SWRHL-41r

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U. S. Department of Health, Education and Welfare
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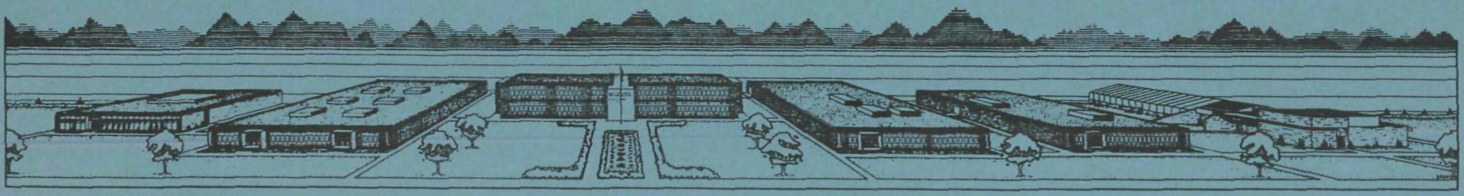

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ABSTRACT

A study was mounted at two dairy farms following the inadvertent release of radioactivity from the site of an underground nuclear test (Pin Stripe) conducted at the Nevada Test Site on April 25, 1966. The study produced some results which were similar to those found after the inadvertent release following the Pike event. At the two study farms the effective half-life of ^{131}I was found to be 4.9 and 4.0 days for field forage while the green chop collected from the cow mangers had effective half-lives of 6.9 and 6.7 days, respectively. In the same order, the effective half-lives of ^{131}I in milk from cows eating the green chop were 5.6 and 4.0 days. The milk-to-forage ratios (pCi/liter divided by pCi/kg) were 0.086 and 0.078, respectively. In one of the herds, uncontaminated hay was substituted for contaminated fresh forage after the third day. Over an eighteen day period this countermeasure reduced the potential thyroid dose of humans consuming one liter of the milk per day to only 29% of the dose which would have resulted had no countermeasure been applied.

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I. INTRODUCTION

Radioactivity inadvertently escaped from the underground Pin Stripe Event which took place at the Nevada Test Site (NTS) at 1138 hours on April 25, 1966. Material from this release reached an agricultural area in the Pahranagat Valley, approximately sixty miles northeast of the NTS. Located in this valley are several dairy farms.

This unexpected occurrence provided an opportunity to study the assimilation of radioiodine into cow's milk under local dairy farming practices and management. Within thirty hours a research team was placed in the area and a cooperative study was initiated between Bioenvironmental Research, Southwestern Radiological Health Laboratory, (SWRHL), U. S. Public Health Service (PHS), and two dairy farm owners.

Generally, dairy cows in the Pahranagat Valley are maintained in feeding pens and not allowed to graze. From about September to about June, baled hay is fed and from about June to about September, green chop* is fed. However, because of unseasonable cold weather in mid-April which had frosted the crops and retarded their growth, the farmers were green chopping their fields to facilitate new growth and were feeding these crops to the livestock.

Eight objectives were formulated for this study:

1. To determine the amounts of radioiodines in milk collected periodically from dairy cows eating fresh green chop contaminated

*This is the terminology used for the local practice of mowing and machine chopping forage from fields and feeding it to the animals before it dries or spoils.

with fresh fission products.

2. At one dairy farm, to determine the amounts of radioiodines in the milk of cows fed uncontaminated hay after being fed contaminated green chop for two days.

3. To determine variation of radioiodines with time in contaminated fresh green chop.

4. To measure, with a portable survey instrument, beta plus gamma and gamma activity at ground level, and gamma activity at three feet over fields of contaminated growing forage.

5. To measure the distribution of radioiodines over fields of contaminated growing forage.

6. To measure levels of radioiodines in hay, grain, and drinking water being consumed by dairy cows.

7. At one dairy farm to determine the probable dose reduction to milk consumers resulting from substituting uncontaminated hay for contaminated green forage.

8. Using methods employed in the early fifties, to compare gross beta activity of the residue from nitric acid digestion of the milk to the ^{131}I milk activity determined by gamma spectrometry.

On April 26, a base of operations was established at a local motel, a SWRHL mobile counting facility was placed in operation, and arrangements were made to conduct a study on a non-interference basis at two farms. The farms selected were the William U. Schofield Dairy Farm at Hiko, Nevada, and the Lorraine Lee Dairy Farm at Alamo, Nevada. The locations of these farms are shown in Figure 1. Additional dairies were not utilized to avoid overdilution of our capabilities for a thorough analysis. However, other dairies were periodically sampled by PHS personnel as a part of the Environmental Surveillance Program.(1)

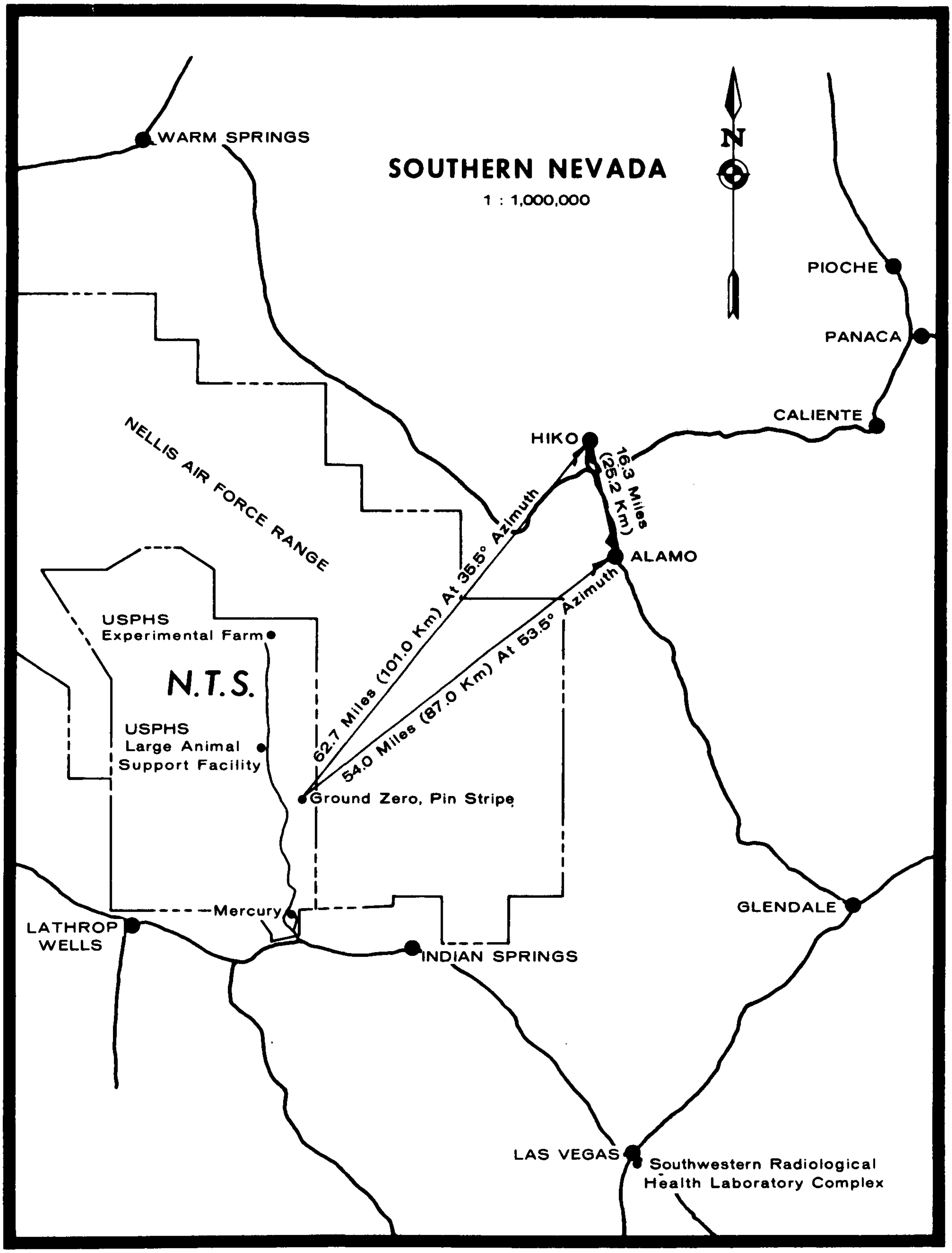

Figure 1. Locations of Study Farms.

Normal procedures at the dairy farms were not altered except at the Schofield Farm when the Atomic Energy Commission (AEC) made arrangements for the substitution of uncontaminated hay for contaminated green forage to minimize potential radiation doses to milk consumers.

II. FARMING OPERATIONS

Hiko

At the William Schofield Dairy Farm there were 138 lactating Holsteins when the study was initiated. All of these animals were being fed green chop *ad libitum* which was cut throughout the day.

On April 28 the feeding of green chop was discontinued and feeding of uncontaminated hay began as recommended by the AEC. To fulfill our first objective and to measure the effective dose reduction four of the initial study cows were relocated to a separate holding pen and continued on green chop. On May 14 these animals were returned to the herd. All cows were fed green chop thereafter and supplemental amounts of grain were fed during milkings.

A summary of the feeding schedule is presented below:

Table 1. Feeding schedule at William Schofield Dairy Farm

Date	Green Chop	Hay	Grain
Through April 27	138 cows	none	138 cows
April 28 through May 13	4 cows	134 cows	138 cows
May 14 to completion	138 cows	none	138 cows

Average daily feedings per cow were estimated to be: hay-25 lbs., or green chop-70 lbs., and grain-8 lbs.

The cows were milked twice daily by groups. Each of these two groups contained approximately fifty animals. The milking barn was equipped with an eight-stall herring bone milking parlor system, four stalls per side. Four cows were milked at a time and their milk piped through a central piping system to holding tanks.

Water was piped from wells to watering troughs in the feeding lots where the water level was maintained by float-operated valves. Bowl waterers were provided for the four separated study cows.

Alamo

Forty Holsteins and one Jersey were being milked at the Lorraine Lee Dairy Farm. They were usually fed green chop which had been aged overnight, but there were some days during which Mr. Lee did not cut any green chop. Consequently, there were times when hay and chop or only hay was fed. The feeding schedule is documented in Table 2. Supplemental amounts of grain were fed during each milking.

The owner's estimate of usual amounts fed to each cow daily were: green chop - 40 lbs., and/or hay - 35 lbs., and grain - 7 lbs.

The dairy barn was equipped with a herring bone milking parlor system with six stalls and three milking units. Since the number of cows at this farm was smaller, no individual grouping was necessary.

Water was available at a watering trough connected to the city water supply. Also, there was an irrigation ditch to which the cows had access.

The available milk production records for the selected study cows at Alamo and Hiko are compiled in Table 3.

Table 2. Feeding schedule at Lorraine Lee Dairy Farm

	a.m.		p.m.	
Date	Hay	Chop	Hay	Chop
D+1		X	X	X
D+2	X		X	X
D+3	X			X
D+4		X	X	X
D+5	X			X
D+6	X	X	X	X
D+7	X	X	X	X
D+8	X	X	X	X
D+9	X	X	X	
D+10		X		X
D+11		X	X	
D+12	X	X		X
D+13		X	X	X
D+14	X		X	
D+15	X		X	
D+16		X	X	
D+17		X	X	
D+18		X		
D+19	End of Study			

Table 3. Data on Pin Stripe Study Cows.

Cow Number	Estimated Age	Calving Date	Average % Butterfat	Estimated 305 Day Production	Estimated Days in Production	Days in Gestation	Production to 5/7/66
				Hiko			
57	2.5 yr.	12/65	4.3	5771 liters	135	Not Bred	2802 liters
97	3.5 yr.	1/66	3.0	6815 liters	127	"	3282 liters
116	4.5 yr.	8/65	3.4	6212 liters	277	"	5604 liters
141	2.5 yr.	12/65	4.3	3784 liters	155	105	2128 liters

Herd Averages: 3.49% butterfat for previous 12 mos., 5204 liters/cow for 305 days.
Herd average per tests on 7 May: 3.35% butterfat, 473 liters/cow for the previous month.
Data from Virgin Valley Dairy Herd Improvement Assn. (DHIA)

Cow Number	Estimated Age	Calving Date	Average % Butterfat	Estimated 305 Day Production	Estimated Days in Production	Days in Gestation	Production to 5/7/66
				Alamo			
1	7.0 yr.	2/66		4780 liters	100		1828 liters
23	7.5 yr.	2/66		3767 liters	100		1454 liters
53	6.0 yr.	11/65		3700 liters	187		2599 liters
72	6.5 yr.	12/65		5154 liters	143		2467 liters
73	5.0 yr.	1/66		3084 liters	127		1542 liters
75	7.0 yr.	1/66		6189 liters	127		3084 liters

Herd Average butterfat was estimated to be 3.1 to 3.4%.
No DHIA records available at this farm.

III. SAMPLE COLLECTION

A. Milk - Hiko

On April 26 the first samples were collected at Hiko. Two one-gallon plastic cubitainers were filled with milk from cows in the second group numbered 11, 57, 62, 68, 87, 97, 116 and 141. Collection was from the pipeline during milking.

On April 28 four cows were randomly selected from the above group (# 57, 97, 116, 141) and were moved to a separate holding pen and continued on green chop while the rest of the herd was fed only uncontaminated hay. A composite sample of two gallons of milk was collected from eight of the hay cows and another two-gallon composite was collected from the four green chop cows. The milk lines were purged with air before and after each collection. The remainder of the milk from the four green chop cows was withheld from human consumption.

On May 13 the radioiodine content in the milk from the four cows eating green chop had decreased enough to allow general feeding of green chop; subsequently, the four cows were returned to the feeding lot and all of the cows were fed green chop. From this point forward, two gallons of milk were collected once each week. The last samples were taken on June 8.

The two gallons of milk were composited in a large 2½-gallon cubitainer, thoroughly mixed, and two separate samples of one gallon each were drawn off. One gallon of milk was preserved with 10 ml of formalin. The preserved milk was gamma scanned and the unpreserved milk was analyzed by a nitric acid procedure.

B. Milk - Alamo

At Alamo, two gallons of milk were collected during each milking, as a composite, from cows numbered 1, 23, 53, 72, 73, and 75. These samples were treated in the same manner as the Hiko samples.

C. Fresh Vegetation

To determine the amounts of fallout and the uniformity of deposition, a grid was superimposed over the alfalfa fields at each farm involved in this study. The lines of the grid were 30 meters apart and were designated as shown in Figure 2 for Alamo. Sample plots were located at the intersection of the grid lines. At the Schofield Dairy, an incomplete grid was used because of the shape of the field (see Figure 3).

Samples were taken by clipping the vegetation 2" above ground level. The samples included all plant material growing within a 0.16 m^2 area.

A daily sample was collected in one specific area of each field to ascertain the disappearance half-life of radioiodines deposited on the crops.

Random samples of green chop were taken daily from the feed bunks to analyze for radioiodine content.

D. Hay

Approximately 100 to 350 gram hay samples were collected in plastic bags daily at each farm. These were random samples taken directly from the feed bunks.

E. Water

At Hiko, water was taken daily from two places during each milking. One gallon was taken from the waterers provided for the green chop cows and another gallon collected from the water tank in the main holding pen.

A one-gallon composite sample was taken daily from an irrigation ditch and a tank at Alamo. The reason for this composite was that the cows had equal access to both sources.

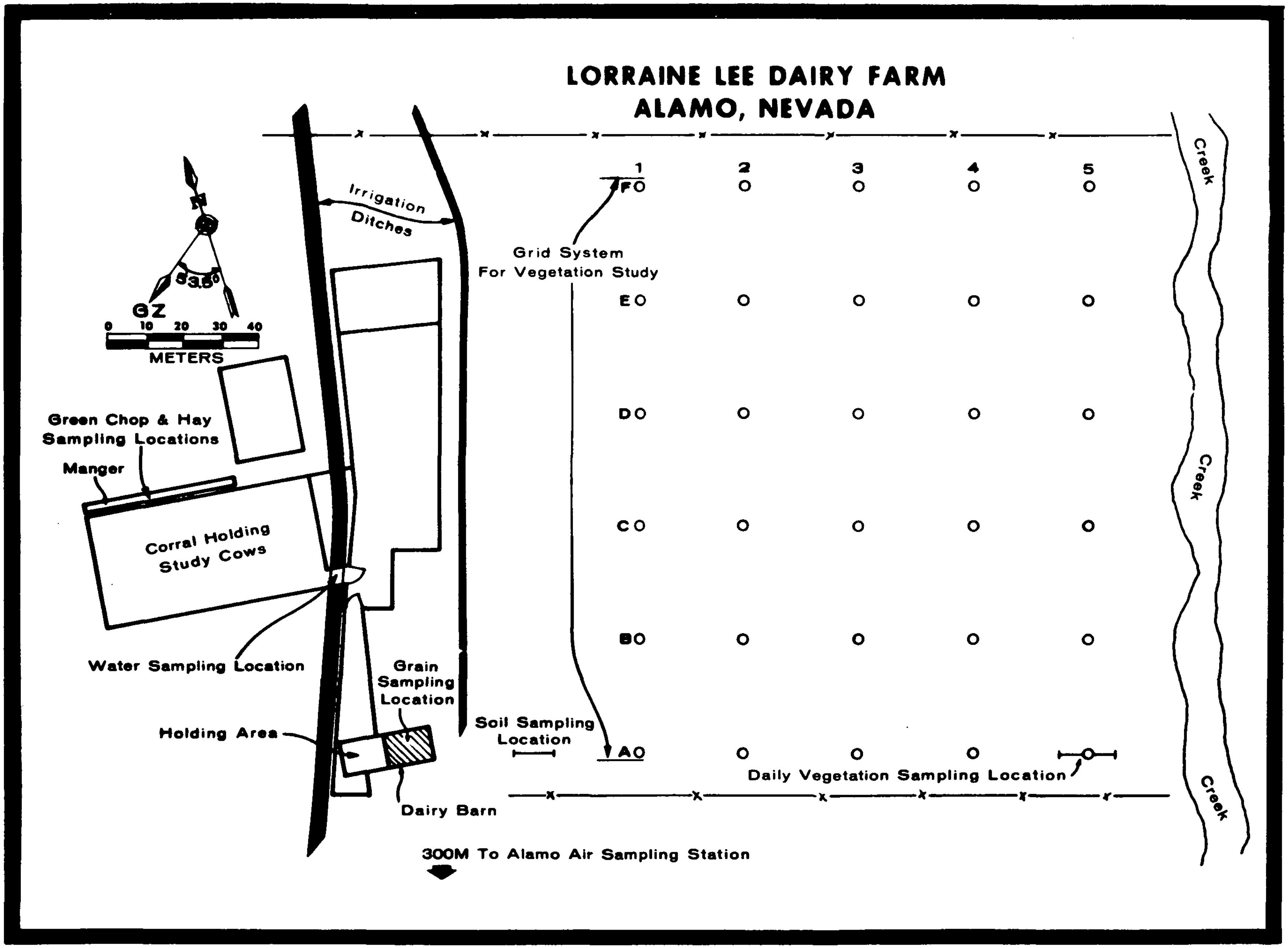

Figure 2. Sketch showing sampling locations at Alamo.

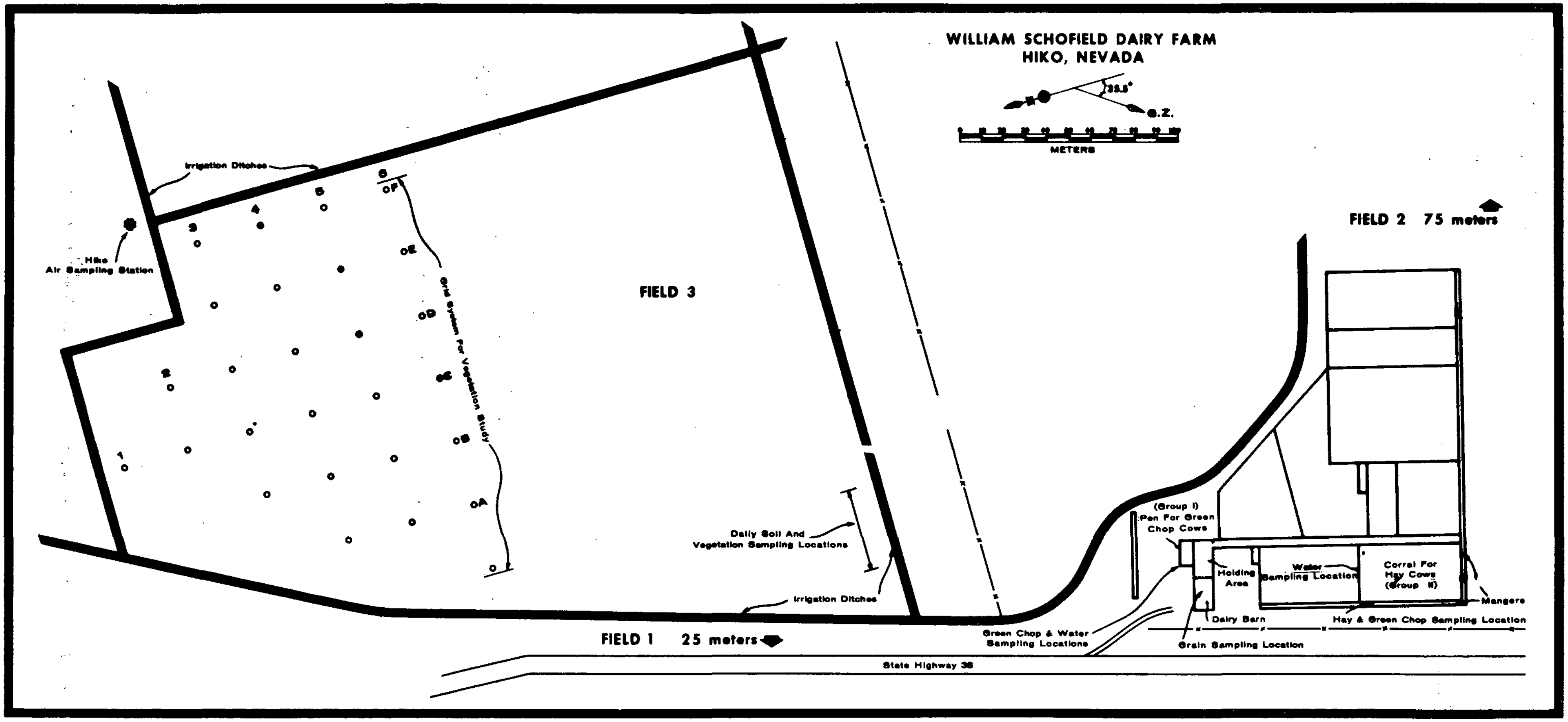

Figure 3. Sketch showing sampling locations at Hiko

F. Grain

At both farms 200 to 250 grams of grain were taken either daily or twice daily. These samples were collected directly from the feeders in the milking barn.

G. Soil

A 500 to 600 gram sample was taken daily from an undisturbed area at each farm from the same general location in the field. For each sample a soil surface area of 0.0350 m^2 was utilized.

H. Eggs

Adjacent to the Schofield Dairy Farm is the Merle Schofield Farm. At this farm, chickens were seen foraging in the fields. On May 1, May 2, May 5 and May 25, eggs were purchased for radioanalysis.

I. Blood Count

On April 28 and May 11, 30 cc of blood was drawn from the jugular vein of each of the selected study cows at both farms for laboratory analysis. A complete blood count was done on each sample and, in addition, each was analyzed for serum protein concentration and protein bound iodine (PBI).

J. Air

Air samplers were in operation at the Merle Schofield Farm at Hiko and at the M. K. Stewart Dairy Farm in Alamo. The Environmental Surveillance, Off-site Section, has established permanent stations at these places as part of its air surveillance network.

K. External Exposure-rate

Exposure-rate readings were taken daily at each farm with an Eberline Model E-500B portable survey instrument until background levels were reached. Exposure-rate from gamma radiation was measured at three feet and ground level. Beta plus gamma was measured at ground level. The readings were taken in the fields.

IV. ANALYTICAL PROCEDURES

A. System Description

Both of the following systems were installed in a special truck designed for mobility.

1. Gamma spectrometry was done with a system consisting of a TMC Model 404C, 400 channel Pulse Height Analyzer, a Model 520P Punch control with high voltage supply, a Model 522 Resolver-Integrator, IBM Model 11C Typewriter, a Tally Model 420 Perforator and a Model 424 Reader. The detector consisted of two 4" x 9" NaI(TI) crystals mounted facing each other with vertical spacing variable from direct contact to 14" separation. Both crystals have one power supply and each crystal is viewed by four 3" photomultiplier tubes. The crystal assembly was mounted in a specially fabricated 12-ton steel shield with 6" walls. The inside dimensions of the shield are 39 x 42 x 42 inches, and the inside is lined with Pb, Cd and Cu sheeting.

2. The beta system consisted of a Beckman Model 1610 Wide-Beta, automatic sample changer with time-of-day and manual slide options. Readout was by means of IBM Model 26 printing card punch. Argon-10%/methan 90% was used as the counting gas.

B. Geometry and Calibration

The efficiencies and geometries used in the counting system are shown in Table 4.

Table 4. Data on counting systems

Sample Type	Geometry	^{131}I Efficiency*	Minimum Detectable Levels
Gamma Counting			
Milk and Water	4-liter plastic cubitainer	18.6%	10 ± 5 pCi/l
Grain	400 ml cottage cheese container	36.2%	80 ± 10 pCi/kg
Hay, field forage and green chop (compressed)	400 ml telescoping plastic container	36.2%	100 ± 15 pCi/kg
Soil	400 ml cottage cheese container	23.8%	300 ± 50 pCi/kg
Beta Counting			
Nitric Acid-Milk Residue	4½" Planchet	37.8%	4 ± 1 pCi/l

*The resolution of the gamma system was 9%; this was based on the ^{137}Cs photopeak and 10 keV per channel.

C. Sample Preparation

1. Milk and Water

Efforts were made to keep the volume of milk and water constant at 4 liters by removing excess milk or water from the cubitainer or adding distilled water to the cubitainer, whichever was required. The 4-liter plastic cubitainer was washed, weighed, placed into a large plastic bag, and sealed with tape prior to gamma scanning.

2. Hay, Field Forage and Green Chop

Each of the vegetation samples was contained in a sealed heavy 9" x 14" plastic bag. Each sample, bagged three-fourths full and semi-tightly packed, was weighed and compressed in a telescoping plastic container, 4" diameter and 2" in height by using a 12 ton "Carver" Laboratory Press. The plastic container was then sealed and placed in a plastic bag, sealed with masking tape and gamma scanned.

3. Grain and Soil

Each of the grain and soil samples was placed in a 400 ml cottage cheese container with a lid and sealed. Each container was weighed, placed in a plastic bag, sealed with masking tape, and counted.

4. Nitric Acid Residue

The residue from the nitric acid procedure was placed on a 4½" planchet. These samples were weighed for gravimetric yield and counted in the Beckman Wide-Beta for gross beta activity. The planchets were later placed in large petri dishes (15 x 2.5 cm), sealed, bagged and gamma scanned.

D. Sample Analysis

All samples were taken to a central location, the sample control trailer located at Alamo, Nevada, logged and numbered in chronological order. All samples were gamma scanned by two 4" x 9" opposed NaI crystals. The samples were counted until either a minimum of 3,000 counts was collected in the 0.36 MeV channel or for a maximum time of 40 minutes. For beta activity, the samples were counted for 10,000 counts or 10 minutes.

E. Computations

The gamma scans on all samples analyzed were punched on Tally tape and the tapes were processed by a matrix method on an IBM 1620 computer for quantitation of various radioisotopes.

All physical and effective half-lives were calculated by use of a least squares best fit line.

V. RESULTS

A. Grain

The results of the gamma scans on grain samples collected from the L. Lee and W. Schofield Dairy Farms are shown in Table I of the Appendix. The peak ^{131}I activities in the grain at the two dairies were 760 and 690 pCi/kg respectively. Indications were that the other iodine isotopes (^{132}I, ^{133}I, and ^{135}I) were not present in concentrations which might contribute significantly to the total intake of contamination by the cows.

B. Water

The radioiodine concentrations calculated from the gamma scans of water samples are shown in Tables II and III of the Appendix. The results indicated that radioiodine contamination was present. The peak ^{131}I values found were 150 pCi/liter at the Lee Dairy farm and 430 pCi/liter at the Schofield Dairy Farm. The other radioiodine isotopes were not contributing significant activity to the total intake.

The level of activity in water from the L. Lee Dairy Farm was lower by a factor of 2 to 3 than that reported for the W. Schofield Dairy Farm. It is apparent that either the fallout material was being resuspended in the Hiko area or there was cross-contamination of activity in water throughout the study.

C. Hay

The results of the gamma scans on the dry hay samples collected from both dairies are reported in Table IV and V of the Appendix. The peak ^{131}I value was 2.8×10^3 pCi/kg for hay samples from the Lee Farm. There was a peak ^{131}I activity of 2.2×10^4pCi/kg in the Schofield hay. It should be noted that the other radioiodines (^{132}I, ^{133}I and ^{135}I) were also lower in hay from the Lee Farm compared to hay from the Schofield Farm. Hay was not being fed to the cows on April 26 through April 28 a.m. at the Schofield Dairy but was on the premises during cloud passage. Uncontaminated hay from Enterprise, Utah, was acquired to reduce the radioiodine intake of the cows. Several samples were taken from the hay bales at the time of delivery to Hiko. The gamma scans on these samples indicated that radioactivity was not present. However, radioiodines were detected in Hiko hay samples collected from April 29 through May 13. It should be noted that the hay samples were collected during the study from random locations in the feed manger. The activity present in the "uncontaminated" hay was probably due to resuspension or cross-contamination because of radioactivity present in the feed manger. In any case, the hay fed to the Schofield cows was not contaminated to any high degree as is shown by the milk results.

D. Green Chop

The results of the cut green chop samples collected from the Lee and Schofield Farms are shown in Table VI and VII of the Appendix. The peak ^{131}I activity in green chop samples collected from the Lee Farm was 1.8×10^4 pCi/kg; whereas, green chop samples from the Schofield Farm had a peak value of 5.6×10^4 pCi/kg.

The ^{131}I results from Tables VI and VII are plotted in Figures 4 and 5. The effective half-life of ^{131}I in the green chop samples from the Lee Farm was 6.69 ± 0.62* days whereas, it was 6.91 ± 1.22* at the Schofield Farm. The fluctuating values were probably due to the resuspension or cross-contamination of activity in the feed mangers where samples were taken.

*Value ± standard deviation

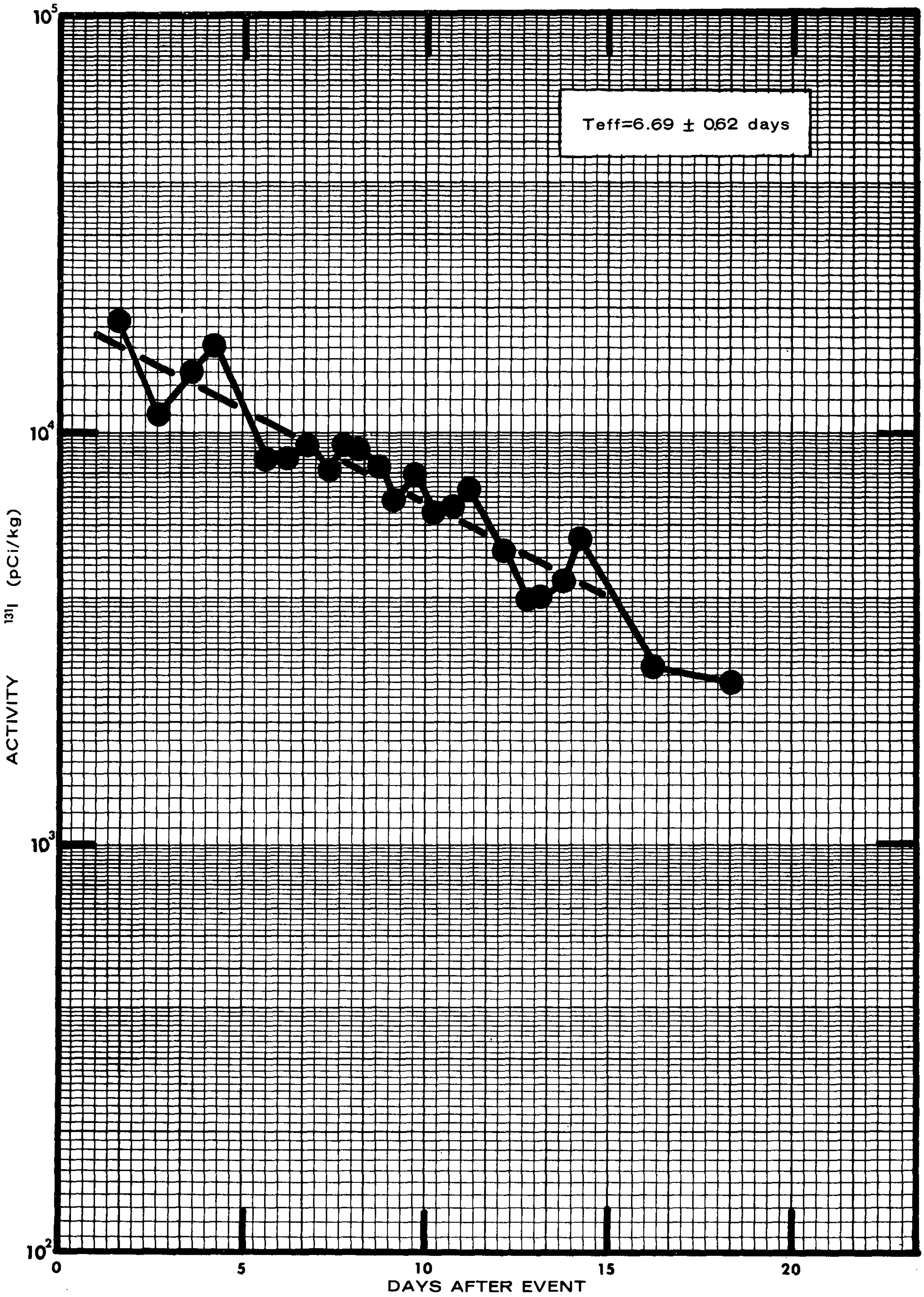

Figure 4. ^{131}I in green chop samples collected from the Lee Dairy.

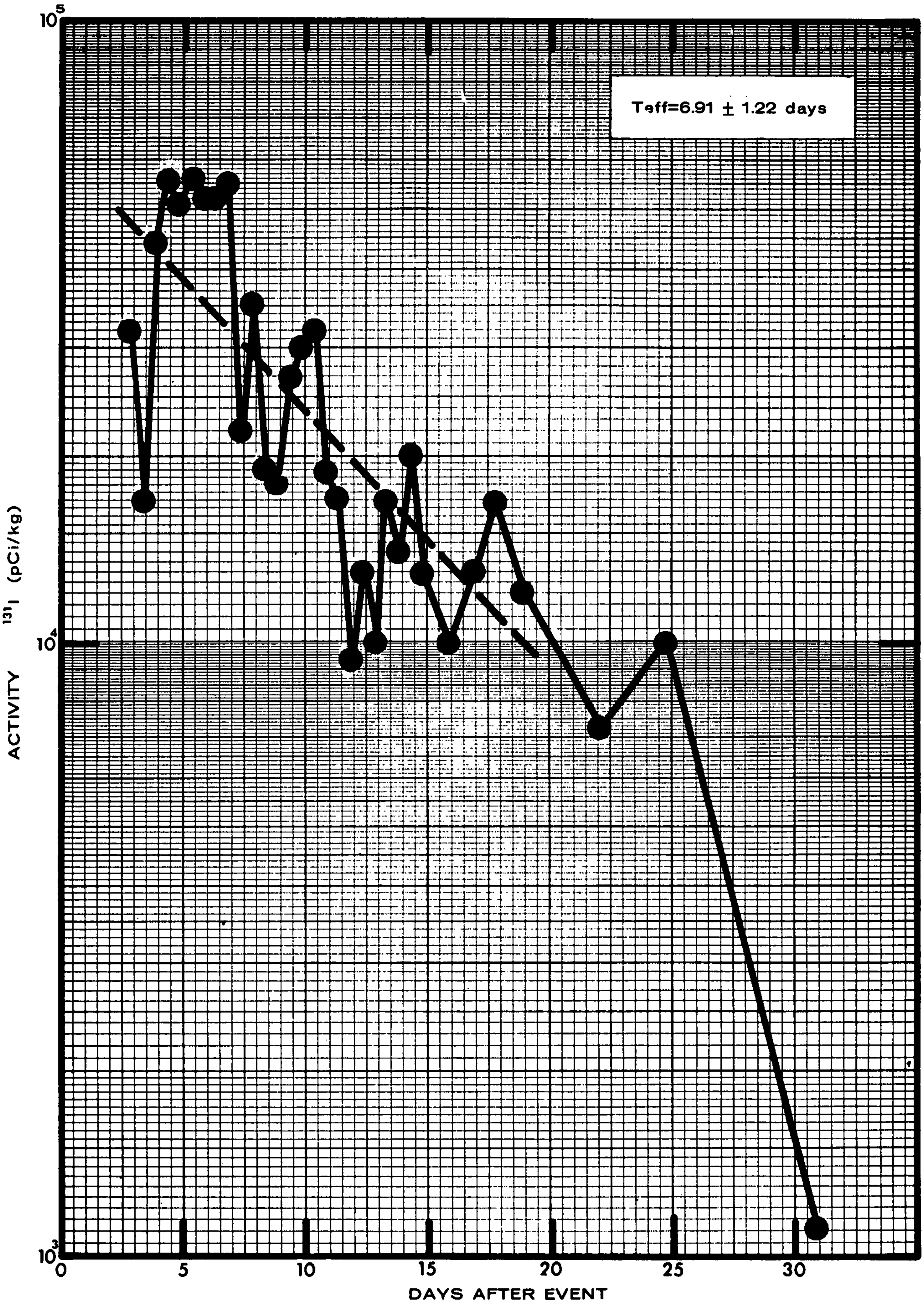

Figure 5. ^{131}I in green chop samples collected from the W. Schofield Dairy.

As shown in Figure 5, the green chop samples collected from the Schofield Farm suggested that a peak activity was reached about April 30, which is an unexpected result. The Lee Farm green chop samples peaked at the first sampling date, April 26, as expected. The other radioiodines (^{132}I, ^{133}I and ^{135}I) were present in the green chop samples collected, with the Lee Farm samples containing about half the activity of those from the Schofield Farm. The peak values in the green chop sample from the Lee Farm were 7.1×10^5 pCi/kg of ^{132}I and 3.3×10^5 pCi/kg of ^{133}I. That green chop had been cut on D-day. The ^{132}I and ^{133}I peak values for the Schofield Farm were 4.9×10^5 pCi/kg and 4.4×10^5 pCi/kg respectively.

The ^{132}I and ^{133}I values from Tables VI and VII are plotted in Figures 6 and 7. The effective half-lives of the two radioiodines from the Lee Farm were 1.61 ± 0.18* and 0.92 ± 0.16* days for ^{132}I and ^{133}I respectively. The effective half-lives for ^{132}I and ^{133}I for the Schofield Farm were 2.02 ± 0.13* and 1.36 ± 0.11 respectively.

E. Field Forage

Field forage samples were taken from fields located on the Lee and Schofield Dairy Farms and the radioiodine values found are shown in Tables VIII and IX of the Appendix. The peak ^{131}I activity found in the field forage samples from the Lee Dairy was 1.3×10^4 pCi/kg. The Schofield Dairy Farm field forage samples contained peak ^{131}I values of 4.6×10^4 pCi/kg. At the Schofield Farm three different fields, labeled 1, 2 and 3 were sampled. In general, the radioiodine values were similar among the three fields. The ^{131}I values in the field forage samples from Field "3" (Table IX) are shown in Figure 8. The effective half-life was 4.92 ± 0.84* days. Rain which fell on May 10 and May 11 apparently

*Value ± standard deviation

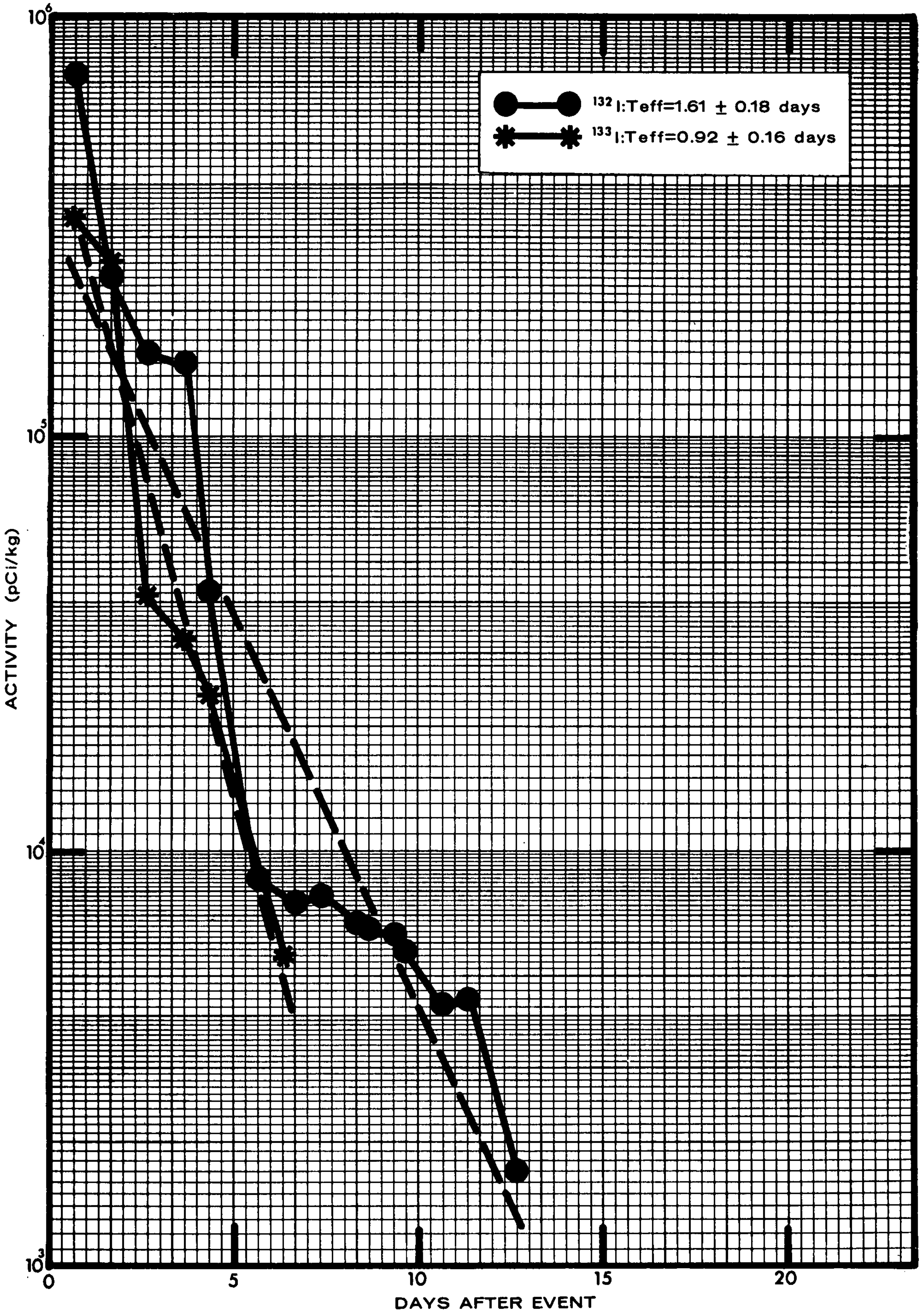

Figure 6. ^{132}I and ^{133}I in green chop samples collected from the L. Lee Dairy.

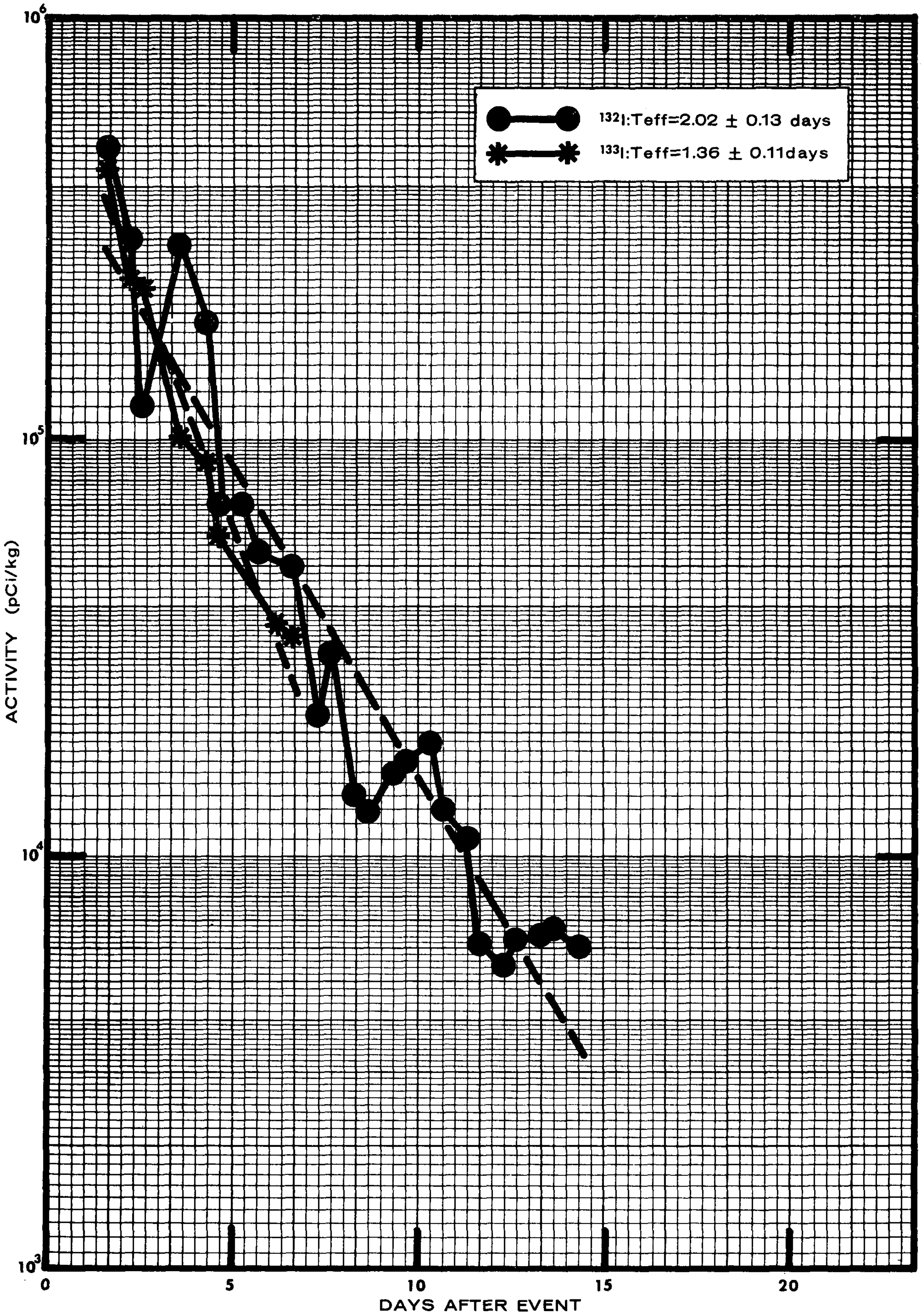

Figure 7. ^{132}I and ^{133}I in green chop samples collected from the Schofield Dairy.

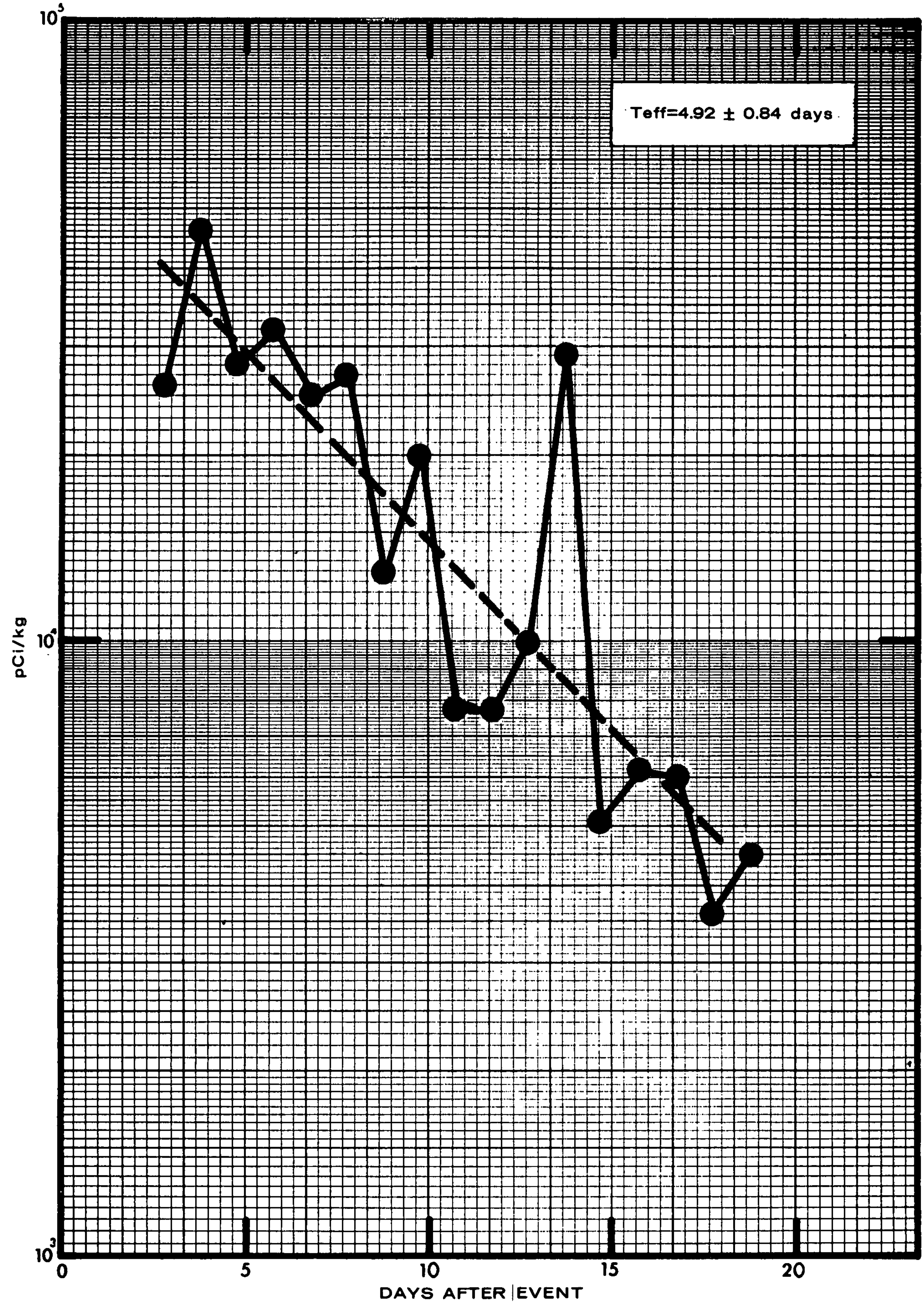

Figure 8. ^{131}I in field forage samples from Schofield Dairy

did not affect the ^{131}I activity. The ^{131}I values were not significantly different among the three fields of the Schofield Farm.

The ^{131}I values in the field forage samples from Field "1" of the Lee Farm are plotted in Figure 9. The effective half-life was 4.02 ± 0.50* days. A total of 0.18 inches of rain fell on May 9 p.m. and May 10 a.m. This rain appeared to have little effect on the field forage ^{131}I activity. It should be noted that the ^{131}I values from the two different fields sampled were not significantly different.

The other iodines, ^{132}I and ^{133}I, were not detected in a sufficient number of forage samples from the Lee Farm for further treatment. The other iodines detected in the Schofield forage samples are displayed in Table IX and graphed in Figure 10.

The peak value of both ^{132}I and ^{133}I, was 3.4×10^5 pCi/kg. The effective half-life for ^{132}I was 1.76 ± 0.31* days; whereas, the half-life for ^{133}I was 1.10 ± 0.12* days.

F. Deposition Study

The characterization of the vegetation on the alfalfa fields at the two dairy farms was determined by the line intercept method. The line was a randomly located transect of the field of interest. It was 100 feet long with sample points at each inch. These data are shown in Table 5.

The activity in the 28 pasture samples taken from the sampling grid at Alamo on April 26 is shown in Table 6. Table 7 shows similar data for samples from Hiko collected on April 27.

G. Milk

The ^{131}I activity in milk from the Lee Dairy Farm is shown in Table X of the Appendix. The peak value of 1.4×10^3 pCi/l ^{131}I in milk was observed on April 28 p.m. These values are plotted in Figure 11. The effective half-life was 3.97 ± 0.31* days.

*Value ± standard deviation

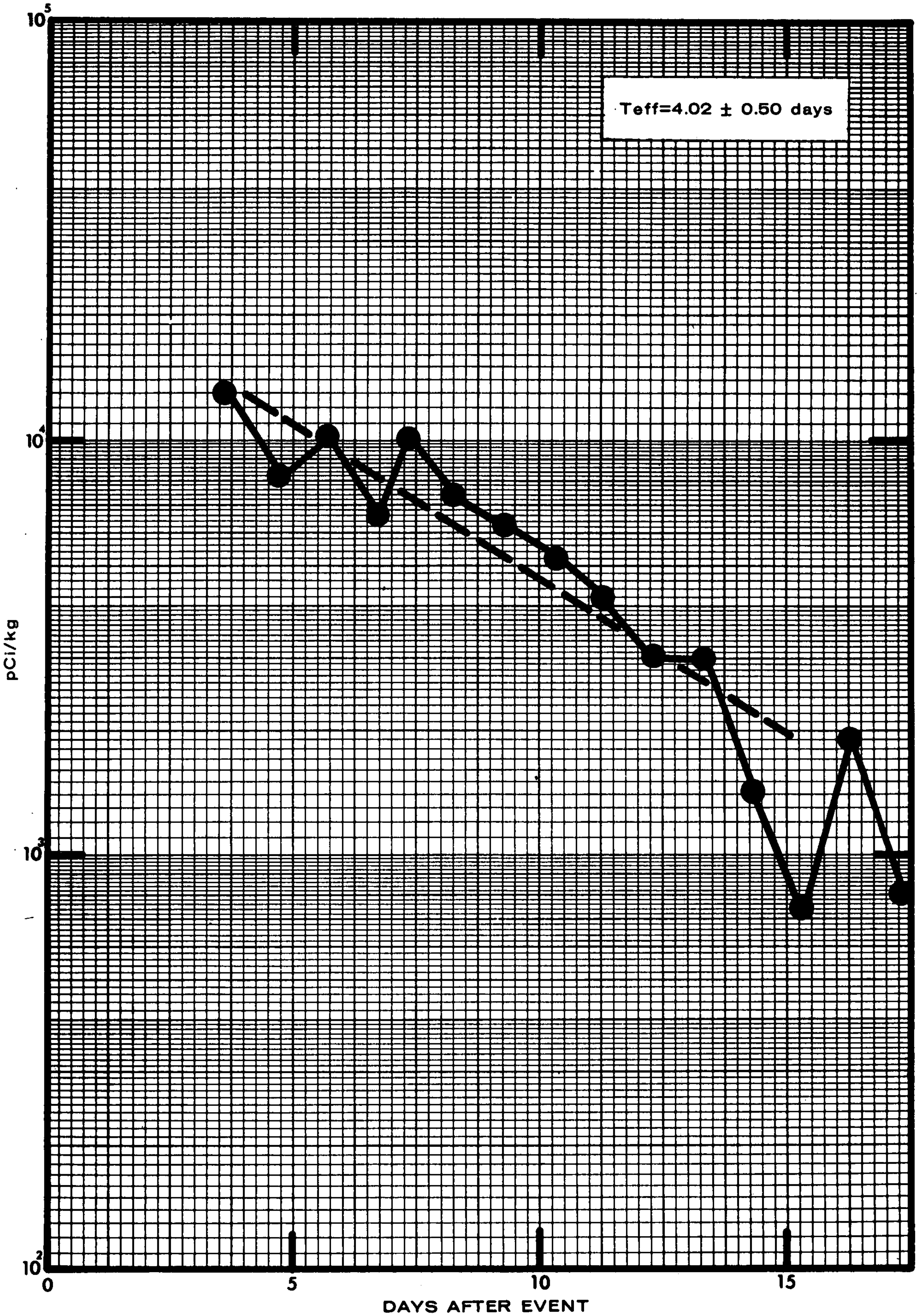

Figure 9. ^{131}I in field forage samples from Lee Dairy.

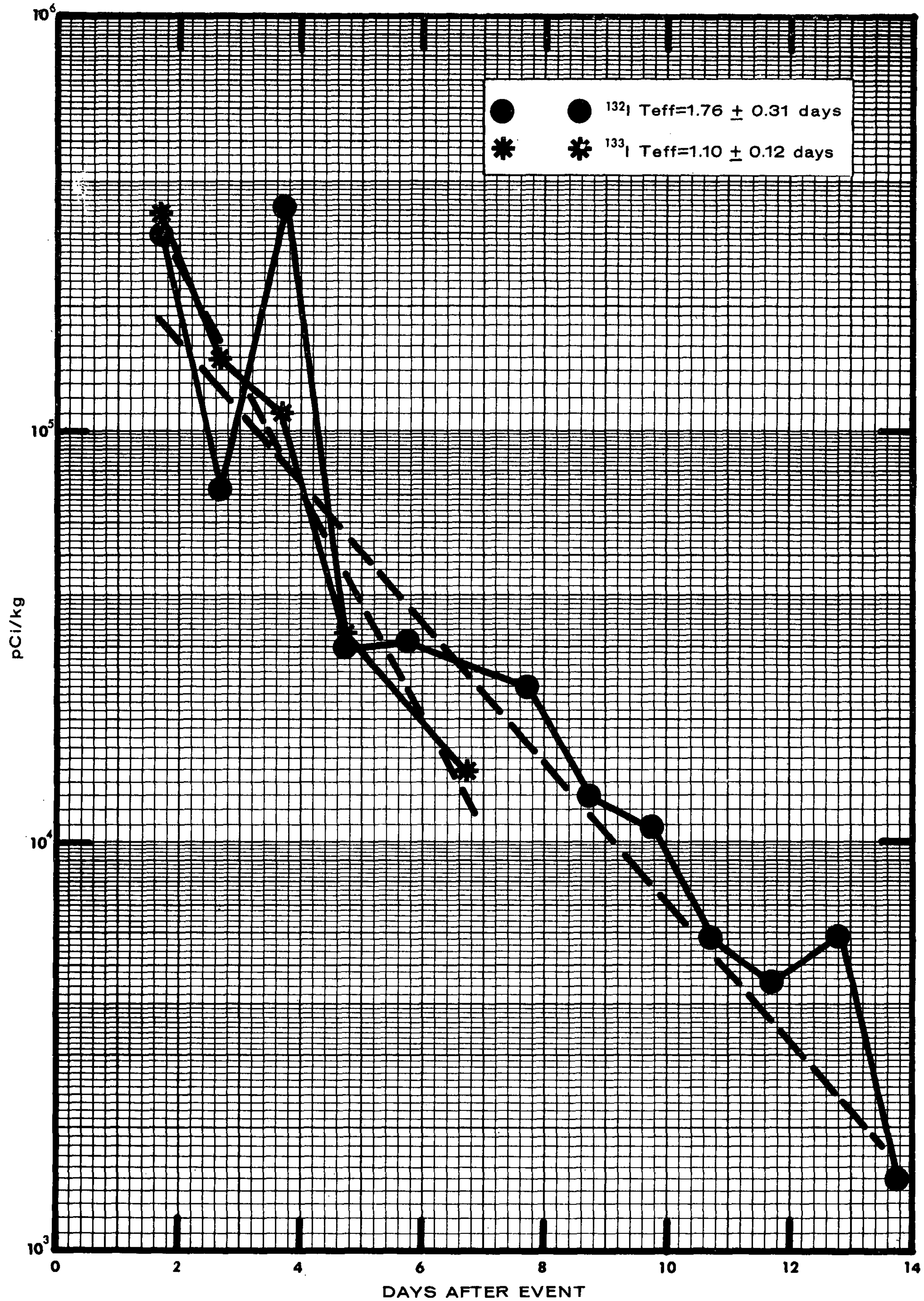

Figure 10. ^{132}I and ^{133}I in field forage samples from Schofield Dairy.

Table 5. Characterization of pastures at Alamo and Hiko

Item	Alamo	Hiko
Forage height	12"	12"
Percent ground cover	90.5	89.8
Density	1.71 kg/m^2	1.54 kg/m^2
Plant species - percent		
Medicago sativa	75.5	80.9
Bromus tectorum	9.9	12.4
Taraxacum officinale	5.1	----*
Unknown spp.	4.6	----
Hordeum spp.	4.0	----
Descurania pinnata	0.4	3.5
Cruciferae spp.	0.3	----
Poa spp.	Trace	----
Erodium cicutarium	Trace	----
Festuca arundinacea	----	3.2

*---- indicates not present.

Table 6. Radioiodine in field forage samples from Lee Dairy Farm, Alamo (Samples collected April 26)

Sampling Point	^{131}I pCi/kg $\times 10^4$	^{131}I pCi/m^2 $\times 10^4$	^{132}I pCi/kg $\times 10^7$	^{133}I pCi/kg $\times 10^5$
A1	.591	1.09	11.40	1.44
A3	1.56	2.39	32.50	2.67
A5	1.01	1.57	9.17	2.08
B1	1.18	1.76	8.25	1.91
B2	.914	1.71	21.40	2.21
B3	.687	1.36	.306	1.08
B4	1.05	1.81	21.30	2.60
B5	1.38	2.16	2.67	3.20
C1	.930	1.76	8.06	1.65
C2	.969	1.57	8.55	1.80
C3	.875	1.57	11.90	2.27
C4	1.24	1.81	8.54	2.09
C5	1.51	2.20	11.30	2.58
D1	1.15	1.82	8.44	1.91
D2	1.02	1.76	8.56	1.69
D3	1.15	2.27	8.12	1.80
D4	1.11	1.93	23.40	2.80
D5	.970	1.48	6.44	1.77
E1	1.27	1.92	9.66	2.19
E2	1.22	2.01	8.92	2.23
E3	.814	1.58	6.37	1.43
E4	.939	1.87	6.89	1.59
E5	1.03	1.68	6.59	1.62
F1	1.02	1.84	1.65	1.64
F2	1.27	2.44	8.20	1.93
F3	.723	1.29	17.10	1.94
F4	1.09	1.92	7.84	1.81
F5	1.02	1.49	27.10	2.41
$\bar{x}$	1.06	1.79	11.09	2.01
s	.22	.32	7.6	.47
CV	21.13	18.00	70.06	23.38

Symbols:

$\bar{x}$ = mean

s = standard deviation

CV = coefficient of variation = $(\frac{s}{\bar{x}})$ (100)

Table 7. Radioiodine in field forage samples from Schofield Dairy Farm, Hiko

(Samples collected April 27)

Sampling Point	^{131}I pCi/kg x 10^4	^{131}I pCi/m^2 x 10^4	^{132}I pCi/kg x 10^6	^{133}I pCi/kg x 10^5
A4	3.01	4.99	7.90	2.44
A5	2.19	4.54	8.33	1.87
A6	3.29	5.80	10.70	2.75
B3	2.71	3.84	7.69	2.22
B4	2.47	4.36	40.70	2.71
B6	2.38	3.64	6.17	2.01
C1	2.82	4.99	7.14	2.29
C2	3.08	4.06	9.11	2.41
C3	2.89	4.93	8.14	2.32
C4	2.86	5.58	43.00	3.03
C5	2.30	2.96	6.83	----
C6	2.83	4.14	41.50	2.87
D3	2.57	3.10	7.77	2.15
D4	2.82	4.12	8.06	2.29
D5	3.07	3.73	44.60	3.17
D6	1.86	3.06	30.90	2.03
E3	3.14	4.67	8.69	2.42
E4	2.26	3.64	3.82	----
E5	3.30	4.81	9.22	2.62
E6	2.99	4.45	52.00	3.22
F3	2.90	3.9	37.90	2.83
F4	2.71	4.41	6.50	2.14
F5	2.47	3.52	39.30	2.57
F6	4.21	6.74	12.40	3.51
$\bar{x}$	2.80	4.33	19.10	2.54
s	.47	.9	16.40	.43
CV	16.84	20.78	83.05	18.00

Symbols:

$\bar{x}$ = mean

s = standard deviation

CV = coefficient of variation = $(\frac{s}{\bar{x}})$ (100)

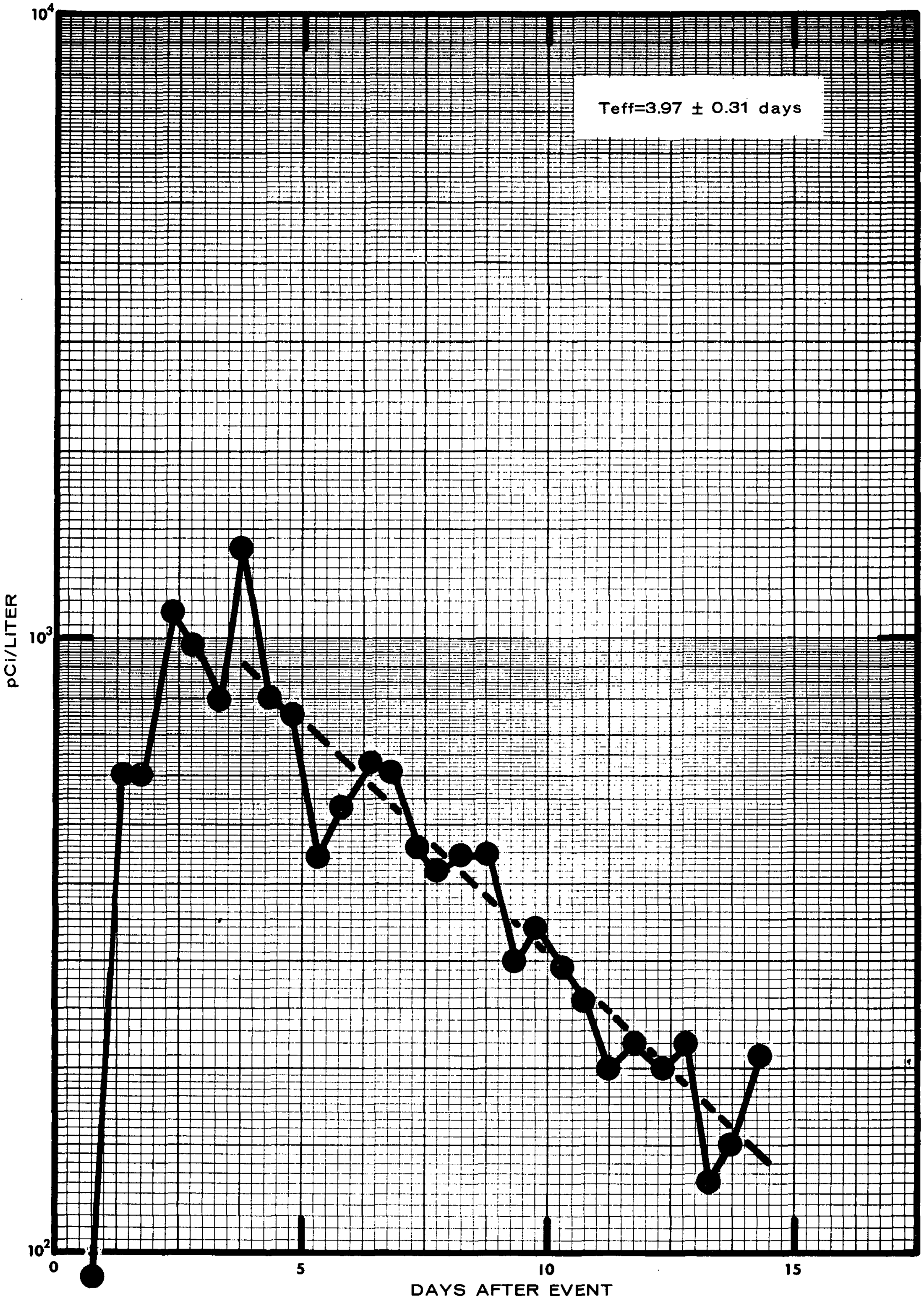

Figure 11. ^{131}I in milk of cows at L. Lee Dairy following ingestion of contaminated hay and green chop.

The other isotopes (^{132}I and ^{133}I) as tabulated in Table X are shown graphically in Figure 12. The ^{132}I activity peaked on April 27 and declined with an effective half-life of 3.07 ± 0.83* days. The effective half-life for ^{133}I was 0.92 ± 0.06* day.

The four cows separated from the Schofield herd on April 28 were continually fed contaminated green chop from April 28 thru June 8. All of the radioiodines (^{131}I, ^{132}I, ^{133}I and ^{135}I) in the milk are tabulated in Table XI of the Appendix. The highest ^{131}I activity, 4.8×10^3 pCi/l, in the milk was observed on April 27 p.m. The ^{131}I values are plotted in Figure 13. The effective half-life was 5.55 ± 0.34* days. The ^{132}I and ^{133}I values are plotted in Figures 14 and 15. The ^{132}I and ^{133}I activities in milk peaked on April 28 and April 27 respectively. The effective half-lives were 1.85 ± 0.25* days and 0.94 ± 0.09* days respectively for ^{132}I and ^{133}I.

After April 27 p.m., uncontaminated hay was fed to Schofield's Dairy herd except for the four cows on green chop. There were two deliveries of hay both of which were checked for possible contamination. The gamma scans on the hay indicated that radioactivity was not present when it was delivered. The radioiodines found in milk from cows fed this hay are recorded in Table XII of the Appendix and plotted in Figure 16. It can be seen that the ^{131}I values dropped quite rapidly after feeding hay. The effective half-life was 1.01 ± 0.06* days in milk from hay fed cows compared to 5.55 ± 0.24* days for the green chop fed cows. The ^{132}I and ^{133}I activities were scanty but the ^{133}I values from Table XII indicated that the effective half-life in milk was 0.46 ± 0.01 day, (Figure 15).

H. Repetitive Counting

Several samples such as milk, green chop and eggs were counted repetitively to determine physical decays of ^{131}I and the activity of other isotopes possibly present in the same channels used to quantitate ^{131}I. The activity in counts per minute, minus back-

*Value ± standard deviation

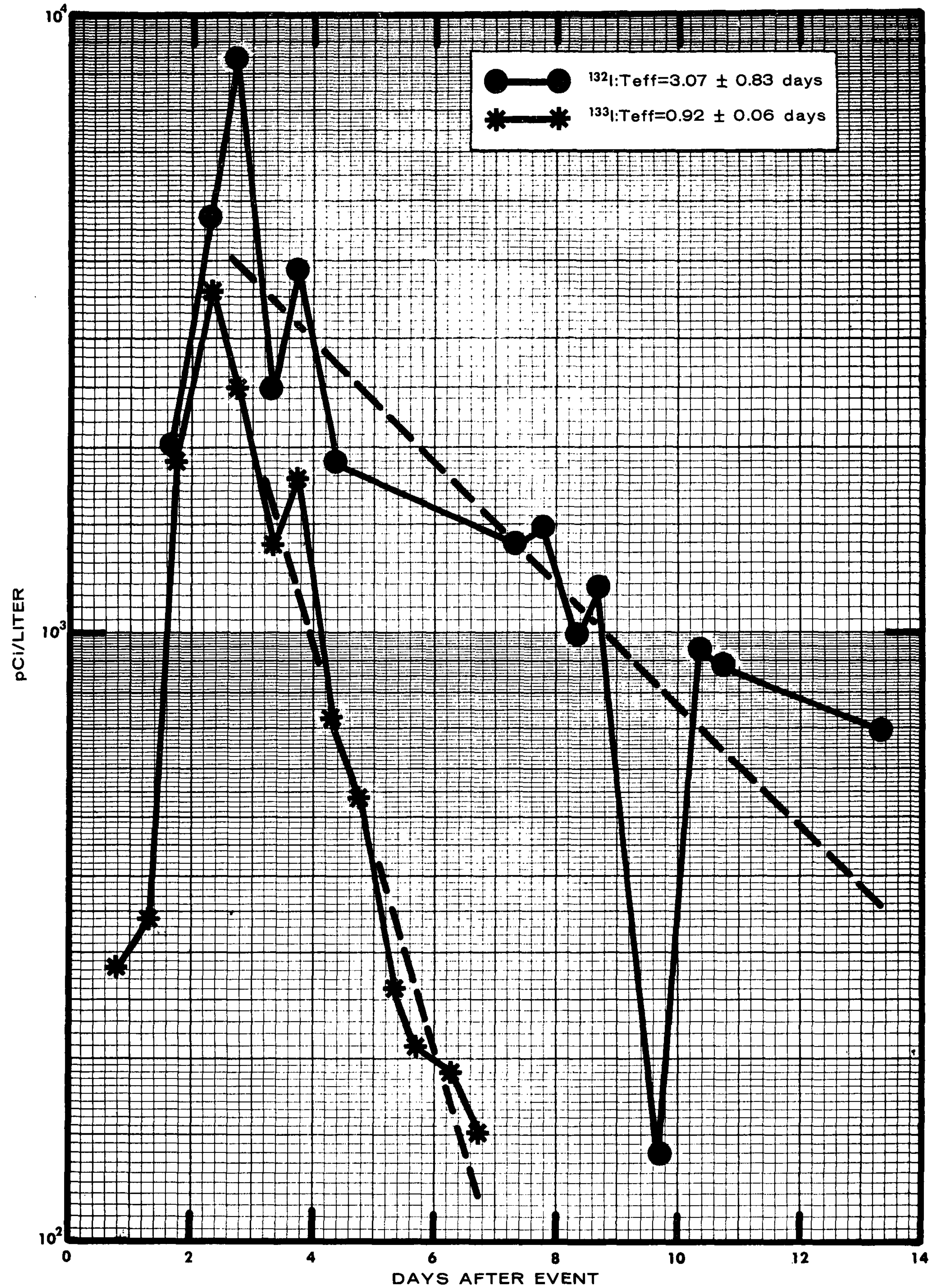

Figure 12. ^{132}I and ^{133}I in milk of cows at L. Lee Dairy following ingestion of contaminated hay and green chop.

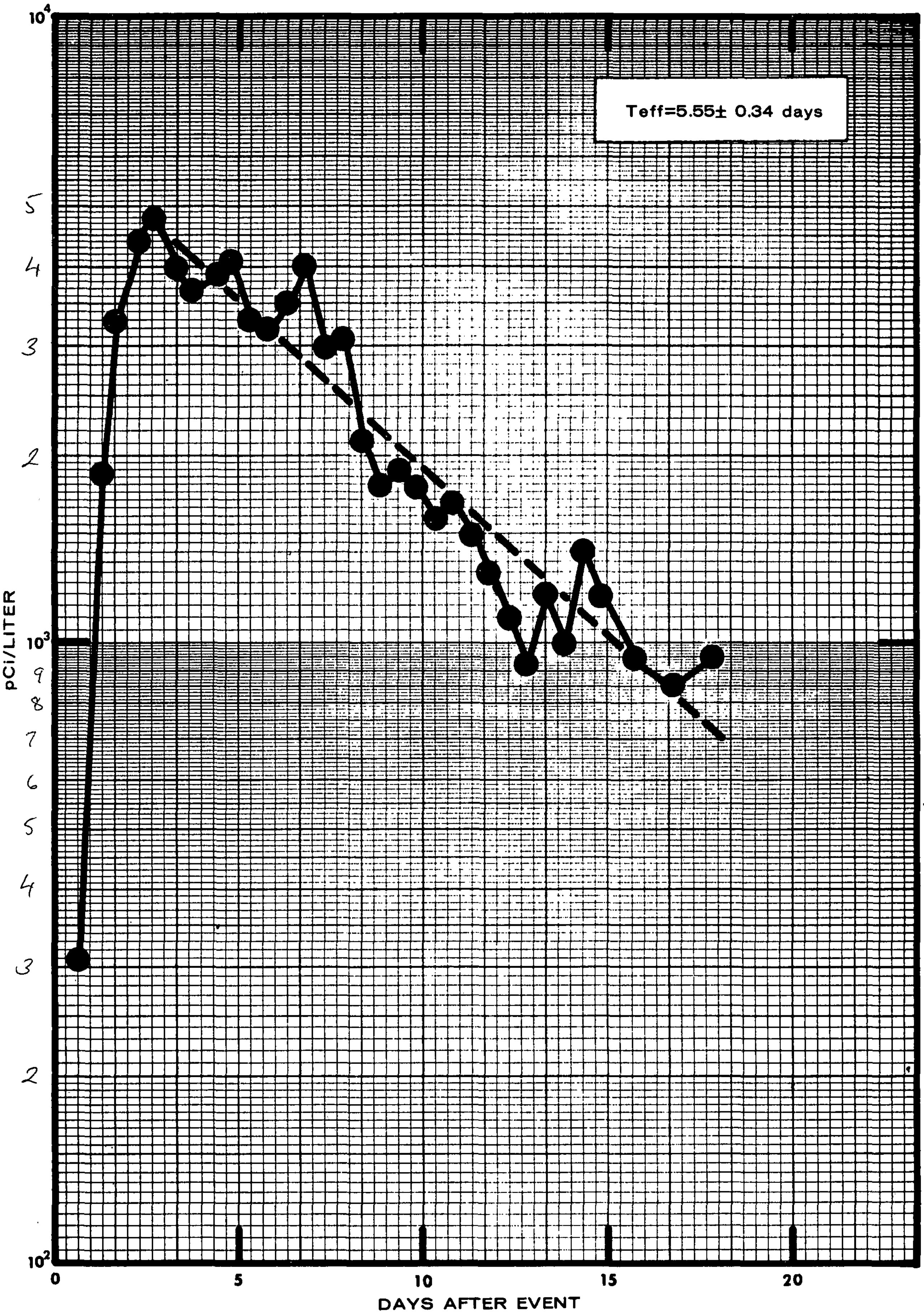

Figure 13. ^{131}I in milk of cows at Schofield Dairy following ingestion of contaminated green chop.

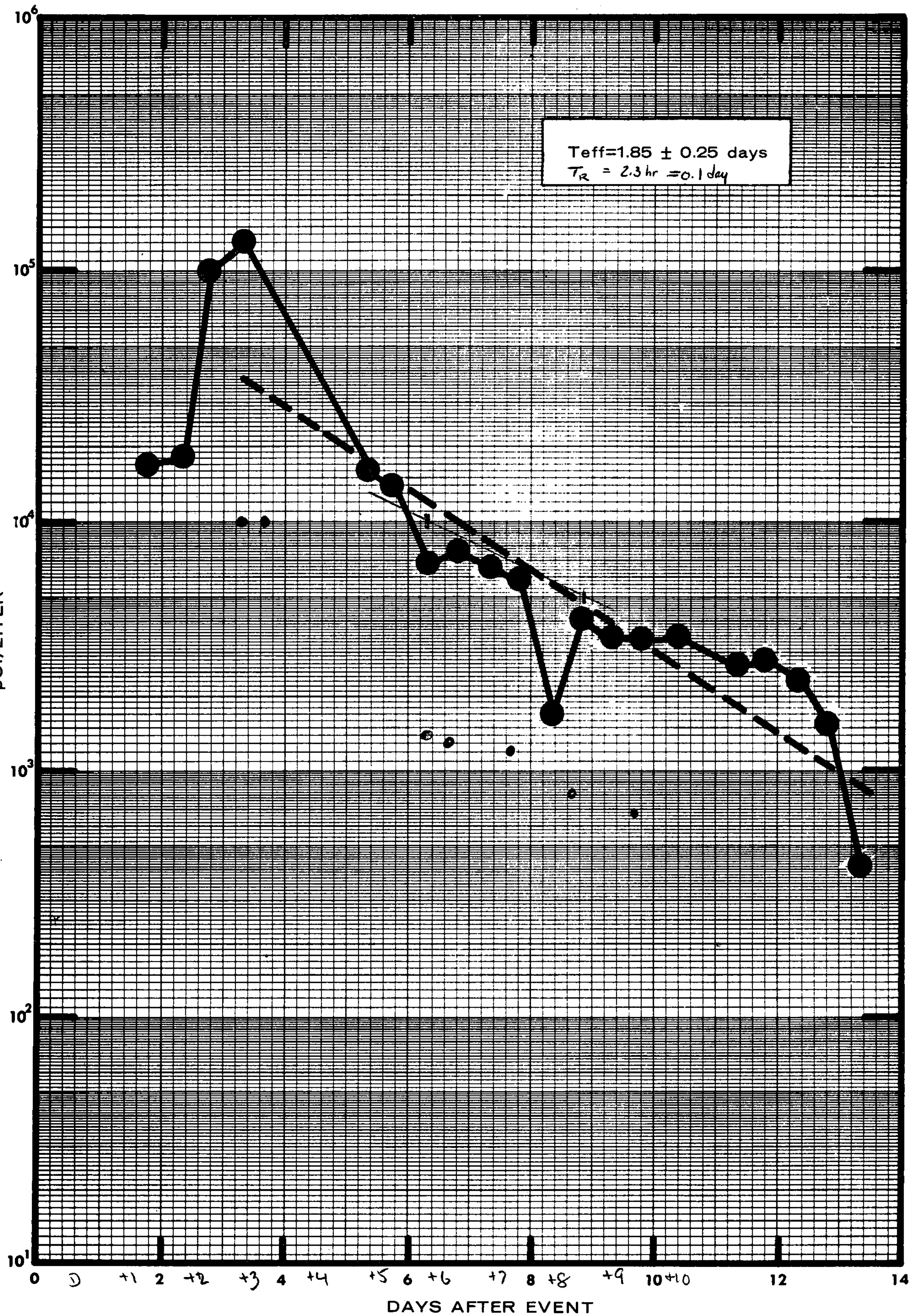

Figure 14. ^{132}I in milk of cows at Schofield Dairy following ingestion of contaminated green chop.

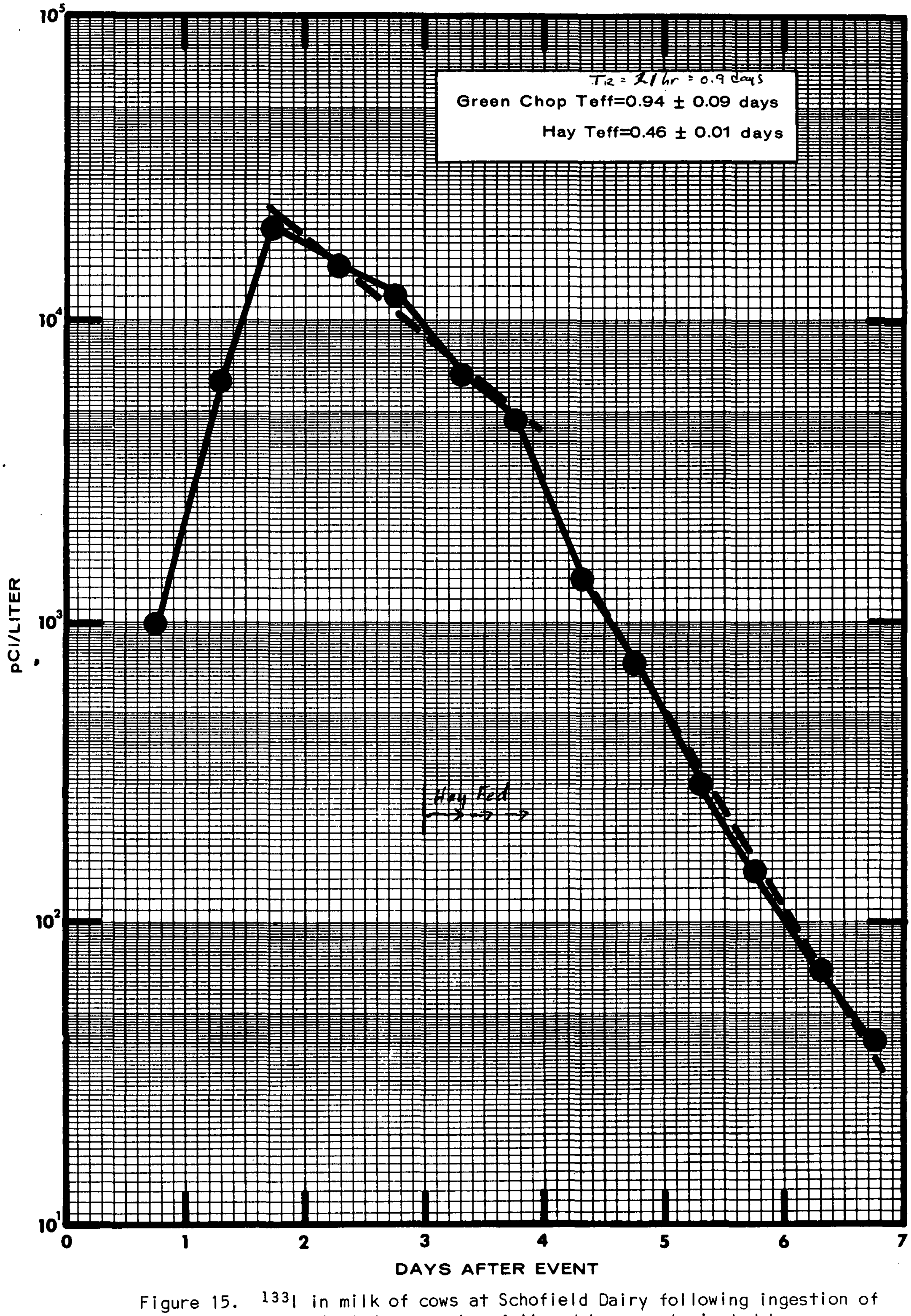

Figure 15. ^{133}I in milk of cows at Schofield Dairy following ingestion of contaminated green chop followed by uncontaminated hay.

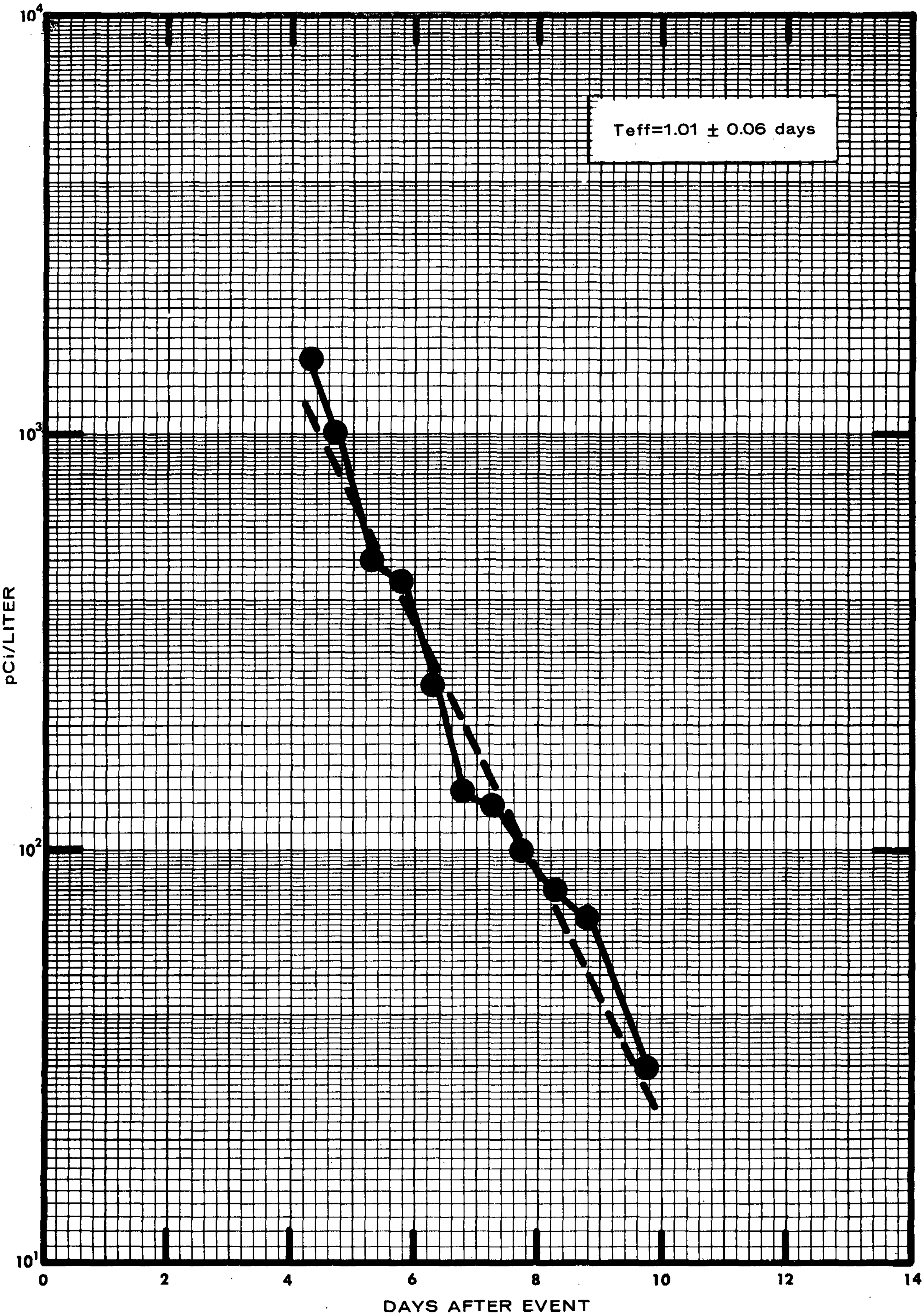

Figure 16. ^{131}I in milk of cows at Schofield Dairy following ingestion of uncontaminated hay.

ground, summed in the ^{131}I channels was calculated on the date counted. A typical graph is shown in Figure 17. These data indicated that a short-lived isotope was present or over-lapping into the ^{131}I channels. The results of the physical half-lives from all repetitive counting are summarized in Table XIII of the Appendix. It is apparent that another isotope was, or other isotopes were, present in the ^{131}I channels from April 26 through April 29. The averaged half-life value beyond April 29 was 8.64 days; which probably represents ^{131}I (8.08days). The ^{131}I values were subtracted from the short-lived isotope curve and the new activity was replotted for physical decay. The average half-life for the short-lived isotope(s) was calculated to be 1.05 days.

The results of the nitric acid procedure on milk have been given in a separate report.[5]

I. Eggs

Eggs were collected from the Merle Schofield Farm at four different times. For each sample six eggs were separated from the shells and gamma scanned. The ^{131}I activities are recorded in Table 8. Note that ^{131}I was present in egg contents rather than the shells. The chickens which produced these eggs were observed eating the contaminated forage near the dairy barn. Also, as reported in the previous section, eggs collected on May 1 were counted repetitively.

Table 8. ^{131}I in eggs from the Schofield Farm

Date	Time	Ave. Wt.* Per Egg (gram)	^{131}I pCi/egg	Shells
D (April 25)				
D + 6	1200	51.3	209	ND
D + 7	1200	56.0	253	ND
D + 10	0725	55.1	420	ND
D + 30	1700	54.0	102	ND

*Analysis of 6 eggs without shells.
ND - Not detectable

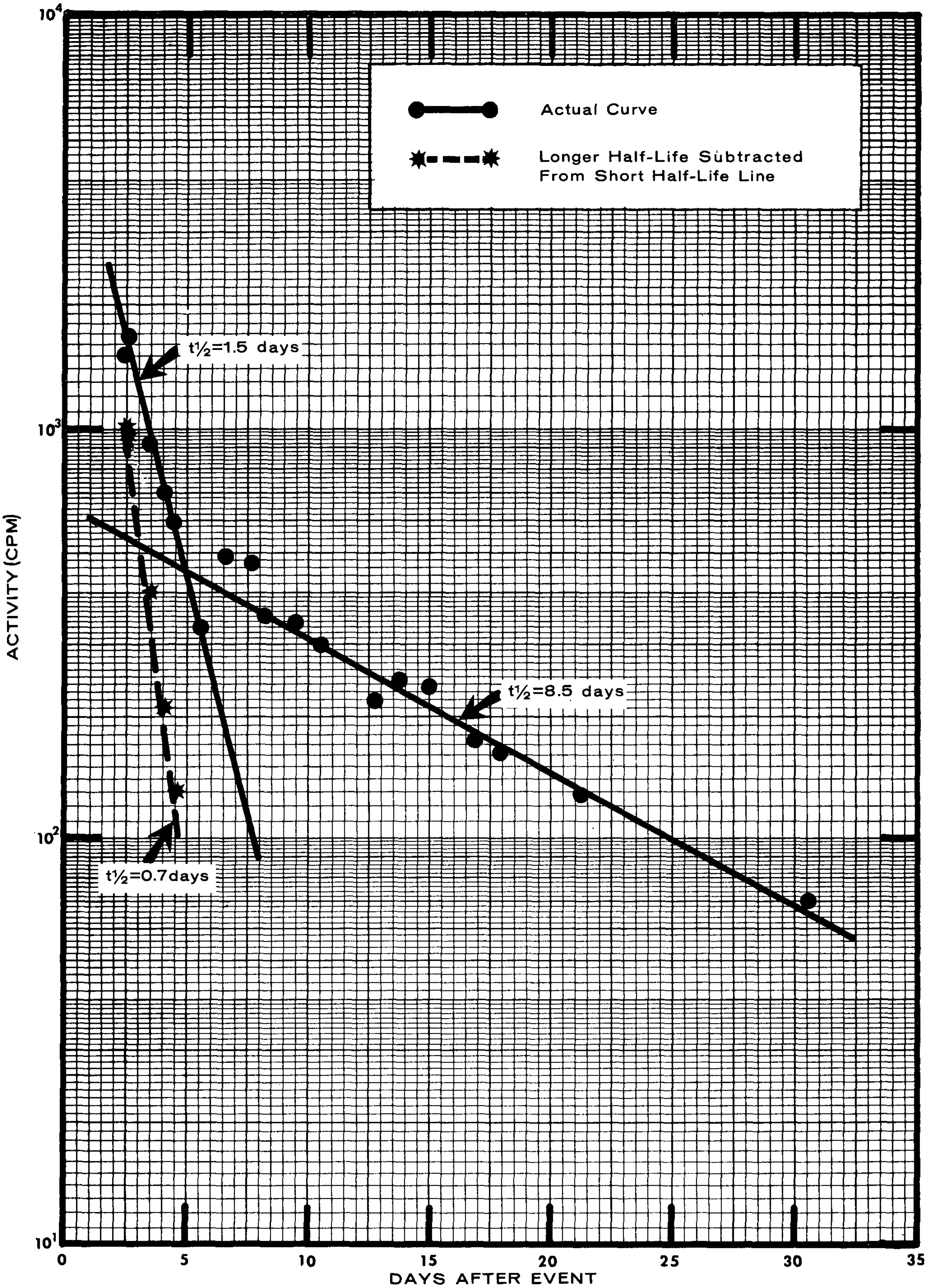

Figure 17. Repetitive counts on a milk composite from green chop fed cows collected on April 26, p.m. (Schofield Farm).

J. Soil

Soil samples were collected at each dairy farm. Analytical results are given in Tables XIV and XV of the Appendix for the Lee and Schofield farms respectively.

K. Blood

The complete blood counts, serum protein values and PBI's done on the study cows were all within normal ranges with no significant changes in these indices being indicated between the two times of blood collection, i.e., 3 and 16 days after the event. Results on blood samples collected are contained in Table XVI of the Appendix.

L. External Exposure-rate

The results of gamma and beta + gamma exposure-rate measurements are shown in Table 9. Since the accuracy of the E-500B survey meters is not known under these field conditions, the results should be considered only on a relative basis.

M. Air Sampling

The results of air sampling conducted by SWRHL environmental surveillance personnel are indicated in Table 10.

Table 9. E-500B exposure-rates on pastures

Days After Event	Time	3' gamma mR/hr	Surface gamma mR/hr	Surface beta + gamma - mR/hr
		Hiko, Nevada		
0	1600	1.6	----	----
+1	1140	0.1	0.12	0.37
+2	1030	0.06	0.06	0.09
+3	1200	0.05	0.04	0.1
+4	----*	----	----	----
+5	1730	0.04	0.05	0.05
+6	1830	0.03	0.04	0.05
		Alamo, Nevada		
0	1600	0.23	----	----
+1	1115	0.04	0.07	0.09
+2	1700	0.03	0.02	----
+3	1030	0.05	0.05	----
+4	1800	0.02	0.02	----
+5	1800	0.02	0.02	----
+6	----	----	----	----

*----indicates reading not taken

Table 10. Radioactivity in air samples - pCi/m³.

Days After Event	Gross Beta	^{131}I	^{132}I	^{133}I	^{135}I
		Prefilter, Hiko			
0	3500	510	1900	650	3600
+1	100	10	22	16	27
+2	16	3	9	12	ND
+3	0.6	ND	ND	ND	ND
+4	5.0	0.8	ND	ND	ND
+5	0.6	0.2	ND	ND	ND
+6	0.5	ND	ND	ND	ND
+7	0.2	ND	ND	ND	ND
		Prefilter, Alamo			
0	710	57	142	110	220
+1	44	2	4	4	ND
+2	0.5	ND	ND	ND	ND
+3	3.0	24	ND	ND	ND
+4	1.0	ND	ND	ND	ND
+5	0.4	ND	ND	ND	ND
+6	0.3	ND	ND	ND	ND
+7	0.3	ND	ND	ND	ND
+8	0.1	ND	ND	ND	ND
+9	0.4	--	--	--	--
+10	0.1	--	--	--	--
		Charcoal Cartridge, Hiko			
0		39	330	150	1700
+1		52	84	290	86
+2		2	1	0.7	ND
+3		ND	ND	ND	ND
+4		0.7	ND	ND	ND
+5		0.6	ND	ND	ND
+6		0.6	ND	ND	ND
+7		ND	ND	ND	ND
		Charcoal Cartridge, Alamo			
0		19	86	75	100
+1		ND	ND	ND	ND
+2		0.9	ND	1	ND
+3		0.8	ND	ND	ND
+4		0.5	ND	ND	ND
+5		ND	ND	ND	ND
+6		ND	ND	ND	ND
+7		0.5	ND	ND	ND
+8		ND	ND	ND	ND
+9		ND	ND	ND	ND
+10		ND	ND	ND	ND

ND - Not detectable

VI. DISCUSSION

The general purpose of this study was to determine the effect of an inadvertent release of radioiodine in fresh fission products from an underground nuclear test on normal dairy farm operations. The procedure was to analyze the radioiodine content in milk, feed (hay, green chop and grain), water, soil and field forage samples collected at the Lee (Alamo, Nev.) and Schofield (Hiko, Nev.) Dairy Farms. Also, an experiment was conducted to determine the effect on radioiodine content in milk which results from feeding uncontaminated hay to cows previously fed contaminated green chop.

The grain and water samples collected from the Schofield and Lee Dairies contained ^{131}I. The levels of ^{131}I activity in grain at both dairies were about the same; whereas, the water samples collected from the waterers of the green chop fed cows at the Schofield Farm contained 2 to 3 times higher levels of ^{131}I compared to both the Lee Farm water and water from the tank of the hay fed cows at the Schofield Farm. It is probable that the ^{131}I contamination was due either to saliva from contaminated cows or resuspension of the contaminated debris. It was shown in a controlled experiment that cow's saliva was contaminated as soon as 30 minutes after a capsule containing ^{131}I was placed in the cow's rumen.(2)

Samples of grain and water were collected from the feed mangers, tank and waterers where the cow's saliva had direct contact. The two irrigation ditch collections from the Lee Farm were not contaminated which indicated that the ^{131}I activity probably came from other sources as mentioned above.

The other radioiodines such as ^{132}I and ^{133}I were not often detected in the grain and water samples collected. These radioiodine isotopes were all so low in concentration in these samples that they could not have contributed much to the total radionuclide intake by the dairy animals.

Hay stored at the Lee and Schofield Dairy Farms was exposed during cloud passage and some radioiodine contamination occurred. The activity in hay at the Schofield Farm was about ten times higher than at the Lee Farm when the peak ^{131}I values are compared. The ^{131}I activity in the hay at Lee's Farm varied from not detectable to 2.8×10^3 pCi/kg during the study. At Lee's Farm, hay and green chop were fed ad libitum.

Although the hay at the Schofield Farm was also exposed during the cloud passage, none was being fed at this time. Green chop was the major feed for the herd from April 25 through April 27. To decrease the radioiodine activity in milk from cows eating the contaminated green chop feed, uncontaminated hay was acquired from Enterprise, Utah, to be fed, in place of green chop, to the dairy herd. Both times that hay was acquired, background samples were taken and no radioactivity was detected.

The radioactive iodines detected in the uncontaminated hay on later samples does not likely represent activity ingested because the radioiodine activity in milk following feeding of hay decreased rapidly as will be discussed later.

The majority of contamination in feed was in the green chop cut from the fields which were exposed during cloud passage at both farms. All the radioiodines reported in green chop from the Schofield Farm were higher by a factor of 2 to 3 than the activity from radioiodines in green chop from Lee's Farm. The effective half-lives for ^{131}I in green chop from the two farms were not significantly different. The activity was highest at Lee's Farm on the first day of collection, whereas, the apparent peak activity at Schofield's Farm was not observed until April 30. This difference may be attributed to normal sampling variations, differing deposition patterns or to a possible recontamination at Schofield's.

There is some evidence to support the possibility of a recontamination since radioactivity continued to seep from the Pin Stripe site for several days following the event and prevailing winds were such, from April 25 through April 30, that additional radioactivity could have been carried from NTS to the Hiko-Alamo area.

On a previous inadvertent release of fresh fission products (Pike Event)(3) which was similar to this study, the green chop ^{131}I values decayed with an estimated effective half-life of 5.3 days. This half-life is in general agreement with the values obtained for this study. The slight difference may be due to the increased levels of activity on this study and contamination in the cow's mangers which built up as the study progressed. The half-lives in the field forage for this study appeared to be slightly shorter than those in the green chop and thus in better agreement with the Pike results.

The deposition study indicated average ^{131}I values of $1.0 \pm 0.2 \times 10^4$ pCi/kg for the Lee Farm on April 26 and $2.8 \pm 0.5 \times 10^4$ pCi/kg for the Schofield Farm on April 27. Since collection at Hiko was 15 hours later than at Alamo, the correction to the same collection time indicates that the Schofield Farm, Hiko, had about 3 times as much ^{131}I and 3.6 times as much ^{133}I on the forage as the Lee Farm. These differences were significant at the .005 level as determined by analysis of variance. These data suggest that Hiko was closer to the center of the "hot line" than Alamo. The coefficient of variation of these samples implies that a deviation of 20% from the mean can be expected for single samples. The separate forage sample collected at Hiko, two days after the event, as shown in Table IX, had a ^{131}I concentration of 2.6×10^4 pCi/kg which is within 20% of the average value listed above.

Autoradiographs of the alfalfa collected two days after deposition indicated that the activity was still on the surface of the plants.

The daily average milk concentration of ^{131}I at Hiko reached a peak value two days after the event. While at Alamo the peak was reached three days after the event. The effective half-lives were significantly different, being 3.97 ± 0.31 days at the Lee Farm and 5.55 ± 0.34 days for the green chop fed cows at the Schofield Farm. This difference in effective half-lives may be related to the type of contaminant deposited at the two locations. The higher activity in the field forage at Hiko indicated that the Schofield Dairy Farm was closer to the "hot line" than Alamo and the Lee Dairy Farm. In addition, the air sampler data, shown in Table 10, indicates that about 92% of the cloud at Hiko was particulate while only 66% of the cloud at Alamo was particulate. The possibility that more recontamination occurred at Hiko than at Alamo, thus leading to a longer effective half-life at Hiko, can not be overlooked.

Another factor which suggests that difference in the type of contaminant at the two locations could have been responsible for the different effective half-lives in milk was the similar effective half-lives of ^{131}I on the green chop fed to the two groups of cows. Of course, the intermittent feeding of less highly contaminated hay, along with green chop, at the Lee Farm was a complicating factor which may have contributed to the shorter effective half-life in milk at that farm. However, this does not seem likely.

The effect of the countermeasure employed in this study, i.e., feeding uncontaminated hay to the dairy herd, can be estimated by comparing the thyroid doses that would have resulted with and without the countermeasure. Since the thyroid dose depends on the radioiodine concentration in the gland, and since the concentration depends on the amount ingested, then, by assuming a constant daily percentage thyroid uptake, the dose to the gland becomes a simple function of the sum of

3.93
3.907

the daily activities in the milk. Adding the ^{131}I activities in the milk from cows fed green chop for the first 18 days, as shown in Table XI, yields a total intake of 3.9×10^4 pCi for an individual drinking one liter per day. Since the countermeasure was instituted three days after the event, then the first three ^{131}I values from Table XI must be added to the values in Table XII, milk from cows fed uncontaminated hay, to get the sum of 1.12×10^4 (1.410×10^4) pCi total intake. The ratio of these two sums is 0.29 suggesting that this countermeasure would reduce the potential thyroid dose by 71 percent. Effects of earlier or later application of this measure would correspondingly have greater or less effect respectively. Figure 18 and Table 11, which is derived from it, predict probable effectiveness if similar countermeasures had been imposed at different times in this situation. The ^{131}I activities detected in the uncontaminated hay fed to these cows, as shown in Table 12, was undoubtedly due to cross-contamination since the hay samples were collected from the feed mangers. That this hay was really uncontaminated is evidenced by the fact that the effective half-life of ^{131}I in milk from cows eating this hay was about one day as would be expected after cessation of ingestion of contamination.

Another similarity with the Pike study is the milk/forage ratio at the two dairy farms involved in this study. Using measured peak concentrations in milk and green chop gives the following ratios:

$$\text{Lee Dairy Farm} - \frac{1.4 \times 10^3 \text{ pCi/liter}}{1.8 \times 10^4 \text{ pCi/kg}} = 0.078$$

$$\text{Schofield Dairy Farm} - \frac{4.8 \times 10^3 \text{ pCi/liter}}{5.6 \times 10^4 \text{ pCi/kg}} = 0.086$$

Similarly, corresponding values were derived for ^{132}I and ^{133}I. Since the short half-lives of these iodines make the timing of measurements critical, the values used were D-day values obtained by extrapolation of the least-squares lines (Figs. 6,7,12,14 and 15) and are shown in Summary Table. All milk-to-forage ratios are summarized in Table 12.

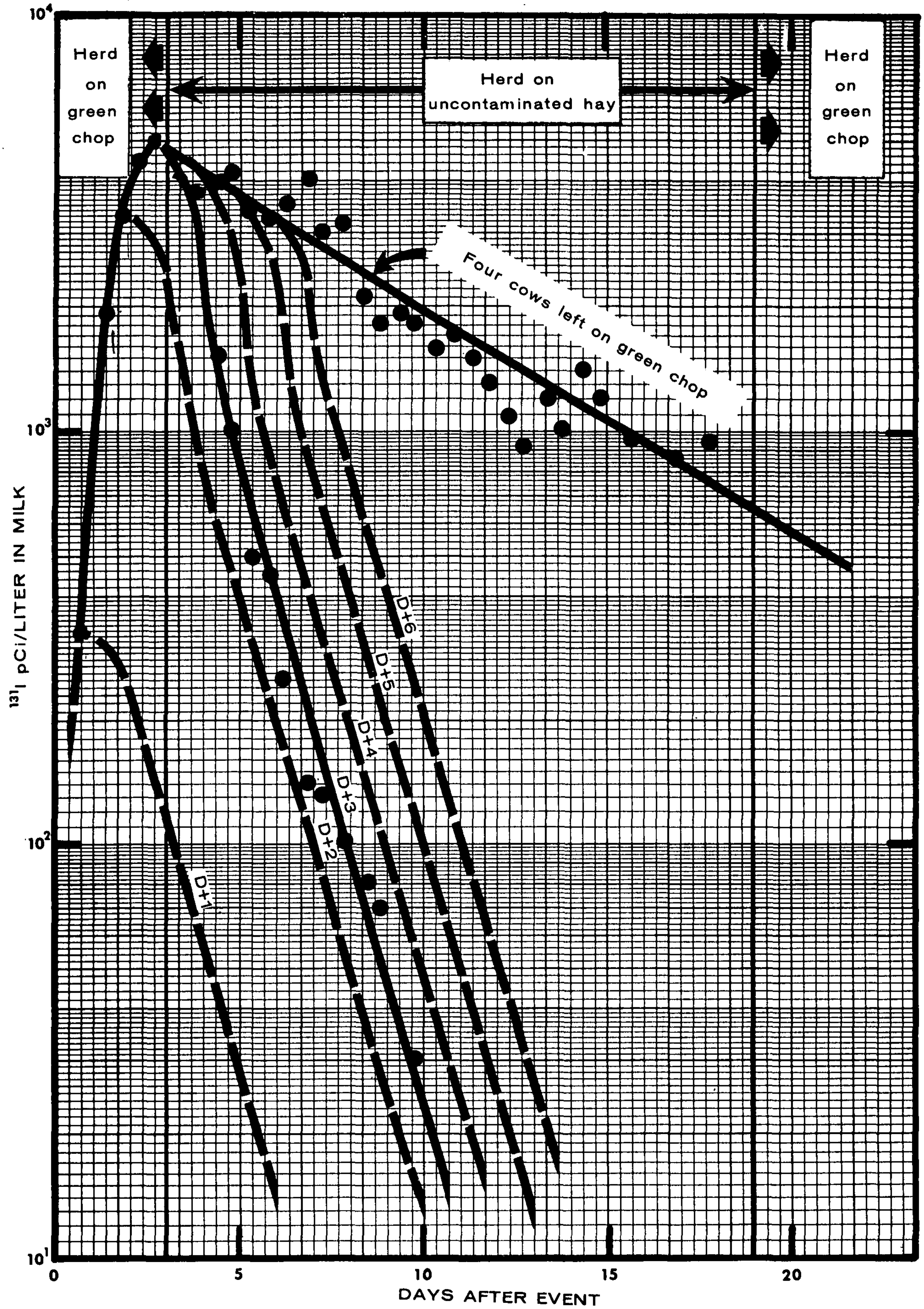

Figure 18. Effect of countermeasure on ^{131}I in milk at Schofield Dairy Farm.

Table 11. ^{131}I dose reduction as a result of countermeasures, considering an 18-day period post event

Uncontaminated Hay Provided On	Total ^{131}I Intake With 1 liter/day Intake (pCi)	Effectiveness of countermeasure (% dose saved)
D (April 25)	0	100
D + 1	600	98
D + 2	7,800	80
D + 3	11,200	71
D + 4	17,000	56
D + 5	20,300	48
D + 6	23,400	40
None	39,000	0

Notes:

1. Uncontaminated hay fed only through 18 days after the event and starting on day indicated.
2. Only source of ^{131}I to cow assumed to be contaminated green chop.

Table 12. Milk to forage ratios for radioiodines

	Alamo	Hiko
^{131}I	0.078	0.086
^{132}I	0.023	0.22
^{133}I	0.038	0.106

The ^{131}I ratios are in close agreement with the ratio of 0.08 (peak in milk divided by peak in green chop) obtained from the data at the Habbart Farm during the Pike study. No reported comparable values for ^{132}I and ^{133}I are available for comparison.

It is interesting to note that all milk to forage ratios at Alamo appear to be smaller than corresponding ones at Hiko suggesting that, for some currently unexplainable reason, the radioiodines at Alamo appeared to be less biologically available than those at Hiko.

A calculation of total percent of ^{131}I ingested which was secreted in the milk at Alamo and at Hiko gave results of 4.9 and 10.4% respectively. This finding tends to support the previous statement on reduced biological availability at Alamo.

All of the results in this report are based on computer analysis using a matrix method. The appearance of a two-component decay curve in the ^{131}I peak channels on repetitive counting suggests that the calibration standards and interference coefficients may not be sufficiently accurate when counting samples containing fresh fission products. Because of this possibility, early milk samples were retained until the short-lived contaminant decayed out; then they were reanalyzed for ^{131}I and the results corrected back to time of collection.

Another item from this study was the detection of ^{131}I in eggs as shown in Table 8. The eggs were collected after chickens were observed eating contaminated forage near the dairy barn. The peak value of 420 pCi ^{131}I/egg, detected in eggs layed 10 days after the event, suggests that eggs would probably not be an important source of human exposure compared to the milk produced in the same area. All of the iodine activity was in the edible portion of the egg, though, as none was detectable in shells.

VII. SUMMARY AND CONCLUSIONS

In general all objectives set forth in Section I were accomplished. Table 13 presents a summary of some ^{131}I data of interest. Table 14 gives a comparable summary for ^{132}I and ^{133}I data. The numbered paragraphs below pertain to the numbered study objectives formulated in Section I.

1. The T_{eff} for ^{131}I in milk at Hiko, 5.6 days, appears to be significantly different from the comparable value at Alamo, 4.0 days. Several possible contributing factors for the difference have been discussed in Section VII, but at this time it is not possible to explain the difference, if it is real, in any clear-cut fashion. The milk to forage ratios for ^{131}I of 0.086 at Hiko and 0.078 at Alamo agree quite well with our Pike value of 0.08 at the Habbart Farm. No comparable data are available with which to compare our ^{132}I and ^{133}I results from this study.

2. Within approximately one day after uncontaminated hay was substituted for contaminated green chop for the dairy herd at Hiko, the T_{eff} for ^{131}I in the milk changed from 5.6 days to 1.0 days. Thus the preventive measure, or countermeasure, utilized at Hiko was extremely effective in rapidly reducing levels of ^{131}I in milk.

3. At Hiko the ^{131}I T_{eff} in green chop was 6.9 days whereas in field cut forage it was 4.9 days. Corresponding values at Alamo were 6.7 and 4.0 days respectively. The apparent longer T_{eff} in green chop compared to field cut forage at both locales suggests that contamination was building up in the cows' mangers over the course of the study.

Table 13. Summary of ^{131}I Results.

Farm	Description	Time of ~~Peak~~ Value in Milk Days	Peak Value in Milk pCi/l	Peak pCi/kg in Feed Green Chop	T_{eff} for Forage Days Green Chop	T_{eff} for Forage Days Field Forage	T_{eff} For Milk Days	~~Ratio of~~ Peak Milk (pCi/l) to Peak Green Chop (pCi/kg)
L. Lee	Hay and Green Chop *ad libitum* intermittently	3	1.4×10^3	1.8×10^4	6.7	4.0	4.0	0.078
W. Schofield	Green Chop Cows	2	4.8×10^3	5.6×10^4	6.9	4.9	5.6	0.086
W. Schofield	Hay*	-	-	-	-	-	-	-

*Uncontaminated hay acquired from Enterprise, Utah, and fed after April 27.

Table 14. Summary of ^{132}I and ^{133}I results.

Farm	Description	^{132}I Probable Peak Values Green Chop pCi/kg	^{132}I Probable Peak Values Milk pCi/liter	^{132}I T_{eff} - Days Green Chop	^{132}I T_{eff} - Days Field Forage	^{132}I T_{eff} - Days Milk	^{133}I Probable Peak Values Green Chop pCi/kg	^{133}I Probable Peak Values Milk pCi/liter	^{133}I T_{eff} - Days Green Chop	^{133}I T_{eff} - Days Field Forage	^{133}I T_{eff} - Days Milk
L. Lee	Hay and Green Chop Feed *ad libitum* intermittently	3.1×10^5	7.2×10^3	2.0	---	3.07	5.0×10^5	1.9×10^4	.92	---	.92
W. Schofield	Green Chop Feed	4.5×10^5	1.0×10^5	1.6	1.76	1.85	7.5×10^5	8.0×10^4	1.40	1.1	.94

4. At Hiko the net open field three foot gamma reading in mR/hr was approximately 0.08 at 24 hours after the Pin Stripe event. The corresponding value at Alamo was 0.02. The peak levels of ^{131}I in milk reached at Hiko and Alamo were 4,800 and 1,400 pCi/l respectively. On the basis of these two pairs of values it is possible to calculate peak ^{131}I level in milk to open field gamma exposure-rate conversion factors of 60,000 and 70,000 for Hiko and Alamo respectively. These measured factors agree quite well with predictions of Knapp(4), who predicts that such conversion factors should be in the range of 25,000 to 100,000.

5. The coefficient of variation for ^{131}I on pCi/kg basis for cut field forage samples at Alamo was 21.1% whereas it was 16.8% at Hiko. These values indicate that the contamination at these two study farms was reasonably homogeneous on this basis. The coefficients of variation on a pCi/m^2 basis were only slightly different from the values cited above on a pCi/kg basis.

6. The levels of radioiodines in hay, grain and drinking water being consumed by cows at Hiko and Alamo were low enough that these additional sources of contamination were probably negligible compared to contaminated green chop.

7. Considering an eighteen-day period after the Pin Stripe event, the substitution of uncontaminated hay for contaminated green chop at the Schofield Farm, beginning three days after the event, reduced the potential thyroid dose of humans consuming one liter of milk per day to only 29% of the dose which would have resulted had no countermeasure been applied. This countermeasure would have been even more effective if it had been imposed earlier after the Pin Stripe event.

8. Results and discussion pertinent to this objective have been reported separately(5).

REFERENCES

1. Interim Report of Off-Site Surveillance for Project Pin Stripe - SWRHL (in press)

2. Single Dose ^{131}I - ^{126}I Ratio Study in Dairy Cows (SWRHL - 27r)

3. Dairy Farm Radioiodine Study Following the Pike Event (SWRHL - 14r)

4. Knapp, H. A., Iodine-131 in Fresh Milk and Human Thyroids Following a Single Deposition of Nuclear Test Fallout, TID - 19266

5. Comparison of ^{131}I and Gross Beta Activities in Milk Following the Pin Stripe Event (in preparation)

APPENDIX

APPENDIX

Table I. Radioiodine activity in grain samples

L. Lee Dairy Farm, Alamo, Nevada

Date	Time	pCi/kg ^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1928	ND			
D + 2	0630	38			
	1646	$2.2E^2$	$3.2E^4$	$7.2E^2$	$9.3E^3$
D + 3	0944	ND			
D + 4	1714	ND		$4.9E^2$	
D + 5	1702	$7.6E^2$			
D + 6	1702	$3.3E^2$			
D + 7	0940	ND			
D + 8	0616	ND			
D + 9	0704	$2.5E^2$			
D + 10	0650	$2.3E^2$			
D + 11	0620	ND			
D + 12	0630	ND			
D + 13	0645	$2.5E^2$			
D + 14	0700	$1.2E^2$			
D + 15	0728	$3.7E^2$			
D + 16	0632	$2.6E^2$			
D + 17	0710	$1.7E^2$			
D + 18	0840	ND			
		W. Schofield Dairy Farm, Hiko, Nevada			
D + 2	0705	ND		$6.0E^2$	
	1815	$3.7E^2$			
D + 3	0705	ND			
D + 4	1735	ND			
D + 5	1845	ND			
D + 6	1735	$6.9E^2$			
D + 7	1635	$4.5E^2$			
D + 8	1735	ND			
D + 9	1715	ND			
D + 10	1745	$6.3E^2$		$4.7E^2$	
D + 11	1735	$4.4E^2$			
D + 12	1815	$4.1E^2$			
D + 13	1805	ND			
D + 14	1745	ND			
D + 15	1735	ND		$2.5E^2$	
D + 16	1735	$1.6E^2$			
D + 17	1735	ND			
D + 18	1725	$2.3E^2$			

ND - Non-detectable
$3.7E^2 = 3.7 \times 10^2$

Table II. Radioiodine activity in water from Lee Dairy Farm

Date	Time	Location	pCi/liter ^{131}I	^{132}I	^{133}I
D (April 26)					
D + 1	1940	Ditch	ND	5.6E^2	6.9E^2
D + 2	0630	Trough	60		
	0630	Ditch	ND		
	1700	Composite	1.2E^2		
D + 3	0636	Compisite	90		60
D + 4	0650	Composite	90		
D + 5	1720	Composite	1.0E^2		
D + 6	1718	Composite	1.5E^2		
D + 7	0856	Composite	ND		
D + 8	0626	Composite	ND		
D + 9	0700	Composite	50		
D + 10	0650	Composite	70		
D + 11	0630	Composite	ND		
D + 12	0630	Composite	ND		
D + 13	0700	Composite	ND	4.2E^2	
D + 14	0710	Composite	30		
D + 15	0726	Composite	30		
D + 16	0620	Composite	80		
D + 17	0710	Composite	ND		
D + 18	0840	Composite	ND		

Composite samples collected from irrigation ditch and trough
5.6E^2 = 5.6×10^2
ND - Non-detectable

Table III. Radioiodine activity in water from Schofield Dairy Farm.

Date	Time	pCi/liter ^{131}I	^{132}I	^{133}I
Hay Fed Cows				
D (April 25)				
D + 3	1705	90		
D + 4	0655	$2.1E^2$		
D + 5	1735	$2.6E^2$		
D + 6	1715	$2.4E^2$		
D + 7	1645	$2.0E^2$		
D + 8	1705	$1.7E^2$		
D + 9	1705	$2.0E^2$		
D + 10	1715	$2.2E^2$		
D + 11	1815	$2.3E^2$	$7.0E^2$	
D + 12	1705	$1.4E^2$	$8.1E^2$	
D + 13	1825	$1.2E^2$		
D + 14	1755	ND		
D + 15	1715	$1.4E^2$		
D + 16	1725	$1.1E^2$		
D + 17	1715	$1.5E^2$		
D + 18	1655	70		

Note: Water Collected from common tank

Green Chop Fed Cows

Date	Time	^{131}I	^{132}I	^{133}I
D + 1	1745	$2.7E^2$		
D + 2	0705	$1.1E^2$		$1.6E^2$
	1715	$2.4E^2$		
D + 3	0705	$1.9E^2$		
	1655	$1.7E^2$		
D + 4	0655	$4.3E^2$		
D + 5	1800	$3.6E^2$		
D + 6	1715	$2.4E^2$		
D + 7	1655	$2.4E^2$		
D + 8	1715	$1.7E^2$		
D + 9	1655	$1.4E^2$		
D + 10	1705	$2.1E^2$		
D + 11	1705	61		
D + 12	1715	$1.1E^2$		
D + 13	1735	96		
D + 14	1745	$1.2E^2$		
D + 15	1711	$1.8E^2$		
D + 16	1725	$1.0E^2$		
D + 17	1725	ND		
D + 18	1655	$2.7E^2$		

Note: Water collected from an automatic waterer (Star Manufacturing C

$2.1\ E^2 = 2.1 \times 10^2$

ND - Non-detectable

Table IV. Radioiodine activity in hay from the Lee Dairy Farm

Date	Time	pCi/kg			
		^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1940	$2.2E^3$			$4.2E^5$
D + 2	1030	ND			
	1656	ND			
D + 3	0638	$9.0E^2$			
D + 4	1728	$6.2E^2$			
D + 5	0644	ND			
D + 7	0636	$1.8E^2$			
	1720	$1.8E^3$			
D + 8	0630	$1.5E^3$	$2.3E^3$		
	1740	$8.8E^2$			
D + 9	0646	$2.8E^3$			
	1720	$1.2E^2$			
D + 10	0650	$2.0E^3$		$2.4E^3$	
	1710	ND	$2.3E^3$		
D + 11	0640	$1.3E^3$			
	1740	ND			
D + 12	0650	$1.0E^2$			
	1700	ND			
D + 13	0703	ND			
	1720	ND			
D + 14	0712	$5.9E^2$			
D + 15	0724	ND			
D + 16	0630	$8.2E^2$			
D + 17	0720	$3.1E^2$			
D + 18	0900	ND			

$2.2E^3 = 2.2 \times 10^3$
ND - Non-detectable
D + 6 - No sample

Table V. Radioiodine activity in hay from the Schofield Dairy Farm.

Date	Time	pCi/kg ^{131}I	^{132}I	^{133}I
D (April 25)				
D + 1	1725*		1.2E5	1.1E5
D + 2	1905*	2.0E3		
D + 3	0705*	2.2E4	1.2E5	6.0E4
	1655*	7.5E2	1.0E4	
	2000†	ND		
D + 4	0655	4.4E3	1.5E4	
	1735	1.0E4	1.4E4	
D + 5	0755	ND		
	1735	2.0E3		
D + 6	0745	ND		9.4E2
	1725	ND		
D + 7	0745	6.0E3		
	1635	1.8E3		
D + 8	0735	1.7E3		
	1705	1.4E3		
D + 9	0645	6.0E3	4.2E3	
	1705	1.3E3		
D + 10	0635	1.2E3		
	1655	9.4E2		
D + 11	0725	ND		
	1635	7.4E2		
D + 12	0655	1.2E3		
	1655†	ND		
D + 13	0745	2.1E3		
	1725	8.7E2		
D + 14	1735	2.9E3		
D + 15	1715	8.6E2		
D + 16	1725	1.7E3		
D + 17	1715	3.0E3		
D + 18	1655	5.3E2		

*Hay on the Schofield farm was exposed during the cloud passage, was not fed. From the evening of D + 3 through D + 18 uncontaminated hay, from Enterprise, Utah, was fed to cows.

†Hay sample was taken immediately after delivery.

$1.2E^5 = 1.2 \times 10^5$
ND - Non-detectable

Table VI. Radioiodine activity in green chop from the Lee Dairy Farm

Date	Time	pCi/kg ^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1600	1.8E4	2.4E5	2.6E5	ND
	1934*	ND	7.1E5	3.3E5	ND
D + 2	1658	1.1E4	1.6E5	4.1E4	6.0E4
D + 3	1700	1.4E4	1.5E5	3.3E4	
D + 4	0640	1.6E4	4.3E4	2.4E4	
D + 5	1714	8.7E3	8.6E3	ND	
D + 6	0646	8.6E3	ND	5.7E3	
	1728	9.2E3	7.6E3		
D + 7	1000	8.1E3	7.9E3		
	1720	9.2E3	ND		
D + 8	0630	9.1E3	6.8E3		
	1730	8.2E3	6.6E3		
D + 9	0646	6.8E3	6.4E3		
	1720	7.8E3	5.8E3		
D + 10	0650	6.4E3	ND		
	1710	6.6E3	4.3E3		
D + 11	0640	7.3E3	4.4E3		
D + 12	0650	5.2E3	ND		
	1710	3.9E3	1.7E3		
D + 13	0655	4.0E3			
	1720	4.4E3			
D + 14	0712	5.5E3			
D + 16	0630	2.7E3			
D + 18	0900	2.5E3			

*Green chop was cut on D-Day p.m.
$1.8E^4 = 1.8 \times 10^4$
ND = Non-detectable

Table VII. Radioiodine activity in green chop from the Schofield Dairy Farm.

Date	Time	pCi/kg ^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1725	ND	$4.9E^5$	$4.4E^5$	ND
D + 2	0805	ND	$3.0E^5$	$2.4E^5$	ND
D + 3	1715	$3.2E^4$	$1.2E^5$	$2.3E^5$	ND
	0705	$1.7E^4$	ND	ND	ND
	1655	$4.4E^4$	$2.9E^5$	$1.0E^5$	$8.7E^4$
D + 4	0655	$5.6E^4$	$1.9E^5$	$8.9E^4$	
	1735	$5.1E^4$	$7.0E^4$	$5.9E^4$	
D + 5	0745	$5.6E^4$	$7.0E^4$	$4.7E^4$	
	1735	$5.2E^4$	$5.4E^4$	ND	
D + 6	0745	$5.2E^4$	ND	$3.6E^4$	
	1725	$5.5E^4$	$5.0E^4$	$3.5E^4$	
D + 7	0745	$2.2E^4$	$2.2E^4$		
	1645	$3.5E^4$	$3.1E^4$		
D + 8	0735	$1.9E^4$	$1.4E^4$		
	1715	$1.8E^4$	$1.3E^4$		
D + 9	0645	$2.7E^4$	$1.6E^4$		
	1655	$3.0E^4$	$1.7E^4$		
D + 10	0635	$3.2E^4$	$1.9E^4$		
	1705	$1.9E^4$	$1.3E^4$		
D + 11	0725	$1.7E^4$	$1.1E^4$		
	1645	$9.4E^3$	$6.1E^3$		
D + 12	0645	$1.3E^4$	$5.5E^3$		
	1705	$1.0E^4$	$6.3E^3$		
D + 13	0805	$1.7E^4$	$6.5E^3$		
	1735	$1.4E^4$	$6.7E^3$		
D + 14	0725	$2.0E^4$	$6.1E^3$		
	1735	$1.3E^4$			
D + 15	1709	$1.0E^4$			
D + 16	1725	$1.3E^4$			
D + 17	1725	$1.7E^4$			
D + 18	1655	$1.2E^4$			
D + 21	1705	$7.2E^3$			
D + 24	1715	$1.0E^4$			
D + 30	1700	$1.1E^3$			

$4.9E^5 = 4.9 \times 10^5$
ND - Non-detectable

Table VIII. Radioiodine activity in field forage from the Lee Dairy Farm

Date	Field*	Time	pCi/kg ^{131}I	^{132}I	^{133}I
D (April 25)					
D + 3	1	1702	$1.3E^4$	ND	ND
D + 4	1	1746	$8.2E^3$	$8.6E^3$	$9.7E^3$
D + 5	1	1728	$1.0E^4$	$8.0E^3$	ND
D + 6	1	1706	$6.6E^3$	$4.9E^3$	
D + 7	1	0906	$1.0E^4$	$1.2E^2$	
D + 8	1	0624	$7.4E^3$	ND	
D + 9	1	0636	$6.2E^3$		
D + 10	1	0630	$5.2E^3$		
D + 11	1	0630	$4.2E^3$		
D + 12	1	0640	$3.0E^3$		
D + 13	1	0710	$3.0E^3$		
D + 14	1	0716	$1.4E^3$		
D + 15	1	0720	$7.5E^2$		
D + 16	1	0610	$1.9E^3$		
	2	0700	$2.5E^3$		
D + 17	1	0720	$8.0E^2$		
	2	0740	$2.4E^2$		
D + 18	2	0850	$1.2E^2$		
	1	0910	ND		

*Field 1 is at the Lee Dairy Farm.
Field 2 is located across the road from the farm (½ mile).

$1.3E^4 = 1.3 \times 10^4$
ND - Non-detectable

Table IX. Radioiodine activity in field forage from the Schofield Dairy Farm.

Date	Field	Time	pCi/kg ^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)						
D + 1	3	1805	ND	$3.0E^5$	$3.4E^5$	$5.3E^5$
D + 2	3	1705	$2.6E^4$	$7.2E^4$	$1.5E^5$	ND
D + 3	3	1715	$4.6E^4$	$3.4E^5$	$1.1E^5$	ND
D + 4	3	1825	$2.8E^4$	$3.2E^4$	$3.3E^4$	ND
D + 5	3	1835	$3.2E^4$	$3.1E^4$	ND	ND
D + 6	3	1835	$2.5E^4$	ND	$1.5E^4$	ND
D + 7	3	1635	$2.7E^4$	$2.4E^4$	ND	ND
D + 8	3	1725	$1.3E^4$	$1.3E^3$		ND
D + 9	2	1825	$1.2E^3$	$5.7E^3$		ND
	1	1805	$1.5E^4$	$8.6E^3$		ND
	3	1725	$2.0E^4$	$1.1E^4$		$6.7E^2$
D + 10	1	0725	$1.3E^4$	$8.7E^3$		ND
	3	1725	$7.8E^3$	$5.9E^3$		
	1	1715	$9.9E^3$	$6.7E^3$		
D + 11	3	1655	$7.7E^3$	$4.6E^3$		
	1	1645	$8.9E^3$	$5.0E^3$		
D + 12	2	1805	$2.0E^4$	$1.0E^4$		
	3	1825	$1.0E^4$	$6.0E^3$		
D + 13	2	1715	$1.2E^4$	ND		
	3	1725	$2.9E^4$	$1.5E^3$		
D + 14	2	1705	$1.0E^4$	$1.4E^3$		
	3	1715	$5.1E^3$	ND		
D + 15	3	1705	$6.2E^3$			
	2	1651	$7.5E^3$			
D + 16	2	1705	$1.0E^4$			
	3	1715	$6.0E^3$			
D + 17	2	1745	$6.7E^3$			
	3	1755	$3.6E^3$			
D + 18	2	1735	$4.1E^3$			
	3	1745	$4.5E^3$			

Field 1 - Northwest of dairy barn - sprinkler system
Field 2 - East of dairy barn - flood irrigation
Field 3 - North of dairy barn - flood irrigation

$3.0E^5 = 3.0 \times 10^5$
ND = Non-detectable

Table X. Radioiodine in milk from the Lee Dairy Farm, Cows Fed Contaminated Green Chop pCi/liter

Date	Time	^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1700	$6.0E^2$	$2.0E^3$	$1.9E^3$	$2.8E^3$
D + 2	0630	$1.1E^3$	$4.7E^3$	$3.6E^3$	$2.2E^3$
	1730	$9.8E^2$	$8.5E^3$	$2.5E^3$	ND
D + 3	0644	$8.0E^2$	$2.5E^3$	$1.4E^3$	
	1748	$1.4E^3$	$3.9E^3$	$1.8E^3$	
D + 4	0710	$8.0E^2$	$1.9E^3$	$7.3E^2$	
	1758	$7.6E^2$	ND	$5.4E^2$	
D + 5	0656	$4.4E^2$	ND	$2.6E^2$	
	1756	$5.3E^2$	ND	$2.1E^2$	
D + 6	0642	$6.3E^2$	ND	$1.9E^2$	
	1800	$6.1E^2$	ND	$1.5E^2$	
D + 7	0642	$4.6E^2$	$1.4E^3$	ND	
	1730	$5.2E^2$	$1.5E^3$		
D + 8	0646	$4.5E^2$	$1.0E^3$		
	1750	$4.5E^2$	$1.2E^3$		
D + 9	0706	$3.0E^2$	ND		
	1730	$3.4E^2$	$1.4E^2$		
D + 10	0700	$2.9E^2$	$9.5E^2$		
	1745	$2.6E^2$	$8.9E^2$		
D + 11	0650	$2.0E^2$	ND		
	1800	$2.2E^2$	ND		
D + 12	0650	$2.0E^2$	ND		
	1740	$2.2E^2$	ND		
D + 13	0715	$1.3E^2$	$7.0E^2$		
	1740	$1.5E^2$	ND		
D + 14	0650	$2.1E^2$	ND		
D + 15	0740	$8.0E^1$	ND		
D + 1	0700	$1.0E^2$	ND		
D + 18	0700	$4.0E^1$	$2.0E^3$		

$6.0E^2 = 6.0 \times 10^2$
ND - Non-detectable

Table XI. Radioiodine in milk from the Schofield Dairy Farm.

Cows Fed Contaminated Green Chop

Date	Time	pCi/liter ^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1735	3.3E3	1.7E4	2.0E4	2.3E4
D + 2	0735	4.4E3	1.8E4	1.5E4	5.0E3
	1810	4.8E3	9.9E4	1.2E4	ND
D + 3	0705	4.0E3	1.3E5	6.7E3	
	1755	3.7E3	ND	4.7E3	
D + 4	0905	3.9E3	ND	ND	
	1735	4.1E3	ND	ND	
D + 5	0745	3.3E3	1.6E4	2.4E3	
	1805	3.2E3	1.4E4	1.4E3	
D + 6	0715	3.5E3	6.9E3	7.2E2	
	1815	4.0E3	7.7E3	ND	
D + 7	0725	3.0E3	6.5E3	1.7E2	
	1805	3.1E3	5.9E3	7.0E1	
D + 8	0725	2.1E3	1.7E3	ND	
	1845	1.8E3	4.1E3		
D + 9	0745	1.9E3	3.5E3		
	1755	1.8E3	3.4E3		
D + 10	0725	1.6E3	3.5E3		
	1805	1.7E3	ND		
D + 11	0705	1.5E3	2.7E3		
	1755	1.3E3	2.8E3		
D + 12	0725	1.1E3	2.3E3		
	1745	9.3E2	1.6E3		
D + 13	0745	1.2E3	4.2E2		
	1805	1.0E3	ND		
D + 14	0715	1.4E3			
	1748	1.2E3			
D + 15	1755	9.5E2			
D + 16	1755	8.6E2			
D + 17	1735	9.5E2			
D + 18	1725	3.8E2			
D + 21	1735	3.7E2			
D + 24	1715	1.6E2			
D + 30	1725	2.9E2			
D + 44	1725	7.4E1			

$3.3E^3 = 3.3 \times 10^3$

ND - Non-detectable

Table XII. Radioiodine in milk from the Schofield Dairy Farm

Cows Fed Uncontaminated Hay

Date	Time		pCi/liter ^{131}I	^{132}I	^{133}I
D (April 25)					
D + 3	0705	3.85	$4.0E^3$	$1.0E^4$	$6.7E^3$
	1735		$3.7E^3$	$1.0E^4$	$4.7E^3$
D + 4	0645	1.25	$1.5E^3$	ND	$1.4E^3$
	1725		$1.0E^3$	ND	$7.3E^2$
D + 5	0735	.475	$5.0E^2$	ND	$2.9E^2$
	1745		$4.5E^2$	ND	$1.5E^2$
D + 6	0705	.199	$2.5E^2$	$1.4E^3$	$7.0E^1$
	1735		$1.4E^2$	$1.3E^3$	$4.0E^1$
D + 7	0715	.115	$1.3E^2$	ND	ND
	1745		$1.0E^2$	$1.2E^3$	
D + 8	0655	.08	$8.0E^1$	ND	
	1825		$7.0E^1$	$8.0E^2$	
D + 9	0725		ND	ND	
	1735		$3.0E^1$	$6.8E^2$	
D + 10	0705		ND	ND	
	1755		$4.0E^1$	ND	
D + 11	0655	.05	$4.0E^1$	ND	
	1725		$6.0E^1$	ND	
D + 12	0715	.03	$3.0E^1$	ND	
	1735		ND	$5.2E^2$	
D + 13	0735	.05	$5.0E^1$	ND	
	1755		$4.0E^1$		

$4.0E^3 = 4.0 \times 10^3$

ND - Non-detectable

Σ avg = 6.1×10^3 pCi

Table XIII. Half-lives from repetitive counting

Date	Time	Sample Type	Location	Physical Half-Life (Days) Short	Long	Short After Subtracting Long
D (April 25)						
D + 1	p.m.	Milk	Schofield	1.5	8.5	0.7
D + 2	a.m.	Milk	Schofield	1.8	8.5	1.0
	p.m.	Milk	Schofield	2.0	9.4	1.0
D + 3	a.m.	Milk	Schofield	2.8	12.0	1.2
D + 4	a.m.	Milk	Schofield	3.0	8.0	1.3
	p.m.	Milk	Schofield	3.5	8.0	1.2
D + 6	p.m.	Milk	Schofield	0	8.0	0
D + 10	p.m.	Milk	Schofield	0	8.0	0
D + 1	p.m.	Green Chop	Schofield	2.5	8.5	1.0
D + 6	p.m.	Eggs	Schofield	0	8.6	0
D + 4	p.m.	Milk	Lee	0	7.7	0
D + 1	p.m.	Green Chop	Lee	2.3	8.5	1.0
Average D + 1 through D + 4				2.42	---	1.05
Overall Average				----	8.64	----

Table XIV. Radioiodine activity in soil samples from L. Lee Dairy Farm

Collection		pCi/kilogram			
Date	Time	^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1930	3.56E3	7.31E4	2.16E4	ND
D + 2	1720	2.04E3	5.75E4	4.20E3	ND
D + 3	1710	1.74E3	5.59E3	1.40E3	ND
D + 4	1754	1.20E3	2.64E4	8.80E2	1.10E4
D + 5	1730	1.30E3	1.44E3	6.90E2	1.60E2
D + 6	1704	4.10E3	4.23E3	1.76E3	7.30E2
D + 7	0900	1.08E3	1.61E3	5.50E2	2.80E2
D + 8	0640	2.41E3	1.36E4	1.51E3	ND
D + 9	0640	1.85E3	2.09E3	1.00E3	2.70E2
D + 10	0620	1.51E3	1.33E3	5.60E2	2.80E2
D + 11	0640	1.36E3	1.05E3	5.90E2	1.30E2
D + 12	0630	1.21E3	1.25E3	6.70E2	
D + 13	0650	1.67E3	1.29E3	5.30E2	
D + 14	0716	1.19E3			
D + 15	0720	9.70E2			
D + 16	0614	9.40E2			
D + 17	0720	1.04E3			
D + 18	0850	1.59E3			

3.56E3 = 3.56×10^3
ND - Non-detectable

Table XV. Radioiodine activity in soil samples from W. Schofield Dairy Farm

Collection		pCi/kilogram			
Date	Time	^{131}I	^{132}I	^{133}I	^{135}I
D (April 25)					
D + 1	1805	$4.20E^3$	$5.82E^4$	$3.71E^4$	$9.10E^3$
D + 2	1825	$4.43E^3$	$1.40E^5$	$1.79E^4$	ND
D + 3	1715	$4.61E^3$	$2.11E^4$	$9.66E^3$	ND
D + 4	1735	$3.37E^3$	$6.37E^3$	$3.88E^3$	$9.00E^2$
D + 5	1800	$1.14E^4$	$1.58E^4$	$8.53E^3$	$2.21E^3$
D + 6	1835	$4.89E^3$	$4.79E^3$	$3.21E^3$	$6.50E^2$
D + 7	1635	$2.15E^3$	$2.78E^3$	$7.60E^2$	ND
D + 8	1710	$1.89E^3$	$1.94E^3$	$8.00E^2$	$2.40E^2$
D + 9	1725	$1.81E^3$	$1.85E^3$	$7.70E^2$	$3.70E^2$
D + 10	1725	$3.16E^3$	$2.58E^3$		$1.80E^2$
D + 11	1655	$2.19E^3$	$1.99E^3$		$2.80E^2$
D + 12	1825	$2.82E^3$	$2.53E^3$		
D + 13	1725	$2.97E^3$	$1.97E^3$		
D + 14	1715	$1.94E^3$			
D + 15	1705	$1.63E^3$			
D + 16	1715	$1.17E^3$			
D + 17	1755	$1.79E^3$			
D + 18	1745	$1.54E^3$			

$4.20E^3 = 4.20 \times 10^3$

ND - Non-detectable

Table XVI. Results of blood analysis

Cow	Date	gms. Hgb	% HCT	1×10^6 RBC	WBC	% JUV.	% STAB.	% SEGS.	% LYMPH	% EOS.	% MONO.	% BASO.	gm/100 TP	µgm PBI
							Alamo							
1	+ 3	13.0	38	5.0	6400	0	4	35	56	2	3	0	8.1	3.00
23	+ 3	12.7	42	5.0	8600	0	0	34	54	7	5	0	8.8	2.25
53	+ 3	13.4	44	5.0	5550	0	2	41	52	4	1	0	7.1	3.65
72	+ 3	12.3	37	4.9	10200	0	2	43	53	1	0	0	8.1	3.65
73	+ 3	13.0	42	4.9	11700	0	2	36	55	5	2	0	8.5	2.45
75	+ 3	13.0	39	4.9	14100	0	3	23	46	22	6	0	8.1	2.50
1	+ 16	12.0	41	4.8	5300	0	3	35	56	3	3	0	7.8	2.70
23	+ 16	12.0	41	4.8	4300	0	2	34	59	3	2	0	8.3	2.60
53	+ 16	12.3	42	4.8	6150	0	2	32	59	6	1	0	6.7	3.35
72	+ 16	11.7	39	4.7	9450	0	3	40	53	4	0	0	7.8	3.30
73	+ 16	11.7	39	4.9	10800	0	3	31	63	3	0	0	7.4	2.85
75	+ 16	12.3	40	4.8	9600	0	4	23	57	14	2	0	7.7	2.85
							Hiko							
57	+ 3	12.0	38	4.9	11800	0	1	44	51	2	2	0	8.0	2.85
68	+ 3	11.3	36	4.7	7900	0	2	28	67	3	0	0	7.6	2.20
85	+ 3	13.9	42	5.1	6100	0	4	38	52	4	2	0	8.3	2.40
97	+ 3	13.0	40	4.9	9500	0	2	35	61	2	0	0	8.3	3.25
112	+ 3	11.7	36	4.8	7300	0	0	30	67	1	2	0	7.7	2.45
116	+ 3	11.7	36	4.7	11300	0	1	40	54	5	0	0	7.7	2.35
137	+ 3	12.7	38	4.9	13800	0	3	40	54	1	2	0	9.5	2.35
141	+ 3	13.4	43	5.1	8100	0	2	43	49	2	4	0	7.5	2.50
57	+ 16	11.3	39	2.8	7700	0	2	32	63	3	0	0	7.2	2.80
97	+ 16	13.0	42	4.9	10700	0	1	43	55	0	1	0	7.9	3.10
116	+ 16	12.7	41	4.9	8850	0	1	45	48	6	0	0	7.1	3.20
141	+ 16	13.0	44	4.8	8150	0	2	39	56	3	0	0	7.5	2.85

Hgb - Hemoglobin
HCT - Hematocrit
RBC - Red blood cells
WBC - White blood cells

JUV - Juveniles
STAB - Neutrophils
SEGS - Segmented neutrophils
LYMPH - Lymphocytes

EOS - Eosinophils
MONO - Monocytes
BASO - Basophils
TP - Total protein
PBI - Protein-bound iodine

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