NRL - F/56

DEPARTMENT OF HEALTH
NEW ZEALAND

# ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT

## 1976



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 Mr T. Baltakmens and Dr K. M. Matthews, and technically by Mr G. N. Connor and Miss M. Roberts.

for H. R. Atkinson
(Director)

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## UNITS AND REFERENCE LEVELS

### Units

The unit of radioactivity, the "Curie" (Ci), equal to $3.7 \times 10^{10}$ 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:

$$pCi/l = \frac{mCi/km^2 \times 100}{\text{centimetres of rain}}$$

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 1976 the deposition of strontium-90 at nine New Zealand stations averaged 0.1 millicuries per square kilometre. This was the lowest value recorded since measurements commenced in 1960:

During 1964 a maximum deposition, averaging 3.6 $mCi/km^2$, resulted from the large scale U.S.S.R. and U.S.A. atmospheric nuclear tests of 1961-2. Subsequently levels decreased and during the French atmospheric tests in the South Pacific from 1966 to 1974 the annual average depositions in New Zealand ranged from 0.3 to 1.4 $mCi/km^2$.

The concentrations of strontium-90 and caesium-137 in milk reflect these changes in fallout deposition. The average concentrations during 1976 were the lowest since measurements commenced.

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

The levels recorded during 1976 were very small fractions of the reference levels and thus do not constitute a public health hazard. Moreover, the radiation dose resulting from the long-term average levels, summarised herein, is small compared not only with natural background but also with common variations in natural background.


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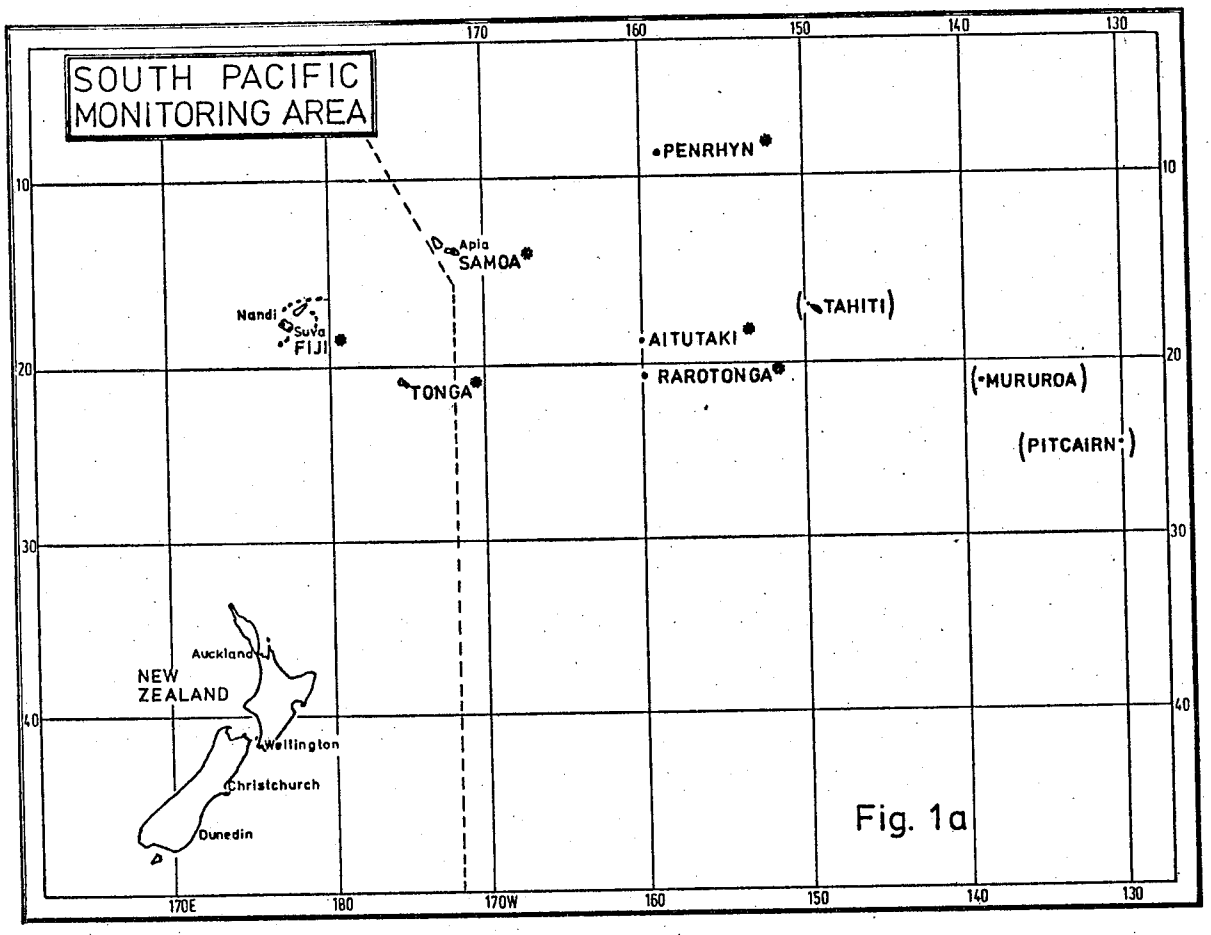


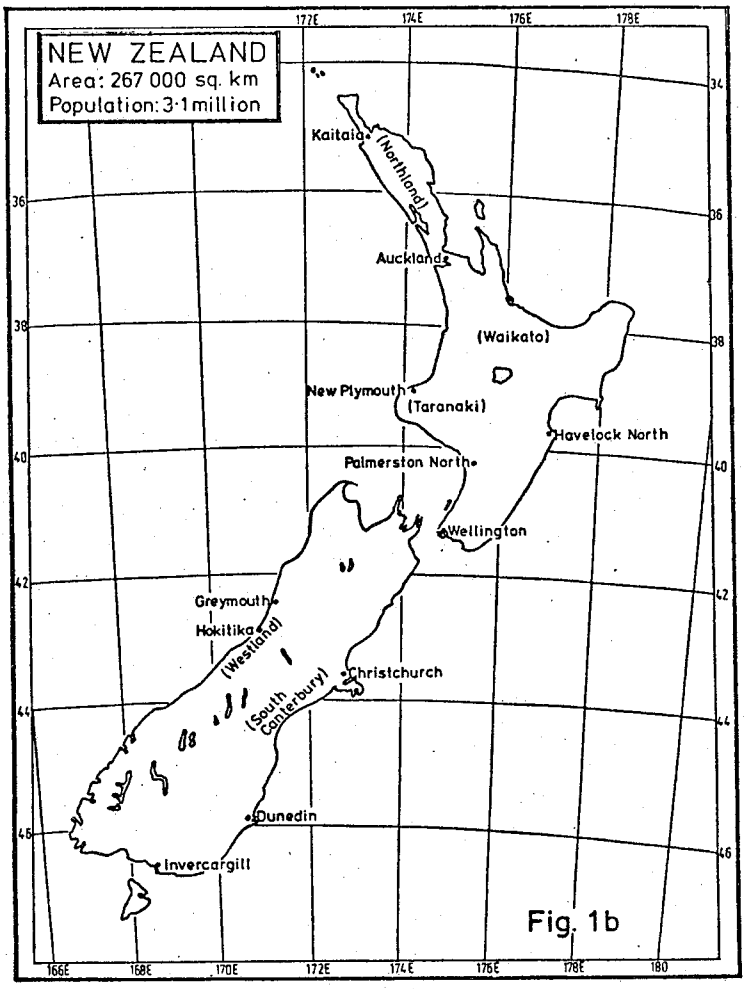


FIG. 1 MONITORING AND COLLECTING STATIONS ON PACIFIC ISLANDS AND IN NEW ZEALAND.

## INTRODUCTION

This report continues the series of annual reports on levels of environmental radioactivity in New Zealand and in the South Pacific area.

In September 1974 France terminated the series of atmospheric nuclear tests which had been conducted in the Tuamotu Archipelago in the South Pacific, and in June 1975 commenced underground testing in the same area. Consequently the Laboratory's monitoring programme was modified in mid-1975 and this programme has been continued during 1976. The modified programme, designed to detect any venting to the atmosphere of fission products from underground tests, consists of daily gamma radiation monitoring at Penrhyn Island and continuous collection of air filter and rainwater samples from five Pacific Island and four New Zealand stations. The samples are sent to the Laboratory for measurement of total beta activity.

The routine programme for measurement of long-term radioactive fallout from earlier atmospheric tests was also continued during 1976. In this programme emphasis is given to the measurement of the two most potentially hazardous long-lived radionuclides, strontium-90 and caesium-137. Monthly 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 Figs. 1 a and b.

Fallout levels during recent years and particularly during 1976 have been very low and this report has been considerably shortened. The reader is referred to the previous annual reports (1), and the reports (2) on special monitoring of French atmospheric nuclear tests (1966-1974). These reports give further information on terms of reference, potential health hazard, adoption of reference levels, and technical information on procedures. They also include graphical presentation of results allowing historical and geographical comparison.

## GAMMA RADIATION MONITORING AT PENRHYN ISLAND

No increases above the normal background radiation level have been detected at Penrhyn Island since this monitoring programme started in July 1975.

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(1) "Environmental Radioactivity":

Annual Report 1971, Report No. NRL-F/48, June 1972
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

(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.

## 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 samples, and also rainwater samples, which are collected for measurement of fission products, are held for four days to allow this natural radioactivity to decay away and are then measured for residual beta activity which is due to radioactive fallout. Hereafter the term "total beta activity" refers only to this residual radioactivity due to fission products.

### 1. Fission Products in Air

During 1976 air was monitored continuously at the New Zealand and Pacific Island stations listed in Table 1 below. The filters were changed three times each week and were measured for total beta activity at the Laboratory. Without exception average levels each month during 1976 were at or below the limit of detection (0.01 pCi/$m^3$) at each station. Therefore, for the first time in this series of reports, individual results or monthly averages are not tabulated in the Appendix. However, the 1976 annual averages are included in Table 1 for comparison with those during 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 | 0.04 - 6.22 pCi/$m^3$ in the | | | | |
| 1970 | 0.16 | 0.12 | (0.12) | 0.10 | South Pacific area during the | | | | |
| 1971 | 0.21 | 0.12 | 0.16 | 0.15 | special monitoring programmes | | | | |
| 1972 | 0.06 | 0.05 | 0.05 | 0.05 | | | | | |
| 1973 | 0.02 | 0.01 | 0.02 | 0.02 | | | | | |
| 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 |

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, averaging 0.01 pCi/$m^3$).

It can be seen that levels in New Zealand have been latitude dependent during the period of 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 3-6 month special monitoring programmes covering these tests, were significantly higher than New Zealand levels, averaging from 0.04 to 6.22 pCi/$m^3$, depending on the locality monitored, the extent of nuclear testing, and meteorological conditions.

Since mid-1975, about nine months after the termination of the French atmospheric nuclear tests, levels have been at the limit of detection at all stations. There has been no indication of fresh fission products, either from venting of underground tests or from Northern Hemisphere atmospheric tests.

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 1976 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 measured for total beta activity. Results for individual samples are given in Table 7 Appendix. The annual totals, since measurements started, are listed for each station in Table 2 below.

TABLE 2 - Total Beta Activity in Rain - Weekly Depositions Summed Annually ($mCi/km^2$)

| | 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 |

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 first 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 $mCi/km^2$).

During 1976 the totalled depositions, ranging from 2 to 4 $mCi/km^2$, were the lowest recorded and the average concentrations, between 1 and 3 pCi/l (see Table 7 Appendix), were very small fractions of the reference level.

# STRONTIUM-90 DEPOSITION

## 1. Routine Measurement

The measurement of strontium-90 deposition started in New Zealand in 1960, and in Suva in 1961. Since 1963 measurements have been made continuously at nine New Zealand stations, and since 1967 at two Pacific Islands. Collections are made each month in high walled stainless steel pots. 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 since 1960 have been averaged for the New Zealand stations and are listed in Table 3 below, together with the annual depositions at each station. (Individual monthly results during 1976 are given in Table 8 Appendix.)

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

| | 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 |
| Rainfall | 138 | 117 | 149 | 78 | 134 | 241 | 60 | 63 | 104 | | 310 | 209 |

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 station in Westland (HK) was at Greymouth from 1960-1975 inclusive and was resited at Hokitika starting Jan. 1976.
3. Values in parenthesis are estimates.
4. The mean annual rainfall is for 1963 to 1976 inclusive (at Rarotonga for 1967-1976). At Westland annual rainfalls at the actual collecting sites were used to obtain the mean.

The large scale Northern Hemisphere (U.S.S.R.) and Pacific area (U.S.A.) nuclear tests, which were conducted in 1961 and 1962 before the signing of the Partial Test Ban Treaty, resulted in a delayed stratospheric fallout over New Zealand. The maximum deposition from these tests was recorded in late 1964 and early 1965. Thereafter the annual deposition steadily decreased until 1968.

During the years 1966 to 1974 a series of smaller scale 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, has taken place during the Southern Hemisphere winter. During these tests a total of 41 nuclear devices were reported to have been exploded in the atmosphere, most of them being in the low to medium power (kiloton) range. However, megaton explosions were reported to have occurred twice in 1968, twice in 1970, and once in 1971 (2). As a result the annual deposition of strontium-90 in New Zealand increased during the period 1969 to 1971 reaching a maximum in 1971 which, however, was less than one-half of the 1964 maximum. Since then the annual depositions have again decreased to reach, during 1976, the lowest values recorded since these measurements were 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).

Unlike the deposition of fresh fission products from the troposphere after the French atmospheric tests, 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. When normalised for rainfall the mean annual deposition at the New Zealand stations, during 1963-1975 inclusive, was 1.08 mCi/km$^2$ per 100 cm of rain (standard deviation 0.06 mCi/km$^2$). However, at Suva during 1974, the year of maximum deposition of stratospheric fallout in New Zealand, the deposition was lower than the New Zealand average, despite the higher rainfall at Suva. This demonstrates a characteristic feature of stratospheric fallout, namely that the tropics receive less stratospheric fallout than mid-latitudes. Since then, during the past ten years depositions at the two Pacific Islands have been similar to the average depositions in New Zealand. During the period of French Pacific nuclear testing it seems that the smaller stratospheric component and larger tropospheric component of the fallout at the Pacific Islands resulted in depositions similar to those in New Zealand where the relative contributions of these components were reversed.

2. Cumulative Deposition

Direct measurement of strontium-90 in soil to determine the cumulative deposition has been made at selected sites since 1953. The most recent routine measurements were made on soils sampled at the end of 1972. Results for this and all previous measurements were tabulated in the 1973 Annual Report (1). Sampling depth was initially 15 cm in 1953. The depth was increased to 20 cm in 1960 and 30 cm in 1970. Such direct measurements frequently give lower values than those obtained by summing annual fallout increments. It was considered that surface run-off of rainwater and leaching of part of the strontium-90 below the sampling depth could account for the lower values.

During 1976 a special survey to investigate the penetration of strontium-90 (and caesium-137) in soil at selected sites was completed (3). The object was to relate the findings to the ion exchange properties of the soils and to the known levels of milk contamination in the same districts. The soils used in the survey had been sampled at the end of 1974 to a depth of 75 cm at Northland, Taranaki, Wellington, Greymouth, and South Canterbury. The total strontium-90 depositions measured at these stations were 19, 25, 16, 31, and 9 mCi/km$^2$ respectively. It was found that strontium-90 had penetrated below 60 cm at three of these stations. However, at least 60% was still in the top 15 cm, and at least 75% was in the top 30 cm at each station.

## 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. Like strontium-90 the subsequent deposition of lead-210 is rainfall dependent and high rainfall areas such as Hokitika show elevated values compared to low rainfall areas such as Christchurch.

Measurement of lead-210 deposition was continued during 1976. Evaluation was made in the same monthly rainwater samples in which strontium-90 was determined. The individual results for 1976 are listed in Table 9 Appendix. Earlier results, including higher levels during 1965 at four stations, and also levels in milk,

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(3) "Profiles of $^{90}$Sr and $^{137}$Cs Concentrations in Selected New Zealand Soils and Their Bearing on Milk Contamination Levels." T. Baltakmens and L. P. Gregory. N.Z. Journal of Science (in press September 1977).

were discussed in the 1971 annual report (1). Annual depositions since 1967 have been averaged for the New Zealand stations and are listed in Table 4 below, together with the annual depositions at each station.

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 | - |

Notes: 1. See Table 3 (Notes 1 and 2) for station names and the resiting of the Westland station at Hokitika.
2. The 1967 results are for May-Dec. only.
3. Estimates have been made for some missing monthly deposition results in order to reduce the resulting bias in the annual total. Where this has not been practicable annual totals are omitted.

During the last nine years the annual deposition in New Zealand has averaged about 1.4 $mCi/km^2$. During the same period the annual deposition of weapons test strontium-90 at the same stations has averaged about 0.7 $mCi/km^2$. At the Pacific Island stations lead-210 depositions at Suva are generally somewhat higher, and at Rarotonga generally somewhat lower, than those in New Zealand.

Since 1967, there does not appear to have been any marked seasonal variation nor, unlike strontium-90, any significant change in the average annual deposition.

## STRONTIUM-90 AND CAESIUM-137 IN MILK

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

### 1. Strontium-90

The all-station average concentrations each year since 1961 are listed in Table 5 below, together with average levels for each station. (Individual quarterly results during 1976 are listed in Table 10 Appendix). The average concentration during 1976, 2.6 pCi/gCa, was the lowest recorded since measurements commenced.

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 |
| Average | 5.8 | 5.2 | 5.1 | 9.3 | 4.4 | 4.7 | 16.2 | 2.0 | 3.1 | 6.3 |

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 fell steadily reaching a minimum of 5.2 pCi/gCa in 1968, about half the 1964-65 maximum. This indicated that the level in milk was dependent to a considerable extent on fallout rate. However, during the period 1965-68, milk levels decreased at a slower rate than the strontium-90 deposition, thus indicating in addition, 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 1969-1971. However, following the subsequent decrease in deposition since 1972, milk levels also decreased again, reaching the minimum level recorded in 1976.

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 nearly three times the country-wide average.

2. Caesium-137

The all-station average concentrations each year since 1964 are listed in Table 6 below, together with average levels for each station. (Individual monthly results during 1976 are listed in Table 11 Appendix.) The average concentration during 1976, 6 pCi/gK, was the lowest recorded since measurements commenced. Again the highest levels were recorded in 1964 and 1965 and they have steadily decreased since then except for a slight increase in 1969 and 1970. The higher levels at Taranaki due to the "soil effect" have been discussed in the 1971 annual report (1), and this effect has been the subject of further investigation (3).

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 |
| Average | 24 | 22 | 38 | 93 | 7 | 10 | 32 | 3 | 5 | 26 |

Note: See Table 5 for station names.

### 3. Comparison of Measured Levels with the Reference Levels

When comparing measured levels in milk with the reference levels, long-term averages are more meaningful. Since measurements commenced, the "country-wide" average levels of strontium-90 (6.3 pCi/gCa) and caesium-137 (26 pCi/gK), have been 2.3% and 0.4% of the reference levels respectively. At the stations with the highest levels of contamination the corresponding percentages are about three times higher.

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

### 1. Monitoring During Visits of Nuclear Powered Ships

The environmental radioactivity section of the Laboratory participated in the special monitoring of harbour environs during the visit of the USS TRUXTUN to Wellington, and the USS LONGBEACH to Auckland in 1976. Pre-visit seawater samples were collected and then regular sampling downstream of the ships was undertaken at each high tide. Sampling of bottom sediments within the swinging distance of the ships' anchorage, and filter feeding molluscs from selected sites was undertaken before the ships' arrival and again after departure. All samples were airmailed to the Laboratory where they were evaluated by gamma spectroscopy. Measurements on the pre-visit samples established the background levels of radioactivity. All samples collected during and after each visit showed only those traces of natural radioactivity, and at the same levels, as were measured in the pre-visit samples.

Air sampling was conducted continuously during each visit at selected sites around the harbours. Sampling was by means of pumps each drawing 17 cubic metres of air per day through a special cartridge. The cartridges were made at the Laboratory from 22 mm diameter plastic cylinders containing a glass-fibre pre-filter for trapping particulates followed by a 35 mm bed of activated charcoal for trapping radioiodines. During routine monitoring, cartridges were changed each day and airmailed to the Laboratory for evaluation. Iodine-131 was below the limit of detection in all cartridges. The limit of detection was less than 1% of the dose limit for continuous exposure over one year for critical groups in the population,

as set by the International Commission on Radiological Protection.

A full report on these monitoring operations has been published (4).

2. International Intercomparison

During 1976 the Laboratory again participated successfully in the intercomparison of measurements on environmental samples, and also for the first time on the testing of tentative radiochemical procedures:

The International Reference Centre, WHO, provided a milk sample for measurement of strontium-90, caesium-137, calcium, and potassium; and also a mineral water sample for measurement of total beta activity, potassium, radium-226, and natural uranium.

The U.S. Environmental Protection Agency provided on three occasions milk samples for measurement of strontium-89, strontium-90, iodine-131, caesium-137, barium-140, and potassium, and also a polonium-210 standard solution for a round robin study. Three Tentative Reference Methods: "Total Alpha and Total Beta Radioactivity in Waters", "Total Radium and Radium-226 in Waters", and "Strontium-89 and Strontium-90 in Waters", were provided by the Agency together with radioactive standards and water samples for testing these procedures with the objective of raising their status to Standard Reference Methods.

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(4) "Report on Radioactive Monitoring During the Visits of Nuclear Powered Ships." National Radiation Laboratory, Department of Health, New Zealand, Report NPS-1, 22 February 1977.

TABLE 7 - Total Beta Activity of Weekly Rainwater Samples 1976 : Deposition (mCi/km$^2$), Rainfall (cm)

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

| AUCKLAND | | | WELLINGTON | | | HOKITIKA | | | CHRISTCHURCH | | | FIJI | | | SAMOA | | | TONGA | | | AITUTAKI | | | RAROTONGA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ |
| Jan 2 | 0.6 | <0.1 | Jan 2 | 0.4 | <0.1 | Jan 2 | 0.4 | <0.1 | Jan 2 | 0.4 | <0.1 | Dec 29 | 3.2 | <0.1 | Dec 28 | 12.7 | <0.1 | Jan 2 | 3.3 | <0.1 | Dec 29 | 0.3 | <0.1 | Jan 2 | 4.8 | <0.1 |
| Jan 9 | 17.2 | 0.2 | Jan 9 | 3.2 | 0.1 | Jan 9 | 9.4 | 0.1 | Jan 9 | 4.0 | <0.1 | Jan 7 | 8.8 | 0.1 | Jan 8 | 21.0 | <0.1 | Jan 9 | 3.4 | <0.1 | Jan 5 | 2.2 | <0.1 | Jan 9 | 8.7 | 0.1 |
| Jan 16 | <0.1 | <0.1 | Jan 16 | 0.5 | <0.1 | Jan 16 | 5.1 | 0.1 | Jan 16 | <0.1 | <0.1 | Jan 14 | 5.6 | <0.1 | Jan 16 | 27.5 | <0.1 | Jan 16 | 13.3 | 0.2 | Jan 12 | 7.7 | <0.1 | Jan 16 | 2.2 | <0.1 |
| Jan 23 | 0.3 | <0.1 | Jan 23 | 6.2 | 0.2 | Jan 23 | 15.1 | N.S. | Jan 23 | 1.4 | <0.1 | Jan 21 | 13.1 | 0.3 | Jan 23 | 3.9 | <0.1 | Jan 23 | 3.1 | <0.1 | Jan 19 | 0.4 | <0.1 | Jan 23 | 8.3 | <0.1 |
| | | | | | | | | | | | | | | | | | | | | | Jan 26 | 1.6 | <0.1 | | | |
| Jan | 18.1 | 0.2 | Jan | 10.3 | 0.4 | Jan | 30.0 | (0.3) | Jan | 5.8 | 0.1 | Jan | 30.7 | 0.5 | Jan | 65.1 | 0.1 | Jan | 23.1 | 0.2 | Jan | 12.2 | <0.1 | Jan | 24.0 | 0.2 |
| Jan 30 | 0.3 | <0.1 | Jan 30 | 0.2 | <0.1 | Jan 30 | 1.7 | N.S. | Jan 30 | 0.6 | <0.1 | Feb 10 | 5.0 | <0.1 | Jan 30 | 9.3 | <0.1 | Jan 30 | 2.3 | 0.1 | Feb 2 | 22.3 | 0.2 | Jan 30 | 10.9 | 0.1 |
| Feb 6 | 4.9 | 0.2 | Feb 6 | 5.0 | 0.1 | Feb 6 | 1.1 | <0.1 | Feb 5 | 3.5 | <0.1 | Feb 18 | 4.6 | 0.1 | Feb 6 | 7.2 | <0.1 | Feb 6 | 5.3 | <0.1 | Feb 8 | 4.8 | <0.1 | Feb 6 | 23.5 | <0.1 |
| Feb 13 | 0.3 | <0.1 | Feb 13 | 1.1 | <0.1 | Feb 13 | 5.8 | 0.3 | Feb 13 | 0.1 | <0.1 | Feb 25 | 2.7 | <0.1 | Feb 13 | 20.2 | 0.2 | Feb 13 | 9.8 | 0.2 | Feb 16 | 4.2 | <0.1 | Feb 13 | 1.0 | <0.1 |
| Feb 20 | <0.1 | <0.1 | Feb 20 | 0.5 | <0.1 | Feb 20 | 1.2 | <0.1 | Feb 20 | 1.6 | <0.1 | | | | Feb 20 | 4.1 | <0.1 | Feb 20 | 4.7 | <0.1 | Feb 23 | 2.3 | 0.1 | Feb 20 | 2.5 | <0.1 |
| | | | | | | | | | | | | | | | Feb 25 | 5.9 | <0.1 | Feb 27 | 15.2 | <0.1 | | | | | | |
| Feb | 5.5 | 0.2 | Feb | 6.8 | 0.2 | Feb | 9.8 | 0.4 | Feb | 5.8 | 0.2 | Feb | 12.3 | 0.1 | Feb | 46.7 | 0.3 | Feb | 37.3 | 0.4 | Feb | 33.6 | 0.4 | Feb | 37.9 | 0.3 |
| Feb 27 | nil | <0.1 | Feb 27 | <0.1 | <0.1 | Feb 27 | 0.2 | <0.1 | Feb 27 | 0.5 | <0.1 | Mar 3 | 11.9 | 0.1 | Mar 5 | 7.1 | 0.2 | Mar 1 | 8.5 | <0.1 | Mar 1 | 0.4 | <0.1 | Feb 27 | 0.1 | <0.1 |
| Mar 5 | 1.0 | <0.1 | Mar 5 | 0.2 | <0.1 | Mar 5 | 7.4 | 0.1 | Mar 5 | <0.1 | <0.1 | Mar 10 | 2.8 | <0.1 | Mar 12 | 2.6 | 0.1 | Mar 5 | 5.2 | <0.1 | Mar 8 | 1.3 | <0.1 | Mar 5 | 0.9 | 0.1 |
| Mar 12 | <0.1 | <0.1 | Mar 12 | <0.1 | <0.1 | Mar 12 | nil | <0.1 | Mar 12 | nil | <0.1 | Mar 17 | 5.2 | <0.1 | Mar 19 | 1.0 | <0.1 | Mar 12 | 5.6 | <0.1 | Mar 15 | 1.3 | <0.1 | Mar 12 | 3.5 | <0.1 |
| Mar 19 | <0.1 | <0.1 | Mar 19 | <0.1 | <0.1 | Mar 19 | 4.3 | <0.1 | Mar 19 | nil | <0.1 | Mar 23 | 0.8 | <0.1 | Mar 26 | 7.9 | 0.1 | Mar 19 | 3.2 | <0.1 | Mar 22 | 1.9 | <0.1 | Mar 20 | 12.4 | <0.1 |
| Mar 26 | 2.3 | <0.1 | Mar 26 | 5.0 | N.S. | Mar 26 | 2.5 | <0.1 | Mar 26 | 1.1 | 0.1 | | | | | | | Mar 26 | 0.3 | <0.1 | | | | | | |
| Mar | 3.4 | 0.2 | Mar | 5.3 | (0.1) | Mar | 14.4 | 0.3 | Mar | 1.6 | 0.1 | Mar | 20.7 | 0.2 | Mar | 18.6 | 0.4 | Mar | 22.8 | 0.1 | Mar | 4.9 | 0.2 | Mar | 16.9 | 0.2 |
| Apr 2 | 0.7 | <0.1 | Apr 2 | 1.1 | <0.1 | Apr 2 | 3.7 | <0.1 | Apr 2 | 1.9 | <0.1 | Mar 31 | 0.8 | <0.1 | Apr 2 | 1.2 | <0.1 | Apr 2 | 5.1 | <0.1 | Mar 29 | 1.5 | <0.1 | Mar 26 | 14.9 | (0.1) |
| Apr 9 | 6.8 | 0.2 | Apr 9 | 4.8 | 0.1 | Apr 9 | <0.1 | <0.1 | Apr 9 | 0.6 | <0.1 | Apr 7 | 7.6 | 0.1 | Apr 9 | 1.7 | <0.1 | Apr 9 | 27.1 | 0.4 | Apr 5 | 21.3 | <0.1 | Apr 16 | 10.9 | <0.1 |
| Apr 16 | 0.4 | <0.1 | Apr 16 | <0.1 | <0.1 | Apr 16 | <0.1 | <0.1 | Apr 15 | <0.1 | <0.1 | Apr 13 | 11.3 | <0.1 | Apr 16 | 0.9 | <0.1 | Apr 16 | 4.4 | <0.1 | Apr 12 | 3.9 | <0.1 | Apr 23 | 13.1 | 0.3 |
| Apr 23 | 5.3 | <0.1 | Apr 23 | 3.6 | 0.1 | Apr 23 | 8.6 | 0.1 | Apr 23 | <0.1 | <0.1 | Apr 21 | 0.8 | 0.2 | Apr 23 | 16.6 | 0.1 | Apr 23 | 0.3 | 0.1 | Apr 19 | 12.7 | 0.3 | | | |
| Apr | 13.2 | 0.3 | Apr | 9.6 | 0.4 | Apr | 12.4 | 0.2 | Apr | 2.6 | <0.1 | Apr | 20.5 | 0.5 | Apr | 20.4 | 0.2 | Apr | 36.9 | 0.6 | Apr | 39.4 | 0.5 | Apr | 38.9 | 0.5 |
| Apr 30 | 3.2 | 0.1 | Apr 30 | 1.6 | 0.1 | Apr 30 | 4.5 | 0.1 | Apr 30 | <0.1 | <0.1 | Apr 28 | 1.7 | <0.1 | Apr 30 | 6.1 | <0.1 | Apr 30 | 7.7 | 0.2 | Apr 29 | 0.9 | <0.1 | Apr 30 | 5.8 | 0.1 |
| May 7 | 2.7 | <0.1 | May 7 | 6.0 | 0.2 | May 7 | 4.9 | <0.1 | May 7 | 1.4 | <0.1 | May 5 | <0.1 | <0.1 | May 7 | 2.5 | <0.1 | May 7 | 0.4 | <0.1 | May 10 | 13.1 | <0.1 | May 7 | 1.5 | <0.1 |
| May 14 | 1.2 | <0.1 | May 14 | 0.9 | <0.1 | May 14 | 12.6 | 0.2 | May 14 | 1.5 | <0.1 | May 12 | nil | 0.1 | May 14 | 13.8 | 0.2 | May 14 | 0.6 | 0.1 | May 16 | 6.1 | <0.1 | May 14 | 2.4 | <0.1 |
| May 21 | 2.8 | <0.1 | May 21 | 0.3 | <0.1 | May 21 | 4.3 | <0.1 | May 21 | 0.8 | <0.1 | May 19 | 0.6 | <0.1 | May 21 | 3.6 | <0.1 | May 21 | <0.1 | <0.1 | May 24 | 4.4 | 0.2 | May 21 | 0.5 | 0.1 |
| May 28 | 0.8 | <0.1 | May 28 | 0.2 | <0.1 | May 28 | 6.7 | 0.3 | May 28 | 0.3 | <0.1 | May 26 | nil | <0.1 | May 28 | 2.0 | <0.1 | May 28 | 0.8 | <0.1 | | | | | | |
| May | 10.7 | 0.3 | May | 9.0 | 0.4 | May | 33.0 | 0.8 | May | 4.0 | 0.1 | May | 2.4 | 0.2 | May | 28.0 | 0.4 | May | 9.5 | 0.5 | May | 24.5 | 0.3 | May | 10.2 | 0.2 |
| Jun 4 | 3.3 | <0.1 | Jun 4 | 4.2 | 0.1 | Jun 4 | 9.5 | 0.1 | Jun 4 | 0.5 | <0.1 | Jun 3 | 2.5 | 0.2 | Jun 4 | 0.9 | <0.1 | Jun 4 | 4.2 | 0.1 | May 31 | 3.8 | <0.1 | May 28 | 25.3 | <0.1 |
| Jun 11 | 6.8 | <0.1 | Jun 11 | 2.9 | <0.1 | Jun 11 | 0.9 | <0.1 | Jun 11 | 0.3 | <0.1 | Jun 15 | 1.0 | <0.1 | Jun 11 | 12.1 | <0.1 | Jun 11 | 0.4 | <0.1 | Jun 7 | 1.4 | <0.1 | Jun 18 | 1.8 | <0.1 |
| Jun 18 | 2.8 | <0.1 | Jun 18 | 6.5 | 0.1 | Jun 18 | 0.9 | <0.1 | Jun 18 | 5.3 | <0.1 | Jun 25 | nil | <0.1 | Jun 18 | 1.2 | <0.1 | Jun 18 | 0.1 | <0.1 | Jun 14 | 1.5 | <0.1 | Jun 25 | 4.7 | <0.1 |
| Jun 25 | 3.8 | <0.1 | Jun 25 | 1.1 | <0.1 | Jun 25 | 8.1 | 0.1 | Jun 25 | 0.3 | <0.1 | | | | Jun 25 | 0.5 | <0.1 | Jun 25 | 0.2 | <0.1 | Jun 21 | 0.8 | <0.1 | | | |
| Jun | 16.7 | 0.2 | Jun | 14.7 | 0.3 | Jun | 19.4 | 0.3 | Jun | 6.4 | <0.1 | Jun | 3.5 | 0.2 | Jun | 14.7 | 0.1 | Jun | 4.9 | 0.2 | Jun | 7.5 | 0.1 | Jun | 31.8 | <0.1 |

APPENDIX

TABLE 7 (continued)

| AUCKLAND | | | WELLINGTON | | | HOKITIKA | | | CHRISTCHURCH | | | FIJI | | | SAMOA | | | TONGA | | | AITUTAKI | | | RAROTONGA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ | Date | cm | mCi/km$^2$ |
| Jul 2 | 10.5 | <0.1 | Jul 2 | 2.3 | <0.1 | Jul 2 | 0.7 | <0.1 | Jul 2 | 1.9 | <0.1 | Jun 30 | nil | <0.1 | Jul 2 | 3.2 | 0.2 | Jul 2 | 0.3 | <0.1 | Jun 28 | 1.4 | 0.1 | Jul 2 | 0.8 | 0.1 |
| Jul 9 | 1.9 | <0.1 | Jul 9 | 7.1 | N.S. | Jul 9 | 10.1 | 0.2 | Jul 9 | 2.4 | <0.1 | Jul 8 | nil | 0.3 | Jul 9 | 8.1 | <0.1 | Jul 9 | 2.0 | <0.1 | Jul 6 | 0.2 | <0.1 | Jul 9 | - | N.S. |
| Jul 16 | 1.6 | <0.1 | Jul 16 | 7.6 | <0.1 | Jul 16 | 5.3 | <0.1 | Jul 16 | 1.5 | 0.1 | Jul 16 | 0.6 | <0.1 | Jul 16 | 6.3 | <0.1 | Jul 16 | 1.8 | <0.1 | Jul 14 | 0.6 | 0.3 | Jul 16 | 7.2 | 0.2 |
| Jul 23 | 1.9 | <0.1 | Jul 23 | 0.9 | <0.1 | Jul 23 | 6.9 | 0.2 | Jul 23 | <0.1 | <0.1 | Jul 26 | 1.1 | <0.1 | | | | Jul 23 | 2.0 | 0.4 | Jul 19 | 4.5 | <0.1 | Jul 23 | 4.3 | <0.1 |
| | | | | | | | | | | | | | | | | | | | | | Jul 26 | 2.4 | <0.1 | | | |
| Jul | 15.9 | 0.2 | Jul | 17.9 | 0.2 | Jul | 23.0 | 0.4 | Jul | 5.8 | 0.3 | Jul | 1.7 | 0.4 | Jul | 17.6 | 0.3 | Jul | 6.1 | 0.6 | Jul | 9.1 | 0.5 | Jul | 12.3 | 0.3 |
| Jul 30 | 3.2 | 0.1 | Jul 30 | 4.1 | <0.1 | Jul 30 | 4.6 | <0.1 | Jul 30 | 1.7 | <0.1 | Aug 2 | 3.2 | <0.1 | Jul 29 | 0.7 | <0.1 | Jul 30 | 1.6 | <0.1 | Aug 2 | 0.5 | 0.2 | Jul 30 | 2.9 | <0.1 |
| Aug 6 | 3.3 | <0.1 | Aug 6 | 1.8 | <0.1 | Aug 6 | 0.9 | <0.1 | Aug 6 | 1.4 | <0.1 | Aug 10 | 0.3 | <0.1 | Aug 6 | 0.2 | 0.1 | Aug 6 | 1.1 | <0.1 | Aug 9 | <0.1 | <0.1 | Aug 6 | <0.1 | <0.1 |
| Aug 13 | 2.1 | <0.1 | Aug 13 | 4.5 | <0.1 | Aug 13 | 2.0 | <0.1 | Aug 13 | 0.4 | <0.1 | Aug 18 | 5.5 | <0.1 | Aug 13 | 0.4 | <0.1 | Aug 13 | <0.1 | <0.1 | Aug 16 | <0.1 | <0.1 | Aug 13 | <0.1 | <0.1 |
| Aug 20 | 0.5 | <0.1 | Aug 20 | 2.3 | <0.1 | Aug 20 | 8.2 | 0.2 | Aug 20 | 2.2 | 0.1 | Aug 25 | nil | <0.1 | Aug 20 | nil | <0.1 | Aug 20 | 3.1 | 0.1 | Aug 23 | 2.4 | <0.1 | Aug 20 | 11.7 | <0.1 |
| Aug 27 | 0.8 | <0.1 | Aug 27 | 4.1 | <0.1 | Aug 27 | nil | <0.1 | Aug 27 | 2.6 | <0.1 | | | | Aug 27 | 2.7 | <0.1 | Aug 27 | 1.3 | <0.1 | | | | Aug 27 | 4.4 | <0.1 |
| Aug | 9.9 | 0.2 | Aug | 16.8 | 0.3 | Aug | 15.7 | 0.3 | Aug | 8.3 | 0.2 | Aug | 9.0 | <0.1 | Aug | 4.0 | 0.3 | Aug | 7.1 | 0.2 | Aug | 3.0 | 0.4 | Aug | 19.0 | 0.2 |
| Sep 3 | 8.6 | <0.1 | Sep 3 | 1.0 | <0.1 | Sep 3 | 0.5 | <0.1 | Sep 3 | 2.7 | <0.1 | Sep 2 | 16.5 | <0.1 | Sep 3 | <0.1 | <0.1 | Sep 3 | 16.5 | <0.1 | Aug 30 | 1.2 | <0.1 | Sep 2 | 5.4 | <0.1 |
| Sep 9 | 3.8 | <0.1 | Sep 10 | 3.9 | <0.1 | Sep 10 | 9.6 | <0.1 | Sep 10 | 3.7 | <0.1 | Sep 7 | 2.8 | <0.1 | Sep 10 | <0.1 | <0.1 | Sep 10 | nil | <0.1 | Sep 6 | 0.1 | <0.1 | Sep 10 | 0.6 | <0.1 |
| Sep 17 | 0.2 | <0.1 | Sep 17 | 0.1 | <0.1 | Sep 17 | 1.1 | <0.1 | Sep 17 | <0.1 | <0.1 | Sep 16 | 0.3 | <0.1 | Sep 17 | 0.1 | <0.1 | Sep 17 | 2.7 | <0.1 | Sep 13 | 0.3 | <0.1 | Sep 17 | 1.4 | <0.1 |
| Sep 24 | 1.3 | <0.1 | Sep 24 | 4.8 | <0.1 | Sep 24 | 0.8 | <0.1 | Sep 24 | 0.1 | <0.1 | Sep 22 | - | N.S. | Sep 24 | 0.3 | <0.1 | Sep 24 | 5.8 | <0.1 | Sep 20 | 3.9 | <0.1 | | | |
| Sep | 13.9 | 0.2 | Sep | 9.8 | 0.1 | Sep | 12.0 | <0.1 | Sep | 6.6 | 0.1 | Sep | 19.6 | <0.1 | Sep | 0.4 | 0.1 | Sep | 25.0 | 0.2 | Sep | 5.5 | 0.2 | Sep | 7.4 | <0.1 |
| Oct 1 | 0.4 | <0.1 | Oct 1 | 1.9 | <0.1 | Oct 1 | 5.2 | <0.1 | Oct 1 | 0.5 | <0.1 | Sep 30 | 3.2 | <0.1 | Oct 1 | <0.1 | 0.2 | Oct 1 | 1.3 | <0.1 | Oct 4 | 0.7 | <0.1 | Oct 1 | 3.2 | 0.3 |
| Oct 8 | - | N.S. | Oct 8 | 1.9 | <0.1 | Oct 8 | 7.0 | 0.1 | Oct 8 | 1.1 | <0.1 | Oct 6 | nil | <0.1 | Oct 8 | 0.8 | 0.1 | Oct 8 | 0.1 | 0.1 | Oct 11 | 0.1 | <0.1 | Oct 8 | <0.1 | <0.1 |
| Oct 15 | 3.7 | <0.1 | Oct 15 | 1.9 | 0.1 | Oct 15 | 8.5 | <0.1 | Oct 15 | 2.6 | 0.1 | Oct 13 | nil | <0.1 | Oct 15 | <0.1 | <0.1 | Oct 15 | 1.9 | <0.1 | Oct 18 | <0.1 | 0.1 | Oct 15 | 2.6 | 0.4 |
| Oct 22 | 1.3 | 0.1 | Oct 22 | 1.3 | 0.1 | Oct 22 | 4.9 | <0.1 | Oct 22 | 1.2 | <0.1 | Oct 21 | 1.6 | <0.1 | Oct 22 | 0.1 | <0.1 | Oct 22 | 6.8 | <0.1 | Oct 25 | 8.4 | 0.2 | Oct 22 | 2.0 | <0.1 |
| Oct | 5.4 | 0.2 | Oct | 7.0 | 0.3 | Oct | 25.6 | 0.3 | Oct | 5.4 | 0.2 | Oct | 4.8 | <0.1 | Oct | 0.9 | 0.3 | Oct | 10.1 | 0.2 | Oct | 9.2 | 0.4 | Oct | 7.8 | 0.7 |
| Oct 29 | 0.2 | <0.1 | Oct 29 | 0.2 | <0.1 | Oct 29 | 3.1 | <0.1 | Oct 29 | 0.4 | <0.1 | Oct 28 | 2.3 | 0.1 | Oct 29 | 6.6 | <0.1 | Oct 29 | 6.9 | <0.1 | Nov 1 | 3.7 | <0.1 | Nov 3 | 7.7 | <0.1 |
| Nov 5 | 0.3 | <0.1 | Nov 5 | 2.5 | <0.1 | Nov 5 | 8.9 | 0.1 | Nov 5 | 0.7 | <0.1 | Nov 3 | <0.1 | <0.1 | Nov 5 | 9.0 | 0.1 | Nov 5 | 0.7 | <0.1 | Nov 8 | nil | <0.1 | Nov 5 | 6.7 | <0.1 |
| Nov 12 | - | N.S. | Nov 12 | - | N.S. | Nov 12 | <0.1 | <0.1 | Nov 12 | 1.4 | 0.2 | Nov 10 | 7.0 | 0.1 | Nov 12 | 0.3 | <0.1 | Nov 12 | 6.7 | 0.2 | Nov 15 | 0.4 | 0.3 | Nov 12 | 4.2 | <0.1 |
| Nov 19 | 1.5 | 0.1 | Nov 19 | 0.9 | <0.1 | Nov 19 | 1.5 | <0.1 | Nov 19 | 0.8 | <0.1 | Nov 18 | nil | 0.2 | Nov 19 | 6.1 | 0.2 | Nov 19 | 8.6 | 0.3 | Nov 22 | 18.9 | 0.3 | Nov 22 | 1.7 | 0.2 |
| Nov 26 | 6.6 | 0.1 | Nov 26 | 2.8 | <0.1 | Nov 26 | 6.4 | 0.1 | Nov 26 | 1.5 | 0.1 | Nov 24 | 2.2 | 0.2 | | | | Nov 26 | 7.9 | 0.2 | | | | | | |
| Nov | 8.6 | 0.3 | Nov | 6.4 | 0.3 | Nov | 20.0 | 0.4 | Nov | 4.8 | 0.3 | Nov | 11.5 | 0.6 | Nov | 22.0 | 0.4 | Nov | 30.8 | 0.8 | Nov | 23.0 | 0.7 | Nov | 20.3 | 0.3 |
| Dec 3 | 1.3 | <0.1 | Dec 3 | 1.0 | <0.1 | Dec 3 | 15.2 | 0.3 | Dec 3 | 1.9 | <0.1 | Dec 1 | 1.4 | <0.1 | Nov 29 | 18.9 | <0.1 | Dec 1 | 0.3 | 0.1 | Nov 29 | 18.0 | 0.1 | Dec 3 | 1.9 | <0.1 |
| Dec 10 | 1.1 | <0.1 | Dec 10 | 1.9 | <0.1 | Dec 10 | 2.7 | <0.1 | Dec 10 | 0.9 | <0.1 | Dec 8 | nil | <0.1 | Dec 7 | 29.4 | <0.1 | Dec 10 | <0.1 | <0.1 | Dec 6 | - | N.S. | Dec 12 | | |
| Dec 17 | 6.7 | <0.1 | Dec 17 | 22.4 | N.S. | Dec 17 | 3.1 | <0.1 | Dec 17 | 3.7 | <0.1 | Dec 15 | 1.0 | <0.1 | Dec 11 | 1.9 | <0.1 | Dec 17 | 1.6 | <0.1 | Dec 13 | - | N.S. | to | | |
| Dec 24 | 1.6 | <0.1 | Dec 24 | 1.4 | <0.1 | Dec 24 | 19.4 | 0.2 | Dec 24 | 0.5 | <0.1 | Dec 22 | 2.3 | <0.1 | Dec 17 | 3.0 | <0.1 | Dec 25 | 0.3 | <0.1 | Dec 20 | - | N.S. | Jan 5 | 18.9 | <0.1 |
| | | | | | | | | | | | | | | | Dec 24 | 7.0 | <0.1 | | | | | | | | | |
| Dec | 10.7 | <0.1 | Dec | 26.7 | <0.1 | Dec | 40.4 | 0.6 | Dec | 7.0 | <0.1 | Dec | 4.7 | <0.1 | Dec | 60.2 | 0.1 | Dec | 2.2 | 0.1 | Dec | 18.0 | 0.1 | Dec | 20.8 | <0.1 |
| TOTAL | 132 | 2.5 | TOTAL | 140 | 3.0 | TOTAL | 256 | 4.3 | TOTAL | 64 | 1.7 | TOTAL | 141 | 2.8 | TOTAL | 299 | 3.0 | TOTAL | 216 | 4.1 | TOTAL | 190 | 3.8 | TOTAL | 247 | 3.0 |
| Average Concentration (pCi/l) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | 2 | | | 2 | | | 3 | | | 2 | | | 1 | | | 2 | | | 2 | | | 1 | |

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TABLE 8 - Strontium-90 in Rain 1976 : Rainfall (cm), Deposition ($mCi/km^2$), Concentration (pCi/l).

| Station | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Av. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kaitaia | Rainfall | 32.5 | 2.4 | 1.8 | 20.1 | 6.5 | 13.0 | 15.2 | 14.7 | 9.4 | 13.0 | 13.0 | 10.2 | 152 | |
| | Deposition | 0.02 | 0.01 | <0.01 | 0.01 | <0.01 | 0.02 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.11 | |
| | Concentration | <0.1 | 0.4 | 0.3 | <0.1 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Auckland | Rainfall | 18.5 | 5.2 | 3.4 | 14.0 | 8.4 | 15.7 | 17.9 | 9.1 | 14.0 | 6.4 | 11.5 | 10.6 | 135 | |
| | Deposition | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.10 | |
| | Concentration | <0.1 | 0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| New Plymouth | Rainfall | 12.8 | 10.7 | 7.8 | 15.9 | 12.3 | 19.1 | 16.4 | 12.8 | 8.4 | 11.7 | 14.1 | 12.0 | 154 | |
| | Deposition | 0.02 | 0.02 | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | 0.02 | 0.01 | <0.01 | <0.01 | <0.01 | 0.13 | |
| | Concentration | 0.1 | 0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Havelock North | Rainfall | 10.2 | 21.5 | 4.1 | 5.2 | 0.8 | 3.8 | 7.4 | 10.4 | 12.6 | 7.3 | 5.1 | 8.6 | 97 | |
| | Deposition | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.07 | |
| | Concentration | <0.1 | <0.1 | 0.1 | <0.1 | 0.5 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Wellington | Rainfall | 11.0 | 5.6 | 8.2 | 7.5 | 9.4 | 21.9 | 20.8 | 21.3 | 12.9 | 11.5 | 7.0 | 42.0 | 179 | |
| | Deposition | 0.01 | 0.02 | 0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.02 | <0.01 | 0.03 | <0.01 | 0.01 | 0.15 | |
| | Concentration | 0.1 | 0.3 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.3 | <0.1 | <0.1 | | <0.1 |
| Hokitika | Rainfall | 30.0 | 9.2 | 13.4 | 14.0 | 30.0 | 23.5 | 24.5 | 15.3 | 12.1 | 26.5 | 15.2 | 45.8 | 260 | |
| | Deposition | 0.02 | 0.02 | 0.01 | <0.01 | 0.01 | 0.02 | 0.02 | 0.02 | <0.01 | 0.01 | <0.01 | 0.03 | 0.19 | |
| | Concentration | <0.1 | 0.2 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Christchurch | Rainfall | 8.8 | 5.8 | 1.6 | 2.6 | 3.7 | 6.7 | 5.9 | 8.1 | 6.6 | 5.5 | 4.2 | 7.5 | 67 | |
| | Deposition | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | <0.01 | 0.01 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | 0.09 | |
| | Concentration | <0.1 | 0.2 | 0.3 | 0.2 | 0.2 | <0.1 | 0.2 | 0.2 | 0.1 | <0.1 | <0.1 | <0.1 | | 0.1 |
| Dunedin | Rainfall | 2.5 | 4.0 | 0.8 | 2.5 | 6.8 | 10.1 | 4.1 | 6.8 | 3.2 | 5.1 | 3.4 | 12.6 | 62 | |
| | Deposition | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.08 | |
| | Concentration | 0.2 | 0.2 | 0.6 | 0.2 | <0.1 | <0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | | 0.1 |
| Invercargill | Rainfall | 9.5 | 2.9 | 5.7 | 6.2 | 14.3 | 16.0 | 11.9 | 4.0 | 1.5 | 7.3 | 6.4 | 7.9 | 94 | |
| | Deposition | 0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.09 | |
| | Concentration | 0.1 | 0.3 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.3 | <0.1 | <0.1 | <0.1 | 0.1 | | <0.1 |
| New Zealand Country-wide Average | Rainfall | 15.1 | 7.5 | 5.2 | 9.8 | 10.2 | 14.4 | 13.8 | 11.4 | 9.0 | 10.5 | 8.9 | 17.5 | 133 | |
| | Deposition | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.11 | |
| | Concentration | 0.1 | 0.2 | 0.2 | <0.1 | 0.1 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Suva, Fiji | Rainfall | 29.8 | 34.6 | 28.0 | 17.1 | 51.1 | 17.6 | 13.7 | 21.1 | 31.8 | 23.0 | 34.0 | 45.1 | 347 | |
| | Deposition | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | <0.01 | <0.01 | 0.01 | 0.12 | |
| | Concentration | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 |
| Rarotonga | Rainfall | 24.3 | 37.9 | 18.4 | 37.1 | 15.1 | 26.6 | 4.3 | 15.6 | 7.4 | 6.1 | 25.4 | 18.8 | 237 | |
| | Deposition | 0.01 | 0.01 | <0.01* | | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | <0.01 | 0.04 | 0.02 | 0.12 | |
| | Concentration | <0.1 | <0.1 | <0.1 * | | <0.1 | <0.1 | 0.2 | <0.1 | <0.1 | <0.1 | 0.1 | <0.1 | | <0.1 |

* 2-monthly collection

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TABLE 9 - Lead-210 in Rain, 1976 : Deposition ($mCi/km^2$)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kaitaia | 0.28 | 0.04 | 0.03 | 0.13 | 0.06 | 0.09 | 0.12 | 0.05 | 0.08 | 0.22 | 0.18 | 0.13 | 1.41 |
| Auckland | 0.17 | 0.05 | 0.05 | 0.09 | 0.16 | 0.11 | 0.13 | 0.15 | 0.08 | 0.10 | 0.11 | (0.13) | 1.33 |
| N. Plymouth | 0.12 | 0.11 | 0.08 | 0.12 | 0.09 | 0.15 | 0.12 | 0.14 | 0.08 | 0.16 | (0.13) | 0.13 | 1.43 |
| Havelock N. | 0.11 | 0.10 | 0.05 | 0.05 | 0.03 | 0.05 | 0.04 | 0.12 | 0.13 | 0.10 | 0.10 | 0.05 | 0.93 |
| Wellington | 0.17 | 0.06 | 0.10 | 0.05 | 0.16 | 0.24 | 0.11 | 0.15 | 0.09 | 0.15 | 0.04 | 0.14 | 1.46 |
| Hokitika | 0.22 | 0.10 | 0.16 | 0.20 | 0.29 | 0.27 | 0.20 | 0.20 | 0.09 | 0.37 | 0.12 | 0.51 | 2.73 |
| Christchurch | 0.06 | 0.06 | 0.04 | 0.06 | 0.05 | 0.06 | 0.05 | 0.08 | 0.08 | 0.07 | (0.04) | 0.05 | 0.70 |
| Dunedin | 0.04 | 0.05 | 0.03 | 0.09 | 0.07 | 0.07 | 0.03 | 0.08 | 0.03 | 0.08 | 0.03 | 0.11 | 0.71 |
| Invercargill | 0.06 | 0.05 | 0.05 | 0.12 | 0.12 | 0.09 | 0.06 | 0.04 | 0.02 | 0.04 | 0.03 | 0.08 | 0.76 |
| NZ Average | 0.14 | 0.07 | 0.07 | 0.10 | 0.11 | 0.13 | 0.10 | 0.11 | 0.08 | 0.14 | 0.09 | 0.15 | 1.27 |
| Suva | 0.11 | 0.08 | 0.12 | 0.08 | 0.19 | 0.14 | 0.17 | 0.15 | 0.25 | 0.32 | 0.27 | 0.15 | 2.03 |
| Rarotonga | 0.13 | 0.17 | 0.24* | | 0.08 | 0.10 | N.S. | N.S. | N.S. | N.S. | N.S. | 0.40 | - |

N.S. No result available. ( ) Estimate * 2-monthly collection

TABLE 10 - Strontium-90 in Milk, 1976 : (pCi/g Ca)

| | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | Average |
|---|---|---|---|---|---|
| Northland | 2.9 | 2.0 | 3.0 | 2.4 | 2.6 |
| Auckland | 2.5 | 2.3 | 2.7 | 2.0 | 2.4 |
| Waikato | 2.3 | 2.5 | 3.0 | 2.0 | 2.5 |
| Taranaki | 2.9 | 3.6 | 3.6 | 3.8 | 3.5 |
| Palmerston North | 1.6 | 1.3 | 2.1 | 1.5 | 1.6 |
| Wellington | 2.3 | 2.1 | 2.9 | 2.2 | 2.4 |
| Westland | 6.5 | 5.7 | 6.1 | 5.9 | 6.1 |
| Christchurch | 1.1 | 0.9 | 1.2 | 1.0 | 1.1 |
| Dunedin | 1.0 | 1.0 | 1.3 | 1.0 | 1.1 |
| NZ Average | 2.6 | 2.4 | 2.9 | 2.4 | 2.6 |

TABLE 11 - Caesium-137 in Milk, 1976 : (pCi/g K)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Av. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Northland | 10 | 8 | 5 | 5 | 3 | 5 | 5 | 4 | 4 | 3 | 10 | 6 | 6 |
| Auckland | 7 | 7 | 6 | 5 | 4 | 2 | <1 | 4 | 3 | 3 | 10 | 4 | 5 |
| Waikato | 14 | 18 | 15 | 15 | 16 | N.S. | 5 | 6 | 6 | 7 | 13 | 8 | 11 |
| Taranaki | 30 | 23 | 22 | 42 | 29 | 24 | 10 | 13 | 18 | 20 | 25 | 24 | 23 |
| Palmerston North | 2 | 3 | <1 | <1 | 4 | N.S. | <1 | 9 | 1 | <1 | <1 | <1 | 2 |
| Wellington | 1 | 2 | <1 | 1 | 3 | <1 | 2 | <1 | <1 | 7 | 1 | <1 | 2 |
| Westland | 8 | 5 | 6 | 4 | 3 | 3 | 2 | 1 | 4 | 11 | 3 | 3 | 4 |
| Christchurch | <1 | 3 | <1 | 1 | <1 | 1 | <1 | <1 | <1 | <1 | <1 | 3 | 1 |
| Dunedin | 1 | 5 | <1 | <1 | <1 | <1 | 5 | <1 | <1 | 6 | 6 | 3 | 2 |
| NZ Average | 8 | 8 | 6 | 8 | 7 | 5 | 3 | 4 | 4 | 6 | 8 | 6 | 6 |

N.S. No sample.