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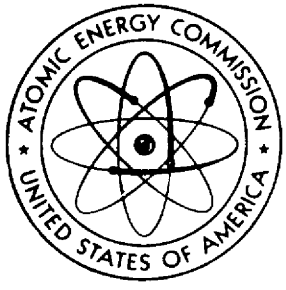
SUMMARY REPORT OF THE 1969 AND 1970 BIKINI SURVEYS



FEBRUARY 1971

UNITED STATES ATOMIC ENERGY COMMISSION
NEVADA OPERATIONS OFFICE
LAS VEGAS, NEVADA

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FOREWORD

This report summarizes the results of radiological surveys of Bikini Atoll in 1969 and 1970 which will be given in detail in Southwestern Radiological Health Laboratory/Environmental Protection Agency (SWRHL/EPA) report No. SWRHL 111r titled "Report of the Radiological Cleanup of Bikini Atoll" and an Atomic Energy Commission (AEC) Nevada Operations Office (NVOO) report No. NVO-269-8 titled "Radiological Resurvey of Animals, Soils and Groundwater at Bikini Atoll, 1969". (These reports should be published by Spring 1971.) This summary also includes results of selected samples from the 1967 survey as reported by P. F. Gustafson in "Radiological Report on Bikini Atoll".

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FIGURES

1. INTRODUCTION

Bikini Atoll (Figure 1) was a site for atmospheric tests of nuclear devices from 1945 to 1958. The population of 166 Bikinians was moved from the atoll in March 1946, first to Rongerik Atoll, then to Kwajalein Atoll and finally, in November 1948 to Kili Island. The land area at Kili is about one-tenth that at Bikini Atoll and there is no lagoon. Therefore, access to Kili is difficult, often impossible, and sea foods are scarce.

The results of a radiological resurvey of Bikini in 1964 by the University of Washington's Laboratory of Radiation Biology indicated that Bikini might be radiologically safe for permanent habitation. A request from the High Commissioner of the Trust Territories of the Pacific to the Atomic Energy Commission (AEC) in 1966, to rehabilitate Bikini, resulted in an extensive survey of the atoll in the spring of 1967. This survey emphasized external radiation measurements, including in situ gamma-ray spectrometry, although some food items were collected to supplement data from the 1964 survey. The 1967 survey party included personnel from the AEC's Health and Safety Laboratory, the Division of Biology and Medicine (DBM), the U.S. Naval Radiological Defense Laboratory, the Trust Territory, and the University of Washington. The data were summarized by DBM and were presented to a panel of experts (referred to as the Ad Hoc Committee in this report) assembled by DBM for evaluation of potential radiological hazards. Most of the participants in the 1967 survey attended the presentation to provide details not included in the summary.

The Committee concluded that Bikini could be safely reoccupied, but recommended some simple measures that should be instituted to reduce exposure to radiation. These included reduction of the coconut crab population (because they contain high concentrations of ^{90}Sr) and covering the village area at Bikini Island with coral gravel from the beaches. The latter is consistent with local custom. The Committee also recommended that old structures and other such debris from the tests be removed from the islands and beaches and that Bikini Island be further monitored during the clean-up. Additional monitoring was necessary because dense vegetation on Bikini and Eneu Islands, especially, made it impractical to survey more than a few transects across the islands in 1967.

The Committee's recommendations were made to the Chairman of the AEC who informed the Secretary of the Interior, the Administrator for the Trust Territory of the Pacific.

2. CLEAN-UP OF BIKINI ATOLL

The clean-up phase of the rehabilitation of Bikini Atoll, a cooperative effort by AEC and Department of Defense, was begun in February 1969,

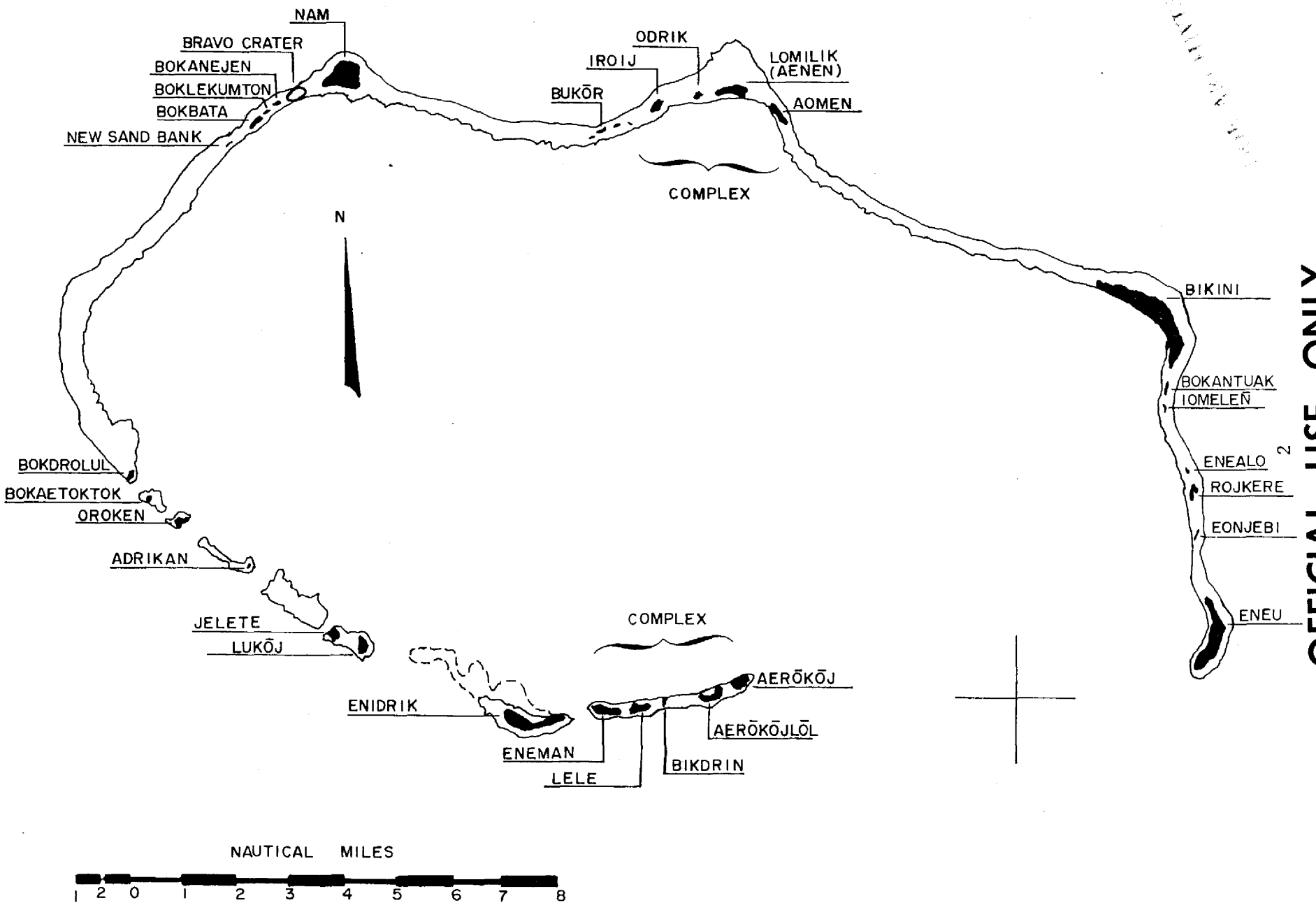


FIGURE I. BIKINI ATOLL

by Joint Task Force Eight. The AEC Nevada Operations Office (NVOO) was responsible for certification of the clean-up portion of the rehabilitation program. This was carried out under guidelines approved by the AEC Division of Operational Safety. At the request of NVOO, the SWRHL/EPA took the responsibility for external radiation measurements and the collection and analysis of those land plants which are food items. The University of Washington Laboratory of Radiation Ecology was asked to collect and analyze other biological and environmental samples.

2.1 OBJECTIVE

The conclusions of the Ad Hoc Committee stated that the Bikini-Eneu complex of islands could be used for continuous occupancy and agricultural development sufficient to support the returning population. Recommended clean-up of these islands require:

1. The removal of all test-related debris with disposal at sea of all radioactive debris.

2. Stripping of the vegetation to permit planting of coconuts, pandanus, breadfruit, etc.

3. Determination of external background radiation levels at each step of the clearing and stripping operations.

4. Obtaining additional samples of available food items for laboratory analysis for comparison with previously collected data.

Although permanent occupancy was to be limited to the islands of Bikini and Eneu, the Ad Hoc Committee further concluded that "radioactive scrap should be removed from the islands adjacent to former shot sites." This removal of radioactive debris would make the scrap unavailable for collection by the natives during food collection trips to these islands.

The final objectives of the clean-up program, therefore, included the elimination of all physical hazards and the disposal of all radioactive scrap from each island of the atoll in addition to the specific measures cited for Bikini and Eneu.

2.2 CRITERIA

Rather than establish firm, restrictive criteria for the removal of radioactive artifacts, or the elimination of high background areas from the islands of the atoll, each situation was viewed in terms of the potential exposure versus benefit. All debris or artifacts having little or no useful value were removed. Scrap metal or concrete with contact gamma readings greater than 100 micro-Roentgen per hour (uR/hr) was treated as radioactive waste and buried at sea. Three specific locations were selected for this burial. In some cases, scrap with contact gamma readings less than 100 uR/hr was buried on land together with nonradioactive debris. This was only done on islands where areas exhibiting background levels in

excess of 100 uR/hr were found. (Surface radiation readings were made at 3 feet.) No radiation debris at any levels of activity was buried on the islands of Bikini, Eneu, or Aerokoj.

The exterior of several bunkers, located on the northern complex (Iroij, Odrik, Lomilik, and Aomen) and Nam, exhibited contact levels of radiation up to 7,000 uR/hr, combined beta and gamma. The net gamma levels were 200 uR/hr maximum. The levels inside the bunkers were less than 10 uR/hr. Natural background in the U.S. is about 20 uR/hr. Since the potential for personnel exposure was negligible and the bunkers were desired as typhoon shelters and storage buildings by the natives, the larger bunkers were left intact.

2.3 BIKINI ISLAND

The island was prepared for agricultural redevelopment by cutting parallel strips through the vegetation along the length of the island. The vegetative cover was knocked down and left in place to provide additional organic matter for the soil. The strips were surveyed and gamma radiation levels recorded at 250-foot intervals along their length. Figure 2 illustrates the variation in these levels by depicting the range and average of gamma radiation measurements taken at three feet above the ground for areas consisting of approximately four strips.

Although a large amount of debris was found on Bikini (from the testing program and World War II), the only material found to be radioactive was a pile of roofing paper scraps contaminated primarily with ^{137}Cs located northwest of center on the lagoon side of the island. This material, which showed a contact reading of approximately 200 uR/hr, was loaded into 55-gallon drums and disposed of in one of the disposal sites in the ocean south of Eneu.

The measured exposure rates were 10 uR/hr or less along the beaches and ranged from 20-120 uR/hr inland. Soil samples taken at three locations in 1969, having measured backgrounds of 20, 70, and 100 uR/hr, showed ^{137}Cs and ^{60}Co to be the major gamma emitting contaminants. These were present in Cs/Co ratios of approximately 25/1, 50/1, and 30/1 respectively for the three samples, and thus the projected exposure rate decay will very closely approximate the decay of ^{137}Cs. In addition, ^{90}Sr was present in amounts ranging from 10 to 50 percent of the ^{137}Cs concentrations.

2.4 ENEU ISLAND

Eneu, the second largest island in the atoll and the site of the base camp for the clean-up operation, was found to have external radiation levels considerably lower than Bikini (Figure 3). Although an exposure rate of 50 uR/hr was obtained at one depressed location during the early stages of clean-up, filling of this "borrow pit" area reduced the level to approximately 10 uR/hr. The exposure rate generally ranged from less than 10 to 20 uR/hr.

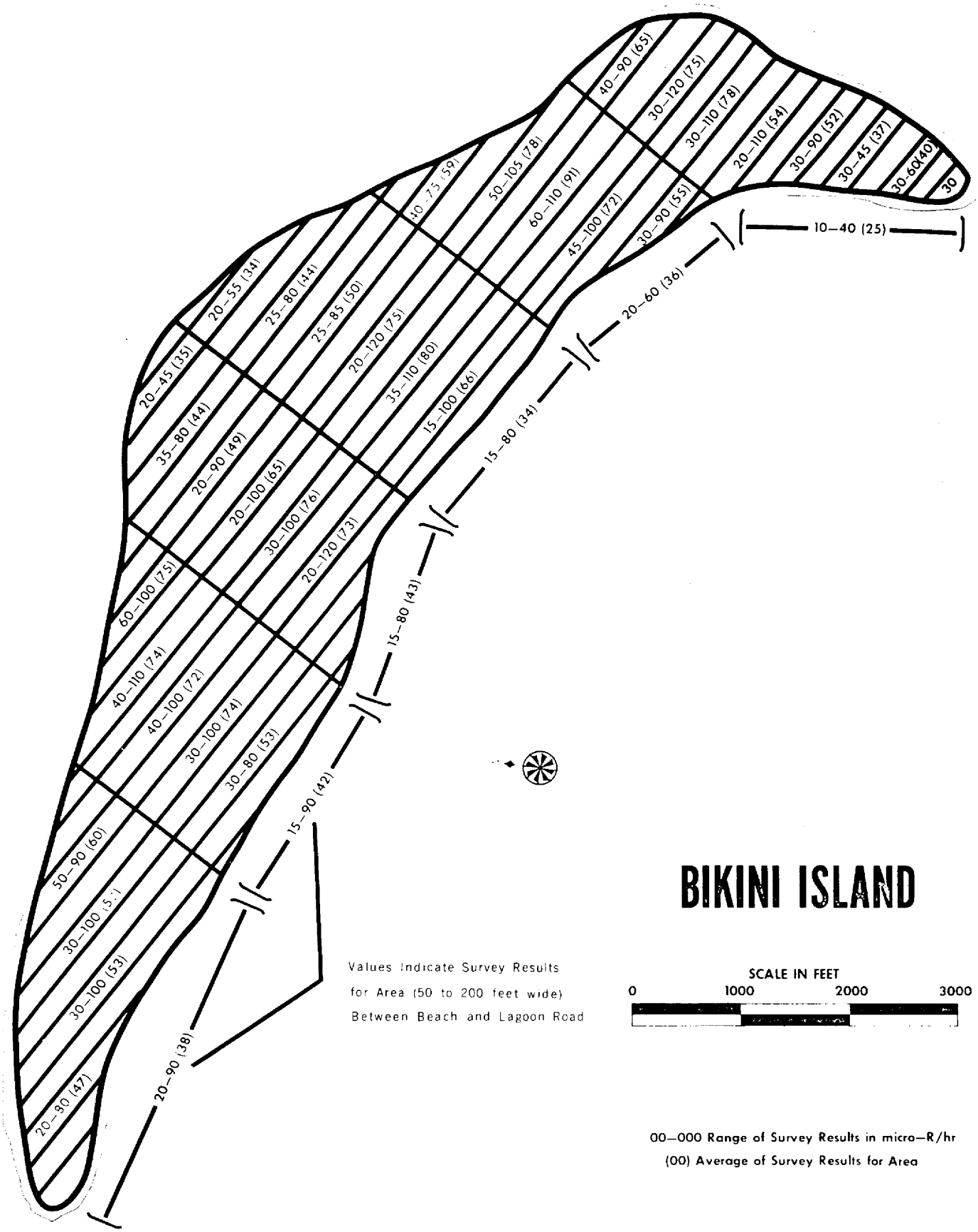


FIGURE 2. BIKINI ISLAND-BACKGROUND RADIATION SURVEY RESULTS

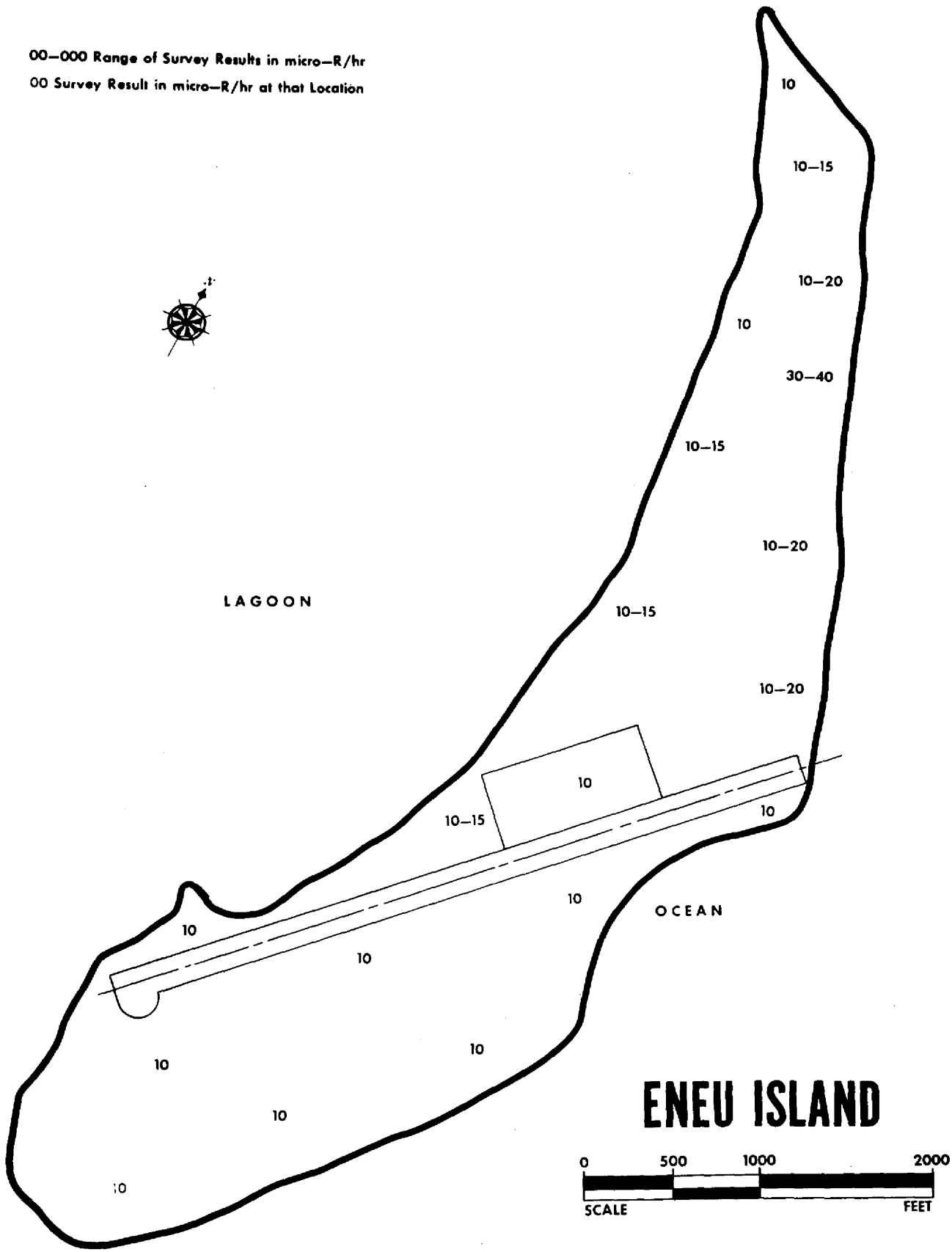


FIGURE 3. ENEU ISLAND-BACKGROUND RADIATION SURVEY RESULTS

3. RADIONUCLIDES IN AIR, SOIL, AND GROUND WATER

3.1 AIR SAMPLES

During the 1970 survey, 9 air samplers were operated, 5 on Bikini, and 4 on Eneu, for 14 days (see Figures 3 and 4 for locations). Data from those air samples will be tabulated in the SWRHL/EPA forthcoming report.

Bikini No. 5 and Eneu No. 1 are considered to be background stations since they were located on the windward side of the respective islands, overhanging the beach.

Values for radionuclide concentrations in air were obtained by analyzing one half of the filter for each day composited by the station over the total 14 day sampling period. For Bikini, the ^{239}Pu air concentrations ranged from 0.6×10^{-4} to 5.4×10^{-4} pCi/m^3. All results for Eneu were 0.4×10^{-4} pCi/m^3. For comparison, the average value for ^{239}Pu background in the U.S. during 1968 was 0.4×10^{-4} pCi/m^3 and the maximum permissible concentrations for the general public for $^{239, 240}Pu$ is 2×10^{-2}. The analytical error associated with these results is approximately $\pm$ 25 percent at the 2 sigma confidence level.

In order to assess the variation in air concentration, the remaining half of the daily samples from Bikini No. 1 were analyzed individually. The range was from less than 0.7×10^{-4} to 7.9×10^{-4} pCi/m^3 for ^{239}Pu. The average for all samples at station No. 1 was approximately 4×10^{-4} pCi/m^3 which compares quite favorably with 5.4×10^{-4} pCi/m^3, the highest value for Bikini. Although some variation in daily levels is evident from these data, the distribution of results appear to be about what one might expect. In any event, it is extremely doubtful that significantly higher concentrations would be encountered under any weather conditions expected to occur in that area.

The results for Bikini No. 1 may be somewhat representative of highest levels to be expected when the island is reoccupied since this air sampler was located adjacent to and downwind of the road and was subjected to frequent dust clouds stirred up by jeep traffic.

3.2 SOIL SAMPLES

Composite soil samples (15 to 22 individual collections) were taken in 1970 to a depth of 1 inch from disturbed and undisturbed areas along rows on Bikini (shown in Figure 4). On Eneu, soil samples were collected from the Camp Blandy and North Central areas (shown in Figure 5). Soil profile samples were taken at well points as shown in Figure 4.

The principal radionuclides in the soils are ^{137}Cs and ^{90}Sr. Average values of ^{137}Cs on Bikini ranged from less than 1 to 470 pCi/g dry soil

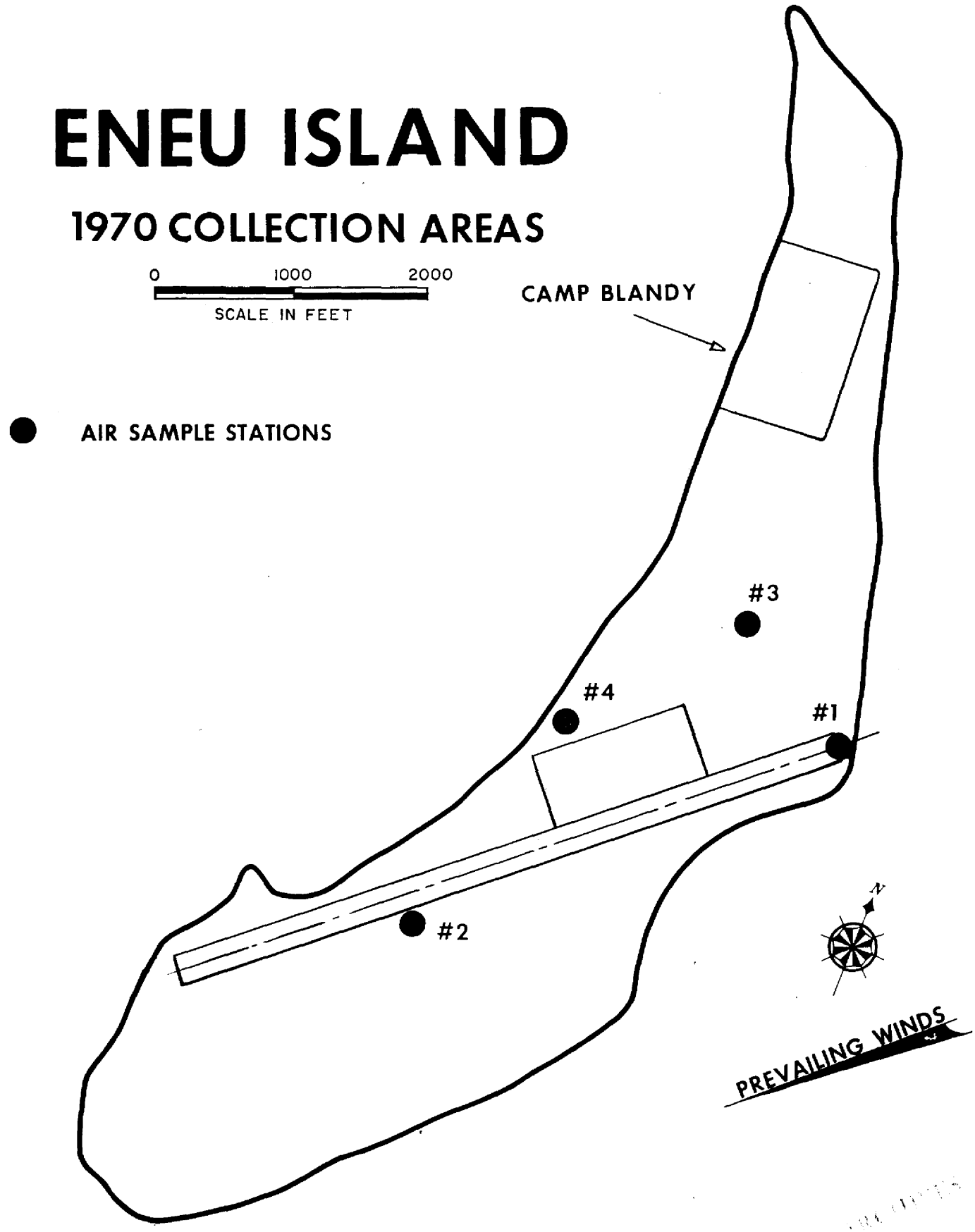
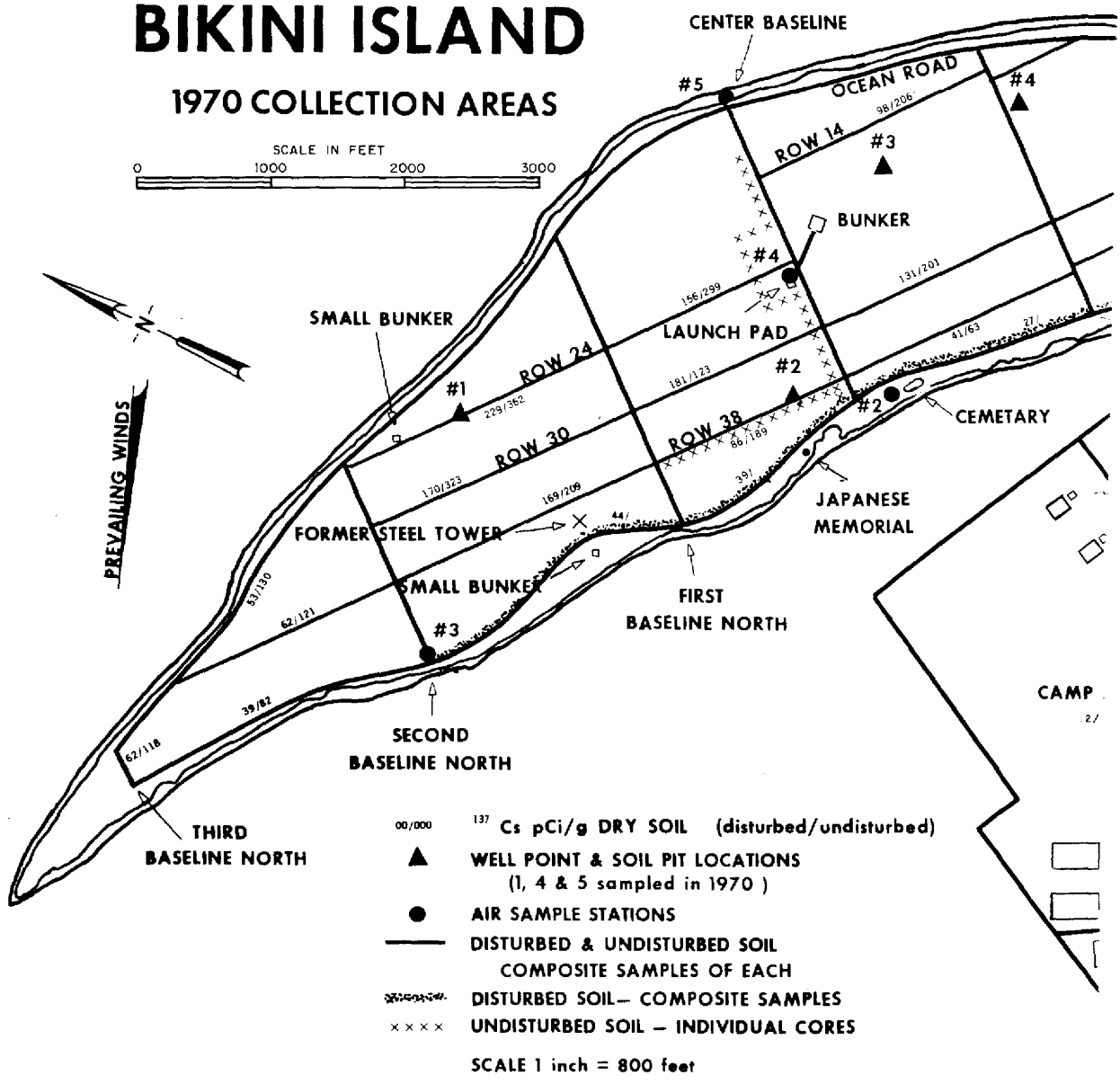

ENEU ISLAND
1970 COLLECTION AREAS
0
1000
2000
SCALE IN FEET
CAMP BLANDY
AIR SAMPLE STATIONS
#3
#4
#1
#2
N
PREVAILING WINDS

FIGURE 5.

BIKINI ISLAND

1970 COLLECTION AREAS



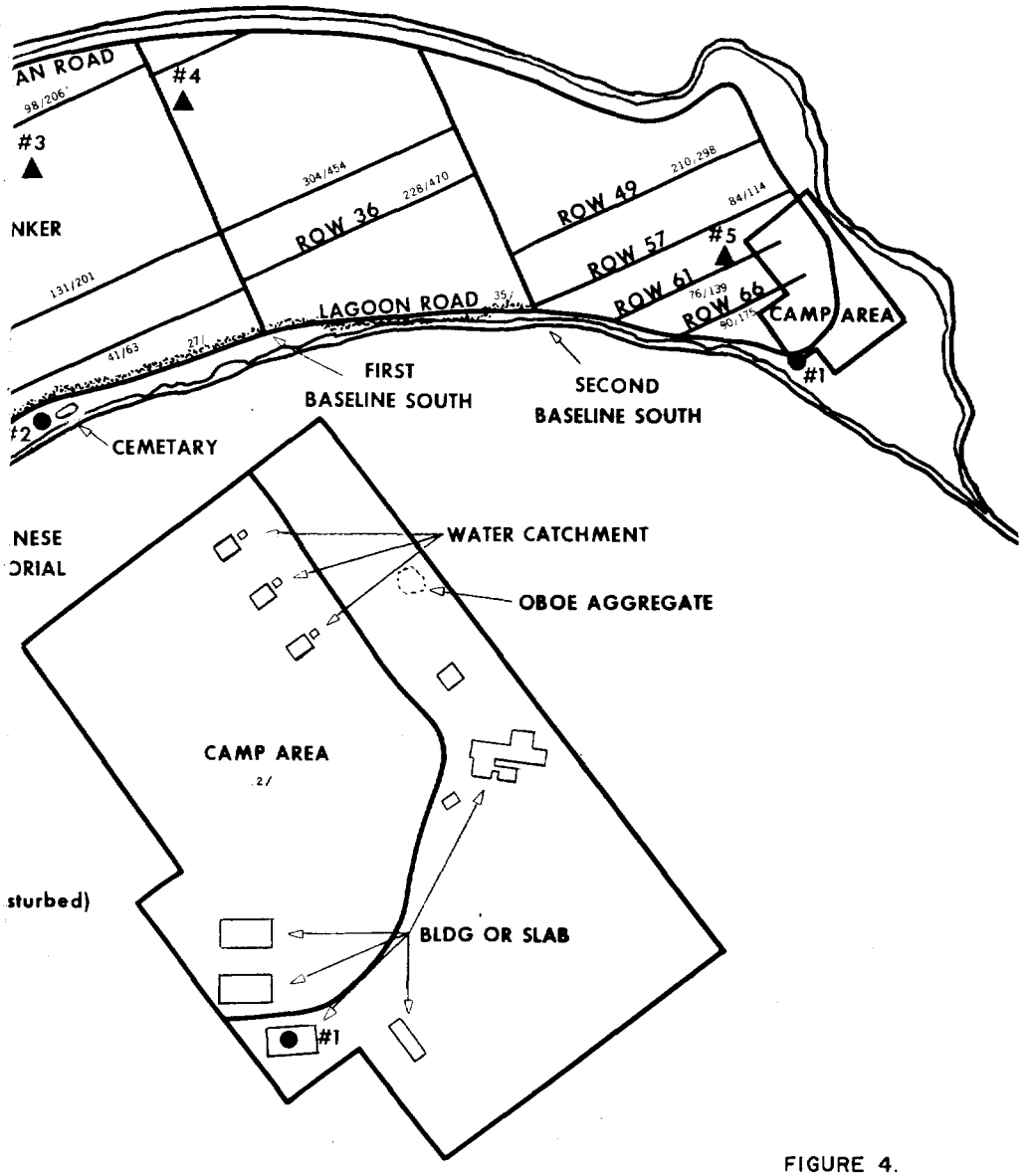

AN ROAD
98/206
#4
#3
NKER
304/454
ROW 36
228/470
ROW 49
210/298
84/114
ROW 57
#5
131/201
ROW 61
76/139
ROW 66
90/175
CAMP AREA
LAGOON ROAD
41/63
27/
FIRST
BASELINE SOUTH
SECOND
BASELINE SOUTH
#1
#2
CEMETARY
NESE
ORIAL
WATER CATCHMENT
OBOE AGGREGATE
CAMP AREA
2/
sturbed)
BLDG OR SLAB
#1

FIGURE 4.

(shown in Figure 4). The radionuclides are concentrated in the surface 2 inches of soil in undisturbed areas.

Soil samples analyzed for plutonium (Table 1) were generally selected from areas with the highest levels of gamma radiation. Exceptions were those obtained from the camp area at Bikini Island and along the runway at Eneu Island. Soils were collected in 1967, 1969, and 1970 from individual soil pits. The area of higher radiation at Eneu Island was one of the few locations relatively undisturbed at Eneu and had an area of approximately 50 square feet; the sample from this area consisted of a composite of four collections. Seven soil samples were analyzed by both SWRHL and University of Washington for an inter-laboratory check (Table 2).

3.3 TRITIUM IN GROUND WATER

Tritium in well water is present at low concentrations; the maximum value found was 14 pCi/ml, or 4300 tritium units (at Nam Island) whereas at Bikini and Eneu Islands, the concentration was 2 pCi/ml, or approximately 600 tritium units. (See Figure 3 for well point locations on Bikini.) These values fall within the range of tritium concentrations in surface waters of the United States in 1966. It has been shown that there is approximately 10,000 times more tritium in "bound" water than in "free" water in soils at Eniwetok Atoll, however, there is little exchange of the bound water with the free water. (Free water is that released or extracted by freeze drying. Bound water represents additional water which could be released upon combustion of the sample.) Hence it is probable that there will be no major changes in the tritium concentration of well water at Bikini Atoll.

4. RADIONUCLIDES IN FOOD

The values of radionuclides observed in food items other than land plants are presented in Table 3.

4.1 EDIBLE PLANTS

Coconut, arrowroot, and pandanus samples were collected in 1967 and 1969 and analyzed (Table 4). Coconut samples were collected from 13 different locations on Bikini in 1969. Green coconuts were used for almost all samples and the meat and milk were analyzed separately. Only ^{137}Cs and ^{90}Sr were detectable in any of the samples. Tritium analyses were performed on the milk from selected coconuts but all results were below the lower limit of detection (0.4 pCi/ml).

4.2 FISH

The fish collected and analyzed are in two main categories: reef fish and pelagic fish. The reef fish, an important item in the Marshallese diet, are caught by throw net while the pelagic fish are caught by trolling.

TABLE 1

PLUTONIUM AND CESIUM-137 IN THE SURFACE ONE INCH OF BIKINI ATOLL SOILS AND BRAVO CRATER SEDIMENT

		N	pCi/g dry $^{239,240}Pu$	^{238}Pu	^{137}Cs
Bikini Island					
1967					
Soil Pit 1			5.1 ± 0.3	*	360 ± 6
Soil Pit 5			117 ± 7.4	*	1200 ± 18
Soil Pit 6			36 ± 2	*	49 ± 1
1969					
Well Point 1			130 ± 8	*	1220 ± 8
Well Point 2			27 ± 2	*	499 ± 3
Well Point 3			111 ± 5	*	1740 ± 15
1970					
1st BL** N to Centerline					
Row 24	Undisturbed	13	74 ± 9	*	299 ± 2
	Disturbed***	13	27 ± 3	*	156 ± 3
1st BL N to 2nd BL N					
Row 30	Undisturbed	20	65 ± 8	*	323 ± 5
	Disturbed	21	56 ± 8	*	170 ± 3
1st BL S to 2nd BL S					
Row 36	Undisturbed	18	87 ± 14	*	470 ± 9
	Disturbed	18	28 ± 4	*	228 ± 3
Camp area to Lagoon Rd.					
Row 66	Undisturbed	14	16 ± 2	*	175 ± 2
	Disturbed	14	6.2 ± 0.9	*	90 ± 1
Base Camp, Random Sample		16	3.9 ± 0.5	*	0.2 to 18

TABLE 1 (Con't)

	N	pCi/g dry $^{239,240}Pu$	^{238}Pu	^{137}Cs
Eneu Island				
1969				
Camp Blandy		.71 ± 0.1	*	6.0 ± 0.3
1970				
North Central				
Undisturbed	5	35 ± 4	*	156 ± 2
Disturbed	4	3.0 ± 0.4	*	21 ± 0.5
Eneman Island				
1969				
SW Corner 0-1" depth		79 ± 3	49 ± 2	19 ± 6
8-9" depth		9.3 ± 0.4	4.1 ± 0.2	3.4 ± 0.5
Bravo Crater				
1969		60 ± 2	4.0 ± 1	

N Number of subsamples in composite sample
* Not detectable
** BL = Baseline
*** Bulldozed planting strip

NOTE: Multiplication of the above values by 3×10^4 will give an approximate value in units of pCi/m^2.

TABLE 2

PLUTONIUM - 239, 240 IN THE SURFACE ONE INCH
OF BIKINI SOILS COLLECTED IN 1967 AND 1969

Collection Site	Date	pCi/g dry SWRHL Analyses	pCi/g dry UW Analyses
Bikini Island			
Pit 1	1967	5.1	5.1
Pit 5	1967	130	117
Pit 6	1967	40	34
Well Point 1	1969	190	129
Well Point 2	1969	30	27
Well Point 3	1969	150	111
Eneu Island			
Camp Blandy	1969	0.39	0.71

TABLE 3

AVERAGE VALUES OF RADIONUCLIDES IN FOOD ITEMS OTHER THAN LAND PLANTS AT BIKINI ATOLL, 1967[1] AND 1969

pCi/g wet

Diet Item	^{55}Fe		^{60}Co		^{90}Sr		^{137}Cs	
	1967	1969	1967	1969	1967	1969	1967	1969
Fish, muscle	100		3.7		.19		.32	
Fish, eviscerated whole[2]		18		2.6		.08		.13
Fish, liver	9200*	382*	44.7				nd	
Fish, viscera[2]		120		13				nd
Tuna, yellowfin								
light muscle		7.8		.02		<.03		.06
dark muscle		88		.26		<.03		.03
liver		120		.41				.02
Tuna, Dogtooth								
light muscle	484	31	.66	.30			.20	.19
dark muscle		241		1.1				.13
liver		478	15	7.1			.06	.17
Spiny lobster[3,4]		2.5	.11	.12	.04		.02	nd
Giant clams[5]		5.9		24				nd
Coconut crabs, muscle			10		19		72	
Coconut crabs, muscle (Bikini)		1.2		.65		12		181
Coconut crabs, muscle (Eneu)		.8		.14		.05		16
Coconut crabs, "liver" (Bikini)		41		7.8		62		170
Coconut crabs, "liver" (Eneu)		16		1.5		5.1		16

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TABLE 3 (Con't)

pCi/g wet

Diet Item	^{55}Fe 1967	^{55}Fe 1969	^{60}Co 1967	^{60}Co 1969	^{90}Sr 1967	^{90}Sr 1969	^{137}Cs 1967	^{137}Cs 1969
Birds, muscle, all species	100	110	3.5		.13		26.5	
Birds, muscle, curlew		24	.94			nd		380
Birds, muscle, turnstone		105	7.7			nd		56
Birds, muscle, terns		155	1.1			nd		.08

(1) Radiological Report on Bikini Atoll. Philip F. Gustafson, Division of Biology and Medicine, USAEC, Washington, D. C., April 1968.
(2) Reef fish only.
(3) The heading, "Clams or Lobster" was used in the 1968 table, but it has been established that the values given are for spiny lobsters from Bikini Island only.
(4) The 1969 value includes spiny lobsters from Nam Island. The average values for ^{60}Co for lobsters from Bikini Island is .07 pCi/g wet.
(5) Clams from near Bikini Island only. Only small clams, not usually eaten, were found off Nam. The maximum value for ^{60}Co was 29 pCi/g wet.
* Jacks (Ulua) only.
nd not detectable

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TABLE 4

MEAN ^{137}Cs AND ^{90}Sr CONCENTRATION IN EDIBLE PLANTS COLLECTED IN 1967 AND 1969

		pCi/g wet			
		^{137}Cs		^{90}Sr	
Location	Sample	1967	1969	1967	1969
Bikini	Coconut Meat	200	120	37	0.31
	Coconut Milk		130		
	Pandanus		130	33	28
	Arrowroot*		0.6		2.4
Eneu	Coconut Meat	28	21	.02	.08
	Coconut Milk		23		
	Pandanus	14	87	3.9	
	Arrowroot*		0.7		0.4
Aerōkōj	Coconut Meat		2.6		0.009
	Coconut Milk		3.0		

*Prepared by grinding, rinsing three times with salt water and once with fresh water (Marshallese method of preparation).

Of the more than 700 species of reef fish at Bikini Atoll, three species commonly eaten by the Marshallese and representative of a different feeding habit were selected: the mullet, a plankton feeder; the convict surgeonfish, a grazing herbivore; and the goatfish, a bottom-feeding carnivore. The specific radionuclides found in fish and their concentrations are often associated with feeding habits, hence this was a necessary consideration in selecting samples representative of the kinds of fish which would be eaten when the Bikinians return. A fourth kind of reef fish, groupers, was also collected as representative of the higher order carnivores.

The pelagic fish are all high-order carnivores and fall into two broad subcategories: resident lagoon fish (ulua, and dogtooth tuna) and migratory fish (yellowfin tuna). Pelagic fish specimens were caught in or near Eneu Pass.

4.3 BIRDS

Thousands of terns nest at Bikini Atoll, mostly on the western islands. Both the birds and their eggs will be used by the natives as food. The terns usually feed at sea (outside the lagoon or reefs) while the curlews and turnstones feed along the shores and on the reef; the curlew also eats the seeds of an endemic shrub, Scaevola serica, or the beach magnolia. Both the curlews and the turnstones are present in small numbers, at most a few hundred. Although these two birds are transients, they contain the higher levels of radionuclides among the birds.

4.4 INVERTEBRATES

The invertebrates sampled were the spiny lobsters (langouste), coconut crab, and "giant" clams (Tridacna sp., and Hippopus hippopus).

5. URINE SPECIMENS

A single urine specimen (24 hours) was obtained from the Trust Territory resident at Bikini. Another specimen was obtained from a member of the 1970 radiological survey team who had been on Bikini for 15 days and who probably had not reached equilibrium. Analyses of these samples indicated no detectable plutonium activity.

6. SIMULATED HOUSE EXPERIMENT

During the 1970 survey, a simple experiment was conducted on Bikini Island to determine how concrete living quarters made of aggregate obtained from the Eneman, Lele, Bikdrin, Aerokojlol, and Aerokoj complex reduces the exposure rate.

A concrete house was simulated by constructing a large, square container with hollow walls 6-inches thick. The walls and the bottom 6 inches were

eventually filled with aggregate (obtained from the same island complex) after the container was placed in an area of relatively high exposure rate (125 uR/hr). A compartment was located in the center of the structure in which a survey meter was placed to measure exposure rates without aggregate, with 6 inches of aggregate on bottom, and with walls of aggregate.

Results of this experiment are as follows:

Background	125 uR/hr
Six inch aggregate bottom	75 uR/hr
Six inch aggregate bottom plus 6-inch walls	45 uR/hr

Similar results were seen when exposure rates were measured inside and outside of a drained concrete cistern in the camp area which was constructed with the same aggregate. The average exposure rate of 10 uR/hr outside of the cistern was reduced to 3 uR/hr at waist height in the center of the cistern. From these observations it is expected that concrete houses made from this aggregate may reduce the exposure rates by a factor of approximately 3.

7. SUMMARY AND RECOMMENDATIONS

The predominant radionuclides in the terrestrial organisms in Bikini Atoll are ^{137}Cs and ^{90}Sr, whereas in marine organisms ^{60}Co and ^{55}Fe predominate. The range in the amount of a radionuclide found in the same tissue from the same species at the same island is wide. When detectable amounts of radionuclides are present, the minimum and maximum values often differ by factors of four or five and sometimes by a factor of ten.

External radiation levels were measured on all islands of Bikini Atoll as part of the clean-up program. The highest exposure rate was 800 uR/hr measured on Eneman in a low lying algae covered area. The maximum exposure rate encountered on the islands scheduled for rehabitation, Bikini and Eneu, was about 120 uR/hr in the interior of Bikini. Other islands exhibiting exposure rates greater than those found on Bikini were:

Enidrik - 300 uR/hr
Lukoj - 180 uR/hr
Jelete - 150 uR/hr
Nam - 500 uR/hr
Lomilik - 500 uR/hr

Analyses of soil samples taken on Bikini indicated that more than 95 percent of the exposure rate was due to ^{137}Cs. Thus, the reduction in exposure rate can be assumed to closely follow the decay of ^{137}Cs. Mixing

of the soil as occurred during the stripping operations on Bikini produced an additional reduction in exposure rates. Soil samples from the other islands showed varying amounts of ^{60}Co and ^{102m}Rh in addition to the ^{137}Cs. The reduction in exposure rate due to radioactive decay on these islands should be much more rapid than for Bikini because of the shorter half lives of ^{60}Co and ^{102m}Rh. By comparison of the decay curves for these islands with that for Bikini, it can be seen that within approximately 10 to 15 years only Eneman will have an external background higher than that of Bikini. It is recommended that a resurvey to verify this projection be conducted in about 10 years in anticipation of unrestricted use of these islands which have higher radiation levels than Bikini. In the meantime, the recommendation of the Ad Hoc Committee restricting rehabitation to the Bikini-Eneu complex should be followed.

The remaining islands of the atoll are lower in radiation levels than Bikini and it would appear that a restriction on continuous occupancy would not be needed. This is particularly true of the Aerokoj, Aerokojlol, Bikdrin complex where the lowest concentrations of radionuclides and lowest levels of radiation are found. Coconuts from Aerokoj were lower in ^{137}Cs and ^{90}Sr content than coconuts from Bikini or Eneu. Agricultural development of these islands should be considered. While the external levels on Lele are as low as those on the other three islands, the fact that it is contiguous with Eneman would make it advisable to restrict the use of this island at the present time. The causeway joining Lele to Bikdrin makes a logical dividing line for indicating this restriction. Analyses of food items growing on the atoll indicated mean concentrations of ^{137}Cs and ^{90}Sr which are essentially in agreement with those obtained in 1967. When new species of food plants are introduced to the atoll, additional analyses of mature specimens will be needed. Internal dose estimates have been performed by Gustafson utilizing the 1967 data and would appear to be valid for the 1969-1970 survey data as well.

The concentrations of ^{90}Sr in the food chain would seem to be of greatest concern with respect to internal dose. Removal of top soil from the site of newly planted pandanus and possibly breadfruit trees, and the addition of a calcium supplement to the diet, as recommended by the Ad Hoc Committee, should be most effective in reducing the dose due to ^{90}Sr.

The results from Eneu air samples are comparable with 1968 air concentrations for ^{239}Pu in the United States. Bikini air sample results range from slightly higher than Eneu to approximately an order of magnitude higher (for the station exposed to the dust from the jeep traffic on the lagoon road).