)^{-1}$] has recently been adopted by the USEPA [3]. The unit risk is based on the increased incidence of skin cancer in humans exposed to arsenic in the drinking water.

Inhalation Exposure. An inhalation RfC is not available for inorganic arsenic [3]. Approximately 40% of an inhaled concentration of arsenic is absorbed [1]. Inhalation of arsenic has not been reported to be fatal in humans, and acute inhalation LC_{50} values are not available [1]. Inhalation of arsenic at concentrations greater than 0.1 mg/m^3 may result in irritation of the nose and throat, leading to laryngitis, bronchitis, or rhinitis [1]. Effects on the skin, nervous system, and gastrointestinal system similar to those found following oral exposure have been observed in humans following inhalation exposure. Of much greater concern, however, is that inhaled arsenic has been found to increase the risk of lung cancer in humans [1]. An inhalation unit risk of 0.0043 $(\mu g/m^3)^{-1}$ was derived by USEPA based on the increased incidence of lung cancer in occupationally exposed workers [3]. Several epidemiology studies have suggested an association between arsenic inhalation and an increased risk of developmental effects (congenital malformations, low birth weight, and spontaneous abortions) [1]. Studies in animals support the view that arsenic is a developmental toxicant, but only at high doses (20 mg/m^3) [1].

Dermal Exposure. Arsenic has not been reported to be fatal following dermal contact [1]. Dermal contact with arsenic may result in mild to severe irritation of the skin and mucous membranes and could lead to dermal sensitization [1].

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BARIUM

CAS NUMBER

7440-39-3

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Decomposes [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 3.51 at 20/20°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Barium is a naturally-occurring element. The concentration of barium in minimally disturbed soils varies tremendously. A collection of 1,319 soil samples from across the conterminous U.S. determined that 86 percent were less than or equal to 700 ppm, with a geometric mean of 440 ppm, but with a maximum value as high as 3,000 ppm.

FATE AND TRANSPORT

Barium is a highly reactive metal that occurs naturally only in the combined state. Most barium released to the environment from industrial sources is in forms that do not become widely dispersed. In the atmosphere, barium is likely to be present in the particulate form. Environmental fate processes may transform one barium compound to another; however, barium itself is not degraded. It is removed from the atmosphere primarily by wet or dry deposition [1].

In aquatic media, barium is likely to precipitate out of solution as an Insoluble salt, or adsorb to suspended particulate matter. Sedimentation of suspended solids removes a large portion of the barium from surface waters. Barium in sediments is found largely in the form of barium sulfate. Bioconcentration in freshwater aquatic organisms is minimal [1].

Barium in soil may either be taken up to a small extent by vegetation, or transported through soil with precipitation. Barium is not very mobile in most soil systems. The higher the level of organic matter, the greater the adsorption. The presence of calcium carbonate will also limit mobility. Mobility is increased in the presence of high

chloride concentrations. Barium complexes with fatty acids, for example, in acidic landfill leachate, will be much more mobile [1].

HUMAN TOXICITY

General. The primary target of barium toxicity is the cardiovascular system [1]. Information regarding the genotoxicity of barium are equivocal. Barium has not been place in a weight-of-evidence cancer group by the USEPA [2].

Oral Exposure. A chronic oral RfD of 0.07 mg/kg-day is based on a NOAEL of 0.21 mg/kg-day for increased blood pressure in a long-term drinking water study in humans [2]. Barium is poorly absorbed following oral exposure (about 5%) [1]. In rats, acute oral LD_{50} values range from 132 to 277 mg/kg [1]. In humans, ingestion of very large amounts of barium (doses not reported) over a short period may cause paralysis or death. Ingestion of lower doses of barium over a short period may result in difficulties in breathing, increased blood pressure, changes in heart rhythm, stomach irritation, minor changes in blood, muscle weakness, changes in nerve reflexes, swelling of the brain, and damage to the liver, kidney, heart, and spleen [1]. Studies in animals report effects similar to those found in humans. Barium sulfate is sometimes given orally or rectally for the purpose of making X-rays. This has not been shown to be harmful [1]. There is no evidence that oral exposure to barium affects human reproduction or development and developmental and reproduction studies in animals are inconclusive [1]. Barium has not been shown to cause cancer in humans or animals following oral exposure, therefore, an oral slope factor is not available [1,2].

Inhalation Exposure. A chronic inhalation RfC of 0.0005 mg/m^3 is based on a NOEL of 0.8 mg/m^3 for fetotoxicity in rats [3]. Approximately 65% of an inhaled concentration of barium is absorbed following inhalation exposure [1]. Barium has not been reported to be fatal to humans or animals following inhalation exposure [1]. Studies examining the toxicity of inhaled barium in humans and animals are extremely limited but suggest that exposure results in effects on the respiratory, cardiovascular, and gastrointestinal systems [1]. There is no evidence that inhaled barium affects human reproduction or development, but studies in animals suggest that barium may have adverse effects on these processes [1]. Barium is not known to cause cancer in humans or animals following inhalation exposure, therefore, an inhalation unit risk is not available [1,2].

Dermal Exposure. Dermal exposure to barium has not been reported to be fatal in humans or animals. Limited animal studies indicate that barium is a dermal and ocular irritant, but the results of this study are inconclusive [1].

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BERYLLIUM

CAS NUMBER

7440-41-7

COMMON SYNONYMS

Glucinium.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 1.848 20/4°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATION

Beryllium is a naturally-occurring element. The concentration of beryllium in minimally disturbed soils varies tremendously. A collection of 1303 soil samples from across the counterminous U.S. determined that 86 percent were less than 2 ppm, with a geometric mean of 0.63 ppm and a maximum value of 15 ppm.

FATE AND TRANSPORT

Pure beryllium is a gray metal, resistant to attack by acids (due to formation of a thin oxide film). In nature, beryllium is present in much greater concentrations in soils and sediments than in water. Beryllium is tightly adsorbed to most types of soils because it displaces divalent cations that share common sorption sites. Consequently, beryllium has limited mobility in soil and is not likely to leach to groundwater. Beryllium will not volatilize from water or soil. In water, beryllium compounds may hydrolyze to form other beryllium compounds. In air, beryllium will probably be in the form of beryllium oxide. It is not known if beryllium will be transformed to more soluble compounds, which will be removed via precipitation. Bioconcentration of beryllium in aquatic organisms will not be significant [1].

HUMAN TOXICITY

General. The major target of beryllium toxicity is the respiratory system [1]. Information regarding the mutagenicity of beryllium are mixed. Beryllium has been placed in weight-of-evidence cancer group B2, indicating that it is a probable human carcinogen [3].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg-day is based on a NOAEL of 0.54 mg/kg-day for no adverse effects in a chronic oral study in rats [3]. Beryllium is poorly absorbed following oral exposure. Information regarding the effects of oral exposure in humans are not available and animal studies are limited. Acute oral LD_{50} values in rodents ranged from 18 to 200 mg/kg-day [1]. Rats fed a diet containing high levels of beryllium (>10 mg/kg-day) developed rickets. When the diet is deficient in calcium, beryllium will substitute for calcium in the bone, resulting in rickets; it is not known if this effect will occur in humans [1]. Information regarding the potential effects of ingested beryllium on reproduction and development in humans and animals are not available. There is no evidence that ingested beryllium causes cancer in humans, but animal studies suggest that beryllium may be carcinogenic following oral exposure [1]. An oral slope factor of 4.3 $(mg/kg\text{-}day)^{-1}$ has been derived based on an increase in the incidence of gross tumors at various sites in rats [3].

Inhalation Exposure. An inhalation RfC for beryllium is not available [3,4]. Beryllium is absorbed following inhalation exposure, but the extent of absorption is not known. Acute, 4-hour inhalation LC_{50} values in animals were 0.15 to 0.86 mg/m^3 in rats and 4.02 mg/m^3 in guinea pigs [1]. Occupational exposure of humans to beryllium dusts, including both inhalation and dermal exposure, is the primary route of beryllium exposure. The respiratory system is the target of beryllium toxicity following both acute and chronic exposure. Short-term exposure results a condition called chemical pneumonitis, which is characterized by cough, a burning in the chest, shortness of breath, anorexia and increasing fatigue. These effects are associated with concentrations >0.1 mg/m^3 [1]. Chronic exposure to beryllium results in a condition known as berylliosis, or chronic beryllium disease, which is characterized by the presence of granulomas, fibrosis, and emphysema in the lungs. Berylliosis has been found to occur at concentrations >0.001 mg/m^3 [1]. The chemical pneumonitis occurs primarily with exposure to soluble beryllium compounds, while the berylliosis results primarily from exposure to Insoluble beryllium compounds. Both conditions may be fatal. Effects on the heart, liver, and kidney may also occur, but are probably secondary to the respiratory effects. There is no evidence that inhaled beryllium will cause developmental effects in humans, but studies in animals indicate that intratracheal exposure to beryllium may result in developmental effects [1]. Lung cancer has also been found in occupationally exposed workers [1]. An inhalation unit risk of 0.0024 $(ug/m^3)^{-1}$ has been derived based on an increase in the incidence of lung tumors in humans [3].

Dermal Exposure. Dermal exposure to beryllium has not been reported to be fatal to humans or animals. Dermal exposure to beryllium may result in allergic reactions in both humans and animals [1]. Skin granulomas (non-cancerous growths) may form on the skin of sensitized individuals [1].

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CADMIUM

CAS NUMBER

7440-43-9

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Neglibible [2]
Henry's Law Constant: NA
Specific Gravity: 8.65 at 25/4°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Pure cadmium is a silver-white, blue-tinged, lustrous metal with a distorted hexagonal close-packed structure and is easily cut with a knife. Cadmium can be found in zinc ores, as greenockite (CdS), and as otavite ($CdCO_3$). The estimated occurrence of cadmium in the earth's crust is from 0.1 to 0.2 ppm [1]. No data on cadmium was gathered as part of the 1984 Department of the Interior survey of conterminous United States soils [3].

FATE AND TRANSPORT

Elemental cadmium is Insoluble in water [1]; while cadmium compounds show varying degrees of solubility depending on the nature of the compounds and the aquatic environment [2]. Cadmium in the environment may be found as cadmium salts, hydrated cations, or organic/inorganic cadmium complexes. As hydrated cations or complexes, cadmium may be considered fairly mobile in water (relative to other heavy metals). Cadmium in soils may leach into water, especially under acidic conditions. It does not volatilize from either waters or soils, but does exhibit a tendency to adsorb strongly to clays, muds, and humic/organic materials in soils and waters. Complexation and sorbing with organic materials are the most important factors in aquatic fate and transport. The evidence indicates that cadmium bioconcentrates in all levels of the food chain. Cadmium accumulation has been reported in many animal and plant species. Reported BCFs range from 113 to 18,000 for invertebrates, and from 3 to 2,213 for fish. The pH and humus content of the water affect bioconcentration [2].

HUMAN TOXICITY

General. Breathing air with very high levels of cadmium severely damages the lungs and can cause death. High cadmium levels in the diet severely irritate the digestive tract, while lower levels consumed over a long period of time may cause kidney damage [2]. The USEPA has placed cadmium in weight-of-evidence cancer group B1, indicating that it is a probable human carcinogen [4].

Oral Exposure. A chronic oral RfD of 0.0005 mg/kg-day for water is based on a NOAEL of 0.005 mg/kg-day for proteinuria following chronic exposures in humans. A chronic oral RfD of 0.001 mg/kg-day for food is based on a NOAEL of 0.01 mg/kg-day for proteinuria following chronic exposures in humans [4]. It is estimated that humans absorb about 5 percent of ingested cadmium [2]. In rats and mice the acute oral LD_{50} values range from about 100 to 300 mg/kg. Two human deaths due to intentional ingestion of cadmium resulted from doses of 25 and 1,500 mg/kg [4]. Symptoms of acute toxic reaction to ingestion may include gastroenteritis, vomiting, diarrhea, abdominal pain, increased salivation, choking, anemia, hypotension, respiratory arrest, pulmonary edema, renal dysfunction, and death. Chronic oral overexposure symptoms may include renal dysfunction and/or failure, as well as anemia [1,2,5]. Cadmium has been implicated as a fetotoxin by the oral route in animal studies [2].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for cadmium [4,6]. It is estimated that humans rapidly absorb about 25% of inhaled cadmium. The 15-minute LC_{50} for rats exposed to cadmium oxide fumes is approximately 33 mg/m^3. It has been estimated that exposure to 1 mg/m^3 for 8 hours might be sufficient to cause death in humans [2]. Symptoms associated with acute cadmium poisoning via inhalation may include fever, headache, dyspnea, pleuritic chest pain, conjuctivitis, rhinitis, sore throat, cough, pulmonary edema, extreme restlessness, respiratory failure, and death. Chronic inhalation overexposure symptoms may include renal dysfunction and/or failure, dyspnea, emphysema, bronchitis, and anemia [1,2,5]. Cadmium has been implicated as a developmental toxin by the inhalation route in animal studies [2]. An inhalation unit risk of 0.0018 $(ug/m^3)^{-1}$ is based on excess lung cancers observed in humans [4].

Dermal Exposure. Cadmium is poorly absorbed through the skin [2]. No other useful information regarding dermal exposure to cadmium was located.

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LEAD

CAS NUMBER

7439-92-1

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C
Henry's Law Constant: NA
Specific Gravity: 11.34 at 20/4°C [2]
Organic Carbon Partition Coefficient: NA

FATE DATA: HALF-LIVES

Note: Data for tetraethyl lead; CAS No. 78-00-2
Soil: 1 to 4 weeks [3]
Air: 2.3 to 9.0 hours [3]
Surface Water: 2.3 to 9.0 hours [3]
Groundwater: 2 to 8 weeks [3]

BACKGROUND CONCENTRATIONS

Lead is a naturally-occurring element which is dispersed throughout the environment primarily as a result of anthropogenic activities [1]. The concentration of lead in minimally disturbed soils varies tremendously. A collection of 1,300 soil samples from across the conterminous U.S. determined that 80 percent were less than or equal to 30 ppm, with a geometric mean of 16 ppm, but with a maximum value as high as 700 ppm [4]. Lead concentrations in Ohio farm soils were found to range from 9 to 39 ppm, with a mean value of 19 ppm [5]. Concentrations along roadways and adjacent to houses with exterior lead-based paints may be as high as 10,000 ppm [1].

FATE AND TRANSPORT

Lead is extremely persistent in both water and soil. Environmental fate processes may transform one lead compound to another; however, lead itself is not degraded. It is largely associated with suspended solids and sediments in aquatic systems, and it occurs in relatively immobile forms in soil. Lead which has been released to soils may become airborne as a result of fugitive dust generation. Tetraethyl lead may occur in the vapor phase [1].

HUMAN TOXICITY

General. The general human population is exposed to lead primarily via the human oral exposure route, with some contribution from the inhalation exposure route. However, in some subpopulations, the predominant route of exposure is via inhalation. The effects of lead are the same regardless of whether it enters the body through breathing or ingestion. The major health threat from lead arises from the damage it causes to the brain, especially in fetuses, infants, and young children. Young and developing humans are highly sensitive to its effects. Also, young children are prone to ingest more lead as a result of normal mouthing behavior. Decreased IQ and reduced growth may result from childhood exposure. Fetal exposure may result in preterm birth, reduced birth weight, and decreased IQ [1]. The Federal Centers for Disease Control recently lowered the threshold at which children are considered to have lead poisoning from 25 to 10 micrograms of lead per deciliter of blood [6]. Some of the health effects of lead, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood levels so low as to be essentially without a threshold [7].

Lead exposure may increase blood pressure in middle-aged men. High-level exposure can severely damage the brain and kidneys in adults or children. In addition, high doses of lead will cause abortion and damage the male reproductive system [1]. The USEPA currently does not provide any toxicity values for lead [7,8]. The USEPA has placed lead in weight-of-evidence group B2, indicating that it is a probable human carcinogen [7].

Oral Exposure. Oral absorption of lead appears to be low in humans. The absorption of lead into the body is highly dependent on its state of complexation. In general, soluble lead compounds tend to be more readily absorbed into the body than insoluble compounds, and are therefore more toxic. Certain organic lead compounds are also readily absorbed. Gastrointestinal absorption is highly dependent on the form of lead and the amount of food present. For example, in one experiment 3% of lead chloride was absorbed when provided with a meal, but 60% was absorbed when animals were fasted. Lead absorption is higher in children than in adults. Oral LD_{50} values were not available. LD_{LO} values for various inorganic lead compounds reportedly ranged from 191 mg/kg in dogs to 20,500 mg/kg in guinea pigs. An LD_{LO} is the lowest dose causing death. The reported adverse effects of lead in laboratory animals following oral exposure include severe CNS damage, elevated blood pressure, impaired heme synthesis, liver damage, kidney damage, fetotoxicity, and damage to the reproductive organs in both males and females. Renal tumors have been observed in laboratory animals following oral administration of lead acetate [1].

Inhalation Exposure. The USEPA does not currently provide an inhalation RfC for lead. Once deposited in the lower respiratory tract, lead is almost completely absorbed, and all chemical forms of lead also appear to be absorbed. Limited experimental evidence suggests that inhaled tetraethyl lead is rapidly absorbed by rats [1]. No other useful information was located regarding specific adverse health effects resulting from inhalation exposure to lead.

Dermal Exposure. Compounds such as lead acetate are poorly absorbed through skin, while tetraethyl lead appears to be rapidly absorbed [1]. No other useful information was located regarding specific adverse health effects resulting from dermal exposure to lead.

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MANGANESE

CAS NUMBER

7439-96-5

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Decomposes [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 7.20 at 20/4°C [1]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Manganese is a naturally-occurring element. The concentration of manganese in minimally disturbed soils varies tremendously. A collection of 1,317 soil samples from across the conterminous U.S. determined that 89 percent were less than or equal to 700 ppm, with a geometric mean of 330 ppm, but with a maximum value as high as 7,000 ppm.

FATE AND TRANSPORT

Environmental fate processes may transform one manganese compound to another; however, manganese itself is not degraded. Elemental manganese and inorganic manganese compounds may exist in air as suspended particulate matter. Such particles are removed from the atmosphere primarily by dry deposition, and, to a lesser extent, by washout. In water, the metal may exist in any of four oxidation states (2+, 3+, 4+, or 7+). Mn(+2) predominates in most waters, and usually combines with carbonate to form a compound of low solubility. In extremely reduced water, poorly soluble sulfides are formed. Manganese is often transported in rivers as suspended sediments. Manganese in water may be significantly bioconcentrated at lower trophic levels. Bioconcentration may not be significant in predatory fish; thus biomagnification may not be significant [1].

Adsorption of manganese to soils may be highly variable, increasing with higher organic content and anion-exchange capacity. At low concentrations, manganese may be "fixed" by clays, and will not be readily released into solution. At higher concentrations, it may be desorbed by ion exchange. For example, the discharge of waste water into estuarine environments resulted in the mobilization of manganese from

the bottom sediments. Also, microorganisms may increase the mobility of manganese under some circumstances [1].

HUMAN TOXICITY

General. The only adverse health effect identified following exposure to high levels of manganese is a condition known as "manganism," which results in psychomotor disturbances. Manganese in small amounts is believed to be an essential nutrient for humans [1]. The USEPA has placed manganese in weight-of-evidence cancer group D; that is, it is not classifiable as to human carcinogenicity [2].

Oral Exposure. The chronic RfD for the manganese ranges from 0.005 mg/kg-day for the ingestion of manganese in water to 0.14 mg/kg-day for the ingestion of manganese in food [2]. Both RfDs are based on a NOAEL for CNS effects determined from human chronic ingestion data [2]. The amount of manganese absorbed from the gastrointestinal tract typically averages 3 to 5%. Most animal studies indicate that manganese compounds have low acute oral toxicity. A NOAEL of 2,300 mg/kg-day in food for 6 months was determined for mice. On the other hand, single doses of highly concentrated solutions of various manganese compounds delivered to rats by gavage produced LD_{50} values ranging from 410 to 820 mg/kg-day. Thus, it was concluded that high doses delivered by gavage did not yield a model relevant for normal environmental exposure. Evidence for the onset of manganism in humans following oral exposure is inconclusive. In animals, changes in the brain have been observed following very high oral exposure [1].

Inhalation Exposure. An RfC of 0.00005 mg/m^3 is based on a LOAEL of 0.15 mg/m^3 for impairment of neurobehavioral function in occupationally exposed workers [2]. The rate and extent of absorption of manganese following inhalation is unknown. A significant fraction of inhaled manganese-containing particles are carried via mucociliary transport to the gastrointestinal tract. Exposure of humans to high levels of manganese dust in air for a prolonged period of time (1 month to several years) may cause mental and emotional disturbances, and the impairment of locomotion and dexterity, a condition known as manganism. However, this condition has only been documented for workers in mines and foundries. Manganism occurs because excessive manganese injures a part of the brain that helps control body movements. Some of the symptoms of manganism can be reduced by medical treatment, but the brain injury is permanent [1].

Dermal Exposure. No information was located on the dermal absorption of manganese or adverse health effects resulting therefrom. It is reasonable to assume that intake via this pathway under normal circumstances is minimal.

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SELENIUM

CAS NUMBER

7782-49-2

COMMON SYNONYMS

Vandex; CI77805; selenium base; selenium dust; colloidal selenium; selenium homopolymer [1].

ANALYTICAL CLASSIFICATION

Metal.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 4.81 at 20°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Selenium is a naturally occurring element, and the concentration of selenium in minimally disturbed soils varies tremendously. A collection of 1,267 soil samples from across the conterminous U.S. determined that 80 percent were less than or equal to 0.5 ppm, with a geometric mean of 0.26 ppm, but with a maximum of 5 ppm [3].

FATE AND TRANSPORT

The behavior of selenium in the environment is dependent upon its oxidation state, and the behavior of the chemical compounds formed as a result of the differing oxidation states. In addition, the oxidation state of selenium in the environment is dependent upon a number of environmental factors, including pH, Eh, and biological activity, etc. For releases of selenium to soils, pH and Eh will be the primary determining factors for its fate and transport. Elemental and/or inorganic selenium may undergo microbial methylation (to dimethyl selenide and dimethyl deselenide), ultimately being volatilized to the atmosphere. Temperature, however, will moderate the methylation of selenium; reductions in temperature from 20°C to 4°C resulted in a methylation rate reduction of 90%. Acidic soil conditions favor the predominance of selenides. Selenides are insoluble and are expected to be immobile in soils. Neutral to alkaline soil conditions favor the predominance of selenates. Selenates are expected to be very mobile in soils, given their high solubility and low sorption potential, and represent a potential for leaching to unprotected groundwaters. For water-soluble selenium compounds (i.e., selenates), terrestrial plant uptake represents a removal/transport mechanism of concern, but will be influenced by a variety of environmental factors (e.g., pH, soil type, reduction oxidation (redox) potentials, etc.) [1].

Selenium released to surface water is expected to be found in the form of salts of selenic and selenious acids. Salts of selenic acid (such as sodium selenate) are generally found in aerobic, alkaline waters and are expected to be highly mobile in the aquatic environment. Salts of selenious acid (selenite salts) are found in neutral to acidic waters and show less environmental mobility than do selenate salts. Under acidic conditions, however, selenite is readily reduced to elemental selenium; selenate, as well, is converted to elemental selenium, but more slowly. Elemental selenium will be stable over a wide range of pH and redox conditions. Aquatic organisms, however, will convert selenium to selenoamino acids and, subsequently, methylated selenium compounds. Neither metabolic product is expected to exist long in the aquatic environment, with the methylated forms volatilizing rapidly to the atmosphere. Selenium in the aquatic environment has been demonstrated to bioaccumulate ($\log_{BAF}$ = 3.60), bioconcentrate ($\log_{BCF}$ = 3.27), and, potentially, biomagnify in aquatic organisms [1].

Atmospheric concentrations of selenium are generally found as inorganic compounds such as selenium dioxide and hydrogen selenide, and organic compounds such as dimethyl selenide and dimethyl diselenide. Dry and/or wet deposition of selenium compounds is expected to account for some removal of these materials from the atmosphere [1].

HUMAN TOXICITY

General. Selenium is considered an essential element. Toxic effects may occur, however, when too much selenium is taken into the body. The major target of selenium toxicity is the lungs, with the heart, liver, and kidneys also being affected. Selenium is considered to be genotoxic [1]. The USEPA placed selenium in weight-of-evidence cancer group D, indicating that it is not classifiable as to human carcinogenicity [4].

Oral Exposure. A chronic oral RfD of 0.005 mg/kg-day is based on a NOAEL of 0.015 mg/kg-day for clinical selenosis in a human epidemiology study [4]. Selenium is readily absorbed following oral exposure. Acute oral LD_{50} values of 4.8 - 7 mg/kg in rats, 3.2 - 3.5 mg/kg in mice, 2.3 mg/kg in guinea pigs, and 1.0 mg/kg in rabbits have been reported for selenium [1]. In humans, selenium exposure has resulted in death, but the fatal dose is not known. Following accidental ingestion of selenium, effects on the lungs (pulmonary edema and breathing difficulties), upset stomachs, and muscular weakness have been noted. The dose resulting in these effects is not known. Symptoms reported in people who ingested selenium over a long period of time include loss of hair, loss of and poorly formed nails, problems with walking, reduced reflexes, and some paralysis. These effects occurred at doses greater than or equal to 0.053 mg/kg-day [1]. Selenium has not been found to cause developmental effects in humans or mammals, but birth defects have been found in birds [1]. Most epidemiological studies indicate that selenium is not carcinogenic to humans. In fact, some animal studies suggest that oral selenium may inhibit cancer. An oral slope factor for cancer is not available for selenium [4].

Inhalation Exposure. A chronic inhalation RfC is not available for selenium [4]. Selenium is readily absorbed following inhalation exposure. Acute inhalation LC_{50} values in guinea pigs ranged from 1-12.7 mg/m^3 for 2 to 8 hours [1]. Inhaled selenium

has not been reported to be fatal in humans. In both humans and animals, the respiratory system is the primary target of inhaled selenium because selenium is an irritant when it comes in contact with water. Short-term exposure to high concentrations of selenium (exact levels not known) results in pulmonary edema, bronchial spasms, symptoms of asphyxiation, and persistent bronchitis [1]. Neurological effects (headaches, dizziness, and malaise) have also been noted following short-term inhalation of selenium. Occupational exposure to low concentrations (0.007-0.05 mg/m^3) has resulted in slight tracheobronchitis [1]. Information regarding the potential effects of inhaled selenium on reproduction and development are not available. Inhaled selenium has not been reported to cause cancer in humans or animals, therefore, an inhalation unit risk is not available [4].

Dermal Exposure. Contact dermatitis and skin rashes have been reported following both acute and chronic exposure to selenium [1]. This is due to the irritative properties of selenium. Other information regarding the toxicity of selenium following dermal exposure are not available.

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3. United States Geological Survey (USGS), 1984. Elemental Concentrations in Soils and Other Surficial Material of the Conterminous United States. USGS Professional Paper 1270, U.S. Department of the Interior. United States Government Printing Office. Washington, D.C. 105 pp.
4. USEPA, 1995. Integrated Risk Information System (IRIS). Data base. Online.

ZINC

CAS NUMBER

7440-66-6

COMMON SYNONYMS

None noted.

ANALYTICAL CLASSIFICATION

Inorganic.

PHYSICAL AND CHEMICAL DATA

Water Solubility: Insoluble [1]
Vapor Pressure: Insignificant at 25°C [1]
Henry's Law Constant: NA
Specific Gravity: 7.14 at 25/4°C [2]
Organic Carbon Partition Coefficient: NA

BACKGROUND CONCENTRATIONS

Zinc is a naturally occurring element essential to many life forms [1]. It is widespread in nature and may be found in many known compounds. The estimated occurrence of zinc in the earth's crust is 0.02 percent by weight [2]. The concentration of zinc in minimally disturbed soils varies tremendously. A collection of 1,248 soils samples from across the conterminous U.S. determined that 87 percent were less than or equal to 74 ppm, with a geometric mean of 48 ppm, but with a maximum as high as 3500 ppm [3].

FATE AND TRANSPORT

Elemental zinc is a bluish-white, lustrous metal having a distorted hexagonal close-packed structure [2]. It is stable in dry air, but upon exposure to moist air will form a white coating composed of basic carbonate. Zinc loses electrons (oxidizes) in aqueous environments [2]. In the environment, zinc is found primarily in the 2^+ oxidation state. Elemental zinc is insoluble; most zinc compounds show negligible solubility as well, with the exception of elements (other than fluoride) from Group VIIa of the Periodic Table compounded with zinc (i.e., $Zn\ Cl_2$, ZnI_2) showing a general 4:1 compound to water solubility level. In polluted waters, zinc often complexes with a variety of organic and inorganic ligands. Therefore, the overall mobility of zinc in an aqueous environment, or through moist-to-wet soils, may be accelerated by compounding/complexing reactions [1].

Zinc has a tendency to adsorb to soils and sediment/suspended solids in waters. Adsorption to sediments/suspended solids is the primary fate for zinc in aqueous environments, and will greatly limit the amount of solubilized zinc. Zinc is an essential element and, therefore, is accumulated by all organisms. Zinc concentrations in air are relatively low except near industrial sources. Volatilization is not an important process from soil or water [1].

HUMAN TOXICITY

General. Zinc is an essential trace element, therefore, toxic effects can result if too much or too little is taken into the body. The Recommended Dietary Allowances (RDAs) for zinc are 15 mg/day for men and 12 mg/day for women [1]. The major targets of zinc toxicity are the gastrointestinal tract following oral exposure and the lungs following inhalation exposure [1]. Zinc is not mutagenic and has been placed in weight-of-evidence group D, indicating that it is not classifiable as to human carcinogenicity, by the USEPA [4].

Oral Exposure. A chronic oral RfD of 0.3 mg/kg-day is based on a LOAEL of 1 mg/kg-day for effects on red blood cells in human females [4]. Approximately 20-30% of an oral dose of zinc is absorbed by the gastrointestinal tract [1]. Zinc has not been reported to be fatal to humans and oral LD_{50} values in animals are not available [1]. In humans, gastrointestinal effects (vomiting, abdominal cramps, and diarrhea) and hematological effects (anemia) have resulted from oral exposure to doses greater than 2 mg/kg-day. Long-term administration of zinc can result in copper deficiency [1]. In animals, effects on the liver and kidneys, as well as the gastrointestinal and hematological systems, have been reported [1]. Studies in animals indicate that exposure to high doses of zinc (200 to 500 mg/kg-day) results in reduced fetal growth and altered concentrations of zinc and copper in both the mother and fetus [1]. There is no evidence that exposure to zinc affects development or reproduction in humans. There is no evidence that zinc causes cancer in humans or animals following oral exposure, therefore, an oral slope factor is not available [4].

Inhalation Exposure. A chronic inhalation RfC is not available for zinc [4]. Zinc is absorbed through the respiratory tract, but the extent of absorption is not known. In humans, death has resulted from exposure to high concentrations (estimated at 97,635 mg/m^3) of zinc-containing smoke [1]. In mice, the reported LCT_{50} (product of lethal concentration and time to kill 50% of the animals) of zinc chloride was 11,800 mg-min/m^3 [1]. Short-term exposure to zinc dust and zinc fumes results in "metal fume fever". This condition is characterized by an acute impairment of pulmonary function. Acute (10-12 minutes) inhalation of 600 mg/m^3 as zinc oxide has resulted in nasal passage irritation, cough, chest pain, lung rales, and decreased vital capacity. No symptoms of metal fume fever were reported following exposure to zinc oxide at 14 mg/m^3 for 8 hours, 45 mg/m^3 for 20 minutes, or occupational exposure to 8-12 mg/m^3 [1]. Information is not available regarding effects on reproduction or development in human or animals following inhalation exposure. There is no evidence that inhaled zinc causes cancer in humans or animals, therefore, an inhalation unit risk is not available [4].

Dermal Exposure. Zinc has not been reported to be fatal in humans or animals following dermal exposure. Topical application of zinc (in the form of zinc oxide or calamine lotion), however, is used to promote healing of burns and wounds [1].

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332579

APPENDIX I

SCREENING OF REMEDAIAL TECHNOLOGIES AND

ALTERNATIVE COST ANALYSIS

332580

SCREENING OF TECHNOLOGIES

APPENDIX G

SCREENING OF REMEDIAL TECHNOLOGIES

1.1 OVERVIEW

This appendix identifies a variety of remedial approaches and technologies that were considered in developing remedial alternatives for Site ST14 (and Site SD13) at Carswell Air Force Base (AFB)/Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. This initial screening was based on three primary evaluation criteria: effectiveness in meeting target risk-based remedial goals that are protective of human health and the environment, technical and administrative implementability, and relative cost. The purpose of this screening was to quickly focus the remedial action plan (RAP) on the most promising and cost-effective methods for remediating Site ST14 and possibly Site SD13. This appendix focuses on how selected active remedial technologies could be combined with intrinsic remediation to achieve an effective site cleanup in a reasonable timeframe.

2.1 SCREENING OF REMEDIAL TECHNOLOGIES

Table 1 provides a summary of the remedial approaches and technologies considered for Site ST14 (and Site SD13). All of these technologies are appropriate for the remediation of fuel-contaminated soils or groundwater. Technologies used to remediate non-fuel contaminants have been purposely deleted from this focused initial screening. Several of the most promising technologies considered during screening were retained as candidates for the development of remedial alternatives and are evaluated in Section 8 of the RAP. The following paragraphs provide a brief description of each remedial approach or technology group and its site-specific applicability for this site.

2.1.1 Long-Term Soil, Soil Gas, and Groundwater Monitoring

Long-term monitoring of soils and groundwater is essential in evaluating the progress of intrinsic and engineered remediation and for ensuring that cleanup criteria are achieved over a specified time interval.

2.1.1.1 Soil and Soil Gas Monitoring

Soil and soil gas monitoring provides information for assessing the effectiveness of an implemented soil remedial technology. Extensive soil sampling at Sites ST14 and SD13 has revealed moderate contamination in unsaturated soils in the source areas and in saturated soils outside of the source areas. Soil gas is used as an indicator of volatile

TABLE 1
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
Long-Term Monitoring	Periodic Groundwater Monitoring	Sentry Wells	Many existing wells are available to confirm the progress of remediation.	Necessary component of all remediation strategies.	Low	Yes
		Point-of-Compliance Wells	Sufficient distance exists between the plume and point-of-compliance to locate several additional wells.	Necessary component of all remediation strategies.	Low	Yes
	Periodic Soil/Soil Gas Monitoring	Installation of Additional Soil Borings	Extensive soil sampling indicates moderate soil contamination. Soil gas monitoring useful for checking progress of natural and enhanced bioremediation.	Additional soil sampling necessary in future to document decrease in benzene concentrations.	Low	Yes
Institutional Controls	Land and Groundwater Use Control	Land Use Control/Regulate Well Permits	Plume area is currently within the Base boundary. Land-use and groundwater use are under Base jurisdiction.	Necessary component of risk-based cleanup.	Low	Yes
		Seal/Abandon Existing Wells	No drinking water wells located within 1,000 feet of plume.	Not required at this site.	Low	No
		Point-of-Use Treatment	No groundwater is extracted from the plume area for use. Other sources of drinking water are available at the site.	Poor	Moderate	No
	Public Education	Meetings/ Newsletters	Important to convey a clear understanding of acceptable land and groundwater use.	Necessary component of all remediation strategies; part of BCT activities.	Low	Yes
Containment of Plume	Hydraulic Controls	Abandonment of French drain and oil/water separator	Subsurface drain system may be intercepting groundwater and routing it to surface water. Abandonment via *in situ* grouting or partial or complete excavation would eliminate these artificial conduits.	Preventative only since no recent evidence of elevated contaminant concentrations in receiving surface water.	Moderate	Yes

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TABLE 1 (Continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
Containment of Plume (cont.)	Hydraulic Controls (cont.)	Minimum Pumping/Gradient Control	A line or semicircle of vertical pumping wells could be located along the leading edge of plume to intercept and halt the advance of the plume. Difficult to place and operate due to heavily-developed area and heterogeneous subsurface.	Low	High	No
	Physical Controls	Slurry Walls/Grout Curtains	Requires significant surface disruption. Limited effectiveness.	Moderate	High	No
		Sheet Piling	Requires significant surface disruption. Limited effectiveness.	Moderate	High	No
	Reactive/Semi-Permeable Barriers	Biologically Active Zones	Natural biodegradation of BTEX/PAH compounds can be stimulated by allowing contaminated groundwater to flow through a treatment zone which has conditions that enhance mass destruction.	Moderate	High	No
In Situ Groundwater Treatment	Biological/ Chemical/Physical	Oxygen and/or Nutrient Enhanced Biodegradation (Biosparging)	Oxygen (air) is either injected upgradient of plume and allowed to migrate downgradient or injected in source area as point-treatment method to enhance biodegradation/ promote volatilization. In theory, this method can more rapidly reduce higher BTEX/PAHs concentrations in and immediately downgradient of the source. Nonhomogeneous hydrogeology will severely limit effectiveness Limited radius of influence and short-circuiting are common problems.	Low	Moderate to High	Yes

322583

TABLE 1 (Continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
In Situ Groundwater Treatment (cont.)	Biological/ Chemical/Physical (cont.)	Intrinsic Remediation	A combination of natural biological, chemical, and physical removal mechanisms which occur to varying degrees on every site. Groundwater sampling at both Sites ST14 and SD13 indicate that this is a major, ongoing remediation process.	High	Low	Yes
Aboveground Groundwater Treatment	Biological	Bioreactors	High flow rates require excessive retention times and large reactors. BTEX is often volatilized in these systems.	Moderate	High	No
	Chemical/Physical	Extraction/ Interception	Can be used if aquifer conditions are favorable. Requires active treatment method before discharge (see hydraulic controls as well).	Moderate	High	Yes
		Air Stripping	Cost-effective technology for removing varying concentrations of BTEX at higher flow rates and longer durations. Potential permitting for air emissions.	High	Moderate	Yes
		Activated Carbon	Cost effective for more dilute concentrations of BTEX/PAHs. Creates a carbon disposal problem.	High	High due to carbon cost	No
		UV/Ozone Reactors	High flow rates require excessive retention times and large, expensive reactors.	Moderate	High	No

022584

TABLE 1 (Continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
Aboveground Groundwater Treatment (cont.)	Chemical/Physical (cont.)	Direct Discharge to Industrial Waste Water Treatment Plant (IWWTP)	Viable option when an IWWTP is available and capable of handling BTEX/PAHs and hydraulic loading. IWWTP not available for this site.	High	High	No
Treated Groundwater Disposal	Discharge to IWWTP or Sanitary Sewer	IWWTP	Viable option when an IWWTP is available and capable of handling BTEX/PAHs and hydraulic loading.	High	High	No
		Sanitary Sewer	Viable option when access to sanitary sewer exists and hydraulic loading is acceptable.	High	Moderate when sewer available	No
	Treated Groundwater Reinjection	Vertical Injection Wells	Not recommended due to clogging and high maintenance.	Moderate	High	No
		Injection Trenches	Require large trenches and can be subject to injection well permitting.	Moderate	High	No
	Discharge to Surface Waters	Direct Discharge to unnamed stream	Viable option but generally requires NPDES or other discharge permit.	High	Moderate Permitting Costs	Yes
Source Reduction/Soil Remediation	Free Product Recovery	Dual-Pump Systems	Best suited for sites with >1 foot free product where aboveground groundwater treatment exists. Site has less than 1 foot of free product. Nonhomogeneous hydrogeology will limit effectiveness.	Low	High	No

023585

TABLE 1 (Continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
Source Reduction/Soil Remediation (cont.)	Free Product Recovery (cont.)	Skimmer Pumps/Bailers/ Wicks	Best suited for sites with <1 foot free product where groundwater pumping is undesirable. Nonhomogeneous hydrogeology will limit effectiveness.	Moderate	High	No
		Total Fluids Pumping	Best suited for sites with thin saturated zones where excessive groundwater will not be pumped. Nonhomogeneous hydrogeology will limit effectiveness.	Moderate	High	No
		Bioslurping	Combined vapor extraction, bioventing, and free product recovery system has been operated at some sites with success.	Moderate	Intermediate	No
	Excavation/ Treatment of Soils	Excavation	Buildings, pipelines, and roads in source area prohibits excavation.	High	High	No
		Biological Landfarming	Buildings, pipelines, and roads in source area prohibits excavation.	Moderate	Moderate	No
		Thermal Desorption	Buildings, pipelines, and roads in source area prohibits excavation.	Moderate	High	No
	In Situ	Bioventing	Bioventing would be successful at Carswell Site ST14 based on pilot test results.	High	Low	Yes
		Soil Vapor Extraction	Vapor extraction has been successfully implemented at other sites; however, off-gas treatment will probably be required.	High	High due to off-gas treatment	Yes

022586

TABLE 1 (Continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL AND GROUNDWATER REMEDIATION SITE ST14, CARSWELL AFB, TEXAS

General Response Action	Technology Type	Process Option	Technical Implementability	Effectiveness in Attaining Target Remedial Goals	Relative Cost	Retain
Source Reduction/Soil Remediation (cont.)	*In Situ* (cont.)	Soil Washing	Additional pore volumes of water and/or surfactant solution are forced through aquifer material to enhance the partitioning of hydrocarbons into the groundwater. Creates special above ground treatment problems.	Moderate	High	No

023587

organic compound (VOC) reduction, and oxygen and carbon dioxide concentrations can indicate the level of natural or enhanced hydrocarbon biodegradation occurring in the soil. Long-term soil gas monitoring and soil confirmatory sampling were retained for further evaluation.

2.1.1.2 Groundwater Monitoring

Groundwater monitoring is essential for evaluating the effectiveness of implemented groundwater remediation technologies, particularly natural chemical attenuation processes. Sentry or model-verification wells can be utilized to monitor chemicals of potential concern (COPCs) and their attenuation within and near the existing plume. The predictions of fate and transport models are often verified using sentry wells within the plume. Point-of-compliance (POC) wells can be established at downgradient locations to ensure that contaminants do not advance beyond an area of exposure control or present an unacceptable risk to downgradient human or ecological receptors. Sufficient sentry wells are now available at this site to assess both vertical and horizontal contaminant transport and attenuation. The suitability of existing wells for POC monitoring is addressed in Section 10 of the RAP, the Long-Term Monitoring Plan. Long-term groundwater monitoring was retained as a key component of the remedial alternatives for this site.

2.1.2 Land and Groundwater Use Control

Some degree of land and groundwater use control will be required until contaminant concentrations in groundwater at Site ST14 and Site SD13 decrease to below appropriate target concentrations. Land and groundwater use controls can be enacted to minimize the potential for direct receptor contact with site contamination.

2.1.2.1 Land Use Control

Physical barriers and deed restrictions/easements can be used to control land use. Access to Site ST14 is currently limited by fencing around the Base perimeter and around the site itself. Access to Site SD13 is restricted by Base perimeter fencing only. Continued physical barriers and deed restrictions on land and resource uses were retained for further evaluation.

2.1.2.2 Groundwater Use Control

Groundwater use controls can eliminate the possibility of direct exposure of site workers to contaminated groundwater. Groundwater use can be controlled by regulating well permits, minimizing excavations below the water table, and when no other source of drinking water is available, installing point-of-use treatment systems. Contaminated groundwater at this site remains within an area under Base control, and no active drinking water wells screened in the Upper Zone aquifer exist on or near the site (Appendix C). The regulation of future well permits in the vicinity of Sites ST14 and SD13 was retained for further evaluation.

2.1.3 Public Education

At many hazardous waste sites, education is required to inform the public and Base personnel of the risks associated with site contamination and to provide the necessary warnings to prevent unintentional contact with site soils or groundwater. Although no public health risk is currently associated with this site (see Section 6), any future release of this property to private citizens or businesses should be accompanied with a clear understanding of where residual fuel hydrocarbons contamination may exist and the appropriate land uses that will prevent exposure to future site workers and/or recreators. Public education was retained for further evaluation.

2.1.4 Containment of the Groundwater Plume

Plume containment uses either hydraulic controls, such as limited groundwater pumping, or physical barriers such as slurry walls, to minimize downgradient plume migration. This strategy is most often used to halt the advance of highly contaminated groundwater before it impacts downgradient drinking waters or surface waters.

2.1.4.1 Hydraulic Controls

Hydraulic controls extract contaminated groundwater to prevent further migration of the plume. Hydraulic controls initially considered for this site include partial and complete abandonment of an existing french drain downgradient from Site SD13, complete abandonment of an oil/water separator that releases groundwater to surface water, and downgradient extraction wells. Hydrogeology at the site is continuous, as discussed in Section 3 of the RAP. All areas of both sites yield groundwater. However, the contaminated area is industrial and heavily developed. Therefore, groundwater pumping to control the flow of contaminants at Sites ST14 and SD13 was retained as a remedial technology.

A french drain was constructed at Site SD13, reportedly to intercept free product emanating from an upgradient source. Unfortunately, very little information is available on the precise location and capture zone of the drain. The only known features of the drain are the oil/water separator at Site SD13 and an inlet pipe. The approximate location of the drain connecting these two locations can be inferred; however, it is not known if the entire length of this drain is intercepting flow. As part of this risk-based remedial action, the location and general design of the drain should be documented, and the capture zone should be determined. This action was retained for further evaluation.

Previous sampling and analyses of the local groundwater discharge from the oil/water separator indicated the presence of petroleum constituents, and increased discharge of contamination has been observed shortly after heavy rains that raise the local water table. Therefore, it is believed that the french drain system acts as an artificial conduit of groundwater to surface water, through both the drain pipe and the pipe bedding. Abandonment of the oil/water separator and abandonment/excavation of the french drain system may have to be considered as a part of this risk-based remedial action if it is necessary to interrupt an exposure pathway to the unnamed stream and Farmers Branch Creek. This action was retained for further evaluation.

2.1.4.2 Physical Groundwater Barriers

Slurry walls, grout curtains, and sheet pilings are physical structures capable of limiting downgradient contaminant migration. However, contaminants are not removed by such physical barriers, they are only temporarily contained. When compared to an interceptor trench where contaminants are contained and removed, containment alone is a less effective option. Physical groundwater barriers were not retained for further consideration.

2.1.4.3 Reactive/Semipermeable Barriers

Reactive, semipermeable barriers are an emerging technology that uses a downgradient chemically reactive wall or biologically active treatment zone to intercept and treat groundwater contaminants as they pass through the treatment zone. This technology has the advantage over simple physical barriers in that contaminants are actually destroyed and groundwater flow is uninterrupted. Installation of a barrier wall may be possible at Site SD13; however, the cost would be very high. Reactive walls and biological active zones were not retained for further evaluation.

2.1.5 *In Situ* Groundwater Treatment

In situ treatment includes both engineered and natural processes that are capable of destroying or immobilizing dissolved contamination in place. *In situ* treatment is generally less expensive than aboveground treatment because there is no need to extract, treat, and then dispose of groundwater.

2.1.5.1 Intrinsic Remediation

As thoroughly discussed in Section 5 of the RAP, natural chemical attenuation takes advantage of destructive and nondestructive attenuation mechanisms to bring about a net reduction in groundwater contaminant concentrations, mass, and toxicity. Destructive attenuation mechanisms include biodegradation, abiotic oxidation, and hydrolysis. Nondestructive attenuation mechanisms include sorption, dilution, and volatilization. At this site, the decrease in dissolved contamination with increasing distance from the source and geochemical evidence both confirm that natural chemical attenuation is a significant process in minimizing exposure-point concentrations or eliminating potential exposure pathways. Therefore, this remedial approach was retained from the screening process.

2.1.5.2 Enhanced/Active Biological Groundwater Treatment via Biosparging

Enhanced *in situ* biodegradation takes advantage of natural biological processes by providing enhanced electron acceptor conditions and, when required, enhanced nitrogen/phosphorus (i.e., nutrient) conditions, to stimulate microbial growth and more rapid biodegradation. Section 5 of the RAP provides geochemical evidence that low oxygen concentrations in shallow groundwater at Sites ST14 and SD13 may be limiting the biodegradation of dissolved contaminants in the plume. Low-flow-rate air injection into groundwater, known as biosparging, can be used to increase dissolved oxygen concentrations in groundwater and promote biodegradation. As discussed in Section 7, a biosparging pilot test was performed at Site ST14. The results of this test suggest

that DO concentrations can be increased in saturated media by biosparging, although the potential for channelized flow exists. The pilot test data indicates that this technology may be used to enhance degradation of VOCs in capillary fringe and saturated soils in East Area sites. This technology was retained for consideration as a point-source treatment method.

2.1.6 Aboveground Groundwater Treatment

Groundwater interception and aboveground groundwater treatment offers the flexibility of more engineering controls than *in situ* remediation, and can usually treat a wider range of contaminants than *in situ* treatment. Groundwater extraction also provides greater control over plume migration and can be focused in areas of greatest contamination. Treatment technologies most appropriate for removing dissolved hydrocarbons from intercepted groundwater include bioreactors, air stripping methods, and activated carbon adsorption. Treatment facility construction, operation, maintenance, and monitoring will require greater financial resources. Pump installations and maintenance also add to the cost of this technology group.

2.1.6.1 Groundwater Extraction/Interception

Groundwater extraction has been a standard approach used to remediate many fuel-contaminated aquifers. This technology has been most successful in sand and gravel aquifers with low natural organic carbon content. Under these conditions organic contaminants are less likely to sorb to soil particles and are more likely to remain dissolved and available for extraction. These favorable aquifer conditions generally do not exist at Sites ST14 and SD13. As mentioned in Section 2.1.4.1, however, limited extraction of the leading edge of the dissolved plume at Site SD13 and treatment of water prior to discharge could provide a conservative margin of protection against unacceptable releases to surface water via the french drain. This approach was retained for further consideration.

2.1.6.2 Bioreactors

Bioreactors typically provide an enhanced environment where biodegradation rates are higher than those observed *in situ*. The *ex situ* nature of the bioreactor allows for greater control of reactor conditions (e.g., temperature, pH, mixing) and some optimization of degradation pathways. The hydraulic loading of bioreactors is often limited because complete biodegradation requires long retention times to degrade low concentrations of hydrocarbons. In the climate of north Texas, bioreactors would require heating during winter months to maintain high degradation rates. Due the high maintenance requirements, and additional costs of operating a bioreactor, this technology was not retained for further consideration.

2.1.6.3 Air Stripping

Air stripping technologies contact contaminated groundwater with clean air to volatilize (strip) dissolve contaminants from the aqueous phase. Air stripping is most effective for compounds with Henry's Law constants greater than 0.001 atm-m^3/mol including benzene, toluene, ethylbenzene, and xylenes which have Henry's Law constants of 0.0054 atm-m^3/mol, 0.0066 atm-m^3/mol, 0.0079 atm-m^3/mol, and 0.0049-

0.007 atm-m^3/mol, respectively. The highest total BTEX concentration measured in the source area during the 1994 RFI was just over 1.5 milligrams per liter (mg/L) at temporary monitoring point B200 at Site ST14A. For long-term operation, air stripping would be the most effective and cost efficient *ex situ* groundwater treatment technology. Therefore, air stripping was retained as a treatment process option.

2.1.6.4 Activated Carbon

Activated carbon is a commonly used method of removing BTEX contaminants from groundwater as it passes through a packed-bed canister of granular activated carbon (GAC). In order to remediate groundwater using GAC, the carbon would have to be replaced or recharged on a regular basis. This replacement would be very expensive and thus cost prohibitive. Activated carbon treatment was not retained as an aboveground treatment technology if groundwater extraction is selected as a site remedy.

2.1.6.5 Direct Discharge to Sanitary Sewer

Direct discharge of extracted, contaminated groundwater to an industrial wastewater treatment plant (IWWTP) may be an alternative for treatment if a treatment plant is available and can accept fuel-tainted waters. Although the Base IWWTP would accept untreated water, the distance to the plant from the site is prohibitive. Trucking of extracted groundwater to a private treatment works is infeasible, due to large transportation costs. Tie-in to a IWWTP was not retained for further evaluation.

2.1.7 Treated Groundwater Discharge/Disposal

The interception and treatment of contaminated groundwater would require a method of disposal for treated water that meets all appropriate discharge standards of the State of Texas and the US Environmental Protection Agency (EPA). Several methods of onsite and offsite disposal were identified for this initial screening.

2.1.7.1 Discharge to a Sanitary Sewer

Sanitary sewer lines exist near the presumed position of the french drain and the outfall of the oil/water separator. Costs for this alternative would be moderate to high, depending on the effort required to tie-in to existing subsurface sanitary sewer lines. Discharge to a sanitary sewer was not retained as a potential disposal method for treated groundwater.

2.1.7.2 Reinjection to Groundwater

Reinjection of treated groundwater into the subsurface can be accomplished through several methods. Surface application using a sprinkler system would be possible during summer months, but freezing conditions would make it impractical during the winter. Reinjection wells have been used to return treated groundwater to the subsurface; however, injection wells require frequent maintenance to reduce the impacts of plugging, which almost always occurs over time. Reinjection trenches were not retained as a possible option for the discharge of treated groundwater.

2.1.7.3 Discharge to Surface Drainage

Under this option, treated groundwater would be discharged into the unnamed stream that originates at the outfall of the existing oil/water separator. This stream eventually discharges into Farmers Branch. A discharge permit and frequent effluent monitoring would be required to ensure protection of sensitive downstream surface waters and compliance with the federal Clean Water Act and TNRCC regulations. As part of this remedial action, the treated effluent from the outfall would be included in the Base-wide National Pollutant Discharge Elimination System (NPDES) permit. Effluent sampling would be performed as required by the permit. This option was retained for further evaluation.

2.1.8 Source Reduction Technologies

The removal or reduction of concentrated contaminants in the source area is normally an important element of a comprehensive site remediation. Two primary sources of contamination can exist at fuel contaminated sites: mobile light nonaqueous phase liquid (LNAPL), or free product, and residual LNAPL, which is adsorbed or occluded within the soil matrix. Although mobile LNAPL has been reported at Site ST14A and SD13, minimal recoverable quantities are believed to exist. The residual LNAPL in unsaturated and capillary fringe soils is believed to be predominant contributor to underlying groundwater contamination at Site ST14.

Residual fuel contamination at this site appears to be spread throughout the entire soil profile in the source areas, and limited to a thin layer of soil in the capillary fringe and saturated soils downgradient from the source area. Depth and thickness of contamination vary with lithology across the site. Analysis of soil samples indicate that hexachlorobenzene is present at one sampling location at a concentration above the TNRCC (1994a) Plan A target concentration that is protective of industrial worker health. However, benzene was measured at concentrations above the Plan A target concentration that are protective of underlying groundwater quality. Common soil remediation technologies such as soil vapor extraction (SVE) and *in situ* bioventing, which depend on soil gas movement, will be effective due to the highly permeable nature of the coarse material found in the contaminated interval at Sites ST14 and possibly SD13. Soil flushing using surfactants is another option for reducing fuel residuals that is evaluated in this section.

2.1.8.1 Soil Vapor Extraction

SVE mechanically withdraws soil gas from the vadose zone to the surface using vent wells. If necessary, offgas can be treated prior to discharge into the atmosphere, although treatment can easily double the cost of this technology. By extracting soil gas from the vadose zone, the desorption of VOCs from soils into soil gas is enhanced by drawing "fresh" soil gas from surrounding clean soils through the contaminated soils. SVE is very effective in highly permeable soil such as the coarse gravels present at this site. Because SVE also results in an influx of oxygenated soil gas from clean soils, it also enhances the biodegradation of less volatile hydrocarbons such as hexachlorobenzene. A liquid rinse vacuum pump is proposed for groundwater extraction at Site SD13. Such a system also extracts soil vapors at a low flow rate. Consequently, low flow SVE was retained for further evaluation.

2.1.8.2 Bioventing

Bioventing is mechanically similar to SVE except that this technology uses much lower air flow rates, usually through air injection into vent wells, to provide the necessary oxygen to sustain biological degradation, and does not create an undesirable discharge of VOCs into the atmosphere. Bioventing rates of air injection are typically one-tenth of vapor extraction rates for the same site. The effectiveness of this technology has been demonstrated in a major pilot testing program conducted at over 140 Air Force sites, including over 50 sites contaminated with JP-4 jet fuel. A bioventing pilot test conducted at Site ST14A is described in Section 7.1 of the RAP. Bioventing proved to be effective in removing BTEX from vadose zone soils at both sites and was retained for further evaluation.

2.1.8.3 Surfactant Soils Washing

Soil washing is used to enhance the natural partitioning of contaminants from the soil into the groundwater, and is generally associated with a groundwater extraction system. The more strongly sorbed compounds may require surfactant soil washing to facilitate the dissolution process. *In situ* soil washing is only effective in more permeable aquifer materials, such as exist at Site ST14. Soil washing usually involves the addition of a surfactant compound that has a nonpolar "tail" to dissolve the contaminant, and a polar end so that the formed miscelle is soluble in water. Biodegradable surfactants are desirable to ensure that new biologically recalcitrant chemicals are not introduced into the aquifer.

Two significant disadvantages are associated with this technology. Because surfactants are added in relatively high concentrations, they will exert a significant biological oxygen demand on the aquifer. This additional organic loading may exceed the natural assimilative capacity of the aquifer and promote the migration of both surfactant and fuel hydrocarbons. A second problem is that when the surfactant solution is recovered, it is difficult to separate contaminants from the surfactants so that surfactants can be recycled. Treatment of surfactant-laden groundwater can be achieved with activated carbon, but the surfactant will rapidly load the carbon, resulting in unacceptable treatment costs. Due to these technical difficulties, surfactant soils washing was not retained for further evaluation.

2.1.8.4 Soil Excavation and Treatment

Excavation and surface treatment of contaminated site soils is not appropriate at this site given the existence of buildings, roads, and pipelines in the source area. Excavation and aboveground treatment options such as biological treatment or thermal treatment were not retained for further evaluation.

3.1 SUMMARY OF RETAINED REMEDIAL TECHNOLOGIES

Based on the initial technology screening discussed in Section 2 of this appendix and summarized in Table 1, several remedial approaches and technologies have been retained for the development of remedial alternatives and more detailed analysis. These technologies were selected to provide a range of passive to more active response actions, all of which may be useful in minimizing the time required to attain Plan B and

eventually Plan A target concentrations at all points throughout the impacted area. All of the presented alternatives will eventually remediate the site to the most stringent Plan A target concentrations, though in different time frames and at different costs. The following remedial approaches and technologies have been retained:

- Long-term soil gas monitoring/confirmatory soil sampling;
- Long-term groundwater monitoring;
- Limited land use controls;
- Groundwater use controls;
- Public education;
- Intrinsic remediation of soil and groundwater contamination;
- Abandonment of oil/water separator and abandonment/excavation of french drain system;
- Air injection bioventing in source area at Site ST14A.
- Biosparging near suspected source area at Sites ST14A;
- Extraction treatment of groundwater with a liquid ring vacuum pump, an oil/water separator, and an air stripper;
- Low-flow-rate SVE;
- Discharge of treated groundwater to surface water at the unnamed creek.

Because intrinsic remediation, and specifically biodegradation, has been effectively removing dissolved compounds from the groundwater and limiting downgradient plume migration, this ongoing remediation process can be enhanced through a reduction of more concentrated dissolved BTEX in the vicinity of the source area at Site ST14A. Abandonment/excavation of the oil/water separator and french drain system was retained as an effective way to eliminate any potential exposure pathways from groundwater to Farmers Branch Creek. Bioventing was retained as the most cost-effective engineered source-reduction technology for Site ST14A. Biosparging was retained as a potential approach for expediting biodegradation of dissolved benzene originating from the suspected secondary source area at Site SD13. Passive groundwater interception and effluent treatment are retained as contingency activities or as required by the Base-wide NPDES permit. This approach will not expedite remediation of groundwater contamination originating from either Site ST14 or Site SD13, but will restrict plume migration and discharge into nearby surface water bodies. Each of these remediation approaches is described in greater detail, and their effectiveness is evaluated in Section 8 of this RAP.

332596

DETAILED COST ANALYSIS

PARSONS ENGINEERING SCIENCE, INC.

Client AFCEE - CARSWELL NASJRB Job No. 725520.04006 332597 Sheet 1 of 3

Subject PRESENT WORTH ANALYSIS - ALTERNATIVES 1, 2, + 3 By R. FRISHMUTH Date 5/2/96

Checked SH Rev.

ALTERNATIVE #1

PRESENT WORTH FACTORS

$i = 7\%$ $i = 7\%$

$T = 6$ YRS $T = 7$

$P/A^{7\%}_{6Y} = 4.7665$ $P/F^{7\%}_{7Y} = 0.62275$

SOURCE: INTEREST TABLES - FUNDAMENTALS OF ENGINEERING, POTTER, M.C., 1990

ALTERNATIVE #1

CAPITAL COSTS:

- DRILL AND INSTALL 2 LTM WELLS $18,178
- ABANDON FRENCH DRAIN + OIL/WATER SEPARATOR $50,000

FUTURE COST:

- SOIL SAMPLING IN 2003 = $33,200

  PRESENT WORTH = $33,200 × $P/F^{7\%}_{7}$ = $20,675

ANNUAL COSTS:

- LTM FOR 6 YEARS (INCLUDING 1996) = $17,920/YR

  PRESENT WORTH = $17,920 × $P/A^{7\%}_{6Y}$ = $85,416

- SITE MAINTENANCE FOR 6 YEARS = $11,280/YR

  PRESENT WORTH = $11,280 × $P/A^{7\%}_{6Y}$ = $53,766

TOTAL PRESENT WORTH = $228,035 ≈ $228,000

PESI-COR-8 (12/94)

PARSONS ENGINEERING SCIENCE, INC. 332598

Client AFCEE - CARSWELL NAS JRB | Job No. 725520.04000 | Sheet 2 of 3

Subject PRESENT WORTH ANALYSIS - ALTERNATIVES 1, 2, AND 3 | By R. FRISHMUTH | Date 5/2/96

Checked SH | Rev.

ALTERNATIVE #2

PRESENT WORTH FACTORS

$i = 7\%$ $\quad$ $i = 7\%$

$T = 5$ YRS. $\quad$ $T = 2$

$P/A^{7\%}_{5Y} = 4.1002$ $\quad$ $P/F = 0.87344$

CAPITAL COSTS

- DRILL AND INSTALL 2 LTM WELLS = $ 18,178
- ABANDON FRENCH DRAIN AND OIL/WATER SEPARATOR = $ 50,000
- DESIGN/INSTALL BIOVENTING/BIOSPARGING SYSTEM = $ 61,957

ANNUAL COSTS

- LTM MONITORING FOR 5 YEARS (INCLUDING 1996)
  $17,920/YR × $P/A^{7\%}_{5}$ = $ 73,475
- SITE MANAGEMENT FOR 5 YEARS
  $11,280/YR × $P/A^{7\%}_{5}$ = $ 46,250

FUTURE COST

- SOIL SAMPLING IN 1998
  $33,200 × $P/F^{7\%}_{2Y}$ = $ 28,998

TOTAL PRESENT WORTH = $278,858 ≈ $278,900

PARSONS ENGINEERING SCIENCE, INC.

Client AFCEE - CARSWELL NAS JRB | Job No. 725520.04000 | 332599 Sheet 3 of 3

Subject PRESENT WORTH ANALYSIS - ALTERNATIVES 1, 2, AND 3 | By R. FRISIANOTTA | Date 5/2/96

Checked SH | Rev.

ALTERNATIVE #3

PRESENT WORTH FACTORS

$i = 7\%$ | $i = 7\%$

$T = 5$ YRS. | $T = 2$ YEARS

$P/A^{7\%}_{5Y} = 4.1002$ | $P/F^{7\%}_{2Y} = 0.87344$

CAPITAL COSTS

SAME AS ALT #2 PLUS EXTRACTION/SVE SYSTEM

ALT #2 COSTS = $130,135

GROUNDWATER EXTRACTION/SVE SYSTEM = $140,225

ANNUAL COSTS

SAME AS ALT #2 = $119,725

FUTURE COST

SAME AS ALT #2 = $28,998

TOTAL PRESENT WORTH $419,083 ≈ $419,000

PESI-COR-8 (12/94)

PARSONS ENGINEERING SCIENCE, INC.

332600

Client AFCEE - CARSWELL NAS JRB | Job No. 725520.04000 | Sheet 1 of 1

Subject PRESENT WORTH ANALYSIS - ALTERNATIVE #2 - PLAN A CRITERIA | By Z. FRISHMUTH | Date 5/3/96 | Checked SH | Rev.

TO ATTAIN PLAN A TARGET LEVELS THROUGH ALTERNATIVE #2 ALL ACTIONS MUST BE PERFORMED AS WITH ATTAINMENT OF PLAN B TARGET LEVELS. THE ONLY DIFFERENCE IN COST IS THE ADDITION AMOUNT OF ANNUAL MONITORING + SITE MANAGEMENT THAT IS REQUIRED AS CONTAMINANTS ATTENUATE TO PLAN A TARGET LEVELS.

COST

- CAPITAL COSTS FROM ALTERNATE #2 PLAN B COST ESTIMATE = 136,135
- PRESENT WORTH OF FUTURE SOIL SAMPLING FROM PLAN B COST ESTIMATE = 28,998

ANNUAL COSTS

LTM FOR 12 YEARS (INCLUDING 1996) AND SITE MANAGEMENT FOR THE SAME PERIOD

PRESENT WORTH FACTOR: $P/A^{7\%}_{12Y} = 7.9426$

GROUNDWATER SAMPLING: \$17,920/YR × $P/A^{7\%}_{12Y}$ = 142,331

SITE MANAGEMENT: \$11,200/YR × $P/A^{7\%}_{12Y}$ = 89,593

TOTAL PRESENT WORTH = \$391,057

PESI-COR-8 (12/94)

Alternative 1: Natural Attenuation, Long-Term Monitoring and Institutional Controls

Standard Rate Schedule — Checked by: SH

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Install New Wells ($)	Task 2 (hrs)	Annual GW Sampling ($)	Task 3 (hrs)	Site Mgt Annual Costs
Word Processor 88/(15)	$30	0	$0	0	$0	20	$600
CADD Operator 58/(25)	$47	4	$188	0	$0	20	$940
Technician 42/(50)	$40	40	$1,600	60	$2,400	20	$800
Staff Level 16/(65)	$57	60	$3,420	40	$2,280	40	$2,280
Project Level 12/(70)	$65	8	$520	4	$260	10	$650
Senior Level 10/(80)	$85	4	$340	0	$0	2	$170
Principal 02/(85)	$97	0	$0	0	$0	0	$0
Total Labor (hrs|$)		116	$6,068	104	$4,940	112	$5,440
ODCs							
Phone			$50		$0		$40
Photocopy			$10		$0		$100
Mail			$100		$300		$50
Computer			$100		$0		$200
CAD			$50		$0		$250
WP			$0		$0		$200
Travel			$500		$500		$0
Per Diem			$1,000		$1,000		$0
Eqpt. & Supplies			$500		$1,800		$0
LTM/POC Well Installation Costs [a/]			$5,800		$0		$0
Laboratory Fees		Soils [b/]	$4,000	18 LTM [c/]	$9,380		$0
Total ODCs			$12,110		$12,980		$840
Other Services							
Abandon French Drain and Oil/Water Separator			$50,000				
Maintain Institutional Controls			$0		$0		$5,000
Confirmatory Soil Sampling (43 Locations) Labor: $7,000 Geoprobe:$3,000 Lab:$33,200 [d/]			$33,200				
Total Other Services			$83,200		$0		$5,000

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$6,068	$4,940	$5,440
ODC's	$12,110	$12,980	$840
Outside Services	$83,200	$0	$5,000
Total by Task	$101,378	$17,920	$11,280

Task 1: Install New LTM/POC Wells, Abandon French Drain, and Confirmatory Sampling
Task 2: Groundwater Sampling per Event
Task 3: Reporting and Project Management per Year
[a/] 2 Wells, 40ft @ $60/ft, $2000mob, $1400 soil handling
[b/] 10 samples BTEX @ $140ea, SVOCs @ $260ea
[c/] 27-BTEX/VOC @ $120ea, 18-Electron receptors @ $150ea, 7-TCE @ $120ea, 10-SVOCs @ $260ea
[d/] 58 samples BTEX @ $140ea, SVOCs @ $260

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Alternative 2 : Bioventing/Biosparging Installation and Operation

Standard Rate Schedule

Checked by: SH

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1	Design ($)	Task 2	Install ($)	Task 3	Operate ($)
Word Processor 88/(15)	$30	20	$600	4	$120	10	$300
CADD Operator 58/(25)	$47	40	$1,880	0	$0	4	$188
Technician 42/(50)	$40	60	$2,400	140	$5,600	100	$4,000
Staff Level 16/(65)	$57	60	$3,420	120	$6,840	50	$2,850
Project Level 12/(70)	$65	20	$1,300	40	$2,600	10	$650
Senior Level 10/(80)	$85	4	$340	4	$340	4	$340
Principal 02/(85)	$97	0	$0	0	$0	2	$194
Total Labor (hrs|$)		204	$9,940	308	$15,500	180	$8,522
ODCs							
Phone			$50		$30		$40
Photocopy			$200		$0		$100
Mail			$45		$100		$50
Computer			$500		$0		$200
CAD			$1,000		$0		$180
WP			$200		$0		$200
Travel/Per Diem			$700		$2,000		$2,000
Blowers and Piping			$0		$4,000		$1,500
Total ODCs			$2,695		$6,130		$4,270
Outside Services							
Well Installation			$0		$10,000		$0
Electrical Costs			$0		$1,200		$0
Asphalt/Concrete Cutting			$0		$0		$0
Laboratory Fees			$0		$1,600		$1,600
Construction Labor			$0		$0		$0
Surveyor			$0		$500		$0
Total Outside Services			$0		$13,300		$1,600

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$9,940	$15,500	$8,522
ODC's	$2,695	$6,130	$4,270
Outside Services	$0	$13,300	$1,600
Total by Task	$12,635	$34,930	$14,392

Total Labor	$33,962
Total ODCs	$13,095
Total Outside Services	$14,900
Total Project	$61,957

Task 1: Systems Design
Task 2: Systems Installation
Task 3: Systems Operation/Reporting

Alternative 3: Groundwater Extraction/SVE at SD13

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Standard Rate Schedule

Checked by: SH

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Design & Install GW Treatment ($)	Task 2 (hrs)	GW System Maintenance (12 X month)	Task 3 (hrs)	End of Year Report ($)
Word Processor 88/(15)	$30	50	$1,500	12	$360	0	$0
CADD Operator 58/(25)	$47	150	$7,050	0	$0	0	$0
Technician 42/(50)	$40	350	$14,000	240	$9,600	0	$0
Staff Level 16/(65)	$57	200	$11,400	80	$4,560	0	$0
Project Level 12/(70)	$65	80	$5,200	20	$1,300	0	$0
Senior Level 10/(80)	$85	20	$1,700	2	$170	0	$0
Principal 02/(85)	$97	4	$388	1	$97	0	$0
Total Labor (hrs|$)		854	$41,238	355	$16,087	0	$0
ODCs							
Phone			$400		$250		$0
Photocopy			$500		$150		$0
Mail			$500		$350		$0
Computer			$300		$200		$0
CAD			$1,200		$0		$0
WP			$350		$200		$0
Travel/Per Diem			$4,200		$8,400		$0
Eqpt. & Supplies			$2,500		$2,400		$0
Total ODCs			$9,950		$11,950		$0
Outside Services							
Prefab Building 200sf			$12,000		$0		$0
Air Stripper Unit w/factory installation			$20,000		$0		$0
Controls			$4,000		$0		$0
Site Preparation/Concrete Pad			$3,500		$0		$0
Electrical Costs			$5,000		$4,000		$0
Laboratory Fees			$1,200		$4,800		$0
Liquid Ring Dewatering Pump &Acc			$6,500		$0		$0
Total Outside Services			$52,200		$8,800		$0

Estimate	Task 1	Task 2	Task 3
Labor	$41,238	$16,087	$0
ODC's	$9,950	$11,950	$0
Outside Services	$52,200	$8,800	$0
Total by Task	$103,388	$36,837	$0
Total Labor	$57,325		
Total ODCs	$21,900		
Total Outside Services	$61,000		
Total Project	$140,225		

Task 1: Design and Install 25 gpm air stripper
Task 2: Monthly System Maintenance/Monitoring
Task 3: Report Preparation

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① Present Worth Cost - Alternative 1

$$PWF = \frac{[1+i]^n - 1}{i(1+i)^n}$$ where i = interest rate, n = # years

for 10 years

$$PWF = \frac{[1+0.07]^{10} - 1}{0.07(1+0.07)^{10}} = \frac{0.967}{0.138} = 7.01$$

Present Worth Calc — Alternative 1

$$= 36,356 + 50,000 + 33,200 + (7.01)(87,610) + (7.01)(11,280)$$

$$= \$812,775$$

② Present Worth Cost — Alternative 2

$$PWF_{10} = 7.01$$

$$PWF_5 = \frac{[1+0.07]^5 - 1}{0.07(1+0.07)^5} = \frac{0.402}{0.098} = 4.11$$

Present Worth

$$= 36,356 + 61,957 + 50,000 + 33,200 + (4.11)(51,770) + (7.01)(35,840) + (7.01)(11280)$$

$$= 724,600$$

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③ Present Worth Cost - Alternative 3

$PWF_s = 4.11$

Cost =

$36,356 + 140,225 + 61,957 + 50,000 + 33,200$
$+ (4.11)(87,610) + (4.11)(11,280) = \underline{728,180}$
$+ 112,000 = \$840,180$

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APPENDIX J
SITE SAMPLING AND ANALYSIS PLAN

DRAFT

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SITE SPECIFIC SAMPLING AND ANALYSIS PLAN

DRAFT

FOR

REMEDIAL ACTION PLAN AND LONG-TERM MONITORING PLAN RISK-BASED APPROACH TO REMEDIATION SITES ST14 AND SD13, CARSWELL AFB/NAS FORT WORTH JRB, TEXAS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
(AFCEE) TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE, TEXAS 78235-5000

USAF CONTRACT F41624-93-C-8044

April 1996

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Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290

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1.0 INTRODUCTION

The purpose of this site-specific sampling and analysis plan (SAP) is to describe the procedures to be followed when collecting data in support of the long-term monitoring plan (LTMP) and remediation verification sampling for the risk-based approach to remediation at Sites ST14 and SD13 at Carswell AFB/NAS Fort Worth/JRB, Texas. Details on analytical requirements, desired quantitation (detection) limits, and proposed sampling locations are identified within Section 10 of the Remedial Action Plan (RAP). Specific quality assurance (QA) sampling requirements for Sites ST14 and SD13 are summarized herein as part of the site-specific sampling procedures. These additional samples will be used to determine the precision, accuracy, completeness, and representativeness of the final data set.

Soil gas sampling is described in Section 2; soil flux sampling is described in Section 3; drilling, soil sampling, lithologic logging, and bioventing/bioslurping and groundwater monitoring well installation procedures are described in Section 4; procedures for remediation verification sampling are presented in Section5; groundwater sampling procedures are described in Section 6; and field quality assurance/quality control (QA/QC) samples are described in Section 7. Section 8 describes analytical specifications, and Section 9 presents the data quality objectives for grounwater and verification sampling. References used in this SAP are listed in Section 10.

2.0 SOIL GAS SAMPLING

Soil gas will be used as an indicator of subsurface hydrocarbon contamination and to assess the effectiveness *in situ* bioventing in removing source contamination at the site. The use of soil gas to delineate potential subsurface contamination and to determine bioventing effectiveness has several economic and technical advantages over more traditional drilling and soil sampling techniques. The labor and equipment cost can be significantly less than a conventional drilling and sampling team. Many new hydraulically driven, multi-purpose probes can be used for soil gas sampling. These probes can be advanced as quickly as conventional augers and do not produce drill cuttings which can require expensive analysis and disposal. Further, soil gas sampling can represent the average chemistry of several cubic feet of soil as compared to a discrete soil sample, which can only describe a few cubic inches of the subsurface. This is of particular importance in risk-based remediation projects where the extent of COPC contamination and the degree of removal of COPCs can most accurately be determined by using multiple soil gas sampling locations.

The test equipment and methods that will be required to conduct field soil gas sampling as part of the risk-based remediation at this site are described fully in the AFCEE document *Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential* (AFCEE, 1994). In summary, soil gas sampling will be conducted initially to establish a contaminant concentration baseline for the site. Sampling will then be conducted every 6 months during bioventing/biosparging system operation to assess contaminant removal rates. Oxygen utilization and carbon dioxide production will also be measured at this time to calculate biodegradation rates. Once soil gas contaminant concentrations and respiration rates indicate that subsurface

contaminants have been biodegraded, confirmatory soil samples will be collected. This is anticipated to take approximately 2 years.

Soil gas sampling will be conducted at the existing vapor monitoring points or groundwater monitoring wells with unsaturated screen. Samples will be collected using air-tight well tops or, in the case of the vapor monitoring points, existing ball valves and hose barbs with flexible tubing.

Gaseous concentrations of carbon dioxide and oxygen will be analyzed onsite using an O_2/CO_2 analyzer. The analyzer will generally have an internal battery-powered sampling pump and range settings of 0 to 25 percent for both oxygen and carbon dioxide. Before analyzing samples, the analyzer must be checked for battery charge level. The analyzer will also be calibrated daily using atmospheric conditions of oxygen (20.9 percent) and carbon dioxide (0.05 percent) and a gas standard containing 0.0 percent oxygen and 5.0 percent carbon dioxide.

Total volatile hydrocarbon (TVH) concentrations will be used as the primary screening tool at this site. The TVH analyzer used at the sites will be capable of measuring hydrocarbon concentrations in the range of 1 to 20,000 parts per million, volume per volume (ppmv). The analyzer must also distinguish between methane and non-methane hydrocarbons. The battery charge level on the TVH analyzer will be checked prior to analysis of each collected soil gas sample. The TVH analyzer will also be calibrated daily using a hexane calibration gas.

All soil gas samples taken during system monitoring at the sites will be collected using 3-liter Tedlar™ bags and vacuum chambers. The soil gas sample will then be analyzed by attaching the O_2/CO_2 and TVH analyzers directly to the Tedlar™ bag. Sample locations identified for analytical compound-specific analysis will be re-sampled using 3-liter Tedlar™ bags and vacuum chambers. The sample will then be transferred to 1-liter SUMMA™ canisters and shipped to the laboratory for compound-specific analysis using EPA Method TO-3 (see Table 2.1 in the RAP).

Field QA/QC procedures for soil gas will include collection of one field duplicate for every 10 samples collected (e.g., frequency of 10 percent), use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the analytical laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., soil gas), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

Soil gas QA/QC sampling for analytical purposes will include field duplicates at a frequency of 10 percent. However, the laboratory should also plan to conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested for soil gas (i.e., required only once for soil gas extracted via soil gas monitoring point or obtained via flux chamber).

3.0 SOIL FLUX SAMPLING

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Several soil flux tests will be conducted at both sites prior to bioventing/biosparging system startup to determine the natural background emissions from the site. Soil flux tests will also be performed at the sample same locations during the first day of system operation. The purpose of these flux tests is to estimate potential air quality impacts from COPC emissions forced from contaminated environmental medium by the subsurface air injection associated with bioventing. Flux samples will be collected at Area D using the procedures outlined in EPA guidance *Measurement of Gaseous Emissions Rates from Land Surfaces Using a Emission Isolation Flux Chamber* (EPA, 1985). The use of a flux box is the preferred method of measurement of surface emission rates of volatile contaminants. A flux box is used to isolate a known surface area from the ambient air, collect surface emissions, and mix the collected emissions with "sweep" air introduced into the chamber at a known flow rate. Data from the flux box can then be combined with a simple dispersion model to identify potential ambient air contamination impacts.

The procedures contained within EPA's protocol document on measuring emission rates (i.e., *Measurement of Gaseous Emission Rates from Land Surfaces using an Emission Isolation Flux Chamber* (EPA/600/8-86/008)) will be followed. In summary, gaseous emissions will be collected from an isolated surface area using a flux chamber and monitored using both "real-time" and discrete methods. Real-time measurements will be made with a portable hydrocarbon analyzer to determine when the chamber reaches steady-state conditions. Discrete samples will then be collected for chemical analysis.

To reduce the potential for cross-contamination, which can occur whenever high level or low level samples are sequentially analyzed, the flux chamber will be purged and tested with a blank after each sample is conducted. Emission tests will only be conducted when soil moisture levels are normal. Increased ground moisture as a result of rain or heavy dew can bias (lower) emission rates.

The sweep air to be used will be dry, organic free air equal to or better than commercial ultra high purity grade (< 0.1 ppmv total hydrocarbon content). Discrete samples will be collected in SUMMA™ canisters and analyzed using EPA Method TO-3 to identify BTEX concentrations.

Field QA/QC procedures for soil flux sample will be identical to those required for soil gas. QA/QC requirements include collection of a field duplicate at a frequency of 10 percent, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the analytical laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., soil gas), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

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Soil flux QA/QC sampling includes collection of a field duplicate at a frequency of 10 percent. However, the laboratory should also plan to conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested for soil gas (i.e., required only once for soil gas extracted via soil gas monitoring point or obtained via flux chamber).

4.0 DRILLING AND GROUNDWATER MONITORING AND BIOVENTING/BIOSPARGING WELL INSTALLATION

To monitor contaminant plume migration at Sites ST14 and SD13, two additional groundwater monitoring wells will be installed at and downgradient from Sites ST14 and SD13. Additionally, two bioventing/biosparging wells will be installed at Site SD13. The following sections describe the proposed well locations and completion intervals, equipment decontamination procedures, drilling procedures, well installation, well development procedures, and well location and datum surveying. All drilling and well installation will proceed from areas suspected to be least contaminated to areas suspected to be more contaminated. Techniques to be used during the collection of confirmatory soil sampling are discussed.

4.1 Well Locations and Completion Intervals

One of the additional groundwater monitoring wells will be installed approximately 200 feet downgradient of Site SD13 to complete an operational point-of-compliance (two existing wells will also be used). If site-related contaminants are detected at concentrations exceeding the applicable Plan A target concentrations at any the POC wells, contingency actions will be considered as outlined in Section 9.3 of the RAP. The other additional monitoring well will be installed near the center of the benzene plume at Site ST14A to monitor the future biodegradation of benzene at the site. All additional wells will be screened from 3 foot above the ground water table to competent bedrock. Based on previous well installation activities at the sites, a 10-foot screened interval should be sufficient. Figure 10.1 in the RAP shows the proposed well locations.

The two bioventing/biosparging wells to be installed at Site SD13 will be 4-inch diameter wells screened from 4 feet bgs to competent bedrock. It is anticipated that up to 20 feet of screen may be required. Constructing wells in this manner will allow for the maximum oxygenation of groundwater and unsaturated soil. Proposed well locations are shown in Figure 9.3 in the RAP.

4.2 Drilling Procedures

This subsection addresses the procedures for drilling soil borings that will be used for soil sampling and completed as new wells. All new monitoring wells will be installed in accordance with general procedures outlined in Section 8.5 of *A Compendium of Superfund Field Methods* (EPA, 1987).

4.2.1 Pre-Drilling Activities

All necessary digging, drilling, and well installation permits will be obtained by Carswell personnel prior to Parsons ES mobilizing to the field. In addition, all utility

lines will be located and proposed drilling locations cleared prior to any drilling activities.

4.2.2 Equipment Decontamination Procedures

Water to be used in drilling, equipment cleaning, or grouting will be obtained from one of the Base's onsite water supplies. Carswell personnel will assist Parsons ES field personnel in locating a suitable source. Water use approval will be verified by contacting the appropriate facility personnel. Only potable water will be used for the activities listed above. A decontamination water blank will be collected from the potable water source. The procedures for the collection of the decontamination water blank will be described in Section 5. The Parsons ES field hydrogeologist will make the final determination as to the suitability of site water for these activities.

Prior to arriving at the site, and between each drilling site, the drill rig, augers, drilling rods, bits, casing, samplers, tools and other downhole equipment will be decontaminated using a high-pressure, steam/hot water wash. Only potable water will be used for decontamination.

During drilling operations, the drill rig, augers, and any down-hole drilling and/or sampling equipment will be decontaminated at a temporary decontamination pad that will be set up at Site ST14A. The temporary decontamination pad will be constructed in a manner so as to contain all decontamination fluids. All decontamination fluids generated at the temporary decontamination pad will be placed in 55-gallon drums. The decontamination fluids will be disposed of following the procedures presented in Section 3.5.

All sampling tools will be cleaned onsite, prior to use and between each sampling event, with a clean water/phosphate-free detergent mix and a clean water rinse. All well completion materials that are not factory sealed will be cleaned onsite prior to use with a high-pressure, steam/hot water wash using approved water. Materials that cannot be cleaned to the satisfaction of the Parsons ES field hydrogeologist will not be used. All decontamination activities will be conducted in a manner so that the excess water will be controlled and not allowed to flow into any open borehole.

If contaminated soils are encountered during drilling (based on visual, olfactory, or volatile organic analyzer indications), and the potential for cross-contamination is anticipated, drilling will be stopped and modified drilling procedures will be implemented to prevent the transfer of contaminants to deeper strata.

Fuel, lubricants, and other similar substances will be handled in a manner consistent with accepted safety procedures and standard operating practices. Well completion materials will not be stored near or in areas which could be affected by these substances. The drill rigs will not be allowed onsite unless they are free from leaks in any hydraulic lines, and are free of any exterior oil and grease.

Surface runoff such as miscellaneous spills and leaks, precipitation, and spilled drilling fluid will not be allowed to enter any boring or well either during or after drilling/well construction. To prevent this from happening, starter casing, recirculation

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tanks, berms around the borehole, and surficial bentonite packs, as appropriate, will be used.

4.2.3 Drilling and Soil Sampling

Drilling in unconsolidated soils will be accomplished using hollow-stem augers. The borings will be drilled and continuously sampled to the proposed total depth of the monitoring well. For installation of ground water monitoring wells, the auger ID will not be less than 4 inches. For installation of the bioventing/biosparging wells, the auger ID will not be less than 8 inches. Determination of well completion details will be at the discretion of the Parsons ES field hydrolgeologist.

If subsurface conditions are such that the planned drilling technique does not produce acceptable results (e.g. unstable borehole walls or poor soil sample recovery) another technique deemed more appropriate to the type of soils present will be used. Any alternate soil sampling procedure used must be approved by the Parsons ES field hydrogeologist and will be appropriate for the subsurface lithologies present at the site.

Continuous soil samples will be obtained using a split-barrel continuous sampling device or another similar method judged acceptable by the Parsons ES field hydrogeologist. Samples will be collected in 5-foot intervals from the ground surface to competent bedrock. The Parsons ES field hydrogeologist will identify which samples from the continuous sampling device will be submitted for chemical analysis. Only soils that exhibit possible contamination will be retained for chemical analysis. If no evidence of contamination is found, a sample will be collected from approximately 1 foot above the beginning of the saturated zone. Soil samples which may be retained for chemical analysis will be placed in sample containers immediately after the core barrel is opened. A maximum of two soil samples for chemical analysis will be collected per borehole. All soil cores will be evaluated for lithologic characteristics, however. All soil samples collected will be removed from the continuous sampler and placed on clean aluminum foil for logging.

Every 2-foot interval of soil sample recovered will be subsampled, composited, and placed in a clean container for PID or similar hydrocarbon vapor analyzer headspace measurements for VOCs. Representative portions of the soil samples collected for the headspace procedure will be quickly transferred to the sample containers, which will be sealed and held for 15 minutes at an ambient temperature of 65 degrees Fahrenheit (°F) or greater. Semiquantitative measurements will be made by puncturing the container seal with the PID probe and reading the concentration of the headspace gases. The PID relates the concentration of total VOCs in the sample to an isobutylene calibration standard. The PID will be calibrated daily to 100 parts per million, volume per volume of isobutylene. It is anticipated that headspace measurements will be performed on all samples collected during the drilling operations to determine which soil samples will be submitted for chemical analysis. The PID will also be used to monitor the worker breathing zone.

As a check on the quality of field sampling activities (sampling, containerization, shipment, and handling) QA/QC trip blanks, field blanks, equipment rinseate samples, and field duplicates will be sent to the laboratory. QA/QC sampling will include

duplicates for soil samples at a frequency of 10 percent, equipment rinseate samples at a frequency of 10 percent, one field blank per sampling event, and a trip blank for each individual cooler sent to the analytical laboratory. The procedures for the collection of field QA/QC samples are discussed below in Section 6. Laboratory QA/QC procedures will include one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested.

The Parsons ES field hydrogeologist will be responsible for observing all drilling and well installation activities, maintaining a detailed descriptive log of subsurface materials recovered, photographing representative samples, and properly labeling and storing samples. An example of the proposed geologic boring log form is presented in Figure 1. The descriptive log will contain:

- Sample interval (top and bottom depth);
- Sample recovery;
- Presence or absence of contamination;
- Soil or rock description, including: relative density, color, major textural constituents, minor constituents, porosity, relative moisture content, plasticity of fines, cohesiveness, grain size, structure or stratification, relative permeability, and any other significant observations;
- Lithologic contacts: the depth of lithologic contacts and/or significant textural changes will be measured and recorded to the nearest 0.1 foot (1 inch); and
- Determination on whether soil sample will be submitted for chemical analysis or segregated as uncontaminated medium.

4.2.4 Minimization and Management of Drilling Residuals

Drilling activities will generate soil cuttings requiring proper handling and, if contaminated, proper disposal. Based on data from previous soil sampling efforts at the site, contamination outside the source area only exists in the narrow smear zone above the groundwater surface. Soils will be screened using a PID or similar hydrocarbon vapor analyzer. This limited drilling event will generate approximately 5 cubic yards of soil. All soils will be placed in a lined roll-on/roll-off box until analytical samples can be collected. If composite samples collected from the box show that the drill cuttings are clean, the soil will be spread on the ground surface in the vicinity of the newly installed wells. If the drill cuttings are contaminated with petroleum hydrocarbons, the soil will be placed in an on-Base land farm or taken of an offsite treatment facility until contaminant concentrations reach acceptable levels.

4.3 Well Installation

Groundwater monitoring wells will be installed at two locations at the site. Bioventing/biosparging wells will be installed at two locations at Site SD13. In both cases, except where specified, the entire thickness of the shallow aquifer will be

screened. Detailed well installation procedures are described in the following paragraphs. A typical well completion diagram is included as Figure 2.

4.3.1 Well Material Decontamination

Well completion materials will be inspected by the Parsons ES field hydrogeologist and determined to be clean and acceptable prior to use. If not factory sealed, casing, screen, and casing plugs and caps will be cleaned with a high-pressure, steam/hot water cleaner using approved water prior to use. Prepackaged sand, bentonite, and Portland® cement will be used in well construction, and the bags will be inspected for possible external contamination before use. Materials that cannot be cleaned to the satisfaction of the Parsons ES field hydrogeologist will not be used.

4.3.2 Well Casing

Upon completion of drilling to the proper boring termination depth, a monitoring well casing will be installed. Well construction details will be noted on a Monitoring Well Installation Record form, as shown in Figure 3. This information will become part of the permanent field record for the site. Blank groundwater monitoring well casing will be constructed of Schedule 40 polyvinyl chloride (PVC) with an ID of 2 inches. Bioventing/biosparging well casing will be constructed of 4-inch ID Schedule 40 PVC. All well casing sections will be flush-threaded; glued joints will not be used. The casing at each well will be fitted with a threaded bottom plug and a top cap constructed of the same type of material as the well casing. The top cap will be vented to maintain ambient atmospheric pressure within the well casing.

The Parsons ES field hydrogeologist will verify and record the boring depth, the lengths of all casing sections, and the depth to the top of all well completion materials placed in the annulus casing and borehole wall. All lengths and depths will be measured to the nearest 0.1 foot.

4.3.3 Well Screen

Groundwater monitoring well screens will be constructed of flush-threaded, Schedule 40 PVC with an ID of 2 inches. The screens will be factory slotted with 0.010-inch openings. Each well will be screened so that seasonal fluctuations of the water table can be measured. The water level in the unconfined aquifer will be allowed to fluctuate within the screened interval. Bioventing/biosparging well screens will be constructed of 4-inch ID Schedule 40 PVC with factory machined 0.040-inch openings. The position of the screen will be selected by the Parsons ES field hydrogeologist after consideration is given to the geometry and hydraulic characteristics of the stratum in which the well will be screened.

4.3.4 Sand Filter Pack and Annular Sealant

A graded sand filter will be placed around the screened interval and will extend at least 2 feet above the top of the screen. The sand filter will consist of 10-20 silica sand for groundwater monitoring wells and 6-9 silica sand for bioventing/biosparging wells. An annular seal will be placed above the gravel pack using sodium bentonite pellets. The pellet seal will be a minimum of 2 feet thick and will be hydrated in place with

potable water. The pellet seal will be overlain by a Portland® cement/sodium bentonite grout that will extend from the top of the pellet seal to approximately 3 feet bgs. The Portland® cement/sodium bentonite grout will consist of one 94-pound sack of cement and about 5 pounds of bentonite for each 7 gallons of water used. The bentonite content of the cement/bentonite will not exceed 8 percent by dry weight. The grout will be overlain with concrete to the ground surface. To reduce heaving of the newly-installed monitoring well caused by freeze-thaw processes, it is imperative that the uppermost concrete seal extend to at least the maximum frost line.

4.3.5 Flush-Mount Protective Cover

Each monitoring well will be completed with an at-grade (flush-mount) protective cover. In areas where pavement is present, the at-grade cover will be cemented in place using concrete which will be blended to the existing pavement. In areas where pavement is not already present, a 6-inch thick, 4-foot-diameter concrete pad will be constructed around the protective cover. In either case, the concrete immediately surrounding the well cover will be sloped gently away from the protective casing to facilitate runoff during precipitation events.

4.4 Well Development

Before any new groundwater monitoring well can be considered in proper condition for monitoring water levels or taking water samples, it must be developed. Bioventing/biosparging wells will not be developed. Development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the well screen. If a well is grouted prior to development, well development will occur no sooner than 48 hours after grouting of the annulus is completed.

Well development will be accomplished using dedicated disposable bailers or a peristaltic pump. The bailer or pump will be lowered to the bottom of the well so that fines which have accumulated in the bottom are agitated and removed from the well in the development water.

Development will be continued until a minimum of three casing volumes of water have been removed from the well and the water pH, temperature, and specific conductivity have stabilized. Temperature, pH and specific conductivity will be monitored during development (one reading for each parameter per well volume). Pumping will continue until these parameters have stabilized to within 10 percent among three consecutive readings and the water is clear and free of fines. The pH and specific conductivity meters will be calibrated on a daily basis. The pH meter will be calibrated by laboratory-prepared standard solutions following the manufactures calibration procedures. The specific conductivity meter will be calibrated using laboratory-prepared known conductivity solutions. If the development water still is turbid after removal of three casing volumes, development will be continued until the water becomes clear or the turbidity of the water produced has been stable after the removal of several casing volumes.

The development procedure specifies that three casing volumes of water be removed from the well. However, some wells completed in marginal aquifers will go dry

during well development prior to the recovery of three casing volumes. In these low-productivity wells, development activity may have to be staged over a period of time to allow water to refill the well bore. In the event three casing volumes of water cannot be recovered, the water volume recovered will be noted in the development records.

All well purge water will be placed in 55-gallon drums supplied by the drilling subcontractor. Parsons ES will be responsible for sampling, laboratory analysis and arranging for the disposal of any contaminated or potentially contaminated purge and development water. Carswell personnel, however, will be required to sign any hazardous materials manifests that may be created as part of the disposal process. Drums will be staged and temporarily stored onsite as directed by Carswell personnel.

4.5 Well Development/Purging Records

A record of well development/purging will be maintained for each well. The well development/purging record will be maintained in a bound field notebook by the field hydrogeologist. Figure 4 is an example of the well development record. A summary well development/purging record form will be prepared for each well and will become part of the written record for the site. Development/purging records will include:

- Well number;
- Date and time of purge;
- Purge method;
- Prepurge water level and well depth;
- Volume of water produced;
- Description of water produced;
- Post-development water level and well depth; and
- Field analytical measurements, including pH and specific conductivity.

4.6 Water Level Measurements

Water levels at all wells will be measured within a short time interval so that the water-level data are comparable. Water levels in the new wells will not be measured until they are developed and the water level has stabilized. The depth to water below the measurement datum will be made using an oil/water interface electric probe to the nearest 1/8 inch (0.01 foot). The oil/water interface probe will be decontaminated prior to use, and between each measurement, following the decontamination procedures presented in Section 4.3.

4.7 Well Location and Datum Survey

The location and elevation of the new wells will be surveyed by a registered surveyor soon after well completion. Horizontal locations will be measured relative to

the state plane coordinate system for the State of Texas. Horizontal coordinates will be measured to the nearest 0.01 foot. Vertical location of the ground surface adjacent to the well casing, the measurement datum (top of the interior casing), and the top of the outer well casing will be measured relative to a USGS MSL datum. The ground surface elevation will be measured to the nearest 0.1 foot, and the measurement datum, outer casing, and surveyor's pin (if present) elevation will be measured to the nearest 0.01 foot.

4.8 Site Restoration

After well installation and sampling is complete, each well site will be restored as closely to its original condition as possible.

5.0 COMPLIANCE SOIL SAMPLING

Compliance soil sampling will be performed as part of the LGMP to ensure that the proposed remedial action, intrinsic remediation and land and groundwater use controls, is reducing concentrations of site-related contaminants below Plan B target concentrations. Approximately 28 soil samples at Site ST14, and 15 soil samples at SD!3 will be collected as part of the compliance sampling program. The following sections describe the proposed soil sampling locations, procedures for equipment decontamination, borehole installation, soil sampling, and datum surveying procedures to be used as part of the proposed field effort. Soil sampling activities will proceed from areas suspected to be least contaminated to areas suspected to be more contaminated.

5.1 Proposed Sampling Locations

5.2 Borehole Installation Procedures

Soil sampling in unconsolidated soils will be accomplished using a Geoprobe® hydraulic sampling rig. The Geoprobe® is a hydraulic hammer unit mounted on a standard pickup truck (Ford F250). Boreholes are advanced by hydraulic push or by hammering a hollow sampler [2-feet-long with a 2-inchoutside-diameter (OD)] and supplemental probe extension rods. As the sampler is hydraulically pushed or hammered into the subsurface, additional probe rods are inserted between the hammer and the sampling tip for further advancement. Boreholes proposed for installation as part of the year 2000 investigation will not be continuously sampled for field screening and lithology because the unsaturated source area has been extensively logged and screened. However, the target sampling interval in each borehole will be sampled for lithology and field screening to verify that samples are being collected from shallow saturated soils. Sample headspace also will be field screened with a photoionization detector (PID) for volatile organic compouinds (VOCs). If subsurface conditions are such that the planned installation technique does not produce acceptable results another technique deemed more appropriate to the type of soils present will be used. Any alternate soil sampling procedure used must be approved by the Parsons Engineering Science, Inc. (Parsons ES) field hydrogeologist and will be appropriate for the subsurface lithologies present at the site.

The Parsosn ES field hydrogeologist will be responsible for observing all borehole installation and sampling activities, maintaining a detailed log of the target sample interval, photographing representative samples, and properly labeling and storing samples. An example of the proposed geologic boring log form is presented in Figure 1. The descriptive log will contain:

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- Sample interval (top and bottom depth);
- Sample recovery;
- Presence or absence of contamination (e.g., staining, odor or elevated headspace screening readings);
- Soil or rock description of the target sampling interval, including relative density, color, major textural constituents, minor constituents, porosity, relative moisture content, plasticity of fines, cohesiveness, grain size, structure or stratification, relative permeability, and any other significant observations; and
- The depth of lithologic contacts and/or significant textural changes, measured and recorded to the nearest 0.1 foot (1 inch) if present within the target interval.

5.3 Soil Sampling

One soil sample will be collected from the source area boreholes, and two samples will be collected from the background borehole using the hollow samplers (2-inch OD by 2 feet long) lined with a plastic (butylene) sleeve to minimize volatilization. All sampling equipment will be decontaminated prior to use and between uses, as described in Section 5.5. Samples will be collected within a 2-foot interval from the capillary fringe and shallow saturated zone. Additional samples may be collected at the discretion of the Parsons ES field hydrogeologist. Soil samples collected for chemical analysis will be obtained by cutting a 4- to 6-inch section of the butylene sleeve extracted from sampler. Samples will be cut from the middle of the 2-foot sleeve, and the exposed ends of the sample sleeve will be capped immediately with plastic end caps to minimize volatilization. All collected soil samples also will be evaluated for lithologic characteristics.

5.3.1 Sample Handling

This section describes the handling of soil samples from the time of sampling until the samples arrive at the laboratory.

5.3.2 Sample Container and Labels

Unused sample sleeves, containers, and end caps will be provided by Parsons ES field personnel. The sample label will be firmly attached to the sample sleeve, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample depth;
- Sampling date;
- Sampling time;
- Sample collector's initials.

5.3.3 Sample Preservation

Samples will be properly prepared for transportation to the laboratory by placing the samples in an adequately padded cooler containing ice to maintain an approximate shipping temperature of 4 degrees centigrade (°C).

5.3.4 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to Evergreen Analytical, Inc. of Wheat Ridge, Colorado, the Air Force Center for Environmental Excellence (AFCEE)-approved laboratory for this demonstration. Samples will be shipped priority overnight via Federal Express®. The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Label shipping container with:
  - Sample collector's name, address, and telephone number;
  - Laboratory's name, address, and telephone number;
  - Description of sample;
  - Quantity of sample; and
  - Date of shipment.

The packaged samples will be delivered to the laboratory as soon as possible after sample acquisition, and in accordance with analytical -method-specific holding times.

5.3.5 Chain-of-Custody Control

After the samples have been collected, chain-of-custody procedures will be followed to establish a written record of sample handling and movement between the sampling site and the laboratory. Each shipping container will have a chain-of-custody form completed in triplicate by the sampling personnel. One copy of this form will be kept by the sampling contractor after sample delivery to the analytical laboratory, and the other two copies will be sent to the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analytical results. The chain-of-custody will contain the following information:

- Sample identification number;
- Sample collector's printed name and signature;
- Date and time of collection;
- Place and address of collection;
- Sample matrix;
- Analyses requested;

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- Signatures of individuals involved in the chain of possession; and
- Inclusive dates of possession.

The chain-of-custody documentation will be placed inside the shipping container so that it will be immediately apparent to the laboratory personnel receiving the container, but will not be damaged or lost during transport. The shipping container will be sealed so that it will be obvious if the seal has been tampered with or broken.

5.3.6 Sampling Records

In order to provide complete documentation of the sampling event, detailed records will be maintained by the Parsons ES field hydrogeologist. At a minimum, these records will include the following information:

- Sample location (facility name);
- Sample identification;
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observations of
  - Sample appearance,
  - Sample odor;
- Weather conditions;
- Sampler's identification;
- Any other relevant information.

5.3.7 Laboratory Analyses

Laboratory analyses will be performed on all soil samples and the required QA/QC samples (see Section 5.3.8 and Section 7). The analytical methods and detection limit requirements for soil compliance samples are listed in Table 10.1 in the RAP. Evergreen Analytical Laboratories of Wheat Ridge, Colorado, will be performing the laboratory analyses. All containers, preservatives, and shipping requirements will be consistent with laboratory protocol. Laboratory personnel will specify any additional QC samples required. Shipping containers, ice chests with adequate padding, and cooling media will be sent by the laboratory to the site.

5.3.8 Quality Assurance/Quality Control Samples

As a check on the quality of field sampling activities (sampling, containerization, shipment, and handling) QA/QC trip blanks, field blanks, equipment rinseate samples, and field replicates will be sent to the laboratory. QA/QC sampling will include approximately

two replicates for soil samples (i.e., frequency of 10 percent),two rinseate samples 322622 frequency of 10 percent), one field blank, and a trip blank for each individual shipping cooler sent to the analytical laboratory containing samples for VOC analysis. The procedures for the collection of field QA/QC samples are discussed below in Section 6. Laboratory QA/QC procedures will include one matrix spike analysis, one laboratory control sample, and one laboratory blank sample test for each specific analysis requested.

5.4 Minimization and Management of Soil Residuals

Borehole installation and soil sampling activities using the Geoprobe® will generate minimal soil cuttings that will require proper handling and, if contaminated, proper disposal. Installation of the 43 boreholes at the sites should generate no more than 1.4 cubic feet (10 gallons) of soil cuttings. Soils will be inspected for the presence of hydrocarbon staining, for any fuel odor, and using a PID or similar hydrocarbon vapor analyzer to differentiate between clean and contaminated soils. Soil cuttings will be placed in a 55 gallon drum for proper treatment and disposal.

5.5 Equipment Decontamination Procedures

Water to be used in equipment cleaning will be obtained from one of the Base's onsite water supplies. Wurtsmith AFB personnel will assist Parsons ES field personnel in locating a suitable source. Water use approval will be verified by contacting the appropriate facility personnel. Only potable water will be used for decontamination. A decontamination water blank will be collected from the potable water source. The procedures for the collection of the decontamination water blank are described in Section 6. The Parsons ES field hydrogeologist will make the final determination as to the suitability of site water for these activities.

Prior to arriving at the site, and between each borehole installation, the Geoprobe® rods, samplers, tools and other downhole equipment will be decontaminated using a hot-water wash. During borehole installation operations, the rig, samplers, and any other downhole equipment will be decontaminated at a temporary decontamination pad that will be set up adjacent to each borehole location. The decontamination fluids will be stored in 55 gallon drums for proper treatment and disposal.

All sampling tools will be cleaned with a clean water/phosphate-free detergent mix, a clean water rinse, isopropyl alcohol rinse, and a final distilled water rinse. Materials that cannot be cleaned to the satisfaction of the Parsons ES field hydrogeologist will not be used. All decontamination activities will be conducted in a manner so that the excess water will be controlled and not allowed to flow into any open borehole.

Fuel, lubricants, and other similar substances will be handled in a manner consistent with accepted safety procedures and standard operating practices. The Geoprobe® rig will not be allowed onsite unless it is free from leaks in all hydraulic and fuel lines, and is free of any exterior oil and grease.

Surface runoff such as miscellaneous spills and leaks, precipitation, and spilled decontamination fluids will not be allowed to enter any boring or well. Berms around the borehole and surficial bentonite packs, as appropriate, will be used to prevent cross-contamination.

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5.6 Survey of Borehole Locations

The horizontal location of the new boreholes will be located by Parsons ES field personnel after completion of sampling procedures. Horizontal locations will be measured relative to previously installed groundwater wells that have established coordinates (previously surveyed by a register surveyor). Horizontal distances will be recorded to the nearest 0.1 foot by measuring the distance from each borehole to three established locations (monitoring wells or other previously surveyed locations deemed more appropriate by field personnel). These distances will be used to locate each borehole on any additional maps generated as part of the risk-based investigation.

5.7 Borehole Abandonment

Boreholes will be abandoned with bentonite after soil sample collection. Geoprobe® sampling operations will produce boreholes that are approximately 2.5 inches in diameter. These holes will be abandoned by filling with granular or pelletized bentonite. Bentonite will be hydrated with potable water during abandonment operations at 2-foot intervals to ensure proper hydration and subsequent sealing of the borehole.

6 GROUNDWATER SAMPLING

This section describes the scope of work required for collecting groundwater samples from the 18 monitoring wells in the long-term monitoring well network at Site ST14 and Site SD13. All water samples collected from groundwater monitoring wells will be obtained using either disposable bailers or a thoroughly decontaminated peristaltic pump and new flexible tubing. Equipment blanks will be collected to assure that all equipment is properly cleaned. In order to maintain a high degree of QC during this sampling event, the procedures described in the following sections will be followed.

Groundwater sampling will be conducted by qualified Parsons ES scientists and technicians trained in the conduct of well sampling, records documentation, and chain-of-custody procedures. In addition, sampling personnel will have thoroughly reviewed the work plan and this site-specific sampling and analysis plan prior to sample acquisition and will have a copy of both available onsite for reference.

Activities that will occur during groundwater sampling are summarized below:

- Assembly and preparation of equipment and supplies;
- Inspection of the well integrity, including:
  - Protective cover, cap and lock,
  - External surface seal and pad,
  - Well stick-up, cap, and datum reference,
  - Internal surface seal,

- Condition of any dedicated equipment, if present;

- Groundwater sampling, including:
  - Water level measurements,
  - Visual inspection of borehole water,
  - Well purging,
  - Sampling;
- Sample preservation and shipment, including:
  - Sample preparation and preservation, as appropriate,
  - Onsite measurement of physical parameters,
  - Sample labeling,
  - Sample packaging in appropriate shipping containers;
- Completion of sampling records;
- Completion of chain-of-custody records; and
- Sample shipment via overnight courier.

Detailed groundwater sampling and sample handling procedures are presented in following sections.

6.1 Groundwater Sampling Locations

Groundwater samples will be collected from the 18 wells shown in Figure 10.1 of the RAP, using either a disposable bailer or a thoroughly decontaminated peristaltic pump with new, dedicated flexible tubing.

6.2 Preparation for Sampling

All equipment to be used for sampling will be assembled and properly cleaned and calibrated (if required) prior to the beginning of the sampling event. In addition, all recordkeeping materials will be gathered prior to leaving the office. A brief organizational meeting will be held to ensure proper communication between project management staff and field personnel.

6.3 Equipment Decontamination

All portions of sampling and test equipment that will contact the sample will be thoroughly cleaned before each use. This equipment may include Teflon® bailers, water-level probe and cable, oil/water interface probe and cable, test equipment for

onsite use, and other equipment or portions thereof that will contact the samples. Based on the chemical constituents present at Sites ST14 and SD13, the following decontamination protocol will be used:

- Clean with potable water and phosphate-free laboratory detergent (Liquinox® or equivalent);
- Rinse with potable water;
- Rinse with distilled or deionized water;
- Rinse with reagent-grade isopropanol;
- Rinse with distilled or deionized water; and
- Air dry the equipment prior to use.

All decontamination fluids will be temporarily placed in 55-gallon D.O.T. approved containers. Final disposal will be determined based on laboratory analytical results. Water with COPC concentrations below TNRCC groundwater quality standards will be discharged onto the ground surface near the source well. Water with contamination above state standards will be filtered through granular activated carbon (GAC), sampled, and then discharged to either the ground surface or the sanitary sewer.

Any deviations from these procedures will be documented in the field scientist's field notebook and on the groundwater sampling form. If pre-cleaned dedicated sampling equipment is used, the decontamination protocol specified above will not be required. Laboratory-supplied sample containers will be cleaned and sealed by the laboratory and therefore will not need to be cleaned in the field. Equipment field blanks and equipment rinseate samples will be collected to assure that all containers and field equipment are free of contamination.

6.4 Equipment Calibration

As required, field analytical equipment will be calibrated according to the manufacturer's specifications prior to field use. This applies to equipment used for onsite chemical measurements such as pH, electrical conductivity, and temperature.

6.5 Sampling Procedures

Special care will be taken to prevent contamination of the groundwater and extracted samples. The two primary ways in which sample contamination can occur are through contact with improperly cleaned equipment and by cross-contamination through insufficient decontamination of equipment between wells. To prevent such contamination, the peristaltic pump and water level probe and cable used to determine static water levels and well total depth will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in section 1.3. In addition to the use of properly cleaned equipment, a clean pair of new, disposable nitrile gloves will be worn each time a different well is sampled. New, clean tubing will be used for the peristaltic pump for each well

sampled. Wells will be sampled sequentially from areas suspected to be least contaminated to areas suspected to be more contaminated. Plastic will be placed around each of the wells to be sampled and sampling equipment will not be allowed to come in contact with the ground surface at any time during the sampling event.

The following paragraphs present the procedures that comprise groundwater sample acquisition from all groundwater sampling locations. These activities will be performed in the same order as presented below. Exceptions to this procedure will be noted in the Parsons ES field scientist's field notebook.

6.5.1 Preparation of Location

Prior to starting the sampling procedure, the area around the well will be cleared of foreign materials, such as brush, rocks, and debris. These procedures will prevent sampling equipment from inadvertently contacting debris around the monitoring well. New, clean plastic (4 to 6 mil) we be placed around the well to prevent the contamination of both the ground surface and any equipment that may come into contact with the ground surface.

6.5.2 Water Level and Total Depth Measurements

Prior to removing any water from the well, the static water level will be measured. An electrical water level probe will be used to measure the depth to groundwater below the datum to the nearest 0.01 foot. If the total depth of the well is not known or is suspected to be inaccurate, total well depth will be measured by slowly lowering the water level probe to the bottom of the well. Total well depth will be measured to the nearest 0.01 foot. Total depth will only be measured when absolutely necessary to minimize the amount of sediment disturbance in the well. Based on water level and total depth information, the volume of water to be purged from the well can be calculated.

6.5.3 Well Purging

The Water will be purged from each well using a peristaltic pump. The well will be purged at a very low flow rate [10 milliliters per minute (mL/min) to 1,000 mL/min]. The objective of micropurging is to remove a small volume of water at a low flow rate from the screened interval of the well without disturbing stagnant water within the casing. Therefore, the well purge rate must never be greater than the recharge rate of the well. During purging, the water level in the well will be monitored to ensure that no drawdown in the well occurs. The water level monitoring will allow the sampling technician to control pumping rates to minimize drawdown. As long as no drawdown is observed during pumping, it may be assumed that the low pumping rate within the screened portion of the well has not pulled stagnant casing water into the sample.

The pH, temperature, dissolved oxygen, and specific conductivity will be continuously monitored during well purging using a flow-through cell. The flow-through cell will be attached directly to the discharge fitting on the well cap assembly using Teflon®-lined polyethylene tubing. New tubing will be used at each well. Purging will continue until the parameters have stabilized (less than 0.2 standard pH units or a 10-percent change for the other parameters over a 5-minute period) and the

water is clear and free of fines. Research conducted on low-flow micropurging has found that dissolved oxygen and specific conductance readings are the most useful field indicator parameters for stabilization of background water chemistry during purging (Barcelona, Wehrmann, and Varljen, January 1994). The research also concluded that stabilization of dissolved oxygen and specific conductance shows some correlation to stabilization of VOC concentrations in "formation" waters.

All purge water will be placed in 55-gallon containers and disposed of properly. Parsons ES will be responsible for sampling, laboratory analysis and arranging for the disposal of any contaminated or potentially contaminated purge and development water. Carswell personnel, however, will be required to sign any hazardous materials manifests that may be created as part of the disposal process. Drums will be staged and temporarily stored onsite as directed by Carswell personnel.

6.5.4 Sample Extraction

Either disposable, polyethylene bailers or a peristaltic pump with new tubing for each well will be used to extract groundwater samples from the well. Bailers will be used only for those wells with known or suspected free product to minimize the potential for sampling equipment contamination. If depth to groundwater exceeds approximately 21 feet it will also be necessary to extract a sample using a bailer because of the vacuum lift limitations of a peristaltic pump. Both types of extraction equipment will be lowered into the water gently to prevent splashing and extracted gently to prevent creation of an excessive vacuum in the well. The sample will be transferred directly to the appropriate sample container. The water sample will be transferred from the bottom of the bailer using a bottom emptying device to allow a controlled flow into the sample container. Water from the peristaltic pump can be directly discharged into the sample container. The water should be carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample containers for VOC analysis will be filled at approximately 200 milliliters per minute (mL/min) and all other sample collection rates will not exceed 400 mL/min. Volatile samples will be collected first, followed by any other analytical samples. Samples for field parameter analysis will be collected last.

Unless other instructions are given by the analytical laboratory, sample containers will be completely filled so that no air space remains in the container. Excess water collected during sampling will be placed into the 55-gallon containers used for well purge waters and disposed of as described in section 5.3.

6.6 Onsite Chemical Parameter Measurement

Because many chemical parameters of a groundwater sample can change significantly within a short time following sample acquisition, these parameters will be measured in the field. Tables 10.1 and 10.2 in the body of the RAP list the chemical analytical protocol for groundwater samples. The following discussion describes the field procedures for obtaining the onsite chemical parameter measurements. However, the discussion does not describe the individual instrument calibration procedures or individual HACH® or CHEMetrics® field analysis methods. For information on instrument calibration, please refer to the manufacture calibration procedure for the

instrument. For information on the individual methods and equipment used in field analyses refer to either the HACH® manual or CHEMetrics® instruction sheets.

Groundwater quality measurements (such as temperature, pH, specific conductivity, dissolved oxygen, and redox potential) will be continuously monitored during well purging using a flow through cell. The flow through cell will be attached directly to the discharge fitting on the well cap assembly using Teflon® lined polyethylene tubing. A new piece of tubing will be used for each well. All groundwater quality measuring equipment will be decontaminated following the procedures described in Section 4.3. The groundwater quality measuring equipment will be calibrated between each well following the manufacturer's recommended calibration procedures. The measurements observed immediately before groundwater sampling begins will be considered the final measurements for the sample and will be recorded in the field notebook and point-specific sampling form.

Groundwater quality measurements (such as nitrate, nitrite, manganese, ferrous iron, sulfate, sulfide, and alkalinity) will be measured in the field using HACH® or CHEMetrics® field analysis methods. All appropriate equipment and glassware associated with the field analysis of groundwater samples will be decontaminated following the procedures described in Section 4.3. Groundwater samples for these measurements will be collected after all sample containers for laboratory analyses have been collected. Two 250 mL bottles of groundwater will be collected and capped for field analysis. The field analysis of groundwater samples should begin immediately after collection. Direct sunlight, contact with air, and high temperatures may greatly affect the concentrations of the analytes in question. If possible, analyses should be run indoors and groundwater samples should be capped and stored in a cooler with a temperature maintained at 4°C when not in use. Duplicate analyses will be run at a frequency of 25 percent, or one duplicate sample for every 4 field analysis. One blank analysis (distilled water) will be performed for each sampling round.

6.7 Sample Handling

This section describes the handling of samples from the time of sampling until the samples arrive at the laboratory.

6.7.1 Sample Container and Labels

Sample containers and appropriate container lids will be provided by the laboratory. The sample containers will be filled as described in section 4.5.4, and the container lids will be tightly closed. Container lids will not be removed at any time prior to sample collection. The sample label will be firmly attached to the container side, and the following information will be legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample type (groundwater, surface water, etc.);
- Sampling date;

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- Sampling time;
- Preservatives added; and
- Sample collector's initials.

6.7.2 Sample Preservation

The laboratory will add any necessary chemical preservatives prior to shipping the containers to the site. Samples will be properly prepared for transportation to the laboratory by placing the samples in a cooler containing ice to maintain a shipping temperature of 4 degrees centigrade (°C).

6.7.3 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to Evergreen Analytical, Inc. of Wheat Ridge, Colorado, the AFCEE-approved laboratory for this demonstration. Samples will be shipped priority overnight via Federal Express®. The following packaging and labeling procedures will be followed:

- Package sample so that it will not leak, spill, or vaporize from its container;
- Label shipping container with:
  - Sample collector's name, address, and telephone number;
  - Laboratory's name, address, and telephone number;
  - Description of sample;
  - Quantity of sample; and
  - Date of shipment.

The packaged samples will be delivered to the laboratory as soon as possible after sample acquisition.

6.7.4 Chain-of-Custody Control

After the samples have been collected, chain-of-custody procedures will be followed to establish a written record of sample handling and movement between the sampling site and the laboratory. Each shipping container will have a chain-of-custody form completed in triplicate by the sampling personnel. One copy of this form will be kept by the sampling contractor after sample delivery to the analytical laboratory, and the other two copies will be retained at the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analytical results. The chain-of-custody will contain the following information:

- Sample identification number;

- Sample collector's printed name and signature;
- Date and time of collection;
- Place and address of collection;
- Sample matrix;
- Chemical preservatives added;
- Analyses requested;
- Signatures of individuals involved in the chain of possession; and
- Inclusive dates of possession.

The original chain-of-custody documentation will be placed inside the shipping container so that it will be immediately apparent to the laboratory personnel receiving the container, but will not be damaged or lost during transport. The shipping container will be sealed with chain-of-custody labels so that it will be obvious if the seal has been tampered with or broken.

6.7.5 Sampling Records

In order to provide complete documentation of the sampling event, detailed records will be maintained by the Parsons ES field hydrogeologist. At a minimum, these records will include the following information:

- Sample location (facility name);
- Sample identification;
- Sample location map or detailed sketch;
- Date and time of sampling;
- Sampling method;
- Field observations of
  - Sample appearance,
  - Sample odor;
- Weather conditions;
- Water level prior to purging;
- Total well depth;
- Purge volume;

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- Water level after purging;
- Well condition;
- Sampler's identification;
- Field measurements of pH, temperature, and specific conductivity; and
- Any other relevant information.

Groundwater sampling activities will be recorded on a groundwater sampling form. Figure 5 shows an example of the groundwater sampling record.

6.8 Laboratory Analyses

Laboratory analyses will be performed on all groundwater samples and the required QA/QC samples (see section 4.9). The analytical methods and detection limit requirements for this sampling event are listed in Tables 10.1 and 10.2 in the body of the RAP. Evergreen Analytical Laboratories of Wheat Ridge, CO, will be performing laboratory analytical analysis for the 1995 annual sampling event.

Prior to sampling, arrangements will be made with the laboratory to provide a sufficient number of appropriate sample containers for the samples to be collected. All containers, preservatives, and shipping requirements will be consistent with laboratory protocol.

Laboratory personnel will specify any additional QC samples and prepare bottles for all samples. For samples requiring chemical preservation, preservatives will be added to containers by the laboratory prior to shipping. Shipping containers, ice chests with adequate padding, and cooling media will be sent by the laboratory to the site. Sampling personnel will fill the sample containers and return the samples to the laboratory.

6.9 Quality Assurance/Quality Control Procedures and Sampling

Field QA/QC samples for groundwater sampling will include collection of field duplicates, equipment rinseate samples, and field and trip blanks. QA/QC procedures will include decontamination of the water level probe, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the analytical laboratory for analysis will be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples will be preserved in accordance with the analytical methods to be used, and water sample containers will be packaged in coolers with ice to maintain a temperature of 4°C.

All field sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature.

Groundwater QA/QC sampling frequency will be 10 percent or one sample for every ten well sampled. In the event that less than ten wells will be sampled in an event, a minimum of one sample will be collected. This ten percent frequency applies to equipment rinseate samples and field duplicates. One decontamination water sample and one field blank will be collected per sampling event. One trip blank will be sent with each sample shipment. The procedures for the collection of field QA/QC samples are described in section 2. The laboratory should plan to conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested.

7.0 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

As a check on field sampling, QA/QC samples, including trip blanks, field blanks, decontamination water blanks, equipment rinseate blanks, and field duplicates will be collected. Each type of QA/QC sample is described below.

7.1 Trip Blanks

A trip blank is defined as a sample bottle filled by the laboratory with analyte-free laboratory reagent-grade water, transported to the site, handled like a sample but not opened, and returned to the laboratory for analysis. One trip blank will accompany every cooler of environmental samples sent to the laboratory. Trip blanks are analyzed only by Method SW8020.

7.2 Decontamination Water Blank

A decontamination water blank is designed to check the purity of potable water used for equipment decontamination during the field operation. One decontamination water blank will be collected for each water source used during the field work. Decontamination water blanks are collected by filling the appropriate sample container directly from the potable water source. Decontamination water blanks are labeled, preserved, handled, and shipped in the same manner as an environmental water sample. The blank will be analyzed for the same analytes and parameters as the environmental samples.

7.3 Field Blanks

A field blank is designed to assess the effects of ambient field conditions on sample results. A field blank will consist of a sample of distilled water poured into a laboratory-supplied sample container while sampling activities are underway. The field blank will be analyzed for the same analytes and parameters as the environmental samples.

7.4 Equipment Rinseate Blanks

Equipment rinseate blanks will be collected from field equipment such as continuous core barrels. Equipment rinseate blanks are prepared by pouring distilled water over field equipment that has been decontaminated. The rinseate water is then collected, transferred to a sample bottle, and analyzed at the laboratory. The results of these sample analyses indicate how well the sampling equipment was decontaminated.

7.5 Field Duplicate/Replicate Samples

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A field duplicate/replicate is defined as two or more samples collected independently at the same sampling location during a single act of sampling. Soil samples are divided into two equal parts for analysis. Duplicates of water samples will be collected by filling additional sample containers at each duplicated sampling event. Replicates of soil samples will be collected by splitting a retrieve sampling sleeve into two samples (see section 1.2).

Field duplicates will be indistinguishable from other samples by the laboratory. One complete sample set will be identified with a coded identifier, which will be in the same format as other identifiers used with this matrix. Both the coded and actual sample identifiers will be recorded in the field notebook. The coded identifier will be used on the chain-of-custody forms.

8.0 ANALYTICAL SPECIFICATIONS

The following section present the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with compliance sampling to be performed at Sites ST14 andSD13. Procedures in this sections set forth a commitment to quality in all activities, products, and services; and are designed to assure that projects and activities are accomplished in an approved, prescribed manner by trained and competent staff.

The requirements of this section apply to contractors and their laboratories. Quality requirements specified in this document are tailored to the needs of the AFCEE risk-based remediation for Sites ST14 and SD13. The primary responsibility for meeting the quality objectives for this investigation remains with the operational personnel. They will perform their work in accordance with the standards of their profession, accepted practices, and applicable regulations. In the absence of specific guidelines, they will follow best scientific or technical judgment. Procedures outline in this section will serve as a controlling mechanism during these investigations to ensure that a sufficient quantity of data is collected and that all data collected are valid, reliable, and defensible.

8.1 Analytical Procedures

Application of a specific analytical method depends on the sample matrix and the analytes to be identified. Methods for each of the parameters likely to be included in the analytical program, as well as detection limits, are discussed in the following subsections. All analytical methods are EPA-approved when possible.

8.1.1 Analytical Methods

Analytical procedures will follow the Air Force Center for Environmental Excellence (AFCEE) recommended, established EPA and/or American Society of Testing Materials (ASTM) methods wherever such methods exist for a specified analyte. All methods are presented in Table 2.1 in Section 2 of this RAP. The referenced methods are located in the following documents:

- U. S. EPA Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020 (EPA, 1983).

- U. S. EPA Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW846, 3rd Edition , Update IIB, (EPA, 1995)
- American Society of Testing Materials methods (ASTM, 1987).

8.1.2 Detection and Quantitation Limits

This section describes the terms, definitions, and formulas that will be used for detection and quantitation limits.

8.1.2.1 Instrument Detection Limit

The instrument detection limit (IDL) reflects the instrument operating efficiency, not sample preparation, or concentration/dilution factors. The IDL is operationally defined as three times the standard deviation of seven replicate analyses at the lowest concentration that is statistically different from a blank. This represents 99-percent confidence that the signal identified is the result of the presence of the analyte, not random noise.

8.1.2.2 Method Detection Limit

An MDL is the lowest concentration at which a specific analyte in a matrix can be measured and reported with 99-percent confidence that the analyte concentration is greater than zero. MDLs are experimentally determined and verified for each analyte of the analytical methods in the sampling program. The laboratory will determine MDLs for each analyte and matrix type prior to analysis of project samples. MDLs are based on the results of seven matrix spikes at the estimated method detection limit and are statistically calculated in accordance with the 40 CFR part 136 from the Federal Register. The standard deviation of the seven replicates is determined and multiplied by 3.14. The 3.14 represents the 99 percent confidence interval from the one-sided student T-test. MDL's must be revalidated annually as a minimum. The MDLs to be used are intended to allow that both nondetects and detects will be usable to the fullest extent possible for the project.

8.1.2.3 Preliminary Remediation Goals

To define analytical data reporting limits that meet project data quality objectives (DQOs), target cleanup criteria have been identified. Tables 4.1 and 4.2 in the main body of the RAP identifies these target criteria.

8.1.2.4 Project Reporting Limit (PRL)

The PRL is equivalent to the current guidance listed in the AFCEE Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS), **(September, 1993)**. Because the project goals are developed for site closure and/or risk assessments, all sample results will be the reported at or above the MDL for each analyte. All results above the MDL but less than the PRL will be qualified in the data deliverable from the laboratory with a "J" flag. The "J" flag will denote the sample result as an estimated concentration. Where practical, MDLs must be lower than the cleanup criteria listed in Tables 4.1 and 4.2. Laboratories must verify the PRLs by including a standards at or below the PRL within the calibration curve.

All analytical results for soils and sediments, (both nondetected and detected) will be reported on a dry weight basis (i.e., corrected for moisture content). Additionally, the moisture content for each soil sample will be reported. The equation for moisture content given in ASTM D-2216 will be modified as follows:

$$W = [(W1-W2)/W1-Wc)] \times 100$$

where W = moisture content, percent by weight

W1 = weight of container and sample as received

W2 = weight of container and oven-dried sample

Wc = weight of container

The result of the sample on a dry weight basis is as follows:

R = result of analysis on a wet weight basis/100-percent moisture

where R = result of analysis on a dry weight basis

8.1.2.5 Sample Quantitation Limit

Sample quantitation limits (SQLs) are defined as the MDL multiplied by the dilution factor (DF) required to analyze the sample, and corrected for moisture or sample size. These adjustments may be due to matrix effects or the high concentration of some analytes. For example, if an analyte is present at a concentration which is greater than the linear range of the analytical method, the sample must be diluted for accurate quantitation. The DF raises the reporting limit to a higher level or SQL. Because the reported SQLs take into account sample characteristics and analytical adjustments, they are the most relevant quantitation limits for evaluating nondetected chemicals.

8.1.2.6 Reporting Units

The following are the prescribed analytical reporting units for all methods listed in Table 2.1.

- Soil and sediment samples - organics: micrograms per kilogram (μg/kg), dry-weight basis;
- Water samples - inorganics/metals: milligrams per liter (mg/L); and
- Water samples - organics: micrograms per liter (μg/L).

8.1.3 Analytical Instrumentation Calibration Requirements

Analytical instruments shall be calibrated in accordance with the analytical methods. All analytes reported shall be present in the initial and continuing calibrations. Records of standard preparation and instrument calibration shall be maintained. Records shall unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards shall be traceable to standard materials.

All calibration criteria shall satisfy SW-846 requirements at a minimum. The initial calibration shall be checked at the frequency specified in the method using materials prepared independently of the calibration standards. Analyte concentrations are determined with either calibration curves or response factors (RFs). For GC and gas chromatography/mass spectroscopy (GC/MS) methods, when using RFs to determine analyte concentrations, the average RF from the initial five point calibration shall be used. The continuing calibration shall not be used to update the RFs from the initial five point calibration.

Standard materials used in calibration and to prepare samples shall be traceable to National Institute Standards and Technology (NIST), EPA, American Association of Laboratory Accreditation (A2LA) or other equivalent approved source, if available. The standard materials shall be current, and the following expiration policy shall be followed: The expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date or one year from the date of receipt, whichever comes first. Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first. The laboratory shall label standard and QC materials with expiration dates.

8.2 Laboratory Quality Control Data

Laboratory QC data are necessary to determine precision and accuracy of the analyses, confirm matrix interferences, and demonstrate target compound contamination of sample results. QC samples will be analyzed routinely by the analytical laboratory, both field and fixed based, as part of the laboratory QC procedures. Laboratories performing definitive data quality require a more stringent QC program than those performing screening level data quality. Definitions for QC samples are presented below.

8.2.1 Holding Time

Holding time for sample extraction and/or analysis as required by the methods shall be met for all samples. Holding time is calculated from the date and time of sample collection to the time of sample preparation and/or analysis. All sample analyses to include dilutions, and second column confirmation will meet the required holding time. Samples exceeding holding time will be qualified as unusable results.

8.2.2 Method Blanks

Method blanks are designed to detect contamination of the field samples from the laboratory environment. Method blanks verify that interferences caused by contaminants in solvents, reagents, glassware, or in other sample processing hardware are known and minimized. The method blank will be ASTM Type II water (or equivalent) for water samples, and a purified solid matrix (Ottawa sand or equivalent) for soil/sediment samples. The concentration of target compounds in the blanks must be less than or equal to the PRL. Exceptions are not made for common laboratory contaminants. If the blank is not under the specified limits, then the source of contamination will be identified and corrective action (including reanalysis of the sample group). Sample quantitation and detection limits will not be raised because of blank contamination. Analytical data will not be corrected for presence of analytes in blanks.

8.2.3 Laboratory Control Samples (LCSs)

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LCSs are blank spikes made from clean laboratory simulated matrices (reference method blank matrices), spiked with known concentrations of all target analytes of interest at levels approximately 10 times greater than the MDL. The LCS is carried through the complete sample preparation and analysis procedures. LCSs are designed to check the instrument and method accuracy. An LCS will be analyzed with every analytical batch. Failure of the LCS to meet recovery criteria requires corrective action before any further analyses can continue. All sample results associated to the out of control LCS must be reanalyzed after control has been reestablished.

8.2.4 Surrogate Spike Analyses

Surrogate spike analyses are used to determine the efficiency of analyte recovery in sample preparation and analysis in relation to sample matrix. Calculated percent recovery of the spike is used to measure the accuracy of the analytical method for an individual sample. A surrogate spike is prepared by adding to an environmental sample (before extraction) a known concentration of a compound similar in type to the target analytes to be analyzed for organic target compounds. Surrogate compounds as specified in the methods will be added to all samples analyzed, including method blanks, MS/MSDs, LCS, field samples, and duplicate samples.

8.2.5 Matrix Spike/Matrix Spike Duplicate

MS samples are designed to check the accuracy of the analytical procedures on sample matrix by analyzing a field sample spiked in the laboratory with a known standard solution containing all the target analytes. MSDs are the second of a pair of laboratory MS samples. The MSDs are designed to check the precision and accuracy of analytical procedures by sample matrix.

One MS/MSD pair will be collected for every group of 20 project samples of similar matrix. Field blanks or duplicates are not to be used as MS/MSDs. If surrogate and target analyte compounds are out of control in the MS/MSD, but the associated accuracy and precision are in control in the LCS, then the out-of-control situation will be attributed to a matrix interference. If the laboratory system is shown to be out-of-control, (LCS out of control) then a re-extraction and reanalysis will be required. The laboratory will report the data from any reanalysis that is performed.

8.2.6 Analytical Batches

Analytical batches will be designated in the laboratory at a minimum of one batch per sample delivery group (SDG). Each SDG will be comprised of a maximum of 20 project samples of similar matrix and collected within a 7-day period. Included in each SDG of 20 (or fewer) samples per analytical method will be an analytical batch identification number. This identification number will clearly allow a reviewer to determine the association between field samples and QC samples. Analytical batches will also be inclusive of preparation lots and calibration periods.

8.2.7 Retention Times

Retention time (RT) is the amount of time required for a target compound to elute from the chromatographic column and the instrument detector to record a signal response. RT windows are the allowable deviation from the true expected RT for any

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one compound. A peak response within this RT window will constitute a positive detection for that compound. RT windows are a requirement of all GC and high performance liquid chromatography (HPLC) methods. RT windows are accomplished through replicate analyses of a standard over multiple days. The calculation of RT windows is described in the SW-846 method SW8000A. Corrective action is required when the RT windows are out of control.

8.2.8 Internal Standards

Internal standards are compounds of known concentrations used to quantitate the concentrations of target detections in field and QC samples. Internal standards are added to all samples and QC after sample extraction or preparation. Because of this, internal standards provide for the accurate quantitation of target detections by allowing for the effects of sample loss through extraction, purging and/or matrix effects. Internal standards are used for any method requiring an internal standard calibration. Corrective action is required when internal standards are out of control.

8.2.9 Second Column Confirmation

Quantitative confirmation of results at or above the PQL for samples analyzed by GC or HPLC shall be required and shall be completed within the method-required holding times. For GC methods, a second-column is used for confirmation. For HPLC methods, a second column or a different detector is used. The result of the first column/detector shall be the result reported.

8.3 Data Reduction, Validation, and Reporting

8.3.1 Review Procedures for Screening Data

The contractor analyst shall review 100 percent of all screening data results prior to reporting. Screening data will constitute all analytical method results from analysis performed in the field laboratory environment. The contractor shall determine if their data quality objective for field data results have been met and also calculate the percent completeness for field data results.

At a minimum, the review of screening data will focus on the following subjects:

- COC forms,
- Holding times,
- Method blanks,
- Laboratory-established detection limits,
- Analytical batch control records including calibrations, and spike recoveries, and
- Completeness of data.

8.3.2 Review Procedures for Definitive Data

The laboratory shall review 100 percent of all definitive data prior to reporting. The establishment of detection and control limits will be verified. Any control limits outside of the acceptable range specified in the analytical methods will be identified. Any trends or problems with the data will be evaluated. Any laboratory established

detection limits that exceed the established limits specified will be identified. The absence of records supporting the establishment of control criteria and detection limits will also be noted. Analytical batch QC, calibration check samples, method calibrations, continuing calibration verifications, corrective action reports, the results of reanalysis, sample holding times, sample preservations, and any resampling and analysis will all be evaluated.

Samples associated with out-of-control QC data will be identified in the data package case narrative, and an assessment of the utility of such analytical results will be made. The check of laboratory data completeness will ensure that:

- All samples and analyses specified in the work plan have been processed;
- Complete records exist for each analysis and the associated QC samples;
- Procedures specified in this SAP have been implemented; and
- The results of the completeness check will be documented.

An analyst other than the original data processor, will be responsible for reviewing all steps of the data processing. All input parameters, calibrations, and transcriptions will be checked. All manually input, computer-processed data will be checked. Each page of checked data will be signed and dated by the verifier.

QC sample results (laboratory control samples, matrix spike, matrix spike duplicates, surrogates, initial calibration standards, and continuing calibration standards) are compared against stated criteria for accuracy and precision. QC data must meet acceptance levels prior to processing the analytical data. If QC standards are not met, the cause will be determined. If the cause can be corrected without affecting the integrity of the analytical data, processing of the data will proceed. If the resolution jeopardizes the integrity of the data, reanalysis will occur.

Decisions to repeat sample collection and analyses may be made by the Contractor project manager based on the extent of the deficiencies and their importance in the overall context of the project.

8.3.3 Laboratory Data Reporting Flags

The following flags must be used by the laboratory when reporting sample results.

Value - If the result is a value greater than or equal to the practical quantitation limit (MDL), the value is reported.

U - Indicates the compound was analyzed for but not detected. The number is the MDL for the sample.

J - Indicates an estimated value. This flag will be used to identify values falling between the MDL and the PQL. This flag is also used to estimate a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicate identification criteria, but the result is less than the specified detection limit.

UJ - A combination of the "U" and "J" qualifiers. The analyte analyzed for was not present above the level of the associated value. The associated

numerical value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample.

B - Used when the analyte is found in the blank, as well as in a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.

8.3.4 Laboratory Data Validation and Assessment of Usability

Data from QC samples will be assessed using the procedures and criteria presented earlier in this section. This assessment will be a continuous process in which QA problems are identified immediately and the appropriate corrective action is implemented. Additionally, the contractor will assess the usability of analytical data. Any limitations on data use will be expressed quantitatively to the extent practicable and will be documented in any reporting of the data.

This data usability review will include a review of the analytical methods, quantitation limits, and other factors important in determining the precision, accuracy, completeness, and representativeness of the final data set. The outcome of this data evaluation will be a data set appropriate to support quantitative fate and transport analyses and risk analysis. The data evaluation methods defined by EPA (1989b) in OSWER Directive 9285.7-01a *Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual* (EPA/540/1-89/002) and OSWER Directive 9285.7-09a *Guidance for Data Usability in Risk Assessment* (EPA, 1992) will be used as appropriate.

9.0 DATA QUALITY ASSESSMENT OBJECTIVES

9.1 Analytical Data Quality Levels

Data quality objectives (DQOs) for the analyses described herein are described in the interim final guidance, Data Quality Objectives Process for Superfund (1993; EPA 540-R-93-071). The analytical levels for this project's DQOs shall conform to the two categories of data defined as: screening data with definitive confirmation, and definitive data.

Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provide analyte identification and quantification, although the quantification may be relatively imprecise. At least 10 percent of the screening data are confirmed using analytical methods and quality assurance/quality control (QA/QC) procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality.

Definitive Data - Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

For the sampling program, the following data quality levels will be used as indicated:

- Screening data with definitive confirmation will be used for the air screening in worker breathing zones for health and safety purposes. It may also be used to screen samples to select portions for further analysis. For example, soil sample headspace may be screened to determine if laboratory analyses are required. In addition, it will be used to determine the presence of compounds supporting the intrinsic remediation option for ground water. These data will be used to evaluate the effectiveness of intrinsic remediation at the site.

- Definitive analyses will be used to satisfy the requirements for ongoing site characterization and site closure decisions. Former EPA Level III data from previous site investigations will be combined with newly acquired definitive data to evaluate the magnitude and extent of contamination at the site.

Laboratory analyses shall be performed in accordance with the SAP.

An effective QA program addresses quality objectives for both field sampling and laboratory methodologies. The contractors field QA efforts are aimed primarily at assuring that samples are representative of the conditions in the various environmental media at the time of sampling. Laboratory QA efforts are aimed primarily at assuring that analytical procedures provide sufficient accuracy and precision to quantify contaminant levels in environmental samples. The laboratory will also ensure that analyzed portions are representative of each sample, and that the results obtained from analysis of each sample are comparable to those obtained from analysis of other similar samples.

9.2 Data Quality Assessment Criteria

The data assessment criteria measure the quality of both the field and laboratory performance for the project and are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability. Procedures used to assess data accuracy and precision are in accordance with Guidelines Establishing Test Procedures for the Analyses of Pollutants, Appendix III, "Example Quality Assurance and Quality Control Procedures for Organic Priority Pollutants," (40 CFR 136), (Section 7.0, "Internal Quality Control Checks,"), and the respective analytical methods from the U.S. EPA Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846, 3rd Edition, Update IIB, (January, 1995).

9.2.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. The results of the laboratory control samples (LCS) demonstrate the precision of the methods. When the LCS results meet the accuracy criteria, results are believed to be precise. This is based on the LCS being in control in comparison to LCS results from previous analytical batches of similar methods and matrices. The relative percent difference (RPD) of field duplicate, laboratory sample duplicate and matrix spike/matrix spike duplicates (MS/MSD) results demonstrate the precision of the sample matrix. Precision will be expressed in terms of RPD between the values resulting from duplicate analyses. RPD is calculated as follows:

$$RPD = [(x1 - x2)/X][100]$$

where:

x1	=	analyte concentration of first duplicate
x2	=	analyte concentration of second duplicate
X	=	average analyte concentration of duplicates 1 and 2.

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Acceptable levels of precision will vary according to the sample matrix, the specific analytical method, and the analytical concentration relative to the method detection limit. For field duplicate samples, the target RPDs are 70 percent for soil and 35 percent for water samples.

9.2.2 Accuracy

Accuracy is a measure of the closeness of a reported concentration to the true value. Accuracy is expressed as a bias (high or low) and is determined by calculating percent recovery (PR) from MS/MSD, LCS, and surrogate spikes. MS/MSD and surrogate spike recoveries indicate accuracy relevant to a unique sample matrix. LCS recoveries indicate accuracy relevant to an analytical batch lot and are strictly a measure of analytical accuracy conditions independent of samples and matrices. The level of recovery of an analyte and the resulting degree of accuracy expected for the analysis of QC spiked samples are dependent upon the sample matrix, method of analysis, and the compound or element being measured. The concentration of the analyte relative to the detection limit of the method is also a major factor in determining the accuracy of the measurement.

Accuracy is expressed as PR and is calculated as follows:

$$PR = [(A-B)/C] \times 100$$

where:

A	=	spiked sample concentration
B	=	measured sample concentration (without spike)
C	=	concentration of spike added.

9.2.3 Completeness

Completeness is defined as the percentage of laboratory measurements, judged to be valid measurements on a method-by-method basis. Valid data will be defined as all data and/or qualified data considered to meet the DQOs for this project. Data completeness is expressed as percent complete (PC) and should be 90 percent or better. The goal for meeting analytical holding times will be 100 percent. At the end of each sampling event, the completeness of the data will be assessed. If any data omissions are apparent, the parameter in question will be resampled and/or reanalyzed, if feasible. The laboratory results will be monitored as they become available to assess laboratory performance and its effect on data completeness requirements. When appropriate, additional samples will be collected to ensure that laboratory performance meets PC requirements.

PC is calculated as follows:

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$$PC = \frac{NA}{NI} \times 100$$

Where:

NA = Actual number of valid analytical results obtained

NI = Theoretical number of results obtainable under ideal conditions.

9.2.4 Comparability

Comparability expresses the confidence with which data from a sample, sampling round, site, laboratory, or project can be compared to those from another. Comparability during sampling involves sampling program design and time periods. Comparability during analysis involves analytical methods, detection limits, laboratories, units of measure, and sample preparation procedures.

The objective for comparability is determined on a qualitative rather than quantitative basis. For this project, comparability of all data collected will be ensured by adherence to standard sample collection procedures, standard field measurement procedures, and standard reporting methods including consistent units. For example, concentrations will be reported in a manner consistent with general practice (e.g., soil data will be reported on a dry-weight basis).

In addition, to support the comparability of analytical results with those obtained in previous or future testing, all samples will be analyzed by EPA-approved methods, where available. The EPA-recommended maximum permissible holding times for organic and inorganic parameters will not be exceeded. All analytical standards will be traceable to a "Standard Reference Material". Instrument calibrations will be performed in accordance with EPA specifications, and will be checked at the frequency specified in the methods. The results of these analyses can then be compared with analyses by other labs and/or with analyses for other sites addressed by this site investigation.

9.2.5 Representativeness

Representativeness expresses the extent to which collected data define site contamination. Where appropriate, sample results will be statistically characterized to determine the degree to which the data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, a process, or an environmental condition.

Sample collection, handling, and analytical procedures will strive to obtain the most representative sample possible. Representative samples will be achieved by the following:

- Collection of samples from a location(s) fully representing site conditions;
- Use of appropriate sampling procedures, including equipment and equipment decontamination;

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- Use of appropriate analytical methodologies for the required parameters and detection limits; and

- Analysis of samples within the required holding times.

Sample representativeness is also affected by the portion of each collected sample which is chosen for analysis. The laboratory will adequately homogenize all samples prior to taking aliquots for analysis to ensure that the reported results are representative of the sample received. Because many homogenization techniques may cause loss of contaminants through volatilization, homogenization for all volatile method analyses will be performed with extreme care to minimize these risks.

Sheet of

GEOLOGIC BORING LOG

332645

BORING NO. _____ CONTRACTOR: _____ DATE SPUD: _____
IENT: _____ RIG TYPE: _____ DATE CMPL: _____
3 NO.: _____ DRLG METHOD: _____ ELEVATION: _____
LOCATION: _____ BORING DIA.: _____ TEMP.: _____
GEOLOGIST: _____ DRLG FLUID _____ WEATHER: _____
COMMENTS: _____

Elev. (ft.)	Depth (ft.)	Pro-file	US CS	Geologic Description	Samples No.	Samples Depth (ft)	Sample Type	Penet. Res.	Remarks TIP = Bkgrnd/Reading (ppm)
	1								
	5								
	10								
	15								
	20								
	25								
	30								

sl – slight	v – very	f – fine	SAMPLE TYPE		
tr – trace	lt – light	m – medium	D – DRIVE	C	Core recovery
sm – some	dk – dark	c – coarse	C – CORE		
& – and	bf – buff	BH – Bore Hole	G – GRAB		Core lost
@ – at	brn – brown	SAA – Same As Above			
w – with	blk – black		Water level drilled		

Figure 1

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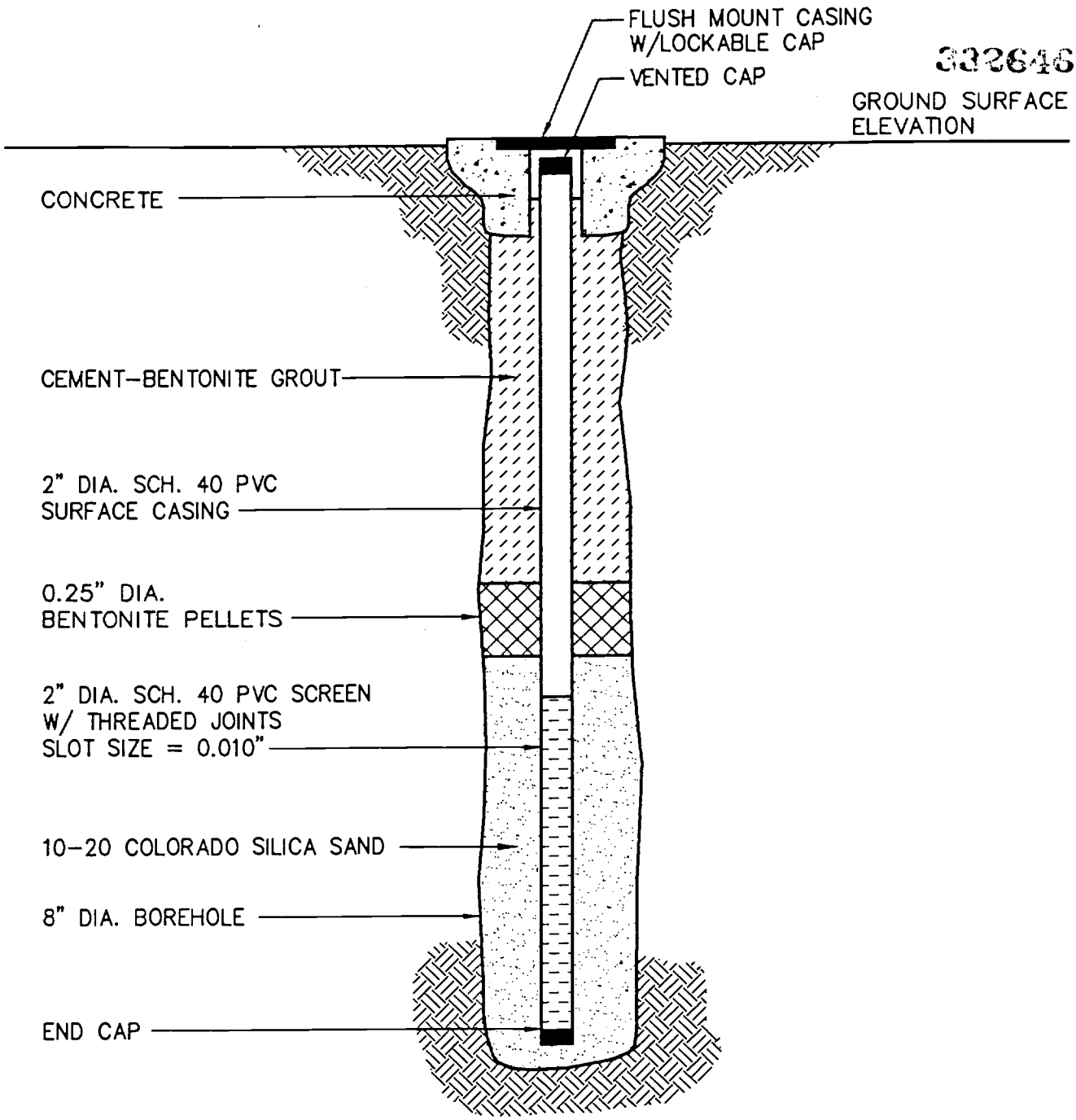

NOT TO SCALE

FIGURE 2

TYPICAL MONITORING WELL COMPLETION DIAGRAM

Site ST14
Remedial Action Plan
Risk-Based Approach to Remediation
Carswell AFB/NAS Fort Worth JRB, TX

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

K:\ELLSWRTH\95DN0910, 06/08/95 at 12:35

WELL CONSTRUCTION FORM

332647

Installation: _____
Site: _____
Well ID: _____
Comp. started ___/___/___ (: m)

Project no. _____
Drilling contractors: _____
Comp. finished: ___/___/___ (: m)

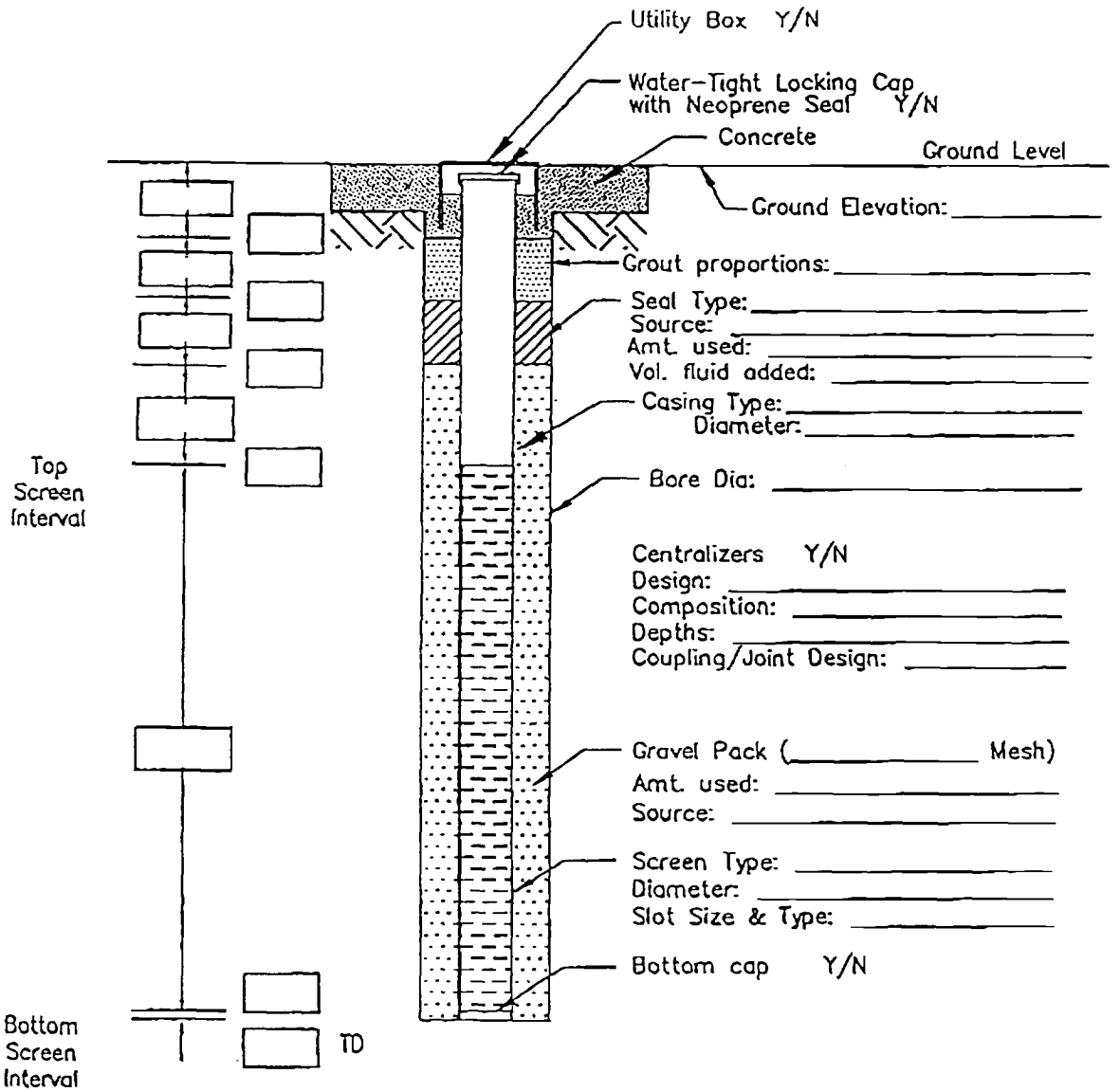

Figure 3

Well Development Record

Job Number_____ Job Name_____
Location_____ By_____ Date_____
Well Number_____ Measurement Datum_____

Pre-Development Information Time (Start):

Water Level: Total Depth of Well:

Water Characteristics

Color_____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material_____
pH_____ Temperature(^{o}F ^{o}C) _____
Specific Conductance(µS/cm)_____

Interim Water Characteristics

Gallons Removed

pH

Temperature (^{o}F ^{o}C)

Specific Conductance(µS/cm)

Post-Development Information Time (Finish):

Water Level: Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color_____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material_____
pH_____ Temperature(^{o}F ^{o}C) _____
Specific Conductance(µS/cm)_____

Comments:

Figure 4

SAMPLING LOCATION _____
SAMPLING DATE(S)_____

GROUND WATER SAMPLING RECORD - MONITORING WELL _____
(number)

REASON FOR SAMPLING: [ ] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: _____, 19___ _____ a.m./p.m.
SAMPLE COLLECTED BY: _____ of _____
WEATHER:_____
DATUM FOR WATER DEPTH MEASUREMENT (Describe):_____
_____
_____

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:_____
INNER PVC CASING CONDITION IS:_____
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):_____
_____
_____

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH_____
Items Cleaned (List):_____
_____
_____

2 [ ] WATER DEPTH _____FT. BELOW DATUM
Measured with:_____

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:_____
Odor:_____
Other Comments:_____

4 [ ] WELL EVACUATION:
Method:_____
Volume Removed:_____
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:_____
Other comments:_____

Figure 5

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5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____
_____

Sample obtained is [ ] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Temp: _____ ° _____ Measured with:_____
pH: _____ Measured with:_____
Conductivity: _____ Measured with:_____
Other: _____
_____

7 [ ] SAMPLE CONTAINERS (material, number, size):_____
_____
_____
_____

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____
_____
_____
_____
_____

Figure 5 (Continued)

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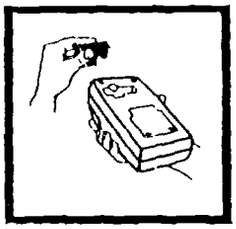
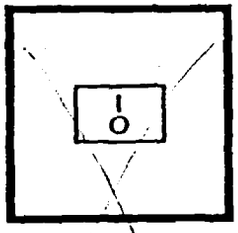
USING ACCUVAC AMPULS

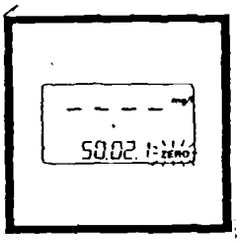


1. Install module
50.01
in a DR/700.

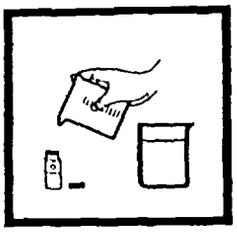
Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not measured.



2. Press: 1 0
The display will show
500 nm
and module
50.01

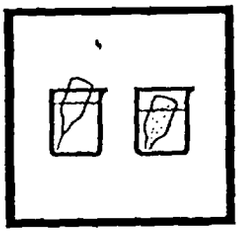


3. After 2 seconds, the display will show a program number, concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number
50.02.1



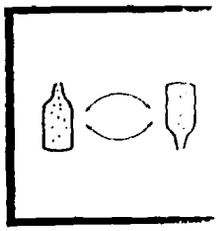
4. Fill a 10-mL cell to the 10-mL line with sample (the blank). Cap. Collect at least 40 mL of sample in a 50-mL beaker.

Note: For proof of accuracy, use a 1.00 mg/L Ferrous Iron Standard Solution (preparation given in Accuracy Check) in place of the sample.



5. Fill a Ferrous Iron AccuVac Ampul with sample.

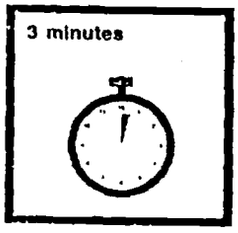
Note: Keep the tip immersed while the ampul fills completely.



6. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: An orange color will develop if ferrous iron is present.

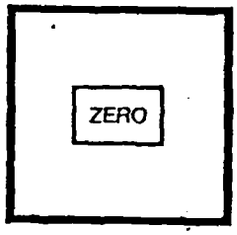
Note: Undissolved powder does not affect accuracy.



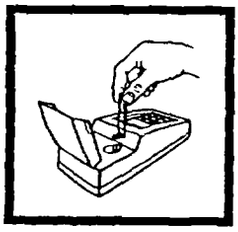
7. Wait 3 minutes.

8. Place the blank in the cell holder.

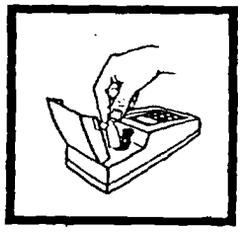
Note: In bright sunlight it may be necessary to close the cell compartment cover.



9. Press: ZERO
The display will count down to 0, then the display will show 0.00 mg/L and the zero prompt will turn off.

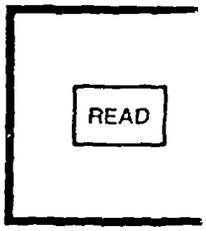


10. Insert the AccuVac Vial Adapter into cell holder.



11. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



12. Press: READ
The display will count down to 0. Then the display will show the results in mg/L ferrous iron (Fe^{2+}).

Step 1.5 and 2.0

Fill a 10-ml cell w/ distilled water, place it in the colorimeter. Hold down the "read" button while turning on the meter. Wait until a "Q" (lightbulb) appears on the lower part of the screen. Release the "read" button. A count down will follow and then a # will appear. Let the # stabilize then press "program" a go to step #3.

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ACCURACY CHECK

Standard Solution Method

Prepare a ferrous iron stock solution (100 mg/L Fe^{2+}) by dissolving 0.7022 grams of Ferrous Ammonium Sulfate, hexahydrate, in deionized water. Dilute to 1 liter. Prepare immediately before use. Dilute 1.0 mL of this solution to 100 mL with deionized water to make a 1.0 mg/L standard solution. Prepare this immediately before use.

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 1.50 mg/L Fe^{2+} concentration samples, the standard deviation was ±0.008 mg/L Fe^{2+}.

Testing zero concentration samples, the limit of detection was 0.007 mg/L Fe^{2+}. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

Using two representative lots of Ferrous Iron AccuVacs Ampuls, the standard deviation was ±0.012 mg/L Fe^{2+} and the limit of detection was 0.014 mg/L Fe^{2+}.

SUMMARY OF METHOD

The 1,10 phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not interfere. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test.

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No.
Ferrous Iron Reagent Powder Pillows, 25-mL	1 pillow	100/pkg	1037-69

REQUIRED APPARATUS (Using Powder Pillows)

Clippers, large, for opening pillows	1	each	968-00
DR/700 Filter Module Number 50.01	1	each	46250-00

REQUIRED REAGENTS (Using AccuVac Ampuls)

Ferrous Iron Reagent AccuVac Ampuls	1 ampul	25/pkg	25140-25

REQUIRED APPARATUS (Using AccuVac Ampuls)

Beaker, 50 mL	1	each	500-41
DR/700 Filter Module Number 50.01	1	each	46250-00

OPTIONAL REAGENTS

Ferrous Ammonium Sulfate, Hexahydrate, ACS	113 g	11256-14
Water, deionized	3.78 L	272-17

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Adapter, AccuVac Vial, DR/700	each	46025-00
Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Flask, volumetric, 100 mL	each	547-42
Flask, volumetric, 1000 mL	each	547-53
Pipet, volumetric, 1 mL	each	515-35
Pipet Filler, safety bulb	each	14651-00
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

Parsons ES
HACH account # 99790

Method Number 8008

IRON (0 to 5.00 mg/L)

For water, wastewater and seawater

FerroVer Method* (Powder Pillows or AccuVac Ampuls), USEPA approved for reporting (digestion—see Section I)†

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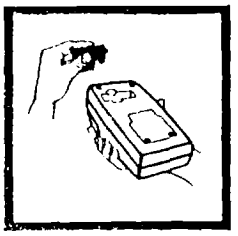
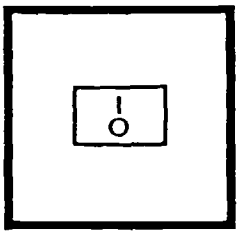
ING POWDER PILLOWS



1. Install module **50.01** in a DR/700.

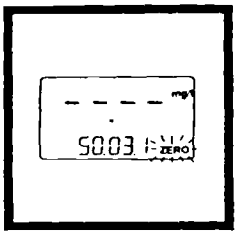
Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps. Adjust pH of stored samples before analysis.

Note: Determination of total iron requires a prior digestion, use the mild, vigorous or Digesdahl digestion (Section I).

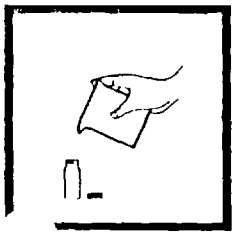


2. Press: I/O

The display will show **500 nm** and module **50.01**



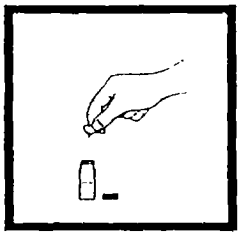
3. After 2 seconds the display will show a program number, concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number **50.03.1**



. ill a 10-mL cell to the 10-mL line with sample.

Note: A 25-mL sample can be tested by using 25-mL sample cells and optional reagents.

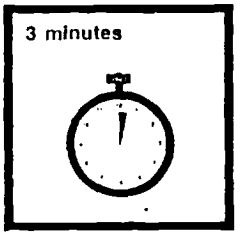
Note: For proof of accuracy, use a 1.0 mg/L iron standard solution (preparation given in the Accuracy Check) in place of the sample.



5. Add the contents of one FerroVer Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap and invert to mix.

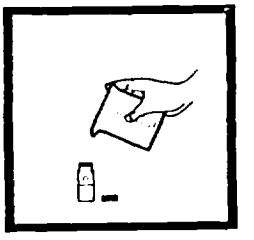
Note: An orange color will form if iron is present.

Note: Accuracy is not affected by undissolved powder.



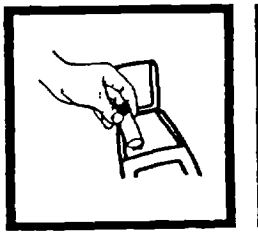
6. Wait 3 minutes.

Note: Samples containing visible rust should be allowed to react at least five minutes.



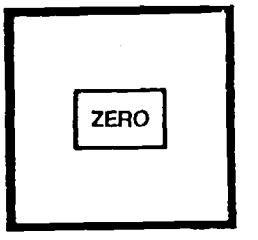
7. Fill a second 10-mL cell to the 10-mL line with sample (the blank). Cap.

Note: For turbid samples, treat the blank with one 0.2-gram scoop of RoVer Rust Remover. Swirl to mix.



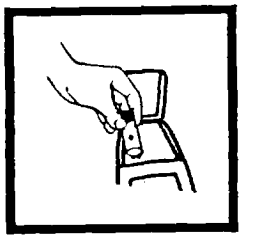
8. Within 30 minutes after the 3-minute period, place the blank in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



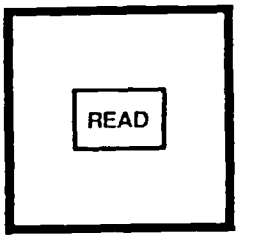
9. Press: **ZERO**

The display will count down to 0. Then the display will show 0.00 mg/l and the zero prompt will turn off.



10. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



11. Press: **READ**

The display will count down to 0. Then the display will show the results in mg/L iron (Fe).

*Adapted from Standard Methods for the Examination of Water and Wastewater (Federal Register, 1980, 45(126), 43459

†

SAMPLING AND STORAGE

Collect samples in acid-cleaned glass or plastic containers. No acid addition is necessary if analyzing the sample immediately. To preserve sample, adjust the pH to 2 or less with concentrated nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature. Adjust the pH to between 3 and 5 with 5.0 N Sodium oxide Standard Solution before analysis. Correct the test result for ac additions; see Sampling and Storage, Volume Additions (Section I) for more information.

If only dissolved iron is to be determined, filter the sample before acid addition using the labware listed under Optional Apparatus.

ACCURACY CHECK

Standard Additions Method

a) Snap the neck off an Iron Voluette Ampule Standard Solution, 50 mg/L.

b) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL water samples and mix thoroughly. (For AccuVac Ampuls, collect 25-mL samples in 50-mL beakers.)

c) Analyze each sample as described above. The iron concentration should increase 0.2 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see Standard Additions (Section I) for more information.

Standard Solution Method

Prepare a 1.0 mg/L iron standard by diluting 1.00 mL of Iron Standard Solution (100 mg/L Fe) to 100 mL with deionized water. Or, use the TenSette Pipet to dilute 1.0 mL of the contents of an Iron Voluette Ampule Standard Solution (50 mg/L) to 50 mL in a volumetric flask. Prepare this solution daily.

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 1.50 mg/L Fe^{3+} concentration samples, the standard deviation was ±0.008 mg/L Fe^{3+}.

g zero concentration samples, the limit of detection was 0.007 mg/L Fe^{3+}. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

Using two representative lots of FerroVer Iron AccuVac Ampuls, the standard deviation was ±0.012 mg/L Fe^{3+} and the limit of detection was 0.014 mg/L Fe^{3+}.

INTERFERENCES

The following will not interfere below the levels shown:

Chloride	185,000 mg/L
Calcium	10,000 mg/L as $CaCO_3$
Magnesium	100,000 mg/L as $CaCO_3$
Molybdate Molybdenum	50 mg/L as Mo

A large excess of iron will inhibit color development. A diluted sample should be tested if there is any doubt about the validity of a result.

FerroVer Iron Reagent Powder Pillows and AccuVac Ampuls contain a masking agent which eliminates potential interferences from copper.

Samples containing some forms of iron oxide require the mild, vigorous or Digesdahl digestion (Section I). After digestion adjust the pH to between 3 and 5 with ammonium hydroxide.

Samples containing large amounts of sulfide should be treated as follows in a fume hood, or well ventilated area: Add 5 mL of hydrochloric acid to 100 mL of sample and boil for 20 minutes. Adjust the pH to between 3 and 5 with 5 N Sodium Hydroxide Standard Solution and readjust the volume to 100 mL with deionized water. Analyze as described above.

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see Interferences, pH (Section I).

REAGENT STORAGE

FerroVer Reagent Powder Pillows are stable indefinitely if stored properly. A cool, dry atmosphere is recommended. The reagent can be checked by adding the contents of a pillow to about 25 mL of water containing visual rust (such as a few drops of Rust Suspension). If the orange color does not form, the reagent should be replaced.

SUMMARY OF METHOD

FerroVer Iron Reagent reacts with all soluble iron and most insoluble forms of iron in the sample, to produce soluble ferrous iron. This reacts with the 1,10 phenanthroline indicator in the reagent to form an orange color in proportion to the iron concentration.

332654

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No.
FerroVer Reagent Powder Pillows, 10 mL	1 pillow	100/pkg	21057-69

REQUIRED APPARATUS (Using Powder Pillows)

DR/700 Filter Module Number 50.01	1	each	46250-00
Clippers, for opening pillow	1	each	968-00

OPTIONAL REAGENTS

Ammonium Hydroxide, ACS	500 mL	106-19
Hydrochloric Acid Standard Solution, 6.0 N (1:1)	500 mL	884-49
FerroVer Reagent Powder Pillows, 25-mL sample	50/pkg	854-66
Iron Standard Solution, 100 mg/L Fe	100 mL	14175-42
Iron Standard Solution, Voluette ampule, 50 mg/L Fe, 10 mL	16/pkg	14254-10
Nitric Acid, ACS	500 mL	152-49
Nitric Acid Solution, 1:1	500 mL	2540-49
RoVer Rust Remover	28 g*	300-20
Rust Suspension	15 mL	1279-36
Sodium Hydroxide Standard Solution, 5.0 N	100 mL	2450-32
Water, deionized	3.78 L	272-17

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Adapter, AccuVac Vial, DR/700	each	46025-00
Ampule Breaker Kit	each	21968-00
Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Cylinder, graduated, 25 mL	each	508-40
Dropper, calibrated, 0.5-mL mark	each	23185-37
Filter Discs, glass, 47 mm	100/pkg	2530-00
Filter Holder, membrane	each	2340-00
Filter Pump	each	2131-00
Flask, erlenmeyer, 125 mL	each	505-43
Flask, erlenmeyer, 50 mL	each	505-41
Flask, filtering, 500 mL	each	546-49
Flask, volumetric, 50 mL	each	547-41
Flask, volumetric, 100 mL	each	547-42
Hot plate, 3 1/2" diameter, 120 Vac	each	12067-01
Hot plate, 3 1/2" diameter, 240 Vac	each	12067-02
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, Hach One	each	43800-00
Pipet, serological, 2 mL	each	532-36
Pipet, serological, 5 mL	each	532-37
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, 0.50 mL	each	14515-34
Pipet, volumetric, Class A, 1.00 mL	each	14515-35
Pipet Filler, safety bulb	each	14651-00
Sample Cell, 10-mL, with screw cap	6/pkg	24276-06
Sample Cell, 25-mL, with screw cap	6/pkg	24019-06
Spoon, measuring, 0.20 g	each	638-00
Thermometer, -20 to 105 °C	each	1877-01

For Technical Assistance, Prices and Ordering

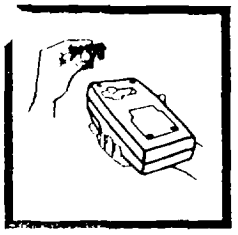
In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

NITRATE, LR (0 to 0.50 mg/L NO_3^-–N)

For water, wastewater and seawater*

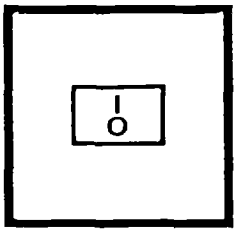
Cadmium Reduction Method

332655



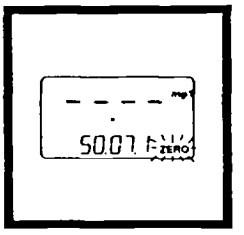
1. Install module 50.01 in a DR/700.

Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps. Adjust the pH of stored samples before analysis.

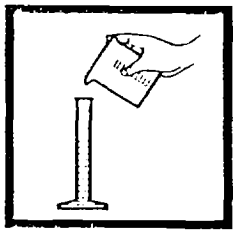


2. Press: I/O

The display will show 500 nm and module 50.01

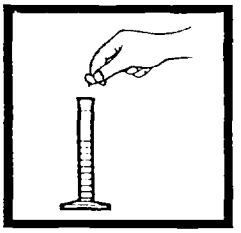


3. After 2 seconds, the display will show a program number, the concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number 50.07.1

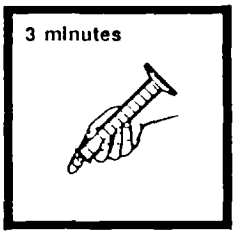


4. Fill a 50-mL graduated mixing cylinder to the 30-mL mark with sample.

Note: For proof of accuracy, use a 0.20 mg/L nitrate nitrogen standard solution (preparation given in Accuracy Check) in place of the sample.



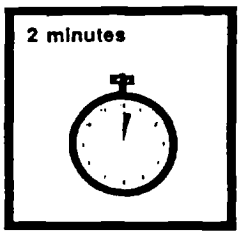
5. Add the contents of one NitraVer 6 Nitrate Reagent Powder Pillow to the cylinder. Stopper.



6. Shake the cylinder continuously for three minutes.

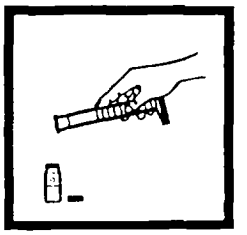
Note: A deposit of unoxidized metal will remain after the NitraVer 6 Nitrate Reagent Powder dissolves. This is normal and will not affect test results.

Note: Shaking time and technique influence color development. For most accurate results, make successive tests on a solution containing a known amount of nitrate and adjust the shaking time to obtain the correct results. See Accuracy Check for more information.



7. Wait 2 minutes.

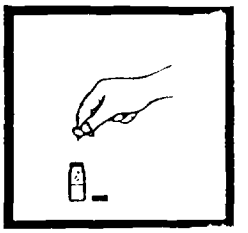
Note: A two-minute period allows cadmium to settle.



8. Fill a 10-mL cell to the 10-mL line with the prepared sample.

Note: Take care not to transfer any cadmium particles.

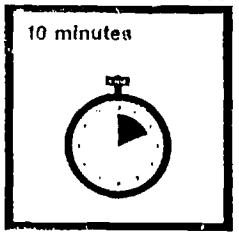
Note: A 25-mL sample can be tested by using 25-mL sample cells and optional NitriVer 3 Reagent.



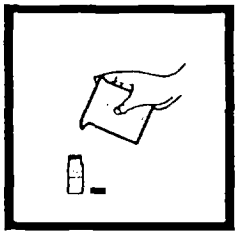
9. Add the contents of one NitriVer 3 Nitrite Reagent Powder Pillow to the sample cell (the prepared sample). Cap and shake to dissolve.

Note: A pink color will develop if nitrate is present.

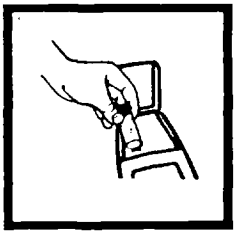
*Seawater requires a manual calibration; see Interferences.



10. Wait 10 minutes.

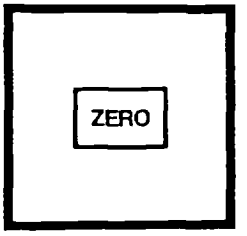


11. Fill another 10-mL cell to the 10-mL line with sample (the blank).



12. Place the blank in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.

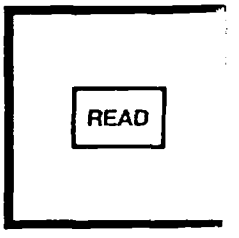


13. Press: ZERO

The display will count down to 0. Then the display will show 0.00 mg/L and the zero prompt will turn off.

14. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



15. Press: READ

The display will count down to 0. Then the display will show the results in mg/L nitrate as nitrogen (NO_3^-–N).

Note: To convert the results to mg/L NO_3, multiply by 4.4.

Note: Rinse the sample cell immediately after use to remove all cadmium particles.

Note: Determine a reagent blank for each new lot of powder pillows. Repeat Step 4 to 15 using deionized water as the sample. Subtract this value from each result obtained with the new lot of reagent.

SAMPLING AND STORAGE

Collect samples in clean plastic or glass bottles. Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods, adjust sample pH to 2 or less with sulfuric acid, ACS (about 2 mL per liter). Sample refrigeration is still required.

Before testing the stored sample, warm to room temperature and neutralize with 5.0 N Sodium Hydroxide Standard Solution. Do not use mercury compounds as preservatives. Correct the test result for volume additions; see Sampling and Storage, Volume Additions, (Section I) for more information.

ACCURACY CHECK

Standard Additions Method

a) Measure 30 mL of sample into three cylinders.

b) Using the TenSette Pipet, add 0.1, 0.2, and 0.3 mL of Nitrate Nitrogen, Voluette Ampule Standard Solution, 12 mg/L as NO_3^--N, to the three samples. Mix well.

c) Analyze each sample as described above. The nitrate nitrogen concentration should increase 0.04 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see Standard Additions (Section I) for more information.

Standard Solution Method

Prepare a 0.20-mg/L nitrate nitrogen standard by diluting 2.00 mL of the 10-mg/L Nitrate Nitrogen Standard Solution to 100 mL with deionized water. Or, using the TenSette Pipet, a 0.12-mg/L nitrate nitrogen standard can be prepared by diluting 1.0 mL of a Nitrate Nitrogen Voluette Ampule Standard Solution, 12 mg/L, to 100 mL with deionized water.

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 0.30 mg/L NO_3^-–N concentration samples the standard deviation was ±0.012 mg/L NO_3^-–N.

Testing zero concentration samples, the limit of detection was 0.024 mg/L NO_3^-–N. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

INTERFERENCES

This method registers both the nitrate and nitrite nitrogen present in the sample. If nitrite is present, the nitrite nitrogen test using program number 50.08.1 should be done on the sample. The amount of nitrite nitrogen found should be subtracted from the results of the nitrate nitrogen test when the following pretreatment is used:

a) Add Bromine Water drop-wise to 30-mL of sample until a yellow color persists. Mix after adding each drop.

b) Add one drop of Phenol Solution. Swirl to destroy the yellow color.

c) Continue with Step 4 of the nitrate procedure.

Calcium interferes in amounts over 100 mg/L as $CaCO_3$.

Chlorides in amounts over 100 mg/L cause low results. To determine nitrate in high chloride samples or seawater, a manual calibration must be performed. See section 3.2.4 in the DR/700 instrument manual. Prepare nitrate standard solutions with the approximate chloride concentration of the samples to be tested.

332656

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see Interferences, pH (Section I).

SUMMARY OF METHOD

Cadmium metal reduces nitrates present in the sample to nitrite. The nitrite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt which couples to chromotropic acid to form a pink-colored product.

REQUIRED REAGENTS

Description	Quantity Per Test	Unit	Cat. No.
NitriVer 3 Nitrite Reagent Powder Pillows	1 pillow	100/pkg	21071-69
NitraVer 6 Nitrate Reagent Powder Pillows	1 pillow	50/pkg	14119-66

REQUIRED APPARATUS

Clippers, for opening powder pillows	1	each	968-00
Cylinder, graduated, mixing, 50 mL	1	each	1896-41
DR/700 Filter Module Number 50.01	1	each	46250-00

OPTIONAL REAGENTS

Bromine Water	29 mL*	2211-20
Nitrate Nitrogen Standard Solution, 10 mg/L as NO_3^-–N	500 mL	307-49
Nitrate Nitrogen Standard Solution, Voluette ampule, 12 mg/L as NO_3^-–N, 10 mL	16/pkg	14333-10
NitriVer 3 Nitrite Reagent Powder Pillows	50/pkg	14065-66
Phenol Solution, 30 g/L	29 mL	2112-20
Pretreatment Kit, contains: (1) 2112-20, (1) 2211-20	each	2268-00
Sodium Hydroxide Standard Solution, 5.0 N	59 mL* SCDB	2450-26
Sulfuric Acid, ACS	500 mL*	979-49
Water, deionized	3.78 L	272-17

*Contact Hach for larger sizes.

OPTIONAL APPARATUS

Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Dropper, for 1-oz bottle	each	2258-00
Flask, volumetric, 100 mL	each	547-42
pH Indicator Paper, 1 to 11 pH	5-roll/pkg	391-33
Pipet, serological, 2 mL	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01, TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, Class A, 2.00 mL	each	14515-36
Pipet Filler, safety bulb	each	14651-00
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06

Nitrate at these levels can also be determined directly using the Nitrate Ion Selective Electrode (Cat. No. 44560-71)

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

Method Number 8039

NITRATE, HR (0 to 30.0 mg/L NO_3^-–N)

For water, wastewater and seawater*

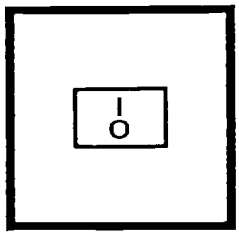
33265.

dmium Reduction Method
wder Pillows or AccuVac Ampuls)

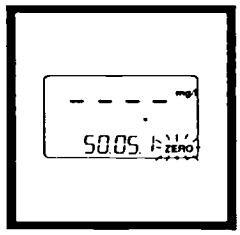
USING POWDER PILLOWS

1. Install module
50.01
in a DR/700.

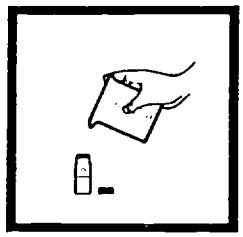
Note: If sample cannot be analyzed immediately, see Sampling and Storage following these steps. Adjust the pH of stored samples before analysis.



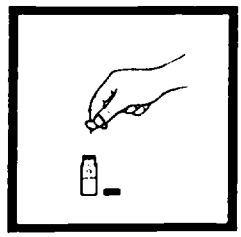
2. Press: I/O
The display will show
500 nm
and module
50.01



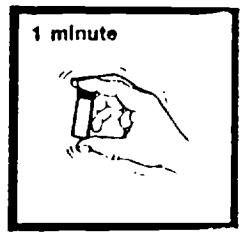
3. After 2 seconds, the display will show a program number, the concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number
50.05.1



4. Fill a 10-mL cell to the 10-mL line with sample.



5. Add the contents of one NitraVer 5 Reagent Powder Pillow to the cell (the prepared sample). Cap.

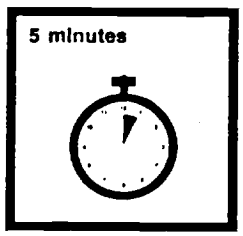


6. Shake the cell vigorously for one minute.

Note: A deposit of unoxidized metal will remain after the NitraVer 5 Nitrate Reagent Powder dissolves. The deposit will not influence test results.

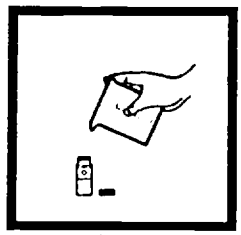
Note: Shaking time and technique influence color development. For most accurate results, make successive tests on a 10 mg/L Nitrate Nitrogen Standard Solution (listed under Optional Reagents). Adjust the shaking time to obtain the correct result.

Note: An amber color will develop if nitrate nitrogen is present.

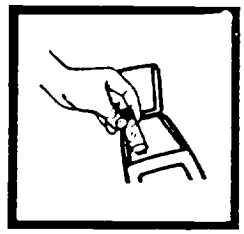


7. Set the cell down and wait 5 minutes.

Note: Do not wait more than 15 minutes before completing Steps 8-12.

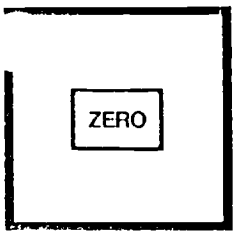


8. Fill a 10-mL cell to the 10-mL line with sample (the blank).

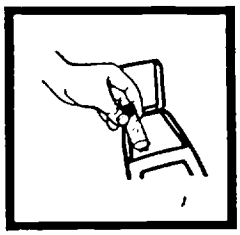


9. Place the blank in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.

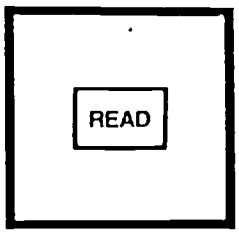


10. Press: ZERO
The display will count down to 0. Then the display will show 0.0 mg/L and the zero prompt will turn off.



11. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



12. Press: READ
The display will count down to 0. Then the display will show the results in mg/L nitrate as nitrogen.

Note: A reagent blank must be determined for each new lot of NitraVer 5. Repeat Steps 4 to 12, using deionized water as the sample. Subtract this value from each result obtained with each lot of reagent.

Note: To convert the results to mg/L nitrate (NO_3^-), multiply by 4.4.

Note: Rinse the sample cell immediately after use to remove all metal particles.

* Seawater, a manual calibration is required; see Interferences.

SAMPLING AND STORAGE

Collect samples in clean plastic or glass bottles. Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods, up to 14 days, adjust sample pH to 2 or less with sulfuric acid, ACS, about 2 mL per liter. Sample refrigeration is still required.

re testing the stored sample, warm to room temperature. Neutralize the sample with 5.0 N Sodium Hydroxide Standard Solution. Do not use mercury compounds as preservatives. Correct test results for volume additions; see Sampling and Storage, Volume Additions, (Section I) for more information.

ACCURACY CHECK

Standard Additions Method

a) Snap the neck off a fresh High Range Nitrate Nitrogen Voluette Ampule Standard, 500 mg/L NO_3^-–N.

b) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL samples. Mix each thoroughly. (For AccuVac ampuls, use 25 mL in 50-mL beakers.)

c) Analyze each sample as described above. The nitrogen concentration should increase 2.0 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see Standard Additions (Section I) for more information.

Standard Solution Method

Use a 10.0 mg/L Nitrate Nitrogen Standard Solution listed under Optional Reagents to check test accuracy. Or, this can be prepared by diluting 1.00 mL of solution from a High Range Nitrate Nitrogen Voluette Ampule Standard Solution, 500 mg/L NO_3^-–N, to 50.0 mL with deionized water.

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 30.0 mg/L NO_3^-–N concentration samples, the standard deviation was ±3.40 mg/L NO_3^-–N.

ing zero concentration samples, the limit of detection was 0.66 mg/L NO_3^-–N. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

Using one representative lot of AccuVacs, the standard deviation was ±2.70 mg/L NO_3^-–N and the limit of detection was 0.64 mg/L NO_3^-–N.

INTERFERENCES

This method registers both the nitrate and nitrite nitrogen present in the sample. If nitrite is present, the nitrite nitrogen test using program number 50.08.1 should be performed on the sample. The amount of nitrite nitrogen found should be subtracted from the results of the nitrate nitrogen test when the following pretreatment is used:

a) Add Bromine Water, 30 g/L, drop-wise to the sample in Step 4 until a yellow color remains.

b) Add one drop of Phenol Solution, 30 g/L, to destroy the color.

c) Proceed with Step 4. Report results as total nitrate and nitrite.

Strong oxidizing and reducing substances will interfere. Ferric iron causes high results and must be absent. Chloride concentrations above 100 mg/L will cause low results. The test may be used at high chloride levels (i.e., seawater), but a calibration must be performed using standards spiked to the same chloride concentration. See Calibrations paragraph 3.2.4 in the DR/700 Instrument Manual for more information.

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see Interferences, pH (Section I).

SUMMARY OF METHOD

inium metal reduces nitrates present in the sample to nitrite. The ite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt. This salt couples to gentisic acid to form an amber-colored product. Nitrate can be determined directly using the Nitrate Ion Selective Electrode (Cat. No. 44560-71).

332658

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No.
NitraVer 5 Nitrate Reagent Powder Pillows, 10 mL size	1	100/pkg	21061-69

REQUIRED APPARATUS (Using Powder Pillows)

Clippers, for opening powder pillows	1	each	968-00
DR/700 Filter Module Number 50.01	1	each	46250-00

OPTIONAL REAGENTS

Bromine Water, 30 g/L	29 mL*	2211-20
Nitrate Nitrogen Standard Solution, 10 mg/L NO_3^--N	500 mL	307-11
Nitrate Nitrogen Standard Solution, Voluette Ampule, 500 mg/L (NO_3^-–N), 10 mL	16/pkg	14260-10
Phenol Solution, 30 g/L	29 mL	2112-20
Sodium Hydroxide Standard Solution, 5.0 N	59 mL*	2450-26
Sulfuric Acid, ACS	500 mL*	979-49
Water, deionized	3.78 L	272-17

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Adapter, AccuVac Vial, DR/700	each	46025-00
Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Dropper, for 1-oz bottle	each	2258-00
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
Pipet, serological, 2 mL	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, 1.0 mL	each	515-35
Pipet Filler, safety bulb	each	14651-00
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

*Contact Hach for larger sizes.

Method Number 8040

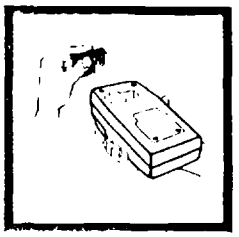
NITRITE, LR (0 to 0.350 mg/L NO_2^--N)

For water, wastewater and seawater

Diazotization Method (Powder Pillows or AccuVac Ampuls), EPA approved for reporting*

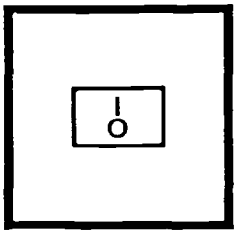
332659

USING POWDER PILLOWS

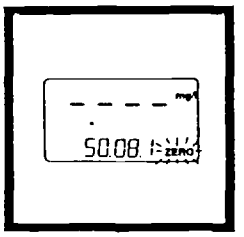


1. Install module number
50.01
in a DR/700

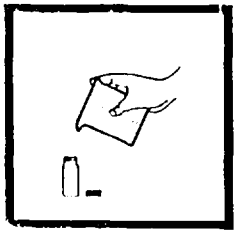
Note: If sample cannot be analyzed immediately, see Sampling and Storage following these steps.



2. Press: I/O
The display will show
500 nm
and module
50.01



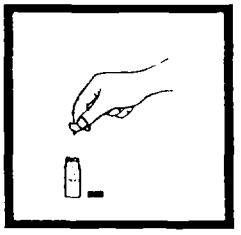
3. After 2 seconds, the display will show a program number, the concentration units, decimal position and the zero prompt. If necessary, press ◇ until the lower display shows program number
50.08.1



4. Fill a 10-mL cell to the 10-mL line with sample.

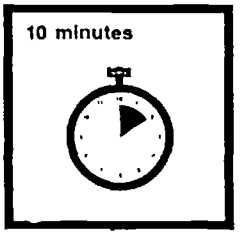
Note: For proof of accuracy, use a 0.10 mg/L nitrite nitrogen standard solution (preparation given in Accuracy Check) in place of the sample.

Note: A 25-mL sample can be tested by using 25-mL sample cells and optional reagents.

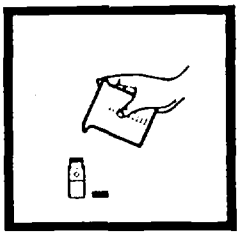


5. Add the contents of one NitriVer 3 Nitrite Reagent Powder Pillow (the prepared sample). Cap and invert to mix.

Note: A pink color will develop if nitrite nitrogen is present.



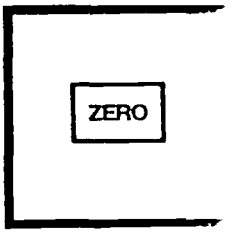
6. Wait 10 minutes.



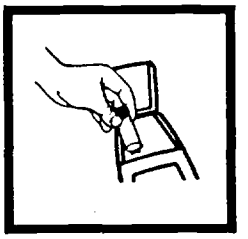
7. Fill a 10-mL cell to the 10-mL line with sample (the blank).

8. Place the blank in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.

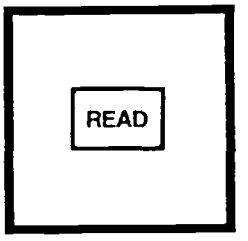


9. Press: ZERO
The display will count down to 0. Then the display will show 0.000 mg/L and the zero prompt will turn off.



10. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



11. Press: READ
The display will count down to 0. Then the display will show the results in mg/L nitrite as nitrogen (NO_2^--N).

Note: To convert the results to mg/L NO_2^-, multiply by 3.3.

*Federal Register, May 1979, 44(85), 25505

SAMPLING AND STORAGE

Collect samples in clean plastic or glass bottles.

Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods, add 4.0 mL of Mercuric Chloride Solution for each liter of sample taken and mix. Sample refrigeration is still required. Do not use acid preservatives.

332600

ACCURACY CHECK

Standard Solution Method

Prepare a nitrite nitrogen standard solution by dissolving 0.493 grams of sodium nitrite, ACS, in 1000 mL of nitrite-free deionized water to give a 100 mg/L nitrite nitrogen (NO_2^--N) standard solution. This solution is not stable and should be prepared daily. Use a TenSette Pipet to dilute 1.0 mL of the stock solution to 1000 mL with nitrite-free deionized water to give a 0.10 mg/L (NO_2^--N) nitrite nitrogen standard solution. Prepare this solution immediately before use.

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 0.091 mg/L NO_2^--N concentration samples the standard deviation was ±0.0010 mg/L NO_2^--N.

Testing zero concentration samples, the limit of detection was 0.0038 mg/L NO_2^--N. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

Using two representative lots of AccuVacs, the standard deviation was ±0.0016 mg/L NO_2^--N and the limit of detection was 0.0089 mg/L NO_2^--N.

INTERFERENCES

Strong oxidizing and reducing substances interfere. Cupric and ferrous ions cause low results. Ferric, mercurous, silver, bismuth, antimonous, lead, auric, chloroplatinate and metavanadate ions interfere by causing precipitation.

Very high levels of nitrate (100 mg/L nitrate as N or more) appear to undergo a slight amount of reduction to nitrite, either spontaneously or during the course of the test. A small amount of nitrite will be found at these levels.

SUMMARY OF METHOD

Nitrite in the sample reacts with sulfanilic acid to form an intermediate diazonium salt. This couples with chromotropic acid to produce a pink colored complex directly proportional to the amount of nitrite present.

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No.
NitriVer 3 Nitrite Reagent Powder Pillows 10 mL size	1	100/pkg	21071

REQUIRED REAGENTS (Using AccuVac Ampuls)

NitriVer 3 Nitrite Reagent AccuVac Ampul	1 ampul	25/pkg	25120

REQUIRED APPARATUS (Using Powder Pillows)

Clippers, for opening powder pillows	1	each	968
DR/700 Filter Module Number 50.01	1	each	46250

REQUIRED APPARATUS (Using AccuVac Ampuls)

Beaker, 50 mL	1	each	500
DR/700 Filter Module 50.01	1	each	46250

OPTIONAL REAGENTS

Mercuric Chloride Solution	100 mL	14994
NitriVer 3 Nitrite Reagent Powder Pillows, 25-mL	50/pkg	14065
Sodium Nitrite, ACS	454 g	2452
Water, deionized	3.78 L	272

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-0
Adapter, AccuVac Vial, DR/700	each	46025-0
Balance, analytical	each	22310-0
Cap for 10- and 25-mL sample cells	12/pkg	24018-1
Flask, volumetric, 1000 mL	each	547-5
Pipet, serological, 10 mL	each	532-3
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-0
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-9
Pipet, volumetric, 1.0 mL	each	515-3
Pipet Filler, safety bulb	each	14651-0
Sample Cell, 10-mL with screw cap	6/pkg	24276-0
Sample Cell, 25-mL with screw cap	6/pkg	24019-0

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

Method Number 8146

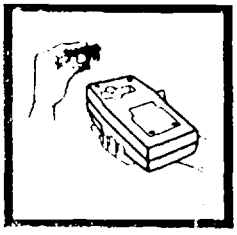
IRON, FERROUS (0 to 5.00 mg/L)

For water, wastewater and seawater

332661

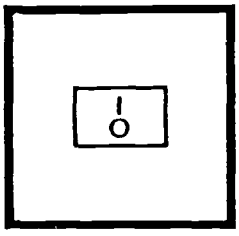
1,10 Phenanthroline Method*
(Powder Pillows or AccuVac Ampuls)

USING POWDER PILLOWS



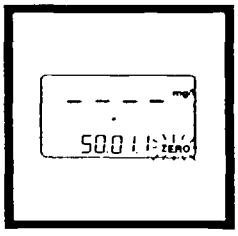
1. Install module **50.01** in a DR/700.

Note: Analyze samples as soon as possible to prevent air oxidation of ferrous iron to ferric iron, which is not measured.

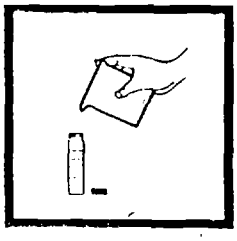


2. Press: I/O

The display will show **500 nm** and module **50.01**

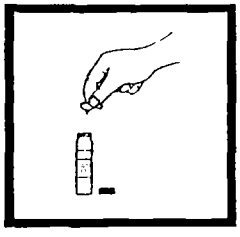


3. After 2 seconds, the display will show a program number, concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number **50.01.1**



4. Fill a 25-mL cell to the 25-mL line with sample.

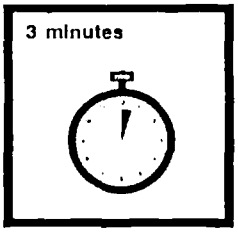
Note: For proof of accuracy, use a 1.00 mg/L ferrous standard solution (preparation given in Accuracy Check) in place of the sample.



5. Add the contents of one Ferrous Iron Reagent Powder Pillow to the sample cell (the prepared sample). Cap and invert to mix.

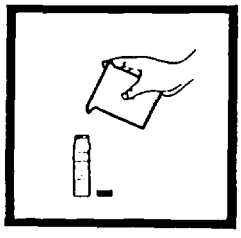
Note: An orange color will develop if ferrous iron is present.

Note: Undissolved powder does not affect accuracy.

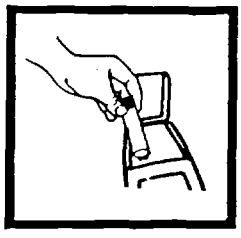


6. Wait 3 minutes.

Note: Steps 7 and 8 can be completed during this reaction period.

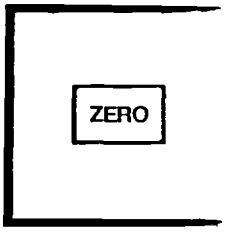


7. Fill a 25-mL cell to the 25-mL line with sample (the blank). Cap.



8. Place the blank in the cell holder.

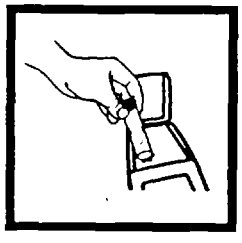
Note: Typical indoor lighting permits the DR/700 to operate with the cell compartment cover open. In bright sunlight, it may be necessary to close the cell compartment cover. Transfer 10 mL of the blank solution to a 10-mL cell. If the 10-mL cell is used for the blank, another 10-mL cell must be used for the sample.



9. Press: ZERO

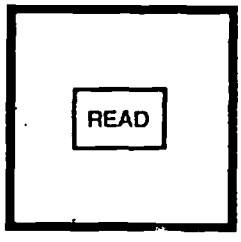
The display will count down to 0. Then the display will show 0.00 mg/L and the zero prompt will turn off

*Adapted from *Standard Methods for the Examination of Water and Wastewater*



10. Place the prepared sample in the cell holder.

Note: Typical indoor lighting permits the DR/700 to operate with the cell compartment cover open. In bright sunlight, it may be necessary to close the cell compartment cover. Transfer 10 mL of the prepared sample to a 10-mL cell. If the 10-mL cell is used for the blank, another 10-mL cell must be used for the sample.



11. Press: READ

The display will count down to 0. Then the display will show the results in mg/L ferrous iron (Fe^{2+}).

ACCURACY CHECK

Standard Solution Method

Prepare a ferrous iron stock solution (100 mg/L Fe^{2+}) by dissolving 0.7022 grams of Ferrous Ammonium Sulfate, hexahydrate, in deionized water. Dilute to 1 liter. Prepare immediately before use. Dilute 1.0 mL of this solution to 100 mL with deionized water to make a 1.0 mg/L standard solution. Prepare this immediately before use.

332662

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 1.50 mg/L Fe^{2+} concentration samples, the standard deviation was ±0.008 mg/L Fe^{2+}.

Testing zero concentration samples, the limit of detection was 0.007 mg/L Fe^{2+}. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, **1980**, *52*, 2242-2249).

Using two representative lots of Ferrous Iron AccuVacs Ampuls, the standard deviation was ±0.012 mg/L Fe^{2+} and the limit of detection was 0.014 mg/L Fe^{2+}.

SUMMARY OF METHOD

The 1,10 phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not interfere. The ferric iron (Fe^{3+}) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test.

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No.
Ferrous Iron Reagent Powder Pillows, 25-mL	1 pillow	100/pkg	1037-69

REQUIRED APPARATUS (Using Powder Pillows)

Nippers, large, for opening pillows	1	each	968-00
DR/700 Filter Module Number 50.01	1	each	46250-00

OPTIONAL REAGENTS

Ferrous Ammonium Sulfate, Hexahydrate, ACS	113 g	11256-1[illegible]
Water, deionized	3.78 L	272-1[illegible]

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-0[illegible]
Adapter, AccuVac Vial, DR/700	each	46025-0[illegible]
Cap for 10- and 25-mL sample cells	12/pkg	24018-1[illegible]
Flask, volumetric, 100 mL	each	547-1[illegible]
Flask, volumetric, 1000 mL	each	547-5[illegible]
Pipet, volumetric, 1 mL	each	515-3[illegible]
Pipet Filler, safety bulb	each	14651-0[illegible]
Sample Cell, 10-mL with screw cap	6/pkg	24276-0[illegible]
Sample Cell, 25-mL with screw cap	6/pkg	24019-0[illegible]

For Technical Assistance, Prices and Ordering

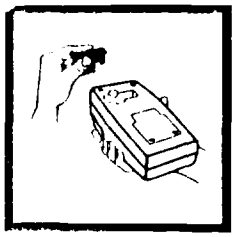
In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

MANGANESE, HR (0 to 20.0 mg/L)

For water and wastewater

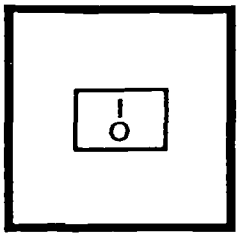
332663

Periodate Oxidation Method*; USEPA approved†—Digestion required; see section 1.



1. Install module **52.01** in a DR/700.

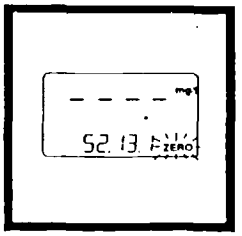
Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps. Adjust the pH of stored samples before analysis.



2. Press: I/O

The display will show **525 nm** and module **52.01**

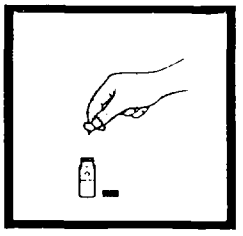
Note: Total manganese determination requires prior digestion; use either the Digesdahl or mild digestion (Section 1).



3. After 2 seconds, the display will show a program number, the concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number **52.13.1**

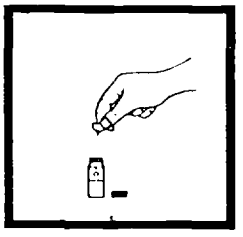
4. Fill a 10-mL cell to the 10-mL line with sample.

Note: A 25 mL sample can be tested by using 25-mL sample cells and optional reagents.



5. Add the contents of one Buffer Powder Pillow, citrate type. Swirl to mix.

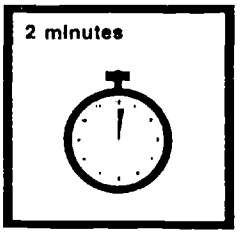
Note: For proof of accuracy, use a 5.0 mg/L manganese standard solution (preparation given in Accuracy Check) in place of the sample.



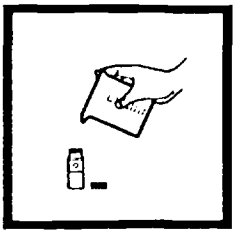
6. Add the contents of one Sodium Periodate Powder Pillow to the sample cell (the prepared sample). Cap and invert several times to mix.

Note: A violet color will develop if manganese is present.

Note: Accuracy is not affected by undissolved powder.



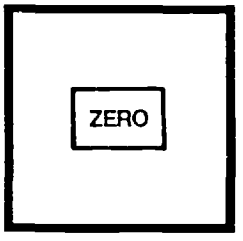
7. Wait 2 minutes.



8. Fill a 10-mL cell to the 10-mL line with sample (the blank). Cap.

9. Place the blank in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.

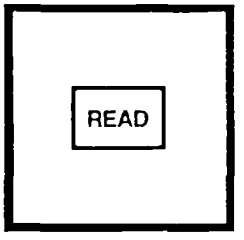


10. Press: **ZERO**

The display will count down to 0. Then the display will show 0.0 mg/L and the zero prompt will turn off.

11. Within 8 minutes after the 2-minute period, place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



12. Press: **READ**

The display will count down to 0. Then the display will show the results in mg/L manganese (Mn).

Note: To convert results to other units, see Table 1.

Table 1. Conversion Factors

To convert from	To	Multiply by
mg/L Mn	mg/L MnO_4^-	2.16
mg/L Mn	mg/L $KMnO_4$	2.88

*Adapted from *Standard Methods for the Examination of Water and Wastewater*
†*Federal Register*, June 14, 1979, *44* (116), 34193

SAMPLING AND STORAGE

Collect samples in acid-washed plastic bottles. Manganese may be lost by adsorption to glass container walls. Adjust the pH to 2 or less with nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature. Adjust the pH to 4 to 5 with 5.0 N and 1.0 N Sodium Hydroxide Standard Solution before analysis. Do not ·ed pH 5, as manganese may be lost as a precipitate. Correct the test it for volume additions; see Sampling and Storage, Volume Additions, (Section I) for more information.

ACCURACY CHECK

Standard Additions Method

a) Snap the neck off a Manganese Voluette Ampule Standard Solution, High Range, 250 mg/L Mn.

b) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL water samples. Mix thoroughly.

c) Analyze each sample as described above. The manganese concentration should increase 1.0 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see Standard Additions (Section I) for more information.

Standard Solution Method

Prepare a 5.00 mg/L manganese standard solution by pipetting 5.00 mL of Manganese Standard Solution, 1000 mg/L Mn, into a 1000-mL volumetric flask. Dilute to the mark with deionized water. Or, prepare this standard by diluting 1.00 mL of the contents of a Voluette Ampule For High Range Manganese to 50 mL, using the TenSette Pipet. Prepare these solutions daily.

INTERFERENCES

The following may interfere when present in concentrations exceeding those listed below:

Calcium	700 mg/L
Chloride	70,000 mg/L
·on	5 mg/L
·esium	100,000 mg/L

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see Interferences, pH (Section I).

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 10.0 mg/L Mn concentration samples, the standard deviation was ±0.11 mg/L Mn.

Testing zero concentration samples, the limit of detection was 0.04 mg/L Mn. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

SUMMARY OF METHOD

Manganese in the sample is oxidized to the purple permanganate state by sodium periodate, after buffering the sample with citrate. The purple color is directly proportional to the manganese concentration.

If only dissolved manganese is to be determined, filter the sample before acid addition.

332664

REQUIRED REAGENTS

Description	Quantity Per Test	Unit	Cat. No.
Buffer Powder Pillows, citrate type for manganese, 10 mL	1 pillow	100/pkg	210[illegible]
Sodium Periodate Powder Pillows for manganese, 10 mL	1 pillow	100/pkg	210[illegible]

REQUIRED APPARATUS

Clippers, for opening powder pillows	1	each	968[illegible]
DR/700 Filter Module Number 52.01	1	each	4625[illegible]

OPTIONAL REAGENTS

Buffer Powder Pillows, Citrate, 25 mL (for manganese)	50/pkg	983-66
Hydrochloric Acid, 6.0 N	500 mL	884-49
Manganese Standard Solution, 1000 mg/L Mn	100 mL*	12791-42
Manganese Standard Solution, Voluette ampule, High Range, 250 mg/L Mn, 10 mL	16/pkg	14258-10
Nitric Acid, ACS	500 mL	152-49
Nitric Acid Solution, 1:1	500 mL	2540-49
Sodium Hydroxide Standard Solution, 1.0 N	100 mL MDB	1045-32
Sodium Hydroxide Standard Solution, 5.0 N	100 mL* MDB	2450-32
Sodium Periodate Powder Pillows for manganese, 25 mL	100/pkg	981-99
Water, deionized	3.78 L	272-[illegible]

OPTIONAL APPARATUS

Ampule Breaker Kit	each	21968-00
Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Dropper, plastic, 0.5 and 1.0 mL marks	each	21247-10
Flask, volumetric, Class A, 50 mL	each	14574-41
Flask, volumetric, Class A, 100 mL	each	14574-42
Flask, volumetric, Class A, 1000 mL	each	14574-53
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, Hach One	each	43800-00
Pipet, serological, 1 mL	each	532-35
Pipet, serological, 5 mL	each	532-37
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, 5.00 mL	each	14515-37
Pipet Filler, safety bulb	each	14651-00
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

Method Number 8051

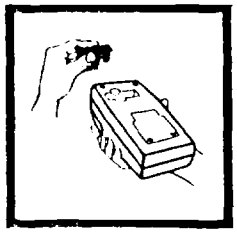
SULFATE (0 to 100 mg/L SO_4^{2-})

For water, wastewater and seawater

332665

SulfaVer 4 Method*‡ (Powder Pillows or AccuVac Ampuls), USEPA approved for reporting**

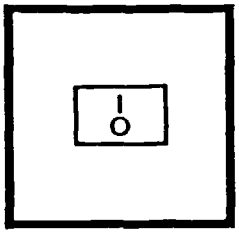
ING POWDER PILLOWS



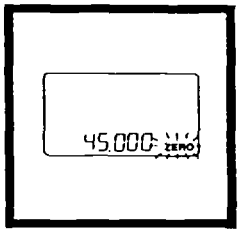
1. Install module
45.01
in a DR/700.

Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps.

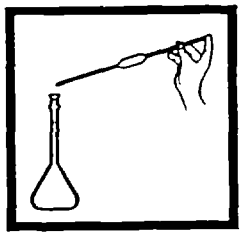
Note: The DR/700 must be calibrated before sample analysis. See Calibration following these steps.



2. Press: I/O
The display will show
450 nm
and module
45.01

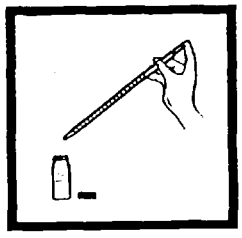


3. After 2 seconds, the display will show a program number, concentration units, decimal position and the zero prompt. Press **PROGRAM** once or twice until the lower display shows program number
45.000
The upper display will show the concentration of a previous calibration standard. If desired, press ◇ to display the other standard.



4. Prepare the displayed standard. For each mg/L displayed, pipet 1.00 mL of 1000 mg/L Sulfate Standard Solution into a 1000-mL volumetric flask. Add deionized water to the mark. Cap and invert 10 times to mix.

Note: For example: to make a 50 mg/L standard, pipet 50.0 mL into the flask. For a zero concentration standard, use only deionized water.



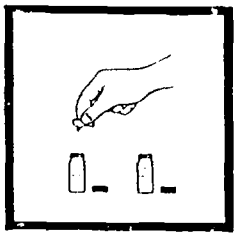
5. Fill a 10-mL cell to the 10-mL line with the displayed standard. Cap.

6. Fill a 10-mL cell to the 10-mL line with sample.

Note: Filter highly coloured or turbid samples. Use labware listed under Optional Apparatus to filter.

Note: A 25-mL sample can be tested by using 25-mL sample cells and optional reagents.

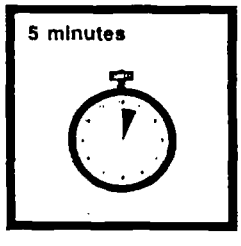
‡User calibration required; range is approximate.
*Adapted from *Standard Methods for the Examination of Water and Wastewater*
**Procedure is equivalent to USEPA method 375.4 for wastewater.



7. Add the contents of one SulfaVer 4 Sulfate Reagent Powder Pillow to each sample cell. Cap and invert several times to mix.

Note: A white turbidity will develop if sulfate is present.

Note: Accuracy is not affected by undissolved powder.



8. Wait 5 minutes.

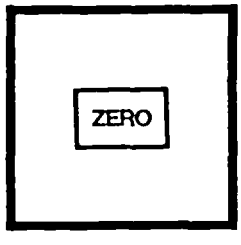
Note: Allow cells to stand undisturbed.

Note: Perform Steps 9-12 within 5 minutes after the 5-minute waiting period.

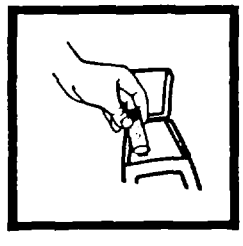
9. Place the prepared standard in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.

Note: If the display is blank, repeat Steps 2 and 3.

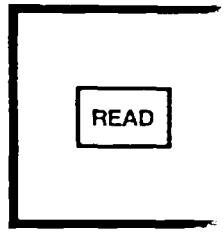


10. Press: **ZERO**
The display will count down to 0. Then the display will show the standard's concentration and the zero prompt will turn off.



11. Place the prepared sample in the cell holder.

Note: In bright sunlight it may be necessary to close the cell compartment cover.



12. Within 5 minutes after the 5-minute period, pre **READ**
The display will cou down to 0. Then the display will show the results in mg/L sulfat (SO_4^{2-}).

Note: Clean the sample c with soap and a brush

SAMPLING AND STORAGE

Collect samples in clean glass or plastic bottles. Samples may be stored up to seven days by cooling to 4 °C (39 °F) or lower. Warm to room temperature before analysis.

332666

ACCURACY CHECK

Standard Additions Method

a) Snap the neck off a Sulfate Voluette Ampule Standard Solution, 2500 mg/L.

b) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of standard to three 25-mL water samples. Mix each thoroughly. (For AccuVac ampuls, use 50-mL beakers.)

c) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see Standard Additions (Section I) for more information.

CALIBRATION

A new calibration is necessary when different manufacturing lots of SulfaVer 4 Powder Pillows or AccuVacs are used. A new calibration is also needed when the water sample to be tested has an expected sulfate concentration which is not between that of the standards last used to calibrate the DR/700 module. Perform a calibration as follows.

Make 2 sulfate standards using the technique described in Step 4 of the test procedure. Make them so one has a slightly lower and the other a slightly higher concentration than that anticipated to be in the water sample. Process each in the same way as the "displayed standard" described in the test procedure.

Next perform paragraph 3.2.4.1, Calibration Using Two Prepared Standards, in the DR/700 instrument manual. Either standard can be used as Standard 1 (S1) or Standard 2 (S2).

INTERFERENCES

Silica and calcium may interfere at levels above 500 mg/L and 20,000 mg/L as $CaCO_3$ respectively.

Chloride and magnesium do not interfere at levels up to at least 40,000 mg/L as Cl and 10,000 mg/L as $CaCO_3$ respectively.

SUMMARY OF METHOD

Sulfate ions in the sample react with barium in SulfaVer 4 Sulfate Reagent and form insoluble barium sulfate turbidity. The amount of turbidity formed is proportional to the sulfate concentration.

REQUIRED REAGENTS (Using Powder Pillows)

Description	Quantity Per Test	Unit	Cat. No
SulfaVer 4 Sulfate Reagent Powder Pillows, 10 mL	2 pillows	100/pkg	21067-69
Sulfate Standard Solution, 1000 mg/L	varies	500 mL	21757-49
Water, deionized	1 L (1000 mL)	3.78 L	272-17

REQUIRED REAGENTS (Using AccuVac Ampuls)

SulfaVer 4 Sulfate AccuVac Ampuls	2 ampuls	25/pkg	25090-25
Sulfate Standard Solution, 1000 mg/L	varies	500 mL	21757-49
Water, deionized	1 L (1000 mL)	3.78 L	272-17

REQUIRED APPARATUS (Using Powder Pillows)

Brush	1	each	690-00
Clippers, for opening powder pillows	1	each	968-00
DR/700 Filter Module Number 45.01	1	each	46245-00
Flask, volumetric, 1000 mL	1	each	14574-53
Pipet Filler, safety bulb	1	each	14651-00

Choose one or more based on Calibration Volume (all Class A):

Pipet, volumetric, 1.00 mL	1	each	14515-35
Pipet, volumetric, 2.00 mL	1	each	14515-36
Pipet, volumetric, 3.00 mL	1	each	14515-03
Pipet, volumetric, 4.00 mL	1	each	14515-04
Pipet, volumetric, 5.00 mL	1	each	14515-37
Pipet, volumetric, 10.00 mL	1	each	14515-38
Pipet, volumetric, 15.00 mL	1	each	14515-39
Pipet, volumetric, 20.00 mL	1	each	14515-20
Pipet, volumetric, 25.00 mL	1	each	14515-40
Pipet, volumetric, 50.00 mL	1	each	14515-41
Pipet, volumetric, 100.00 mL	1	each	14515-42

OPTIONAL REAGENTS

Sulfate Standard Solution, 50 mg/L	500 mL	2578-49
Sulfate Standard Solution, Voluette Ampule, 2500 mg/L, 10 mL	16/pkg	14252-10
SulfaVer 4 Sulfate Reagent Powder Pillows, 25 mL	50/pkg	12065-66

OPTIONAL APPARATUS

Ampule Breaker Kit	each	21968-00
AccuVac Snapper Kit	each	24052-00
Adapter, AccuVac Vial, DR/700	each	46025-00
Beaker, 50 mL	each	500-41
Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Filter Paper, folded, 12.5 cm	100/pkg	1894-57
Funnel, poly, 65 mm	each	1083-67
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06

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In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

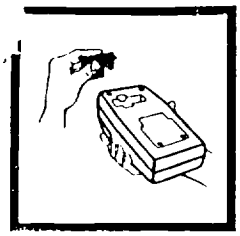
Method Number 8131

SULFIDE (0 to 0.600 mg/L S^{2-})

For water, wastewater and seawater

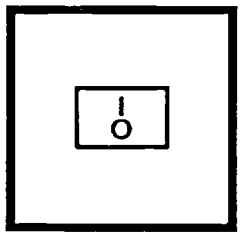
Methylene Blue Method*; USEPA approved for reporting**

332667



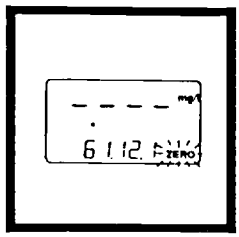
1. Install module **61.01** in a DR/700.

Note: Sample must be analyzed immediately and cannot be preserved for later analysis. Avoid excessive agitation.

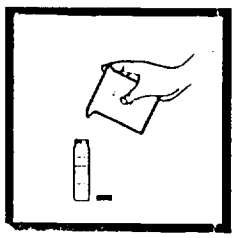


2. Press: I/O

The display will show **610 nm** and module **61.01**

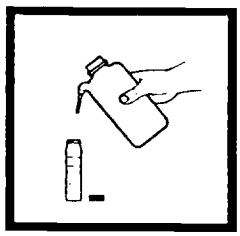


3. After 2 seconds, the display will show a program number, the concentration units, decimal position and the zero prompt. If necessary, press △ until the lower display shows program number **61.12.1**

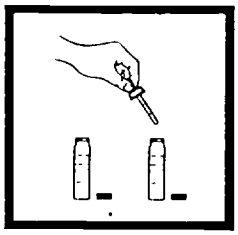


4. Fill a 25-mL sample cell to the 25-mL line with sample (the prepared sample).

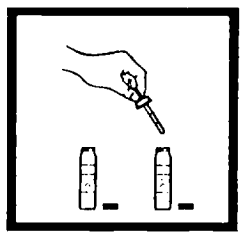
Note: For turbid samples, see Interferences following these steps for pretreatment instructions.



5. Fill another 25-mL cell to the 25-mL line with deionized water (the blank).

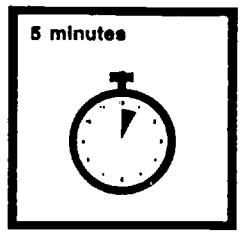


6. Add 1.0 mL of Sulfide 1 Reagent to each cell and cap. Swirl to mix.

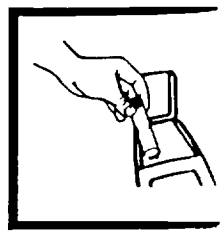


7. Add 1.0 mL of Sulfide 2 Reagent to each cell and cap. Immediately swirl to mix.

Note: A pink color will develop. Then the solution will turn blue if sulfide is present.

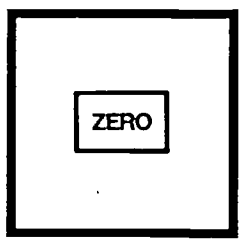


8. Wait 5 minutes.



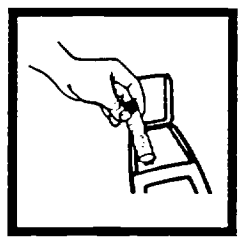
9. Place the blank in the cell holder.

Note: Typical indoor light permits the DR/700 to operate with the cell compartment cover open. In bright sunlight, it may be necessary to close the cell compartment cover. Transfer 10 mL of the blank solution to a 10-mL cell. If the 10-mL cell is used for the blank, another 10-mL cell must be used for the sample.



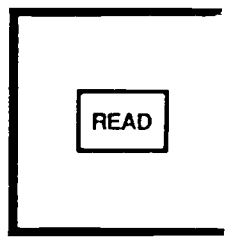
10. Press: **ZERO**

The display will count down to 0. Then the display will show 0.000 mg/L and the zero prompt will turn off.



11. Immediately place the prepared sample in the cell holder.

Note: Typical indoor lighting permits the DR/700 to operate with the cell compartment cover open. In bright sunlight, it may be necessary to close the cell compartment cover. Transfer 10 mL of the prepared sample to a 10-mL cell. If the 10-mL cell is used for the blank, another 10-mL cell must be used for the sample.



12. Press: **READ**

The display will count down to 0. Then the display will show the results in mg/L sulfide (S^{2-}).

*Adapted from *Standard Methods for the Examination of Water and Wastewater*

**Procedure is equivalent to USEPA method 376.2 and Standard Method 4500-S^{2-} for wastewater.

ACCURACY CHECK

Standard Solution Method

Sulfide standard solutions are very unstable and should be prepared from sodium sulfide and standardized as described in *Standard Methods for the Examination of Water and Wastewater*, 16th ed., page 475 or in the 17th ed., page 4-195.

332668

STATISTICAL EVALUATION

A single operator repetitively tested samples of two laboratory prepared solutions, using one DR/700, matched sample cells and two representative lots of testing reagents. Testing 0.595 mg/L S^{2-} concentration samples, the standard deviation was ±0.008 mg/L S^{2-}.

Testing zero concentration samples, the limit of detection was 0.010 mg/L S^{2-}. The limit of detection was calculated as three times the standard deviation when testing zero concentration samples (Adapted from *Analytical Chemistry*, 1980, *52*, 2242-2249).

INTERFERENCES

For turbid samples, a sulfide-free blank should be prepared as follows. Use it in place of deionized water in Step 5.

a) Measure 25 mL of sample into a flask.

b) Add Bromine Water drop-wise until a yellow color remains.

c) Add Phenol Solution dropwise until the yellow color just disappears. Use of this blank solution will compensate for turbidity in the sample.

Strong reducing agents such as sulfite, thiosulfate and hydrosulfite interfere by reducing the blue color or preventing its development. High concentrations of sulfide may inhibit full color development, requiring a dilution of the sample. Some loss of sulfide may occur when the sample is diluted.

SUMMARY OF METHOD

Hydrogen sulfide and acid-soluble metal sulfides react with N,N-dimethyl-p-phenylenediamine oxalate to form methylene blue. The intensity of the blue color is proportional to the sulfide concentration.

High sulfide levels in oil-field waters may be determined after proper dilution.

Determine soluble sulfides by centrifuging the sample in completely filled, capped tubes and analyzing the supernatant. Insoluble sulfides are then estimated by subtracting the soluble sulfide concentration from the total sulfide result.

REQUIRED REAGENTS

	Cat. No.
Sulfide Reagent Set (100 Tests)	22445-00
Includes: (2) 1816-32, (2) 1817-32	

Description	Quantity Per Test	Unit	Cat. No.
Sulfide 1 Reagent	2 mL	118 mL MDB	1816-32
Sulfide 2 Reagent	2 mL	118 mL MDB	1817-32

REQUIRED APPARATUS

DR/700 Filter Module Number 61.01	1	each	46261-00

OPTIONAL REAGENTS

Bromine Water, 30 g/L	29 mL	2211-20
Phenol Solution, 30 g/L	29 mL	2112-20
Sodium Sulfide, ACS	114 g	785-14

OPTIONAL APPARATUS

Cap for 10- and 25-mL sample cells	12/pkg	24018-12
Cylinder, graduated, 25 mL	each	508-40
Dropper, for 1 oz bottle	each	2258-00
Flask, erlenmeyer, 50 mL	each	505-41
Sample Cell, 10-mL with screw cap	6/pkg	24276-06
Sample Cell, 25-mL with screw cap	6/pkg	24019-06
Standard Methods for the Examination of Water and Wastewater	each	22708-00

For Technical Assistance, Prices and Ordering

In the U.S.A.—Call 800-227-4224 toll-free for more information.
Outside the U.S.A.—Contact the Hach office or distributor serving you.

332669

YSI MODEL 50B
Dissolved Oxygen Meter Instructions

YSI Incorporated
Yellow Springs, Ohio 45387 USA
513 767-7241 • 800 765-4974 • Fax 513 767-9353 • Telex 205437

YSI MODEL 50B OPERATING INSTRUCTIONS

IMPORTANT: Before using this instrument, operators should be familiar with the Model 50B manual and with the 5700 Series oxygen probe instructions.

YSI Incorporated
Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387 USA

SETUP

1. Prepare and connect a YSI 5700 Series dissolved oxygen probe. (See probe instruction sheet or instrument manual for more details.)

2. Switch to TEMP °C; observe reading for stability within ± 0.2°C.

3. Replace batteries if **LO BAT** appears on the display.

4. Errors in instrument operation are automatically signaled by the following messages:

E .0	System ROM
E .00	Lost calibration value
E .01	Defective RAM
E .1	Temperature probe
E .2	High background
E .3	Low sensitivity
E .4	High output

CALIBRATION

CALIBRATION TO 100% AIR SATURATION
(Other calibration procedures are described in the CALIBRATION section of your instrument manual.)

1. Place YSI 5700 Series Probe in BOD bottle containing about 1" of water. (Place 5739 probe in calibration bottle with moist sponge or wrap in moist cloth to provide stable humidity.) Wait for temperature equilibration; temperature stability is essential for precise calibration.

2. Set switch to % CAL. To calibrate in mg/L, see instruction manual.

3. Press CAL button once and switch to %. **100.0** (± 0.2) will appear on the display. Observe reading for stability for at least one minute.

MEASUREMENT

TEMPERATURE

1. Place probe in sample.

2. Switch to TEMP °C. Observe reading for stability.

OXYGEN

1. Place calibrated probe in sample and stir.

2. Switch to % and wait until you can ascertain probe equilibration by observing temperature and dissolved oxygen readings that are stable for a full minute. (To read in mg/L, see instruction manual.)

3. For measuring low levels of dissolved oxygen (1.00 mg/L or 10.0% air saturation), refer to "Highest Accuracy Measurements" in the instruction manual. Also, consult the manual for a discussion of salinity compensation.

4. The instrument should normally be left on during the work day to avoid the delay of waiting for probe repolarization.

5. The rightmost DISPLAY SET button can be used to toggle between displaying and suppressing the last digit of the DO reading.

6. Autoread function: Pushing the CAL button causes the instrument to beep when the reading is stable in % and mg/L modes.

CARE AND MAINTENANCE

Replace the membrane every 2 to 4 weeks, depending on application. Probes should be stored in humid environment to prevent drying out.

TABLE I. SOLUBILITY OF OXYGEN IN WATER EXPOSED TO WATER SATURATED AIR AT 760 mm Hg PRESSURE

Temp. °C	Solubility mg/L	Temp. °C	Solubility mg/L	Temp. °C	Solubility mg/L
0	14.62	16	9.87	32	7.31
1	14.22	17	9.67	33	7.18
2	13.83	18	9.47	34	7.07
3	13.46	19	9.28	35	6.95
4	13.11	20	9.09	36	6.84
5	12.77	21	8.92	37	6.73
6	12.45	22	8.74	38	6.62
7	12.14	23	8.58	39	6.52
8	11.84	24	8.42	40	6.41
9	11.56	25	8.26	41	6.31
10	11.29	26	8.11	42	6.21
11	11.03	27	7.97	43	6.12
12	10.78	28	7.83	44	6.02
13	10.54	29	7.69	45	5.93
14	10.31	30	7.56	46	5.84
15	10.08	31	7.43	47	5.74

TABLE II. CALIBRATION VALUES FOR VARIOUS ATMOSPHERIC PRESSURES AND ALTITUDES.

Pressure			Altitude		Calibration
inches Hg	mm Hg	kPa	Ft.	m	Value (%)
30.23	768	102.3	−276	−84	101
29.92	760	101.3	0	0	100
29.61	752	100.3	278	85	99
29.33	745	99.3	558	170	98
29.02	737	98.3	841	256	97
28.74	730	97.3	1126	343	96
28.43	722	96.3	1413	431	95
28.11	714	95.2	1703	519	94
27.83	707	94.2	1995	608	93
27.52	699	93.2	2290	698	92
27.24	692	92.2	2587	789	91
26.93	684	91.2	2887	880	90
26.61	676	90.2	3190	972	89
26.34	669	89.2	3496	1066	88
26.02	661	88.2	3804	1160	87
25.75	654	87.1	4115	1254	86
25.43	646	86.1	4430	1350	85
25.12	638	85.1	4747	1447	84
24.84	631	84.1	5067	1544	83
24.53	623	83.1	5391	1643	82
24.25	616	82.1	5717	1743	81
23.94	608	81.1	6047	1843	80
23.62	600	80.0	6381	1945	79
23.35	593	79.0	6717	2047	78
23.03	585	78.0	7058	2151	77
22.76	578	77.0	7401	2256	76
22.44	570	76.0	7749	2362	75
22.13	562	75.0	8100	2469	74
21.85	555	74.0	8455	2577	73
21.54	547	73.0	8815	2687	72
21.26	540	71.9	9178	2797	71
20.94	532	70.9	9545	2909	70
20.63	524	69.9	9917	3023	69
20.35	517	68.9	10293	3137	68
20.04	509	67.9	10673	3253	67
19.76	502	66.9	11058	3371	66

Item 050046 PN A50046 C
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INITIAL SETUP

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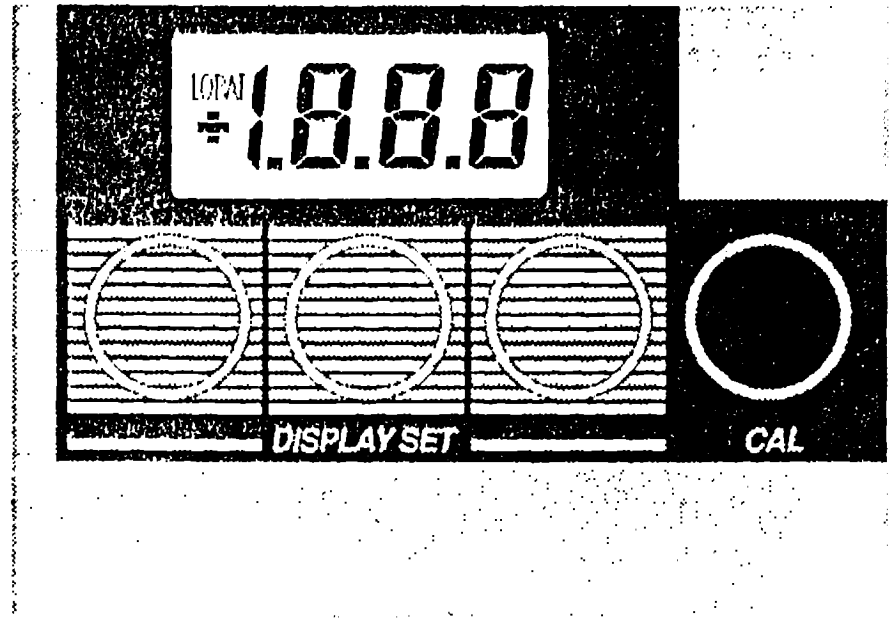
1. Prepare the probe according to the 5700 probe instructions.

2. Connect the probe cable to the meter.

3. Any of the YSI 5700 Series BOD probes may be placed in a BOD bottle containing about 1" of water to provide a 100% relative humidity calibration environment. To calibrate the YSI 5739 probe, place a moist sponge or a wet piece of cloth in the plastic calibration bottle provided with the probe. Slip the bottle over the probe guard up to the body. Place the probe in a protected location where temperature is not changing, or wrap in a cloth or other insulator, and allow 3 to 5 minutes for temperature equilibration.

4. Turn on the instrument by setting the function switch to the ℃ position. An audible tone will sound. This is a signal that the micro-processor's Power On Self Testing (POST) diagnostic mode has been activated. Simultaneously, the display shown below will appear. Check to see that all meter segments are displayed. A second tone will sound in about 7 seconds to signal the end of the POST diagnosis, and the display will blank briefly.



The Model 50B Meter Display and Keyboard.

332672

5. If the POST diagnosis discovers a fault in instrument operation, the display shown in the illustration will not appear, or will "freeze." Should this occur, it is necessary to return the instrument for repair to the dealer or to YSI. See Warranty and Repair.

6. Temperature will be displayed after the second tone. Observe the reading for stability. Temperature equilibration may take up to 5 minutes.

7. Set the function switch to either the **%** or the **mg/L** position and allow 15 minutes for the system to stabilize. If calibration is attempted prematurely, calibration values will drift and may be out of specification.

It is not necessary or desirable to turn the instrument off after each measurement. In normal laboratory use, the meter may be left on in any switch position between measurements, and turned off only at the end of the day. Each startup from **OFF** could require a 5 to 15 minute wait

Calibration is accomplished by exposing the probe to a known oxygen concentration, such as water-saturated air (%), or water of a known oxygen content (mg/L), and then adjusting the calibration controls so the display shows a reading that matches the oxygen concentration of the known sample.

The Model 50B may be calibrated in either air or in water. Both pressure compensated and uncompensated calibration methods are described in the following instructions, which include procedures for Winkler Titration and for calibration in salt water.

Daily calibration is generally appropriate. Calibration can be disturbed by physical shock, touching the membrane, fouling of the membrane or drying out of the electrolyte. Check calibration after each series of measurements, and in time you will develop a realistic schedule for recalibration. When probes are not in use, store them according to the procedures recommended in the probe instruction sheet.

IMPORTANT NOTE: For measurements of the very highest accuracy, particularly when measuring very low oxygen samples, it is desirable to offset the meter zero in order to cancel out any background signals which might influence the reading. This should be done before calibration. For the appropriate procedures, consult Highest Accuracy Measurements, at the end of the OPERATION section.

Calibration in Air

Air calibration is one of the prescribed methods in "Standard Methods for the Examination of Water and Wastewater."

It is quicker and easier to calibrate in air than in water. Experience has shown air calibration to be reliable and accurate, and it is the technique recommended by YSI for the Model 50B.

Calibration in air, for either the % air saturation or the mg/L mode, is quick and simple. Instructions for compensated calibration in air are also given.

Calibration to 100% Air Saturation: 332674

The measurement displayed when the function switch is set to the **%** position is the percent of oxygen saturation in a liquid sample saturated with air under a barometric pressure of 1013 millibars (760 mm or 29.92 inches of mercury). Measurements resulting from calibration by this method should be reported as % air saturation corrected to "standard pressure."

For highest accuracy, calibrate at a temperature as close as possible to the temperature of the sample to be measured. Proceed as follows:

1. Follow **INITIAL SETUP** procedure.

2. Set the function switch to **% CAL.**

3. Press the **CAL** key once. **100.0** will appear on the display.

4. Turn the function switch to **%. CAL** will appear on the display, then one or two audible tones will sound, followed by the display of **100.0** (±0.2). Observe the reading for stability for one minute. Drift in the reading of more than ±0.2 may mean that insufficient time was allowed for instrument stabilization.

This completes Calibration to 100% Air Saturation.

NOTE: If you are calibrating at an altitude or pressure significantly different from "standard," you should adjust the calibration value according to the data in Table B.

EXAMPLE: At 5067 feet, or 631 mm Hg, the calibration value you would enter (see Using The Model 50B Keyboard) instead of 100% would be 83.0%.

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Calibration in Air in mg/L for Fresh Water Measurements:

1. Follow the **INITIAL SETUP** procedures.

2. Set the function switch to **mg/L CAL.**

3. Press the **CAL** key once. The mg/L reading will automatically correspond to the percentage of oxygen in the air sample. This is true for fresh water (zero salinity) only.

5. Turn the function switch to **mg/L.** The display will show **CAL.** In a few seconds one or two audible tones will sound.

Next, the appropriate calibration value in mg/L (±0.02 mg/L) will be displayed. Observe the reading for stability for two or three minutes. Drift in the reading of more than two digits may mean that insufficient time was allowed for instrument stabilization.

This completes Calibration in Air in mg/L for fresh water measurements.

Calibration in Air in mg/L, Correcting for Atmospheric Pressure or Altitude

1. Follow the **INITIAL SETUP** procedures.

2. Set the function switch to **℃.**

3. Read the sample temperature. From the Solubility of Oxygen Chart (Table A), find the mg/L value for zero salinity corresponding to the temperature indicated on the display. This chart appears later in the manual and on the back panel of the instrument.

4. Determine the local altitude or the true atmospheric pressure. (Note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level.) Using the Atmospheric Pressures and Altitudes Chart (Table B), determine the calibration correction for your pressure or altitude.

5. Multiply the value in mg/L found in step 3 by the correction factor determined in step 4.

EXAMPLE USING ALTITUDE: At a temperature of 21°C, the oxygen value at sea level or 760 mm Hg atmospheric pressure is 8.92 mg/L for saturated air (Table A).

At an altitude of 1400 feet, the calibration correction is 95% (Table B).

The correct calibration value is 8.92 mg/L x 95% = 8.47 mg/L.

EXAMPLE USING ATMOSPHERIC PRESSURE: At a temperature of 18°C, the oxygen value at sea level is 9.47 mg/L.

At a pressure of 745 mm Hg, the calibration correction is 98%.

The correct calibration value is 9.47 mg/L x 98% = 9.28 mg/L.

6. Turn the function switch to **mg/L CAL**. Using the keys beneath the digit positions in the display, set the calibration value determined in step 5.

Each separate pressure on a key lowers the displayed digit by one count. Continuous pressure will cause the displayed value to cycle.

7. Turn the function switch to **mg/L**. The display will show **CAL**. In a few seconds one or two audible tones will sound, followed by the display of the calibration value you have set will appear. Observe the reading for stability for two or three minutes. Drift in the reading of more than two digits may mean that insufficient warm-up time was allowed.

This completes the Manual Calibration in Air in mg/L.

Calibration in Water

Calibration in air-saturated water may also be accomplished by both semi-automatic and manual methods. These are described below.

Note that oversaturating or undersaturating the sample will affect calibration accuracy.

Calibration in Air Saturated Water to 100% Air Saturation:

1. Follow the **INITIAL SETUP** procedures.

2. Air-saturate a volume of water by aerating for at least 15 minutes at a constant temperature.

3. Place the probe in the sample and stir.

4. Set the function switch to **% CAL**. Press the CAL key once. **100.0** will appear on the display.

5. Turn the function switch to **%**. The display will show **CAL**. In a few seconds one or two audible tones will sound.

Next, the display will show the calibration value **100.0** (±0.2). Leave the probe in the sample for two minutes to ascertain stability. Repeat steps 4 and 5 if necessary.

This completes Calibration in Air Saturated Water to 100% Air Saturation.

Calibration in Air Saturated Water in mg/L:

1. Follow the **INITIAL SETUP** procedures.

2. Air-saturate a volume of water by aerating for at least 15 minutes at a constant temperature.

3. Place the probe in the sample and stir. Set the function switch to **℃**. From the Solubility of Oxygen Chart (Table A), find the mg/L value for zero salinity corresponding to the temperature indicated.

4. Determine the local altitude or the true atmospheric pressure. (Note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level.) Using the Atmospheric Pressures and Altitudes Chart (Table B), determine the calibration correction for your pressure or altitude.

5. Multiply the value in mg/L found in step 3 by the correction factor determined in step 4.

EXAMPLE: At a temperature of 21℃, the oxygen value at sea level or 760 mm Hg atmospheric pressure is 8.92 mg/L (Table A).

At an altitude of 1400 feet, the calibration correction is 95% (Table B).

The correct calibration value is 8.92 mg/L x 95% = 8.47 mg/L.

EXAMPLE USING ATMOSPHERIC PRESSURE: At a temperature of 18°C, the oxygen value at sea level is 9.47 mg/L.

At a pressure of 745 mm Hg, the calibration correction is 98%.

The correct calibration value is 9.47 mg/L x 98% = 9.28 mg/L.

6. Turn the function switch to **mg/L CAL**. Using the key beneath the digit positions in the display, set the calibration value determined in step 5. Each time you press a key, the displayed digit is lowered by one count. Continuous pressure will cause the displayed value to cycle.

7. Turn the function switch to **mg/L**. The display will show CAL. In a few seconds one or two audible tones will sound.

Next, the calibration value you have set (±0.02 mg/L) will appear. Observe the reading for stability for two to three minutes. Drift in the reading of more than two digits may mean that insufficient warm-up time was allowed.

This completes the Manual Calibration in Air Saturated Water in mg/L.

NOTE: If a calibration value for fresh water in mg/L was set, the value in the % saturation mode will automatically correspond to the mg/L value. However, if a mg/L value was entered for a non-fresh water sample, or a sample that is not 100% saturated, the value in the % saturation mode will neither correspond nor be correct. In other words, when measuring fresh water, you may switch from **mg/L** to **%** and back without recalibrating; when measuring saline water, you may not switch between measurement modes without recalibrating.

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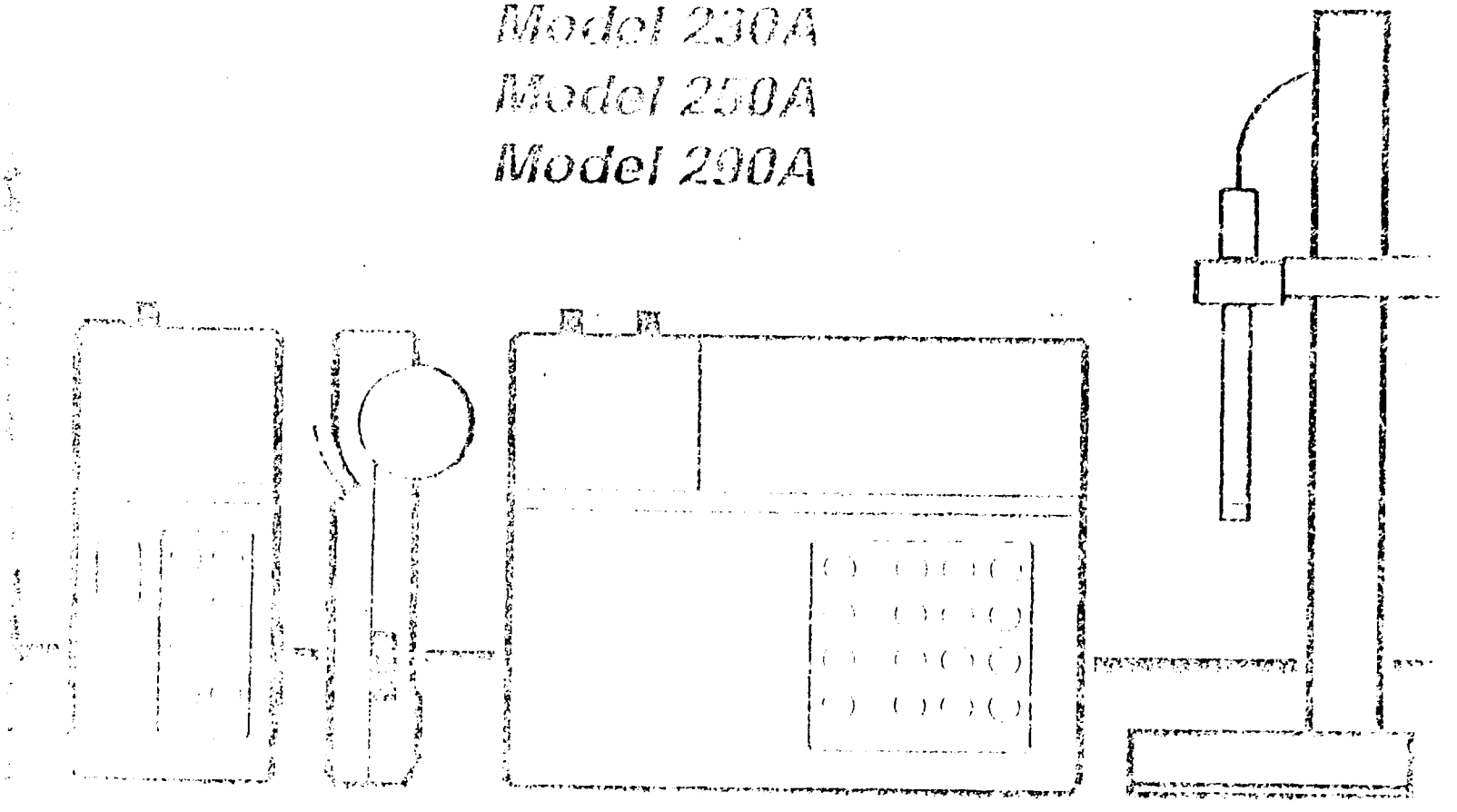
ORION

LABORATORY PRODUCTS GROUP
PORTABLE pH/ISE METERS
INSTRUCTION MANUAL

Model 230A
Model 250A
Model 290A



Power Up and Checkout

332600

1. Attach BNC Shorting Plug (Orion Cat. No. 090045) to BNC connector on top of meter.

2. Press power key to turn meter on.

3. If *battery* indicator remains on replace battery or use line adapter.

4. Press the POWER key to turn meter off.

5. Press the POWER key and *quickly* press the YES key to start the self-test. (Alternatively, press and hold the yes key while pressing the power key). The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the self-test section of the trouble shooting guide, page 47, for a more detailed explanation.

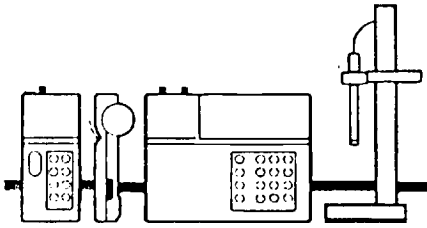
6. After code 7 a "0" will appear on the display. Press each key (the numeric digits will change).

   Note: All keys must be pressed within 10 seconds to complete test 7.

7a. **Model 230A**: After the keypad test the meter will shut off.

7b. **Model 250A or Model 290A**: After the keypad test the meter will turn off then back on again. After completing the self-test the meter will resume normal operations

8. If any problems are found during self-test the meter will display the operator assistance code until acknowledged. Check the trouble-shooting section on page 47.



Chapter VI. Model 290A

Display (Model 290A)

1. **Operating Mode** — Indicates instrument operating mode.

   SETUP — *Indicates meter is in setup mode. Used to define operating parameters.*

   CALIBRATE — *Indicates meter is in calibration mode. Accessed by pressing **2nd cal**.*

   MEASURE — *Indicates meter is in measurement mode. Accessed by pressing the **measure** key.*

2. **Main Field** — Displays pH, millivolts, relative millivolts or concentration depending on the meter measurement mode.

3. **ON/OFF** — During SETUP on/off indicates if a particular feature is active or not.

4. **Lower Field** — Displays temperature in degrees Celsius. The °C designation is displayed when temperature is displayed.

5. **ATC** — Displayed when a temperature probe is attached.

6. **2nd** — Displayed when the 2nd key has been pressed, indicating the meter is ready to perform a secondary function.

7. **READY** — Displayed when the electrode is stable. READY may be turned on or off in the SETUP menu.

8. **HOLD** — Displayed when the reading is frozen after reaching stability. The HOLD feature may be turned on or off in the SETUP menu.

9. **TIMER** — Displayed when the timer function has been activated.

10. **BAT.** — Displayed when the battery is low and needs to be replaced.

11. **Mode Indicator** — Designates instrument operating mode either pH, millivolts (mV), Relative millivolts (Rel mV), or Concentration (conc).

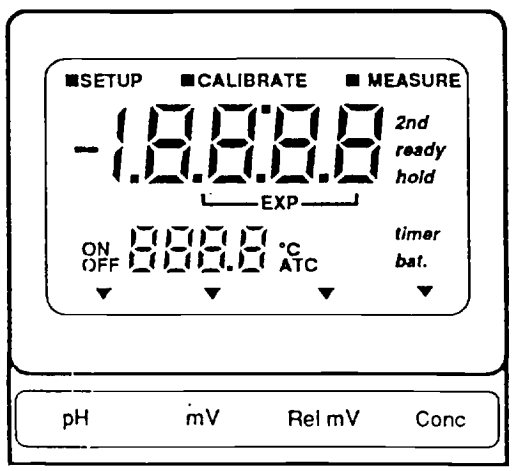


Figure 12

Keypad

(See Figure 13)

Primary Functions

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel to change to a parameter before entering.

measure Press for sample analysis. Instrument will remain in measure mode until another key is pressed. Press to unlock hold during sample analysis.

mode Press to change operating modes. The options are pH, mV, REL mV, or Concentration.

2nd Press to access second functions, cal, timer, setup, or print.

Λ Press to increase value.

V Press to decrease value.

power Press to turn meter on or off.

Second Functions

All second functions are accessed by first pressing the 2nd key.

cal Press to start calibration.

timer Press to start the timer. When the preset time has elapsed, the instrument will beep for 1 minute (or until a key is pressed).

setup Press to access the setup menu. This is used for setting instrument operating parameters.

print Press to print current display data and/or to enter data into the internal datalogger. Selection of either option or both can be made in the setup menu. At the end of each calibration all data is printed automatically. (Pressing print during calibration will cause data from the previous cal to be printed until the calibration sequence is completed.)

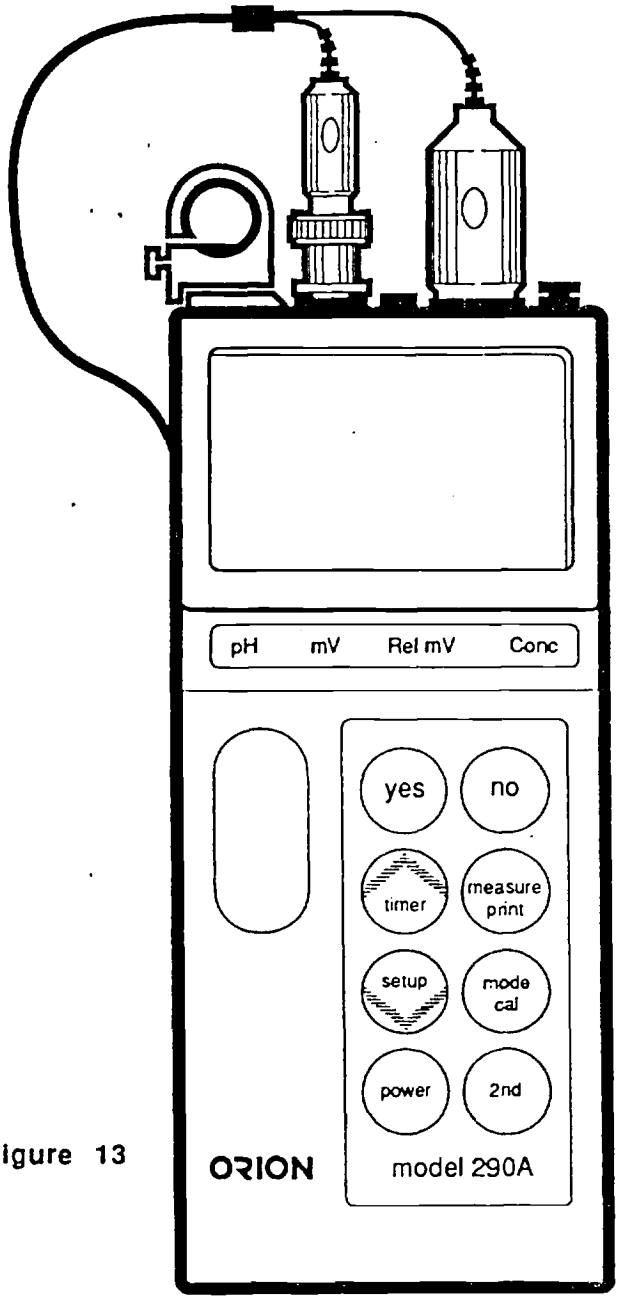


Figure 13

Checkout Procedure

1. Perform the self-test as described on page 10.

   Note: To change a value press one of the ^ v keys. The first digit will flash, continue scrolling until the first digit equals the correct value then press ***yes****. The second digit will flash. Scroll to the correct value then press* ***yes****. When all digits have been changed press* ***yes*** *to enter the new value.*

   Note: If this is the first time this proceedure has been performed the reading should be 6.997 ± .02

2. After completing the self check the meter will be in MEASURE mode. The legend MEASURE will be displayed.
   - **a.** Press the mode key until the pH mode indicator is displayed. Main display should read a steady 7.00 ±0.02.
   - **b.** If not, press **2nd cal**. The display will flash 7.00, press **yes**.
   - **c.** Press **measure** the main display should read 100.0 with the legend SLP in the lower display. If so press **yes**.
   - **d.** If not scroll until the display reads 100.0 then press **yes**. The meter advances to MEASURE and the display should now read a steady 7.00.

3. Press the **mode** key to enter millivolt mode. Display should read 0.0 ±.01.

4. Press mode key to enter REL mV mode. Display should read 0.0 ±.01. If not press **2nd cal** then press **yes** to enter the value 0.00. The meter will return to measure mode.

5. Press the mode key until the concentration mode indicator is displayed. Display should read 1.00.

   Note: If this is the first time this proceedure has been performed the reading should be 0.996.

   - **a.** If not press **2nd cal** At the P1 prompt press **yes** to enter 1.00.
   - **b.** Press **measure.** SLP and 59.2 should be displayed. If so, press **yes**.
   - **c.** If not enter 59.2. Meter automatically returns to measure mode and display should read a steady 1.00.

6. After successfully completing steps 1 through 5 the meter is ready for use with electrodes. Remove the shorting plug.

SETUP Menu (Model 290A) 332653

The setup menu is used to identify and change instrument operating parameters. While in setup the **yes** key is used to scroll through the menu without changing any parameters.

To enter the setup menu press **2nd** then **setup**. 1-1 and READY will be displayed. The on or off indicator flashes indicating the current status. Press **yes** to accept and continue through the menu. Press a scroll key, ^ v, to change. After changing a setting press **yes** to enter. Pressing **no** reverts the parameter to its former state (if done before entering the new setting).

To change a numeric value press the ^ or v key, the first digit will start flashing, scroll until the first digit is the desired value then press **yes**. The second digit will flash, scroll until the desired value is displayed then press **yes**. Continue in this manner until all digits have been changed then press **yes** to enter the new value.

Scroll through the SETUP menu accepting or changing parameters as desired.

To exit the SETUP menu press **2nd cal** to begin the calibration sequence or **measure** to analyze samples.

The following parameters are accessed in the setup menu.

1-1	**READY**	Turning READY on will cause the ready indicator to be displayed when the electrode signal is stable. The default setting is on.
1-2	**HOLD**	Turning HOLD on will cause the display to freeze during sample measurements when the electrode signal is stable. The default setting is off. Press the measure key to unlock HOLD during analysis
1-3	**BEEP**	Turning BEEP on will cause an audible signal to sound on ready, when a key is pressed, and when an operator assistance code occurs. The default setting is on.

1-4	**AUTO-SHUTOFF**	Turning AUTO-SHUTOFF on will cause the meter to turn off if no keys have been pressed for 10 minutes. This feature will save battery life. The default setting is on.
2-1	**SLOPE**	Allows review of electrode slope in memory at any time. Value cannot be changed in the setup menu.
2-2	**RESOLUTION**	Allows selection of resolution. For pH choose from 0.1 to 0.01 to 0.001. Press the scroll key to change the resolution then press **yes** to enter and continue through the menu. In Concentration mode, select 1,2 or 3 significant digits. Example: pressing the scroll key changes the concentration value from 19900 → 19000 → 1000 → 19900. Select the number of digits desired then press **yes** to enter. The default setting is .001 for pH and 3 digits for concentration.
2-3	**ISO-POTENTIAL POINT**	Use to change the iso - potential point for a particular pH electrode. In pH mode the default value is 7.000. The isopotential point may not be changed in any other mode.
2-4	**RESET**	Allows all the setup options and calibration data to be set to factory default values. This is particularly useful during troubleshooting or prior to calibrating with a new electrode. To RESET press a scroll key, the ON will flash and the audio signal will ring rapidly. Press **yes** to reset.

Note: Setup function 2-3 Isopotential Point is only accessible in pH mode. SETUP Functions 2-1 Slope and 2-2 Resolution are only accessible in pH and concentration modes.

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3-1	**TIMER INTERVAL**	Used to set the timer interval. The maximum interval that can be set is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the TIMER INTERVAL code, (3-1), is displayed the current interval hours setting will be displayed in the main field. Press **yes** to accept or scroll to change then press **yes**. Next the current interval minutes:seconds will be displayed. Press **yes** to accept current setting or scroll to desired value then press **yes** to enter. The default setting is five (5) seconds.
3-2	**REMAINING TIME**	Shows time remaining before timer is set to ring.
3-3	**SET REAL TIME**	Used to set the time of day. The meter uses a 24 hour clock. When the code 3-3 is displayed in the lower field the current time (hours:minutes) will be displayed in the main field. If correct press **yes** to accept otherwise change as required and press yes to enter.
3-4	**SET DATE**	Used to set the current date. When the code 3-4 is displayed in the lower field the current date (month:day) is displayed in the main field. Press **yes** to accept or change the date as needed then press **yes** to enter the new date.
4-H	**HIGH ALARM LIMIT**	Used to set the high alarm limit for the current measurement mode. When the reading exceeds the set limit the alarm will ring. The maximum limits are 19.999 for pH, 19900 for concentration, +1600.0 mV, and +1999.9 relative millivolts. To change the current setting use the scroll keys then press **yes** to enter.

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4-L	**LOW ALARM LIMIT**	Used to set the low alarm limit for the current measurement mode. When the reading falls below the set limit the alarm will ring. The minimum limits are -2.000 pH, 0.0 for Concentration, -1600.0 mV, and -1999.9 for relative millivolts. To change the low limit use the scroll keys then press **yes** to enter.
5-1	**PRINT MODE**	Sets the print mode. When 5-1 is displayed in the lower field the current print mode will flash in the main field. The options are: **1.**Manual Print, indicates no automatic output to the printer and the user may print on command by pressing **2nd print**; **2.**Print on READY, the meter will send information to the printer whenever the electrode signal is stable; **3.**Print on a timed interval, printing occurs at user selected timed intervals. Use the scroll keys to change the setting then press **yes** to enter the new setting. The default setting is 1 PRINT on command.
5-2	**SET PRINT INTERVAL**	Used to set the timed print interval. The maximum print interval is 23 hours, 59 minutes, and 59 seconds. The minimum print interval is five (5) seconds. When the code 5-2 is displayed in the lower field the current print interval hours will flash in the main display indicated by an H in the leftmost position. Press **yes** to accept or change using the scroll keys then press **yes** to enter. Next the print interval minutes:seconds will be displayed in the main field. Press **yes** to accept or change then press **yes** to enter the new setting. The default setting is (1) one minute.
6-1	**DATA-LOGGER MODE**	Sets the datalogger mode. Up to 25 points may be stored in memory at any one time. The four options are: **0**-Off, when 0 is selected no datalogging of any kind will take place. **1**-Manual datalog, no automatic output to the datalogger will occur, the user presses the **2nd print** key to log data;. **2**-Datalog on ready, data-logging occurs when the electrode signal is stable (on ready); **3**-Timed datalog, data-logging occurs at a preset timed interval. When the code 6-1 is displayed in the lower field the current datalogger mode will flash in the main display. Use the scroll keys to change then press YES to enter the new choice. The default setting is 0; OFF.

6-2	**DATALOG INTERVAL**	Sets the timed datalogger interval. The maximum interval is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the code 6-2 is displayed in the lower field the current datalogger interval hours are displayed in the main field indicated by an H in the left position. Use the scroll keys to change the setting then press **yes** to enter. Next the current datalogger interval minutes:seconds will be displayed in the main field. Use the scroll keys to change the setting, then press **yes** to enter. The default setting is (5) seconds.
6-3	**TRANSFER DATA**	Use this setting to transfer data from the datalogger to a printer or a computer. When the code 6-3 is displayed the OFF will flash, to transfer the data press a scroll key until ON is displayed. Then press YES. Once the data has been transferred the meter advances to the next setup option.

Note: Down loading the data does not clear the memory. To clear memory see step 6-4 below.

6-4	**CLEAR DATA**	This function clears all data from the datalogger memory. When the code 6-4 is displayed the OFF will flash. To clear the data press a scroll key until ON is displayed. The alarm will ring rapidly to indicate the memory is about to be erased. Press **yes** to clear.

Calibration and Measurement Procedures (Model 290A)

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pH Measurements

The model 290A can perform up to a five (5) point pH calibration. Either autocalibration, manual calibration, or a combination of the two may be used.

A one, two, or multi-point calibration should be performed using fresh buffers before pH is measured. It is recommended that a minimum of a two point calibration using buffers that bracket the expected sample range be performed at the beginning of each day to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in memory Perform a one buffer calibration every two hours to compensate for electrode drift. Use a fresh aliquot of one of the calibration buffers.

Note: If a three or more point calibration is being used recalibrate using all buffers.

Prior to calibration scroll through the setup menu and ensure all parameters are set properly for the analysis you want to perform. Select the resolution desired and verify the isopotential point is set correctly for the electrode.

There are two ways of calibrating the 290A Meter, autocalibration or manual calibration. Following are descriptions and instructions for each method.

Autocalibration

Autocalibration is a feature of the Model 290A Meter that automatically recognizes five buffers 1.68, 4.01, 7.00, 10.01, and 12.46 within a range of ±0.5 pH units. During calibration the user waits for a stable pH reading. Once the electrode is stable the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing **yes** enters the value in memory.

Note: Do not scroll when using autocalibration.

The 290A Meter compares actual values to theoretical values to determine if the buffer is within range. Results greater than ± 0.5 pH units from the correct value will trigger an operator assistance code. For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and buffers should be at the same temperature or use manual temperature compensation.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.45 use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are scrolled in. To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit. When the correct buffer value is displayed press **yes** to enter.

Note: For manual calibration you must use the scroll keys otherwise the meter assumes you are performing an autocalibration. Even if the buffer value is correct you must press a scroll key to start the editing process. Then press yes to accept each digit.

For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and standards should be at the same temperature or use manual temperature compensation. See page 43.

Multipoint pH Calibration

Up to a five (5) point multipoint calibration can be performed on the 290A. Both autocalibration and manual calibration may be used within the same calibration curve. For example autocalibration may be used with the 1.68, 7.00, and 10.01 buffers while manual calibration would be used with 3.78 and 9.18 buffers.

The instrument uses a point to point calibration scheme, i.e. the meter stores in memory the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve the electrode slope for that region is employed in the calculation of sample pH. The electrode slope displayed after calibration is an average slope for all the segments of the entire calibration curve. Use of this scheme increases accuracy in the different regions of the calibration curve. However, the electrode slope may be lower than normal, especially if buffers from the pH extremes ≤2.00 or ≥12.00 are used.

It is recommended that automatic temperature compensation be used. If not, all buffers and samples should be at the same temperature or use manual temperature compensation. See temperature compensation section, page 43.

Calibration With 2 or More Buffers

Prior to calibration set the resolution to the desired level, check the isopotential point, and change any parameters in the setup menu.

1. Select and prepare the buffers to be used. A maximum of five buffers may be used.

2. Press the **mode** key until the pH mode indicator is displayed.

3. Place electrodes into the first buffer.

4. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field indicating the meter is ready for the first buffer.

5. Wait for a stable pH reading.

   If using autocalibration press **yes**. If not manually enter the value using the scroll keys then press **yes**. To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit. When the correct buffer value is displayed press **yes** to enter.

   The P2 prompt is then displayed for the second buffer.

6. Rinse electrodes and place into second buffer. Wait for a stable reading and enter the correct buffer value then press **yes**. The P3 prompt for the third buffer will be displayed.

7. Continue in this manner until all buffers have been entered. If using less than five buffers press **measure** once all the buffers you are using have been entered. The electrode slope will then be displayed with the prompt SLP in the lower field. If using five buffers the meter automatically advances to MEASURE once the buffers have been entered.

8. Rinse electrodes and place into sample. Record pH and temperature directly from the meter display.

One Buffer Calibration

1. Connect electrode(s) to meter. Choose a buffer which most closely approximates the expected sample pH. Place electrode(s) into buffer.

2. Press the **mode** key until the pH mode indicator is displayed

3. Place electrodes in the buffer.

4. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field.

5. Wait for a stable pH display (display will flash).

   If using autocalibration press **yes**. If not manually enter the value using the scroll keys. To enter a value press the ^ or v key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit.

6. The P2 prompt will be displayed in the lower field. Press **measure**.

7. The slope prompt, SLP, will now be displayed in the lower field and the electrode slope will be displayed in the main field. Press **yes** to enter the current electrode slope or scroll in a new value then press **yes**.

   The meter automatically advances to measure mode.

8. Rinse electrode(s) and place into sample. Read sample pH directly from the meter display. Sample temperature is displayed in the lower field.

Concentration Measurements

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A one, two, or multi-point calibration should be performed before concentration is measured. It is recommended that a two point standard calibration be performed at the beginning of each day and every time electrodes are changed to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in memory. Perform a calibration with one standard every two hours to compensate for possible electrode drift. Use a fresh aliquot of one of the standards used for calibration.

Note: When calibrating with 3 or more standards, repeat the calibration using fresh aliquots of all standards.

During calibration always use the most dilute standard first. The 290A will automatically recognize slope direction (i.e. will recognize anion or cation electrodes).

Up to a five point calibration may be performed on the 290A. The instrument uses a point to point calibration scheme, i.e. the meter stores in memory the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve the electrode slope for that region is employed in the calculation of sample concentration. The electrode slope displayed after calibration is the average slope for all the segments of the entire calibration curve. Use of this scheme increases accuracy in the different regions of the calibration curve however the electrode slope may be lower than normal, especially if standards close to the electrode limit of detection are used in the calibration.

Blank correction occurs automatically when three or more standards are used. This feature automatically calculates and corrects for background levels of the species of interest. The standards used for calibration do not need to include a blank. This improves results as typical blanks contain low levels of the species to be measured and hence are unstable and difficult to measure accurately. To take advantage of this feature select 3 or more standards for calibration. If the profile of the calibration curve does not indicate a background level of ion concentration then blank correction will not be invoked and the standard point to point scheme will be used.

During calibration to enter a new concentration value you must use the scroll keys. Each digit is edited in turn (similar to a multifunction watch with LCD display). First set the decimal point, then edit each digit of the display. Keep in mind that there are 4.5 digits and a polarity sign.

Any convenient units of concentration units can be used, for example: molarity, ppm, % etc.

All standards and samples should be at the same temperature. In concentration mode the temperature probe is used for temperature measurements only and does not provide temperature corrected concentration measurements.

Prior to calibration set the number of significant digits required in the setup menu. Check the other parameters and verify each is set appropriately for your measurement procedures.

Calibration with Two or More Standards

1. See electrode instruction manual for electrode preparation, required solutions and any special requirements.

2. Prepare the standards. The standards should bracket the expected sample range and be in the same concentration units.

3. Add ionic strength adjustor, or pH adjustor, as recommended in the electrode instruction manual.

4. Connect electrode(s) to the meter. Press the **mode** key until the CONC mode indicator is displayed.

5. Place electrodes into the least concentrated standard.

6. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed indicating the meter is ready for the first standard.

7. When the reading is stable use the scroll keys to enter the value of the standard. To enter a value, press the Λ or V key. The value will flash. Press the key again and the decimal point will flash. Position the decimal then press yes. The first digit will flash. Scroll to the desired value then press yes. Continue for each digit on the display. There are 4 1/2 digits plus a polarity sign and decimal point. The display will freeze for three seconds then P2 will be displayed in the lower field.

8. Rinse electrodes and place into second standard. When the reading is stable enter the value of the standard. The reading will freeze for three seconds then P3 will be displayed in the lower field indicating the meter is ready for the third standard.

9. If using only two standards press **measure**. The electrode slope will be displayed for a few seconds then the meter will advance to MEASURE mode.

   If more than two standards are to be used continue entering standards as described above. When all standards have been entered press **measure**. The meter displays the electrode slope for three seconds then advances to MEASURE. After five standards have been entered the meter automatically displays slope then advances to MEASURE.

10. Rinse electrodes and place into sample. Wait for a stable reading, then record concentration directly from the main meter display. Temperature is displayed in the lower field.

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Calibration with One Standard

1. See electrode instruction manual for electrode preparation, required solutions and any special requirements.

2. Prepare a standard which best approximates the expected sample concentration.

3. Add ionic strength adjustor, or pH adjustor, as recommended in the electrode instruction manual.

4. Connect electrode(s) to the meter and press the **mode** key until the CONC mode indicator is displayed.

5. Place electrodes into the standard.

6. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field indicating the meter is ready for the standard.

7. Wait for a stable reading. Enter the value of the standard. The display will freeze for a few seconds then P2 will be displayed in the lower field.

8. Press **measure**. The electrode slope in memory will now be displayed in the main field and SLP will be displayed in the lower field. If correct press **yes** to enter and advance to measure otherwise enter the correct electrode slope.

9. Rinse electrode(s) and place into sample. Record sample concentration from the main meter display and temperature from the lower display.

Millivolt Measurements

The Model 290A Meter can be used to measure absolute or relative millivolts. The millivolt modes are useful for potentiometric titrations and preparing calibration curves. Detailed instructions for any ORION electrode are given in the electrode instruction manual. Titration instructions are included in the ORION Redox Electrode (Model 96-78 or 97-78) Instruction Manual, or in standard analytical chemistry texts.

Absolute Millivolts

Absolute millivolts are displayed with 0.1 mV resolution in the range of -1600.0 to +1600.0.

Access the absolute millivolt mode by pressing the **mode** key until the mV mode indicator is displayed.

Relative Millivolts

Relative millivolts are displayed to 0.1 mV resolution over the range of -1999.9 to +1999.9 (Absolute millivolt range of ±1600.0 mV).

1. Select the relative millivolt mode by pressing the **mode** Key until the Rel mV mode indicator is displayed.

2. Set the relative millivolt offset by pressing **2nd cal**. CALIBRATE will be displayed and the current absolute millivolts will be displayed in the main field.

3. When the reading is stable 0.0 will flash. If this is correct press **yes**. Otherwise use the scroll keys to set the desired mV value for the solution. Press **yes** to enter. The meter automatically returns to MEASURE and all Relative millivolt measurements will be based on the offset.

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