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Sequim Marine Research Laboratory Routine Environmental Measurements During CY-1978

J. R. Houston
P. J. Blumer

March 1979

Prepared for the U.S. Department of Energy
under Contract EY-76-C-06-1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

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PNL-2924

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PACIFIC NORTHWEST LABORATORY
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BATTELLE
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UNITED STATES DEPARTMENT OF ENERGY
Under Contract EY-76-C-06-1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy $____*; Microfiche $3.00

*Pages	NTIS Selling Price
001-025	$4.00
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SEQUIM MARINE RESEARCH LABORATORY ROUTINE ENVIRONMENTAL MEASUREMENTS DURING CY-1978

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P.J. Blumer

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Prepared for
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Pacific Northwest Laboratory
Richland, Washington 99352

SUMMARY

Environmental data collected during 1978 in the vicinity of the Marine Research Laboratory show continued compliance with all applicable state and federal regulations and furthermore show no detectable change from conditions that existed in previous years.

CONTENTS

TABLES

INTRODUCTION

A routine environmental surveillance program has been conducted at the Marine Research Laboratory (MRL) at Sequim, Washington, since 1976. The purpose of the program is to assess the impact of laboratory operations on the MRL environs. During the first two years of operation, sufficient data were collected to provide a base of information against which later measurements could be compared.

The program is designed primarily to determine the concentrations of radionuclides in selected biota in Sequim Bay. The biota sampled are selected because of their presence near the laboratory and their capacity to concentrate trace elements. Several other samples are obtained to determine the radionuclide concentrations in Sequim Bay, the surface deposition of fallout radionuclides, and the concentration of radionuclides in laboratory drinking water. Ambient radiation exposure rates at several locations around the laboratory are also measured. Methods used to analyze the samples are summarized in the Appendix.

All data collected each year are presented and evaluated in a series of annual reports.[1,2] Included in this report are data collected during calendar year 1978 and analytical data available from previous years. Evaluation of the data is based on comparison with historical data and on regulatory requirements promulgated by the state of Washington or the U.S. Environmental Protection Agency.

SAMPLE ANALYSIS AND EVALUATION

A number of environmental media from the MRL environs were sampled and analyzed during 1978. The collection and analysis schedule for these samples is shown in Table 1. Specific details on the analysis of each medium and its evaluation follow.

DRINKING WATER

Results of radiological analyses for gross beta and gross alpha activity, tritium, and gamma-emitting radionuclides in drinking-water samples are shown in Table 2. Concentrations that are less than the associated counting uncertainty are considered to be below detection capabilities. With the exception of an occasional result, all those listed in Table 2 are below detection capabilities. The two 1978 results that are above the detection limit are attributed to radionuclides from worldwide fallout. There is no indication that MRL activities have contributed to the observed concentrations.

Coliform analyses were performed quarterly by the Olympic Health District in 1978. The results, presented in Table 3, continue to show that the drinking water is within state standards of less than 2 organisms per 100 ml of water.

BAY WATER

Shown in Table 4 are the results of the radiochemical analyses of Sequim Bay water samples. With a few exceptions, the radionuclide concentrations are all below detection capabilities. The positive values are attributed to naturally occurring radionuclides and/or worldwide fallout. There is no indication that MRL operations have contributed to the observed concentrations.

Bay water samples were not analyzed for copper or oil and grease in 1978 due to an oversight. Data from previous years are shown in Table 5.

CLAMS

Results for the three varieties of clam collected to date are shown in Table 6. In 1978, naturally occurring ^{40}K was detected in the clams as expected, in addition to plutonium from worldwide fallout. Concentrations of all other radionuclides were below the detection limit. None of the detectable radioactivity is attributable to MRL operations.

SEAWEED

The analytical results for kelp and eelgrass collected from Sequim Bay are shown in Table 7. Detectable radionuclides are either naturally occurring (^{40}K) or due to worldwide fallout (^{90}Sr and Pu). Here again, none of the detectable radionuclides are attributable to MRL operations.

SOIL

The results of radiochemical analyses of soil samples collected to date from two locations in the immediate vicinity of MRL are shown in Table 8. Sampling locations are shown in Figure 1. The relatively low concentrations of naturally occurring ^{40}K, ^{224}Ra, and ^{226}Ra are typical of many coastal areas.[3]

During 1978, small positive results were obtained from analyses for ^{90}Sr, ^{137}Cs, and $^{239-240}Pu$. All of this observed radioactivity is attributed to worldwide fallout. All values were within the expected range of soil activity for the MRL environs.

AMBIENT RADIATION EXPOSURE

External radiation levels measured at four locations at MRL are summarized in Table 9. These measurements were made using thermoluminescent dosimeters placed 1 meter above ground level. Each dosimeter consists of five chips of CaF_2:Mn (Harshaw TLD-400) encased in an opaque capsule lined with 0.002 inches of lead and 0.01 inches of tantalum.[4] The dosimeters are exposed for periods of about one month at the locations shown in Figure 1, then changed and read out. The exposure periods overlap a few days because

of mail and processing delays. The annual external radiation dose of about 45 mrad found in 1978 is significantly lower than the dose observed in most inland areas but is typical of the dose in many coastal plain areas.[3] The relatively low ambient external dose rate is due to the relatively low concentrations of naturally occurring radionuclides at MRL. Results for 1978 are consistent both from month to month and from location to location and are essentially the same as those for previous years, indicating no contribution from MRL operations.

TABLE 1. MRL Environmental Sampling Schedule

Sample Type	Number of Locations	Frequency	Quantity Sampled	Analyses	
				Radiological	Other
TLD[a]	4	Monthly	--	External Radiation	
Bay Water	1	Semiannually	4 ℓ	Gamma scan Gross beta Gross alpha Tritium	Heavy metals[b] Oil and grease
Drinking Water	1	Semiannually	1 ℓ	Gamma scan Gross beta Gross alpha Tritium	Coliforms
Kelp	1	Quarterly	2 kg	Gamma scan ^{90}Sr Total Pu	
Eelgrass	1	Quarterly	2 kg	Gamma scan ^{90}Sr Total Pu	
Clams	1		2 kg	Gamma scan ^{90}Sr Total Pu	
Soil	2	Annually	2 kg	Gamma scan ^{90}Sr Total Pu	

[a] Thermoluminescent dosimeters.

[b] Analysis for heavy metals is dependent on their use in laboratory research projects. Only Cu analysis has been done to date.

TABLE 2. Concentrations of Radionuclides in Drinking-Water Samples from Sequim (Grab Samples)

Date	Concentration[a] (10^{-9} µCi/ml)							
	Beta	Alpha	^{3}H	^{46}Sc	^{51}Cr	^{60}Co	^{65}Zn	^{137}Cs
1976								
8/2	3.9 ± 5.5	0.25 ± 0.39	-0.02 ± 140			0.93 ± 28 8	-0.32 ± 55	0.55 ± 31
10/6	2.4 ± 5.9	0.34 ± 0.35	-170 ± 110			2.5 ± 28	13 ± 57	4.0 ± 31
12/2	7.5 ± 6.1	0.34 ± 0.35	280 ± 200	0.09 ± 36	0.38 ± 490	0.16 ± 28	-0.003 ± 56	0.05 ± 31
1977								
1/4	2.9 ± 5.8	1.00 ± 0.52	-65 ± 230			8.9 ± 28	-4.1 ± 57	-0.12 ± 31
3/3	4.0 ± 6.0	0.10 ± 0.27	56 ± 310			7.4 ± 28	-0.02 ± 60	-0.21 ± 31
6/3	3.5 ± 6.1	0.55 ± 0.42	250 ± 300			7.0 ± 28	-2.8 ± 56	-0.09 ± 31
10/5	3.8 ± 4.1	0.37 ± 0.45	-260 ± 280			-0.17 ± 28	-27 ± 58	1.4 ± 31
1978								
5/1	0.32 ± 57	0.25 ± 0.37	5.1 ± 220	-0.64 ± 37	-22 ± 540	-0.06 ± 28	-18 ± 56	2.1 ± 31
8/31	13 ± 10	0.65 ± 0.76	510 ± 360			5.0 ± 28	-4.0 ± 56	3.2 ± 31

[a] Analytical results ± 2-sigma counting uncertainty. Negative results do not reflect a physical reality but result from the statistical uncertainty of discriminating between the sample and instrument background count rate.

TABLE 4. Concentrations of Radionuclides in Bay Water Samples from Sequim (Grab Samples)

Date	Concentration[a] (10^{-9} µCi/ml)										
	Beta	Alpha	^{3}H	^{14}C	^{40}K	^{46}Sc	^{51}Cr	^{60}Co	^{65}Zn	^{137}Cs	U
1976											
8/2	120 ± 28	0.35 ± 2.6	260 ± 110	19 ± 80	160 ± 240			0.006 ± 14	1.6 ± 28	-1.1 ± 15	
9/2	130 ± 29	2.4 ± 1.9	550 ± 200	-9.9 ± 2.6	210 ± 170			11 ± 11	-1.9 ± 20	-0.89 ± 10	
10/6	220 ± 34	2.7 ± 2.2	80 ± 100	7.2 ± 8.8	180 ± 170			0.06 ± 11	-0.35 ± 20	2.0 ± 10	
11/15	440 ± 44	2.3 ± 1.4	-47 ± 180	5.6 ± 6.9	190 ± 170	-0.16 ± 17	-19 ± 230	0.63 ± 11	-3.8 ± 20	-0.75 ± 10	
12/2	450 ± 45	2.5 ± 2.0	200 ± 540	3.3 ± 7.3	190 ± 170	0.03 ± 14	-12 ± 150	0.06 ± 11	-2.7 ± 19	-1.3 ± 10	
1977											
1/4	440 ± 53	1.6 ± 1.2	-160 ± 140	5.7 ± 14	260 ± 170			0.06 ± 11	-4.7 ± 20	-1.1 ± 10	
2/1	260 ± 43	3.6 ± 1.6	16 ± 120	0.45 ± 5.1	230 ± 170			2.4 ± 11	0.002 ± 20	-1.9 ± 10	4.8 ± 2.0
3/3	86 ± 11	2.9 ± 1.6	240 ± 380	20 ± 32	190 ± 170			0.63 ± 11	-1.7 ± 20	-1.4 ± 10	
4/4	410 ± 5.1	0.93 ± 1.3	590 ± 170	9.1 ± 13	180 ± 170			0.06 ± 11	7.3 ± 21	-1.6 ± 10	
5/4	370 ± 49	3.0 ± 1.6	970 ± 350	1.5 ± 2.2	230 ± 170			2.6 ± 11	-1.9 ± 19	1.6 ± 10	
6/3	240 ± 37	2.6 ± 2.2	23 ± 220	1.2 ± 4.4	210 ± 170			9.4 ± 11	-3.4 ± 20	4.4 ± 10	
7/2	400 ± 59	0.48 ± 0.3	81 ± 180	-15 ± 12	210 ± 170			1.7 ± 11	4.1 ± 21	-0.32 ± 10	
8/1	410 ± 90	1.5 ± 1.3	49 ± 440	-2.1 ± 10	180 ± 170			3.6 ± 11	-4.4 ± 19	-1.4 ± 10	
9/6	460 ± 57	0.76 ± 1.6	-44 ± 390	-26 ± 12	260 ± 170		5.2 ± 210	4.5 ± 11	3.6 ± 20	3.5 ± 10	
10/15	320 ± 44	1.7 ± 1.9	-97 ± 260	-7.5 ± 14	210 ± 170			1.7 ± 11	-4.7 ± 20	0.15 ± 10	
11/7	360 ± 45	2.8 ± 2.4	-350 ± 67	12 ± 51	200 ± 170			4.5 ± 11	7.8 ± 19	1.7 ± 10	
12/5	420 ± 48	2.1 ± 1.9	-47 ± 290	49 ± 77	180 ± 170	0.04 ± 15	7.1 ± 180	0.06 ± 11	2.2 ± 20	2.6 ± 10	
1978											
5/1	330 ± 42	2.2 ± 2.1	17 ± 220		160 ± 480	-0.25 ± 37	0.72 ± 540	15 ± 28	3.2 ± 56	1.9 ± 31	
8/31	430 ± 88	4.6 ± 6.2	340 ± 250		310 ± 660			0.25 ± 45	-1.4 ± 79	-2.2 ± 41	

[a] Analytical results ± 2 sigma counting uncertainty. Negative results do not reflect a physical reality but result from the statistical uncertainty of discriminating between the sample and instrument background count rate.

TABLE 3. Total Coliform Analyses of Sequim MRL Drinking Water

Date	Total Coliform Concentration (organisms per 100 ml of water)
1976	
8/2	<2.0
10/6	<2.0
1977	
10/5	<2.0
1978[a]	
1st Qtr	<2.0
2nd Qtr	<2.0
3rd Qtr	<2.0
4th Qtr	<2.0

[a] Performed by the Olympic Health District

TABLE 5. Concentrations of Oil and Copper in Bay Water Samples from Sequim (Grab Samples)

Date	Bay Water		Incoming Lab Bay Water	
	Oil & Grease (mg/l)	Copper (µg/l)	Oil & Grease (mg/l)	Copper (µg/l)
1976				
8/2	4.3	2.0	-	-
10/6	1.4	2.0	1.8	2.0
1977				
8/1	<1.0	3.0	-	-
1978[a]	-	-	-	-

[a] No samples taken.

TABLE 6. Concentrations of Radionuclides in Clams Collected at Sequim

Date	Sample	Concentration[a] (10^{-6} µCi/g)						
		^{40}K	^{59}Fe	^{60}Co	^{90}Sr	^{106}Ru	^{137}Cs	Total Pu
1976								
1/15	Saxidomus Giganteus	0.89 ± 0.64		0.00008 ± 0.05	0.0006 ± 0.003	0.003 ± 0.87	0.004 ± 0.04	0.0008 ± 0.001
1/15	Prototheca Staminae	1.2 ± 0.82	1.2 ± 3.0	0.002 ± 0.06	0.003 ± 0.003		-0.01 ± 0.05	0.0007 ± 0.0001
1/15	Tresus Nuttallii	0.70 ± 0.76		-0.004 ± 0.06	0.003 ± 0.003		-0.003 ± 0.05	0.001 ± 0.0001
7/30	Saxidomus Giganteus	1.5 ± 0.68		-0.007 ± 0.05	0.007 ± 0.003		-0.02 ± 0.04	0.0009 ± 0.0001
1977								
2/1	Saxidomus Giganteus	1.8 ± 0.54		0.0002 ± 0.04	0.0006 ± 0.001		0.003 ± 0.03	0.0004 ± 0.00004
2/1	Saxidomus Giganteus	1.8 ± 0.56		0.014 ± 0.04	0.0002 ± 0.001		-0.0005 ± 0.04	0.00005 ± 0.00002
2/1	Prototheca Staminae	1.7 ± 0.58		0.011 ± 0.04	0.002 ± 0.001		-0.0007 ± 0.04	0.0005 ± 0.00005
7/28	Saxidomus Giganteus	1.8 ± 0.55		0.0002 ± 0.04	0.0003 ± 0.001		0.009 ± 0.03	0.002 ± 0.0001
7/28	Saxidomus Giganteus	1.7 ± 0.53		0.0002 ± 0.04	0.001 ± 0.001		0.01 ± 0.03	0.0008 ± 0.0004
1978								
9/5	Saxidomus Giganteus	3.1 ± 1.4		0.07 ± 0.09	0.009 ± 0.01		0.005 ± 0.08	-0.0007 ± 0.01

[a] Analytical results ± 2-sigma counting uncertainty. Negative results do not reflect a physical reality but result from the statistical uncertainty of discriminating between the sample and instrument background count rate.

TABLE 7. Concentrations of Radionuclides in Kelp and Eelgrass Samples from Sequim

Date	Sample	Concentration[a] (10^{-6} μCi/g) ^{40}K	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs	Total Pu
1976							
1/19	Kelp	66 ± 2.4	0.0009 ± 0.16	0.31 ± 0.47	0.005 ± 0.004	0.09 ± 0.14	0.01 ± 0.006
7/30	Kelp	73 ± 2.3	0.020 ± 0.14	0.27 ± 0.25	0.002 ± 0.004	0.08 ± 0.13	0.006 ± 0.004
7/30	Eelgrass	9.8 ± 3.8	0.001 ± 0.26		0.002 ± 0.008	-0.07 ± 0.23	0.06 ± 0.02
1977							
5/4	Kelp	68 ± 2.1	0.08 ± 0.13	0.04 ± 0.23	0.01 ± 0.01	0.06 ± 0.12	0.002 ± 0.0003
5/4	Eelgrass	22 ± 2.9	0.001 ± 0.19	0.13 ± 0.34	0.02 ± 0.01	0.15 ± 0.18	0.002 ± 0.0003
7/28	Eelgrass	25 ± 5.9	-0.04 ± 0.16	-0.20 ± 0.30	0.01 ± 0.004	0.07 ± 0.17	0.004 ± 0.0004
7/28	Eelgrass	17 ± 4.1	0.02 ± 0.13	-0.09 ± 0.24	0.05 ± 0.005	0.10 ± 0.13	0.002 ± 0.0003
7/28	Kelp	77 ± 9.2	-0.19 ± 0.16	-0.03 ± 0.30	0.05 ± 0.005	-0.12 ± 0.15	0.003 ± 0.0004
7/28	Kelp	50 ± 6.1	0.12 ± 0.14	0.02 ± 0.23	0.05 ± 0.005	-0.03 ± 0.10	0.001 ± 0.0001
1978							
1/31	Eelgrass	14 ± 3.9	0.01 ± 0.27	0.17 ± 0.50	0.004 ± 0.008	0.12 ± 0.24	0.003 ± 0.0002
6/5	Eelgrass	4.7 ± 2.6	0.02 ± 0.17	0.05 ± 0.30	0.06 ± 0.03	-0.04 ± 0.16	0.0004 ± 0.0006
6/5	Kelp	5.5 ± 1.9	0.02 ± 0.13	-0.04 ± 0.22	0.03 ± 0.03	-0.005 ± 0.12	result lost in lab
9/5	Eelgrass	14 ± 6.3	0.11 ± 0.43	0.09 ± 0.77	0.001 ± 0.01	0.02 ± 0.39	0.01 ± 0.003
9/5	Kelp	67 ± 6.2	0.002 ± 0.41	-0.06 ± 0.73	0.08 ± 0.01	0.04 ± 0.37	0.02 ± 0.009

[a] Analytical results ± 2-sigma counting uncertainty. Negative results do not reflect a physical reality but result from the statistical uncertainty of discriminating between the sample and instrument background count rate.

TABLE 8. Concentrations of Radionuclides in Sequim Soil Samples

Sample Location	Concentration[(a)] (10^{-6} µCi/g)						
	Naturally Occurring Radionuclides			Artificially Produced Radionuclides			
	^{40}K	^{224}Ra	^{226}Ra	^{54}Mn	^{58}Co	^{60}Co	^{90}Sr
1976							
Near Well	7.4 ± 1.1	0.36 ± 0.06	0.26 ± 0.07	-0.008 ± 0.02	0.0009 ± 0.02	0.006 ± 0.02	0.01 ± 0.004
Near Storage Basin	7.9 ± 1.1	0.33 ± 0.06	0.30 ± 0.08	-0.007 ± 0.02	0.005 ± 0.02	0.001 ± 0.02	0.004 ± 0.004
1977							
Near Storage Basin	5.6 ± 0.98	0.20 ± 0.06	0.23 ± 0.07	0.04 ± 0.03	-0.01 ± 0.02	0.004 ± 0.02	0.05 ± 0.02
Near Well	8.7 ± 1.2	0.34 ± 0.06	0.24 ± 0.07	0.008 ± 0.03	0.02 ± 0.03	-0.02 ± 0.03	0.01 ± 0.01
1978							
Near Storage Basin	8.5 ± 1.1	0.41 ± 0.06	0.29 ± 0.07	0.02 ± 0.03	0.01 ± 0.02	-0.004 ± 0.02	0.03 ± 0.02
Near Well	7.8 ± 1.0	0.37 ± 0.06	0.37 ± 0.08	0.009 ± 0.03	0.02 ± 0.02	-0.009 ± 0.02	0.08 ± 0.03

Sample Location	Artificially Produced Radionuclides							
	$^{95}ZrNb$	^{106}Ru	^{134}Cs	^{137}Cs	^{144}Ce	^{154}Eu	^{238}Pu	$^{239-240}Pu$
1976								
Near Well	0.008 ± 0.03	-0.04 ± 0.15	-0.02 ± 0.02	0.07 ± 0.03			0.0003 ± 0.003	0.002 ± 0.001
Near Storage Basin	0.04 ± 0.03	-0.05 ± 0.15	0.01 ± 0.02	0.04 ± 0.03		0.004 ± 0.17	0.0007 ± 0.003	0.0004 ± 0.001
1977								
Near Storage Basin	0.05 ± 0.05	0.01 ± 0.16		0.32 ± 0.05			0.05 ± 0.02	0.07 ± 0.03
Near Well	0.0007 ± 0.03	-0.03 ± 0.16		0.32 ± 0.03			0.008 ± 0.003	0.003 ± 0.002
1978								
Near Storage Basin	0.008 ± 0.03	-0.02 ± 0.14	0.02 ± 0.03	0.03 ± 0.03	0.26 ± 0.12		-0.001 ± 0.004	0.001 ± 0.004
Near Well	0.006 ± 0.03	-0.15 ± 0.14	-0.01 ± 0.02	0.08 ± 0.03	0.11 ± 0.11		0.002 ± 0.005	0.006 ± 0.006

(a) Analytical results ± 2 sigma counting uncertainty. Negative results do not reflect a physical reality but result from the statistical uncertainty of discriminating between the sample and instrument background count rate.

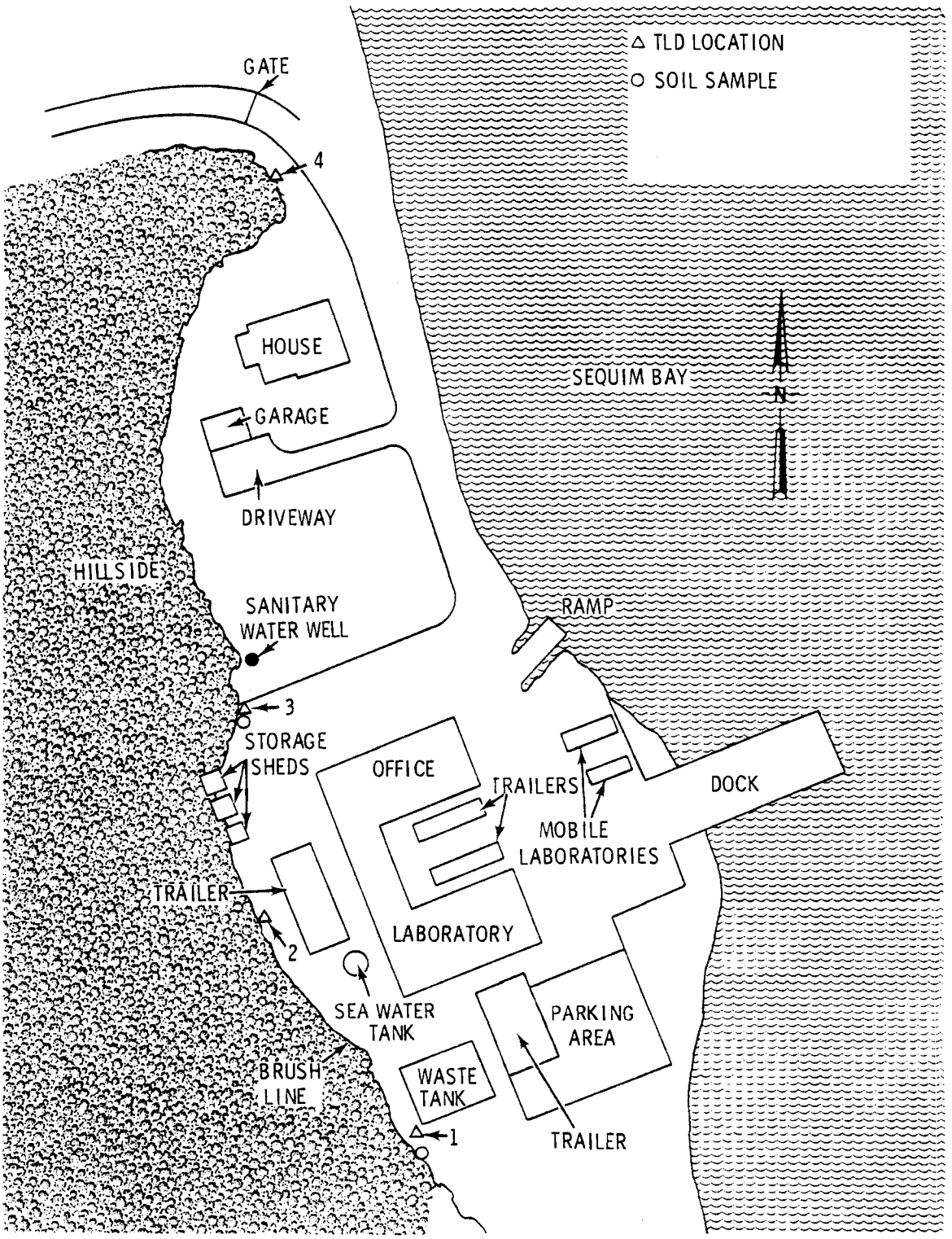

FIGURE 1. TLD and Soil Sample Locations at MRL

TABLE 9. External Radiation Dose Rates at MRL

Exposure Periods	Dose Rate (mR/day) Near Tile Field (Location 1)	Near Back Trailor (Location 2)	Near Well (Location 3)	N. End Near Transformer (Location 4)
1976				
8/2 - 9/16	0.12	0.12	0.12	0.11
9/2 - 10/7	0.11	0.11	0.12	0.11
9/29 - 12/6	0.11	0.11	0.11	0.11
11/4 - 12/6	0.12	0.11	0.12	0.12
11/29 - 1/18	0.11	0.10	0.11	0.11
1977				
12/28 - 2/8	0.15	0.14	0.15	0.13
1/28 - 3/4	0.13	0.13	0.13	0.13
2/28 - 4/8	0.13	0.12	0.12	0.13
3/30 - 5/5	0.14	0.13	0.13	0.14
4/28 - 6/6	0.12	0.12	0.12	0.12
5/30 - 7/27	0.10	0.10	0.09	0.10
6/28 - 8/2	0.15	0.13	0.14	0.14
7/27 - 9/13	0.11	0.11	0.11	0.11
8/29 - 10/14	0.12	0.12	0.12	0.12
9/28 - 11/10	0.13	0.12	0.13	0.12
10/27 - 12/7	0.12	0.12	0.13	0.12
11/28 - 1/17	0.12	0.12	0.12	0.11
1978				
12/29 - 2/7	0.12	0.12	0.11	0.12
1/26 - 3/3	0.12	0.11	0.12	0.12
2/27 - 4/3	0.13	0.12	0.13	0.13
3/27 - 5/5	0.13	0.11	0.13	0.11
4/27 - 6/7	0.12	0.12	0.12	0.12
5/30 - 7/7	0.14	0.13	0.14	0.14
6/26 - 8/4	0.13	0.12	0.12	0.13
7/27 - 9/11	0.12	0.12	0.12	0.12
8/28 - 10/9	0.11	0.11	0.12	0.12
9/27 - 11/16	0.12	0.10	0.12	0.11
10/30 - 12/5	0.12	0.14	0.12	0.13
11/30 - 1/5	0.13	0.12	0.12	0.13

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APPENDIX

ANALYTICAL PROCEDURES

APPENDIX

ANALYTICAL PROCEDURES

The environmental samples collected were analyzed for radionuclides by United State Testing Company of Richland, Washington and for coliforms, oil and grease, and copper by Hanford Environmental Health Foundation of Richland, Washington. The radiological data shown in Tables 2, 4, 6, 7, and 8 include the counting result plus or minus the 2-sigma counting uncertainty. Whenever the counting result is less than the uncertainty, the counting result is considered to be less than the detection limit (2-sigma uncertainty) of the analysis. Because of the statistical nature of radionuclide counting, an occasional counting result may be slightly greater than the 2-sigma uncertainty even if the radionuclide is not present. For this reason, several environmental samples must be analyzed to provide a reliable estimate of the radionuclides present. A brief description of the analytical procedures used follows.

RADIOLOGICAL ANALYSES

Water Samples

Gross Beta

Gross beta activity is measured by a direct count of the dried residue with a gas-flow proportional counter. The counter is calibrated with a ^{90}Sr-Y equilibrium source.

Gross Alpha

Gross alpha activity is measured by a low-level alpha counter following extraction of the activity into ether from a strong nitric acid. The ether phase is evaporated off and the residue plated on a stainless steel planchet. The planchet is counted with the gas-flow proportional counter, which is calibrated with a ^{239}Pu source.

Gamma-Emitting Radionuclides

Gamma-emitting radionuclides are determined by the direct count of 500 ml of sample in the well of a 9-inch x 9-inch NaI(TL) well detector using a multichannel gamma-ray spectrometer.

Strontium-90

Strontium-90 in water samples is precipitated with fuming nitric acid, scavenged with barium chromate, precipitated as a carbonate, transferred to a stainless steel planchet, and beta counted with a low-level beta proportional counter. After a 125-day period, the yttrium-90 daughter is separated and counted with a low-level beta proportional counter.

Tritium

Tritium is measured in distilled water samples using a liquid scintillation spectrometer.

Clams; Eelgrass and Kelp Samples

Gamma-Emitting Radionuclides

Gamma-emitting radionuclides are determined by a direct count of the sample in the well of a 9-inch x 9-inch NaI(TL) well detector using a multichannel gamma-ray spectrometer.

Plutonium

After the sample is ashed in a furnace and wet ashed with concentrated nitric acid, plutonium is extracted from the sample using cation exchange resin and thenoyl trifluoroacetone. Plutonium in the eluate is electrodeposited on a stainless steel disk, exposed to nuclear track film, and then counted.

Soil Samples

Gamma-Emitting Radionuclides

Approximately 500 grams of sample are placed into a marinelli beaker and counted on a lithium-drifted germanium detector using a multichannel pulse height analyzer.

Plutonium and Strontium-90

Soil is dried, mixed thoroughly, leached with a mixture of nitric acid and hydrochloric acids, and then passed through an ion exchange resin in 8N nitric acid. The 8N nitric acid retains strontium and other metal ions. This phase is precipitated with fuming nitric acid, scavenged with barium chromate, precipitated as a carbonate, and transferred to a stainless steel planchet. The sample is counted using a low-background beta proportional counter.

The plutonium is eluted from the resin column with 0.4N HNO_3-0.01N HF and electrodeposited on a stainless steel disk for alpha spectrometric analyses.

NON-RADIOLOGICAL ANALYSES

Coliforms

Standard total coliform MPN technique as described in Standard Methods, 14th edition, p. 916 is used to determine coliform counts.(5)

Copper

Copper analysis is performed using the atomic absorption spectrophotometric technique, following concentration and extraction using ammonium pyrrolidine dithiocarbamate (APDC) and methyl isobutyl ketone (MIBK), as given in Standard Methods, 14th ed. pp. 148-152.(5)

Oil and Grease

The partition-gravimetric method as given in Standard Methods, 14th edition, p. 515, is used to analyze for oil and grease.(5)

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