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Biota Dose Assessment of Small Mammals Sampled Near Uranium Mines in Northern Arizona

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Savannah River National Laboratory™
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EXECUTIVE SUMMARY

In support of environmental studies being conducted by the U.S. Geological Survey, the Savannah River National Laboratory performed a biota dose assessment of small mammals sampled near several uranium mines in Northern Arizona. The RESRAD-BIOTA (version 1.8) dose model was used for this assessment. Nearly 50 small mammals were sampled and initially analyzed for gross alpha and gross beta activity. Concentrations ranged from non-detect (reporting limit of 4 pCi/g) to 11.0 pCi/g for gross alpha and from non-detect (reporting limit of 10 pCi/g) to 16.9 pCi/g for gross beta. Based on the highest gross alpha concentrations, 11 tissue samples were further analyzed for naturally occurring uranium (U-234, U-235, and U-238), thorium (Th-228, Th-230, and Th-232), and radium (Ra-226) radioisotopes. Using maximum and average concentrations, separate assessments were performed for animals sampled near the Pinenut Mine, Arizona 1 Mine, and Kanab North Mine, all of which are located in the Kanab Plateau of Northern Arizona. Initial estimates show that the potential biota doses are below the U.S. Department of Energy's biota dose standard of 0.1 rad/d (1 mGy/d).

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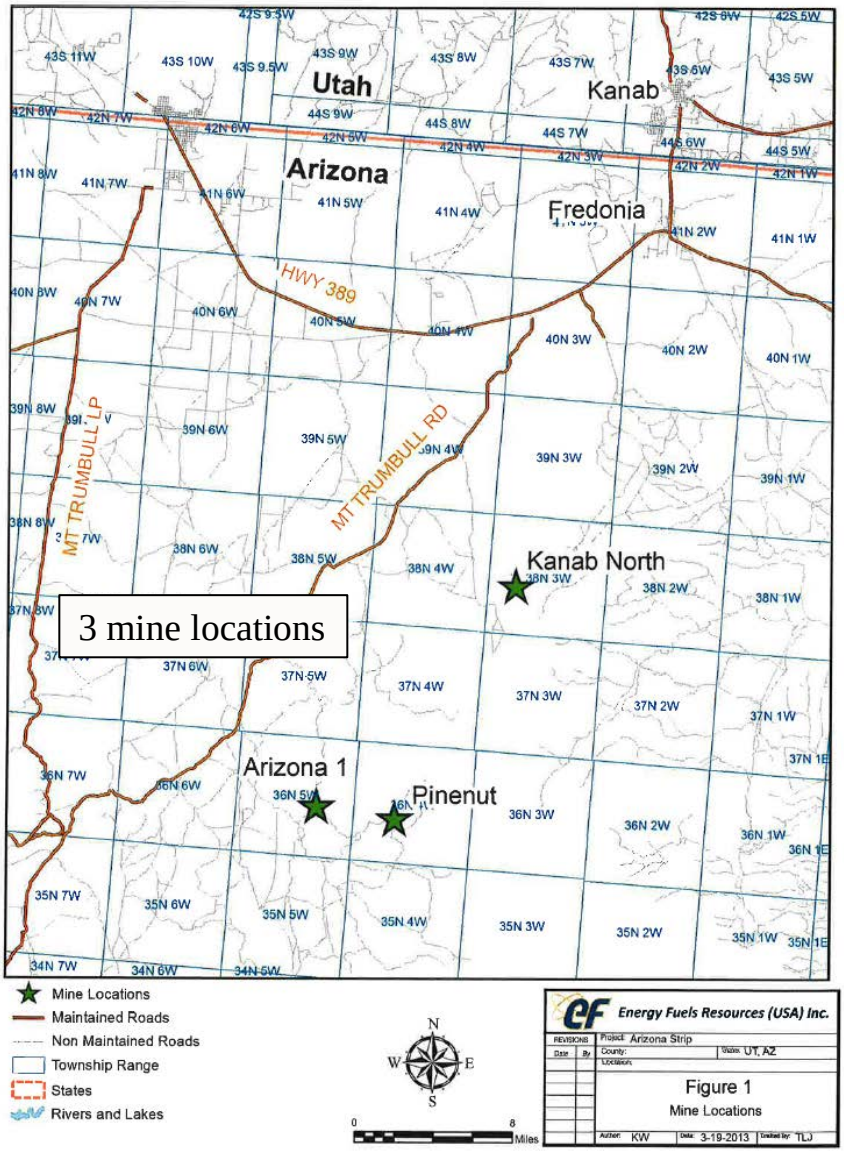
LIST OF ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
BIV	Bioaccumulation Factor
DOE	U. S. Department of Energy
EFRI	Energy Fuels Resources (U.S.A.) Inc.
IAEA	International Atomic Energy Agency
MDC	minimum detectable concentration
NCRP	National Council on Radiation Protection and Measurements
RESRAD	RESidual RADioactivity
RL	reporting limit
SRNL	Savannah River National Laboratory
USGS	U. S. Geological Survey

1.0 Introduction

In 2015, the U. S. Geological Survey (USGS) collected approximately 50 small mammal carcasses from Northern Arizona uranium mines and other background locations. Based on the highest gross alpha results, 11 small mammal samples were selected for radioisotopic analyses. None of the background samples had significant gross alpha results. The 11 small mammals were identified relative to the three 'indicator' mines located south of Fredonia, AZ on the Kanab Plateau (Kanab North Mine, Pinenut Mine, and Arizona 1 Mine) (Figure 1-1) and are operated by Energy Fuels Resources Inc. (EFRI). EFRI annually reports soil analysis for uranium and radium-226 using Arizona Department of Environmental Quality (ADEQ)-approved Standard Operating Procedures for Soil Sampling (EFRI 2016a, 2016b, 2017). In combination with the USGS small mammal radioiosotopic tissue analyses, a biota dose assessment was completed by Savannah River National Laboratory (SRNL) using the RESidual RADioactivity-BIOTA (RESRAD-BIOTA, V. 1.8) dose assessment tool provided by the Argonne National Laboratory (ANL 2017).

Figure 1-1. Three 'indicator' mine small mammal sample locations near Fredonia, AZ (EFRI 2016)



2.0 Tissue Sample Data

In 2016, 11 freeze-dried small mammal carcasses were transmitted to GEL Laboratories in Charleston, SC. Isotopic uranium and thorium analyses by alpha spectroscopy according to DOE EML HASL-300 (U-02-RC Modified and Th-01-RC modified, respectively) were conducted. Since radium is usually the "dose-driver," Ra-226 analyses were requested and conducted by GEL in 2017. Provided by USGS to SRNL, Table 2-1 documents the dry-weight results by GEL Laboratories of the isotopic tissue concentrations for 11 small mammals. The contractor's reporting limit (RL) was 1 pCi/g for all isotopic analytes. It is likely that results above the minimum detectable concentration (MDC) but below the RL have higher associated uncertainty. These measurements have been highlighted in red.

Based on the decay chain of the natural uranium series (4n+2), U-238, U-234, Th-230, and Ra-226 are expected to be in secular equilibrium which should be represented in the sample results. However, except for sample ID 63749/KNB4C, Ra-226 results are 1.25 to 5.5 times more than the U-238, U-234, and Th-230 results. Because radium acts chemically and biologically similar to calcium, these results suggest that radium may be more mobile in this environment or bioaccumulates in these mammals.

For RESRAD-BIOTA dose calculations, the dry-weight sample concentrations needed to be converted into wet-weight concentrations. Using the initial percent moisture retention of the small mammal samples, dry-weight tissue results from GEL for the small mammal samples were converted to wet-weight tissue concentrations (Table 2-2). This conversion was performed using a simple mass-mass ratio for 1 gram of dry tissue. For example, using sample ID 63679/AZA2C concentration for Ra-226 with a 66.5% initial moisture, it is approximated that every gram of dry tissue represents 33.5% of the total mass (Equation 1). Equation 1 can then be rearranged to calculate the wet-weight mass proportional to 1 gram of dry-weight mass (Equation 2). The wet-weight to dry-weight proportion is then used to convert the dry-weight concentrations to wet-weight concentrations (Equation 3). Since the RESRAD-BIOTA dose assessment is a deterministic model, standard deviation was omitted. Table 2-2 provides the adjusted radioisotopic results for wet-weight dose calculations.

$$\mathbf{1\ g\ (dry) = 0.335 \times Wet\ Weight\ Mass} \tag{1}$$

$$Wet\ Weight\ Mass = \frac{1\ g\ (dry)}{0.335} = 2.99\ g\ (wet) \tag{2}$$

$$2.87\ {}^{pCi}/_{g\ (dry)} \times \frac{1\ g\ (dry)}{2.99\ g\ (wet)} = 0.9599\ \approx \mathbf{0.96}\ {}^{\mathbf{pCi}}/_{\mathbf{g}\ (\mathbf{wet})} \tag{3}$$

To evaluate the data for any unidentified alpha emitters, the concentration for Th-228, Th-230, Th-232, U-234, U-235, U-238, and Ra-226 were totaled and compared to the gross alpha concentration measurements per sample. The gross alpha concentration is representing all alpha emitters if the fraction of total alphas is greater than 0.75 or 75% of the gross alpha measurement. Because sample 63697/AZB9C alpha emitters only represent 35% of the gross alpha measurement (highlighted in Table 2-3), it is considered to have an unidentified alpha source. To account for the unidentified alpha source, the difference (1.15 pCi/g) in total alpha vs. gross alpha for sample 63697/AZB9C concentration was conservatively approximated assuming a Ra-226 source (Table 2-2).

Table 2-1. Dry-Weight results from the isotopic uranium, thorium, and radium radiochemical analyses of small mammal carcasses collected from indicator mines in the Kanab Plateau (pCi/g)

GEL ID	USGS ID	Matrix (carcass)	Th-228	Th-230[b]	Th-232	U-234[b]	U-235	U-238[b]	Ra-226[b]	Gross α	Gross β
Indicator Mine: Arizona 1 Mine											
63679	AZA2C	Deer mouse	ND	1.38±0.43 (0.39)	0.40±0.23 (0.19)	0.77±0.51 (0.50)	ND	1.11±0.58 (0.40)	2.87±0.648 (0.29)	7.61±3.32 (3.82)	10.5±2.63 (3.03)
63681	AZA4C	Deer mouse	ND	1.27±0.40 (0.36)	0.30±0.19 (0.18)	1.83±0.78 (0.48)	ND	2.03±0.82 (0.55)	3.01±0.607 (0.18)	11.00±3.86 (3.95)	9.88±2.95 (3.91)
63682	AZA5C	Deer mouse	ND	0.89±0.35 (0.17)	0.30±0.19 (0.17)	1.52±0.71 (0.58)	ND	0.92±0.55 (0.46)	3.78±0.751 (0.27)	7.06±3.19 (3.91)	14.50±2.84 (3.09)
63694	AZB6C	Deer mouse	ND	1.00±0.35 (0.35)	0.35±0.20 (0.17)	0.80±0.53 (0.39)	0.71±0.56 (0.30)	0.63±0.48 (0.39)	2.56±0.604 (0.28)	5.44±2.85 (3.85)	13.5±3.2 (4.25)
63697	AZB9C	Brush mouse	ND	0.37±0.27 (0.46)	ND	0.57±0.46 (0.51)	0.52±0.47 (0.43)	ND	0.342±0.239 (0.11)	5.20±2.82 (3.82)	9.79±2.97 (4.16)
Indicator Mine: Pinenut Mine											
63711	PNA9C	Deer mouse	0.43±0.31 (0.36)	0.46±0.27 (0.36)	0.26±0.17 (0.12)	ND	0.42±0.38 (0.41)	1.08±0.49 (0.26)	5.05±0.942 (0.26)	5.87±3.03 (3.90)	12.5±2.8 (3.13)
63712	PNA10C	Deer mouse	ND	1.10±0.36 (0.35)	0.46±0.22 (0.18)	1.25±0.62 (0.49)	ND	1.18±0.59 (0.34)	3.31±0.720 (0.28)	5.22±3.01 (3.91)	9.72±2.85 (3.57)
63713	PNA11C	Deer mouse	0.38±0.27 (0.15)	0.77±0.33 (0.36)	0.18±0.15 (0.17)	0.98±0.62 (0.73)	0.72±0.55 (0.53)	1.10±0.59 (0.52)	6.33±0.958 (0.32)	5.41±3.00 (3.81)	9.47±2.71 (3.40)
63716	PNA14C	Botta pocket gopher	NA	0.88±0.33 (0.34)	ND	0.76±0.50 (0.40)	ND	1.11±0.59 (0.44)	1.71±0.502 (0.33)	5.06±3.19 (3.96)	5.51±2.86 (4.35)
Indicator Mine: Kanab North Mine											
63746	KNB1C	Deer mouse	ND	0.64±0.31 (0.38)	0.26±0.19 (0.20)	0.92±0.51 (0.43)	0.54±0.43 (0.23)	0.80±0.45 (0.19)	4.49±0.821 (0.33)	9.11±3.29 (3.76)	16.9±2.7 (2.88)
63749	KNB4C	Deer mouse	ND	1.00±0.42 (0.47)	0.24±0.20 (0.22)	1.58±0.65 (0.36)	ND	1.48±0.63 (0.42)	1.89±0.575 (0.45)	4.95±2.56 (3.66)	11.5±2.4 (3.08)

a. Positive detection nomenclature = Result ± Counting Uncertainty (MDC). ND denotes that the result was below the detection limit or reporting limit.

b. U-238, U-234, Th-230, and Ra-226 are expected to be in secular equilibrium which should be represented in the sample results. However, except for sample ID 63749/KNB4C, Ra-226 results are 1.25 to 5.5 times more than the U-238, U-234, and Th-230 results.

Table 2-2. Adjusted results from radiochemical analyses for wet-weight input in biota dose assessments (pCi/g)

GEL ID	USGS ID	Matrix (carcass)	Initial Moisture	Th-228	Th-230	Th-232	U-234	U-235	U-238	Ra-226	Gross α
Indicator Mine: Arizona 1 Mine											
63679	AZA2C	Deer mouse	66.5%	ND	0.46	0.13	0.26	ND	0.37	0.96	2.55
63681	AZA4C	Deer mouse	68.0%	ND	0.41	0.10	0.59	ND	0.65	0.96	3.52
63682	AZA5C	Deer mouse	65.6%	ND	0.31	0.10	0.52	ND	0.32	1.30	2.43
63694	AZB6C	Deer mouse	68.8%	ND	0.31	0.11	0.25	0.22	0.20	0.80	1.70
63697	AZB9C	Brush mouse	66.1%	ND	0.13	ND	0.19	0.18	ND	~~0.12~~ 1.27[a]	1.76
Indicator Mine: Pinenut Mine											
63711	PNA9C	Deer mouse	65.9%	0.15	0.16	0.09	ND	0.14	0.37	1.72	2.00
63712	PNA10C	Deer mouse	66.8%	ND	0.37	0.15	0.42	ND	0.39	1.10	1.73
63713	PNA11C	Deer mouse	67.8%	0.12	0.25	0.06	0.32	0.23	0.35	2.04	1.74
63716	PNA14C	Botta pocket gopher	70.0%	NA	0.26	ND	0.23	ND	0.33	0.51	1.52
Indicator Mine: Kanab North Mine											
63746	KNB1C	Deer mouse	70.6%	ND	0.19	0.08	0.27	0.16	0.24	1.32	2.68
63749	KNB4C	Deer mouse	67.2%	ND	0.33	0.08	0.52	ND	0.49	0.62	1.62

a. Ra-226 concentration plus unidentified alpha concentration (See Table 2-3)

Table 2-3. Total alpha vs. gross alpha wet-weight tissue concentration comparison

GEL ID	USGS ID	Total α Concentration (pCi/g)	Gross α Concentration (pCi/g)	Fraction of Total α / Gross α
Indicator Mine: Arizona 1 Mine				
63679	AZA2C	2.19	2.55	0.86
63681	AZA4C	2.70	3.52	0.77
63682	AZA5C	2.55	2.43	1.05
63694	AZB6C	1.89	1.70	1.11
63697	AZB9C	0.61	1.76	0.35
Indicator Mine: Pinenut Mine				
63711	PNA9C	2.63	2.00	1.31
63712	PNA10C	2.42	1.73	1.40
63713	PNA11C	3.37	1.74	1.93
63716	PNA14C	1.34	1.52	0.88
Indicator Mine: Kanab North Mine				
63746	KNB1C	2.25	2.68	0.84
63749	KNB4C	2.03	1.62	1.25

3.0 Soil Sample Data

Soil sample results from the EFRI 2015 Annual Survey Report for Arizona Mine 1 and Pinenut Mine and soil sample results from the Kanab North Mine Interim Clean Closure Report for Kanab North Mine were compiled (EFRI 2016a, 2016b, 2017). From the available data, the maximum soil concentration inputs conservatively approximate each indicator mine for total uranium and Ra-226. Since soil concentrations near the Kanab North Mine are much greater than the Arizona 1 and Pinenut mine, the average uranium and Ra-226 soil concentrations for Kanab North Mine were also provided. Using the specific activity and percent abundance of naturally occurring uranium, maximum total uranium soil concentrations in mg/kg were converted to U-238, U-235, and U-234 concentrations in pCi/g. Expected to be in secular equilibrium, Th-230 concentrations were approximated to be equal to U-234. All other radionuclides found in the small mammals were unaccounted for in the soil analysis and therefore approximated at 0 pCi/g.

Table 3-1. Maximum EFRI soil sample concentrations for three indicator mines on the Kanab Plateau for input in RESRAD-BIOTA

Indicator Mine	Uranium Total (mg/Kg)	Maximum Soil Concentration Inputs (pCi/g)				
		Th-230	U-234	U-235	U-238	Ra-226
Arizona 1 Mine	18.4	6.30	6.30	0.286	6.14	9.70
Pinenut Mine	8.52	2.92	2.92	0.133	2.84	4.60
Kanab North Mine	235	80.4	80.4	3.66	78.4	230
		Average Soil Concentration Inputs (pCi/g)				
Kanab North Mine	110	37.67	37.67	1.71	36.73	48.2

4.0 RESRAD-BIOTA

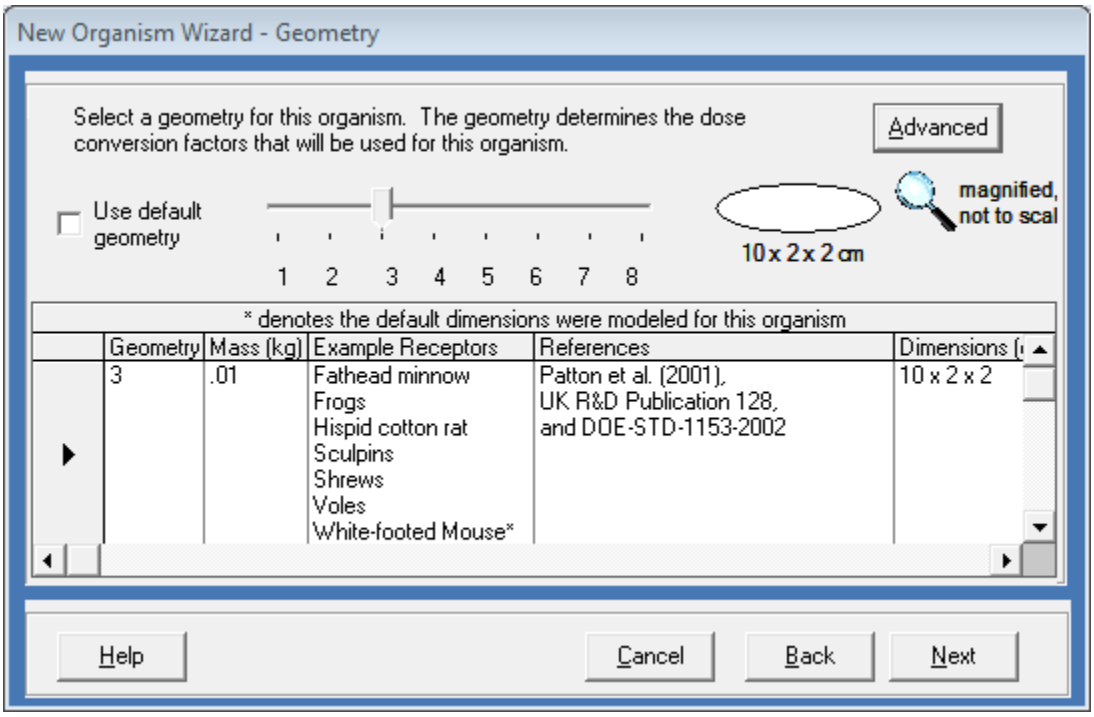
RESRAD-BIOTA is the “Go-To” biota dose assessment tool in the United States. It is available free online though Argonne National Laboratory and is extensively benchmarked with international models (ERICA, etc.). “The code was designed to be consistent with and provide a tool for implementing the DOE *Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002; DOE 2002), and to provide advanced analysis capabilities in a manner that will support the anticipated needs of DOE and other agencies” (DOE 2004).

Based on the National Council on Radiation Protection and Measurements (NCRP) and the International Atomic energy Agency (IAEA), the U. S. Department of Energy (DOE) established the following dose limits for biota protection:

- Aquatic animals – 1 rad per day
- Terrestrial plants – 1 rad per day
- Terrestrial animals – 0.1 rad per day.

The small mammals found near the Northern Arizona Mines fall under the terrestrial animal category with a biota dose limit of 0.1 rad per day. Using the wet-weight tissue concentrations as an input source and maximum soil sample data, an initial RESRAD-BIOTA Level 3 Dose Assessment was executed for a ‘deer mouse’ receptor with internal and external dose conversion factors established for a labeled geometric 3 organism (Figure 4-1). Appendix A provides screen shots of the ‘deer mouse’ specific parameters along with an example parameter report for sample ID 63679/AZB9C.

Figure 4-1. RESRAD-BIOTA parameters for deer mouse receptor



5.0 Results

Prior to executing the biota dose assessments using tissue and soil concentrations, a 'soil only' biota dose assessment was executed using maximum soil concentrations (Appendix B). While all calculated external doses remain below the DOE biota dose limit for terrestrial animals, the internal dose estimated by the Kanab North Mine soil samples was 4.25E-01 rad/d which exceeds the 0.1 rad/d dose limit. Following the graded approach method, the Kanab North Mine soil sample averages were executed. The average soil concentrations produced a biota dose less than 0.1 rad/d (9.46E-02 rad/d) and remain within the DOE limits for biota dose standards. These results can be found in Table B-4, Appendix B.

Because a tissue concentration was entered rather than a bioaccumulation factor (BIV) or allometric parameters, the internal dose to the organism from the radionuclide is calculated based on the inputted tissue concentration and is not attributed to any media (i.e. water, soil, or sediment). Therefore, since the maximum soil concentrations produced external doses within DOE limits, the maximum soil concentrations were used in combination with the tissue concentrations for evaluating the small mammals biota dose.

The total dose for each small mammal carcass is approximated by adding the total external dose (soil) and the total internal dose (tissue). Appendix C provides a detailed output for all 11 small mammal carcasses. Table 5-1 provides a summary of the total external, total internal, and overall total dose the 11 small mammals received and compared to the total biota dose limit. The maximum biota dose was 7.42E-02 rad/d for sample ID 63713/PNA11C found near the Pinenut Mine with the internal dose (tissue) accounting for 99% of the total dose. Table 5-2 details the sample ID 63713/PNA11C internal dose. With the highest tissue concentration analysis, Ra-226 dose makes up about 84% of the total internal dose.

Table 5-1. RESRAD-BIOTA total dose to 11 small mammal carcasses (rad/d)

GEL ID	USGS ID	Matrix	External Dose	Internal Dose	**Total Dose**
Indicator Mine: Arizona 1 Mine					
63679	AZA2C	Deer mouse - carcass	9.06E-04	3.93E-02	**4.02E-02**
63681	AZA4C	Deer mouse - carcass	9.06E-04	4.08E-02	**4.17E-02**
63682	AZA5C	Deer mouse - carcass	9.06E-04	4.89E-02	**4.98E-02**
63694	AZB6C	Deer mouse - carcass	9.06E-04	3.31E-02	**3.40E-02**
63697	AZB9C	Brush mouse - carcass	9.06E-04	4.11E-02	**4.20E-02**
Indicator Mine: Pinenut Mine					
63711	PNA9C	Deer mouse - carcass	4.29E-04	6.38E-02	**6.43E-02**
63712	PNA10C	Deer mouse - carcass	4.29E-04	4.47E-02	**4.52E-02**
63713	PNA11C	Deer mouse - carcass	4.29E-04	7.38E-02	**7.42E-02**
63716	PNA14C	Botta pocket gopher	4.29E-04	1.94E-02	**1.98E-02**
Indicator Mine: Kanab North					
63746	KNB1C	Deer mouse - carcass	2.11E-02	4.73E-02	**6.83E-02**
63749	KNB4C	Deer mouse - carcass	2.11E-02	2.82E-02	**4.93E-02**
				Dose Limit =	**1.00E-01**

Table 5-2. Deer mouse sample 63713/PNA11C internal dose by radionuclide

Nuclide	**Tissue Concentration (pCi/g wet weight)**	**Internal Dose (rad per day)**	**Percent of Total (%)**
Ra-226	2.04E+00	6.22E-02	84.30%
Th-228	1.20E-01	3.99E-03	5.40%
Th-230	2.50E-01	1.21E-03	1.60%
Th-232	6.00E-02	2.25E-03	3.00%
U-234	3.20E-01	1.58E-03	2.10%
U-235	2.30E-01	1.04E-03	1.40%
U-238	3.50E-01	1.54E-03	2.10%
	Total:	**7.38E-02**	

6.0 Discussion and Conclusion

Biota dose determinations for the small mammals sampled by USGS near the 3 Northern Arizona uranium mines do not exceed the 0.1 rad per day biota dose limit. Tissue concentrations (<1.0 pCi/g) of U-238, U-234, and Th-230 were, as expected, in approximate equilibrium. However, Ra-226 concentrations were up to 5.5 times more due to its environmental mobility and bioavailability. Ra-226 is the “dose-driver” and the contaminant of most concern.

7.0 References

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Appendix A. Deer Mouse Specific Parameters

Figure A-1. Deer Mouse Geometric 3 Organism Parameters

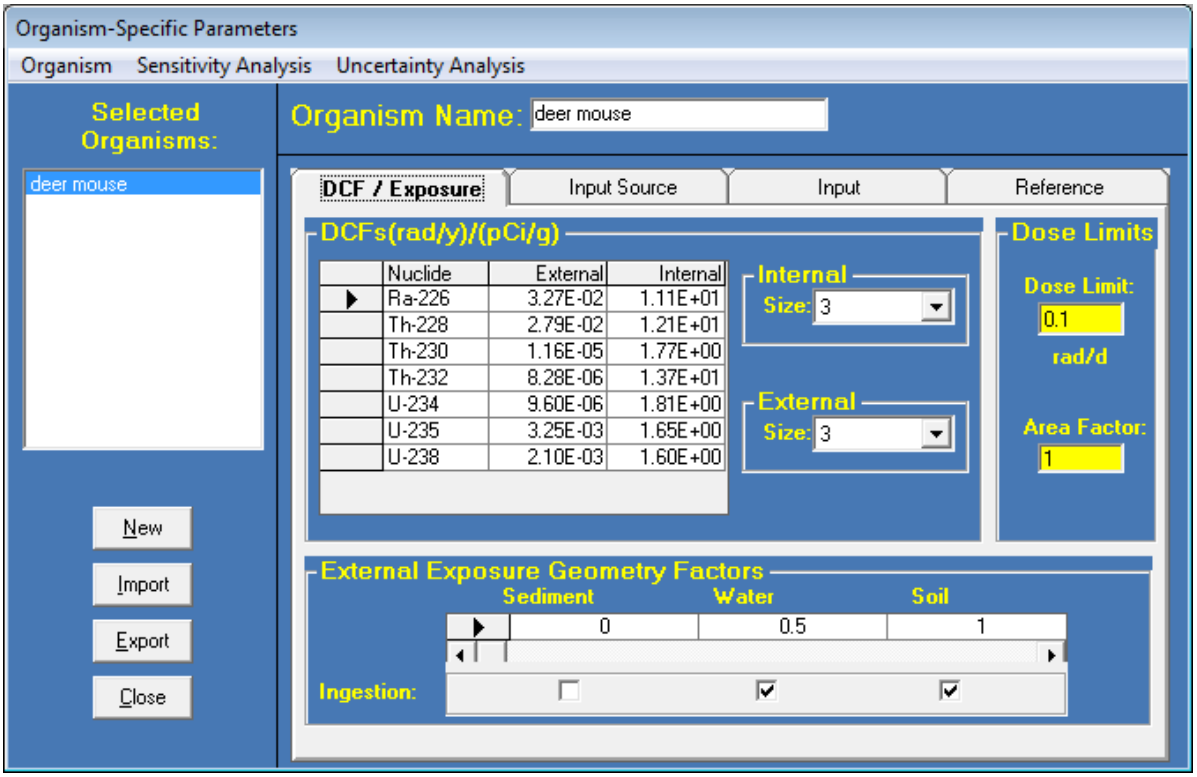

Figure A-2. Deer Mouse 'Use Tissue" Input Source Selection

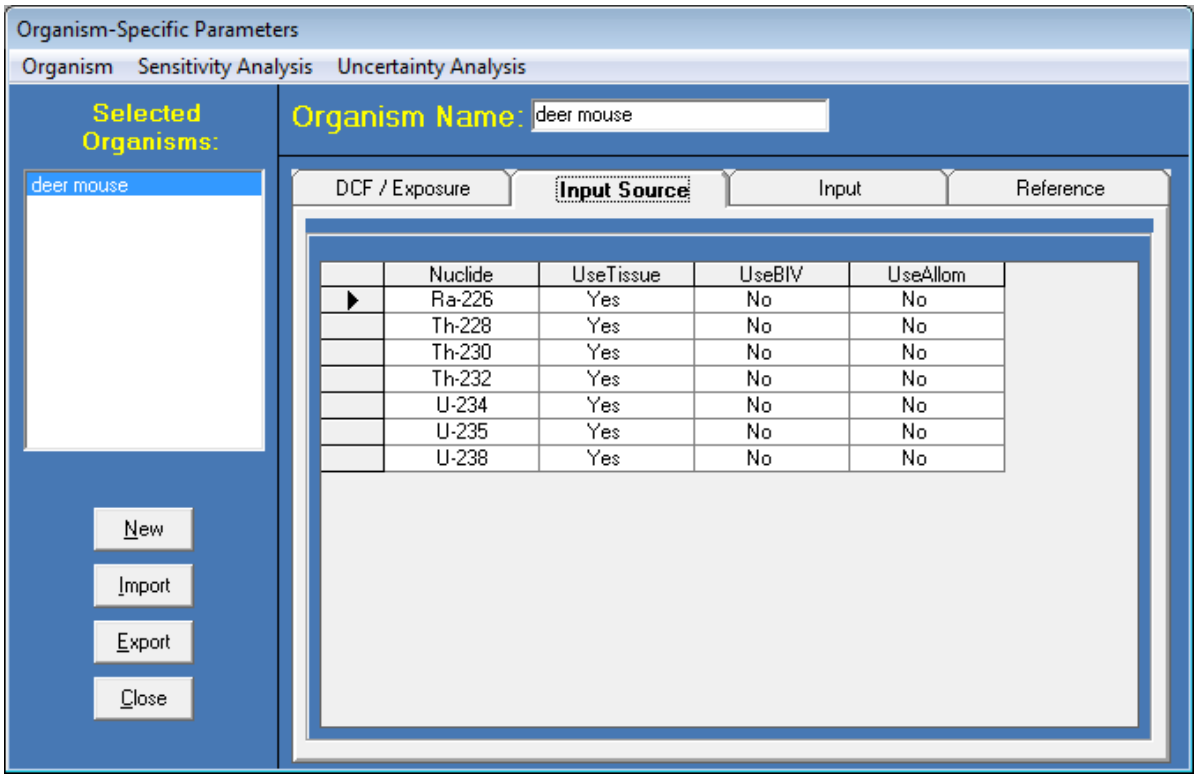

Figure A-3. Deer Mouse Tissue Concentration Input for 63679/AZB9C

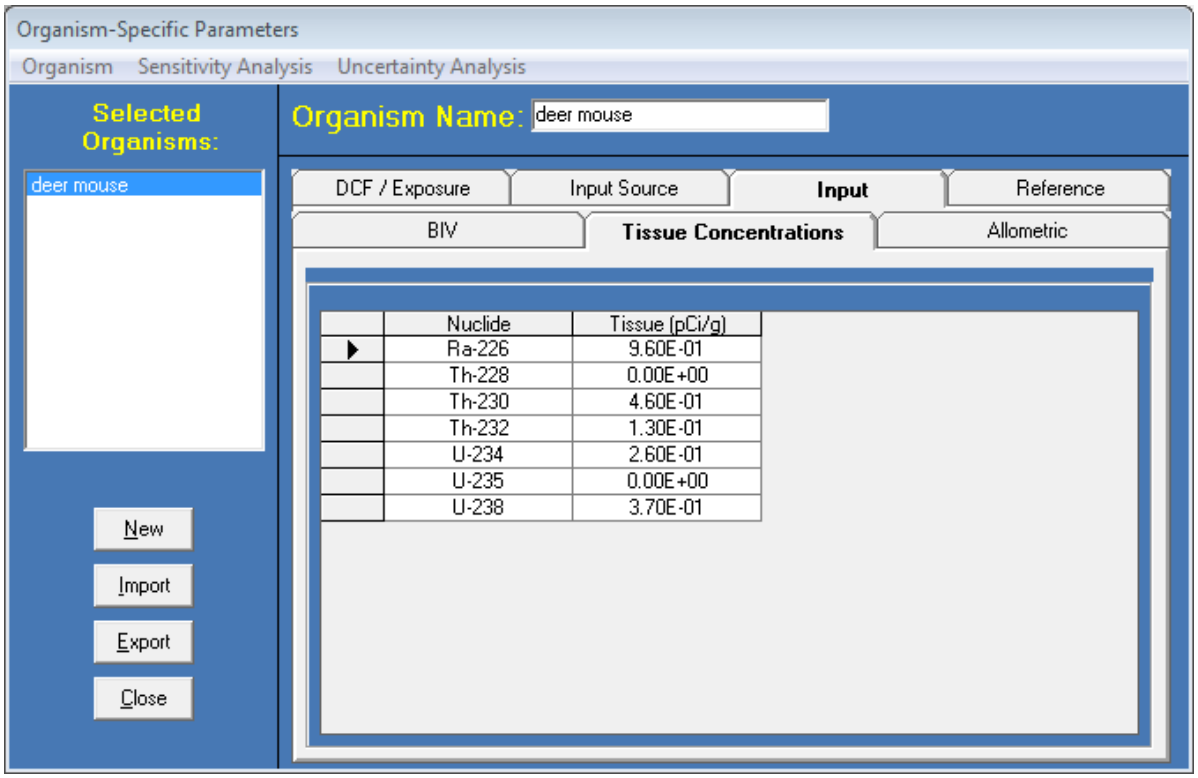

Figure A-4. RESRAD-BIOTA Input Parameter Report for Sample ID 63679/AZB9C using Maximum Soil Inputs

RESRAD-BIOTA Input Parameter Report

General Case Information

Title:	63679 - AZB9C - MAX
Ecosystem:	Terrestrial
Level:	3
Units:	Traditional

Radionuclide Specific Data

Concentrations			
Radionuclide	**Soil (pCi/g)**	**Water (pCi/L)**	**Sediment (pCi/g)**
Ra-226	9.7	0	0
Th-228	0	0	0
Th-230	6.299	0	0
Th-232	0	0	0
U-234	6.299	0	0
U-235	0.286	0	0
U-238	6.141	0	0

RBE Values			
Alpha	**Beta**	**Gamma**	**Cut-off Half-life**
20	1	1	100 years

Organism Specific Data

Organism Data				
Name	**Dose Limit (rad/d)**	**Area Factor**	**Internal Size**	**External Size**
deer mouse	0.1	1	SmallFish_Mouse	SmallFish_Mouse

BIV Values				
Organism	Radionuclide	Soil	Water	Sediment
deer mouse	Ra-226	6.00E-02	4.00E-01	0.00E+00
deer mouse	Th-228	1.91E-03	4.54E-02	0.00E+00
deer mouse	Th-230	1.91E-03	4.54E-02	0.00E+00
deer mouse	Th-232	1.60E-03	4.54E-02	0.00E+00
deer mouse	U-234	3.80E-03	4.98E-02	0.00E+00
deer mouse	U-235	3.70E-03	4.98E-02	0.00E+00
deer mouse	U-238	3.73E-03	4.98E-02	0.00E+00

Allometric Data

Metabolism						
Radionuclide	Organism	F1	a	b	PT/IT	L_rad
Ra-226	Terrestrial Animal	2.00E-01	2.00E+00	2.50E-01	3.00E+00	1.19E-06
Th-228	Terrestrial Animal	2.00E-04	3.30E+00	8.10E-01	7.50E+02	9.93E-04
Th-230	Terrestrial Animal	2.00E-04	3.30E+00	8.10E-01	7.50E+02	2.52E-08
Th-232	Terrestrial Animal	2.00E-04	3.30E+00	8.10E-01	7.50E+02	1.36E-13
U-234	Terrestrial Animal	5.00E-02	8.00E-01	2.80E-01	7.00E+03	7.75E-09
U-235	Terrestrial Animal	5.00E-02	8.00E-01	2.80E-01	3.50E+03	2.71E-12
U-238	Terrestrial Animal	5.00E-02	8.00E-01	2.80E-01	4.00E+03	4.25E-13

Intake Parameters						
Organism	mass (kg)	a	c (kcal/g)	d	x (g/m^3)	f
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01
Terrestrial Animal	7.50E-01	2.00E+00	5.00E+00	4.40E-01	1.00E-04	1.00E-01

No food chain data for this case.

Tissue Concentration Data

Radionuclide	Organism	Tissue Concentration
Ra-226	deer mouse	9.60E-01
Th-228	deer mouse	0.00E+00
Th-230	deer mouse	4.60E-01
Th-232	deer mouse	1.30E-01
U-234	deer mouse	2.60E-01
U-235	deer mouse	0.00E+00
U-238	deer mouse	3.70E-01

Appendix B. Level 3 'Soil-Only' Dose Report (rad/d)

Table B-1. Arizona 1 Mine

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	1.78E-02	0.00E+00	1.78E-02	0.00E+00	1.86E-02	0.00E+00	1.86E-02
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	5.83E-05	0.00E+00	5.83E-05	0.00E+00	5.85E-05	0.00E+00	5.85E-05
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	1.18E-04	0.00E+00	1.18E-04	0.00E+00	1.19E-04	0.00E+00	1.19E-04
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	4.78E-06	0.00E+00	4.78E-06	0.00E+00	7.33E-06	0.00E+00	7.33E-06
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	1.01E-04	0.00E+00	1.01E-04	0.00E+00	1.36E-04	0.00E+00	1.36E-04
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	1.80E-02	0.00E+00	1.80E-02	0.00E+00	1.89E-02	0.00E+00	1.89E-02

Table B-2. Pinenut Mine

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.12E-04	0.00E+00	4.12E-04	0.00E+00	8.42E-03	0.00E+00	8.42E-03	0.00E+00	8.83E-03	0.00E+00	8.83E-03
Th-230	0.00E+00	9.30E-08	0.00E+00	9.30E-08	0.00E+00	2.70E-05	0.00E+00	2.70E-05	0.00E+00	2.71E-05	0.00E+00	2.71E-05
U-234	0.00E+00	7.67E-08	0.00E+00	7.67E-08	0.00E+00	5.48E-05	0.00E+00	5.48E-05	0.00E+00	5.49E-05	0.00E+00	5.49E-05
U-235	0.00E+00	1.18E-06	0.00E+00	1.18E-06	0.00E+00	2.22E-06	0.00E+00	2.22E-06	0.00E+00	3.41E-06	0.00E+00	3.41E-06
U-238	0.00E+00	1.63E-05	0.00E+00	1.63E-05	0.00E+00	4.66E-05	0.00E+00	4.66E-05	0.00E+00	6.30E-05	0.00E+00	6.30E-05
Summed	0.00E+00	4.29E-04	0.00E+00	4.29E-04	0.00E+00	8.55E-03	0.00E+00	8.55E-03	0.00E+00	8.98E-03	0.00E+00	8.98E-03

Table B-3. Kanab North Mine - Maximum

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	2.06E-02	0.00E+00	2.06E-02	0.00E+00	4.21E-01	0.00E+00	4.21E-01	0.00E+00	4.42E-01	0.00E+00	4.42E-01
Th-230	0.00E+00	2.56E-06	0.00E+00	2.56E-06	0.00E+00	7.45E-04	0.00E+00	7.45E-04	0.00E+00	7.47E-04	0.00E+00	7.47E-04
U-234	0.00E+00	2.11E-06	0.00E+00	2.11E-06	0.00E+00	1.51E-03	0.00E+00	1.51E-03	0.00E+00	1.51E-03	0.00E+00	1.51E-03
U-235	0.00E+00	3.25E-05	0.00E+00	3.25E-05	0.00E+00	6.11E-05	0.00E+00	6.11E-05	0.00E+00	9.37E-05	0.00E+00	9.37E-05
U-238	0.00E+00	4.50E-04	0.00E+00	4.50E-04	0.00E+00	1.29E-03	0.00E+00	1.29E-03	0.00E+00	1.74E-03	0.00E+00	1.74E-03
Summed	0.00E+00	2.11E-02	0.00E+00	2.11E-02	0.00E+00	4.25E-01	0.00E+00	4.25E-01	0.00E+00	4.46E-01	0.00E+00	4.46E-01

Table B-4. Kanab North Mine - Average

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.31E-03	0.00E+00	4.31E-03	0.00E+00	8.83E-02	0.00E+00	8.83E-02	0.00E+00	9.26E-02	0.00E+00	9.26E-02
Th-230	0.00E+00	1.20E-06	0.00E+00	1.20E-06	0.00E+00	3.49E-04	0.00E+00	3.49E-04	0.00E+00	3.50E-04	0.00E+00	3.50E-04
U-234	0.00E+00	9.90E-07	0.00E+00	9.90E-07	0.00E+00	7.08E-04	0.00E+00	7.08E-04	0.00E+00	7.09E-04	0.00E+00	7.09E-04
U-235	0.00E+00	1.52E-05	0.00E+00	1.52E-05	0.00E+00	2.86E-05	0.00E+00	2.86E-05	0.00E+00	4.39E-05	0.00E+00	4.39E-05
U-238	0.00E+00	2.28E-04	0.00E+00	2.28E-04	0.00E+00	6.51E-04	0.00E+00	6.51E-04	0.00E+00	8.79E-04	0.00E+00	8.79E-04
Summed	0.00E+00	4.56E-03	0.00E+00	4.56E-03	0.00E+00	9.00E-02	0.00E+00	9.00E-02	0.00E+00	9.46E-02	0.00E+00	9.46E-02

Appendix C. Level 3 Dose Reports for 11 Small Mammal Carcasses (rad/d)

Table C-1. Sample 63679/AZA2C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.93E-02	0.00E+00	8.68E-04	0.00E+00	3.01E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	0.00E+00	0.00E+00	2.23E-03	0.00E+00	0.00E+00	0.00E+00	2.23E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-03	0.00E+00	0.00E+00	0.00E+00	4.87E-03
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	0.00E+00	0.00E+00	1.29E-03	0.00E+00	1.66E-07	0.00E+00	1.29E-03
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-06	0.00E+00	2.55E-06
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	0.00E+00	0.00E+00	1.63E-03	0.00E+00	3.53E-05	0.00E+00	1.66E-03
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	0.00E+00	0.00E+00	3.93E-02	0.00E+00	9.06E-04	0.00E+00	4.02E-02

Table C-2. Sample 63681/AZA4C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.93E-02	0.00E+00	8.68E-04	0.00E+00	3.01E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	0.00E+00	0.00E+00	1.99E-03	0.00E+00	0.00E+00	0.00E+00	1.99E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-03	0.00E+00	0.00E+00	0.00E+00	3.74E-03
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	0.00E+00	0.00E+00	2.92E-03	0.00E+00	1.66E-07	0.00E+00	2.92E-03
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-06	0.00E+00	2.55E-06
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	0.00E+00	0.00E+00	2.86E-03	0.00E+00	3.53E-05	0.00E+00	2.89E-03
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	0.00E+00	0.00E+00	4.08E-02	0.00E+00	9.06E-04	0.00E+00	4.17E-02

Table C-3. Sample 63682/AZA5C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	0.00E+00	0.00E+00	3.96E-02	0.00E+00	8.68E-04	0.00E+00	4.05E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	0.00E+00	0.00E+00	1.50E-03	0.00E+00	0.00E+00	0.00E+00	1.50E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-03	0.00E+00	0.00E+00	0.00E+00	3.74E-03
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	0.00E+00	0.00E+00	2.57E-03	0.00E+00	1.66E-07	0.00E+00	2.57E-03
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-06	0.00E+00	2.55E-06
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	0.00E+00	0.00E+00	1.41E-03	0.00E+00	3.53E-05	0.00E+00	1.44E-03
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	0.00E+00	0.00E+00	4.89E-02	0.00E+00	9.06E-04	0.00E+00	4.98E-02

Table C-4. Sample 63694/AZB6C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	0.00E+00	0.00E+00	2.44E-02	0.00E+00	8.68E-04	0.00E+00	2.53E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	0.00E+00	0.00E+00	1.50E-03	0.00E+00	0.00E+00	0.00E+00	1.50E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-03	0.00E+00	0.00E+00	0.00E+00	4.12E-03
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	0.00E+00	0.00E+00	1.24E-03	0.00E+00	1.66E-07	0.00E+00	1.24E-03
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	0.00E+00	0.00E+00	9.94E-04	0.00E+00	2.55E-06	0.00E+00	9.96E-04
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	0.00E+00	0.00E+00	8.79E-04	0.00E+00	3.53E-05	0.00E+00	9.14E-04
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	0.00E+00	0.00E+00	3.31E-02	0.00E+00	9.06E-04	0.00E+00	3.40E-02

Table C-5. Sample 63697/AZB9C + UI alpha

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	8.68E-04	0.00E+00	8.68E-04	0.00E+00	0.00E+00	0.00E+00	3.87E-02	0.00E+00	8.68E-04	0.00E+00	3.96E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.01E-07	0.00E+00	2.01E-07	0.00E+00	0.00E+00	0.00E+00	6.30E-04	0.00E+00	0.00E+00	0.00E+00	6.30E-04
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	1.66E-07	0.00E+00	1.66E-07	0.00E+00	0.00E+00	0.00E+00	9.39E-04	0.00E+00	1.66E-07	0.00E+00	9.39E-04
U-235	0.00E+00	2.55E-06	0.00E+00	2.55E-06	0.00E+00	0.00E+00	0.00E+00	8.13E-04	0.00E+00	2.55E-06	0.00E+00	8.16E-04
U-238	0.00E+00	3.53E-05	0.00E+00	3.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.53E-05	0.00E+00	3.53E-05
Summed	0.00E+00	9.06E-04	0.00E+00	9.06E-04	0.00E+00	0.00E+00	0.00E+00	4.11E-02	0.00E+00	9.06E-04	0.00E+00	4.20E-02

Table C-6. Sample 63711/PNA9C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.12E-04	0.00E+00	4.12E-04	0.00E+00	0.00E+00	0.00E+00	5.24E-02	0.00E+00	4.12E-04	0.00E+00	5.29E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.99E-03	0.00E+00	0.00E+00	0.00E+00	4.99E-03
Th-230	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.75E-04	0.00E+00	0.00E+00	0.00E+00	7.75E-04
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.37E-03	0.00E+00	0.00E+00	0.00E+00	3.37E-03
U-234	0.00E+00	7.67E-08	0.00E+00	7.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.67E-08	0.00E+00	7.67E-08
U-235	0.00E+00	1.18E-06	0.00E+00	1.18E-06	0.00E+00	0.00E+00	0.00E+00	6.32E-04	0.00E+00	1.18E-06	0.00E+00	6.34E-04
U-238	0.00E+00	1.63E-05	0.00E+00	1.63E-05	0.00E+00	0.00E+00	0.00E+00	1.63E-03	0.00E+00	1.63E-05	0.00E+00	1.64E-03
Summed	0.00E+00	4.29E-04	0.00E+00	4.29E-04	0.00E+00	0.00E+00	0.00E+00	6.38E-02	0.00E+00	4.29E-04	0.00E+00	6.43E-02

Table C-7. Sample 63712/PNA10C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.12E-04	0.00E+00	4.12E-04	0.00E+00	0.00E+00	0.00E+00	3.35E-02	0.00E+00	4.12E-04	0.00E+00	3.40E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	9.30E-08	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	1.79E-03	0.00E+00	0.00E+00	0.00E+00	1.79E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E-03	0.00E+00	0.00E+00	0.00E+00	5.62E-03
U-234	0.00E+00	7.67E-08	0.00E+00	7.67E-08	0.00E+00	0.00E+00	0.00E+00	2.08E-03	0.00E+00	7.67E-08	0.00E+00	2.08E-03
U-235	0.00E+00	1.18E-06	0.00E+00	1.18E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-06	0.00E+00	1.18E-06
U-238	0.00E+00	1.63E-05	0.00E+00	1.63E-05	0.00E+00	0.00E+00	0.00E+00	1.71E-03	0.00E+00	1.63E-05	0.00E+00	1.73E-03
Summed	0.00E+00	4.29E-04	0.00E+00	4.29E-04	0.00E+00	0.00E+00	0.00E+00	4.47E-02	0.00E+00	4.29E-04	0.00E+00	4.52E-02

Table C-8. Sample 63713/PNA11C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.12E-04	0.00E+00	4.12E-04	0.00E+00	0.00E+00	0.00E+00	6.22E-02	0.00E+00	4.12E-04	0.00E+00	6.26E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.99E-03	0.00E+00	0.00E+00	0.00E+00	3.99E-03
Th-230	0.00E+00	9.30E-08	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	1.21E-03	0.00E+00	0.00E+00	0.00E+00	1.21E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-03	0.00E+00	0.00E+00	0.00E+00	2.25E-03
U-234	0.00E+00	7.67E-08	0.00E+00	7.67E-08	0.00E+00	0.00E+00	0.00E+00	1.58E-03	0.00E+00	7.67E-08	0.00E+00	1.58E-03
U-235	0.00E+00	1.18E-06	0.00E+00	1.18E-06	0.00E+00	0.00E+00	0.00E+00	1.04E-03	0.00E+00	1.18E-06	0.00E+00	1.04E-03
U-238	0.00E+00	1.63E-05	0.00E+00	1.63E-05	0.00E+00	0.00E+00	0.00E+00	1.54E-03	0.00E+00	1.63E-05	0.00E+00	1.55E-03
Summed	0.00E+00	4.29E-04	0.00E+00	4.29E-04	0.00E+00	0.00E+00	0.00E+00	7.38E-02	0.00E+00	4.29E-04	0.00E+00	7.42E-02

Table C-9. Sample 63716/PNA14C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	4.12E-04	0.00E+00	4.12E-04	0.00E+00	0.00E+00	0.00E+00	1.56E-02	0.00E+00	4.12E-04	0.00E+00	1.60E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	9.30E-08	0.00E+00	9.30E-08	0.00E+00	0.00E+00	0.00E+00	1.26E-03	0.00E+00	0.00E+00	0.00E+00	1.26E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234	0.00E+00	7.67E-08	0.00E+00	7.67E-08	0.00E+00	0.00E+00	0.00E+00	1.14E-03	0.00E+00	7.67E-08	0.00E+00	1.14E-03
U-235	0.00E+00	1.18E-06	0.00E+00	1.18E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-06	0.00E+00	1.18E-06
U-238	0.00E+00	1.63E-05	0.00E+00	1.63E-05	0.00E+00	0.00E+00	0.00E+00	1.45E-03	0.00E+00	1.63E-05	0.00E+00	1.47E-03
Summed	0.00E+00	4.29E-04	0.00E+00	4.29E-04	0.00E+00	0.00E+00	0.00E+00	1.94E-02	0.00E+00	4.29E-04	0.00E+00	1.98E-02

Table C-10. Sample 63746/KNB1C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	2.06E-02	0.00E+00	2.06E-02	0.00E+00	0.00E+00	0.00E+00	4.02E-02	0.00E+00	2.06E-02	0.00E+00	6.08E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.56E-06	0.00E+00	2.56E-06	0.00E+00	0.00E+00	0.00E+00	9.21E-04	0.00E+00	0.00E+00	0.00E+00	9.21E-04
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00	3.00E-03
U-234	0.00E+00	2.11E-06	0.00E+00	2.11E-06	0.00E+00	0.00E+00	0.00E+00	1.33E-03	0.00E+00	2.11E-06	0.00E+00	1.34E-03
U-235	0.00E+00	3.25E-05	0.00E+00	3.25E-05	0.00E+00	0.00E+00	0.00E+00	7.23E-04	0.00E+00	3.25E-05	0.00E+00	7.55E-04
U-238	0.00E+00	4.50E-04	0.00E+00	4.50E-04	0.00E+00	0.00E+00	0.00E+00	1.05E-03	0.00E+00	4.50E-04	0.00E+00	1.50E-03
Summed	0.00E+00	2.11E-02	0.00E+00	2.11E-02	0.00E+00	0.00E+00	0.00E+00	4.73E-02	0.00E+00	2.11E-02	0.00E+00	6.83E-02

Table C-11. Sample 63749/KNB4C

deer mouse												
Nuclide	**External**				**Internal**				**Total**			
	ext_Wtr	**ext_Soil**	**ext_Sed**	**ext_Sum**	**int_Wtr**	**int_Soil**	**int_Sed**	**int_Sum**	**tot_Wtr**	**tot_Soil**	**tot_Sed**	**tot_Sum**
Ra-226	0.00E+00	2.06E-02	0.00E+00	2.06E-02	0.00E+00	0.00E+00	0.00E+00	1.89E-02	0.00E+00	2.06E-02	0.00E+00	3.95E-02
Th-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	2.56E-06	0.00E+00	2.56E-06	0.00E+00	0.00E+00	0.00E+00	1.60E-03	0.00E+00	0.00E+00	0.00E+00	1.60E-03
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	0.00E+00	0.00E+00	0.00E+00	3.00E-03
U-234	0.00E+00	2.11E-06	0.00E+00	2.11E-06	0.00E+00	0.00E+00	0.00E+00	2.57E-03	0.00E+00	2.11E-06	0.00E+00	2.57E-03
U-235	0.00E+00	3.25E-05	0.00E+00	3.25E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E-05	0.00E+00	3.25E-05
U-238	0.00E+00	4.50E-04	0.00E+00	4.50E-04	0.00E+00	0.00E+00	0.00E+00	2.15E-03	0.00E+00	4.50E-04	0.00E+00	2.60E-03
Summed	0.00E+00	2.11E-02	0.00E+00	2.11E-02	0.00E+00	0.00E+00	0.00E+00	2.82E-02	0.00E+00	2.11E-02	0.00E+00	4.93E-02

Distribution:

Tim Jannik, 999-W
Kenneth Dixon, 773-42A
Brooke Stagich, 999-W
John Mayer, 999-W
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