

SUMMARY REPORT
THIRD AND FOURTH QUARTERS
1982

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COLORADO STATE UNIVERSITY
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ERSP SUMMARY REPORT COVER SHEETENVIRONMENTAL RADIATION SURVEILLANCE PROGRAMSummary Report
for the periodJuly through December 1982

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I. Introduction to Radiation Surveillance Data for the Second Half of 1982.

During the second half of 1982 the Fort St. Vrain Nuclear Generating Station produced power as follows:

Month (1982)	Dates With Electrical Generation	# of Days Without Generation	Gross Electrical Energy Generation (MWH)
July	1-31	0	145,313
August	1-31	0	155,067
September	1-30	0	149,021
October		31	0
November		30	0
December		31	0

The energy generation was $2.4 \times$ that in the previous 6 month reporting period. The reactor did not operate during the first 3.5 months of 1982. Radioactivity released by normal effluent routes, however, was not negligible during the shut down period (see Table II.B.3b). This is due to scheduled clean up and maintenance operations. A complete and detailed listing of radioactivity released by all effluent routes may be found in the Public Service Company of Colorado semi-annual Effluent Release Report to the U.S.N.R.C. When possible in this report we have discussed any correlation of radioactivity in environmental samples with the effluent release data. This analysis is found in each sample type section and in the summary section, II.H.

The most recent Chinese atmospheric nuclear weapon test was conducted in October of 1980. The influx of tropospheric fallout from

this test was noted during all of 1981 but air concentrations during all of 1982 were at pretest background levels.

Significant tropospheric fallout from Chinese weapon tests has been observed during the entire preoperational and operational period of the reactor. The fallout has been extremely variable and does not allow direct comparison of preoperational and post operational data. Fallout deposition and natural background must be subtracted before any such comparisons are made.

The environmental sampling and analysis program was essentially identical to that used in the most recent 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 has been well documented that even independent of the above reasons, environmental data exhibit great inherent variability. This is due to sampling and analysis variability but most importantly due to true environmental or biological variability. As a result, the overall variability of the surveillance data is quite large, and it is necessary to use mean values from a rather large sample size to make any conclusions about the absolute radioactivity concentrations in any environmental pathway.

Environmental radiation surveillance data commonly exhibit nonnormal frequency distributions. Usually 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 is less than MDA or MDC, (the minimum detectable concentrations of activity in that sample type),

calculation of true mean values is impossible. Therefore in these reports we have chosen not to 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 reporting period as well as for the last 12 months. We also list the geometric means and geometric standard deviations for the last year of data reporting. If any data points measured resulted in negative values, these values were used in calculating the true mean values in Table II.H.1. (negative values are possible due to the statistical nature of radioactivity counting). 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 the MDC is dependent upon variables such as the background count time and sample size, the 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 ($\alpha = 0.05$).

In this report we have added to appropriate tables the maximum permissible concentration applicable to that radionuclide. We have chosen to list the maximum permissible concentrations as found in Appendix B Table II of 10 CFR 20. This is the concentration of any radionuclide which if ingested or inhaled continuously, would singularly produce the maximum permissible dose rate to a member of the general public. That value is 170 millirem/year, but must include the dose from

all sources and routes excluding background radiation and medical radiation. The MPC values are given only for comparison of the measured effluent values. As stated in 10 CFR 20 they are the maximum concentrations above natural background that a licensee may release to an unrestricted area. It is generally assumed that no direct ingestion or inhalation of effluent concentration can occur right at the restricted area boundary and that dilution and dispersion decreases the concentration before it reaches nearby residents. This is certainly the case for the Fort St. Vrain environs.

There is no specified maximum permissible dose rate or dose commitment for residents near the Fort St. Vrain reactor. Such limits for water cooled reactors are found in 10 CFR 50 Appendix I. These are judged the "As Low as Reasonably Achievable" dose rates from such reactor types and are not directly applicable to the Fort St. Vrain gas cooled reactor.

A limit that does apply is the independent maximum permissible dose commitment rate set by the E.P.A. (40 CFR 190) for any specified member of the general public from any part of the nuclear fuel cycle. This value is 25 mrem/year as the dose to the whole body from all contributing radionuclides. As will be noted in this report, dose commitments are calculated for any concentrations noted in unrestricted areas that are significantly above control values.

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 unavailable.
- g. Analysis in progress.
- h. Sample not collected (actual reason given).
- N.A. Not applicable.

II. Surveillance Data for July through December 1982 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 $\text{CaF}_2:\text{Dy}$ (TLD-200) dosimeters at each of 37 locations (see Table III.B.1-III.B.3). Two TLD chips per package are installed at each site and the mean value is reported for that site if neither value is aberrant. The mean calculated total exposure is then divided by the number of days that elapsed between pre-exposure and post-exposure annealing to obtain the average daily 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 II.B.1 and II.B.2 and Tables 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 0.47 mR/day. The mean exposure rate was 0.46 mR/day for the Adjacent area and 0.45 mR/day for the Reference area. There were no significant differences between the values for the Facility, Adjacent and Reference areas. There was also no significant difference from the values measured during the first half of 1982.

The exposure rate measured at all sites is due to a combination of exposure from cosmic rays, from natural gamma-ray emitters in the earth's crust and from surface deposition of fission products from world-wide fallout. The variation in measured values is due to true variation of the above sources plus the variation due to the measurement method. The purpose of the TLD ring around the reactor is not to

measure gamma-rays generated from the reactor facility itself but to document the presence or absence of gamma-ray emitters deposited upon the ground from the reactor effluents. Since the inception of power production by the reactor there has been no detectable increase in the external exposure rate due to reactor releases.

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

b) Second half 1982.

<u>Facility Area</u> <u>Locations</u>	Average Daily Gamma Exposure Rates					
	July	August	September	October	November	December
F 1	.47	.44	.43	.48	.48	.46
F 3	.48	.41	.45	.48	.48	.46
F 4	.79	.40	.46	.47	.42	.41
F 7	.45	.39	.43	.47	.42	.45
F 8	.50	.43	.44	.47	.47	.45
F 9	.48	.40	.44	.49	.48	.47
F 11	.43	.38	.43	.46	.47	.42
F 12	.51	.42	.49	.49	.50	.50
F 13	.49	.36	b	.47	.44	.46
F 14	.48	.37	.45	.44	.45	.40
F 46	.50	.41	.47	.48	.46	.45
F 47	.45	.36	.45	.48	.43	.43
F 51	.50	.42	.51	.51	.48	.47
X	.48	.40	.45	.48	.46	.45
<u>Adjacent Area</u> <u>Locations</u>						
A 5	.48	.40	.47	.51	.48	.44
A 6	.41	.36	.42	.42	.43	.39
A 27	.44	b	.44	b	.39	.43
A 28	.43	.36	.43	.45	.39	.37
A 29	.45	.40	.45	.48	.42	.43
A 30	.47	.42	.47	.50	.46	.44
A 31	.43	.38	.40	.42	.43	.42
A 32	.44	.39	.42	.44	.44	.41
A 33	.46	.43	.45	.47	.48	.47
A 34	.52	.45	.49	.50	.47	.52
A 35	.49	.45	.46	.50	.50	.48
A 36	.45	.41	.44	.46	.46	.44
X	.46	.40	.45	.47	.45	.44
<u>Reference Area</u> <u>Locations</u>						
R 15	.45	.38	.38	.43	.41	.39
R 16	.51	.44	.42	.51	.44	.43
R 17	.42	.36	.35	.38	.38	.36
R 18	.43	.38	.38	.40	.40	.38
R 19	.42	.38	.37	.39	.42	.40
R 20	.45	.41	.41	.46	.46	.44
R 21	.42	.40	.41	.44	.46	.42
R 22	.48	.49	.44	.44	.45	.42
R 23	.46	.40	.42	.40	.41	.44
R 24	.51	.50	.50	.52	.50	.48
R 25	.46	.39	.42	.45	.45	.43
R 26	.43	.38	.42	.44	.46	.40
X	.45	.41	.41	.44	.44	.42

b Sample missing at site.

II.B. Air Sampling Data

1. Gross alpha and beta activity.

The concentrations of gross alpha and gross beta activity measured weekly on air particulates for the Facility and Adjacent sampling sites are listed in Tables II.B.1 and II.B.2. Although the activity is due to a mixture of radionuclides, the concentrations are listed in units of femtocuries per cubic meter of air.

It was observed that the concentration of gross alpha emitting radionuclides at all sites was statistically the same as for the first half of 1982. Although not significantly different, the mean values for all sites were lower during the third quarter than during the 4th quarter. It should be noted that the reactor operated during the third quarter but not during the fourth quarter of 1982.

Gross beta concentrations were essentially identical to those measured during the first half of the year and lower than those observed in 1981. This indicates that the contribution due to fallout from the Chinese weapon test of December 1980 has decreased to insignificant levels.

There was no statistically significant difference between facility and adjacent sites for either gross alpha or gross beta concentrations during either quarter. There has never been a significant difference observed between the facility and adjacent sites. Thus it can be concluded that gaseous effluents of particulate fission products or activation products is not a pathway of concern for the Fort St. Vrain reactor.

Table II. B.1

Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m³).

a) Third Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-4-82	4.6 (1.2)*	2.5 (0.7)	3.4 (0.9)	3.7 (1.0)	c ₁	4.6 (1.1)	5.6 (1.2)
7-10-82	4.0 (1.1)	4.6 (1.3)	1.6 (0.8)	3.6 (1.0)	3.2 (1.0)	5.7 (1.6)	5.8 (1.5)
7-17-82	3.5 (0.9)	2.2 (0.6)	c ₂	4.1 (1.1)	4.7 (1.2)	6.7 (1.5)	5.5 (1.4)
7-25-82	7.3 (1.5)	7.1 (1.3)	8.0 (1.6)	12.6 (2.2)	4.6 (1.6)	**	9.6 (2.3)
7-31-82	3.5 (1.0)	1.6 (0.6)	c ₂	3.3 (1.1)	3.4 (1.1)	2.2 (1.0)	1.1 (2.1)
8-7-82	5.9 (1.4)	4.0 (1.0)	2.8 (1.3)	6.4 (1.5)	1.4 (0.7)	c ₂	3.9 (1.3)
8-14-82	3.0 (0.8)	1.8 (0.6)	1.4 (0.5)	2.5 (0.9)	3.7 (1.0)	4.7 (1.1)	4.6 (1.8)
8-21-82	3.5 (1.0)	2.8 (0.8)	2.6 (0.8)	4.5 (1.1)	3.8 (1.1)	4.1 (1.3)	1.3 (1.6)
8-28-82	6.9 (1.4)	4.4 (1.2)	4.5 (1.3)	9.7 (2.0)	6.0 (1.4)	**	h
9-4-82	8.5 (1.9)	7.1 (1.7)	2.0 (0.6)	9.5 (2.0)	4.4 (1.4)	**	h
9-12-82	6.9 (1.5)	c ₅	0.8 (0.5)	3.4 (1.0)	5.9 (1.4)	9.4 (1.9)	6.3 (1.4)
9-18-82	0.6 (0.3)	c ₅	1.2 (0.5)	c ₃	0.6 (0.5)	1.0 (0.5)	c ₄
9-25-82	5.2 (1.2)	c ₆	3.7 (0.9)	6.6 (1.3)	7.3 (1.3)	8.0 (1.7)	4.2 (1.0)
Average	4.9	3.8	2.9	5.4	4.1	5.2	4.7
Quarterly (49 Samples)				Quarterly (32 Samples)			
minimum : 0.6				minimum: 0.6			
maximum : 12.6				maximum: 9.6			
\bar{X} : 4.2				\bar{X} : 4.5			

All concentrations are expressed in femtocuries per cubic meter of air: 1fCi/m³ = 10⁻¹⁵ μ Ci/ml.* Uncertainties (in parentheses) are for the 95% confidence interval (± 1.96 S.D.)

** Weight exceeded for alpha counting.

c₁ Filter separator left in.c₂ Pump down. Taken in for repair.c₃ Pump unplugged.c₄ Filter damaged due to weather.c₅ Flow rate on pump had stopped due to wet cartridge, time uncertain.c₆ Fuse blown on pump.

h Sample collection not possible. Site owners requested removal of air sampling station.

Table II. B.1

Concentrations of Long-Lived Gross Alpha Activity in Airborne Particles (fCi/m³).

b) Fourth Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-2-82	7.5 (1.5)*	c ₁	4.3 (1.0)	2.9 (0.9)	4.6 (1.1)	4.3 (1.3)	4.3 (1.1)
10-9-82	2.7 (0.7)	c ₁	4.9 (1.1)	4.3 (1.0)	6.0 (1.4)	4.2 (1.2)	1.7 (0.6)
10-16-82	3.6 (0.7)	c ₁	3.0 (0.7)	2.5 (0.5)	3.4 (0.8)	4.2 (1.0)	2.3 (0.7)
10-23-82	4.4 (0.9)	3.4 (0.9)	5.1 (1.0)	7.9 (1.4)	5.3 (1.1)	4.7 (1.2)	3.7 (0.8)
10-30-82	9.1 (1.4)	6.4 (1.2)	c ₂	4.9 (1.0)	6.7 (1.4)	11.0 (2.3)	6.1 (1.2)
11-6-82	12.6 (1.8)	11.1 (1.7)	7.5 (1.2)	9.0 (1.3)	14.8 (2.4)	5.4 (1.2)	10.5 (1.6)
11-13-82	4.8 (1.0)	6.3 (1.1)	11.2 (1.8)	8.2 (1.3)	c ₁	5.8 (1.2)	2.1 (0.6)
11-20-82	4.1 (0.9)	3.7 (0.8)	6.0 (1.1)	3.8 (0.9)	c ₁	13.2 (2.7)	4.5 (0.9)
11-27-82	4.6 (0.9)	3.8 (0.8)	4.6 (0.9)	5.5 (1.0)	4.5 (1.1)	5.1 (1.8)	3.0 (0.7)
12-4-82	4.5 (1.2)	c ₁	4.4 (1.1)	5.4 (1.2)	5.4 (1.5)	c ₁	5.3 (1.3)
12-11-82	2.8 (0.7)	3.0 (0.8)	1.9 (0.7)	2.6 (0.7)	2.8 (1.0)	1.2 (0.4)	5.2 (1.4)
12-19-82	5.2 (1.0)	4.7 (1.0)	5.0 (1.0)	4.7 (1.0)	7.1 (1.4)	4.6 (1.2)	5.8 (1.2)
12-26-82	c ₁	2.5 (0.7)	2.7 (0.7)	2.8 (0.9)	3.6 (1.2)	2.8 (1.0)	5.1 (1.3)
Average	5.5	5.0	5.1	5.0	5.5	5.5	4.6
Quarterly (46 Samples) minimum : 1.9 maximum : 12.6 \bar{x} : 5.2				Quarterly (36 Samples) minimum: 1.2 maximum: 14.8 \bar{x} : 5.2			

All concentrations are expressed in femtocuries per cubic meter of air: 1fCi/m³ = 10⁻¹⁵ μ Ci/ml.

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

c₁ Pump stopped, brought in for repair.

c₂ Filter damaged due to weather.

Table II.B.2

Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m³).

a) Third Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-4-82	23 (2)*	19 (1)	23 (2)	18 (2)	c ₁	18 (2)	18 (2)
7-10-82	17 (2)	17 (2)	12 (2)	11 (2)	12 (2)	19 (2)	15 (2)
7-17-82	23 (2)	16 (1)	c ₂	21 (2)	21 (2)	2 (2)	22 (2)
7-25-82	27 (2)	24 (2)	25 (2)	32 (2)	26 (2)	37 (3)	27 (3)
7-31-82	15 (2)	5 (1)	c ₂	14 (2)	16 (2)	9 (1)	14 (7)
8-7-82	22 (2)	22 (2)	26 (3)	22 (2)	11 (2)	c ₂	21 (2)
8-14-82	15 (2)	13 (1)	8 (1)	14 (1)	23 (2)	21 (1)	22 (4)
8-21-82	11 (2)	18 (1)	20 (2)	20 (2)	17 (2)	12 (2)	28 (6)
8-28-82	25 (2)	23 (2)	21 (2)	31 (2)	28 (2)	39 (3)	h
9-4-82	30 (2)	28 (2)	18 (2)	29 (2)	26 (2)	42 (3)	h
9-12-82	23 (2)	c ₅	18 (2)	18 (1)	26 (2)	26 (2)	16 (2)
9-18-82	8 (1)	c ₅	9 (2)	c ₃	6 (1)	6 (1)	c ₄
9-25-82	29 (2)	c ₆	25 (2)	28 (2)	30 (2)	32 (2)	29 (2)
Average	21	19	19	22	20	24	21
Quarterly (46 samples)				Quarterly (34 samples)			
minimum : 5				minimum : 6			
maximum : 32				maximum : 42			
\bar{X} : 20				\bar{X} : 22			

All concentrations are expressed in femtocuries per cubic meter of air: 1fCi/m³ = 10⁻¹⁵ Ci/ml.* Uncertainties (in parentheses) are for the 95% confidence interval (± 1.96 S.D.)c₁ Filter separator left in.c₁ Pump down. Taken in for repair.c₂ Pump unplugged.c₃ Filter damaged due to weather.c₄ Flow rate on pump stopped due to wet cartridge, time uncertain.c₅ Fuse blown on pump.c₆ Sample collection not possible. Site owners requested removal of air sampling station.

Table II.B.2
Concentrations of Long-lived Gross Beta Activity in Airborne Particles (fCi/m³).
b) Fourth Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-2-82	20 (2) [*]	c ₁	20 (2)	19 (1)	16 (2)	25 (2)	20 (2)
10-9-82	16 (1)	c ₁	18 (2)	20 (2)	19 (2)	20 (2)	10 (1)
10-16-82	13 (1)	c ₁	13 (1)	12 (1)	10 (1)	12 (1)	10 (1)
10-23-82	21 (1)	22 (2)	27 (2)	25 (2)	21 (1)	21 (2)	25 (2)
10-30-82	17 (2)	16 (2)	c ₂	15 (1)	14 (2)	19 (2)	16 (1)
11-6-82	25 (2)	27 (2)	20 (1)	19 (1)	15 (2)	20 (2)	24 (2)
11-13-82	10 (1)	23 (2)	29 (2)	21 (2)	c ₁	18 (2)	9 (1)
11-20-82	27 (2)	30 (2)	27 (2)	25 (2)	c ₁	23 (4)	17 (1)
11-27-82	21 (1)	19 (1)	22 (1)	22 (1)	23 (2)	13 (3)	18 (1)
12-4-82	26 (2)	c ₁	20 (2)	20 (2)	31 (2)	c ₁	14 (2)
12-11-82	46 (2)	45 (2)	46 (2)	46 (2)	43 (2)	21 (1)	39 (2)
12-19-82	20 (1)	23 (2)	21 (1)	20 (1)	28 (2)	16 (2)	20 (2)
12-26-82	c ₁	11 (1)	13 (1)	9 (1)	11 (2)	9 (1)	14 (2)
Average	22	24	23	21	21	18	18
Quarterly (46 samples) minimum: 9 maximum: 46 \bar{X} : 22				Quarterly (36 samples) minimum: 9 maximum: 43 \bar{X} : 19			

All concentrations are expressed in femtocuries per cubic meter of air: 1fCi/m³ = 10⁻¹⁵ μ Ci/ml.

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

c₁ Pump stopped, brought in for repair.

c₂ Filter damaged due to weather.

2. Tritium Activity. Tropospheric water vapor samples are collected continuously by absorption 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. From the measured relative humidity the corresponding air concentration of tritium can be calculated and these values are given in Table II.B.3a.

The influence of plant liquid effluent tritium can be observed from the tables. The values at sites F1 and F2 during July, October, November and December are significantly greater than those at either of the other two Facility sites or at any of the Adjacent sites. F1 and F2 are closest to the Goosequill ditch effluent pathway. The tritium measured at those sites has always been greater than at the other sites during reactor release periods. The elevated values are assumed to be due to evaporation of tritiated water from the discharge ditch. The reactor effluent release of tritium is given by release mode in Table II.B.3b. There is a high correlation with peak values observed at F1 and F2 during the months noted and the total activity released via the batch liquid mode. There is of course, variability in the measured tropospheric air concentrations due to variations in temperature, humidity, ditch flow rate, wind direction, and the fact that the release time is short compared to the sample collection period.

In spite of the high values measured at F1 and F2 and occasionally at other sites, the mean for all facility sites was low (only slightly greater than the minimum detectable concentration) and not significantly different from the three adjacent sites.

A hygrothermograph is located at site F4 only. Using the temperature and relative humidity 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/m³). This is used 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/m³ of air. The first equation is used to determine the vapor pressure of water (1):

$$\log_{10} P = A - B (C + t), \text{ where: } \begin{array}{l} P = \text{vapor pressure (mm Hg)} \\ t = \text{temperature (C)} \\ A = 9.10765 \\ B = 1750.286 \\ C = 235.0 \end{array}$$

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":

$$PV = nRT, \text{ where: } \begin{array}{l} P = \text{vapor pressure (atmosphere)} \\ V = \text{volume (liters)} \\ n = \text{number of moles of gas} \\ R = 0.08206 \text{ liter-atmospheres/mole-K} \\ T = \text{temperature in K} \end{array}$$

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/m³. This procedure has been applied to data collected for the second half of 1982 and listed in Table II.B.3a. The weekly integrated relative humidity

at the F4 site is relatively constant, and the correlation of measured tritium specific activity in atmospheric water vapor and air concentration is very high. It is for this reason that a hygrothermograph is located at only one site. Inspection of Table II.B.3a shows the same site dependence on reactor effluent discussed above.

Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).
a) Third Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-4-82	1,130 * (264)	2,420 (276)	< 289	490 (258)	< 289	< 289	< 289
7-10-82	1,010 (251)	1,220 (253)	< 277	< 277	< 277	< 277	341 (244)
7-17-82	< 283	1,660 (263)	< 283	337 (250)	314 (250)	479 (252)	< 283
7-25-82	< 295	905 (268)	< 295	< 295	e	< 295	< 295
7-31-82	< 295	< 295	< 295	< 295	< 295	< 295	< 295
8-6-82	< 285	< 285	< 285	< 285	< 285	< 285	< 285
8-14-82	< 300	< 300	< 300	< 300	< 300	< 427	< 300
8-21-82	< 300	< 300	< 300	< 300	< 300	< 300	< 300
8-28-82	< 295	< 295	< 295	< 295	< 295	< 295	< 295
9-4-82	< 298	< 476	< 298	< 298	< 298	< 298	e
9-11-82	< 300	< 300	< 300	< 300	< 300	< 300	< 300
9-18-82	< 300	< 300	< 300	< 300	< 300	< 300	< 300
9-25-82	< 300	< 300	< 300	< 300	< 300	458 (250)	526 (251)

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

Table II. B.3
Tritium Concentrations in Atmospheric Water Vapor (pCi/l).
b) Fourth Quarter, 1982

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-2-82	< 282	443 (250)*	386 (250)	< 282	< 282	564 (252)	315 (249)
10-9-82	e	769 (254)	438 (250)	330 (249)	< 282	402 (250)	< 282
10-16-82	339 (251)	823 (256)	< 284	< 284	< 284	e	348 (251)
10-23-82	987 (245)	955 (244)	389 (239)	625 (241)	827 (243)	775 (243)	e
10-30-82	741 (260)	1,050 (263)	< 289	< 289	< 289	349 (256)	442 (257)
11-6-82	848 (261)	1,210 (265)	302 (259)	2,920 (281)	< 289	e	e
11-13-82	933 (257)	1,340 (261)	e	< 284	< 284	357 (252)	< 284
11-20-82	1,010 (270)	2,740 (287)	< 296	< 296	387 (264)	< 296	< 296
11-27-82	351 (264)	995 (270)	< 296	< 296	< 296	< 296	< 286
12-4-82	357 (258)	499 (259)	< 290	< 290	< 290	351 (263)	< 295
12-11-82	297 (252)	768 (256)	< 285	< 285	< 285	319 (252)	333 (252)
12-19-82	578 (258)	777 (260)	564 (258)	< 288	584 (258)	632 (258)	714 (259)
12-26-82	382 (256)	476 (257)	712 (259)	2,340 (275)	396 (256)	461 (257)	< 288

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

Table II.B.3a
Tritium Concentrations in Air (pCi/m³)
a) Third quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
7-4-82	11.4	24.3	< 2.90	4.92	< 2.90	< 2.90	< 2.90
7-10-82	8.99	10.9	< 2.47	< 2.47	< 2.47	< 2.47	3.04
7-17-82	< 2.34	13.7	< 2.34	2.79	2.60	3.96	< 2.34
7-25-82	< 3.20	9.83	< 3.20	< 3.20	e	< 3.20	< 3.20
7-31-82	< 2.74	< 2.74	< 2.74	< 2.74	< 2.74	< 2.74	< 2.74
8-7-82	< 3.18	< 3.18	< 3.18	< 3.18	< 3.18	< 3.18	< 3.18
8-14-82	< 3.56	< 3.56	< 3.56	< 3.56	< 3.56	< 5.06	< 3.56
8-21-82	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52	< 3.52
8-28-82	< 9.87	< 9.87	< 9.87	< 9.87	< 9.87	< 9.87	< 9.87
9-4-82	< 2.68	4.28	< 2.68	< 2.68	< 2.68	< 2.68	e
9-12-82	< 2.62	< 2.62	< 2.62	< 2.62	< 2.62	< 2.62	< 2.62
9-18-82	< 2.63	< 2.63	< 2.63	< 2.63	< 2.63	< 2.63	< 2.63
9-25-82	< 2.37	< 2.37	< 2.37	< 2.37	< 2.37	3.61	4.15

³H MPC_a = 2x10⁵ pCi/m³. (10CFR20, Appendix B, Table II).

e Insufficient volume for analysis.

Table II.B.3a
Tritium Concentrations in Air (pCi/m³)
b) Fourth Quarter, 1982.

Date Collected	Facility Areas				Adjacent Areas		
	1	2	3	4	5	6	35
10-2-82	< 1.69	2.66	2.32	< 1.69	< 1.69	3.39	1.89
10-9-82	e	3.28	1.87	1.41	< 1.20	1.71	< 1.20
10-16-82	1.16	2.82	< 0.974	< 0.974	< 0.974	e	1.19
10-23-82	3.35	3.24	1.32	2.12	2.80	2.63	e
10-30-82	1.06	4.12	< 1.13	< 1.13	< 1.13	1.37	1.74
11-6-82	2.28	3.26	0.813	7.86	< 0.778	e	e
11-13-82	2.98	4.28	e	< 0.908	< 0.908	< 0.908	< 0.908
11-20-82	2.54	6.88	< 0.743	< 0.743	0.972	< 0.743	< 0.743
11-27-82	< 0.674	< 0.674	< 0.674	< 0.674	< 0.674	< 0.674	< 0.674
12-4-82	0.762	1.07	< 0.619	< 0.619	< 0.619	0.749	< 0.630
12-11-82	0.750	1.94	< 0.719	< 0.719	< 0.719	0.805	0.841
12-19-82	1.18	1.59	1.15	< 0.589	1.19	1.29	1.46
12-26-82	0.791	0.985	1.47	4.84	0.820	0.950	0.596

³H MPC_a = 2x10⁵ pCi/m³. (10CFR20, Appendix B, Table II).

e Insufficient volume for analysis.

Table II.B.3b

Tritium Released in Reactor Effluents (Ci) in 1982

Mode	July	Aug	Sept	Oct	Nov	Dec	Total
Continuous	0.57	0.59	0.47	3.1	1.8	0.86	7.3
Liquid Effluent (Turbine building sump and reactor sump)							
Batch Liquid	13.1	0.30	0.02	30.8	54.0	8.4	106.6
Gaseous Stack	1.32	0.09	0.29	0.15	0.14	0.21	2.2
Total	15.0	0.98	0.78	34.1	55.9	9.5	116.3

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 seven air sampling stations. All charcoal samples are counted on the Ge(Li) detector approximately 20 days post collection to allow Rn-222 decay and minimize decay of I-131. Background is determined from counts of unused charcoal. 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 would be weapons testing fallout or reactor stack effluent.

The composite air concentrations of I-131 measured during the second half of 1982 were less than during 1981. The mean value for this reporting period was not significantly different from zero. The Effluent Release Report data indicated negligible reactor release of I-131 during the period. The few calculated values above MDC therefore are the result of method variability. There was no known source term for I-131 during the period as that from the Chinese test of December 1980 has decayed to essentially zero values. The method currently in use is active absorption on charcoal. Radon-222 is trapped at the same time and, as pointed out above, a decay time of 20 days is allowed. However, in periods when ambient radon is extremely high, e.g. during prolonged inversion periods, it is likely that sufficient decay of radon

has not occurred. In addition, even a decay time of 20 days produces an I-131 decay correction factor of 5.6. Thus for this case any positive uncertainty in the calculated I-131 air concentration is magnified by 5.6. For comparison purposes it can be noted that the maximum permissible air concentration of I-131 for the general public is $100,000 \text{ fCi/m}^3$ (10 CFR 20, Appendix B Table II).

Table II.B.5 lists the results of the gamma-ray spectrum analysis of weekly composites of the membrane air filters from each of the seven samplers. Mean values of Ru-106, Zr-Nb-95 and Cs-137 were essentially the same as during the first half of 1982 and lower than during 1981 when fission product debris from the most recent Chinese weapon test was apparent. All samples are counted after decay of Radon and Thoron daughters, several of which are gamma-ray emitters.

The radoruthenium 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 weapon test, a high proportion is expected to be Ru-103, and at later times predominately Ru-106. Since the element ruthenium and its compounds have negligible biological availability, neither isotope have any consequence 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)
7-4-82	< 7.12
7-10-82	< 8.55
7-17-82	< 7.24
7-25-82	8.84 (2.81)*
7-31-82	22.8 (7.17)
8-7-82	11.8 (3.91)
8-14-82	18.3 (6.26)
8-21-82	12.5 (5.17)
8-28-82	< 7.90
9-4-82	38.0 (10.8)
9-12-82	26.5 (5.16)
9-18-82	21.2 (5.30)
9-25-82	6.59 (4.07)
10-2-82	7.54 (3.06)
10-9-82	< 6.40
10-16-82	< 6.40
10-23-82	12.0 (2.59)
10-30-82	19.4 (2.41)
11-6-82	< 6.74
11-13-82	< 6.74
11-20-82	20.1 (3.21)
11-27-82	21.4 (3.57)
12-4-82	< 7.82
12-11-82	< 5.91
12-18-82	< 5.14
12-26-82	< 6.36

All concentrations are expressed in femtocuries per cubic meter of air: 1 fCi/m³ = 10⁻¹⁵ μCi/ml.

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

^{131}I MPC_a = 10⁵ fCi/m³. (10CF20, Appendix B, Table II)

Table II. B.5
Gamma-ray Emitting Radionuclide Concentrations in Air (Taken from
Composites of all Air Sampling Stations) (fCi/m³).

b) Second Half, 1982.

Sample Ending Dates	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
7-4-82	< 2.07	< 0.463	< 0.201
7-10-82	< 2.69	< 0.603	< 0.261
7-17-82	65.2 (8.85)*	< 1.68	< 0.728
7-25-82	< 2.38	1.92 (0.570)	< 0.226
7-31-82	< 10.7	< 2.35	8.48 (0.999)
8-7-82	< 2.56	0.911 (0.673)	< 0.242
8-14-82	< 1.47	3.40 (0.435)	0.165 (0.192)
8-21-82	< 2.02	1.82 (0.541)	< 0.191
8-28-82	< 8.29	< 1.82	< 0.788
9-4-82	< 8.31	2.21 (1.61)	< 0.791
9-12-82	< 5.85	1.66 (1.14)	< 0.557
9-18-82	< 7.54	4.01 (1.50)	1.50 (0.697)
9-25-82	2.39 (3.46)	3.30 (0.582)	1.26 (0.248)
10-2-82	< 6.73	8.82 (1.39)	0.792 (0.730)
10-9-82	< 6.61	< 1.46	< 0.631
10-16-82	< 2.14	2.25 (0.531)	1.70 (0.315)
10-23-82	< 5.71	1.51 (1.15)	1.36 (0.623)
10-30-82	< 1.97	1.78 (0.513)	0.570 (0.202)
11-6-82	< 2.44	2.05 (0.647)	1.05 (0.307)
11-13-82	< 6.94	2.07 (1.40)	1.78 (0.612)
11-20-82	5.56 (3.07)	2.36 (0.523)	1.25 (0.208)
11-27-82	3.30 (2.49)	1.94 (0.400)	0.214 (0.239)
12-4-82	< 8.08	4.52 (1.03)	0.953 (0.887)
12-11-82	< 6.05	1.59 (1.19)	< 0.580
12-18-82	< 5.32	0.861 (1.02)	< 0.510
12-26-82	< 1.86	0.806 (0.474)	0.554 (0.195)

All concentrations are expressed in femtocuries per cubic meter of air:
1 fCi/m³ = 10⁻¹⁵ µCi/ml.

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

¹⁰⁶Ru MPC_a = 3x10⁶ fCi/m³. ¹³⁷Cs MPC_a = 2x10⁶ fCi/m³. ⁹⁵Zr MPC_a = 4x10⁶ fCi/m³.

(10CFR20, Appendix B, Table II)

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 study area.

Values of gross beta concentrations in surface water fluctuated at upstream, downstream and effluent sites by approximately a factor of 2, but the mean upstream and the mean downstream values were essentially identical. The mean upstream value was 10.2 pCi/L, and the mean downstream value was 10.6 pCi/L. There was no significant difference between these mean values. Mean values were slightly greater than those measured during the first half of 1982 but the increase was not statistically significant. The gross beta concentrations in the two potable water sources were lower than, but as variable as surface water. The concentrations in potable water should be lower due to any water purification which removes suspended solids. The variation is probably due to mixing of different reservoir or well water sources which vary due to different runoff areas or aquifers.

Weekly samples were collected at E-38, at the farm pond on the effluent pathway. This is the principal route for liquid discharge from the reactor, and a monthly sample is not adequate to reflect discharges of tritium. It must be noted, however, that tritium is lost during the evaporation step for gross beta activity determination, and therefore the gross beta does not include tritium. Gross beta concentrations in these samples are shown in Table II.C.1a. The mean concentration was 11.3 pCi/L. During the first half of 1982, the mean concentration was 11.0 pCi/L. The values observed were quite constant and presumably correlate to the effluent release patterns and to runoff

from fallout deposition as well as naturally occurring radioactivity. It is again important to note that the effluent mean concentration observed during this period was not statistically different from the upstream mean value. This implies that the major source of beta product activity was not due to the reactor effluent. The effluent does have high tritium concentrations, which is discussed below.

Table II.C.2 lists tritium in surface water and potable water supplies for each monthly collection for the second half of 1982. As observed during all of 1981 and 1982, the downstream tritium concentration exceeded the upstream value. The upstream mean value during 1982 was less than the lower limit of detection and the downstream arithmetic mean value was 1,070 pCi/L. The highest concentrations during this period were observed at site D-45. The mean measured value for the period at this site was 1,396 pCi/L and this can be taken for the worst credible case. If this increase was indeed due only to reactor effluents, radiation dose commitment calculations can be performed for possible dose pathways in the immediate reactor environs. Using U.S. NRC Regulatory Guide 1.109 parameters and methodology the dose commitment calculation would proceed as follows:

1. Assume the "maximum" infant to be the critical individual.
2. The annual water intake of an infant is 330L/year and the tritium ingestion dose factor is 3.08×10^{-7} mrem/pCi.
3. The measured downstream concentration of tritium was highest at sampling location D-45. The mean value for the second half of 1982 at this location was 1,396 pCi/L. Taking the mean value to be 328 pCi/L (the geometric mean value for all of 1982) the net concentration that can be attributed to reactor effluent would be 1,068 pCi/L.

4. Assuming an infant ingested water at this concentration for a period of one year, the 50 year dose commitment rate for the maximum infant would be:

$$1,068 \text{ pCi/L} \times 330\text{L/year} \times 3.08 \times 10^{-7} \text{ mrem/pCi} \times 1 \text{ year} = 0.11 \text{ mrem}$$

This would be a whole-body dose. These values were all close to the MDC values and mean values for each category were not significantly different. For comparison purposes the limit in 10 CFR 50 Appendix I is 3 mrem/year for light water power reactors. Background whole-body dose rates in the reactor vicinity are approximately 200 mrem/year. The EPA independently has set an upper limit total dose rate of 25 mrem/year (40 CFR 190) to any individual from any part of the nuclear fuel cycle.

No dose calculations were performed for the farm pond water. Although this is considered an unrestricted area, it is located on company property and as such there is no credible occurrence for the pond water to be ingested.

The tritium concentrations in the potable water supplies again showed no significant variation. No reason for the high value observed at D-39 on 10/16/82 can be given. Evidently these sources are comprised partly from tributary water and partly from well water. True well water should have essentially no tritium activity. A study of tritium concentrations in a large number of wells around the reactor has recently been completed and will be discussed in the next report.

Table II.C.3 and II.C.4 lists Sr-90 and Sr-89 concentrations in surface water at the same sampling locations. These values were all close to the MDC values and mean values for each category were not significantly different. Table II.C.4a lists the same radionuclides as well as tritium in reactor effluent water samples collected weekly at E-38.

Significantly high tritium values have always been observed at

effluent sampling sites, and this was true for the first half of 1982 (See Table II.C.4a). This is directly attributed to liquid effluent releases by Fort St. Vrain.

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. This data is shown in Table II.C.5a. The concentrations of all of the fission products measured in water are similar to those previously measured.

Table II.C.1

Gross Beta Activity in Surface Water (pCi/L)

Sampling Locations	Monthly Collection Dates					
	7-10-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	17.2 (2.59) *	10.6 (2.36)	11.6 (2.43)	11.0 (2.39)	8.39 ** (2.33)	7.37 (2.29)
E 41: Goosequill Ditch	11.3 (2.42)	16.9 (2.59)	13.2 (2.51)	7.57 (2.30)	7.96 (2.32)	3.48 (2.14)
<u>Downstream</u>						
D 37: Lower Latham Reservoir	11.8 (2.42)	14.5 (2.48)	13.1 (2.54)	9.72 (2.39)	9.78 (3.88)	15.1 (2.55)
D 40: S. Platte River Below Confluence	10.6 (2.39)	10.4 (2.37)	8.01 (2.23)	17.3 (2.58)	8.62 (2.33)	9.05 (2.35)
D 45: St. Vrain Creek	5.08 (2.21)	8.37 (2.32)	7.92 (2.30)	7.17 (2.32)	10.6 (2.76)	7.17 (2.26)
<u>Upstream</u>						
U 42: St. Vrain Creek	13.5 (2.49)	9.38 (2.35)	9.56 (2.35)	9.06 (2.37)	4.14 (2.15)	6.05 (2.28)
U 43: S. Platte River	15.6 (2.48)	11.2 (2.42)	14.1 (2.47)	13.5 (2.47)	10.0 (2.37)	11.2 (2.40)
<u>Potable</u>						
F 49: Visitor's Center	1.26 (0.503)	4.82 (2.00)	5.73 (5.26)	6.25 (5.29)	6.29 (4.33)	9.24 (4.40)
D 39: Gilcrest City Water	16.3 (2.66)	6.29 (2.14)	11.3 (5.53)	9.65 (5.46)	12.1 (4.57)	19.3 (4.69)

* Uncertainties (in parentheses) are for the 95% confidence interval, (± 1.96 S.D.)MPC_w = 30 pCi/L Table II, Appendix B limit 10 CFR20 for an unidentified mixture of radionuclides in water 'if either the identity or the concentration of any radionuclide is not known.'

** Sample collected 11-30-82

Table II. C.1.A.

Gross Beta Activity in Effluent Water, Goosequill Pond, E-38. (pCi/L)

Collection Date	Total Water Concentrations
7-4-82	19.4 (2.58)*
7-10-82	17.2 (2.59)
7-17-82	15.2 (2.55)
7-25-82	10.7 (2.38)
7-31-82	15.1 (2.51)
8-6-82	11.7 (2.40)
8-14-82	15.0 (2.51)
8-21-82	14.5 (2.49)
8-28-82	10.6 (2.36)
9-4-82	8.10 (2.30)
9-12-82	10.5 (2.41)
9-18-82	11.6 (2.43)
10-2-82	13.0 (2.44)
10-9-82	8.78 (2.33)
10-16-82	11.0 (2.39)
10-23-82	12.7 (2.45)
10-30-82	10.7 (2.39)
11-30-82	8.39 (2.33)
12-4-82	10.6 (2.39)
12-11-82	7.37 (2.29)
12-19-82	8.92 (2.34)
12-26-82	7.03 (2.30)

MPC_w = 30 pCi/L Table II, Appendix B limit 10 CFR20 for an unidentified mixture of radionuclides in water 'if either the identity or the concentration of any radionuclide is not known.'

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

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

Sampling Locations	Monthly Collection Dates					
	7-10-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	< 287	< 295	1,580 * (264)	353,000 (3,800)	1,290 ** (273)	993 (271)
E 41: Goosequill Ditch	1,250 (263)*	< 295	2,290 (268)	2,080 (281)	1,100 (271)	360 (265)
<u>Downstream</u>						
D 37: Lower Latham Reservoir	< 287	< 295	831 (254)	303 (238)	357 (264)	< 296
D 40: S. Platte River Below Confluence	717 (258)	< 295	521 (251)	717 (267)	577 (266)	418 (265)
D 45: St. Vrain Creek	< 287	< 295	< 282	1,130 (271)	5,700 (316)	1,180 (273)
<u>Upstream</u>						
U 42: St. Vrain Creek	< 287	< 295	377 (250)	389 (264)	332 (264)	< 296
U 43: S. Platte River	< 287	< 295	368 (250)	< 296	447 (265)	< 296
<u>Potable</u>						
F 49: Visitor's Center	< 287	< 295	< 282	423 (265)	< 296	< 296
D 39: Gilcrest City Water	< 287	< 295	< 282	3,490 (300)	519 (265)	< 296

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

$^3\text{H MPC}_w = 3 \times 10^6$ pCi/L (10CFR20, Appendix B, Table II)

** Sample collected 11-30-82.

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

Sampling Locations	Monthly Collection Dates					
	7-10-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	< 0.833	< 0.846	< 0.761	< 0.768	< 1.19**	< 1.24
E 41: Goosequill Ditch	< 0.893	< 1.02	< 0.875	< 1.22	< 1.17	< 0.842
<u>Downstream</u>						
D 37: Lower Latham Reservoir	< 0.834	1.96 (1.10)	< 0.807	< 0.781	< 0.959	< 0.790
D 40: S. Platte River Below Confluence	< 0.789	< 1.03	< 0.964	< 1.20	< 1.08	< 1.39
D 45: St. Vrain Creek	< 0.816	< 0.859	< 0.819	< 1.27	< 0.945	< 1.03
<u>Upstream</u>						
U 42: St. Vrain Creek	< 0.869	< 0.856	< 0.735	< 1.18	< 1.02	< 0.705
U 43: S. Platte River	< 0.979	< 0.884	< 0.876	< 1.23	< 1.06	< 1.35
<u>Potable</u>						
F 49: Visitor's Center	< 0.815	< 0.780	0.957 (0.978)	< 1.08	< 0.887	< 1.26
D 39: Gilcrest City Water	< 0.785	< 1.14	< 0.911	< 0.752	1.13 (0.939)	< 0.681

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

⁹⁰Sr MPC_w = 300 pCi/L. (10CFR20, Appendix B, Table II).

** Sample collected 11-30-82.

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

Sampling Locations	Monthly Collection Dates					
	7-10-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	< 0.703	0.925 (1.25)*	< 0.650	< 0.637	< 0.729**	< 0.984
E 41: Goosequill Ditch	< 0.738	< 0.956	< 0.740	2.94 (1.99)	< 0.938	< 0.696
<u>Downstream</u>						
D 37: Lower Latham Reservoir	0.793 (0.989)	< 0.697	< 0.715	< 0.654	1.08 (1.02)	< 0.667
D 40: S. Platte River Below Confluence	< 0.687	< 0.911	< 0.817	7.63 (2.07)	< 0.900	< 1.04
D 45: St. Vrain Creek	< 0.712	< 0.758	< 0.697	2.38 (2.17)	< 0.763	< 0.847
<u>Upstream</u>						
U 42: St. Vrain Creek	< 0.755	< 0.753	< 0.655	< 0.881	< 0.845	< 0.617
U 43: S. Platte River	0.881 (1.18)	< 0.752	< 0.748	2.98 (2.04)	< 0.864	< 1.08
<u>Potable</u>						
F 49: Visitor's Center	< 0.704	0.858 (1.22)	< 0.752	1.79 (1.86)	< 0.770	< 1.05
D 39: Gilcrest City Water	1.04 (0.989)	< 0.991	1.22 (1.37)	< 0.642	< 0.719	< 0.605

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

^{89}Sr MPC_w = 3×10^3 pCi/L. (10CFR20, Apperdix B, Table II).

** Collected 11-30-82.

Table II.C.4.A

Tritium, Strontium 89, and Strontium 90 Concentrations in Effluent Water, Goosequill Pond, E-38.

a) Third Quarter, 1982.

Collection Date	Tritium (pCi/l)	Strontium 89 (pCi/l)	Strontium 90 (pCi/l)
7-4-82	4,740 (297)*	< 0.818	< 0.973
7-10-82	< 287	< 0.703	< 0.833
7-17-82	3,060 (277)	< 0.732	< 0.827
7-25-82	2,790 (287)	< 0.815	< 0.939
7-31-82	488 (254)	< 0.712	< 0.840
8-6-82	638 (269)	< 0.726	< 0.842
8-14-82	1,950 (282)	1.03 (1.21)	< 0.871
8-21-82	786 (270)	1.66 (1.14)	< 0.866
8-28-82	< 295	0.925 (1.25)	< 0.846
9-4-82	< 298	< 0.786	< 0.960
9-12-82	< 300	< 1.01	< 1.27
9-18-82	1,580 (264)	< 0.650	< 0.761

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

$^3\text{H MPC}_w = 3 \times 10^6$ pCi/L (10 CFR 20, Appendix B, Table II).

$^{89}\text{Sr MPC}_w = 3 \times 10^3$ pCi/L (10 CFR 20, Appendix B, Table II).

$^{90}\text{Sr MPC}_w = 300$ pCi/L (10 CFR 20, Appendix B, Table II).

Table II.C.4.A
Tritium, Strontium 89, and Strontium 90 Concentrations in Effluent
Water, Goosequill Pond, E-38. Fourth Quarter, 1982.

Collection Date	Tritium (pCi/l)	Strontium 89 (pCi/l)	Strontium 90 (pCi/l)
10-2-82	840 (256)*	< 0.620	< 0.697
10-9-82	1,590 (284)	< 0.692	< 0.784
10-16-82	353,000 (3,800)	< 0.637	< 0.768
10-23-82	2,260 (283)	< 0.718	1.55 (1.08)
10-30-82	7,900 (338)	< 0.785	< 0.974
11-30-82	1,290 (273)	< 0.729	< 1.19
12-4-82	364 (265)	< 0.824	< 0.945
12-11-82	993 (271)	< 0.984	< 1.24
12-19-82	< 296	0.631 (0.835)	< 0.654
12-26-82	544 (266)	< 0.683	1.06 (1.02)

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

^3H MPC_w = 3×10^6 pCi/L (10 CFR 20, Appendix B, Table II).

^{89}Sr MPC_w = 3×10^3 pCi/L (10 CFR 20, Appendix B, Table II).

^{90}Sr MPC_w = 300 pCi/L (10 CFR 20, Appendix B, Table II).

Table II. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)
 Collected July 10, 1982.

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 2.18	1.76 (0.827)*	< 0.290
E 41: Goosequill Ditch	< 0.684	< 0.214	< 0.0912
<u>Downstream</u>			
D 37: Lower Latham Reservoir	2.92 (3.08)	0.999 (0.821)	< 0.290
D 40: S. Platte River Below Confluence	< 2.18	< 0.680	< 0.290
D 45: St. Vrain Creek	5.17 (3.09)	1.00 (0.821)	< 0.290
<u>Upstream</u>			
U 42: St. Vrain Creek	< 2.18	< 0.680	< 0.290
U 43: S. Platte River	< 2.18 (3.04)	< 0.680	< 0.290
<u>Potable</u>			
F 49: Visitor's Center	< 2.81	< 0.870	< 0.372
D 39: Gilcrest City Water	< 2.59	0.806 (0.631)	< 0.343

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

Table II. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)

Collected August 28, 1982

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & NL
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 2.20	< 0.675	< 0.288
E 41: Goosequill Ditch	< 1.55	2.93 (0.733) *	0.358 (0.352)
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 0.665	0.794 (0.323)	< 0.087
D 40: S. Platte River Below Confluence	< 2.20	< 0.675	< 0.288
D 45: St. Vrain Creek	< 0.696	< 0.213	< 0.091
<u>Upstream</u>			
U 42: St. Vrain Creek	< 2.20	< 0.675	< 0.288
U 43: S. Platte River	< 2.35	< 0.719	< 0.307
<u>Potable</u>			
F 49: Visitor's Center	< 2.55	< 0.781	< 0.334
D 39: Gilcrest City Water	< 0.906	< 0.277	< 0.118

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

Table 11. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)
Collected September 18, 1982.

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 0.795	7.00 (0.570)*	5.79 (0.306)
E 41: Goosequill Ditch	2.57 (2.25)	< 0.265	2.63 (0.314)
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 2.33	1.54 (0.873)	0.495 (0.503)
D 40: S. Platte River Below Confluence	< 0.607	5.20 (0.315)	0.428 (0.179)
D 45: St. Vrain Creek	38.6 (4.52)	3.39 (0.509)	5.14 (0.335)
<u>Upstream</u>			
U 42: St. Vrain Creek	< 0.834	1.85 (0.553)	0.595 (0.316)
U 43: S. Platte River	< 2.20	3.44 (0.843)	1.63 (0.588)
<u>Potable</u>			
F 49: Visitor's Center	< 2.56	0.947 (0.634)	0.681 (0.490)
D 39: Gilcrest City Water	< 2.57	1.55 (0.637)	0.654 (0.442)

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

Table II. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)
Collected October 16, 1982.

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 2.20	2.42 (0.835) *	1.13 (0.416)
E 41: Goosequill Ditch	< 0.727	1.09 (0.538)	0.423 (0.221)
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 0.823	3.20 (0.574)	0.643 (0.252)
D 40: S. Platte River Below Confluence	< 0.621	< 0.192	< 0.081
D 45: St. Vrain Creek	< 2.17	2.06 (0.826)	0.610 (0.710)
<u>Upstream</u>			
U 42: St. Vrain Creek	< 2.17	1.75 (0.816)	0.425 (0.463)
U 43: S. Platte River	< 0.692	2.10 (0.604)	0.691 (0.311)
<u>Potable</u>			
F 49: Visitor's Center	< 0.759	< 0.235	< 0.999
D 39: Gilcrest City Water	< 2.57	1.44 (0.642)	0.966 (0.395)

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

Table II. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)

Collected November 27, 1982.

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond ** (Goosequill)	3.00 * (4.12)	7.16 (0.878)	2.99 (0.486)
E 41: Goosequill Ditch	< 2.17	2.41 (0.837)	0.942 (0.451)
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 0.825	2.63 (1.14)	0.911 (0.522)
D 40: S. Platte River Below Confluence	< 0.811	1.83 (0.617)	1.00 (0.337)
D 45: St. Vrain Creek	< 2.17	2.41 (0.830)	0.942 (0.666)
<u>Upstream</u>			
U 42: St. Vrain Creek	< 2.17	1.34 (1.01)	0.926 (0.538)
U 43: S. Platte River	< 2.17	2.97 (0.837)	0.728 (0.363)
<u>Potable</u>			
F 49: Visitor's Center	< 2.57	< 0.796	< 0.339
D 39: Gilcrest City Water	< 0.690	0.985 (0.238)	0.971 (0.147)

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

**Sample collected 11/30/82

Table II. C.5.

Gamma-ray Emitting Radionuclide Concentrations in Surface Water. (pCi/L)
Collected December 11, 1982.

Sample Location	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 0.759	1.71 (0.547) *	0.849 (0.295)
E 41: Goosequill Ditch	< 2.17	1.39 (0.822)	0.651 (0.437)
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 0.687	1.23 (0.610)	0.486 (0.330)
D 40: S. Platte River Below Confluence	< 2.17	1.58 (0.822)	0.825 (0.426)
D 45: St. Vrain Creek	< 2.57	2.05 (0.900)	1.58 (0.496)
<u>Upstream</u>			
U 42: St. Vrain Creek	< 0.693	2.11 (0.601)	1.10 (0.317)
U 43: S. Platte River	3.13 (3.25)	3.14 (0.792)	0.853 (0.439)
<u>Potable</u>			
F 49: Visitor's Center	3.19 (2.66)	1.92 (0.671)	< 0.368
D 39: Gilcrest City Water	< 0.882	< 0.273	< 0.116

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

^{106}Ru MPC_w = 1×10^4 pCi/L

^{137}Cs MPC_w = 2×10^4 pCi/L

$^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II)

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

Collection Date	^{106}Ru	^{137}Cs	^{95}Zr & Nb
7-4-82	< 0.912	< 0.283	< 0.121
7-10-82	< 2.18	1.76 (0.830)*	< 0.290
7-17-82	7.63 (3.09)	2.88 (0.844)	0.410 (0.355)
7-25-82	< 0.679	0.302 (0.323)	< 0.0883
7-31-82	4.35 (1.36)	4.03 (0.335)	3.02 (1.201)
8-6-82	< 2.13	2.38 (0.806)	< 0.279
8-14-82	< 0.733	0.271 (0.335)	0.449 (0.250)
8-21-82	< 2.20	4.31 (0.822)	< 0.288
8-28-82	< 2.20	< 0.675	< 0.288
9-4-82	6.71 (1.34)	5.49 (0.350)	3.19 (0.156)
9-12-82	< 2.20	1.09 (0.813)	< 0.288
9-18-82	< 0.795	7.00 (0.570)	5.79 (0.306)
10-2-82	< 2.20	5.28 (1.01)	0.749 (0.407)
10-9-82	21.39 (2.62)	< 0.551	0.636 (0.336)
10-16-82	< 2.20	2.42 (0.835)	1.13 (0.416)
10-23-82	9.34 (2.60)	2.24 (0.579)	2.77 (1.05)
10-30-82	< 2.17	0.566 (0.815)	1.11 (0.600)
11-30-82	3.00 (4.12)	7.16 (0.878)	2.99 (0.486)
12-4-82	< 2.17	2.36 (0.831)	1.59 (0.425)
12-11-82	< 0.759	1.71 (0.547)	0.849 (0.295)
12-19-82	6.50 (2.67)	3.01 (0.695)	0.938 (0.664)
12-26-82	5.62 (3.25)	5.28 (0.859)	1.12 (0.421)

^{106}Ru MPC_w = 1×10^4 pCi/L ^{137}Cs MPC_w = 2×10^4 pCi/L $^{95}\text{Zr-Nb}$ MPC_w = 6×10^4 pCi/L

(10CFR20, Appendix B, Table II).

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

II.C.2 Radionuclide Concentrations in Sediment

Sediment is the major compartment for radionuclide contaminants in a fresh water ecosystem due to the high concentration factors for fission products in the sediment mineral matrices. Although the samples are always collected at the same point, it is impossible to collect a sample with a known surface area to volume ratio as can be done for soils. Therefore, activity is reported as concentration values in pCi/kg rather than as deposition in $\mu\text{Ci}/\text{m}^2$. The values cannot be used to predict environmental transport of activity and serve only as monitoring information. The sample itself is a result of sediment movement downstream and is therefore a function of water flowrate which fluctuates greatly during the year.

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 were, as always, nearly identical. they were not significantly different (see Table II.H.1) and indicate that the sediment samples are very homogeneous. The mean values were in fact slightly less than during the first half of 1982 even though the power generation was higher during the last half. This further substantiates the point that the gross beta activity is predominately from naturally occurring radionuclides from the uranium and thorium decay series and K-40.

Table II.C.7 and II.C.8 list the Sr-90 and Sr-89 concentrations in the same sediment samples respectively. The mean concentrations

of both radionuclides were not significantly different between the three sampling areas, e.g., effluent, downstream and upstream. 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 samples types (Table II.H.1) indicate no significant difference for any of the fission products in each of the sampling locations. Sediment samples are subject to leaching and solubility differences between the three radionuclides, which should be expected.

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 should contain essentially all of the radioactivity, both natural and that due to reactor effluents. Tritium of course is lost in the heat drying of the sample.

The high minimum detectable concentrations are due to the fact that sediment samples are counted by Ge(Li) gamma-ray spectrometry. High resolution gamma-ray spectrum analysis is necessary due to the presence of members of the Ra-226 and Th-232 decay series.

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

Sampling Locations	Monthly Collection Dates					
	7-17-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	32,700 * (1,520)	32,600 (1,350)	32,100 (1,470)	30,800 (1,440)	30,700** (1,490)	35,200 (1,540)
E 41: Goosequill Ditch	31,500 (1,490)	33,300 (1,470)	29,400 (1,450)	23,900 (1,270)	29,200 (1,460)	23,900 (1,370)
<u>Downstream</u>						
D 37: Lower Latham Reservoir	31,800 (1,460)	28,400 (1,470)	29,700 (1,420)	44,600 (1,600)	36,800 (1,620)	30,300 (1,510)
D 40: S. Platte River Below Confluence	33,700 (1,510)	31,100 (1,410)	31,700 (1,430)	32,200 (1,470)	33,900 (1,520)	33,300 (1,550)
D 45: St. Vrain Creek	34,500 (1,490)	34,300 (1,430)	29,000 (1,400)	34,000 (1,470)	34,200 (1,460)	26,000 (1,370)
<u>Upstream</u>						
U 42: St. Vrain Creek	23,400 (1,370)	28,400 (1,380)	31,800 (1,490)	33,800 (1,480)	41,300 (1,740)	32,200 (1,360)
U 43: S. Platte River	38,500 (1,650)	40,300 (1,660)	36,400 (1,560)	29,700 (1,340)	37,200 (1,580)	30,400 (1,380)

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

** Sample collected 11-30-82

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

Sampling Locations	Monthly Collection Dates					
	7-17-82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	< 272	< 270	< 370	68.9 * (201)	< 177 ***	< 280
E 41: Goosequill Ditch	< 168	< 193	< 265	< 164	< 142	< 163
<u>Downstream</u>						
D 37: Lower Latham Reservoir	< 217 **	< 172	< 173	< 143	< 173	38.3 (208)
D 40: S. Platte River Below Confluence	< 219 **	< 205	< 257	< 173	< 200	< 211
D 45: St. Vrain Creek	< 274	< 348	< 198	< 176	< 220	< 168
<u>Upstream</u>						
U 42: St. Vrain Creek	< 197	< 370	< 215	< 162	< 184	< 172
U 43: S. Platte River	< 305	< 382	< 210	248 (202)	< 206	< 155

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

** Sample collected 7-10-82.

*** Sample collected 11-10-82

Table II. C.8

Strontium 89 Activity Concentrations in Bottom Sediment (pCi/kg).

Sampling Locations	Monthly Collection Dates					
	7-1 -82	8-28-82	9-18-82	10-16-82	11-27-82	12-11-82
<u>Effluent</u>						
E 38: Farm Pond (Goosequill)	< 231	308 (363) *	< 307	< 137	< 152 ***	< 226
E 41: Goosequill Ditch	< 145	< 168	224 (409)	< 138	< 122	< 134
<u>Downstream</u>						
D 37: Lower Latham Reservoir	< 188 **	< 155	< 159	< 125	< 149	< 151
D 40: S.Platte River Below Confluence	< 186 **	< 175	< 220	< 141	< 173	< 179
D 45: St. Vrain Creek	< 229	< 299	216 (293)	< 149	< 181	< 138
<u>Upstream</u>						
U 42: St. Vrain Creek	< 170	393 (494)	301 (348)	< 134	243 (249)	< 144
U 43: S. Platte River	< 253	< 327	< 181	< 146	< 172	< 130

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

** Collected 7-10-82

*** Collected 11-30-82

Table II. C.9

Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected July 17, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 2,910	< 502	< 184
E 41: Goosequill Ditch	< 2,770	< 479	< 175
<u>Downstream</u>			
D 37: Lower Latham ** Reservoir	3,420 (4,860) *	760 (685)	< 188
D 40: S. Platte River ** Below Confluence	< 3,190	< 551	< 202
D 45: St. Vrain Creek	< 3,350	596 (743)	< 212
<u>Upstream</u>			
U 42: St. Vrain Creek	< 3,390	1,400 (829)	< 214
U 43: S. Platte River	< 3,220	< 557	< 204

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

** Collected 7-10-82

Table II. C.9

Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected August 28, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 2,960	< 512	< 186
E 41: Goosequill Ditch	< 2,190	< 378	< 137
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 3,990	< 689	< 251
D 40: S. Platte River Below Confluence	< 3,120	< 540	< 196
D 45: St. Vrain Creek	< 2,290	< 395	< 143
<u>Upstream</u>			
U 42: St. Vrain Creek	< 2,920	< 505	< 183
U 43: S. Platte River	< 2,770	< 479	< 174

* 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 September 18, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 3,120	< 539	< 196
E 41: Goosequill Ditch	< 3,660	< 633	< 230
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 3,740	< 646	< 235
D 40: S. Platte River Below Confluence	< 7,760	2,890 (1,800)*	1,310 (1,070)
D 45: St. Vrain Creek	< 3,320	< 573	< 208
<u>Upstream</u>			
U 42: St. Vrain Creek	< 4,910	2,290 (1,140)	749 (513)
U 43: S. Platte River	< 5,100	< 882	< 321

* 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 October 16, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	3,610 (5,820)*	< 566	< 205
E 41: Goosequill Ditch	< 5,680	< 986	< 358
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 2,980	< 515	< 187
D 40: S. Platte River Below Confluence	< 6,370	< 1,110	< 402
D 45: St. Vrain Creek	< 3,120	< 541	< 196
<u>Upstream</u>			
U 42: St. Vrain Creek	< 3,150	< 545	< 198
U 43: S. Platte River	< 3,600	< 623	< 226

* 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 November 27, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond ** (Goosequill)	< 4,230	< 733	< 266
E 41: Goosequill Ditch	< 3,150	< 545	< 198
<u>Downstream</u>			
D 37: Lower Latham Reservoir	< 2,830	< 489	< 177
D 40: S. Platte River Below Confluence	< 2,900	< 502	< 182
D 45: St. Vrain Creek	< 2,840	< 491	< 178
<u>Upstream</u>			
U 42: St. Vrain Creek	< 3,120	< 540	< 196
U 43: S. Platte River	< 3,090	< 534	< 194

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

** Collected 11-30-82

Table II. C.9

Gamma-ray Emitting Radionuclide Concentrations in Bottom Sediment (pCi/kg)
for Samples Collected December 11, 1982.

Sampling Locations	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Effluent</u>			
E 38: Farm Pond (Goosequill)	< 5,200	< 901	< 327
E 41: Goosequill Ditch	< 3,670	< 635	< 231
<u>Downstream</u>			
D 37: Lower Latham Reservoir	3,850 * (4,290)	< 341	340 (258)
D 40: S. Platte River Below Confluence	< 5,430	< 942	< 342
D 45: St. Vrain Creek	< 3,150	< 545	< 198
<u>Upstream</u>			
U 42: St. Vrain Creek	< 6,550	< 1,140	< 413
U 43: S. Platte River	4,150 (5,430)	< 619	< 225

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

II.C.3 Precipitation

Gross beta and tritium deposition values are given in Table II.C.10. Precipitation funnel 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 this value can be used to predict food chain transport. Studies of world-wide fallout have produced models that predict forage and subsequent milk or meat concentrations from deposition values. The deposition measured is actually the sum of dry and precipitation deposition as the collectors are washed down at sample collection monthly or after a large rain or snowfall. The tritium deposition is calculated as the product of the concentration measured in the water and the total volume collected. (The wash water is subtracted).

From Table II.C.10 and Table II.H.1 it can be observed that there is essentially no difference in gross beta deposition at the two collection sites and the tritium deposition was less than the minimum detectable value at both sites. The mean values were again significantly lower than during 1981. The decrease was due to the lower air concentrations of Chinese weapon test fallout and resuspension of previously deposited fallout.

Since the F1 collector is near the liquid effluent pathway it would be expected to collect some increased tritium deposition from the evaporation as discussed in II.B.3. This, however, is apparently not the case. During all of 1982 the mean values were less than MDC at both locations. In fact, the tritium deposition at

F1 has never been significantly greater than at F4. These collection sites are at opposite directions from the reactor and in the predominant wind directions.

Tables II.C.11 and II.C.12 list the precipitation deposition of Ru-106, Cs-137 and Zr-Nb-95. The only source of these radionuclides has been world wide fallout. The mean values at F-1 and F-4 were not significantly different due to the high standard deviation values. Cs-137 values are higher than the other radionuclides measured because it has a much longer half-life and it is held strongly by ion exchange to the clay minerals in soil. Therefore the Cs-137 deposition is trapped on the surface of the soil. These surface soil particles are resuspended by wind and deposited in the collection funnel.

Table II.C.13 lists the deposition of the strontium radioisotopes. These as well have their origin in world wide fallout. The values are extremely variable as the concentration in water is extremely low. Due to the large water volume collected, small uncertainties in the concentrations produce large variations in the total deposition estimate. Sr-90 penetrates deeper into the soil profile than Cs-137 and therefore the values are somewhat lower. Sr-89 has a short half-life and it cannot be detected above counter background.

Table II. C.10

Gross Beta and Tritium Deposition from Precipitation at Locations F1 and F4.

Sample Ending Dates	Cumulative Volume * (liters)		Total Gross Beta Deposition (pCi/m ²)		Tritium Deposition (pCi/m ²)	
	F1	F4	F1	F4	F1	F4
7-31-82	164	139	264 (47.4) **	172 (36.9)	< 297	< 297
8-28-82	57	55	67.7 (15.1)	258 (18.2)	< 300	< 300
9-25-82	92	102	67.9 (24.6)	104 (26.5)	< 284	< 284
10-30-82	120	120	74.1 (31.8)	75.9 (29.9)	< 296	< 296
11-27-82	50	50	36.5 (13.4)	28.2 (13.2)	< 296	< 296
12-25-82	23.5	28	103 (13.4)	41.7 (13.2)	377 (256)	485 (257)

* Samples are analyzed at the end of each month.

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

Table II. C.11

Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location Fl.

Sample Ending Date	Total	Total Deposition (pCi/m ²)		
	Volume*	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
7-31-82	164	< 31.7	< 9.70	< 4.14
8-28-82	57	< 10.8	< 9.10	< 1.20
9-25-82	92	< 10.4	36.9 (7.50)**	8.72 (6.60)
10-30-82	102	< 58.7	61.9 (29.1)	20.8 (15.3)
11-27-82	50	4.63 (4.33)	5.35 (1.10)	1.74 (0.572)
12-25-82	23.5	27.5 (16.3)	40.4 (4.19)	8.64 (2.21)

* Samples are analyzed at the end of each month.

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

Table II. C.12

Gamma-ray Emitting Radionuclide Deposition from Precipitation at Location F4.

Sample Ending Date	Total	Total Deposition (pCi/m ²)		
	Volume*	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
7-31-82	139	< 41.1	25.1 (27.6)**	< 5.37
8-28-82	55	< 34.0	30.1 (12.3)	6.03 (10.8)
9-25-82	102	< 20.3	117 (14.8)	22.9 (9.47)
10-30-82	120	< 59.5	33.6 (22.6)	16.2 (17.2)
11-27-82	50	97.0 (15.8)	47.3 (3.77)	16.7 (2.94)
12-25-82	28	43.2 (21.0)	38.1 (5.62)	13.9 (2.73)

* Samples are analyzed at the end of each month.

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

Table II. C.13

Radiostrontium Deposition from Precipitation at Locations F1 and F4 (pCi/m²).

Sample Ending Dates	Cumulative Volume (liters) *		Strontium 89		Strontium 90	
	F1	F4	F1	F4	F1	F4
7-31-82	164	139	< 45.8	< 40.8	< 54.6	< 48.4
8-28-82	57	55	< 11.5	< 8.49	< 13.9	< 10.3
9-25-82	92	102	26.9 (38.5) **	< 14.0	< 20.8	< 17.2
10-30-82	120	120	< 26.3	< 22.2	< 33.9	< 27.8
11-27-82	50	50	< 11.4	< 12.0	< 13.8	< 14.3
12-26-82	23.5	28	9.68 (10.9)	< 6.16	< 9.96	< 7.94

* Samples are analyzed at the end of each month.

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

II.D Food Chain Data

1. Milk. Milk is the most important radiation dose commitment pathway for H-3, I-131, Cs-137 and Sr-89,90. Tritium concentrations in milk are summarized in Table II.D.1. There was no significant difference in mean tritium values in water extracted from milk at the only dairy in the Facility area (F-44), and the Adjacent Composite and the Reference Composite mean values for the second half of 1982 (see Table II.H.1). In fact, none of the values or the arithmetic means were significantly different from MDC. Since the mean tritium values for all three sampling zones were not significantly different, this implies the tritium in the plant effluents is not contributing dose via the milk pathway.

Tritium concentrations in milk should respond rapidly to changes in tritium concentrations of the forage water intake or drinking 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 (\pm 3-4%, depending on the cow breed, 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 and is not

significant for dose considerations.

Tables II.D.2 and II.D.3 list the Sr-90 and Sr-89 concentrations in milk. The mean of the facility milk samples was not significantly different than the means for the other two areas. Variations noted during this reporting period are typical of past periods and attributed to differences in feeding practices and not to reactor effluents. The mean values for Sr-89 were also not significantly different.

The concentrations of I-131, Cs-137 and K-nat in milk are given in Table II.D.4. The arithmetic mean values of I-131 and Cs-137 (Table II.G.1) for the reporting period were not significantly different from each other as they were during the last reporting period.

K-natural, as measured by K-40 is very constant in milk. The mean literature value is 1.5 g/L. K-nat is measured and reported therefore only for a quality control measure of Cs-137 and I-131 determined in the same sample by gamma-ray spectrometry.

A close relationship between forage deposition and milk concentrations should be expected for tritium, 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. At times it can even be cuttings from the previous year. This makes correlation of milk concentrations with air concentrations very difficult. On the other hand, if elevated I-131 or tritium concentrations in milk are noted, the surface depositions must have been reasonably related in time and location due to the short effective half lives of these radionuclides.

Table II. D.1

Tritium Concentrations in Water Extracted from Milk (pCi/l).

Sample Ending Dates	Facility Area 44	Adjacent Composite *	Reference Composite *
<u>Pasture Season</u>			
7-4-82	< 289	< 289	< 289
7-10-82	< 287	< 287	342 (254) **
7-17-82	652 (253)	393 (251)	647 (253)
7-25-82	< 295	< 295	< 295
7-31-82	< 285	< 285	< 285
8-6-82	< 285	< 285	< 285
8-14-82	< 295	< 295	< 295
8-21-82	< 295	< 295	< 295
8-28-82	< 298	< 298	< 298
9-4-82	< 298	< 298	< 298
9-11-82	< 300	< 300	< 300
9-18-82	< 300	< 300	< 300
9-25-82	515 (251)	326 (249)	508 (252)
<u>Post Pasture Season</u>			
10-9-82	< 284	< 284	< 284
11-13-82	< 296	< 296	< 296
12-11-82	< 296	369 (265)	< 296

* 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, (\pm 1.96 S.D.)

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

Sample Ending Dates	Facility Area 44	Adjacent Composite *	Reference Composite *
<u>Pasture Season</u>			
7-3-82	< 1.19	< 3.08	1.50 (1.31)**
7-10-82	< 1.34	2.76 (1.35)	1.58 (1.41)
7-17-82	< 1.02	< 1.26	2.02 (1.27)
7-25-82	< 3.96	< 2.08	< 2.42
7-31-82	< 3.14	3.03 (1.57)	2.30 (3.11)
8-6-82	1.93 (1.50)	< 2.19	1.97 (1.46)
8-14-82	< 2.59	2.36 (2.23)	< 2.64
8-21-82	< 1.64	< 1.77	< 3.31
8-28-82	2.59 (1.89)	< 2.00	< 1.75
9-4-82	1.32 (1.38)	< 1.43	< 2.18
9-12-82	< 3.93		< 4.61
9-18-82	2.02 (1.24)	< 2.60	1.95 (2.68)
9-25-82	1.69 (1.40)	< 5.31	< 2.16
<u>Post-Pasture Season</u>			
10-9-82	< 1.23	< 1.33	2.55 (1.52)
11-13-82	< 1.35	1.17 (1.34)	1.55 (1.46)
12-11-82	1.08 (1.34)	< 1.71	< 1.17

* 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.).

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

Sample Ending Dates	Facility Area 44	Adjacent Composite *	Reference Composite *
<u>Pasture Season</u>			
7-4-82	1.53 (1.19)**	2.85 (3.67)	< 1.03
7-10-82	< 1.26	< 1.02	< 0.969
7-17-82	< 0.990	< 1.21	< 0.994
7-25-82	< 3.47	< 1.91	< 2.12
7-31-82	4.45 (4.05)	< 2.03	< 1.58
8-6-82	< 1.22	< 2.39	< 1.15
8-14-82	4.87 (3.42)	2.67 (2.79)	5.84 (3.98)
8-21-82	2.43 (1.80)	9.31 (2.06)	9.85 (4.41)
8-28-82	2.24 (1.90)	4.16 (2.46)	2.42 (2.10)
9-4-82	< 1.23	< 1.35	< 1.98
9-12-82	< 3.47	< 2.04	4.92 (6.13)
9-18-82	< 1.10	< 2.31	< 9.79
9-25-82	< 1.06	< 4.52	1.99 (2.73)
<u>Post-Pasture Season</u>			
10-9-82	< 1.23	< 1.32	< 1.27
11-13-82	< 1.42	< 1.30	< 1.29
12-11-82	< 0.988	< 1.55	< 1.17

* 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.)

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)
7-4-82	Facility	< 0.129	6.30 (0.909)**	1.54 (0.0151)
	Adjacent	< 0.124	6.70 (0.897)	1.50 (0.0148)
	Reference	< 0.133	< 0.136	1.37 (0.0152)
7-10-82	Facility	< 0.126	< 0.129	1.39 (0.0148)
	Adjacent	< 0.142	< 0.145	1.37 (0.0157)
	Reference	< 0.123	< 0.125	1.31 (0.0145)
7-17-82	Facility	< 0.155	< 0.158	1.56 (0.0168)
	Adjacent	< 0.146	< 0.149	1.36 (0.0159)
	Reference	< 0.115	< 0.118	1.37 (0.0141)
7-25-82	Facility	< 0.131	< 0.134	1.41 (0.0151)
	Adjacent	6.92 (3.00)	0.310 (1.04)	1.51 (0.0180)
	Reference	< 0.124	< 0.126	1.34 (0.0154)
7-31-82	Facility	< 0.152	< 0.154	1.49 (0.0205)
	Adjacent	< 0.150	< 0.153	1.54 (0.0205)
	Reference	9.35 (2.18)	0.158	1.50 (0.0248)
8-7-82	Facility	9.94 (1.43)	< 0.160	1.40 (0.0169)
	Adjacent	< 0.134	< 0.138	1.40 (0.0187)
	Reference	< 0.123	< 0.127	1.50 (0.0181)
8-14-82	Facility	< 0.191	< 0.197	1.49 (0.0231)
	Adjacent	< 0.153	< 0.158	1.50 (0.0201)
	Reference	< 0.127	< 0.130	1.34 (0.0152)
8-21-82	Facility	< 0.121	< 0.131	1.68 (0.0150)
	Adjacent	< 0.123	< 0.132	1.38 (0.0148)
	Reference	< 0.118	< 0.127	1.47 (0.0146)
8-28-82	Facility	< 0.126	< 0.129	1.39 (0.0148)
	Adjacent	< 0.142	< 0.145	1.37 (0.0157)
	Reference	< 0.120	< 0.124	1.47 (0.0179)
9-4-82	Facility	< 0.117	< 0.121	1.40 (0.0147)
	Adjacent	c	c	c
	Reference	< 0.189	< 0.195	1.50 (0.0231)

* 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.).

c Instrument malfunction, NaI scintillation malfunction.

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)
9-11-82	Facility	6.69 (3.52)**	< 0.609	c
	Adjacent	< 0.143	< 0.147	1.28 (0.0160)
	Reference	8.70 (2.57)	< 0.185	1.58 (0.0185)
9-18-82	Facility	2.77 (2.32)**	2.18 (0.973)	1.61 (0.0166)
	Adjacent	< 0.187	2.01 (1.07)	1.40 (0.0186)
	Reference	< 0.175	< 0.180	1.51 (0.0185)
9-25-82	Facility	< 0.140	0.816 (0.923)	1.52 (0.0156)
	Adjacent	< 0.123	< 0.127	1.38 (0.0197)
	Reference	2.62 (1.55)	< 0.132	1.48 (0.0183)
10-2-82	Facility	0.345 (1.29)	< 0.159	1.71 (0.0173)
	Adjacent	< 0.131	< 0.134	1.44 (0.0153)
	Reference	< 0.177	< 0.121	1.52 (0.0146)
11-9-82	Facility	< 0.133	< 0.136	1.54 (0.0154)
	Adjacent	< 0.126	< 0.129	1.50 (0.0150)
	Reference	< 0.171	< 0.175	1.37 (0.0176)
12-11-82	Facility	< 0.132	< 0.134	1.60 (0.0149)
	Adjacent	< 0.115	< 0.117	1.34 (0.0135)
	Reference	< 0.130	< 0.132	1.42 (0.0145)

* 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.).

c Instrument malfunction, NaI scintillation malfunction.

II.D. Food Chain Data

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 were essentially the same as during the first half of 1982. There were no significant differences in mean tritium values between Facility, Adjacent and Reference locations. The tritium in forage water was as expected, similar to the concentration observed in milk.

Strontium-89 and Sr-90 concentrations were also not significantly different for the three sampling zones. Sr-89 mean values were less than MDC. Although the Sr-90 facility mean was higher than that for the other two areas, due to the high standard deviation, the mean values were not statistically different ($\alpha = 0.05$).

Table II.D.6 lists Ru-106, Cs-137 and Zr-Nb-95 activities in forage samples for the first half of 1982. No significant differences were observed.

Gross beta concentrations in soil and forage collected at the same locations are given in Table II.D.7. No statistically significant differences were observed. The forage concentrations are of course lower than soil as all of the radionuclides in the soil are not biologically available for plant uptake. Also it is true that a major fraction of the forage activity is due to soil particles trapped on the plant surface from resuspension.

A cattle forage sample, 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 samples must be collected. These samples may or may not be harvested locally and may represent different fallout periods. This presents obvious difficulties in data interpretation.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in
Forage for Samples Collected July 17, 1982.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
<u>Facility</u>			
4	e	< 37.5	241 (63.2)*
44	753 (254)	< 19.9	146 (35.3)
<u>Adjacent</u>			
6	441 (251)	< 17.7	124 (20.3)
28	470 (252)	15.2 (17.6)	35.6 (13.3)
31	508 (252)	28.8 (22.3)	66.7 (16.0)
36	< 283	< 18.3	167 (31.2)
48	418 (251)	< 8.76	122 (15.6)
50	1,250 (259)	< 6.92	69.5 (11.7)
<u>Reference</u>			
16	470 (252)	< 29.2	66.0 (33.6)
17	791 (255)	< 16.7	82.0 (20.0)
20	< 283	< 11.2	76.6 (14.4)
22	314 (250)	< 10.4	76.9 (13.1)
23	e	< 5.15	73.1 (9.17)
25	e	< 15.6	134 (27.8)

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

e Insufficient weight or volume for analysis.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in
Forage for Samples Collected August 6, 1982.

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
<u>Facility</u>			
4	< 285	38.1 (33.2)*	215 (41.7)
44	387 (253)	< 5.11	26.6 (6.74)
<u>Adjacent</u>			
6	< 285	< 14.3	58.1 (18.2)
28	661 (255)	< 13.7	50.0 (16.9)
31	< 285	< 15.3	55.5 (17.3)
36	452 (253)	< 8.72	45.7 (10.2)
48	e	15.4 (16.8)	61.6 (10.1)
50	< 285	< 17.8	53.4 (18.7)
<u>Reference</u>			
16	< 285	< 10.2	34.4 (13.0)
17	290 (252)	< 16.2	65.5 (17.9)
20	< 285	< 19.7	63.9 (18.0)
22	580 (254)	< 11.4	76.9 (15.7)
23	431 (253)	< 12.6	91.5 (15.5)
25	e	20.7 (22.7)	107 (18.1)

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

e Insufficient weight or volume for analysis.

Table II. D.5
Tritium, Strontium 89, and Strontium 90 Concentrations in
Forage for Samples Collected September 18, 1982 .

Areas	Tritium (pCi/l)	Strontium 89 (pCi/kg)	Strontium 90 (pCi/kg)
<u>Facility</u>			
4	e	28.9 (28.8)*	58.5 (14.0)
44	e	84.6 (47.7)	36.7 (24.9)
<u>Adjacent</u>			
6	< 300	14.6 (40.3)	18.9 (18.5)
28	< 300	17.9 (24.1)	29.2 (15.2)
31	< 300	18.1 (18.7)	85.9 (12.9)
36	< 300	< 22.8	50.3 (30.4)
48	< 300	< 13.8	122 (16.3)
50	< 300	< 32.8	132 (30.4)
<u>Reference</u>			
16	< 300	< 8.71	77.6 (12.2)
17	< 300	< 12.5	80.0 (16.7)
20	< 300	17.6 (20.5)	120 (14.2)
22	< 300	< 10.5	94.5 (15.1)
23	< 300	119 (40.3)	97.7 (17.5)
25	< 300	125 (47.1)	182 (29.0)

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

e Insufficient weight or volume for analysis.

Table II. D.6
Gamma-ray Emitting Radionuclide Concentrations in Forage
(pCi/kg) for Samples Collected July 17, 1982.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Facility</u>			
4	< 105	296 (30.1)*	84.4 (15.7)
44	< 81.9	54.5 (22.4)	50.7 (12.0)
<u>Adjacent</u>			
6	< 57.6	33.6 (15.8)	14.3 (8.52)
28	< 6.94	10.6 (2.27)	4.54 (1.18)
31	147 (61.5)	65.5 (15.2)	15.1 (7.52)
36	< 95.1	32.5 (24.7)	26.4 (13.1)
48	< 64.6	< 19.8	< 8.46
50	< 28.8	19.0 (8.39)	31.2 (3.65)
<u>Reference</u>			
16	< 18.7	21.4 (6.17)	16.0 (3.13)
17	< 70.2	49.2 (18.3)	< 9.21
20	< 42.1	111 (13.6)	< 5.62
22	< 67.7	33.8 (18.0)	12.9 (9.88)
23	< 59.3	32.0 (17.0)	15.3 (8.26)
25	< 17.4	43.2 (5.79)	7.84 (2.79)

* 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 August 6, 1982.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Facility</u>			
4	< 73.3	125 (23.5)*	70.2 (13.9)
44	< 9.76	< 2.99	10.8 (2.57)
<u>Adjacent</u>			
6	< 196	< 59.9	245 (44.3)
28	< 12.8	20.8 (4.92)	17.1 (3.39)
31	< 68.7	39.5 (18.6)	45.9 (14.1)
36	< 40.9	< 12.5	6.05 (8.04)
48	< 48.8	< 15.0	25.3 (10.1)
50	< 10.7	169 (3.67)	13.8 (2.52)
<u>Reference</u>			
16	< 78.5	< 24.0	10.5 (14.7)
17	< 86.8	58.4 (23.0)	31.7 (16.5)
20	< 64.5	66.6 (18.2)	32.0 (12.9)
22	< 43.0	< 13.4	< 5.70
23	< 24.0	< 7.35	< 3.14
25	324 (47.0)	132 (11.9)	29.4 (6.37)

* 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 September 18, 1982.

Areas	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Facility</u>			
4	185 (14.6)*	85.3 (3.48)	52.5 (3.86)
44	< 342	< 106	104 (98.8)
<u>Adjacent</u>			
6	< 129	70.1 (34.0)	79.8 (38.6)
28	< 44.8	34.9 (12.3)	27.4 (7.92)
31	< 687	869 (181)	< 89.9
36	176 (140)	56.3 (31.6)	52.6 (35.4)
48	< 31.0	36.9 (10.0)	13.9 (5.61)
50	< 40.5	195 (13.1)	61.0 (7.58)
<u>Reference</u>			
16	< 73.7	59.4 (21.0)	78.6 (24.1)
17	< 63.0	32.6 (16.7)	< 8.25
20	63.1 (24.3)	45.8 (5.49)	50.3 (6.24)
22	< 66.3	32.4 (17.5)	39.1 (11.3)
23	< 60.5	56.2 (17.5)	78.7 (15.2)
25	79.9 (80.9)	103 (19.3)	75.6 (17.3)

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

Table II. D.7

Gross Beta Concentrations in Soil and Forage (pCi/kg) for
Samples Collected Third Quarter, 1982.

Sampling Location	July 17, 1982		August 6, 1982		September 18, 1982	
	Soil	Forage	Soil	Forage	Soil	Forage
<u>Facility</u>						
4	31,300 (1,520)*	17,400 (561)	30,300 (1,420)	16,800 (968)	30,800 (1,430)	10,500 (221)
44	27,000 (1,300)	19,800 (378)	31,300 (1,420)	9,990 (154)	30,100 (1,450)	26,700 (474)
<u>Adjacent</u>						
6	30,100 (1,440)	18,500 (392)	26,900 (1,300)	16,300 (241)	25,900 (1,340)	18,100 (373)
28	24,100 (1,280)	10,900 (231)	21,100 (1,180)	15,400 (266)	24,400 (1,390)	14,100 (300)
31	26,000 (1,310)	8,940 (200)	25,200 (1,210)	15,900 (259)	27,500 (1,370)	11,500 (352)
36	23,600 (1,270)	2,330 (389)	22,600 (1,240)	15,800 (256)	23,400 (1,300)	9,560 (182)
48	26,900 (1,320)	15,900 (272)	24,900 (1,280)	12,100 (199)	30,600 (1,500)	15,500 (257)
50	30,300 (1,410)	11,800 (245)	25,400 (1,270)	16,300 (261)	31,300 (1,470)	16,400 (392)
<u>Reference</u>						
16	27,300 (1,340)	28,800 (458)	24,500 (1,290)	17,700 (240)	21,200 (1,220)	24,000 (375)
17	17,700 (1,150)	15,700 (270)	18,200 (1,220)	18,800 (279)	20,900 (1,250)	15,500 (247)
20	28,100 (1,430)	9,620 (197)	25,500 (1,270)	20,800 (330)	24,300 (1,270)	15,500 (271)
22	28,800 (1,390)	16,800 (301)	26,800 (1,330)	20,800 (292)	23,800 (1,260)	11,500 (233)
23	26,200 (1,200)	19,700 (355)	19,400 (1,170)	19,900 (313)	27,200 (1,450)	24,100 (442)
25	20,100 (1,180)	14,600 (284)	23,000 (1,220)	16,100 (281)	24,300 (1,300)	11,600 (324)

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

II.D. Food Chain Data

3. Soil. 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 cm². Bulk soil density is approximately 1 g/cm³. Table II.D.8 presents gross beta activity of soil per unit surface area for the second half of 1982. This parameter is calculated from the gross beta concentration in soil (Table II.D.7) multiplied by the mass per unit surface area of the sample core. Since reactor effluents or fallout will result in deposition on the soil surface, activity per unit surface area is the parameter of choice to document environmental contamination. The mean value for the facility area was significantly greater than that measured for the adjacent or reference areas (Table II.H.1). This difference is most certainly due to a higher concentration of the natural Uranium and Thorium decay series and natural K-40. The difference is not due to fission product activity. Table II.D.9 and the calculated mean values indicate that there is no significant difference for Ru-106, Cs-137 or Zr-Nb-95 between the facility, adjacent or reference sampling zones.

Tritium, Sr-89, and Sr-90 in soil are shown in Table II.D.10. Tritium specific activity in soil water is statistically the same as that in other environmental samples, e.g. water, forage and milk. The activity per unit surface area of the strontium radioisotopes were again quite variable. Due to the large standard deviations there was no statistical difference in the mean values between the three sampling zones. It should be noted that the Sr-90 values are

considerably lower than measured for Cs-137. This is because the Cs-137 is trapped near the soil surface by ion exchange and the Sr-90 is leached down the soil profile to depths greater than collected by our coring method.

Table II. D.8

Gross Beta Activity in Soil per Unit Surface Area ($\mu\text{Ci}/\text{m}^2$) for Samples Collected Third Quarter, 1982.

Sampling Locations	July 17, 1982	August 6, 1982	September 18, 1982
<u>Facility</u>			
4	4.04 (0.196)*	3.91 (0.183)	3.98 (0.185)
44	3.49 (0.167)	4.02 (0.183)	3.89 (0.187)
<u>Adjacent</u>			
6	3.88 (0.185)	3.47 (0.168)	3.34 (0.173)
28	3.12 (0.165)	2.72 (0.153)	3.15 (0.179)
31	3.36 (0.168)	3.25 (0.156)	3.55 (0.177)
36	3.04 (0.163)	2.92 (0.160)	3.02 (0.167)
48	3.47 (0.171)	3.22 (0.165)	3.95 (0.193)
50	3.91 (0.182)	3.28 (0.163)	4.04 (0.190)
<u>Reference</u>			
16	3.52 (0.173)	3.16 (0.166)	2.74 (0.158)
17	2.28 (0.148)	2.35 (0.157)	2.70 (0.162)
20	3.63 (0.184)	3.29 (0.164)	3.14 (0.164)
22	3.72 (0.179)	3.45 (0.171)	3.07 (0.162)
23	3.38 (0.158)	2.50 (0.151)	3.50 (0.187)
25	2.59 (0.153)	2.97 (0.157)	3.13 (0.167)

* 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/m²) for Samples Collected July 17, 1982.

Sampling Location	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
<u>Facility</u>			
4	< 240	< 41.4	< 15.1
44	< 273	< 47.1	< 17.2
<u>Adjacent</u>			
6	< 274	< 47.2	< 17.2
28	< 311	< 53.6	< 19.5
31	< 268	< 46.2	< 16.9
36	< 441	< 76.1	32.2 (46.6)*
48	< 4,530	< 781	< 286
50	< 465	< 80.5	< 29.3
<u>Reference</u>			
16	< 366	< 63.2	< 23.2
17	< 267	< 46.0	< 16.8
20	233 (407)	< 40.1	< 14.6
22	< 270	< 46.5	< 16.9
23	< 616	125 (108)	< 39.0
25	314 (472)	< 54.3	< 19.9

* 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/m²) for Samples Collected August 6, 1982.

Sampling Location	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
<u>Facility</u>			
4	< 263	126. (59.2)*	< 16.5
44	< 203	84.1 (53.9)	< 12.7
<u>Adjacent</u>			
6	< 255	< 44.1	< 16.0
28	< 477	< 82.5	< 30.0
31	< 268	< 46.2	< 16.8
36	< 341	172 (75.9)	21.4 (39.5)
48	< 313	< 54.1	< 19.7
50	< 265	< 45.8	< 16.6
<u>Reference</u>			
16	< 293	< 50.7	< 18.4
17	< 274	< 47.3	< 17.2
20	< 290	< 50.1	< 18.2
22	< 308	< 53.2	< 19.4
23	< 185	< 31.8	< 11.6
25	< 336	150 (78.4)	49.7 (42.2)

* 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/m²) for Samples Collected September 18, 1982 .

Sampling Location	¹⁰⁶ Ru	¹³⁷ Cs	⁹⁵ Zr & Nb
<u>Facility</u>			
4	< 441	< 76.4	< 27.7
44	< 258	< 44.7	18.9 (38.3)*
<u>Adjacent</u>			
6	< 168	89.1 (50.0)	17.7 (33.4)
28	< 259	80.1 (58.2)	< 16.3
31	< 327	< 56.7	< 20.6
36	< 226	73.3 (58.3)	< 16.7
48	< 221	< 38.2	< 13.9
50	< 313	< 54.2	81.2 (48.8)
<u>Reference</u>			
16	< 244	83.0 (56.1)	< 15.3
17	< 259	< 44.9	< 16.3
20	< 474	92.6 (86.5)	30.5 (62.9)
22	< 262	< 45.2	< 16.4
23	< 475	< 82.5	36.5 (53.7)
25	< 260	< 45.0	69.3 (44.5)

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

Table II. D.10
Tritium, concentration in soil water and Strontium 89,
Strontium 90 Activity per unit surface of Soil for
Samples Collected July 17, 1982.

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/m ²)	Strontium 90 (pCi/m ²)
<u>Facility</u>			
4	< 283	< 14.3	< 16.6
44	602 (253)*	< 12.4	< 14.7
<u>Adjacent</u>			
6	< 283	17.9 (23.1)	< 17.3
28	521 (252)	< 11.0	< 12.5
31	< 295	< 9.48	< 11.1
36	515 (252)	< 10.4	16.2 (13.7)
48	< 295	< 12.9	< 15.4
50	396 (251)	< 14.1	< 16.9
<u>Reference</u>			
16	< 283	< 11.1	15.3 (15.0)
17	560 (252)	< 13.9	< 15.7
20	< 283	< 12.3	< 14.3
22	e	< 11.0	< 13.1
23**	< 295	< 13.9	20.7 (29.8)
25	598 (253)	< 9.45	97.8 (14.3)

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

** Collected 7-25-82.

e Insufficient weight or volume for analysis.

Table II. D.10
Tritium, concentration in soil water and Strontium 89,
Strontium 90 Activity per unit surface area of Soil for
Samples Collected August 6, 1982.

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/m ²)	Strontium 90 (pCi/m ²)
<u>Facility</u>			
4	< 297	< 9.61	96.3 (15.1)*
44	< 297	74.9 (39.6)	< 19.8
<u>Adjacent</u>			
6	< 297	12.2 (21.4)	< 14.0
28	e	< 11.6	< 13.0
31	< 297	48.8 (27.6)	< 14.5
36	< 297	< 11.9	21.4 (15.6)
48	< 297	74.0 (30.5)	< 15.2
50	e	34.4 (24.5)	< 12.5
<u>Reference</u>			
16	< 297	14.6 (22.0)	< 14.3
17	< 297	45.2 (23.9)	< 15.2
20	< 297	25.3 (20.4)	12.6 (14.2)
22	< 297	18.5 (29.6)	< 16.9
23	< 297	40.1 (15.9)	< 10.7
25	< 297	28.5 (18.0)	36.6 (14.0)

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

e Insufficient volume for analysis.

Table II. D.10
Tritium, concentration in soil water and Strontium 89,
Strontium 90 Activity per unit surface of Soil for
Samples Collected September 18, 1982.

Sampling Location	Tritium (pCi/l)	Strontium 89 (pCi/m ²)	Strontium 90 (pCi/m ²)
<u>Facility</u>			
4	d	< 9.70	24.0 (13.5)*
44	d	< 8.61	< 10.6
<u>Adjacent</u>			
6	d	< 12.8	< 15.6
28	d	< 7.99	18.3 (12.6)
31	d	< 8.56	14.8 (13.6)
36	d	< 8.08	13.3 (12.7)
43	d	11.4 (24.4)	< 11.9
50	d	< 13.2	< 16.4
<u>Reference</u>			
16	d	< 8.40	55.9 (13.1)
17	d	10.2 (15.6)	< 11.0
20	d	< 8.62	< 10.3
22	d	< 8.44	15.6 (12.6)
23	d	< 8.44	< 10.3
25	d	< 8.16	25.4 (13.1)

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

II.E. Aquatic Biota

Table II.E.1 shows gross beta and strontium concentrations observed in aquatic biota collected during the second half of 1982. Gross beta concentrations in the sample types are higher than any particular fallout fission product because of the presence of the naturally occurring radionuclides, e.g. K-40. The Strontium-89, Sr-90, and gross beta concentrations observed were essentially the same, but in many cases less than observed during the last half of 1981. There was no indication that downstream values were higher than upstream. Concentrations measured in aquatic biota in the effluent streams were not different than upstream. This further supports the contention that particulate fission product release from the reactor is negligible. Due to the low number of samples collected for each report period, statistical analyses are tentative at best.

Table II.E.2 lists Ru-106, Cs-137, and Zn-Nb-95 concentrations measured in the same samples. These concentrations appear to be similar to those measured during the first half of 1982. The input of fallout from the 1980 Chinese Nuclear Weapon Test appears to be at undetectable levels presently.

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. Seston radionuclide concentrations are generally higher than for the other sample types.

The presence of Corbicula fluminea, a species of freshwater clam, is being monitored at several sites around the Fort St. Vrain Nuclear Generating Station in Platteville. Corbicula have been introduced to North America from Asia. The freshwater clams are now found in large river systems in the U.S. from coast to coast. The Colorado Division of Wildlife has stated that Corbicula have been found in Northern Colorado, Boyd Lake, some 30 miles from the Ft. St. Vrain Nuclear Generating Station. To this date, our samplings have indicated no evidence of Corbicula in any of the sampling sites immediately upstream of the reactor.

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected July, 1982 .**

Sampling locations	Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
<u>Fish</u>			
Upstream 7-7-82	8,650 (347)	< 25.8	44.6 (26.0)
Downstream 7-7-82	7,590 (258)	< 26.6	< 28.9
Effluent 7-7-82	7,480 (288)	< 14.6	17.5 (23.0)
<u>Benthic Organisms</u>			
Upstream	f	f	f
Downstream	f	f	f
Effluent 7-7-82	3,930 (326)	< 38.4	72.6 (34.6)
<u>Vascular Plants</u>			
Upstream 7-10-82	30,000 (671)	< 60.3	< 74.5
Downstream 7-10-82	24,500 (501)	< 33.8	57.5 (43.3)
Effluent 7-10-82	33,800 (590)	< 27.9	77.3 (54.8)
<u>Seston</u>			
Upstream	f	f	f
Downstream 7-7-82	24,700 (1,070)	307 (367)	< 226
Effluent	f	f	f

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

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

f Sample unavailable.

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected August 31, 1982 .**

Sampling locations	Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
<u>Fish</u>			
Upstream 8-31-82	10,900 (382)*	< 33.0	< 28.6
Downstream	f	f	f
Effluent 8-31-82	8,850 (267)	< 38.7	< 22.0
<u>Benthic Organisms</u>			
Upstream	f	f	f
Downstream 8-31-82	6,280 (457)	< 85.0	107 (76.0)
Effluent 8-31-82	7,670 (396)	< 59.6	61.0 (49.8)
<u>Vascular Plants</u> ***			
Upstream 8-28-82	17,400 (299)	< 15.3	43.9 (14.8)
Downstream 8-28-82	13,300 (205)	< 11.7	24.4 (11.1)
Effluent 8-28-82	22,000 (371)	24.0 (23.4)	83.4 (19.0)
<u>Seston</u>			
Upstream 8-31-82	23,600 (867)	329 (91.3)	< 89.0
Downstream 8-31-82	1,100 (581)	177 (141.)	< 121
Effluent 8-31-82	23,900 (1,120)	< 103	< 97.7

* Upstream Composite: U 42, U 43.

Downstream Composite: D 40, D 45.

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

*** Collected 8-28-82

f Sample Unavailable

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected September 24, 1982.**

Sampling locations	Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
<u>Fish</u>			
Upstream 9-24-82	6,770 (273)*	< 21.9	82.3 (19.0)
Downstream 9-24-82	7,910 (291)	< 31.7	93.6 (24.6)
Effluent 9-24-82	7,790 (288)	< 26.8	50.9 (19.3)
<u>Benthic Organisms</u>			
Upstream 9-24-82	8,880 (469)	< 30.2	136 (33.9)
Downstream 9-24-82	10,700 (543)	< 131	159 (97.3)
Effluent 9-24-82	8,840 (439)	< 76.8	185 (74.4)
<u>Vascular Plants ***</u>			
Upstream 9-12-82	615 (59.0)	< 12.5	44.1 (9.39)
Downstream 9-12-82	14,400 (233)	< 13.4	40.5 (12.2)
Effluent 9-12-82	21,700 (353)	< 40.5	55.3 (30.8)
<u>Seston</u>			
Upstream 9-24-82	28,500 (1,080)	< 47.7	< 54.9
Downstream 9-24-82	29,800 (1,230)	< 66.3	< 80.9
Effluent 9-24-82	11,300 (760)	< 55.0	55.0 (60.1)

* Upstream Composite: U 42, U 43.

Downstream Composite: D 40, D 45.

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

*** Sample collected 9-12-82.

Table II. E.1

Analysis of Composite* Aquatic Biota
For Samples collected Fourth Quarter, 82.**

Sampling locations	Gross Beta pCi/Kg	Strontium 89 pCi/Kg	Strontium 90 pCi/Kg
<u>Fish</u>			
Upstream 12-22-82	17,100 (695)**	< 34.7	75.3 (32.2)
Downstream 12-22-82	10,400 (404)	< 38.4	73.9 (29.3)
Effluent 12-22-82	7,790 (408)	< 30.8	78.9 (19.4)
<u>Benthic Organisms</u>			
Upstream	f	f	f
Downstream	f	f	f
Effluent 12-10-82	7,420 (562)	< 152	67.4 (99.7)
<u>Vascular Plants</u>			
Upstream 10-16-82	4,950 (139)	70.6 (34.0)	48.1 (19.7)
Downstream 10-16-82	7,770 (204)	126 (51.4)	88.5 (30.7)
Effluent 10-16-82	12,400 (237)	< 10.9	36.6 (10.6)
<u>Seston</u>			
Upstream 12-10-82	26,200 (1,040)	155 (139)	< 95.8
Downstream	f	f	f
Effluent 12-10-82	16,700 (829)	< 31.1	< 27.0

* Upstream Composite: U 42, U 43.

Downstream Composite: D 40, D 45.

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

f Sample unavailable.

Table II. E.2

Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected July, 1982 **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Fish</u>			
Upstream 7-7-82	< 250	< 78.2	< 33.4
Downstream 7-7-82	1,230 (112)	493 (29.9)	308 (12.5)
Effluent 7-7-82	< 250	< 78.2	< 33.4
<u>Benthic Organisms</u>			
Upstream	f	f	f
Downstream	f	f	f
Effluent 7-7-82	< 511	< 160	< 68.2
<u>Vascular Plants</u>			
Upstream 7-10-82	275 (77.2)	286 (19.8)	269 (11.6)
Downstream 7-10-82	< 12.4	94.3 (4.88)	70.4 (2.60)
Effluent 7-10-82	< 61.2	81.4 (18.2)	54.5 (10.8)
<u>Seston</u>			
Upstream	f	f	f
Downstream 7-7-82	e	e	e
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.).

e Insufficient weight or volume for analysis.

f Sample unavailable.

Table II. E.2

Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected August, 1982. **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Fish</u>			
Upstream 8-31-82	< 255	< 77.7	< 33.2
Downstream	f	f	f
Effluent 8-31-82	< 255	< 77.7	< 33.2
<u>Benthic Organisms</u>			
Upstream	f	f	f
Downstream 8-31-82	< 255	126. (62.4)*	33.6 (25.4)
Effluent 8-31-82	< 255	122. (62.5)	< 33.2
<u>Vascular Plants</u>			
Upstream 8-28-82	< 484	773. (115)	1,090. (128)
Downstream 8-28-82	< 477	< 146	< 62.5
Effluent 8-28-82	< 192	< 58.8	27.6 (36.5)
<u>Seston</u>			
Upstream 8-31-82	< 5,710	< 984	< 358
Downstream 8-31-82	< 4,320	< 745	< 271
Effluent 8-31-82	< 6,130	< 1,060	< 385

* 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.

Table II. E.2

Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected September, 1982. **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Fish</u>			
Upstream 9-24-82	< 253	< 77.2	< 33.0
Downstream 9-24-82	< 253	103 (60.8) **	< 33.0
Effluent 9-24-82	< 94.9	< 28.9	14.6 (13.4)
<u>Benthic Organisms</u>			
Upstream 9-24-82	< 144	75.8 (37.5)	75.1 (18.7)
Downstream 9-24-82	615 (191)	< 57.9	83.2 (23.8)
Effluent 9-24-82	< 79.8	104 (24.9)	60.3 (12.1)
<u>Vascular Plants</u>			
Upstream 9-12-82	< 589	< 179	< 76.7
Downstream 9-12-82	< 165	171 (51.1)	34.5 (28.4)
Effluent 9-12-82	< 202	209 (62.3)	42.5 (35.0)
<u>Seston</u> ***			
Upstream 9-24-82	< 7,320	2,250 (1,620)	602 (725)
Downstream 9-24-82	952 (235)	565 (559)	785 (61.0)
Effluent 9-24-82	< 21,000	< 3,620	< 1,310

* 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.).

*** Counted on Ge(li) .

Table II. E.2

Gamma-ray Emitting Radionuclide Concentrations in Aquatic Biota Samples
(pCi/kg) for Samples Collected Fourth Quarter, 1982. **

Sampling Locations *	^{106}Ru	^{137}Cs	^{95}Zr & Nb
<u>Fish</u>			
Upstream 12-22-82	< 259	103 (64.9)**	< 34.2
Downstream 12-22-82	352 (87.9)	72.6 (24.5)	16.9 (10.2)
Effluent 12-22-82	< 238	79.8 (58.9)	< 31.4
<u>Benthic Invertebrates</u>			
Upstream	f	f	f
Downstream	f	f	f
Effluent 12-10-82	< 999	< 309	146 (117)
<u>Vascular Plants</u>			
Upstream 10-16-82	< 640	396 (160)	132 (137)
Downstream 10-16-82	< 499	239 (124)	164 (72.8)
Effluent 10-16-82	< 315	305 (86.5)	< 41.2
<u>Seston ***</u>			
Upstream 12-10-82	< 26,300	< 4,560	< 1,650
Downstream	f	f	f
Effluent 12-10-82	< 23,700	< 4,110	< 1,490

* 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.).

*** Counted on Ge(li) detector.

f Sample unavailable.

II.F. Beef Cattle. Two head of beef 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 of humans. If thyroid I-131 contamination were significant this would be detected from the whole body count. Detectable I-131 activity has never been observed.

Table II.F.1 gives values for whole body counting of beef cattle for the second half of 1982. The animals are selected at random; however, the animal number is recorded and the animal may be retrieved and recounted if necessary. The Cs-137 body burdens are greater than during the first half of 1982, but similar to those observed during the last several years. Variation in Cs-137 concentration reflects a different cutting and/or source of hay and pasture for the animals.

The Cs-137 concentration is expressed as pCi per gram of K in the whole animal. This is done to more easily compare the counts between different size 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 because the K concentration of fat free muscle is very constant.

Table II.F.2 lists Cs-137, tritium and radiostrontium in muscle and bone samples from an animal slaughtered out of the facility herd. Note that this animal shows a Cs-137 concentration, normalized to potassium, of 1.45 pCi/gK. This is considerably lower than the fourth

quarter whole body counting values above. The difference is probably because the animal was on a different fattening ration just prior to slaughter. The tritium concentration in muscle water was low and the Sr-90 concentration in bone was easily detectable.

Table II.F.1. Radionuclides in Facility Area Beef Cattle

In-vivo Gamma-ray activity in Fort St. Vrain Area beef cattle.

		Quarter Values
9-18-82	^{131}I	^{137}Cs pCi/g K
Cow 1	None detected	5.45
Cow 2	None detected	5.49
11-27-82		Quarter Values
Cow 1	None detected	5.86
Cow 2	None detected	5.72

Table II.F.2.

Radionuclides in Beef Sample from Local Herd.
Animal Slaughtered, Fourth Quarter, 1982 *

Hamburger

^{137}Cs pCi/Kg	K g/kg	Tritium pCi/l
4.48 (0.956)*	3.10 (0.0199)	436 (265)*

Bone

^{89}Sr pCi/Kg	^{90}Sr pCi/Kg
< 118	913 (150)

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

II.G.1 Sample Cross Check Data.

To assure the precision and accuracy of the environmental data obtained from the radiation surveillance program provided for the Fort St. Vrain reactor, Colorado State University participates in the Environmental Protection Agency (EPA) sponsored laboratory intercomparison studies program. This involves the analysis of a variety of environmental media containing various levels of radioactivity. The media, type of analysis and frequency of analysis are summarized below.

The media, type of analysis and frequency of analysis

Medium	Analysis (radionuclide)	Frequency
Water	^3H	bimonthly
Water	gross α , gross β	bimonthly
Water	^{51}Cr , ^{60}Co , ^{65}Zn , ^{106}Ru , ^{134}Cs , ^{137}Cs	triannually
Water	^{89}Sr , ^{90}Sr	triannually
Water	^{131}I	triannually
Air particulate filters	^{90}Sr , ^{137}Cs , gross α , gross β	triannually
Milk	^{89}Sr , ^{90}Sr , ^{131}I , ^{137}Cs , ^{40}K	triannually

For each radionuclide analysis of a particular medium, three independent determinations are performed and the mean value is then calculated. The percentage deviation of our determined mean value from the EPA specified value is then calculated.

Table II.G.1 gives the EPA cross check data for the last half of 1982. The EPA has chosen to use the term Estimated Laboratory Precision (ELP), calculated as $3\sigma/N$, as the control parameter where N = the number of analyses. Whenever our mean value falls outside this limit, the sample calculations are rechecked and the sample reanalyzed if possible. Of the 26 cross check results reported for this period, only 4 fall outside the ELP. These values are footnoted in Table II.G.1. The recheck process and conclusion is given below for each of these individual samples.

1. September Air filter, Sr-90. This sample result was only marginally outside the ELP. The sample was recounted but no reason for the discrepancy was discovered.
2. October Water Sample, Cr-51. The sample result was outside the ELP even after several recounts. It was concluded that the primary calibration is in error and the ratio between measured and expected values was taken as a correction factor for future Cr-51 EPA sample analyses.
3. October Water Sample, Cs-134. The sample as noted in (2) was recounted several times and the result was outside the ELP. It was concluded that the error was in the spectrum stripping program. This is being corrected.
4. October Water Sample, Cs-137. As discussed in (3), it was concluded that the error was in the spectrum stripping program.

Table II.G.2 lists the results of a cross-check study between this program, the Colorado Department of Health and the Public Service Company counting laboratory at the reactor. Water samples are now collected monthly by personnel at the Colorado Department of Health and then split between the three groups. The results for the study for the second half of 1982 were acceptable.

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

Date	Radio nuclide	CSU Value	EPA Value	Standard Deviation	Estimated Laboratory Precision*	% deviation from known
<u>Water, Tritium pCi/l</u>						
8-13-82	³ H	2,423	2,890	360	619	- 16
10-8-82	³ H	2,810	2,560	350	607	+ 10
12-10-82	³ H	2,043	1,990	345	598	+ 2.7
<u>Water, Alpha & Beta pCi/l</u>						
7-16-82	gross α	15	16	5	8.7	- 6.3
	gross β	20	15	5	8.7	+ 33
9-16-82	gross α	18	29	7.5	13	- 38
	gross β	37	40	5	8.7	- 7.5
11-16-82	gross α	13	19	5	8.7	- 32
	gross β	23	24	5	8.7	- 4.2
<u>Water, Strontium 89 & 90, pCi/l</u>						
9-3-82	⁸⁹ Sr	20	25	5	8.7	- 20
	⁹⁰ Sr	14	15	1.5	2.6	- 6.7
<u>Air Filters, pCi/l</u>						
9-24-82	gross α	23	32	8	13.8	- 28
	gross β	60	67	5	8.7	- 10
	⁹⁰ Sr	(1) 17	20	1.5	2.6	- 15
	¹³⁷ Cs	22	27	5	8.7	- 19
<u>Gamma Milk, pCi/l</u>						
10-22-82	⁸⁹ Sr	3	-	-	-	-
	⁹⁰ Sr	19	19	1.5	2.6	0
	¹³¹ I	43	42	5.8	10	+ 2.4
	¹³⁷ Cs	27	34	5	8.7	- 21
	K	1,581	1,560	79	135	+ 1.3
<u>Water, Iodine-131, pCi/l</u>						
8-6-82	¹³¹ I	82	87	8.7	15	- 5.7
<u>Gamma Water, pCi/l</u>						
10-1-82	⁵¹ Cr	(2) 67	51	5	8.7	+ 31
	⁶⁰ Co	28	20	5	8.7	+ 25
	⁶⁵ Zn	17	24	5	8.7	- 29
	¹³⁴ Cs	(3) 58	19	5	8.7	+178
	¹³⁷ Cs	(4) 33	20	5	8.7	+ 65

* $3\sigma/\sqrt{n}$

Table II.G.2 Crosscheck Analyses on Split Water Samples Determined by Colorado State University, Colorado Department of Health and Public Service Company of Colorado.

Collection Date	Sample Location	Gross Beta pCi/L			Tritium pCi/L		
		CSU	CDH	PSC	CSU	CDH	PSC
7-9-82	E38	8	13	< 57	23,200	22,400	27,000
	E41	9	15	< 57	638	456	< 624
	U42	6	15	< 57	503	< 350	< 624
8-14-82	E38	10	21	< 61	2,320	2,950	2,270
	E41	14	21	< 61	< 297	1,350	< 623
	U42	7	15	< 61	< 297	477	< 623
9-27-82	E38	8	26	< 59	1,540	1,010	1,830
	E41	14	55	< 53	1,430	1,210	1,810
	U42	6	18	< 50	602	522	1,010
10-29-82	E38	11	17	99	89,200	95,700	76,400
	E41	7	18	< 54	23,500	21,700	23,900
	U42	9	27	< 54	213	< 350	< 604
11-26-82	E38	10	19	< 57	19,900	20,500	18,200
	E41	9	21	< 57	< 296	< 350	809
	U42	8	22	< 57	< 296	< 350	634
12-23-82	E38	8	16	< 53	6,360	7,480	6,600
	E41	7	14	< 53	4,400	6,020	4,940
	U42	7	15	< 53	614	450	< 625

II.H. Summary and Conclusions

Table II.H.1 presents the primary summary and analysis of data collected during the second half of 1982. The tabular data may be used for comparison to previous reactor operational periods and for comparison to other operating power reactors. 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 geometric standard deviations are 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 in all cases 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 better estimate of 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 nature of radioactive decay it is statistically possible to obtain sample count rates less than background and hence a negative result.

Tritium also produces the smallest dose commitment per unit activity intake of any of the radionuclides that might possibly be released by the reactor. During the current reporting period slightly less tritium was released than during the previous period and the downstream tritium concentrations were correspondingly lower. It must be noted, however, that the resulting "worst case" dose commitment calculation produced essentially negligible dose. The calculated dose commitment was 0.11 mrem compared to the limit of 3 mrem/year¹ and a background rate of approximately 200 mrem/year.

2. The fallout from the October 17, 1980, Chinese Nuclear Weapon test was essentially undetectable during this reporting period. Only the previous deposition as observed in soil samples was still noted but air concentrations and precipitation deposition values were at present levels. Nuclear weapon test fallout, however, has since the inception of the project been noted to be the predominant contribution to background. It is the variation in fallout deposition that requires so many environmental samples to detect any possible increase due to reactor effluents. A simple comparison of preoperational and post operational values is of little value for most sample types because the fallout deposition was considerably greater during the preoperational period.

¹NCR (10CFR50) Appendix I, LWR design criteria.

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 abscissa 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 50th percentile. In a normal distribution the arithmetic standard deviation is an additive parameter to the arithmetic mean; i.e., $(\bar{x} \pm \sigma)$, whereas in the log-normal distribution the geometric standard deviation σ_g is a multiplicative parameter to the geometric mean $(\bar{x}_g \pm \sigma_g)$. The area between \bar{x}_g divided by σ_g , and \bar{x}_g multiplied by σ_g should contain 68% of the frequency values. The log normal statistical treatment is tentative 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 either actual values or 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. Tritium was again the predominant radionuclide observed in the effluent pathways from the reactor. In fact it is the only radionuclide that can be attributed to reactor operation, that can be measured above background in any of the sample types. Since the tritium is released as tritiated water, the dilution by the surrounding hydrosphere is great.

3. A comparison of Table II.H.1 with the same table in previous reports implies that except for tritium as noted above, there is no evidence that effluents from reactor operation have produced any statistically significant off-site concentrations of radionuclides in any sample type.

4. 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 bimodal or even trimodal log-normal distributions. This is generally interpreted to mean that there is more than one significant activity source term. 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 due to outside sources, e.g., air and precipitation, tended to be bimodal or trimodally distributed, particularly when weapon fallout is present.

5. As in every previous report, it was again apparent that for most sample types 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.

6. It can also be concluded again that the radiation dose commitments calculated for nearby inhabitants or other parts of the nearby ecosystems from current reactor effluents is negligible compared to natural background radiation dose and the dose from atmospheric weapon testing fallout.

Table II.B.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	σ_g	\bar{x}	\bar{x}
					1 Year		1 Year	6 Months
TLD External (mR/day)	Facility	77	0.36	0.79	0.47	1.10	0.47	0.46
	Adjacent	70	0.36	0.52	0.46	1.11	0.46	0.44
	Reference	72	0.35	0.52	0.45	1.11	0.45	0.43
Air Gross α (fCi/m ³)	Facility	93	0.60	12.6	4.21	1.75	4.85	4.73
	Adjacent	68	0.60	14.8	4.77	1.75	5.43	4.91
Air Gross β (fCi/m ³)	Facility	92	5	46	19.4	1.48	20.8	21.1
	Adjacent	70	6	43	18.7	1.46	20.0	20.3
Air Tritium (pCi/l)	Facility	102	< 277	2,740	316	2.81	157	252
	Adjacent	73	< 277	827	259	1.78	< 277	43.4
Air ¹³¹ I (fCi/m ³)	Composite	26	< 5.14	38.0	7.42	2.37	0.577	< 5.14
Air ¹⁰⁶ Ru (fCi/m ³)	Composite	26	< 1.47	65.2	3.66	2.95	< 1.47	< 1.47

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	\bar{x} 1 Year	\bar{x} 6 Months
Air ^{137}Cs (fCi/m ³)	Composite	26	< 0.463	8.82	1.31	2.47	1.24	1.97
Air ^{95}Zr (fCi/m ³)	Composite	26	< 0.191	8.48	0.413	3.37	0.375	0.737
Water Gross β (pCi/l)	Effluent	28	3.48	19.4	10.6	1.37	11.1	11.4
	Downstream	18	5.08	17.3	9.80	1.28	10.1	10.2
	Upstream	12	4.14	15.6	9.70	1.36	10.1	10.6
	Potable	12	1.26	19.3	6.11	1.91	7.32	9.04
Water Tritium (pCi/l)	Effluent	28	< 287	353,000	1,030	6.37	14,000	20,200
	Downstream	18	< 282	5,700	471	3.06	1,070	631
	Upstream	12	< 287	447	281	1.54	15.0	101
	Potable	12	< 282	3,490	273	2.95	186	326
Water ^{90}Sr (pCi/l)	Effluent	28	< 0.654	1.55	0.490	2.90	0.0959	0.183
	Downstream	18	< 0.781	1.96	0.453	2.97	0.111	0.0982
	Upstream	12	< 0.735	< 1.35	0.444	2.81	0.138	0.102
	Potable	12	< 0.681	1.13	0.703	4.08	< 0.681	< 0.681

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	< 0.629	2.94	0.552	2.44	0.240	0.135
	Downstream	18	< 0.654	7.63	0.589	3.11	0.462	0.564
	Upstream	12	< 0.617	2.98	0.534	3.18	0.369	0.291
	Potable	12	< 0.605	1.79	0.609	2.29	0.458	0.405
Water ^{106}Ru (pCi/l)	Effluent	34	< 0.679	20.4	1.79	2.64	< 0.679	< 0.679
	Downstream	18	< 0.607	38.6	1.51	2.34	< 0.607	< 0.607
	Upstream	12	< 0.692	3.13	1.44	1.73	< 0.692	< 0.692
	Potable	12	< 0.690	3.19	0.955	3.28		
Water ^{137}Cs (pCi/l)	Effluent	34	< 0.214	7.16	0.981	3.21	1.32	2.37
	Downstream	18	< 0.192	5.20	0.908	2.77	0.115	1.58
	Upstream	12	< 0.675	3.44	0.676	3.61	0.356	1.35
	Potable	12	< 0.235	1.92	0.545	2.58	0.162	0.623
Water ^{95}Zr (pCi/l)	Effluent	34	< 0.121	5.79	0.462	3.59	0.674	1.16
	Downstream	18	< 0.081	5.14	0.382	3.07	0.0586	0.523
	Upstream	12	< 0.288	1.63	0.278	2.98	0.139	0.374
	Potable	12	< 0.116	0.971	0.284	2.46	< 0.116	< 0.116
Sediment Gross β (pCi/kg)	Effluent	12	23,900	33,300	32,100	1.12	32,200	30,400
	Downstream	18	26,000	44,700	32,900	1.14	33,200	32,800
	Upstream	12	23,400	41,300	34,700	1.14	35,000	33,600

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	\bar{x} 1 Year	\bar{x} 6 Months
Sediment ^{90}Sr (pCi/kg)	Effluent	12	< 142	68.9	105	2.56	53.9	30.6
	Downstream	18	< 143	38.3	103	3.11	< 143	< 143
	Upstream	12	< 155	248	130	2.70	< 155	< 155
Sediment ^{89}Sr (pCi/kg)	Effluent	12	< 122	308	88.6	3.07	30.3	33.6
	Downstream	18	< 125	216	129	2.56	79.8	26.5
	Upstream	12	< 130	393	162	2.14	63.5	51.4
Sediment ^{106}Ru (pCi/kg)	Effluent	12	< 2,190	3,610	2,990	1.52	< 2,190	< 2,190
	Downstream	18	< 2,290	3,850	2,640	2.66	< 2,290	< 2,290
	Upstream	12	< 2,770	4,150	2,820	2.24	< 2,770	< 2,770
Sediment ^{137}Cs (pCi/kg)	Effluent	12	< 378	< 986	284	3.64	< 378	< 378
	Downstream	18	< 341	2,890	315	3.84	141	44.5
	Upstream	12	< 479	2,290	459	2.15	172	282
Sediment ^{95}Zr (pCi/kg)	Effluent	12	< 137	< 358	154	2.09	< 137	< 137
	Downstream	18	< 143	1,310	151	2.67	26.4	< 143
	Upstream	12	< 174	749	153	2.66	16.5	29.8
Precipitation Gross β (pCi/m ²)	F-1	6	36.5	264	73.5	1.85	88.9	102
	F-4	6	28.2	258	71.4	2.13	93.0	113

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
Precipitation	F-1	6	< 284	377	159	3.22	< 284	< 284
Tritium (pCi/m ²)	F-4	6	< 284	485	325	1.23	< 284	< 284
Precipitation	F-1	6	< 10.4	27.5	12.7	1.96	< 10.4	< 10.4
¹⁰⁶ Ru (pCi/m ²)	F-4	6	< 20.3	97.0	17.4	2.75	< 20.3	< 20.3
Precipitation	F-1	6	< 9.70	61.9	13.5	3.85	20.4	26.8
¹³⁷ Cs (pCi/m ²)	F-4	6	25.1	117	17.1	3.80	29.3	48.5
Precipitation	F-1	6	< 1.20	20.8	3.19	3.02	< 1.20	2.94
⁹⁵ Zr (pCi/m ²)	F-4	6	< 5.37	22.9	5.45	3.19	4.46	9.02
Precipitation	F-1	6	< 9.96	< 54.6	9.59	3.43	1.08	7.37
⁹⁰ Sr (pCi/m ²)	F-4	6	< 7.94	< 48.4	6.17	3.41	2.08	5.12
Precipitation	F-1	6	< 11.4	26.9	8.77	3.21	2.68	< 11.4
⁸⁹ Sr (pCi/m ²)	F-4	6	< 6.10	40.8	5.10	4.60	6.10	< 6.10
Milk	Facility	16	< 284	652	235	1.90	< 287	< 287
Tritium	Adjacent	16	< 284	393	170	4.36	< 284	< 284
(pCi/l)	Reference	16	< 284	647	259	1.78	< 284	< 284

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	\bar{x} 1 Year	\bar{x} 6 Months
Milk ^{90}Sr (pCi/l)	Facility	16	< 1.02	2.59	1.54	1.90	1.48	1.06
	Adjacent	16	< 1.26	4.77	1.47	1.98	0.963	0.825
	Reference	16	< 1.17	2.55	1.63	1.63	0.796	0.664
Milk ^{89}Sr (pCi/l)	Facility	16	< 0.990	4.87	1.26	1.99	0.253	0.818
	Adjacent	16	< 1.02	9.31	1.15	3.51	0.905	1.65
	Reference	16	< 0.969	9.85	1.12	3.19	0.525	1.41
Milk ^{131}I (pCi/l)	Facility	16	< 0.117	6.69	0.279	4.35	< 0.117	< 0.117
	Adjacent	15	< 0.115	6.92	0.243	4.21	< 0.115	< 0.115
	Reference	16	< 0.117	9.35	0.262	4.29	< 0.117	< 0.117
Milk ^{137}Cs (pCi/l)	Facility	16	< 0.121	6.30	0.310	3.96	< 0.121	< 0.121
	Adjacent	15	< 0.117	6.70	0.285	4.29	< 0.117	< 0.117
	Reference	16	< 0.121	< 0.195	0.168	2.13	< 0.101	< 0.121
Milk Nat. K (g/l)	Facility	16	1.39	1.71	1.52	1.07	1.52	1.52
	Adjacent	15	1.28	1.54	1.44	1.06	1.44	1.42
	Reference	16	1.31	1.58	1.42	1.07	1.43	1.44
Forage Tritium (pCi/l)	Facility	3	285	753	395	1.57	32.3	269
	Adjacent	17	< 283	1,250	277	2.24	64.4	78.8
	Reference	15	< 283	791	267	2.33	108	143

Table II.II.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	\bar{x} 1 Year	\bar{x} 6 Months
Forage ^{89}Sr (pCi/kg)	Facility	6	< 5.11	84.6	16.1	2.43	< 5.11	< 5.11
	Adjacent	18	< 6.92	28.8	8.96	2.35	< 6.92	< 6.92
	Reference	18	< 5.15	125	12.8	2.22	< 5.15	< 5.05
Forage ^{90}Sr (pCi/kg)	Facility	6	26.6	241	86.6	2.04	107	120
	Adjacent	18	18.9	167	60.3	1.78	70.0	74.9
	Reference	18	34.4	182	81.4	1.41	86.0	88.9
Forage ^{106}Ru (pCi/kg)	Facility	6	< 9.76	185	64.2	3.72	8.90	9.76
	Adjacent	18	< 6.94	176	42.2	2.74	< 6.94	< 6.94
	Reference	18	< 17.4	324	56.1	1.83	< 17.4	< 17.4
Forage ^{137}Cs (pCi/kg)	Facility	6	< 2.99	296	61.2	3.84	98.7	99.1
	Adjacent	18	< 12.5	869	26.7	3.51	48.0	68.7
	Reference	18	< 7.35	132	28.9	2.95	40.7	48.7
Forage ^{95}Zr (pCi/kg)	Facility	6	10.8	104	31.7	2.74	43.0	62.1
	Adjacent	18	< 8.46	245	18.6	2.82	25.4	32.1
	Reference	18	< 3.14	78.7	16.6	3.46	24.6	24.2
Forage Gross β (pCi/kg)	Facility	6	9,990	26,700	14,500	1.61	15,900	16,900
	Adjacent	18	2,330	18,500	14,200	1.55	15,200	13,600
	Reference	18	9,620	28,800	16,700	1.49	17,800	17,900

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	\bar{x}	\bar{x}
					1 Year		1 Year	6 Months
Soil Gross β (pCi/kg)	Facility	6	27,000	31,300	30,000	1.04	30,000	30,100
	Adjacent	18	21,100	31,300	26,000	1.11	26,200	26,100
	Reference	18	17,700	28,800	23,900	1.16	24,100	23,700
Soil Gross β ($\mu\text{Ci}/\text{m}^2$)	Facility	6	3.49	4.04	3.86	1.04	3.87	3.89
	Adjacent	18	2.72	4.04	3.36	1.11	3.38	3.37
	Reference	18	2.28	3.72	3.08	1.16	3.11	3.06
Soil ^{106}Ru (nCi/ m^2)	Facility	6	< 203	< 441	210	2.25	< 203	< 203
	Adjacent	18	< 168	< 4530	220	4.01	< 168	< 168
	Reference	18	< 185	314	206	1.99	< 185	< 185
Soil ^{137}Cs (nCi/ m^2)	Facility	6	< 41.4	126	63.1	2.16	53.9	30.0
	Adjacent	18	< 38.2	172	45.9	2.72	3.92	< 38.2
	Reference	18	< 31.8	150	37.0	2.03	29.6	32.1
Soil ^{95}Zr (nCi/ m^2)	Facility	6	< 12.7	18.9	14.8	2.25	< 12.7	< 12.7
	Adjacent	18	< 13.9	81.2	16.0	3.76	< 13.9	< 13.9
	Reference	18	< 11.6	69.3	12.8	2.85	0.548	5.39
Soil Tritium (pCi/l)	Facility	4	< 283	602	328	1.31	< 283	< 283
	Adjacent	10	< 283	521	283	1.64	< 283	283
	Reference	11	< 283	598	283	1.62	< 283	3.66

Table II.II.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 ^{89}Sr (pCi/m ²)	Facility	6	< 8.61	74.9	12.1	1.92	4.41	10.0
	Adjacent	18	< 7.99	74.0	9.36	3.61	8.40	11.2
	Reference	18	< 8.16	45.2	9.22	2.24	3.97	8.42
Soil ^{90}Sr (pCi/m ²)	Facility	6	< 10.6	96.3	13.9	4.81	27.6	22.7
	Adjacent	18	< 11.1	21.4	8.27	2.55	5.36	5.63
	Reference	18	< 10.3	97.8	11.2	3.00	14.4	16.4
Aquatic Biota	Upstream	4	6,770	17,100	9,450	1.41	9,970	10,900
Fish	Downstream	3	7,590	10,400	8,060	1.16	8,310	8,630
Gross β (pCi/kg)	Effluent	4	7,480	8,850	7,920	1.26	8,090	7,980
Aquatic Biota	Upstream	1	NA	NA	8,880	NA	8,880	8,880
Benthic	Downstream	2	6,280	10,700	8,150	1.25	8,310	8,490
Gross β (pCi/kg)	Effluent	4	3,930	8,840	7,140	1.42	7,450	6,970
Aquatic Biota	Upstream	4	615	30,000	11,100	4.10	17,700	13,200
Vascular Plants	Downstream	4	7,770	24,500	14,400	1.44	15,300	15,000
Gross β (pCi/kg)	Effluent	4	12,400	33,800	18,800	1.46	20,000	22,500
Aquatic Biota	Upstream	3	23,600	28,500	27,600	1.12	27,800	26,100
Seston	Downstream	3	1,100	29,800	15,500	3.66	22,200	18,500
Gross β (pCi/kg)	Effluent	3	16,700	31,300	21,700	1.33	22,500	2,400

Table II.II.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	\bar{x} 1 Year	\bar{x} 6 Months
Aquatic Biota	Upstream	4	< 21.9	< 34.7	20.6	1.45	< 21.9	6.74
Fish	Downstream	3	< 26.6	< 38.4	10.3	3.92	< 26.6	< 25.6
⁸⁹ Sr	Effluent	4	< 14.6	< 38.7	24.4	1.62	< 14.6	< 14.6
(pCi/kg)								
Aquatic Biota	Upstream	1	N/A	N/A	30.2	N/A	< 30.2	< 30.2
Benthic	Downstream	2	< 85.9	< 131	69.5	1.75	< 85.9	< 85.9
⁸⁹ Sr	Effluent	4	< 38.4	< 152	67.9	1.67	< 38.4	< 38.4
(pCi/kg)								
Aquatic Biota	Upstream	4	< 12.5	70.6	15.3	2.42	20.4	27.0
Vascular Plants	Downstream	4	< 11.7	126	20.5	2.65	< 11.7	24.6
⁸⁹ Sr	Effluent	4	< 10.9	24.0	17.6	2.15	< 10.9	< 10.9
(pCi/kg)								
Aquatic Biota	Upstream	3	< 47.7	329	63.8	4.03	119	172
Seston	Downstream	3	< 66.3	307	69.5	5.06	126	162
⁸⁹ Sr	Effluent	3	< 31.1	< 103	19.3	3.45	29.9	29.9
(pCi/kg)								
Aquatic Biota	Upstream	4	< 28.6	82.3	37.8	1.97	45.0	57.4
Fish	Downstream	3	< 28.9	93.6	39.5	1.79	39.5	52.2
⁹⁰ Sr	Effluent	4	< 22.0	78.9	30.2	1.82	30.4	33.2
(pCi/kg)								
Aquatic Biota	Upstream	1	N/A	N/A	136	N/A	136	136
Benthic	Downstream	2	107	159	127	1.19	129	133
⁹⁰ Sr	Effluent	4	< 84.1	185	86.0	1.59	94.3	96.5
(pCi/kg)								
Aquatic Biota	Upstream	4	< 74.5	48.1	23.2	1.93	27.7	37.9
Vascular Plants	Downstream	4	24.4	88.5	45.0	1.52	48.6	52.7
⁹⁰ Sr	Effluent	4	36.6	83.4	54.2	1.81	63.0	63.2
(pCi/kg)								

Table II.II.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	c_g 1 Year	\bar{x} 1 Year	\bar{x} 6 Months
Aquatic Biota Seston ^{90}Sr (pCi/kg)	Upstream Downstream Effluent	3 3 3	< 54.9 < 80.9 < 27.0	< 95.8 < 226 55.0	30.7 115 21.9	8.45 2.12 3.32	< 54.9 < 80.9 31.6	< 54.9 < 80.9 31.6
Aquatic Biota Fish ^{106}Ru (pCi/kg)	Upstream Downstream Effluent	4 3 4	< 250 < 253 < 94.9	< 259 1,230 < 255	170 271 107	2.39 2.67 2.47	< 250 < 253 < 94.9	< 250 259 < 94.9
Aquatic Biota Benthic ^{106}Ru (pCi/kg)	Upstream Downstream Effluent	1 2 4	< 144 < 255 < 79.8	< 144 615 < 999	< 144 541 179	N/A 2.01 2.23	< 144 < 255 17.4	< 144 198 2.50
Aquatic Biota Vascular Plant ^{106}Ru (pCi/kg)	Upstream Downstream Effluent	4 4 4	< 589 < 12.4 < 61.2	275 < 499 < 315	456 201 242	1.80 3.73 2.12	< 589 < 12.4 < 61.2	< 589 < 12.4 < 61.2
Aquatic Biota Seston ^{106}Ru (pCi/kg)	Upstream Downstream Effluent	3 2 3	< 5,710 < 4,320 < 6,130	< 26,300 952 < 23,700	7,730 3,590 6,890	2.80 3.97 4.99	< 5,710 5,150 < 6,130	< 5,710 < 4,320 < 6,130
Aquatic Biota Fish ^{137}Cs (pCi/kg)	Upstream Downstream Effluent	4 3 4	< 77.2 72.6 < 28.9	103 493 79.8	56.8 64.6 61.4	2.91 3.90 2.63	43.3 117 69.8	23.6 223 8.48
Aquatic Biota Benthic ^{137}Cs (pCi/kg)	Upstream Downstream Effluent	1 2 4	75.8 < 57.9 < 160	75.8 126 122	75.8 100 205	N/A 3.61 2.47	75.8 < 57.9 263	75.8 75.6 82.9

Table II.II.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	< 179	773	155	5.25	236	358
Vascular Plant	Downstream	4	< 146	239	97.4	2.15	< 146	132
^{137}Cs	Effluent	4	< 58.8	305	119	1.91	47.5	109
(pCi/kg)								
Aquatic Biota	Upstream	3	< 984	2,250	2,090	1.74	573	< 984
Seston	Downstream	2	< 745	565	681	2.15	300	459
^{137}Cs	Effluent	3	< 1,060	< 4,110	735	6.81	< 1,060	< 1,060
(pCi/kg)								
Aquatic Biota	Upstream	4	< 33.0	< 34.2	33.0	1.09	< 33.0	< 33.0
Fish	Downstream	3	< 33.0	308	32.0	3.45	46.2	106
^{95}Zr	Effluent	4	< 31.4	14.6	12.0	3.95	< 31.4	< 31.4
(pCi/kg)								
Aquatic Biota	Upstream	1	75.1	75.1	75.1	N/A	75.1	75.1
Benthic	Downstream	2	33.6	83.2	72.4	2.03	< 136	58.4
^{95}Zr	Effluent	4	< 33.2	146	86.3	2.18	88.9	50.8
(pCi/kg)								
Aquatic Biota	Upstream	4	< 76.7	1,090	178	2.44	220	355
Vascular Plants	Downstream	4	< 62.5	164	55.7	1.86	< 62.5	23.5
^{95}Zr	Effluent	4	< 41.2	54.5	49.5	1.41	< 41.2	< 41.2
(pCi/kg)								
Aquatic Biota	Upstream	3	< 358	602	730	1.75	< 358	< 358
Seston	Downstream	2	< 271	785	209	2.30	243	526
^{95}Zr	Effluent	3	< 385	< 1,490	659	2.49	< 385	< 385
(pCi/kg)								
Beef	F-44	4	5.45	5.86	3.85	1.70	4.27	5.63
^{137}Cs								
pCi/g Nat K								

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 Specification.

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. Tables III.B.1, III.B.2, and III.B.3 give some detail of the sampling sites in the Facility, Adjacent and Reference zones respectively.

Sampling location A35 was relocated 1/4 mile east of the previous location, due to farm owner's request.

No other changes in sampling sites were necessary during the current reporting period.

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

Exposure Routes or Media & Sample Types (No. of Locations/zone) ¹	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 (F-13, A-12, R-12)	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 cartridge for iodine. (F-4, A-3)	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 ² (F-2)	Specific activity of tritium in atmospheric water vapor by passive absorption and liquid scintillation counting.		
	QUARTERLY	MONTHLY	WEEKLY
WATER Potable water (F-1, A-1)	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 (F-2)	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 (F-3, A-4)	Gross beta, tritium ² 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 (F-2, A-6, R-6)	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 (F-2, A-6, R-6)	Tritium, gamma spectrum and Sr 89 & 90 analyses on composite: Facility Area only, QUARTERLY.		Same as for Level 2, but WEEKLY during pasture season, otherwise, MONTHLY.
AQUATIC BIOTA (2 streams, above and below discharge points) (F-2, A-2)	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.		Same as for Level 2, plus Sr 89 & 90 analyses.
		MONTHLY during summer; otherwise QUARTERLY, as available.	

*Table 5 9-1, in *Technical Specifications*.

1. Legend:

F — Facility Zone

A — Adjacent Zone

R — Reference Zone

2. Tritium Analysis of Surface Water Only

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 ₂ O	AQB	Distance and Direction from Reactor; 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
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.
 H₂O = 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						Location Description (see Figs. II.B.1 and II.B.2)	
	TLD	AIR	M	S	H ₂ O	AQU	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;
A 27	*						5.0 mi. NW;	TLD on pole 30 ft. N of parlor.
A 28	*		*	*			6.0 mi. NW;	1 mi. S of Colo. 56, 1 mi. E of I-25, pole on NE corner.
A 29	*						3.5 mi. NNW;	Virgil Podtburg dairy; Colo. 60, 2 mi. W of Johnstown; TLD on last pole on NE corner.
A 30	*						3.5 mi. NE;	3 mi. S; 1.6 mi. E of Johnstown, TLD on pole by the stand of trees.
A 31	*		*	*			6.0 mi. ENE;	1 mi. S of Colo. 256 on Colo. 60, pole on NE corner.
A 32	*						4.0 mi. E;	1.5 mi. E of Peckham; TLD on pole in front of house.
A 33	*						5.0 mi. SE;	3 mi. N of Platteville; 1.2 mi. E of US 85; NW pole.
A 34	*						6.5 mi. SW;	Niles Miller Dairy; 0.2 mi. S, 0.5 mi. E of Platteville.
A 35	*	*					3.5 mi. SSW;	1 mi. E of I-25 at Colo. 254; pole on SW corner.
A 36	*		*	*			8.0 mi. W;	Ritchie Pyeatt; 9826 Hwy 66, 1/4 mi W of Jt Co. 66 & Rd 21
A 48			*	*			9.5 mi. NW;	Dave Gruber dairy; 2 mi. W of I-25 on Colo. 56, then 1.5 mi. S. TLD 0.5 mi. W.
A 50			*	*			5.0 mi. SE;	Bill Ray dairy 2 mi. E and 1 mi N of Peckham.
D 37					*		12.5 mi. ENE;	0.8 mi. E of Platteville.
D 39					*		5.0 mi. ENE;	Lower Lathan Res.; 2.5 mi. E of LaSalle.
D 40					*	*	5.5 mi. ENE;	Gilcrest water from U.S. Post Office
D 45					*	*	1.0 mi. N;	South Platte River at Colo. 60.
								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.

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

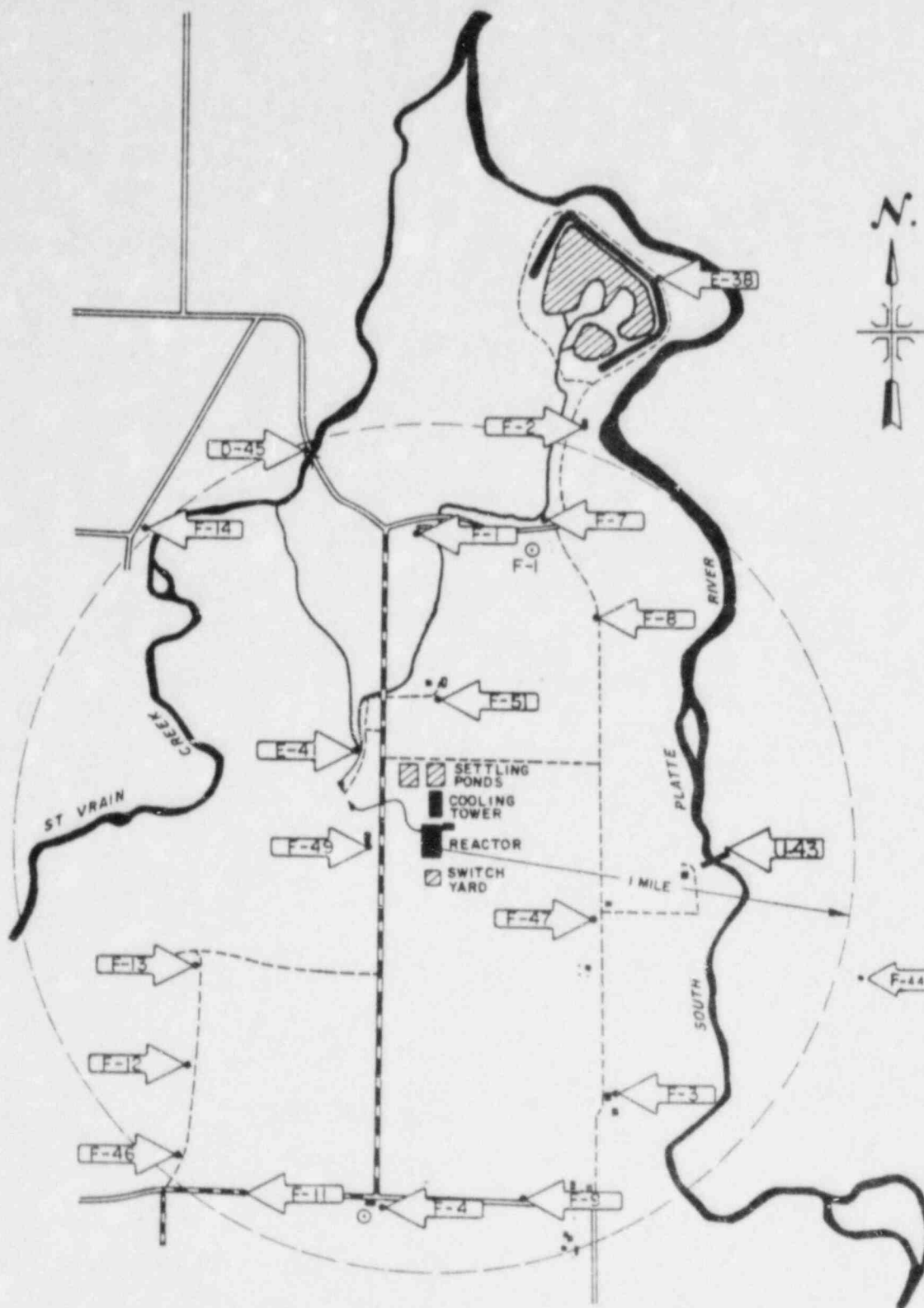
Loc. No.	Media Sampled at Location						Location Description (see Figs. II. B.1. and II. B.2.)	
	TLD	AIR	M	S	H ₂ O	AQB	Distance and Direction from Reactor; Comments.	
R 15	*						11.5 mi. NW;	4.2 mi. W of I-25 on Colo. 60; TLD on pole W of farm driveway.
R 16	*		*	*			11.8 mi. NNW;	Mountain View Farms; 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;	Dick Stroh dairy; 2 mi. E; 1.6 mi. S of LaSalle; TLD on pole W 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;	Hagane 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;	Dick Silver; 3.5 mi. W 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.

III.B. Sampling Location Maps.

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



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

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

