

DEPARTMENT OF HEALTH
NEW ZEALAND

ENVIRONMENTAL RADIOACTIVITY
ANNUAL REPORT
1980

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 Laboratory's Environmental Radioactivity Section 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

(NB: Change in Units)

Units: The International System of Units (SI), increasingly being used in science, industry and trade, is now used for the first time in this report series. Conversion factors are given in the tables for the relationship between the new units and the units previously used.

The SI unit of radioactivity is the "becquerel" (Bq), equal to 1 disintegration per second. The only multiple of this unit used here is the megabecquerel (MBq) = 10^6 Bq, and the only submultiple used is the millibecquerel (mBq) = 10^{-3} Bq.

Deposition is given in megabecquerels per square kilometre (MBq/km²).

Concentration

- in air: is given in millibecquerels per cubic metre (mBq/m³)
- in rain: is given in becquerels per litre (Bq/l). It is calculated by dividing the deposition by the rainfall in millimetres.
- in milk: strontium-90 (⁹⁰Sr) is given in becquerels per gram of calcium (Bq/gCa)
caesium-137 (¹³⁷Cs) is given in becquerels per gram of potassium (Bq/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: 11 000 mBq/m³
- in rain: 220 Bq/l
- strontium-90 in milk: 10 Bq/gCa
- caesium-137 in milk: 260 Bq/gK

SUMMARY

During 1980 and the previous three years the average deposition of strontium-90 at nine New Zealand stations did not exceed 3 megabecquerels per square kilometre. These are the lowest annual depositions measured since monitoring commenced in 1960.

During 1964 a maximum deposition (averaging 133 MBq/km² at 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 9 to 51 MBq/km² 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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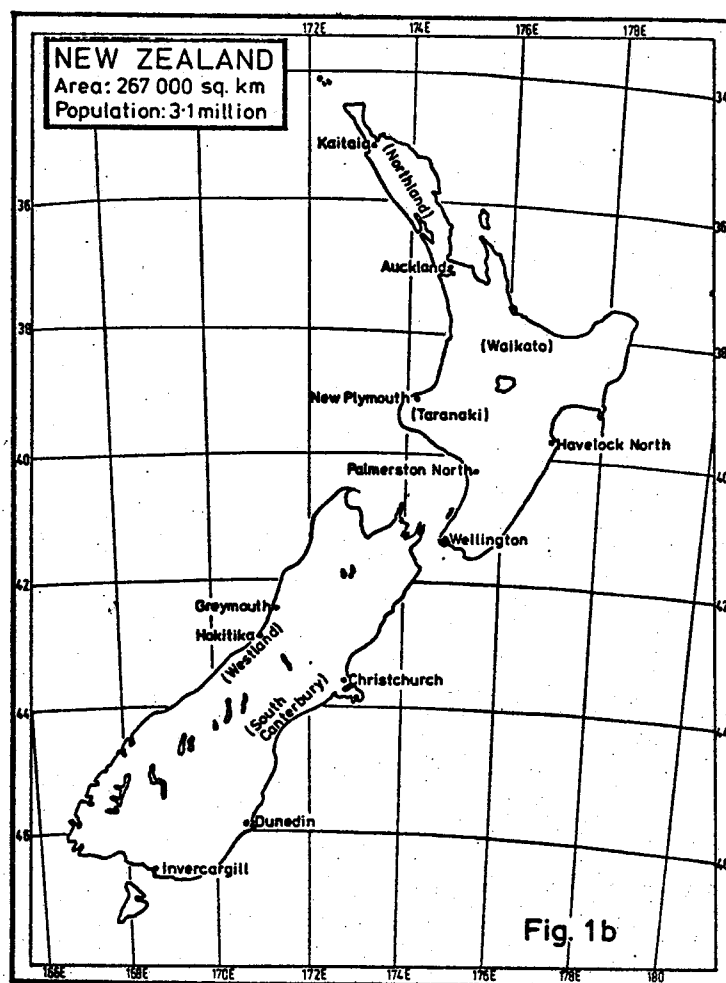
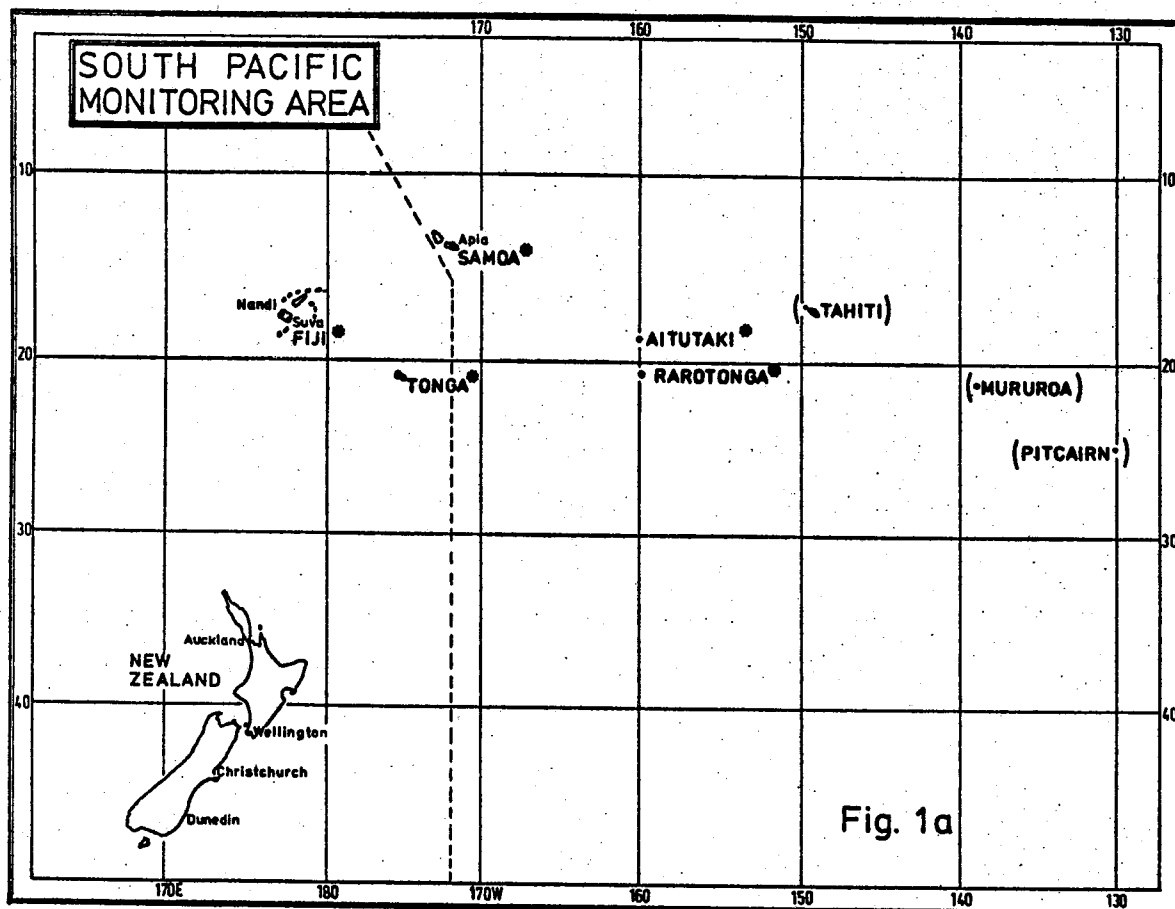


FIG. 1 MONITORING AND COLLECTING STATIONS ON PACIFIC ISLANDS AND IN NEW ZEALAND.

INTRODUCTION

This report continues the series of reports on environmental radioactivity monitoring 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 programme was changed to monitor 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 for monitoring long-term radioactive fallout from earlier atmospheric tests was also continued during 1980. 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 2 000 and 20 000 millibecquerels per cubic metre (mBq/m³), but under certain conditions the beta activity may be up to ten times the upper value of this range.

(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	(abridged)
Annual Report 1977, Report No. NRL-F/57, April 1978	(abridged)
Annual Report 1978, Report No. NRL-F/58, April 1979	(abridged)
Annual Report 1979, Report No. NRL-F/59, April 1980	(abridged)

(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.

Air filter and rainwater samples are measured four days after collection when naturally-occurring beta activity has decayed and any residual beta activity from radioactive fallout can be assessed. Hereafter the term "total beta activity" refers to this residual fission product radioactivity in the sample and excludes naturally-occurring radioactivity.

1. Fission Products in Air

During 1980 air was monitored continuously at the New Zealand and Pacific Island stations listed in Table 1. The air filters were changed three times each week and were despatched to the Laboratory for measurement of total beta activity. Average concentrations each month during 1980 did not exceed the limit of detection at any station. Because the levels were so low, the results of measurements are not tabulated in the Appendix. However, the average concentrations during 1980 are included in Table 1 for comparison with those of previous years.

TABLE 1 - Total Beta Activity in Air: Average Concentrations (mBq/m³)

To convert mBq/m³ to pCi/m³ multiply by 0.027.

	New Zealand				Pacific Islands				
	AK	WN	HK	CH	FJ	SM	TO	AI	RA
1966	5.2	(3.7)		4.1	1966 - 1974 (French atmospheric nuclear tests) range: 1.5 - 230 mBq/m ³ at Pacific Islands during the special monitoring programmes (2)				
1967	3.0	1.9		2.2					
1968	4.4	3.7		2.6					
1969	4.4	3.3		2.6					
1970	5.9	4.4	(4.4)	3.7					
1971	7.8	4.4	5.9	5.6					
1972	2.2	1.9	1.9	1.9					
1973	0.7	0.4	0.7	0.7					
1974	3.0	1.9	2.6	1.9					
1975	1.1	1.1	1.1	0.7	<0.3	<0.3	0.4	<0.3	0.4
1976	0.4	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
1977	<0.3	<1.1	<0.3	<0.3	<0.3	<0.3	<1.1	<1.1	<0.3
1978	<0.3	<0.3	<0.3	<0.3	<1.1	<1.1	<1.1	<1.1	<1.1
1979	<0.3	<0.3	<0.3	<0.3	<1.1	<1.1	<1.1	<1.1	<1.1
1980	<0.3	<0.3	<0.3	<0.3	<1.1	<1.1	<1.1	<1.1	<1.1

- Notes: 1. The stations are: Auckland, Wellington, Hokitika, Christchurch, Fiji, Samoa, Tonga, Aitutaki, and Rarotonga.
2. Values in parentheses are estimates: At Wellington measurements commenced July 1966; at Hokitika, May 1970.
3. At the Pacific Islands the 1975 results are for June-December only (during the second half 1975 the New Zealand results were similar).
4. Starting 1977 the limit of detection is either 0.3 or 1.1 mBq/m³ depending on the air sampling equipment in use.

The concentration of fission products in air at New Zealand stations was latitude dependent during the French South Pacific atmospheric tests (1966-1974). For example, concentrations were usually higher at Auckland than at Christchurch. Moreover, at the Pacific Islands concentrations were significantly higher, e.g., during the special monitoring programmes, lasting from 3-6 months, average concentrations ranged from 1.5 - 230 mBq/m³ depending on the locality, the meteorological conditions, and the extent of nuclear testing (2).

Since mid-1975, about nine months after the termination of the French atmospheric nuclear tests, concentrations have been near or below the limit of detection at all stations. No fresh fission products have been detected since underground testing started.

Concentrations of fission products in air tabulated here, particularly those during recent years, are very small fractions of the reference levels.

2. Fission Products in Rain

During 1980 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 for processing and measurement of total beta activity. Results are given in deposition units - megabecquerels per square kilometre (MBq/km²): Quarterly cumulative results during 1980 are given in Table 7, Appendix and annual totals since measurements started are listed for each station in Table 2 (rounded to the nearest 10 MBq/km²).

TABLE 2 - Total Beta Activity in Rain: Total Deposition (MBq/km²)

To convert MBq/km² to mCi/km² multiply by 0.027.

	New Zealand				Pacific Islands				
	AK	WN	HK	CH	FJ	SM	TO	AI	RA
1963				1040					
1964				560					
1965				630					
1966			3920	1180					
1967			2850	520					
1968			7590	1040					
1969			2260	670					
1970	3740	2780	4920	960					
1971	3630	2960	3660	1180					
1972	930	810	1220	560					
1973	190	260	300	150					
1974	2180	2220	1550	810					
1975	340	470	710	460	90	140	70	110	140
1976	90	110	160	60	100	110	150	140	110
1977	70	100	120	60	110	170	130	140	150
1978	120	100	180	70	160	230	210	230	220
1979	100	110	190	60	120	120	250	220	190
1980	70	100	140	60	100	180	70	200	160

1966 - 1974
(French atmospheric nuclear tests)
range: 100 - 20 000 MBq/km²
at Pacific Islands during the
special monitoring programmes (2)

- 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-December 1966 only). The station was transferred to Hokitika starting January 1976.
 3. Measurement commenced at AK and WN in May 1970 (the 1970 results are for May-December only).
 4. At the Pacific Islands the 1975 results are for June-December only (during the second half 1975 the New Zealand results were similar).

Since 1976 annual depositions ranged from 60 to 250 MBq/km². They are the lowest recorded since measurements started. The average concentrations ranged from 0.03 to 0.15 becquerels per litre (Bq/l). 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 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 rainwater sample is passed through a column of cation exchange resin on 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 quarterly results during 1980 are given in Table 8 Appendix.)

TABLE 3 - Annual Deposition of Strontium-90 (MBq/km²), Mean Annual Rainfall (mm)

To convert MBq/km² to mCi/km² multiply by 0.027.

	New Zealand Stations									Pacific Islands	
	KA	AK	NP	HN	WN	HK	CH	DN	IN	Av	SU RA
1960		46		26	28	56	18		17	32	
1961		40		28	42	81	24		43	43	38
1962		65		35	68	102	26		43	57	60
1963	67	72	73	37	75	137	46	38	63	68	90
1964	153	147	195	59	126	288	48	66	112	133	91
1965	114	108	154	62	144	219	63	74	102	115	73
1966	58	47	71	31	59	81	26	27	41	49	44
1967	38	33	46	18	35	63	14	24	32	34	28 (33)
1968	33	27	35	21	32	53	16	15	20	28	38 24
1969	57	46	54	25	39	83	26	25	45	44	46 27
1970	37	32	45	22	45	79	19	20	25	36	33 35
1971	75	50	68	38	44	92	24	30	40	51	(56) (12)
1972	33	27	32	18	30	65	16	21	32	30	35 28
1973	16	10	13	7	14	21	6	7	11	12	14 (21)
1974	13	9	11	6	10	17	6	6	7	9	11 11
1975	10	9	11	6	10	21	7	6	10	10	9 5
1976	4	4	5	3	6	7	3	3	3	4	4 4
1977	3	3	3	1	4	5	1	1	2	3	3 1
1978	3	2	2	2	2	6	1	2	1	2	3 1
1979	3	3	3	2	3	6	1	1	1	3	3 1
1980	3	2	2	2	3	5	1	1	2	2	2 2
mm Rain	1410	1080	1460	870	1490	2520	700	700	1040		3410 1930

- 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 and was resited at Hokitika starting January 1976. Rainfall at the actual site is used in calculating the mean.
4. Values in parentheses 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 occurred in 1964 and 1965, exceeding a station average of 100 MBq/km². Annual depositions then decreased markedly.

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 powder (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.

Because the deposition rates have been so low in recent years, samples collected since 1976 have been aggregated quarterly to obtain increased measurement sensitivity. Depositions during the last five years were the lowest recorded since this programme 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).

Measurement of long-term strontium-90 deposition, which includes a significant stratospheric component, shows no latitude dependence within New Zealand. The deposition, however, is rainfall dependent and high rainfall areas such as Greymouth or Hokitika in Westland show elevated values compared to low rainfall areas such as Christchurch on the east coast: excluding the minimal fallout in recent years, the mean annual deposition (normalised for rainfall) at the nine New Zealand stations during 1963-1975 inclusive was 40 ± 2 MBq/km² 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 a characteristic feature of stratospheric fallout, the tropics receiving less stratospheric fallout than mid-latitudes. Since then depositions at the Pacific Islands have been similar to those in New Zealand. It is probable that during the French tests the larger tropospheric component and smaller stratospheric component in the Pacific area resulted in depositions similar to those in New Zealand where the relative contribution of the two components was reversed.

The cumulative depositions 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 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 1980, 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).

There does not appear to be any marked seasonal variation nor, unlike strontium-90, any significant change in the New Zealand station average annual deposition which is consistently about 50 MBq/km². Because of the current low strontium-90 deposition, lead-210 deposition is now about 20 times higher.

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 1980 are given in Table 9 Appendix.)

TABLE 4 - Annual Deposition of Lead-210 (MBq/km²)To convert MBq/km² to mCi/km² multiply by 0.027.

	New Zealand Stations										Pacific Islands	
	KA	AK	NP	HN	WN	HK	CH	DN	IN	Av	SU	RA
1967*	23	43	64	27	38	88	13	21	37	39	46	22
1968	65	61	77	31	69	118	24	28	39	57	91	23
1969	68	49	57	33	44	146	21	34	48	56	71	36
1970	53	37	67	23	56	114	24	27	34	48	68	31
1971 *	77	38	36	24	47	87	19	27	40	44	68	-
1972	84	60	74	33	63	126	26	45	48	62	98	-
1973	71	53	85	30	67	122	18	25	30	56	78	-
1974	46	40	65	28	60	105	26	24	21	46	69	148
1975	60	56	67	41	73	146	34	34	41	61	108	52
1976	52	49	53	34	54	101	26	26	28	47	75	-
1977	49	41	62	28	57	97	23	27	40	47	62	-
1978	60	42	60	28	52	107	27	33	37	50	83	-
1979	70	56	70	38	76	167	27	34	38	64	79	-
1980	74	49	66	34	68	144	26	41	48	61	74	-

Note: See Table 3 (Notes 1 and 3) for station names and the resiting of the Westland station.

*1967 results are for May-December only.

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 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 and calcium determinations.

1. Strontium-90

Average levels in New Zealand milk reached maximum values of 0.40 and 0.43 Bq/gCa during 1964 and 1965 when the rate of strontium-90 deposition was also a maximum. Levels then decreased reaching a minimum of 0.19 Bq/gCa in 1968, indicating that the levels are dependent on the rate of fallout. During the period 1965-68, however, strontium-90 in milk 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, levels increased slightly during the period 1969-71. However, with decreasing fallout depositions since 1973, levels in milk also decreased again. The average concentration during 1980, 0.07 Bq/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.

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 1980 are given in Table 10 Appendix.)

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

To convert Bq/gCa to pCi/gCa multiply by 27.

	ND	AK	WK	TA	PN	WN	WD	CH	DN	Av
1961	0.17		0.15	0.26			0.47	0.06		0.22
1962	0.23	0.20	0.18	0.35	0.16		0.50	0.08	0.11	0.23
1963	0.28	0.20	0.21	0.37	0.18		0.64	0.10	0.14	0.26
1964	0.41	0.34	0.35	0.63	0.26		0.96	0.10	0.15	0.40
1965	0.39	0.35	0.36	0.62	0.31	0.33	1.07	0.16	0.27	0.43
1966	0.24	0.23	0.23	0.46	0.18	0.23	0.84	0.09	0.15	0.29
1967	0.19	0.19	0.19	0.38	0.14	0.20	0.66	0.07	0.11	0.24
1968	0.15	0.14	0.15	0.30	0.13	0.18	0.52	0.06	0.09	0.19
1969	0.23	0.22	0.20	0.35	0.21	0.19	0.66	0.06	0.11	0.25
1970	0.19	0.19	0.19	0.36	0.13	0.17	0.78	0.08	0.09	0.24
1971	0.27	0.21	0.22	0.38	0.19	0.18	0.68	0.07	0.11	0.26
1972	0.18	0.17	0.16	0.30	0.19	0.15	0.54	0.07	0.11	0.21
1973	0.14	0.13	0.13	0.21	0.10	0.13	0.40	0.04	0.07	0.15
1974	0.12	0.11	0.10	0.20	0.09	0.11	0.33	0.05	0.07	0.13
1975	0.11	0.10	0.11	0.19	0.09	0.13	0.32	0.04	0.06	0.13
1976	0.10	0.09	0.09	0.13	0.06	0.09	0.23	0.04	0.04	0.10
1977	0.08	0.08	0.09	0.14	0.05	0.08	0.19	0.04	0.04	0.09
1978	0.06	0.08	0.08	0.11	0.06	0.08	0.14	0.04	0.04	0.08
1979	0.06	0.07	0.09	0.16	0.06	0.07	0.14	0.04	0.03	0.08
1980	0.06	0.06	0.09	0.14	0.05	0.07	0.13	0.03	0.04	0.07
Average	0.18	0.17	0.17	0.30	0.14	0.15	0.51	0.07	0.10	0.20

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

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 1980 are given in Table 11 Appendix.)

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

To convert Bq/gK to pCi/gK multiply by 27.

	ND	AK	WK	TA	PN	WN	WD	CH	DN	Av
1964	1.8	1.9	2.6	6.2	0.7		2.8	0.3	0.4	2.1
1965	2.0	2.0	3.1	6.8	1.0	1.1	2.8	0.4	0.7	2.2
1966	1.4	1.2	2.2	5.2	0.4	0.7	1.6	0.1	0.3	1.5
1967	1.0	1.0	1.8	4.6	0.3	0.5	1.2	0.1	0.2	1.2
1968	0.6	0.7	1.3	3.8	0.1	0.3	0.8	<0.1	0.1	0.9
1969	1.0	1.0	1.5	3.7	0.2	0.3	1.4	0.1	0.1	1.0
1970	0.8	0.7	1.3	3.3	0.2	0.4	1.4	0.1	0.2	0.9
1971	0.9	0.7	1.3	3.0	0.3	0.3	1.1	0.1	0.2	0.9
1972	0.8	0.6	1.0	2.7	0.1	0.3	0.8	0.1	0.1	0.7
1973	0.5	0.3	0.8	1.8	0.1	0.1	0.5	<0.1	0.1	0.5
1974	0.3	0.3	0.6	1.5	0.1	0.1	0.3	<0.1	<0.1	0.4
1975	0.3	0.3	0.5	1.3	<0.1	0.1	0.3	<0.1	<0.1	0.3
1976	0.2	0.2	0.4	0.9	0.1	0.1	0.1	<0.1	0.1	0.2
1977	0.2	0.1	0.4	1.1	<0.1	0.1	0.2	<0.1	<0.1	0.3
1978	0.1	0.1	0.3	0.7	<0.1	<0.1	0.1	<0.1	<0.1	0.2
1979	0.1	0.1	0.4	1.2	<0.1	<0.1	0.1	<0.1	<0.1	0.2
1980	0.2	0.2	0.4	1.0	<0.1	<0.1	0.2	<0.1	<0.1	0.2
Average	0.7	0.7	1.2	2.9	0.2	0.3	0.9	0.1	0.2	0.8

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. Levels have decreased steadily since then. During the last five years the average level has remained at about 0.2 Bq/l, the lowest recorded since measurements commenced.

The "soil effect" leading to high caesium-137 concentrations in milk at Taranaki, and to a lesser extent at Waikato and Auckland, has been the subject of a special survey which was referred to in the 1977 annual report (1).

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 (0.20 Bq/gCa) and caesium-137 (0.8 Bq/gK) have been 2% 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: During 1980 the Laboratory participated in intercomparisons of measurement of radionuclides in wheat and seawater samples provided by the WHO International Reference Centre, and in milk samples provided by the U.S. Environmental Protection Agency.

2. Port Monitoring During the Visit of a Nuclear Ship: The Port of Wellington was monitored during the visit of the USS Truxtun on 22-29 September 1980. Continuous air sampling was conducted at 9 foreshore sites using air cartridges designed for collecting particulates and radioiodines. The cartridges were changed daily. Mussels from 12 selected areas were collected and measured before and after the visit. No change in background levels was detected.

3. Beryllium-7 in the Atmosphere: The 2-year study of beryllium-7 levels in the atmosphere concluded in June 1980. The study was designed to investigate mixing of stratospheric and tropospheric air masses, and complement work done overseas.

4. Strontium-90 and Caesium-137 in Samoan Fish Samples: Eight samples were analysed at the request of the Department of Paediatrics, Auckland Medical School. Concentrations measured were very low and of no health significance.

5. The following Surveys listed in this Section of last year's report NRL-F/59 have been published or are in press:

- (a) Potable Water Survey (3) (4)
- (b) Radionuclides in Lichens (5)
- (c) Low Background Scintillation Counter (6) (7)

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- (3) "Radioactivity of Potable Waters, Nation-Wide Survey." L.P. Gregory, Report NRL 1980/4. National Radiation Laboratory.
 - (4) "Radioactivity of Potable Waters in New Zealand." L.P. Gregory, New Zealand Journal of Science, 1980, Vol. 23 : 407-413.
 - (5) "The Use of Lichens in a Study of Geothermal Radon Emissions in New Zealand." K.M. Matthews, Environmental Pollution (in press).
 - (6) "The National Radiation Laboratory's Low-Level α/β Scintillation Counter." L.P. Gregory and K.M. Matthews, NRL 1980/8.
 - (7) "A Four-Sample, Low Background α and β Scintillation Counter." L.P. Gregory and K.M. Matthews, Nuclear Instruments and Methods, (in press).

APPENDIX

TABLE 7 - Total Beta Activity in Rain 1980 (Weekly Collections):
Cumulative Rainfall (mm), Cumulative Deposition (MBq/km²)*,
Average Concentration (Bq/l)*

To convert MBq/km² to mCi/km² multiply by 0.027
 To convert Bq/l to pCi/l multiply by 27

<u>Station</u>	<u>1st Quarter</u>	<u>2nd Quarter</u>	<u>3rd Quarter</u>	<u>4th Quarter</u>	<u>1980</u>
Auckland					
mm	309	208	242	254	1013
MBq/km ²	36 ± 7	7 ± 7	13 ± 7	10 ± 7	66 ± 14
Bq/l	0.11 ± 0.02	0.03 ± 0.03	0.05 ± 0.03	0.04 ± 0.03	0.07 ± 0.01
Wellington					
mm	357	398	267	280	1302
MBq/km ²	38 ± 7	24 ± 6	23 ± 7	15 ± 7	100 ± 14
Bq/l	0.11 ± 0.02	0.06 ± 0.01	0.09 ± 0.03	0.05 ± 0.03	0.08 ± 0.01
Hokitika					
mm	634	497	739	429	2299
MBq/km ²	40 ± 7	24 ± 6	42 ± 7	38 ± 7	144 ± 14
Bq/l	0.06 ± 0.01	0.05 ± 0.01	0.06 ± 0.01	0.09 ± 0.02	0.06 ± <0.01
Christchurch					
mm	200	182	71	95	548
MBq/km ²	20 ± 7	21 ± 7	4 ± 6	15 ± 6	60 ± 13
Bq/l	0.10 ± 0.03	0.11 ± 0.04	0.05 ± 0.09	0.16 ± 0.06	0.11 ± 0.02
NZ Station Av.					
MBq/km ²	34	19	21	20	93
Bq/l	0.10	0.06	0.06	0.09	0.08
Nandi, Fiji					
mm	703	161	216	340	1420
MBq/km ²	21 ± 20	44 ± 16	17 ± 19	19 ± 20	101 ± 38
Bq/l	0.03 ± 0.03	0.27 ± 0.10	0.08 ± 0.09	0.06 ± 0.06	0.07 ± 0.03
Samoa					
mm	1106	779	1013	830	3728
MBq/km ²	49 ± 26	44 ± 23	49 ± 24	41 ± 22	183 ± 48
Bq/l	0.04 ± 0.02	0.06 ± 0.03	0.05 ± 0.02	0.05 ± 0.03	0.05 ± 0.01
Tonga					
mm	318	328	353	923	1922
MBq/km ²	32 ± 20	14 ± 21	10 ± 19	9 ± 21	65 ± 41
Bq/l	0.10 ± 0.06	0.04 ± 0.06	0.03 ± 0.06	0.01 ± 0.02	0.03 ± 0.02
Aitutaki					
mm	670	601	87	535	1893
MBq/km ²	59 ± 22	82 ± 24	26 ± 19	34 ± 21	201 ± 43
Bq/l	0.09 ± 0.03	0.14 ± 0.04	0.30 ± 0.22	0.06 ± 0.04	0.11 ± 0.02
Rarotonga					
mm	1028	419	320	1096	2863
MBq/km ²	19 ± 26	72 ± 21	29 ± 21	40 ± 22	160 ± 45
Bq/l	0.02 ± 0.03	0.17 ± 0.05	0.09 ± 0.07	0.04 ± 0.02	0.06 ± 0.02

* The plus or minus (±) error term is two standard deviations (95% confidence level)

TABLE 8 - Strontium-90 in Rain 1980: Rainfall (mm), Deposition (MBq/km²)†, Concentration (Bq/l)†

Station		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total	Av
Kaitia	mm	556	323	377	312	1568	
	MBq/km ²	0.8	0.4	0.6	0.7	2.5	
	Bq/l	0.001	0.001	0.002	0.002		0.002
Auckland	mm	328	192	252	255	1027	
	MBq/km ²	0.6	0.3	0.4	0.6	1.9	
	Bq/l	0.002	0.002	0.002	0.002		0.002
New Plymouth	mm	386	341	398	404	1529	
	MBq/km ²	0.7	0.3	0.6	0.7	2.3	
	Bq/l	0.002	0.001	0.001	0.002		0.002
Havelock North	mm	286	262	162	249	959	
	MBq/km ²	0.6	0.4	0.1	0.6	1.7	
	Bq/l	0.002	0.001	0.001	0.002		0.002
Wellington	mm	479	468	387	284	1618	
	MBq/km ²	1.0	0.4	0.6	0.6	2.6	
	Bq/l	0.002	0.001	0.002	0.002		0.002
Hokitika	mm	764	571	824	502	2661	
	MBq/km ²	1.5	0.6	0.9	1.6	4.6	
	Bq/l	0.002	0.001	0.001	0.003		0.002
Christchurch	mm	307	175	70	95	647	
	MBq/km ²	0.6	0.2	0.1	0.3	1.2	
	Bq/l	0.002	0.001	0.002	0.003		0.002
Dunedin	mm	245	123**	151	178	697	
	MBq/km ²	0.5	0.1**	0.3	0.3	1.2	
	Bq/l	0.002	0.001	0.002	0.002		0.002
Invercargill	mm	299	251	339	230	1119	
	MBq/km ²	0.7	0.3	0.3	0.4	1.7	
	Bq/l	0.002	0.001	0.001	0.002		0.002
New Zealand Country-Wide Average	mm	406	301	329	279	1315	
	MBq/km ²	0.8	0.3	0.4	0.6	2.1	
	Bq/l	0.002	0.001	0.002	0.002		0.002
Suva, Fiji	mm	559*	1565	712	1216	4052	
	MBq/km ²	0.3*	0.4	0.4	0.6	1.7	
	Bq/l	<0.001	<0.001	0.001	<0.001		<0.001
Rarotonga	mm	1160	472	316	735	2683	
	MBq/km ²	1.3	0.2	0.2	0.3	2.0	
	Bq/l	0.001	<0.001	0.001	<0.001		<0.001

* January, February only

** April, May only

TABLE 9 - Lead-210 in Rain 1980: Deposition (MBq/km²)†

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
KA	10.1	7.1	2.3	2.2	2.5	6.1	5.9	3.3	12.6	6.3	5.7	10.3	74.4
AK	3.5	3.1	4.9	1.3	2.8	4.4	5.2	2.9	2.8	1.9	9.0	7.2	49.0
NP	5.8	3.9	7.8	3.4	4.9	7.9	6.1	5.0	7.6	(5.4)	5.0	3.5	66.3
HN	2.4	2.8	3.5	2.4	1.7	2.4	2.2	2.3	1.8	1.5	3.9	7.5	34.4
WN	6.0	5.1	5.8	4.7	5.2	4.8	4.1	8.6	6.7	5.0	8.1	4.3	68.4
HK	15.7	8.7	11.7	7.7	11.1	13.5	5.8	13.9	14.9	16.2	17.8	7.1	144.1
CH	3.0	2.5	1.7	4.8	1.9	2.1	1.8	1.0	1.3	1.7	2.5	1.3	25.6
DN	5.8	2.6	2.1	2.3	2.2	(7.4)	1.8	2.6	1.0	(3.3)	(5.5)	3.9	40.5
IN	6.7	1.3	1.9	1.1	5.3	2.7	2.5	6.0	2.5	3.2	4.5	10.1	47.8
NZ Av	6.6	4.1	4.6	3.3	4.2	5.7	3.9	5.1	5.7	4.9	6.9	6.1	61.2
SU	5.4	4.8	N.S.	3.7	3.1	5.7	3.2	6.9	9.4	10.2	11.0	6.4	(73.8)
RA	10.4	3.7	3.3	N.S.	N.S.	9.4	1.9	3.8	2.5	2.8	2.8	14.6	-

N.S. No result available.

() Estimate.

The station names are abbreviated and in the same sequence as in Table 8.

† Conversion factors for deposition and concentration are given in Table 7.

TABLE 10 - Strontium-90 in Milk 1980 : (Bq/gCa)

To convert Bq/gCa to pCi/gCa multiply by 27						
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Av	
Northland	0.077	0.046	0.059	0.055	0.059	
Auckland	0.071	0.054	0.062	0.052	0.060	
Waikato	0.105	0.078	0.083	0.086	0.088	
Taranaki	0.209	0.137	0.098	0.101	0.136	
Palmerston North	0.052	0.040	0.054	0.050	0.049	
Wellington	0.073	0.066	0.062	0.062	0.066	
Westland	0.160	0.113	0.126	0.122	0.130	
Christchurch	0.032	0.035	0.035	0.027	0.032	
Dunedin	0.040	0.037	0.037	0.027	0.035	
NZ Average	0.091	0.067	0.068	0.065	0.073	

TABLE 11 - Caesium-137 in milk 1980 : (Bq/gK)

To convert Bq/gK to pCi/gK multiply by 27													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av
Northland	0.22	0.15	0.22	0.19	0.11	0.11	0.11	0.11	0.11	0.19	0.11	0.26	0.16
Auckland	0.19	0.26	0.26	0.19	0.22	0.11	0.26	0.26	0.04	0.15	0.15	0.19	0.19
Waikato	0.44	0.56	0.56	0.48	0.37	0.37	0.26	0.30	0.30	0.33	0.33	0.37	0.39
Taranaki	1.59	1.78	1.67	0.96	0.89	1.22	0.63	0.48	0.56	0.63	0.85	0.74	1.00
Palmerston North	0.07	<0.04	0.07	<0.04	<0.04	<0.04	<0.04	<0.04	0.11	<0.04	0.04	0.19	0.05
Wellington	0.07	0.15	<0.04	0.07	0.15	<0.04	0.19	<0.04	0.07	<0.04	0.07	0.07	0.08
Westland	0.22	0.30	0.22	0.30	0.04	0.07	0.04	0.04	0.04	0.15	0.15	0.22	0.15
Christchurch	<0.04	<0.04	0.07	0.07	0.04	<0.04	<0.04	<0.04	<0.04	0.04	0.15	0.11	0.05
Dunedin	0.04	(0.04)	0.04	(0.04)	(0.04)	<0.04	0.07	<0.04	0.07	<0.04	0.11	0.04	0.05
NZ Average	0.32	0.36	0.35	0.26	0.21	0.22	0.18	0.14	0.15	0.17	0.22	0.24	0.24
() estimate													

() estimate