



**AUSTRALIAN ATOMIC ENERGY COMMISSION**  
**RESEARCH ESTABLISHMENT**  
**LUCAS HEIGHTS**

**ENVIRONMENTAL SURVEY AT THE A.A.E.C.**  
**RESEARCH ESTABLISHMENT, LUCAS HEIGHTS**  
**RESULTS FOR 1965, 1966 AND 1967**

by

**J.E. COOK**  
**A. DUDAITIS**  
**M.S. GILES**



AUSTRALIAN ATOMIC ENERGY COMMISSION  
RESEARCH ESTABLISHMENT  
LUCAS HEIGHTS

ENVIRONMENTAL SURVEY AT THE A.A.E.C.  
RESEARCH ESTABLISHMENT, LUCAS HEIGHTS  
RESULTS FOR 1965, 1966 AND 1967

by

J. E. COOK

A. DUDAITIS

M. S. GILES

ABSTRACT

This report is a supplement to AAEC/E151, Results of the Lucas Heights Biological Survey, December 1959 – December 1964, and gives the results of environmental surveys for 1965, 1966 and 1967. They are tabulated and compared with derived maximum permissible concentrations appropriate to the local environment.

Where found, concentrations of radioisotopes attributable to Research Establishment operations were generally at or below one thousandth of these derived maximum permissible concentrations and there is no indication that such operations give rise to any exposure of the local population to radiation.





## CONTENTS (continued)

### (List of Tables)

- |     |  |   |                                     |
|-----|--|---|-------------------------------------|
| 11  | Woronora Samples   | — | Miscellaneous 1965–1967             |
| 12a | Terrestrial Samples  |   | Grass 1965                          |
| 12b | "  | " | " 1966                              |
| 12c | "  | " | " 1967                              |
| 13a | "  | " | Milk 1965                           |
| 13b | "  | " | " 1966                              |
| 13c | "  | " | " 1967                              |
| 14a | "  | " | Rain 1965                           |
| 14b | "  | " | " 1966                              |
| 14c | "  | " | " 1967                              |
| 15  | "  | " | Miscellaneous 1965–1967             |
| 16  | "  | " | Solid Waste Burial Ground 1966–1967 |
| 17  | "  | " | Effluent Pipeline 1967              |
| 18  | Woronora Samples: Annual averages expressed as fractions of the derived maximum permissible concentrations                         |   |                                     |
| 19  | Milk Samples: Annual average strontium-90 and caesium-137 contents and fractions of the derived maximum permissible concentrations |   |                                     |
| 20  | Limits of detection or percentage accuracy   |   |                                     |

### LIST OF FIGURES

Figure 1 Terrestrial sampling stations (1967)

Figure 2 Woronora Estuary sampling stations (1967)

## 1. INTRODUCTION

This report gives results obtained from samples collected for the environmental survey programme at Lucas Heights during 1965, 1966 and 1967. It continues the tabulation of results reported by Giles and Stockdale (1966). That report also described the methods of measurement used.

The sampling programme adopted in 1965 is given in Tables 1 and 2, together with details of collection and preparation of samples for analysis. New sampling locations adopted in 1965 are shown on Figures 1 and 2. The sampling programme has been maintained with minor modifications throughout the period under review.

The programme was extended in 1966 by including sampling at the low level solid waste burial ground (Figure 1) and again in 1967 by including a survey along the length of the low-level liquid effluent pipeline from the Establishment to the discharge point in the Woronora Estuary.

## 2. RESULTS

The results are given in Tables 3 to 17. Tables 3 to 11 refer to samples taken from the Woronora Estuary, which receives treated low-level liquid effluent, and Tables 12 to 17 refer to terrestrial samples which may be exposed to airborne effluent or to contamination arising from low level liquid or solid waste operations. A blank space in the tables indicates that no measurement was made and a dash indicates that nothing was detected. Limits of detection and percentage accuracy of results are given in Table 20. Since the accuracy varies between determinations the figures quoted should only be taken as a rough guide.

## 3. RADIOLOGICAL SIGNIFICANCE OF OBSERVED LEVELS OF CONCENTRATION

The measured annual average concentrations are compared with the derived maximum permissible concentrations (m.p.c.) appropriate to the materials sampled and to the radioisotopes identified, wherever such derived levels are available (Fry 1966, Bryant 1966). They are shown at the foot of each table as fractions of the derived maximum permissible concentrations and are collected together in Tables 18 and 19.

This is done whether the presence of the radioisotope identified may be attributed to Research Establishment operations, weapons test fallout, or natural radioactivity. The figures are generally below one thousandth of the derived maximum permissible concentrations with the exception of fallout strontium-90 in whole fish and in milk, where concentrations are of the order of one hundredth of the derived m.p.c. In the cases of radioisotopes unequivocally attributable to Research Establishment operations, for example tritium in estuarine water, zinc-65 in oysters and cobalt-60 in fish, the levels are of the order of one ten thousandth of the derived maximum permissible concentrations.

It is concluded that the contribution to possible exposure of the local population from contamination arising from waste disposal operations at the Research Establishment during the period was significantly less than that arising from weapons test fallout and is negligible.

## 4. DISCUSSION OF RESULTS

### 4.1 Woronora Estuary Samples

The major means of exposure for the range of radioisotopes likely to be discharged into the Woronora Estuary as low level liquid effluent from the Research Establishment are considered to be the consumption of oysters (grown commercially) and fish, direct radiation from beach sand, and uptake by immersion in water (Fry 1966). These materials are sampled regularly. Other samples taken are used as general indicators of change in levels (for example, bottom sand and the estuarine plant *Zostera*), although there are no obvious human exposure pathways connected with them.

Oysters were bought at three-monthly intervals from three farms in the estuary in 1965 and from two farms in 1966-67, and also from the Hawkesbury River north of Sydney, which is a control area for natural activity and weapons test fallout levels. Results of oyster analyses are shown in Tables 3a, b and c. Taking all three years together it can be seen that gross alpha and beta counts are similar in all samples. The levels are attributed to natural activity. Radiochemical assay for strontium-90 shows barely detectable amounts in all samples, and this is attributed to fallout. Gamma spectrometry shows zinc-65 in samples from 4.4 miles, attributable to waste disposal; a 0.5 MeV gamma emission in all samples, which is attributable to naturally occurring beryllium-7 and fallout ruthenium-103 and ruthenium-106; but no other gamma activities.

Fish were caught throughout the period. Results of analyses of whole fish are given in Tables 4a, b and c and of flesh, abdominal cavity contents and remainder in Table 5. Gross alpha and beta activity detected is attributed to natural activity and strontium-90 and the gamma emitters generally may be attributed to fallout, except for cobalt-60 which must be attributed to discharged waste. Comparisons of the figures for separated fish (Table 5) with those for whole fish of the same sampling dates in Table 4c show that concentrations in the edible flesh were all less than those in whole fish by factors up to ten.

It should be noted here that the derived maximum permissible concentrations used in Tables 4a, b and c for whole fish are those appropriate to edible flesh (the figures given by Fry (1966) for oyster flesh are used). Consequently the ratios over-estimate the significance of the observed concentrations.

Beach sand was sampled at three places along the estuary; results are given in Tables 6a, b and c. There is no statistically significant variation with sampling position or year and the observed gross alpha and beta activity is attributed to natural activity.

Bottom sand was sampled at the effluent discharge point and 1.5 miles downstream. Results are given in Tables 7a, b and c. The discharge point results are all significantly greater than the downstream results. Because of the irregular distribution of sediment on the generally rocky bottom at the discharge point, it is difficult to sample reproducibly and it is not clear whether the observed variations with time are genuine or due to this sampling difficulty. The major gamma emitter detected is cobalt 60, which is attributable to waste discharges. Other gamma emitters detected could be fallout or natural activity, although the fluctuations in the caesium-137 levels suggest that some of the activity may be due to waste, which has occasionally contained detectable quantities of caesium-137. Similarly some of the thorium-232 series observed may have been present in waste. No derived maximum permissible concentrations for bottom sand contamination have been established because of the difficulty of defining the exposure route; however, using the figures for gross alpha and beta activity in beach sand as guides, the observed concentrations represent an order of one hundredth of the maximum permissible level.

Water was sampled weekly at the discharge point and 1.5 miles downstream. Results of analyses are given in Tables 8a, b and c and 9a, b and c. Gross alpha and beta activities were generally at the limit of detection. Intermittent alpha spectrometry of water samples detected members of the natural uranium and thorium series only, with uranium and thorium concentrations of the order of 0.01 pCi/ml (N. Conway, unpublished). Tritium levels in natural waters are currently of the order of 0.1 pCi/ml and the observed tritium levels are attributable to waste discharges.

The estuarine plant *Zostera* was sampled at two places along the estuary in 1965 and five places in 1966 and 1967. The results are given in Tables 10a, b and c. The gross alpha and beta activities are attributed mainly to natural activity (there is no statistically significant variation of gross alpha activity with position). The material is chiefly of interest as an indicator of cobalt-60, which shows a roughly exponential decrease with distance downstream.

Table 11 gives results of some miscellaneous sampling.

#### 4.2 Terrestrial Samples

Spot grass and milk samples and cumulative rain samples were taken to check on the deposition of airborne radioactivity. Samples are taken at the Research Establishment (grass and rain), at Engadine, 1.2 miles east (grass); at Menai, 3 miles north (milk); and at Campbelltown, 11 miles west and Richmond, 32 miles northwest (grass, milk and rain). The latter two sampling points serve as controls. Results are shown in Tables 12a, b and c, 13a, b and c, 14a, b and c. Natural activity and weapons test fallout were recorded for all sampling points and for all samples. No radioactivity attributable to Research Establishment operations was found.

The strontium-90 and caesium-137 levels in milk at 3 miles were about twice those at other stations. This has been observed consistently in the past and is attributed to differences in soil fertility (Giles and Stockdale 1966). Table 19 shows that average strontium-90 levels in milk in 1967 were the same as those in 1966 and about half those of 1965. Caesium-137 levels were about 40 per cent higher than in 1966, the 1966 levels being about half the 1965 levels. The reversal of the trend between 1965-66 and 1966-67 is attributable to the French tests in the Pacific in 1966.

The presence of shorter-lived fission products, detected by gamma spectrometry, in rain and grass samples from mid-1966 onwards is also attributable to the French tests.

The results from samples of locally grown vegetables analysed during the period are given in Table 15. No significant activity was detected.

Table 16 gives the results of analyses of samples collected at the low-level solid waste burial ground. The ground-water samples showed only gross alpha and beta activity and no detectable gamma activity. Vegetation samples also showed weapons test fallout. There was no indication of any leaching and movement of radioactivity from the buried waste.

Table 17 gives results from soil and vegetation samples taken at selected points along the low-level liquid effluent pipe-line, which runs above ground from the Research Establishment to the Woronora Estuary. The samples in some cases showed activity levels or components other than natural background or fallout. In particular the soil sample from the area of scour valve number 5 and the gymea lily (*Doryanthes excelsa*) sample from scour valve number 4 both showed cobalt-60.

As a guide to the significance of the gross alpha and beta activities found in the soil sample, they may be compared with the derived maximum permissible concentrations for beach sand of 3000 and 2500 pCi/g respectively (Fry 1966). The measured concentrations represent 0.05 and 0.12 m.p.c. (maximum permissible concentrations are based on the external radiation hazard which is appropriate in this case, there being no obvious food chain involving the material). These levels do not constitute a source of significant possible exposure of local population.

## 5. SUMMARY

During 1965, 1966 and 1967 no radioactivity attributable to aerial dispersion from the Research Establishment was detected in the local terrestrial environment. No leaching of low level solid waste was detected at the low level waste burial ground. In the Woronora Estuary a number of radioisotopes other than those that occur naturally or in fallout, or in quantities in excess of natural or fallout concentrations, were detected and they are attributed to discharges of low-level liquid effluent. Those found were tritium (as water), cobalt-60 (in fish, *Zostera* and bottom sand from the discharge point), zinc-65 (in oysters), and possibly caesium-137, thorium-232 daughters and excess gross alpha activity (in bottom sand at the discharge point). These isotopes, except zinc-65 and tritium, were also found in selected soil and vegetation samples taken along the liquid waste pipe-line.

Activity levels were less than one thousandth of the derived m.p.c. with the exception of gross alpha and beta activity of the bottom sand at the discharge point and in soil at one point along the pipe-line, where the concentrations were respectively of the order of one hundredth and one tenth of the derived maximum permissible concentrations.

## 6. ACKNOWLEDGEMENTS

The authors acknowledge the assistance received from members of Health and Safety Division, Works and Operations Section, and Analytical Chemistry Section in the collection, processing, and chemical and radiochemical analysis of samples.

## 7. REFERENCES

- Bryant, P.M., (1966). -- Derivation of working limits for continuous release rates of  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$  to atmosphere in a milk producing area. *Health Physics*, 12: 1393.
- Fry, R.M. (1966). -- A reformulation of the Lucas Heights liquid effluent discharge authorisation, AAEC/E156.
- Giles, M.S., Stockdale, J.A. (1966). -- Results of the Lucas Heights Biological Survey, December 1959 - December 1964, AAEC/E151.



ENVIRONMENTAL SURVEY RESULTS 1965 - 1967

TABLES 1 - 20

Note: Upper limits shown in Tables 3 - 19 are at the 95 per cent confidence level of the counting statistics. Where an upper limit is given for an average this is the upper limit of the average of all results and not the average of all the upper limits.



TABLE 1

## DETAILS OF COLLECTION AND PREPARATION OF ESTUARINE SAMPLES

Sample Type	Station	Collection Frequency	Collection Details	Special Steps in Preparation
Estuary Water	E0.0 E1.5	Weekly Weekly	From surface by bucket	Boiled to dryness and then ashed
Oyster Flesh	E4.4 E5.0 E5.8 Control	Quarterly Quarterly Quarterly Quarterly	Obtained from commercial leases	Opened by commercial openers. Liquid is removed by placing on a sieve for five minutes
Beach Sands	E0.8 E2.9 E3.7	Half Yearly Half Yearly Half Yearly	Taken by scoop from the top 2 in. of sand in the intertidal region	A special fraction between 60 and 120 mesh B.S.S. is removed for $\alpha$ counting after ashing
Bottom Sands	E0.0 E1.5	Quarterly Quarterly	Taken by pump	As for beach sand
Blackfish	E4.0	Half Yearly	Caught by Seine net	Whole fish ashed
Mullet	E4.0	Half Yearly	As above	As above
Crabs	E3.7	Half Yearly	Taken by hand from the intertidal region	Whole crab ashed
Riverweed (Zostera)	E1.5 E1.0	Quarterly Quarterly	Pulled from bottom by rake or hand	Ashed

TABLE 2

DETAILS OF COLLECTION AND PREPARATION OF TERRESTRIAL SAMPLES

Sample Type	Station	Collection Frequency	Collection Details	Special Steps in Preparation
Rainwater	T0 T11 T32	Quarterly Quarterly Quarterly	Collected in polythene pots having a funnel diameter of 10 in. 50 ml of A.R. HNO <sub>3</sub> , 50 mg Cs <sup>++</sup> and 50 mg of Sr <sup>++</sup> are added as carrier	The water is passed through 200 ml of Amberlite IRC 120 resin which is then ashed
Grass	T0 T1.2 T11 T32	Quarterly Quarterly Quarterly Quarterly	The grass is cut by rotary mower or hand clippers to within 1 in. of the ground	Whole unwashed grass is ashed
Milk	T3.1 T11 T32	Quarterly Quarterly Quarterly	Milk is obtained from bulk milk supplies	Whole milk is ashed
Vegetables	T2.3 T4.1	Yearly	Bought from small market gardens	Whole vegetables are ashed

TABLE 3a

## WORONORA SAMPLES - OYSTER FLESH 1965

Station	Date 1965	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Zn-65			
E4.4	27.1	0.1	0.7	0.001	0.18	3700	1800	0.0008
	13.4	0.1	0.7	0.002	0.13	2400	1700	0.0011
	9.7	0.05	0.7	0.001	0.13	2800	1700	0.0019
	17.11	0.05	<0.5	<0.001	0.14	3000	1300	0.0006
	Average		0.1	0.5	0.001	0.14		
E5.0	25.1	0.2	<0.5	0.001	0.17	3300	2600	0.0010
	3.5	0.05	<0.5	<0.001	0.11	3100	1200	0.0005
	15.7	0.1	0.6	<0.001	0.11	2800	1000	0.0007
	Average		0.1	<0.3	<0.001	0.13		
E5.8	27.1	0.3	<0.5	0.001	-	3500	1700	0.0009
	8.4	0.05	<0.4	<0.001	0.03	2300	1900	0.0012
	15.7	0.05	1.5	<0.001	0.04	2700	1000	0.0007
	2.12	0.25	<0.4	0.001	-	3000	1200	0.0012
	Average		0.15	<0.4	<0.001	0.02		
Hawkes- bury River (H.R.)	25.1	0.6	<0.5	0.001	-	3100	2500	0.0019
	13.4	0.2	<0.5	0.001	-	3100	1400	0.0026
	19.7	0.4	<0.6	0.001	-	3400	1600	0.0039
	29.11	0.1	<0.5	0.001	-	3200	1500	0.0003
	Average		0.3	<0.3	0.001	-		
Derived m.p.c.				1	1000			
E4.4	Fraction of m.p.c.			0.001	$10^{-4}$			
E5.0	"			<0.001	$10^{-4}$			
E5.8	"			<0.001	$2 \times 10^{-5}$			
H.R.	"			0.001	-			

TABLE 3b

## WORONORA SAMPLES - OYSTER FLESH 1966

Station	Date 1966	Radioactivity, pCi/g Fresh Weight					K ppm	Ca ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters				
					Zn-65	0.5 (a) MeV			
E4.4	16.3	0.2	<0.2	<0.0004	0.09	-	2800	1500	0.0008
	28.6	0.1	<0.4	0.0003	0.25	-	1900	600	0.0005
	21.9	0.3	<0.7	<0.003	0.30	0.02	3200	2700	0.0011
	8.12	0.2	<0.4	<0.002	0.15	0.04	2800		
	Average	0.2	<0.4	<0.001	0.20	0.02			
E5.8	16.3	0.5	<0.1	0.0004	-	-	3100	1500	0.0010
	20.6	0.3	<0.4	<0.0008	0.002	-	2300	900	0.0007
	21.9	0.4	<0.5	<0.003	0.030	0.08	3100	2900	0.0003
	8.12	0.2	<0.4	<0.002	-	0.03	3200		
	Average	0.4	<0.4	<0.002	<0.01	0.03			
Hawkesbury River (H.R.)	16.3	0.3	<0.2	<0.0008	-	-	2700	2600	0.0030
	20.6	0.3	<0.3	<0.0003	-	-	2200	700	0.0012
	21.9	0.6	<0.7	<0.001	-	0.10	3200	1900	0.0030
	8.12	0.2	<0.7	<0.001	-	0.10	2900		
	Average	0.3	<0.5	<0.001	-	0.05			
Derived m.p.c.				1	1000	100 (b)			
E4.4 Fraction of m.p.c.				<0.001	$2 \times 10^{-4}$	$2 \times 10^{-4}$			
E5.8 "				<0.002	$<10^{-5}$	$3 \times 10^{-4}$			
H.R. "				<0.001	-	$5 \times 10^{-4}$			

(a) Amongst the gamma-ray peaks detected by gamma spectrometry in the environmental samples are two which do not uniquely determine specific isotopes. These are at approximately 0.14 MeV, which could be either Ce-141 (0.146 MeV, 32.5 day half-life), Ce-144 (0.134 MeV, 255 day half-life) or Ba-140 (0.16 MeV, 12.8 day half-life) and at approximately 0.50 MeV, which could be either Be-7 (0.48 MeV, 53 day half-life), Ru-103 (0.50 MeV, 40 day half-life) or Ru-106 (0.51 MeV, 1.0 year half-life). Where these gamma rays have been detected they have generally been recorded as such and not attributed to specific isotopes, and the unit pCi/g refers to the disintegrations per gram emitting a gamma photon of the energy quoted. Be-7 is a cosmic ray produced atmospheric activation product; the remainder are fission products. Ba-140 can be inferred from the presence of its daughter La-140.

(b) Assumed all Ru-106 as being the most restrictive of Be-7, Ru-103 and Ru-106.

TABLE 3c

## WORONORA SAMPLES - OYSTER FLESH 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight					K ppm	Ca ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters				
					Zn-65	0.5 (a) MeV			
E4.4	18.4	0.3	<0.1	<0.003	0.11	trace	2700	2700	0.0010
	13.7	0.2	0.3	<0.002	0.11	-	2400	1200	0.0006
	28.9	0.2	<0.1	<0.001	0.07	0.03	2600	2400	0.0003
Average		0.2	<0.2	<0.002	0.10	0.01			
E5.8	30.3	0.4	0.1	<0.003	-	0.2	2300	2800	0.0008
	14.7	0.2	0.4	<0.001	-	-	2700	2300	0.0010
	26.9	0.3	<0.1	<0.001	-	0.03	2100	2700	0.0006
	21.12	0.2	0.2	0.002	-	trace	2600	4000	0.0020
Average		0.3	0.2	<0.002	-	0.06			
Hawkesbury River (H.R.)	31.3	0.2	0.1	<0.001	-	0.2	1800	2700	0.0028
	10.7	0.1	0.4	<0.001	-	-	2400	1500	0.0030
	20.9	0.2	0.6	<0.002	-	0.03	1800	2700	0.0015
Average		0.2	0.4	<0.001	-	0.08			
Derived m.p.c.				1	1000	100 <sup>(b)</sup>			
E4.4	Fraction of m.p.c.			<0.002	10 <sup>-4</sup>	10 <sup>-4</sup>			
E5.8	"			<0.002	-	6 x 10 <sup>-4</sup>			
H.R.	"			<0.001	-	8 x 10 <sup>-4</sup>			

(a) Amongst the gamma-ray peaks detected by gamma spectrometry in the environmental samples are two which do not uniquely determine specific isotopes. These are at approximately 0.14 MeV, which could be either Ce-141 (0.146 MeV, 32.5 day half-life), Ce-144 (0.134 MeV, 255 day half-life) or Ba-140 (0.16 MeV, 12.8 day half-life) and at approximately 0.50 MeV, which could be either Be-7 (0.48 MeV, 53 day half-life), Ru-103 (0.50 MeV, 40 day half-life) or Ru-106 (0.51 MeV, 1.0 year half-life). Where these gamma rays have been detected they have generally been recorded as such and not attributed to specific isotopes, and the unit pCi/g refers to the disintegrations per gram emitting a gamma photon of the energy quoted. Be-7 is a cosmic ray produced atmospheric activation product; the remainder are fission products. Ba-140 can be inferred from the presence of its daughter La-140.

(b) Assumed all Ru-106 as being the most restrictive of Be-7, Ru-103 and Ru-106.

TABLE 4a

WORONORA SAMPLES - WHOLE FISH 1965

Station	Date 1965	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters			
E4.0 Mullet	5.4	0.8	0.5	0.012	trace Th-232+dtrs	3200	12000	0.024
" "	30.8	0.3	<0.4	0.100	trace Th-232 +dtrs	3100	14000	0.009
E4.0 Blackfish	5.4	0.4	<0.3	0.002	trace Th-232 +dtrs	3400	10000	0.020
" "	30.8	0.3	<0.3	0.002	-	3400	9000	0.003
Overall averages		0.4	<0.3	0.03				
Derived m.p.c.				1				
Fraction of m.p.c.				0.03				

TABLE 4b

WORONORA SAMPLES - WHOLE FISH 1966

Station	Date 1966	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters			
E0.8 Mullet	23.5	0.4	<0.7	0.003	0.1 Co-60 trace Th-232 + dtrs	2800	11000	0.014
" "	15.9	0.9	<1.3	0.006	0.4 Co-60 0.15 Zr + Nb-95 0.04 0.5 MeV	2800	13000	0.014
" "	15.11	0.2	<0.1		-	3000		
E0.8 Blackfish	15.9	0.7	<1.1	0.004	0.7 Co-60 0.3 Zr + Nb-95 0.6 Ce-144 0.04 0.5 MeV	3000	8400	0.006
E4.0 Mullet	11.2	0.8	<0.6	0.04	trace Th-232 + dtrs	2400	9300	0.017
" "	23.5	1.6	<0.9	0.004	" " " "	2800	13000	0.011
" "	15.9	0.6	<0.9	0.008	0.2 Co-60	3100	15000	0.008
" "	15.11	0.4	<0.7		trace Co-60 0.12 Zr + Nb-95 0.04 0.5 MeV	2400		
E4.0 Blackfish	11.2	0.7	<0.7	0.015	trace Th-232 + dtrs	3100	11000	0.018
" "	23.5	1.0	<0.7	0.007	" " " "	3000	12000	0.004
" "	15.9	0.9	<0.8	0.004	trace Th-232 + dtrs " Co-60	3200	11000	0.005
" "	15.11	1.4	<0.1		0.11 Zr + Nb-95 0.06 0.5 MeV	3700		
E4.0 Leather-jacket	23.5	1.8	<1.1	0.002	trace Th-232 + dtrs	2800	10000	0.005
" "	15.9	0.8	<0.1	0.003	" " " "	2800	12000	0.003
Overall averages		0.9	<0.3	0.009	0.1 Co-60 0.05 Zr + Nb-95 0.005 Ce-144 0.01 0.5 MeV			
Derived m.p.c.				1	500, 600, 100, 100	} Figures relate respectively to gamma emitters listed under overall averages. 0.14 MeV is assumed to be Ce-144 and 0.5 MeV, Ru-106		
Fractions of m.p.c.				0.009	2 x 10 <sup>-4</sup> , 10 <sup>-4</sup> , 5 x 10 <sup>-5</sup> , 10 <sup>-4</sup>			

TABLE 4c

## WORONORA SAMPLES - WHOLE FISH 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm	Be ppm	
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters				
E0.8 Mullet	5.5	0.5	<0.1	0.012	trace	Co-60	3800	11000	0.0070
" "	27.10	0.8	0.4	0.014	0.05	Cs-137	2800	11000	0.013
					0.05	Co-60			
					<0.01	0.14 MeV			
E0.8 Perch	5.5	0.3	<0.1	0.009	0.13	Co-60	3100	9200	0.0008
E0.8 Tailer	27.10	<0.1	0.3	0.002	0.05	Cs-137	3200	7400	0.0015
E0.8 Blackfish	27.10	0.6	1.0	0.006	0.3	Co-60	2500	9200	0.017
					trace	0.5 MeV			
					trace	Zr+Nb-95			
E4.0 Mullet	12.4	0.9	<0.1	0.010	-	-	2800	10000	0.011
" "	20.9	0.4	0.5	0.012	0.06	Zr+Nb-95	3300	11000	0.042
					0.02	0.5 MeV			
					0.02	0.14 MeV			
E4.0 Blackfish	26.4	0.5	<0.1	0.004	-	-	3200	10000	0.002
" "	20.9	0.2	0.2	0.003	trace	Th-232+dtrs	3600	9700	0.004
Overall averages		0.5	0.3	0.008	0.05	Co-60			
					0.01	Zr+Nb-95			
					0.01	0.14 MeV			
					0.01	0.5 MeV			
					0.01	Cs-137			
Derived m.p.c.				1	500,600,100,100,200				
Fractions of m.p.c.				0.008	1 x 10 <sup>-4</sup> , 2 x 10 <sup>-5</sup> , 10 <sup>-4</sup> , 10 <sup>-4</sup> , 5 x 10 <sup>-5</sup>				

Figures relate respectively to gamma emitters listed under overall averages. 0.14 MeV is assumed to be Ce-144 and 0.5 MeV, Ru-106

TABLE 5

WORONORA SAMPLES - FISH FLESH, GUT AND REMAINDER 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm	Be ppm		
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters					
E0.8 Mullet	27.10	0.1	0.2	0.009	0.03	Cs-137	3000	7800	0.0017	
Flesh					trace					Co-60
Gut					5.3					
					0.35	Co-60				
					0.04	0.14 MeV				
Rest		0.4	0.2	0.023	-	-	2600	20000	0.0035	
E4.0 Mullet	20.9	0.1	0.1	0.007	-	-	4100	7800	0.0003	
Flesh										
Gut					1.9					2.6
					0.14	0.5 MeV				
					0.13	0.14 MeV				
Rest		0.2	0.1	0.020	-	-	3000	22000	0.075	

Note: Flesh = the edible fraction of the fish.

Gut = the entire contents of the abdominal cavity.

Rest or remainder = the residue, i.e. bones, skin, etc.

TABLE 6a

WORONORA SAMPLES - BEACH SAND 1965

Station	Date 1965	Radioactivity, pCi/g Dry Weight		K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)		
E0.8	9.4	8.2	<1.1	1100	0.25
	6.8	2.2	3.5		
	5.11	9.7	1.5	1100	0.13
	Average	6.7	2.0		
E2.9	9.4	3.3	3.1	1800	0.26
	6.8	1.2	4.0		
	5.11	2.9	0.9	1000	0.13
	Average	2.5	2.7		
E3.7	6.8	1.2	3.7	1400	0.21
	19.11	10	1.0	800	0.13
	Average	5.6	2.3		
Derived m.p.c.		3000	2500		
Average fraction of m.p.c.		0.002	0.0008		

TABLE 6b

## WORONORA SAMPLES - BEACH SAND 1966

Station	Date 1966	Radioactivity, pCi/g Dry Weight		K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)		
E0.8	4.4	4.0	<0.7	1100	0.17
	17.6	<2.3	1.7	1400	0.40
	23.9	17	1.1	1400	0.18
	13.12	6.2	1.4	1600	0.21
	Average	7.1	1.1		
E2.9	4.4	2.8	<0.9	1200	0.17
	17.6	2.2	<0.5	1600	0.25
	23.9	11	2.8	1100	0.06
	13.12	2.8	4.5	1800	0.20
	Average	4.8	1.8		
E3.7	4.4	8.6	<1.0	800	0.14
	17.6	2.1	1.1	1300	0.21
	23.9	6.8	2.4	1300	0.05
	13.12	15	1.6	1600	0.20
	Average	8.1	1.3		
Derived m.p.c.		3000	2500		
Average fraction of m.p.c.		0.002	0.0006		

TABLE 6c

## WORONORA SAMPLES - BEACH SAND 1967

Station	Date 1967	Radioactivity, pCi/g Dry Weight		K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)		
E0.8	13.3	2.8	1.9	900	0.10
	19.6	3.5	1.2	800	0.13
	20.10	4.8	< 0.7	1100	0.11
	Average	3.7	1.1		
E2.9	13.3	2.8	1.4	1400	0.16
	19.6	3.7	1.1	1200	0.17
	20.10	3.2	2.2	1200	0.07
	Average	3.2	1.6		
E3.7	13.3	5.1	3.0	800	0.16
	19.6	4.4	2.7	800	0.09
	20.10	3.2	<1.2	4300	0.15
	Average	4.2	2.0		
Derived m.p.c.		3000	2500		
Average fraction of m.p.c.		0.0012	0.0006		

TABLE 7a

WORONORA SAMPLES -- BOTTOM SAND 1965

Station	Date 1965	Radioactivity, pCi/g Dry Weight			K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Gamma Emitters		
E0	9.4	3	6	trace Th-232 + dtrs	1400	0.05
	6.8	10	24	4.5 Co-60	3100	0.54
	5.11	14	7	trace Th-232 + dtrs	1100	0.20
		Average	9	12		
E1.5	26.2	4.3	<1.3	—	900	0.01
	9.4	< 1.0	<0.8	—	1500	0.08
	6.8	2.5	4.8	—	1600	0.19
	5.11	5.5	1.8	—	600	0.11
	Average	3.3	2.2	—		

TABLE 7b

## WORONORA SAMPLES - BOTTOM SAND 1966

Station	Date 1966	Radioactivity, pCi/g Dry Weight			K ppm	Be ppm	
		Gross Alpha	Gross Beta (less K-40)	Gamma Emitters			
E0	4.4	58	40	23 Co-60 1.7 Cs-137 3.2 Ce-144	3100	1.6	
	17.6	17	40	33 Co-60 1.1 Cs-137 trace Th-232 + dtrs	4500	0.4	
	5.8	5	16	18 Co-60 trace Zr + Nb-95 trace Cs-137 trace Th-232 + dtrs	5000		
	23.9	17	13	10 Co-60 trace Zr + Nb-95 trace Cs-137 trace Th-232 + dtrs	3100		
	14.10	11	18	12 Co-60	2900		
	22.11	13	9	11 Co-60	3000		
	13.12	16	22	5 Co-60	2400		
	Average	20	23	16 Co-60			
	E1.5	4.4	1.9	<0.5	1.8 Zn-65	800	
		17.6	<2.2	2.4	0.6 Co-60	1300	
23.9		12	1.3		1300		
13.12		8	2.7		1400		
Average		5.6	1.6				

TABLE 7c

## WORONORA SAMPLES - BOTTOM SAND 1967

Station	Date 1967	Radioactivity, pCi/g Dry Weight			K ppm	Be ppm	
		Gross Alpha	Gross Beta (less K-40)	Gamma Emitters			
E0	13.1	55	55	130 Co-60	4800	0.3	
	13.3	16	-	15 Co-60 trace Cs-137	4000	1.0	
	17.4	48	10	5 Co-60	2700	1.0	
	3.5	32	9	6 Co-60	2600	0.6	
	19.6	73	100	170 Co-60 trace Cs-137 trace Zr + Nb-95 trace Th-232 + dtrs	4100	0.5	
	21.7	30	19	13 Co-60 trace Cs-137 trace Zr + Nb-95 trace Th-232 + dtrs	5700	0.5	
	29.8	18	12	8 Co-60	1400	0.2	
	20.10	50	75	50 Co-60 11 Cs-137 trace Zr + Nb-95 trace 0.14 MeV trace Th-232 + dtrs	2300	0.3	
	17.11	25	45	15 Co-60 4 Cs-137 0.7 0.14 MeV	2900	0.2	
	Average		38	37			
	E1.5	17.3	11	0.4		700	0.1
		19.6	12	3.0	-	800	0.08
		20.10	9	0.1	-	1000	0.07
	Average		10.7	1.1	-		

TABLE 8a

## WORONORA SAMPLES - WATER FROM DISCHARGE POINT (E0) 1965

Date 1965	Radioactivity, pCi/ml		K ppm	Date 1965	Radioactivity, pCi/ml		K ppm
	Gross Alpha	Gross Beta (less K-40)			Gross Alpha	Gross Beta (less K-40)	
11.1	<0.02	<0.09	410	30.7	<0.01	<0.01	15
18.1	<0.06	<0.08	370	6.8	<0.01	<0.03	80
29.1	<0.06	<0.09	400	13.8	<0.01	<0.08	120
5.2	<0.02	<0.08	420	20.8	<0.04	<0.11	210
15.2	<0.02	<0.08	400	27.8	<0.01	<0.04	110
19.2	<0.03	<0.17	460	3.9	<0.02	<0.14	120
26.2	<0.03	<0.08	410	10.9	<0.01	<0.20	150
5.3	<0.03	<0.08	410	17.9	<0.01	<0.06	120
12.3	<0.05	<0.09	420	24.9	<0.04	<0.03	180
19.3	<0.06	<0.08	410	1.10	<0.07	<0.04	250
26.3	<0.03	<0.08	380	8.10	<0.03	<0.07	150
2.4	<0.09	<0.08	420	15.10	<0.08	<0.04	250
9.4	<0.10	<0.08	400	22.10	<0.01	<0.01	2
15.4	<0.03	<0.03	80	29.10	<0.01	<0.01	3
23.4	<0.08	<0.10	420	5.11	<0.06	<0.01	30
30.4	<0.04	<0.07	290	12.11	<0.02	<0.04	160
7.5	<0.02	<0.06	290	19.11	<0.06	<0.04	210
14.5	<0.02	<0.04	220	26.11	<0.04	<0.08	270
21.5	<0.02	<0.04	240	3.12	<0.06	<0.07	200
28.5	<0.04	<0.06	330	10.12	<0.03	<0.07	150
4.6	<0.04	<0.06	350	17.12	<0.05	<0.07	270
11.6	<0.09	<0.08	320	23.12	<0.05	<0.03	260
18.6	<0.05	<0.06	360	31.12	<0.04	<0.06	330
25.6	<0.01	<0.06	100				
2.7	<0.01	<0.01	190	Average	<0.04	<0.06	
9.7	<0.01	<0.08	170				
16.7	<0.06	<0.05	240				
23.7	<0.01	<0.01	5				

(continued) ↑

TABLE 8b

## WORONORA SAMPLES - WATER FROM DISCHARGE POINT (E0) 1966

Date 1966	Radioactivity, pCi/ml			K ppm	Date 1966	Radioactivity, pCi/ml			K ppm
	Gross Alpha	Gross Beta (less K-40)	H-3			Gross Alpha	Gross Beta (less K-40)	H-3	
7.1	<0.05	<0.05		340	19.8	<0.06	<0.08		210
14.1	<0.07	<0.05		350	30.8	<0.01	<0.01		40
21.1	<0.07	<0.05		370	2.9	<0.03	<0.01		90
4.2	<0.12	<0.02		390	9.9	<0.11	<0.03		130
11.2	<0.07	<0.09		380	16.9	<0.01	<0.01		30
18.2	<0.06	<0.13		380	23.9	<0.01	<0.11		250
25.2	<0.03	<0.05		350	30.9	<0.01	<0.07		50
4.3	<0.03	<0.05		310	7.10	<0.01	<0.11		180
11.3	<0.03	<0.05		340	14.10	<0.01	<0.04		270
18.3	<0.01	<0.01		190	21.10	<0.03	<0.07		50
25.3	<0.02	<0.02		350	28.10	<0.04	<0.11		240
1.4	<0.05	<0.12		240	4.11	<0.07	<0.12		260
7.4	<0.01	<0.03		110	11.11	<0.01	<0.05		2
15.4	<0.07	<0.03		350	18.11	<0.01	<0.01		4
22.4	<0.07	<0.01		360	24.11	<0.01	<0.08	50	30
29.4	<0.03	<0.01		70	2.12	<0.09	<0.04	16	140
6.5	<0.06	<0.03		150	9.12	<0.01	<0.02	45	50
13.5	<0.09	<0.03		220	16.12	<0.03	<0.02	13	100
20.5	<0.05	<0.05		310	22.12	<0.01	<0.07	20	70
27.5	<0.07	<0.06		220	30.12	<0.01	<0.10	7	180
3.6	<0.10	<0.04		320					
10.6	<0.06	<0.01		300					
17.6	<0.03	<0.03		10					
24.6	<0.03	<0.05		30	Average	<0.02	<0.02	25	
1.7	<0.03	<0.01		40	Derived				
8.7	<0.01	<0.13		170	m.p.c.			$3 \times 10^4$	
15.7	<0.03	<0.05		250	Fraction				
22.7	<0.02	<0.03		140	of m.p.c.			$8 \times 10^{-4}$	
29.7	<0.03	<0.14		270					
5.8	<0.07	<0.16		250					
16.8	<0.12	<0.10		260					
			(continued)						

TABLE 8c

## WORONORA SAMPLES - WATER FROM DISCHARGE POINT (E0) 1967

Date 1967	Radioactivity, pCi/ml			K ppm	Date 1967	Radioactivity, pCi/ml			K ppm
	Gross Alpha	Gross Beta (less K-40)	H-3			Gross Alpha	Gross Beta (less K-40)	H-3	
6.1	< 0.01	< 0.05	5	190	21.7	< 0.01	< 0.01	3	30
13.1	< 0.03	< 0.06	5	300	2.8	< 0.02	< 0.04	2	140
20.1	< 0.04	< 0.06	5	290	4.8	< 0.02	< 0.03	3	110
27.1	< 0.01	< 0.01	< 1	5	11.8	< 0.01	< 0.01	< 1	1
3.2	< 0.01	< 0.01	< 1	2	18.8	< 0.01	< 0.01	1	5
10.2	< 0.01	< 0.01	< 1	2	25.8	< 0.01	< 0.01	< 1	1
17.2	< 0.02	< 0.02	6	110	1.9	< 0.01	< 0.01	1	20
24.2	< 0.01	< 0.05	< 1	190	8.9	Sample too small		< 1	1
3.3	< 0.01	< 0.01	< 1	2	15.9	to count		4	1
10.3	< 0.01	< 0.01	< 1	1	22.9	< 0.01	< 0.01	5	15
17.3	< 0.01	< 0.01	< 1	2	29.9	< 0.03	< 0.05	6	110
22.3	< 0.01	< 0.01	1	10	6.10	< 0.01	< 0.03	6	80
31.3	< 0.01	< 0.01	< 1	30	16.10	< 0.01	< 0.01	5	70
7.4	< 0.02	< 0.03	1	140	20.10	< 0.04	< 0.04	7	110
14.4	< 0.02	< 0.02	1	120	27.10	< 0.02	< 0.03	25	100
21.4	< 0.01	< 0.02	< 1	90	3.11	< 0.01	< 0.01	5	40
28.4	< 0.01	< 0.01	< 1	40	10.11	< 0.01	< 0.02	8	180
5.5	< 0.03	< 0.05	19	200	17.11	< 0.01	< 0.05	4	160
12.5	< 0.02	< 0.02	2	90	24.11	< 0.02	< 0.08	6	180
19.5	< 0.03	< 0.05	18	210	1.12	< 0.07	< 0.11	35	240
29.5	< 0.06	< 0.10	17	280	8.12	< 0.03	< 0.16	19	230
2.6	< 0.04	< 0.08	11	270	15.12	< 0.07	< 0.10	27	270
9.6	< 0.02	< 0.01	5	20	21.12	< 0.03	< 0.09	21	320
16.6	< 0.01	< 0.01	8	1	28.12	< 0.10	< 0.09	17	240
23.6	< 0.01	< 0.01	11	2					
30.6	< 0.01	< 0.01	9	10	Average	< 0.02	< 0.04	6.8	
7.7	< 0.01	< 0.01	13	20	Derived			$3 \times 10^{-4}$	
14.7	< 0.01	< 0.02	8	40	m.p.c.				
		(continued)			Fraction			$2 \times 10^{-4}$	
					of m.p.c.				

TABLE 9a

## WORONORA SAMPLES - WATER FROM TOLOFIN (E1.5) 1965

Date 1965	Radioactivity, pCi/ml		K ppm	Date 1965	Radioactivity, pCi/ml		K ppm
	Gross Alpha	Gross Beta (less K-40)			Gross Alpha	Gross Beta (less K-40)	
19.2	<0.09	<0.08	420	6.8	<0.04	<0.03	170
26.2	<0.08	<0.08	420	13.8	<0.04	<0.07	210
19.3	<0.02	<0.08	420	20.8	<0.03	<0.15	260
26.3	<0.04	<0.08	410	27.8	<0.03	<0.15	270
2.4	<0.09	<0.08	410	3.9	<0.01	<0.10	250
9.4	<0.05	<0.08	450	10.9	<0.01	<0.14	270
15.4	<0.03	<0.06	270	17.9	<0.01	<0.22	240
23.4	<0.08	<0.12	360	24.9	<0.04	<0.04	250
30.4	<0.05	<0.09	350	1.10	<0.05	<0.04	180
7.5	<0.02	<0.06	350	8.10	<0.06	<0.04	280
14.5	<0.03	<0.07	310	5.11	<0.02	<0.02	120
21.5	<0.04	<0.08	360	12.11	<0.05	<0.04	230
28.5	<0.02	<0.06	340	19.11	<0.05	<0.03	230
11.6	<0.02	<0.08	380	26.11	<0.05	<0.06	310
18.6	<0.02	<0.02	400	3.12	<0.08	<0.07	280
25.6	<0.03	<0.03	210	10.12	<0.06	<0.08	300
2.7	<0.02	<0.06	160	17.12	<0.07	<0.04	280
9.7	<0.01	<0.19	220	23.12	<0.04	<0.04	340
16.7	<0.02	<0.10	290				
23.7	<0.01	<0.01	7	Average	<0.06	<0.06	
30.7	<0.01	<0.08	120				

(continued) ↑

TABLE 9b

## WORONORA SAMPLES - WATER FROM TOLOFIN (E1.5) 1966

Date 1966	Radioactivity, pCi/ml			K ppm	Date 1966	Radioactivity, pCi/ml			K ppm
	Gross Alpha	Gross Beta (less K-40)	H-3			Gross Alpha	Gross Beta (less K-40)	H-3	
4.2	<0.10	<0.13		430	30.8	<0.07	<0.09		310
11.2	<0.05	<0.05		430	2.9	<0.03	<0.05		70
18.2	<0.05	<0.01		480	9.9	<0.01	<0.07		210
25.2	<0.05	<0.11		350	16.9	<0.02	<0.11		260
4.3	<0.03	<0.12		350	23.9	<0.03	<0.13		260
11.3	<0.07	<0.11		400	7.10	<0.04	<0.10		320
18.3	<0.03	<0.05		330	14.10	<0.01	<0.07		320
25.3	<0.14	<0.17		380	21.10	<0.01	<0.05		260
1.4	<0.04	<0.08		260	28.10	<0.01	<0.04		280
15.4	<0.07	<0.07		360	4.11	<0.03	<0.05		320
22.4	<0.11	<0.03		410	11.11	<0.01	<0.01		5
29.4	<0.04	<0.01		80	18.11	<0.03	<0.01		40
6.5	<0.01	<0.01		310	24.11	<0.01	<0.07	25	80
13.5	<0.06	<0.04		270	2.12	<0.03	<0.03	14	160
20.5	<0.01	<0.08		250	9.12	<0.01	<0.03	13	120
27.5	<0.13	<0.09		310	16.12	<0.01	<0.12	9	190
3.6	<0.07	<0.03		340	22.12	<0.03	<0.16	11	210
10.6	<0.06	<0.09		350	30.12	<0.01	<0.09	6	290
17.6	<0.03	<0.09		20					
24.6	<0.03	<0.23		140					
1.7	<0.06	<0.12		220	Average	<0.01	<0.02	13	
8.7	<0.25	<0.03		250					
15.7	<0.02	<0.05		260	Derived			3 x 10 <sup>-4</sup>	
22.7	<0.07	<0.05		280	m.p.c.				
29.7	<0.09	<0.11		280	Fraction			4 x 10 <sup>-4</sup>	
5.8	<0.01	<0.12		320	of m.p.c.				
19.8	<0.09	<0.11		320					

(continued)

TABLE 9c

## WORONORA SAMPLES - WATER FROM TOLOFIN (E1.5) 1967

Date 1967	Radioactivity, pCi/ml			K ppm	Date 1967	Radioactivity, pCi/ml			K ppm
	Gross Alpha	Gross Beta (less K-40)	H-3			Gross Alpha	Gross Beta (less K-40)	H-3	
6.1	< 0.02	< 0.04	5	260	25.8	< 0.01	< 0.02	2	60
13.1	< 0.02	< 0.07	2	340	1.9	< 0.01	< 0.01	2	100
13.3	< 0.01	< 0.01	2	5	8.9	< 0.01	< 0.03	1	2
17.3	< 0.01	< 0.05	3	30	15.9	< 0.01	< 0.01	7	10
22.3	< 0.01	< 0.02	< 1	50	22.9	< 0.02	< 0.02	9	100
31.3	< 0.01	< 0.03	5	140	29.9	< 0.04	< 0.03	6	140
7.4	< 0.02	< 0.03	1	170	6.10	< 0.04	< 0.08	5	230
14.4	< 0.03	< 0.02	< 1	200	16.10	< 0.02	< 0.02	7	200
21.4	< 0.05	< 0.04	2	250	20.10	< 0.03	< 0.03	4	190
28.4	< 0.02	< 0.04	2	260	27.10	< 0.02	< 0.08	7	220
5.5	< 0.08	< 0.05	35	290	3.11	< 0.04	< 0.05	6	240
12.5	< 0.04	< 0.09	5	290	10.11	< 0.04	< 0.05	6	160
19.5	< 0.05	< 0.08	28	350	17.11	< 0.05	< 0.06	4	210
29.5	< 0.02	< 0.15	15	310	24.11	< 0.09	< 0.12	7	260
2.6	< 0.07	< 0.06	7	300	1.12	< 0.05	< 0.09	12	290
9.6	< 0.02	< 0.02	12	110	8.12	< 0.03	< 0.13	13	300
16.6	< 0.01	< 0.01	9	40	15.12	< 0.06	< 0.08	25	300
23.6	< 0.03	< 0.02	10	60	21.12	< 0.04	< 0.07	15	370
30.6	< 0.03	< 0.09	15	20	28.12	< 0.04	< 0.13	18	240
7.7	< 0.03	< 0.03	6	110					
14.7	< 0.02	< 0.06	10	150					
21.7	< 0.04	< 0.06	2	210	Average	< 0.03	< 0.05	7.8	
2.8	< 0.01	< 0.06	4	180	Derived m.p.c.			$3 \times 10^4$	
4.8	< 0.05	< 0.06	4	270	Fraction of m.p.c.			$3 \times 10^{-4}$	
11.8	< 0.01	< 0.01	2	10					
18.8	< 0.01	< 0.03	8	40					
		(continued)							

TABLE 10a  
WORONORA SAMPLES -- ZOSTERA 1965

Station	Date 1965	Radioactivity, pCi/g Fresh Weight							K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters					
					0.14 MeV	Mn-54	Co-60	Zn-65		
E1.0	26.2	4.6	2.2	0.008	0.05	0.3	1.1	0.8	1500	0.05
	7.5	1.0	1.6	0.008	-	0.3	1.5	1.5	4100	0.02
	6.8	1.6	1.0	0.010	0.02	-	0.5	-	2000	0.05
	5.11	2.3	3.2	0.006	-	0.6	0.5	-	4600	0.05
	Average	2.4	2.0	0.008	0.02	0.3	0.9	0.6		
E1.5	26.2	1.9	1.4	0.006	0.02	0.2	0.4	0.5	2500	0.02
	9.4	0.5	1.4	0.005	-	0.2	0.4	0.6	3900	0.04
	6.8	2.1	1.7	0.008	0.02	-	0.5	-	1800	0.08
	19.11	0.9	2.6	0.002	-	0.6	0.7	-	5800	0.02
	Average	1.4	1.8	0.005	0.01	0.3	0.5	0.3		

TABLE 10b

## WORONORA SAMPLES - ZOSTERA 1966

Station	Date 1966	Radioactivity: pCi/g Fresh Weight						K ppm	Be ppm
		Gross Alpha	Gross Beta (less K-40)	Gamma Emitters					
				Cr-51	Mn-54	Co-60	Ba/La-140		
E1.0	1.4	1.2	1.6	-	-	2.4	-	3700	0.04
	1.4	1.7	1.6	-	-	1.2	-	3200	0.03
	2.5	1.7	0.8	-	-	3.6	-	3600	0.02
	3.6	2.9	<0.7	-	-	3.9	-		
	30.6	2.1	2.0	-	-	6.0	-		
	10.10	0.4	3.0	-	-	4.4	trace		
	Average		1.8	1.5	-	-	3.6	-	
E1.5	4.3	0.9	1.0	-	0.8	1.6	-	4100	0.03
	1.4	1.4	1.4	-	-	1.1	-	3700	0.02
	2.5	1.2	1.1	-	-	3.6	-	3100	0.02
	3.6	3.2	<0.7	0.5	0.2	4.8	-		
	30.6	1.8	2.1	-	-	7.0	-		
	10.10	0.3	3.1	-	-	4.8	trace		
	Average		1.5	1.5	0.1	0.2	3.8	-	
E2.9	1.4	1.2	<0.7	-	0.02	0.15	-	4000	0.03
	2.5	0.8	<0.5	-	-	0.4	-	3000	0.01
	3.6	3.0	<0.7	-	-	0.25	-		
	30.6	1.8	<0.5	-	-	0.7	-		
	10.10	0.4	1.5	-	-	0.6	trace		
	Average		1.4	<0.9	-	-	0.4	-	
E4.4	1.4	0.6	<0.7	-	-	-	-	4400	0.02
	2.5	1.0	<0.5	-	-	0.1	-	2900	0.03
	3.6	2.2	<0.5	-	-	0.25	-		
	30.6	0.9	<0.6	-	-	0.35	-		
	10.10	0.4	1.3	-	-	0.2	trace		
	Average		1.0	<0.8	-	-	0.2	-	
E5.8	1.4	1.2	<0.7	-	-	-	-	3900	0.04
	2.5	0.8	<0.6	-	-	0.07	-	3300	0.03
	3.6	1.2	<0.6	-	-	-	-		
	30.6	0.8	0.8	-	-	trace	-		
	10.10	0.8	<0.6	-	-	-	-		
	Average		1.0	<0.7	-	-	0.02	-	

TABLE 10c

## WORONORA SAMPLES - ZOSTERA 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight				
		Gross Alpha	Gross Beta (less K-40)	Gamma Emitters		
				Co-60	0.5 MeV	Zr+Nb-95
E1.0	22.3	1.6	1.1	2.1	trace	trace
	2.8	1.3	1.0	1.6	"	"
	13.11	1.1	2.4	2.3	"	"
	Average	1.3	1.5	2.0	"	"
E1.5	22.3	1.8	1.2	1.7	trace	trace
	2.8	1.4	1.2	1.2	"	"
	13.11	1.9	2.5	1.3	"	"
	Average	1.7	1.6	1.4	"	"
E2.9	22.3	1.5	0.5	0.4	trace	trace
	2.8	1.0	0.9	0.4	"	"
	13.11	1.8	1.6	0.4	"	"
	Average	1.4	1.0	0.4	"	"
E4.4	22.3	1.3	0.3	0.2	trace	trace
	2.8	1.5	1.0	trace	"	"
	13.11	2.7	0.8	0.2	"	"
	Average	1.8	0.7	0.1	"	"
E5.8	22.3	1.5	0.1	-	trace	trace
	2.8	0.5	0.1	-	"	"
	13.11	1.9	1.4	trace	"	"
	Average	1.3	0.5	-	"	"

TABLE 11

## WORONORA SAMPLES -- MISCELLANEOUS 1965--1967

Station	Sample	Date	Radioactivity, pCi/g Fresh Weight			K ppm	Ca ppm	Be ppm
			Gross Alpha	Gross Beta <sup>(a)</sup>	Gamma Emitters			
E3.7	Plankton plus suspended solids (b)	29. 4.65	0.09	0.45	--			
E3.7	Crabs	23. 8.65	1.5	0.6	trace Th-232 + dtrs	2000	41000	0.02
E0.8	Worms	18. 3.66	0.25	1.5	1.8 Co-60 trace Th-232 + dtrs			
E0.8	Pippi flesh	18. 3.66	1.2	2.4	0.7 Co-60 1.4 Zn-65 0.2 Cs-137			
E0.8	Pippi shell	18. 3.66	2.5	1.5	--			
E2.7	Plankton <sup>(b)</sup>	20. 4.66	3.7	3.1	0.15 0.14 MeV 0.4 Co-60 0.06 Zr + Nb-95			
E3.7	Crabs	4. 3.66	1.0	1.8	trace Th-232 + dtrs	2100	46000	0.02
E3.7	Crabs	15. 6.66	1.5	0.6	--	2000	44000	0.01
E3.7	Crabs	11.10.66	2.4	0.9	trace Th-232 + dtrs	2200		
E3.7	Crabs	3. 1.67	1.1	0.4	--	2400	41000	0.02
E3.7	Crabs	3. 4.67	2.8	0.7	--	2100	44000	0.02
E4.4	Crabs	10.11.67	1.7	0.6	trace Th-232 + dtrs	2900	40000	0.03

(a) Not corrected for K-40 except for the crab sample results.

(b) The units here are pCi per mass of plankton and suspended solids contained in one gallon of water.

TABLE 12a  
TERRESTRIAL SAMPLES - GRASS 1965

Station	Date 1965	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters		
T0	28.1	<0.4	<1.8	0.2	0.05 0.14 MeV 0.15 0.5 MeV 0.10 Mn-54	7600	1800
	15.4	<0.4	3.7	0.8	0.15 0.14 MeV 0.8 0.5 MeV 0.2 Mn-54	14000	4400
	27.7	<0.8	3.6	0.7	0.02 0.14 MeV 0.6 0.5 MeV 0.6 Cs-137 0.2 Mn-54	4500	3000
	1.11	<0.2	<1.0	0.2	0.01 0.14 MeV 0.02 0.5 MeV 0.1 Cs-137	6700	1700
T1.2	28.1	<1.0	<1.6	0.1		6300	900
	8.4	<0.2	<1.1	0.1		5500	800
	27.7	<0.7	1.2	0.2		5100	1800
	2.11	<0.1	<1.1	0.1		7400	800
T11	21.1	<1.2	5.9	1.0	0.2 0.14 MeV 0.4 0.5 MeV 0.4 Mn-54	8300	3700
	7.4	1.5	4.7	0.4	0.9 0.14 MeV 0.2 0.5 MeV 0.2 Mn-54	5100	2100
	14.7	2.5	7.9	1.2		3900	3800
	27.10	<0.3	<1.1	0.1		4600	1000
T32	20.1	1.7	5.7	1.0	0.15 0.14 MeV 0.4 0.5 MeV 0.2 Mn-54	7000	2400
	6.4	<1.2	14	1.8	0.4 0.14 MeV 0.8 0.5 MeV 0.5 Mn-54	2700	2500
	13.7	4.7	5.4	0.5	0.08 0.14 MeV 0.3 0.5 MeV 0.7 Cs-137 0.1 Mn-54	3600	1300
	28.10	0.3	<1.4	0.2		3300	700

TABLE 12b  
TERRESTRIAL SAMPLES - GRASS 1966

Station	Date 1966	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters		
T0	9.2	0.5	2.8	0.5	0.04 0.14 MeV 0.15 0.5 MeV 0.05 Mn-54 0.5 Cs-137	7900	3600
	18.4	1.0	1.7	0.4	0.04 0.14 MeV 0.2 0.5 MeV 0.03 Mn-54 0.4 Cs-137	8700	3500
	11.7	5.1	3.6	0.3	0.03 0.14 MeV 0.2 0.5 MeV 0.5 Cs-137	6000	3800
	17.10	0.8	1.9	0.4	0.2 0.14 MeV 0.5 0.5 MeV 1.7 Zr + Nb-95	5500	
T1.2	7.2	1.0	<1.4	0.10		6000	1000
	14.4	1.8	<1.7	0.02		9000	2000
	11.7	4.4	1.3	0.07		6800	3900
	17.10	0.5	<1.5	0.07		7200	
T11	9.2	1.7	4.1	0.6		4100	3000
	13.4	3.8	3.2	0.6	0.07 0.14 MeV 0.5 0.5 MeV 0.05 Mn-54 0.8 Cs-137	10500	4400
	5.7	2.1	3.1	0.4		3100	3600
	6.10	0.4	1.6	0.2		5500	
T32	8.2	0.8	1.8	0.4	0.02 0.14 MeV 0.05 0.5 MeV 0.2 Cs-137	6100	1800
	14.4	4.4	3.7	0.8	0.05 0.14 MeV 0.4 0.5 MeV 0.04 Mn-54 0.6 Cs-137	8200	2900
	7.7	5.4	7.0	0.3	0.1 0.14 MeV 0.2 0.5 MeV 0.5 Cs-137	5300	1800
	12.10	0.25	<0.8	0.2	0.06 0.14 MeV 0.1 0.5 MeV 0.4 Zr + Nb-95	5000	

TABLE 12c  
TERRESTRIAL SAMPLES - GRASS 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Sr-90	Gamma Emitters		
T0	23.1	0.3	1.7	0.2	0.2 0.14 MeV 0.4 0.5 MeV 1.5 Zr+Nb-95	11000	2400
	13.4	0.6	0.5	0.2	0.9 0.14 MeV 0.3 0.5 MeV 0.4 Zr+Nb-95	7200	1800
	14.7	0.4	2.2	0.2	0.1 0.14 MeV 0.4 0.5 MeV 0.7 Zr+Nb-95	5700	2500
	17.10	0.7	0.3	0.2	0.1 0.14 MeV 0.3 Zr+Nb-95	5400	1900
T1.2	23.1	1.5	1.9	0.1		17000	3700
	13.4	1.9	0.6	0.1		5400	1000
	19.7	0.9	1.5	0.1		6200	1400
	31.10	1.4	2.7	0.1		6800	1400
T11	17.1	0.5	2.8	0.1		7200	1600
	10.4	0.4	1.1	0.1		4500	1000
	6.7	0.9	0.6	0.1		4900	2000
	10.10	0.7	3.5	0.2		5500	2800
T32	18.1	2.5	11.5	1.1	0.5 0.14 MeV 0.9 0.5 MeV 4.0 Zr+Nb-95	12000	4400
	5.4	0.4	0.4	0.2	0.1 0.14 MeV 0.1 0.5 MeV 0.1 Zr+Nb-95	5100	900
	4.7	1.4	1.5	0.4	0.1 0.14 MeV 0.5 0.5 MeV 0.3 Zr+Nb-95	5300	2100
	11.10	0.2	0.6	0.2	0.1 0.14 MeV 0.1 0.5 MeV 0.3 Zr+Nb-95	4100	850

TABLE 13a

## TERRESTRIAL SAMPLES - MILK 1965

Station	Date 1965	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Cs-137	Sr-90		
T3	2.2	<0.01	<0.3	0.054	0.014	1800	1000
	9.4	<0.01	<0.6	0.044	0.028	1700	1200
	16.7	<0.01	<0.2	0.037	0.016	1500	1400
	3.11	<0.02	<0.2	0.030	0.012	1600	1300
T11	21.1	<0.01	<0.2	0.019	0.006	1500	900
	7.4	<0.01	<0.4	0.017	0.003	1600	1100
	14.7	<0.01	<0.4	0.011	0.009	1600	1100
	27.10	<0.01	<0.2	0.017	0.001	1700	1000
T32	20.1	<0.01	<0.3	0.017	0.006	1900	900
	6.4	<0.02	<0.4	0.014	0.006	1500	1000
	13.7	<0.01	<0.4	0.013	0.006	1800	1100
	28.10	<0.02	<0.2	0.026	0.006	1800	1100
<u>Averages</u>							
T3				0.041	0.017		
T11 and T32				0.017	0.005		
<u>Fractions of derived m.p.c. (a)</u>							
T3				0.002	0.02		
T11 and T32				0.0008	0.005		

(a) Derived maximum permissible concentrations taken from Bryant (1966)

TABLE 13b

## TERRESTRIAL SAMPLES - MILK 1966

Station	Date 1966	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Cs-137	Sr-90		
T3	9.2	0.01	<0.2	0.030	0.007	1800	1200
	18.4	0.01	<0.1	0.027	0.010	1600	1300
	8.7	0.07	<0.1	0.017	0.007	1600	1100
	20.10	0.03	<0.2	0.023	0.007	1600	1000
T11	9.2	0.01	<0.2	0.016	0.005	2100	1400
	13.4	<0.01	<0.1	0.005	0.003	1600	1100
	5.7	<0.02	<0.2	0.004	0.004	1500	1100
	6.10	0.01	<0.1	0.013	0.003	1700	1000
T32	8.2	0.02	<0.2	0.017	0.003	1600	1100
	14.4	<0.01	<0.1	0.013	0.003	1800	1100
	7.7	<0.01	<0.2	0.008	0.005	1900	1300
	12.10	<0.01	<0.1	0.018	0.003	1800	1200
<u>Averages</u>							
T3				0.024	0.008		
T11 and T32				0.012	0.003		
<u>Fractions of derived m.p.c.<sup>(a)</sup></u>							
T3				0.001	0.01		
T11 and T32				0.0005	0.003		

(a) Derived maximum permissible concentrations taken from Bryant (1966)

TABLE 13c  
TERRESTRIAL SAMPLES - MILK 1967

Station	Date 1967	Radioactivity, pCi/g Fresh Weight				K ppm	Ca ppm
		Gross Alpha	Gross Beta (less K-40)	Cs-137	Sr-90		
T3	27.1	< 0.01	< 0.1	0.021	0.009	1600	1200
	19.4	< 0.01	< 0.2	0.039	0.012	1600	1600
	13.7	< 0.02	0.4	0.024	0.009	1500	1200
	19.10	< 0.02	< 0.2	0.026	0.007	1500	1100
T11	17.1	0.07	< 0.1	0.013	0.003	1600	1100
	10.4	< 0.01	< 0.1	0.023	0.004	1600	1100
	6.7	< 0.01	< 0.6	0.011	0.005	1500	1100
	10.10	< 0.01	< 0.3	0.013	0.003	1200	1000
T32	18.1	< 0.01	< 0.1	0.024	0.004	1900	1100
	5.4	< 0.01	0.3	0.017	0.003	1300	1200
	4.7	< 0.02	< 0.1	0.014	0.004	1700	1000
	11.10	< 0.01	< 0.2	0.014	0.003	1600	1100
<u>Averages</u>							
T3				0.028	0.009		
T11 and T32				0.016	0.004		
<u>Fractions of derived m.p.c. (a)</u>							
T3				0.001	0.01		
T11 and T32				0.0005	0.004		

(a) Derived maximum permissible concentrations taken from Bryant (1966).

TABLE 14a

## TERRESTRIAL SAMPLES - RAIN 1965

Station	Collection Period	Rainfall in Period (Points)	Radioactivity, pCi/m <sup>2</sup> /day						
			Gross Alpha	Gross Beta	Sr-90	Cs-137	0.14 MeV	0.5 MeV	Mn-54
T0	16.10.64 to 28. 1.65	578	4.6	40	4.9	4.2	1.2	3.4	2.2
	28. 1.65 to 15. 4.65	590	7.7	73	3.2	11	1.0	4.3	1.6
	15. 4.65 to 20. 7.65	783	4.0	24		6.4	0.3	3.2	0.9
	20. 7.65 to 2.11.65	913			0.7	7.6	0.7	5.8	0.7
	2.11.65 to 7. 2.66	310			1.8	3.0	-	1.9	-
T11	15.10.64 to 21. 1.65	414	4.5	26	4.9	5.4	3.2	-	trace
	21. 1.65 to 7. 4.65	55	4.1	38	4.1	19	1.3	2.8	1.4
	7. 4.65 to 14. 7.65	531	3.8	23	0.9	8.6	0.2	1.2	0.4
	14. 7.65 to 27.10.65	669			1.0	8.1	0.5	3.4	0.9
	27.10.65 to 9. 2.66	262	14	19	1.4	3.2	-	2.0	0.3
T32	14.10.64 to 20. 1.65	704	12	72	7.2	4.5	2.6	6.2	2.7
	20. 1.65 to 6. 4.65	84	12	60	2.2	22	1.5	1.8	2.0
	6. 4.65 to 13. 7.65	481	5.1	19	0.8	9.3	0.3	2.4	0.8
	13. 7.65 to 28.10.65	1256			0.9	12	0.6	5.9	1.2
	28.10.65 to 8. 2.66	444	3.9	12	2.0	4.0	0.2	2.1	-

TABLE 14c  
TERRESTRIAL SAMPLES - RAIN 1967

Station	Collection Period	Rainfall in Period (Points)	Radioactivity pCi/m <sup>2</sup> /day						
			Gross Alpha	Gross Beta	Sr-90	Cs-137	0.14 MeV	0.5 MeV	Zr+ Nb-95
T0	23. 1.67 to 9. 3.67	1299	3.1	21	6.6	6.8	3.1	6.3	9.5
	9. 3.67 to 13. 4.67	193	4.0	23			2.3	6.9	7.4
	13. 4.67 to 10. 7.67	875	0.2	2	0.9	1.1	0.4	0.9	0.4
	10. 7.67 to 17.10.67	1427	0.4	8	2.1	1.7	2.1	2.1	5.9
	17.10.67 to 30. 1.68	999	1.2	6	2.3	3.4	0.2	1.0	1.4
T11	17. 1.67 to 7. 3.67	1148	0.1	4	5.2	2.6	1.1	3.1	6.8
	7. 3.67 to 10. 4.67	169	0.8	7			2.5	1.5	2.7
	10. 4.67 to 6. 7.67	377	0.8	2	0.4	0.5	trace	trace	trace
	6. 7.67 to 10.10.67	1020	0.9	7	1.4	2.5	1.6	2.3	4.5
	10.10.67 to 25. 1.68	778	0.5	4	1.8	3.7	0.1	0.7	trace
T32	18. 1.67 to 7. 3.67	1267	1.2	11	4.6	3.9	0.9	2.6	7.1
	7. 3.67 to 5. 4.67	187	1.2	14			1.7	1.4	4.7
	5. 4.67 to 4. 7.67	732	0.8	2	0.8	0.7	0.3	0.6	0.5
	4. 7.67 to 11.10.67	888	0.8	7	1.1	2.4	1.2	1.9	3.1
	11.10.67 to 23. 1.68	1156	1.2	7	1.9	3.9	0.1	1.2	1.9

TABLE 14b

## TERRESTRIAL SAMPLES - RAIN 1966

Station	Collection Period	Rainfall in Period (Points)	Radioactivity: pCi/m <sup>2</sup> /day											
			Gross Alpha	Gross Beta	Sr-90	Cs-137	0.14 MeV	0.5 MeV	Ba/La-140	Zr+Nb-95				
T0	7. 2.66 to 18. 4.66	586												
	18. 4.66 to 11. 7.66	829	<1.1	3.0	1.1	1.5	-	1.1	-	-	-	-	-	-
	11. 7.66 to 7. 9.66	406			0.2		7.5	17.5	3.5	19				
	7. 9.66 to 17.10.66	199	1.8	10		2.9	35	50	0.7	80				
	17.10.66 to 23. 1.67	1261	1.5	45	5.0	4.7	33	12.5	-	31				
T11	9. 2.66 to 13. 4.66	519	6.2	14		5.2	-	4.5	-	-	-	-	-	-
	13. 4.66 to 5. 7.66	434	<1.1	1.0	0.5	-	-	1.8	-	-	-	-	-	-
	5. 7.66 to 6. 9.66	248			0.3		10	14	13	28				
	6. 9.66 to 12.10.66	148	0.1	14			33	80	20	63				
	12.10.66 to 17. 1.67	1461	0.6	21	4.6	4.6	5.0	4.5	-	13				
T32	8. 2.66 to 14. 4.66	519	5.3	19		3.5	-	5.5	-	-	-	-	-	-
	14. 4.66 to 7. 7.66	486	1.5	2.0	0.5	1.4	-	1.0	-	-	-	-	-	-
	7. 7.66 to 6. 9.66	178			0.3		13	19	5.1	70				
	6. 9.66 to 12.10.66	104	2.2	12		2.0	55	90	1.2	22				
	12.10.66 to 18. 1.66	1235	1.0	28	5.3	4.4	4.0	5.0	-	31				

TABLE 15

## TERRESTRIAL SAMPLES - MISCELLANEOUS 1965-1967

Station	Date	Sample	Radioactivity, pCi/g Fresh Weight			K ppm	Be ppm
			Gross Alpha	Gross Beta (less K-40)	Gamma Emitters		
T4.1	8. 4.65	Cabbages	<0.03	<0.2	0.01 Cs-137	1900	0.0002
T2.3	9. 3.66	Tomatoes	<0.05	<0.5	-	2900	0.0002
T4.1	9. 3.66	Beans	<0.03	<0.3	-	2500	-
T2.3	29. 3.67	Tomatoes	<0.01	<0.4	-	2800	-
T4.1	13. 4.67	Beans	0.01	<0.3	-	2300	0.001

TABLE 16

TERRESTRIAL SAMPLES - SOLID WASTE BURIAL GROUND 1966-1967

Location	Sample	Date	Radioactivity, pCi/g Fresh Weight			K ppm	Be ppm
			Gross Alpha	Gross Beta (a)	Gamma Emitters		
North	Acacia	9. 3.66	0.6	1.7	0.25 0.14 MeV 0.30 0.5 MeV 0.03 Mn-54 0.40 Cs-137	3500	0.01
West	Acacia	9. 3.66	0.4	<1.0		4400	0.01
East	Acacia	9. 3.66	0.25	<0.6	0.05 0.14 MeV 0.07 0.5 MeV 0.01 Mn-54 0.09 Cs-137	3700	0.004
West	Acacia	11, 1.67	0.5	1.7	0.1 0.14 MeV 0.2 0.5 MeV 0.9 Zr +Nb-95	3800	0.006
North	Acacia	11. 1.67	0.3	2.2	0.1 0.14 MeV 0.4 0.5 MeV 1.1 Zr +Nb-95	4100	0.004
			pCi/litre				
Bore Hole 1	Ground-water	11. 1.67	2.3	1.4	-		
" " 3-5	Ground-water	11. 1.67	5.8	4.0	-		
" " 6-7-8	Ground-water	11. 1.67	2.7	2.5	-		
" " 10	Ground-water	11. 1.67	5.5	2.5	-		
" " SH 1-2	Ground-water	11. 1.67	4.4	2.2	-		

(a) including K-40 for water results; excluding it for vegetation.

TABLE 17  
TERRESTRIAL SAMPLES -- EFFLUENT PIPELINE 1967

Location	Date 1967	Sample	Radioactivity, pCi/g Fresh Weight			K ppm
			Gross Alpha	Gross Beta (less K-40)	Gamma Emitters	
Near scour valve No. 3	25.10	Soil	12	11	trace Cs-137 trace Co-60 trace Th-232 + dtrs	3300
2nd joint from river	25.10	Soil	5	7	0.8 Cs-137 trace Th-232 + dtrs	1200
Joint above scour valve No. 5	14.11	Soil	150	300	600 Co-60 100 Cs-137 trace Th-232 + dtrs	3000
Near scour valve No. 4	14.11	Gynea Lily	0.5	2.8	0.2 0.14 MeV 0.1 0.5 MeV 0.5 Co-60 trace Zr+Nb-95	4900

TABLE 18

WORONORA SAMPLES: ANNUAL AVERAGES EXPRESSED AS FRACTIONS  
OF THE DERIVED MAXIMUM PERMISSIBLE CONCENTRATIONS (a)

Sample	Radioisotope and m.p.c.	Fraction of m.p.c.		
		1965	1966	1967
Water	H-3 30 nCi/ml			
E0			$8 \times 10^{-4}$	$2 \times 10^{-4}$
E1.5				$4 \times 10^{-4}$
Oyster Flesh	Zn-65, 1000 pCi/g			
E4.4		$1 \times 10^{-4}$	$2 \times 10^{-4}$	$1 \times 10^{-4}$
E5.8 Hawkesbury		$2 \times 10^{-5}$	$1 \times 10^{-5}$	—
	Sr-90 1 pCi/g	—	—	—
E4.4		$1 \times 10^{-3}$	$< 1 \times 10^{-3}$	$< 2 \times 10^{-3}$
E5.8 Hawkesbury		$< 1 \times 10^{-3}$	$< 2 \times 10^{-3}$	$< 2 \times 10^{-3}$
		$1 \times 10^{-3}$	$< 1 \times 10^{-3}$	$< 1 \times 10^{-3}$
Fish	Co-60 500 pCi/g	—	$2 \times 10^{-4}$	$1 \times 10^{-4}$
(average of all samples)	Sr-90 1 pCi/g	$3 \times 10^{-2}$	$9 \times 10^{-3}$	$8 \times 10^{-3}$
Beach Sand	gross alpha			
(average of all samples)	3000 pCi/g	$1 \times 10^{-3}$	$2 \times 10^{-3}$	$1 \times 10^{-3}$
	gross beta			
	2500 pCi/g	$1 \times 10^{-3}$	$5 \times 10^{-4}$	$5 \times 10^{-4}$

(a) Derived maximum permissible concentrations are taken from Fry (1966).

TABLE 19

MILK SAMPLES: ANNUAL AVERAGE STRONTIUM 90 AND  
CAESIUM 137 CONTENTS AND FRACTIONS OF THE DERIVED  
MAXIMUM PERMISSIBLE CONCENTRATIONS (a)

Sampling Station	1965	1966	1967	1965	1966	1967
	Annual average content					
	pCi Sr-90/g Ca			pCi Cs-137/g K		
T3 (Menai)	15	7	7	27	15	18
T11 (Campbell-town)	5	3.5	3.5	11	5	10
T32 (Richmond)	6	3.5	3.5	14	8	11
	Fractions of derived m.p.c. (a)					
T3	$1.8 \times 10^{-2}$	$9 \times 10^{-3}$	$9 \times 10^{-3}$	$1.4 \times 10^{-3}$	$8 \times 10^{-4}$	$9 \times 10^{-4}$
T11	$6 \times 10^{-3}$	$4 \times 10^{-3}$	$4 \times 10^{-3}$	$7 \times 10^{-4}$	$3 \times 10^{-4}$	$5 \times 10^{-4}$
T32	$7 \times 10^{-3}$	$4 \times 10^{-3}$	$4 \times 10^{-3}$	$8 \times 10^{-4}$	$4 \times 10^{-4}$	$6 \times 10^{-4}$

(a) Derived maximum permissible concentrations (Bryant 1966):

Sr-90 0.8 nCi/g Ca

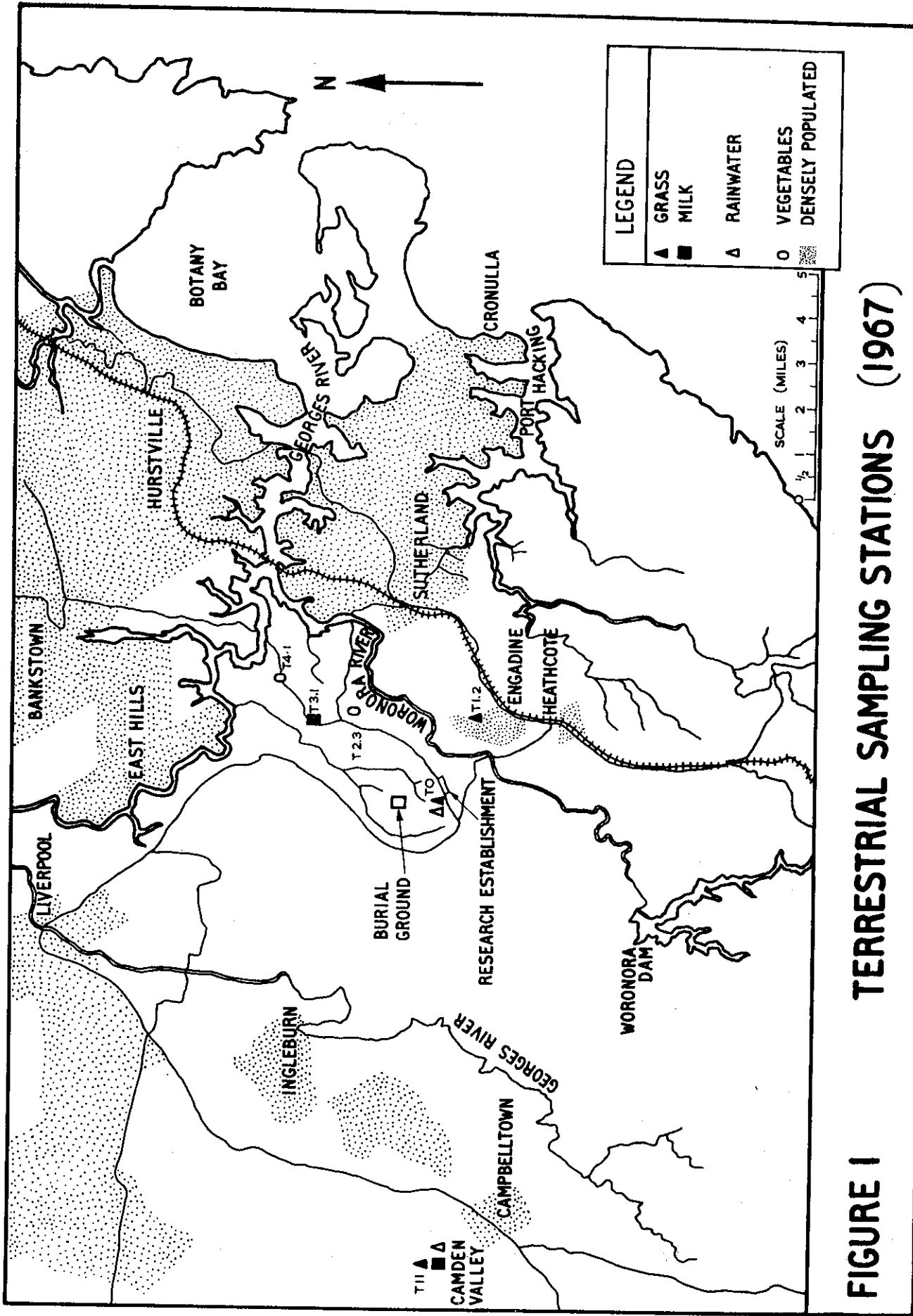
Cs-137 20 nCi/g K

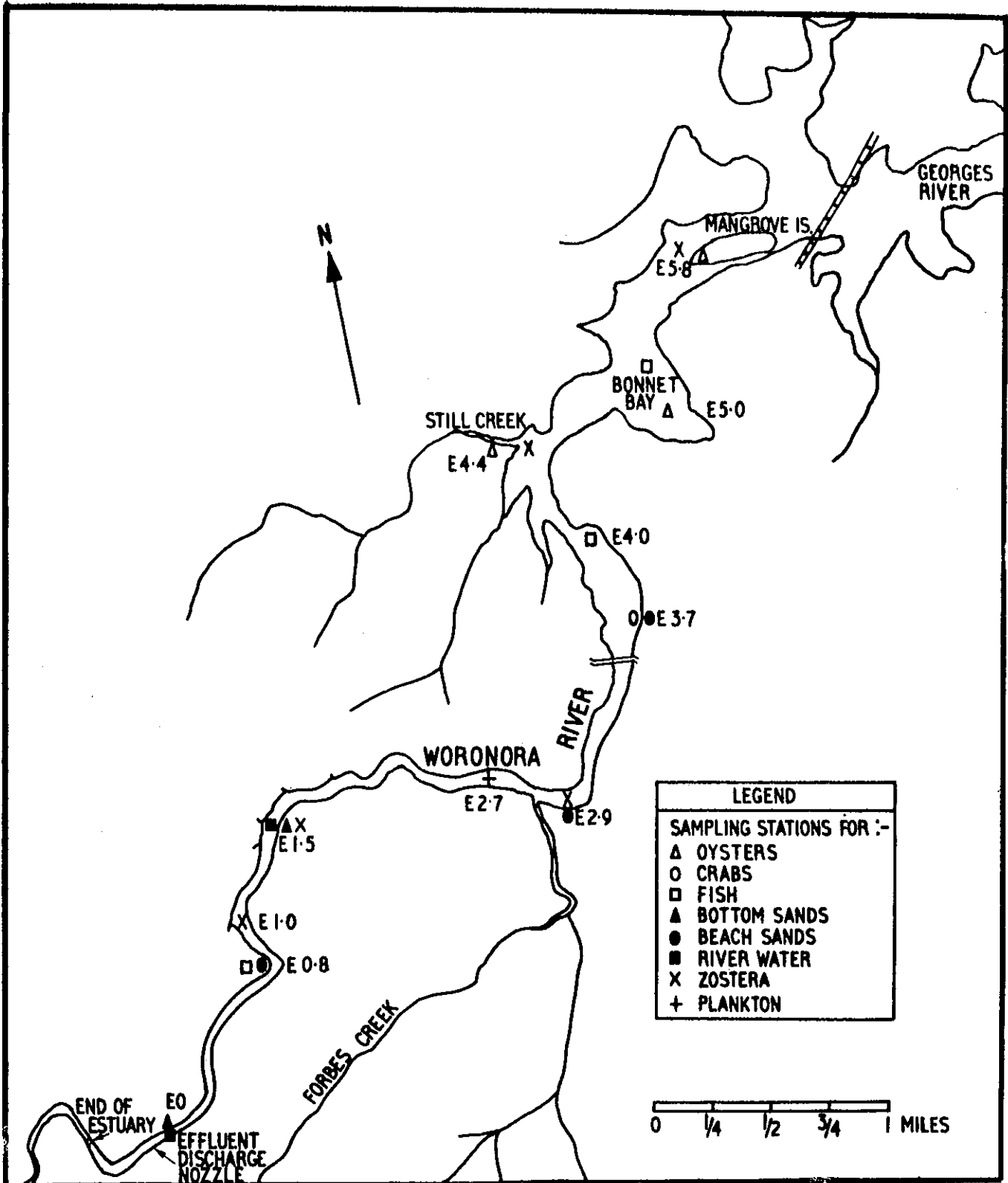
TABLE 20

LIMITS OF DETECTION OR PERCENTAGE ACCURACY

Sample	Measurement					
	Gross Alpha Activity	Gross Beta Activity	Sr-90	K	Be	Ca
Estuary water	0.02	0.04				
Oyster flesh	0.05	0.4	0.001	5%	10%	5%
Whole fish	0.1	0.3	0.001	5%	10%	
Bottom sand	0.5	0.4	0.001	5%	10%	
Beach sand	0.5	0.4		5%	10%	
Zostera	0.1	0.5	0.002	5%	10%	5%
Crab	0.4	0.4		5%	10%	
Grass	0.1	0.3	0.01	5%	10%	5%
Milk	0.003	0.3	0.001	5%	10%	5%
Rain	5%	5%				
Vegetables	0.01	0.1		5%	10%	5%

Note: Units are those used in the tables of results.





**FIGURE 2** WORONORA ESTUARY SAMPLING STATIONS (1967)