DEC 1 0 1990

Mr. George Durfee
Wyman-Gordon Company
244 Worcester Street
Box 8001
North Grafton, MA 01536-8001

Dear Mr. Durfee:

In accordance with our agreement we are enclosing the analytical data for the groundwater samples obtained from wells adjacent to the magnesium-thorium disposal area at the Wyman-Gordon site in North Grafton and five private wells in the vicinity of the Wyman-Gordon site. These samples were filtered in accordance with the Environmental Protection Agency's (EPA's) sampling procedures. Our analyses were performed by the Radiological and Environmental Sciences Laboratory (RESL) in Idaho Falls, ID. Gross alpha measurements on all the samples indicate concentrations are below the EPA drinking water requirements of 15 pCi/l. The RESL gross beta measurements indicate concentrations less than 6 pCi/l. Compliance with the EPA drinking water requirements is assumed without further analysis if the average annual concentration of gross beta activity is less than 50 pCi/l and if tritium is less than 20,000 pCi/l and strontium-90 is less than 8 pCi/l. The gross beta measurements indicate compliance with EPA groundwater standards.

We also received unfiltered groundwater samples. These samples are currently undergoing isotopic analysis at RESL. We expect to have results from these assays by January 15, 1991. We will transmit these data to you when we receive them.

We have also enclosed information on natural thorium concentrations. These data are from National Council on Radiation Protection Report No. 50, "Environmental Radiation Measurements."

If you have any questions, please contact me at 301-492-0558.

Sincerely, ORIGINAL SIGNED BY
Timothy C. Johnson

Timothy C. Johnson, Section Leader
Decommissioning Section
Division of Low-Level Waste Management
and Decommissioning

Enclosure: As stated
Distribution: Central File# NMSS r/f LLRB r/f TCJohnson
JAustin JGreeves RBangart JKinneman,RI MKnapp,RI
JSurmeier PLohaus
PDR YES X NO ___ Category: Proprietary ___ or CF Only ___
ACNW YES X NO ___
SUBJECT ABSTRACT: GROUNDWATER SAMPLES

OFC	:LLRB	:LLRB	:
NAME	:TCJohnson	:JAustin	:
DATE	:12/10/90	:12/10/90	:

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WYMAN GORDON SAMPLE RESULTS

Sample Number	Sample Description	NRC alpha (pCi/l)	NRC beta (pCi/l)	MA alpha (pCi/l)	MA beta (pCi/l)	WG alpha (pCi/l)	WG beta (pCi/l)
WG-1	Private Well	2.3±1.3	3±5	2.0±1.5	4.0±2.2		
WG-2	Private Well	0.3±0.9	2±5	1.8±1.4	2.1±2.1		
WG-3	Private Well	4±2	1±5	0.9±1.1	3.6±1.9		
WG-4	Private Well	2.6±1.6	4±5	2.7±1.2	5.4±2.0		
WG-5	Private Well	2.3±1.2	1.8±0.6	1.2±1.6	4.2±2.2		
WGE-3	WG Well	0.2±0.6	-2±4			1.0±0.6	2.2±0.6
WGE-7	WG Well	-0.2±0.7	1±4			0.8±0.5	3.9±0.7
WGE-8	WG Well	-0.3±0.9	6±5			0.1±0.4	10.4±1.3

The above results are all for filtered samples. The sediment from the filtration has only been analyzed by Wyman Gordon's consultants (See separate results). RESL (NRC lab) is planning to conduct a similar analysis soon. The above results can best be summarized by saying that no filtered sample exceeded 3 pCi/l gross alpha and only one (10.4) exceeded 6 pCi/l gross beta. Region I does not consider the differences in analytical results significant in the context of these samples.

ADDRESS LIST FOR DRINKING WATER SAMPLES

Identification	Address
WG 1c	Van Dal 220 Brigham Hill Road
WG 2c	Pepper's Auto & Truck Repair 99 Creeper Hill Road
WG 3c	All Steel Company 84 Creeper Hill Road
WG 4c	Power 96 Creeper Hill Road
WG 5c	Roadrunner Motor Line 105 Creeper Hill Road

All samples collected after 3-1/2 minutes of open tap.

No pretreatment.

Drinking water samples.

Robert T. Watkins, sample collector, MDPH.

GLD/nas
10/22/90

TO MAGNESIUM - THORIUM ALLOY WASTES BURIED AT CRAFTON PLANT SITE

DESCRIPTION	ACTINIUM 228 (1) UNFILTERED SAMPLES, pCi/l	LEAD 212 (1) UNFILTERED SAMPLES, pCi/l	LEAD 214 (1) UNFILTERED SAMPLES, pCi/l	CESIUM 134 (1) UNFILTERED SAMPLES, pCi/l	CESIUM 137 (1) UNFILTERED SAMPLES, pCi/l	SEDIMENT CONCENTRATION GRAMS/8.5 LITERS	THORIUM (2) 228 pCi/g (dry)	THORIUM (2) 230 pCi/g (dry)	THORIUM (2) 232 pCi/g (dry)
MONITORING WELLS MGE - 3,7, & 8 ARE DOWNGRADIENT FROM MG-TH SITE									
MGE - 3 GROUND WATER SAMPLE	LT 40	22 +,- 15	LT 20	LT 9	LT 9	40.1	1.4 +,- 0.2	1.0 +,- 0.2	1.0 +,- 0.2
MGE - 7 " " "	LT 30	LT 15	LT 20	LT 8	LT 8	293.1	0.8 +,- 0.3	0.3 +,- 0.7	0.6 +,- 0.2
MGE - 8 " " "	LT 40	LT 15	LT 20	LT 8	LT 8	29.2	3.6 +,- 0.5	1.7 +,- 0.4	2.3 +,- 0.6
MGE - 3 SEDIMENT (pCi/g)									
MGE - 7 " "									
MGE - 8 " "									
UNFILTERED GROUND WATER SAMPLES:									
MGE - 3 (2a) 20 GL									
MGE - 3 (3a) 20 GL									
MGE - 7 (4a) 20 GL									
MGE - 7 (5a) 15 GL									
MGE - 8 (1a) 20 GL									
MONITORING WELLS MGE-7 & MGE-13 CANNOT BE IMPACTED BY MG-TH WASTES BURIED ON SITE. WELLS: MGE - 13 LOCATED EAST OF EAST BROOK AND MGE - 7 LOCATED ON THE WEST SIDE OF PLANT.	THE FOLLOWING NOTE APPLIES ACROSS THE COLUMNS ABOVE, BELOW, AND TO THE RIGHT AND CONTINUING ON P 2 OF THIS TABLE: LT - LESS THAN 2 STANDARD DEVIATION IN THE BKY COUNT OR THE PROCEDURE DETECTION LIMIT.								
MGE - 7 GROUND WATER SAMPLE									
MGE - 13 " " "									
MONITORING WELLS MGE-9 AND MGE-10 ARE MORE THAN 100 FT UPGRADIENT FROM SOUTHERN BOUNDARY OF BURIED MG-TH ALLOY WASTES.									
MGE - 9 SOIL SAMPLE FROM BORING						NOT APPLICABLE	1.1 +,- 0.3	1.0 +,- 0.3	1.5 +,- 0.3
MGE - 10 " " " "						" "	0.8 +,- 0.3	0.5 +,- 0.3	0.8 +,- 0.3
MGE - 9 SEDIMENT (pCi/g)									
MGE - 10 " "									

TEST DATA DENOTED AS FOLLOWS: (1) CLEAR BARRIES ANALYTICAL SERVICES,

(2) ACCU-LABS RESEARCH, (3) PROF. OTTO HARLING OF MIT.

NRC (L Tripp)
Prof Harling

TO MAGNESIUM - THORIUM ALLOY WASTES BURIED AT GRAFTON PLANT SITE

DESCRIPTION	GROSS ALPHA (1) UNFILTERED SAMPLES, pCi/l	GROSS BETA (1) UNFILTERED SAMPLES, pCi/l	GROSS ALPHA (1) FILTERED SAMPLES, pCi/l	GROSS BETA (1) FILTERED SAMPLES, pCi/l	GROSS ALPHA (3) FILTERED SAMPLES, pCi/l	GROSS BETA (3) FILTERED SAMPLES, pCi/l	GROSS ALPHA (3) UNFILTERED SAMPLES, pCi/l	GROSS BETA (3) UNFILTERED SAMPLES, pCi/l
MONITORING WELLS MGE - 3,7, & 8 ARE DOWNGRADIENT FROM MG-TH SITE.								
MGE - 3 GROUND WATER SAMPLE	120 +,- 20	140 +,- 20	1.0 +,- 0.6	2.2 +,- 0.5	0.46 + 0.60	8.1 + 1.6		
MGE - 7 " " "	90 +,- 20	133 +,- 14	0.8 +,- 0.5	3.9 +,- 0.7	0.33 + 0.82	13.8 + 1.8		
MGE - 8 " " "	410 +,- 80	440 +,- 50	0.1 +,- 0.4	10.4 +,- 1.3	0.23 +,- 0.39	14.2 + 1.8		
MGE - 3 SEDIMENT (pCi/g)	14 +,- 7	53 +,- 8	} New Data 11/21/90					
MGE - 7 " "	7 +,- 5	25 +,- 6						
MGE - 8 " "	21 +,- 8	57 +,- 8						
UNFILTERED GROUND WATER SAMPLES:								
MGE - 3 (2A) 20 RL							59 +,- 16	112 +,- 31
MGE - 3 (3A) 20 RL							39 +,- 15	472 +,- 63
MGE - 7 (4A) 20 RL							144 +,- 17	75 +,- 30
MGE - 7 (5A) 15 RL							90 +,- 23	77 +,- 40
MGE - 8 (3A) 20 RL							51 +,- 16	99 +,- 30
MONITORING WELLS MGW-7 & MGE-13 CANNOT BE IMPACTED BY MG-TH WASTES BURIED ON SITE. WELLS: MGE - 13 LOCATED EAST OF EAST BROOK AND MGW - 7 LOCATED ON THE WEST SIDE OF PLANT.								
MGW - 7 GROUND WATER SAMPLE	14 +,- 4	27 +,- 3	3 +,- 2	12 +,- 3				
MGE - 13 " " "	31 +,- 3	25 +,- 2	0.7 +,- 0.4	2.0 +,- 0.7				
MONITORING WELLS MGE-9 AND MGE-10 ARE MORE THAN 100 FT UPGRADIENT FROM SOUTHERN BOUNDARY OF BURIED MG-TH ALLOY WASTES.								
MGE - 9 SOIL SAMPLE FROM BORING								
MGE - 10 " " " "								
MGE - 9 SEDIMENT (pCi/g)	19 +,- 7	50 +,- 6	} New Data 11/21/90					
MGE - 10 " "	7 +,- 5	39 +,- 5						

TEST DATA DENOTED AS FOLLOWS: (1) CLEAR HARBORS ANALYTICAL SERVICES.

NCRP REPORT No. 50

Environmental Radiation Measurements

Recommendations of the
NATIONAL COUNCIL ON RADIATION
PROTECTION AND MEASUREMENTS

Issued December 27, 1976
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Second Reprinting September 1, 1988

National Council on Radiation Protec
7910 WOODMONT AVENUE / BETHESD

uted but have relatively short half-lives. Among the former are ^{41}Ar, ^{135}Xe, ^{133}Xe, ^{87}Kr, ^{88}Kr, ^{138}Cs, ^{88}Rb, and ^{131}I that are released by some nuclear facilities in measurable quantities and contribute most of the additional nearby dose rate (e.g., Beck *et al.*, 1972a). Among the latter are ^{140}Ba–^{140}La, ^{124}Sb, and ^{103}Ru, as well as ^{41}Ar and ^{131}I.

2.2.2 *General Distribution Pat*

A common feature of many environmental radiation measurement programs is the study of radionuclide distributions and concentrations. Information of this type has been accumulated by many investigations directed toward a variety of goals, but only in recent years has it been put together in a coherent fashion because of the practical need for a quantitative assessment of man's perturbations of the radiation environment. The considerable but scattered literature has been summarized by the United Nations Scientific Committee on the Effects of Atomic Radiation in a number of reports, most recently in 1972 (UNSCEAR, 1972). Earlier references include Lowder and Soion (1956) and Klement (1965).

2.2.2.1 *Lithosphere*. Potassium-40 and the radionuclides of the uranium and thorium series contribute most of the naturally-occurring radioactivity in rocks. Potassium-40 constitutes 0.0118 percent of natural potassium, which in turn constitutes about 2.6 percent of the accessible lithosphere (Adams, 1962). The resulting average abundance by weight of ^{40}K is comparable to that of uranium and about one-fourth that of thorium (Adams *et al.*, 1959). Rubidium-87 is considerably more abundant than any of these nuclides, but is a much less significant nuclide because of its long half-life and low-energy beta-particle emission.

Although the radionuclide content of rocks is a complicated function of their geochemical history, varying considerably among the various types, certain generalizations can be made that derive from extensive geological investigations. For example, the radioactivity in igneous rocks is related to the quantity of silicates, being highest in acidic varieties and lowest in the ultrabasic rocks (e.g., dunites). Igneous rocks generally exhibit higher radioactivity than sedimentary rocks, while metamorphic rocks have concentrations typical of the unmetamorphosed rocks from which they are derived. Certain sedimentary rocks, including some shales and phosphate rocks, are highly radioactive, while other types, notably limestone and various evaporites (e.g., halite, anhydrite, and gypsum), are quite low in radionuclide content. Table 2-6 shows typical natural radioactivity concentrations in common rocks. These values and those for other

media in the following tables should be regarded as approximate expectation values.

The radioactivity of soil, usually a more direct determinant of radiation levels in the outdoor environment, depends not only on that of the parent rock (which may not be identical with the local bedrock) but also on soil formation and transport processes. Typical uranium, thorium, and total potassium contents of a wide variety of soils in North America and Europe are 2 μg g^{-1}, 8 μg g^{-1} and 1.5 percent, respectively, though observed contents are a strong function of soil type and soil horizon (Baranov and Morozova, 1973). Thus, significant variations of soil radioactivity with location and depth are common. Table 2-7 lists typical *in situ* soil concentrations of the natural radionuclides.

The relatively few simultaneous measurements of the radium and uranium contents of soil indicate that radioactive equilibrium is roughly attained in many soils, but large deviations from equilibrium are also observed due to different geochemical properties of radium and uranium compounds. Departure from equilibrium occurs even

TABLE 2-6—*Radionuclides in rocks*

Type of Rock	K	U	Th
	percent	ppm	ppm
Igneous			
Silica (e.g., granites)	3.3	4.7	20.0
Intermediate (e.g., diorites)	2.3	1.8	8.0
Mafic (e.g., basalt)	0.8	0.9	2.7
Ultramafic (e.g., dunites)	0.5	0.03	6.0
Sedimentary			
Limestones	0.3	2.2	1.7
Carbonates	–	2.1	1.9
Sandstones	1.2	~1.5	~3.0
Shales	2.3	3.5	11.0
Mean value (Earth's crust)	2.3	3.0	11.4

References: Adams (1962); Vinogradov (1959).

TABLE 2-7—*Radionuclides in soil*

Radionuclide	Soil concentration		Mean specific activity
	Typical range	World average	
	g g^{-1} soil	g g^{-1} soil	Ci g^{-1}
^{40}K	(0.5–3.0) × 10^{-2}	1.5 × 10^{-2}	1.0 × 10^{-11}
^{87}Rb	–	4.0 × 10^{-5}	3.5 × 10^{-12}
^{226}Ra	(0.5–2.0) × 10^{-12}	8.0 × 10^{-12}	8.0 × 10^{-12}
^{232}Th	(2–12) × 10^{-6}	6.0 × 10^{-6}	6.5 × 10^{-12}
^{238}U	(1–4) × 10^{-6}	2.0 × 10^{-6}	6.7 × 10^{-12}

more readily for those ^{238}U daughters beyond ^{222}Rn because of the escape of gaseous radon from the soil matrix into the pore spaces and subsequent migration elsewhere prior to decay. This phenomenon is much less marked in the ^{232}Th series because of the shorter half-life of gaseous ^{220}Rn.

The mean soil content of ^{87}Rb is 40 $\mu g\ g^{-1}$, which results in a beta activity of the order of 10 percent that of ^{40}K.

Two manmade radionuclides widely distributed in near-surface soils are ^{90}Sr and ^{137}Cs deposited by fallout from nuclear weapons tests. Though their geographic and depth distribution patterns are somewhat irregular, most of each nuclide is generally retained in the upper 15 cm of soil, with the concentrations usually decreasing roughly exponentially with depth. The ^{90}Sr and ^{137}Cs concentrations near the soil surface are strongly time dependent, because of their variable deposition rates over many years, and their gradual depletion by decay, erosion and leaching.

Given the typical soil contents of the natural radionuclides indicated above, it can be inferred that the natural alpha-particle activity of soils is contributed by the thorium and uranium series in about a 2:1 ratio. Potassium-40 accounts for at least one-half of the natural beta activity, with the two series plus ^{87}Rb making roughly comparable contributions to the remainder. Potassium and the thorium series each contribute about 40 percent of the natural gamma-emission rate from soil, with the uranium series accounting for the remaining 20 percent. The manmade nuclides ^{90}Sr and ^{137}Cs are present in sufficient quantities to contribute significantly to the total soil activity. Their beta-activity concentrations in surface soil have recently been comparable to that of ^{87}Rb ($\sim$1 pCi g^{-1}), and the gamma-activity concentration of ^{137}Cs has been approximately one-half that of the uranium series. Thus, the contribution of fallout radionuclides to the total beta or gamma activity of surface soils is now about 10 percent.

The environmental radiation inside buildings from sources in the lithosphere can differ significantly from that in the nearby out-of-doors environment. In general, two competing effects are observed. The building provides shielding against outdoor environmental radiation, but the building material itself is an additional radiation source. Oakley (1972) has summarized the few studies of indoor radiation in the literature, and Hultqvist (1956) and Hamilton (1971) have reported radioactivity concentrations in building materials in Sweden and the United Kingdom, respectively. On the average, indoor gamma-radiation levels are comparable to those in the outdoor environment.

2.2.2.2 *Atmosphere*. The radionuclides normally found in ground-