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ANNUAL REPORT FOR THE

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GROUNDWATER PLUME TREATMENT SYSTEMS

January through December 2001

MARCH 27, 2002

1/39

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TABLES

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ACRONYM LIST

CAD/ROD	Corrective Action Decision/ Record of Decision
CDPHE	Colorado Department of Public Health and the Environment
CWTF	Consolidated Water Treatment Facility
DOE	Department of Energy
EPA	Environmental Protection Agency
FY	Fiscal Year
GAC	Granular Activated Carbon
gpm	gallons per minute
HRC™	Hydrogen Release Compound™
ITS	Interceptor Trench System
mg/l	milligrams per liter
MIPs	Material Insertion Points
OU	Operable Unit
pCi/l	picoCuries per liter
pCi/µg	picoCuries per microgram
PU&D	Property Utilization and Disposal
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RMRS	Rocky Mountain Remediation Services
SAP	Sampling and Analysis Plan
SCFA	DOE Subsurface Contaminant Focus Area
SITE	Superfund Innovative Technology Evaluation
SVOCs	Semi-volatile Organic Compounds
µg/l	Micrograms per liter
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This report describes calendar year 2001 activities and performance monitoring data for five groundwater collection and treatment systems and a treatability study at the Rocky Flats Environmental Technology Site (RFETS) Table 1 summarizes these six projects and the groundwater treatment processes employed

Table 1. Groundwater Treatment Projects at RFETS

Project	Contaminant Type	Treatment Process
Mound Site Plume Treatment System	Volatile Organic Compounds, Radionuclides	Passive collection trench with submerged zero-valent iron treatment cells
East Trenches Plume Treatment System	Volatile Organic Compounds	Passive collection trench with submerged zero-valent iron treatment cells
Solar Ponds Plume Treatment System	Nitrates, Uranium	Passive collection trench with submerged bio-reactors containing wood chips and zero-valent iron
Operable Unit 1, 881 Hillside Groundwater Treatment System	Volatile Organic Compounds, Radionuclides	Collection well with ultraviolet light / hydrogen peroxide treatment followed by an ion exchange process*
OU 7 – Present Landfill Seep Collection And Leachate Treatment System	Volatile Organic Compounds	Passive seep interception system with passive aeration treatment
Property Utilization and Disposal (PU&D) Yard Plume Treatability Study	Volatile Organic Compounds	In situ bioremediation using a polylactate ester

* The modified treatment system can now treat a variety of components. The process units listed represent those components from the original treatment system that were designed to treat this contaminant stream.

This report provides information on the performance of each of these projects from January 2001 through December 2001. The primary purpose of these groundwater projects is to prevent contaminants in the groundwater from entering surface water and affecting downstream receptors The passive barrier treatment systems are designed to intercept the distal end of a groundwater plume prior to it reaching the surface or, in the case of the Operable Unit (OU) 7 system, at the point where it does reach the surface. These systems are effective in low-flow, low-permeability regimes. With the exception of the Operable Unit 1 treatment system, all of these treatment/collection systems are essentially passive, low-maintenance/low-profile systems that are designed for long-term treatment

The Property Utilization and Disposal (PU&D) treatability study differs from the groundwater treatment systems, as it is an in-situ process that treats the source area of the plume rather than capturing a plume front It also addresses both soil and groundwater contamination The performance of this project from its inception in February 2001 through December 2001 is presented in Section 7 0

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2.0 MOUND SITE PLUME TREATMENT SYSTEM

The Mound Site Plume Treatment System uses reactive barrier technology to collect and treat contaminated groundwater derived from the Mound Site area The source area was excavated as an accelerated action in 1997 Installation of the 220-foot-long collection system and two treatment cells containing reactive iron was completed in 1998 (Figure 1) The system is designed to meet the Groundwater Action Level Framework Tier II concentrations defined in the Rocky Flats Cleanup Agreement (RFCA) (DOE 1996) The Mound Site Plume System employs innovative technology to treat groundwater contaminated with chlorinated organic compounds and low levels of radionuclides The effectiveness and feasibility of using this technology on other contaminated groundwater plumes was demonstrated by this project

The Mound Site Plume Treatment Project was a cooperative effort between RFETS and the Department of Energy Subsurface Contaminant Focus Area (SCFA), with support from the US Environmental Protection Agency (EPA) Superfund Innovative Technology Evaluation (SITE) Program Funds were provided by SCFA in Fiscal Year (FY) 2000 for additional sampling beyond that required by the Mound Site Plume Decision Document (DOE 1997a). This additional sampling provided extensive data to various research organizations on the effectiveness and feasibility of reactive barriers

2.1 Project Events

Flow monitoring equipment was inoperable during portions of July, August, and September and was changed from an ultrasonic flow meter to a bubbler system on September 13, 2001. No other maintenance was required for this collection and treatment system except for raking of the surface of the treatment media in the two treatment cells The upper one foot of media in each cell is a mixture of 90% pea gravel and 10% iron, which facilitates raking and reduces crust formation Site personnel performed quarterly water level monitoring and semiannual analytical sample collection.

2.2 Treatment Effectiveness

For the period from January 2001 through December 2001, 118,876 gallons of contaminated water were measured that flowed through the treatment system The total volume of groundwater treated as of December 31, 2001 was approximately 780,300 gallons. Measured flow rates ranged from 0 06 gallons per minute (gpm) during January, to a high flow rate of 2.51 gpm in early May that was related to a 1 9-inch rainfall Monthly average flow rates range from 0 10 to 0.57 gpm. Because the flow meter was inoperable during parts of July, August, and September, the actual volume of water treated was not recorded and therefore was probably higher than the measured volume Figure 2 shows the average monthly flow rate for the Mound Treatment System compared to precipitation The Mound Plume Treatment System responds relatively rapidly to precipitation events

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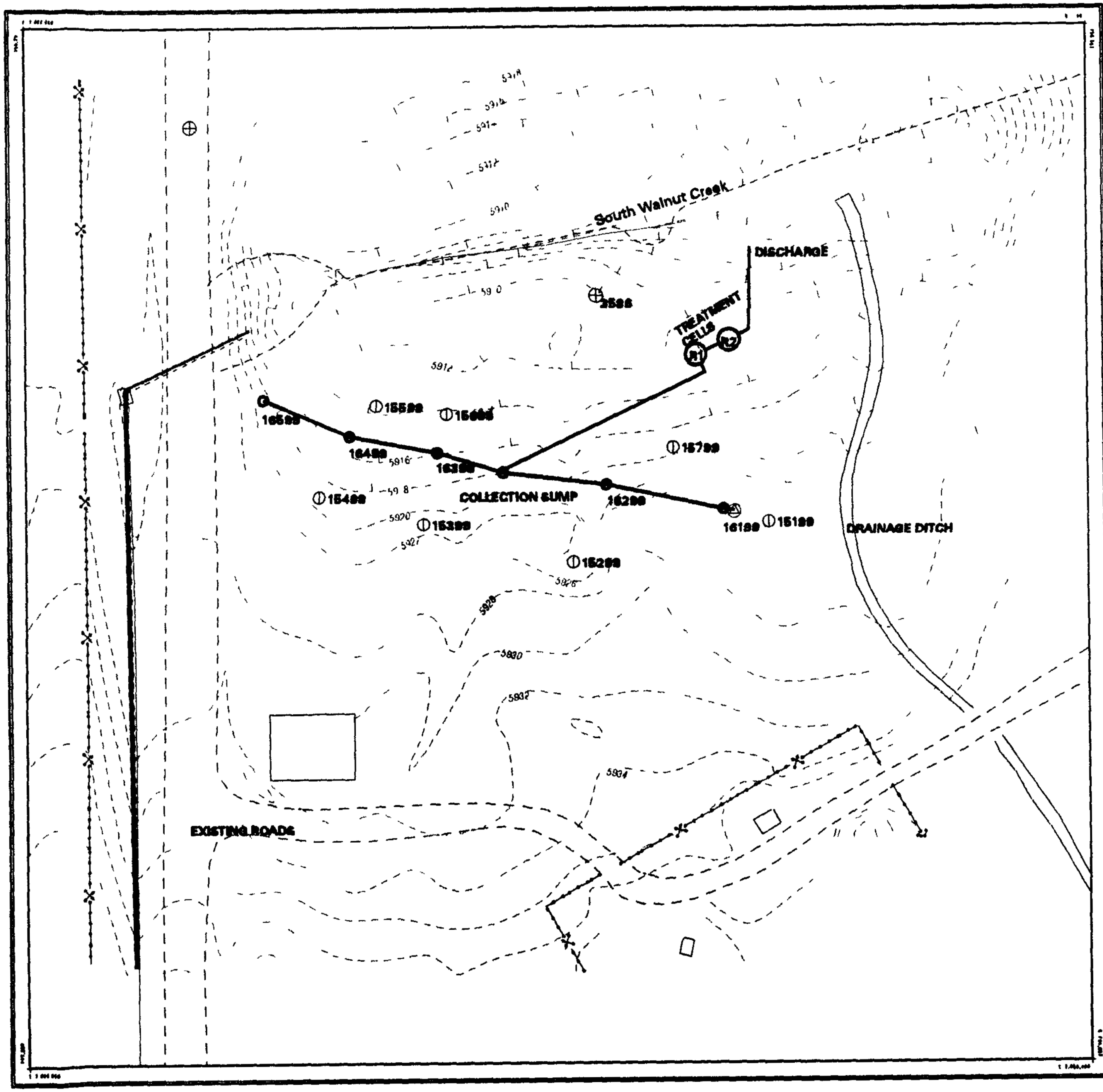

Figure 1

Mound Plume Treatment System Locations

Rocky Flats Environmental Technology Site

EXPLANATION

- New Ground Water Well
- Existing Ground Water Well
- New Trench Water Level Monitoring Probes
- New Trench Cleanout
- Contours
- Fences
- 72 Culvert
- Trench System

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Source for all Detailed Key layers except the new groundwater wells is International Technology Corporation (IT) prepared for MSE Technology Applications, Inc in Butte, Montana.

Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 830
1 inch represents approximately 69 feet

20 0 40 80 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U S Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp — THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

March 14, 2002

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Water levels within the collection trench were monitored quarterly at five piezometers The piezometer at the west end of the collection trench was dry throughout the year Water levels measured in the remaining piezometers are fairly constant, with water levels in these piezometers varying less than 0 1 foot over the year These piezometers remained wet throughout the year

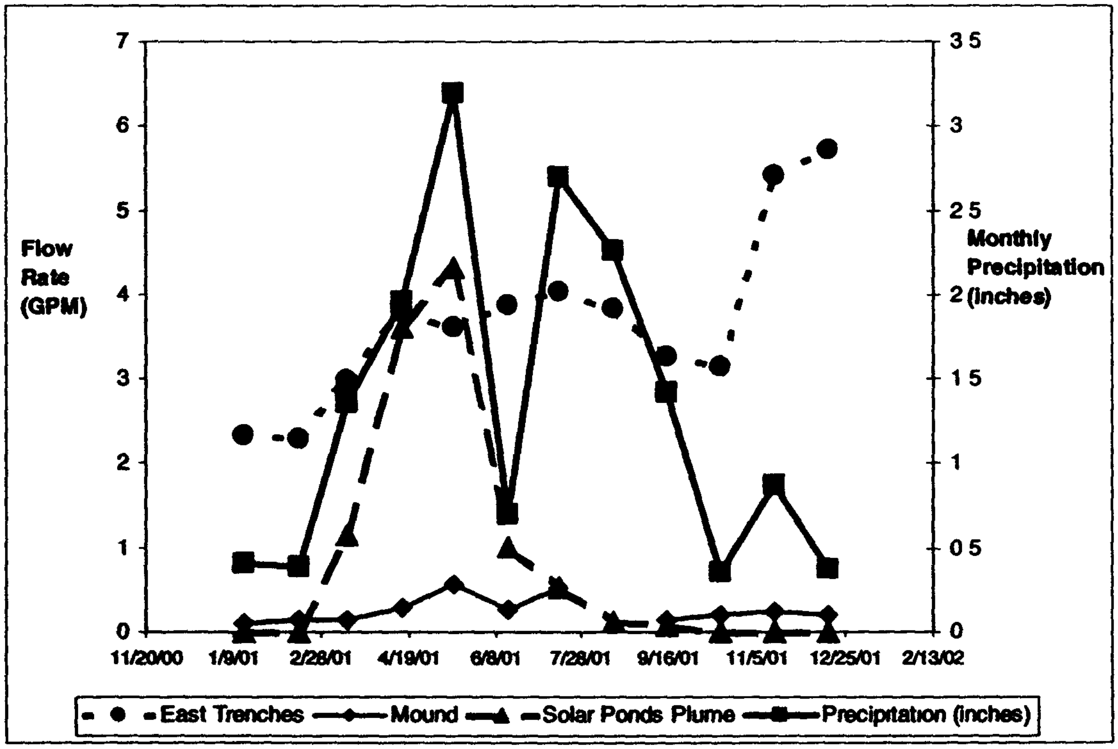

Figure 2. Comparison of Average Monthly Flow Rate for Mound, East Trenches, and Solar Ponds Systems Compared to Monthly Precipitation

Water levels were also monitored quarterly at seven locations surrounding the collection trench (three upgradient, three downgradient, and one to the east) as shown in Table 2 The water elevation upgradient of the collection trench was approximately 5,918 feet. The water elevation downgradient of the collection trench was 10 feet lower at around 5,908 feet, with piezometer 15599 dry These data indicate that the collection system is working as designed and that flow is towards the trench. Seasonal water fluctuations are approximately 2-3 feet at both upgradient and downgradient locations Water elevations in Well 3586, near South Walnut Creek, were about 5,900 feet and are likely to be influenced by the nearby Creek, which has surface elevation of 5,903 feet

Table 2. Mound Plume Upgradient and Downgradient Water Elevations

Well	Location	1/4/01	4/2/01	7/5/01	10/3/01
15199	Eastern	5917 01	5917 48	5919 81	5917 63
15299	Upgradient	5915 2	5918 78	5917 52	5915 8
15399	Upgradient	5917 48	5917 57	5918 19	5916 8
15499	Upgradient	5918 05	5918 28	5918 88	5918
15599	Downgradient	Dry	Dry	Dry	Dry
15699	Downgradient	5907 5	5907 67	5908 66	5908 24
15799	Downgradient	Dry	Dry	5910 72	5909 99

2.2.1 Treatment System Effectiveness

Analytical results continue to show that the treatment system is effectively removing the volatile organic compounds (VOCs) and radionuclides Semiannual analytical sample results are summarized below in Table 3 The contaminants of concern are chlorinated solvents and uranium

The organic contaminants entering the treatment system are tetrachloroethene, trichloroethene, and carbon tetrachloride and their degradation products. The presence of p-dichlorobenzene might be due to laboratory cross-contamination as there is no indication that it was used in the area nor does it appear that it is a common degradation product At this time, there does not appear to be any evidence that the iron is being depleted This demonstrates the long-term treatment capability that was anticipated when the project was initiated

Table 3. Summary of Mound Plume Year 2001 Sampling Events

Contaminant	Influent (R1I) Concentration (µg/l) Range	Reactor 2 Effluent (R2E) Concentration (µg/l) Range	RFCA Groundwater Tier II Action Levels (µg/l)
Trichloroethene	74-76	ND	5
Tetrachloroethene	44-50	ND	5
Carbon Tetrachloride	73-130	ND	5
Chloroform	20-23	ND-0 6J	100
Cis 1,2-Dichloroethene	23-38	0 26J-3	70
1,1-Dichloroethene	5-5 1	ND	7
1,1-Dichloroethane	1 2-2J	0 63J-2	5
1,2-Dichloroethane	ND-0 59J	ND	5
Methylene Chloride	ND	ND-6	5
1,1,1-Trichloroethane	3 4-4	ND	200
p-Dichlorobenzene	ND-0 34J	0 24J	75
Total Uranium (pCi/l)	15 03	0 19J	2 84

J = Detected at concentrations below the detection limit for this analysis
ND = Not detected at the detection limit for this analysis
µg/l = micrograms per liter
pCi/L = picoCuries per liter

Upgradient concentrations in Well 00897 (located in the high contaminant part of the upgradient plume but not shown on Figure 1) are significantly higher than the influent concentrations Tetrachloroethene concentrations were between 15,000-22,000 µg/l and trichloroethene was 1,500 µg/l This indicates that considerably higher VOC concentrations are still present in the upgradient plume

2.2.2 Downgradient Water Quality

As stated in the Decision Document (DOE 1997a), the collection system was installed near South Walnut Creek "to capture the contaminated groundwater to the extent practicable " The wells downgradient of the collection system are located within the cut-off downgradient portion of the plume which was not intended to be treated (also known as the "zone of sacrifice") Analytical results from these wells are provided below in Table 4

Analytical samples are collected from the four downgradient wells for the collection trench (see Figure 1) As noted above, Well 15599 was dry throughout 2001 (See Table 2). Well 15799 was dry in January and April and although there was sufficient water to measure the water elevation, it did not provide sufficient water to sample in October Well 15699 contained sufficient water for regular sampling Well 3586 was also sampled, but it is farther downgradient near South Walnut Creek

Elevated contaminant concentrations downgradient of the treatment system appear to be the result of residual contamination rather than contamination that has bypassed the treatment system The downgradient Well 15699 is located within the preferential flow path for the Mound Site Plume and along the trend of the highest plume concentrations defined in the pre-remedial investigation (DOE 1997a) The analytical results from the pre-remedial groundwater investigation from nearby Geoprobe™ hole 10797 were 844 µg/l trichloroethene, and 261 µg/l tetrachloroethene. As shown in Table 4, these analytical results are roughly the same order of magnitude as those currently seen in Well 15699. In comparison, the historical concentration of trichloroethene within the collection trench ranges from 67 to 160 µg/l. The trench concentrations are lower because groundwater is collected from across the plume area, including lower concentration areas Based on the similarity between recent downgradient water quality and the pre-remedial downgradient concentrations and the disparity between downgradient and collection trench water quality, the contaminant concentrations observed in Well 15699 are most likely due to residual contamination as opposed to contaminants leaking from the collection system This conclusion is further supported by the groundwater elevation difference between the upgradient and downgradient wells that indicates that the collection system is working as designed

Well 3586 is downgradient of the collection system near South Walnut Creek VOC concentrations at this location have been consistently below Tier II RFCA Action Levels throughout the year as shown in Table 4

Uranium activities are elevated above RFCA Tier II Action Levels at both downgradient wells (see Table 4) As with the VOC concentrations these are likely the result of residual contaminants and it is anticipated that over time these activities will eventually decrease

Table 4. Downgradient Well Analytical Results (in µg/l unless otherwise noted)

	Well Location				RFCA Tier II ALF
	15699		3586		
Sample Date	**4/17/01**	**10/22/01**	**4/17/01**	**10/22/01**	
Analyte					
1,1,1-Trichloroethane (ug/L)	ND	10	ND	0 43 J	200
1,1-Dichloroethane	ND	15	27	23	3650
1,1-Dichloroethene	16	86	ND	ND	7
1,2-Dichloroethane	ND	4 6	0 52 J	0 7 J	5
Benzene	ND	ND	ND	0 52 J	5
Chloroethane	ND	ND	2	1 2	29 4
Cis-1,2-Dichloroethene	66 D	200	5	5 4	70
Tetrachloroethene	190	920	ND	0 47 J	5
Trans-1,2-Dichloroethene	ND	ND	ND	0 47 J	70
Trichloroethene	350	1400	ND	0 49 J	5
Vinyl Chloride	ND	ND	5	5 4	2
Uranium-233,234 (pCi/l)	15	17 7	2 13	1 89	1 06
Uranium-235 (pCi/l)	0 57	0 974 J	0 044 U	0 0947 U	1 01
Uranium-238 (pCi/l)	13	11 7	1 71	1 28	0 768

U = Under the detection limit
J = Detected at concentrations below the detection limit for this analysis
ND = Not detected at the detection limit for this analysis

2.3 Conclusions and Planned Changes

The Mound Site Plume Treatment Project is fully operational and treating contaminated groundwater to below specified system performance concentrations. The ongoing treatment system maintenance, raking the iron media, retrieving flow rate and water level data, and monitoring water quality are the only necessary operational activities. Media raking will be reduced because the crust formation has been minimal. Semiannual sampling of downgradient wells and the treatment system will continue. Water levels will also continue to be measured on a quarterly basis.

3.0 EAST TRENCHES PLUME TREATMENT SYSTEM

The East Trenches Plume Treatment System collects and treats the contaminated groundwater that resulted from contaminants leaching out of burial trenches on the east side of RFETS The primary sources for the contaminated groundwater plume, Trenches 3 and 4, were remediated in 1996 as an accelerated action

Installation of the 1,200-foot collection system and two reactive iron treatment cells, similar to the Mound Plume System, was completed in September 1999 as an accelerated action Locations of these structures are shown in Figure 3 VOCs are reduced in the treatment cells to the Groundwater Action Level Framework Tier II level concentrations defined in the RFCA (DOE 1996) This system requires little maintenance and provides long-term protection of surface water by collecting and treating the contaminated groundwater before it reaches South Walnut Creek

3.1 Project Events

The flow meter was changed from an ultrasonic flow meter to a bubbler system on September 18, 2001 The high humidity present in the East Trenches flow monitoring system caused reflection of the ultrasonic waves and resulted in erroneous water level data and flow rates

The upper one-foot of treatment media was previously removed from the first treatment system vessel and replaced with a mixture of 90% pea gravel and 10% zero-valent iron This action was performed to cut down on severe crusting that was occurring at the top of the vessel This has stopped crusting and made raking the media possible No other maintenance was required for this collection and treatment system except for raking of the surface of the treatment media. System maintenance was performed along with water level monitoring and sample collection

3.2 Treatment Effectiveness

Total volume of groundwater treated by the system as of December 31, 2001 was approximately 4.7 million gallons with 1 9 million gallons of groundwater treated in 2001 Daily average flow rates ranged from 0 43 to 7 99 gpm and averaged 3 7 gpm As with the Mound Plume System, the highest flow rates correlate with heavier precipitation in May and July (Figure 2) The change in flow rates at the East Trenches System is not as dramatic as Mound Plume System because this treatment system has a higher base flow volume Increased flow was observed in November and December including the peak daily average flow rate of 7.99 gpm that was not directly associated with heavy precipitation events The cause this apparent increase in flow might be the result of the replacement of the flow meter or from the effect of increased infiltration from snowmelt. As additional data are collected, it might be possible to determine whether this is an anomaly or an actual increase in flow.

Water levels within the collection trench and wells and piezometer downgradient of the collection trench were measured monthly at three piezometers. Monitoring results are presented in Table 5.

Table 5. 2001 East Trenches Plume Piezometer and Well Water Levels (elevation above sea level)

Well	Jan.	Feb	March	April	May	June	July	Aug.	Sept	Oct.	Nov	Dec
23296	5852.4	5852.5	5852.5	5852 6	5852 9	5853 0	5852.0	5851 4	5851 0	5851 2	5851 9	5852 1
95099	5848 9	5849 3	5849.2	5849 2	5843 1	5847 3	5849 1	5849 3	5849.5	5849 6	5842 0	5846 0
95199	5870 6	5870 3	5870 1	5870.2	5869.5	5871 1	5870 1	5870 0	5870 0	5870 2	5865 9	5870 7
95299	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry-	Dry
95699	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
95799	5877 1	5877 0	5876 7	5877 3	5879 8	5881 4	5880 1	5880 1	5879 4	5879 2	5878 7	5879 1
95899	5888.5	5888 5	5888 5	5888 5	5888 6	5888 6	5888 6	5888 6	Dry	5888 6	5888 7	5888 6

12

13

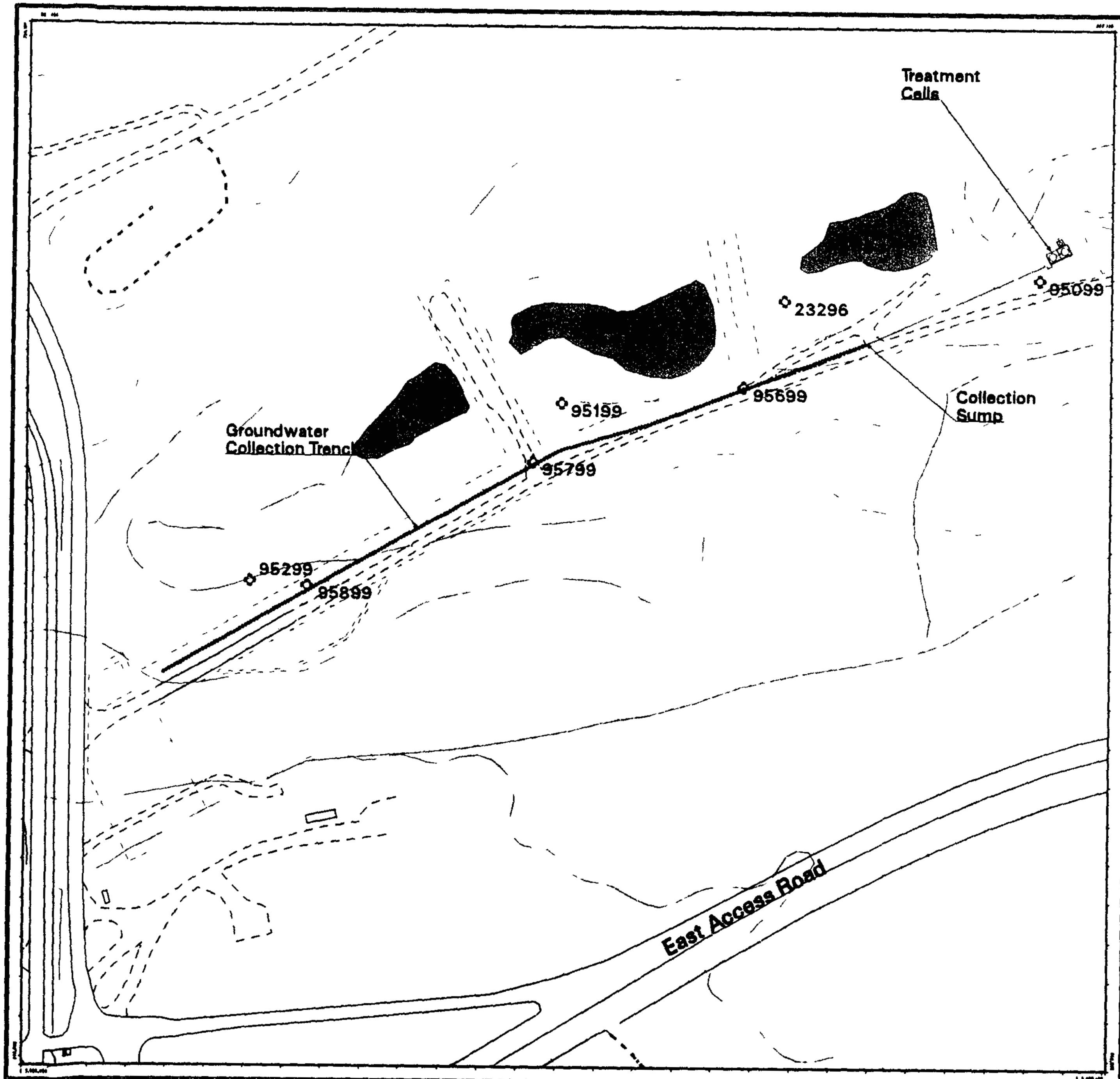

Figure 3
East Trenches Plume
Treatment System Locations

EXPLANATION

Surface Water Drainage

- Collection Trench
- Monitoring Well

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

DISCLAIMER:

Scale = 1 : 2740
1 inch represents approximately 228 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: DynCorp
Prepared for: KAISER HILL

March 14, 2002

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The water elevations at this area continue to demonstrate a strong downgradient trend to the east, with the water elevations in the piezometers within the collection trench generally 10 feet higher than the corresponding piezometers downgradient of the collection trench After installation of the collection system, the water elevation at the western collection trench piezometer (95899) dropped The decrease in water elevation in 95899 between October 1999 and January 2001 was about 1 5 feet This may be a result of dewatering of the Arapahoe Number One Sandstone, which is intersected by the collection trench at this location It now appears that the water elevation has stabilized at an elevation 5888 6 feet (See Table 5) There is virtually no fluctuation in this well or reaction due to precipitation or seasonal effects, which is another indication that this water is from the Arapahoe Sandstone and that past water elevation differences were due to dewatering. The associated downgradient piezometer (95299) was dry indicating that the pathway was cut

The water elevation at 95799 (middle collection trench piezometer) has also dropped about one foot from its height in October 1999 It has fluctuated over a 3 to 4 foot range during the 2001 The water elevation in the associated downgradient piezometer (95199) fluctuated from 5,871.1 feet above sea level to 5869.5 feet above sea level. Finally, at the far eastern end of the collection trench, the collection trench piezometer 95699 was dry.

The water elevation in Well 23296 by South Walnut Creek was relatively constant at an elevation of around 5,852 feet above sea level. Well 23296 is downgradient of the B-2 Dam adjacent to South Walnut Creek. Water levels at this location are controlled to a large degree by adjacent surface water features including South Walnut Creek, Pond B-2 and Pond B-3

The water elevation at 95099, located east of the collection trench, fluctuated the most, from 5,842 to 5,850 feet above sea level. This end of the trench is probably more influenced by the Rocky Flats Alluvium and therefore more susceptible to fluctuation caused by precipitation events

Water level data from wells and piezometers located upgradient, within, and downgradient of the collection system trench together with the volume of water recovered in the collection system, indicate that the collection trench is working as designed

3.2.1 Treatment System Effectiveness

Analytical samples were collected semiannually at the influent and effluent of the treatment system to monitor treatment effectiveness, and a summary of these sampling events is provided below in Table 6 The contaminants of concern for this plume are primarily trichloroethene, tetrachloroethene, and carbon tetrachloride

With the exception of methylene chloride and one instance of tetrachloroethene, contaminants were reduced to levels below the RFCA Tier II Action Levels Methylene chloride is probably a laboratory cross-contaminant or the result of degradation of one of the other contaminants Although it was not found in the laboratory blank, it is a common lab contaminant and it was not in the influent It is also possible that it could be the result of degradation of carbon tetrachloride One sample had a tetrachloroethene concentration that was 0 3 µg/l over the action level Although it is anticipated that the concentrations will increase as the iron is oxidized, the concentrations are still relatively low and might not represent a trend This is also probably not a result of removing the zero-valent iron from top of the vessel because this iron was probably not available due to the formation of crust It is more likely that these values reflect laboratory error and the natural variability of the system The next round of samples will be closely monitored to determine whether the tetrachloroethene concentrations represent an increasing trend requiring action

Table 6. Summary of East Trenches Plume 2001 Sample Results

Compound	**Influent Concentration (µg/l)**		**Effluent Concentration (µg/l)**		**RFCA Groundwater Tier II Action Levels (µg/l)**
	4/18/01	10/25/01	4/18/01	10/25/01	
1,1-Dichloroethane	ND	ND	1	1.5	3650
1,1-Dichloroethene	ND	4 9J	ND	ND	7
Cis-1,2-Dichloroethene	ND	32	5	6 6	70
1,1,1-Trichloroethane	ND	6 2	ND	ND	200
Acetone	ND	ND	ND	3.5J	3650
Benzene	ND	ND	ND	0 42J	5
Carbon Tetrachloride	160	160	ND	ND	5
Chloroform	79J	84	ND	ND	100
Methylene chloride	ND	ND	15	ND	5
Tetrachloroethene	240	350	0 6J	5 3	5
Trichloroethene	2,900	2,500	ND	0 66J	5

J = Detected at concentrations below the detection limit for this analysis
ND = Not detected at the detection limit for this analysis

Well 11891 lies upgradient of the treatment system For 2001, the concentrations of carbon tetrachloride, tetrachloroethene, and trichloroethene ranged between 470 to 490 µg/l, 210 to 220 µg/l, and 46 to 49 µg/l respectively. As can be seen from Table 6, the influent concentration has lower concentrations of carbon tetrachloride but higher concentrations of trichloroethene and tetrachloroethene than Well 11891. This is probably because there is variation in concentration across the plume for major VOCs. It does appear likely that the collection system is recovering portions of the plume that do have significant VOC concentrations.

3.2.2 Downgradient Water Quality

Analytical samples were collected where possible from the three downgradient wells and one well east of the collection trench as shown in Table 7 As noted above, Well 95299 was dry However, Wells 23296, 95099 and 95199 contain sufficient water for regular sampling

Table 7. Downgradient Well Analytical Results (in µg/l)

Well	Date	Carbon Tetrachloride	Chloroform	Cis-1,2-Dichloroethene	Methylene Chloride	Tetrachlo-roethene	Trichloro-ethene
23296	4/24/01	6 J	16	63	10 B	17	530 D
	10/23/01	10	10	150	ND	12	380
95099	4/01/01	ND	ND	ND	ND	ND	ND
	10/22/01	0 2 J	ND	ND	ND	ND	ND
95199	4/12/01	ND	ND	2 D	ND	2 JD	65 D
	10/23/01	ND	ND	2 5	ND	2	51
RFCA Tier II ALF		5	100	70	5	5	5

B = Present in the laboratory blank (possible lab contamination)
J = Detected at concentrations below the detection limit for this analysis
ND = Not detected at the detection limit for this analysis

Wells 23296 and 95199 show consistent VOC concentrations (Table 7) higher than the RFCA Tier II Action Levels, although much lower than the concentrations seen at the treatment cells (Table 6) These downgradient wells are located within the downgradient portion of the plume that was not intended to be treated (also known as the "zone of sacrifice") Well 95099 is located east of the collection system and outside of the East Trenches Plume. It was installed in that location to determine whether the plume was spreading to the east as a result of the collection system Water quality at this location has remained substantially unchanged both historically and, as is shown in Table 7, for the current reporting period

Well 23296 is located near South Walnut Creek where the East Trenches Plume exits to surface water Higher VOC concentrations observed at this well were an early indication that a remedial action should be considered for this plume Trichloroethene was the primary contaminant observed, with concentrations ranging between 380 µg/l in October 1999 to 530 µg/l in February 2000. Well 95199 exhibits the same pattern as Well 23296, but to a lesser extent with the highest concentrations of trichloroethene observed in March 2000 and the lowest concentration in October 1999. Concentration fluctuations may be a result of precipitation, with periods of increased infiltration resulting in lower concentrations. Little rainfall was observed in February, with wetter weather from mid March (immediately following sampling) through July. Because infiltration is a major source of groundwater recharge, the rainfall apparently caused a decrease in plume concentrations. The proximity of these wells to the ponds could also be influencing concentrations because higher levels in the ponds could also be increasing groundwater flow in these areas

3.3 Conclusions and Planned Changes

The East Trenches Plume Treatment System is fully operational and treating contaminated groundwater to specified system performance requirements Ongoing maintenance (i.e raking the iron filings and retrieving flow rate and water level data) is the only required activity Sampling of the treatment system is expected to continue semiannually Analytical results will be watched closely for signs that indicate that the iron needs to be replaced

4.0 SOLAR PONDS PLUME TREATMENT SYSTEM

The Solar Ponds groundwater plume contains low levels of nitrate and uranium generally attributed to storage and evaporation of radioactive and hazardous liquid wastes in the Solar Evaporation Ponds from 1953 to 1986 These ponds were drained and the sludge removed by 1995. Six interceptor trenches were installed in 1971 to de-water the hillside north and downgradient of the ponds The original six trenches were abandoned in place, and the Interceptor Trench System (ITS) was installed in 1981 The ITS was replaced with a 1,100-foot-long collection system and passive treatment cell containing iron and wood chips in September 1999 The system components are shown on Figure 4 This system intercepts the water previously collected by the now defunct ITS

The Solar Ponds Plume system is different from the passive, flow-through systems installed for the Mound Plume and East Trenches Plume As originally designed, the treatment cell was to be located near North Walnut Creek Water was expected to be intercepted and flow by gravity to the treatment cell without detention in the collection trench Because the Preble's Meadow Jumping Mouse (a Federally Listed Threatened Species) is present at the optimal location for a flow-through treatment cell, the treatment cell was located immediately adjacent to the collection trench, not 400 feet downgradient as was originally planned As a result, the collection trench for this system must hold approximately 11 feet of groundwater at the treatment system inlet to develop sufficient hydraulic head for the groundwater to flow into the treatment cell. This causes water to backup along several hundred feet of the collection trench length. This has reduced the amount of water treated, however, it does not appear to have had an impact on the removal efficiency of the treatment system

Maintenance requirements consist of water level monitoring and sample collection Because the iron is more dispersed, the media does not require raking or other maintenance Based on vendor experience, it is expected that media replacement will be required 10 years after installation

4.1 Project Events

The Solar Ponds Plume system is currently collecting groundwater containing nitrate and uranium from the Solar Ponds Plume However, some untreated groundwater is also reaching surface water at the discharge gallery This results in higher nitrate and uranium levels in North Walnut Creek than were observed prior to system installation

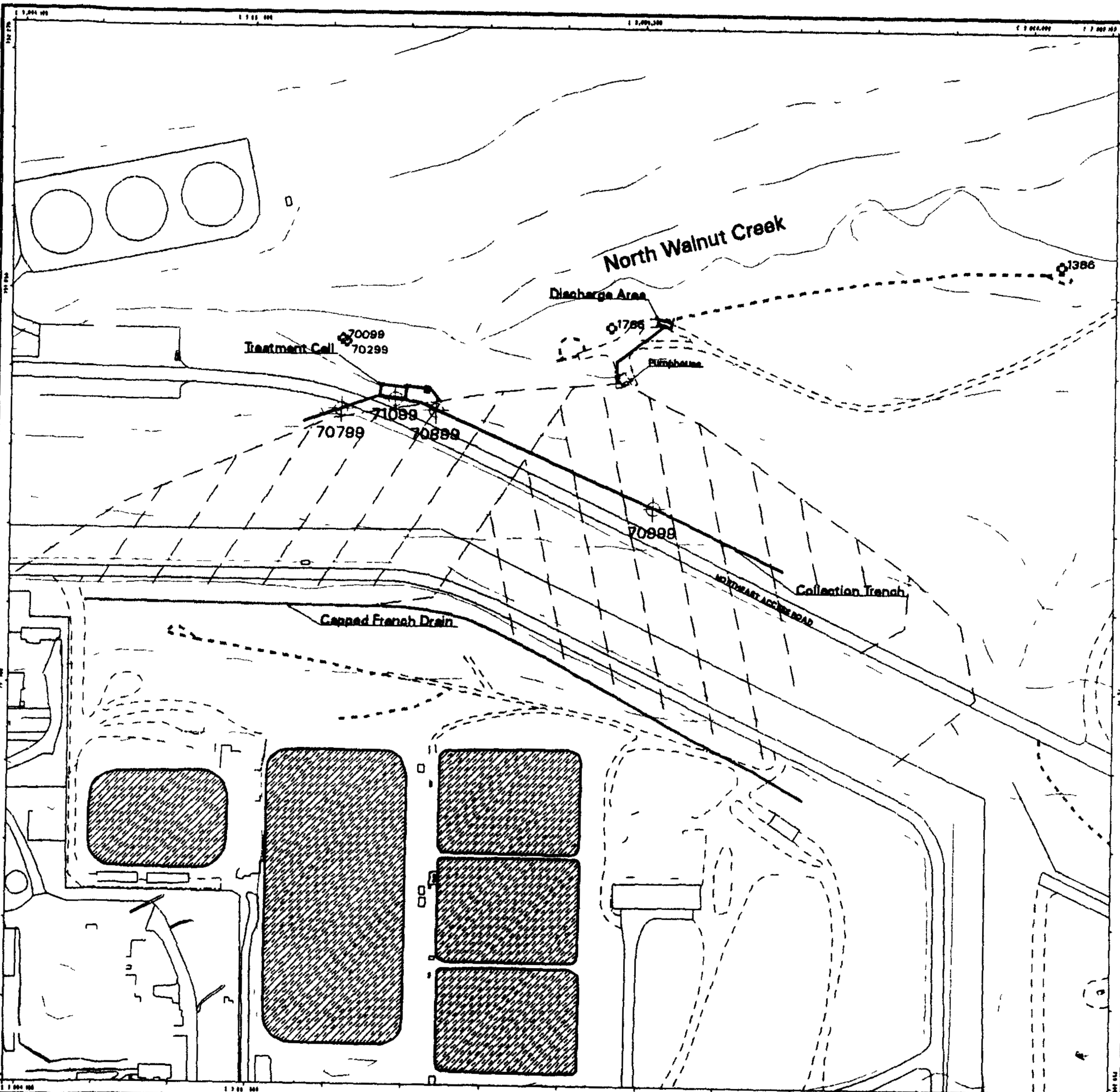

Figure 4
Solar Ponds Plume Treatment System Locations

EXPLANATION

- ITS
- In Trench Piezometer Location
- Monitoring Well

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:

DISCLAIMER:

Scale = 1 : 3220
1 inch represents approximately 268 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U S Department of Energy
Rocky Flats Environmental Technology Site

Prepared by
DynCorp
THE ART OF TECHNOLOGY

Prepared for
KAISER HILL

March 14, 2002

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Like the Mound and East Trenches Treatment Systems, the flow meter was changed on September 25, 2001 from ultrasonic flow meter to a bubbler system The flume in the flow meter sometimes produced erroneous readings due to water backup in the flume The flow meter flume on the Solar Ponds is now cleaned and the calibration checked quarterly to improve the accuracy of these measurements No other maintenance activities were performed for this collection and treatment system Site staff performed regular water level monitoring and sample collection

4.2 Treatment Effectiveness

As of December 31, 2001, the total volume of water treated by the system since March 2000 was 452,780 gallons 423,836 gallons or about 94% of the water treated to date was treated in 2001 Most of this water was treated between March and July of 2001 Flow through the treatment cell occurs after precipitation events; however, enough precipitation fell in late spring and early summer to keep the system running steady during this time period Flow rates ranged from 0 to 12 70 gpm The maximum flow rate occurred on May 5th following a four-day period in which 2 15 inches of rain fell Due to the design of the collection system. flow to the treatment system tends to start and stop abruptly depending on the level of water in the collection system relative to the treatment system inlet

Water levels within the collection trench are monitored at five piezometers. The inlet into the treatment cell is at 5,885 feet above sea level and the bottom of the collection trench below the inlet is approximately 5,875 feet above sea level and Water levels in four of piezometers fluctuate between 5,880 and 5,885 feet above sea level (Figure 5) The fifth piezometer is at the east end of the trench and generally has a water elevation of 5,900 feet. By design, water collected in this part of the trench drains to the west and is not allowed to build up. This piezometer is generally dry when the water level of the other piezometers drops to 5,880 feet.

There are a number of indicators that groundwater is bypassing the collection system. Water levels in the collection trench fluctuate rather than hold a constant level of 11 feet, which is the height of the treatment cell inlet Elevated nitrate and uranium levels in North Walnut Creek indicate that untreated groundwater is reaching surface water. Elevated concentrations might be due to this phenomenon also. Water quality in North Walnut Creek continues to be well below applicable standards for nitrate and uranium despite apparent bypass of the treatment system.

Water levels in the newly installed wells downgradient of the system are monitored monthly as shown on Figure 6 These data are provided in Table 8. Water elevations in the colluvial well (70099) have fluctuated over a range of approximately 6 feet since installation while the bedrock well (70299) has a more constant water elevation. At the same time, water levels within the collection trench fluctuated between 5,880 and 5,887 feet above sea level

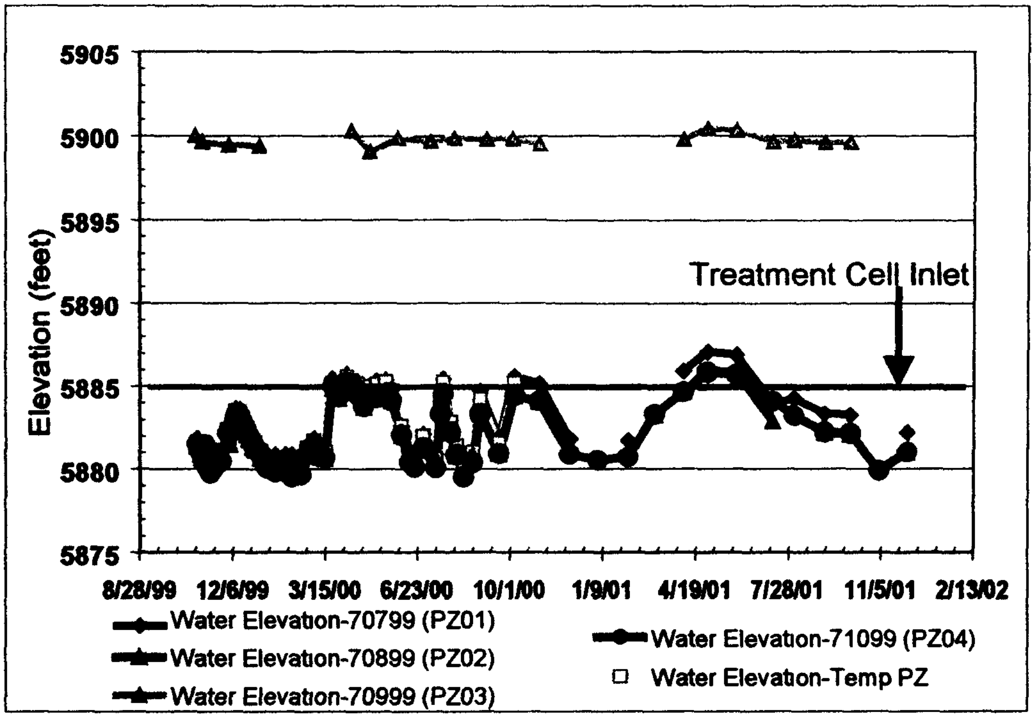

Figure 5. Solar Ponds Plume Collection Trench Piezometer Water Levels

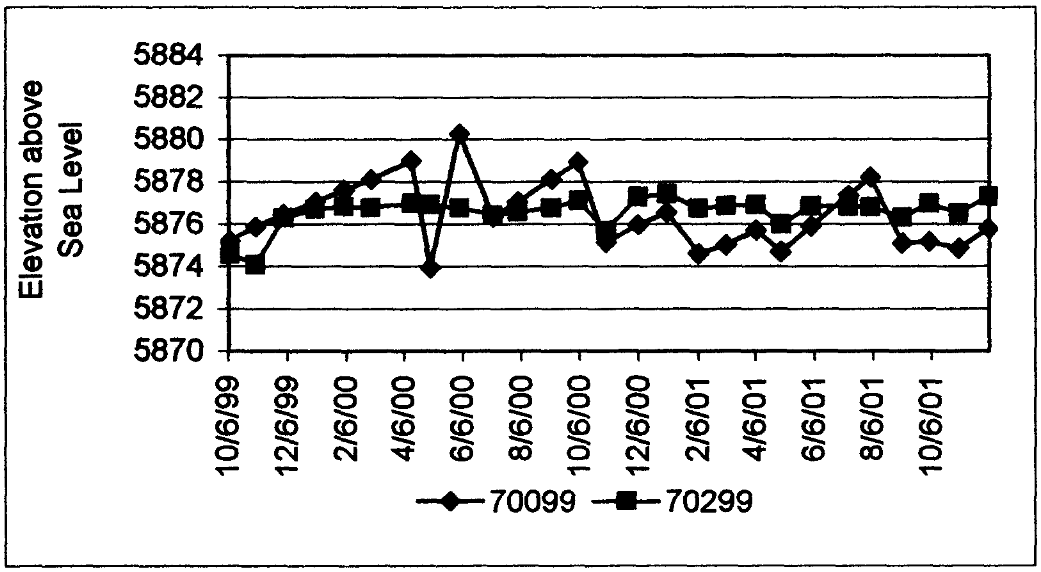

Figure 6. Solar Ponds Plume System Downgradient Well Water Elevations

Table 8. Elevation of Groundwater in Solar Ponds System Wells

	1/3/01	2/5/01	3/5/01	4/5/01	5/1/01	6/1/01	7/10/01	8/2/01	9/4/01	10/2/01	11/2/01	12/3/01
70099	5876 5	5874 6	5875 0	5875 7	5874 7	5875 9	5877 4	5878 2	5875 1	5875 2	5874 8	5875 8
70299	5877 4	5876 7	5876 9	5876 9	5876 0	5876 9	5876 8	5876 8	5876 3	5877 0	5876 5	5877 3

4.2.1 Treatment System Effectiveness

Monthly samples for nitrate and uranium are collected from the treatment system influent, effluent, and discharge gallery and available data for 2001 are provided in Table 9 and shown on Figures 7 and 8 Influent and discharge gallery nitrate concentrations in October and November were above average, most likely because of drier conditions. However, uranium activities are not as elevated Discharge gallery nitrate concentrations are similar to those seen in August 2000 samples, another dry period The November influent nitrate concentration of 212 mg/l is the highest concentration seen to date at this location

The effluent concentrations continue to be much lower than predicted It was previously thought that was most likely a result of the increased residence time due to low flow rates, however, higher flow rates have been achieved and the system continues to remove over 99% of the nitrates and uranium in the influent The flow rate hit a peak value of 12 7 gallons per minute occurred in early May At these higher flow rates, the treatment system's removal efficiency was still 96% for nitrates and uranium removal efficiency was over 99%

Table 9. Summary of Solar Ponds Plume Treatment System 2001 Analytical Results

	SPP Influent		SPP Effluent		SPP Discharge Gallery	
Collection date	Nitrate in mg/l	Total Uranium in pCi/l	Nitrate in mg/l	Total Uranium in pCi/l	Nitrate in mg/l	Total Uranium in pCi/l
30-Jan-01	140	25 06	-	-	130	25 66
26-Feb-01	150	26 44	-	-	140	24.51
19-Mar-01	120	25 58	0 07	0 15	110	28 84
13-Apr-01	140	24 43	<0 05	0 003	120	20 2
25-Apr-01	130	24 58	<0 05	0 05	130	28.55
3-May-01	110	24 82	0 13	0 091	150	24 79
8-May-01	150	23 66	5 3	0 11	140	26 6
23-May-01	130	27 97	<0 05	0 002	180	31 16
21-Jun-01	120	25 49	<0 05	0 168	220	50 38
16-Jul-01	150	21 3	0 11	0	130	55 4
10-Aug-01	140	24 51	<0 05	0 1	150	28
26-Sep-01	109	26 22	-	-	202	41 64
31-Oct-01	168	22 64	-	-	257	37 15
30-Nov-01	212	25 67	-	-	268	32 48
28-Dec-01	156	24 70	-	-	211	35 81

- = not sampled
nr = not received

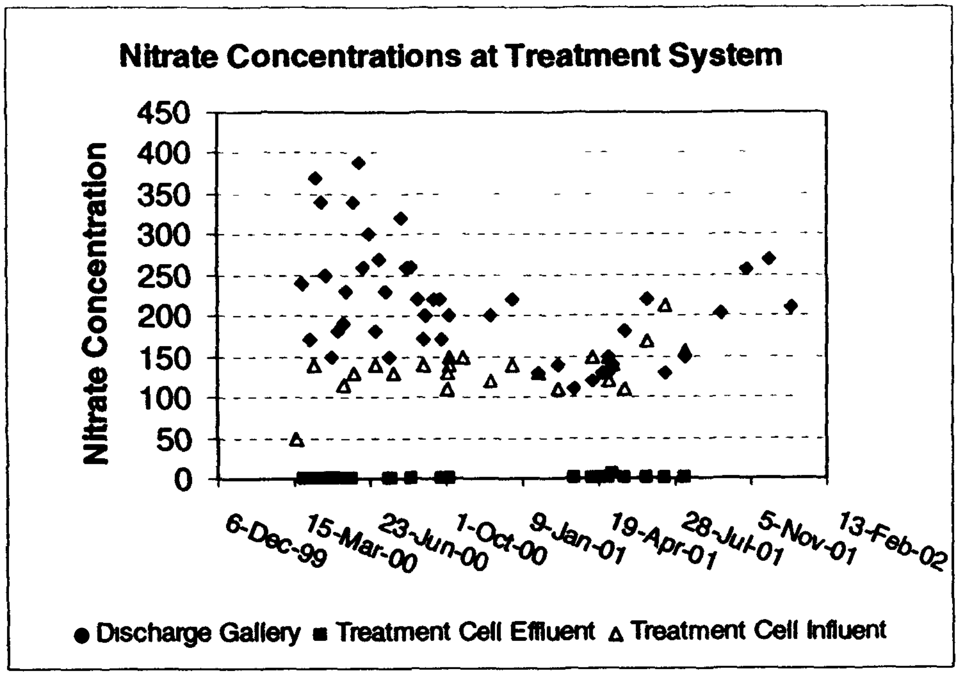

Figure 7. Solar ponds Plume Treatment System Nitrate Concentrations

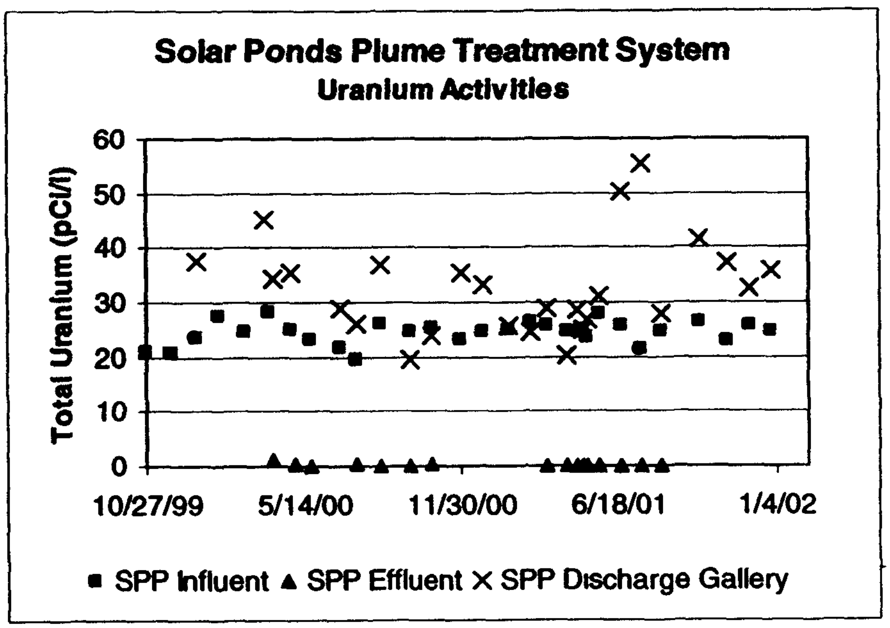

Figure 8. Solar ponds Plume Treatment System Uranium Activities

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It appears that the discharge gallery is discharging both groundwater that is bypassing the treatment cell, and groundwater derived from the pre-existing downgradient part of the plume that has nitrate concentrations consistently above 500 mg/l This downgradient part of the plume is contributing to the higher nitrate and uranium concentrations at the discharge gallery than are observed at the treatment system influent

Upgradient from the collection system, the nitrate concentration ranged between 160 and 186 mg/l The uranium activities in this well for Uranium 233/234, 235 and 238 ranged from 26 5 to 32 pCi/l, 1 13 to 1 8 pCi/l and 21 7 to 26 pCi/l, respectively. The nitrate concentrations are slightly higher than the influent concentrations to the treatment system and the uranium levels are about twice as high Over time it is anticipated that the influent concentrations for nitrates will remain about the same but that the uranium levels will very slowly increase This is because the nitrates are much more mobile than the uranium

4.2.2 Downgradient Water Quality

Analytical samples were collected quarterly from the two downgradient wells and data are provided in Table 10 Typically, the bedrock well consistently contains sufficient water for sampling while the adjacent colluvial well does not However, this year there was sufficient water to sample both wells throughout the year

Nitrate concentrations are lower than anticipated in both wells, especially in comparison to the levels in the discharge gallery Alternatively, the uranium activity found in the colluvial well (70099) is higher than elsewhere in the collection and treatment system, and also much higher than that of the adjacent bedrock well

Table 10. Solar Ponds Plume Downgradient Well Analytical Results

Well	Date	Nitrate/Nitrite (mg/l)	Uranium-233,-234 (pCi/l)	Uranium-235 (pCi/l)	Uranium-238 (pCi/l)
70099	1/23/01	2 4	115	3 69	81 9
	4/20/01	1 9	96	3.5	68
	8/14/01	2 2	93	3 09	65
	10/16/01	1 8	98 1	4 06	72 4
	10/26/01	2 2	79	2	58
70299	1/22/01	0 25	9 01	0 224	5 98
	4/20/01	0 66	6 6	0 22	4
	8/16/01	0 064	5 46	0 319	5 04
	10/16/01	0 092	5 12	0 199	3 31
	10/26/01	0 05	7 8	0 16	5 3

Water quality was measured at the Solar Ponds Plume discharge gallery, surface water station GS13 located in North Walnut Creek immediately downgradient of the Solar Ponds Plume, and downgradient Pond A-3 which accepts the water that passes through GS13 GS13 and Pond A-3 were monitored frequently to verify that concentrations at both locations are well below the temporary stream standard for nitrate of 100 mg/l The

100 mg/l nitrate standard is a temporary modification of the underlying stream standard of 10 mg/l nitrate in North Walnut Creek (DOE 1999) Table 11 provides a summary of the analytical data Figure 9 shows downgradient water levels for nitrate

The discharge gallery nitrate concentrations were higher than the concentrations observed in the collection trench The pre-existing downgradient part of the plume adjacent to the discharge gallery has nitrate concentrations above 500 mg/l This part of the nitrate plume is believed to be seeping to the surface at the discharge gallery, contributing to the higher nitrate concentrations As shown in Figure 9, there is an overall downward trend in nitrate concentrations in the discharge gallery. Part of this trend might be attributable to the influx of treated water from the treatment system However, because the water from treatment system is intermittent, there are other factors contributing to this trend such as phytoremediation or influences from previous collection systems

Table 11. Solar Ponds Plume Summary of Downgradient Surface Water Locations

Date	SPP Discharge Gallery	GS13	Pond A-3	SPP Discharge Gallery	GS13
	Nitrate (mg/l)			Total Uranium (pCi/l) *	
30-Jan-01	130	20	7 9	25 66	9 15
26-Feb-01	140	18	11	24 51	8 85
19-Mar-01	110	13	8 2	28 84	5 89
13-Apr-01	120	7 8	4 1	20 2	2 999
25-Apr-01	130	10	5 4	28 55	2 936
3-May-01	150	2 9	4 5	24 79	1 328
4-May-01**	130				
8-May-01	140	12	5 3	26 6	4 08
23-May-01	180	15	5 6	31 16	5 53
21-Jun-01	220	4 3	2 9	50 38	2 33
16-Jul-01	130	11	2.2	55 4	3 705
10-Aug-01	150	8 9	1.5	28	4 4
26-Sep-01	202	27 4	1 9	41 64	9 18
31-Oct-01	257	26 5	4 9	37 15	8 02
30-Nov-01	268	20 2	7	32 48	7 89
28-Dec-01	211	26 5	7 7	35 8	9 9
Minimum	110	2.9	1 5	20 2	1 328
Maximum	268	27 4	11	55 4	9 9
Average	166 8	14 9	5 3	32 7	5 75

** Uranium is not measured at Pond A-3*
*** Only the discharge gallery was sampled on this date*

GS13 is the performance monitoring location for the Solar Ponds Plume System (DOE 1999) located in North Walnut Creek Since January 2001, the nitrate concentrations have generally been below 30 mg/l but tend to fluctuate depending upon precipitation and other factors For calendar year 2001, the 85th percentile concentration of nitrate is 25 9 mg/l This is about a 25% increase over the calendar year 2000 85th percentile nitrate concentration of 20 5 mg/l. This still remains well below the applicable surface water standard of 100 mg/l specified in the Solar Ponds Plume Decision Document (DOE

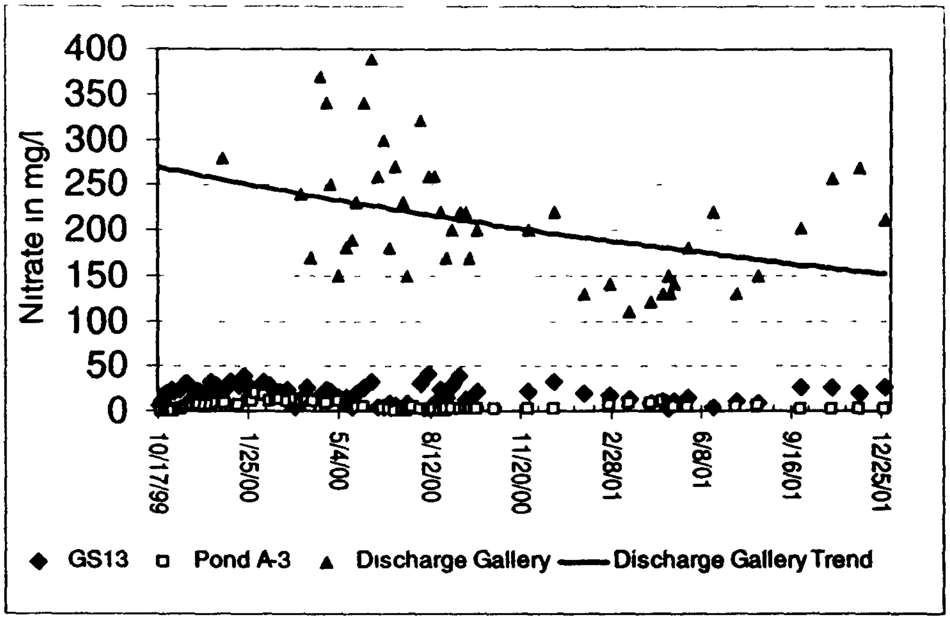

Figure 9. Nitrate Concentrations (mg/l) in Solar Ponds Surface Water Locations

1999) At Pond A-3, located downstream of GS13, nitrate concentrations have been steadily declining since March 2000 and were generally below 10 mg/l throughout 2001. The concentrations are lower in Pond A-3 than GS13, which is probably due to dilution from downstream sources

Surface water quality continues to be below applicable standards of 10 pCi/l uranium specified in the Solar Ponds Plume Decision Document (DOE 1999) Figure 10 shows uranium activities at the treatment system as well as surface water station GS13. Although activities at the treatment system are above the standard, the activities downstream at GS13 are below the standard. Further downstream at the Pond A-4 Outfall is a RFCA Point-of-Compliance for uranium. There had been a concern that uranium activities may approach the Surface Water standard of 10 pCi/l due to the discharge of Solar Ponds Plume water into this drainage. Because Pond A-4 discharge is infrequent, the outfall sampling is rare; however, in the past when samples are collected during discharge, uranium activities were approximately 2 to 4 pCi/l, well below the standard. These data were within the range of historical uranium activities for this location

4.3 Conclusions and Planned Changes

The Solar Ponds Plume system is currently collecting groundwater containing nitrate and uranium from the Solar Ponds Plume. The treatment cell is providing treatment for nitrate and uranium as designed. Performance monitoring data shows that the surface water is well below the applicable standards of 10 pCi/l uranium and 100 mg/l nitrate as specified in the Decision Document (DOE 1999) The 100 mg/l nitrate standard is a temporary modification of the underlying stream standard for nitrate (10 mg/l) in North Walnut Creek (DOE 1999) System performance continues to be evaluated through monitoring water levels in the collection trench, collecting samples at additional locations, and with increased sampling frequency.

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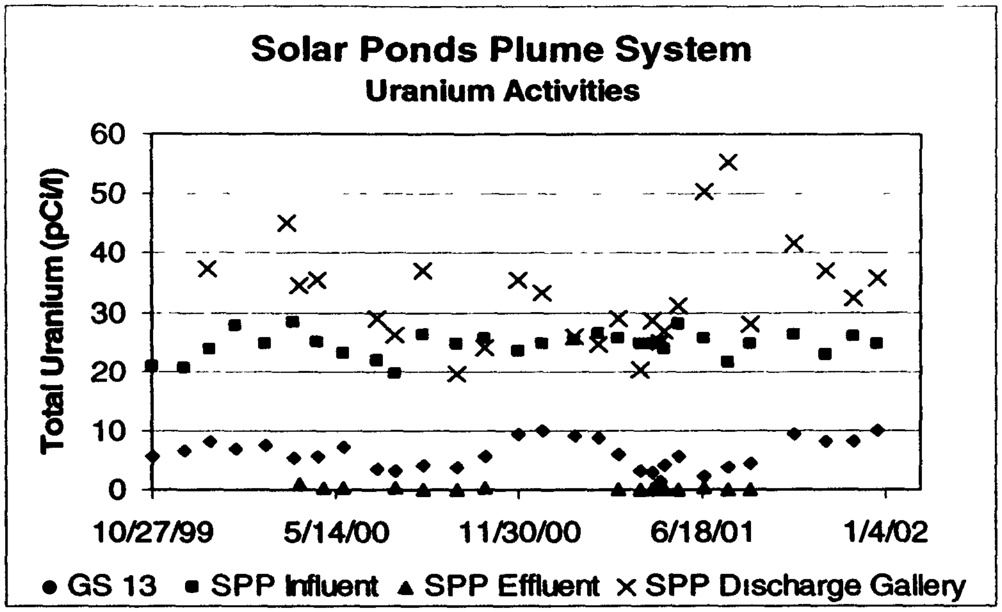

Figure 10. Uranium Activities (pCi/l) in Solar Ponds Surface Water Locations

Water levels within the collection trench and nearby wells will be monitored on a monthly basis. Samples at GS13, treatment system influent, effluent and discharge gallery will be collected on a monthly basis to monitor system performance and the impact to surface water. Analytical results continue to suggest that there may be seasonality to the system performance with normal treatment during fall and winter, and treatment augmented by phytoremediation during the spring and summer At this time, the Site plans to continue to monitor the system for an additional year to document seasonal impacts and to determine if other actions are required.

5.0 OPERABLE UNIT 1, 881 HILLSIDE GROUNDWATER TREATMENT SYSTEM

The Operable Unit 1 (OU 1) - 881 Hillside groundwater collection and treatment system was installed in 1992 and consisted of a 1,435-foot-long French Drain and a separate upgradient Collection Well The Collection Well collects VOC-contaminated groundwater from within the plume Trichloroethene is the primary contaminant

The French Drain was installed to prevent potential downgradient contaminant migration Collected water was treated in the Consolidated Water Treatment Facility (CWTF) Because groundwater collected by the French Drain was consistently below RFCA Tier II Action Levels, the OU 1 Corrective Action Decision (CAD)/Record of Decision (ROD) (DOE 1997b) included decommissioning the French Drain The French Drain was decommissioned in 2000 Data are no longer collected at this location

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Based on the declining concentrations of VOCs in the plume, the OU 1 CAD/ROD Modification was signed in February 2001 (DOE 2001) and included continued extraction and treatment of groundwater from the Collection Well for a one-year period

Currently, water from the collection well is pumped into a portable trailer, then transported to the CWTF for treatment The total water volume treated from the collection well was 9,625 gallons for the period January through the end of December 2001 Table 12 presents the volume of water collected monthly

Table 12. Volume of Groundwater Collected From the OU 1 Collection Wells

Month	Volume of Water Collected (gallons)
January	1,010
February	780
March	645
April	745
May	750
June	1,330
July	970
August	940
September	695
October	705
November	645
December	410
Total	9,625

5.1 Project Events and Effectiveness

The Collection Well is sampled quarterly VOC analytes above detection limits from the four 2001 samples are reported below in Table 13 Figure 11 shows the behavior of trichloroethene concentrations relative to time. This graph is the updated version of the graph in the OU 1 CAD/ROD Modification (DOE 2001). Figure 11 illustrates the general trend of higher concentrations during dryer periods and the overall downward trend.

Table 13. OU 1 Collection Well Analytical Results for 2001 Sampling Event

Analyte	Concentration (µg/l)	RFCA Groundwater Tier II Action Levels (µg/l)
1,1,2-Trichlorotrifluoroethane	ND - 3 J	-
1,1-Dichloroethene	10 JD-23	7
1,1,1-Trichloroethane	ND - 3 J	200
Carbon Tetrachloride	10 J –20 J	5
Chloroform	ND - 1 J	100
Methylene Chloride	ND -81 BD	5
Tetrachloroethene	28 - 33	5
Trichloroethene	300 - 420	5

B = Detected in sample blank
D = Diluted sample
J = Detected at concentrations below the detection limit for this analysis

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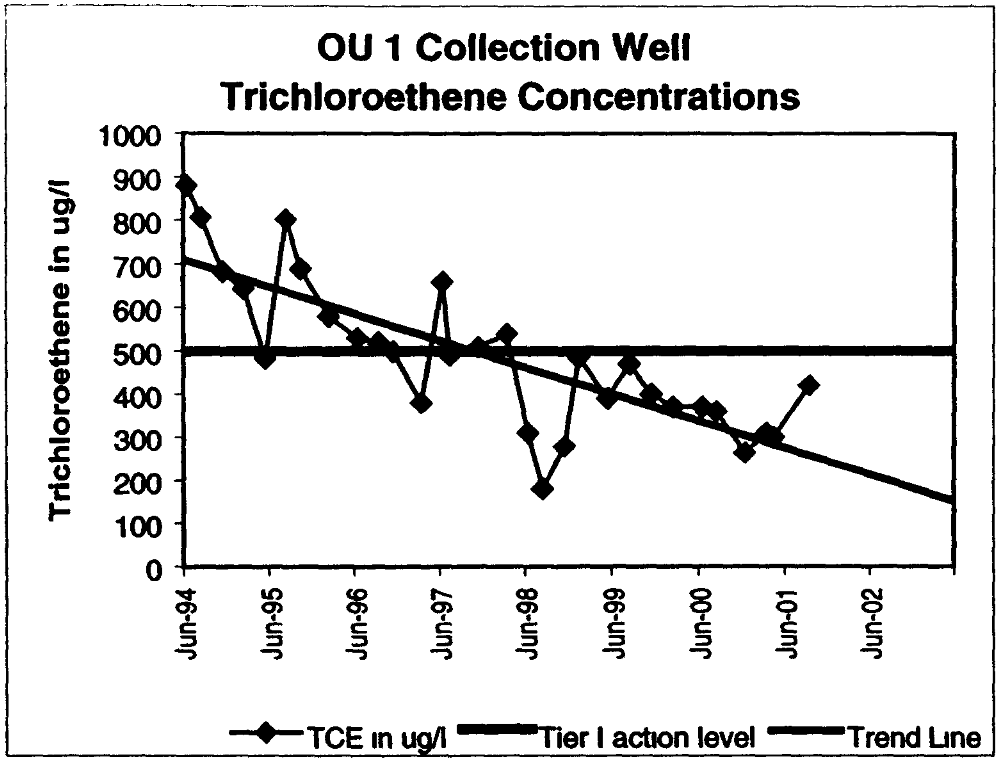

Figure 11. OU 1 Collection Well Trichloroethene Concentrations

5.2 Conclusions and Planned Changes

Based on the analytical data, beginning in April 2002, water from the collection well will no longer be collected. This is consistent with the modified CAD/ROD, which states that the collection well will be operated for one year after the signing of the final modification (DOE 2001). Also per the modified CAD/ROD, monitoring of the collection well will continue in order to verify that levels stay below RFCA Tier I Action levels.

6.0 OU 7 – PRESENT LANDFILL SEEP COLLECTION AND LEACHATE TREATMENT SYSTEM

Groundwater contaminated with low concentrations of VOCs and semi-volatile organic compounds (SVOCs) discharges at a seep at the eastern end of the Present Landfill (OU 7). The main contaminants that have periodically occurred above RFCA Action Levels are vinyl chloride and benzene.

A passive seep interception and treatment system operated between May 1996 and October 1998 The system used granular activated carbon (GAC) to reduce the contaminant concentrations before discharging water to the Landfill Pond However, the GAC did not effectively remove all contaminants and required a monthly change-out to maintain the appropriate operating efficiency

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The treatment system was modified in October 1998 to treat the seep water by passive aeration The modified system minimizes waste generation and is more effective in removing vinyl chloride The modified system also results in some treatment of the SVOCs, although the passive aeration treatment system is primarily designed to treat VOCs

In the passive aeration treatment system, the water is collected in a settling basin, flows through a pipe to a set of stepped flagstones, and then flows over a six-foot long bed of gravel before discharging into the Landfill Pond Flow is measured at the point of discharge Water quality samples are collected from the treatment system discharge endpoint (SW00196), defined as the point six feet downstream from the last aeration step Water released from the treatment system is collected in the Landfill Pond, which is periodically pumped into Pond A-3 in North Walnut Creek All water in North Walnut Creek passes through two regulatory control points (RFCA points of compliance) before discharge from the Rocky Flats Site

The OU 7 passive aeration treatment has operated since October 26, 1998 The performance of the system was previously reported in Evaluation of OU 7 Aeration Treatment System, November 1998-October 1999 (Kaiser-Hill 2000)

6.1 Volume of Seep Water/Leachate Treated

The total volume of seep flow measured and leachate treated, was 1,050,030 gallons for 2001 The volume treated by month is as follows.

Table 14. Volume Treated in Present Landfill Seep Collection And Leachate Treatment System

Month	Volume (gallons)
January	56,191
February	45,075
March	45,193
April	62,365
May	86,358
June	143,851
July	142,123
August	117,659
September	105,094
October	93,922
November	80,121
December	72,078

6.2 Treatment Effectiveness

Samples are collected and analyzed semi-annually in June and December. Sampling requirements are based on the Performance Evaluation Report (Kaiser Hill 2000) and on the Sampling and Analysis Plan (SAP) (Kaiser-Hill 2001a) The SAP was revised during

2000 and finalized in 2001 Comments from the Colorado Department of Public Health and Environment (CDPHE) and EPA were incorporated into the final SAP dated January 12, 2001 The CDPHE and EPA approved the SAP on July 26, 2001 Analytical results are compared to RFCA surface water standards to assess treatment system performance The standards are shown in the Table 15 below

Table 15 OU 7 Treatment System Water Analytes and Performance Standards

VOC Analytes	RFCA Surface Water Standard (µg/l)
Cis 1,2-Dichloroethene	70
Benzene	1
Chloromethane	5 7
Ethylbenzene	680
Methylene Chloride	5
Tetrachloroethene	5
Toluene	1,000
Trichloroethene	2 7
Vinyl Chloride	2
Xylene (Total)	10,000

RFCA values are based on RFCA Attachment 5, Table 1, Surface Water Action Levels & Standards, March 2000

In accordance with the SAP, only VOC samples are currently collected and analyzed All parameters analyzed in 2001 were within RFCA standards except benzene. However, the benzene concentration was either 1 or 2 µg/l for all sampling events The RFCA standard for Segment 4 is 1 µg/l

The SAP states that if a RFCA standard is exceeded in the semi-annual monitoring, then a sample will be collected and analyzed the month following receipt of validated data. Preliminary data are received from the analytical laboratory within a month of sampling and validated results are received one month later. Therefore, based on analytical results, sampling was performed quarterly in 2001 for benzene. The results are shown below in Table 16 for the years 2000 and 2001.

Table 16. Benzene Concentration in Present Landfill Leachate Treatment System Effluent

Month	Benzene Concentration (µg/l)
June 2000	1
July 2000	1 (special sample)
December 2000	2
March 2001	1
June 2001	2 (duplicate sample concentration was 1 µg/l)
September 2001	1 4
December 2001	0 3 (estimated below detection limit)

Note The results for September and December 2001 were reported to the tenth of a microgram because of differences in protocols and reporting between different laboratories

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The water discharging from the OU 7 seep treatment system into the Landfill Pond meets all surface water action levels, except benzene on an intermittent basis As stated in the RFCA Action Level Framework, the Segment 5 temporary modification to the stream standard for benzene is 5 µg/l, and the Segment 4 stream standard is 1 µg/l (The RFCA action level is applied as a standard in Segment 4) The temporary modification is in place until December 31, 2009 While the Landfill Pond is located in Segment 4, water from the pond is transferred about once a year to the A-series ponds in Segment 5 Benzene is not an analyte of interest at either the A-4 or the Walnut and Indiana Street Points of Compliance

6.3 Conclusions and Planned Changes

If validated analytical results exceed a RFCA Surface Water Standard for two consecutive sampling periods, quarterly VOC sampling will begin and continue until two consecutive sampling events show no exceedance or another remedy, either new or revised, is implemented Otherwise, the sampling frequency will return to a semi-annual basis Operation and maintenance of the treatment system will be evaluated if a standard is exceeded for two consecutive sampling periods

The collection and treatment of landfill leachate, as well as a permanent remedy, will be evaluated as part of the comprehensive closure plan for the landfill

7.0 PU&D YARD PLUME TREATABILITY STUDY

A plume of VOC-contaminated groundwater is derived from a contaminant source located in the PU&D Yard at RFETS Investigation results indicate that subsurface VOC contamination is present in only a few locations and that the primary contaminant is tetrachloroethene (Kaiser-Hill 2001b)

A treatability study is in progress to evaluate the effectiveness of Hydrogen Release Compound® (HRC®) for enhancing natural attenuation of the VOCs in the groundwater and soil at the PU&D Yard Plume. HRC® is a proprietary, environmentally safe, food quality, polylactate ester formulated for slow release of lactic acid upon hydration. The HRC® is expected to stimulate rapid degradation of chlorinated VOCs found in groundwater and soil at this location by making low concentrations of hydrogen available to the resident microbes to use for dechlorination. The HRC® is expected to be a one-time application According to the manufacturer (Regenesis), the material is expected to stimulate contaminant degradation at the project site for approximately one year and a half

The product has been used at other sites to stimulate rapid degradation of chlorinated VOC contaminants in groundwater and soil This study is evaluating the effectiveness of HRC® in the low-flow groundwater regimes common at RFETS (Kaiser-Hill 2001b) This project is a cooperative effort between RFETS and the Department of Energy (DOE) Subsurface Contaminant Focus Area (SCFA) and funding is provided by DOE SCFA

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7.1 Project Events

The treatability study is located within the source area and that portion of the PU&D Yard Plume exhibiting the highest contaminant concentrations (Figure 12) Monitoring Well 30900 was installed in this area immediately adjacent to borehole 17497 where the highest concentrations of VOCs in soils were detected An additional monitoring well (31001) was installed slightly downgradient of the source area in January 2001 as part of this study Baseline samples were collected from these two monitoring wells prior to insertion of the HRC®

Beginning in February 2001, 16 material insertion points (MIPs) were used to place over 800 pounds of HRC® into the subsurface A 10-foot by 6-foot grid was used for material insertion and was located within the source area of the plume immediately surrounding borehole 17497 (Figure 13) The initial grid consisted of nine points, additional Geoprobe™ boreholes used as material insertion points were spaced between these initial locations biased to the upgradient part of the source area HRC® insertion was completed on March 1, 2001 Subsurface conditions were allowed to stabilize for two months, then monthly sampling was initiated April 30, 2001

Groundwater samples were to be collected from the northwest and southwest corners of the insertion grid as possible (Kaiser-Hill 2001b) Sufficient groundwater was present at southwest corner of the insertion grid (MIP3) to collect a groundwater sample prior to insertion of the HRC®. There was insufficient water encountered at the northwest corner of the insertion grid (MIP1) to collect a groundwater sample at this location

7.2 Treatment Effectiveness

Results from the initial baseline samples and the monthly sampling events through late November 2001 are reported in Table 17. For completeness, the previous samples from the pre-existing monitoring well (30900) in the source area are also included In addition, results from the one-time-only groundwater sample from MIP3 are also shown Table 17

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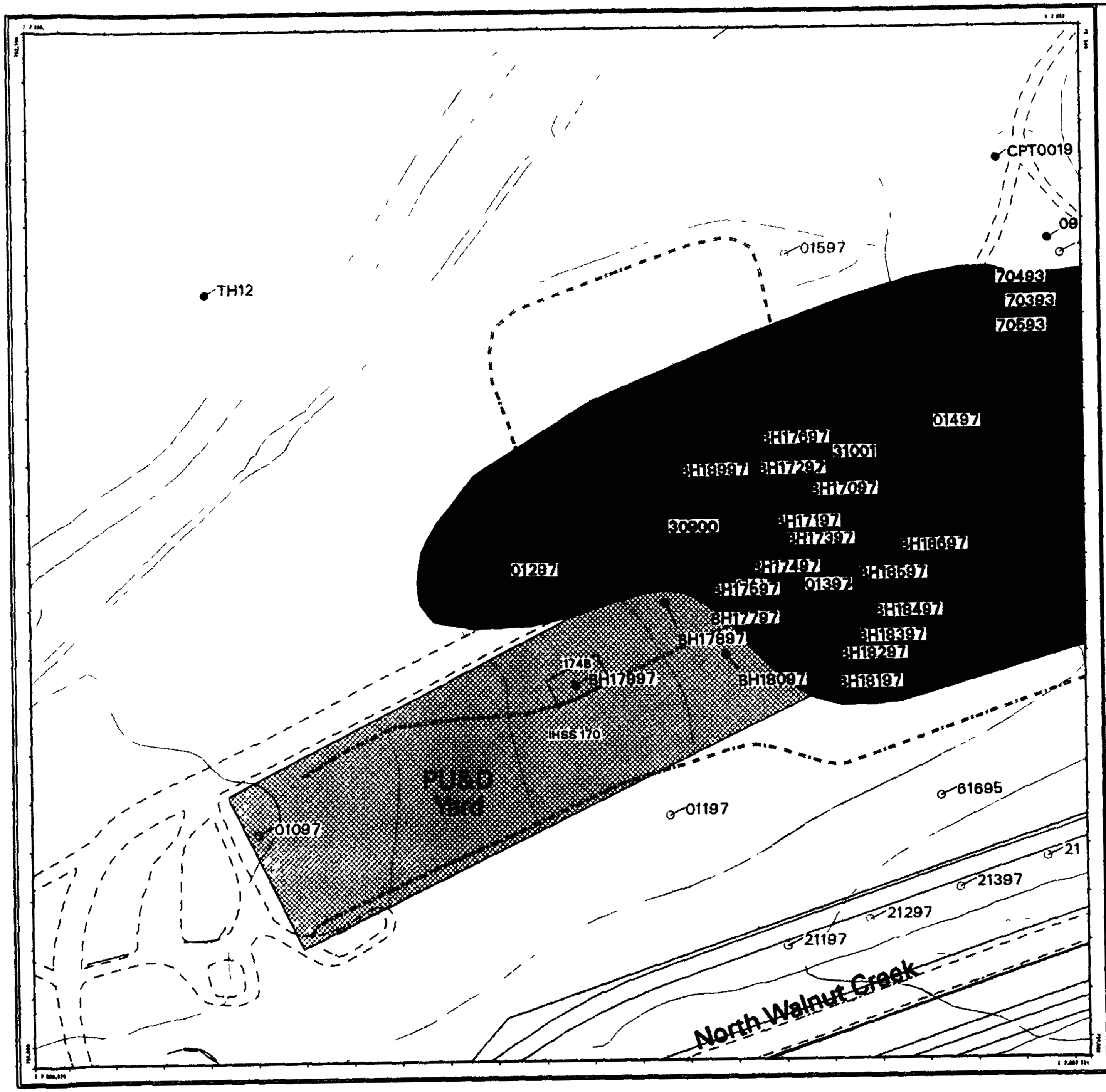

Figure 12
PU&D Yard Groundwater VOC Plume Project Area

EXPLANATION

- PU&D Yard Monitoring Well
- Groundwater Monitor Well UHSU Surficial Material
- Groundwater Monitor Well UHSU Bedrock
- Groundwater Monitor Well LHSU Bedrock
- Borehole Locations
- Abandoned Monitor Well
- Material Insertion Point
- Composite VOC Groundwater Plume (concentration equal to MCL)
- PU&D Yard IHSS

Standard Map Features

- Buildings and other structures
- Landfill Pond
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (5-Foot)
- Paved roads
- Dirt roads

NOTES:
Source of GIS data available upon request

Scale = 1 : 2570
1 inch represents approximately 214 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U S Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL

March 14, 2002

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Figure 13
PU&D Yard
Groundwater VOC Plume
Material Insertion Point Configuration

EXPLANATION

- PU&D Yard Monitoring Well
- Groundwater Monitor Well UHSU Surficial Material
- Groundwater Monitor Well UHSU Bedrock
- Groundwater Monitor Well LHSU Bedrock
- Borehole Locations
- Abandoned Monitor Well
- Material Insertion Point
- Composite VOC Groundwater Plume (concentration equal to MCL)
- PU&D Yard IHSS

Standard Map Features

- Buildings and other structures
- Landfill Pond
- Streams ditches or other drainage features
- Fences and other barriers
- Topographic Contour (5-Foot)
- Paved roads
- Dirt roads

NOTES
Sou ce of Gis dat a a l ble upon eq st

N

Scale = 1 70
1 inch represents approximately 6 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U S Department of Energy
Rocky Flats Environmental Technology Site

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Table 17. Preliminary Treatabilıty Study Results (in micrograms per liter (µg/l))

Location	Sample Date	Tetrachloro-ethene	Trıchloro-ethene	Cis 1,2 Dıchloro-ethene	Trans 1,2, Dıchloro-ethene	1,1-Dichloro-ethene	Vınyl Chloride
MIP3	2/20/01	4 9	ND	ND	ND	ND	ND
30900	10/21/00	96	7 4	53 1	ND	ND	ND
	2/7/01	120	7	78	0 5	0 5	ND
	4/30/01	180	11	110	0 1	0 4	ND
	5/30/01	350	23	210	ND	ND	ND
	6/27/01	240	15	140	0 2	0 5	ND
	7/31/01	93 6	10 6	91 4	0 19	0 31	0 21
	8/28/01	116	15	100	ND	0 39	ND
	10/1/01	50	5	77	ND	ND	ND
	10/31/01	34	3 1	36	ND	ND	ND
	11/29/01	30	3 6	45	ND	0 28	ND
	1/7/02	18 5	2 92	88 6	0 212J	ND	ND
31001	2/7/01	18	5.5	1 2	ND	2 6	ND
	4/30/01	130	20	52	0 1	4	ND
	5/30/01	41	18	4	ND	ND	ND
	6/27/01	120	25	38	ND	1	ND
	7/31/01	105	16 3	189	0 13	1 49	0 12
	8/29/01	81	22	93	ND	ND	ND
	10/1/01	67	7 7	71	ND	0 6	ND
	11/1/01	18	4 8	30	ND	0 65	ND
	11/30/01	15	3 7	24	ND	0 47	ND
	1/07/02	12	3 78	12 1	ND	0 88	ND
Groundwater Tıer I Actıon Levels		500	500	700	700	700	200
Groundwater Tıer II Actıon Levels		5	5	7	7	7	2

ND - not detected

As shown ın Table 17 and on Fıgure 14, concentrations of tetrachloroethene, trıchloroethene, and cıs 1,2-dıchloroethene in the source area well (30900) ıncreased after ınsertıon of the HRC®, then decreased Trıchloroethene and cıs 1, 2-dichloroethene are common degradatıon products of tetrachloroethene. According to Regenesis, approxımately 70% to 80% of project sıtes see an ınıtıal ıncrease ın VOC concentratıons before a downward trend ıs observed As shown below, thıs downward trend has contınued as predıcted

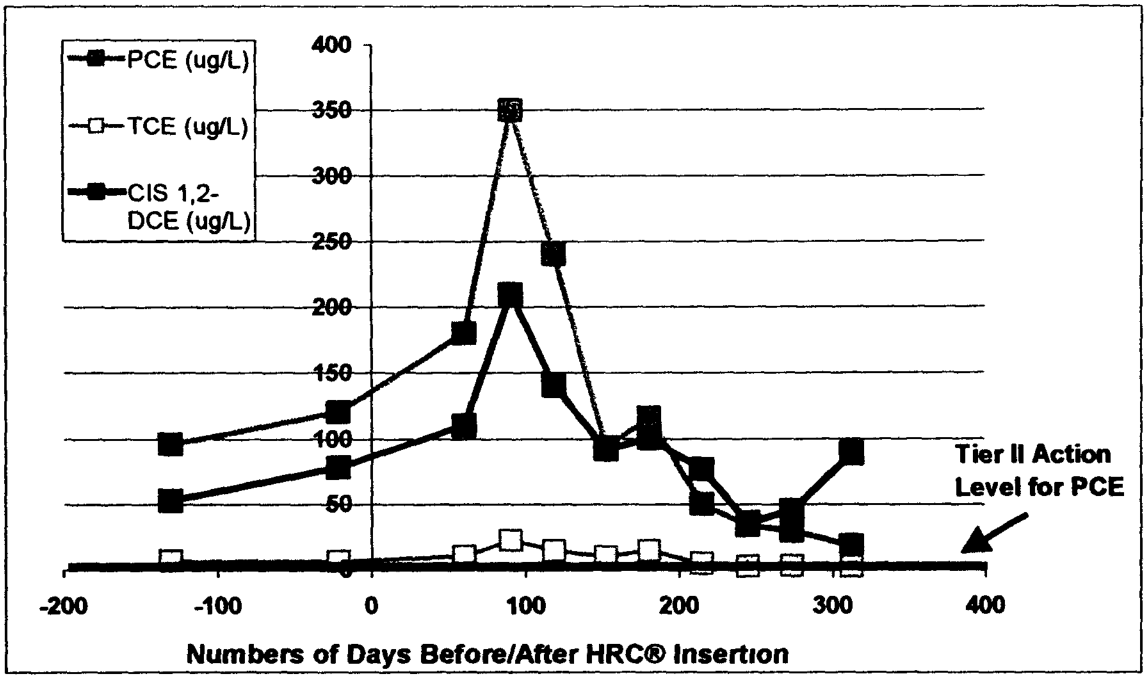

Figure 14. Tetrachloroethene and Degradation Products Concentration versus Time in 30900

As shown on Figure 15, data from Well 31001 show a similar pattern with the exception of the sample taken on May 30, 2001 (Day 90) that had lower than anticipated volatile organic values It is possible that there are problems with this sample although no errors could be found in the sample documentation

The initial increase in tetrachloroethene groundwater concentrations was most likely due to one or a combination of the following conditions

- A change in the surface tension of free phase solvents in the pores that would cause more solvent to be released from the pores
- A change in the relative solubility of the individual VOCs due to the presence of the lactic acid in the aqueous phase that would allow more VOCs to go into solution
- Other changes in liquid and organic phases caused by changes in pH, temperature, oxidation-reduction potential, etc caused by addition of lactic acid or by increases in biological activity
- A seasonal increase due to the rising water table and release of additional contaminants from the vadose zone

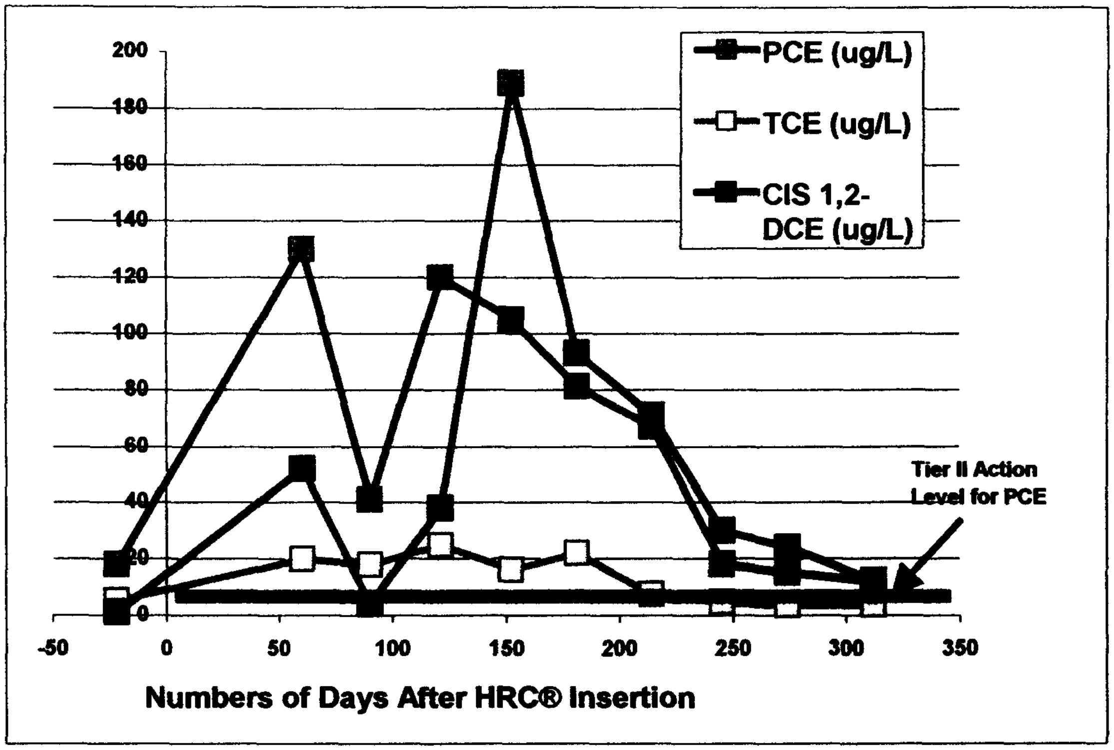

Figure 15. Tetrachloroethene and Degradation Products Concentration versus Time in 31001

The initial increases in concentrations indicate that VOCs are being transferred from the soil to an aqueous phase, potentially accelerating both soil and water remediation Typically, the VOCs trapped in the saturated zone have been the most difficult phase to remediate and continue to act as a contaminant source If these are being mobilized and then biologically degraded along with the dissolved phase, this will prove to be a much more robust treatment methodology than simply biologically degrading the dissolved fraction

As shown in Table 17, the presence of other degradation products such as trans 1,2-dichloroethene, 1,1-dichloroethene and vinyl chloride demonstrates that degradation is occurring because these contaminants were not associated with releases at the PU&D Yard Vinyl chloride is the last degradation product generated prior to the degradation to ethene The small quantities of ethene produced are expected to offgas rather than be detected

The increase in the ratio of degradation products relative to tetrachloroethene concentrations confirms that degradation is occurring Figure 16 shows the relative changes of mole fractions of tetrachloroethene and its degradation products in 31001 This trend, in combination with the overall reduction of tetrachloroethene, indicates that even though additional tetrachloroethene was liberated to the aquifer, much of this has been degraded It is anticipated that over time there will be a further decrease in these degradation products as well

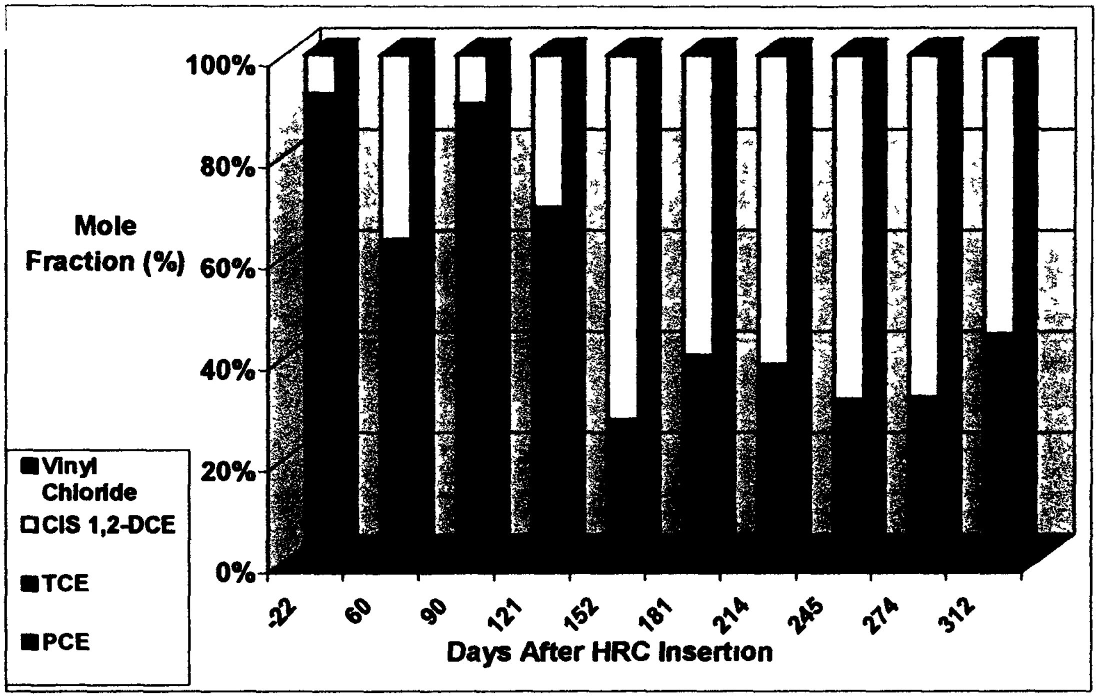

Figure 16. Mole Fraction of Tetrachloroethene in Well 31001 Relative to its Degradation Products over Time

7.3 Conclusions and Work Planned

The continued decrease in tetrachloroethene and appearance of its byproducts provide direct evidence that the contaminant plume is being degraded However, monthly monitoring will continue until sufficient data are collected to establish the effectiveness of the HRC® and the results will be presented in the Quarterly Plume Reports A treatability study report was completed in October 2001 and provides additional information on the treatability study (Kaiser-Hill 2001c)

8.0 REFERENCES

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