

Kansas Department of Health and Environment
Report of Radiological Environmental Monitoring of the Environs Surrounding
Wolf Creek Generating Station



July 2011-June 2012
Division of Health, Bureau of Environmental Health
Radiation and Asbestos Control Section
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 Environmental Radiation Surveillance Report
 Wolf Creek Generating Station
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Introduction

Wolf Creek Generating Station (WCGS) is a pressurized water nuclear reactor capable of producing over 1,200 megawatts of electrical power. Located near Burlington Kansas, the plant is operated by Wolf Creek Nuclear Operating Corporation (WCNOC). The facility releases radioactive material to the environment in the form of liquid and gaseous effluents. This report details the results of surveillance of the environs surrounding WCGS conducted by the Kansas Department of Health and Environment (KDHE) from July 1, 2011 through June 30, 2012.

KDHE's Wolf Creek Environmental Radiation Surveillance program began in 1979 in accordance with Kansas Administrative Regulation (K.A.R.) 28-19-81 with the initial selection of surface water sampling locations. The Environmental Radiation Surveillance program parallels (and partially overlaps) the WCNOC Radiological Environmental Monitoring Program (REMP).

The purpose of the Environmental Radiation Surveillance program is to detect, identify, and measure radioactive material and direct radiation released to the environment from the operation of WCGS. Data indicating the release of elevated levels of radioactive material will be used to determine the need for corrective and/or protective actions to protect the health and safety of the public.

The Environmental Radiation Surveillance program includes the following monitoring methods:

- Measurement of ambient external radiation levels using optically stimulated luminescence dosimeters
- Monitoring of radionuclides present in ambient air through weekly collection and laboratory analysis of continuous air samples
- Monitoring of radionuclides present in water, terrestrial vegetation, aquatic vegetation, fish, sediments, and soil through scheduled and random sample collection and laboratory analysis.

Results Summary

The most significant radionuclide present in surface water samples collected in the Coffey County Lake is tritium (^3H), a beta emitter. The highest ^3H concentration measured in the Coffey County Lake during SFY 2012 was 13,768 pCi/l in July, 2011. This maximum Coffey County Lake ^3H concentration is 68% of the National Primary Drinking Regulation maximum contaminant level (MCL) of 20,000 pCi/l. *The water from the Coffey County Lake is not used as a drinking water source.* The average CCL surface water ^3H concentration for SFY 2012 was 11,752 pCi/l, or 62% of the MCL. Coffey County Lake is not approved for any aquatic recreation other than fishing. All other non-CCL surface water and ground water samples collected in the environs of WCGS during SFY 2012 indicated no radionuclides present attributable to the operation of WCGS.

Aquatic vegetation samples are the best indicators for monitoring the seasonal fluctuations of fission and activation product levels in the Coffey County Lake. No aquatic vegetation sample showed any nuclides attributable to WCGS operation.

Sediment samples have been excellent indicators for the long-term buildup of fission and activation product activity levels in the Coffey County Lake. The highest fission product activity in sediments during SFY 2012 was 458 pCi/kg-dry ^{137}Cs in a shoreline sediment sample from east of the Coffey County Lake dam (WCRSS-L-1-219-4.2).

Airborne sample analysis indicated that no radionuclides attributable to the operation of WCGS were present above the lower limits of detection during SFY 2012.

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCGS during SFY 2012 indicated no radionuclides present attributable to the operation of WCGS.

Samples of nine species of fish were taken from the Coffey County Lake during SFY 2012. Sample analysis of edible fish portions collected in the environs of WCGS during SFY 2012 indicated that no gamma emitters attributable to WCGS operation were present. The highest ^3H concentration in tissue was 10,651 pCi/kg-wet found in a walleye sample taken from the CCL. Using an ICRP 30 dose conversion factor for ingestion ($h_{E,50}$) of 6.40×10^{-8} mrem per pCi ^3H ingested, a standard man consuming 21 kg/y of fish containing 10,651 pCi/kg ^3H would receive

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a committed effective dose equivalent of 0.01 mrem. The projected dose equivalent is far below the 100 mrem/yr regulatory limit for a member of the public.

Data from direct radiation monitoring sites revealed no significant changes from preoperational data. The lowest direct radiation levels are found closest to the WCGS. The direct radiation levels on the Coffey County Lake baffle dikes at the 1,200 m exclusion area boundary are the lowest of any monitored site. The limestone used to construct the baffle dikes has a lower natural background radioactivity than the original soil present before the construction of the Coffey County Lake. This effect of construction on the terrestrial component of natural background radiation was noted on radiation surveys conducted around the WCGS site before bringing the initial fuel load on the site. The water from the Coffey County Lake also acts as an effective shield from terrestrial radiation that was present before Coffey County Lake filling.

The ratio of KDHE results to WCNOG results ranged from 0.5-1.6. A summary of comparison data may be found in the Results Comparison Table.

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Results Summary Table

Type of Sample	Number of Sampling Stations	Total Samples Collected
Air (particulate and iodine)	5	520
Soil	5	6
Random Soil	10	10
Direct Radiation	31	248
Surface Water	5	42
Offsite Ground Water	6	24
Onsite Ground Water	4	16
Sediments	6	13
Random Sediments	16	16
Aquatic Vegetation	6	6
Random Aquatic Vegetation	7	7
Milk	2	8
Fish	2	21
Game Animals/Domestic Meat	0	1
Terrestrial Vegetation	8	9
Random Terrestrial Vegetation	10	10
Total	122	929

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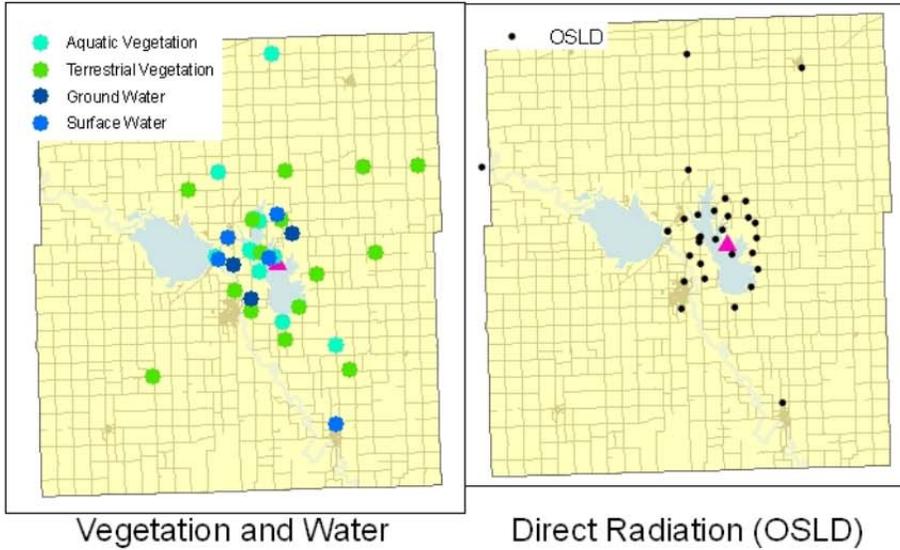
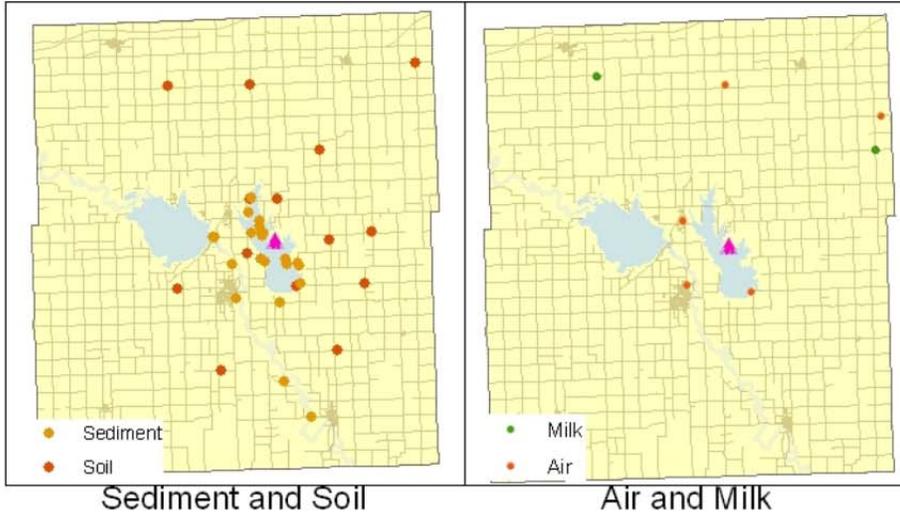
Results Comparison Table

Description	Average	Standard Deviation	Minimum	Maximum	N
OSLD direct radiation, mR per 90 day quarter	15.8	2.9	6.5	21.5	124
Airborne particulate and radioiodine cartridge gamma isotopic analysis, pCi/m ³	0.12	0.009	<0.02	0.224	260
Coffey County Lake Surface water tritium (³ H), pCi/l	11753	1520	6445	13768	24
John Redmond Reservoir, control (N-1/MUSH) (³ H), pCi/l	<350	NA	NA	NA	12
Coffey County Lake (J1A/DC) (³ H), pCi/l	12256	1006	10364	13768	12
Coffey County Lake MUDS (³ H), pCi/l	11207	1890	6445	13609	12
Neosho River Near LeRoy (³ H), pCi/l	<628.8	309	575	1,071	5
New Strawn City Lake (³ H), pCi/l	<350	NA	NA	NA	1
Offsite ground water tritium (³ H), pCi/l (All Stations)	<350	NA	NA	NA	24
Onsite ground water tritium (³ H), pCi/l (Stations where activity was detected)	2023	812	1183	3770	8
Surface and Ground Water Gamma Isotopic Analysis	Gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface water or ground water sample evaluated.				
Gamma isotopic analysis of soil, pasturage, garden vegetables, and grain.	Gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, milk, pasturage, garden vegetable and grain sample evaluated.				
Maximum activity attributable to Wolf Creek Generating Station operation, pCi/kg					
Coffey County Lake Shoreline Sediment, Dry	458 pCi/kg ¹³⁷ Cs, East of CCL Dam, 3/28/2012				
Coffey County Lake Fish, Wet	10651 pCi/kg ³ H, 10/18/2011				
Comparison Of KDHE and WCNOG Results					
<u>Analysis</u>	<u>Average Ratio of KDHE results to WCNOG Results</u>				<u>Comments</u>
OSLD Direct Radiation	0.86, N=48				12 Collocated Sites Coffey County Lake Spillway Comparison of ⁴⁰ K results
Surface Water (³ H)	1.09, N=12				
Sediment gamma isotopic	1.42, N=10				
Fish tritium (³ H)	0.75, N=3				

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Sample Location Maps

2012 Wolf Creek ERS Program



Sample Results

Inhalation Pathway

Air Particulate and Iodine

Air samples were collected weekly. Five air-sampling sites, four of which are collocated with WCNOG, have continuously operating low-volume air samplers contained in a fiberglass housing mounted on utility poles approximately one meter from the ground. Air samplers are located at Sharpe, KS (A-1), east of the Coffey County Lake dam (H-1), Burlington, KS (L-1), New Strawn, KS (P-1), and near the intersection of 20th Road and Yearling Road near Westphalia (D-2). The collocated sites include the highest calculated annual average ground level relative concentration (X/Q) area at Sharpe, the highest calculated annual average ground level relative deposition (D/Q) area at New Strawn, and a control location near Westphalia. An average flow rate of 30 liters per minute is used with 47 mm diameter glass fiber particulate filters and 5 percent triethylenediamine (TEDA) impregnated carbon cartridges for radioiodine activity (the major isotope of concern is ¹³¹I). TEDA binds the iodine chemically and reduces losses from desorption.

Field assay of each particulate filter was performed at the time of collection. The particulate filter was counted using a thin window GM 'pancake' detector (Ludlum Model 44-40 or equivalent) and a count rate instrument. A sample net count rate of greater than two times the net count rate of the current control (Westphalia D-2) air sample indicates a potential anomaly and the filter is then flagged for individual gamma isotopic analysis.

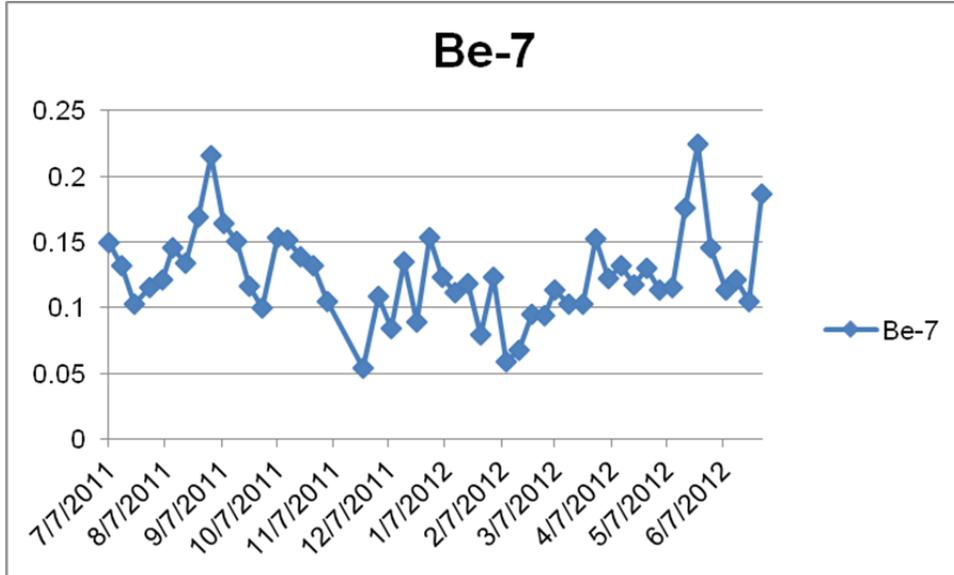
Gamma isotopic analysis was performed on two composite samples, one composed of the five particulate filters and the other of the five charcoal cartridges. Indication of ¹³¹I or any other fission or activation product requires gamma isotopic analysis of each individual particulate filter and associated charcoal cartridge.

Table 1, Weekly Air Particulate/iodine Monitoring, pCi/m³

Number of Samples	Average ⁷ Be Concentration	Average Iodine Concentration
260	0.12 ± 0.09	<0.33

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Graph 1, Weekly Particulate ⁷Be Concentration, pCi/m³



Airborne Pathway

Soil

Four indicator, two control, and ten random annual soil samples were collected. Indicator soil samples were collected near Stringtown Cemetery, east of the CCL dam, at the CCL MUDS area, and at the public environmental education area. Two control soil samples were collected east of WCGS at the Scott Valley Church. Random soil samples were collected at ten locations within the ten mile zone around WCGS. Soil samples collected from the Coffey County public use areas are split with WCNOG.

A gamma isotopic analysis is performed on all soil samples collected.

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Table 2, Annual Samples for Radionuclide Deposition on Soil, pCi/kg KDHE (WCNOC)

Nuclide	A-1 Near Stringtown <u>Cemetery</u> 9/14/2011	E-1 Scott Valley Church <u>(Control)</u> 9/14/2011	H-1 <u>East of CCL Dam</u> 5/2/2012
²²⁸ Ac	<28.0	<28.0	1520 ± 30
¹³⁷ Cs	98 ± 6	405 ± 11	250 ± 11
⁴⁰ K	13646 ± 609	12061 ± 341	12600 ± 600
	<u>P-1 (MUDS)</u> 3/1/2012	<u>R-1 (EEA)</u> 3/13/2012	
²²⁸ Ac	1145 ± 16	<28.0	
¹³⁷ Cs	337 ± 69	124 ± 5 (155.2 +/- 44.9)	
⁴⁰ K	11338 ± 337	8732 ± 265 (8,520.0 +/- 628.2)	

Table 3, Random Samples for Radionuclide Deposition on Soil, pCi/kg

<u>Location</u>	<u>Date</u>	¹³⁷ Cs	Nuclide	⁴⁰ K
Near 20th and Planter	10/6/2011	141 ± 5		11820 ± 351
Near 13th and Garner	11/2/2011	633 ± 16		11219 ± 318
Near Trefoil and 16th	12/22/2011	12.0 ± 1		12300 ± 364
13th and Underwood	1/3/2012	135 ± 6		12014 ± 357
9th Rd. Between Quail and Planter	1/4/2012	35 ± 3		13570 ± 601
Near 11th Rd. and Native Rd.	1/23/2012	10 ± 1		8422 ± 253
9th Rd. Between Juneberry and Kafir	1/31/2012	93 ± 4		16000 ± 470
Highway 58 near Planter Rd.	2/21/2012	<8.0		12437 ± 368
23 rd Rd. Between Native and Oxen Rd.	3/26/2012	<8.0		17800 ± 529
Milo Rd. between 18th and 19th Rd.	11/30/2012	127 ± 5		16300 ± 479

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Direct Radiation Pathway

Direct Radiation Monitoring

Direct radiation monitoring was accomplished using Landauer Luxel optically stimulated luminescence dosimeters (OSLDs). OSLDs are read by Landauer. OSLD readings are corrected for transit and handling exposure.

Thirty-one locations around the WCGS were monitored by KDHE, including three control locations greater than ten miles from WCGS. Two OSLDs were used per site to generate an average quarterly reading. The dosimeters are contained in specially constructed holders suspended approximately one meter above the ground. Staff members exchange OSLDs quarterly. KDHE has collocated OSLDs with WCNOG at twelve sites.

Table 4, Quarterly Direct Radiation Monitoring, mR/qtr

Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1. A-1 (1), North of WCGS	14.8	20.5	19.2	18.0
2. A-2, Sharpe	12.8	20.0	17.7	17.5
3. A-3, Forward Staging Area	11.3	16.0	17.2	15.0
4. B-1, East Sharpe	14.3	20.0	19.2	16.5
5. B-2, Waverly Control	13.8	19.0	18.2	15.0
6. C-1, near residence	13.3	20.0	18.2	13.0
7. D-1 (9), near residence	13.3	17.5	17.2	15.5
8. E-1, near residence	13.3	20.5	17.7	15.0
9. F-1, near residence	13.8	18.5	19.7	14.0
10. G-1 (14), WCNOG gate	15.8	20.5	19.2	16.5
11. H-0 (42), CCL baffle dike A	9.3	13.0	16.7	6.5
12. H-1, east of CCL dam	11.3	17.5	15.7	15.0
13. H-2, LeRoy control	13.3	18.0	17.2	14.5
14. J-1, near residence	10.3	16.5	16.7	13.0
15. K-1 (29), near residence	9.8	15.5	14.2	10.5
16. L-1 (27), near residence	13.8	18.5	17.7	15.0
17. L-2, Burlington	13.3	18.0	17.7	15.0
18. L-3, Coffey County Shop	11.3	16.5	16.2	12.5
19. M-1 (26), near residence	14.3	17.5	15.7	14.5
20. N-1, near pasture	14.3	19.5	18.2	16.5
21. P-0 (43), CCL baffle dike B	8.8	13.0	14.2	6.5
22. P-1, New Strawn	12.8	18.5	17.7	17.0
23. P-2, Hartford Control	11.8	17.5	16.2	12.0
24. P-3, CCL entrance	16.8	19.5	17.2	15.5
25. P-4 (46), CCL near MUDS	13.3	19.0	18.7	14.5
26. P-5, JRR public use area	15.3	19.0	17.7	15.5
27. Q-1, near residence	13.8	18.5	18.2	16.0
28. R-0 (41), Stringtown cemeter	12.8	21.5	18.7	16.0
29. R-1 (37), near residence	12.8	19.0	16.2	16.0
30. R-2 (44), CCL EEA	13.3	18.5	17.7	15.5
31. R-3, near Coffey County Airp	13.3	16.0	18.2	17.0

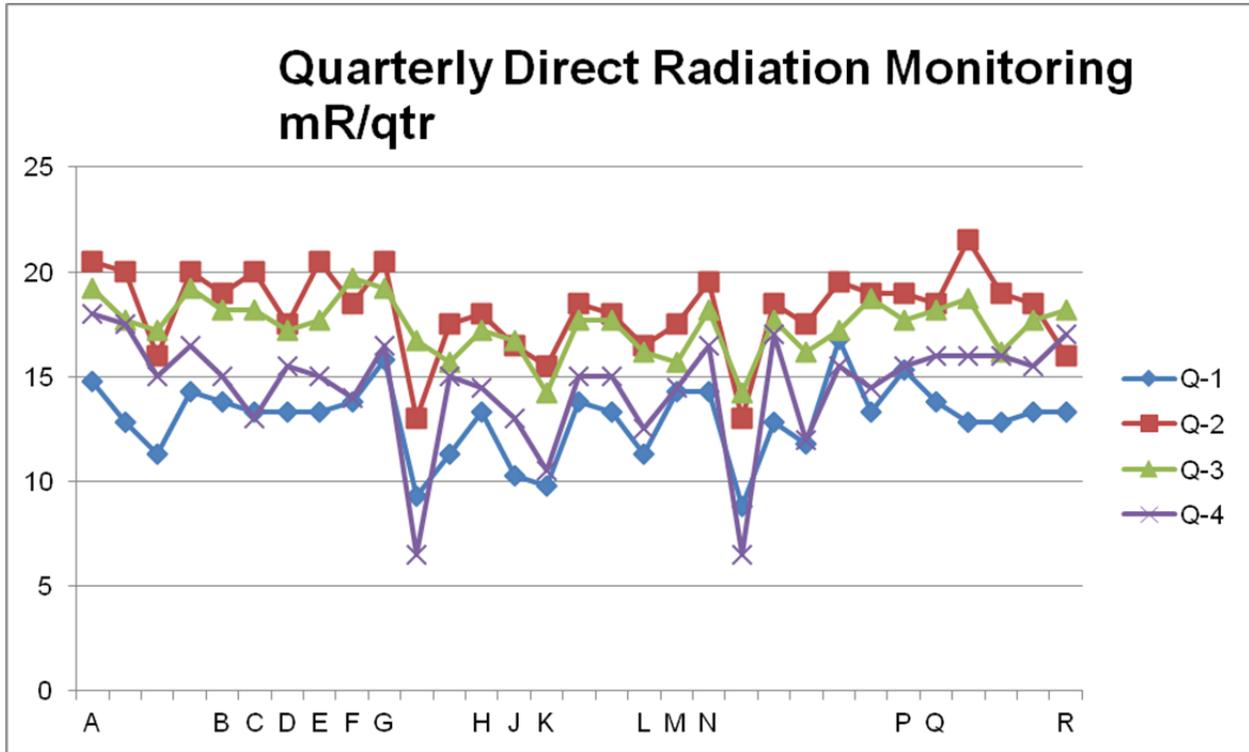
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Table 5, Quarterly Collocated Direct Radiation Monitoring, mR/qtr

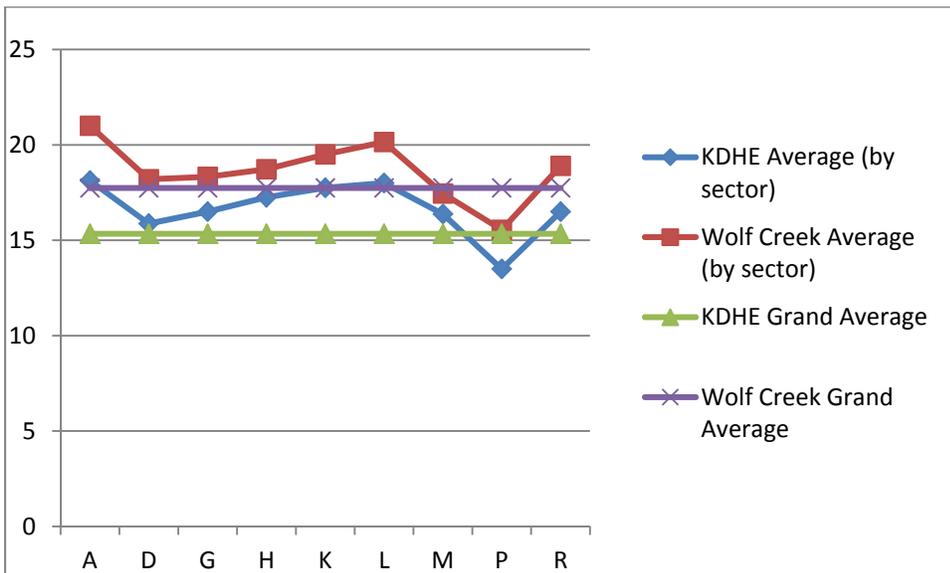
Location KDHE(WCNOC)	KDHE Monitoring Period	KDHE	WCNOC
1. A-1 (1)	7/8/2011-10/4/2011	14.8	22.9
	10/4/2011-1/9/2012	20.5	20.1
	1/9/2012-4/4/2012	19.2	17.6
	4/4/2012-7/3/2012	18.0	23.4
2. D-1 (9)	7/8/2011-10/4/2011	13.3	20.4
	10/4/2011-1/9/2012	17.5	17.9
	1/9/2012-4/4/2012	17.2	16.8
	4/4/2012-7/3/2012	15.5	17.7
3. G-1 (14)	7/8/2011-10/4/2011	15.8	20.9
	10/4/2011-1/9/2012	20.5	19.5
	1/9/2012-4/4/2012	19.2	19.9
	4/4/2012-7/3/2012	16.5	20.3
4. H-0 (42)	7/8/2011-10/4/2011	9.3	10.1
	10/4/2011-1/9/2012	13.0	13.6
	1/9/2012-4/4/2012	16.7	11.0
	4/4/2012-7/3/2012	6.5	12.8
5. K-1 (29)	7/8/2011-10/4/2011	9.8	15.5
	10/4/2011-1/9/2012	15.5	16.5
	1/9/2012-4/4/2012	14.2	16.5
	4/4/2012-7/3/2012	10.5	16.8
6. L-1 (27)	7/8/2011-10/4/2011	13.8	23.9
	10/4/2011-1/9/2012	18.5	18.4
	1/9/2012-4/4/2012	17.7	17.4
	4/4/2012-7/3/2012	15.0	21.5
7. M-1 (26)	7/8/2011-10/4/2011	14.3	18.5
	10/4/2011-1/9/2012	17.5	17.9
	1/9/2012-4/4/2012	15.7	16.2
	4/4/2012-7/3/2012	14.5	16.5
8. P-0 (43)	7/8/2011-10/4/2011	8.8	12.1
	10/4/2011-1/9/2012	13.0	11.8
	1/9/2012-4/4/2012	14.2	10.0
	4/4/2012-7/3/2012	6.5	13.8
9. P-4 (46)	7/8/2011-10/4/2011	13.3	23.4
	10/4/2011-1/9/2012	19.0	17.4
	1/9/2012-4/4/2012	18.7	16.8
	4/4/2012-7/3/2012	14.5	19.1
10. R-0 (41)	7/8/2011-10/4/2011	12.8	23.9
	10/4/2011-1/9/2012	21.5	19.1
	1/9/2012-4/4/2012	18.7	14.7
	4/4/2012-7/3/2012	16.0	19.3
11. R-1 (37)	7/8/2011-10/4/2011	12.8	19.0
	10/4/2011-1/9/2012	19.0	17.5
	1/9/2012-4/4/2012	16.2	18.1
	4/4/2012-7/3/2012	16.0	16.5
12. R-2 (44)	7/8/2011-10/4/2011	13.3	22.0
	10/4/2011-1/9/2012	18.5	18.0
	1/9/2012-4/4/2012	17.7	17.6
	4/4/2012-7/3/2012	15.5	21.1

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Graph 2, Quarterly Direct Radiation Results for KDHE OSLD Sites

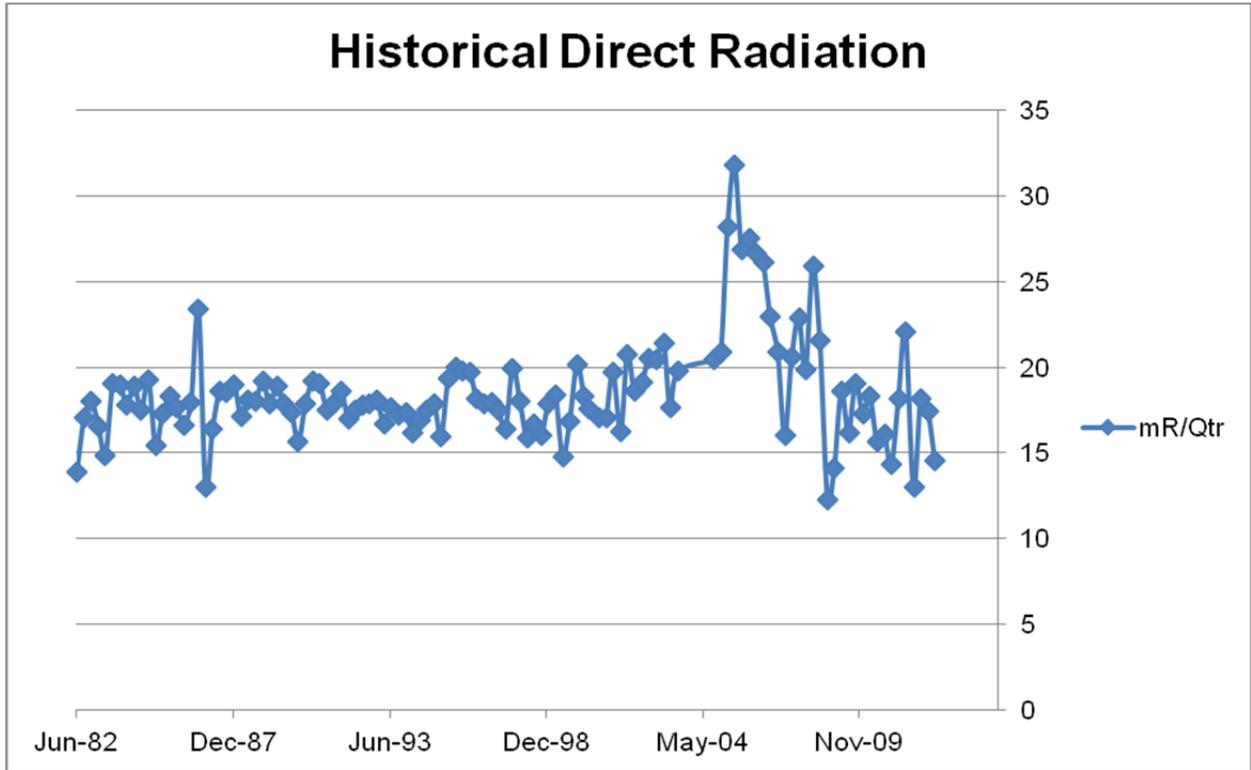


Graph 3 Direct Radiation Monitoring Results for Collocated OSLD Sites (mR/Quarter)



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Graph 4 Historical KDHE Direct Radiation Monitoring Results



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Waterborne Pathway

Surface Water

Surface water sampling was accomplished through the collection of one-gallon grab samples at the indicated locations. A control sample was collected monthly from John Redmond Reservoir. One sample was collected monthly from the Coffey County Lake (CCL) at the spillway. One sample was collected monthly at the public fishing area on CCL, near the Makeup Discharge Structure (MUDS). Samples were collected monthly from the Neosho River near Leroy only when Coffey County Lake was overflowing to Wolf Creek at the spillway. A sample was also collected annually from the New Strawn City Lake.

A gamma isotopic and tritium (^3H) analysis was done on each CCL water sample and ^3H analysis was done quarterly on a composite sample from JRR. Samples from John Redmond Reservoir and the Coffey County Lake Spillway were split with WCNOC.

Table 6, Monthly Samples for Waterborne Radionuclides (^3H) in Surface Water, pCi/L

Q-1 CCL Spillway			N-1 (JRR/MUSH) Control			P-1 MUDS	
Date	KDHE	WCNOC	Date	KDHE	WCNOC	Date	KDHE
7/18/2011	13768 ± 470	12794 ± 334	7/18/2011	<350	<152	7/14/2011	13609 ± 468
8/8/2011	13023 ± 487	12,670 ± 336	8/8/2011	<350	<185	8/18/2011	10823 ± 455
9/14/2011	12207 ± 477	11590 ± 315	9/14/2011	<350	<144	9/6/2011	11656 ± 471
10/17/2011	11864 ± 472	11095 ± 307	10/17/2011	<350	<145	10/14/2011	11720 ± 472
11/21/2011	10525 ± 318	9847 ± 292	11/21/2011	<350	<137	11/17/2011	11439 ± 329
12/22/2011	10364 ± 319	10186 ± 299	12/22/2012	<350	<151	1/18/2012	10661 ± 329
1/23/2012	12543 ± 309	10337 ± 296	1/18/2012	<350	<146	1/31/2012	10807 ± 328
2/27/2012	12050 ± 340	11290 ± 312	2/27/2012	<350	<141	2/21/2012	12935 ± 353
3/26/2012	12574 ± 344	9076 ± 290	3/26/2012	<350	<152	3/13/2012	10396 ± 324
4/16/2012	13178 ± 349	12545 ± 333	4/16/2102	<350	<150	4/11/2012	12788 ± 347
5/7/2012	12900 ± 400	11622 ± 319	5/7/2012	<350	<148	5/24/2012	6445 ± 305
6/11/2012	12077 ± 479	11619 ± 301	6/11/2012	<350	<140	6/15/2012	11713 ± 471

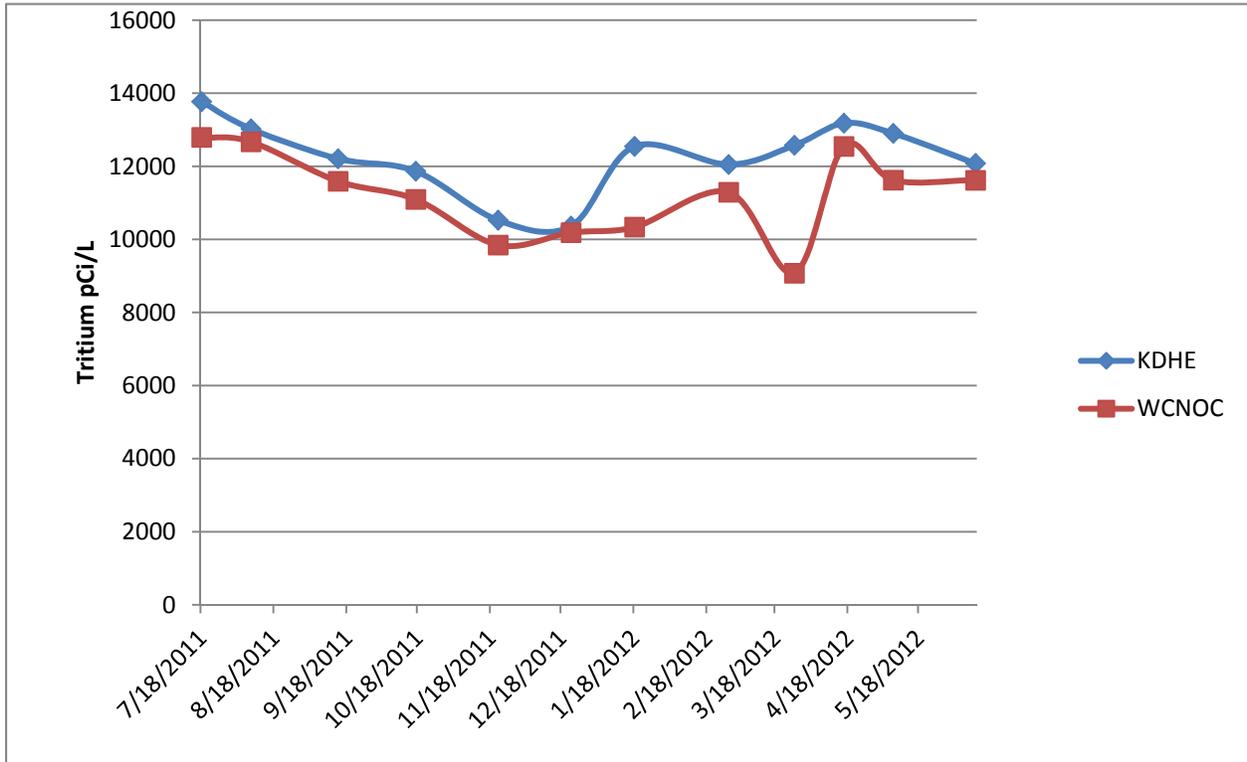
H-1 Neosho River Near Leroy	
Date	KDHE
12/1/2011	798 ± 180
1/18/2012	575 ± 174
2/21/2012	<350
3/21/2012	1071 ± 195
4/11/2012	<350

Table 7 Annual Samples for Deposition of Airborne Radionuclides in Surface Water, pCi/L

<u>Location</u>	<u>Date</u>	<u>^3H</u>
P-1, New Strawn City Lake	1/31/2012	<350

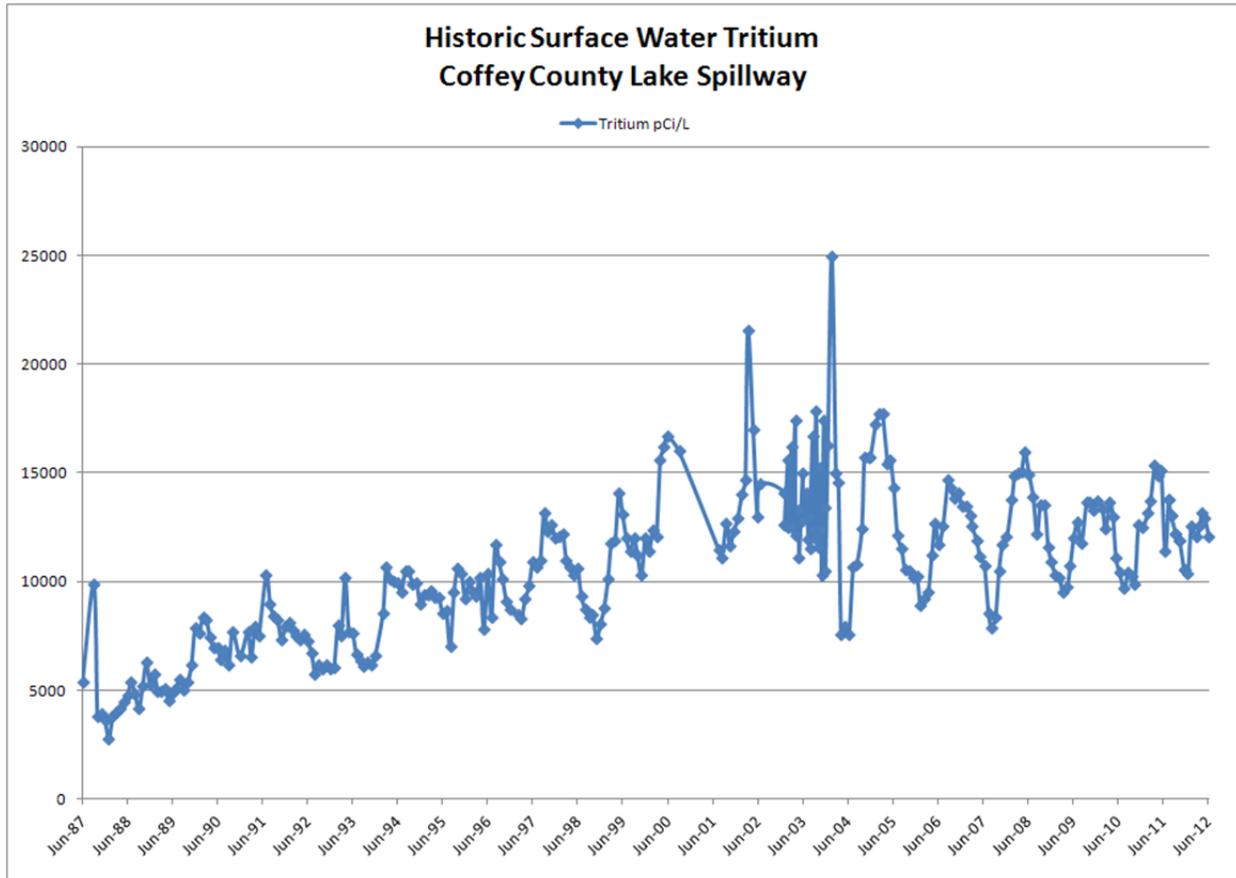
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Graph 6 Comparison of CCL Spillway Monthly Surface Water Tritium Results (pCi/L)



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Graph 7, Historical KDHE Surface Water Tritium Results (CCL Spillway)



Ground Water

Ground water was collected quarterly offsite at wells in sectors B (control), C, F, G, and J. The control sample location was hydrologically up gradient from the facility and the other five are hydrologically down gradient. Samples were split with WCNO. Samples were collected within the Wolf Creek owner controlled area along the Essential Service Water buried pipe (two locations) and in the Wolf Creek protected area near the Auxiliary Building.

Gross alpha, beta, tritium and gamma isotopic analysis are done on each sample.

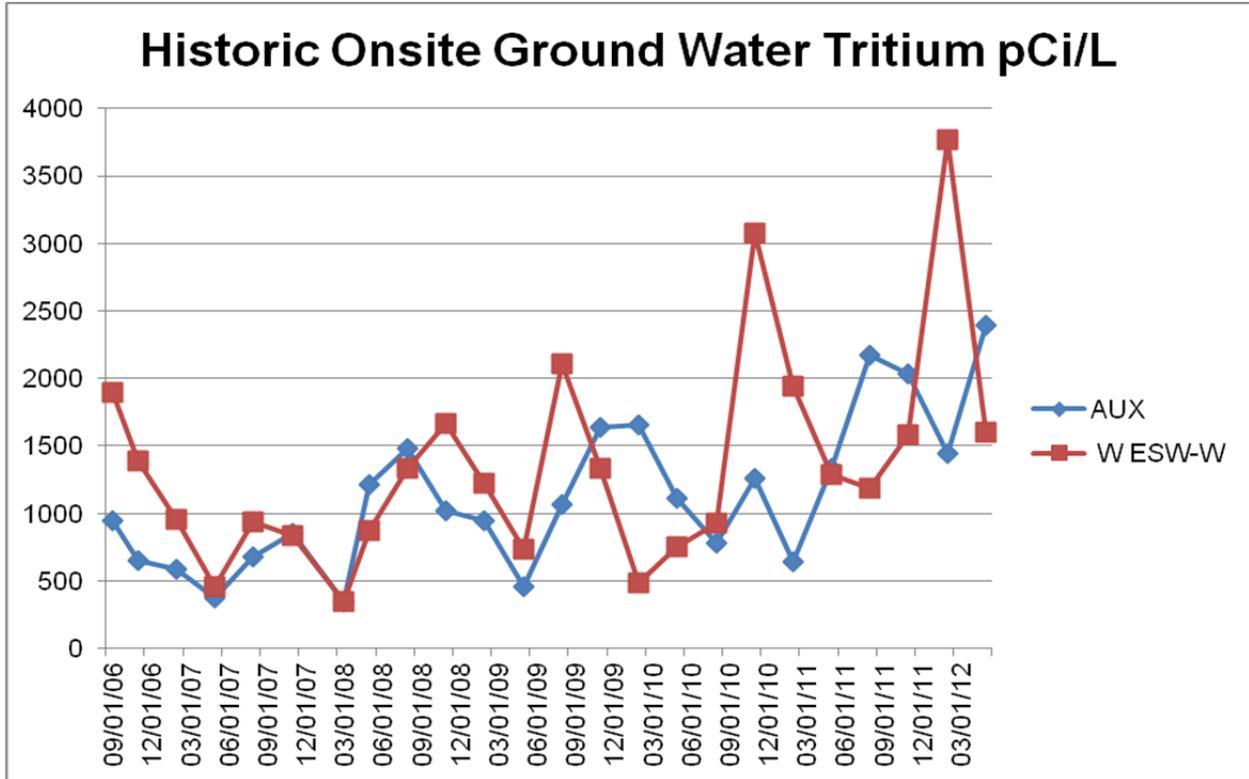
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Table 8, Quarterly Samples for Waterborne Radionuclides in Ground Water, pCi/L

Offsite Ground Water					
<u>B-1 (B-12)</u>			<u>G-1 (G-2)</u>		
Date	³ H KDHE	³ H WCNOG	Date	³ H KDHE	³ H WCNOG
8/8/2011	<350	<185	8/8/2011	<350	<185
11/21/2011	<350	<137	11/21/2011	<350	<137
2/27/2012	<350	<141	2/27/2012	<350	<141
5/7/2012	<350	<148	5/7/2012	<350	<148
<u>F-1 (F-1)</u>			<u>C-2 (C-49)</u>		
Date	³ H KDHE	³ H WCNOG	Date	³ H KDHE	³ H WCNOG
8/8/2011	<350	<185	8/8/2011	<350	<185
11/21/2011	<350	<137	11/21/2011	<350	<137
2/27/2012	<350	<141	2/27/2012	<350	<141
5/7/2012	<350	<148	5/7/2012	<350	<148
<u>J-1 (J-2)</u>			<u>C-1 (C-10)</u>		
Date	³ H KDHE	³ H WCNOG	Date	³ H KDHE	³ H WCNOG
8/8/2011	<350	<185	8/8/2011	<350	<185
11/21/2011	<350	<137	11/21/2011	<350	<137
2/27/2012	<350	<141	2/27/2012	<350	<141
5/7/2012	<350	<148	5/7/2012	<350	<148
Onsite Ground Water					
<u>Auxiliary Building</u>			<u>WEST ESW-W</u>		
Date	³ H KDHE	³ H WCNOG	Date	³ H KDHE	³ H WCNOG
8/17/2011	2172 ± 290	1999 ± 141	8/17/2011	1183 ± 264	1037 ± 113
11/9/2011	2035 ± 201	1915 ± 144	11/9/2011	1581 ± 193	1361 ± 128
2/22/2012	1448 ± 198	1523 ± 138	2/22/2012	3770 ± 240	3676 ± 191
5/24/2012	1603 ± 230	1618 ± 138	5/24/2012	2392 ± 150	2118 ± 150
			<u>EAST ESW-W</u>		
			Date	³ H KDHE	³ H WCNOG
			8/17/2011	<350	<139
			11/9/2011	<350	<147
			2/22/2012	<350	<163
			5/24/2012	<350	<145

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Graph 8 Historic Owner Controlled Area (Onsite) Groundwater Tritium, pCi/L



Shoreline and Bottom Sediments

Shoreline sediment and bottom sediment were collected in the environment surrounding WCGS. Indicator bottom sediment samples were collected in the Coffey County Lake discharge cove, public environmental education area, and the CCL MUDS public access fishing area. A control sample of bottom sediment was obtained from John Redmond Reservoir. Indicator shoreline sediment was collected at the CCL discharge cove, the CCL MUDS public access fishing area, Wolf Creek below the CCL dam, and Stringtown Cemetery. A control sample of shoreline sediment was collected at JRR. Eight random bottom sediments were collected on CCL. Eight random shoreline sediments were collected on CCL and the Neosho River. The CCL and JRR samples are split with WCNOG.

A gamma isotopic analysis is done on all sediment samples collected.

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Table 9 Annual Samples for Waterborne Radionuclides in Sediments. pCi/kg dry

Location	Type	Date	¹³⁷ Cs KDHE (WCNOC)	⁶⁰ Co KDHE (WCNOC)	⁴⁰ K KDHE (WCNOC)
J-1 Wolf Creek	Bottom	9/6/2011	29 ± 2	<11.0	10433 ± 311
Q-1 CCL Discharge Cove	Bottom	11/23/2011	96 ± 9 (107.1 ± 42.1)	<11.0 (<32.4)	13941 ± 444 (12271 ± 1040.0)
	Shoreline	11/23/2011	8 ± 2 (<20.2)	<11.0 (<10.0)	10423 ± 299 (7581.8 ± 496.8)
	Bottom	5/2/2012	206 ± 14 (66.6 ± 39.0)	<11.0 (<30.6)	20500 ± 500 (10,035.0 ± 1,063.0)
	Shoreline	5/2/2012	130 ± 12 (<48.2)	<11.0 (<17.2)	12800 ± 600 (8464.3 ± 914.7)
N-1 John Redmond Reservoir (Control)	Bottom	11/23/2011	85 ± 8 (91.2 ± 49.4)	<11.0 (<12.6)	16087 ± 513 (12,002.0 ± 1,002.0)
	Shoreline	11/23/2011	21 ± 3 (<12.4)	<11.0 (<6.0)	6910 ± 220 (6,478.7 ± 402.8)
	Bottom	5/2/2012	154 ± 11 (121.8 ± 54.9)	<11.0 (<18.0)	<828.0 (11,955.0 ± 1,125.0)
	Shoreline	5/2/2012	<8.0 (<24.7)	<11.0 (<19.0)	10400 ± 500 (10,239.0 ± 678.5)
R-1 Wolf Creek Environmental Education Area	Bottom	4/11/2012	61 ± 15 (49.8 ± 15.0)	<11.0 (<12.6)	13400 ± 600 (11179.0 ± 566.5)
	Shoreline	5/29/2012	309 ± 12 (234.3 ± 58.9)	<11.0 (<28.1)	12900 ± 400 (8620.8 ± 993.9)
P-1 Wolf Creek Public Fishing Area (MUDS)	Bottom	9/6/2011	29.2 (<20.7)	<11.0 (<11.1)	10433 ± 311 (9989.6 ± 659.4)
R-2 Stringtown Cemetery	Bottom	6/15/2012	22.0 ± 2 (<25.0)	<11.0 (<15.2)	12700 ± 5533 (10,824.0 ± 653.6)

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Table 10 Random Samples for Waterborne Radionuclides in Sediments, pCi/kg dry

<u>Type</u>	<u>Location</u>	<u>Date</u>	¹³⁷ Cs	<u>Isotope</u> ⁶⁰ Co
Shoreline Sediment	Neosho River at Burlington Fairgrounds	8/3/2011	14 ± 1	<11.0
	NW End of CCL	9/28/2011	13 ± 1	<11.0
	Near Low Water Dam in Burlington	11/2/2011	15 ± 3	<11.0
	East of CCL Dam	3/28/2012	458 ± 3	<11.0
	Neosho River at bend in Planter Rd	5/2/2012	17 ± 2	<11.0
	East of CCL Dam	5/29/2012	108 ± 6	<11.0
	CCL East of Bird Blind	5/29/2012	68 ± 4	<11.0
	0.25 Mi. North of Stringtown Cemetery	6/15/2012	67.0 ± 4	<11.0
Bottom Sediment	Neosho River Near LeRoy	9/6/2011	<8.0	<11.0
	West Side of CCL	10/3/2011	10 ± 1	<11.0
	West Side of CCL	10/3/2011	17 ± 1	<11.0
	West Side of CCL	10/3/2011	9 ± 1	<11.0
	West Side of CCL	10/3/2011	<8.0	<11.0
	West Side of CCL	10/3/2011	<8.0	<11.0
	Black Bear Bosin Park	6/12/2012	<8.0	<11.0
	Near the Boat Ramps	6/25/2012	<8.0	<11.0

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Aquatic Vegetation and Algae

Annual aquatic vegetation (algae and/or rooted) indicator samples were collected from the Coffey County Lake and Wolf Creek below the Coffey County Lake dam. Control samples of aquatic vegetation were obtained at John Redmond Reservoir. The Coffey County Lake samples are split with WCNOG.

Gamma isotopic analysis is performed on all aquatic vegetation samples.

Table 11, Annual Samples for Waterborne Radionuclides in Aquatic Vegetation

**KDHE, pCi/kg (dry)
 (WCNOG), pCi/kg (wet)**

<u>Location</u>	<u>Sample Type</u>	<u>Date</u>	<u>⁴⁰K</u>	<u>⁷Be</u>
Wolf Creek	Water Willow	8/17/2011	13229 ± 558	3080 ± 173
JRR above dam	Cattails	6/12/2012	15000 ± 853	485 ± 125
CCL MUDS	Pondweed	9/6/2011	870 ± 339 (2637.7 ± 316.1)	427 ± 59 (288.7 ± 132.1)
CCL Alternate DC	American Lotus	7/27/2011	16358 ± 560 (3629.9 ± 310.3)	1882 ± 97 (309.3 ± 127.1)
CCL DC	Cattails	5/29/2012	<860 (2,127.2 ± 297.4)	<152 (<139.1)
CCL EEA	Spikerush	6/12/2012	19800 ± 669 (4600.8 ± 225.6)	2230 ± 135 (454.7 ± 76.7)

Table 12 Random Samples for Waterborne Radionuclides in Aquatic Vegetation KDHE, pCi/kg

<u>Location</u>	<u>Sample Type</u>	<u>Date</u>	<u>⁴⁰K</u>	<u>⁷Be</u>
Mathias Lake North Shoreline	Rose Mallow	7/14/2011	21300 ± 856	21300 ± 856
Near Trefoil Rd. Between 18th/19th	Calamus	7/7/2011	35623 ± 1397	35623 ± 1397
Neosho River Burlington	Algae	8/3/2011	11434 ± 382	11434 ± 382
Near 13th and 75 HWY	Duckweed	7/18/2011	19642 ± 856	19642 ± 856
Neosho River at Burlington Fairgrounds	Algae	8/3/2011	1144 ± 382	1144 ± 382
West Side of Mathias Lake	American Lotus	8/17/2011	15466 ± 537	15466 ± 537
West End of CCL	Pondweed	10/3/2011	13757 ± 586	13757 ± 586

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Ingestion Pathway

Milk

Milk was sampled quarterly in Coffey County at two locations. Indicator samples were obtained from the Sunrise Dairy near Westphalia, KS. Control samples were obtained from Linsey Dairy near Lebo, KS. Each milk sample is analyzed for low levels of radioiodine and other gamma emitting nuclides. No gamma emitting nuclides attributable to Wolf Creek operation were detected in any milk sample.

Table 13 Quarterly Samples for Radionuclides in Milk, pCi/L

Linsey Dairy			Sunrise Dairy		
Date	¹³¹ I	⁴⁰ K	Date	¹³¹ I	⁴⁰ K
8/18/2011	<1	2283 ± 85	8/26/2011	<1	1424 ± 50
12/13/2011	<1	1603 ± 69	12/20/2011	<1	1550 ± 80
3/22/2012	<1	1554 ± 66	3/13/2012	<1	1093 ± 24
04/26/12	<1	1470 ± 100	6/14/2012	<1	1490 ± 60

Fish/Game Animals/Domestic Meat

Fish samples were collected from the Coffey County Lake and below John Redmond Reservoir on the Neosho River. Sample portions from fish collected in the Coffey County Lake and below John Redmond Reservoir on the Neosho River were split with WCNOG. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. Fourteen fish for a total of nine species were sampled from Coffey County Lake.

Game animal sampling is usually limited to the collection of edible meat portions from road-killed deer. Sample portions of road-killed deer are usually collected as available by WCNOG and split with KDHE for laboratory analysis. One deer sample was obtained during SFY 2012.

A gamma isotopic analysis is done on all samples collected. Sample portions were edible. Tritium in tissue analysis (fat and water) is done on at least one species of fish from each location sampled.

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Table 14, Annual Samples for Radionuclides in Fish, pCi/kg, (wet)

Location	Date	Type	³ H KDHE (WCNOC)	Gamma Activity
Coffey County Lake	7/26/2011	White Bass	¹ NA (8807 ± 249)	No Gamma Activity Was Detected Above MDA in Any Fish Sample (⁵⁸ Co<9.0, ⁶⁰ Co<11.0, ¹³⁷ Cs<9.0, ¹³¹ I<10.0)
		Channel Catfish	<1200 (9641 ± 262)	
		Common Carp	¹ NA (9032 ± 255)	
		Smallmouth Bass	¹ NA (8149 ± 243)	
Coffey County Lake	10/18/2011	Blue Catfish	3238 ± 218 (8021 ± 240)	
		Common Carp	¹ NA (7879 ± 235)	
		White Bass	¹ NA (8289 ± 238)	
		Channel Catfish	¹ NA (8069 ± 239)	
		White Crappie	¹ NA (7726 ± 232)	
		Walleye	10651 ± 450 (7583 ± 217)	
John Redmond Reservoir	11/23/2011	Common Carp	¹ NA (<110)	
		Smallmouth Buffalo	¹ NA (<113)	
		Channel Catfish	<1200 (<110)	
Coffey County Lake	5/22/2012	Smallmouth Buffalo	¹ NA (8116 ± 225)	
		Freshwater Drum	¹ NA (8151 ± 239)	
		Smallmouth Bass	¹ NA (8948 ± 250)	
		Common Carp	7282 ± 303 (8370 ± 240)	
John Redmond Reservoir	5/22/2012	Common Carp	<1200 (<118)	
		Smallmouth Buffalo	¹ NA (<114)	
		Channel Catfish	¹ NA (<114)	
		Freshwater Drum	¹ NA (<117)	

¹ KDHE Radiochemistry laboratory performs tritium analysis on only one species of fish per batch of samples.

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Table 15 Random Samples for Radionuclides in Game, pCi/kg

<u>Sample Location</u>	<u>Date</u>	<u>Sample Type</u>	⁷ Be, KDHE (WCNOC)	⁴⁰ K, KDHE (WCNOC)
1.8 Mi. NNW of WCNOC	10/2/2011	Roadkill Deer	<78 (Not Reported)	3132 ± 120 (2756 ± 379.9)

Terrestrial Vegetation and Food Products

Terrestrial vegetation samples were taken at various locations around WCGS. This includes samples of crops grown throughout Coffey County, broadleaf vegetation taken from gardens near the WCGS boundary, and pasturage near WCGS. Samples collected on WCNOC property and samples of crops were split with WCNOC. A control sample was collected at Scott Valley Church approximately six miles from WCGS. Ten random samples were collected from locations around WCGS within the 50 mile zone.

A gamma isotopic analysis was done on each vegetation sample and edible portions of food products collected.

Table 16 Annual Samples for Terrestrial Vegetation and Food Products, pCi/kg

Sample ID	Location	Sample Type	Date	⁴⁰ K KDHE (WCNOC)	⁷ Be KDHE (WCNOC)
WCFV-1-E-087-5.8	Scott Valley Church (Control)	Shattercane	10/14/2011	4570 ± 17	1137.0 ± 54.0
NR-U1	Sector K, 4.5 mi. SSW of Wolf Creek	Irrigated Soybeans	10/1/2011	12094 ± 361 (12212 ± 448.4)	<360 (<85.1)
NR-D2	Kerry Trostle Farm	Irrigated Soybeans	10/5/2011	17100 ± 505 (14440 ± 634.3)	<360 (<129.6)
NR-D1	Coffey County	Irrigated Soybeans	10/14/2011	14995 ± 444 (15148 ± 611.2)	<360 (<70.1)
NR-U1	Sector K, 4.5 mi. SSW of Wolf Creek	Corn	9/2/2011	3503.0 ± 116 (3378.6 ± 162)	< 360.0 (<40.2)
WCFV-1-A-005-2.5	Sharpe	Chicory	6/25/2012	22100 ± 1050	1443 ± 152
WCFV-1-R-330-2.9	EEA	Pasturage	6/12/2012	20900 ± 674 (13379 ± 532.9)	2240 ± 119 (1084.0 ± 181.1)
WCFV-3-P-289-1.6	MUDS	Pasturage	9/6/2011	<152 (3310.2 ± 480.8)	7173 ± 351 (2558.7 ± 309.3)
WCFV-1-H-157-3.1	East of Dam	Prairie Grass	5/29/2012	12300 ± 400	<157

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Table 17, Random Samples for Vegetation and Food Products, pCi/kg

Location	Sample Type	Date	⁴⁰K	⁷Be
20th and Reaper	Wheat	7/1/2011	3891 ± 135	<360
7th and Shetland	Corn on Cob	8/17/2011	5764 ± 192	<360
0.25 Mi wayside on 18th	Corn on Cob	9/8/2011	3014 ± 101	<360
Near 16th and Reaper	White Milo	9/28/2011	4716 ± 229	389 ± 53
Near Melvern Lake off US-75	Red Milo	10/6/2011	3726 ± 189	658 ± 53
Near EEA on West Side	Sunflower with Seeds	10/13/2011	18035 ± 586	597 ± 51
Near 10th and Native Road	Soybeans	10/14/2011	18999 ± 602	<360
20th Rd. Between Kafir and Lynx	Soybeans	10/17/2011	15686 ± 498	791 ± 65
Field Near 20th and Planter	Sunflower with Seeds	11/2/2011	9309 ± 297	<360
Field Near 9 th and Oxford	Wheat	6/15/2012	3280 ± 165	638 ± 61

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KDHE Radiochemistry Laboratory

Quality Assurance

The KDHE Radiation Laboratory has an established internal Quality Assurance program. Quality Control elements include routine calibrations and performance checks on counting equipment and participation in an environmental radioactivity laboratory intercomparison studies program. This program is currently accomplished with blind samples purchased from Environmental Resource Associates. Results for SFY 2012 are presented in Table 18.

Equipment

The following is a description of the equipment used by the KHEL Radiochemistry laboratory.

Multichannel gamma-spectrometer

Gamma radiation is measured spectra determined with a Canberra Genie-2000 Multichannel Analyzer (MCA) system. Detectors available are three high purity germanium detectors (efficiencies – 20 % - 40%) and one germanium-lithium (GeLi) Detector (efficiency 20%).

Low background alpha/beta system

Low background alpha/beta gas-flow internal proportional counters – one Tennelec LB5100, one Oxford Series 5XLB, one Tennelec LB4000 multi-detector and one Canberra 2201.

Internal proportional counter (IPC)

Gross alpha and radium analyses are performed with windowless gas-flow internal proportional counters – four Protean MPC 2000 and two NMC PC5.

Liquid scintillation

Analysis for tritium in water is performed using a one Wallac 1409 and one PE Tri-Carb 3100 TR.

Miscellaneous equipment

The Radiochemistry Section has various devices used for special purposes. A Ludlum Model 2200 single channel analyzer is used with a radon flask scintillation counter for radon and radium analyses. Another Ludlum Model 2200 single channel analyzer is used with a halogen quenched GM pancake probe for routine monitoring of personnel and incoming samples.

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Table 18 KDHE Radiochemistry Laboratory ERA Intercomparison Studies

Analyte	Date	Average Reported Value pCi/L	Assigned Value (pCi/L)	Acceptance Limits (pCi/L)	Performance Evaluation
Sr-89	7/15/2011	56.6	52.3	41.4-59.8	Acceptable
	1/20/2012	46.5	42.5	32.7-49.6	Acceptable
	5/8/2012	68.1	58.5	46.9-66.2	Not Acceptable ^{1,2}
Sr-90	7/15/2011	22.3	26.4	19.1-30.8	Acceptable
	1/20/2012	17.8	24.2	17.4-28.3	Acceptable
	5/8/2012	26.4	37.4	27.4-43.1	Not Acceptable ^{1,2}
Ba-133	8/3/2011	46.6	51.6	42.5-57.2	Acceptable
	10/13/2011	90.9	96.9	81.8-106	Acceptable
	1/11/2012	52.6	51.7	47.3-63.0	Acceptable
Cs-134	8/3/2011	77.5	84.1	68.9-92.5	Acceptable
	10/13/2011	32.2	33.4	26.3-36.7	Acceptable
	1/11/2012	59.0	64.0	52.0-70.4	Acceptable
Cs-137	8/3/2011	97.6	109	98.1-122	Not Acceptable ^{1,3}
	10/13/2011	42.8	44.3	39.4-51.7	Acceptable
	1/11/2012	91.5	91.2	82.1-103	Acceptable
Co-60	8/3/2011	108.1	109	98.1-122	Acceptable
	10/13/2011	120	119	107-133	Acceptable
	1/11/2012	50.3	48.9	44.0-56.4	Acceptable
Zn-65	8/3/2011	56.1	52.8	46.3-64.8	Acceptable
	10/13/2011	75.3	76.8	68.9-92.5	Acceptable
	1/11/2012	80.0	71.8	64.2-86.7	Acceptable
Gross Alpha	1/26/2012	41	35.7	18.4-45.9	Acceptable
	5/3/2012	71	62.9	33.0-78.0	Acceptable
Gross Beta	7/22/2011	61	63.4	43.8-70.0	Acceptable
	1/12/2012	27	26.8	18.3-36.6	Acceptable
	4/12/2012	38	44.2	29.6-51.5	Acceptable
I-131	7/7/2011	30.0	26.0	21.6-30.7	Acceptable
	1/11/2012	28.6	25.7	21.3-30.3	Acceptable
H-3	7/15/2011	7688	7620	6300-8370	Acceptable
	1/26/2012	19500	19200	16800-21100	Acceptable

¹ The KDHE radiochemistry laboratory, under certification of the Environmental Protection Agency is required to pass one PT study for certified analytes per year, and participates in extra PT studies throughout the year as additional Quality Assurance checks.

² Investigation revealed an incorrect concentration of Strontium Carrier solution used for the analysis. The solution was standardized and the new concentration was used to re-calculate the results of the RAD90 PT study. The re-calculated results were acceptable Sr-89 : 47.4 pCi/L and Sr-90: 28.3 pCi/L. All other samples analyzed with this carrier solution were re-evaluated and no reporting limits were exceeded.

³Reported result was chosen from several repetitions, review revealed that results not chosen were within the acceptance range, as was original result when analytical uncertainty was applied.

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Table 19, Method Detection Limits

GeLi [HPGe] detection system ^a						
Environmental Sampling						
	Water and Milk	Filter	Wipe	Soil and Sediment	Biota	Vegetation and Food Products
Minimum sample size	2000 ml	1500 m ³	Total	0.45 kg	0.3 kg	1 kg
Minimum Counting Time	8 hr.	3 hr	3 hr.	15 hr.	15 hr.	15 hr.
Method Detection Limit	pCi/L	pCi/m ³	pCi/wipe	pCi/kg-dry	pCi/kg-wet	pCi/kg-dry
⁷ Be	64 [22]	0.03 [0.02]	N/A	346 [186]	231 [144]	360 [19]
⁴⁰ K	88 [39]	0.03 [0.02]	N/A	828 [654]	459 [262]	152 [72]
⁵¹ Cr	52 [32]	0.01 [0.009]	5 [3]	35 [22]	41 [32]	55 [46]
⁵⁴ Mn	4 [2]	0.004 [0.003]	1 [0.7]	7 [11]	30 [15]	51 [24]
⁵⁸ Co	4 [2]	0.008 [0.002]	2 [1]	11 [23]	37 [20]	60 [36]
⁵⁹ Fe	8 [3]	0.01 [0.01]	3 [2]	22 [16]	41 [15]	107 [52]
⁶⁰ Co	11 [7]	0.01 [0.0053]	2.5 [1.7]	11 [35]	43 [26]	56 [50]
⁶⁵ Zn	8 [4]	0.01 [0.007]	N/A	48 [30]	38 [22]	125 [63]
⁹⁵ Nb	7 [3]	0.009 [0.007]	2.5 [1.4]	13 [30]	44 [26]	48 [4]
⁹⁵ Zr	6 [3]	0.01 [0.002]	0.5 [0.3]	20 [27]	27 [19]	86 [54]
⁹⁹ Mo	5 [3]	0.002 [0.0014]	1 [0.6]	83 [43]	33 [21]	****
¹⁰³ Ru	10 [7]	0.004 [0.003]	N/A	10 [20]	29 [21]	44 [47]
¹⁰⁶ Ru	55 [43]	0.07 [0.05]	1.5 [1]	100 [192]	43 [29]	46 [65]
^{110m} Ag	4 [3]	0.006 [0.0002]	N/A	47 [33]	47 [34]	86 [55]
¹²⁵ Sb	35 [12]	0.02 [0.01]	N/A	30 [44]	96 [51]	126 [6]
¹³¹ I	5 [3] (1) ^b	0.00027 [0.00027] ^c	1.5 [1]	10 [20]	37 [23]	45 [13]
¹³⁴ Cs	5 [3]	0.007 [0.004]	1.4 [1]	14 [29]	37 [24]	57 [39]
¹³⁷ Cs	7 [4]	0.006 [0.004]	1 [0.3]	11 [29]	32 [21]	52 [56]
¹⁴⁰ Ba	10 [6]	0.004 [0.003]	N/A	36 [17]	24 [15]	157 [39]

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Table 19, Continued	Water and Milk	Filter	Wipe	Soil and Sediment	Biota	Vegetation and Food Products
¹⁴⁰ La	9 [5]	0.01 [0.02]	N/A	12 [9]	34 [21]	47 [6]
¹⁴¹ Ce	8 [3]	0.002 [0.001]	N/A	19 [23]	22 [13]	63 [3]
¹⁴⁴ Ce	35 [14]	0.013 [0.0096]	N/A	96 [103]	110 [70]	267 [14]
²²⁶ Ra	116 [69]	0.05 [0.03]	N/A	3048 [654]	323 [195]	858 [51]
²²⁸ Ac	30 [18] 15 h	0.0127 [0.0099]	N/A	68 [33]	146 [87]	27 [12]
²²⁸ Th	387 [142]	0.09 [0.06]	N/A	859 [317]	944 [356]	2100 [167]
²³⁴ Th	618 [87] 15 h	0.159 [0.0423]	N/A	1009 [378]	1300 [556]	570 [94]
²³⁵ U	N/A	N/A	45 [30] 15 h	N/A	N/A	N/A
²³⁹ Np	41 [33]	0.01 [0.009]	5 [3]	64 [44]	40 [30]	97 [71]

^a GeLi = Germanium lithium; HPGe = High purity germanium.

^b Two methods of analysis are done: **1)** 8 hour direct gamma isotopic analysis of a 2000 ml milk or water sample that has a method detection limit (MDL) of 3 pCi/l, and **2)** 3 hour gamma isotopic analysis of ion exchange resin after a 1500 ml milk sample is filtered through an ion exchange column that has an MDL of 1 pCi/l.

^c The MDL for ¹³¹I when analyzing a charcoal cartridge is 0.03 [0.02] pCi/m³ based upon a 250 m³ sample volume. If the sample volume is increased to 1500 m³, the MDL is 0.002 [0.001] pCi/m³.

NOTE: Method detection limits of present analytical methods for selected radionuclides monitored by the KHEL Radiochemistry Laboratory. These limits are intended as guides to order of magnitude sensitivities and are calculated with a 95% level of confidence (activity will be detected 95% of the time if it is present).

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Low Background Alpha and Beta Counting System					
	Water	Milk	Wipe	Soil & Sediment	Vegetation & Food Products
Minimum Sample Size	1000 ml	1000 ml	Total	0.01 kg	0.1 kg
Minimum Counting Time	200 min.	200 min.	200 min.	200 min.	200 min.
Method Detection Limit	pCi/L	pCi/L	pCi/wipe	pCi/kg-dry	pCi/kg-dry
⁸⁹ Sr	1	2	3	200	500
⁹⁰ Sr	1	2	4	200	500
¹³¹ I	1	N/A	N/A	N/A	N/A
²²⁸ Ra	1.2	N/A	0.3	60	N/A
Gross Beta					
	Water	Filter	Wipe	Soil and Sediment	
Minimum Sample Size	200 ml	250 m ³	Total	0.001kg	
Minimum Counting Time	200 min.	100 min.	100 min.	100 min.	
Method Detection Limit	4 pCi/l	0.004 pCi/m ³	2 pCi/Wipe	160 pCi/kg-dry	
Gross Alpha					
	Water	Filter	Wipe		
Minimum Sample Size	200 ml	250 m ³	Total		
Minimum Counting Time	200 min.	100 min.	100 min.		
Method Detection Limit	1 pCi/l	0.0006 pCi/m ³	0.5 pCi/Wipe		
Random Scintillation Counting System					
²²⁶ Ra (radium) in water					
Minimum Sample Size	1000 ml				
Minimum Counting Time	200 min.				
Method Detection Limit	0.04 pCi/l				
Liquid Scintillation Counting System					
	Tritium (³ H)		²²² Rn (Radon)		
	<u>In water</u>	<u>In Tissue</u>	<u>In Water</u>		
Minimum Sample Size	10 ml	3 g	10 ml		
Minimum Counting Time	100 min.	120 min.	60 min.		
Method Detection Limit	350 pCi/l	1200 pCi/kg-wet	25 pCi/l		