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DEPARTMENT OF HEALTH
NEW ZEALAND

ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT

1979

NATIONAL RADIATION LABORATORY
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ACKNOWLEDGEMENT

We gratefully acknowledge the assistance given by the staff of this and other Government Departments, and in particular the New Zealand Meteorological Service and the managers of milk processing plants. Without their continued co-operation in making collections and providing samples the Laboratory's monitoring programme would not be possible.

The Environmental Radioactivity Section of the Laboratory organised the monitoring operations and analysed the samples. The Officer in Charge of this section, Mr L. P. Gregory, was responsible for reporting and interpreting results. He was assisted professionally by Dr K. M. Matthews, and technically by Miss M. Roberts.

for H. R. Atkinson
(Director)

Published with the authority of the Director-General of Health.

UNITS AND REFERENCE LEVELS

Units

The unit of radioactivity, the "Curie" (Ci), equal to 3.7×10^{10} disintegrations per second, is too large for environmental levels, and subdivisions are used in this report: the millicurie (mCi) = 10^{-3} Ci, and the picocurie (pCi) = 10^{-12} Ci or 2.22 disintegrations per minute.

Deposition of radioactivity is given as millicuries per square kilometre (mCi/km^2)

Concentration of radioactivity

in air: is given as picocuries per cubic metre (pCi/m^3)

in rain: is given as picocuries per litre (pCi/l) and is derived from the relationship:

$$pCi/l = \frac{mCi/km^2 \times 1000}{\text{millimetres of rain}}$$

in milk: strontium-90 (^{90}Sr) concentration is given as picocuries per gram of calcium (pCi/gCa)

caesium-137 (^{137}Cs) concentration is given as picocuries per gram of potassium (pCi/gK)

(One litre of milk contains about 1.2 g of calcium and about 1.4 g of potassium)

Reference Levels

The following reference levels, against which measured levels reported herein may be compared, have been adopted for New Zealand:

Mixed fission products between 10 and 80 days old (Total Beta Activity)

	in air:	300 pCi/m^3
	in rain:	6000 pCi/l
strontium-90	in milk:	270 pCi/gCa
caesium-137	in milk:	7000 pCi/gK

SUMMARY

During 1979 and the previous two years annual depositions of strontium-90 at nine New Zealand stations averaged less than 0.1 millicuries per square kilometre. These were the lowest annual depositions measured since monitoring commenced in 1960.

During 1964 a maximum deposition (averaging 3.6 mCi/km^2 for the New Zealand stations), resulted from the large-scale USSR and USA atmospheric nuclear tests of 1961-62. Subsequently annual depositions decreased. During French atmospheric tests in the South Pacific from 1966 to 1974 average depositions in New Zealand ranged from 0.3 to 1.4 mCi/km^2 per year.

The concentrations of strontium-90 and caesium-137 in New Zealand milk have reflected the changes in fallout deposition. The average concentrations during the past few years have been the lowest recorded since measurements commenced.

French underground nuclear tests in the South Pacific commenced in mid-1975. Since then continuous monitoring has also been conducted at five Pacific Island stations. No fresh fission products, from possible venting of underground nuclear tests, have been detected since this programme started.

The levels recorded during recent years are very small fractions of the reference levels and thus do not constitute a public health hazard. Moreover, the radiation dose to the general population resulting from the long-term average levels, summarised herein, is small compared not only with the dose from the natural background but also with that from common variations in the natural background.

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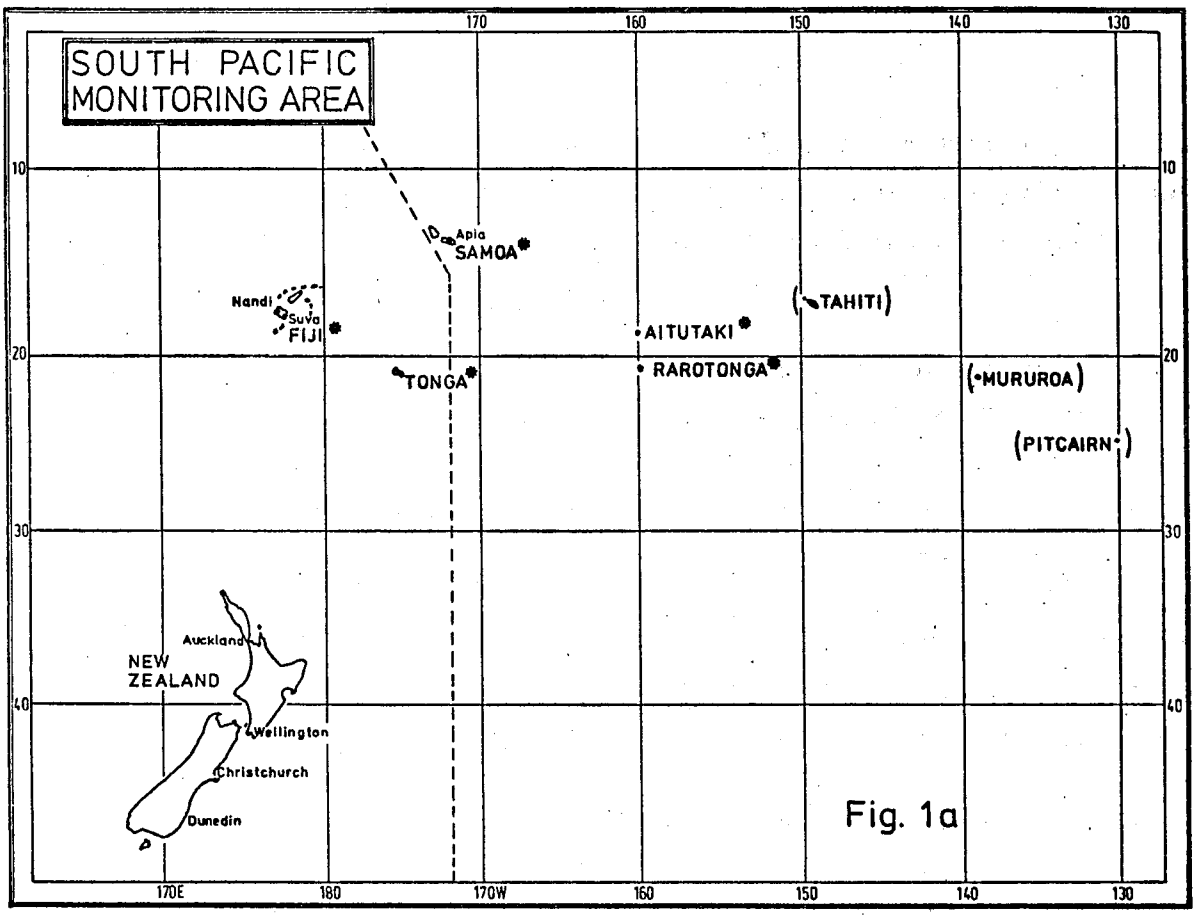

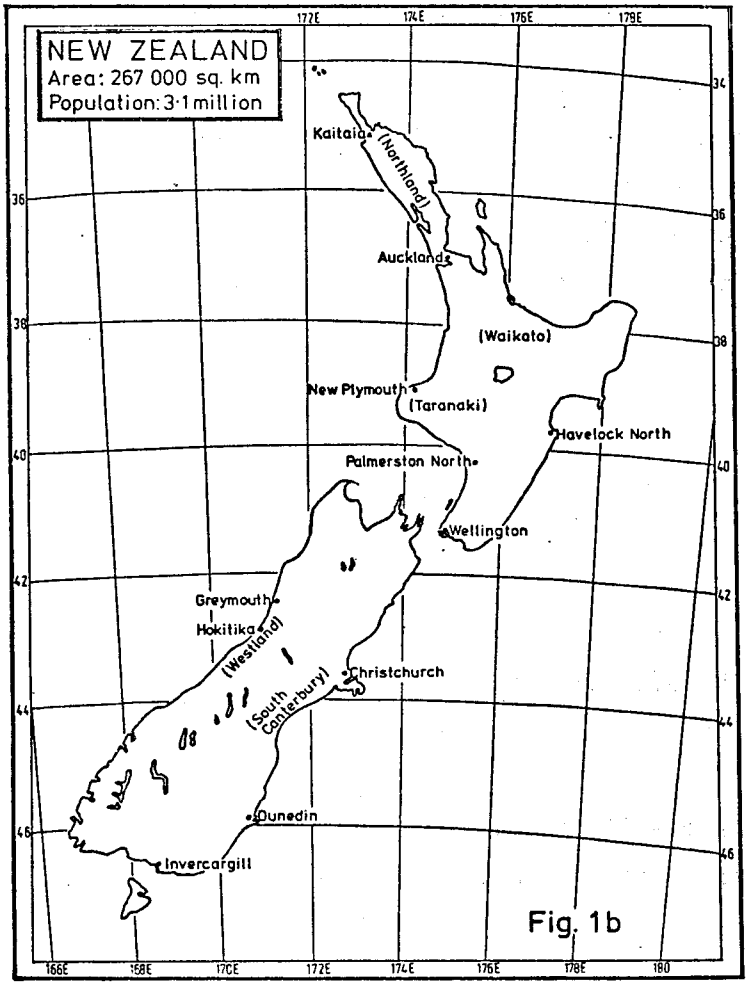

FIG. 1 MONITORING AND COLLECTING STATIONS ON PACIFIC ISLANDS AND IN NEW ZEALAND.

INTRODUCTION

This report continues the series of reports on environmental radioactivity in New Zealand, and in the South Pacific area, which have been published since 1961.

In September 1974 France terminated atmospheric nuclear testing which had been conducted in the Tuamotu Archipelago in the South Pacific since 1966, and in June 1975 commenced underground testing in the same area. Consequently the Laboratory's monitoring programme was changed to detect any venting to the atmosphere of fission products from underground tests. The programme consists of continuous air and rainwater monitoring at five Pacific Island and four New Zealand stations. Samples are sent to the Laboratory for measurement of total beta activity.

The routine programme monitoring long-term radioactive fallout from earlier atmospheric tests was also continued during 1979. Here emphasis is given to the measurement of the two most potentially hazardous long-lived radionuclides, strontium-90 and caesium-137. Depositions of strontium-90 in rain are measured at nine New Zealand and two Pacific Island stations. (Naturally-occurring lead-210 is also evaluated concurrently.) Strontium-90 and caesium-137 concentrations are measured in milk from nine New Zealand stations.

Monitoring and sample collecting stations are shown in Fig. 1 a and b.

Fallout levels in recent years and particularly since 1976 have been very low and reports covering this period have been abbreviated. The reader is referred to the earlier annual reports(1), and special reports on French atmospheric nuclear tests (2). These give additional information on terms of reference, potential health hazard, adoption of reference levels, and technical information on procedures. They also include graphical presentations of results allowing historical and geographical comparisons.

TOTAL BETA ACTIVITY IN AIR AND RAIN

Normally the short-lived decay products of naturally-occurring radon account for most of the beta activity in air. Ground level air over continents has a beta activity commonly ranging between 60 and 600 picocuries per cubic metre, but under certain conditions the beta activity may be up to ten times the upper value of this range.

Air filter and rainwater samples are measured four days after collection when naturally-occurring beta activity has decayed and residual beta activity from radioactive fallout can be assessed. Hereafter the term "total beta activity"

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(1) "Environmental Radioactivity":

Annual Report 1971, Report No. NRL-F/48, June 1972 (summarising previous results)
Annual Report 1972, Report No. NRL-F/50, April 1973
Annual Report 1973, Report No. NRL-F/52, June 1974
Annual Report 1974, Report No. NRL-F/54, June 1975
Annual Report 1975, Report No. NRL-F/55, June 1976
Annual Report 1976, Report No. NRL-F/56, April 1977 (shortened version)
Annual Report 1977, Report No. NRL-F/57, April 1978 (shortened version)
Annual Report 1978, Report No. NRL-F/58, April 1979 (shortened version)

(2) "Environmental Radioactivity. Fallout from Nuclear Weapons Tests Conducted by France in the South Pacific . . . and comparisons with previous test series." Report Nos: NRL-F/47, March 1972 (summarising all previous monitoring results since 1966); NRL-F/49, October 1972; NRL-F/51, November 1973, and NRL-F/53, November 1974.

refers to residual fission product radioactivity in the sample and excludes naturally-occurring radioactivity.

1. Fission Products in Air

During 1979 air was monitored continuously at the New Zealand and Pacific Island stations listed in Table 1. The filters were changed three times each week and were despatched to the Laboratory for measurement of total beta activity. Average levels each month during 1979 did not exceed the limit of detection at any station. Because of the very low levels individual results and monthly averages are not tabulated in the Appendix. However, the 1979 annual average results are included in Table 1 for comparison with average levels in previous years.

TABLE 1 - Total Beta Activity in Air - Annual Averages (pCi/m^3)

	New Zealand				Pacific Islands				
	AK	WN	HK	CH	FJ	SM	TO	AI	RA
1966	0.14	(0.10)		0.11					
1967	0.08	0.05		0.06					
1968	0.12	0.10		0.07	Average levels ranged from				
1969	0.12	0.09		0.07					
1970	0.16	0.12	(0.12)	0.10	0.04 - 6.22 pCi/m^3 in the				
1971	0.21	0.12	0.16	0.15	South Pacific area during the				
1972	0.06	0.05	0.05	0.05					
1973	0.02	0.01	0.02	0.02	special monitoring programmes				
1974	0.08	0.05	0.07	0.05					
1975	0.03	0.03	0.03	0.02	<0.01	<0.01	0.01	<0.01	0.01
1976	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1977	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.01
1978	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02
1979	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02

Notes:
1. The stations are: Auckland, Wellington, Hokitika, Christchurch, Fiji, Samoa, Tonga, Aitutaki, and Rarotonga.
2. Values in parenthesis are estimates: At Wellington measurements commenced 12 July 1966; at Hokitika, 1 May 1970.
3. At the Pacific Islands the 1975 results are for June-Dec. only (during this period the New Zealand results were similar average 0.01 pCi/m^3).
4. Starting 1977 the limit of detection is either 0.01 or 0.02 pCi/m^3 depending on the air sampling equipment in use.

Levels in New Zealand have been latitude dependent during the French atmospheric tests (1966-1974). For example, levels at Auckland are higher in most cases than those at Christchurch. Moreover, levels at the Pacific Islands, during the 3 to 6 month programmes monitoring these tests, were significantly higher, averaging from 0.04 to 6.22 pCi/m^3, depending on the monitoring station, meteorological conditions and the extent of nuclear testing (2).

Since mid-1975, about nine months after the termination of the French atmospheric nuclear tests, levels have not exceeded the limit of detection at any station, and no fresh fission products have been detected since underground testing started.

All levels of fission products in air tabulated here and particularly those during recent years have been very small fractions of the reference levels.

2. Fission Products in Rain

During 1979 weekly funnel and bottle collections of rainwater were made at the same stations providing air filter samples. The rainwater samples were despatched to the Laboratory where they were processed and measured for total beta activity.

Annual totals, since measurements started, are listed for each station in Table 2. (Individual weekly results during 1979 are given in Table 7a, and quarterly cumulative results in Table 7b, in the Appendix.)

TABLE 2 - Total Beta Activity in Rain - Annual Totals (mCi/km^2)

	New Zealand				Pacific Islands				
	AK	WN	HK	CH	FJ	SM	TO	AI	RA
1963				28					
1964		-		15					
1965				17					
1966			106	32					
1967			77	14					
1968			205	28					
1969			61	18					
1970	101	75	133	26					
1971	98	80	99	32					
1972	25	22	33	15					
1973	5	7	8	4					
1974	59	60	42	22					
1975	9	13	19	13	3	4	2	3	4
1976	3	3	4	2	3	3	4	4	3
1977	2	3	3	2	3	5	4	4	4
1978	3	3	5	2	4	6	6	6	6
1979	3	3	5	2	3	3	7	6	5

Average depositions ranged from 3 - 540 mCi/km^2 in the South Pacific area during the special monitoring programmes

Notes:
1. See Table 1 (Note 1) for station names.
2. Measurements commenced in Westland at Greymouth in July 1966 (the first result is for July-Dec. 1966 only). The station was transferred to Hokitika starting Jan. 1976.
3. Measurement commenced at AK and WN in May 1970 (the 1970 results are for May-Dec. only).
4. At the Pacific Islands the 1975 results are for June-Dec. only (during this period the New Zealand results were similar, averaging about 4 mCi/km^2).

Since 1976 the annual depositions range from 2 to 7 mCi/km^2 and are the lowest recorded since measurements started. The average concentrations range from 1 to 4 pCi/l (see Table 7 Appendix). These concentrations are very small fractions of the reference level.

STRONTIUM-90 DEPOSITION

1. Routine Measurement

Strontium-90 deposition measurements started at six stations in New Zealand in 1960, and at Suva in 1961. Since 1963 measurements have been made continuously at nine New Zealand stations, and since 1967 at Rarotonga also. Collections are made continuously in high walled stainless steel pots which are changed each month. The collected rainwater is passed through a column of cation exchange resin at the collecting site. The resin is then mailed to the Laboratory for measurement of strontium-90.

Annual depositions at each station since measurements commenced are listed in Table 3. The New Zealand station average deposition is also listed. (Individual results, aggregated quarterly during 1979, are given in Table 8 Appendix.)

TABLE 3 - Annual Deposition of Strontium-90 (mCi/km^2), Mean Annual Rainfall (mm)

	New Zealand Stations										Pacific Islands	
	KA	AK	NP	HN	WN	HK	CH	DN	IN	Average	SU	RA
1960		1.2		0.7	0.8	1.5	0.5		0.5	0.9		
1961		1.1		0.8	1.1	2.2	0.7		1.2	1.2	1.0	
1962		1.8		1.0	1.8	2.8	0.7		1.2	1.6	1.6	
1963	1.8	2.0	2.0	1.0	2.0	3.7	1.2	1.0	1.7	1.8	2.4	
1964	4.1	4.0	5.3	1.6	3.4	7.8	1.3	1.8	3.0	3.6	2.5	
1965	3.1	2.9	4.2	1.7	3.9	5.9	1.7	2.0	2.8	3.1	2.0	
1966	1.6	1.3	1.9	0.8	1.6	2.2	0.7	0.7	1.1	1.3	1.2	
1967	1.0	0.9	1.3	0.5	1.0	1.7	0.4	0.6	0.9	0.9	0.8	(0.9)
1968	0.9	0.7	1.0	0.6	0.9	1.4	0.4	0.4	0.5	0.8	1.0	0.7
1969	1.5	1.3	1.5	0.7	1.1	2.2	0.7	0.7	1.2	1.2	1.3	0.7
1970	1.0	0.9	1.2	0.6	1.2	2.1	0.5	0.5	0.7	1.0	0.9	1.0
1971	2.0	1.3	1.9	1.0	1.2	2.5	0.7	0.8	1.1	1.4	(1.5)	(0.9)
1972	0.9	0.7	0.9	0.5	0.8	1.8	0.4	0.6	0.9	0.8	0.9	0.8
1973	0.4	0.3	0.3	0.2	0.4	0.6	0.2	0.2	0.3	0.3	0.4	0.6
1974	0.3	0.2	0.3	0.2	0.3	0.5	0.2	0.2	0.2	0.3	0.3	0.3
1975	0.3	0.2	0.3	0.2	0.3	0.6	0.2	0.2	0.3	0.3	0.2	0.1
1976	0.1	0.1	0.1	<0.1	0.2	0.2	<0.1	<0.1	<0.1	0.1	0.1	0.1
1977	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1978	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1979	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
mm	1370	1090	1470	840	1450	2490	690	680	1020		3300	1850

Notes:
1. The New Zealand stations are: Kaitaia, Auckland, New Plymouth, Havelock North, Wellington, Hokitika, Christchurch, Dunedin and Invercargill. The Pacific Island stations are: Suva (Fiji), and Rarotonga.
2. The mean annual rainfall, rounded to the nearest 10 mm, is given for the last 10 years.
3. The station in Westland (HK) was at Greymouth from 1960-1975 inclusive and was resited at Hokitika starting Jan. 1976. Rainfalls at the actual collecting sites were used for calculating the mean.
4. Values in parenthesis are estimates.

The large scale Northern Hemisphere (USSR) and Pacific area (USA) nuclear tests, conducted in 1961 and 1962 before the signing of the Partial Test Ban Treaty, resulted in a delayed stratospheric fallout over New Zealand. Maximum annual depositions, exceeding an average of 3 mCi/km^2, occurred in New Zealand in 1964 and 1965. Annual depositions then decreased steadily until 1968.

From 1966 to 1974 smaller scale atmospheric nuclear tests were conducted by France in the South Pacific each year except 1969. Each series, lasting from one to three months and comprising from three to eight nuclear explosions, took place during the Southern Hemisphere winter. Forty-one nuclear devices were reported to have been exploded, most of them being in the low to medium power (kiloton) range. However, megaton explosions were reported twice in 1968, twice in 1970, and once in 1971 (2). The annual deposition of strontium-90 in New Zealand increased again during the period 1969 to 1971 reaching a second smaller maximum in 1971, less than one-half of the 1964 maximum. Since then the annual depositions have decreased progressively.

During 1976 monthly results were nearing the limit of detection. Samples collected since then have been aggregated quarterly to obtain sufficient analytical sensitivity. Annual depositions during the last four years have been the lowest recorded since this strontium-90 monitoring started.

Estimates of the French nuclear tests' contribution to the total strontium-90 deposition in New Zealand, and also comparisons of New Zealand and Northern Hemisphere depositions were made in earlier reports (1).

The long term strontium-90 deposition, which includes a significant stratospheric component, has shown no latitude dependence within New Zealand. The deposition, however, is rainfall dependent and high rainfall areas such as Greymouth or Hokitika in Westland have shown elevated values compared to low rainfall areas such as Christchurch on the east coast: excluding the last four years of minimal fallout, the mean annual deposition (normalised for rainfall) at the nine New Zealand stations during 1963-1975 inclusive was 1.08 ± 0.06 mCi/km^2 per 1000 mm of rain.

In 1964, the year of maximum strontium-90 fallout, the deposition at Suva was less than that in New Zealand despite the much higher rainfall at Suva. This is characteristic of stratospheric fallout, tropics receiving less stratospheric fallout than mid-latitudes. Since then depositions at the Pacific Islands have been similar to the New Zealand average. It is probable that during French Pacific nuclear testing a larger tropospheric component and smaller stratospheric component in the Pacific resulted in depositions similar to those in New Zealand where the relative contribution of the two components was reversed.

The cumulative deposition of strontium-90 at selected sites, and the special "profile survey" conducted during 1976, were discussed in the 1977 annual report (1).

LEAD-210 DEPOSITION

Lead-210 is a naturally-occurring radionuclide produced in the atmosphere by decay of gaseous radon which is exhaled from land surfaces. The deposition of lead-210 is rainfall dependent, like strontium-90, and high rainfall areas such as Hokitika show elevated values compared to low rainfall areas such as Christchurch.

Lead-210 monitoring was continued during 1979, using the same monthly rainwater samples collected for strontium-90 monitoring. Earlier results, including higher levels during 1965 at four stations, and levels in milk, were discussed in the 1971 annual report (1).

Annual depositions at each station since 1968 are listed in Table 4. The New Zealand station average deposition is also listed. (Individual monthly results during 1979 are given in Table 9 Appendix.)

TABLE 4 - Annual Deposition of Lead-210 (mCi/km^2)

	New Zealand Stations										Pacific Islands	
	KA	AK	NP	HN	WN	HK	CH	DN	IN	Average	SU	RA
1967*	0.62	1.15	1.72	0.73	1.02	2.38	0.36	0.56	0.99	1.06	1.25	0.60
1968	1.75	1.64	2.08	0.84	1.86	3.20	0.64	0.76	1.06	1.54	2.46	0.61
1969	1.83	1.33	1.54	0.88	1.20	3.94	0.56	0.92	1.29	1.50	1.91	0.98
1970	1.43	1.00	1.82	0.63	1.52	3.09	0.65	0.74	0.92	1.31	1.85	0.85
1971	2.07	1.04	0.96	0.65	1.26	2.34	0.52	0.74	1.09	1.19	1.83	-
1972	2.28	1.62	1.99	0.88	1.70	3.41	0.70	1.22	1.31	1.68	2.65	-
1973	1.92	1.42	2.29	0.80	1.80	3.31	0.48	0.67	0.81	1.50	2.11	-
1974	1.24	1.08	1.76	0.76	1.61	2.85	0.71	0.66	0.58	1.25	1.86	4.00
1975	1.61	1.51	1.81	1.12	1.97	3.94	0.92	0.91	1.11	1.66	2.91	1.40
1976	1.41	1.33	1.43	0.93	1.46	2.73	0.70	0.71	0.76	1.27	2.03	-
1977	1.33	1.10	1.68	0.75	1.55	2.61	0.63	0.74	1.09	1.27	1.68	-
1978	1.61	1.14	1.61	0.75	1.40	2.88	0.73	0.88	0.99	1.33	2.24	-
1979	1.89	1.50	1.88	1.02	2.05	4.50	0.74	0.91	1.03	1.72	2.13	-

Note: See Table 3 (Notes 1 and 2) for station names and the resiting of the Westland station. *1967 results are for May-Dec. only.

There does not appear to be any marked seasonal variation nor, unlike strontium-90, any significant change in the annual deposition, which consistently averages about 1.4 mCi/km^2 at New Zealand stations. Because of the current low strontium-90 deposition, lead-210 deposition is now at least an order of magnitude higher.

STRONTIUM-90 AND CAESIUM-137 IN MILK

Monitoring of strontium-90 in New Zealand milk started in 1961, and caesium-137 in 1964. Since 1965 continuous measurements have been made on milk samples from nine collecting stations. Caesium-137 and potassium are determined monthly by gamma spectroscopy. Samples are then aggregated quarterly for strontium-90 analysis, and for the determination of calcium.

1. Strontium-90

Annual average concentrations of strontium-90 in milk at each station since 1961 are listed in Table 5. The station average each year is also listed. (Individual quarterly results during 1979 are given in Table 10 Appendix.)

TABLE 5 - Strontium-90 in Milk - Annual Averages (pCi/gCa)

	ND	AK	WK	TA	PN	WN	WD	CH	DN	Average
1961	4.5		4.1	7.1			12.7	1.6		6.0
1962	6.3	5.5	4.9	9.4	4.3		13.5	2.1	3.0	6.1
1963	7.5	5.3	5.6	9.9	4.9		17.2	2.7	3.7	7.1
1964	11.2	9.1	9.5	17.1	7.1		26.0	2.6	4.1	10.8
1965	10.6	9.4	9.8	16.7	8.4	8.8	28.8	4.3	7.4	11.6
1966	6.5	6.1	6.3	12.5	4.8	6.1	22.7	2.4	4.0	7.9
1967	5.1	5.2	5.0	10.4	3.9	5.4	17.8	1.9	3.1	6.4
1968	4.1	3.8	4.1	8.0	3.6	4.8	14.0	1.6	2.4	5.2
1969	6.3	6.0	5.4	9.4	5.8	5.1	17.9	1.7	3.0	6.7
1970	5.2	5.1	5.2	9.7	3.6	4.7	21.0	2.2	2.5	6.6
1971	7.3	5.8	6.0	10.2	5.0	4.8	18.3	2.0	3.0	6.9
1972	4.8	4.6	4.4	8.2	5.0	4.1	14.7	1.9	3.1	5.6
1973	3.8	3.4	3.5	5.7	2.7	3.5	10.8	1.2	1.9	4.1
1974	3.3	3.0	2.7	5.4	2.5	3.0	8.8	1.3	1.9	3.5
1975	3.1	2.7	3.0	5.1	2.4	3.4	8.7	1.2	1.6	3.5
1976	2.6	2.4	2.5	3.5	1.6	2.4	6.1	1.1	1.1	2.6
1977	2.1	2.1	2.4	3.9	1.4	2.1	5.0	1.0	1.2	2.3
1978	1.7	2.1	2.2	2.9	1.5	2.1	3.9	1.0	1.1	2.1
1979	1.6	1.8	2.5	4.2	1.5	1.9	3.9	1.0	0.9	2.1
Average	5.1	4.6	4.7	8.4	3.9	4.1	14.3	1.8	2.7	5.6

Note: The stations are: Northland, Auckland, Waikato, Taranaki, Palmerston North, Wellington, Westland, Christchurch, and Dunedin.

Average levels in New Zealand milk reached maximum values of 10.8 and 11.6 pCi/gCa during 1964 and 1965 when the rate of strontium-90 deposition was also a maximum. Milk levels then decreased steadily, reaching a minimum of 5.2 pCi/gCa in 1968, indicating that milk levels are dependent on the rate of fallout. During the period 1965-68, however, milk levels decreased at a slower rate than strontium-90 deposition, indicating some uptake by grass of the cumulative deposit in the soil. After the start of French Pacific nuclear tests in 1966, milk levels increased slightly during the period 1969-71. However, after the decrease in fallout deposition since 1973, milk levels decreased again. The average concentration during 1978 and 1979, 2.1 pCi/gCa, was the lowest recorded since measurements commenced.

Milk samples from the lowest and highest rainfall stations, i.e, Christchurch and Westland, give the range of strontium-90 contamination in New Zealand milk. Generally the extent of this range is from about one-third to about two and a half times the country-wide average.

2. Caesium-137

Annual average concentrations of caesium-137 in milk at each station since 1964 are listed in Table 6. The station average each year is also listed. (Individual monthly results during 1979 are given in Table 11 Appendix.)

TABLE 6 - Caesium-137 in Milk - Annual Averages (pCi/gK)

	ND	AK	WK	TA	PN	WN	WD	CH	DN	Average
1964	49	51	69	168	19		76	7	11	56
1965	54	53	84	185	26	29	77	11	18	60
1966	37	33	60	141	11	18	43	4	9	39
1967	26	26	48	123	7	13	33	3	5	31
1968	15	18	36	102	3	7	21	1	3	23
1969	27	26	41	101	5	9	38	2	4	28
1970	22	18	35	89	6	11	39	4	5	25
1971	23	18	36	80	7	9	30	3	5	23
1972	21	15	28	72	2	7	22	2	4	19
1973	14	9	21	49	3	4	14	1	2	13
1974	7	7	16	41	2	3	8	1	1	10
1975	9	7	14	34	1	3	8	1	1	9
1976	6	5	11	23	2	2	4	1	2	6
1977	6	4	12	29	1	2	6	1	1	7
1978	3	3	8	18	1	<1	4	<1	<1	4
1979	3	4	10	32	<1	1	3	<1	<1	6
Average	20	19	33	80	6	8	27	3	5	22

Note: See Table 5 for station names.

The highest levels were recorded in 1964 and 1965 when strontium-90 deposition and concentration in milk were also at their highest values. Levels have decreased steadily since then while still showing the slight increase during 1969-1971 which had been observed for strontium-90.

The average concentration during 1979, 6 pCi/gK, was slightly higher than that in the previous year and this was due mainly to the significant increase in Taranaki milk which had its highest concentration for four years.

The "soil effect" leading to high caesium-137 levels at Taranaki, and to a lesser extent at Waikato and Auckland, has been the subject of a special survey and was commented on in the 1977 annual report (1). (Similar but smaller increases in strontium-90 in milk at Taranaki and Waikato can also be seen in Table 5.)

3. Comparison of Measured Levels with the Reference Levels

When measured levels in milk are compared with the reference levels, long-term averages are more meaningful. Since measurements commenced, the country-wide average levels of strontium-90 (5.6 pCi/gCa) and caesium-137 (22 pCi/gK), have been 2.1% and 0.3% of the reference levels respectively. The stations with the highest levels of contamination have corresponding percentages about 2.5 times and 3.5 times higher respectively.

Thus the long-term average levels, even at the stations with highest concentrations, are very small fractions of the reference levels and do not constitute a public health hazard.

MISCELLANEOUS, SPECIAL SURVEYS AND PROJECTS

1. International Intercomparison: The Laboratory participated in the following intercomparisons during 1979:

(a) Participation with the U.S. Environmental Protection Agency:

Total alpha and beta radioactivity in water; radium-226 and radium-228 in water; iodine-131 in water (on two separate occasions); strontium-90, strontium-89, iodine-131, barium-140, caesium-137 and potassium in milk (on two separate occasions).

(b) Participation with WHO International Reference Centre:

Mixed gamma emitters in marine sediment; strontium-90, caesium-137, calcium, and potassium in milk

2. Port Monitoring During Visit of a Nuclear Ship: During the visit of the nuclear submarine USS Haddo to Auckland on 19-24 January 1979 port monitoring was conducted. Air cartridges, seawater, sediment, and shellfish samples were collected and measured. No increases in background levels were detected. Monitoring procedures were similar to those conducted during the previous visit to Auckland of the USS Pintado in 1978 and reported more fully in the 1978 issue of this series.

A full report on monitoring during the 1979 visit has been published (3).

3. Potable Water Survey: A nation-wide survey of natural radioactivity in potable water, which commenced in August 1978, was concluded in December 1979. Sampling was restricted to population groups of 5000 or more. More than one hundred samples were measured for total alpha activity, total beta activity, and screened for radon content. Where radon concentrations were significant, further accurate sampling and remeasurement of radon was undertaken. Concentrations of radioactivity in all samples were below the levels at which WHO recommends further radiological examination. A report on this survey is in press.

4. Suspected Atmospheric Test in the South African Area: The U.S. Vela satellite was reported to have detected an atmospheric nuclear explosion somewhere between South Africa and Antarctica on 22 September 1979. However, no fresh fission products were subsequently reported to be present in the Southern Hemisphere. Our routine results showed no increase in levels. September and October air filters from Christchurch, Hokitika, Wellington, and Auckland, representing particulates from 40 000 m^3 of air, were then combined together with the Hokitika October resin (containing the concentrated fallout from the station with highest rainfall for the month). This composite sample was given a long measurement on the high resolution gamma spectrometer. No traces of fresh fission products were detected. Extra extractions of selected resin samples for barium-140 and measurements of strontium-89 also failed to indicate any traces of these short-lived radionuclides.

5. Radionuclides in Lichens: It is well known that lichens accumulate trace elements from rainwater. Concentrations of natural lead-210 and artificial caesium-137 (both washed out of air by rain) were studied in certain species of lichens in New Zealand. This study was intended to investigate the possibility of using the lead-210/caesium-137 ratio to gauge long-term atmospheric radon (the radioactive parent of lead-210) levels in geothermal areas, particularly Wairakei. Measurements are continuing.

As part of this investigation, the concentration of lead-210 in rainwater collected at Rotorua was monitored during April-September 1979.

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(3) "Report on Radioactive Monitoring During the Visit of a Nuclear Powered Submarine", National Radiation Laboratory, Department of Health, New Zealand, Report NPS-3, February 1979.

6. Extraction of Trace Elements from Seawater: A simple technique for extracting trace amounts of radionuclides from large volumes of seawater is being developed. The absorptive properties of manganese dioxide may eventually be utilized in such applications as nuclear ship monitoring and marine radioactivity surveys.

7. Beryllium-7 in the Atmosphere: A 2-year study of beryllium-7 levels in the atmosphere continued during 1979. The study is designed to investigate mixing of stratospheric and tropospheric air masses and should complement other work done overseas.

8. Low Background Beta Scintillation Counter: A prototype low background anti-coincidence counter capable of measuring four samples simultaneously has been designed and constructed. Each sample has a one-inch photomultiplier tube and thin plastic phosphor as detector and the assembly of four is elevated into the inverted well of a cosmic guard machined from a plastic phosphor block and viewed by a single 5-inch photomultiplier tube.

At the end of 1979 initial performance trials were being undertaken. It is anticipated that beta scintillation counting will solve our problems of replacement of obsolete equipment reliably and economically.

9. Computer Analysis of Gamma Spectra: Complex gamma spectra obtained using the Laboratory's high-resolution gamma spectrometer require computer analysis for results to be available quickly and conveniently. Computer techniques have been investigated during the year, using the Canterbury University computer facilities. Development will continue during 1980. A simple, but limited, procedure was also developed for use with a programmable desk-top calculator (4).

10. Installation of Massive Lead Shield: A 3-tonne lead shield for the high-resolution gamma detector was commissioned early in 1979.

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(4) "Determination of Peak Areas in High Resolution Gamma Spectroscopy using a Desk-Top Calculator. An Operator's Guide to Programmes and their Application in Environmental Monitoring", K.M. Matthews and A. Yeabsley, NRL 1979/3.

TABLE 7a - Total Beta Activity of Weekly Rainwater samples 1979 : Deposition (mCi/km^2), Rainfall (mm)

The collection period is from the date shown to the start of the next collection.
N.S. No sample or no result available.

AUCKLAND			WELLINGTON			HOKITIKA			CHRISTCHURCH			FIJI			SAMOA			TONGA			AITUTAKI			RAROTONGA		
Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2
Dec 29	2	<0.1	Jan 5	2	0.1	Dec 29	49	<0.1	Dec 29	5	<0.1	Jan 3	37	<0.1	Dec 29	93	0.2	Dec 30	5	<0.1	Jan 1	71	0.3	Dec 29	16	0.2
Jan 5	0	<0.1	Jan 12	7	<0.1	Jan 5	92	0.3	Jan 5	2	<0.1	Jan 10	106	<0.1	Jan 5	105	<0.1	Jan 5	39	<0.1	Jan 8	102	0.2	Jan 5	65	0.3
Jan 12	5	<0.1	Jan 19	2	<0.1	Jan 12	58	0.2	Jan 12	1	<0.1	Jan 17	25	0.2	Jan 12	128	<0.1	Jan 12	65	0.1	Jan 15	61	<0.1	Jan 12	16	<0.1
Jan 19	4	<0.1	Jan 26	3	0.1	Jan 19	9	<0.1	Jan 19	0	<0.1	Jan 24	26	<0.1	Jan 19	12	<0.1	Jan 19	8	<0.1	Jan 22	29	<0.1	Jan 19	4	<0.1
Jan 26	15	<0.1				Jan 26	48	<0.1	Jan 26	1	<0.1				Jan 26	78	<0.1	Jan 26	6	<0.1				Jan 26	10	<0.1
Jan	26	0.2	Jan	14	0.2	Jan	256	0.7	Jan	9	0.2	Jan	194	0.4	Jan	416	0.4	Jan	123	0.3	Jan	263	0.5	Jan	111	0.5
Feb 2	10	<0.1	Feb 2	11	<0.1	Feb 2	18	<0.1	Feb 2	1	<0.1	Jan 31	-	N.S.	Feb 2	36	0.1	Feb 2	2	<0.1	Jan 29	110	0.2	Feb 2	96	<0.1
Feb 9	-	N.S.	Feb 9	17	<0.1	Feb 9	88	<0.1	Feb 9	4	<0.1	Feb 7	54	0.2	Feb 16	67	<0.1	Feb 9	0	0.1	Feb 5	50	0.1	Feb 5	1	<0.1
Feb 16	-	N.S.	Feb 16	28	<0.1	Feb 16	15	<0.1	Feb 16	32	<0.1	Feb 14	35	0.1	Feb 18	124	<0.1	Feb 16	60	0.2	Feb 12	7	0.2	Feb 9	20	0.2
Feb 23	18	<0.1	Feb 23	31	<0.1	Feb 23	33	<0.1	Feb 23	12	<0.1	Feb 21	91	0.2	Feb 23	63	0.2	Feb 23	15	<0.1	Feb 19	0	<0.1			
Feb	28	0.1	Feb	87	0.2	Feb	154	0.3	Feb	49	0.1	Feb	180	0.5	Feb	290	0.4	Feb	77	0.4	Feb	167	0.5	Feb	117	0.2
Mar 2	<1	<0.1	Mar 2	0	<0.1	Mar 2	201	0.2	Mar 2	1	<0.1	Feb 28	54	<0.1	Mar 5	61	0.1	Mar 2	189	0.1	Feb 26	9	<0.1	Feb 26	20	<0.1
Mar 9	35	<0.1	Mar 9	48	<0.1	Mar 9	42	0.1	Mar 9	36	<0.1	Mar 7	70	0.1	Mar 12	0	0.1	Mar 9	36	<0.1	Mar 5	70	<0.1	Mar 10	146	0.3
Mar 16	69	<0.1	Mar 16	42	0.1	Mar 16	4	<0.1	Mar 16	118	<0.1	Mar 14	24	<0.1	Mar 16	57	0.1	Mar 16	3	<0.1	Mar 12	99	0.1	Mar 16	91	<0.1
Mar 23	6	<0.1	Mar 23	64	<0.1	Mar 23	50	<0.1	Mar 23	18	<0.1	Mar 20	143	0.1	Mar 23	244	0.2	Mar 23	27	0.2	Mar 19	134	0.1			
												Mar 28	79	<0.1							Mar 26	48	0.1			
Mar	110	<0.1	Mar	154	0.2	Mar	297	0.3	Mar	173	0.1	Mar	370	0.3	Mar	362	0.5	Mar	255	0.3	Mar	360	0.3	Mar	257	0.3
Mar 30	2	<0.1	Mar 30	67	<0.1	Mar 30	109	<0.1	Apr 6	6	<0.1	Apr 4	2	<0.1	Mar 30	12	<0.1	Mar 30	75	<0.1	Apr 2	21	<0.1	Mar 26	7	<0.1
Apr 6	71	0.1	Apr 6	67	0.1	Apr 6	159	0.1	Apr 13	<1	<0.1	Apr 11	56	<0.1	Apr 6	35	<0.1	Apr 6	62	<0.1	Apr 9	65	0.1	Apr 10	41	<0.1
Apr 14	29	<0.1	Apr 13	4	<0.1	Apr 13	0	<0.1	Apr 20	<1	<0.1	Apr 18	66	0.2	Apr 13	3	<0.1	Apr 13	51	<0.1	Apr 11	73	0.3	Apr 14	45	<0.1
Apr 20	19	0.1	Apr 20	<1	<0.1	Apr 20	88	0.2				Apr 25	11	<0.1	Apr 20	23	<0.1	Apr 20	4	<0.1	Apr 23	97	0.2	Apr 20	90	0.3
Apr 27	3	<0.1	Apr 27	12	<0.1										Apr 27	109	<0.1									
Apr	124	0.3	Apr	150	0.3	Apr	356	0.4	Apr	6	0.1	Apr	135	0.2	Apr	182	0.1	Apr	192	0.2	Apr	256	0.6	Apr	183	0.4
May 4	11	<0.1	May 4	115	0.2	Apr 27	261	0.2	Apr 27	60	0.1	May 2	23	0.2	May 4	-	N.S.	Apr 28	3	<0.1	Apr 30	5	<0.1	Apr 28	26	0.1
May 11	62	<0.1	May 11	61	<0.1	May 11	65	0.2	May 11	31	<0.1	May 9	6	<0.1	May 7	8	0.1	May 4	58	<0.1	May 7	55	<0.1	May 4	24	0.1
May 18	<1	<0.1	May 18	69	<0.1	May 18	<1	<0.1	May 18	13	<0.1	May 18	35	<0.1	May 14	61	0.1	May 11	5	<0.1	May 21	0	<0.1	May 11	2	<0.1
May 25	12	<0.1	May 25	15	<0.1	May 25	57	0.1	May 25	3	<0.1	May 23	16	0.1	May 18	78	0.2	May 18	130	0.5	May 28	0	<0.1	May 18	0	<0.1
																		May 25	28	<0.1				May 25	7	0.1
May	85	0.2	May	260	0.3	May	383	0.5	May	107	0.2	May	80	0.3	May	147	0.4	May	224	0.6	May	60	0.1	May	59	0.4
Jun 1	57	0.1	Jun 1	14	<0.1	Jun 1	<1	<0.1	Jun 1	<1	<0.1	May 30	42	0.3	May 28	28	<0.1	Jun 1	11	0.3	Jun 4	42	0.3	Jun 1	3	<0.1
Jun 8	52	<0.1	Jun 8	17	<0.1	Jun 8	70	<0.1	Jun 8	0	<0.1	Jun 6	0	0.2	Jun 8	43	<0.1	Jun 11	2	0.1	Jun 11	16	0.2	Jun 9	1	<0.1
Jun 15	3	<0.1	Jun 15	<1	<0.1	Jun 15	17	<0.1	Jun 15	<1	<0.1	Jun 15	1	<0.1	Jun 15	25	<0.1	Jun 15	31	<0.1	Jun 18	131	0.2	Jun 15	86	0.2
Jun 22	20	0.1	Jun 22	19	<0.1	Jun 22	57	0.1	Jun 22	<1	<0.1	Jun 20	1	0.1	Jun 22	27	0.1	Jun 22	231	0.3	Jun 25	82	0.1	Jun 22	28	<0.1
												Jun 27	9	0.1												
Jun	132	0.3	Jun	50	0.1	Jun	144	0.2	Jun	<1	<0.1	Jun	53	0.7	Jun	123	0.1	Jun	275	0.7	Jun	271	0.8	Jun	118	0.2

TABLE 7a (contd)

	AUCKLAND		WELLINGTON			HOKITIKA			CHRISTCHURCH			FIJI			SAMOA			TONGA			AITUTAKI			RAROTONGA		
Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2	Date	mm	mCi/km^2
Jun 29	139	<0.1	Jun 29	99	<0.1	Jun 29	68	<0.1	Jun 29	17	0.1	Jul 4	13	<0.1	Jun 29	2	<0.1	Jun 29	9	0.2	Jun 29	38	<0.1	Jun 29	58	0.2
Jul 3	11	<0.1	Jul 6	<1	<0.1	Jul 6	29	<0.1	Jul 13	39	0.1	Jul 11	1	<0.1	Jul 6	8	0.1	Jul 6	69	<0.1	Jul 9	19	0.2	Jul 6	<1	0.1
Jul 10	30	<0.1	Jul 13	31	<0.1	Jul 13	37	0.1	Jul 20	<1	<0.1	Jul 18	0	<0.1	Jul 13	82	<0.1	Jul 13	<1	<0.1	Jul 23	30	0.2	Jul 13	4	<0.1
Jul 20	35	0.2	Jul 20	10	<0.1	Jul 20	40	0.1	Jul 27	60	<0.1	Jul 25	0	<0.1	Jul 20	158	0.1	Jul 20	10	0.2				Jul 20	55	0.3
Jul 27	88	0.1	Jul 27	83	<0.1	Jul 27	62	0.1							Jul 27	6	0.2	Jul 23	<1	0.1				Jul 27	2	0.1
Jul	303	0.4	Jul	223	0.1	Jul	236	0.4	Jul	116	0.2	Jul	14	0.1	Jul	256	0.5	Jul	88	0.6	Jul	87	0.5	Jul	119	0.7
Aug 3	35	<0.1	Aug 3	13	<0.1	Aug 3	31	<0.1	Aug 3	24	<0.1	Aug 2	21	0.2	Aug 3	42	<0.1	Aug 3	40	0.2	Jul 30	2	0.2	Aug 3	107	0.1
Aug 10	22	<0.1	Aug 10	73	0.1	Aug 10	89	0.1	Aug 10	1	<0.1	Aug 22	-	N.S.	Aug 13	<1	<0.1	Aug 10	3	<0.1	Aug 6	46	0.2	Aug 10	3	0.1
Aug 17	64	0.1	Aug 17	24	<0.1	Aug 17	6	<0.1	Aug 17	3	<0.1				Aug 21	<1	<0.1	Aug 17	48	0.1	Aug 13	<1	0.1	Aug 17	1	0.1
Aug 24	30	0.1	Aug 24	73	<0.1	Aug 24	18	<0.1	Aug 24	24	0.1							Aug 25	137	0.3	Aug 20	<1	<0.1	Aug 23	22	0.1
																					Aug 27	23	0.3			
Aug	151	0.4	Aug	183	0.2	Aug	144	0.1	Aug	52	0.2	Aug	21	0.2	Aug	42	<0.1	Aug	228	0.6	Aug	71	0.8	Aug	133	0.4
Sep 3	8	<0.1	Aug 31	52	<0.1	Aug 31	54	0.2	Aug 31	1	<0.1	Aug 29	0	<0.1	Aug 31	45	0.1	Aug 31	3	<0.1	Sep 3	45	0.2	Aug 31	4	0.2
Sep 7	13	<0.1	Sep 7	12	<0.1	Sep 7	99	0.1	Sep 7	<1	<0.1	Sep 13	0	<0.1	Sep 7	76	<0.1	Sep 7	12	0.2	Sep 10	20	<0.1	Sep 7	78	<0.1
Sep 14	43	<0.1	Sep 14	51	0.1	Sep 14	46	<0.1	Sep 14	10	<0.1	Sep 19	138	<0.1	Sep 14	9	<0.1	Sep 14	4	<0.1	Sep 17	3	<0.1	Sep 14	20	<0.1
Sep 21	<1	<0.1	Sep 21	12	<0.1	Sep 21	11	<0.1	Sep 21	7	<0.1	Sep 26	35	<0.1	Sep 21	99	0.2	Sep 21	101	0.3	Sep 24	3	0.1	Sep 24	3	0.2
Sep	64	<0.1	Sep	127	0.2	Sep	210	0.4	Sep	18	<0.1	Sep	173	<0.1	Sep	229	0.3	Sep	120	0.5	Sep	71	0.3	Sep	105	0.4
Sep 28	44	<0.1	Sep 28	39	<0.1	Sep 28	49	0.1	Sep 28	3	<0.1	Oct 3	4	0.1	Sep 28	68	<0.1	Sep 29	8	<0.1	Oct 1	14	0.2	Sep 28	7	<0.1
Oct 5	34	<0.1	Oct 5	41	<0.1	Oct 5	37	<0.1	Oct 5	22	<0.1	Oct 10	<1	<0.1	Oct 5	21	<0.1	Oct 8	0	<0.1	Oct 8	16	0.2	Oct 6	14	0.2
Oct 12	13	<0.1	Oct 12	67	0.1	Oct 12	164	0.2	Oct 12	30	<0.1	Oct 17	<1	<0.1	Oct 12	0	<0.1	Oct 12	<1	<0.1	Oct 15	12	<0.1	Oct 12	27	<0.1
Oct 19	12	<0.1	Oct 19	20	<0.1	Oct 19	16	<0.1	Oct 19	15	<0.1	Oct 25	14	<0.1	Oct 19	240	0.1	Oct 19	6	0.2	Oct 22	13	<0.1	Oct 19	93	0.2
Oct 26	33	<0.1	Oct 26	22	<0.1	Oct 26	150	0.2	Oct 26	38	<0.1				Oct 26	120	<0.1	Oct 26	37	<0.1	Oct 29	39	0.2			
Oct	136	0.2	Oct	189	0.3	Oct	416	0.6	Oct	108	0.1	Oct	18	0.2	Oct	449	0.1	Oct	51	0.3	Oct	94	0.7	Oct	141	0.5
Nov 2	4	<0.1	Nov 2	2	<0.1	Nov 2	10	<0.1	Nov 2	6	<0.1	Nov 2	24	<0.1	Nov 2	80	<0.1	Nov 1	58	0.3	Nov 3	33	0.2	Nov 9	30	0.1
Nov 9	39	0.1	Nov 9	-	N.S.	Nov 9	18	0.1	Nov 9	21	<0.1	Nov 7	6	<0.1	Nov 9	15	<0.1	Nov 8	<1	0.2	Nov 12	2	0.1	Nov 16	31	0.2
Nov 16	48	0.2	Nov 16	21	0.1	Nov 16	173	0.2	Nov 16	5	<0.1	Nov 14	15	0.1	Nov 16	3	0.1	Nov 16	37	<0.1	Nov 19	96	0.1	Nov 23	14	0.2
Nov 23	3	<0.1	Nov 23	18	0.1	Nov 23	154	0.2	Nov 23	4	<0.1	Nov 23	45	<0.1	Nov 23	119	<0.1	Nov 23	6	<0.1	Nov 27	15	0.2			
Nov	94	0.3	Nov	41	0.2	Nov	355	0.5	Nov	36	0.1	Nov	90	0.1	Nov	217	0.1	Nov	101	0.6	Nov	146	0.6	Nov	75	0.5
Nov 30	27	<0.1	Nov 30	27	0.1	Nov 30	106	0.3	Nov 30	9	<0.1	Nov 28	2	0.2	Nov 26	122	0.2	Nov 30	22	1.6	Dec 3	27	0.1	Nov 30	79	<0.1
Dec 7	15	<0.1	Dec 7	60	0.3	Dec 7	102	0.1	Dec 7	2	<0.1	Dec 5	<1	<0.1	Dec 9	183	<0.1	Dec 7	5	<0.1	Dec 9	61	0.1	Dec 10	135	0.4
Dec 14	4	<0.1	Dec 14	4	0.1	Dec 14	84	0.1	Dec 14	4	<0.1	Dec 12	35	0.1	Dec 15	3	<0.1	Dec 14	0	<0.1	Dec 17	38	<0.1	Dec 14	5	<0.1
Dec 21	54	0.1	Dec 21	19	0.1	Dec 21	90	0.3	Dec 21	12	<0.1	Dec 27	<1	<0.1	Dec 21	112	0.1	Dec 21	15	<0.1	Dec 24	3	<0.1	Dec 24	53	<0.1
Dec 28	31	<0.1	Dec 28	36	0.1	Dec 28	24	<0.1	Dec 28	123	0.1							Dec 28	7	<0.1						
Dec	131	0.2	Dec	146	0.7	Dec	406	0.8	Dec	150	0.2	Dec	37	0.3	Dec	420	0.3	Dec	49	1.6	Dec	129	0.3	Dec	272	0.5
TOTAL	1384	2.6	TOTAL	1624	3.0	TOTAL	3357	5.2	TOTAL	824	1.5	TOTAL	1365	3.3	TOTAL	3133	3.2	TOTAL	1783	6.7	TOTAL	1975	6.0	TOTAL	1690	5.0
Average Concentration (pCi/l)																										
	1.9			1.8			1.5			1.8			2.4			1.0			3.8			3.0			3.0	

NOTE: This form of presentation will be replaced by that in TABLE 7b in future reports.

TABLE 7b - Total Beta Activity in Rain 1979 (Weekly Collections): Cumulative Rainfall (mm), Cumulative Deposition (mCi/km^2)*, Average Concentration (pCi/l)*

Station	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1979
Auckland					
mm	164	341	518	361	1384
mCi/km^2	0.31 ± 0.17	0.76 ± 0.18	0.80 ± 0.20	0.71 ± 0.19	2.58 ± 0.37
pCi/l	1.9 ± 1.0	2.2 ± 0.5	1.5 ± 0.4	2.0 ± 0.5	1.9 ± 0.3
Wellington					
mm	255	460	533	376	1624
mCi/km^2	0.61 ± 0.18	0.67 ± 0.18	0.48 ± 0.18	1.23 ± 0.19	2.99 ± 0.37
pCi/l	2.4 ± 0.7	1.5 ± 0.4	0.9 ± 0.3	3.3 ± 0.5	1.8 ± 0.2
Hokitika					
mm	707	883	590	1177	3357
mCi/km^2	1.34 ± 0.20	1.11 ± 0.17	0.93 ± 0.20	1.90 ± 0.21	5.28 ± 0.39
pCi/l	1.9 ± 0.3	1.3 ± 0.2	1.6 ± 0.3	1.6 ± 0.2	1.6 ± 0.1
Christchurch					
mm	231	113	186	294	824
mCi/km^2 *	0.41 ± 0.18	0.32 ± 0.17	0.43 ± 0.18	0.43 ± 0.19	1.59 ± 0.36
pCi/l	1.8 ± 0.8	2.8 ± 1.5	2.3 ± 1.0	1.5 ± 0.6	1.9 ± 0.4
NZ Station Av.					
mCi/km^2	0.67	0.72	0.66	1.07	3.11
pCi/l	2.0	2.0	1.6	2.1	1.8
Nandi, Fiji					
mm	744	268	208	145	1365
mCi/km^2	1.23 ± 0.50	1.19 ± 0.54	0.31 ± 0.43	0.57 ± 0.50	3.30 ± 0.99
pCi/l	1.7 ± 0.7	4.4 ± 2.0	1.5 ± 2.1	3.9 ± 3.4	2.4 ± 0.7
Samoa					
mm	1068	452	527	1086	3133
mCi/km^2	1.26 ± 0.58	0.57 ± 0.52	0.84 ± 0.56	0.50 ± 0.64	3.17 ± 1.15
pCi/l	1.2 ± 0.5	1.3 ± 1.2	1.6 ± 1.1	0.5 ± 0.6	1.0 ± 0.4
Tonga					
mm	455	691	436	201	1783
mCi/km^2	0.95 ± 0.58	1.52 ± 0.64	1.70 ± 0.60	2.49 ± 0.60	6.66 ± 1.21
pCi/l	2.1 ± 1.3	2.2 ± 0.9	3.9 ± 1.4	12.4 ± 3.0	3.7 ± 0.7
Aitutaki					
mm	790	587	229	369	1975
mCi/km^2	1.30 ± 0.64	1.46 ± 0.56	1.59 ± 0.52	1.55 ± 0.56	5.90 ± 1.14
pCi/l	1.6 ± 0.8	2.5 ± 1.0	6.9 ± 2.3	4.2 ± 1.5	3.0 ± 0.6
Rarotonga					
mm	485	360	357	488	1690
mCi/km^2	1.03 ± 0.50	0.97 ± 0.56	1.52 ± 0.60	1.46 ± 0.55	4.98 ± 1.11
pCi/l	2.1 ± 1.0	2.7 ± 1.6	4.3 ± 1.7	3.0 ± 1.1	2.9 ± 0.7

* The plus or minus (±) error term, which is given in these reports for the first time, is two standard deviations (95% confidence level).

APPENDIX

TABLE 8 - Strontium-90 in Rain 1979: Rainfall (mm), Deposition (mCi/km^2), Concentration (pCi/l)

Station		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total	Av
Kaitaia	mm	365	550	472	379	1766	
	mCi/km^2	0.02	0.02	0.02	0.03	0.09	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Auckland	mm	300	478	377	348	1503	
	mCi/km^2	0.02	0.01	0.02	0.02	0.07	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
New Plymouth	mm	198	473	357	414	1442	
	mCi/km^2	0.02	0.01	0.03	0.02	0.08	
	pCi/l	0.1	<0.1	<0.1	<0.1		<0.1
Havelock North	mm	397	138	292	144	971	
	mCi/km^2	0.02	<0.01	0.02	0.02	0.06	
	pCi/l	<0.1	<0.1	<0.1	0.1		<0.1
Wellington	mm	331	495	401	507	1734	
	mCi/km^2	0.03	0.01	0.02	0.03	0.09	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Hokitika	mm	684	865	707	1054	3310	
	mCi/km^2	0.05	0.03	0.03	0.05	0.16	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Christchurch	mm	231	118	174	169	692	
	mCi/km^2	0.02	<0.01	<0.01	<0.01	0.03	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Dunedin	mm	180	173	167	194	714	
	mCi/km^2	0.02	<0.01	<0.01	0.01	0.04	
	pCi/l	0.1	<0.1	<0.1	<0.1		<0.1
Invercargill	mm	277	339	258	184	1058	
	mCi/km^2	0.02	0.01	0.01	<0.01	0.04	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
New Zealand Country-wide Average	mm	329	403	356	377	1465	
	mCi/km^2	0.02	0.01	0.02	0.02	0.07	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Suva, Fiji	mm	1063	1332	451	356	3202	
	mCi/km^2	0.02	0.01	0.02	0.02	0.07	
	pCi/l	<0.1	<0.1	<0.1	<0.1		<0.1
Rarotonga	mm	-	161	346	394	901	
	mCi/km^2	N.S.	<0.01*	<0.01	0.01	0.02	
	pCi/l	-	<0.1	<0.1	<0.1		<0.1

N.S. No Sample
* May and June only

TABLE 9 - Lead-210 in Rain 1979 : Deposition (mCi/km^2)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
KA	0.07	0.10	0.15	0.09	0.13	0.22	0.20	0.21	0.14	0.24	0.15	0.19	1.89
AK	0.04	0.24	0.08	0.10	0.07	0.14	0.14	(0.18)	0.11	0.13	0.13	0.14	1.50
NP	0.09	0.17	0.11	0.14	0.29	0.05	0.18	0.15	0.15	0.21	0.18	0.16	1.88
HN	0.06	0.09	0.15	0.05	0.05	0.07	0.09	0.22	0.05	0.07	0.05	0.07	1.02
WN	0.13	0.16	0.18	0.10	0.28	0.11	0.13	0.15	0.09	0.34	0.21	0.17	2.05
HK	0.45	(0.25)	0.40	0.51	0.34	0.20	0.26	0.21	0.41	0.46	0.45	0.56	4.50
CH	0.04	0.07	0.10	0.05	0.07	0.03	0.04	0.04	0.04	0.08	0.14	0.04	0.74
DN	0.12	0.06	0.09	0.07	0.07	0.03	0.08	0.05	0.09	0.06	0.08	0.11	0.91
IN	0.19	0.05	0.05	0.09	0.11	0.07	0.08	0.06	0.12	0.04	0.05	0.12	1.03
NZ Av	0.13	0.13	0.15	0.13	0.16	0.10	0.13	0.14	0.13	0.18	0.16	0.17	1.72
SU	0.10	0.15	0.10	0.20	0.25	0.17	0.14	0.27	0.23	0.16	0.20	0.16	2.13
RA	N.S.	0.10	N.S.	N.S.	0.07	0.10	0.12	0.10	0.08	N.S.	0.07	0.22	-

N.S. No result available. ( ) Estimate.
The station names are abbreviated and in the same sequence as in Table 8.

APPENDIX

TABLE 10 - Strontium-90 in Milk 1979 : (pCi/gCa)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average
Northland	1.6	1.5	1.9	1.5	1.6
Auckland	1.9	1.7	2.0	1.7	1.8
Waikato	2.5	2.2	2.6	2.5	2.5
Taranaki	3.8	3.7	4.3	4.9	4.2
Palmerston North	1.3	1.5	1.7	1.4	1.5
Wellington	1.9	1.8	1.9	1.9	1.9
Westland	4.4	3.1	3.9	4.0	3.9
Christchurch	1.0	1.0	1.0	0.9	1.0
Dunedin	0.9	1.1	0.9	0.8	0.9
NZ Average	2.1	2.0	2.2	2.2	2.1

TABLE 11 - Caesium-137 in Milk 1979 : (pCi/gK)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av
Northland	3	4	1	1	<1	4	<1	1	3	8	4	5	3
Auckland	4	6	4	4	<1	3	3	3	3	3	5	5	4
Waikato	12	13	15	12	10	9	2	8	6	8	9	11	10
Taranaki	25	37	36	32	37	39	15	33	30	32	33	39	32
Palmerston North	<1	<1	<1	N.S.	N.S.	<1	2	<1	<1	<1	1	1	<1
Wellington	1	<1	<1	2	<1	<1	4	1	<1	2	2	3	1
Westland	4	5	3	4	2	1	3	1	2	3	5	4	3
Christchurch	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	1	<1	<1
Dunedin	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	<1	<1
NZ Average	5	7	7	6	6	6	3	5	5	6	7	8	6

N.S. No Sample