Groundwater Pathway Scoping Analysis for Disposal of APT and TEF Wastes

by

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**GROUNDWATER PATHWAY SCOPING ANALYSIS
FOR DISPOSAL OF APT AND TEF WASTES**

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**GROUNDWATER PATHWAY SCOPING ANALYSIS
FOR DISPOSAL OF APT AND TEF WASTES**

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8/20/98
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Design Check

8/20/98
(per Manual E7, Procedure 2.40)

Approvals/Review

8/21/98
B. T. Butcher, Level 4 Manager, Waste Processing Technology Date

GROUNDWATER PATHWAY SCOPING ANALYSIS OF APT AND TEF WASTES

Introduction and Summary

The methods used to analyze the long-term performance of APT and TEF waste, with respect to the groundwater pathway, disposed in Intermediate Level vaults are described in this report. The purpose of this work is to reduce the number of radionuclides that need to be considered in a detailed analysis of performance. A methodology was selected that is more rigorous than the screening analysis described earlier¹, but still conservative enough that radionuclides shown to have minimal dose impact using the methodology can be neglected with assurance that they would not have produced significant results if included in a detailed computer model.

The screening analysis started with 826 radionuclides and reduced the number to 56 that could potentially be of concern. The screening study used a methodology developed by the National Council on Radiation Protection and Measurements² for releases of radionuclides to groundwater.

The PATHRAE computer code³ was used for this scoping study. The code is described in the following section. This is followed by a description of the conceptual model used and a discussion of the important parameter values used and their sources. Lastly the results of the study are presented.

This work further reduced the number of radionuclides needing detailed analysis from 56 to 23.

Description of the PATHRAE Code

The purpose of the PATHRAE computer code³ is to calculate doses and health effects which might be caused by disposal of waste material in the near surface environment. The code was developed by Rogers and Associates Engineering Corporation, of Salt Lake City, Utah, for the U.S. Environmental Protection Agency, and is accepted by that organization. PATHRAE was selected for use in the Environmental Impact Statement on Waste Management Activities and Groundwater Protection at the Savannah River Site⁴.

Input to the code consists of a number of parameters which describe the waste and the characteristics of the disposal site and the surrounding area. The more that is known about the waste and the site, the more confidence there will be in the results produced by the code.

The PATHRAE code can calculate doses due to a number of exposure pathways: groundwater transport to a surface stream, groundwater use in a nearby well, surface erosion and subsequent waste exposure, trench overflow (bathtub effect), food grown on the site, biointrusion into the waste, direct gamma exposure, inhalation of dust on-site, inhalation of radon gas, and atmospheric transport of particulates off-site.

The code assumes that the waste inventory is evenly distributed throughout the waste volume. For the groundwater transport pathways a specified fraction of the inventory is leached from the waste each year and transported vertically through the unsaturated zone, and then horizontally to hypothetical wells at locations at 1 meter, 100 meters, and to a nearby stream. The water velocity through the unsaturated zone is calculated in the code from input values for infiltration, soil porosity and saturated hydraulic conductivity. The average linear velocity in the water table aquifer is a code input, the value of which is taken from three-dimensional numerical modeling work performed for the E- Area Vault Performance Assessment⁵.

The velocity of each radionuclide considered is calculated based on the partition coefficient (commonly called K_d , and referred to as aquifer sorption in PATHRAE) and the water velocity. A quantity called the retardation factor is calculated from the partition coefficient and used to modify the velocity of a species relative to the water velocity.

The Erosion pathway considers the effects of erosion of the cover material and transport and deposition in a nearby stream.

The pathway called the Bathtub Effect calculates doses due to disposal trenches overflowing if geologic and precipitation conditions are such that this phenomenon might occur.

The Food Grown on Site pathway assumes that at some time in the future someone moves onto the disposal facility and constructs a home with a basement and a water well. Excavation of the basement and well construction brings some portion of the buried waste to the surface, which is then used to grow food in a small garden. The person is thus exposed to radiation from the food he eats.

The Biointrusion pathway is essentially the same as the Food Grown on site except that no home is constructed.

The Direct Gamma pathway considers the effects of penetrating gamma radiation from the buried waste both to workers during the operational phase and to someone occupying the disposal site and disturbing the waste sometime in the future.

The Dust pathway considers inhalation of resuspended dust by an intruder at the waste disposal facility due to house construction and well drilling.

The Radon Inhalation pathway calculates doses due to radon in-growth and radon daughters in a structure built over a disposal facility.

The Atmospheric Transport pathway considers off-site transport of materials due to dust resuspension, incineration, or trench fire.

In each of these pathways a hypothetical person is exposed to radiation released from the disposal facility. The PATHRAE code calculates the dilution, dispersion, or attenuation provided by the waste site and the environment, and thus the curie concentration of each radionuclide to which the person will be exposed. For the ingestion and inhalation exposure pathways, dose conversion factors from the U. S. Department of Energy⁶ are used to calculate annual doses from curie concentrations. Dose conversion factors for direct gamma exposure are taken from the PRESTO data base⁷.

As stated above, the PATHRAE code was used as the basis for dose calculations for the Groundwater Protection and Waste Management Environmental Impact Statement issued by DOE in 1987. One of the supporting documents for the EIS was a quality assurance report on the models used.⁸ Several levels of review are documented in this report, (1) review of code documentation, history of use, and previous validation and verification studies, (2) comparison of model results to alternate models using different boundary conditions, (3) comparison of model predictions to measured concentrations, and (4) sensitivity analysis to identify critical input parameters.

In this work, only the Groundwater to a Well pathway was used.

Conceptual Model

For the purpose of scoping, the entire 40 year projected inventory of both APT and TEF waste was assumed to be disposed in one Intermediate Level vault measuring 85 m long, 15 m wide and 8 m high. This inventory is shown in Table 1. Vault and site characteristics were taken from the EAV PA.⁴

A study of corrosion rate of both the wasteforms and the steel boxes⁹ was used to estimate the time of release and the release rate into the Intermediate Level Vault. All of the inventory was assumed to be in one waste form. A corrosion rate of 2.5 microns/yr was assumed for the wasteform. Assuming that contamination is distributed evenly throughout the assumed 1 cm thickness of the wasteform, the contaminant release fraction is $2. \times 10^{-4}$ per year.

The corrosion rate given for the waste containers was 1×10^{-5} m/yr. The containers are ½ inch thick. Assuming the containers will fail when they have corroded to one-half of their original thickness, the time of failure will be 635 years. This length of time is greater than the intact period of the Intermediate Level Vault (575 years). Therefore, for the scoping model it was assumed that no release or corrosion occurred in the first 635 years after disposal.

Partition coefficient values for the elements included in the scoping analysis and the source of the values are given in Table 2.

All parameters for the PATHRAE code were taken from values used in the EAV Performance Assessment for new radioactive waste disposal⁴. The parameters used can be found in Attachment 1, the output from the PATHRAE program.

Results

The peak concentrations, doses and the years of the peak occurrences are given in Table 3. Those radionuclides that had a peak dose greater than 1 mrem/year were selected for inclusion in the detailed model. These are shown in Table 4.

Table 1. Inventory used in scoping analysis

	APT	APT	APT	APT	APT	TEF	TEF	Totals
	Tungston	Window	Steel	Aluminum	Lead	TPBARS	Baseplate	
	Ci	Ci	Ci	Ci	Ci	Ci	Ci	Ci
H-3	2.1E+08	2.7E+07	5.4E+07	9.2E+06	8.8E+07	1.9E+09		2.3E+09
Be-10	1.8E+00	3.7E-01	7.4E-01	1.4E+00	5.8E+00			1.0E+01
C-14	2.5E+03	2.1E+02	4.1E+02	4.1E+02	8.5E+03	1.5E+03	3.8E+03	1.7E+04
Na-22	1.1E+05	1.7E+06	3.4E+06	1.1E+07	5.6E+06			2.2E+07
Al-26	1.6E+00	3.2E+01	6.4E+01	7.1E+02	4.5E+02			1.3E+03
Si-32	1.4E+00	6.4E-01	1.3E+00	6.3E-05	5.0E-02			3.4E+00
Cl-36	2.3E+01	1.6E+02	3.1E+02	8.1E-10	1.2E+01			5.1E+02
K-40	5.7E-03	3.4E-02	6.8E-02	1.6E-08	2.8E-02			1.4E-01
Ca-41	7.1E+01	3.1E+02	6.2E+02	7.3E+00	3.0E+02			1.3E+03
Ti-44	1.6E+04	1.3E+05	2.5E+05	1.1E-09				4.0E+05
V-49	2.9E+05	1.8E+06	3.7E+06	7.4E+04	1.1E+05			6.0E+06
Mn-53	1.5E+01	2.0E+01	4.0E+01	2.1E-09	3.4E-01			7.5E+01
Fe-60	1.9E-01	4.0E-01	7.9E-01	6.2E-06	7.3E-01			2.1E+00
Ni-59	2.5E+02	1.0E+03	2.0E+03	6.2E-06	1.9E-02	3.7E+03	1.7E+04	2.4E+04
Ge-68	1.2E+03	5.3E+03	1.1E+04		3.8E+04			5.6E+04
Se-79	1.7E+01	2.0E-03	4.0E-03		8.9E+01			1.1E+02
Sr-90	8.5E+03	4.1E-02	8.2E-02		1.1E+05			1.2E+05
Zr-93	8.2E-01	5.6E-01	1.1E+00		3.0E+00	1.8E+01		2.3E+01
Nb-94	2.7E+01	3.7E+02	7.5E+02		1.1E+02	6.1E+01	4.0E+01	1.4E+03
Mo-93	1.8E+00	4.4E+02	8.7E+02		7.7E+02	1.2E+02		2.2E+03
Tc-97	6.1E-01	1.7E-06	3.4E-06		9.1E-01			1.5E+00
Tc-98	1.4E-01	2.8E-05	5.6E-05		3.4E-01			4.8E-01
Tc-99	5.4E+00	4.8E+00	9.7E+00		3.2E+01	3.1E+01	1.0E+01	9.3E+01
Rh-101	2.2E+05				5.8E+05			8.0E+05
Rh-102m	1.2E+02				9.3E+03			9.4E+03
Rh-102	6.2E+04	2.2E-09	4.4E-09		1.3E+05			1.9E+05
Ag-108m	2.2E+01				1.3E+01			3.5E+01
Sb-126					1.2E-05			1.2E-05
I-129	1.8E-02				3.3E-02			5.0E-02
Cs-135	9.0E-03				2.7E-01			2.8E-01
Cs-137	5.4E-02				1.2E+01			1.2E+01
Ba-133	3.8E+06				1.4E+05			3.9E+06
La-137	1.4E+03				1.3E+01			1.4E+03
La-138	6.5E-05				6.9E-06			7.2E-05
Pm-145	5.2E+06				4.8E+04			5.2E+06
Sm-146	1.4E+00				3.0E-02			1.4E+00
Sm-147	8.9E-04				1.5E-05			9.1E-04
Sm-151	3.8E+04				5.0E+03			4.3E+04
Eu-150	1.9E+05				8.5E+03			2.0E+05
Eu-152	1.3E+06				9.7E+03			1.3E+06
Eu-154	1.3E+06				4.7E+04			1.3E+06
Gd-148	1.4E+06				4.2E+04			1.4E+06

Table 1. Inventory used in scoping analysis (continued)

	APT	APT	APT	APT	APT	TEF	TEF	Totals
	Tungston	Window	Steel	Aluminum	Lead	TPBARS	Baseplate	
	Ci	Ci	Ci	Ci	Ci	Ci	Ci	Ci
Tb-157	6.4E+05				2.0E+04			6.6E+05
Tb-158	3.4E+05				1.8E+04			3.6E+05
Ho-166m	1.6E+03				3.3E+02			1.9E+03
Hf-178m	4.1E+02				4.2E+00			4.1E+02
Hf-182	2.8E+00				7.0E-04			2.8E+00
W-181	4.6E+04				8.5E+05			9.0E+05
W-185	3.1E+02				4.1E+02			7.2E+02
Pt-193	2.8E+01				4.1E+06			4.1E+06
Tl-204					5.7E+07			5.7E+07
Pb-202					1.7E+04			1.7E+04
Pb-205					2.3E+02			2.3E+02
Bi-207					1.0E+06			1.0E+06

Table 2. K_d values used in scoping study

Radionuclide	K_d (mL/g)	Reference
Ag	90	10
Al	1500	11
Ar	0	assumed value for inert gas
Ba	52	12
Be	250	10
Bi	100	10
C	2	13
Ca	5	10
Cd	80	10
Cl	1.7	12
Co	60	10
Cs	330	15
Eu	240	10
Fe	220	10
Gd	240	12
Ge	130	assumed same as Sn
H	0	10
Hf	450	10
Ho	250	10
I	0.6	14
K	15	10
Kr	0	assumed value for inert gas
La	1200	12
Mn	50	10
Mo	10	10
Na	76	12
Nb	160	10
Ni	400	10
Pb	270	10
Pm	240	12
Pt	30	assumed same as Au
Rh	52	12
Se	150	10
Si	35	10
Sm	245	10
Sn	130	10
Sr	10	14
Tb	240	12
Tc	0.36	14
Tl	390	12
Ti	600	assumed same as Zr
V	160	assumed same as Nb
W	100	12
Zr	600	10

Table 3. Results of Scoping Analysis at the 1 meter well

Radionuclide	Year of Peak	Peak Concentration pCi/L	Peak Dose (mrem/yr)
Ag-108m	1590	1.89×10^{-1}	1.03×10^{-3}
Al-26	17714.9	4.73×10^4	2.73×10^2
Ba-133	1088.7	1.25×10^{-24}	2.92×10^{-27}
Be-10	7020.2	2.22×10^3	6.82
Bi-207	1506.8	1.38×10^{-7}	4.94×10^{-10}
C-14	735.6	8.23×10^0	1.26×10^4
Ca-41	875.8	6.84×10^3	5.99×10^2
Cl-36	721.9	2.69×10^3	5.90×10^2
Cs-135	7552.9	4.73×10^1	2.45×10^{-1}
Cs-137	3508	6.64×10^{-34}	2.42×10^{-35}
Fe-60	8114.2	5.23×10^2	5.73×10^1
Gd-148	2726	1.25×10^{-3}	1.92×10^{-4}
H-3	643.4	2.18×10^{-4}	1.00×10^{-8}
Hf-182	20441.7	3.51×10^2	3.59
Ho-166m	4603.1	1.41×10^4	8.00×10^1
I-129	805.4	2.65×10^1	5.41
K-40	1340.9	7.41×10^1	1.03
La-137	15188.6	5.59×10^4	1.76×10^1
La-138	15785.3	3.43×10^{-3}	1.48×10^{-5}
Mn-53	2943.4	3.97×10^4	2.87
Mo-93	1103.3	9.36×10^5	8.88×10^2
Nb-94	5951.2	3.99×10^3	1.49×10^3
Ni-59	10283.4	3.10×10^0	4.52×10^2
Pb-202	7884.8	3.45×10^0	9.81×10^4
Pb-205	10534.5	4.74×10^4	5.20×10^1
Pt-193	965.6	2.33×10^2	1.87×10^{-2}
Se-79	6097	3.82×10^4	2.32×10^2
Si-32	1404.2	3.39×10^3	4.20
Sm-146	10622.9	3.19×10^2	4.65×10^1
Sm-151	2769.6	1.23×10^{-4}	3.06×10^{-8}
Sr-90	765.3	6.69×10^{-2}	6.35×10^{-3}
Tb-157	2907.3	1.53×10^1	1.11×10^{-3}
Tb-158	4444.8	2.92×10^0	8.52×10^3
Tc-97	798.8	7.94×10^2	8.69×10^{-2}
Tc-98	798.8	2.54×10^2	8.90×10^{-1}
Tc-99	669	4.91×10^4	4.66×10^1
Ti-44	4030.8	4.61×10^{-20}	6.40×10^{-22}
Zr-93	10417.5	2.18×10^3	2.55

Table 4. Radionuclide requiring detailed analysis

Radionuclide	Peak Dose (mrem/yr)
Al-26	2.73×10^2
Be-10	6.82
C-14	1.26×10^4
Ca-41	5.99×10^2
Cl-36	5.90×10^2
Fe-60	5.73×10^1
Hf-182	3.59
Ho-166m	8.00×10^1
I-129	5.41
K-40	1.03
La-137	1.76×10^1
Mn-53	2.87
Mo-93	8.88×10^2
Nb-94	1.49×10^3
Ni-59	4.52×10^2
Pb-202	9.81×10^4
Pb-205	5.20×10^1
Se-79	2.32×10^2
Si-32	4.20
Sm-146	4.65×10^1
Tb-158	8.52×10^3
Tc-99	4.66×10^1
Zr-93	2.55

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ATTACHMENT I

OUTPUT FROM PATHRAE COMPUTER PROGRAM

PATHRAE-RAD(PC) Version 2.2d February 1995

Date: 7-31-1998

Time: 9:50:16

***** PATHRAE INPUT SUMMARY *****

THERE ARE 80 ISOTOPES IN THE DOSE FACTOR LIBRARY
NUMBER OF TIMES FOR CALCULATION IS 2
YEARS TO BE CALCULATED ARE ...

.00 10000.00

THERE ARE 59 ISOTOPES IN THE INVENTORY FILE
THE VALUE OF IFLAG IS 0
NUMBER OF PATHWAYS IS 1

PATHWAY	TYPE OF USAGE FOR UPTAKE FACTORS
2 GROUNDWATER TO WELL	3

TIME OF OPERATION OF WASTE FACILITY IN YEARS	0.
LENGTH OF REPOSITORY (M)	80.
WIDTH OF REPOSITORY (M)	15.
RIVER FLOW RATE (M**3/YR)	1.00E+10
STREAM FLOW RATE (M**3/YR)	1.00E+00
DISTANCE TO RIVER (M)	100.

OPERATIONAL SPILLAGE FRACTION	0.00E+00
DENSITY OF AQUIFER (KG/M**3)	1500.
LONGITUDINAL DISPERSIVITY (M)	1.00E-04
LATERAL DISPERSION COEFFICIENT -- Y AXIS (M**2/YR)	0.00E+00
NUMBER OF MESH POINTS FOR DISPERSION CALCULATION	100
FLAG FOR GAMMA PATHWAY OPTIONS	0
FLAG FOR GAMMA BUILDUP CALCULATION	0
FLAG FOR ATMOSPHERIC PATHWAY	0

COVER THICKNESS OVER WASTE (M)	6.00
THICKNESS OF WASTE IN PITS (M)	7.90
TOTAL WASTE VOLUME (M**3)	7.300E+03
DISTANCE TO WELL -- X COORDINATE (M)	-1.
DISTANCE TO WELL -- Y COORDINATE (M)	0.
DENSITY OF WASTE (KG/M**3)	1500.

FRACTION OF FOOD CONSUMED THAT IS GROWN ON SITE	.500
FRACTION OF YEAR SPENT IN DIRECT RADIATION FIELD	1.000
DEPTH OF PLANT ROOT ZONE (M)	1.000
AREAL DENSITY OF PLANTS (KG/M**2)	1.000
AVERAGE DUST LOADING IN AIR (KG/M**3)	1.00E-07
ANNUAL ADULT BREATHING RATE (M**3/YR)	8000.

FRACTION OF YEAR EXPOSED TO DUST	1.000
CANISTER LIFETIME (YEARS)	635.
INVENTORY SCALING FACTOR	1.00E+00
HEIGHT OF ROOMS IN RECLAIMER HOUSE (CM)	240.
AIR CHANGE RATE IN RECLAIMER HOUSE (CHANGES/SEC)	5.56E-04
RADON EMANATING POWER OF THE WASTE	2.00E-01

DIFFUSION COEFF. OF RADON IN WASTE (CM**2/SEC)	2.00E-02
DIFFUSION COEFF. OF RN IN CONCRETE (CM**2/SEC)	3.00E-04
THICKNESS OF CONCRETE SLAB FLOOR (CM)	200.0
DIFFUSION COEFF. OF RADON IN COVER (CM**2/SEC)	1.00E-01
ATMOSPHERIC STABILITY CLASS	4
AVERAGE WIND SPEED (M/S)	5.00
FRACTION OF TIME WIND BLOWS TOWARD RECEPTOR	.1000
RECEPTOR DISTANCE FOR ATMOSPHERIC PATHWAY (M)	100.0
DUST RESUSPENSION RATE FOR OFFSITE TRANSPORT (M**3/S)	1.00E-06
DEPOSITION VELOCITY (M/S)	.1000
STACK HEIGHT (M)	.0
STACK INSIDE DIAMETER (M)	.00
STACK GAS VELOCITY (M/S)	.0
HEAT EMISSION RATE FROM BURNING (CAL/S)	0.00E+00
DECAY CHAIN FLAGS	0 0 0 0 0 0 0
FLAG FOR INPUT SUMMARY PRINTOUT	1
FLAG FOR DIRECTION OF TRENCH FILLING	0
FLAG FOR GROUNDWATER PATHWAY OPTIONS	1
AMOUNT OF WATER PERCOLATING THROUGH WASTE ANNUALLY (M)	4.00E-01
DEGREE OF SOIL SATURATION	.500
RESIDUAL SOIL SATURATION	.100
PERMEABILITY OF VERTICAL ZONE (M/YR)	10.00
SOIL NUMBER	.250
POROSITY OF AQUIFER	.30
POROSITY OF UNSATURATED ZONE	.30
DISTANCE FROM AQUIFER TO WASTE (M)	8.0
AVERAGE VERTICAL GROUNDWATER VELOCITY (M/YR)	1.00E+01
HORIZONTAL VELOCITY OF AQUIFER (M/YR)	10.0
LENGTH OF PERFORATED WELL CASING (M)	10.000
SURFACE EROSION RATE (M/YR)	2.000E-04
LEACH RATE SCALING FACTOR	1.000E+00
ANNUAL RUNOFF OF PRECIPITATION (M)	5.00E-01

NUCLIDE	INGESTION DOSE FACTORS (MREM/PCI)	INHALATION DOSE FACTORS (MREM/PCI)	DIRECT GAMMA DOSE FACTORS (MREM-M2/PCI-YR)	HALF LIFE (YR)
Ag-108m	7.500E-06	2.000E-04	1.700E-04	1.270E+02
Al-26	7.900E-06	5.900E-06	2.500E-04	7.200E+05
Ar-39	0.000E+00	0.000E+00	0.000E+00	2.690E+02
Ar-42	0.000E+00	0.000E+00	0.000E+00	3.300E+01
Ba-133	3.200E-06	6.900E-06	6.200E-05	1.050E+01
Be-10	4.200E-06	2.700E-07	0.000E+00	1.600E+06
Bi-207	4.900E-06	1.400E-05	1.500E-04	3.340E+01
C-14	2.100E-06	2.100E-06	0.000E+00	5.730E+03
Ca-41	1.200E-06	1.300E-06	2.100E-09	1.030E+05
Cd-113m	1.500E-04	1.400E-03	0.000E+00	1.370E+01
Cl-36	3.000E-06	2.000E-05	4.700E-12	3.010E+05
Co-60	2.600E-05	1.500E-04	2.300E-04	5.270E+00
Cs-135	7.100E-06	4.500E-06	0.000E+00	2.300E+06
Cs-137	5.000E-05	3.200E-05	6.100E-05	3.020E+01
Eu-150	1.500E-06	6.100E-07	0.000E+00	5.000E+00
Eu-152	6.000E-06	2.200E-04	1.100E-04	1.360E+01
Eu-154	9.100E-06	2.600E-04	1.200E-04	8.800E+00
Fe-60	1.500E-04	7.600E-04	0.000E+00	3.000E+05
Gd-148	2.100E-04	3.300E-01	0.000E+00	8.400E+01
Ge-68	1.100E-06	4.900E-05	1.200E-07	7.900E-01
H-3	6.300E-08	6.300E-08	0.000E+00	1.230E+01
Hf-178m	2.000E-05	2.000E-03	0.000E+00	1.360E-07
Hf-182	1.400E-05	2.800E-03	0.000E+00	9.000E+06
Ho-166m	7.800E-06	7.200E-04	1.600E-04	1.200E+03
I-129	2.800E-04	1.800E-04	2.200E-06	1.570E+07
K-40	1.900E-05	1.200E-05	1.400E-05	1.280E+09
Kr-85	0.000E+00	0.000E+00	2.300E-07	1.070E+01
La-137	4.300E-07	7.300E-05	0.000E+00	6.000E+04
La-138	5.900E-06	1.400E-03	0.000E+00	1.100E+11
Mn-53	9.900E-08	4.300E-07	1.600E-08	3.700E+06
Mo-93	1.300E-06	2.800E-05	5.800E-07	3.500E+03
Na-22	1.200E-05	8.000E-06	2.100E-04	2.600E+00
Nb-93m	5.300E-07	2.800E-05	1.000E-07	1.460E+01
Nb-94	5.100E-06	3.300E-04	1.600E-04	2.030E+04
Ni-59	2.000E-07	2.700E-06	4.200E-08	7.500E+04
Ni-63	5.400E-07	6.300E-06	0.000E+00	1.000E+02
Pb-202	3.900E-05	9.900E-05	0.000E+00	3.000E+05
Pb-205	1.500E-06	3.700E-06	7.600E-08	1.510E+07
Pm-145	4.600E-07	2.700E-05	2.900E-06	1.770E+01
Pt-193	1.100E-07	2.100E-07	5.600E-08	5.000E+01
Rh-101	2.300E-06	3.200E-05	0.000E+00	5.000E+00
Rh-102m	3.500E-06	4.200E-05	0.000E+00	5.750E-01
Rh-102	8.500E-06	8.700E-05	0.000E+00	2.900E+00
Se-79	8.300E-06	8.900E-06	0.000E+00	6.500E+04
Si-32	1.700E-06	1.000E-03	0.000E+00	3.300E+02
Sm-146	2.000E-04	7.800E-02	0.000E+00	7.000E+07
Sm-151	3.400E-07	2.900E-05	5.200E-10	9.000E+01
Sn-121m	1.300E-06	8.900E-06	0.000E+00	7.600E+01
Sr-90	1.300E-04	1.300E-03	0.000E+00	2.860E+01
Tb-157	1.000E-07	9.000E-06	4.700E-07	1.500E+02
Tb-158	4.000E-06	2.500E-04	0.000E+00	1.200E+03
Tc-97	1.500E-07	8.900E-07	6.400E-07	2.600E+06
Tc-98	4.800E-06	1.700E-05	1.400E-04	4.200E+06
Tc-99	1.300E-06	7.500E-06	6.300E-11	2.130E+05
Ti-44	1.900E-05	8.900E-04	1.700E-05	4.730E+01
Tl-204	3.200E-06	2.300E-06	1.300E-07	3.780E+00
V-49	5.400E-08	2.800E-07	7.500E-09	9.000E-01
W-181	3.100E-07	1.500E-07	4.700E-06	3.300E-01
Zr-93	1.600E-06	3.200E-04	0.000E+00	1.530E+06

NUCLIDE	VOLATILITY FRACTION	GAMMA ENERGY (MEV)	GAMMA ATTENUATION (1/M)
Ag-108m	0.000E+00	4.710E-01	1.440E+01
Al-26	0.000E+00	9.940E-01	1.010E+01
Ar-39	0.000E+00	0.000E+00	0.000E+00
Ar-42	0.000E+00	0.000E+00	0.000E+00
Ba-133	0.000E+00	1.540E-01	2.220E+01
Be-10	0.000E+00	0.000E+00	0.000E+00
Bi-207	0.000E+00	8.350E-01	1.110E+01
C-14	0.000E+00	0.000E+00	0.000E+00
Ca-41	0.000E+00	3.000E-03	5.000E+02
Cd-113m	0.000E+00	0.000E+00	0.000E+00
Cl-36	0.000E+00	5.110E-01	1.390E+01
Co-60	0.000E+00	1.253E+00	9.200E+00
Cs-135	0.000E+00	0.000E+00	0.000E+00
Cs-137	0.000E+00	0.000E+00	0.000E+00
Eu-150	0.000E+00	5.030E-01	1.390E+01
Eu-152	0.000E+00	4.970E-01	1.400E+01
Eu-154	0.000E+00	6.570E-01	1.250E+01
Fe-60	0.000E+00	0.000E+00	0.000E+00
Gd-148	0.000E+00	0.000E+00	0.000E+00
Ge-68	0.000E+00	0.000E+00	0.000E+00
H-3	0.000E+00	0.000E+00	0.000E+00
Hf-178m	0.000E+00	0.000E+00	0.000E+00
Hf-182	0.000E+00	2.710E-01	1.770E+01
Ho-166m	0.000E+00	4.600E-01	1.450E+01
I-129	0.000E+00	3.100E-02	1.310E+02
K-40	0.000E+00	9.860E-01	1.030E+01
Kr-85	0.000E+00	5.140E-01	1.380E+01
La-137	0.000E+00	0.000E+00	0.000E+00
La-138	0.000E+00	1.240E+00	9.270E+00
Mn-53	0.000E+00	0.000E+00	0.000E+00
Mo-93	0.000E+00	0.000E+00	0.000E+00
Na-22	0.000E+00	7.840E-01	1.140E+01
Nb-93m	0.000E+00	1.420E-02	3.300E+03
Nb-94	0.000E+00	7.870E-01	1.140E+01
Ni-59	0.000E+00	0.000E+00	0.000E+00
Ni-63	0.000E+00	0.000E+00	0.000E+00
Pb-202	0.000E+00	0.000E+00	0.000E+00
Pb-205	0.000E+00	1.000E-02	5.060E+03
Pm-145	0.000E+00	3.390E-02	1.020E+02
Pt-193	0.000E+00	9.000E-03	4.360E+03
Rh-101	0.000E+00	1.700E-01	2.080E+01
Rh-102m	0.000E+00	5.200E-01	1.370E+01
Rh-102	0.000E+00	6.890E-01	1.220E+01
Se-79	0.000E+00	0.000E+00	0.000E+00
Si-32	0.000E+00	0.000E+00	0.000E+00
Sm-146	0.000E+00	0.000E+00	0.000E+00
Sm-151	0.000E+00	2.200E-02	3.460E+02
Sn-121m	0.000E+00	0.000E+00	0.000E+00
Sr-90	0.000E+00	0.000E+00	0.000E+00
Tb-157	0.000E+00	2.120E-02	3.380E+02
Tb-158	0.000E+00	7.690E-01	1.160E+01
Tc-97	0.000E+00	1.660E-02	7.260E+02
Tc-98	0.000E+00	6.960E-01	1.210E+01
Tc-99	0.000E+00	8.900E-02	2.920E+01
Ti-44	0.000E+00	6.700E-02	3.340E+01
Tl-204	0.000E+00	5.100E-02	4.420E+01
V-49	0.000E+00	4.490E-03	5.420E+01
W-181	0.000E+00	4.560E-02	5.420E+01
Zr-93	0.000E+00	0.000E+00	0.000E+00

NUCLIDE	INPUT LEACH RATE (1/YR)	FINAL LEACH RATE (1/YR)	SOLUBILITY (MOLE/L)	INPUT INVENTORY (CI)
Ag-108m	2.540E-04	2.540E-04	0.000E+00	3.500E+01
Al-26	2.540E-04	2.540E-04	0.000E+00	1.300E+03
Ar-39	2.540E-04	2.540E-04	0.000E+00	1.500E+05
Ar-42	2.540E-04	2.540E-04	0.000E+00	1.500E+04
Ba-133	2.540E-04	2.540E-04	0.000E+00	3.900E+06
Be-10	2.540E-04	2.540E-04	0.000E+00	1.000E+01
Bi-207	2.540E-04	2.540E-04	0.000E+00	1.000E+06
C-14	2.540E-04	2.540E-04	0.000E+00	1.700E+04
Ca-41	2.540E-04	2.540E-04	0.000E+00	1.300E+03
Cd-113m	2.540E-04	2.540E-04	0.000E+00	2.300E+02
Cl-36	2.540E-04	2.540E-04	0.000E+00	5.100E+02
Co-60	2.540E-04	2.540E-04	0.000E+00	3.600E+07
Cs-135	2.540E-04	2.540E-04	0.000E+00	2.800E-01
Cs-137	2.540E-04	2.540E-04	0.000E+00	1.200E+01
Eu-150	2.540E-04	2.540E-04	0.000E+00	2.000E+05
Eu-152	2.540E-04	2.540E-04	0.000E+00	1.300E+06
Eu-154	2.540E-04	2.540E-04	0.000E+00	1.300E+06
Fe-60	2.540E-04	2.540E-04	0.000E+00	2.100E+00
Gd-148	2.540E-04	2.540E-04	0.000E+00	1.400E+06
Ge-68	2.540E-04	2.540E-04	0.000E+00	5.600E+04
H-3	2.540E-04	2.540E-04	0.000E+00	2.300E+09
Hf-178m	2.540E-04	2.540E-04	0.000E+00	4.100E+02
Hf-182	2.540E-04	2.540E-04	0.000E+00	2.800E+00
Ho-166m	2.540E-04	2.540E-04	0.000E+00	1.900E+03
I-129	2.540E-04	2.540E-04	0.000E+00	5.000E-02
K-40	2.540E-04	2.540E-04	0.000E+00	1.400E-01
Kr-85	2.540E-04	2.540E-04	0.000E+00	1.200E+05
La-137	2.540E-04	2.540E-04	0.000E+00	1.400E+03
La-138	2.540E-04	2.540E-04	0.000E+00	7.200E-05
Mn-53	2.540E-04	2.540E-04	0.000E+00	7.500E+01
Mo-93	2.540E-04	2.540E-04	0.000E+00	2.200E+03
Na-22	2.540E-04	2.540E-04	0.000E+00	2.200E+07
Nb-93m	2.540E-04	2.540E-04	0.000E+00	6.800E+05
Nb-94	2.540E-04	2.540E-04	0.000E+00	1.400E+03
Ni-59	2.540E-04	2.540E-04	1.000E-02	2.400E+04
Ni-63	2.540E-04	2.540E-04	1.000E-02	2.800E+06
Pb-202	2.540E-04	2.540E-04	0.000E+00	1.700E+04
Pb-205	2.540E-04	2.540E-04	0.000E+00	2.300E+02
Pm-145	2.540E-04	2.540E-04	0.000E+00	5.200E+06
Pt-193	2.540E-04	2.540E-04	0.000E+00	4.100E+06
Rh-101	2.540E-04	2.540E-04	0.000E+00	8.000E+05
Rh-102m	2.540E-04	2.540E-04	0.000E+00	9.400E+03
Rh-102	2.540E-04	2.540E-04	0.000E+00	1.900E+05
Se-79	2.540E-04	2.540E-04	0.000E+00	1.100E+02
Si-32	2.540E-04	2.540E-04	0.000E+00	3.400E+02
Sm-146	2.540E-04	2.540E-04	0.000E+00	1.400E+00
Sm-151	2.540E-04	2.540E-04	0.000E+00	4.300E+04
Sn-121m	2.540E-04	2.540E-04	0.000E+00	1.100E+03
Sr-90	2.540E-04	2.540E-04	0.000E+00	1.200E+05
Tb-157	2.540E-04	2.540E-04	0.000E+00	6.600E+05
Tb-158	2.540E-04	2.540E-04	0.000E+00	3.600E+05
Tc-97	2.540E-04	2.540E-04	0.000E+00	1.500E+00
Tc-98	2.540E-04	2.540E-04	0.000E+00	4.800E-01
Tc-99	2.540E-04	2.540E-04	0.000E+00	9.300E+01
Ti-44	2.540E-04	2.540E-04	0.000E+00	4.000E+05
Tl-204	2.540E-04	2.540E-04	0.000E+00	5.700E+07
V-49	2.540E-04	2.540E-04	0.000E+00	6.000E+06
W-181	2.540E-04	2.540E-04	0.000E+00	9.000E+05
Zr-93	2.540E-04	2.540E-04	0.000E+00	2.300E+01

NUCLIDE	AQUIFER SORPTION	AQUIFER RETARDATION	VERTICAL SORPTION	VERTICAL RETARDATION
Ag-108m	9.000E+01	4.510E+02	9.000E+01	9.010E+02
Al-26	1.500E+03	7.501E+03	1.500E+03	1.500E+04
Ar-39	0.000E+00	1.000E+00	0.000E+00	1.000E+00
Ar-42	0.000E+00	1.000E+00	0.000E+00	1.000E+00
Ba-133	5.200E+01	2.610E+02	5.200E+01	5.210E+02
Be-10	2.500E+02	1.251E+03	2.500E+02	2.501E+03
Bi-207	1.000E+02	5.010E+02	1.000E+02	1.001E+03
C-14	2.000E+00	1.100E+01	2.000E+00	2.100E+01
Ca-41	5.000E+00	2.600E+01	5.000E+00	5.100E+01
Cd-113m	8.000E+01	4.010E+02	8.000E+01	8.010E+02
Cl-36	1.700E+00	9.500E+00	1.700E+00	1.800E+01
Co-60	6.000E+01	3.010E+02	6.000E+01	6.010E+02
Cs-135	3.300E+02	1.651E+03	3.300E+02	3.301E+03
Cs-137	3.300E+02	1.651E+03	3.300E+02	3.301E+03
Eu-150	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Eu-152	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Eu-154	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Fe-60	2.200E+02	1.101E+03	2.200E+02	2.201E+03
Gd-148	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Ge-68	1.300E+02	6.510E+02	1.500E+02	1.501E+03
H-3	0.000E+00	1.000E+00	0.000E+00	1.000E+00
Hf-178m	4.500E+02	2.251E+03	4.500E+02	4.501E+03
Hf-182	4.500E+02	2.251E+03	4.500E+02	4.501E+03
Ho-166m	2.500E+02	1.251E+03	2.500E+02	2.501E+03
I-129	6.000E-01	4.000E+00	1.000E+00	1.100E+01
K-40	1.500E+01	7.600E+01	1.500E+01	1.510E+02
Kr-85	0.000E+00	1.000E+00	0.000E+00	1.000E+00
La-137	1.200E+03	6.001E+03	1.200E+03	1.200E+04
La-138	1.200E+03	6.001E+03	1.200E+03	1.200E+04
Mn-53	5.000E+01	2.510E+02	5.000E+01	5.010E+02
Mo-93	1.000E+01	5.100E+01	1.000E+01	1.010E+02
Na-22	7.600E+01	3.810E+02	7.600E+01	7.610E+02
Nb-93m	1.600E+02	8.010E+02	1.600E+02	1.601E+03
Nb-94	1.600E+02	8.010E+02	1.600E+02	1.601E+03
Ni-59	4.000E+02	2.001E+03	4.000E+02	4.001E+03
Ni-63	4.000E+02	2.001E+03	4.000E+02	4.001E+03
Pb-202	2.700E+02	1.351E+03	2.700E+02	2.701E+03
Pb-205	2.700E+02	1.351E+03	2.700E+02	2.701E+03
Pm-145	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Pt-193	3.000E+01	1.510E+02	3.000E+01	3.010E+02
Rh-101	5.200E+01	2.610E+02	5.200E+01	5.210E+02
Rh-102m	5.200E+01	2.610E+02	5.200E+01	5.210E+02
Rh-102	5.200E+01	2.610E+02	5.200E+01	5.210E+02
Se-79	1.500E+02	7.510E+02	1.500E+02	1.501E+03
Si-32	3.500E+01	1.760E+02	3.500E+01	3.510E+02
Sm-146	2.450E+02	1.226E+03	2.450E+02	2.451E+03
Sm-151	2.450E+02	1.226E+03	2.450E+02	2.451E+03
Sn-121m	1.300E+02	6.510E+02	1.300E+02	1.301E+03
Sr-90	1.000E+01	5.100E+01	1.000E+01	1.010E+02
Tb-157	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Tb-158	2.400E+02	1.201E+03	2.400E+02	2.401E+03
Tc-97	3.600E-01	2.800E+00	3.600E-01	4.600E+00
Tc-98	3.600E-01	2.800E+00	3.600E-01	4.600E+00
Tc-99	3.600E-01	2.800E+00	3.600E-01	4.600E+00
Ti-44	3.900E+02	1.951E+03	3.900E+02	3.901E+03
Tl-204	6.000E+02	3.001E+03	6.000E+02	6.001E+03
V-49	1.600E+02	8.010E+02	1.600E+02	1.601E+03
W-181	1.000E+02	5.010E+02	1.000E+02	1.001E+03
Zr-93	6.000E+02	3.001E+03	6.000E+02	6.001E+03

BIOACCUMULATION FACTORS

NUCLIDE	SOIL-PLANT Bv	SOIL-PLANT Br	FORAGE-MILK Fm (D/L)	FORAGE-MEAT Ff (D/KG)
Ag-108m	1.500E-01	1.500E-02	5.000E-02	1.700E-02
Al-26	6.600E-04	6.600E-05	1.200E-03	4.000E-02
Ar-39	6.000E-01	6.000E-02	2.000E-02	2.000E-02
Ar-42	6.000E-01	6.000E-02	2.000E-02	2.000E-02
Ba-133	5.000E-03	5.000E-04	4.000E-04	3.200E-03
Be-10	4.200E-04	4.200E-05	1.000E-04	1.000E-03
Bi-207	1.500E-01	1.500E-02	5.000E-04	1.300E-02
C-14	5.500E+00	5.500E-01	1.200E-02	3.100E-02
Ca-41	3.600E-02	3.600E-03	8.000E-03	4.000E-03
Cd-113m	3.000E-01	3.000E-02	1.200E-04	5.300E-04
Cl-36	5.000E+00	5.000E-01	5.000E-02	8.000E-02
Co-60	9.400E-03	9.400E-04	1.000E-03	1.300E-02
Cs-135	1.000E-02	1.000E-03	1.200E-02	4.000E-03
Cs-137	1.000E-02	1.000E-03	1.200E-02	4.000E-03
Eu-150	2.500E-03	2.500E-04	5.000E-06	4.800E-03
Eu-152	2.500E-03	2.500E-04	5.000E-06	4.800E-03
Eu-154	2.500E-03	2.500E-04	5.000E-06	4.800E-03
Fe-60	6.600E-04	6.600E-05	1.200E-03	4.000E-02
Gd-148	2.600E-03	2.600E-04	5.000E-06	3.400E-03
Ge-68	2.500E-03	2.500E-04	2.500E-03	8.000E-02
H-3	4.800E+00	4.800E-01	1.000E-02	1.200E-02
Hf-178m	1.700E-04	1.700E-05	5.000E-06	4.000E-01
Hf-182	1.700E-04	1.700E-05	5.000E-06	4.000E-01
Ho-166m	2.600E-03	2.600E-04	5.000E-06	4.400E-03
I-129	2.000E-02	2.000E-03	6.000E-03	2.900E-03
K-40	3.700E-01	3.700E-02	1.000E-02	1.200E-02
Kr-85	3.000E+00	3.000E-01	2.000E-02	2.000E-02
La-137	2.500E-03	2.500E-04	5.000E-06	2.000E-04
La-138	2.500E-03	2.500E-04	5.000E-06	2.000E-04
Mn-53	2.900E-02	2.900E-03	2.500E-04	8.000E-04
Mo-93	1.200E-01	1.200E-02	7.500E-03	8.000E-03
Na-22	5.200E-02	5.200E-03	4.000E-02	3.000E-02
Nb-93m	9.400E-03	9.400E-04	2.500E-03	2.800E-01
Nb-94	9.400E-03	9.400E-04	2.500E-03	2.800E-01
Ni-59	1.900E-02	1.900E-03	6.700E-03	5.300E-03
Ni-63	1.900E-02	1.900E-03	6.700E-03	5.300E-03
Pb-202	6.800E-02	6.800E-03	6.200E-04	2.900E-04
Pb-205	6.800E-02	6.800E-03	6.200E-04	2.900E-04
Pm-145	2.500E-03	2.500E-04	5.000E-06	4.800E-03
Pt-193	1.300E+01	1.300E+00	5.000E-03	1.500E-03
Rh-101	1.300E+01	1.300E+00	1.000E-02	1.500E-03
Rh-102m	1.300E+01	1.300E+00	1.000E-02	1.500E-03
Rh-102	1.300E+01	1.300E+00	1.000E-02	1.500E-03
Se-79	1.300E+00	1.300E-01	4.500E-02	1.500E-02
Si-32	5.500E+00	5.500E-01	1.200E-02	3.100E-02
Sm-146	2.500E-03	2.500E-04	5.000E-06	5.000E-03
Sm-151	2.500E-03	2.500E-04	5.000E-06	5.000E-03
Sn-121m	2.500E-03	2.500E-04	2.500E-03	8.000E-02
Sr-90	1.700E-02	1.700E-03	8.000E-04	6.000E-04
Tb-157	2.600E-03	2.600E-04	5.000E-06	3.400E-03
Tb-158	2.600E-03	2.600E-04	5.000E-06	3.400E-03
Tc-97	2.500E-01	2.500E-02	2.500E-02	4.000E-01
Tc-98	2.500E-01	2.500E-02	2.500E-02	4.000E-01
Tc-99	2.500E-01	2.500E-02	2.500E-02	4.000E-01
Ti-44	2.500E-04	2.500E-05	2.200E-03	2.400E-03
Tl-204	2.500E-01	2.500E-02	2.200E-02	4.000E-02
V-49	2.500E-04	2.500E-05	2.200E-03	2.400E-03
W-181	1.200E-01	1.200E-02	7.500E-03	8.000E-03
Zr-93	1.700E-04	1.700E-05	5.000E-06	3.400E-02

***** PEAK CONCENTRATIONS AND TIMES FOR PATHWAY 2 *****
 ***** WELL AT 1.0 M *****

NUCLIDE	PEAK CONCENTRATION (PCI/L)	PEAK TIME (YR)	AVERAGE DOSE AT PEAK TIME (MREM/YR)	AVERAGE RISK AT PEAK TIME (HE/YR)
Ag-108m	1.89E-01	1590.0	1.03E-03	5.17E-10
Al-26	4.73E+04	17714.9	2.73E+02	1.37E-04
Ar-39	1.51E+07	643.4	0.00E+00	0.00E+00
Ar-42	1.07E+01	643.4	0.00E+00	0.00E+00
Ba-133	1.25E-24	1088.7	2.92E-27	1.46E-33
Be-10	2.22E+03	7020.2	6.82E+00	3.41E-06
Bi-207	1.38E-07	1506.8	4.94E-10	2.47E-16
C-14	8.23E+06	735.6	1.26E+04	6.31E-03
Ca-41	6.84E+05	875.8	5.99E+02	3.00E-04
Cd-113m	6.34E-27	1332.4	6.94E-28	3.47E-34
Cl-36	2.69E+05	721.9	5.90E+02	2.95E-04
Cs-135	4.73E+01	7552.9	2.45E-01	1.23E-07
Cs-137	6.64E-34	3508.0	2.42E-35	1.21E-41
Fe-60	5.23E+02	8114.2	5.73E+01	2.87E-05
Gd-148	1.25E-03	2726.0	1.92E-04	9.60E-11
H-3	2.18E-04	643.4	1.00E-08	5.02E-15
Hf-182	3.51E+02	20441.7	3.59E+00	1.79E-06
Ho-166m	1.41E+04	4603.1	8.00E+01	4.00E-05
I-129	2.65E+01	805.4	5.41E+00	2.70E-06
K-40	7.41E+01	1340.9	1.03E+00	5.14E-07
Kr-85	5.03E-11	643.4	0.00E+00	0.00E+00
La-137	5.59E+04	15188.6	1.76E+01	8.78E-06
La-138	3.43E-03	15785.3	1.48E-05	7.38E-12
Mn-53	3.97E+04	2943.4	2.87E+00	1.43E-06
Mo-93	9.36E+05	1103.3	8.88E+02	4.44E-04
Nb-93m	5.61E-36	2029.6	2.17E-39	1.08E-45
Nb-94	3.99E+05	5951.2	1.49E+03	7.43E-04
Ni-59	3.10E+06	10283.4	4.52E+02	2.26E-04
Ni-63	5.86E-06	4118.9	2.31E-09	1.15E-15
Pb-202	3.45E+06	7884.8	9.81E+04	4.90E-02
Pb-205	4.74E+04	10534.5	5.20E+01	2.60E-05
Pt-193	2.33E+02	965.6	1.87E-02	9.34E-09
Se-79	3.82E+04	6097.0	2.32E+02	1.16E-04
Si-32	3.39E+03	1404.2	4.20E+00	2.10E-06
Sm-146	3.19E+02	10622.9	4.65E+01	2.33E-05
Sm-151	1.23E-04	2769.6	3.06E-08	1.53E-14
Sn-121m	7.04E-04	1866.3	6.68E-07	3.34E-13
Sr-90	6.69E-02	765.3	6.35E-03	3.18E-09
Tb-157	1.53E+01	2907.3	1.11E-03	5.57E-10
Tb-158	2.92E+06	4444.8	8.52E+03	4.26E-03
Tc-97	7.94E+02	798.8	8.69E-02	4.34E-08
Tc-98	2.54E+02	798.8	8.90E-01	4.45E-07
Tc-99	4.91E+04	669.0	4.66E+01	2.33E-05
Ti-44	4.61E-20	4030.8	6.40E-22	3.20E-28
Zr-93	2.18E+03	10417.5	2.55E+00	1.27E-06

***** PEAK CONCENTRATIONS AND TIMES FOR PATHWAY 2 *****
 ***** WELL AT 100.0 M *****

NUCLIDE	PEAK CONCENTRATION (PCI/L)	PEAK TIME (YR)	AVERAGE DOSE AT PEAK TIME (MREM/YR)	AVERAGE RISK AT PEAK TIME (HE/YR)
Ag-108m	4.72E-12	6059.3	2.59E-14	1.29E-20
Al-26	4.41E+04	92294.7	2.54E+02	1.27E-04
Ar-39	1.47E+07	653.3	0.00E+00	0.00E+00
Ar-42	8.71E+00	653.3	0.00E+00	0.00E+00
Be-10	2.20E+03	20409.2	6.75E+00	3.38E-06
C-14	8.12E+06	844.5	1.25E+04	6.23E-03
Ca-41	6.83E+05	1134.4	5.98E+02	2.99E-04
Cl-36	2.69E+05	826.2	5.90E+02	2.95E-04
Cs-135	4.69E+01	29681.0	2.43E-01	1.21E-07
Fe-60	5.11E+02	17688.6	5.60E+01	2.80E-05
H-3	1.25E-04	653.3	5.74E-09	2.87E-15
Hf-182	3.48E+02	32934.1	3.56E+00	1.78E-06
Ho-166m	1.09E+01	16996.2	6.20E-02	3.10E-08
I-129	2.65E+01	854.9	5.41E+00	2.70E-06
K-40	7.41E+01	2278.0	1.03E+00	5.14E-07
Kr-85	2.65E-11	653.3	0.00E+00	0.00E+00
La-137	2.77E+04	75589.0	8.69E+00	4.34E-06
La-138	3.38E-03	113396.5	1.46E-05	7.29E-12
Mn-53	3.96E+04	5555.0	2.87E+00	1.43E-06
Mo-93	8.46E+05	1609.0	8.03E+02	4.02E-04
Nb-94	3.03E+05	13936.7	1.13E+03	5.64E-04
Ni-59	2.60E+06	27837.9	3.79E+02	1.90E-04
Pb-202	3.34E+06	21277.7	9.50E+04	4.75E-02
Pb-205	4.74E+04	25017.9	5.19E+01	2.59E-05
Pt-193	2.25E-07	2461.9	1.80E-11	9.02E-18
Se-79	3.53E+04	13403.2	2.14E+02	1.07E-04
Si-32	8.68E+01	3147.4	1.08E-01	5.39E-08
Sm-146	3.18E+02	19724.6	4.65E+01	2.32E-05
Sn-121m	1.88E-29	8317.1	1.79E-32	8.94E-39
Sr-90	3.20E-07	1266.8	3.04E-08	1.52E-14
Tb-157	1.90E-23	14809.2	1.39E-27	6.94E-34
Tb-158	3.01E+03	16253.8	8.79E+00	4.39E-06
Tc-97	7.94E+02	833.5	8.69E-02	4.34E-08
Tc-98	2.54E+02	833.5	8.90E-01	4.45E-07
Tc-99	4.91E+04	698.0	4.66E+01	2.33E-05
Zr-93	2.13E+03	39890.6	2.48E+00	1.24E-06

**GROUNDWATER PATHWAY SCOPING ANALYSIS
FOR DISPOSAL OF APT AND TEF WASTES**

WSRC-RP-98-00729

Distribution:

W. E. Stevens, 773-A
J. R. Cook, 773-43A
E. L. Wilhite, 773-A
T. Hang, 773-42A
L. B. Collard, 773-43A
V. J. Reymers, 773-43A
R.A. Hane, 773-43A
D.E. Grove, 730-1B
S.S. Patel, 730-1B
G.T. Chandler, 773-A
H. Shih, Burns & Roe
G. DeCamp, Burns & Roe
K. Barbour, Burns & Roe
J.L. Anderson, LANL

W. T. Goldston, 705-3C
M. J. Ades, 705-3C
D. F. Sink, 724-15E
L.C. Thomas, 705-3C
M.W. Lewis, 724-7E
R.M. Seaborn, 705-3C
P.I. Hudson, 705-3C
G.R. Vozniak, 730-1B
J.R. Purucker, 730-1B
E.A. Clark, 773-A
P.L. Nowacki, 730-1B
A. Ugelow, Burns & Roe
A. Coons, Burns & Roe

R. W. Reynolds, 703-45A
J. L. England, LANL
S. O. Sheetz, LANL
R. H. Hsu, 773-A
R. A. Smith, 730-1B
J.S. Roberts, 703-45A
F.H. Brown, 730-1B
W.F. Brizes, 730-1B
D. Morris, Burns & Roe
C. Drewry, Burns & Roe
P. Lanik, Burns & Roe
H. Cohen, Burns & Roe
M. Richards, GA-LANL