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SUMMARY STATEMENT

RADIOLOGICAL CONTAMINATION AT ENIWETOK ATOLL

Background

Eniwetok was approved as a testing site in December 1947. The Eniwetok people, about a 120 in number, were moved to Ujelang Atoll where they still reside. The first nuclear test of the first series (Sandstone) conducted at Eniwetok was detonated on the island of Engebi on a 200-foot tower on April 15, 1948. There followed a series of tests conducted on this atoll during the years 1951 (Greenhouse), 1952 (Ivy), 1954 (Castle), 1956 (Redwing), and 1958 (Hardtack, Phase 1). The last test was in July 1958. The total number of announced tests at Eniwetok was 35 compared to 23 at Bikini Atoll. There were eight unannounced tests at Eniwetok.

Earlier this year it was announced that as a result of negotiations between representatives of the United States Government and of the people of the United States Trust Territory of the Pacific, Eniwetok is to be turned back to the Trust Territory at the end of 1973. Before this is done it is desirable that a detailed survey be made of the radiological contamination resulting from past testing. Before the atoll can be inhabited it will be necessary to carry out cleanup operations to remove any materials that would be hazardous, and to assure that the atoll will be a safe and healthful place. Thus, the rehabilitation of Eniwetok is a parallel problem to the rehabilitation of Bikini Atoll.

Prior to return of Eniwetok, DOD-DNA plans to do certain nonnuclear cratering experiments (PACE) within the area of the atoll where nuclear tests were previously conducted.

At the request of Air Foce (PACE), staff of the AEC Nevada Operations Office (NV) with assistance of staff of the Southwestern Radiological Health Laboratory of the Environmental Protection Agency (EPA) conducted a preliminary survey, in July 1971, of islands at Eniwetok on which PACE events were being planned. The results of this cursory survey revealed a serious problem of plutonium contamination for the island of Runit (Yvonne). This was confirmed by additional measurements and samples obtained by EPA staff in September 1971. These surveys were not sufficient to determine if similar problems existed on other islands containing ground zero locations such as Engebi (Janet) and Aomon (Sally). To date it has not been possible to determine the extent to which ground containing plutonium contamination was covered with cleaner soil during the test series, so the area could be used again for a ground zero location. The 1971 survey on Runit indicated that such action had been taken and an area containing

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plutonium contaminated soil had been covered. The results available from soil sampling on Runit indicate that there is an area containing significant plutonium contamination both on the surface and at depth. The data are presented later in this report. The area of contamination lies North and West of the bunker/tower which is located near the center of the lagoon shore. Results of the July 1971 survey were provided to staff of PACE along with recommendations regarding the precautions that should be taken. These were discussed at a meeting between United States Air Force (USAF) personnel responsible for PACE and AEC representatives on August 30, 1971.

In May 1972, an AEC team was sent to Bikini to perform another in the series of followup surveys at that atoll with an added objective of collecting that information and data at Eniwetok that would assist in planning a more detailed survey of that atoll to be conducted later this year. This latter survey is to provide the necessary data for assisting in the determination of cleanup measures that will be required at Eniwetok.

The May 1972 team was equipped with portable instruments to survey for plutonium. The team walked over the area on Runit containing the highest levels of plutonium as identified in the 1971 survey. There were many locations showing positive readings. In two locations a search was made and the source of radiation identified. Chunks of material containing plutonium were isolated from the surface or near surface of the ground. Material was collected for later analysis.

Data for Runit

Eight nuclear devices were detonated on Runit and 24 events produced measurable contamination of this island. Subsequent earth and debris moving activities have resulted in a complex radiological situation in which adjacent areas may be quite different as to levels and vertical distribution of radioactivity in soil. Historical records contain contradictory reports of radioactive waste disposal actions. Contact with personnel who participated in testing at Eniwetok have indicated the possible existence of experiment-related radioactive materials in addition to that of the devices themselves.

Actual surveys have been superficial but have confirmed the presence of a plutonium bearing sand layer outcropping on the ocean side of the island about midway of its length, and the existence of apparently solid plutonium bearing chunks, grains and other particulate on the island surface and near surface. The areas containing this contamination are not fully delineated but appear to be extensive.

Scrap metal debris is extensive and located throughout the island. Much of this metal appears activated with individual pieces indicating

as high as ninety mR/hr contact. General island exposure rates however are usually quite low, about 5 - 10 μR/hr. The island can best be described as a heterogenous conglomeration of nuclear test debris of various radioactivities from the surface to the maximum depth of soil displacement (i.e., water table), in which the actual radiological conditions can be evaluated only on an individual sample basis.

Figure 1 shows gamma isodose rate contours for Runit taken on a 50 foot grid starting at the bunker/tower and continuing to the area of the Cactus Crater. The measurements were made with a low range field survey instrument. These levels are very low except near the craters.

Figure 2 shows isopleths for the same area taken with a portable dual channel pulse height analyzer designed and calibrated to measure the 17 and 60 keV gamma rays from ^{239}Pu and ^{241}Am. A much more complex picture is seen here than in Figure 1. While these results are not definitive for ^{239}Pu due to the presence of other radionuclides having gamma energies near these values, these measurements along with the results of ^{239}Pu analysis of soils with locations as shown in Figure 3 suggest the presence of a significant area of alpha contamination on Runit on the surface, at depth in the soil, and along the lagoon shore. The levels of ^{239}Pu in soils collected on the island ranged from 0.01 pCi/g to 3,200 pCi/g. Table 1 shows the highest and lowest concentrations and the depths at which these levels occurred for each location. Analyses of dredge samples are shown in Table II. While analyses for ^{239}Pu have not yet been performed these measurements tend to show that the area of contamination extends out into the lagoon.

The same instruments used to obtain the isopleths in Figure 2 were also used to detect fragments of bomb material which later proved to consist of ^{239}Pu and Be. Collection sites for these samples are also shown in Figure 2. The chunk of material having a total weight of about 700 mg was found to contain about 40 mg of ^{239}Pu. Figure 4 depicts the area surveyed by portable instrument for surface alpha contamination. This instrument utilizes a very thin layer of a scintillating material (ZnS) and must be held nearly in contact with the surface being measured. A film of moisture can degrade the alpha particle energy to the point where it cannot be measured. As a result, only limited use was made of this instrument during the 1971 or 1972 surveys.

Other Locations

The current problem involving ^{239}Pu at Eniwetok has focused attention on Runit. There are other locations of concern such as Sally and Janet each having three GZ's. There is one marked Pu burial location on Sally and indications of another contaminated waste burial location mid-island along the lagoon shore. See Figure 5. We are not now assured that

similar conditions do not exist on Janet. Extremely limited information on ^{239}Pu in soil on Janet shows low levels. See Figure 6 for sampling locations. However, in a number of samples taken at depths to about 20 cm, the levels of ^{239}Pu increased with depth. At sampling site No. 3, which is the GZ location for Easy Shot, the highest observed level of ^{239}Pu in soil was 10 pCi/gm at a depth range of 14 to 20 cm, the maximum depth sampled. At site No. 4, the observed concentration had a value of about 10 pCi/gm and did not change significantly with depths down to 20 cm. At site No. 5, the highest value was 39 pCi/gm at a depth range of 8 to 14 cm. Not enough samples are available to say whether the plutonium contamination of this island is characterized by these values.

Considering the limited sampling for ^{239}Pu in soil on Sally and Janet, it is not now possible to make any generalized statements of the character and extent of ^{239}Pu contamination or to describe the situation for other long lived radionuclides.

We have been advised by PACE staff that a great many soil samples were collected on Sally during the preparational phase of their program and that there is no problem from a radiological standpoint. However, the results of soil sample analysis have not been made available to us.

Summary:

The cleanup of Eniwetok, unlike Bikini, will be much more extensive and complicated because of the larger number of nuclear events and remaining debris. In addition, there appears to be a plutonium contamination problem, the magnitude of which cannot be determined from the data available to us.

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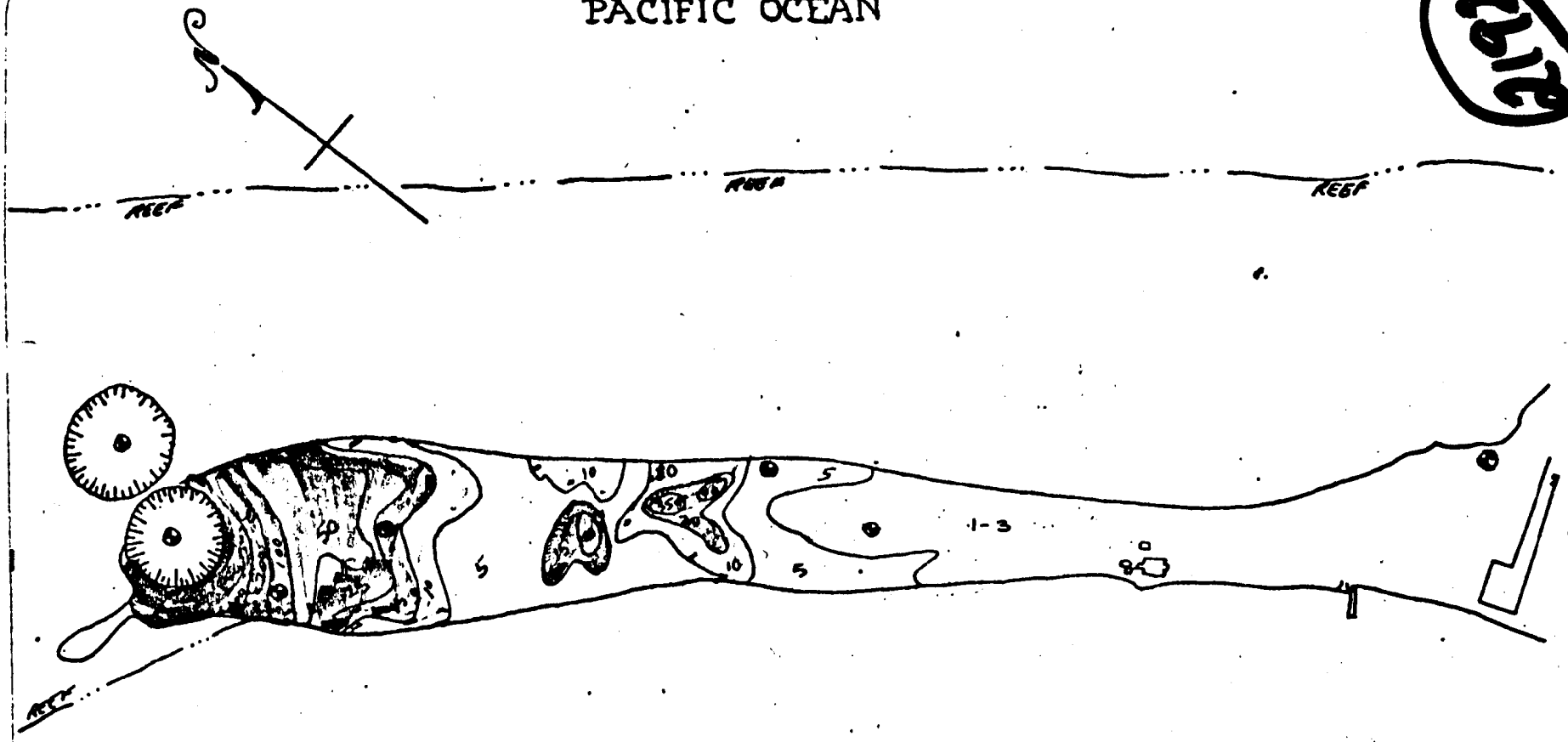
PACIFIC OCEAN



GAMMA EXPOSURE RATES

μR/hr MICRO ROENTGENS PER HOUR

Figure 1

LAGOON

RUNIT (YVONNE)

ENIWETOK ATOLL, MARSHALL ISLANDS

MAY 1972

SGZ

JUN 15 1972

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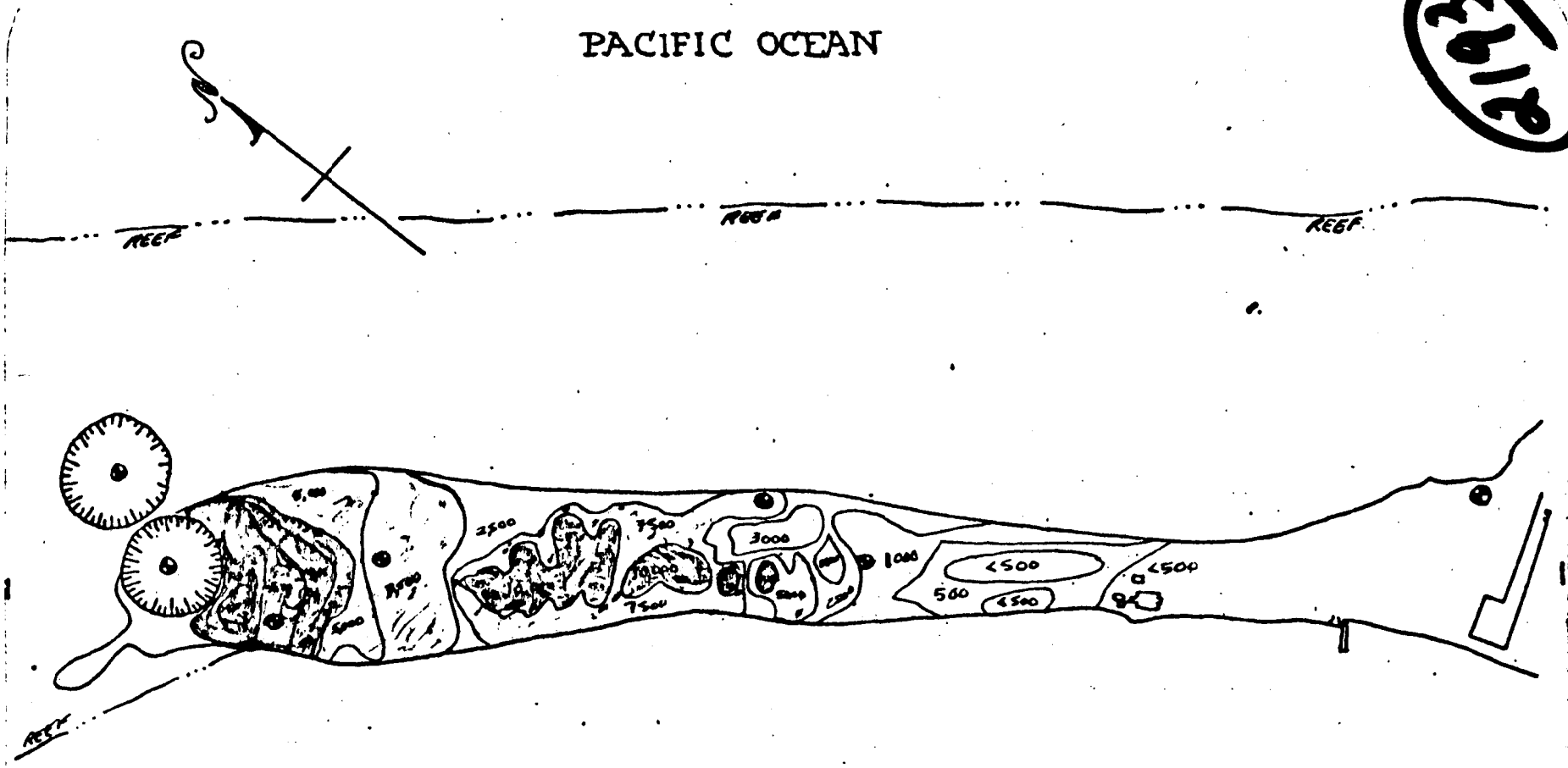
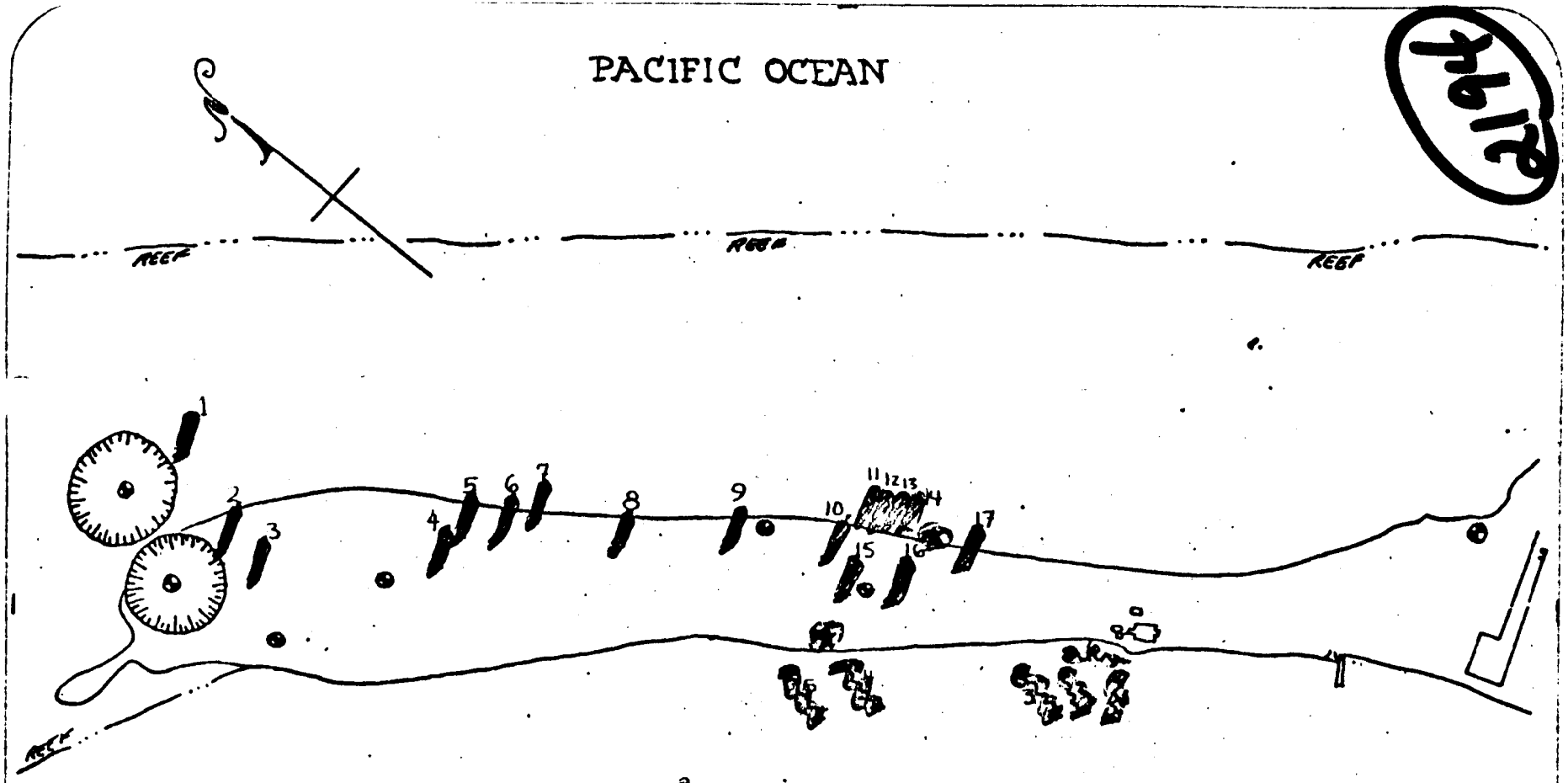


FIDLER ^{241}Am. SCINT DETECTOR READINGS
APPROXIMATE CONTOUR LINES COUNTS PER MINUTE

Figure 2.

LAGOON

RUNIT (YVONNE)
ENIWETOK ATOLL, MARSHALL ISLANDS
MAY 1972

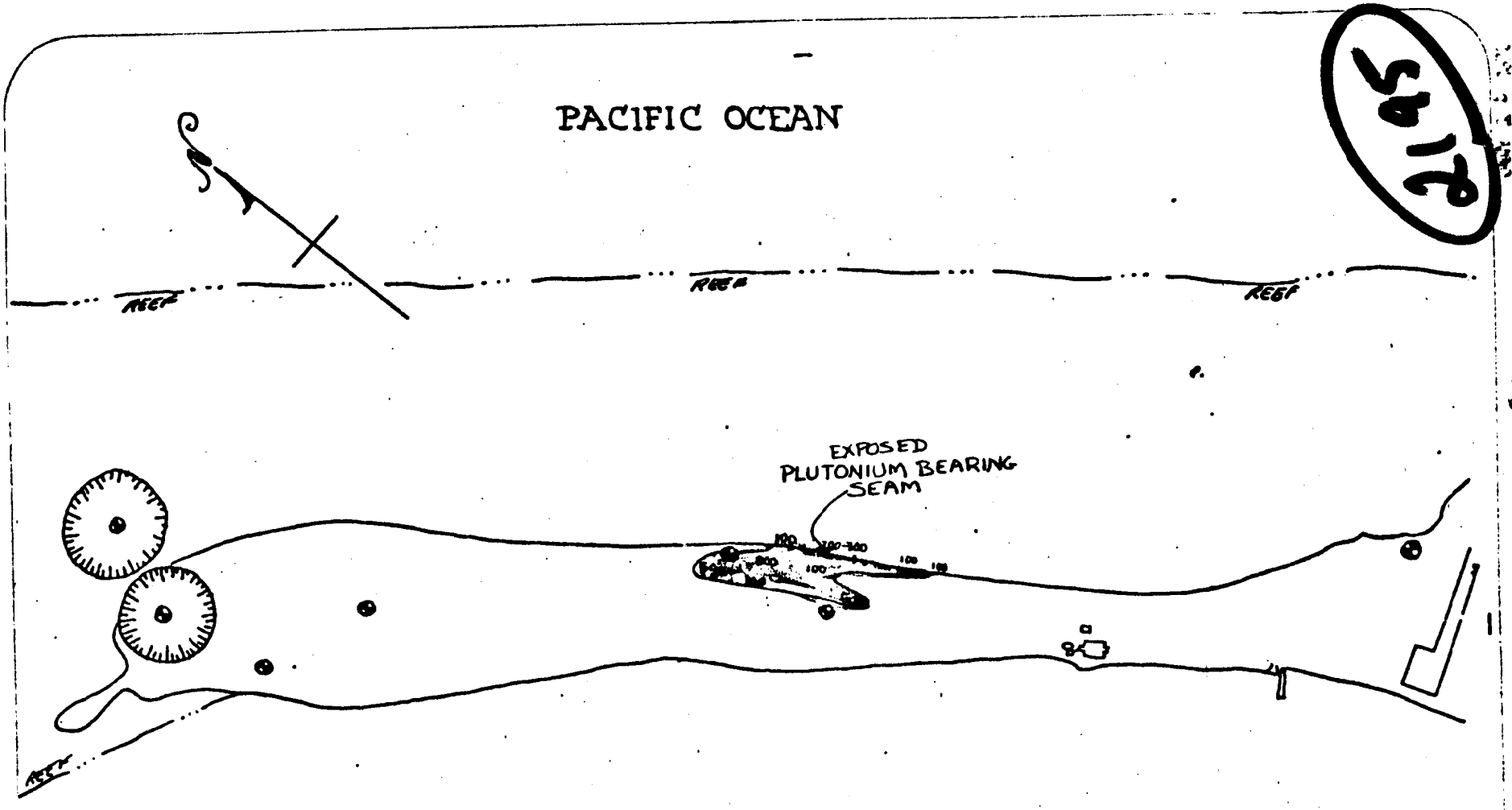


SOIL SAMPLE LOCATIONS
DREDGE LOCATIONS
Pu-Be FRAGMENTS

Figure 3

RUNIT (YVONNE)

ENIWETOK ATOLL, MARSHALL ISLANDS
MAY 1972



SURFACE ALPHA CONTAMINATION

PAC-1S READINGS cpm/55 cm²

Figure 4.

RUNIT (YVONNE)

ENIWETOK ATOLL, MARSHALL ISLANDS

MAY 1972

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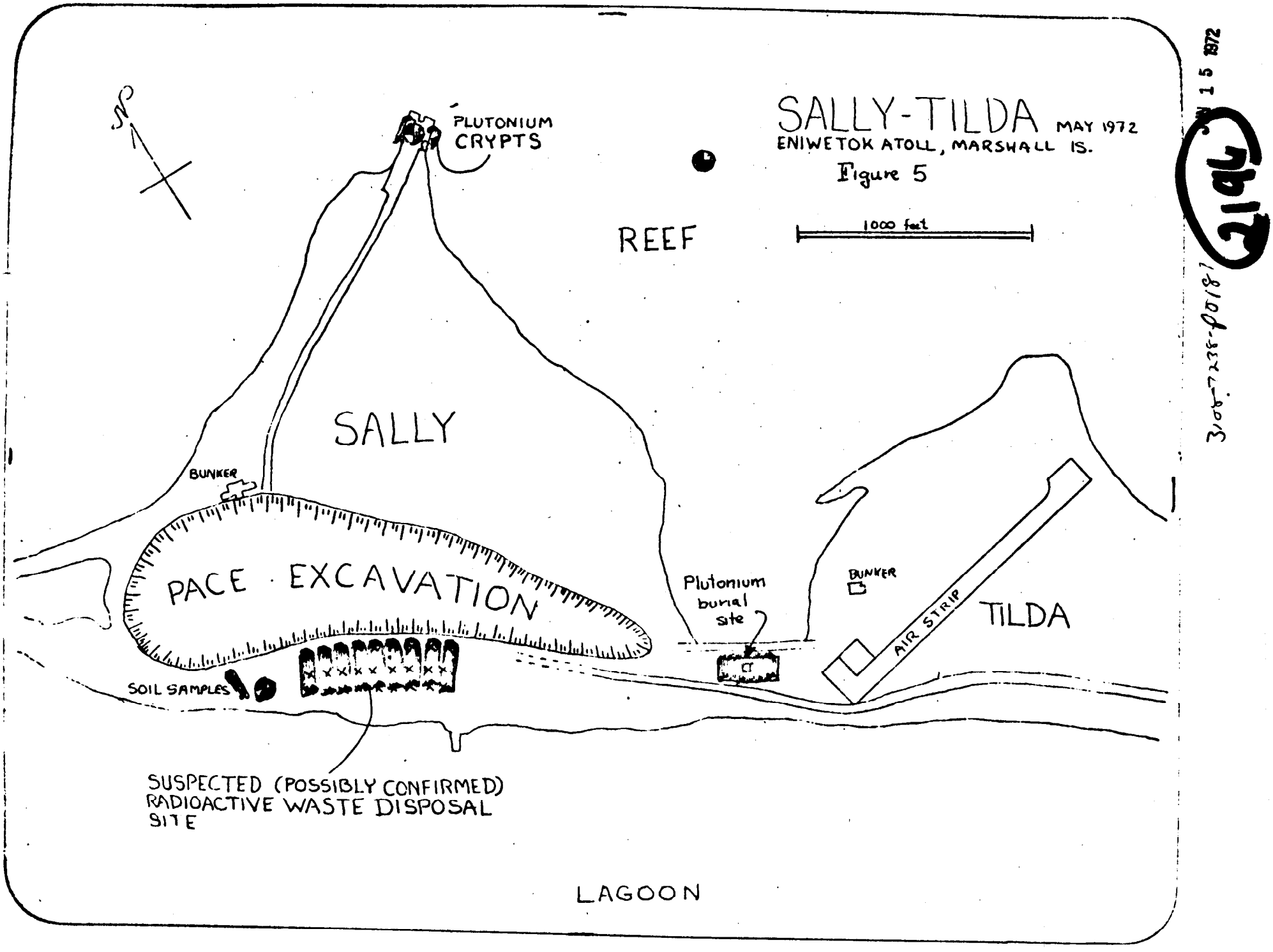
SALLY-TILDA MAY 1972
ENIWETOK ATOLL, MARSHALL IS.
Figure 5
PLUTONIUM CRYPTS
REEF
1000 feet
SALLY
BUNKER
PACE · EXCAVATION
SOIL SAMPLES
Plutonium burial site
BUNKER
AIR STRIP
TILDA
SUSPECTED (POSSIBLY CONFIRMED) RADIOACTIVE WASTE DISPOSAL SITE
LAGOON

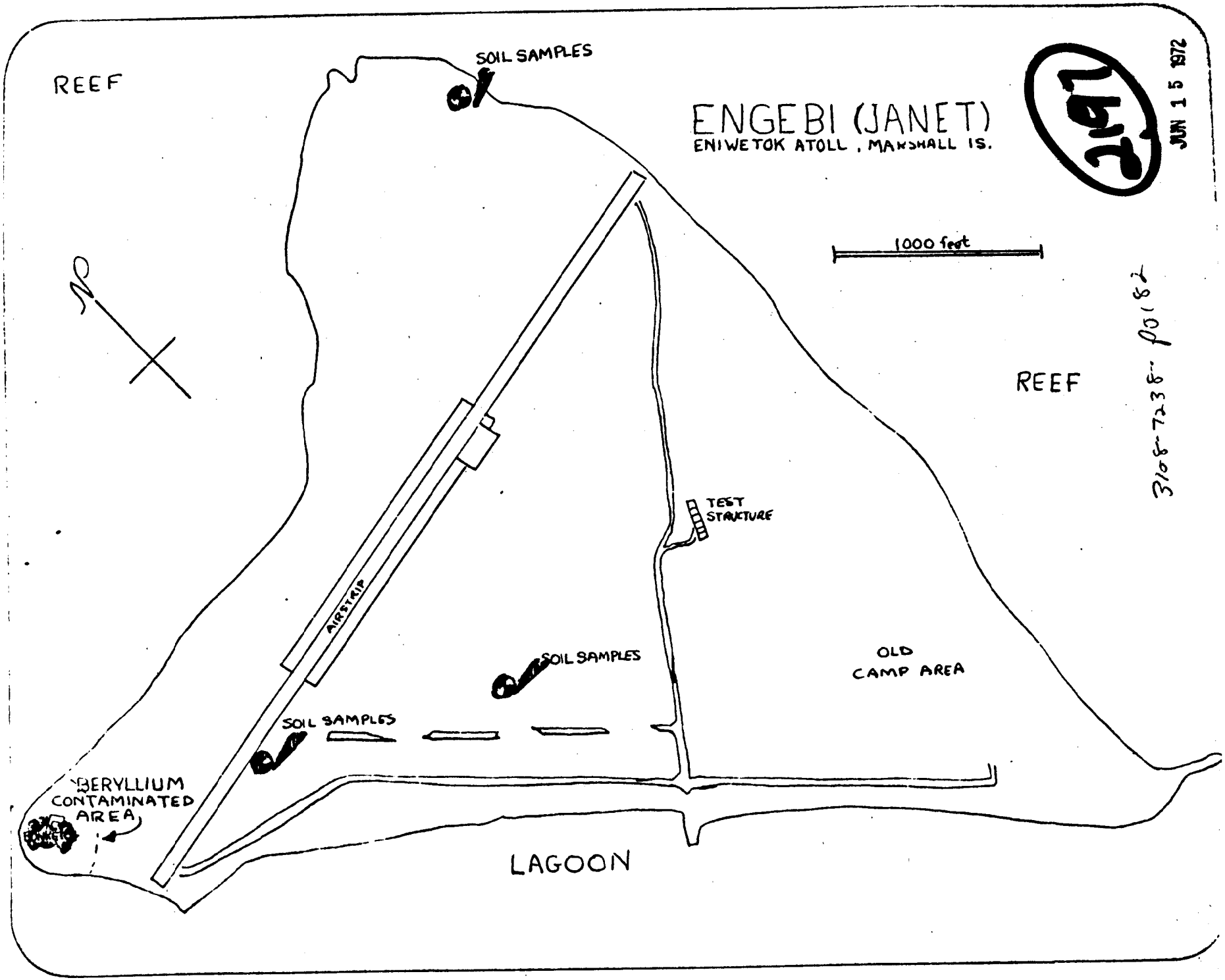
REEF
SOIL SAMPLES
ENGEBI (JANET)
ENIWETOK ATOLL, MARSHALL IS.
JUN 15 1972
1000 feet
REEF
TEST STRUCTURE
AIRSTRIP
SOIL SAMPLES
OLD CAMP AREA
SOIL SAMPLES
BERYLLIUM CONTAMINATED AREA
LAGOON

TABLE I

ANALYSIS OF PLUTONIUM IN SOIL - RUNIT

(pCi/g)

Location*	Highest Concentration	Depth	Lowest Concentration	Depth
1	7.8	14-20 cm	-	-
2	600	0-5 cm	-	-
3	34	Surface 1"	0.18	Drillcutting 10 ft.
4	22	Surface 1"	-	-
5	10.2	Surface 1"	0.06	Drillcuttings 5 ft.
6	6.7	Surface 1"	-	-
7	14.1	1-3"	0.08	21-23"
8	144	19-21"	5.4	9-11"
9	7.6	Surface 1"	0.01	17-19"
10	7.3	Surface 1"	0.01	15-17"
11	3200	face of seam on ocean beach		
12	2500	face of seam on ocean beach		
13	800	12" 1 cm - 12" 2 cm		
14	800	from plastic bag on beach surface		
15	1300	Surface 1"	0.08	17-19"
16	550	3 - 5"	3.7	21-23"
17	79	Surface 1"	0.04	15-17"

*These locations are identified on RUNIT soil sample locations.

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TABLE II

DREDGE SAMPLE RESULTS - RUNIT

(pCi/g dry)

Dredge #	^{241}Am	^{155}Eu	^{241}Am/^{155}Eu
1	2.6 ± 0.1	8.3 ± 0.3	0.31
2	3.0 ± 0.1	13.2 ± 0.3	0.23
3	2.7 ± 0.3	10.7 ± 0.4	0.25
4	1.1 ± 0.1	2.6 ± 0.1	0.42
5	1.8 ± 0.3	5.2 ± 0.3	0.35
6	28.7 ± 0.5	4.6 ± 0.1	6.2

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