RAS 10996

Baird et al. 1990b

RAE-9000/16-1

U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of Louisiana Energy Services, L.P.
Docket No. 70-3103-ML Official Exhibit No. NRS/RC 171
OFFERED by: Applicant/Licensee Intervenor NRS/RC
NRC Staff Other
IDENTIFIED on 10/23/05 Witness/Panel Makhijani
Action Taken: ADMITTED REJECTED WITHDRAWN
Reporter/Clerk Bethany Engel

ADDITIONAL RADIONUCLIDE CONCENTRATION LIMITS FOR THE NORM DISPOSAL SITE AT CLIVE, UTAH

DOCKETED USNRC
2005 DEC 21 PM 3:30
OFFICE OF THE SECRETARY
ADJUDICATIONS STAFF

R.D. Baird
G.B. Merrell
D.E. Bernhardt
V.C. Rogers

August 1990

Rogers and Associates Engineering Corporation
P.O. Box 330
Salt Lake City, Utah 84110-0330

9211040260 921024
PDR ADOCK 04008989
C PDR

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SECY-02

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1. INTRODUCTION

The limiting radionuclide concentrations have been calculated for additional radionuclides in NORM wastes at the disposal facility at Clive, Utah. Several exposure scenarios and pathways were evaluated in a previous study conducted by Rogers and Associates Engineering (RAE). Radionuclide concentration limits for a variety of exposure scenarios were calculated and critical scenarios were identified. The details of this analysis are documented in the RAE report entitled "Evaluation of the Public Health Impacts Associated with Radioactive Waste Disposal at a Site near Clive, Utah."[1]

The purpose of the present study is to supplement the original report by including concentration limits for some additional radionuclides. This report also utilizes an improved methodology for calculating the external gamma doses. The improved methodology eliminates some of the extra conservatism in the original gamma dose calculations. The resulting concentrations are given for the additional radionuclides

The effect of daughter ingrowth has also been examined in greater detail for radionuclides where this is important. Since significant ingrowth of radioactive daughters can occur on a time scale of months or years, it is important to know how long the ingrowth has been occurring at the time of waste handling and disposal. The effects of daughter ingrowth from radium-228 have been evaluated for time periods of one, five, and ten years. Different concentration limits are given for each time period. Thus, if the origin and history of a particular waste stream are sufficiently well known, the appropriate concentration limits for worker protection can be chosen.

The original report[1] concluded that when all reasonable exposure scenarios are considered, the worker exposures are generally the most limiting. Based on this conclusion, the present study focusses on worker exposures. Concentration limits due to offsite exposures or to future onsite intruder scenarios are not addressed.

2. METHODOLOGY AND RESULTS

As was done in the previous report, doses to workers were calculated using the PATHRAE computer code.[3] Doses from external gamma exposure and from dust inhalation were summed to get the total worker dose. A source concentration of 1 pCi/g was initially assumed. The resulting doses were then compared to the 1250 mrem/quarter criterion and the allowable radionuclide concentrations in waste were determined by scaling linearly.

Several radionuclides are included in this report which did not appear in the original report. Table 2-1 lists the new radionuclides. Many of the added radionuclides are gamma emitters. Some (Pb-210 and Po-210) are part of the Ra-226 decay series and are typical constituents of NORM waste. The Ra-228 is part of the Th-232 decay series and is sometimes found, without its parent radionuclides, in waste from water treatment plants. The depleted uranium is assumed to be in metallic or oxide form. For purposes of this report, the depleted uranium is distinguished from U-238 in the original report by its waste form. The depleted uranium is in a form which can not be inhaled and therefore does not contribute to the dust inhalation dose.

Compared to the previous report, the external gamma doses have been calculated using a more refined methodology. The current methodology eliminates some of the conservatism by treating the low energy gamma rays differently. Photons with energies below 15 keV were not included in the average gamma energy used by the PATHRAE code. Radionuclides with significant emissions below 15 keV were then examined individually and an appropriate correction factor was determined. The methodology previously used in the PATHRAE code is very sensitive to the parameters used to characterize the low energy end of the spectrum. The approach used for the current analysis has been found to produce more realistic results.

Using a source concentration of 1 pCi/g for all radionuclides, the external gamma and dust inhalation doses were calculated for workers exposed for 2000 hours each year. The gamma, dust, and total doses are shown in Table 2-2. The doses in Table 2-2 are based on a source concentration of 1 pCi/g of each radionuclide.

Table 2-1. Additional radionuclides

Ag-110m
Be-7
K-40
Ca-45
Cr-51
Co-56
Co-58
Sb-124
Sb-125
Eu-152
Eu-154
Ir-192
Hg-203
Pb-210
Po-210
Ra-228
Depleted U

Table 2-2. Onsite worker doses.

Nuclide	Dose (mrem/yr per pCi/g) Gamma	Dust	Total
Be 7	1.3E-01	2.5E-07	1.3E-01
K-40	5.0E-01	1.1E-05	5.0E-01
Ca-45	0.0E+00	5.6E-06	5.6E-06
Cr-51	7.3E-02	2.4E-07	7.3E-02
Co-56	1.4E+01	2.4E-05	1.4E+01
Co-58	3.1E+00	6.5E-06	3.1E+00
Ag-110m	9.0E+00	4.8E-05	9.0E+00
Sb-124	6.3E+00	1.9E-05	6.3E+00
Sb-125	9.5E-01	8.9E-06	9.5E-01
Eu-152	2.9E+00	2.0E-04	2.9E+00
Eu-154	3.5E+00	2.4E-04	3.5E+00
Ir-192	2.0E+00	2.1E-05	2.0E+00
Hg-203	4.8E-01	5.9E-06	4.8E-01
Pb-210	1.9E-03	1.2E-02	1.4E-02
Bi-210	0.0E+00	1.7E-04	1.7E-04
Po-210	0.0E+00	7.4E-03	7.4E-03
Ra-228	0.0E+00	3.8E-03	3.8E-03
Ac-228	2.8E+00	2.6E-04	2.8E+00
Th-228	3.9E-03	2.8E-01	2.8E-01
Ra-224	2.1E-02	2.6E-03	2.4E-02
Rn-220	1.5E-03	0.0E+00	1.5E-03
Po-216	0.0E+00	0.0E+00	0.0E+00
Pb-212	2.7E-01	1.5E-04	2.7E-01
Bi-212	6.0E-01	1.9E-05	6.0E-01
Po-212	0.0E+00	0.0E+00	0.0E+00
Tl-208	3.3E+00	0.0E+00	3.3E+00
Depleted U	6.3E-04	0.0E+00	6.3E-04
Th-234	1.2E-02	0.0E+00	1.2E-02
Pa-234m	3.3E-02	0.0E+00	3.3E-02

Table 3. Radionuclide doses and concentration limits for worker scenario.

Nuclide	Total Dose (mrem/yr (per pCi/g)	Waste Concentration Limit (pCi/g)
Be-7	1.3E-01	3.8E+04
K-40	5.0E-01	1.0E+04
Ca-45	5.6E-06	8.9E+08
Cr-51	7.3E-02	6.8E+04
Co-56	1.4E+01	3.6E+02
Co-58	3.1E+00	1.6E+03
Ag-110m	9.0E+00	5.6E+02
Sb-124	6.3E+00	7.9E+02
Sb-125	9.5E-01	5.3E+03
Eu-152	2.9E+00	1.7E+03
Eu-154	3.5E+00	1.4E+03
Ir-192	2.0E+00	2.5E+03
Hg-203	4.8E-01	1.0E+04
Ra-226*	3.6E+00	1.4E+03
Pb-210*	2.2E-02	2.3E+05
TH-232*	7.3E+00	6.8E+02
Ra-228	2.8E+00	1.8E+03
Ra-228* 1 yr	4.2E+00	1.2E+03
Ra-228* 5 yr	7.5E+00	6.7E+02
Ra-228* 10 yr	8.9E+00	5.6E+02
Depleted U	4.6E-02	1.1E+05

* Denotes limit generated by nuclide plus significant daughters.

REFERENCES

1. R.D. Baird, M.K. Bollenbacher, E.S. Murphy, R. Shuman, R.B. Klein, "Evaluation of Public Health Impacts Associated with Radioactive Waste Disposal at a Site Near Clive, Utah," Rogers and Associates Engineering Corporation, RAE 9004/2-1, June 1990

2. G.B. Merrell, V.C. Rogers, M.K. Bollenbacher, "The PATHRAE RAD Performance Assessment Code for the Land Disposal of Radioactive Wastes," Rogers and Associates Engineering Corporation, RAE 8511/28, August 1986

3. Letter for Bureau of Radiation Control from R.D. Baird, Rogers and Associates Engineering Corporation, June 19, 1990

< TRANSACTION REPORT >

10-01-1992(THU) 10:00

[RECEIVE]

NO.	DATE	TIME	DESTINATION STATION	PG.	DURATION	MODE	RESULT
7842	10-01	09:56	801 537 7345	10	0°03'47"	NORM.E	OK
				10	0°03'47"		

562

ENVIROCARE OF UTAH, INC

ENVIROCARE OF UTAH, INC
215 South State #1160
Salt Lake City UT 84111

TRANSMISSION REQUEST

TRANSMISSION TO:

NAME: Sandra Martin

FAX NO:

COMPANY:

LOCATION:

REMARKS: Fax for Ann Andrews

TRANSMISSION FROM: ENVIROCARE OF UTAH, INC. Verify: (801)532-1230

NAME: Linda Romaley

DATE: 10/1/92

NO. OF PAGES (INCLUDING COVER): 2

FAX NO: (801) 537-7315

REMARKS

10 CFR 20 POINTS OF COMPLIANCE

This list compares specific section of the Application ... requirements under 10 CFR 20, Standards for Radiation Protection

10 CFR SECTION	APPLICATION SECTION
20.101	17.5.6.8.2
20.102	17.5.6.8.2 (Two Paragraphs Added)
20.103(a)(1), (2)	17.5.5.4.2
	17.5.6.8.2
20.103(a)(3)	17.5.6.8.5
20.103(b)(1)	17.5.6.8.2
20.103(b)(2)	17.5.6.8
20.103(c)	Appendix B - Procedure for Respiratory Protection
20.104	17.5.6.8.2
20.105; Also, 40 CFR 100	17.1.3.2
	17.1.3.3
	17.1.4
20.106	17.1.2.2
	17.1.4
	17.1.4.1
	17.1.4.2
	17.1.4.3
	Section 5
20.201	17.5.6.8
	17.5.5.4.1
	17.5.5.4.2
	17.2
20.202	17.5.6.8.2
20.203	17.2
20.204	17.5.6.2
20.311	15.1
20.401	14.17.5
20.407	Appendix C

TRANSACTION REPORT

[illegible]-01-1992(THU) [illegible]

[RECEIVE]

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				2	[illegible]		

BINGHAM ENVIRONMENTAL
A Bingham Engineering Company
5160 Wiley Post Way, Salt Lake City, Utah 84116, (801) 532 2230, FAX (801) 328-3381

TRANSMITTAL

To: Mr. Latif Hamden
U.S. Nuclear Regulatory Commission
11558 Rockville Pike, M/S 5E2, One White Flint North
Rockville, MD 20852

Date: October 16, 1992

Project: Envirocare 11e(2) License Application

No. 1534-004

Subject: Environmental Report

We are sending you ☒ attached ☐ under separate cover via _____ the following items:

- Well Inventory within 10 mile radius of Site
- Porosity Information

These are transmitted as checked below:

☐ For Approval
☐ For Your Records
☐ For Review and Comment
☐ As Requested
☐ Distribution
☒ For Your Information

Providing information used to estimate effective porosity for the shallow, unconfined aquifer. Reference for Figure 2-17 is Practical Treatise on Underground Water, Castany 1967. Chapter 2 of the Environmental Report has been updated based on an effective porosity of 0.30 and to include the well inventory information.

cc: George Hellstrom

By: Stanley Plaisier

Stanley L. Plaisier, P.E.

Table 2-14
ENVIROCARE LANDFILL FACILITY
SUMMARY OF WELL INVENTORY*

Map ID# (1)	Location	Owner and/or Name	Aquifer (2)	Well LOC (3)	Well Diameter (inches)	Well Depth (feet)	Depth to Water Below Land Surface (feet)	Well Use (4)	Comments
0	T1N, R12W, Sec.24	Khosrow B. Semnani	Confined	D 8.5	4-C	184	NA	D, I	
1	T1N, R12W, Sec. 23	Khosrow B. Semnani	Confined	D 9	4-C	201	NA	D, I	
2	T1N, R11W, Sec. 26	US Bureau of Land Mgmt.	Confined	D 7.1	6-C	175	140	S	
3	T1S, R10W, Sec. 5	Utah Dept. of Trans.	Confined	D 7.5	8-C	420	300	D, IR	
4	T1S, R10W, Sec. 16	Aptus	Confined	L 7.4	10-C	730	462	I	
4	T1S, R10W, Sec. 16	Aptus	Confined	L 7.4	6	900	NA	I	
4	T1S, R10W, Sec. 16	Aptus	Confined	L 7.4	6	900	NA	I	
5	T1S, R10W, Sec. 16	Haynes Land & Livestock Co.	Confined	L 7.8	6-C	644	522	S	
6	T1S, R12W, Sec. 13	USPCI	Confined	D 3.3	12	452	NA	I	
7	T1S, R11W, Sec. 18	Envirocare of Utah	Confined	D 3.3	10	352	NA	I	
8	T1S, R12W, Sec. 17	Magnesium Corp. of America	Confined	D 6	8-C	615	23	I	
9	T1S, R10W, Sec. 16	Aptus	Confined	L 7	12	100-200	NA	D, I	
A	T1S, R11W, Sec. 36	Skull Valley Co.	Confined	L 3.5	6-C	276	264	S	
D	T1S, R10W, Sec. 32	USPCI	Confined	L 5.5	10	1000	NA	D, I	
E	T1S, R10W, Sec. 31	USPCI	Confined	L 5.5	10	100-1000	NA	D	
I	T1S, R10W, Sec. 33	USPCI	Confined	L 6.5	10	100-1000	NA	D, I	
J	T1S, R12W, Sec. 36	USPCI	Confined	L 2.1	12	600	NA	I	
K	T2S, R11W, Sec. 1	USPCI	Confined	L 4.3	10	1000	NA	D, I	
L	T2S, R11W, Sec. 6	USPCI	Confined	L 4.9	10	1000	NA	D, I	
L	T2S, R11W, Sec. 6	USPCI	Confined	L 4.9	10	910	NA	D, I	
M	T2S, R10W, Sec. 8	USPCI	Confined	L 6.2	10	100-1000	NA	D, I	
N	T2S, R11W, Sec. 35	USPCI	Confined	L 6.2	10	1000	NA	D, I	

* Based on inventory performed in October 1992

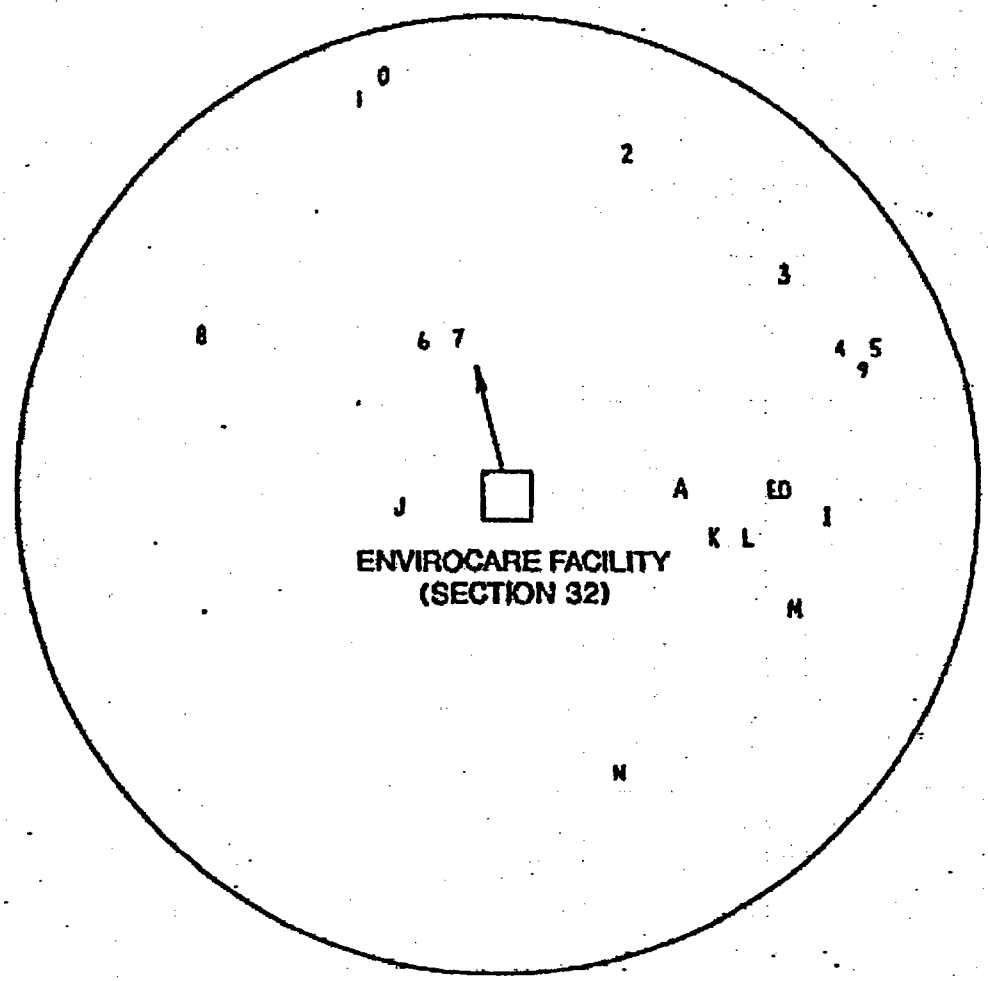
lga 10/15/92

(1) Wells are located on Figure 2-14 using this arbitrary numbering system.
(2) Aquifers are approximated by well depths, water levels, artesian flows, and/or lithologic descriptions from well logs.
(3) Location and distance (in miles) of well with respect to Envirocare 11e.(2) facility:

- U Upgradient
- D Downgradient
- L Located laterally to the side of the 11e.(2) facility

(4) Well use:

- D Domestic
- I Industrial
- S Stockwater
- M Monitor Well
- IR Irrigation



LEGEND

GENERAL DIRECTION OF GROUNDWATER FLOW

0 20,000 40,000

Scale in Feet

BINGHAM ENVIRONMENTAL
SALT LAKE CITY – (801) 532-2230

WELL INVENTORY MAP

FIGURE 2-1

ENVIROCARE LANDFILL
11a (2) PERMIT
EFFECTIVE POROSITY ESTIMATES

Bingham Engineering SALT LAKE CITY, UTAH 801-532-2520

SHEET NO 1 OF 1
PROJECT NO. 1534-004
BY SLP DATE 10/7/9
CK'D DATE

SAMPLES FROM SILTY SAND AQUIFER:

SAMPLE I.D	LAB POROSITY	MEAN GRAIN SIZE (mm)	PERCENT ADJUSTMENT	ESTIMATED EFFECTIVE POROSITY
GW-17A, L-5	0.37	0.1	18%	0.30
GW-18, S-4	0.42	0.05	14%	0.36
GW-19B, L-5	0.32	0.1	18%	0.26

AVERAGE EFF. POROSITY = 0.30

BASED ON FIGURE 2-17 THE PERCENT REDUCTION TO EFFECTIVE POROSITY FROM TOTAL POROSITY AS A FUNCTION OF MEAN GRAIN SIZE IS:

MEAN GRAIN SIZE	TOTAL POROSITY	EFF. POROSITY	PERCE[illegible] CHANG[illegible]
0.1 mm	.34	.28	18[illegible]
0.05 mm	.37	.32	14[illegible]

ENVIROCARE OF UTAH

PHYSICAL PROPERTIES

Sample I.D.	Depth (ft)	Soil Type	Unit	Average Field Water Content (% by weight)	Average Porosity (cc/cc)	Average Field Density Summary (g/cc)
GW-16, S-1	3-5	Silty Clay	2	0.36	0.38	1.66
GW-16, B-7	34.5-36	Silty Clay	2	0.38	0.38	1.66
GW-17A, L-2	7-9.5	Silty Clay	4	0.50	0.50	1.37
GW-17A, L-5	19.5-22	Silty Sand	3	0.16	0.37	1.67
GW-17A, L-7	27-29.5	Silty Clay	2	0.49	0.51	1.32
GW-18, S-4	20-22	Silty Sand	3	0.23	0.42	1.55
GW-19A, S-1	5-7	Silty Clay	4	0.45	0.51	1.32
GW-19B, L-5	22-24.5	Silty Sand	3	0.33	0.32	1.79

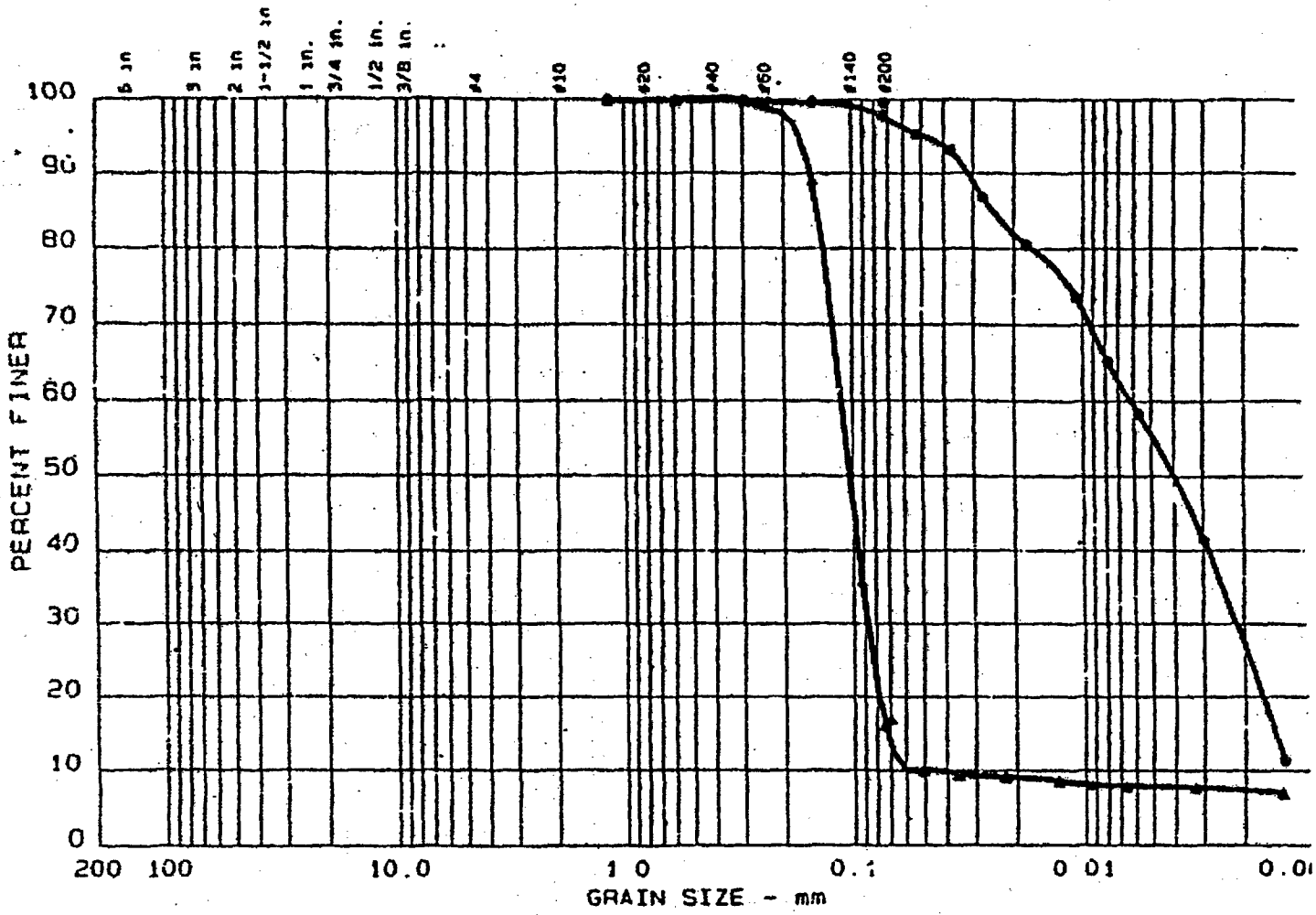
AVERAGE POROSITY OF SILTY SAND

0.37
0.42
0.32

$\boxed{0.37}$

APPENDIX D

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	8	0.0	0.0	2.1	42.3	55.6
▲	13	0.0	0.0	83.8	8.4	7.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	34	14			0.00	0.002	0.0015			
▲	N/A	N/A	0.14	0.11	0.10	0.087	0.0724	0.0575	1.18	1.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Silty Clay with Trace Fine Sand	CL	A-6
▲ Brown Silty Fine Sand with Trace Clay	SM	UNCLASSIFIE

Project No.. 1416-007

Project. Envirocare Hydrogeological Study

● Location: GW-17A L-2 Depth: 7'-9.5'

▲ Location: GW-17A L-5 Depth: 19.5'-22' MEAN GRAIN SIZE = 0.1 MM

Date: 03-07-91

Remarks:

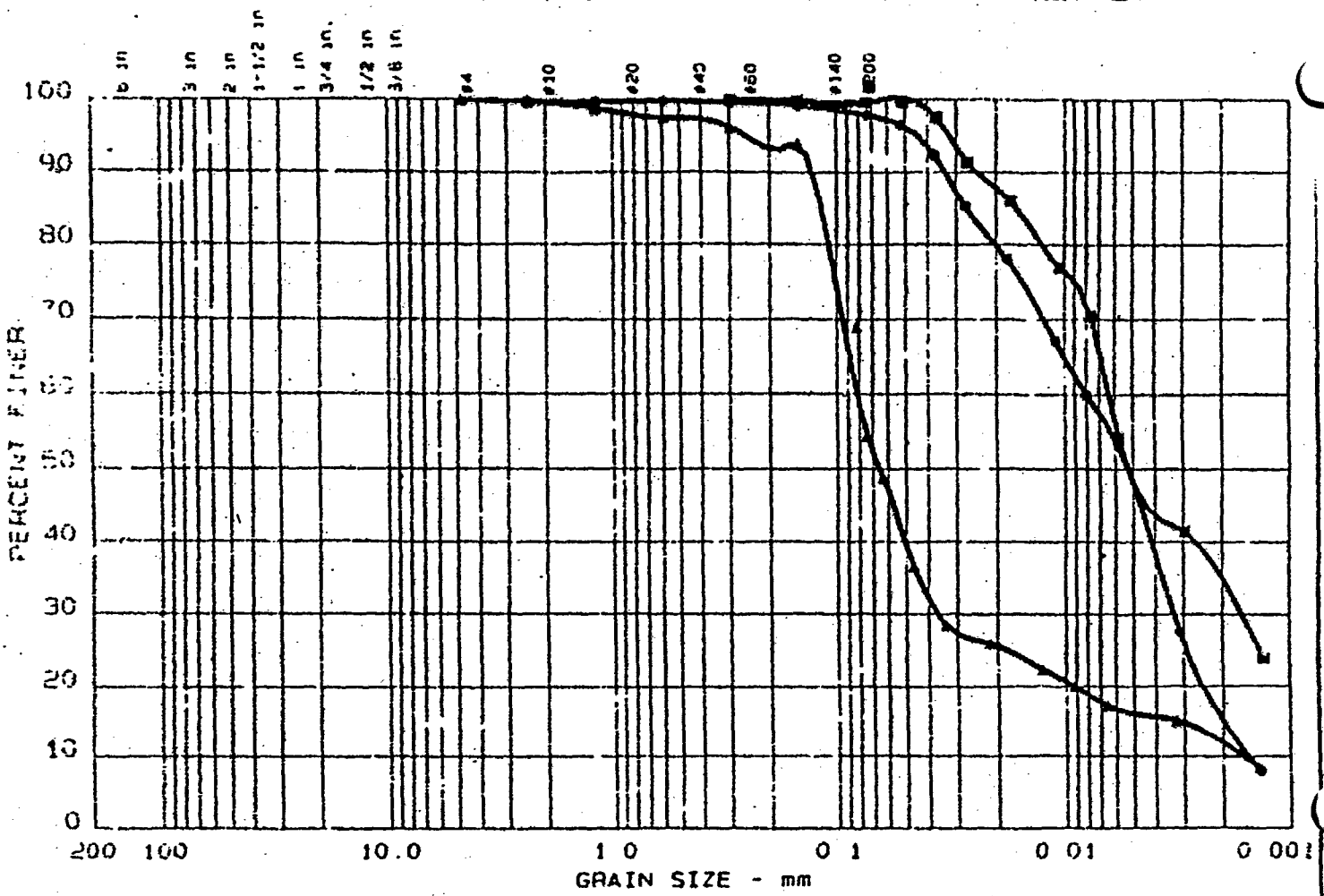
Tested By: DA

GRAIN SIZE DISTRIBUTION TEST REPORT

Bingham Engineering

Figure No B-15

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	15	0.0	0.0	2.0	49.9	48.1
▲	14	0.0	0.0	45.5	38.7	15.8
■	11	0.0	0.0	0.4	51.6	48.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	34	13			0.01	0.003	0.0020	0.0015	0.90	5.2
▲	N/A	N/A	0.12	0.08	0.06	0.036	0.0033	0.0016	10.12	50.7
■	40	18			0.01	0.002				

	MATERIAL DESCRIPTION	USCS	AASHTO
●	Brown Silty Clay with Trace Fine Sand	CL	A-6
▲	Brown Silty Fine Sand with Some Clay	SM	A-4
■	Brown Silty Clay with Trace Fine Sand	CL	A-6

Project No. 1416-007

Project Envirocare Hydrogeological Study

● Location GW-18 B-1 Depth 5'-6.5'

▲ Location GW-18 S-4 Depth 20'-22'

Location GW-18 S-6 Depth 30'-32'

Date. 05-07-91

MEAN GRAIN SIZE = .05 MM

Remarks

Tested By. DA

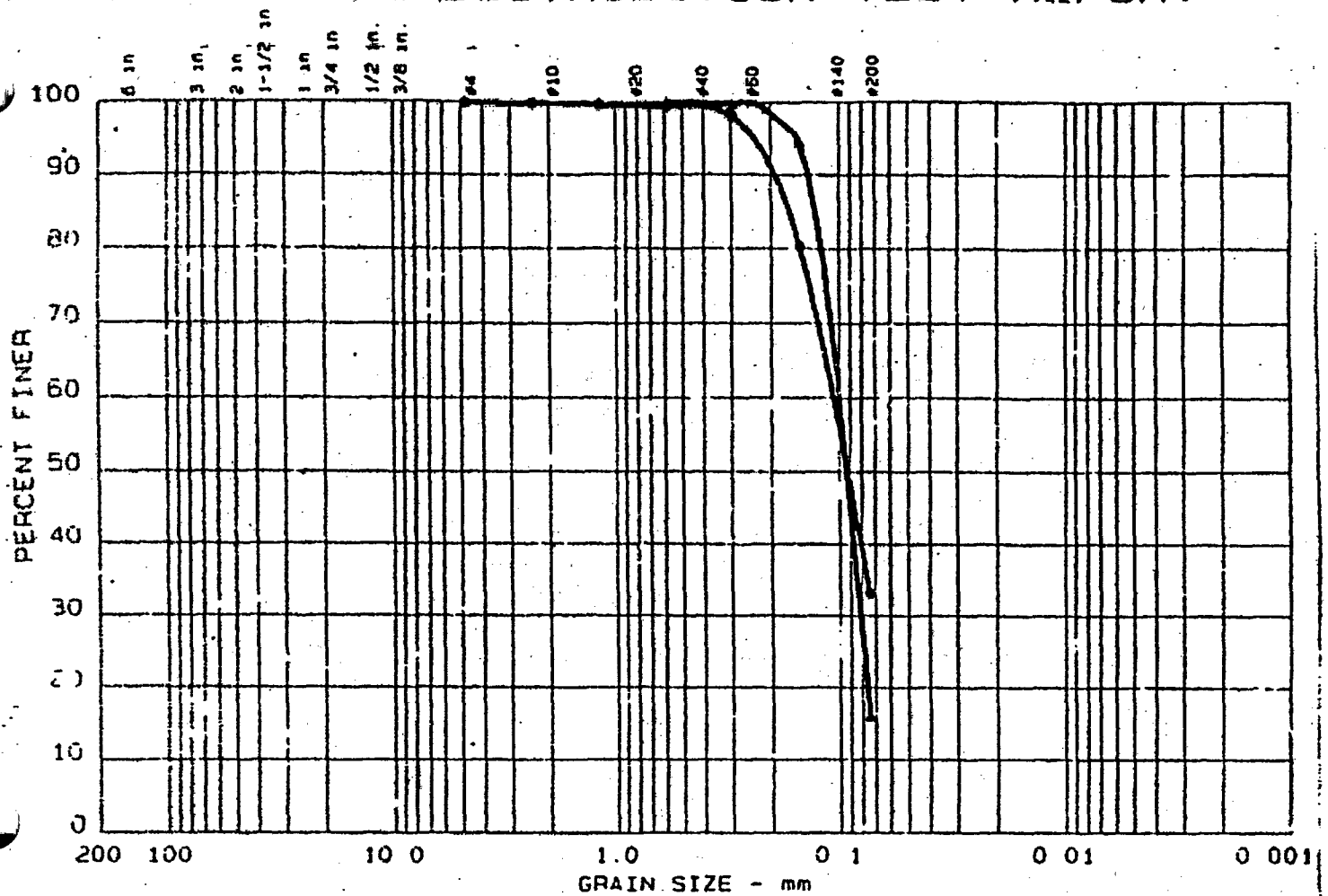
GRAIN SIZE DISTRIBUTION TEST REPORT

Bingham Engineering

B-16

Figure No

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	%+75mm	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0 0	0.0	66.7	33 3	
▲	6	0 0	0.0	83.8	16 2	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	N/A	N/A	0.17	0.11	0.09					
▲	N/A	N/A	0.13	0.10	0.09	0.081				

MATERIAL DESCRIPTION	USCS	AASHTO
● Tan Silty Fine Sand	SM	A-2-4
▲ Tan Silty Fine Sand	SM	UNCLASSIFIE

Project No : 1416-007
Project. Envirocare Hydrogeological Study
● Location GW-198 L-1 Depth. 17'-19'
▲ Location GW-198 L-5 Depth: 22'-24 5

MEAN GRAIN SIZE = 0.1 mm.

Date 02-25 90

Remarks.

Tested By: DA

GRAIN SIZE DISTRIBUTION TEST REPORT

Bingham Engineering B-18

Figure No

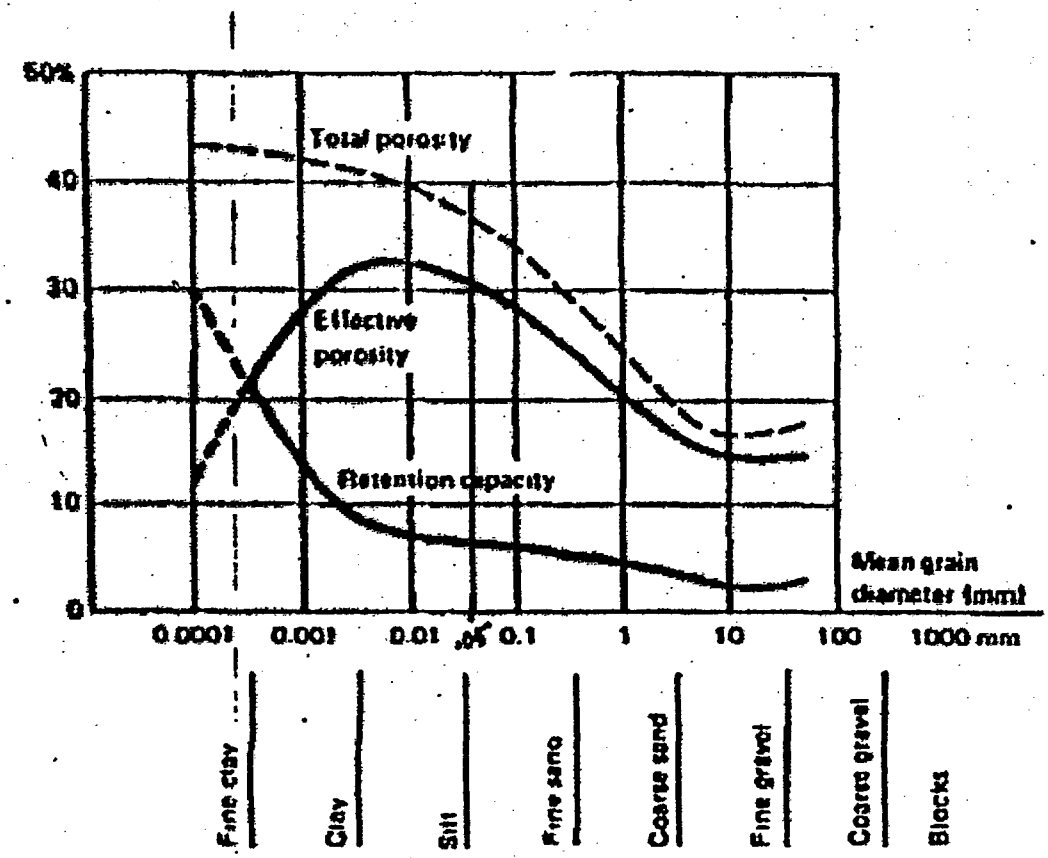


Fig. 2.17. Porosity components as a function of grain size. [After Castany (1967)].

CONVERSATION RECORD

Name of Person Contacted: Vernon Andrews **Organization:** Envirocare of Utah

Telephone No: 801-532 1330 **Time received Call:** 2:20 p.m.

Subject: Envirocare Dose Assessment **Date:** October 20, 1992

SUMMARY:

Mr. Vernon Andrews of Envirocare of Utah called today (October 20, 1992) at 2:20 p.m. to inform of the following:

1. Envirocare is currently conducting dose assessment for off-site maximum reasonably exposed individuals and for population within 50 miles of the site area. Mr. Andrew mentioned that Envirocare is using AIRDOSE code in such assessment. He emphasized that all input parameters used in this assessment belong to Envirocare 11e.(2) proposed site. Specifically he reiterated that source term values, physical parameters, population data, and environmental information (e.g. wind data) all belong to the 11e.(2) site.

2. Mr. Andrews informed that preliminary runs, of AIRDOSE code, indicated off-site maximally exposed individual (receptor was assumed a worker at USCI facility, nearly three miles away from the site) will receive an annual dose much less than 25 mrem.

3. Mr. Andrews informed that he will send today, to NRC by FAX, all input/output information (e.g. source term, site characteristic data, environmental date and actual output results of the dose assessment).

4. Mr. Andrews also informed that Envirocare (through Rogers and Associates) is using PATHRAE code to evaluate on-site worker potential exposure. He mentioned that preliminary runs showed that dose criteria limits may be exceeded. He reiterated that input/output data will also be sent to NRC by FAX today or tomorrow after review of the results.

5. It was emphasized by Mr. Andrew that Envirocare has disregarded all previous dose assessment, since they corresponded to the LLW site, and started freshly the new assessment using site-specific source terms and site-specific physical and environmental parameters.

Mr. Andrew was informed that I (as a person) do not have objection to look at such preliminary data. However, Envirocare should conduct the complete radiological dose assessment in a consolidated manner using site specific source term, and site specific physical and environmental parameters. Envirocare is also requested to address the following issues in their dose assessment:

1. Select the appropriate codes/models taking into consideration objectives of the code/model, availability and type of site specific data, and degree of accuracy needed.

2. Assess impacts on humans and the environment to include: on-site workers, population within 50 miles, off-site maximum reasonably exposed individuals, and potential intruders.

3. Provide input/output data employed in the assessment and all site specific and default parameters used in the site modeling.

4. Provide justification for all assumptions, scenarios, and pathways used in the dose/risk assessment approach.

Action Required:

Look at the new information to be received by fax, discuss with MFW, and the PL, SL, and BC of the LLUR Branch; and wait to receive additional information on on-site worker dose assessment. Further discussion with concerned staff and management will be made before responding to Envirocare.

ENVIROCARE OF UTAH, INC.

ENVIROCARE OF UTAH, INC.
215 South State #1160
Salt Lake City, UT. 84111

5E4

TRANSMISSION REQUEST

TRANSMISSION TO:

NAME: Boby Abu-Eid	FAX NO: 301-504-2260
COMPANY: NRC	LOCATION: Rockville, MD
REMARKS: Mail Stop 5E4	

TRANSMISSION FROM: ENVIROCARE OF UTAH, INC. Verify: (801) 532-1330

NAME: Vern Andrews	DATE: 10/20/92
NO. OF PAGES (INCLUDING COVER) 21	FAX NO: (801) 537-7345
REMARKS:	

40 CFR [illegible] 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: SOUTH CLIVE
Address: TOOELE COUNTY UT
CLIVE NV. 84000
Annual Assessment for Year: 1993
Date Submitted: 10/20/92

Comments: 11E2 POPULATION DOSES

Prepared By:

Name: VERNON ANDREWS
Title: CORPORATE RSO
Phone #: (801) 532-1330

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

CLEAN AIR ACT COMPLIANCE REPORT

Facility: SOUTH CLIVE
Address: TOOELE COUNTY City: CLIVE State: NV
Comments: 11E2 POPULATION DOSES
Year: 1993

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	950.0
Highest Organ Dose Is to ENDOSTEUM	8900.0

EMISSION INFORMATION

Radio-nuclide	Class	Amod	Area #1 (ci/y)	Area #2 (ci/y)
RA-226	W	1.0	4.4E-02	9.0E-03
TH-230	W	1.0	4.4E-02	9.0E-03
TH-232	W	1.0	1.2E-01	2.3E-03
U-238	Y	1.0	4.4E-03	9.0E-04
U-232	Y	1.0	4.4E-03	9.0E-04
U-234	Y	1.0	4.4E-03	9.0E-04
U-235	Y	1.0	2.0E-03	4.0E-03
PB-210	D	1.0	4.4E-02	9.0E-03
PO-210	W	1.0	4.4E-02	9.0E-03
Total Area (m**2)			4.0E+06	9.3E+02

SITE INFORMATION

Wind Data	CLIVE D,UNO	Temperature (C)	11
Food Source	LOCAL	Rainfall (cm/y)	15
Distance to Individuals (m)	300	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/Y)
GONADS	1.1E+01
BREAST	1.1E+01
RED MARROW	7.1E+02
LUNGS	4.7E+03
THYROID	1.1E+01
ENDOSTEUM	8.9E+03
REMAINDER	9.7E+01
EFFECTIVE	9.5E+02

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/Y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE ENDOSTEUM (mrem/Y)
INGESTION	5.9E+01	8.6E+02
INHALATION	8.9E+02	8.0E+03
AIR IMMERSION	4.1E-06	5.1E-06
GROUND SURFACE	1.3E-01	1.4E-01
TOTAL:	9.5E+02	8.9E+03

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF DISTANCE IN THE DIRECTIONS OF THE
MAXIMALLY EXPOSED INDIVIDUAL FOR
ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : WEST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
300	9.5E+02
1000	1.1E+02
3000	1.7E+01
10000	2.5E+00
80000	6.9E-02

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION
OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL
RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS: / DISTANCE (METERS):	N	NNE	NE	ENE	E	ESE	SE	SSE
300	5.0E+02	4.2E+02	3.5E+02	2.9E+02	2.1E+02	1.6E+02	1.6E+02	1.1E+02
1000	5.0E+01	4.7E+01	3.3E+01	3.4E+01	1.8E+01	1.5E+01	2.2E+01	9.7E+00
3000	7.6E+00	7.3E+00	5.2E+00	5.3E+00	2.8E+00	2.3E+00	3.3E+00	1.5E+00
10000	1.1E+00	1.1E+00	8.1E-01	8.2E-01	4.4E-01	3.6E-01	5.1E-01	2.3E-01
80000	3.3E-02	3.7E-02	2.8E-02	2.7E-02	1.6E-02	1.3E-02	1.6E-02	7.5E-03

DISTANCE (METERS):	S	SSW	SW	WSW	W	WNW	NW	NNW
300	7.8E+01	1.4E+02	3.4E+02	7.5E+02	[illegible]	7.9E+02	5.8E+02	5.4E+02
1000	2.7E+00	1.9E+01	2.2E+01	1.1E+02	[illegible]	8.3E+01	4.7E+01	6.4E+01
3000	4.2E-01	3.0E+00	3.4E+00	1.6E+01	1.7E+01	1.3E+01	7.1E+00	9.6E+00
10000	6.5E-02	4.6E-01	5.0E-01	2.4E+00	2.5E+00	1.9E+00	1.1E+00	1.4E+00
80000	2.3E-03	1.5E-02	1.4E-02	6.9E-02	6.9E-02	5.6E-02	2.9E-02	3.6E-02

WIND SPEED - KNOTS

Winds From Direction	Deg	1-3	4-6	7-10	11-16	17-21	>21
N	0.00	0.00000	0.00694	0.00000	0.00000	0.00000	0.00000
NNE	22.50	0.00694	0.02778	0.00000	0.00000	0.00000	0.00000
NE	45.00	0.01389	0.01389	0.00000	0.00000	0.00000	0.00000
ENE	67.50	0.06944	0.05903	0.00347	0.00000	0.00000	0.00000
E	90.00	0.07639	0.05208	0.00000	0.00000	0.00000	0.00000
ESE	112.50	0.04861	0.06250	0.00000	0.00000	0.00000	0.00000
SE	135.00	0.03125	0.02431	0.00000	0.00000	0.00000	0.00000
SSE	157.50	0.04861	0.01736	0.00000	0.00000	0.00000	0.00000
S	180.00	0.03125	0.02778	0.00694	0.00000	0.00000	0.00000
SSW	202.50	0.01736	0.06250	0.00694	0.00000	0.00000	0.00000
SW	225.00	0.00694	0.04861	0.02431	0.00000	0.00000	0.00000
WSW	247.50	0.01389	0.03125	0.02083	0.00000	0.00000	0.00000
W	270.00	0.00000	0.03819	0.01389	0.00000	0.00000	0.00000
WNW	292.50	0.00347	0.02083	0.01042	0.00000	0.00000	0.00000
NW	315.00	0.01042	0.02083	0.00347	0.00000	0.00000	0.00000
NNW	337.50	0.00347	0.01389	0.00000	0.00000	0.00000	0.00000
	1.00000	0.38194	0.52778	0.09028	0.00000	0.00000	0.00000

FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.066	0.00	0.00	0.00	1.91	0.00	0.00	0.00
NNW	0.066	0.00	0.00	0.00	1.25	0.00	0.00	0.00
NW	0.056	0.00	0.00	0.00	1.56	0.00	0.00	0.00
WNW	0.111	0.00	0.00	0.00	1.78	0.00	0.00	0.00
W	0.128	0.00	0.00	0.00	1.50	0.00	0.00	0.00
WSW	0.132	0.00	0.00	0.00	1.67	0.00	0.00	0.00
SW	0.028	0.00	0.00	0.00	1.67	0.00	0.00	0.00
SSW	0.035	0.00	0.00	0.00	2.21	0.00	0.00	0.00
S	0.007	0.00	0.00	0.00	2.57	0.00	0.00	0.00
SSE	0.017	0.00	0.00	0.00	2.21	0.00	0.00	0.00
SE	0.035	0.00	0.00	0.00	2.21	0.00	0.00	0.00
ESE	0.035	0.00	0.00	0.00	2.93	0.00	0.00	0.00
E	0.052	0.00	0.00	0.00	3.05	0.00	0.00	0.00
ENE	0.066	0.00	0.00	0.00	2.76	0.00	0.00	0.00
NE	0.080	0.00	0.00	0.00	2.96	0.00	0.00	0.00
NNE	0.087	0.00	0.00	0.00	2.36	0.00	0.00	0.00

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.066	0.00	0.00	0.00	1.25	0.00	0.00	0.00
NNW	0.066	0.00	0.00	0.00	0.95	0.00	0.00	0.00
NW	0.056	0.00	0.00	0.00	1.11	0.00	0.00	0.00
WNW	0.111	0.00	0.00	0.00	1.27	0.00	0.00	0.00
W	0.128	0.00	0.00	0.00	1.08	0.00	0.00	0.00
WSW	0.132	0.00	0.00	0.00	1.16	0.00	0.00	0.00
SW	0.028	0.00	0.00	0.00	1.19	0.00	0.00	0.00
SSW	0.035	0.00	0.00	0.00	1.75	0.00	0.00	0.00
S	0.007	0.00	0.00	0.00	2.57	0.00	0.00	0.00
SSE	0.017	0.00	0.00	0.00	1.75	0.00	0.00	0.00
SE	0.035	0.00	0.00	0.00	1.55	0.00	0.00	0.00
ESE	0.035	0.00	0.00	0.00	2.32	0.00	0.00	0.00
E	0.052	0.00	0.00	0.00	2.89	0.00	0.00	0.00
ENE	0.066	0.00	0.00	0.00	1.89	0.00	0.00	0.00
NE	0.080	0.00	0.00	0.00	2.39	0.00	0.00	0.00
NNE	0.087	0.00	0.00	0.00	1.79	0.00	0.00	0.00

Reciprocal-Average
Wind Speed

Dose
(MREM)

	0.0 N	22.5 NNE	45.0 NE	67.5 ENE	90.0 E	112.5 ESE	135.0 SE	157.5 SSE
1,000	5.60E+01	4.70E+01	3.30E+01	3.40E+01	1.80E+01	1.50E+01	2.20E+01	9.70E+00
2,400	1.10E+01	1.10E+01	7.60E+00	7.70E+00	4.10E+00	3.40E+00	4.90E+00	2.20E+00
10,000	1.10E+00	1.10E+00	8.10E-01	8.20E-01	4.40E-01	3.60E-01	5.10E-01	2.30E-01
16,000	5.40E-01	5.30E-01	3.90E-01	3.90E-01	2.21E-01	1.70E-01	2.40E-01	1.10E-01
24,000	2.70E-01	2.80E-01	2.00E-01	2.00E-01	1.10E-01	9.00E-02	1.20E-01	5.60E-02
32,000	1.70E-01	1.70E-01	1.30E-01	1.30E-01	7.10E-02	5.70E-02	7.70E-02	3.50E-02
40,000	1.20E-01	1.20E-01	8.90E-02	8.80E-02	5.00E-02	4.00E-02	5.30E-02	2.50E-02
48,000	8.50E-02	8.90E-02	6.70E-02	6.50E-02	3.70E-02	3.00E-02	3.90E-02	1.80E-02
56,000	5.90E-02	6.30E-02	4.80E-02	4.60E-02	2.70E-02	2.10E-02	2.80E-02	1.30E-02
64,000	4.60E-02	5.00E-02	3.90E-02	3.70E-02	2.10E-02	1.70E-02	2.20E-02	1.00E-02
72,000	3.80E-02	4.10E-02	3.10E-02	3.00E-02	1.80E-02	1.40E-02	1.80E-02	8.30E-03
80,000	3.30E-02	3.70E-02	2.80E-02	2.70E-02	1.60E-02	1.30E-02	1.60E-02	7.50E-03

20.92 12:28 ☎901 537 7345 ENVIROCARE 2009

Dose (MREM)	180.0 S	202.5 SSW	225.0 SW	247.5 WSW	270.0 W	WNW	315.0 NW	337.5 NNW
1,000	2.70E+00	1.90E+01	2.20E+01	1.10E+02	1.10E+02	8.30E+01	4.70E+01	6.40E+01
2,400	6.10E-01	4.40E+00	4.90E+00	2.40E+01	2.50E+01	1.90E+01	1.00E+01	1.40E+01
10,000	6.50E-02	4.60E-01	5.00E-01	2.40E+00	2.50E+00	1.90E+00	1.10E+00	1.40E+00
16,000	3.10E-02	2.20E-01	2.30E-01	1.10E+00	1.20E+00	8.90E-01	4.90E-01	6.50E-01
24,000	1.60E-02	1.10E-01	1.20E-01	5.70E-01	5.80E-01	4.50E-01	2.50E-01	3.20E-01
32,000	1.00E-02	7.10E-02	7.40E-02	3.50E-01	3.60E-01	2.80E-01	1.50E-01	2.00E-01
40,000	7.30E-03	4.90E-02	5.00E-02	2.40E-01	2.50E-01	1.90E-01	1.00E-01	1.30E-01
48,000	5.40E-03	3.60E-03	3.70E-03	1.80E-01	1.80E-01	1.40E-01	7.60E-02	9.70E-02
56,000	3.90E-03	2.60E-02	2.60E-02	1.20E-01	1.20E-01	9.90E-02	5.30E-02	6.70E-02
64,000	3.10E-03	2.00E-02	2.00E-02	9.50E-02	9.60E-02	7.70E-02	4.10E-02	5.10E-02
72,000	2.60E-03	1.70E-02	1.60E-02	7.70E-02	7.70E-02	6.30E-02	3.30E-02	4.10E-02
80,000	2.30E-03	1.50E-02	1.40E-02	6.90E-02	6.90E-02	5.60E-02	2.90E-02	3.60E-02

Population	0.0 N	22.5 NNE	45.0 NE	67.5 ENE	90.0 E	112.5 ESE	135.0 SE	157 SSE
1,000								
2,400								
10,000								
16,000								
24,000								
32,000				8				
40,000					11	30	21	
48,000							20	
56,000					2771	26	7	
64,000					1921	125	52	
72,000					1398	14801	124	
80,000					852	3223	12	

Population	180.0 S	202.5 SSW	225.0 SW	247.5 WSW	270.0 W	292.5 WNW	315.0 NW	337.5 NNW
',000								
2,400								
10,000					25			
16,000								
24,000								
32,000								
40,000								
48,000								
56,000								
64,000								
72,000								
80,000								

10 20 92 12 29 ☎401 337 7343 ENVIROCARE 2.011

Dose
(Person-Rem)

	0.0 N	2.25E+01 NNE	45.0 NE	67.5 ENE	90.0 E	112.5 ESE	135.0 SE	157.5 SSE
1,000	0	0	0	0	0	0	0	0
2,400	0	0	0	0	0	0	0	0
10,000	0	0	0	0	0	0	0	0
16,000	0	0	0	0	0	0	0	0
24,000	0	0	0	0.0016	0	0	0	0
32,000	0	0	0	0	0.000781	0.00171	0.001617	0
40,000	0	0	0	0	0	0	0.00106	0
48,000	0	0	0	0	0.102527	0.00078	0.000273	0
56,000	0	0	0	0	0.049167	0.002625	0.001456	0
64,000	0	0	0	0	0.029358	0.251617	0.002728	0
72,000	0	0	0	0	0.015336	0.045122	0.000216	0
80,000	0	0	0	0	0	0	0	0

Dose
(Person-Rem)

	180.0 S	202.5 SSW	225.0 SW	247.5 WSW	270.0 W	292.5 WNW	315.0 NW	337.5 NNW
1,000	0	0	0	0	0	0	0	
2,400	0	0	0	0	0.625	0	0	0
10,000	0	0	0	0	0	0	0	0
16,000	0	0	0	0	0	0	0	0
24,000	0	0	0	0	0	0	0	0
32,000	0	0	0	0	0	0	0	0
40,000	0	0	0	0	0	0	0	0
48,000	0	0	0	0	0	0	0	0
56,000	0	0	0	0	0	0	0	0
64,000	0	0	0	0	0	0	0	0
72,000	0	0	0	0	0	0	0	0
80,000	0	0	0	0	0	0	0	0

Rogers & Associates
Input Parameters
for PATHRAE

Envirocare @ Clive
C9200/20
19-Oct-92

ASSUMPTIONS:

1. Receptor is at the property boundary 24 hours per day, 365 days per year.

2. Dust loading in the active area is at the OSHA limits for nuisance dust in the work place (5 mg/m3) 24 hours per day, 365 days per year.

3. Active area is 10 percent of the total disturbed area of 46,475 m2.

4. No portion of the disturbed area is closer than 91 m from the property. boundary.

5. Neutral (D) stability.

METHODOLOGY:

1. Virtual point source model described in PATHRAE User's Manual: Virtual distance is the actual distance from the edge of the active area plus 2.5137 * the width of the active area.

2. Dispersion coefficients (sigma's) calculated using Briggs formulation. For D stability, sigma = 0.06 * distance.

3. Dose calculated as the product of Chi/Q, U, C, DCF, and R, where:
   Chi/Q = as calculated, Ci/m3 per Ci/sec.
   U = 8000, m3/yr.
   C = as shown, pCi/g.
   DCF = as shown, mrem/pCi.
   R = sigma-z * Ubar * dust loading / width, g/sec.

4. Doses are calculated for the maximum point on the property boundary, considering three general active areas (SW, SE, and NE corners) and 16 wind directions with respective frequencies and average speeds.

5. Chi/Q is calculated as the sector average, as described in PATHRAE User's Manual.

Envirocare @ Clive
C9200/20
19-Oct-92

	Average Concentration (pCi/g)	Inhalation Dose Conversion Factor (mrem/pCi)	Southwest Corner Maximum Fenceline Dose Rate (mrem/yr)	Southeast Corner Maximum Fenceline Dose Rate (mrem/yr)	Northeast Corner Maximum Fenceline Dose Rate (mrem/yr)
Ra-226 + Daughters	340	0.02	3.10E+00	3.10E+00	3.32E-01
Th-230	340	0.38	5.55E+01	5.55E+01	5.94E+00
Th-232 + Daughters	910	0.55	2.17E+02	2.17E+02	2.32E+01
Natural Uranium	35	0.10	1.50E+00	1.50E+00	1.60E-01
		TOTALS	2.77E+02	2.77E+02	2.96E+01

Envirocare @ Clive SOUTHWEST CORNER

C9200/20 FACE X-COORDINATE (m): 91

19-Oct-92 FACE Y-COORDINATE (m): 91

SECTOR	ANGLE (radians)	Actual Distance (m)	Virtual Distance (m)	Sigma (m)	Chi/Q (Ci/m3 per Ci/sec)	
1	0.00	1518	1689	101	8.20E-08	
2	0.39	1643	1814	109	1.80E-07	
3	0.79	2147	2318	139	1.19E-07	
4	1.18	1643	1814	109	9.88E-07	
5	1.57	1518	1689	101	1.12E-06	
6	1.96	238	409	25	1.45E-05	
7	2.36	129	300	18	1.50E-05	
8	2.75	98	270	16	2.51E-05	<--MAX
9	3.14	91	262	16	2.10E-05	
10	3.53	98	270	16	1.99E-05	
11	3.93	129	300	18	1.17E-05	
12	4.32	98	270	16	1.41E-05	
13	4.71	91	262	16	8.86E-06	
14	5.11	98	270	16	6.44E-06	
15	5.50	129	300	18	7.15E-06	
16	5.89	238	409	25	1.77E-08	
Σfi					2.51E-05	

Envirocare @ Clive SOUTHEAST CORNER
C9200/20 FACE X-COORDINATE (m): 741
19-Oct-92 FACE Y-COORDINATE (m): 91

SECTOR	ANGLE (radians)	Actual Distance (m)	Virtual Distance (m)	Sigma (m)	Chi/Q (Ci/m3 per Ci/sec)	
1	0.00	1518	1689	101	3.20E-08	
2	0.39	1643	1814	109	1.80E-07	
3	0.78	1228	1399	84	3.27E-07	
4	1.18	940	1111	67	2.50E-06	
5	1.57	868	1039	62	2.96E-06	
6	1.96	238	409	25	1.45E-05	
7	2.36	129	300	18	1.50E-05	
8	2.75	98	270	16	2.51E-05	<--MAX
9	3.14	91	262	16	2.10E-05	
10	3.53	98	270	16	1.99E-05	
11	3.93	129	300	18	1.17E-05	
12	4.32	238	409	25	6.15E-06	
13	4.71	741	912	55	7.33E-07	
14	5.11	802	973	58	4.85E-07	
15	5.50	1048	1219	73	4.33E-07	
16	5.89	1643	1814	109	9.02E-08	
ΣR					2.51E-05	

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NORTHEAST CORNER

FACE X-COORDINATE (m): 741
FACE Y-COORDINATE (m): 555

SECTOR	ANGLE (radians)	Actual Distance (m)	Virtual Distance (m)	Sigma (m)	Chi/Q (Ci/m3 per Ci/sec)	
1	0.00	1054	1225	74	6.08E-08	
2	0.39	1141	1312	79	3.45E-07	
3	0.78	1228	1399	84	3.27E-07	
4	1.18	940	1111	67	2.50E-06	
5	1.57	868	1039	63	2.96E-06	
6	1.96	940	1111	67	1.96E-06	
7	2.36	785	956	57	1.47E-06	
8	2.75	601	772	46	3.06E-06	<--MAX
9	3.14	555	726	44	2.74E-06	
10	3.53	601	772	46	2.43E-06	
11	3.93	785	956	57	1.15E-06	
12	4.32	802	973	58	1.09E-06	
13	4.71	741	912	55	7.38E-07	
14	5.11	802	973	58	4.95E-07	
15	5.50	1048	1219	73	4.33E-07	
16	5.89	1141	1312	79	1.72E-07	
Σfi					3.06E-06	

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SECTOR	ANGLE (radians)	Southwest Corner Chi/Q (Ci/m3 per Ci/sec)	Southeast Corner Chi/Q (Ci/m3 per Ci/sec)	Northeast Corner Chi/Q (Ci/m3 per Ci/sec)
1	0.00	3.20E-08	3.20E-08	6.08E-08
2	0.39	1.80E-07	1.80E-07	3.45E-07
3	0.79	1.19E-07	3.27E-07	3.27E-07
4	1.18	9.38E-07	2.50E-06	2.50E-06
5	1.57	1.12E-06	2.96E-06	2.96E-06
6	1.96	1.45E-05	1.45E-05	1.96E-06
7	2.36	1.50E-05	1.50E-05	1.47E-06
8	2.75	2.51E-05	2.51E-05	3.06E-06
9	3.14	2.10E-05	2.10E-05	2.74E-06
10	3.53	1.99E-05	1.99E-05	2.43E-06
11	3.93	1.17E-05	1.17E-05	1.15E-06
12	4.32	1.41E-05	6.15E-06	1.09E-06
13	4.71	8.86E-06	7.33E-07	7.33E-07
14	5.11	6.44E-06	4.85E-07	4.95E-07
15	5.50	7.15E-06	4.83E-07	4.33E-07
16	5.89	1.77E-06	9.02E-08	1.72E-07
Σfi		2.51E-05	2.51E-05	3.06E-06

Envirocare @ Clive
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FACE WIDTH (m): 68 <-10% of total active area

PROPERTY BOUNDARY COORDINATES:

North (m):	1609
East (m):	1609
South (m):	0
West (m):	0

SECTOR	ANGLE (radians)	1-3 KNOTS 2	4-6 KNOTS 5	7-10 KNOTS 8.5	Σfi	Ubar or Σfi/Σ(fi/ui) (m/s)
1	0.00	0.0000	0.0069	0.0000	0.0069	2.57
2	0.39	0.0069	0.0278	0.0000	0.0347	1.96
3	0.79	0.0139	0.0139	0.0000	0.0278	1.47
4	1.18	0.0694	0.0590	0.0035	0.1319	1.45
5	1.57	0.0764	0.0521	0.0000	0.1285	1.36
6	1.96	0.0486	0.0625	0.0000	0.1111	1.55
7	2.36	0.0313	0.0243	0.0000	0.0556	1.40
8	2.75	0.0486	0.0174	0.0000	0.0660	1.22
9	3.14	0.0313	0.0278	0.0069	0.0660	1.54
10	3.53	0.0174	0.0625	0.0069	0.0868	2.03
11	3.93	0.0069	0.0486	0.0243	0.0799	2.56
12	4.32	0.0139	0.0313	0.0208	0.0660	2.17
13	4.71	0.0000	0.0382	0.0139	0.0521	2.89
14	5.11	0.0035	0.0208	0.0104	0.0347	2.51
15	5.50	0.0104	0.0208	0.0035	0.0347	1.63
16	5.89	0.0035	0.0139	0.0000	0.0174	1.98
Σfi		0.3819	0.5278	0.0903	1.0000	