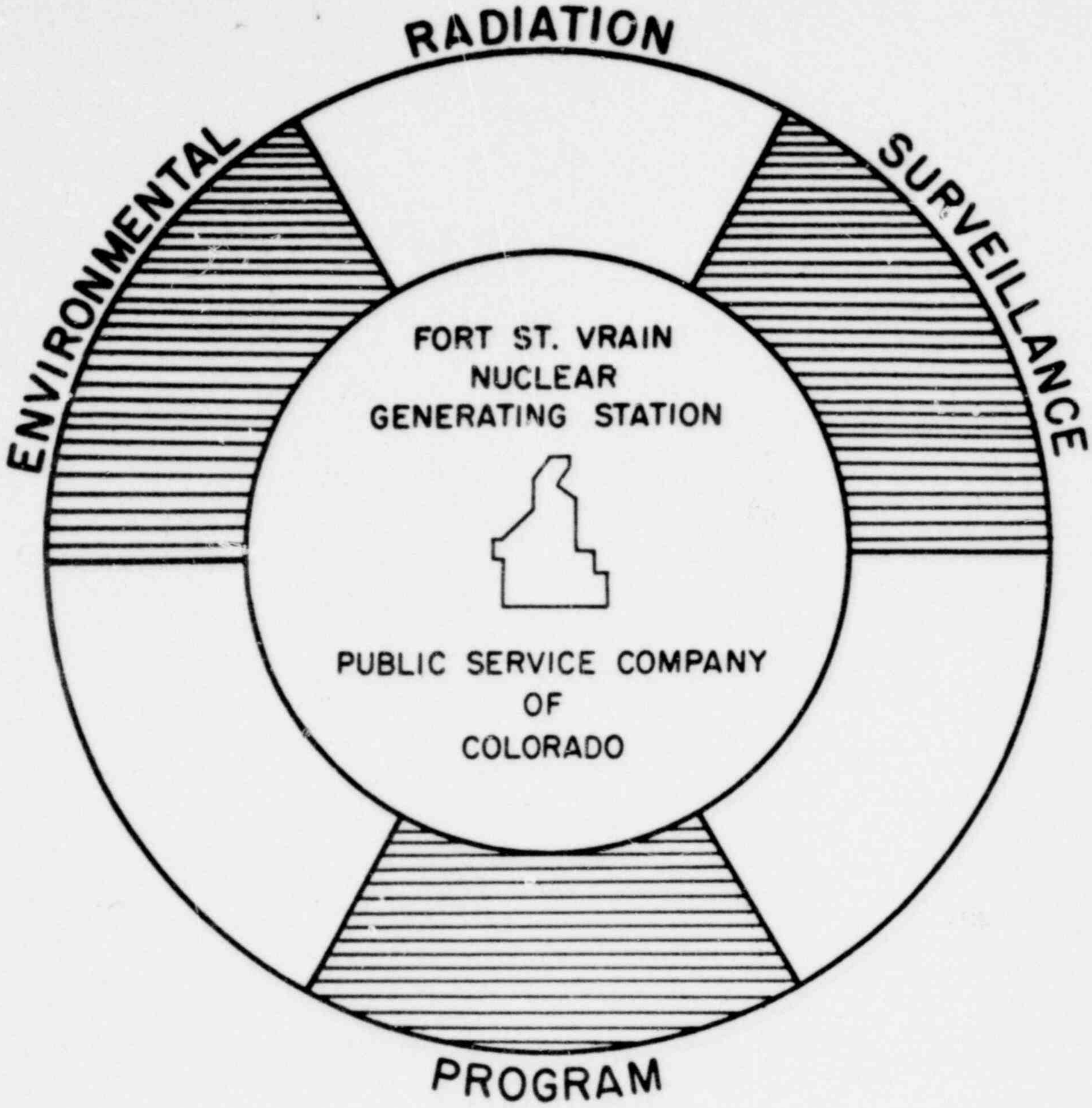

SUMMARY REPORT
FIRST AND SECOND QUARTERS
1979

PURCHASE ORDER 38951

1048 140

COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80521

7909270480

FORT ST. VRAIN NUCLEAR GENERATING STATION

ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM

Summary Report
for the period
January 1, 1979 - June 30, 1979

Prepared by:/s/ James Johnson — 8/10/79
James E. Johnson, Professor, Colorado State University — Date

Reviewed by:/s/ Don R Alexander — 8/15/79
Health Physics Department, Fort St. Vrain — Date

Reviewed by:/s/ R. A. Petzke — 8/16/79
Nuclear Project Department — Date

Approved by:/s/ [signature] — 8/16/79
Operations Manager, Fort St. Vrain — Date

Approved & Issued by:/s/ M. H. Holmes — 8/23/79
Nuclear Project Department — Date

ENVIRONMENTAL RADIATION SURVEILLANCE

conducted in the vicinity of the

FORT ST. VRAIN NUCLEAR GENERATING STATION

for the

PUBLIC SERVICE COMPANY OF COLORADO

Purchase Order No. 38951

SUMMARY REPORT

for the period

JANUARY - JUNE 1979

by
James E. Johnson

Department of Radiology and Radiation Biology
Department of Animal Sciences

COLORADO STATE UNIVERSITY

Fort Collins, Colorado

July 1979

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Kati Tengerdy

Frank Vumbaco

Marilyn Watkins

Susan White

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I. Introduction to Radiation Surveillance Data for the First Half of 1979.

During the first six months of 1979 the Fort St. Vrain Nuclear Generating Station generated power as follows:

Month	Dates With Electric Generation	Number of Days Without Generation	Gross Generation (MWH)
January	1-19, 23-31	3	109,306
February*	1	27	546
March*	0	31	0
April*	0	30	0
May*	0	31	0
June*	0	30	0

*Refueling outage from February 1, 1979 through end of reporting period.

It is important to note that the reactor was shut down for nearly the entire reporting period. Reactor effluents were therefore minimal during the period and due only to scheduled releases from various holding systems.

It should also be noted that the Republic of China conducted an atmospheric test of a nuclear weapon December 14, 1978. Any tropospheric and/or stratospheric radioactive debris from this test should have been evident during the present reporting period.

The environmental sampling and analysis program was essentially unchanged as compared to previous reporting periods. Essentially all radioactivity data measured on this project are near background levels and more importantly near the minimum detectable activity (MDA) levels for each radionuclide and sample type. It is well documented that even independent of the above reasons, environmental data exhibit great inherent

variability. As a result, the overall variability of the surveillance data is quite large and it is necessary to use mean values to make any conclusions about the true absolute radioactivity concentrations in any environmental pathway.

It is well documented that environmental radiation surveillance data commonly exhibit non-normal frequency distributions. More often than not the data can be satisfactorily treated using log-normal statistics. However, when the number of observations is small, i.e. less than 10, log-normal treatment is tentative.

When a high percentage of data points are less than MDA or MDC, the minimum detectable concentrations of activity in that sample type, calculation of true mean values is impossible. Therefore in this report we have chosen to not include mean values with each data table. At the end of this report in Section II.H., Conclusions and Summary, we have listed the calculated arithmetic means and confidence intervals for the entire reporting period as well as for the last year. We also list the geometric means and standard deviations for the last year of data reporting. If the data point measured resulted in a negative value, this value was used in calculating the true mean value in Table II.H.1. This is the current accepted practice by the U. S. Nuclear Regulatory Commission. It should be noted that we have not used any footnote for values less than MDC. Rather we list the measured value as less than the actual MDC value. Because this value is dependent upon variables such as the background count time and sample size, the MDC value will be different for each sample type and even within sample type.

Many sets of data were compared in this report. The statistical test used was either a "t"-test or a paired "t"-test. If data sets are noted to be significantly different or not significantly different, the confidence for the statement is at the 95% level (α=0.05).

The following is the footnote system used in this report.

a. Sample lost prior to analysis.

b. Sample missing at site.

c. Instrument malfunction.

d. Sample lost during analysis.

e. Insufficient weight or volume for analysis.

f. Sample unavailabe.

g. Analysis in progress.

N.A. Not applicable.

II. Surveillance Data for January through June 1979 and Interpretation of Results.

A. External Gamma-ray Exposure Rates

The average gamma-ray exposure rates expressed in mR/day are given in Table II.A.1. The values were determined by CaF_2:Dy (TLD-200) crystals for each of the 37 locations (See Table III.B.1). The total exposure recorded by each TLD was divided by the number of days that elapsed between pre-exposure and post-exposure annealing to obtain the average exposure rate. The TLD devices are changed monthly at each location.

The data are grouped for Facility (F), Adjacent (A) and Reference (R) zones. See Figures III.B.1 and III.B.2 and Table III.B.1, III.B.2, and III.B.3 for the exact TLD locations.

The TLD data indicate that the mean measured exposure rate in the Facility area was approximately 168 mR/year. The standard deviation was 10.4 mR/year. There were no significant differences between the values for the Facility, Adjacent and Reference areas. The exposure rate is due to cosmic rays, to natural gamma-ray emitters in the earth's crust and to surface deposition of fission products from world wide fallout.

Inspection of the values recorded for the Adjacent area again show a pattern of high values for the station A-35. Figure II.A.1 shows that this pattern has been observed since June of 1978, and has been extremely regular. In June of 1979, we set out 5 additional TLD devices at the A-35 site and collected one per week. This data showed that a high value occurred during the period 7/12 to 7/17. The daily mean exposure rate for that 5-day period was 6.2 mR/day.

More importantly the correction is not performed so that the data collected during the preoperational phase may be compared directly to postoperational. The fading is particularly evident in the TLDs that are left at each site for a one-year period. The mean values for those are significantly lower than for the TLDs changed monthly. The mean value for the Facility area was not significantly different from the values for the Adjacent or Reference areas.

The variation observed between collection dates at the same site are due to true site variation and variation in the TLD readout procedure. As mentioned in previous reports the latter is probably the largest component of this variation.

Table II. A.1 Gamma Exposure Rates Measured by the TLD Technique (mR/day)

Facility Area Locations	Average Daily Gamma Exposure Rates						Annual
	Jan.	Feb.	Mar.	April	May	June	1978-1979
F 1	.43	.39	.45	.46	.50	.42	.37
F 3	.45	.45	.48	.47	.49	.40	.28
F 4	.42	.40	.41	.41	.48	.41	.25
F 7	.48	.40	.51	.41	.48	.42	.37
F 8	.48	.44	.46	.45	.50	.46	b
F 9	.48	.42	.54	.46	.49	.43	.24
F 11	.45	.38	.48	.42	.49	.46	.33
F 12	.49	.46	.51	.41	.53	.49	.38
F 13	.50	.40	.45	.46	.49	.49	.24
F 14	.46	.39	.36	.40	.47	.45	.29
F 46	.50	.44	.53	.45	.49	.49	.41
F 47	.52	.43	.49	.45	.48	.44	.20
F 51	.47	.42	.45	.42	.49	.42	.21
Adjacent Area Locations							
A 5	.49	.43	.44	.46	.45	.47	.33
A 6	.44	.43	.42	.36	.43	.41	.27
A 27	.46	.40	.44	.41	.44	.45	.30
A 28	.44	.39	.40	.41	.44	.42	.32
A 29	.45	.40	.44	.42	.47	.46	.15
A 30	b	.45	.49	.42	.47	.48	b
A 31	.41	.38	.39	.41	.46	.42	.28
A 32	.49	.40	.44	.42	.43	b	.29
A 33	.47	.43	.46	.40	.50	.42	.31
A 34	.52	.47	.51	.49	.50	.46	.33
A 35	.52	1.09	*.47	2.50	.51	.38	.22
A 36	.47	.53	.44	.42	.49	.48	.32
Reference Area Locations							
R 15	.43	.39	.45	.43	.41	.49	.34
R 16	.50	.39	.54	.47	.55	.49	.27
R 17	.42	.36	.43	.39	.42	.42	.23
R 18	.41	.36	.44	.41	.42	.44	.31
R 19	.41	.36	.44	b	.42	.40	.28
R 20	.45	.41	b	.42	.45	.45	.26
R 21	.46	.41	.46	.42	.41	.47	.34
R 22	.45	.41	.46	.42	.49	.47	.37
R 23	.42	.41	.47	.40	.45	.42	.17
R 24	.52	.44	.54	.51	.54	.52	.40
R 25	.47	.39	.46	.45	.38	.48	.38
R 26	.42	.41	.44	.38	.42	.45	.29

*. TLD Moved to new site March 3
b. Sample missing at site

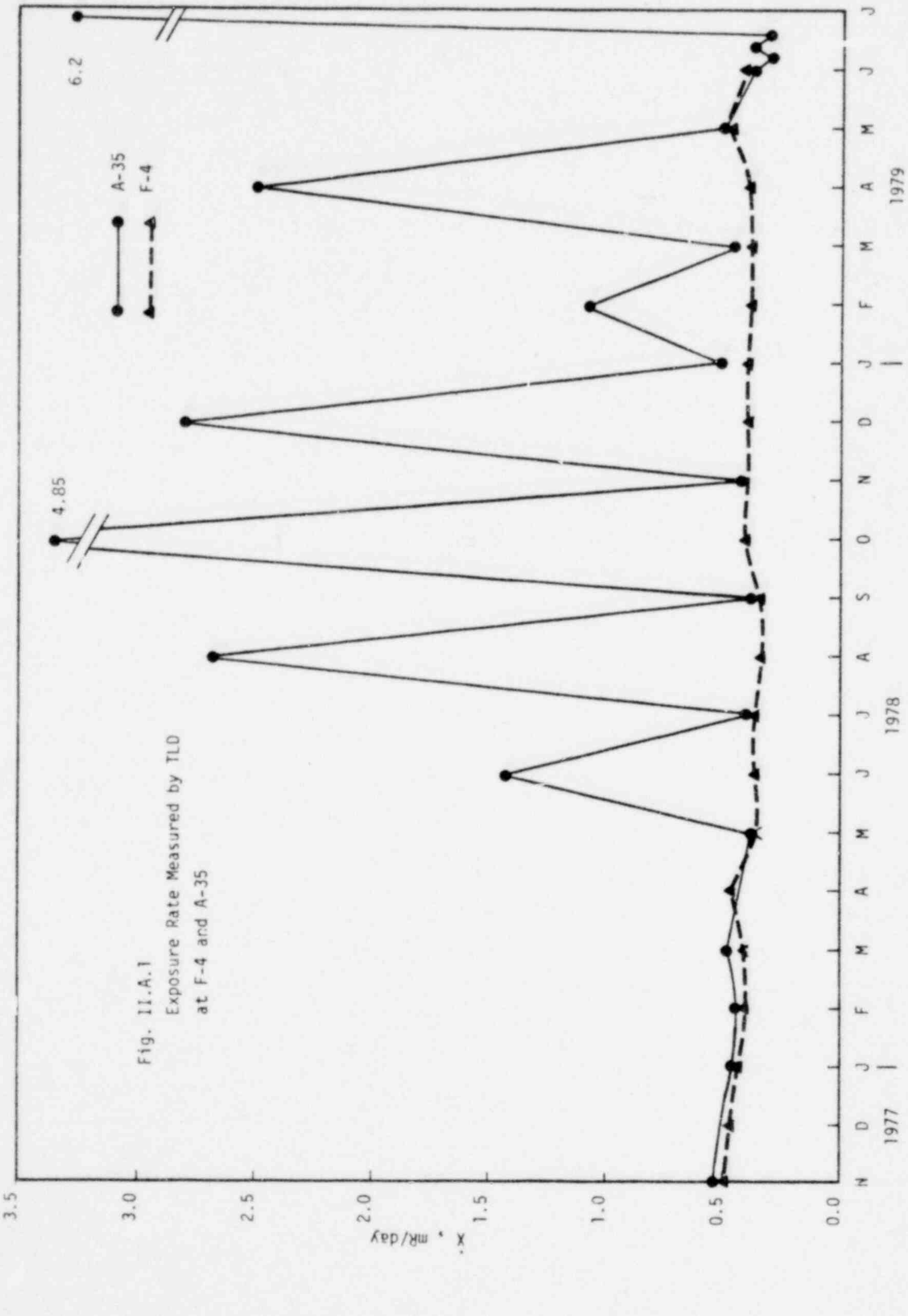

Fig. II.A.1
Exposure Rate Measured by TLD
at F-4 and A-35

II.B. Air Sampling Data

1. Gross alpha and beta activity

The concentrations of gross alpha and beta activity measured on air particulates for the Facility and Adjacent sampling sites are listed in Table II.B.1 and II.B.2. Figure II.B.1 shows the data from F-1, F-4 and A-35. There is slight evidence of tropospheric debris from the December 14, 1978, Republic of China nuclear weapon test and also slight evidence of a spring time injection of stratospheric debris from previous weapons test. There is no correlation of air concentrations measured at A-35 and the exposure rate data.

As discussed in the previous section and in III.A. the A-35 location was changed in February of 1979.

Table II. B.1
Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m^3).
a) First Quarter, 1979.

Date Collected 1979	Facility Areas 1	2	3	4	Adjacent Areas 5	6	35
Jan. 6	4.6 (0.8)*	4.6 (0.8)	9.8 (1.4)	6.9 (1.2)	4.2 (0.7)	6.0 (1.1)	***
Jan. 13	4.6 (0.9)	5.8 (1.1)	5.4 (1.0)	5.4 (1.0)	4.3 (0.7)	8.3 (1.5)	***
Jan. 20	8.4 (1.1)	6.3 (1.0)	5.2 (0.8)	4.0 (0.7)	4.5 (0.7)	9.0 (1.2)	***
Jan 27	2.5 (0.6)	5.4 (1.0)	1.7 (0.5)	4.9 (1.0)	a	2.9 (0.8)	***
Feb. 3	1.0 (0.4)	1.7 (0.5)	1.2 (0.4)	6.5 (1.2)	2.6 (0.5)	3.9 (0.8)	***
Feb. 10	2.6 (0.9)	1.6 (0.4)	0.4 (0.2)	2.3 (0.6)	1.2 (0.3)	2.9 (0.8)	0.9 (0.3)
Feb. 17	5.0 (1.1)	4.2 (0.8)	2.9 (0.6)	3.2 (0.8)	3.0 (0.6)	2.8 (0.6)	4.9 (1.0)
Feb. 24	5.2 (1.0)	0.6 (0.2)	1.7 (0.4)	7.1 (1.2)	2.4 (0.6)	3.3 (0.8)	4.1 (0.8)
Mar. 3	4.4 (1.0)	3.2 (0.7)	2.4 (0.5)	4.0 (0.9)	1.4 (0.3)	2.6 (0.6)	3.0 (0.7)
Mar. 10	2.4 (0.5)	2.0 (0.4)	1.4 (0.3)	4.6 (1.0)	2.3 (0.5)	2.4 (0.7)	3.0 (0.8)
Mar. 17	3.6 (1.1)	3.3 (0.7)	7.3 (1.0)	5.1 (1.2)	2.1 (0.6)	3.6 (0.7)	2.9 (0.8)
Mar. 24	3.2 (0.9)	a	1.2 (0.3)	2.6 (0.6)	2.1 (0.4)	2.0 (0.5)	1.9 (0.4)
Mar. 31	3.3 (0.8)	2.1 (0.6)	1.4 (0.4)	7.9 (1.3)	0.6 (0.4)	1.5 (0.4)	**
Quarterly (51 samples)		-minimum 0.4 -maximum 9.8 -average 3.8			Quarterly (32 samples)		--minimum 0.6 -maximum 9.0 -average 3.1

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} µCi/ml.
* Uncertainties (in parenthesis) are for the 95% confidence interval (1.96 S.D.).
** Excessive dust loading, analysis uncertain.
*** Pump removed from field 11/4/78. New site being located.
a Sample lost prior to analysis.

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Table II. B.1
Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m^3).
b) Second Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1979							
April 7	7.8 (1.2)*	1.2 (0.4)	4.7 (0.6)	4.1 (0.9)	1.4 (0.4)	2.1 (0.6)	4.8 (0.8)
April 14	1.8 (0.6)	1.8 (0.5)	<0.8	2.9 (0.8)	a	1.1 (0.3)	1.7 (0.4)
April 21	11.1 (1.5)	5.8 (0.9)	4.0 (0.7)	11.0 (1.8)	3.9 (0.7)	5.5 (1.1)	7.1 (1.1)
April 28	7.9 (1.5)	5.0 (0.9)	4.9 (0.8)	8.9 (1.6)	3.7 (0.7)	5.6 (1.1)	5.8 (1.0)
May 5	6.4 (1.1)	2.1 (0.5)	3.4 (0.7)	7.4 (1.4)	3.4 (0.8)	4.2 (0.8)	2.5 (0.6)
May 12	2.2 (0.4)	1.0 (0.3)	0.9 (0.3)	3.0 (0.8)	2.4 (0.7)	0.8 (0.3)	1.4 (0.4)
May 19	5.1 (1.0)	2.3 (0.4)	1.6 (0.4)	10.9 (1.7)	3.4 (0.8)	4.1 (0.9)	2.3 (0.5)
May 26	6.4 (1.1)	6.3 (0.8)	2.7 (0.6)	14.7 (2.9)	4.3 (0.9)	2.1 (0.6)	2.9 (0.6)
June 2	4.8 (1.0)	6.0 (1.0)	3.5 (0.1)	5.6 (0.1)	3.4 (6.7)	3.5 (0.8)	3.6 (0.7)
June 9	6.0 (0.1)	7.0 (0.1)	3.9 (0.7)	10.3 (0.2)	6.4 (1.5)	3.2 (0.7)	4.2 (0.8)
June 16	4.7 (0.9)	5.9 (0.1)	3.2 (0.6)	11.8 (0.2)	5.7 (0.9)	6.1 (1.0)	2.4 (0.5)
June 23	4.5 (1.1)	7.4 (1.6)	8.4 (0.1)	7.1 (0.1)	4.6 (0.1)	3.4 (0.7)	2.1 (0.4)
June 30	4.6 (1.1)	7.5 (1.6)	8.6 (1.7)	8.4 (2.1)	**	4.8 (1.0)	12.7 (1.3)
Quarterly (52 samples)				-minimum 0.8 -maximum 14.7 -average 5.6	Quarterly (38 samples)		-minimum 0.8 -maximum 12.7 -average 3.8

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} μCi/ml.
* Uncertainties (in parentheses) are for the 95% confidence interval (1.96 S.D.).
** Excessive dust loading, analysis uncertain.
a Sample lost prior to analysis.

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Table II.B.2

Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m^3).

b.) First Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1979							
Jan. 6	28 (1)*	40 (2)	29 (2)	48 (2)	21 (1)	28 (1)	**
Jan. 13	23 (1)	26 (1)	30 (1)	25 (1)	17 (1)	39 (2)	**
Jan. 20	19 (1)	23 (1)	20 (1)	18 (1)	16 (1)	23 (1)	**
Jan. 27	12 (1)	16 (1)	13 (1)	25 (2)	a	17 (1)	**
Feb. 3	20 (1)	8 (1)	16 (1)	32 (2)	12 (1)	22 (1)	**
Feb. 10	31 (2)	10 (1)	11 (1)	13 (1)	7 (1)	6 (1)	9 (1)
Feb. 17	37 (2)	25 (1)	19 (1)	24 (2)	15 (1)	21 (1)	29 (1)
Feb. 24	29 (2)	5 (1)	11 (1)	27 (2)	11 (1)	16 (1)	17 (1)
Mar. 3	29 (2)	21 (1)	16 (1)	26 (2)	5 (1)	12 (1)	20 (1)
Mar. 10	18 (1)	11 (1)	9 (1)	22 (1)	10 (1)	15 (1)	12 (1)
Mar. 17	39 (2)	25 (1)	19 (1)	40 (2)	17 (1)	17 (1)	26 (1)
Mar. 24	24 (1)	a	9 (1)	17 (1)	6 (1)	13 (1)	12 (1)
Mar. 31	19 (1)	14 (1)	10 (1)	19 (1)	9 (2)	12 (1)	10 (1)

Facility Areas			Adjacent Areas		
Quarterly	-minimum	5	Quarterly	-minimum	5
(51 samples)	-maximum	48	(33 samples)	-maximum	39
	-average	22		-average	16

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} µCi/ml.

* Uncertainties (in parenthesis) are for the 95% confidence interval, (1.96 S.D.).

** Pump removed from field 11/4/78. New site being located.

a. Sample lost prior to analysis.

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Table II.B.2
Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m^3).
b) Second Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1979							
April 7	15 (1)*	11 (1)	6 (1)	20 (1)	7 (1)	10 (1)	11 (1)
April 14	22 (1)	16 (1)	12 (1)	23 (2)	a	7 (1)	11 (1)
April 21	24 (1)	19 (1)	11 (1)	31 (2)	14 (1)	17 (1)	21 (1)
April 28	30 (2)	20 (1)	16 (1)	31 (2)	11 (1)	16 (1)	19 (1)
May 5	25 (1)	9 (1)	10 (1)	29 (2)	15 (1)	13 (1)	10 (1)
May 12	9 (1)	5 (1)	8 (1)	18 (1)	16 (1)	5 (1)	8 (1)
May 19	25 (1)	13 (1)	9 (1)	31 (2)	19 (1)	15 (1)	15 (1)
May 26	23 (1)	12 (1)	11 (1)	54 (4)	20 (1)	13 (1)	14 (1)
June 2	20 (1)	28 (2)	9 (1)	25 (1)	13 (1)	11 (1)	11 (1)
June 9	23 (1)	35 (2)	11 (1)	25 (2)	25 (1)	9 (1)	11 (1)
June 16	16 (1)	28 (2)	11 (1)	26 (2)	17 (9)	9 (1)	11 (17)
June 23	20 (1)	39 (1)	24 (1)	27 (1)	17 (1)	8 (1)	13 (1)
June 30	15 (1)	32 (2)	23 (1)	24 (1)	17 (1)	9 (1)	8 (1)
Quarterly (52 samples)				-minimum 5 -maximum 54 -average 20	Quarterly (39 samples)		-minimum 5 -maximum 25 -average 15

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} μCi/ml.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a Sample lost prior to analysis.

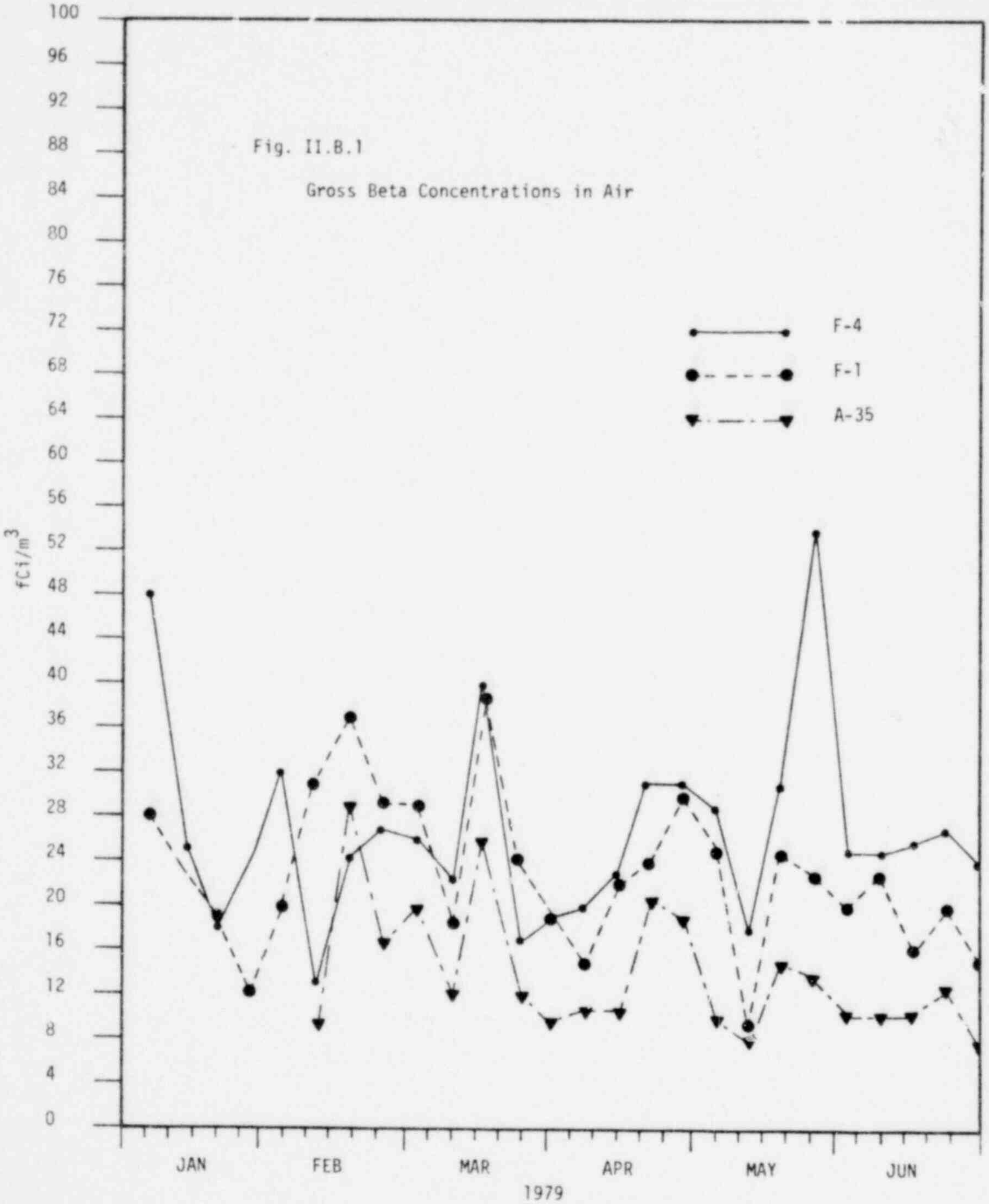

Fig. II.B.1
Gross Beta Concentrations in Air
F-4
F-1
A-35
fCi/m3
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
JAN
FEB
MAR
APR
MAY
JUN
1979

2. Tritium Activity. Tropospheric water vapor samples are collected continuously on Silica Gel at all seven air sampling stations (four in the Facility area and three in the Adjacent area). The specific activity of tritium in water in weekly samples from these stations is listed in Table II.B.3. The air concentration of tritium for the same weekly samples is listed in Table II.B.3a.

The variation of the measured tritium specific activity in tropospheric water vapor is large at all facility and adjacent air sampling sites. Figure II.B.2 shows the values for the facility sites and figure II.B.3 shows the values for the adjacent sites for the first half of 1979. There is general temporal agreement at all sites. Table II.B.3b shows the tritium activity released from the reactor by month for all modes of release. It can be noted that the batch liquid releases accounted for 95% of the total tritium released during the period. The individual batch release data is shown in Figure II.B.4. The temporal correlation of the release data and the measured specific activity in air water vapor is only reasonably correlated.

The peak values observed at all sites for the week ending 1/20/79 does correspond to the high batch release of 1/15 and 1/17 but the peak specific activity values observed at all sites for the week ending 2/3/79 proceeded the high batch releases of 2/13 and 2/15. It must be noted again that during this general time period tropospheric fallout debris from the 12/14/79 Republic of China weapon test was appearing in this area. It can be concluded that both the weapon test fallout and the liquid batch releases were responsible for the elevated tritium specific activity values. The values at F-2 which is closest to the principal liquid effluent discharge pathway seems to show the highest values and is probably the result of evaporation of tritium from the surface water. The actual measured concentration and temporal correlation is a function of environmental

temperature and humidity as well as surface water impoundment and flow rate.

It can be seen in Table II.C.2 and in Table II.H.1 that tritium specific activity in surface water has greater average values than in atmospheric water vapor. Ostlund (1) and Jacobs (2) noted that tritiated water precipitation that falls into the ocean is rapidly diluted. Subsequently, reevaporation of water into water vapor and precipitation on land has a much lower tritium content. Reevaporation from land surfaces undergoes less dilution and therefore, this water retains a higher tritium content. This observation implies that the current major source of background tritium in water vapor (and also precipitation) is the oceans which have lower tritium concentrations due to their great dilution ability (1).

At location F-4 a hygrothermograph has been operational for most of the first half of 1979. Using the temperature and relative humidity data from the hygrothermograph it is possible to convert specific activity data from the hygrothermograph it is possible to convert specific activity of tritiated water collected on Silica Gel (pCi/liter) to activity per unit volume of air (pCi/m^3). This is critical if calculation of immersion dose from tritiated water vapor were ever necessary. Two equations are used in the conversion of pCi/liter of water to pCi/m^3 of air. The first equation is used to determine the vapor pressure of water (3):

$\log_{10} P = A - B\ (C+t)$, where: P = vapor pressure (mm Hg)
t = temperature (C)
A = 8.10765
B = 1750.286
C = 235.0

The temperature used is the integrated weekly value taken from the hygrothermograph. The conversion is completed in the second equation

which is the "Ideal Gas Equation:"

$PV = nRT$, where

P = vapor pressure (atmospheres)
V = volume (liters)
n = number of moles of gas
R = 0.08206 liter-atmospheres/mole-^{o}K
T = temperature in ^{o}K

The number of grams of water per cubic meter of air is then determined.

The value of "n" obtained is for saturated air. The relative humidity is therefore integrated over the week and this percentage of the saturated air value is taken. The final value is reported in pCi/m^3. This procedure has been applied to data collected for the first and second quarters of 1979 and listed in Table II.B.3a. These values are functions of both specific activity of tritium in water and the concentration of water in the air and show essentially the same location and time variations as the data in Table II.B.3.

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(1) H. G. Ostlund. Tritium in the Atmosphere and Oceans. In Tritium. Edited by A. A. Moghissi and M. W. Carter, 1971.

(2) Jacobs, D. G., 1968, "Sources of Tritium and Its Behavior Upon Release to the Environment," Oak Ridge National Laboratory, USAEC Report TID-24635.

(3) H. A. Lange, Handbook of Chemistry. 19th edition, revised. McGraw-Hill Book Co., New York, 1967. pp. 1436-1450.

Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).
a) First Quarter, 1979.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1-6-79	991 (292)*	783 (289)	367 (285)	<304	812 (290)	e	928 (291)
1-13-79	1,370 (396)	1,030 (292)	462 (286)	500 (286)	1,070 (292)	592 (287)	914 (287)
1-20-79	1,940 (301)	2,260 (305)	1,180 (294)	579 (281)	846 (290)	1,030 (292)	933 (290)
1-27-79	535 (283)	987 (287)	938 (286)	454 (281)	1,107 (288)	977 (286)	e
2-3-79	3,320 (816)	4,750 (324)	1,380 (291)	2,200 (300)	3,420 (312)	2,550 (304)	e
2-10-79	734 (284)	596 (284)	<299	358 (280)	561 (283)	389 (281)	322 (280)
2-17-79	593 (284)	1,020 (287)	383 (281)	790 (285)	<299	474 (282)	669 (284)
2-24-79	644 (301)	554 (300)	741 (302)	<318	<318	<318	<318
3-3-79	<318	759 (302)	984 (305)	<318	1,038 (305)	777 (303)	1,470 (310)
3-10-79	<359	1,218 (307)	<318	<318	<318	395 (298)	404 (295)
3-17-79	<359	<359	<359	<359	<359	<359	<359
3-24-79	<318	<318	334 (298)	<318	364 (298)	<318	<318
3-31-79	<311	380 (292)	505 (292)	349 (291)	<311	408 (292)	<311

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient weight or volume for analysis.

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Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).
b)Second Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
4-7-79	330 (256)*	276 (256)	400 (257)	422 (257)	288 (256)	434 (257)	486 (258)
4-24-79	476 (258)	307 (258)	729 (261)	597 (259)	436 (257)	<273	324 (256)
4-21-79	<279	<279	<279	<279	654 (265)	<279	<279
4-28-79	284 (261)	501 (263)	664 (265)	423 (263)	516 (264)	353 (262)	475 (263)
5-5-79	<310	<310	<310	372 (291)	<310	457 (292)	503 (293)
5-12-79	648 (295)	616 (294)	363 (291)	261 (290)	418 (292)	627 (295)	599 (294)
5-19-79	<310	897 (298)	743 (290)	744 (296)	991 (298)	767 (296)	622 (294)
5-26-79	393 (292)	814 (296)	612 (294)	1,060 (300)	629 (295)	1,180 (301)	666 (260)
6-2-79	<310	690 (295)	699 (295)	748 (296)	735 (296)	875 (248)	775 (246)
6-9-79	e	259 (234)	<250	<250	376 (236)	<250	<250
6-16-79	255 (234)	708 (239)	288 (235)	328 (235)	<250	<250	397 (236)
6-23-79	404 (273)	1,120 (260)	659 (275)	698 (276)	379 (272)	<290	615 (275)
6-30-79	649 (275)	1,310 (282)	<290	<290	<290	334 (272)	1,060 (280)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient weight or volume for analysis.

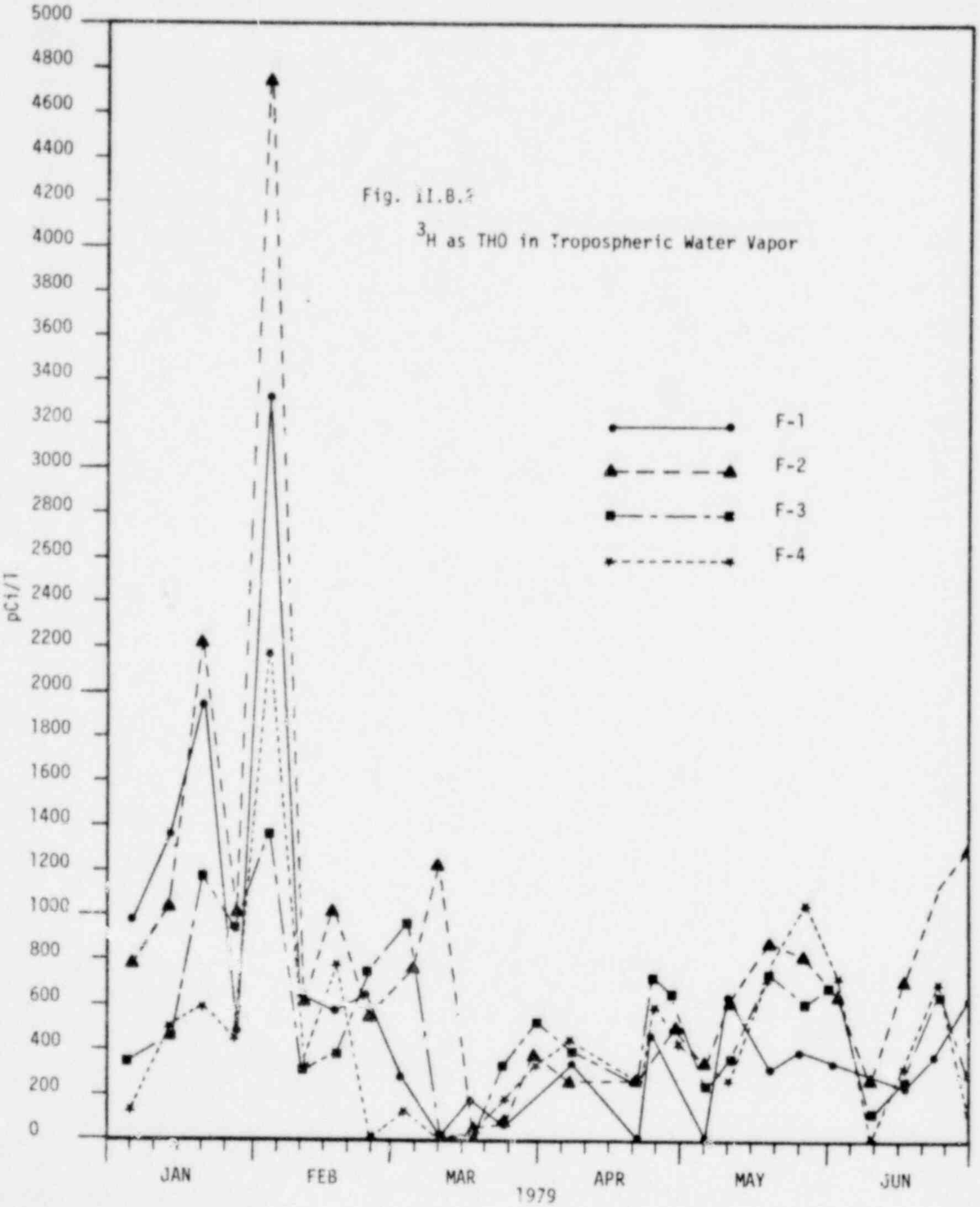

Fig. II.B.?

^3H as THO in Tropospheric Water Vapor

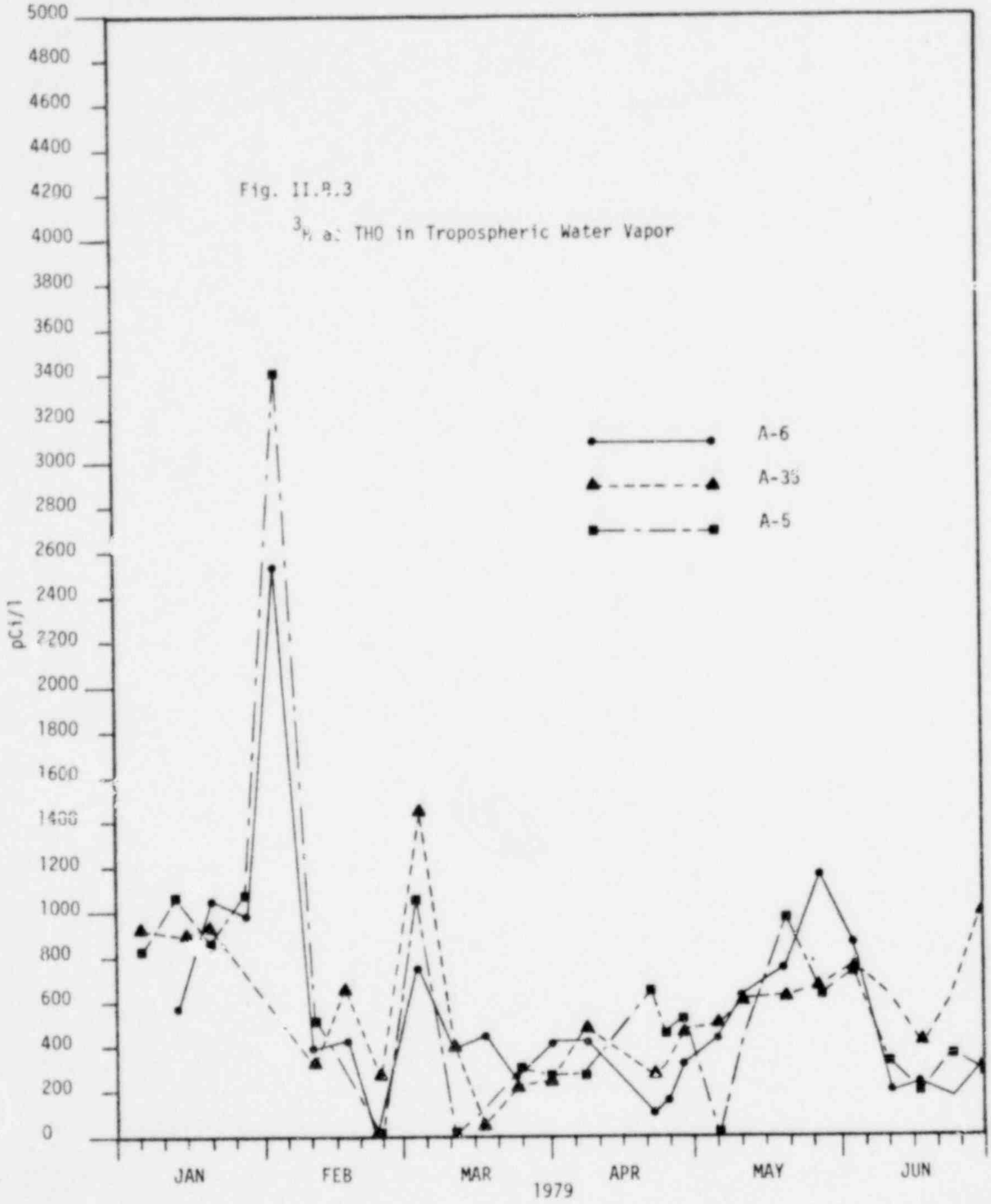
Fig. II.8.3
^{3}H as THO in Tropospheric Water Vapor
A-6
A-35
A-5
pCi/l
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
JAN
FEB
MAR
APR
MAY
JUN
1979

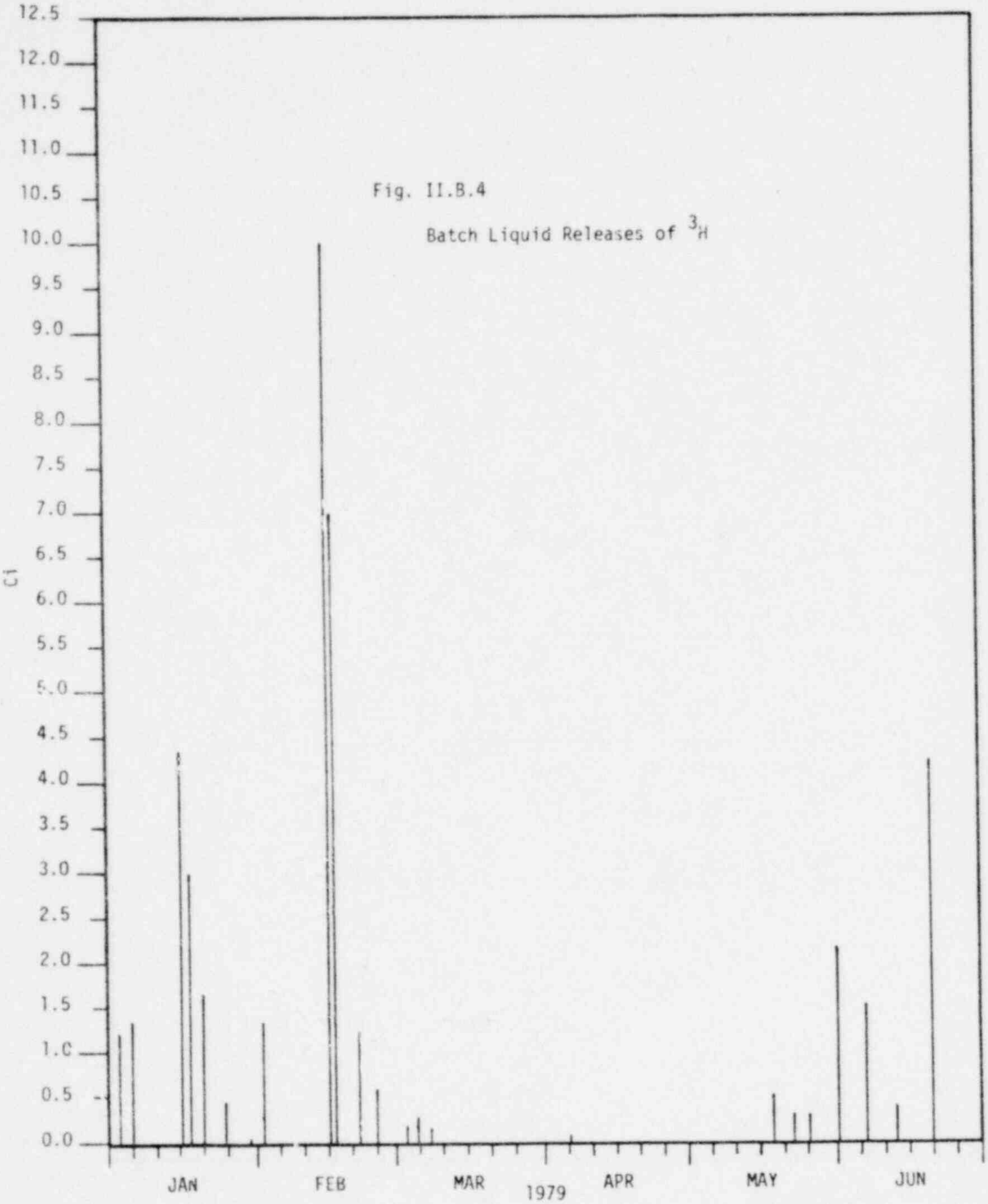
Fig. II.B.4
Batch Liquid Releases of ^3H
Ci
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
JAN
FEB
MAR
1979
APR
MAY
JUN

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Table II.B.3a
Tritium Concentrations in Air (pCi/m^3)

a) First Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
1-6-79	c	c	c	c	c	c	c
1-13-79	c	c	c	c	c	c	c
1-20-79	c	c	c	c	c	c	c
1-27-79	c	c	c	c	c	c	c
2-3-79	c	c	c	c	c	c	c
2-10-79	c	c	c	c	c	c	c
2-17-79	c	c	c	c	c	c	c
2-24-79	1.93	1.66	2.22	<0.953	<0.953	<0.953	<0.953
3-3-79	1.05	2.50	3.25	<0.970	3.42	2.56	4.85
3-10-79	<1.20	4.08	<1.20	<1.20	<1.20	1.32	1.35
3-17-79	<1.27	<1.27	<1.27	<1.27	<1.27	<1.27	<1.27
3-24-79	<1.27	<1.27	1.33	<1.27	1.45	<1.27	<1.25
3-31-79	<1.50	1.84	2.44	1.69	<1.50	2.03	<1.50

c - Instrument malfunction

Table II.B.3a
Tritium Concentrations in Air (pCi/m^3)

b) Second Quarter, 1979

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
4-7-79	1.21	1.01	1.46	1.55	1.05	1.59	1.78
4-14-79	2.10	1.35	3.21	2.63	1.92	<1.20	1.43
4-21-79	<1.52	<1.52	<1.52	<1.52	3.56	<1.52	<1.52
4-28-79	1.58	2.78	3.68	2.35	2.86	1.96	2.64
5-5-79	<1.59	<1.59	<1.59	1.91	<1.59	2.35	2.58
5-12-79	3.42	3.25	1.92	1.38	2.21	3.31	3.16
5-19-79	<2.42	7.12	5.89	5.91	7.87	6.09	4.93
5-26-79	3.53	7.31	5.49	9.52	5.65	10.6	5.98
6-2-79	2.18	5.03	5.09	5.45	5.36	6.38	5.65
6-9-79	e	2.25	<2.17	<2.17	3.27	<2.17	<2.17
6-16-79	c	c	c	c	c	c	c
6-23-79	4.13	11.4	6.73	7.13	3.87	<2.96	6.28
6-30-79	7.17	14.5	<3.20	<3.20	<3.20	3.69	11.7

c - Instrument malfunction

e - Insufficient weight or volume for analysis

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Table II.B.3b Tritium Released (Ci) in Reactor Effluents, 1979.

Mode	Jan	Feb	Mar	Apr	May	June	Total
Continuous liquid effluent, turbine sump and reactor sump	0.857	0.114	0.099	0.152	0.142	0.053	1.33 Ci
Gaseous, stack	0.240	0.205	0.067	0.048	0.068	0.036	0.664 Ci
Batch liquid	12.2	20.1	0.9	0.31	3.38	6.20	43.1 Ci
Total	13.3	20.4	1.07	0.51	3.59	6.29	45.2 Ci

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3. Activity of gamma-ray emitting radionuclides in air.

Table II.B.4 lists the concentrations of I-131 observed in air by activated charcoal sampling and gamma-ray spectrum analysis. The sample counted is a composite from all air sampling stations. All charcoal samples are counted approximately 20 days post collection to allow Rn-222 decay and minimize decay of I-131. The I-131 concentrations presented are the result of decay correction back to the midpoint of the sampling period. Decay correction to the midpoint of the sampling period is appropriate as any I-131 in air does not arrive at the sampling station at a constant rate, but rather in pulses short compared to the collection period. This is the case whether the I-131 source term is weapons testing fallout or reactor stack effluent. Table II.B.4 shows air concentrations of I-131 during the first half of 1979 to be generally lower than the last half of 1978. The peak values during January are the result of the Chinese weapons test of December 14, 1978.

Table II.B.5 lists the results of the gamma-ray spectral analyses of weekly composites of the membrane air filters in each sample head. Evidence of the December 14, Chinese weapons test was minimal.

The radioruthenium data is listed in the tables as Ru-106. However, it is true that the activity measured is often a mixture of Ru-103 and Ru-106. Both isotopes have gamma-rays at essentially the same energy and they cannot be separated by NaI(Tl) spectral analysis. No separation by half-life determination was attempted on the data. Since the half-life of Ru-103 is 40 days and that of Ru-106 is one year, in periods soon after an atmospheric test, a high proportion is expected to be Ru-103, and at later times predominately Ru-106. Since the ruthenium isotopes have negligible biological availability, neither has any consequences in calculation of population dose and efforts to separate them are not warranted.

Table II. B.4
Iodine-131 Concentrations in Air (Taken From Composites of Activated Charcoal at all Air Sampling Stations and Determined by Gamma Spectrometry).

Sample Ending Dates	^{131}I (fCi/m^3)
1-6-79	<4.76
1-13-79	303 (27.7)*
1-20-79	<4.22
1-27-79	193 (31.0)
2-3-79	<4.65
2-10-79	<4.53
2-17-79	<4.05
2-24-79	<3.68
3-3-79	<3.79
3-10-79	<3.70
3-17-79	89.8 (18.1)
3-24-79	<3.88
3-31-79	<4.08
4-7-79	<3.35
4-14-79	<4.24
4-21-79	<3.36
4-28-79	<3.33
5-5-79	<3.24
5-12-79	<3.16
5-19-79	<3.01

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m^3 = 10^{-15} μCi/ml.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table 'I. B.4
Iodin'-131 Concentrations in Air (Taken From Composites of Activated Charcoal at all Air Sampling Stations and Determined by Gamma Spectrometry).

Sample Ending Dates	^{131}I (fCi/m^3)
5-26-79	<3.42
6-2-79	<3.68
6-9-79	<4.18
6-16-79	16.4 (22.6)*
6-23-79	45.3 (22.0)
6-30-79	<4.28

All concentrations are expressed in femtocuries per cubic meter of air: $1\ fCi/m^3 = 10^{-15}\ \mu Ci/ml$.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II. B.5
Gamma-ray Emitting Radionuclide Concentrations in Air (Taken from Composites of all Air Sampling Stations) (fCi/m^3).

Sample Ending Dates	^{106}Ru	^{137}Cs	^{95}Zr & Nb
1-6-79	<1.76	0.779 (0.367)*	0.587 (0.227)
1-13-79	<4.72	4.71 (0.901)	1.22 (0.523)
1-20-79	<4.42	<0.980	0.667 (0.458)
1-27-79	<5.94	<1.32	<0.567
2-3-79	<1.61	0.932 (0.339)	0.664 (0.156)
2-10-79	<2.08	0.493 (0.484)	0.439 (0.228)
2-17-79	<4.27	<0.948	<0.405
2-24-79	12.4 (4.82)	<0.871	<0.376
3-3-79	10.9 (4.96)	<0.896	<0.386
3-10-79	8.92 (3.94)	<0.874	<0.377
3-17-79	6.05 (4.78)	<0.872	<0.376
3-24-79	8.10 (5.23)	3.17 ([illegible])	2.71 (0.371)
3-31-79	<4.28	<0.952	<0.412
4-7-79	<3.48	<0.771	<0.334
4-14-79	3.30 (2.38)	0.752 (0.399)	<0.123
4-21-79	<3.50	1.49 (0.708)	<0.335
4-28-79	6.06 (4.37)	1.48 (0.702)	<0.333
5-5-79	<3.35	0.832 (0.674)	<0.322
5-12-79	5.86 (1.32)	0.734 (0.223)	<0.0594
5-19-79	4.03 (3.85)	1.30 (0.634)	0.605 (0.275)
5-26-79	<3.45	2.29 (0.720)	0.374 (0.286)
6-2-79	<3.88	0.874 (0.767)	<0.371
6-9-79	<4.28	1.79 (0.872)	<0.411
6-16-79	<4.00	1.88 (0.831)	0.804 (0.387)
6-23-79	1.84 (2.38)	1.56 (0.397)	0.525 (0.172)
6-30-79	<4.38	3.15 (0.910)	0.801 (0.361)

All concentrations are expressed in femtocuries per cubic meter of air: $1\ fCi/m^3 = 10^{-15}\ \mu Ci/ml$.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.C.1 Radionuclide Concentrations in Surface Water

Table II.C.1 lists the gross beta activity in surface water and potable water supplies in the vicinity of the reactor. Values are given for both the suspended and dissolved solids fraction of the total water sample. The suspended solids fraction contains algae and sediment particles which have very high concentration factors for radionuclides and consequently is considerably higher than the dissolved solids fraction. These values are given for samples collected monthly. Potable water retains a negligible suspended solids fraction and consequently the gross beta values for potable water are significantly lower.

Values of gross beta concentrations in surface water fluctuated within upstream, downstream and effluent sites but the mean upstream and the mean downstream values were very similar. There was no significant difference between upstream and downstream water sample mean values. Mean values were slightly less than those measured during the last half of 1978. The gross beta concentrations in both potable water sources are lower but more variable than in surface water. The concentrations should be lower due to water purification which removes suspended solids and the variation is probably due to mixing of different reservoir sources.

Weekly samples, although not required by the Technical Specifications, were collected at E-38, the farm pond on the Goosequill ditch. This is the principal effluent route for liquid discharges from the reactor and a monthly sample may not be adequate to reflect periodic discharges. Gross beta concentrations are shown in Table II.C.1A. The mean concentration was 12.1 pCi/L and the standard deviation was 3.3. The mean was not significantly different from downstream or upstream values.

Table II.C.2 lists tritium in surface water and potable water supplies for each monthly collection for the first half of 1979. Values occasionally

fluctuate widely within Upstream and Downstream sites, but this variability cannot be attributed to any direct cause. The mean values for Upstream, Downstream and Potable water locations for tritium are not significantly different even though there were extremely wide variations. No reason can be given for these wide variations, particularly for the potable water supplies.

Significantly high tritium values were again observed at effluent sampling sites in the first half of 1979. This is directly attributed to liquid effluent releases by Fort St. Vrain. Downstream locations did not reflect any significant increases in tritium concentration, therefore no dose commitment calculations are warranted. Tritium values observed for weekly samples taken from E-38 are comparable to average tritium values in monthly composites. Note that Table II.C.2 indicates especially large values observed in March.

Table II.C.3 and II.C.4 lists Sr-90 and Sr-89 concentrations in surface water at the same sampling locations. Table II.C.4.A lists the same radionuclides as well as tritium in reactor effluent water samples collected weekly at E-38. Note that Table II.B.3b and Table II.C.4.A indicates the major tritium releases to be in February. This discrepancy with Table II.C.2 substantiates the need for continuous monitoring at E-38. A continuous sampling station will be designed for operation during the last half of 1979.

The concentrations of Ru-106, Cs-137 and Zr-Nb-95 in surface and potable water are given in Table II.C.5. The same radionuclides were measured in the weekly samples collected at E-38 and this data is shown in Table II.C.5.A. The elevated measure concentrations of the three fission products observed 1/27 and 4/21 cannot be explained at this time.

It is suspected that Ra-226 and/or throrium-232 contamination from soil particulates may be responsible. The samples will be counted again after a significant decay period to check on this possibility.

Table II. C.1
Gross Beta Activity in Water for Samples Collected January 20, 1979.

Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
Effluent			
E 38: Farm Pond (Goosequill)	<45,900	3,850 (1,880) *	20.1 (2.91)
E 41: Slough to St. Vrain Creek	<130,000	<2,530	7.45 (2.49)
Downstream			
D 37: Lower Latham Reservoir	<20,200	10,300 (2,020)	12.4 (2.64)
D 40: S. Platte River Below Confluence	<1,210,000	4,910 (1,880)	22.2 (2.97)
D 45: St. Vrain Creek	<135,000	22,000 (3,570)	13.8 (2.74)
Upstream			
U 42: St. Vrain Creek	<74,300	32,100 (3,920)	20.5 (2.96)
U 43: S. Platte River	<116,000	15,300 (2,800)	12.9 (2.63)
Potable			
F 49: Visitor's Center	N.A.	23,300 (7,270)	1.65 (0.516)
D 39: Gilcrest City Water	N.A.	8,460 (2,200)	8.60 (2.23)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Cross Beta Activity in Water for Samples Collected February 24, 1979.

Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
Effluent			
E 38: Farm Pond (Goosequill)	<55,300	4,110 (2,990)*	10.9 (2.55)
E 41: Slough to St. Vrain Creek	<193,000	13,600 (2,770)	10.3 (2.62)
Downstream			
D 37: Lower Latham Reservoir	16,600 (16,100)	9,470 (2,140)	11.5 (2.53)
D 40: S. Platte River Below Confluence	<75,600	9,320 (2,570)	6.87 (2.50)
D 45: St. Vrain Creek	<49,400	6,060 (2,270)	5.58 (2.39)
Upstream			
U 42: St. Vrain Creek	<60,900	9,370 (2,410)	8.32 (2.50)
U 43: S. Platte River	<88,600	8,200 (2,300)	6.78 (2.50)
Potable			
F 49: Visitor's Center	N.A.	19,400 (9,290)	1.01 (0.483)
D 39: Gilcrest City Water	N.A.	7,670 (2,250)	7.42 (2.18)

N.A. Not applicable.
* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected March 3, 1979 .

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	<50,800	14,500 (3,040)*	10.6 (2.55)
E 41:	Slough to St. Vrain Creek	<133,000	<2,430	<1.25
	Downstream			
D 37:	Lower Latham Reservoir	43,000 (16,700)	10,200 (2,170)	14.2 (2.49)
D 40:	S. Platte River Below Confluence	<25,400	11,600 (2,780)	10.5 (2.46)
D 45:	St. Vrain Creek	<33,300	8,080 (2,580)	7.75 (2.38)
	Upstream			
U 42:	St. Vrain Creek	<145,000	8,670 (2,190)	8.50 (2.50)
U 43:	S. Platte River	26,100 (15,800)	14,400 (3,110)	12.7 (2.48)
	Potable			
F 49:	Visitor's Center	N.A.	16,300 (11,800)	0.634 (0.460)
D 39:	Gilcrest City Water	N.A.	8,880 (2,450)	8.85 (2.23)

N.A. Not applicable.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected April 21, 1979.

	Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
	Effluent			
E 38:	Farm Pond (Goosequill)	24,800 (6,330)*	12,760 (3,640)	13.0 (2.32)
E 41:	Slough to St. Vrain Creek	<13,900	12,840 (3,240)	7.40 (2.51)
	Downstream			
D 37:	Lower Latham Reservoir	<48,500	3,070 (721)	11.7 (2.83)
D 40:	S. Platte River Below Confluence	<45,700	10,100 (3,530)	5.94 (2.37)
D 45:	St. Vrain Creek	<49,000	12,433 (3,300)	8.18 (2.46)
	Upstream			
U 42:	St. Vrain Creek	36,000 (13,100)	4,760 (4,260)	5.71 (2.14)
U 43:	S. Platte River	52,800 (21,900)	10,700 (2,790)	11.6 (2.40)
	Potable			
F 49:	Visitor's Center	N.A.	41,100 (10,500)	2.09 (0.533)
D 39:	Gilcrest City Water	N.A.	6,330 (2,240)	1.49 (0.527)

N.A. Not applicable.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.1
Gross Beta Activity in Water for Samples Collected May 26, 1979.

Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
Effluent			
E 38: Farm Pond (Goosequill)	<17,500	12,800 (2,930)*	11.1 (2.49)
E 41: Slough to St. Vrain Creek	d	d	d
Downstream			
D 37: Lower Latham Reservoir	<44,200	9,180 (2,010)	10.2 (2.59)
D 40: S. Platte River Below Confluence	<49,800	10,500 (4,580)	3.83 (2.34)
D 45: St. Vrain Creek	41,100 (18,300)	13,000 (6,220)	6.95 (2.22)
Upstream			
U 42: St. Vrain Creek	23,100 (18,100)	12,400 (9,920)	5.69 (2.25)
U 43: S. Platte River	87,200 (46,000)	9,220 (2,640)	9.95 (2.39)
Potable			
F 49: Visitor's Center	N.A.	44,300 (3,950)	9.04 (0.805)
D 39: Gilcrest City Water	N.A.	9,630 (2,260)	2.44 (0.0571)

N.A. Not applicable.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Sample lost in analysis.

Table II. C.1
Gross Beta Activity in Water for Samples Collected June 16,1979.

Sampling Locations	Suspended Solids pCi/kg	Dissolved Solids pCi/kg	Total Water Concentration pCi/l
Effluent			
E 38: Farm Pond (Goosequill)	28,000 (10,800)*	16,800 (4,790)	10.9 (2.35)
E 41: Slough to St. Vrain Creek	81,200 (58,300)	17,500 (4,390)	10.4 (2.41)
Downstream			
D 37: Lower Latham Reservoir	139,000 (56,000)	10,700 (2,240)	14.4 (2.50)
D 40: S. Platte River Below Confluence	59,500 (16,400)	21,300 (6,690)	11.5 (2.26)
D 45: St. Vrain Creek	55,700 (18,000)	15,700 (9.410)	7.24 (2.15)
Upstream			
U 42: St. Vrain Creek	69,700 (19,400)	20,300 (9,820)	8.84 (2.17)
U 43: S. Platte River	48,400 (36,700)	25,600 (8,020)	8.18 (2.33)
Potable			
F 49: Visitor's Center	N.A.	50,300 (35,[illegible]0)	0.654 (0.460)
D 39: Gilcrest City Water	N.A.	12,200 (2,780)	2.50 (0.568)

N.A. Not applicable.

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II.C.1.A.
Gross beta activity in effluent water, Goosequill Pond , E-38.

First Quarter, 1979

Collection Date	Suspended Solids pCi/kg*	Dissolved Solids pCi/kg*	Total Water Concentrations pCi/l
1-6-79	480,000 (302,000) *	5,790 (1,660)	10.8 (2.43)
1-13-79	44,900 (28,300)	3,710 (1,360)	7.95 (2.42)
1-20-79	< 45,900	3,850 (1,880)	20.1 (2.91)
1-27-79	70,300 (57,900)	10,500 (2,000)	14.2 (2.61)
2-3-79	< 32,400	15,400 (2,840)	11.9 (2.66)
2-10-79	< 310,000	14,100 (2,900)	11.1 (2.57)
2-17-79	< 57,800	20,600 (3,070)	17.9 (2.72)
2-24-79	< 55,300	4,110 (2,990)	10.9 (2.55)
3-3-79	< 94,000	20,100 (4,530)	9.16 (2.51)
3-10-79	< 50,800	14,500 (3,040)	10.6 (2.55)
3-17-79	43,800 (28,800)	11,300 (4,300)	7.19 (2.28)
3-24-79	< 56,700	14,700 (3,160)	11.2 (2.51)
3-31-79	< 40,800	13,200 (3,230)	9.45 (2.46)

* Uncertainties (in parentheses) are for the 95% confidence interval.

Table II.C.1.A.
Gross beta activity in effluent water, Goosequill Pond, E-38.

Second Quarter, 1979.

Collection Date	Suspended Solids pCi/kg*	Dissolved Solids pCi/kg*	Total Water Concentrations pCi/l
4-7-79	<64,700	23,000 (6,000)*	7.70 (2.43)
4-14-79	27,700 (10,900)	14,400 (4,550)	9.94 (2.30)
4-21-79	24,800 (6,330)	12,760 (3,640)	13.0 (2.32)
4-28-79	2,810 (1,220)	13,800 (3,510)	12.1 (2.53)
5-5-79	25,600 (19,600)	14,100 (3,050)	12.3 (2.50)
5-12-79	31,100 (8,500)	19,500 (4,970)	13.6 (2.34)
5-19-79	161,000 (64,600)	11,100 (2,770)	12.1 (2.41)
5-26-79	<17,500	12,800 (2,930)	11.1 (2.49)
6-2-79	a	a	a
6-9-79	42,400 (29,300)	21,400 (4,840)	11.6 (2.45)
6-16-79	28,000 (10,800)	16,800 (4,790)	10.9 (2.35)
6-23-79	41,800 (6,140)	21,200 (5,300)	19.7 (2.27)
6-30-79	46,100 (7,650)	15,300 (5,350)	14.9 (2.18)

*Uncertainties (in parentheses) are for the 95% confidence interval.

a Sample lost prior to analysis.

Table II. C.2
Tritium Concentrations in Surface Waters (pCi/l).

Sampling Locations	Monthly Collection Dates					
	1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-9-79
Effluent						
E 38: Farm Pond (Goosequill)	4,400 (321)*	2,249 (318)	6,520 (318)	913 (263)	11,400 (276)	1,190 (285)
E 41: Slough to St. Vrain Creek	573 (284)	1,300 (343)	14,200 (373)	1,620 (270)	f	581 (277)
Downstream						
D 37: Lower Latham Reservoir	<299	2,262 (318)	509 (260)	711 (261)	221 (275)	410 (277)
D 40: S. Platte River Below Confluence	<299	1,220 (307)	1,100 (265)	517 (258)	<295	<295
D 45: St. Vrain Creek	522 (282)	924 (264)	956 (264)	541 (257)	225 (275)	<295
Upstream						
U 42: St. Vrain Creek	<299	<359	1,130 (266)	745 (261)	726 (281)	354 (277)
U 43: S. Platte River	425 (281)	<359	871 (263)	542 (257)	625 (279)	<295
Potable						
F 49: Visitor's Center	3,520 (312)	740 (262)	590 (260)	477 (258)	5,940 (327)	<295
D 39: Gilcrest City Water	<299	843 (303)	968 (264)	747 (261)	753 (281)	416 (277)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable.

Table II. C.3
Strontium 90 Concentrations in Surface Waters (pCi/l).

Sampling Locations	Monthly Collection Dates					
	1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
Effluent						
E 38: Farm Pond (Goosequill)	21.9 (23.8)*	<0.838	0.756 (0.878)	d	<0.253	<0.815
E 41: Slough to St. Vrain Creek	<0.854	<0.798	0.821 (0.880)	d	d	<2.35
Downstream						
D 37: Lower Latham Reservoir	<0.700	<0.659	2.57 (1.12)	d	1.59 (5.23)	<0.768
D 40: S. Platte River Below Confluence	0.953 (0.671)	<0.973	0.725 (1.06)	d	<0.946	0.576 (0.574)
D 45: St. Vrain Creek	1.36 (1.18)	<0.657	0.868 (1.25)	<0.693	<1.46	1.36 (1.08)
Upstream						
U 42: St. Vrain Creek	1.29 (0.675)	<0.789	d	d	<1.51	<0.686
U 43: S. Platte River	1.21 (0.765)	<0.562	<1.06	d	<0.973	1.82 (1.53)
Potable						
F 49: Visitor's Center	2.51 (1.28)	0.720 (0.883)	<0.644	<0.785	<1.25	3.19 (1.65)
D 39: Gilcrest City Water	<0.699	<0.665	<0.949	d	<0.749	<0.699

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
d. Sample lost in analysis.

Table II. C.4
Strontium 89 Concentrations in Surface Waters (pCi/l).

Sampling Locations	Monthly Collection Dates					
	1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
Effluent						
E 38: Farm Pond (Goosequill)	<11.1	<0.667	<0.653	d	0.755 (1.45)	<0.720
E 41: Slough to St. Vrain Creek	<0.696	<0.624	<0.590	d	d	<1.88
Downstream						
D 37: Lower Latham Reservoir	<0.600	5.05 (1.64)*	<0.824	d	<0.619	2.64 (1.17)
D 40: S. Platte River Below Confluence	<0.588	4.36 (1.83)	<0.698	d	<0.888	<0.456
D 45: St. Vrain Creek	<0.964	2.94 (1.41)	<0.831	2.19 (2.84)	<1.09	< 0.803
Upstream						
U 42: St. Vrain Creek	<0.616	5.33 (2.17)	d	d	<1.18	< 0.669
U 43: S. Platte River	<0.626	<0.560	<0.904	d	<0.973	<1.15
Potable						
F 49: Visitor's Center	<1.10	<0.606	<0.678	1.67 (2.60)	2.35 (3.10)	<1.29
D 39: Gilcrest City Water	<0.503	<0.629	<0.659	d	<0.690	<0.573

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d. Sample lost in analysis.

Table II.C.4.A
Tritium, Strontium 89, and Strontium 90 Concentrations in Effluent Water, Goosequill Pond, E-38.
First and Second Quarter, 1979

Collection Date	Tritium (pCi/l)	Strontium 89 (pCi/ l)	Strontium 90 (pCi/l)
1-6-79	460 (286)*	<0.726	<0.776
1-13-79	154,000 (1,010)	<0.532	<0.560
1-20-79	4,400 (321)	<11.1	21.9 (13.8)
1-27-79	18,400 (439)	<9.54	2.28 (1.08)
2-3-79	39,500 (568)	1.56 (2.31)	<9.01
2-10-79	57,800 (560)	<0.898	<0.822
2-17-79	316,000 (1,420)	<0.728	<0.915
2-24-79	2,249 (318)	<0.667	<0.838
3-3-79	10,200 (344)	<0.546	12.4 (1.82)
3-10-79	6,520 (318)	<0.653	0.756 (0.878)
3-17-79	809 (263)	<1.24	1.70 (1.66)
3-24-79	381 (258)	<1.11	<1.33
3-31-79	1,240 (267)	<0.904	1.34 (1.17)
4-7-79	1,250 (267)	<0.843	1.10 (1.18)
4-14-79	882 (263)	<6.02	<0.818
4-21-79	913 (263)	d	d
4-28-79	1,160 (301)	<0.921	2.39 (1.15)
5-5-79	746 (261)	<0.658	<0.903
5-12-79	606 (259)	<0.828	<0.936
5-19-79	21,700 (448)	<0.774	<1.07
5-26-79	11,400 (276)	0.755 (1.45)	<0.253
6-2-79	a	a	a
6-9-79	1,190 (285)	<0.664	<0.508
6-16-79	715 (276)	<0.720	<0.815
6-23-79	50,800 (612)	<1.77	2.70 (2.69)
6-30-79	34,700 (527)	0.733	<0.833

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.)

a. Sample lost prior to analysis

d Sample lost in analysis.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected January 20,1979 .

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	<83,500	<26,000	<11,100	<516	<161	<68.0	<4.53	<0.809	<0.290
E 41: Slough to St. Vrain Creek	<220,000	<68,100	75,000 (31,200)*	< 468	304 (157)	184 (73.8)	<4.53	0.929 (0.551)	1.05 (0.305)
Downstream									
D 37: Lower Latham Reservoir	<38,900	<12,100	<5,170	3,110 (1,940)	4,170 (614)	987 (259)	3.69 (3.20)	4.79 (0.838)	1.31 (0.439)
D 40: S. Platte River Below Confluence	<970,000	309,000 (233,000)	218,000 (136,000)	< 2,170	696 (544)	< 284	< 4.53	1.47 (0.789)	0.720 (0.434)
D 45: St. Vrain Creek	<291,000	<90,600	<38,400	< 3,010	<933	<397	<4.53	<0.809	<0.290
Upstream									
U 42: St. Vrain Creek	48,000 (47,700)	52,800 (11,900)	35,700 (6,980)	< 2,640	<818	<351	<4.53	0.951 (0.550)	0.501 (0.308)
U 43: S. Platte River	349,000 (175,000)	89,400 (45,000)	52,100 (21,200)	< 2,640	<816	<344	<4.53	1.20 (0.806)	0.842 (0.462)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	< 30,100	9,980 (7,550)	7,330 (3,900)	<2.58	0.855 (0.647)	0.628 (0.334)
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	< 2,870	<892	462 (536)	<2.39	<0.741	0.383 (0.445)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

1048 192

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected February 24,1979 .

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	333,000 * (112,000)	129,000 (28,200)	88,900 (15,900)	<544	<170	113 (162)	7.19 (2.25)	2.57 (0.561)	1.89 (0.323)
[illegible] 41: Slough to St. Vrain Creek	767,000 (648,000)	274,000 (163,000)	321,000 (96,200)	<783	<243	315 (156)	<4.53	0.939 (0.569)	1.40 (0.338)
Downstream									
D 37: Lower Latham Reservoir	64,700 (29,100)	<9,270	<3,940	<484	298 (161)	154 (99.2)	4.93 (2.26)	<0.809	<0.290
D 40: S. Platte River Below Confluence	<90,300	<28,000	<11,900	<844	287 (266)	<112	<4.53	<0.809	<0.290
D 45: St. Vrain Creek	316,000 (52,900)	214,000 (13,200	193,000 (7,860)	<2,420	<750	<320	<4.53	3.39 (0.578)	3.44 (0.349)
Upstream									
U 42: St. Vrain Creek	<94,200	<29,300	<12,500	<2,690	1,180 (670)	382 (423)	<4.53	1.02 (0.705)	<0.290
U 43: S. Platte River	251,000 (68,300)	278,000 (17,000)	240,000 (10,200)	4,620 (2,530)	5,390 (660)	1,930 (403)	8.20 (2.47)	9.35 (0.636)	5.38 (0.387)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<24,800	13,700 (6,190)	4,590 (3,910)	<2.59	1.43 (0.647)	0.480 (0.408)
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	<2,080	<650	380 (352)	<2.35	<0.735	0.430 (0.398)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

1048 193

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected March 10, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	<98,400	<30,500	17,100 (16,000)*	<2,730	3,860 (724)	1,730 (524)	<4.53	<3.90 (0.8[illegible])	1.91 (0.429)
E 41: Slough to St. Vrain Creek	<107,000	<33,200	32,000 (20,800)	3,510 (2,820)	1,000 (702)	<385	<4.53	1.04 (0.850)	<0.290
Downstream									
D 37: Lower Latham Reservoir	<26,900	<8,300	<3,560	<1,910	2,230 (502)	1,070 (365)	<4.73	2.93 (0.837)	1.29 (0.598)
D 40: S. Platte River Below Confluence	<42,900	<13,300	10,500 (7,020)	<2,530	<785	<335	<4.73	<0.809	0.562 (0.506)
D 45: St. Vrain Creek	<61,100	<18,900	<8,090	1,300 (960)	331 (236)	438 (148)	<4.73	<0.809	<0.290
Upstream									
U 42: St. Vrain Creek	<163,000	<50,500	62,500 (27,300)	<2,060	<639	<273	<4.73	<0.809	1.14 (0.511)
U 43: S. Platte River	<52,900	<16,300	<6,990	<995	<309	<132	<4.73	<0.809	<0.290
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<11,000	5,730 (3,930)	<1,450	<4.73	<0.809	<0.290
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	<2,140	720 (538)	589 (400)	<4.73	0.809 (0.605)	0.662 (0.449)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected April 21, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	107,000 (6,910)*	28,900 (1,720)	33,900 (988)	<4,610	<1,430	< 610	14.6 (2.59)	2.22 (0.641)	2.23 (0.395)
E 41: Slough to St. Vrain Creek	<118,000	<36,500	<15,600	<2,930	4,340 (782)	3,950 (543)	< 4.53	1.69 (0.476)	1.37 (0.380)
Downstream									
D 37: Lower Latham Reservoir	< 26,100	<8,040	< 3,440	<1,820	1,500 (452)	477 (311)	< 4.53	1.81 (0.554)	0.542 (0.363)
D 40: S. Platte River Below Confluence	<106,000	<32,800	<14,000	<2,780	< 862	< 367	< 4.53	<0.809	<0.290
D 45: St. Vrain Creek	<107,000	33,200	<14,100	< 790	464 (259)	633 (180)	< 4.53	<0.809	0.827 (0.374)
Upstream									
U 42: St. Vrain Creek	<21,100	<6,520	<2,790	3,770 (1,620)	923 (396)	430 (258)	< 4.53	1.18 (0.527)	0.527 (0.339)
U 43: S. Platte River	<36,600	21,100 (9,250)	5,160 (5,450)	5,110 (2,600)	1,320 (644)	528 (416)	< 4.53	2.41 (0.790)	0.775 (0.488)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<13,400	4,900 (4,350)	9,930 (2,990)	< 0.824	0.302 (0.268)	0.613 (0.184)
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	<7,630	<2,370	1,230 (1,230)	< 2.49	<0.774	0.403 (0.401)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

1048 195

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected May 26, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	<31,300	<9,710	6,130 (3,690)*	<3,000	1,040 (744)	<396	<4.53	1.41 (0.795)	0.407 (0.389)
E 41: Slough to St. Vrain Creek	d	d	d	d	d	d	d	d	d
Downstream									
D 37: Lower Latham Reservoir	<66,000	<20,500	<8,720	<702	<217	1,060 (115)	<4.53	<0.809	1.41 (0.282)
D 40: S. Platte River Below Confluence	<95,800	<29,700	18,900 (11,100)	<5,500	<1,700	<725	<4.53	<0.809	<0.290
D 45: St. Vrain Creek	<33,500	<10,400	<4,410	<8,770	<2,710	<1,150	<4.53	<0.809	<0.290
Upstream									
U 42: St. Vrain Creek	<34,300	<10,700	<4,540	<6,520	<2,020	1,930 (786)	<4.53	0.742 (0.783)	0.880 (0.372)
U 43: S. Platte River	<31,900	<9,870	<4,200	<846	362 (294)	488 (176)	<4.53	<0.809	<0.290
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<3,110	<961	<435	<2.50	<0.772	<0.350
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	< 1,890	< 585	< 249	< 2.44	< 0.759	< 0.323

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.
d. Lost in analysis.

Table II.C.5.A.
Gamma-ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
1-6-79	<1,260,00	<392,000	<167,000	<1,670	3,320 (452)*	874 (231)	<4.53	4.71 (0.837)	1.33 (0.508)
1-13-79	<53,300	<16,600	<7,080	<1,400	<434	<186	<4.53	<0.809	<0.290
1-20-79	<83,500	<26,000	<11,100	<516	<161	<68.0	<4.53	<0.809	<0.290
1-27-79	6,310,000 (179,000)	1,930,000 (40,500)	3,140,000 (40,300)	<3,530	<1,100	1.07 (0.782)	129 (4.38)	39.1 (0.998)	64.0 (0.943)
2-3-79	<336,000	<104,000	<44,200	2,890 (2,320)	<672	292 (438)	<4.53	<0.809	<0.209
2-10-79	<115,000	<35,700	<15,200	799 (1,170)	<246	269 (210)	<4.73	<0.809	0.330 (0.462)
2-17-79	<162,000	<50,200	<21,300	<2,550	<796	<339	<4.73	<0.809	<0.290
2-24-79	333,000 (112,000)	129,000 (28,200)	88,900 (15,900)	<544	<170	113 (162)	7.19 (2.25)	2.57 (0.561)	1.89 (0.323)
3-3-79	1,510,000 (136,000)	<36,200	<15,500	<3,230	<998	<428	27.7 (3.62)	<0.809	<0.290
3-10-79	<98,400	<30,500	17,100 (16,000)	<2,730	3,860 (724)	1,730 (524)	<4.53	3.90 (0.828)	1.91 (0.429)

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II.C.5.A.
Gamma-ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
3-17-79	<57,700	<17,800	15,000 (9,920)*	<2,990	1,120 (752)	<395	<4.73	1.19 (0.822)	0.813 (0.566)
3-24-79	<125,000	<38,500	<16,500	1,430 (1,250)	408 (307)	134 (187)	<4.73	<0.809	0.300 (0.358)
3-31-79	<92,000	<28,400	16,000 (13,600)	<2,700	<833	599 (396)	<4.73	<0.809	0.921 (0.482)
4-7-79	<42,800	<13,200	<5,650	<3,390	2,680 (874)	1,510 (472)	<4.73	2.02 (0.619)	1.05 (0.334)
4-14-79	<8,080	4,000 (2,930)	<1,070	<3,860	<1,190	540 (485)	<4.73	<0.809	0.392 (0.305)
4-21-79	107,000 (6,910)	28,900 (1,720)	33,900 (988)	<4,610	<1,430	<610	14.6 (2.59)	2.22 (0.641)	2.23 (0.395)
4-28-79	30,900 (20,900)	6,450 (5,280)	<2,860	5,940 (1,980)	823 (487)	551 (290)	8.32 (2.72)	0.969 (0.677)	0.372 (0.385)
5-5-79	<37,400	<11,600	5,410 (4,380)	<2,970	1,300 (750)	2,750 (687)	<4.53	<0.809	2.47 (0.561)
5-12-79	<18,100	<5,580	<2,390	9,310 (2,080)	2,190 (535)	1,010 (265)	<4.73	1.16 (0.548)	0.336 (0.319)
5-19-79	<114,000	<35,300	<15,000	<2,710	<837	<359	<4.73	<0.809	<0.290

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

1048 198

Table II.C.5.A.
Gamma-ray Emitting Radionuclide Concentrations in Effluent Water, Goosequill Pond , E-38.

Collection Date	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
6-2-79	d	d	d	d	d	d	d	d	d
6-9-79	<44,900	<13,900	<5,910	<1,430	<440	<189	<4.53	<0.809	<0.290
6-16-79	<16,000	<4,980	<2,110	3,870	3,110	1,800	4.53	1.63	1.05
					(994)	(672)		(0.798)	(0.460)
6-23-79	<9,270	<2,870	<1,220	5,540	8,230	2,710	4.53	3.89	1.13
					(1,450)	(846)		(0.799)	(0.432)
6-30-79	<11,700	<3,620	<1,540	4,150	4,640	1,390	4.53	1.80	0.593
					(1,140)	(627)		(0.642)	(0.451)

* Concentrations (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
d. Lost in analysis.

Table II. C.5
Gamma-ray Emitting Radionuclide Concentrations in Water
for Samples Collected June 16, 1979.

Sampling Locations	Suspended Solids (pCi/kg)			Dissolved Solids (pCi/kg)			Water (pCi/l)		
	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb	106 Ru	137 Cs	95 Zr&Nb
Effluent									
E 38: Farm Pond (Goosequill)	< 16,000	< 4,980	< 2,110	<3,870	3,110 (994)	1,800 (672)	4.53	1.63 (0.798)	1.05 (0.460)
E 41: Slough to St. Vrain Creek	<128,000	<39,800	<16,900	<3,930	<1,220	1,100 (711)	<4.53	<0.809	0.749 (0.477)
Downstream									
D 37: Lower Latham Reservoir	< 36,400	<11,300	< 4,780	<1,860	642 (468)	631 (273)	<4.53	<0.809	0.727 (0.311)
D 40: S. Platte River Below Confluence	< 11,200	< 3,460	6,880 (1,920)*	<1,900	1,860 (695)	1,740 (468)	<4.53	<0.809	1.13 (0.199)
D 45: St. Vrain Creek	< 30,500	< 9,430	< 4,030	<7,470	10,200 (1,970)	4,190 (1,410)	<4.53	3.50 (0.817)	1.56 (0.509)
Upstream									
U 42: St. Vrain Creek	< 33,200	<10,300	< 4,370	<8,230	<2,550	1,090	<4.53	<0.809	<0.290
U 43: S. Platte River	< 57,800	32,100 (14,400)	10,200 (7,370)	12,600 (7,300)	2,670 (1,890)	8,380 (1,240)	<4.53	2.12 (0.839)	3.25 (0.495)
Potable									
F 49: Visitor's Center	N.A.	N.A.	N.A.	<21,800	13,300 (5,460)	10,200 (4,050)	<3.05	1.86 (0.765)	1.43 (0.569)
D 39: Gilcrest City Water	N.A.	N.A.	N.A.	<1,930	<599	<256	<2.69	<0.837	<0.357

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
N.A. Not applicable.

1048 200

II.C.2. Radionuclide Concentrations in Sediment

Sediment is always the major compartment for radionuclide contaminants in a fresh water system due to the high concentration factors for fission products in the sediment mineral matrices. Table II.C.6 lists gross beta activity in sediment samples from the sampling sites in the water courses. The mean values for effluent, upstream, and downstream samples are very constant and were not significantly different (Table II.H.1).

Tables II.C.7 and II.C.8 list the Sr-90 and Sr-89 concentrations in the same sediment samples respectively. Table II.C.9 shows the concentration in sediment of the fission products Ru-106, Cs-137, and Zr-Nb-95. Although occasional high values appear, the mean values for these sample types (Table II.H.1) indicate no significant difference for any of the fission products in each of the sampling locations.

It should be noted that the sand fraction of the sediment samples is removed and only the silt plus clay mineral fraction is analyzed. These two particle size fractions contain essentially all of the radioactivity.

Table II. C.6
Gross Beta Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations		Monthly Collection Dates					
		1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
	Effluent						
E 38:	Farm Pond (Goosequill)	31,500 (1,480)*	36,000 (1,610)	a	29,900 (1,450)	43,200 (1,720)	31,900 (1,550)
E 41:	Slough to St. Vrain Creek	35,400 (1,580)	27,800 (1,290)	31,000 (1,480)	39,200 (1,630)	33,600 (1,620)	42,100 (1,630)
	Downstream						
D 37:	Lower Latham Reservoir	34,700 (1,550)	35,000 (1,550)	a	28,100 (1,420)	36,700 (1,590)	32,700 (1,600)
D 40:	S. Platte River Below Confluence	35,300 (1,560)	27,200 (1,390)	a	39,100 (1,640)	30,000 (1,450)	f
D 45:	St. Vrain Creek	f	30,700 (1,460)	a	30,000 (1,450)	33,100 (1,520)	32,300 (1,610)
	Upstream						
U 42:	St. Vrain Creek	33,900 (1,530)	31,200 (1,480)	a	28,000 (1,420)	35,300 (1,580)	33,300 (1,630)
U 43:	S. Platte River	35,500 (1,560)	34,500 (1,540)	a	12,700 (1,030)	33,300 (1,520)	32,700 (1,660)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a Sample lost prior to analysis.
f Sample unavailable.

Table II. C.7
Strontium 90 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
Effluent						
E 38: Farm Pond (Goosequill)	117 (194)*	193	a	<228	298 (366)	<166
E 41: Slough to St. Vrain Creek	212 (189)	<146	708 (272)	<512	298 (366)	281 (296)
Downstream						
D 37: Lower Latham Reservoir	<179	<107	a	<215	<248	292 (199)
D 40: S. Platte River Below Confluence	512 (263)	<130	a	<155	231 (202)	f
D 45: St. Vrain Creek	f	<144	a	289 (288)	<850	<295
Upstream						
U 42 St. Vrain Creek	<198	<144	a	<305	<303	<163
U 43: S. Platte River	<224	g	a	226 (220)	<261	<257

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a. Sample lost prior to analysis.
f. Sample unavailable.

1048 203

Table II. C.8
Strontium 89 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	1-20-79	2-24-79	3-10-79	4-21-79	5-26-79	6-16-79
Effluent						
E 38: Farm Pond (Goosequill)	<197	898 (401)*	a	<277	<429	<129
E 41: Slough to St. Vrain Creek	<158	769 (317)	<242	<521	<429	<188
Downstream						
D 37: Lower Latham Reservoir	<152	595 (226)	a	<199	<178	<172
D 40: S.Platte River Below Confluence	<145	733 (288)	a	<139	<189	f
D 45: St. Vrain Creek	f	809 (314)	a	<233	<502	<231
Upstream						
U 42: St. Vrain Creek	<168	624 (366)	a	<276	<195	<144
U 43: S. Platte River	<152	g	a	<165	<194	<210

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a Sample lost prior to analysis.
f Sample unavailable.

1048 204

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected January 20, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent			
E 38: Farm Pond (Goosequill)	<3800	<664	609 (402)*
E 41: Slough to St. Vrain Creek	<3910	972 (780)	318 (449)
Downstream			
D 37: Lower Latham Reservoir	<5590	<933	<352
D 40: S. Platte River Below Confluence	<3910	<653	<247
D 45: St. Vrain Creek	f	f	f
Upstream			
U 42: St. Vrain Creek	<3910	<771	<234
U 43: S. Platte River	<3910	<654	<235

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable.

1048 205

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg) for Samples Collected February 24, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent			
E 38: Farm Pond (Goosequill)	<3,780	1,040 (754)*	407 (543)
E 41: Slough to St. Vrain Creek	<4,260	915 (850)	2,890 (632)
Downstream			
D 37: Lower Latham Reservoir	<3,780	1,360 (749)	498 (548)
D 40: S. Platte River Below Confluence	<3,760	<646	<234
D 45: St. Vrain Creek	<3,730	<650	<230
Upstream			
U 42: St. Vrain Creek	<3,780	813 (744)	331 (553)
U 43: S. Platte River	<3,730	<650	291 (589)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

1048 206

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected March 10, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent			
E 38: Farm Pond (Goosequill)	a	a	a
E 41: Slough to St. Vrain Creek	<3,720	1,220 (861)*	442 (548)
Downstream			
D 37: Lower Latham Reservoir	a	a	a
D 40: S. Platte River Below Confluence	a	a	a
D 45: St. Vrain Creek	a	a	a
Upstream			
U 42: St. Vrain Creek	a	a	a
U 43: S. Platte River	a	a	a

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
a Sample lost prior to analysis.

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg) for Samples Collected April 21, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent E 38: Farm Pond (Goosequill)	5,670 (3,750)*	1,060 (772)	<237
E 41: Slough to St. Vrain Creek	<3,750	<653	<237
Downstream D 37: Lower Latham Reservoir	40,800 (7,460)	2,830 (870)	<237
D 40: S. Platte River Below Confluence	<4,400	<778	<276
D 45: St. Vrain Creek	<3,740	<652	<234
Upstream U 42: St. Vrain Creek	<3,750	734 (764)	<237
U 43: S. Platte River	<3,740	<652	<234

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected May 26, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent			
E 38: Farm Pond (Goosequill)	<5,240	<933	<332
E 41: Slough to St. Vrain Creek	6,750 (7,320)*	<822	<293
Downstream			
D 37: Lower Latham Reservoir	<4,420	<7[illegible]	553 (445)
D 40: S. Platte River Below Confluence	<4,410	<785	<279
D 45: St. Vrain Creek	6,010 (7,200)	<785	<279
Upstream			
U 42: St. Vrain Creek	<4,260	<704	<257
U 43: S. Platte River	<5,100	<908	437 (495)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. C.9
Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg) for Samples Collected June 9, 1979.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Effluent			
E 38: Farm Pond (Goosequill)	<5,010	2,060 (917)*	460 (566)
E 41: Slough to St. Vrain Creek	<5,010	1,390 (856)	380 (548)
Downstream			
D 37: Lower Latham Reservoir	<5,010	< 656	453 (549)
D 40: S. Platte River Below Confluence	f	f	f
D 45: St. Vrain Creek	6,640 (9,780)	1,110 (861)	493 (564)
Upstream			
U 42: St. Vrain Creek	<5,010	1,820 (869)	313 (512)
U 43: S. Platte River	<5,010	1,250 (879)	663 (564)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f. Sample unavailable.

II.C.3 Precipitation

Gross beta and tritium deposition values are given in Table II.C.10. Precipitation collectors of size sufficient to produce a significant sample are located at two locations, F-1 and F-4. Values are expressed as deposition (i.e. pCi/m^2) as only this value can be correlated to food chain transport. Studies of world-wide fallout have shown that forage and subsequent milk or meat values can be reasonably predicted from deposition values. The deposition measured is the sum of dry and precipitation deposition. Tritium values have generally decreased in recent years and exhibit variability that originates from the variability of the source of the precipitation (i.e. thunderstorms, precipitation associated with fronts, etc.). Although there were great differences in the deposition of tritium between sites F-1 and F-4, particularly in January, the mean deposition for the 6 month period was not statistically significant between the two sites. It should be noted here that no significant differences have ever been observed for F-1 and F-4. Since these collection sites are at opposite directions from the reactor this observation verifies the fact that observed deposition values are due to world-wide fallout and not to reactor effluents.

Table II.C.11 and II.C.12 list the precipitation deposition of Ru-106, Cs-137 and Zr-Nb-95. The mean values at F-1 and F-4 were not significantly different.

Table II.C.13 lists the deposition of the strontium radioisotopes. There were no significant differences in Sr-90 between the mean values for F-1 and F-4 locations.

Note that radioruthenium data is listed in the tables as Ru-106. However, it is true that the activity measured is often a mixture of Ru-103 and Ru-106. Both isotopes have gamma-rays at essentially the same energy and they cannot be separated by NaI(Tl) spectral analysis. No

separation by half-life determination was attempted on the data. Since the half-life of Ru-103 is 40 days and that of Ru-106 is one year, in periods soon after an atmospheric test, a high proportion is expected to be Ru-103 and at later times predominately Ru-106. Since the ruthenium isotopes have negligible biological availability, neither has any consequences in calculation of population dose and efforts to separate them is not warranted.

Table II. C.10
Gross Beta and Tritium Deposition from Precipitation at Locations F1 and F4.

Sample Ending Dates	Cumulative Volume * (liters)		Gross Beta Deposition (pCi/m^2)						Tritium Deposition (pCi/m^2)	
			Suspended Solids		Dissolved Solids		Total			
	F1	F4	F1	F4	F1	F4	F1	F4	F1	F4
1-27-79	10	20	< 3.41	< 10.7	4.42 (1.21)**	<10.8	0.666 (3.07)	7.90 (3.74)	16,500 (426)	2,360 (306)
2-24-79	40	52	35.8 (10.6)	50.0 (12.7)	22.3 (5.02)	24.7 (6.03)	58.1 (11.0)	74.7 (13.2)	1,120 (266)	838 (263)
3-31-79	100	100	37.7 (28.0)	< 9.53	33.7 (11.4)	22.4 (10.3)	71.4 (27.9)	< 9.53	415 (259)	663 (261)
4-28-79	100	100	<21.4	139 (37.7)	34.2 (11.5)	31.4 (10.7)	23.7 (31.6)	171 (34.2)	396 (364)	411 (364)
5-26-79	135	150	73.6 (38.6)	81.9 (41.0)	128 (19.0)	218 (22.6)	202 (40.8)	299 (44.7)	345 (373)	349 (374)
6-30-79	50	50	39.7 (16.2)	9.45 (13.2)	18.2 (6.60)	11.7 (5.70)	58.0 (16.1)	21.2 (13.4)	1,060 (280)	576 (274)

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II. C.11
Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location F1.

Sample Ending Dates	Total* Volume (liters)	Suspended Solids (pCi/m^2)			Dissolved Solids (pCi/m^2)			Total (pCi/m^2)		
		^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb
1979										
January	10	<106	<32.9	<14.0	<66.1	51.0 (17.2)	9.87 (14.5)	<106	44.5 (30.2)	<14.0
February	40	<9.19	11.2 (2.91)	2.81 (2.19)	<31.9	<8.58	<3.65	16.3 (28.9)	15.5 (6.96)	5.06 (4.85)
March	100	<4.73	<1.46	<0.620	<12.8	<3.99	<1.70	<4.73	<1.46	<0.620
April	100	<16.8	<5.16	4.10 (2.22)	27.5 (26.1)	13.4 (6.03)	13.1 (5.03)	14.6 (18.5)	11.4 (6.47)	17.2 (5.11)
May	135	<35.5	36.7 (15.4)	15.6 (7.62)	<30.8	15.9 (7.38)	8.07 (4.05)	<35.5	52.6 (16.1)	23.1 (8.25)
June	50	<25.5	<7.89	<3.35	<21.4	7.35 (5.39)	9.67 (3.80)	<25.5	3.41 (8.20)	12.4 (4.03)

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II. C.12
Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location F4.

Sample Ending Dates	Total* Volume (liters)	Suspended Solids (pCi/m^2)			Dissolved Solids (pCi/m^2)			Total (pCi/m^2)		
		^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb	^{106}Ru	^{137}Cs	^{95}Zr-Nb
1979										
January	20	<35.5	<11.0	<4.66	<7.39	<2.29	5.97 (1.56)	<7.39	<2.29	5.23 (3.13)
February	52	<11.5	10.0 (3.17)	3.18 (2.42)	10.2 (10.5)	6.08 (2.58)	<1.12	9.41 (16.9)	16.1 (4.07)	2.20 (2.87)
March	100	<13.6	< 4.19	<1.80	<3.86	<1.21	0.835 (0.619)	<3.86	2.81 (3.32)	1.02 (1.75)
April	100	<30.5	12.11 (6.62)	5.91 (3.27)	26.9 (13.9)	9.66 (3.97)	<0.701	<30.5	21.7 (7.49)	2.18 (2.31)
May	150	<13.6	5.11 (6.07)	<1.80	<11.5	13.6 (6.62)	8.95 (5.81)	<13.6	18.7 (8.97)	9.50 (5.81)
June	50	<26.8	<8.32	<3.51	<18.5	9.31 (4.25)	7.80 (3.26)	<26.8	8.47 (6.83)	10.8 (6.32)

* Samples are analyzed at the end of each month if sufficient volume has accumulated.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

1048 215

Table II. C.13

Radiostrontium Deposition from Precipitation at Locations F1 and F4 (pCi/m^2).

Sample Ending Dates	Cumulative Volume (liters) *		Strontium 89		Strontium 90	
	F1	F4	F1	F4	F1	F4
1-27-79	10	20	<0.360	<2.47	3.31 (2.33)**	2.90 (2.90)
2-24-79	40	52	<4.25	<6.29	<5.17	<7.08
3-31-79	100	100	18.7 (47.2)	<17.2	<15.2	20.0 (22.0)
4-28-79	100	100	8.58 (54.6)	15.5 (47.4)	<11.0	<10.9
5-26-79	135	150	<24.7	46.9 (91.8)	<25.1	<25.5
6-30-79	50	50	<13.5	<10.6	<25.9	22.1 (17.3)

* Samples are analyzed at the end of each month if sufficient volume has accumulated.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.D. Food Chain Data

1. Milk. Tritium concentrations in milk are summarized in Table II.D.1. There was no significant difference in mean tritium values obtained from water extracted from milk at the only dairy in the Facility area (F-44), the Adjacent Composite, and the Reference Composite, for the first half of 1979 (see also Table II.H.1). Tritium mean values for Facility, Adjacent and Reference sites were 455, 473 and 372 pCi/l respectively and were similar to values observed the last half of 1978. Tritium concentrations in milk should respond rapidly to changes in tritium concentrations of the water intake to the cow due to the short biological half-life for water in the cow (about three days for the lactating cow). As noted in previous reports, tritium activity per liter reflects the tritium in the water extracted from the milk and not the activity per liter of milk. Whole milk is approximately 87% water (±3-4%, depending on the cow, pasture, and feed). Skim milk accordingly has a higher water content. It may be assumed though that the remaining solids in milk (proteins, carbohydrates, and lipids) also contain some tritium due to exchange of tritium with hydrogen on these large molecular structures. This tritium concentration will be very much lower than in the water fraction.

Tables II.D.2 and II.D.3 list the Sr-90 and Sr-89 concentrations in milk. There was no significant difference between the three sampling zones.

The concentrations of I-131, Cs-137 and K-nat in milk are given in Table II.D.4. Although there is some relationship between measured I-131 and Cs-137 concentrations in milk and those in air (Table II.B.4), the correlation is low and is due to feeding practices discussed below. K-nat, as measured by K-40 is very constant in milk. The mean literatue

value is 1.5 g/L. K-nat is measured and reported therefore only as a quality control measure of the other radionuclides Cs-137 and I-131 measured in the same sample by gamma-ray spectrometry.

Due to the availability of a large NaI(Tl) scintillation crystal, shield and pulse height analyzer that has been dedicated to only counting project milk samples, we have lowered our MDC for I-131. A counting time of 3000 minutes per sample with a slight reduction in background has achieved a MDC value of approximately 0.6 pCi/L. This is preferable to any chemical concentration process and nearly all milk sample data reported here were for 3000 minutes counting time.

It should also be noted here that a close relationship between forage deposition and milk concentrations should be expected for the strontium radioisotopes, for Cs-137 and for I-131 only if the cows are on pasture or fed green cut grass or alfalfa. This unfortunately is not the general feeding practice at the dairies around the reactor. Nearly all cattle feed is hay grown either locally, from Nebraska or the North Park region of Colorado. It can at times be even cuttings from the previous year. This makes correlation of milk concentrations very difficult. On the other hand, if elevated I-131 concentrations are noted, the surface deposition must have been reasonably related in time and location.

Table II. D.1
Tritium Concentrations in Water Extracted from Milk (pCi/l).

Sample Ending Dates, 1978	Facility Area 44	Adjacent Composite *	Reference Composite *
Pre-Pasture Season			
January 6	583 (283)**	327 (280)	<299
February 3	<311	357 (292)	342 (291)
March 3	480 (293)	<311	687 (295)
Pasture Season			
April 7	588 (260)	<275	<275
April 14	<275	<275	<275
April 21	<290	930 (263)	706 (261)
April 28	906 (263)	1,009 (264)	606 (259)
May 5	639 (275)	704 (260)	597 (257)
May 12	498 (256)	569 (257)	552 (274)
May 19	620 (275)	419 (273)	603 (259)
May 26	667 (260)	776 (261)	728 (261)
June 2	<290	734 (276)	<290
June 9	774 (276)	<290	<290
June 16	392 (272)	596 (275)	390 (272)
June 23	523 (274)	288 (271)	342 (272)
June 30	495 (273)	659 (275)	455 (273)

* Adjacent Composite Locations: A6, A28, A31, A50, A 36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II. D.2
Strontium 90 Activity in Milk (pCi/l).

Sample Ending Dates, 1979	Facility Area 44	Adjacent Composite *	Reference Composite *
Pre-Pasture Season			
January 6	2.59 (2.25)**	2.96 (1.40)	<4.03
February 3	<8.09	2.82 (1.13)	4.11 (1.79)
March 3	3.36 (1.58)	2.80 (2.05)	2.84 (3.94)
Pasture Season			
April 7	<1.06	<1.56	<2.36
April 14	<5.12	<2.16	<4.33
April 21	5.31 (5.55)	5.13 (2.12)	9.04 (6.61)
April 28	5.66 (2.58)	15.7 (11.1)	5.62 (3.30)
May 5	<2.53	<6.21	<9.04
May 12	<2.75	<4.16	<8.16
May 19	g	1.25 (1.24)	<6.52
May 26	g	d	<5.55
June 2	<17.2	<9.35	4.02 (2.80)
June 9	11.9 (8.32)	3.34 (2.48)	<4.06
June 16	d	<3.40	<7.50
June 23	d	d	d
June 30	2.59 (1.69)	<6.50	d

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Sample lost in analysis.

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Table II. D.3
Strontium 89 Activity in Milk (pCi/l).

Sample Ending Dates, 1979	Facility Area 44	Adjacent Composite *	Reference Composite *
Pre-Pasture Season			
January 6	<2.06	<1.27	<3.22
February 3	<7.05	<1.04	<1.56
March 3	<1.46	<1.01	<1.62
Pasture Season			
April 7	3.44 (3.50)**	<1.30	<1.46
April 14	<7.61	<1.68	<4.06
April 21	<4.16	<1.75	<5.04
April 28	<2.34	<9.08	<2.39
May 5	<2.27	8.83 (18.6)	<7.97
May 12	4.71 (7.80)	6.00 (11.7)	<7.91
May 19	g	<0.840	<4.71
May 26	g	d	<4.08
June 2	<10.2	<5.81	<1.96
June 9	<5.22	<1.62	<2.98
June 16	d	<4.05	<8.57
June 23	d	d	d
June 30	<1.33	<4.58	d

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
Reference Composite Locations: R16, R17, R20, R22, R23, R25.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
d Sample lost in analysis.

Table II. D.4
Gamma-ray Emitting Radionuclide Concentrations in Composite Milk Samples.

Samples Collected	Area *	^{131}I (pCi/l)	^{137}Cs (pCi/l)	Nat. K (g/l)
1-6-79	Facility	10.5 (1.10)**	11.3 (0.853)	1.54 (0.0118)
	Adjacent	18.0 (1.43)	11.1 (0.850)	1.62 (0.0118)
	Reference	9.56 (2.30)	4.26 (0.947)	1.52 (0.0137)
2-3-79	Facility	46.6 (1.02)	26.5 (0.860)	1.52 (0.116)
	Adjacent	17.2 (1.98)	10.4 (0.845)	1.49 (0.0117)
	Reference	22.9 (2.34)	6.23 (0.836)	1.59 (0.0117)
3-3-79	Facility	7.72 (1.06)	9.50 (0.823)	1.49 (0.0115)
	Adjacent	11.7 (1.52)	4.99 (0.843)	1.54 (0.0117)
	Reference	33.6 (3.58)	7.90 (0.830)	1.61 (0.0117)
4-7-79	Facility	11.7 (0.797)	13.1 (0.682)	1.48 (0.0101)
	Adjacent	<0.104	4.62 (0.929)	1.62 (0.0126)
	Reference	<0.123	1.23 (0.966)	1.45 (0.0133)
4-14-79	Facility	17.0 (1.12)	13.6 (0.943)	1.61 (0.0126)
	Adjacent	<0.149	2.74 (1.04)	1.56 (0.0150)
	Reference	1.54 (1.90)	3.63 (1.14)	1.51 (0.0168)
4-21-79	Facility	<0.104	5.33 (0.927)	1.45 (0.0124)
	Adjacent	0.922 (1.05)	2.13 (0.753)	1.50 (0.0110)
	Reference	2.00 (1.20)	3.12 (0.722)	1.42 (0.0103)
4-28-79	Facility	6.24 (0.868)	6.26 (0.737)	1.49 (0.0105)
	Adjacent	4.71 (1.30)	5.21 (0.859)	1.46 (0.0129)
	Reference	6.27 (1.53)	5.02 (0.925)	1.50 (0.0143)
5-5-79	Facility	6.55 (0.882)	7.33 (0.750)	1.57 (0.0108)
	Adjacent	12.1 (1.33)	7.37 (0.945)	1.59 (0.0130)
	Reference	<0.103	2.62 (0.914)	1.46 (0.0124)
5-12-79	Facility	2.72 (0.913)	4.93 (0.767)	1.51 (0.0110)
	Adjacent	4.22 (1.67)	5.61 (1.00)	1.55 (0.0157)
	Reference	<0.179	3.35 (0.993)	1.46 (0.0155)
5-19-79	Facility	<0.102	2.76 (0.750)	1.47 (0.0107)
	Adjacent	<0.179	2.77 (0.998)	1.62 (0.0159)
	Reference	<0.179	2.53 (0.990)	1.44 (0.0154)

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

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Table II. D.4
Gamma-ray Emitting Radionuclide Concentrations in Composite Milk Samples.

Samples Collected	Area *	^{131}I (pCi/l)	^{137}Cs (pCi/l)	Nat. K (g/l)
5-26-79	Facility	<0.186	<0.185	1.50 (0.0165) **
	Adjacent	<0.179	<0.169	1.56 (0.0156)
	Reference	<0.107	<0.107	1.45 (0.0119)
6-2-79	Facility	<0.108	3.77 (0.893)	1.53 (0.0120)
	Adjacent	<0.186	<0.185	1.42 (0.0163)
	Reference	<0.174	<0.173	1.44 (0.0156)
6-9-79	Facility	12.8 (1.13)	11.9 (0.811)	1.53 (0.0116)
	Adjacent	20.8 (1.68)	9.82 (0.931)	1.66 (0.0142)
	Reference	13.9 (2.06)	5.50 (0.959)	1.53 (0.0148)
6-16-79	Facility	6.98 (1.14)	12.7 (0.824)	1.47 (0.0118)
	Adjacent	8.28 (1.99)	3.48 (0.929)	1.49 (0.0143)
	Reference	<0.122	<0.124	1.30 (0.0122)
6-23-79	Facility	0.583 (1.24)	18.6 (0.897)	1.52 (0.0123)
	Adjacent	12.7 (1.49)	7.50 (0.893)	1.62 (0.0126)
	Reference	10.3 (1.75)	5.20 (1.14)	1.56 (0.0178)
6-30-79	Facility	<0.124	9.32 (0.942)	1.46 (0.0135)
	Adjacent	7.85 (1.51)	4.89 (0.984)	1.53 (0.0145)
	Reference	18.1 (1.60)	7.43 (0.876)	1.49 (0.0121)

* Adjacent Composite Locations: A6, A28, A31, A50, A36, A48.
** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.D. Food Chain Data

2. Forage. Table II.D.5 lists the tritium specific activity in water extracted from forage samples as well as Sr-89 and Sr-90 concentrations in the forage dry matter. Tritium values that were obtained were similar to those reported in past reports. There were no significant differences in mean tritium values between Facility, Adjacent and Reference locations. The tritium in forage water was statistically the same as the concentration in milk.

Table II.D.6 lists Ru-106, Cs-137 and Zr-Nb-95 activities in forage samples for the first half of 1979.

Gross beta concentrations in soil and forage collected at the same locations are given in Table II.D.7.

From Table II.H.1 it is observed that mean values for all radionuclides in each sample type are very close to those measured in 1978.

Cattle forage samples, i.e. fresh cut grass or alfalfa hay is the sample of choice for several reasons. Forage integrates atmospheric wet and dry deposition over a large surface area per unit weight and also is a direct link in the dairy and beef food chain transport of H-3, Cs-137, and the strontium radioisotopes. Such samples are collected when possible. However, due to feeding practices, vagaries of weather and other factors, often silage or cut hay samples must be collected. These samples may or may not be harvested locally and may represent different fallout periods. This often presents difficulties in data interpretation.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected May 12, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	<273	g	g
44	467 (258)*	<31.2	184 (28.9)
Adjacent			
6	334 (256)	<47.0	359 (52.7)
28	861 (262)	<61.4	145 (80.7)
31	570 (257)	<22.1	190 (20.2)
36	406 (257)	<35.8	134 (28.3)
48	e	<21 6	86.0 (23.1)
50	637 (260)	<38.7	185 (30.7)
Reference			
16	393 (257)	<43.3	178 (43.0)
17	673 (260)	<13.7	85.4 (16.4)
20	e	61.8 (26.6)	<12.7
22	<273	<18.9	133 (16.3)
23	527 (257)	<146	1,485 (114)
25	581 (259)	<30.7	115 (25.5)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
e Insufficient weight or volume for analysis.
g Analysis in progress.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in Forage for Samples Collected June 9, 1979.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	526 (278) *	<36.1	263 (27.0)
44	583 (277)	<36.8	442 (24.8)
Adjacent			
6	376 (277)	<27.9	267 (19.0)
28	<295	31.5 (39.6)	150 (24.5)
31	572 (277)	<20.2	137 (15.4)
36	891 (282)	<18.7	600 (19.9)
48	617 (279)	g	g
50	465 (278)	<70.2	90.0(17.6)
Reference			
16	426 (277)	<60.5	388 (50.9)
17	<295	<33.5	226 (26.9)
20	482 (278)	<24.6	184 (18.6)
22	416 (277)	38.1 (24.1)	107 (14.8)
23	762 (281)	390 (50.4)	179 (20.3)
25	<295	<18.4	126 (14.1)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
g Analysis in progress.

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage (pCi/kg) for Samples Collected May 19, 1979.

Areas	^{106}Ru		^{137}Cs		^{95}Zr & Nb	
Facility						
4	<69.1		281	(22.0)*	99.2	(13.9)
44	29.6	(70.3)	106	(7.94)	2,030	(541)
Adjacent						
6	1,490	(62.7)	<15.3		63.2	(9.81)
28	80.6	(17.5)	41.7	(4.36)	20.0	(2.88)
31	<13.0		19.9	(4.55)	14.4	(2.70)
36	<55.4		81.3	(16.5)	22.3	(10.4)
48	61.0	(54.1)	108	(14.1)	48.2	(8.80)
50	<48.1	(59.5)	430	(16.1)	28.9	(8.79)
Reference						
16	70.5	(28.6)	171	(7.41)	37.6	(4.79)
17	<47.5		35.2	(13.3)	11.5	(8.83)
20	90.2	(55.7)	102	(14.7)	55.5	(9.66)
22	<54.9		<17.1		8.47	(8.82)
23	<50.2		33.1	(13.7)	9.20	(8.06)
25	<57.0		40.6	(16.1)	17.0	(10.8)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage (pCi/kg) for Samples Collected June 9, 1979.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<38.3	92.5 (11.6)*	29.3 (6.10)
44	<46.7	235 (15.4)	36.2 (8.33)
Adjacent			
6	<57.9	185 (5.65)	22.1 (2.99)
28	<14.9	57.4 (5.42)	23.4 (3.24)
31	<11.9	39.9 (4.41)	24.8 (2.69)
36	<21.4	46.1 (6.25)	13.3 (3.72)
48	<17.7	54.7 (5.56)	26.2 (2.32)
50	<44.9	131 (14.1)	41.3 (8.13)
Reference			
16	<61.6	119 (18.3)	36.6 (10.3)
17	<49.0	327 (16.2)	50.3 (8.08)
20	<51.5	31.9 (15.1)	12.9 (8.74)
22	<44.0	22.3 (12.2)	14.1 (7.40)
23	37.0 (27.2)	263 (7.82)	29.4 (4.20)
25	<22.8	33.9 (7.34)	25.5 (4.54)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.D. Food Chain Data

3. Soil. Table II.D.8 presents gross beta activity of soil per unit surface area for the first and second quarter of 1979.

Soil samples are collected at the same time and location as forage samples. A core borer is used to collect the sample. The sample depth is 10.3 cm and the area is 102 cm^2. Gross soil density is approximately 1 g/cm^3.

There was no significant difference in the gross beta activity values between the Facility, Adjacent and Reference collection areas. The gross beta concentrations are very constant and due primarily to naturally occurring radionuclides.

The activities of the fission products Ru-106, Cs-137 and Zr-Nb-95 per unit surface area are given in Table II.D.9 for the same period. Essentially only Cs-137 can be measured in the local soil. This is because the recent deposition of Ru-106 and Zr-Nb-95, the short-lived fission products, is minimal to the past deposition of Cs-137. Cs-137 has a half-life of 30 years and is trapped by ion exchange in the top 2-3 cm of soils with clay minerals. For this reason soils that are disturbed or turned over for agricultural purposes will have widely varying Cs-137 concentrations.

Tritium, Sr-89 and Sr-90 in soil are shown in Table II.D.10. Tritium specific activity in soil is statistically the same as that in other environmental samples. e.g. water, forage and milk. The concentrations of the strontium radioisotopes was quite variable. Sr-89 was essentially zero and the mean concentration of Sr-90 was 426 , 549 and 330 pCi/kg for the Facility, Adjacent and Reference zones respectively. These mean values are not significantly different.

The numbers given in parentheses next to all values above the minimum detectable concentration are the 95% confidence intervals for each measured value. This number is calculated solely on the basis of counting statistics. Obviously this uncertainty is only a part measure of the total expected variation that must be assigned to any measured analytical value. The total variation must include the true environmental (sometimes called sampling) variation as well as the analytical or methodological variation. The variation due to counting is only part of the methodological variation. While the true environmental variation cannot be determined directly the methodological variation can be measured. An experiment was conducted during the last reporting period in which a single large soil sample was thoroughly homogenized and 10 aliquots taken for Sr-90 analysis. The standard deviation as a percentage of the mean value (coefficient of variation) was 63%. This is the methodological standard deviation which in the experiment included counting statistics. The environmental variation is expected to be considerably greater. This is due to the fact that Sr-90, like Cs-137, is deposited largely on the soil surface, and when the surface is disturbed the surface layer is often greatly diluted or not even part of the sample collected. For these reasons the variation in reported Sr-90 and Sr-89 soil concentrations, although large, should be expected.

Table II. D.7
Gross Beta Concentrations in Soil and Forage (pCi/kg) for Samples Collected Second Quarter, 1979.

Sampling Location	April 28**		May 19		June 9	
	Soil	Forage	Soil	Forage	Soil	Forage
Facility						
4	35,800 (1,570)*		27,400 (1,400)	12,900 (342)	29,400 (1,680)	17,700 (341)
44	27,600 (1,400)		27,800 (1,410)	21,700 (373)	31,200 (1,580)	20,600 (397)
Adjacent						
6	27,900 (1,410)		29,500 (1,450)	16,100 (347)	29,400 (1,520)	12,600 (318)
28	24,200 (1,330)		18,800 (1,200)	18,900 (375)	26,000 (1,560)	24,800 (423)
31	23,900 (1,320)		32,700 (1,760)	22,300 (957)	24,100 (1,440)	20,400 (370)
36	23,800 (1,320)		24,900 (1,350)	32,700 (665)	27,400 (1,600)	20,300 (448)
48	27,700 (1,410)		33,500 (1,530)	12,200 (806)	27,000 (1,590)	8,860 (245)
50	28,600 (1,430)		28,400 (1,430)	29,900 (703)	29,400 (1,720)	21,7[illegible] (437)
Reference						
16	25,500 (1,360)		17,500 (1,170)	28,400 (1,200)	24,600 (1,500)	23,500 (532)
17	21,500 (1,260)		17,100 (1,180)	14,200 (609)	26,000 (1,500)	12,800 (448)
20	31,600 (1,490)		26,700 (1,380)	23,700 (461)	26,900 (1,500)	24,000 (423)
22	29,900 (1,450)		29,600 (1,450)	14,400 (666)	27,800 (1,530)	15,300 (306)
23	28,800 (1,430)		29,300 (1,440)	16,600 (676)	29,500 (1,610)	19,800 (392)
25	21,700 (1,270)		25,100 (1,350)	15,300 (686)	32,100 (1,610)	17,000 (434)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

** No forage collected until growing season.

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Table II. D.8
Gross Beta Activity in Soil per Unit Surface Area ($\mu Ci/m^2$) for Samples Collected Second Quarter, 1979.

Sampling Locations	April 28	May 19	June 9
Facility			
4	4.62 (0.202)*	3.54 (0.181)	3.79 (0.217)
44	3.56 (0.181)	3.59 (0.182)	4.03 (0.084)
Adjacent			
6	3.60 (0.182)	3.80 (0.187)	3.79 (0.196)
28	3.12 (0.171)	2.42 (0.155)	3.36 (0.201)
31	3.08 (0.170)	4.22 (0.227)	3.11 (0.186)
36	3.07 (0.170)	3.22 (0.174)	3.54 (0.206)
48	3.58 (0.181)	4.32 (0.198)	3.49 (0.205)
50	3.69 (0.184)	3.66 (0.184)	3.79 (0.222)
Reference			
16	3.29 (0.175)	2.26 (0.150)	3.17 (0.194)
17	2.78 (0.163)	2.21 (0.150)	3.34 (0.194)
20	4.08 (0.192)	3.45 (0.179)	3.47 (0.202)
22	3.86 (0.187)	3.81 (0.187)	3.59 (0.197)
23	3.71 (0.184)	3.78 (0.186)	3.80 (0.208)
25	2.80 (0.164)	3.24 (0.174)	4.14 (0.208)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected April 28, 1979.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<346	235 (70.2) *	<20.9
44	<406	86.6 (74.0)	<24.5
Adjacent			
6	<413	93.9 (75.1)	<25.0
28	<468	<77.5	<28.3
31	<366	103 (68.6)	57.0 (47.6)
36	<430	73.5 (76.2)	28.5 (53.0)
48	<392	<64.9	<23.7
50	<383	159 (73.0)	<23.2
Reference			
16	<384	177 (73.4)	<23.2
17	<335	<55.3	42.2 (48.2)
20	<326	91.3 (64.9)	<19.7
22	<399	73.8 (72.2)	<24.1
23	<356	115 (68.6)	<21.5
25	<359	87.2 (68.0)	<21.7

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected May 12,1979.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<366	113 (70.0)*	<22.1
44	<423	101 (76.0)	<25.5
Adjacent			
6	<338	246 (69.3)	<20.4
28	<366	213 (74.4)	71.2 (53.4)
31	<326	86.8 ([illegible]4.9)	10.7 (42.8)
36	<387	110 (72.5)	30.6 (53.8)
48	<390	142 (73.4)	29.4 (53.5)
50	<454	104 (78.7)	<27.5
Reference			
16	<731	253 (132)	107 (98.3)
17	<326	97.4 (64.6)	<19.7
20	<366	103 (70.3)	<22.1
22	<412	96.6 (75.2)	<24.9
23	613 (699)	107 (79.5)	<27.6
25	<366	110 (69.5)	<22.1

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected June 9, 1979.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<366	264 (73.4)*	27.1 (40.6)
44	<392	111 (73.1)	<23.7
Adjacent			
6	<455	223 (83.1)	<27.6
28	<409	113 (74.9)	48.6 (43.0)
31	1,260 (878)	152 (78.1)	64.0 (44.9)
36	<415	84.8 (75.6)	27.2 (42.8)
48	437 (872)	114 (77.4)	25.8 (44.4)
50	<400	95.5 (74.0)	<24.1
Reference			
16	<433	126 (97.8)	<19.9
17	<433	81.8 (70.7)	<19.9
20	<3[illegible]	141 (70.2)	<22.1
22	<433	183 (78.9)	<19.9
23	1,020 (909)	116 (80.3)	53.9 (46.8)
25	<366	104 (69.9)	<22.1

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected April 28, 1979 .

Sampling Location	Tritium (pCi/l)		Strontium 89 (pCi/kg)		Strontium 90 (pCi/kg)	
Facility						
4	493	(263) *	<108		252	(120)
44	714	(266)	<101		297	(121)
Adjacent						
6	<279		<499		2,780	(559)
28	657	(265)	<95		314	(93)
31	720	(266)	<180	(164)	<75	
36	669	(265)	<286		3,210	(1,270)
48	713	(266)	<106		367	(122)
50	905	(268)	<87		176	(126)
Reference						
16	516	(264)	330	(366)	486	(137)
17	790	(267)	<119		386	(154)
20	523	(264)	<68.0		<74.0	
22	584	(264)	<124		122	(189)
23	514	(264)	929	(443)	652	(167)
25	629	(265)	<91.0		252	(120)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected May 12, 1979 .

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	636 (236)*	<91.9	171 (94.5)
44	497 (237)	<93.6	143 (149)
Adjacent			
6	758 (240)	d	d
28	767 (240)	<174	554 (167)
31	774 (240)	<98.3	185 (133)
36	745 (240)	<201	<238
48	497 (237)	646 (126)	<75.5
50	743 (240)	<1[illegible]4	170 (143)
Reference			
16	307 (235)	<297	1,650 (249)
17	756 (240)	<1,010	<114
20	538 (237)	<91.9	109 (120)
22	711 (239)	<80.2	<80.2
23	812 (240)	<101	<117
25	863 (241)	348 (334)	277 (159)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Sample lost in analysis.

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected June 9, 1979 .

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	483 (237)*	<223	1,440 (195)
44	527 (237)	<130	251 (180)
Adjacent			
6	520 (237)	165	761 (157)
28	<250	120 (220)	132 (135)
31	<250	<114	170 (135)
36	535 (237)	<121	168 (151)
48	897 (291)	<126	<155
50	774 (240)	<92	<131
Reference			
16	629 (236)	<123	491 (124)
17	<250	<141	<176
20	496 (237)	<109	205 (150)
22	706 (239)	<12	310 (139)
23	546 (237)	<144	410 (229)
25	776 (240)	<85	174 (109)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

II.E. Aquatic Biota

Table II.E.1 shows gross beta and strontium concentrations observed in aquatic biota collected during the first half of 1979.

The collection of macroinvertebrates and algae (benthic organisms and seston) was seriously impeded this spring due to exceptionally high runoff. The combination of turbid water conditions, and late and frequent snow storms caused water temperatures to remain unseasonably low and delayed Decapod emergence. Collection at Goosequill was hampered as the water was drawn down to critically low levels. This prevented algae growth and left macroinvertebrate traps on dry ground. The extremely high water levels in the South Platte and St. Vrain rivers hampered fish collection.

The gross beta concentrations observed in all aquatic biota sample types were more constant and generally lower than observed during the last half of 1978.

Table II.E.2 lists Ru-106, Cs-137 and Zr-Nb-95 concentrations.

The high MDC values for seston are due to the fact that such samples are counted by a Ge(Li) spectrometer system rather than the NaI used for most other sample types. This is because seston, which is principally algae, collects and concentrates particulate radioactivity and high resolution is necessary for radionuclide measurement of fission product activity in the presence of Ra-226 and Th-232 natural radioactivity.

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected First Quarter, 1979. **

Sampling Locations *		Gross Beta	Strontium 89	Strontium 90
Fish				
Upstream	2-24-79	11,400 (417)	<28.8	70.6 (28.5)
Downstream	2-24-79	8,970 (298)	<33.5	87.6 (48.3)
Effluent	2-24-79	7,500 (265)	<27.4	93.6 (37.0)
Benthic Organisms				
Upstream	3-31-79	6,940 (503)	e	e
Downstream	3-31-79	5,370 (443)	e	e
Effluent	3-31-79	6,170 (457)	503 (340)	<79.2

* Upstream Composite: U 42, U 43.
Downstream: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

e. Insufficient weight or volume for analysis.

1048 240

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected First Quarter, 1979**.

Sampling Locations *		Gross Beta		Strontium 89		Strontium 90	
Vascular Plants							
Upstream	2-24-79	21,500	(500)	<34.4		331	(30.2)
Downstream	2-24-79	26,200	(602)	751	(145)	258	(35.3)
Effluent	2-24-79	24,900	(539)	458	(103)	20.3	(24.9)
Seston							
Upstream	2-25-79	25,100	(1,020)	<11.8		108	(181)
Downstream	2-25-79	31,400	(1,270)	313	(139)	291	(61.1)
Effluent	2-25-79	3,050	(134)	26.9	(27.0)	<9.18	

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected April,1979. **

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Fish			
Upstream 4-7-79	11,300 (390)	<44.7	68.3 (56.3)
Downstream 4-22-79	9,550 (356)	<31.5	<38.6
Effluent 4-7-79	16,300 (421)	<27.2	71.5 (43.1)
Benthic Organisms			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable.

1048 242

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected May, 1979 **

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Fish			
Upstream 5-16-79	8,650 (384)	<95.8	240 (198)
Downstream 5-16-79	9,270 (388)	<104	205 (152)
Effluent 5-16-79	9,160 (690)	<52.4	114 (74.4)
Benthic Organisms			
Upstream 5-16-79	7,220 (469)	g	g
Downstream	f	f	f
Effluent 5-16-79	6,800 (431)	g	g
Vascular Plants			
Upstream 5-26-79	23,600 (443)	<52.8	159 (49.5)
Downstream 5-26-79	857 (117)	<58.1	150 (60.6)
Effluent 5-26-79	40,400 (670)	<27.0	201 (33.8)
Seston			
Upstream	g	g	g
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.),
f Sample unavailable.
g Analysis in progress.

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected June 1979.**

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Fish			
Upstream	f	f	f
Downstream	f	f	f
Effluent	g	g	g
Benthic Organisms			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f
Vascular Plants			
Upstream 6-9-79	19,200 (416)	< 23.6	46.4 (31.7)
Downstream 6-9-79	25,400 (492)	< 29.4	122 (26.0)
Effluent 6-9-79	34,400 (596)	< 33.7	270 (16.7)
Seston			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.),
f Sample unavailable.

g Analysis in progress.

1048 244

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected First Quarter, 1979. **

Sampling Locations *		^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish				
Upstream	2-24-79	655 (147)	<39.7	17.1 (19.9)
Downstream	2-24-79	760 (255)	<79.7	<33.9
Effluent	2-24-79	536 (252)	<79.7	<33.9
Benthic Organisms				
Upstream		e	e	e
Downstream		e	e	e
Effluent	3-31-79	187 (140)	98.0 (36.2)	27.2 (17.4)
Vascular Plants				
Upstream	2-24-79	<404	<126	<53.7
Downstream	2-24-79	793 (396)	201 (93.5)	272 (69.1)
Effluent	2-24-79	2,920 (436)	1,190 (110)	1,050 (78.0)
Seston				
Upstream	2-25-79	<6,720	<1,140	700 (905)
Downstream	2-25-79	<7,630	<1,290	<472
Effluent	2-25-79	<26,100	<4,450	<1,640

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

e Insufficient weight of volume for analysis.

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected April, 1979.**

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish			
Upstream 4-7-79	< 249	< 77.1	112 (72.0)
Downstream 4-22-79	< 79.9	< 24.7	29.9 (25.5)
Effluent 4-7-79	< 249	80.6 (62.6)	136 (72.3)
Benthic Organisms			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f
Vascular Plants			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f
Seston			
Upstream	f	f	f
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

f Sample unavailable.

1048 246

Table II. E.2
Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected May, 1979.**

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish			
Upstream 5-16-79	<142	<43.9	49.2 (29.5)
Downstream 5-16-79	<98.2	<30.3	50.1 (22.6)
Effluent 5-16-79	<100	<31.1	43.0 (23.2)
Benthic Organisms			
Upstream 5-16-79	<503	169 (127)	146 ((49.9)
Downstream	f	f	f
Effluent 5-16-79	<845	< 261	177 (82.7)
Vascular Plants			
Upstream 5-26-79	<89.7	<27.8	<11.8
Downstream 5-26-79	<255	<79.1	<33.5
Effluent 5-26-79	<297	<92.3	<39.1
Seston			
Upstream	g	g	g
Downstream	f	f	f
Effluent	f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

f Sample unavailable.

g Analysis in progress.

Table II. E.2

Gamma-ray Emitting Radionuclide Concentrations in Aq atic Biota Samples (pCi/kg) for Samples Collected June, 1979 .**

Sampling Locations *		^{106}Ru	^{137}Cs	^{95}Zr & Nb
Fish				
Upstream		f	f	f
Downstream		f	f	f
Effluent		g	g	g
Benthic Organisms				
Upstream		f	f	f
Downstream		f	f	f
Effluent		f	f	f
Vascular Plants				
Upstream	6-9-79	< 88.5	152 (29.7)	82.2 (16.1)
Downstream	6-9-79	<252	<78.4	<33.2
Effluent	6-9-79	<255	<79.1	<33.5
Seston				
Upstream		f	f	f
Downstream		f	f	f
Effluent		f	f	f

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 9"% confidenc interval, (1.96 S.D.).

f Sample unavailable.

g Analysis in progress.

100

1048 248

II.F. Beef Cattle. Two head of cattle that graze the Facility area are counted each quarter in the CSU whole-body counter. The animals are washed carefully and counted for 20 minutes each. This method is far more sensitive than counting meat samples and is the method of choice for detecting Cs-137 in the meat food chain to humans. If thyroid I-131 contamination were significant this would be detected from the whole body count.

Table II.F.1 gives values for the first half of 1979 for whole body counting of beef cattle. The animals are selected each quarter at random; however, the animal number is recorded and the animal may be retrieved and recounted if necessary. The Cs-137 concentrations are nearly identical to those observed during the last half of 1978. The slightly lower concentrations in the second quarter of 1979 probably only reflects a different cutting and/or source of hay for these animals.

The Cs-137 activity is expressed as pCi per gram of K in the whole animal. This is done to more easily compare the counts between animals. K and Cs are both intracellular cations and by normalizing the Cs-137 activity to K, differences due to fat percentage in the animals are eliminated.

Table II.F. 1 In-Vivo Gamma Ray Activity in Fort St. Vrain Area Beef Cattle.

Date	I-131	Cs-137 (pCi/gK)
3/24/79	None Detected	24.7
3/24/79	None Detected	23.5
6/16/79	None Detected	16.3
6/16/79	None Detected	20.3

1048 249

II.G.1 Sample Cross Check Data

Since 1975 we have participated in a national EPA sponsored laboratory intercomparison analytical program. We analyze air filters as well as milk and water samples. The results obtained since the last report are given in Table II.G.1. Although we analyze cross check samples at the maximum frequency offered by the EPA a full complement was not received during the last period due to unknown reasons.

Inspection of Table II.G.1 reveals few aberrant measured values i.e. greater than the 3 signed control limit. Our laboratory has not completed a calibration for Cr-51. This will be completed during the last half of 1979.

Other cross check possibilities exist for this program. We have participated with the reactor health physics group in a TLD intercomparison. We analyze many duplicate samples with the state health department and we currently are participating in an international cross check program sponsored by the I.A.E.A. (International Atomic Energy Agency) in Vienna. The report for the end of 1979 will present a major analysis of these cross check values as well as an analysis of all the experience with the EPA program through that date.

Table II.G.1. EPA Cross-Check Data Summary

Date	Radio nuclide	CSU Value	Actual Value	Precision (1 sigma)	Control Limits (3 Sigma)	% deviation from known
			Air Filters, pCi/filter			
1/5/79	^{90}Sr	9	6	1.5	4.5	50
	^{137}Cs	d	6	5	15	--
	Gross α	6	5	5	15	20
	Gross β	15	18	5	15	17
3/30/79	^{90}Sr	33	21	1.5	4.5	57
	^{137}Cs	25	21	5	15	19
	Gross α	18	14	5	15	29
	Gross β	53	63	5	15	16
			Milk, pCi/l			
1/26/79	^{89}Sr	34	53	5	15	36
	^{90}Sr	25	19	1.5	4.5	67
	^{131}I	151	105	5	15	44
	^{137}Cs	93	49	5	15	90
	^{140}Ba	0	0	--	--	--
	K	1630	1560	78	234	4
			Water, tritium pCi/l			
12/15/78	^{3}H	1982	2030	346	1038	2
2/9/79	^{3}H	999	1280	331	993	22
4/13/79	^{3}H	2136	2270	349	1047	6
			Water, Alpha and Beta pCi/l			
1/19/79	Gross α	9	6	5	15	50
	Gross β	10	16	5	15	38
3/23/79	Gross α	16	10	5	15	60
	Gross β	8	16	5	15	50
			Water, Gamma pCi/l			
2/2/79	^{51}Cr	65	0	--	--	--
	^{60}Co	11	9	5	15	22
	^{65}Zn	36	21	5	15	70
	^{106}Ru	1	0	--	--	--
	^{134}Cs	10	6	5	15	67
	^{137}Cs	15	12	5	15	25

d. Sample lost in analysis.

Table II.G.1. EPA Cross-Check Data Summary

Date	Radio nuclide	CSU Value	Actual Value	Precision (1 sigma)	Control Limits (3 Sigma)	% deviation from known
			Water, Strontium 89 and 90			
1/5/79	^{89}Sr	23	14	5	15	39
	^{90}Sr	14	6	1.5	4.5	133

II.H. Summary and Conclusions

Table II.H.1 presents a summary and analysis of data collected during the first half of 1979. The tabular data may be used for comparison to other operating power reactors. For each sample type the number of samples analyzed in the reporting period and the maximum and minimum values for each sample type are given. From log-normal analysis of each data set for the last 12 month period the geometric mean and standard deviation is presented. The arithmetic mean is also calculated back for the entire year and for the reporting period. It should be noted that the tabular data presented in the body of this report contain only positive calculated values. Any calculated values less than zero or less than the minimum detectable concentration (MDC) are listed as less than the actual MDC for that sample analysis. However, the actual result was used in the calculation for the arithmetic mean values for the last six months. Therefore all values, negative as well as positive, were included. This procedure is now generally accepted and gives a closer approximation to the true mean value. Because of this procedure, however, the values listed in Table II.H.1 cannot be calculated directly from the tabular values in the report.

It must be emphasized that while it is true that no sample can contain less than zero radioactivity due to the random n[illegible]e of radioactive decay it is statistically possible to obtain sample count rates less than the background and hence a negative result.

The log-normal probability treatment is to plot all data for each sample type over the last full year on log-probit coordinates. The samples are ranked by increasing activity concentration and the cumulative percentage of rankings are plotted on the probit abcissa versus the activity concentration on the log ordinate. The geometric mean value $\bar{x}_g$, is determined directly from the 50th percentile point. The geometric standard deviation

is simply the slope of the line, which can be calculated from the ratio between the 84.1 percentile and the 50 percentile. In a normal distribution the arithmetic standard deviation is an additive parameter to the arithmetic mean ($\bar{x} \pm \sigma$), whereas in the log-normal distribution the geometric standard deviation σ_g, is a multiplcative parameter to the geometric mean ($x_g \div \sigma_g$), i.e., the area between $\bar{x}_g$ divided by σ_g, and $\bar{x}_g$ multiplied by σ_g should contain 68% of the grequency values. The log-normal statistical treatment is difficult when the number of samples in the group is small. For this reason only the last full year of data points is treated by this method. With the log-normal analysis, no bias results from using less than MDC values.

From the values presented in Table II.H.1 and the tabular data of the report the following observations and conclusions may be drawn:

1. No sample types except those collected in the effluent stream show radioactivity concentrations significantly different when comparing Facility, Adjacent or Reference mean values. This supports the conclusion that radioactivity released from the reactor has not produced concentrations off-site that are different from either background or that are due to weapon testing fallout.
2. There was only slight evidence in several sample types of tropospheric debris from the December 14, 1978 Chinese nuclear weapon test.
3. The log-normal treatment of all the data revealed that for most of the data such analysis is appropriate. However, sigmoid distributions were quite often observed. Sigmoid distributions can be resolved into biomodal or even trimodal log-normal distributions. This is generally interpreted to mean that there is more than one significant activity source. It was again noted that for all of the data analyzed over the past year by the log-normal treatment, those sample types that are

reservoirs or sinks for activity, e.g., soil, sediment and TLD, tended to be described by a single distribution. Those sample types which are less stable and fluctuate, e.g., air and precipitation tended to be bimodal or trimodally distributed.

4. As in every previous report, it was again apparent that the variability observed around the mean values was great. This variability is due to counting statistics and methodological error, but principally due to true environmental variation. It must be recognized and accounted for in analysis of any set of environmental data before meaningful conclusions can be drawn.

5. Environmental radioactivity data has been collected on this project since 1969. The methods or approach have not significantly changed since that time. During this period the reactor began power production. Probably no more extensive or complete radiation surveillance program exists for any reactor in the U.S.A. For this reason a detailed and thorough analysis of all past data is warranted. At the end of the next reporting period we will present a complete statistical summary of all data collected on this project since its inception.

Table II.H.1. Mean Values for all Sample Types.

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
TLD External (mR/day)	Facility	90	.20	.54	.43	(1.23)	.44	.43
	Adjacent	81	.15	2.50	.4	(1.20)	.42	.42
	Reference	82	.17	.55	.41	(1.19)	.42	.42
	Composite	253	.15	2.50	.4	(1.19)	.42	.43
Air Gross α (fCi/m^3)	Facility	103	<0.8	14.7	3.98	(2.25)	5.54	4.77
	Adjacent	69	0.6	13	4.39	(2.37)	7.09	3.56
	Composite	172	<0.8	13	4.16	(2.31)	6.25	4.29
Air Gross β (fCi/m^3)	Facility	103	5	54	22.8	(1.98)	29.9	21.0
	Adjacent	71	5	81	20.1	(2.51)	36.9	15.4
	Composite	174	5	81	21.7	(2.20)	32.7	18.7
Air Tritium (pCi/l)	Facility	103	<250	4,750	496	(2.43)	352	594
	Adjacent	75	<250	3,420	448	(2.77)	740	538
	Composite	178	<250	4,750	475	(2.58)	401	576
Air ^{131}I (fCi/m^3)	Composite	26	<3.01	303	6.75	(5.45)	<3.01	<3.01
Air ^{106}Ru (fCi/m^3)	Composite	26	<1.32	12.4	4.41	(2.34)	1.63	.0841

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Table II.H.1. Mean Values for all Sample Types.(Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Air ^{137}Cs (fCi/m^3)	Composite	26	<0.771	4.71	1.32	(1.91)	1.33	1.03
Air ^{95}Zr (fCi/m^3)	Composite	26	<0.123	2.71	0.473	(3.19)	0.507	0.317
Water Gross β (pCi/l)	Effluent	11	<1.25	13.0	14.5	(2.12)	17.4	10.3
	Downstream	18	3.83	2[illegible].2	11.5	(1.86)	13.6	10.4
	Upstream	12	5.71	20.5	12.8	(1.81)	15.6	9.97
	Potable	12	0.634	9.04	3.23	(2.76)	5.43	3.86
	Composite	53	<1.25	22.2	9.29	(2.56)	13.1	8.80
Water Tritium (pCi/l)	Effluent	11	573	14,200	2,880	(7.18)	99,200	4,090
	Downstream	18	<295	1,220	577	(2.51)	798	496
	Upstream	12	<299	1,130	613	(3.08)	1,380	487
	Potable	12	<295	5,940	861	(2.09)	1,150	1,260
	Composite	53	<295	14,200	911	(3.94)	23,300	789
Water ^{90}Sr (pCi/l)	Effluent	28	0.253	21.9	1.41	(3.38)	3.28	2.28
	Downstream	16	<0.657	2.57	1.30	(5.58)	5.31	<0.657
	Upstream	9	<0.562	1.82	1.91	(6.27)	8.01	0.696
	Potable	11	<0.644	3.19	1.34	(6.44)	5.88	<0.644
	Composite	64	<0.253	21.9	1.44	(4.78)	5.01	1.30

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Water ^{89}Sr (pCi/l)	Effluent	28	<0.532	1.56	1.89	(2.78)	<0.532	<0.532
	Downstream	16	<0.456	5.05	1.34	(2.16)	<0.456	<0.456
	Upstream	9	<0.560	5.33	1.06	(3.42)	<0.560	<0.560
	Potable	11	<0.503	2.35	0.750	(3.60)	<0.503	<0.503
	Composite	64	<0.456	5.33	1.16	(2.89)	<0.456	<0.456
Water ^{106}Ru (pCi/l)	Effluent	31	<4.53	129	2.73	(4.00)	<4.53	<4.53
	Downstream	18	<4.53	4.93	3.11	(1.80)	<4.53	<4.53
	Upstream	12	<4.53	8.20	3.60	(1.72)	<4.53	<4.53
	Potable	12	<2.35	2.79	1.54	(2.62)	<4.53	<4.53
	Composite	73	<2.35	129	2.69	(2.90)	<4.53	<4.53
Water ^{137}Cs (pCi/l)	Effluent	31	<0.809	39.1	0.974	(2.63)	1.61	2.23
	Downstream	18	<0.809	4.79	0.774	(3.25)	1.14	1.16
	Upstream	12	<0.809	9.35	0.866	(3.02)	1.34	1.54
	Potable	12	<0.735	1.86	0.878	(2.03)	0.896	0.432
	Composite	73	<0.735	39.1	0.886	(2.73)	1.33	1.55
Water ^{95}Zr (pCi/l)	Effluent	31	<0.290	64.0	0.515	(3.27)	1.60	2.64
	Downstream	18	<0.290	3.44	0.511	(2.46)	0.665	0.732
	Upstream	12	<0.290	5.35	0.649	(2.47)	0.925	1.05
	Potable	12	<0.290	1.43	0.486	(1.91)	0.407	<0.290
	Composite	73	<0.290	64.0	0.528	(2.69)	1.05	1.51
Sediment Gross β (pCi/kg)	Effluent	11	27,800	43,200	35,200	(1.23)	47,800	34,700
	Downstream	13	27,200	39,100	33,800	(1.33)	35,200	32,700
	Upstream	10	12,700	33,900	33,000	(1.34)	33,800	31,000
	Composite	34	12,700	43,200	34,000	(1.30)	45,500	32,600

Table II.H.1. Mean Values for all Sample Types (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Sediment	Effluent	11	<146	708	263	(3.95)	1,040	227
^{90}Sr	Downstream	13	<107	512	304	(2.93)	543	107
(pCi/kg)	Upstream	10	<144	267	234	(2.86)	643	<144
	Composite	34	<107	708	271	(3.17)	719	135
Sediment	Effluent	11	<129	898	310	(3.05)	<129	<129
^{89}Sr	Downstream	13	<139	809	231	(5.51)	<139	<139
(pCi/kg)	Upstream	10	<144	624	371	(3.21)	<144	<144
	Composite	34	<129	898	286	(4.07)	<129	<129
Sediment	Effluent	11	<3,720	6,750	3,750	(2.22)	<3,720	<3,720
^{106}Ru	Downstream	13	<3,730	40,800	2,750	(2.89)	<3,730	<3,730
(pCi/kg)	Upstream	10	<3,730	<3,730	3,110	(1.90)	<3,730	<3,730
	Composite	34	<3,720	40,800	3,130	(2.40)	<3,720	<3,720
Sediment	Effluent	11	<653	2,060	759	(1.60)	<653	792
^{137}Cs	Downstream	13	<646	2,830	352	(3.41)	<646	<646
(pCi/kg)	Upstream	10	<560	1,820	648	(1.59)	<650	<650
	Composite	34	<646	2,830	530	(2.51)	<646	<646
Sediment	Effluent	11	<237	2,890	251	(2.43)	237	434
^{95}Zr	Downstream	13	<230	553	193	(2.31)	<230	<230
(pCi/kg)	Upstream	10	<234	663	213	(2.14)	<234	236
	Composite	34	<230	2,890	215	(2.29)	<230	268
Precipitation	F-1	6	0.670	202	52.5	(5.52)	142	69.0
Gross β	F-4	6	<9.53	299	74.5	(5.04)	196	92.9
(pCi/m^2)	Composite	12	<9.53	299	62.3	(5.14)	169	81.0

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ (σ_g) 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Precipitation	F-1	6	345	16,500	733 (3.19)	1,970	3,310
Tritium	F-4	6	349	2,360	521 (1.84)	620	866
(pCi/m^2)	Composite	12	345	16,500	818 (2.52)	1,290	2,080
Precipitation	F-1	6	<4.73	16.3	33.5 (3.01)	23.5	11.0
^{106}Ru	F-4	6	<3.86	9.41	13.2 (5.38)	16.2	<3.86
(pCi/m^2)	Composite	12	<3.86	16.3	20.3 (4.41)	19.9	<3.86
Precipitation	F-1	6	<1.46	52.6	14.0 (4.02)	29.0	21.2
^{137}Cs	F-4	6	<2.29	21.7	12.5 (2.59)	16.9	10.3
(pCi/m^2)	Composite	12	<1.46	52.6	13.2 (3.21)	23.0	15.7
Precipitation	F-1	6	<0.620	23.1	6.12(6.08)	9.40	9.18
^{95}Zr	F-4	6	1.02	10.8	5.29(2.49)	7.46	5.16
(pCi/m^2)	Composite	12	<0.620	23.1	5.79(4.07)	8.66	7.62
Precipitation	F-1	6	<5.17	331	24.8 (8.68)	62.5	<5.17
^{90}Sr	F-4	6	<7.08	221	11.2 (4.73)	48.5	7.23
(pCi/m^2)	Composite	12	<5.17	331	16.7 (6.59)	44.4	<5.17
Precipitation	F-1	6	<0.360	18.7	11.3 (5.57)	0.360	<0.360
^{89}Sr	F-4	6	<2.47	46.9	13.0 (2.88)	2.47	<2.47
(pCi/m^2)	Composite	12	<0.360	46.9	12.1 (4.04)	0.360	<0.360
Milk	Facility	16	< 275	906	300 (2.65)	367	455
Tritium	Adjacent	16	< 275	1,009	344 (2.00)	361	473
(pCi/l)	Reference	16	< 275	728	286 (2.67)	343	372
	Composite	48	< 275	1,009	309 (2.43)	357	433

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Milk	Facility	14	<0.950	11.9	2.64	(2.67)	3.51	3.72
^{90}Sr	Adjacent	14	<3.40	15.7	3.89	(2.52)	5.13	3.40
(pCi/l)	Reference	14	<4.03	9.04	<4.03		4.03	<4.03
	Composite	42	<0.950	15.7	3.30	(2.45)	4.04	3.30
Milk	Facility	14	<0.982	4.71	3.20	(2.54)	<0.982	<0.982
^{89}Sr	Adjacent	14	<1.01	8.83	3.15	(2.64)	<1.01	<1.01
(pCi/l)	Reference	14	<1.56	<1.56	3.45	(2.95)	<1.56	<1.56
	Composite	42	<0.982	8.83	3.26	(2.68)	<0.982	<0.982
Milk	Facility	16	<0.102	46.6	1.18	(8.07)	<0.101	5.82
^{131}I	Adjacent	16	<0.104	20.8	2.00	(7.16)	6.03	5.16
(pCi/l)	Reference	16	<0.103	33.6	2.14	(8.67)	8.30	4.15
	Composite	48	<0.102	46.6	1.72	(7.92)	2.38	4.35
Milk	Facility	16	<0.185	26.5	3.71	(5.25)	7.40	9.63
^{137}Cs	Adjacent	16	<0.169	11.1	3.82	(3.35)	4.98	5.31
(pCi/l)	Reference	16	<0.107	7.43	3.26	(4.04)	3.38	2.73
	Composite	48	<0.107	26.5	3.59	(4.14)	5.37	5.78
Milk	Facility	16	1.45	1.61	1.49	(1.04)	1.49	1.51
Nat. K	Adjacent	16	1.42	1.66	1.54	(1.06)	1.54	1.55
(g/l)	Reference	16	1.30	1.61	1.48	(1.05)	1.48	1.48
	Composite	48	1.30	1.61	1.50	(1.05)	1.50	1.51
Forage	Facility	4	<273	583	381	(4.03)	583	400
Tritium	Adjacent	11	<295	891	618	(1.49)	667	573
(pCi/l)	Reference	11	<273	762	426	(1.86)	488	483
	Composite	[illegible]	<273	891	487	(2.10)	578	426

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Forage	Facility	g						
^{89}Sr	Adjacent	g						
(pCi/kg)	Reference	12	<13.7	390	23.5	(7.38)	<13.7	<13.7
	Composite	g						
Forage	Facility	g						
^{90}Sr	Adjacent	g						
(pCi/kg)	Reference	12	<12.7	1,485	127	(3.75)	241	257
	Composite	g						
Forage	Facility	4	<38.3	29.5	62.4	(1.82)	18.0	13.0
^{106}Ru	Adjacent	12	<11.9	61.0	61.2	(3.20)	107	142
(pCi/kg)	Reference	12	<22.8	90.2	59.3	(2.50)	37.2	8.4
	Composite	28	<11.9	90.2	60.6	(2.67)	74.9	66.5
Forage	Facility	4	92.5	235	152	(1.53)	164	179
^{137}Cs	Adjacent	12	<15.3	430	89.0	(2.42)	124	109
(pCi/kg)	Reference	12	<17.1	327	87.1	(2.52)	125	99.4
	Composite	28	<15.3	430	95.4	(2.37)	130	135
Forage	Facility	4	29.3	2,030	83.8	(3.31)	260	549
^{95}Zr	Adjacent	12	13.3	63.2	43.0	(2.08)	56.2	29.0
(pCi/kg)	Reference	12	8.47	55.5	33.2	(2.66)	46.5	25.7
	Composite	28	13.3	2,030	42.3	(2.60)	81.6	102
Forage	Facility	4	12,900	31,200	17,400	(2.11)	20,600	18,200
Gross β	Adjacent	12	8,860	32,700	16,900	(2.08)	20,200	20,100
(pCi/kg)	Reference	12	12,800	32,100	16,000	(1.63)	17,600	18,800
	Composite	28	8,860	32,700	17,000	(1.99)	20,000	19,200

Table II.H.1. Mean Values for all Sample Types.(Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	8	26,500	35,800	30,300	(1.11)	30,500	29,700
Gross β	Adjacent	24	18,800	33,500	26,900	(1.14)	27,100	26,700
(pCi/kg)	Reference	24	17,100	31,600	25,800	(1.19)	26,200	26,000
	Composite	56	17,100	35,800	26,900	(1.16)	27,200	26,800
Soil	Facility	8	3.42	4.60	3.92	(1.11)	3.94	3.83
Gross β	Adjacent	24	2.42	4.32	3.48	(1.13)	3.51	3.45
($\mu Ci/m^2$)	Reference	24	2.21	4.14	3.33	(1.18)	3.37	3.36
	Composite	56	2.21	4.62	3.47	(1.16)	3.51	3.47
Soil	Facility	8	<366	<366	377	(1.13)	<366	<366
^{106}Ru	Adjacent	22	<326	<326	393	(1.15)	<326	<326
(nCi/m^2)	Reference	20	<326	<326	355	(1.66)	<326	<326
	Composite	50	<326	<326	375	(1.40)	<326	<326
Soil	Facility	8	86.6	264	79.7	(2.37)	107	119
^{137}Cs	Adjacent	22	73.5	223	78.3	(2.45)	89.9	92.7
(nCi/m^2)	Reference	20	62.8	183	85.9	(1.59)	88.4	94.4
	Composite	50	62.8	264	81.7	(2.07)	91.8	97.2
Soil	Facility	8	<19.7	27.1	12.3	(3.47)	24.8	14.1
^{95}Zr	Adjacent	22	<19.5	71.2	24.8	(2.77)	24.1	15.4
(nCi/m^2)	Reference	20	<19.5	107	27.4	(2.99)	57.9	20.0
	Composite	50	<19.5	107	23.3	(3.02)	38.6	17.2
Soil	Facility	6	483	714	430	(1.62)	490	558
Tritium	Adjacent	18	<250	905	524	(1.72)	585	617
(pCi/l)	Reference	18	<250	790	503	(1.63)	552	604
	Composite	42	<250	790	500	(1.66)	554	603

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ (σ_g) 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	6	<91.9	<91.9	118 (1.40)	<91.9	<91.9
^{89}Sr	Adjacent	17	<92.0	646	144 (1.94)	<92.0	<92.0
(pCi/kg)	Reference	18	<68.0	929	111 (3.52)	<68.0	<68.0
	Composite	41	<68.0	929	125 (2.55)	<68.0	<68.0
Soil	Facility	6	143	1,440	271 (2.37)	395	426
^{90}Sr	Adjacent	17	<75.0	3,210	197 (5.39)	508	549
(pCi/kg)	Reference	18	<74.0	1,650	210 (2.36)	307	330
	Composite	41	<74.0	3,210	213 (3.46)	402	509
Aquatic Biota	Upstream	3	8,650	11,400	8,900 (2.21)	10,700	10,400
Fish	Downstream	3	8,970	9,550	11,900 (2.35)	16,500	9,260
Gross β	Effluent	3	7,500	16,300	13,800 (2.41)	21,800	11,000
(pCi/kg)	Composite	9	7,500	16,300	11,300 (2.27)	16,300	0,200
Aquatic Biota	Upstream	2	6,940	7,220	6,400 (5.76)	30,100	7,080
Benthic	Downstream	1	5,370	5,370	15,300 (3.36)	30,700	5,370
Gross β	Effluent	2	6,170	6,800	12,100 (2.28)	16,500	6,490
(pCi/kg)	Composite	5	5,370	7,220	10,300 (3.66)	25,500	6,500
Aquatic Biota	Upstream	3	19,200	23,000	10,200 (2.85)	14,800	21,400
Vascular Plants	Downstream	3	857	26,200	7,120 (3.02)	11,000	17,400
Gross β	Effluent	3	24,900	40,400	8,960 (4.04)	16,600	33,200
(pCi/kg)	Composite	9	857	40,400	9,110 (3.20)	14,800	24,000
Aquatic Biota	Upstream	1	25,100	25,100	35,800 (1.70)	41,100	25,100
Seston	Downstream	1	31,400	31,400	32,200 (1.30)	33,200	31,400
Gross β	Effluent	1	3,050	3,050	21,700 (2.70)	29,300	3,050
(pCi/kg)	Composite	3	3,050	31,400	28,800 (2.00)	34,300	19,900

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	3	<28.8	<28.8	59.7	(1.66)	<28.8	<28.8
Fish	Downstream	3	<31.5	<31.5	75.6	(1.86)	<31.5	<31.5
^{89}Sr	Effluent	3	<27.2	<27.2	33.4	(1.58)	<27.2	<27.2
(pCi/kg)	Composite	9	<27.2	<31.5	53.2	(1.85)	<27.2	<27.2
Aquatic Biota	Upstream	9						
Benthic	Downstream	0	NA	NA			166	NA
^{89}Sr	Effluent	9						
(pCi/kg)	Composite	9						
Aquatic Biota	Upstream	5	<23.6	<23.6	63.7	(2.75)	<23.6	<23.6
Vascular Plants	Downstream	6	<29.4	751	57.2	(2.77)	<29.4	166
^{89}Sr	Effluent	6	<27.6	458	67.4	(3.21)	<27.6	<27.6
(pCi/kg)	Composite	16	<23.6	751	62.6	(2.80)	<23.6	<23.6
Aquatic Biota	Upstream	4	<11.8	1,920	356	(6.27)	384	768
Seston	Downstream	4	<133	1,680	470	(3.18)	504	525
^{89}Sr	Effluent	2	26.9	2,590	150	(5.62)	586	1,310
(pCi/kg)	Composite	10	<11.8	2,590	304	(4.79)	479	745
Aquatic Biota	Upstream	3	68.3	240	150	(2.04)	184	126
Fish	Downstream	3	<38.6	205	127	(1.87)	145	110
^{90}Sr	Effluent	3	71.5	114	114	(1.43)	121	93.0
(pCi/kg)	Composite	9	<38.6	240	129	(1.76)	150	110
Aquatic Biota	Upstream	9						
Benthic	Downstream	0	NA	NA			162	NA
^{90}Sr	Effluent	9						
(pCi/kg)	Composite	9						
Aquatic Biota	Upstream	4	46.4	331	91.9	(2.00)	112	169
Vascular Plants	Downstream	4	122	258	152	(1.49)	183	158
^{90}Sr	Effluent	4	20.3	270	87.9	(3.98)	119	177
(pCi/kg)	Composite	12	20.3	331	98.5	(2.60)	132	168

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	s_g	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	1	108	108	99.5	(3.21)	83.6	108
Seston	Downstream	1	291	291	160	(2.18)	209	291
^{90}Sr	Effluent	1	10.3	10.3	147	(4.54)	128	10.3
(pCi/kg)	Composite	3	10.3	291	132	(3.04)	141	136
Aquatic Biota	Upstream	3	<142	644	228	(1.90)	271	291
Fish	Downstream	3	< 79.9	760	201	(2.91)	315	199
^{106}Ru	Effluent	3	<100	536	218	(1.84)	254	356
(pCi/kg)	Composite	9	< 79.9	760	216	(2.14)	280	270
Aquatic Biota	Upstream	1	<503	<503	141	(1.78)	211	211
Bent[illegible]c	Downstream	e	<	<	361	(1.36)	265	-
^{106}Ru	Effluent	1	<845	<845	124	(11.2)	<253	130
(pCi/kg)	Composite	2	503	<845	163	(4.95)	<253	135
Aquatic Biota	Upstream	3	88.5	<404	194	(2.27)	39.4	<88.5
Vascular Plant	Downstream	3	252	793	185	(2.87)	174	62.7
^{106}Ru	Effluent	3	255	2,920	462	(2.35)	318	1,374
(pCi/kg)	Composite	9	88.5	2,920	255	(2.66)	205	364
Aquatic Biota	Upstream	1	<6,720	<6,720	6,600	(1.25)	<6,720	<6,720
Seston	Downstream	1	<7,630	<7,630	3,960	(2.98)	<7,630)	<7,630
^{106}Ru	Effluent	1	<26,100	<26,100	5,910	(2.42)	<26,100	<26,100
(pCi/kg)	Composite	3	<6,700	<26,100	5,390	(2.25)	<26,100	<26,100
Aquatic Biota	Upstream	3	<39.7	< 77.1	45.0	(2.90)	55.6	< 39.7
Fish	Downstream	3	<24.7	< 79.7	20.5	(7.05)	43.0	< 24.7
^{137}Cs	Effluent	3	<31.1	80.6	56.9	(2.21)	47.0	< 31.1
(pCi/kg)	Composite	9	<24.7	80.6	37.4	(3.94)	35.1	< 24.7
Aquatic Biota	Upstream	1	169	169	171	(1.17)	172	169
Benthic	Downstream	-	-	-	211	(1.33)	218	-
^{137}Cs	Effluent	2	<261	98.0	140	(3.39)	<261	<261
(pCi/kg)	Composite	3	<261	169	175	(2.00)	<261	<261

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\ddot{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	3	<27.8	152	111	(1.95)	126	40.2
Vascular Plant	Downstream	3	<78.4	201	134	(2.03)	142	<78.4
^{137}Cs	Effluent	3	<79.1	1,190	166	(2.49)	100	377
(pCi/kg)	Composite	9	<27.8	1,190	135	(2.13)	123	153
Aquatic Biota	Upstream	1	<1,140	<1,140	1,130	(1.38)	<1,140	<1,140
Seston	Downstream	1	<1,290	<1,290	685	(2.19)	<1,290	<1,290
^{137}Cs	Effluent	1	<4,450	<4,450	1,000	(3.34)	<4,450	<4,450
(pCi/kg)	Composite	3	<1,140	<4,450	924	(2.35)	<1,140	<1,140
Aquatic Biota	Upstream	3	17.1	112	31.1	(1.99)	12.7	59.4
Fish	Downstream	3	29.2	50.1	32.8	(2.05)	34.0	30.0
^{95}Zr	Effluent	3	<33.9	136	25.5	(3.05)	40.5	64.8
(pCi/kg)	Composite	9	17.1	136	29.7	(2.27)	29.1	51.3
Aquatic Biota	Upstream	1	146	146	114	(1.70)	129	146
Benthic	Downstream	e	-	-	120	(1.29)	108	-
^{95}Zr	Effluent	2	27.2	177	87.8	(2.24)	112	102
(pCi/kg)	Composite	3	27.2	177	104	(1.80)	121	117
Aquatic Biota	Upstream	3	<11.8	<537	50.1	(2.12)	46.9	19.1
Vascular Plants	Downstream	3	<33.2	272	68.7	(2.65)	90.5	72.0
^{95}Zr	Effluent	3	<33.5	1,050	96.2	(2.93)	176	329
(pCi/kg)	Composite	9	11.8	1,050	69.2	(2.58)	106	140
Aquatic Biota	Upstream	1	700	700	545	(1.30)	177	700
Seston	Downstream	1	<472	<472	267	(4.16)	<472	<472
^{95}Zr	Effluent	1	<1,640	<1,640	619	(1.77)	<1,640	<1,640
(pCi/kg)	Composite	3	<472	<1,640	456	(2.50)	<472	<472
Beef	F-44							
^{137}Cs								
pCi/g Nat K		4	16.3	24.7	24.5	(1.31)	25.3	21.2

II.I. ERRATA

The following tables give data for samples on which the analysis was in progress at the date of the last progress report. The tabular data was included in Table II.H.1, the mean value table and this table is also presented for update purposes. The soil values in Table II.D.9 again show great variation but all elevated values are within the 95% confidence level dictated by counting statistics and within the methodological variation dictated by the appropriate method as discussed in the soil section of this report.

Table II. C.7
Strontium 90 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	7-8-78	8-5-78	9-9-78	10-14-78	11-11-78	12-23-78
Effluent						
E 38: Farm Pond (Goosequill)	<198	<259	541 (275)	<250	<306**	<365
E 41: Slough to St. Vrain Creek	<254	<359	265 (299)	<192	<198	<409
Downstream						
D 37: Lower Latham Reservoir	<525	436 (216) *	<212	<209	<343	<303
D 40: S. Platte River Below Confluence	<215	636 (356)	<202	<189	<340	<454
D 45: St. Vrain Creek	<113	767 (419)	<256	<229	<316	<397
Upstream						
U 42: St. Vrain Creek	<236	<377	<178	<184	< 605	<346
U 43: S. Platte River	<246	481 (356)	<216	217 (235)	<297	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** E38 collected 11/14/78.
f Sample unavailable.

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Table II. C.8
Strontium 89 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	7-8-78	8-5-78	9-9-78	10-14-78	11-11-78	12-23-78
Effluent						
E 38: Farm Pond (Goosequill)	303 (4,180)*	4,310 (1,600)	565 (778)	220 (100)	419 (907)**	<271
E 41: Slough to St. Vrain Creek	5,900 (5,340)	2,270 (1,900)	<242	305 (609)	<177	<338
Downstream						
D 37: Lower Latham Reservoir	1,640 (9,560)	<204	<199	<193	<271	<243
D 40: S.Platte River Below Confluence	<188	<281	<193	644 (603)	<261	<356
D 45: St. Vrain Creek	474 (2,540)	<313	<216	248 (768)	<221	1,070 (774)
Upstream						
U 42: St. Vrain Creek	<224	2,230 (3,600)	600 (733)	<181	<502	1,170 (675)
U 43: S. Platte River	1,240 (5,560)	4,170 (1,840)	<216	<182	<249	f

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** E38 collected 11/14/78.
f Sample unavailable.

Table II. D.7
Gross Beta Concentrations in Soil and Forage (pCi/kg) for Samples Collected Third Quarter, 1978.

Sampling Location	July 22					
	Soil	Forage	Soil	Forage	Soil	Forage
Facility						
4	35,000 (1,560)					
44	32,500 (1,500)					
Adjacent						
6	29,300 (1,440)					
28	26,800 (1,390)					
31	27,600 (1,400)					
36	29,400 (1,440)					
48	33,100 (1,520)					
50	f					
Reference						
16	f					
17	19,500 (1,210)					
20	28,600 (1,420)					
22	28,900 (1,410)					
23	32,000 (1,500)					
25	25,300 (1,350)					

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

f. Sample unavailable.

Table II. D.8
Gross Beta Activity in Soil per Unit Surface Area ($\mu Ci/m^2$) for Samples Collected Third Quarter, 1978.

Sampling Locations	July 22		
Facility			
4	4.54 (0.201)*		
44	4.19 (0.194)		
Adjacent			
6	3.78 (0.185)		
28	3.46 (0.179)		
31	3.55 (0.181)		
36	3.80 (0.186)		
48	4.27 (0.196)		
50	f		
Reference			
16	f		
17	2.51 (0.156)		
20	3.69 (0.183)		
22	3.60 (0.182)		
23	4.13 (0.193)		
25	3.26 (0.174)		

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
f Sample unavailable.

Table II. D.9
Gamma-ray Emitting Radionuclide Activity per Unit Surface Area of Soil (nCi/m^2) for Samples Collected July 22, 1978.

Sampling Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
Facility			
4	<433	<58.1	<19.9
44	<433	<58.1	115 (373)
Adjacent			
6	<433	<58.1	80.5 (268)
28**	<433	64.9 (61.4)	53.9 (292)
31	<433	<58.1	42.9 (422)
36**	474 (1,110)	<58.1	<19.9
48	<442	145 (71.5)	133 (384)
50	f	f	f
Reference			
16	f	f	f
17	<433	<58.1	347 (281)
20	<433	90.7 (61.9)	309 (268)
22	<433	<58.1	155 (307)
23	<433	91.0 (61.6)	197 (271)
25**	<433	<58.1	192 (293)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
** Collected July 29, 1978
f Sample unavailable.

Table II. D.10
Tritium, Strontium 89, and Strontium 90 Concentrations in Soil for Samples Collected July 22, 1978.

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
Facility			
4	<288	<214	519 (256)*
44	<288	2,350 (9,300)	<235
Adjacent			
6	585 (274)	d	d
28	<288	<145	374 (194)
31	475 (272)	<181	<212
36	e	<176	341 (240)
48	421 (272)	<146	428 (235)
50	f	f	f
Reference			
16	f	f	f
17	349 (270)	<147	154 (140)
20	<288	<184	408 (230)
22	<288	<172	380 (242)
23	<288	904 (8,830)	<265
25	<288	<79.1	121 (97.5)

* Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).
d Sample lost in analysis.
e Insufficient weight or volume for analysis.
f Sample unavailable.

Table II. E.1
Gross Beta and Radiostrontium Concentrations in Aquatic Biota Samples (pCi/kg) for Samples Collected December 1978 **.

Sampling Locations *	Gross Beta	Strontium 89	Strontium 90
Vascular Plants			
Upstream 12/23/78	5,040 (113) **	<31.8	140 (36.9)
Downstream 12/23/78	7,030 (222)	<34.5	100 (24.4)
Effluent 12/23/78	2,000 (94.6)	<185	218 (150)
Seston			
Upstream 12/27/78	29,700 (1,340)	666 (330)	<167
Downstream 12/21/78	34,400 (1,420)	454 (445)	<188
Effluent 12/21/78	16,400 (1,030)	d	d

* Upstream Composite: U 42, U 43.
Downstream Composite: D 40, D 45.
Effluent: E 38.

** Uncertainties (in parentheses) are for the 95% confidence interval, (1.96 S.D.).

d Lost in analysis.

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Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{\bar{x}}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Sediment	Effluent	12	<192	359	155	(2.71)	141	138
^{90}Sr	Downstream	18	<113	636	213	(2.03)	68.4	6.11
(pCi/kg)	Upstream	11	<178	481	142	(2.45)	124	121
	Composite	41	<113	636	173	(2.37)	104	79.5
Sediment	Effluent	12	<177	5,900	393	(2.77)	701	1,240
^{89}Sr	Downstream	18	<193	1,640	136	(5.70)	85.0	65.2
(pCi/kg)	Upstream	11	<182	4,170	300	(2.76)	41.7	723
	Composite	41	<177	5,900	229	(4.24)	199	585
Sediment	Effluent	12	<3,810	31,300	3,750	(1.89)	<3,810	<3,810
^{106}Ru	Downstream	18	<3,880	4,470	3,320	(2.85)	1,260	891
(pCi/kg)	Upstream	12	<3,810	<3,990	3,140	(2.57)	<3,810	<3,810
	Composite	42	<3,810	31,300	3,400	(2.47)	<3,810	<3,810
Sediment	Effluent	12	<663	810	378	(2.42)	64.6	<663
^{137}Cs	Downstream	18	<655	1,080	411	(2.57)	123	13.3
(pCi/kg)	Upstream	12	<655	< 799	533	(1.79)	287	124
	Composite	42	<663	1,080	424	(2.47)	132	<648
Sediment	Effluent	12	<117	<457	191	(1.75)	<117	<117
^{95}Zr	Downstream	18	<239	633	196	(2.08)	<231	60.5
(pCi/kg)	Upstream	12	<235	434	214	(2.42)	155	105
	Composite	42	<117	633	201	(2.03)	<117	<117
Precipitation	F-1	6	49.3	935	147	(3.81)	355	75.1
Gross β	F-4	6	<25.1	834	249	(6.72)	947	300
(pCi/m^2)	Composite	12	<25.1	935	210	(5.24)	651	188

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	2	32,500	35,000	42,800	(1.29)	43,850	33,800
Gross β	Adjacent	5	26,800	33,100	33,500	(1.40)	35,300	29,200
(pCi/kg)	Reference	5	19,500	32,000	31,400	(1.26)	32,200	26,900
	Composite	12	19,500	35,000	33,500	(1.40)	37,900	29,000
Soil	Facility	2	4.19	4.54	5.51	(1.29)	5.68	4.37
Gross β	Adjacent	5	3.40	4.27	4.32	(1.40)	4.55	3.77
(μCi/m^2)	Reference	5	2.51	4.13	4.05	(1.26)	4.15	3.44
	Composite	12	2.51	4.54	4.35	(1.34)	4.54	3.73
Soil	Facility	2	<433	<433	400	(1.65)	389	<433
^{106}Ru	Adjacent	5	<433	474	306	(1.87)	359	<433
(nCi/m^2)	Reference	5	<433	<433	403	(1.60)	448	<433
	Composite	12	<433	474	340	(1.80)	527	<433
Soil	Facility	2	<58.1	<58.1	61.8	(2.64)	89.6	<58.1
^{137}Cs	Adjacent	5	<58.1	145	63.9	(1.93)	109	<58.1
(nCi/m^2)	Reference	5	<58.1	91.0	49.8	(2.47)	63.1	<58.1
	Composite	12	<58.1	145	57.2	(2.24)	97.0	<58.1
Soil	Facility	2	<19.9	115	19.1	(2.92)	27.8	66.0
^{95}Zr	Adjacent	5	<19.9	133	22.6	(2.91)	31.0	<19.9
(nCi/m^2)	Reference	5	155	347	28.5	(1.73)	67.4	240
	Composite	12	<19.9	347	23.3	(2.80)	60.5	113
Soil	Facility	2	<288	<288	416	(1.57)	466	<288
Tritium	Adjacent	4	<288	585	458	(1.44)	598	440
(pCi/l)	Reference	5	<288	349	497	(1.66)	531	<288
	Composite	11	<288	585	479	(1.49)	503	<288

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Soil	Facility	2	<214	2,350	35.0	(1.93)	41.1	<214
^{89}Sr	Adjacent	4	<145	<145	18.8	(7.78)	34.9	<145
(pCi/kg)	Reference	5	<79.1	904	34.9	(2.69)	89.6	<79.1
	Composite	11	<79.1	2,350	26.9	(4.15)	58.1	<79.1
Soil	Facility	2	<235	519	240	(1.70)	239	302
^{90}Sr	Adjacent	4	<212	428	154	(2.43)	210	333
(pCi/kg)	Reference	5	<265	408	221	(1.71)	251	<265
	Composite	11	<212	519	193	(1.97)	231	278
Aquatic Biota	Upstream	4	1,630	19,800	6,840	(3.63)	10,600	10,900
Fish	Downstream	4	3,580	43,800	14,400	(3.20)	27,100	29,600
Gross β	Effluent	4	6,650	88,900	18,400	(3.98)	21,900	30,000
(pCi/kg)	Composite	12	3,580	88,900	12,490	(2.95)	16,900	20,400
Aquatic Biota	Upstream	4	5,490	159,000	9,480	(7.36)	34,200	42,100
Benthic	Downstream	4	7,400	111,000	19,800	(3.42)	43,684	37,000
Gross β	Effluent	4	5,790	47,200	16,500	(2.36)	41,800	41,800
(pCi/kg)	Composite	12	5,490	159,000	14,600	(3.83)	31,100	67,700
Aquatic Biota	Upstream	6	1,970	31,800	6,030	(2.70)	29,400	37,300
Vascular Plants	Downstream	6	3,070	16,300	7,070	(3.07)	18,600	7,723
Gross β	Effluent	6	1,090	18,200	6,600	(1.86)	16,500	13,000
(pCi/kg)	Composite	18	1,090	16,300	4,700	(3.54)	47,500	27,460
Aquatic Biota	Upstream	5	22,800	95,100	38,500	(1.75)	46,300	44,320
Seston	Downstream	5	23,200	50,700	2,900	(1.19)	33,600	33,600
Gross β	Effluent	6	15,400	50,000	30,100	(1.71)	37,400	33,600
(pCi/kg)	Composite	16	15,400	50,000	33,300	(1.60)	39,300	37,000

Table II.H.1. Mean Values for all Sample Types. (Cont'd.)

Sample Type	Area	Number of Samples Analyzed 6 Months	Minimum Value Observed 6 Months	Maximum Value Observed 6 Months	$\bar{x}_g$ 1 Year	σ_g 1 Year	$\bar{x}$ 1 Year	$\bar{x}$ 6 Months
Aquatic Biota	Upstream	4	<35.6	<35.6	52.2	(2.56)	<26.0	<35.6
Fish	Downstream	4	<76.7	164	92.9	(1.47)	<51.1	<76.7
^{89}Sr	Effluent	4	<14.2	<14.2	54.1	(2.41)	<14.2	<14.2
(pCi/kg)	Composite	12	<14.2	164	71.8	(1.87)	<14.2	<14.2
Aquatic Biota	Upstream	2	<68.1	413	158	(3.58)	30.0	142
Benthic	Downstream	2	<60.7	305	129	(1.93)	76.4	166
^{89}Sr	Effluent	4	<113	<113	135	(3.36)	<43.4	<43.4
(pCi/kg)	Composite	10	<60.7	413	158	(2.42)	<43.4	<43.4
Aquatic Biota	Upstream	5	<26.8	391	109	(3.64)	127	<26.8
Vascular Plants	Downstream	6	<29.0	51.4	58.1	(2.80)	<29.0	<29.0
^{89}Sr	Effluent	6	<27.6	<27.6	80.6	(4.69)	25.8	<27.6
(pCi/kg)	Composite	17	<26.8	391	82.1	.68)	50.9	<26.8
Aquatic Biota	Upstream	5	<204	1720	242	(2.49)	493	646
Seston	Downstream	5	<133	2070	714	(3.27)	542	542
^{89}Sr	Effluent	4	<60.1	2590	206	(4.29)	200	291
(pCi/kg)	Composite	14	<60.1	2590	398	(3.49)	417	507
Aquatic Biota	Upstream	4	81.4	355	147	(2.83)	180	227
Fish	Downstream	4	111	237	157	(1.30)	162	344
^{90}Sr	Effluent	4	100	222	122	(1.62)	152	142
(pCi/kg)	Composite	12	100	355	141	(1.91)	157	180
Aquatic Biota	Upstream	2	170	391	276	(1.54)	292	281
Benthic	Downstream	4	62.2	252	192	(2.57)	242	162
^{90}Sr	Effluent	4	253	590	359	(1.42)	181	181
(pCi/kg)	Composite	10	62.2	590	258	(1.89)	234	193
Aquatic Biota	Upstream	5	<87.2	228	117	(1.74)	134	131
Vascular Plants	Downstream	6	92 5	246	131	(1.45)	153	156
^{90}Sr	Effluent	6	4.52	218	60.3	(3.18)	271	157
(pCi/kg)	Composite	17	4.25	246	96.8	(2.30)	193	149

g Analysis in progress.

III. ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM SCHEDULE

III.A. Environmental Radiation Surveillance Schedule

Table III.A.1 outlines the collection and analysis schedule for the radiation surveillance program. This is identical to Table 5.9-1 in the Technical Specifications.

The surveillance program provides for collection and analysis of environmental samples within an area extending to a twenty-mile radius from the reactor site. A concentrated area of sampling within a one-mile radius is designated the "Facility" zone; the area from one to ten miles, the "Adjacent" zone; while the "Reference" zone extends from ten to twenty miles. The data obtained from the Facility zone are statistically compared to those from the Adjacent and Reference zones to test for any significant differences in values. A similar rationale is used for surface waters and sediments. These are partitioned into "Effluent" (Farm Pond and Slough), "Downstream" and "Upstream" locations for statistical analysis.

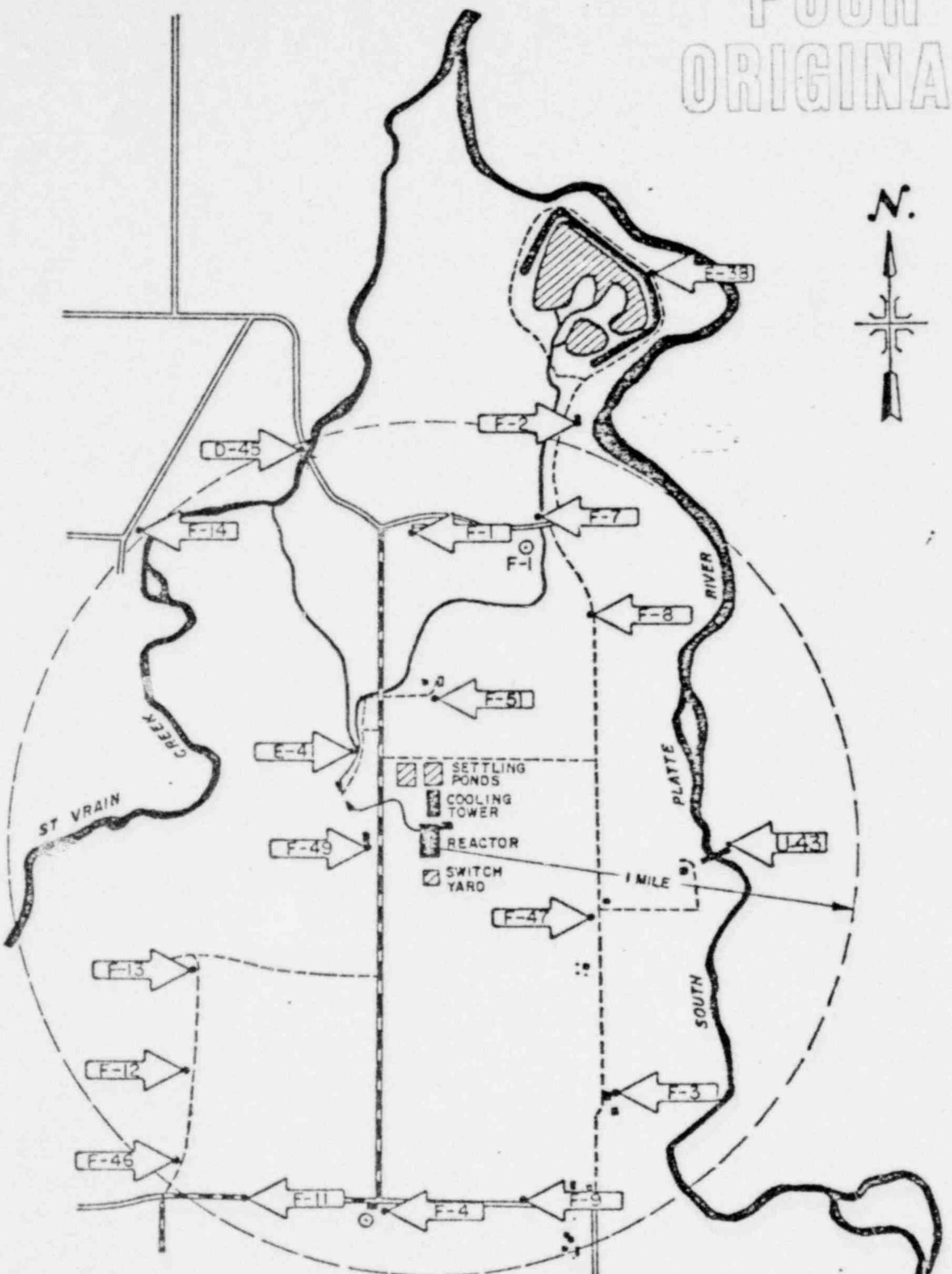
The sampling locations are shown in Figures III.B.1 and III.B.2. Table II.B.1, III.B.2 and III.B.3 give some detail of the sampling sites in the Facility, Adjacent and Reference zones respectively.

It should be noted that the air sampler at the A-35 site was unoperative for a long period at the end of 1978. The owner apparently turned the power off after the sample collection personnel would install the new air filter. (This did not affect collecting water vapor by Silica Gel or the TLD operation). A new site could not be procured due to local innabitant reluctance and became operational until February 10, 1979. The new site is the Roy Miller farm on the corner of Colorado 66 and Weld County Road 19.

TABLE III. A.1. ENVIRONMENTAL RADIATION SURVEILLANCE PROGRAM SCHEDULE

Exposure Routes or Media & Sample Types (No. of Locations)	SAMPLING FREQUENCIES AND ANALYSES - by Action Levels, based upon actual emissions as percentages of release rates authorized by 10 CFR 20		
	Action Level 1: Less than 3%	Action Level 2: 3% to 10%	Action Level 3: Greater than 10%
EXTERNAL EXPOSURE TLD Chips (36 locations)	Average mR/day determined by QUARTERLY cumulative exposures; collection and analysis in rotation of 1/3 of all TLDs MONTHLY.		Average mR/day determined by MONTHLY analysis of all TLDs.
ATMOSPHERE Membrane filters for particulates; charcoal cartridges for iodine. (7 locations)	Gross beta, every filter, WEEKLY; gamma spectrum of filter and cartridge composites, MONTHLY.	Same as for Level 1, plus gross alpha on one weekly set of filters, MONTHLY.	Gross alpha and beta, every filter; gamma spectrum of filter and cartridge composites, all WEEKLY.
Tritium oxide (7 locations)	Specific activity of tritium in atmospheric water vapor by passive absorption and liquid scintillation counting. QUARTERLY	MONTHLY	WEEKLY
WATER Potable water (2 locations: F49 & D39)	Gross beta, tritium and gamma spectrum analyses; Facility area and nearest off-site supply (shallow wells at town of Gilcrest, 6 miles northeast). QUARTERLY	MONTHLY	MONTHLY, plus Sr 89 & 90 analyses
Precipitation (2 locations: F1 & F[illegible])	No collection or analyses of precipitation at Level 1.	Gross beta, MONTHLY	Gross beta, tritium and Sr 89 & 90, MONTHLY; gamma spectrum of composite, QUARTERLY.
Surface water & silt (7 locations)	Gross beta, tritium and gamma spectrum, QUARTERLY.	Same as for Level 1, but MONTHLY.	Same as for Level 2, plus Sr 89 & 90 analyses, MONTHLY.
FOOD CHAINS Soil, forage & crops (14 locations)	Tritium and gamma spectrum analyses of forage and crops in the most probable routes to man. QUARTERLY, as available (i.e., spring, summer and fall).	MONTHLY during growing season (i.e., approx. April to October).	Same as Level 2, plus Sr 89 & 90, plus concurrent soil samples analyzed for the same nuclides, MONTHLY during growing season.
Beef cattle (F-1)	No analysis of beef at Level 1.	Gamma spectrum, tritium and Sr 89 & 90 analyses on one meat sample from beef raised in Facility Area; ANNUALLY, at end of grazing season (i.e., late fall).	Same as for Level 2, plus total body count of 2 to 4 animals from Facility Area, QUARTERLY.
Milk (13 locations)	Tritium, gamma spectrum and Sr 89 & 90 analyses on composite: Facility Area only, QUARTERLY.	Facility, Adjacent and Reference Areas; MONTHLY during pasture season, otherwise QUARTERLY.	Same as for Level 2, but WEEKLY during pasture season, otherwise, MONTHLY.
AQUATIC BIOTA (2 streams, above and below discharge points)	Gross beta and gamma spectrum analyses of composites of each of 4 categories: (1) suspended organisms, (2) benthic organisms, (3) vascular plants and (4) fish. QUARTERLY, as available.	MONTHLY during summer; otherwise QUARTERLY, as available.	Same as for Level 2, plus Sr 89 & 90 analyses.

Figure III.B.1. On-site Sampling Locations.



On-site and close-in sampling locations.
F = facility area, E = effluent stream,
U = upstream, D = downstream.

Figure III.B.2. Off-site Sampling Locations.

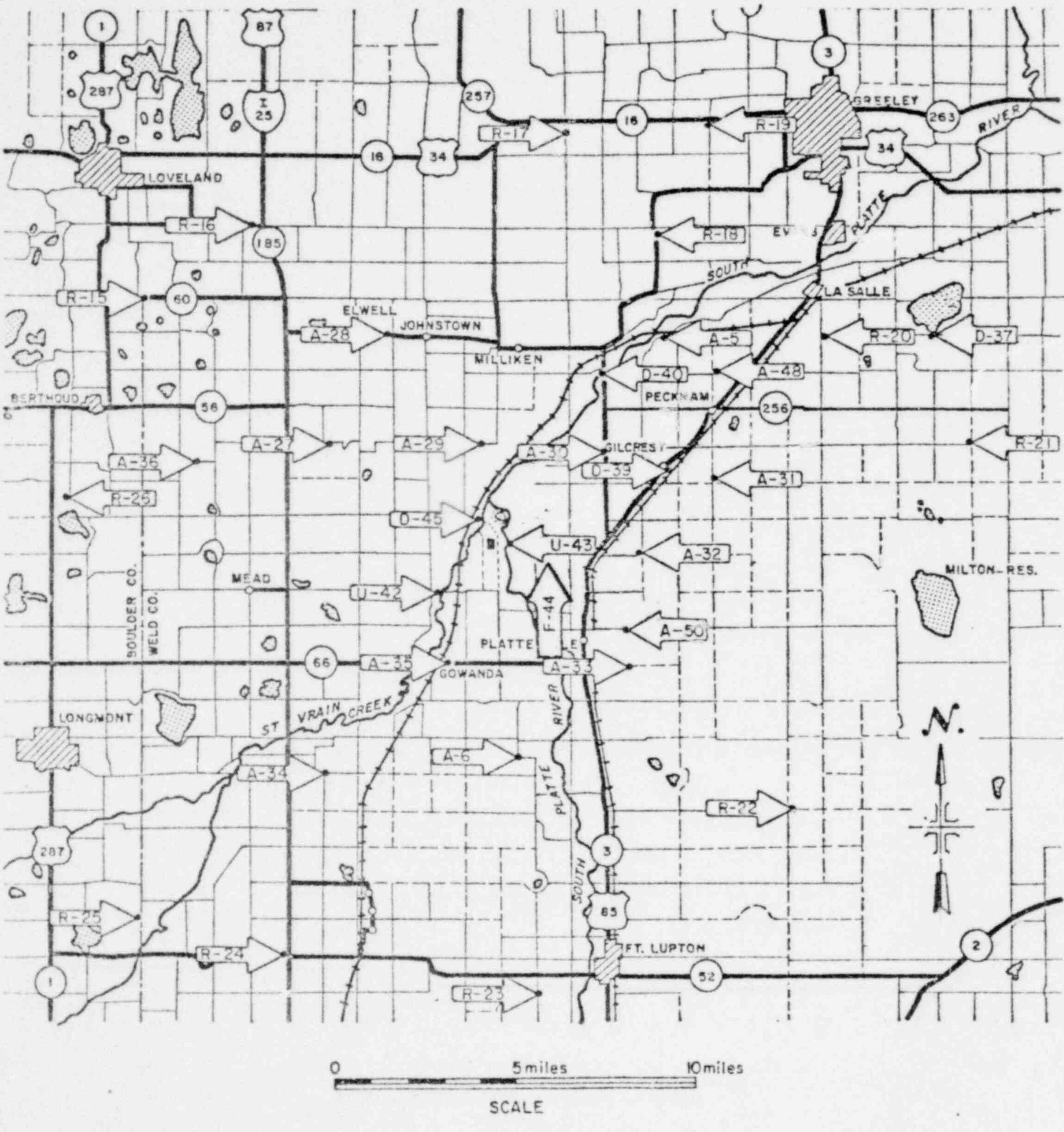


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Table III.B.1. Facility area and effluent sampling locations for environmental media.

Loc. No.	Media Sampled at Location						Location and Description (see Fig. II.B.1)	
	TLD	AIR	M	S	H_2O	AQB	Distance and Direction from Peactor; Comments	
F 1	*	**					0.8 mi. N;	potato cellar; TLD on pole at NE corner barn; precipitation on hill E of barn
F 2		*					1.1 mi. NNE;	cabin.
F 3	*	*					0.7 mi. SE;	old dairy barn ; TLD on 1st pole N of drive.
F 4	*	**		*			0.8 mi. S;	first shed along drive; precipitation in corral; forage and soil S of shed.
F 7	*						0.8 mi. NNE;	pole by gate at corner of Goosequill Rd.
F 8	*						0.6 mi. NE;	2nd pole S of cattle-guard on hill.
F 9	*						0.8 mi. SSE;	2nd pole W of pump house.
F 11	*						0.9 mi. SSW;	0.3 mi. W of intersection of 19½ and 34.
F 12	*						0.8 mi. SW;	7th pole N of intersection.
F 13	*						0.6 mi. WSW;	pole nearest intersection.
F 14	*						1.0 mi. NW;	pole nearest corner.
F 44			*	*			1.1 mi. E;	Leroy Odenbaugh dairy.
F 51	*						0.3 mi. N;	Ted Horst farm, pole SW of house.
F 46	*						1.0 mi. SW;	2nd pole N of intersection, near Aristocrat Angus office.
F 47	*						0.4 mi. E;	pole near driveway to pump house.
F 49					*		0.1 mi. W;	tap outside Visitors Center (well water)
E 38					*	*	1.3 mi. NNE;	Goosequill pond.
E 41					*		0.2 mi. NW;	Concrete slough above and below point of entry of plant water.

Codes:
- F = Facility area (within one mile).
- E = Effluent surface streams.
- TLD = Thermoluminescent Dosimeter for measuring external gamma exposure.
- AIR = Air sampling location; ** = atmospheric precipitation collected.
- M = Milk sampling locations.
- H_2O = Water sampling locations; silt also sampled from surface sources.
- AQB = Aquatic biota sampling locations.
- S = Soil and Forage sampling locations.

Table III.B.2 Adjacent area sampling locations for environmental media.

Loc. No.	Media Sampled at Location: TLD	AIR	M	S	H_2O	AQB	Location Description (see Figs. II.B.1 and II.B.2): Distance and Direction from Reactor	Comments
A 5	*	*					4.5 mi. NNE;	Lloyd Rumsey farm; 2 mi. N, 1.5 mi. W of Peckham.
A 6	*	*	*	*			5.5 mi. S;	Clifton Wissler farm; 2 mi. W, 2.5 mi. S of Platteville; TLD on pole 30 ft. N of parlor.
A 27	*						5.0 mi. NW;	1 mi. S of Colo. 56, 1 mi. E of I-25, pole on NE corner.
A 28	*		*	*			6.0 mi. NW;	Virgil Podtburg dairy; Colo. 60, 2 mi. W of Johnstown; TLD on last pole on NE corner.
A 29	*						3.5 mi. NNW;	3 mi. S; 1.6 mi. E of Johnstown, TLD on pole by the stand of trees.
A 30	*						3.5 mi. NE;	1 mi. S of Colo. 256 on Colo. 60, pole on NE corner.
A 31	*		*	*			6.0 mi. ENE;	1.5 mi. E of Peckham; TLD on pole in front of house.
A 32	*						4.0 mi. E;	3 mi. N of Platteville; 1.2 mi. E of US 85; NW pole.
A 33	*						5.0 mi. SE;	Niles Miller Dairy; 0.2 mi. S, 0.5 mi. E of Platteville.
A 34	*						6.5 mi. SW;	1 mi. E of I-25 at Colo. 254; pole on SW corner.
A 35	*	*					3.0 mi. SSW;	Roy Miller farm; corner of Colo. 66 and Weld Co. Rd. 19.
A 36	*		*	*			8.0 mi. W;	Bob Johnson dairy; 2 mi. W of I-25 on Colo. 56, then 1.5 mi. S. TLD 0.5 mi. W.
A 48			*	*			6.0 mi. NNE;	Bill Ewing Dairy; 1 mi. E of Peckham.
A 50			*	*			6.5 mi. SE;	Corner of Road 33 and 34, D. Dinnel dairy.
D 37					*		12.5 mi. ENE;	Lower Lathan Res.; 2.5 mi. E of LaSalle.
D 39					*		5.0 mi. ENE;	Gilcrest water from U.S. Post Office
D 40					*	*	5.5 mi. ENE;	South Platte River at Colo. 60.
D 45					*	*	1.0 mi. N;	St. Vrain Creek at Jct. Rd. 19½, 0.2 mi. from discharge.

Codes: A = Adjacent area (one to ten miles from reactor).
D = Downstream potable or surface waters.

All other symbols same as for Table III.B.1.

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Table III. B.3. Reference area and upstream sampling locations for environmental media

Loc. No.	Media Sampled at Location: TLD	AIR	M	S	H_2O	AQB	Location Description (see Figs. II. B.1. and II. B.2.) Distance and Direction from Reactor; Comments.
R 15	*						11.5 mi. NW; 4.2 mi. W of I-25 on Colo. 60; TLD on pole W of farm driveway.
R 16	*	*	*	*			11.8 mi. NNW; Mountain View Farms; N side of Colo. 402 W of I-25.
R 17	*		*	*			11.8 mi. NNE; Bob Schneider Dairy; 1 mi. S of US 34 on RD 25; on pole 0.5 mi. N of parlor on RD 25.
R 18	*						10.0 mi. NNE; on pole on SE corner of intersection of 65th Ave. and 37th Street (Greeley).
R 19	*						13.3 mi. NNE; US 34 at 47th Ave. (Greeley); pole on SW corner, opposite golf course.
R 20	*		*	*			11.1 mi. ENE; Wally Kaufman dairy; 0.5 mi. E; 1.6 mi. S of LaSalle; TLD on pole W of parlor.
R 21	*						11.9 mi. E; 5 mi. E of US 85 on Colo. 256; then 1 mi. S; TLD on pole on SW corner.
R 22	*		*	*			11.1 mi. SE; Hagans Bros. Dairy; 4.2 mi. S of Platteville; 4.2 mi. E of US 85; TLD on 1st pole E of drive.
R 23	*		*	*			11.5 mi. S; Alvin Dechant Dairy; 2.2 mi. W; 0.3 mi. S of Ft. Lupton; TLD on 1st pole W on drive.
R 24	*						12.2 mi. SSW; I-25 at Colo. 52; pole W. of the frontage road; NW corner.
R 25	*		*	*			11.7 mi. WSW; Angelo Vendegna Dairy; 4 mi. N of Colo. 52 on RD 1.
R 26	*						12.2 mi. WNW; On US 287, 2.5 mi. of Colo. 56, 2nd pole S on RD 2E.
U 42					*	*	1.5 mi. WSW; St. Vrain Creek at bridge, RD 34.
U 43					*	*	0.6 mi. E South Platte River, at dam and inlet ponds.

Codes: R = Reference area (greater than 10 miles from reactor).
U = Upstream from effluent discharge points.

All other symbols as in Table III B.1.