U-004-304.13

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SUBMITTAL OF REQUESTED CHANGE PAGES FOR THE OPERABLE UNIT 1 AND 2 DOCUMENTS (OPERABLE UNIT 2 RI REPORT) REF: 5303, 5304

03/16/94

DOE-1175-94
DOE-FN/EPA
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LETTER
OU2

Department of Energy
Fernald Environmental Management Project
P.O. Box 398705
Cincinnati, Ohio 45239-8705
(513) 738-6357

-5305

MAR 16 1994
DOE-1175-94

Mr. James A. Saric, Remedial Project Director
U. S. Environmental Protection Agency
Region V-5HRE-8J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Graham E. Mitchell, Project Manager
Ohio Environmental Protection Agency
40 South Main Street
Dayton, Ohio 45402-2086

Dear Mr. Saric and Mr. Mitchell:

SUBMITTAL OF REQUESTED CHANGE PAGES FOR THE OPERABLE UNIT 1 AND 2 DOCUMENTS

As requested during the February 24, 1994, meeting between U.S. Environmental Protection Agency (USEPA), Ohio Environmental Protection Agency (OEPA), Department of Energy (DOE), and Fernald Environmental Restoration Management Company (FERMCO), this letter provides a description of the language that will be added to the Operable Unit 1 (OU1) and Operable Unit 2 (OU2) Remedial Investigation and Feasibility Studies (RI/FS) to address the trespassing and recreational exposure scenarios.

The following language will be added to both the OU1 and OU2 RI/FS descriptions of the expanded trespasser scenario.

"For purposes of establishing preliminary remediation goals (PRGs) for the Future Land Use With Continued Federal Ownership, an on-property trespassing receptor was established. Under this exposure scenario, access to the site would be restricted and would be discouraged through the construction and maintenance of signs, fences, and locked gates around the perimeter of the restricted area. Despite these controls, it is assumed that trespassing would occur. The expanded trespassing scenario assumes a youth (ages 6 to 18) trespasses 110 days per year for two hours each day and the same person trespasses as an adult (ages 18 to 50) 40 days per year for one hour each day. This receptor and the associated exposure factors apply only to OUs 1, 2, and 4. The risk assessment for the OU5 FS will include additional trespassing as well as recreational exposure scenarios, which are to be fully developed on a site-wide basis within the OU 5 RI/FS. A full array of trespassing and recreational exposure scenarios from no trespassing through full recreational use of the site will be developed."

01

Recycled and Recyclable

Change pages for the OU1 RI and OU2 RI/FS are included as an enclosure to this letter. Change pages containing the agreed upon language for addressing risks from dermal absorption of PAHs and child inhalation rates are also included. A description of the trespassing and recreational exposure scenarios for OU5 along with the associated exposure factors will be submitted to USEPA and OEPA for approval by March 31, 1994.

If you have any comments concerning these conclusions please contact Randy C. Janke at (513) 648-3123 if there are any additional questions regarding this submittal.

Sincerely,

Johnny Reising

for Jack R. Craig
Fernald Remediation Action
Project Manager

FN:RC Janke

Enclosures: As Stated

cc w/enc:

K. A. Chaney, EM-424, TREV
D. R. Kozlowski, EM-424, TREV
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J. Kwasniewski, OEPA-Columbus
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F. Bell, ATSDR
AR Coordinator, FERMCO

OPERABLE UNIT 2
REMEDIAL INVESTIGATION

March 15, 1994

- On-Property Building User - This scenario considers risks from occupancy of an existing on-site building by a hypothetical receptor. This receptor was not considered since no existing habitable structures exist in Operable Unit 2.

- Hunter - this scenario examines risks due to consumption of animal products from wild animals found on the FEMP property. This receptor, as stated in the Risk Assessment Work Plan Addendum, will be evaluated in Operable Unit 5.

To evaluate risk to potential future receptors, it is assumed that the FEMP site will either be retained by the federal government (federal ownership) or will be released for private development (without federal ownership). If it is assumed that the most likely option of the FEMP site under federal ownership is continued restrictive access, therefore, the most likely future receptor might be an expanded trespasser. Potential exposures to an off-property farm family are also evaluated, assuming that the most likely off-site future land use would be agricultural. Specific exposure pathways by which these receptors may be exposed to contaminants on or migrating from Operable Unit 2 source areas are listed in Table 6-1.

For the purpose of establishing preliminary remediation goals (PRGs) for the Future Land Use With Continued Federal Ownership scenario, an on-property trespassing receptor was established. Under this exposure scenario, access to the site would be restricted and discouraged through the construction and maintenance of signs, fences, and locked gates around the perimeter of the restricted area. Despite these controls, it was assumed that trespassing would occur. The expanded trespasser scenario assumes a youth (ages 6 to 18) trespasses 110 days per year for two hours each day and the same person trespasses as an adult (ages 18 to 50) 40 days per year for one hour each day. This receptor and the associated exposure factors apply only to Operable Units 1, 2, 3, and 4. The risk assessment for the Operable Unit 5 FS will include additional trespassing and recreational exposure scenarios, which are to be fully developed on a site-wide basis within the Operable Unit 5 RI/FS. A full array of trespassing and recreational exposure scenarios from no trespassing through full recreational use of the site will be developed.

As summarized in Table 6-1, future land use receptors, assuming federal ownership, include:

- Expanded Trespasser - This scenario assumes that the same visitor will routinely visit what is now the Operable Unit 2 Study Area after. The expanded trespasser is assumed to wander unrestricted over the entire site. Exposure routes include:

  - Inhalation of fugitive dust, VOCs, and gases.

04

- Incidental ingestion of, dermal contact with, and external radiation from contaminated soil.
- Incidental ingestion of and dermal contact with surface water.
- Incidental ingestion of, dermal contact with, and external radiation sediment.

- Off-Property Resident Farmer (Adult and Child) - This scenario assumes that a farm family lives immediately adjacent to the FEMP property boundary. Exposure routes for this receptor include those listed for the same receptor assuming current land use, in addition to ingestion, dermal contact, and inhalation from groundwater.

- User of the Great Miami River (Adult and Child) - This scenario considers risks to an off-property resident who uses the river for recreational purposes. Exposure routes include:

  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, dermal contact with, and external radiation from sediment.
  - Ingestion of fish.

If the FEMP property does not remain under the federal ownership, it is assumed that it will be held in private ownership and developed for agricultural use. As summarized in Table 6-1, future land use receptors, assuming private ownership, include:

- Reasonable Maximum Exposure (RME) On-Property Resident Farmer Receptor (Adult and Child) - This exposure assumes that a farmer resides on the property and conducts agricultural activities. Typical activities may include food and feed production, livestock production, and general farm work. This scenario includes only household use of perched groundwater because the perched groundwater because the perched groundwater zone would not be sufficient to support agricultural uses. Exposure routes include:

  - Inhalation of fugitive dust, VOCs, and gases.
  - Ingestion of groundwater (separate evaluations for groundwater from the Great Miami Aquifer and for perched groundwater).
  - Dermal contact and inhalation while using groundwater in the home.
  - Consumption of foodstuff grown on the property including vegetables, meat, and milk.
  - Incidental ingestion of, external radiation from, and dermal contact with soil.
  - Inhalation of indoor radon.

- Central Tendency (CT) On-Property Resident Farmer Receptor (Adult and Child) - This exposure assumes that a farmer resides on the property and conducts agricultural activities. This exposure is similar to the RME on-property resident farmer with modifications of exposure parameter values to more closely reflect values typical of the CT of exposure. Exposure routes for this receptor include those listed for the RME on-property resident farmer receptor, excluding ingestion of perched groundwater.

- Future Home Builder - This exposure scenario involves exposures to workers building residences or other structures within Operable Unit 2. This scenario includes only household use of perched groundwater because the perched groundwater zone would not be sufficient to support aggricultural uses. Exposure routes include:

  - Incidental ingestion of, and dermal contact with, and external radiation from soil.
  - Inhalation of fugitive dust, VOCs, and gases.

- A Perched Groundwater User - This exposure scenario involves exposures to users of perched groundwater within Operable Unit 2. Exposure routes include:

  - Inhalation and dermal contact while using perched groundwater
  - Ingestion of perched groundwater

- User of the Great Miami River (Adult and Child) - This scenario considers risks to an off-property resident who uses the river for recreational purposes. Exposure routes include:

  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, dermal contact with, and external radiation from sediment.
  - Ingestion of fish.

TABLE 6-12A

CURRENT LAND USE
SOUTH FIELD
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
Soil					
Total Rad Risk	1.1E-05	1.4E-07	2.6E-09	N/A[a]	6.3E-04
Total Chem Risk	1.3E-05	3.2E-08	2.7E-09	N/A	1.9E-05
Total Risk	2.56E-05	1.8E.07	5.3E-09	N/A	6.5E.04
Sediment					
Total Rad Risk	7.0E-06	N/A	N/A	N/A	N/A
Total Chem Risk	5.0E-05	N/A	N/A	N/A	N/A
Total Risk	5.7E-05	N/A	N/A	N/A	N/A
Surface Water					
Total Rad Risk	2.2E-08	N/A	N/A	N/A	N/A
Total Chem Risk	-[b]	N/A	N/A	N/A	N/A
Total Risk	N/A	N/A	N/A	N/A	N/A
Homegrown Produce (Dust Affected)					
Total Rad Risk	N/A	2.6E-09	1.9E-10	N/A	N/A
Total Chem Risk	N/A	3.4E.08	1.2E-08	N/A	N/A
Total Risk	N/A	3.7E-08	1.2E-08	N/A	N/A
Beef/Milk (Dust Affected)					
Total Rad Risk	N/A	7.7E-10	1.3E-10	6.6E-09	N/A
Total Chem Risk	N/A	4.9E-07	2.8E-07	4.2E-06	N/A
Total Risk	N/A	4.9E-07	2.8E-07	4.2E-06	N/A

[a]N/A signifies that exposure of the receptor to the indicated medium is not applicable.
[b]No risk greater than the threshold level of $1x10^{-6}$

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TABLE 6-13A

SOUTH FIELD
FUTURE LAND USE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
Soil							
Total Rad Risk	1.7E-05	1.4E-07	2.6E-09	1.7E-03	1.2E-04	N/A[a]	N/A
Total Chem Risk	5.1E-05	3.2E-08	2.7E-09	6.9E-04	1.9E-04	N/A	N/A
Total Risk	7.1E-05	1.8E-07	5.3E-09	2.7E-03	4.3E-04	N/A	N/A
Sediment							
Total Rad Risk	4.9E-06	N/A	N/A	N/A	N/A	2.0E-05	8.1E-06
Total Chem Risk	1.5E-04	N/A	N/A	N/A	N/A	2.0E-05	9.8E-06
Total Risk	1.5E-04	N/A	N/A	N/A	N/A	4.2E-05	1.9E-05
Groundwater							
Total Rad Risk	N/A	2.0E-05	8.5E-07	3.9E-04	1.7E-05	N/A	N/A
Total Chem Risk	N/A	-[b]	-	-	-	N/A	N/A
Total Risk	N/A	2.0E-05	8.5E-07	3.9E-04	1.7E-05	N/A	N/A
Surface Water							
Total Rad Risk	5.7E-07	N/A	N/A	N/A	N/A	1.6E-06	6.5E-07
Total Chem Risk	N/A	N/A	N/A	N/A	N/A	6.9E-05	4.5E-05
Total Risk	5.7E-07	N/A	N/A	N/A	N/A	7.0E-05	4.5E-05
Homegrown Produce (Dust Affected)							
Total Rad Risk	N/A	7.5E-08	5.5E-09	6.2E-07	4.6E-08	N/A	N/A
Total Chem Risk	N/A	9.6E-07	3.3E-07	8.0E-06	2.8E-06	N/A	N/A
Total Risk	N/A	1.0E-06	3.4E-07	8.6E-06	2.8E-06	N/A	N/A
Homegrown Produce (Groundwater Affected)							
Total Rad Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Total Chem Risk	-	-	-	-	-	N/A	N/A
Total Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Beef/Milk (Dust Affected)							
Total Rad Risk	N/A	2.3E-08	3.9E-09	1.9E-07	3.2E-08	N/A	N/A
Total Chem Risk	N/A	1.4E-05	8.0E-06	1.2E-04	6.9E-05	N/A	N/A
Total Risk	N/A	1.4E-05	8.0E-06	1.2E-04	6.9E-05	N/A	N/A

See footnotes at end of table

TABLE 6-14A

SOUTH FIELD
SUMMARY OF TOTAL CARCINOGENIC RISK
FOR SELECTED FUTURE LAND USE RECEPTOR
OPERABLE UNIT 2 REMEDIAL INVESTIGATION
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME)[a]			
			COC[b]				COC				COC	
Media	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total
Soil	1.8E-07[c]	0.22%	-[d]		7.1E-05	31.15%	Th-228	4.62%	2.7E-03	62.57%	Th-228	27.64%
							Ra-228	2.01%			Ra-228	12.46%
							Beryllium	19.23%			Beryllium	8.74%
							Aroclor-1254	1.31%			Benzo(a)-pyrene	4.53%
Sediment	NA[e]		-		1.5E-04	68.59%	Th-228	1.43%	NA		-	
							Beryllium	64.85%				
							Arsenic	1.48%				
Groundwater	2.0E-05	69.57%	U-238	44.97%	NA		-		3.9E-04	29.13%	U-238	18.83%
			U-234	23.27%							U-234	9.76%
Home Grown Produce (Dust Affected)	1.0E-06[c]	1.28%	-		NA		-		8.6E-06	0.23%	Benzo(a)-pyrene	0.11%
Hone Grown Produce (Groundwater Affected)	8.4E-06	10.43%	U-238	6.73%	NA		-		1.6E-04	4.36	U-238	2.82%
			U-234	3.49%							U-234	1.46%
Beef/Milk (Dust Affected)	1.4E-05	17.26%	Indeno(1,2,3-cd)pyrene	13.99%	NA		-		1.2E-04	3.20%	Indeno(1,2,3-cd)pyrene	2.60%
Beef/Milk (Groundwater Affected)	1.0E-06[c]	1.24%	-		NA		-		1.9E-05	0.51%	U-238	0.33%
											U-234	0.17%
ALL MEDIA	8.1E-05				2.2E-04				3.8E-03			

[a]RME = Reasonable Maximum Exposure
[b]COC = Contaminant of Concern
[c]Below risk threshold level - provided for comparison purposes
[d]No major risk contributors
[e]NA = not applicable to conceptual model

FER\CRU2RI\TLC\SECTION6\TAB6-14A\March 14, 1994 10:38am

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TABLE 6-16A

CURRENT LAND USE
INACTIVE FLYASH PILE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
Soil					
Total Rad Risk	6.7E-06	4.5E-08	8.2E-10	N/A[a]	1.8E-05
Total Chem Risk	2.5E-05	2.4E-08	2.0E-09	N/A	3.2E-05
Total Risk	3.1E-05	6.9E-08	2.8E-09	N/A	5.1E-05
Sediment					
Total Rad Risk	1.6E-06	N/A	N/A	N/A	N/A
Total Chem Risk	1.6E-07	N/A	N/A	N/A	N/A
Total Risk	1.7E-06	N/A	N/A	N/A	N/A
Surface Water					
Total Rad Risk	3.7E-08	N/A	N/A	N/A	N/A
Total Chem Risk	9.6E-09	N/A	N/A	N/A	N/A
Total Risk	4.6E-08	N/A	N/A	N/A	N/A
Homegrown Produce (Dust Affected)					
Total Rad Risk	N/A	4.9E-10	3.6E-11	N/A	N/A
Total Chem Risk	N/A	1.4E-08	4.9E-09	N/A	N/A
Total Risk	N/A	1.5E-08	4.9E-09	N/A	N/A
Beef/Milk (Dust Affected)					
Total Rad Risk	N/A	8.2E-11	1.4E-11	1.1E-09	N/A
Total Chem Risk	N/A	2.3E-09	5.3E-10	3.0E-08	N/A
Total Risk	N/A	2.4E-09	5.4E-10	3.2E-08	N/A

[a]N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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TABLE 6-17A

INACTIVE FLYASH PILE
FUTURE LAND USE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
Soil							
Total Rad Risk	9.2E-06	4.5E-08	8.2E-10	9.8E-04	7.3E-05	N/A[a]	N/A
Total Chem Risk	1.0E-04	2.4E-08	2.0E-09	9.9E-04	1.9E-04	N/A	N/A
Total Risk	1.1E-04	6.9E-08	2.8E-09	2.0E-03	2.8E-04	N/A	N/A
Sediment							
Total Rad Risk	1.1E-06	N/A	N/A	N/A	N/A	1.9E-05	7.5E-06
Total Chem Risk	2.E-07	N/A	N/A	N/A	N/A	1.0E-06	6.6E-07
Total Risk	1.3E-06	N/A	N/A	N/A	N/A	2.1E-05	8.7E-06
Groundwater							
Total Rad Risk	N/A	5.6E-05	2.4E-06	1.1E-03	4.7E-05	N/A	N/A
Total Chem Risk	N/A	-[b]	-	-	-	N/A	N/A
Total Risk	N/A	5.6E-05	2.4E-06	1.1E-03	4.7E-05	N/A	N/A
Surface Water							
Total Rad Risk	9.4E-07	N/A	N/A	N/A	N/A	2.7E-08	1.1E-08
Total Chem Risk	1.4E-07	N/A	N/A	N/A	N/A	2.7E-07	6.1E-08
Total Risk	1.1E-06	N/A	N/A	N/A	N/A	3.0E-07	7.2E-08
Homegrown Produce (Dust Affected)							
Total Rad Risk	N/A	4.9E-10	3.6E-11	6.4E-09	4.8E-10	N/A	N/A
Total Chem Risk	N/A	1.4E-08	4.9E-09	1.9E-07	6.5E-08	N/A	N/A
Total Risk	N/A	1.5E-08	4.9E-08	1.9E-07	6.5E-08	N/A	N/A
Homegrown Produce (Groundwater Affected)							
Total Rad Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
Total Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Beef/Milk (Dust Affected)							
Total Rad Risk	N/A	8.2E-11	1.4E-11	9.9E-10	1.7E-10	N/A	N/A
Total Chem Risk	N/A	2.3E-09	5.3E-10	2.8E-08	6.3E-09	N/A	N/A
Total Risk	N/A	2.4E-09	5.4E-10	2.9E-08	6.5E-09	N/A	N/A

See footnotes at end of table

TABLE 6-20A

CURRENT LAND USE
SOLID WASTE LANDFILL
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
Soil					
Total Rad Risk	5.4E-06	3.2E-08	5.8E-10	N/A[a]	1.5E-05
Total Chem Risk	7.8E-06	2.4E-09	2.0E-10	N/A	9.4E-06
Total Risk	1.3E-05	3.5E-08	7.9E-10	N/A	2.4E-05
Sediment					
Total Rad Risk	2.2E-06	N/A	N/A	N/A	N/A
Total Chem Risk	2.4E-07	N/A	N/A	N/A	N/A
Total Risk	2.6E-06	N/A	N/A	N/A	N/A
Surface Water					
Total Rad Risk	2.7E-09	N/A	N/A	N/A	N/A
Total Chem Risk	1.1E-09	N/A	N/A	N/A	N/A
Total Risk	3.8E-09	N/A	N/A	N/A	N/A
Homegrown Produce (Dust Affected)					
Total Rad Risk	N/A	3.1E-10	2.3E-11	N/A	N/A
Total Chem Risk	N/A	5.0E-09	1.7E-09	N/A	N/A
Total Risk	N/A	5.3E-09	1.8E-09	N/A	N/A
Beef/Milk (Dust Affected)					
Total Rad Risk	N/A	5.6E-11	1.0E-11	3.4E-09	N/A
Total Chem Risk	N/A	6.4E-09	3.6E-09	3.8E-07	N/A
Total Risk	N/A	6.4E-09	3.6E-09	3.9E-07	N/A

[a]N/A signifies that exposure of the receptor to the indicated medium is not applicable.

TABLE 6-21A

SOLID WASTE LANDFILL
FUTURE LAND USE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Home-builder	Perched Groundwater User	Perched Groundwater Child	Great Miami River User (Adult)	Great Miami River User (Youth)
Soil										
Total Rad Risk	9.1E-06	9.8E-07	1.8E-08	8.4E-04	6.0E-05	2.7E-06	N/A[a]	N/A	N/A	N/A
Total Chem Risk	1.7E-07	5.3E-10	4.5E-11	2.9E-04	8.0E-06	1.1E-06	N/A	N/A	N/A	N/A
Total Risk	9.3E-06	9.8E-07	1.8E-08	1.1E-03	1.2E-04	3.9E-06	N/A	N/A	N/A	N/A
Sediment										
Total Rad Risk	1.6E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.9E-06	3.9E-06
Total Chem Risk	9.6E-07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.2E-07	2.0E-07
Total Risk	2.6E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0E-05	1.0E-05
Groundwater										
Total Rad Risk	N/A	0.0E+00	0.0E+00	0.0E+00	0.0E+00	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	-[b]	-	-	-	-	-	-	N/A	N/A
Total Risk	N/A	0.0E+00	0.0E+00	0.0E+00	0.0E+00	N/A	N/A	N/A	N/A	N/A
Perched Groundwater										
Total Rad Risk	N/A	N/A	N/A	N/A	N/A	N/A	5.3E-03	1.1E-03	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	-	-	-	N/A	N/A
Total Risk	N/A	N/A	N/A	N/A	N/A	N/A	5.3E-03	1.1E-03	N/A	N/A
Surface Water										
Total Rad Risk	6.8E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.5E-08	2.2E-08
Total Chem Risk	2.5E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.0E-11	2.6E-11
Total Risk	9.3E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.5E-08	2.2E-08
Homegrown Produce (Dust Affected)										
Total Rad Risk	N/A	7.3E-09	5.4E-10	5.0E-07	3.7E-08	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	1.2E-07	4.0E-08	8.0E-06	2.8E-06	N/A	N/A	N/A	N/A	N/A
Total Risk	N/A	1.2E-07	4.1E-08	8.5E-06	2.8E-06	N/A	N/A	N/A	N/A	N/A

TABLE 6-22A

SOLID WASTE LANDFILL
SUMMARY OF TOTAL CARCINOGENIC RISK
FOR SELECTED FUTURE LAND USE RECEPTORS
OPERABLE UNIT 2 REMEDIAL INVESTIGATION
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

MEI Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME)[a]			
			COC[b]				COC				COC	
Media	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total
Soil	9.8E-07[c]	79.35%	-[d]		9.3E-06	93.98%	Th-228	8.26%	1.1E-03	98.48%	Th-228	32.89%
							U-238	5.47%			Ra-228	17.59%
							Ra-228	4.37%			U-238	14.47%
							Beryllium	71.41%			U-235/236	2.53%
											Beryllium	21.11%
Sediment	NA[e]		-		2.6E-06	5.81%	-		NA		-	
Home Grown Produce (Dust Affected)	1.2E-07[c]	9.27%	-		NA		-		8.5E-06	0.73%	Arsenic	0.62%
Beef/Milk (Dust Affected)	1.5E-07[c]	11.24%	-		NA		-		9.0E-06	0.78%	Indeno(1,2,3-cd)pyrene	0.63%
ALL MEDIA	1.3E-06				4.4E-05				1.2E-03			

[a]RME = Reasonable Maximum Exposure
[b]COC = Contaminant of Concern
[c]Below risk threshold level - provided for comparison purposes
[d]No major risk contributors
[e]NA = not applicable to conceptual model

TABLE 6-24A

CURRENT LAND USE
LIME SLUDGE PONDS
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
Soil					
Total Rad Risk	7.6E-06	1.2E-07	2.2E-09	N/A[a]	2.2E-05
Total Chem Risk	2.0E-05	2.3E-09	2.0E-10	N/A	2.5E-05
Total Risk	2.8E-05	1.2E-07	2.4E-09	N/A	4.8E-05
Sediment					
Total Rad Risk	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	N/A	N/A	N/A	N/A
Total Risk	N/A	N/A	N/A	N/A	N/A
Surface Water					
Total Rad Risk	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	N/A	N/A	N/A	N/A
Total Risk	N/A	N/A	N/A	N/A	N/A
Homegrown Produce (Dust Affected)					
Total Rad Risk	N/A	6.3E-09	4.7E-10	N/A	N/A
Total Chem Risk	N/A	3.3E-08	1.1E-08	N/A	N/A
Total Risk	N/A	3.9E-08	1.2E-08	N/A	N/A
Beef/Milk (Dust Affected)					
Total Rad Risk	N/A	1.0E-09	1.8E-10	9.2E-08	N/A
Total Chem Risk	N/A	6.2E-08	3.5E-08	5.4E-06	N/A
Total Risk	N/A	6.3E-08	3.5E-08	5.5E-06	N/A

[a]N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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TABLE 6-25A

LIME SLUDGE PONDS
FUTURE LAND USE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Perched Groundwater User (Adult)	Perched Groundwater User (Child)
Soil							
Total Rad Risk	1.0E-05	1.2E-07	2.2E-09	1.1E-03	8.2E-05	N/A[a]	N/A
Total Chem Risk	8.8E-05	2.3E-09	2.0E-10	7.5E-04	1.2E-04	N/A	N/A
Total Risk	9.8E-05	1.2E-07	2.4E-09	1.9E-03	2.2E-04	N/A	N/A
Groundwater							
Total Rad Risk	N/A	9.1E-09	3.9E-10	1.6E-07	6.9E-09	N/A	N/A
Total Chem Risk	N/A	-[b]	-	-	-	N/A	N/A
Total Risk	N/A	9.1E-09	3.9E-10	1.6E-07	6.9E-09	N/A	N/A
Perched Groundwater							
Total Rad Risk	N/A	N/A	N/A	N/A	N/A	6.7E-08	2.9E-09
Total Chem Risk	N/A	N/A	N/A	N/A	N/A	7.0E-07	1.4E-07
Total Risk	N/A	N/A	N/A	N/A	N/A	7.0E-07	1.4E-07
Homegrown Produce (Dust Affected)							
Total Rad Risk	N/A	6.3E-09	4.7E-10	5.5E-07	4.1E-08	N/A	N/A
Total Chem Risk	N/A	3.3E-08	1.1E-08	2.9E-06	1.0E-06	N/A	N/A
Total Risk	N/A	3.9E-08	1.2E-08	3.4E-06	1.0E-06	N/A	N/A
Homegrown Produce (Groundwater Affected)							
Total Rad Risk	N/A	2.6E-09	1.9E-10	4.5E-08	3.3E-09	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
Total Risk	N/A	2.6E-09	1.9E-10	4.5E-08	3.3E-09	N/A	N/A
Beef/Milk (Dust Affected)							
Total Rad Risk	N/A	1.0E-09	1.8E-10	9.2E-08	1.6E-08	N/A	N/A
Total Chem Risk	N/A	6.2E-08	3.5E-08	5.4E-06	3.0E-06	N/A	N/A
Total Risk	N/A	6.3E-08	3.5E-08	5.5E-06	3.1E-06	N/A	N/A

TABLE 6-27A

OPERABLE UNIT 2-WIDE
FUTURE LAND USE
SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	On-Property Resident Farmer (RME)	Great Miami River User (Adult)	Great Miami River User (Youth)
Soil					
Total Rad Risk	1.7E-05	7.0E-05	1.7E-03	N/A[a]	N/A
Total Chem Risk	4.7E-05	1.1E-05	6.5E-04	N/A	N/A
Total Risk	6.7E-05	8.1E-05	2.6E-03	N/A	N/A
Groundwater					
Total Rad Risk	N/A	6.0E-05	3.9E-04	N/A	N/A
Total Chem Risk	N/A	6.9E-09	-[b]	N/A	N/A
Total Risk	N/A	6.0E-05	3.9E-04	N/A	N/A
Surface Water					
Total Rad Risk	1.8E-06	N/A	N/A	1.3E-04	5.2E-08
Total Chem Risk	5.9E-08	N/A	N/A	7.1E-08	4.6E-08
Total Risk	1.8E-06	N/A	N/A	2.0E-07	9.8E-08
Homegrown Produce (Dust Affected)					
Total Rad Risk	N/A	7.5E-08	6.2E-07	N/A	N/A
Total Chem Risk	N/A	9.6E-07	8.0E-06	N/A	N/A
Total Risk	N/A	1.0E-06	8.0E-06	N/A	N/A
Homegrown Produce (Groundwater Affected)					
Total Rad Risk	N/A	9.0E-06	1.6E-04	N/A	N/A
Total Chem Risk	N/A	9.0E-10	0.0E+00	N/A	N/A
Total Risk	N/A	9.0E-06	1.6E-04	N/A	N/A
Beef/Milk (Dust Affected)					
Total Rad Risk	N/A	1.1E-06	1.9E-07	N/A	N/A
Total Chem Risk	N/A	8.0E-11	1.2E-04	N/A	N/A
Total Risk	N/A	1.1E-06	1.2E-04	N/A	N/A

See footnotes at end of table

TABLE 6-28A

OPERABLE UNIT 2 WIDE
SUMMARY OF TOTAL CARCINOGENIC RISK
FOR SELECTED FUTURE LAND USE RECEPTORS
OPERABLE UNIT 2 REMEDIAL INVESTIGATION
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME)[a]			
			COC[b]				COC				COC	
Media	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total
Soil	8.1E-05	48.78%	U-238	12.20%	6.7E-05	97.20%	Th-228	15.48%	2.6E-03	62.15%	Th-228	27.95%
			Th-230	10.03%			Ra-226	6.75%			Ra-228	12.60%
			Th-228	8.63%			Beryllium	64.48%			Cs-137	1.11%
			U-234	5.66%			Benzo(a)pyrene	2.88%			Beryllium	8.84%
			Chromium	3.19%							Benzo(a)pyrene	4.58%
Groundwater	6.0E-05	36.11%	U-238	23.21%	NA[c]		-[d]		3.9E-04	29.45%	U-238	19.04%
			U-234	12.03%							U-234	9.87%
Surface Water	NA		-		1.8E-06	2.80%	Th-228	2.60%	NA		-	
Homegrown Produce (Dust Affected)	1.0E-06	0.63%	-		NA		-		8.6E-06	0.23%	Benzo(a)pyrene	0.11%
Home Grown Produce (Groundwater Affected)	9.0E-06	5.42%	U-238	3.48%	NA		-		1.6E-04	4.41%	U-238	2.85%
			U-234	1.80%							U-234	1.48%
Beef/Milk (Dust Affected)	1.4E-05	8.43%	Indeno(1,2,3-cd)pyrene	6.83%	NA		-		1.2E-04	3.24%	Indeno(1,2,3-cd)pyrene	2.63%
			Benzo(a)pyrene	0.81%							Benzo(a)pyrene	0.31%
Beef/Milk (Groundwater Affected)	1.1E-06	0.64%	-		NA		-		1.9E-05	0.51%	U-238	0.33%
											U-234	0.17%
ALL MEDIA	1.7E-04				6.6E-05				3.7E-03			

[a]RME = Reasonable Maximum Exposure
[b]COC = Contaminant of Concern
[c]NA = not applicable to conceptual model
[d]No major hazard contributors

FER\CRU2RI\CME\SECTION6\TAB6-28A.NEW\March 14, 1994 10:54am

The current land use configuration used in this risk assessment reflects the physical state of Operable Unit 2 as it exists today. Exposures assuming current land use are based on the following assumptions:

- The Active Flyash Pile and Lime Sludge Ponds remain on site, untreated, uncovered, and vegetated as they are currently
- Existing DOE access restrictions remain
- No additional removal actions are taken
- Mobility of groundwater throughout the site is unaltered
- Pathways of surface water runoff are unaltered
- Vegetative cover remains unchanged
- The effects of radiological and chemical decay of the source are assumed to be minimal.

As indicated in Table B.2-1, receptors listed in the Risk Assessment Work Plan Addendum (DOE 1992a) that were not evaluated under current land use for this risk assessment include:

- Visitor - This scenario is intended to evaluate exposures incurred by the activities of a regular visitor to the FEMP site who is not covered by a health and safety or radiation protection program. An example of this receptor would be a delivery person making regular deliveries to a given building on the site. This receptor was not considered applicable since no visitor would consistently visit the Operable Unit 2 area.
- On-Property Building User - This scenario considers risks from occupancy of an existing building on site by a hypothetical receptor. This receptor was not considered since no existing habitable structures exist in Operable Unit 2.
- Hunter - this scenario examines risks due to consumption of animal products from wild animals found on the FEMP property. This receptor, as stated in the Risk Assessment Work Plan, will be evaluated in the Operable Unit 5 RI report.

B.2.2.2.2 Future Exposure Scenarios

Under future land use assumptions it is assumed that the FEMP site will either be retained by the federal government (federal ownership) or will be released for private development (without federal ownership). It is assumed that the FEMP site may remain restricted under federal ownership. Hence the most appropriate future on-property receptor to evaluate is the expanded trespasser. For the purpose of establishing preliminary remediation goals (PRGs) for the Future Land Use With Continued Federal Ownership scenario, an on-property trespassing receptor was established. Under

this exposure scenario, access to the site would be restricted and discouraged through the construction and maintenance of signs, fences, and locked gates around the perimeter of the restricted area. Despite these controls, it was assumed that trespassing would occur. The expanded trespasser scenario assumes a youth (ages 6 to 18) trespasses 110 days per year for two hours each day and the same person trespasses as an adult (ages 18 to 50) 40 days per year for one hour each day. This receptor and the associated exposure factors apply only to Operable Units 1, 2, 3, and 4. The risk assessment for the Operable Unit 5 FS will include additional trespassing and recreational exposure scenarios, which are to be fully developed on a site-wide basis within the Operable Unit 5 RI/FS. A full array of trespassing and recreational exposure scenarios from no trespassing through full recreational use of the site will be developed.

Potential exposures to an off-property farm family and recreational user of the Great Miami River were also evaluated. It was assumed that the most likely off-site future land use would be for it to remain

agricultural. For the Great Miami River user, it was assumed that Operable Unit 2 has potential to contaminate the Great Miami River and Paddys Run. This receptor is evaluated for both federal ownership and private ownership. Specific exposure pathways which these receptors may be exposed to constituents on, or migrating from Operable Unit 2 source areas are summarized in the CSM and listed in Table B.2-2.

As summarized in the CSM (Figure B.2-2), future land use receptors assuming federal ownership, include:

- The Expanded Trespasser - This scenario assumes that access to the area remains restricted in the future and that either an adult or child trespasser routinely visit the area and be exposed to CPCs. Exposure routes include:

  - Inhalation of fugitive dust, VOCs, and gases.
  - Ingestion of, dermal contact with, and external radiation from, contaminated soil.
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion and dermal contact with sediment.
  - External radiation from contact with sediment.

- The Off-Property Resident Farmer (Adult and Child) - This scenario assumes that a farm family lives immediately adjacent to the FEMP property boundary. Exposure routes for this receptor include those listed for the same receptor assuming current land use, in addition to ingestion, dermal contact, and inhalation from groundwater.

- User of the Great Miami River (Adult and Child) - This scenario considers risks to an off-property resident who uses the river for recreation purposes. Exposure routes include:

  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of and dermal contact with sediment.
  - Ingestion of fish.

If the FEMP property does not remain under the federal ownership, it is assumed that it will be held in private ownership and developed for agricultural use. As illustrated in the CSM (Figure B.2-2) and summarized in Table B.2-2, future land use receptors, assuming private ownership, include:

- The RME On-Property Resident Farmer Receptor (Adult and Child) - This exposure assumes that a farmer resides on the property and conducts agricultural activities. Typical activities may include food and feed production, livestock production, and general farm work. Exposure routes include:

  - Inhalation of fugitive dust, VOCs, and gases.
  - Ingestion of groundwater (separate evaluations for groundwater from the Great Miami Aquifer and for perched groundwater).
  - Dermal contact and inhalation while using groundwater in the home.

EF = exposure frequency (events/year)

BW = body weight (kg)

AT = averaging time (days); for noncarcinogens, AT equals (ED) (365 days/yr); for carcinogens, AT equals (70-year lifetime) (365 days/yr)

Soil dermal absorption coefficients are presented in Table B.2-6A.

Dermal Exposures to PAHs

Reliable cancer slope factors for dermal exposure to polycyclic hydrocarbons (PAHs) are currently unavailable. Current policy indicates it is inappropriate to extrapolate dermal slope factors from oral slope factors for PAHs. Also, extrapolation from other routes of exposure is inappropriate due to varied absorption, metabolic transformations, and target organ end point responses. However, PAHs are potent skin carcinogens. Current information on the contribution to cancer risk from dermal exposure to PAHs indicates the toxicity from the dermal pathway may be as toxic as from oral route of exposure. In order to provide an estimate of the risk contribution from PAHs via dermal exposure for all direct contact pathways, the risk posed for dermal exposure was assumed equal to the risk from oral exposure.

Body Surface Area for Dermal Exposure

The 95th percentile body surface area value of 2.3m^2, recommended by EPA, was the physiological parameter used for the human body surface area during calculation of dermal exposures for all risk assessments. However, this value is currently being re-evaluated by EPA, but until a determination can be reached, the 95th percentile body surface area value will be used.

B.2.4.2.5 Inhalation Of Gases and Particulates

The equations used to quantify intake from the inhalation pathway adapted from EPA (EPA 1989a) are:

$$(\text{radionuclides})I_a = (C_a)(IR)(ED)(ET)(EF) \qquad \text{(B.2-24)}$$

$$(\text{chemicals})I_a = (C_a)(IR)(ET)(EF)(ED)/(BW)(AT) \qquad \text{(B.2-25)}$$

where:

I_a = intake from inhalation (pCi) (mg/kg-day)

TABLE E.IV-31
ILCRs FOR ON-PROPERTY HOME BUILDER FUTURE LAND USE, FUTURE SOURCE TERM

Transfer Media:	Air	Surface Soil and Exposed Waste Pit Material			Buried Pit Material
Exposure Pathways: / Contaminants of Concern	Inhalation	Incidental Ingestion	Dermal Contact[b]	External Exposure	External Exposure[a]
Radionuclides					
Cs_{137+1d}	7.4E-11	4.6E-09	NA	5.8E-07	
Np_{237+1d}	8.7E-08	2.6E-08	NA	9.0E-08	
Pu_{238}	6.8E-09	4.8E-09	NA	1.1E-12	
$Pu_{239/240}$	2.9E-08	1.1E-08	NA	2.3E-12	
Ra_{226+6d}	1.7E-07	5.5E-07	NA	7.5E-06	
Ru_{106}	9.9E-11	6.3E-11	NA	ND	
Sr_{90+1d}	7.0E-11	2.5E-09	NA	ND	
Tc_{99}	9.2E-10	6.5E-09	NA	5.3E-12	
Th_{230}	1.8E-05	3.6E-07	NA	2.7E-09	
$Th_{232+10d}$	2.2E-06	1.2E-07	NA	1.1E-05	
U_{234}	3.6E-06	9.1E-08	NA	3.0E-10	
U_{235+1D}	9.4E-07	1.9E-08	NA	5.0E-07	
U_{238+2d}	2.6E-05	7.1E-07	NA	1.6E-06	
Rn_{222+4d}	3.6E-11	NA	NA	NA	
Total Radionuclides	5.1E-05	1.9E-06		2.1E-05	2.7E-06
Chemicals					
arsenic	1.6E-05	4.4E-05	5.5E-07	NA	NA
beryllium	5.9E-09	1.6E-07	1.9E-06	NA	NA
cadmium	7.5E-09	ND	ND	NA	NA
chromium vi	2.9E-07	ND	ND	NA	NA
lead	ND	ND	ND	NA	NA
nickel	1.2E-08	ND	ND	NA	NA
pcbs	ND	1.8E-07	8.4E-08	NA	NA
benzo(a)anthracene	1.0E-11	1.5E-09	1.5E-09	NA	NA
benzo(a)pyrene	5.1E-11	4.9E-09	4.9E-09	NA	NA
benzo(b)fluoranthene	1.3E-11	9.5E-10	9.5E-10	NA	NA
benzo(k)fluoranthene	2.2E-13	2.1E-10	2.1E-10	NA	NA
chrysene	ND	4.1E-11	4.1E-11	NA	NA
dibenzo(a,h)anthracene	NA	NA	NA	NA	NA
indeno(1,2,3-cd)pyrene	ND	1.6E-10	1.6E-10	NA	NA
n-nitrosodipropylamine	ND	2.0E-09	8.0E-10	NA	NA
pentachlorophenol	ND	9.7E-11	3.9E-10	NA	NA
vinyl chloride	NA	NA	NA	NA	NA
tetrachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA
tetrachlorodibenzofuran	NA	NA	NA	NA	NA
pentachlorodibenzofuran	NA	NA	NA	NA	NA
hexachlorodibenzo-p-dioxin	2.1E-11	4.5E-10	3.2E-10	NA	NA
hexachlorodibenzofuran	NA	NA	NA	NA	NA
heptachlorodibenzo-p-dioxin	7.2E-11	1.6E-09	1.1E-09	NA	NA
heptachlorodibenzofuran	9.0E-12	2.0E-10	1.4E-10	NA	NA
octachlorodibenzo-p-dioxin	8.3E-11	1.8E-09	1.3E-09	NA	NA
octachlorodibenzofuran	4.7E-12	1.0E-10	7.4E-11	NA	NA
chloroform	NA	NA	NA	NA	NA
tetrachloroethene	6.6E-13	2.1E-10	1.1E-09	NA	NA
benzene	NA	NA	NA	NA	NA
methylene chloride	NA	NA	NA	NA	NA
SUM (TEF for PAHs):	1.6E-05	4.4E-05	2.6E-06		
SUM (BaP for PAHs):	1.6E-05	4.4E-05	2.6E-06		
TOTAL RAD. & CHEM.	6.7E-05	4.6E-05	2.6E-06	2.1E-05	2.7E-06
TOTAL RAD. & CHEM.	6.7E-05	4.6E-05	2.6E-06	2.1E-05	2.7E-06

NA – Not applicable. Chemical not a chemical of interest for media or exposure pathway not applicable.
ND – No data for toxicity assessment for exposure pathway.
[a] Risk from external radiation exposure is calculated from total exposure to all gamma radiation sources.
[b] Risk from dermal contact to PAH's is assumed to equal risk from oral ingestion of PAH's.

C_a = concentration in air (pCi/m^3) (mg/m^3)

IR = inhalation rate (m^3/hr)

ET = exposure time (hr/d)

EF = exposure frequency (days/yr)

ED = exposure duration (yr)

BW = body weight (kg)

AT = averaging time (days); for noncarcinogens, AT equals (ED) (365 days/yr); for carcinogens, AT equals (70-year lifetime) (365 days/yr)

Child Inhalation Rate

An inhalation rate (IR) of 0.5m^3/hour was calculated for the child receptors to be used for residential exposure scenarios. This value was developed utilizing currently used physiological parameters by pediatric medical practitioners from the Children's Hospital at the University of Cincinnati Medical Center. The ventilation volumes and rates used approximate the normal active child, in a conservative manner. The value developed for risk assessments is an upward adjustment of the normal child to the moderately active child whose ventilation rate and volume are on the high side of the normal range. Accordingly, the value of 0.5m^3/hour is used as the IR for children, 0 to 6 years of age, and accounts for an increased activity above the normal resting level of activity. This value, developed in consultation with the physicians, is based upon current medical parameters used to treat patients. A value of 0.83m^3/hour was used for trespassing scenarios to account for even higher ventilation volumes.

B.2.4.2.6 External Exposure

The equation used to estimate intake from exposure to direct penetrating radiation is calculated in the following manner:

$$I_{ER} = (C_r)(CF)(EF)(ED)[ET_{OUT} \times (1 - SH_{OUT}) + ET_i \times (1-SH_{IN})] \qquad (B.2\text{-}26)$$

I_{ER}	=	intake from external radiation
C_r	=	concentration in soil (pCi/g)
ET_{OUT}	=	outdoor exposure time (hr/day)
ET_{IN}	=	indoor exposure time (hr/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
SH_{IN}	=	shielding factor for indoors (unitless = 0.5)
SH_{OUT}	=	shielding factor for outdoors (unitless = 0)
CF	=	conversion factor (1.14×10^{-4} yr/hr)

B.2.4.2.7 Ingestion of Water

The equations used to estimate intake from drinking water are adapted from EPA (1989a). The intake equations are:

$$(\text{radionuclides})I_w = (C_w)(IR)(EF)(ED) \qquad \text{(B.2-27)}$$

$$(\text{chemicals})I_w = (C_w)(IR)(ED)(EF)/(BW)(AT) \qquad \text{(B.2-28)}$$

where:

I_w	=	intake from drinking water (pCi) (mg/kg-day)
C_w	=	concentration in water (pCi/L) (mg/L)
IR	=	ingestion rate (L/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals (ED) (365 days/yr); for carcinogens, AT equals (70-year lifetime) (365 days/yr)

These equations can also be modified to quantify intake from incidental ingestion of surface water. The modification consists of replacing IR (L/day) with IR (L/hr) and adding ET (hr/day).