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Continuation of the Marshall Islands Dose Assessment and Radioecology Program

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Water and Environment Program
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Background

Standard approach to risk management in relation to radioactively contaminated sites is to control the Total Effective Dose Equivalent (TEDE).

The annual TEDE is the sum of;

<external radiation dose in a year >

(dominated by gamma radiation from residual ^{137}Cs in the soil)

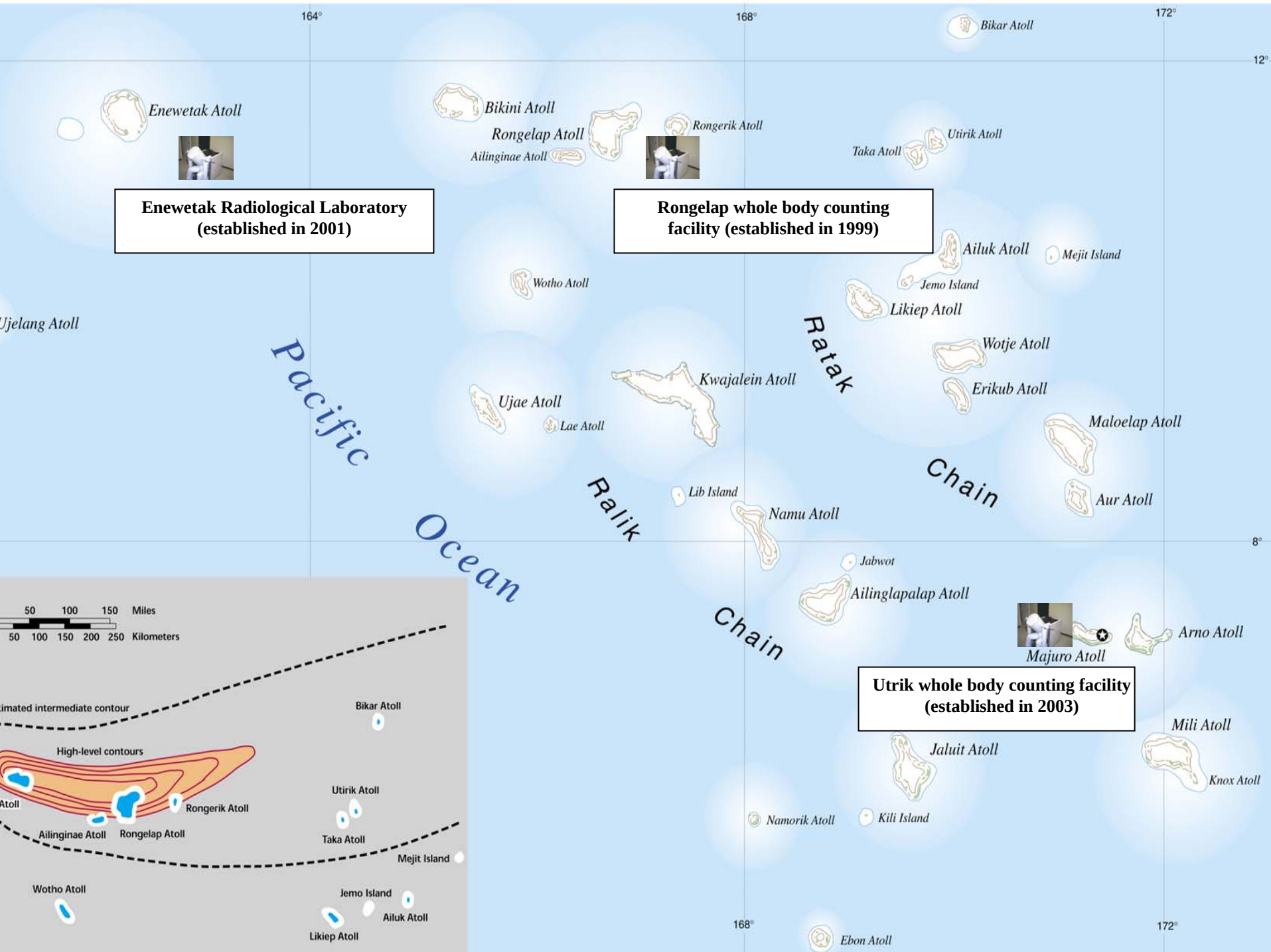
+

< committed dose from intakes of radionuclides during that year>

(intakes of ^{137}Cs, ^{90}Sr, and the TRUs [plutonium isotopes and ^{241}Am])

Overview of presentation

1. **Results of the individual radiation protection monitoring programs based on whole body counting and plutonium bioassay**
2. **Results from the Enewetak environmental characterization studies**
3. **Update on the Rongelap resettlement support activities**


164°
168°
172°
12°
8°
Bikar Atoll
Enewetak Atoll
Bikini Atoll
Rongelap Atoll
Ailinginae Atoll
Rongerik Atoll
Taka Atoll
Utirik Atoll
Enewetak Radiological Laboratory (established in 2001)
Rongelap whole body counting facility (established in 1999)
Ailuk Atoll
Mejit Island
Jemo Island
Likiep Atoll
Wotho Atoll
Ujelang Atoll
Pacific
Ocean
Ratak
Chain
Ralik
Chain
Wotje Atoll
Erikub Atoll
Kwajalein Atoll
Ujae Atoll
Lae Atoll
Maloelap Atoll
Aur Atoll
Lib Island
Namu Atoll
Jabwot
Ailinglapalap Atoll
Majuro Atoll
Arno Atoll
Utrik whole body counting facility (established in 2003)
Mili Atoll
Jaluit Atoll
Knox Atoll
Namorik Atoll
Kili Island
Ebon Atoll
50 100 150 Miles
50 100 150 200 250 Kilometers
imated intermediate contour
High-level contours
Bikar Atoll
Utirik Atoll
Rongerik Atoll
Ailinginae Atoll
Rongelap Atoll
Taka Atoll
Mejit Island
Wotho Atoll
Jemo Island
Ailuk Atoll
Likiep Atoll

Whole Body Counting – Tracking Database FY'04

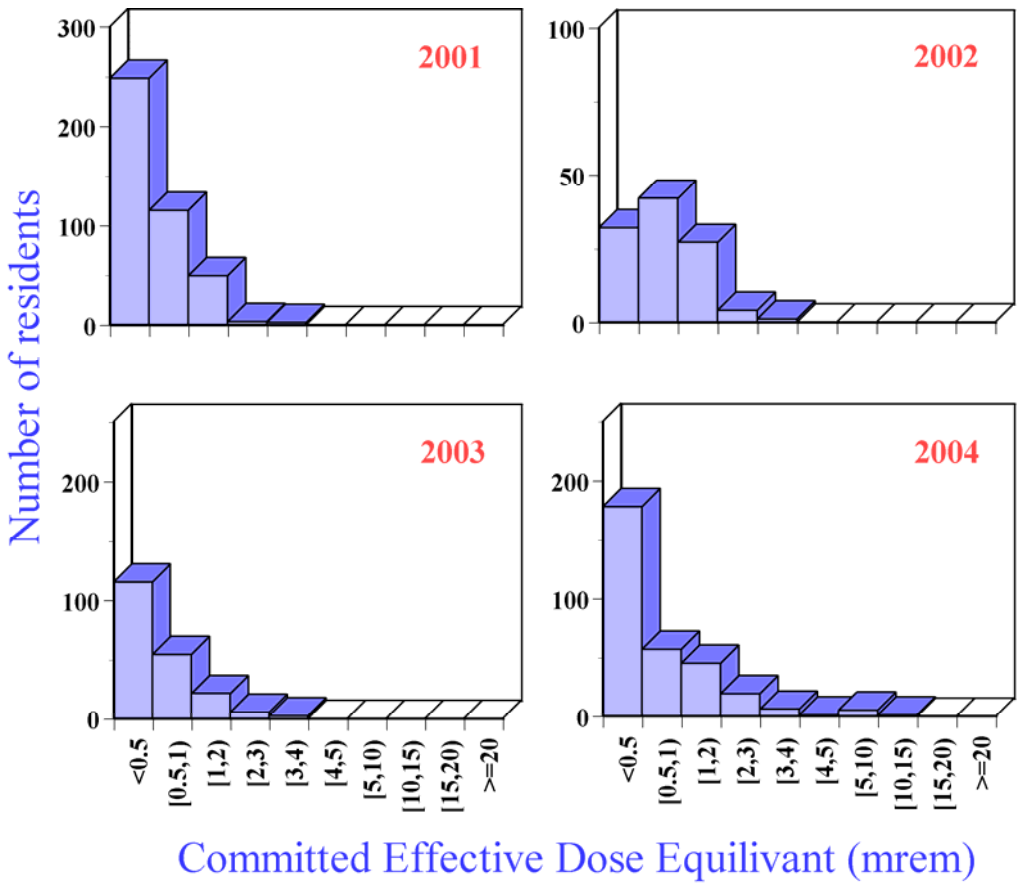
For FY'04		RI* Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl	RI Steven Kehl
		planning	Step 1. baseline monthly	Step 2. baseline monthly	Step 3. baseline monthly	Step 4. baseline monthly	Step 5. baseline monthly	Step 6. baseline monthly	Step 7. baseline monthly	Step 8. baseline monthly
Red=Partial Month Totals										
Facility Location	Month	Number of personnel counts	Transfer QC systems files and print	Update personnel database file (import files into database)	Input of .crf spectra files from vivo software	Copy new .pic files (sort by date and copy)	Copy cal detector arrangement files (& other as needed)	Perform data review, electronic mail spectra and vivo databases, generate transfer file and unresolved listing	Email corrections to BN and verify action pending	Split out all rex files into .crf
Rongelap		Cumulative Total - 98								
Enewetak	October	0	–	–	–	–	–	–	–	–
	November	58	x	x	x	x	x	x	x	x
	December	85	x	x	x	x	x	x	x	x
	January	38	x	x	x	x	x	x	x	x
	February	39	x	x	x	x	x	x	x	x
	March	86	x	x	x	x	x	x	x	x
	April	68	x	x	x	x	x	x	x	x
	May	44	x	x	x	x	x	x	x	x
	June	64	x	x	x	x	x	x	x	x
	July	72	x	x	x	x	x	x	x	x
	August	13	x	x	x	x	x	x	x	x
	September	8	x	x	x	x	x	x	x	x
		Cumulative Total - 575								
Majuro		Cumulative Total - 298								

Note: *RI - 'Responsible Individual'

Committed effective dose equivalent from intakes of cesium-137 in the measurement year

Enewetak Atoll

- No restriction on volunteer participation
- Agricultural workers (originally identified as most critical group), monthly schedule
- Those people showing elevated whole body burdens of cesium-137, perform follow-up (monthly counts)
- Excellent participation from the community (large numbers of children/teenagers included in program over past 12 months)
- Technicians becoming much more knowledgeable and more active within the community

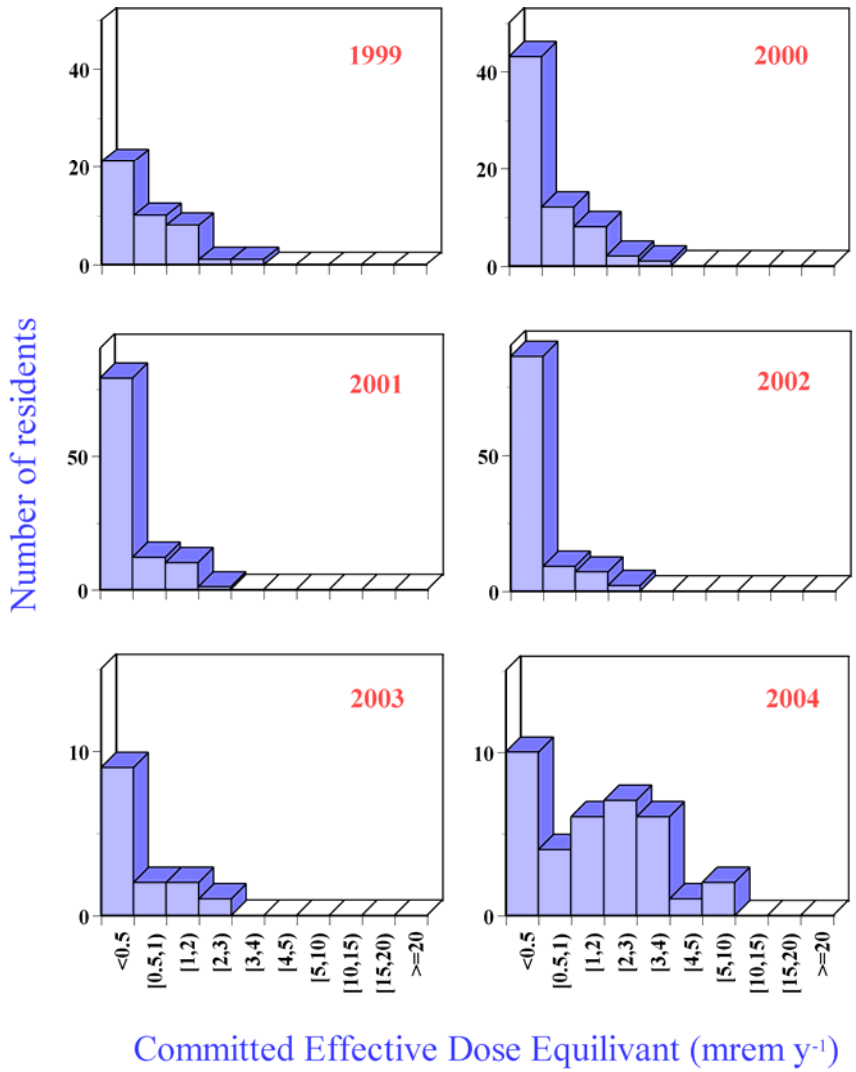


Committed effective dose equivalent from intakes of cesium-137 in the measurement year

Rongelap Atoll (1999-2004)

- **Initial focus on resettlement workers but include other volunteers visiting the island, workers on a monthly schedule.**
- **Indication of higher cesium-137 intakes over the past 12-18 months (higher % of counts on maintenance staff who spend more time on the island).**

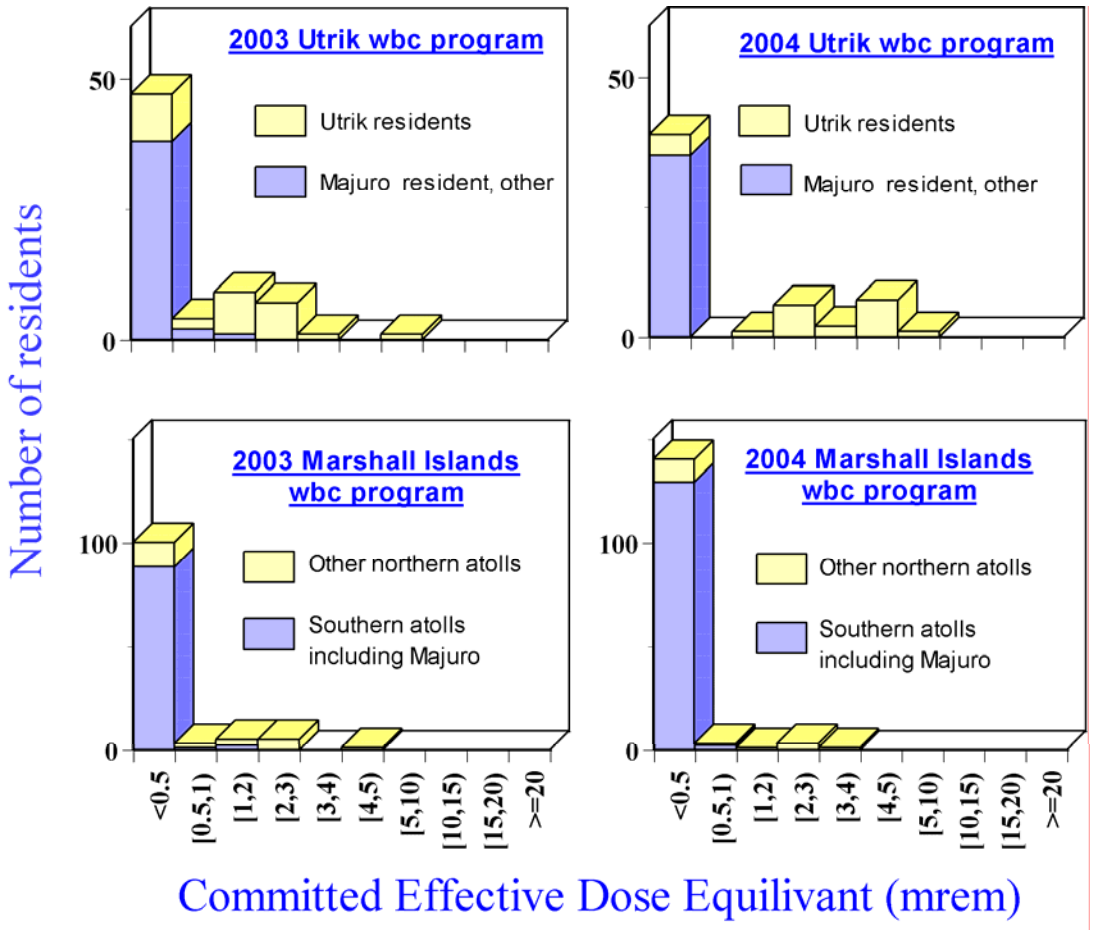
“Perhaps more representative of what we might find in a resident population”



Committed effective dose equivalent from intakes of cesium-137 in the measurement year

Utrik Atoll (2003-2004)

- **Facility established under the UALG MOU agreement but the local government has agreed to share the use of the facility**
- **Clear indication of cesium-137 uptake into the majority of Utrik residents as compared with fellow citizens living on Majuro**
- **Clear indication of cesium-137 uptake into majority of people living on other northern atolls (e.g., Ailuk Atoll).**
- **Very low doses (risk) from exposure in residual fallout for people living elsewhere in the Marshall Island.**
- **Low participation**



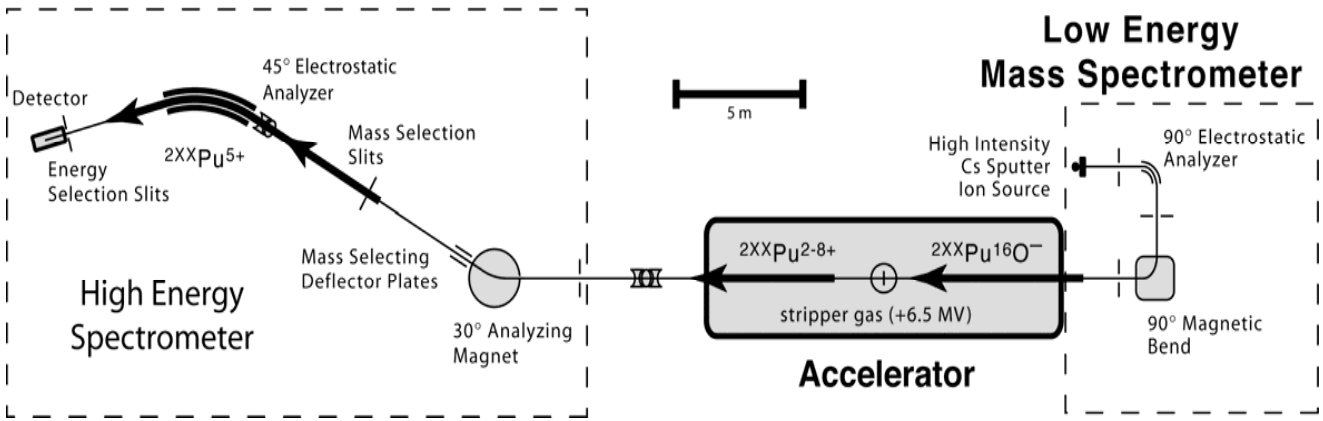
Plutonium urinalysis

- **Plutonium urinalysis or bioassay is a method used to estimate the amount of internally deposited plutonium in the human body.**
- **Livermore have developed a state-of-the-art technology to conduct these tests (much improved over previously used measurement techniques)**
- **This new technique is based on accelerator mass spectrometry (AMS)**

Low-level plutonium measurements at LLNL

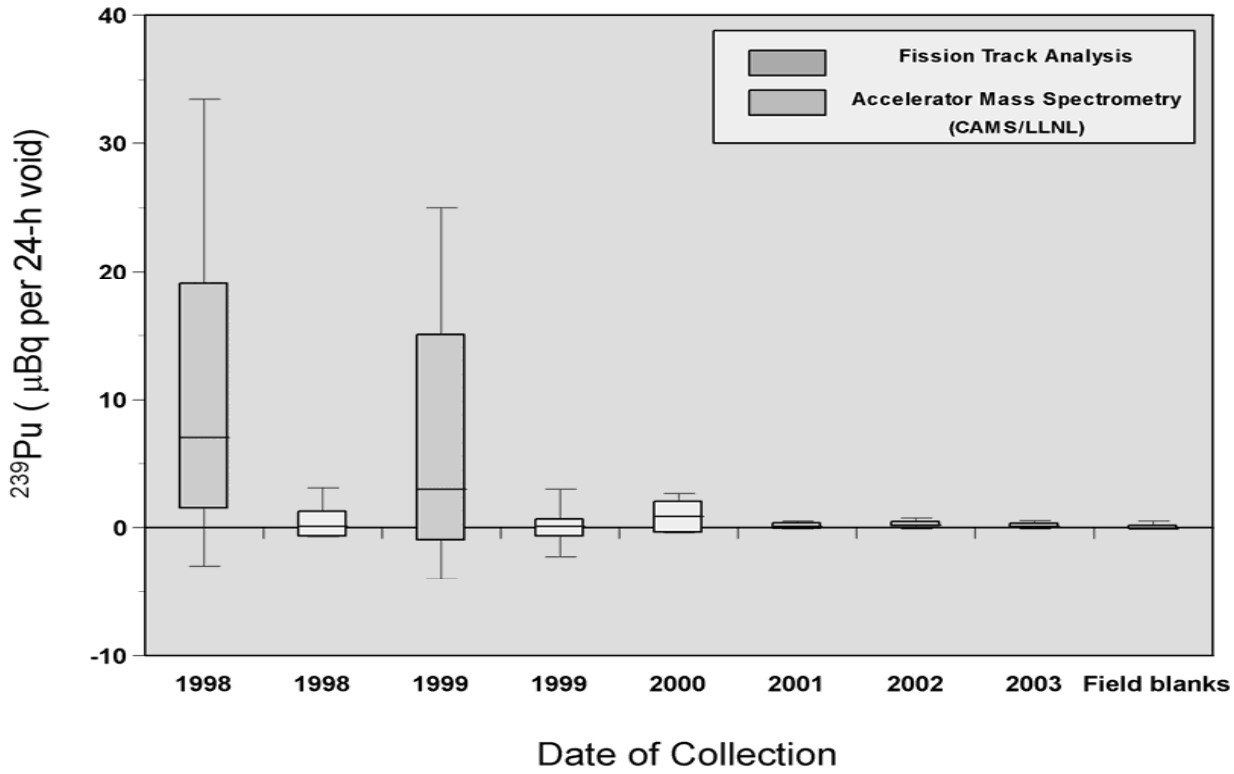
- AMS system counts number of atoms (measures mass) rather than the the radioactive properties of the elements. Technique offers advantages in advantages in terms of sensitivity and is less susceptible to interferences interferences

- Techniques used at Livermore have been independently validated by the by the National Institute of Science and Technology (NIST) and the Oak Oak Ridge National Laboratory.



Historical perspective on excretion of plutonium versus different techniques

Rongelap Resettlement Workers (1998-2003)

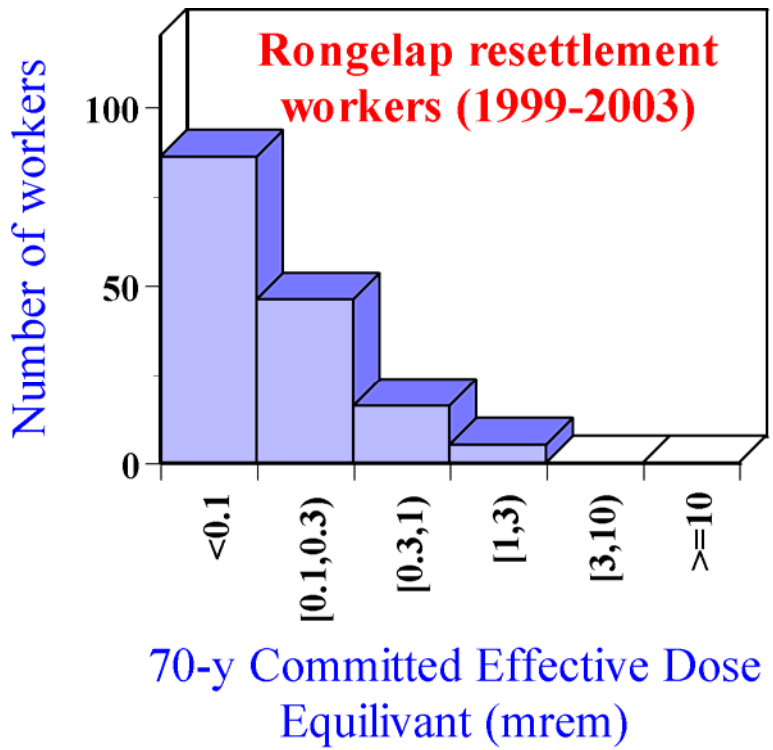


Explanation: The lowest, second lowest, middle, second highest and highest box points represent the 10th, 25th, median, 75th and 90th percentiles, repectively.

Committed dose from measured whole body burdens of plutonium based on AMS bioassay

Rongelap resettlement plutonium bioassay program

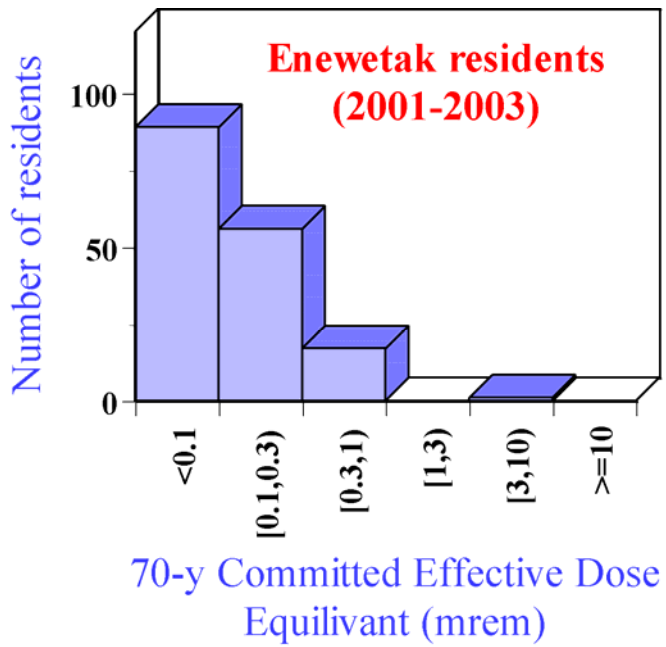
- **Sampling strategy based on monitoring Rongelap resettlement workers (original intent was to include all workers – this was not practical or achievable). Modified the call to those workers spending the most time living on Rongelap**
- **Additional funding received from DOE in the later half FY2004 to allow us to complete the analyses of all samples collected under the program.**
- **No further bioassay sampling planned for Phase 1 resettlement activities**
- **Good cooperation from resettlement contractor, Pacific International Inc.**



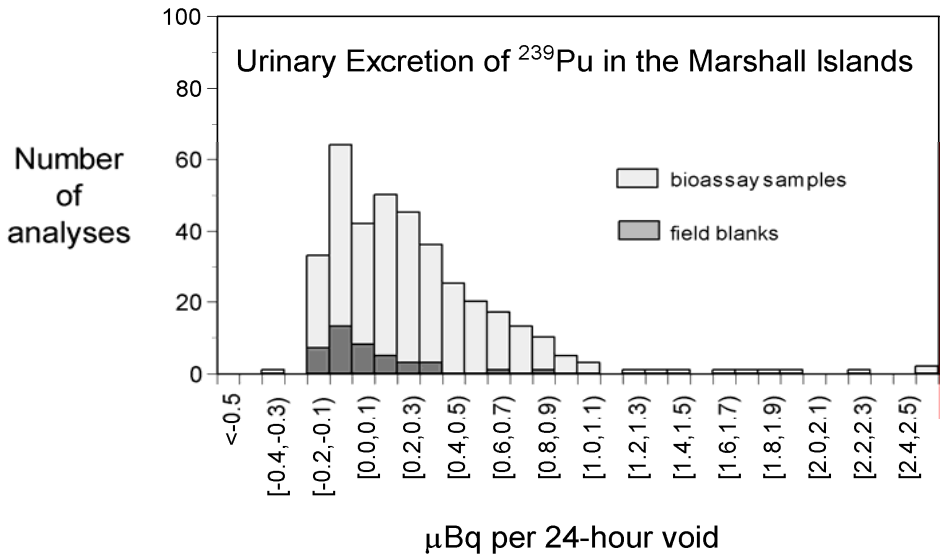
Committed dose from measured whole body burdens of plutonium based on AMS bioassay

Enewetak plutonium bioassay program

- **Sampling strategy**
  - **Agricultural workers (thought to be most likely to come into contact with contaminated soil)**
  - **People born 1950s through early 1960s, period when likely to have seen maximum ground air concentration of plutonium in the Marshall Islands**
  - **People born on and/or living on Enewetak since resettlement in 1980**
  - **LLNL added quality control collections which account for 10 to 12 additional samples per annual collection**
- **Conducted 4 annual collections on Enewetak since 2001 in compliance with terms of the MOU agreement**
- **Additional funding received from DOE in the later half FY2004 enabling the analyses to be performed on the last collection (December 2003)**
- **Very pleased with upkeep of the Enewetak Radiological Laboratory which enables us to make clean sample collections**



Excretion of plutonium in the Marshall Islands by AMS detection and measurement



Geometric mean (bioassay samples) = 0.2 μBq per 24-h void

Very low amount of plutonium found in Marshallese people we have tested

'Existing levels of systemic plutonium uptake are low and, based on these data, have always been low'

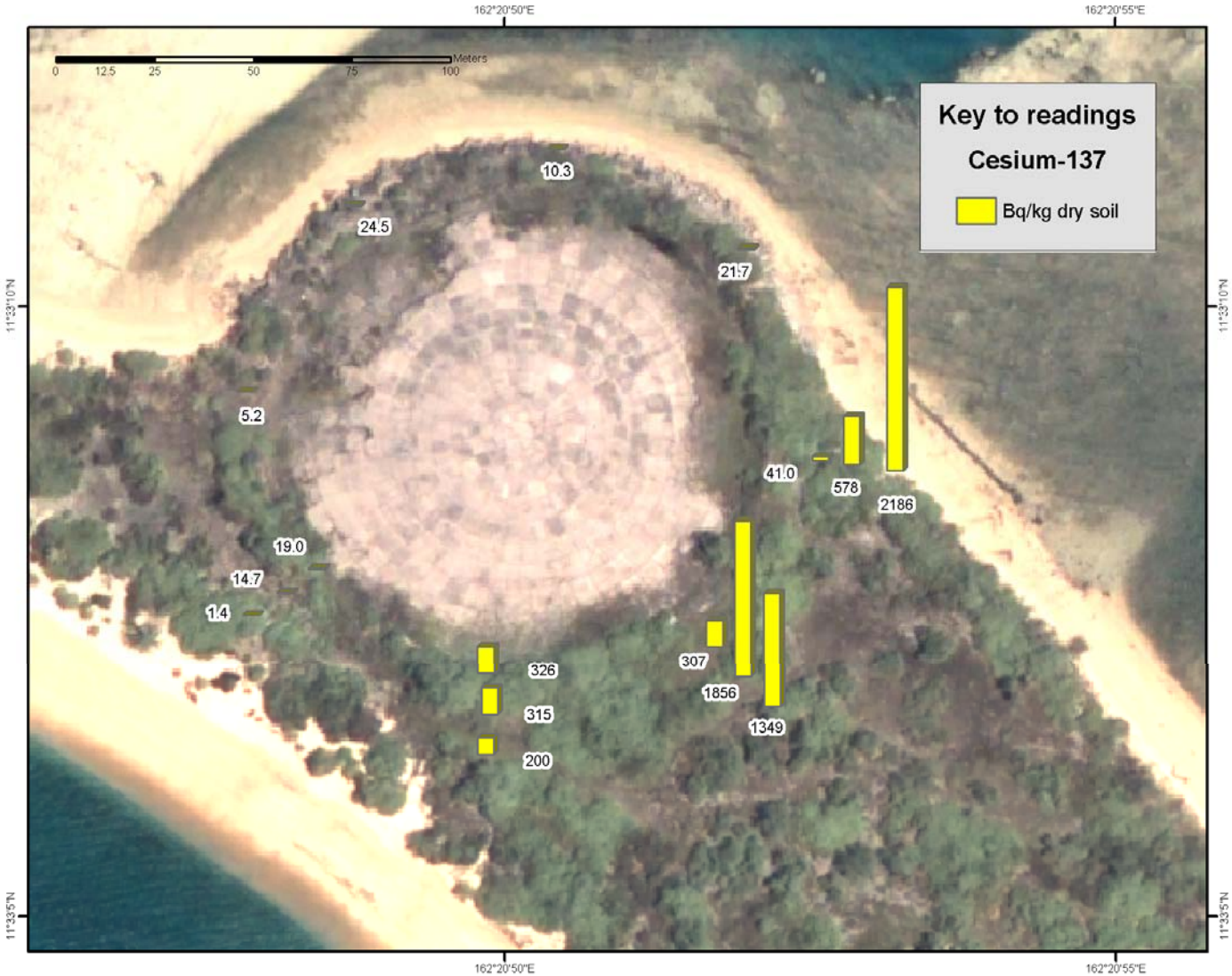
Enewetak Cleanup Program (1978-1980)

Island	TRU Activity GBq	Soil removal (m^3) to crater	Soil removal (m^3) to Dome	$^{240}Pu/^{239}Pu$ atom ratio
Aomon	48.1	8,100	0	0.23
Aomon Crypt	33.3	342	7,130	0.24
Boken	37	322	3,450	_
Enjebi	96.2	32,890	7,633	0.34
Lujor	63	0	11,415	0.27
Runit	267.4	0	8,210[b]	0.06

[b.] most activity and soil in central donut under dome

"Recognized $^{240}Pu/^{239}Pu$ ratio might be used as an investigative tool to assess impacts of leakage from the dome"

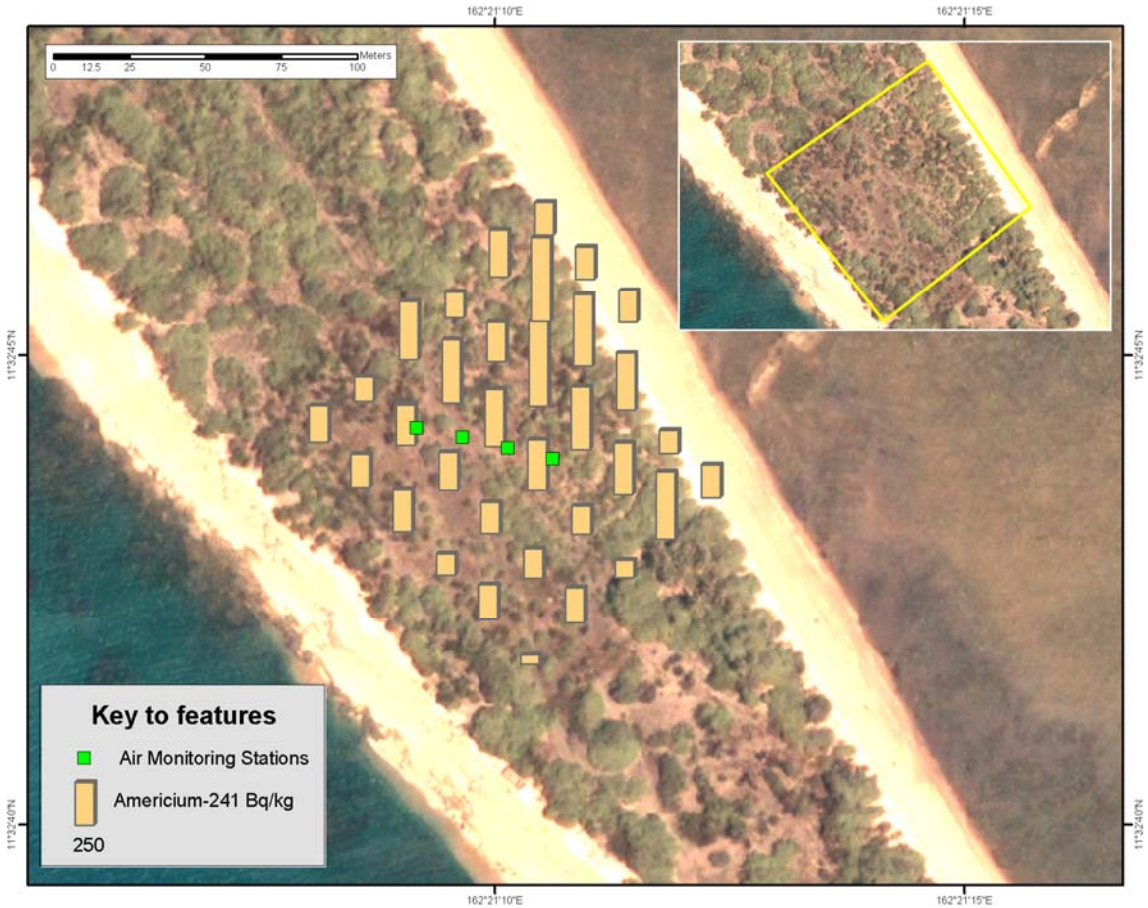
Terrestrial sampling around Runit dome



Radionuclide concentrations around the dome

Field Log #	transect (magnetic)	distance from dome	Activity Concentration (Bq kg^{-1}, dry soil)				$^{240}Pu/^{239}Pu$
			^{137}Cs	^{239}Pu	$^{239+240}Pu$	^{241}Am	atom ratio
00EY-1000	north	adjacent	10.26± 0.40	122.8± 0.7	159.6± 0.7	30.14± 3.0	0.0813± 0.001
00EY-1001	NE	adjacent	21.71± 0.60	180.9± 0.9	225.1± 0.9	34.97± 2.4	0.0663± 0.0004
00EY-1002	east	10 m	41.00± 0.60	52.7± 0.3	68.2± 0.3	7.64± 1.2	0.0799± 0.001
00EY-1008	east	20 m	577.60± 2.1	1915± 28	2367± 40	383.01± 4.8	0.064± 0.004
00EY-1009	east	30 m	2185.50± 4.6	14659± 44	18770± 46	2326.40± 9.6	0.0760± 0.0001
00EY-1003	SE	10 m	307.40± 1.4	306.2± 1.3	390.4± 1.4	50.72± 2.3	0.0747± 0.0003
00EY-1010	SE	20 m	1855.80± 3.7	402.8± 2.5	505.5± 2.6	60.11± 2.9	0.0691± 0.0003
00EY-1011	SE	30 m	1349.00± 3.1	412.3± 1.3	526.3± 1.5	82.18± 2.5	0.0750± 0.0003
00EY-1004	south	10 m	325.95± 1.5	244.1± 2.4	313.7± 2.6	50.94± 1.8	0.0774± 0.0005
00EY-1012	south	20 m	315.12± 1.7	258.2± 1.6	330.5± 1.7	35.21± 4.4	0.0759± 0.0003
00EY-1013	south	30 m	200.08± 1.7	188.6± 1.2	239.5± 1.2	20.66± 1.6	0.0732± 0.0003
00EY1005	SW	10 m	18.95± 0.40	287.9± 4.5	364.5± 4.7	66.45± 1.6	0.0722± 0.001
00EY-1014	SW	20 m	14.74± 0.50	223.4± 1.4	278.6± 1.5	42.73± 3.4	0.0671± 0.0003
00EY-1015	SW	30 m	1.41± 0.20	113.6± 0.7	141.0± 0.8	36.83± 1.2	0.0654± 0.0003
00EY1006	west	10 m	5.17± 0.30	95.4± 1.4	132.1± 1.6	24.45± 0.5	0.1044± 0.001
00EY-1007	NW	10 m	24.54± 0.70	514.6± 7.6	652.4± 7.9	88.49± 3.5	0.0726± 0.0004
Soil profile off Cactus dome (mag. SE, 20 m)							
	depth (cm)						
00EY-1018	0-5 cm		488.84± 1.2	360.5± 2.2	458.2± 2.4	54.03± 0.70	0.0734± 0.0003
00EY-1019	5-10 cm		249.18± 1.9	256.0± 1.6	323.5± 1.7	52.13± 5.3	0.0715± 0.0003
00EY-1020	10-15 cm		261.58± 1.4	180.1± 1.5	225.7± 1.6	29.42± 2.0	0.0687± 0.0005
00EY-1021	15-25 cm		418.62± 2.7	612.7± 4.4	783.8± 4.6	97.83± 7.6	0.0757± 0.0004
00-EY1022	25-40 cm		474.35± 1.8	724.4± 4.5	926.3± 4.7	142.11± 5.5	0.0756± 0.0002
00EY-1023	40-60 cm		523.93± 2.0	829.0± 5.1	1059± 5	146.67± 2.7	0.0752± 0.0002
Soil profile off Cactus dome (mag. South, 20 m)							
00EY-1024	0-5 cm		1.29± 0.05	197.3± 3.4	252.7± 3.6	44.35± 4.9	0.0761± 0.0006
00EY-1025	5-10 cm		0.67± 0.02	235.6± 4.0	303.2± 4.2	41.92± 1.5	0.0778± 0.0006
00EY-1026	10-15 cm		1.12± 0.05	338.3± 5.5	422.7± 5.7	36.84± 4.4	0.0698± 0.0004
00EY-1027	15-25 cm		0.72± 0.03	222.4± 3.6	285.7± 3.8	45.99± 3.5	0.0771± 0.0005
00EY-1028	25-40 cm		0.76± 0.02	169.5± 0.9	217.4± 1.0	30.73± 3.4	0.0765± 0.0006
00EY-1029	40-60 cm		0.68± 0.03	236.1± 0.8	303.4± 0.9	45.64± 2.2	0.0773± 0.0003

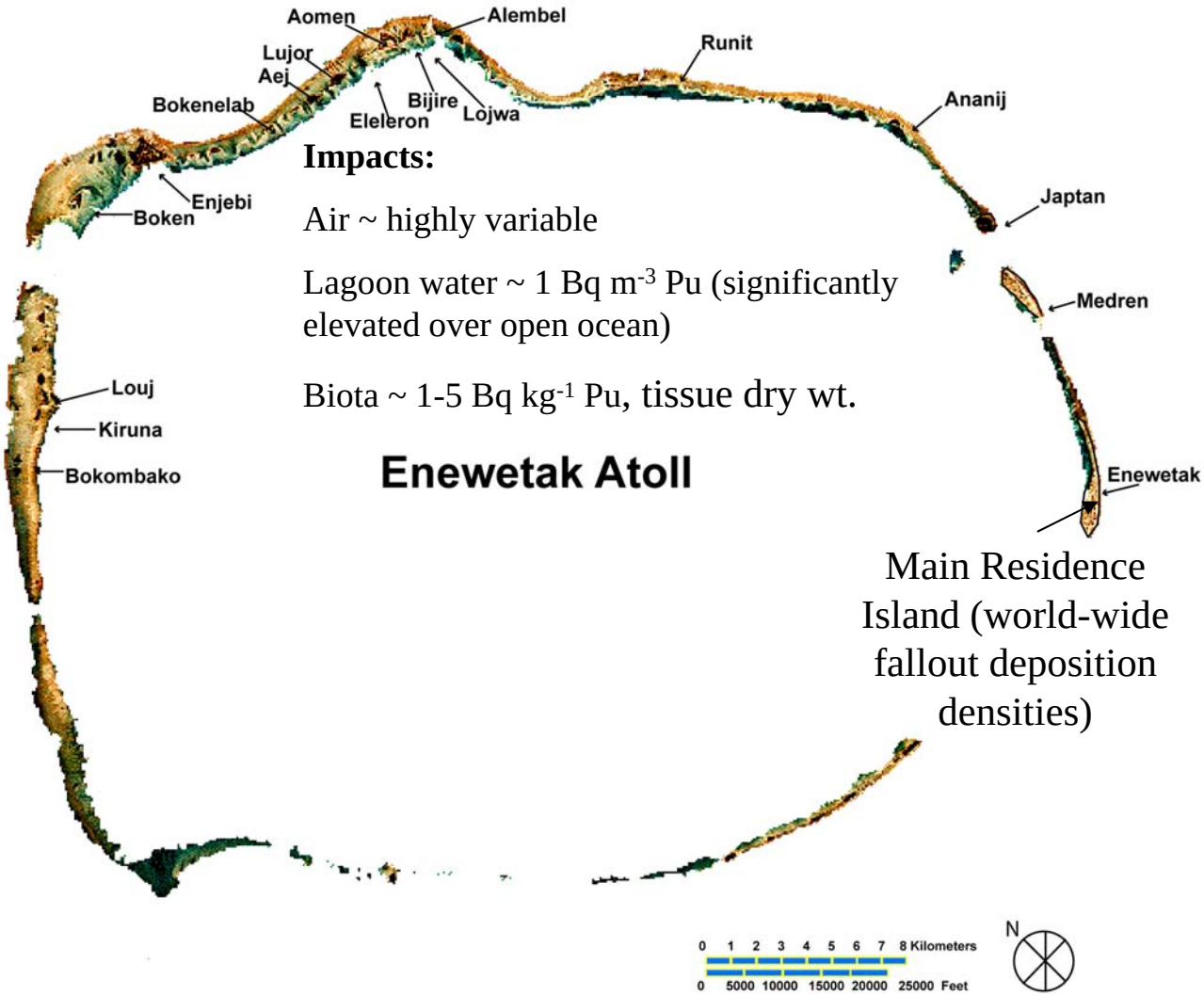
Terrestrial sampling around Fig-Quince



Radionuclides concentration on Fig-Quince

Field Log #	Grid Point	Activity Concentration (Bq kg^{-1}, dry soil)				^{240}Pu/^{239}Pu
		^{137}Cs	^{239}Pu	$^{239+240}$Pu	^{241}Am	atom ratio
00EY-1104	GRID PT. (0,0)	4.89± 0.40	643.0± 4.7	795.3± 4.8	225.35± 2.9	0.0642± 0.0003
00EY-1105	GRID PT. (2,0)	35.59± 0.50	841.1± 6.1	1,049± 6	203.95± 3.1	0.0670± 0.0002
00EY-1106	GRID PT. (4,0)	33.85± 0.70	1097± 8	1,340± 8	262.45± 5.0	0.0603± 0.0002
00EY-1107	GRID PT. (6,0)	43.48± 0.80	1276± 9	1,550± 9	132.45± 4.6	0.0581± 0.0002
00EY-1108	GRID PT. (8,0)	47.80± 1.20	1478± 4	1,785± 5	214.73± 2.8	0.0564± 0.0001
00EY-1109	GRID PT. (10,0)	20.69± 1.10	390.6± 2.8	494.2± 3.0	60.48± 1.6	0.0719± 0.0003
00EY-1110	GRID PT. (0,2)	20.10± 0.60	541.7± 3.9	691.3± 4.1	151.79± 4.8	0.0749± 0.0003
00EY-1111	GRID PT. (2,2)	52.39± 0.90	1268± 9	1593± 10	248.74± 2.9	0.0694± 0.0002
00EY-1112	GRID PT. (4,2)	52.62± 0.80	830.8± 6.0	1,061± 6	232.94± 2.4	0.0750± 0.0003
00EY-1113	GRID PT. (6,2)	116.72± 1.10	1125± 8.1	1506± 9	193.06± 1.5	0.0917± 0.0003
00EY-1114	GRID PT. (8,2)	31.82± 0.70	719.7± 2.2	890.8± 2.3	182.51± 3.9	0.0645± 0.0002
00EY-1115	GRID PT. (10,2)	50.74± 0.50	890.6± 6.4	1102± 7	218.62± 1.6	0.0645± 0.0002
00EY-1116	GRID PT. (0,4)	115.11± 0.60	1195± 9	1510± 9	361.35± 2.0	0.0717± 0.0002
00EY-1117	GRID PT. (2,4)	33.18± 0.60	1533± 11	1868± 11	394.46± 3.0	0.0592± 0.0002
00EY-1118	GRID PT. (4,4)	32.21± 0.50	1736± 13	2113± 13	356.10± 1.6	0.0588± 0.0002
00EY-1119	GRID PT. (6,4)	28.18± 0.80	1328± 10	1619± 10	310.36± 5.4	0.0594± 0.0002
00EY-1120	GRID PT. (8,4)	26.72± 0.60	1086± 8	1325± 8	174.37± 4.4	0.0595± 0.0002
00EY-1121	GRID PT. (10,4)	25.87± 0.70	978.6± 6.0	1192± 6	108.38± 2.1	0.0591± 0.0003
00EY-1122	GRID PT. (0,6)	10.56± 0.40	705.9± 3.7	856.3± 3.8	160.13± 2.9	0.0578± 0.0003
00EY-1123	GRID PT. (2,6)	10.55± 0.50	1013± 3	1227± 4	246.55± 2.4	0.0571± 0.0003
00EY-1124	GRID PT. (4,6)	34.20± 0.70	582.0± 4.2	711.8± 4.4	528.58± 3.6	0.0605± 0.0002
00EY-1125	GRID PT. (6,6)	31.84± 0.60	1926± 8	2333± 8	386.88± 4.6	0.0573± 0.0001
00EY-1126	GRID PT. (8,6)	8.81± 0.40	1433± 6	1739± 6	315.83± 2.8	0.0580± 0.0001
00EY-1127	GRID PT. (10,6)	7.57± 0.40	2302± 7	2783± 8	414.40± 5.1	0.0567± 0.0001
00EY-1128	GRID PT. (0,8)	5.60± 0.40	1452± 6	1753± 6	290.98± 2.7	0.0561± 0.0001
00EY-1129	GRID PT. (2,8)	7.84± 0.30	2533± 8	3062± 8	521.74± 3.1	0.0567± 0.0001
00EY-1130	GRID PT. (4,8)	9.14± 0.40	1675± 5	2032± 5	441.52± 3.1	0.0577± 0.0001
00EY-1131	GRID PT. (6,8)	5.03± 0.30	1643± 5	1996± 5	353.09± 2.8	0.0583± 0.0001
00EY-1132	GRID PT. (8,8)	5.18± 0.90	1038± 3	1272± 3	141.81± 2.5	0.0609± 0.0001
00EY-1133	GRID PT. (10,8)	4.62± 0.60	1030± 3	1264± 3	201.97± 5.1	0.0614± 0.0001
00EY-1134	GRID PT. (0,10)	7.17± 0.20	765.0± 2.5	927± 2.6	203.37± 2.0	0.0573± 0.0001
00EY-1135	GRID PT. (2,10)	3.88± 0.50	931.0± 2.8	1137± 3	202.52± 4.0	0.0600± 0.0002
00EY-1136	GRID PT. (4,10)	3.01± 0.30	898.7± 2.7	1094± 3	194.17± 2.7	0.0590± 0.0002

Enewetak Atoll



Impacts:

Air ~ highly variable

Lagoon water ~ 1 Bq m^{-3} Pu (significantly elevated over open ocean)

Biota ~ 1-5 Bq kg^{-1} Pu, tissue dry wt.

Main Residence Island (world-wide fallout deposition densities)

Radionuclide concentrations in sediment samples

Station	Location		Activity Concentration (Bq kg^{-1}, dry sediment)				^{240}Pu/^{239}Pu
	Latitude (°N)	Longitude (°E)	^{137}Cs	^{239}Pu	$^{239+240}$Pu	^{241}Am	atom ratio
3	11.53	162.35	3.5±0.6	814.6±1.4	1003.6±1.8	94.2±1.4	0.0629±0.0004
11	11.53	162.34	–	233.5±0.3	286.9±0.4	43.8±0.9	0.0620±0.0003
10	11.54	162.34	3.9±0.4	1057.2±1.1	1306.5±1.3	215.8±1.5	0.0639±0.0002
7	11.55	162.33	4.0±0.5	618.8± 0.5	757.3±0.7	119.0±1.4	0.0607±0.0002
12	11.59	162.32	–	66.0± 0.1	90.5±0.2	25.4±0.6	0.1004±0.0007
2	11.62	162.29	4.5±0.8	125.8±0.2	198.0±0.4	94.2±1.4	0.1555±0.0006
14	11.62	162.23	7.7±0.6	146.4±0.2	229.2±0.4	120.0±1.4	0.1533±0.0007
9	11.63	162.26	1.9±0.4	55.9±0.3	102.1±0.5	60.3±1.0	0.224±0.002
19	11.64	162.16	30.1±0.5	283.4±0.4	499.6±0.7	245.3±1.3	0.2069±0.0006
16	11.65	162.23	18.3±0.6	1054.7±1.3	1370.5±1.7	308.3±1.3	0.0812± 0.0003

Radionuclide concentration in marine biota

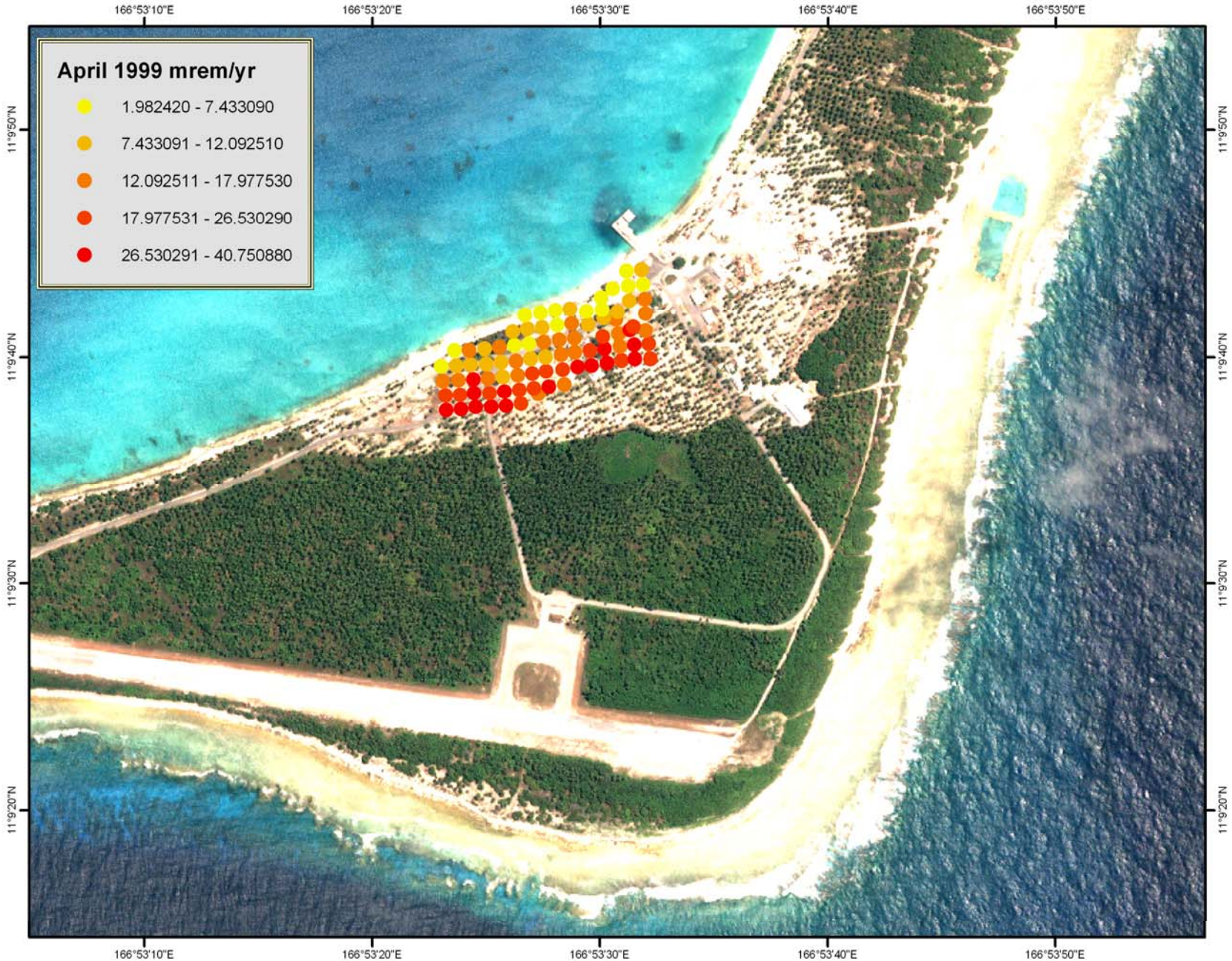
marine biota/ tissue type	Location	^{137}Cs	^{239}Pu	$^{239+240}$Pu	^{240}Pu/^{239}Pu
		(Bq kg^{-1}, wet weight)			atom ratio
Fish/muscle tissue	Enjebi (N=8)	1.5 ± 2.2	0.05 ± 0.1	0.1 ± 0.3	0.18 ± 0.07
	Runit (N=10)	0.5 ± 0.3	0.07 ± 0.2	0.1 ± 0.3	0.08 ± 0.01
Clam/muscle tissue & mantel	Enjebi (N=1)	<0.2	0.0076 ± 0.0002	0.0146 0.0003	0.25 ± 0.01
	Runit (N=3)	<2	0.5 ± 0.4	0.6 ± 0.5	0.063 ± 0.003
clam/stomach and stomach contents	Enjebi (N=1)	<0.2	0.59 ± 0.01	1.09 0.01	0.225 ± 0.005
	Runit (N=3)	<1.2	43.3 ± 28.9	53.5 ± 35.4	0.065 ± 0.002
sea cucumber/ cleaned (whole)	Enjebi (N=1)	<0.5	0.0071 ± 0.0002	0.0123 ± 0.0003	0.20 ± 0.01
	Runit (N=1)	<0.3	0.0090 ± 0.0003	0.0117 ± 0.0003	0.08 ± 0.01

Summary

- **Levels of radioactive contamination of the marine environment at Enewetak Atoll appear to be decreasing over time with the possible exception of the TRUs (e.g., plutonium isotopes)**
- **Based on plutonium isotopic signatures in sediments, biota and water, there appears to be no detectable (discernable) radioactive contamination of the marine environment that can be directly linked to leakage of material from inside Runit dome**
- **Levels of plutonium contamination in clam muscle and especially in clam stomach are higher than those observed for other species. Consequently, clams provide a potential indicator species for monitoring of plutonium contamination in the marine environment**
- **Based on the small number of sediment samples analyzed, levels of plutonium (and amercium-241) contamination in sediments collected from around Runit Island are generally higher than at other locations in the north of the atoll. However, there are exceptions that appear to be associated with close-in fallout from specific test events.**

Environmental Characterization in Support of Rongelap Resettlement

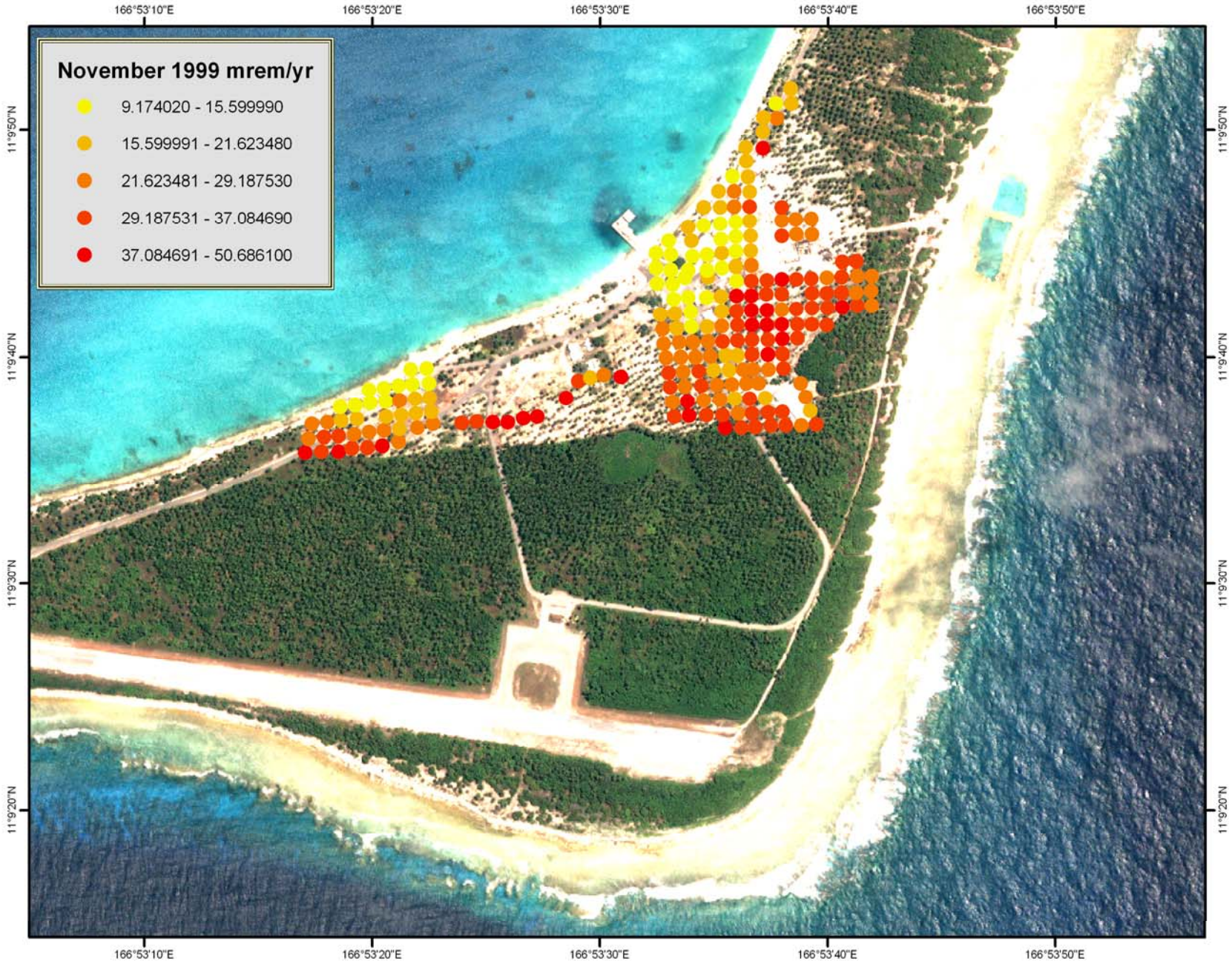
Sites Sampled April 1999



Satellite Imagery from Digital Globe
Collection dates 3/19/03 - 4/24/03

Cartographer: Lynn Wilder
GIS Group at LLNL (925) 422-3880

Sites Sampled November 1999



Satellite Imagery from Digital Globe
Collection dates 3/19/03 - 4/24/03

Cartographer: Lynn Wilder
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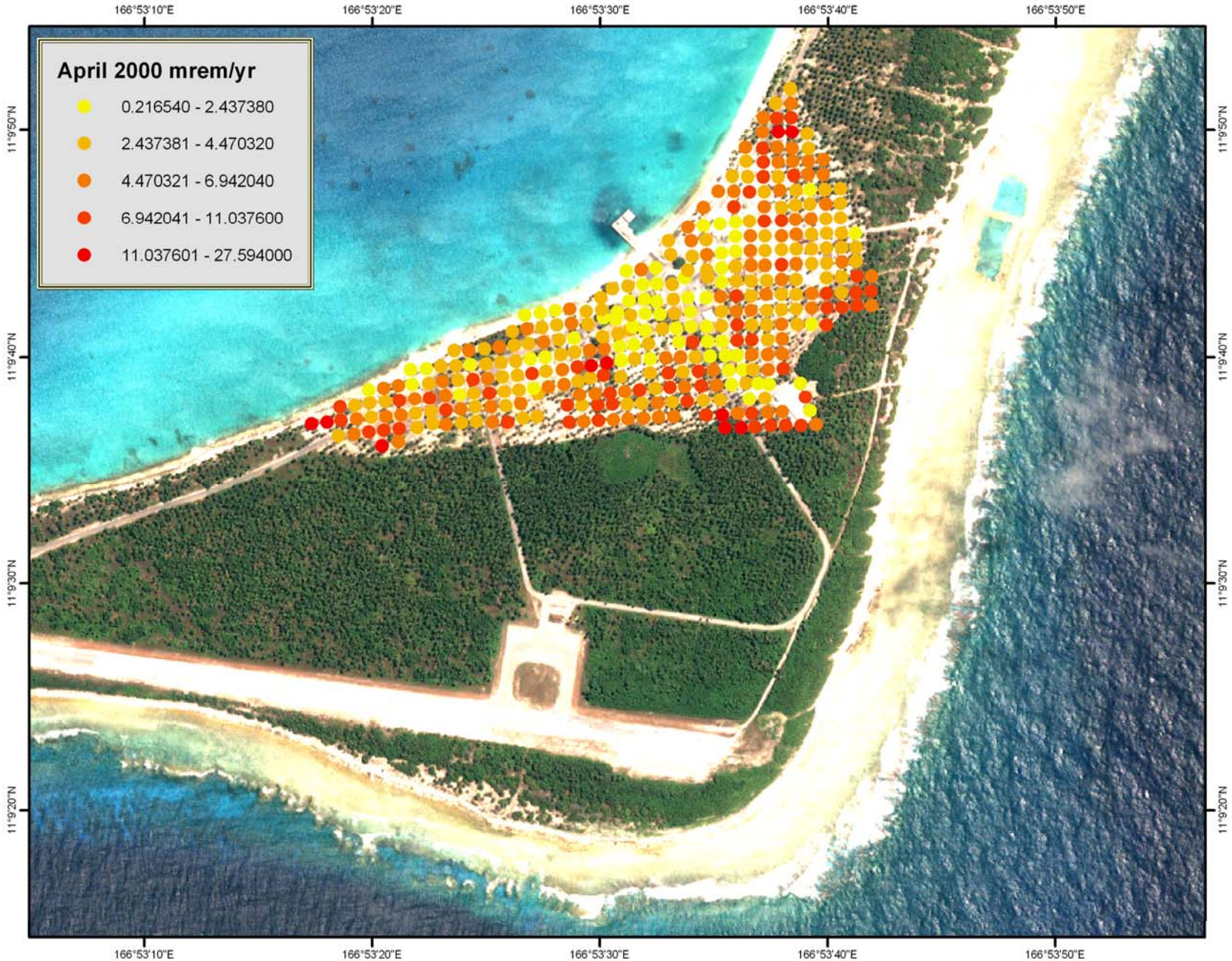
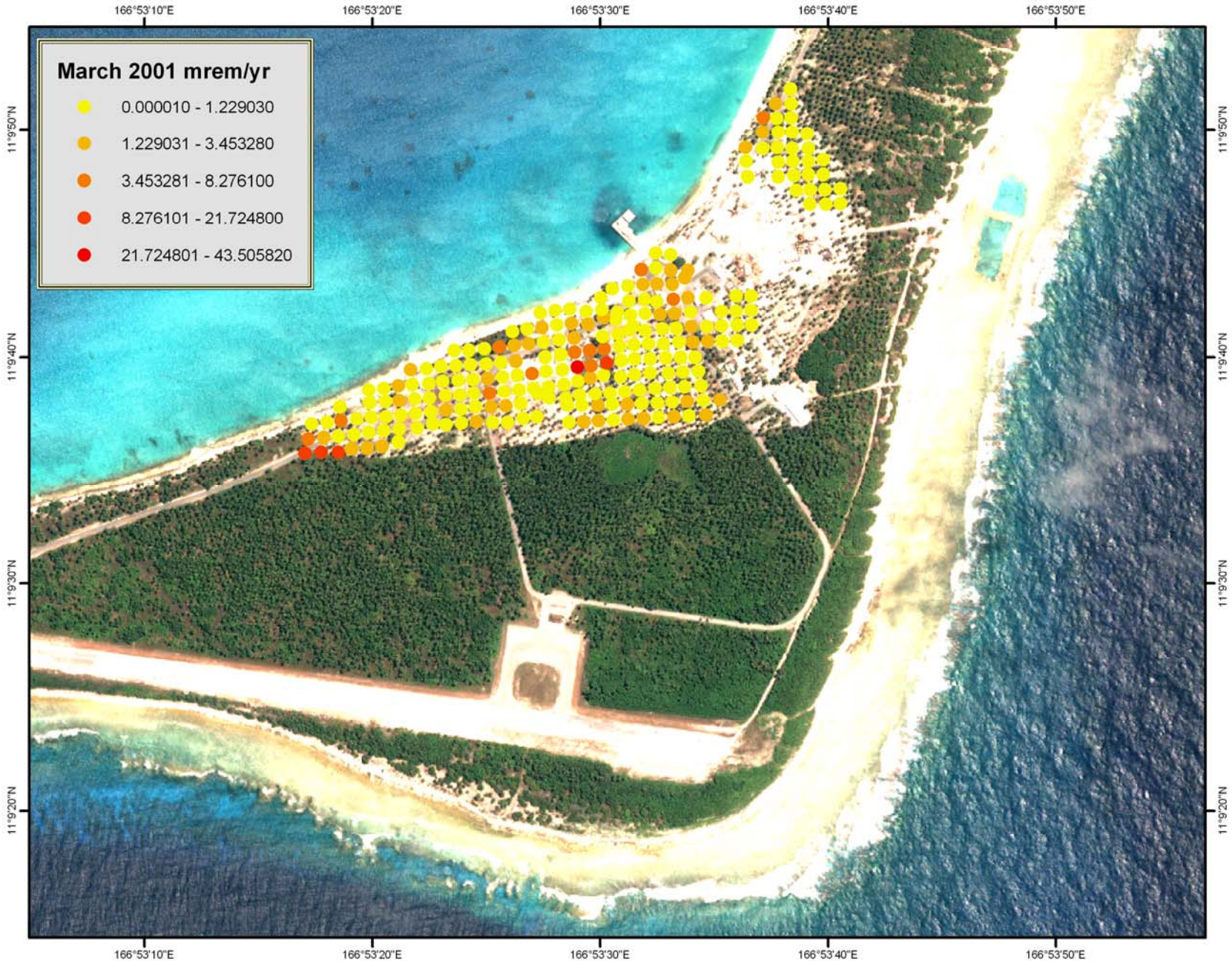
Sites Sampled April 2000



Satellite Imagery from Digital Globe
Collection dates 3/19/03 - 4/24/03

Cartographer: Lynn Wilder
GIS Group at LLNL (925) 422-3880

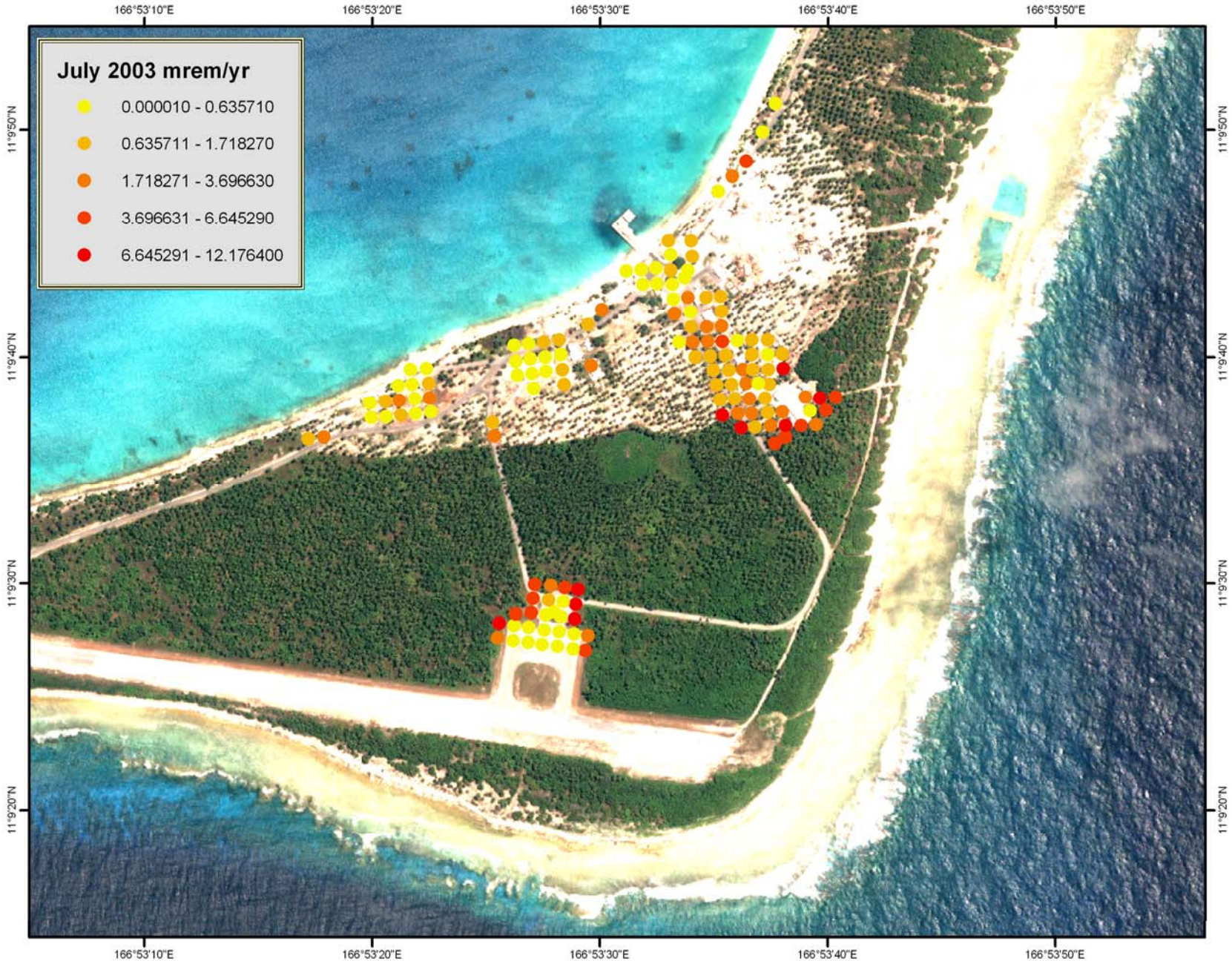
Sites Sampled March 2001



Satellite Imagery from Digital Globe
Collection dates 3/19/03 - 4/24/03

Cartographer: Lynn Wilder
GIS Group at LLNL (925) 422-3880

Sites Sampled July 2003



Satellite Imagery from Digital Globe
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UCRL-ID-143680-Pt-1

April 2001 Lawrence Livermore National Laboratory

Rongelap Resettlement Support—Preliminary Report Part 1

In-Situ Gamma Spectrometric Measurements around the Service and Village Area on Rongelap Island

Terry Hamilton
Steven Kehl
James Brunk
Frank Gouveia
William Robison

This report was prepared in partial fulfillment of LLNL program level goals and actions supporting the Rongelap Atoll settlement as formally outlined under a Memorandum of Understanding (MOU) between the U. S. Department of Energy (DOE), the Rongelap Atoll Local Government (RALGOV), and the Republic of the Marshall Islands (RMI).

LLNL Marshall Islands Program

Verification of effects of potassium treatment

sampling period	^{137}Cs (Bq kg^{-1}, wet weight)				maximum annual effective dose (mrem y^{-1})#		reference
	drinking coconut meat		copra meat				
NIMRS + (1986+1993)	58.3	+/-50.1	98.5	+/-81.7	21.3		Robison et al., 1995
	(N=436)		(N=122)				
2003	20.7	+/-18.0	17.3	+/-2.5	7.6		RALGOV - LLNL resettlement support program
	(N=98)		(N=3)				

all data decay corrected to August 2003; dose estimate for the 2003 sampling collection based on the ^{137}Cs concentration ratio found in drinking coconut meat compared with that reported by Robison et al. 1995

Rongelap Resettlement Support

Annual Total Effective DOSE Equivalent (TEDE)

external radiation in a year

(place/time/distance)

‘cesium-137 in soil’

Village/ housing

??
?

Agricultural areas

+

committed dose from intakes of radionuclides during that year

Rongelap Resettlement Support

Annual Total Effective DOSE Equivalent (TEDE)

external radiation in a year

+

committed dose from intakes of radionuclides during that year

(concentration of Cs-137, Sr-90 in foods)

(annual intakes of locally grown foods)

(variability, biokinetic behavior & environ. conc.)

(changing conditions, lifestyle etc.)

] Models???
(Predictive)

WBC is a direct measure of internally deposited cesium-137

(on-land facility – benefits of assessing 'high end' doses, seasonal trends and other changes)

[plutonium isotopes, Sr-90]

Summary

- **Soil remediation work has been very successful**
- **Based on preliminary data, the effect of adding potassium on reducing cesium-137 uptake into coconut has been less than that observed on Bikini**
- **More work will be required to accurately assess external gamma exposure rates on Rongelap Islands, especially around individual home sites located outside the community center and in open agricultural fields**
- **Additional sampling and analysis of food crops are planned for FY2005 to include measurements of cesium-137 and possibility strontium-90**