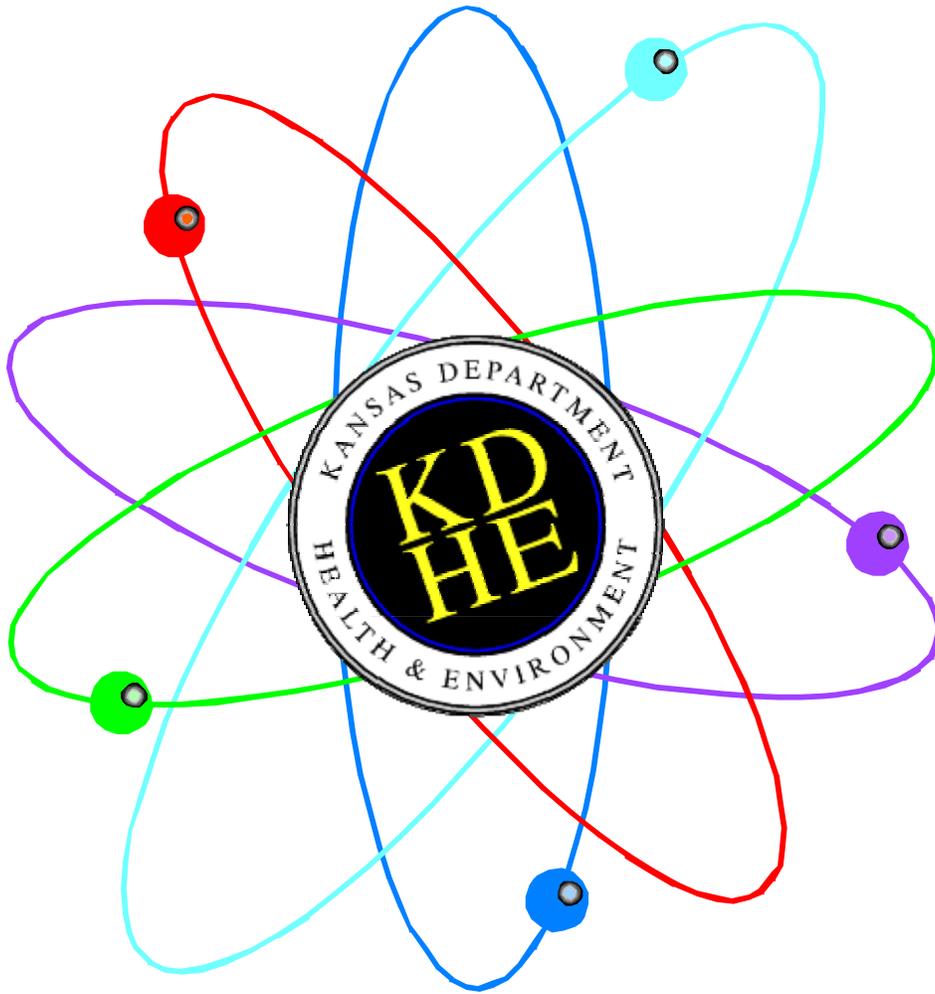


**Kansas Department of Health and Environment**  
Report of Radiological Environmental Monitoring of the Environs Surrounding  
**Wolf Creek Generating Station**



**July 2003-June 2004**  
**Division of Environment, Bureau of Air and Radiation**  
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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, 2002 through June 30, 2003.

KDHE's Wolf Creek Environmental Radiation Surveillance (ERS) 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 ERS program was ready for operational use in 1984, which allowed for one year of baseline data collection prior to the commercial operation of WCGS, which commenced in August 1985. The ERS program parallels (and partially overlaps) the WCNOC Radiation Environmental Monitoring Program (REMP).

The purpose of the ERS program, instituted in 1985, is to detect, identify, and measure radioactive material 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.

Following an internal review in SFY 2002 necessary improvements in the efficiency and the quality of the science were identified. As a result, in July 2002 a revised program was approved and implemented by KDHE. The changes included adjustment of the number of random samples obtained and allows the discretionary use of certain interchangeable sample media. The primary purpose of the program remains the same, the focus being the detection of radioactive material from effluent releases and evaluation of the long-term effects of Wolf Creek operations on the environment of Coffey County and Kansas.

Although not its primary function, the ERS program is also essential to the State's *Nuclear Facilities Incident Response Plan*. If an unplanned release of radioactive materials from WCGS should occur, data collected from air and radiation-monitoring sites will be used to determine doses to affected populations and to assess potential environmental impacts.

The ERS program includes the following monitoring methods:

- Measurement of ambient external radiation levels using thermoluminescent dosimetry (TLD)
- Monitoring of radionuclides present in ambient air through weekly collection and laboratory analysis of continuous air samples
- Monitoring of radionuclides present in water, milk, terrestrial vegetation, aquatic vegetation, fish, sediments, and soil through scheduled and random sample collection and laboratory analysis.

A tabular summary of the WCGS environmental radiation surveillance program conducted during SFY 2003 is presented as Table I.

### **Program Description and Elements**

State program samples were delivered to Kansas Health and Environment Laboratories (KHEL) Radiochemistry Laboratory at Forbes Field for analysis. State TLDs were processed by the Environmental Radiation and Emergency Preparedness (ER&EP) section of the Radiation and Asbestos Control Program of the Bureau of Air and Radiation.

Wolf Creek Resource Protection personnel collect samples for the WCNOG REMP. WCNOG has a contract with Environmental Inc., Midwest Laboratory, of Northbrook, IL for laboratory analysis of REMP samples. Enrico Fermi Unit 2 dosimetry department processes and evaluates WCNOG TLDs.

The ERS utilizes the WCNOG emergency planning sector logic for identification of the sample geographic sector relative to WCGS plant center. Sixteen 22.5-degree sectors are established and designated by letter. The first sector, sector A, is 11.25 degrees east west of true north to 11.25 degrees west of true north, i.e. from 348.75 degrees true to 11.25 degrees true. The remaining sectors continue in a clockwise direction, from B to R (the letters I and O are not used). The main thrust of the program is within the 10-mile emergency-planning zone (EPZ).

#### **Air**

Air samples are 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 Harris, KS (D-1). 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, the community with the highest population at Burlington, and a control location at Harris. An average flow rate of 30 liters per minute is used with 47 mm diameter glass fiber particulate filters and 5 percent TEDA (Triethylene diamine) impregnated carbon cartridges for radioiodine activity (the major isotope of concern is <sup>131</sup>I). TEDA binds the iodine chemically and reduces losses from desorption.

Field assay of each particulate filter is performed at the time of collection. The particulate filter is counted using a thin window GM 'pancake' detector (Ludlum Model 22-40 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 (Harris D-1) air sample indicates a potential anomaly and the filter is flagged for individual gamma isotopic analysis.

Gamma isotopic analysis is done on two composite samples, one composed of the five particulate filters and the other of the five charcoal cartridges. Indication of <sup>131</sup>I or any other

fission or activation product requires gamma isotopic analysis of each individual particulate filter and associated charcoal cartridge.

### **Direct Radiation Monitoring**

Direct radiation monitoring is accomplished using Victoreen Model 2600-49 axial bulb manganese-doped calcium fluoride ( $\text{CaF}_2: \text{Mn}$ ) TLDs. The TLDs are read on a Victoreen 2800M reader. Dosimeters are individually calibrated to  $^{137}\text{Cs}$  (cesium) and each reading is corrected for fading, self-irradiation, and dose received in transit.

Thirty-one locations around the WCGS are monitored by KDHE, including three control locations greater than ten miles from WCGS. Three bulb dosimeters are used per site to generate an average quarterly reading. The dosimeters are contained in specially constructed PVC plastic holders suspended approximately one meter above the ground. Staff members exchange TLDs quarterly. KDHE has collocated TLDs with WCNOG at fourteen sites. WCNOG uses Panasonic Model UD-814-AQ TLDs. Each dosimeter consists of one lithium borate element and three calcium sulfate elements in a plastic case.

### **Surface water**

Surface water sampling is done by the collection of one-gallon grab samples at the indicated locations. A control sample is collected monthly below the John Redmond Reservoir dam near the makeup screen house. Two samples are collected from the Coffey County Lake, one monthly at the discharge cove and the other at the spillway. A sample is also collected annually from the New Strawn City Lake.

A gamma isotopic and tritium ( $^3\text{H}$ ) analysis is done on each CCL water sample and  $^3\text{H}$  analysis is done quarterly on a composite sample from JRR. Gross alpha+beta analysis is done on each CCL discharge cove sample. Samples are split with WCNOG.

### **Ground water**

Ground water is collected annually at wells in sectors B (control), J, L, and N. The control sample location is hydrologically up gradient from the facility and the other three are hydrologically down gradient. Samples are split with WCNOG.

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

### **Drinking water**

Two public water supplies, which use the Neosho River as their source, were sampled for drinking water. Burlington, upstream from WCGS, was sampled as a control location, and LeRoy, the first public water supply downstream of WCGS, was sampled as a monitoring location. Both sites are collocated with WCNOG. WCNOG operated and maintained water

samplers both at Burlington and at LeRoy. WCNOC water samplers collect 10 ml every hour over a 30-day period. WCNOC personnel collect the samples monthly. The LeRoy samples are split with KDHE. Sample collection at both locations was terminated when LeRoy stopped operating its water plant and started purchasing drinking water from Burlington in

Samples are analyzed for tritium, and gamma isotopes. An annual composite of consecutive samples is analyzed for strontium ( $^{89}\text{Sr}$  and  $^{90}\text{Sr}$ ).

### **Milk**

Milk samples were collected quarterly in Coffey County at the Linsey Dairy near Lebo, KS. These samples are controls as there are no indicator locations available within the 10-mile Emergency Planning Zone of WCGS.

Each milk sample is analyzed for low levels of radioiodine and other gamma emitting nuclides. A strontium analysis is done annually.

### **Sediment and soil**

Shoreline sediment, bottom sediment and soil samples were taken in the environment surrounding WCGS. Sediment samples for trending were collected annually in the Coffey County Lake discharge cove, public environmental education area, and public fishing area. Sediment samples for trending were also collected on Wolf Creek below the Coffey County Lake dam and at John Redmond Reservoir. The sediment samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake and John Redmond Reservoir trending sediment samples are split with WCNOC.

Random sediment samples were collected at 12 locations (bottom or shoreline) on Coffey County Lake and 4 locations on the Neosho River and Wolf Creek.

Annual soil samples for trending were collected close to Sharpe, east of WCGS at the Scott Valley Church (control), east of the Coffey County Lake dam, and at the Coffey County Lake public fishing and environmental education areas. Trending soil samples collected from the Coffey County public use areas are split with WCNOC. Random soil samples were collected at 15 locations within the 50-mile IPZ concentrating in downwind sectors within the 10-mile EPZ.

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

### **Fish, game animals, and 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 WCNOC. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. A total of seven species of fish were sampled.

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 road-kill deer specimen was obtained.

Domestic meat samples are obtained on an as available basis.

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.

### **Terrestrial and aquatic vegetation**

Terrestrial vegetation samples were taken at various locations around WCGS. This includes samples of crops grown throughout Coffey County, broad leaf vegetation taken from gardens near the WCGS boundary, pasturage near WCGS, and crops irrigated with water from the Neosho River. Pasturage samples were usually collected concurrently with soil samples. Samples collected on WCNOG property, garden vegetables collected from gardens near WCGS, and samples of crops irrigated with water from the Neosho River were split with WCNOG. There were five annual pasturage, two annual garden trending and two grain (feed) samples collected. There were fourteen random samples for pasturage, food and feed collected.

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

As available, semiannual aquatic vegetation (algae and/or rooted aquatics) trending samples are normally collected from the Coffey County Lake, Wolf Creek below the Coffey County Lake dam, and John Redmond Reservoir. The aquatic vegetation samples obtained at John Redmond Reservoir are used as controls. The Coffey County Lake samples are split with WCNOG.

Gamma isotopic analysis is done on all aquatic vegetation samples collected. Strontium analysis is done on any aquatic vegetation sample collected in the Coffey County Lake discharge cove and may be done on other aquatic vegetation samples based upon the gamma isotopic analysis results.

### **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 a Harshaw 3-inch x 3-inch NaI (TI) crystal, a

105cc (20 percent efficiency) GeLi crystal, a 40 percent efficient high purity Ge crystal, and a 15 percent efficient high purity Ge crystal.

### **Low background alpha/beta system**

An Oxford Series 5XLB and a Tennelec 5100 alpha/beta low background IPC system is used for strontium ( $^{89}\text{Sr}$  and  $^{90}\text{Sr}$ ), radium ( $^{228}\text{Ra}$ ), and gross beta counting.

### **Internal proportional counter (IPC)**

Gross alpha and radium analyses are performed with Nuclear Measurement Corporation (NMC) windowless gas flow IPC systems.

### **Liquid scintillation**

Analysis for tritium in water is performed using a Beckman LS-230 and a Wallace-1409 liquid scintillation system.

### **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.

## **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 (see Table 14.0). This program is currently accomplished with blind samples purchased from Environmental Resource Associates.

### **Units**

The unit of radioactivity used is the picoCurie (pCi). One pCi is equal to 2.22 disintegrations per minute or 0.037 Becquerels (Bq). Radioactivity concentrations in liquids such as water and milk are expressed in picoCuries per liter (pCi/l), radioactivity concentrations in air are expressed in picoCuries per cubic meter ( $\text{pCi}/\text{m}^3$ ), and radioactivity in solids such as soil or vegetation is expressed in picoCuries per kilogram (pCi/kg). TLD exposure results are expressed as milliRoentgen (mR) per a 90-day quarter. One mR is equivalent to ten micro-Grays ( $10 \mu\text{Gy}$  or  $10^{-5} \text{Gy}$ ).

### **Uncertainty statistics**

Radioactive decay of unstable atomic nuclei is a random event. The greater the number of total counts obtained (a function of sample count time), the closer the measurements will be to the actual value. Due to the large number of samples analyzed and the limited resources available for counting individual samples, each sample is counted only once and for the minimum time necessary to reduce the statistical error to an acceptable level. Unless otherwise specified, results for all samples are reported at the 95 percent confidence level. Because systematic (non-random) uncertainties involved in sample collection and sample preparation are highly subjective and generally difficult or impossible to quantify with substantial accuracy, the KHEL Radiochemistry Laboratory reports only the uncertainty resulting from random processes (propagation of statistical counting error).

A "less than" value reported indicates that the radioactivity in the sample is below the lower limit of detection for the procedures, equipment, and counting time used. The KHEL Radiochemistry Laboratory method detection limits (MDLs) for various analyses are summarized in Table 15.0 of this report. MDLs will vary based on sample matrix, sample size, counting time, detector efficiencies, and type of measurement required. WCNO's lower limits of detection values are found in Table 16.0.

## RESULTS

Results are reported in the following data tables for the samples taken around WCGS during SFY 2003. Radionuclides detected in the environment surrounding WCGS during SFY 2003 include  $^{228}\text{Ac}$ ,  $^7\text{Be}$ ,  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$ ,  $^3\text{H}$ ,  $^{40}\text{K}$ ,  $^{226}\text{Ra}$ ,  $^{125}\text{Sb}$  and  $^{228}\text{Th}$ . The isotopes  $^{228}\text{Ac}$ ,  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{226}\text{Ra}$ , and  $^{228}\text{Th}$  are naturally occurring radionuclides common in the environment. The isotopes  $^{137}\text{Cs}$  and  $^3\text{H}$  are fission products from WCGS nuclear reactor operation. The isotopes  $^{60}\text{Co}$  and  $^{125}\text{Sb}$  are activation products, also the result of WCGS nuclear reactor operation. A small background component of the  $^3\text{H}$  (half-life = 12.3 y) and  $^{137}\text{Cs}$  (half-life = 30.1 y) activity is attributable to previous nuclear weapons tests. Small amounts of  $^3\text{H}$  are also produced naturally from cosmic ray interactions with water vapor in the upper atmosphere. Background levels of  $^{137}\text{Cs}$  and  $^3\text{H}$  are accounted for in control samples and in preoperational data. The fission and activation product activity levels found to date in the environment surrounding WCGS are not above expected regulated levels and are very small when compared with activity levels due to naturally occurring radionuclides.

The most significant radionuclide present in surface water samples collected in the Coffey County Lake is tritium ( $^3\text{H}$ ), a beta emitter. The highest  $^3\text{H}$  concentration measured in the Coffey County Lake during SFY 2003 was 14,081 pCi/l in March 2003. This maximum Coffey County Lake  $^3\text{H}$  concentration is 70% 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  $^3\text{H}$  concentration for SFY 2003 was 12,027 pCi/l, or 60% of MCL. Coffey County Lake is not approved for any aquatic recreation other than fishing. All other non-CCL surface water, ground water, and drinking water samples collected in the environs of WCGS during SFY 2003 indicated no radionuclides present attributable to the operation of WCGS.

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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. A total of twelve samples were taken this SFY; seven random samples and five routine trending samples.

Sediment samples have been excellent indicators for the long-term buildup of fission and activation product activity levels in the Coffey County Lake. A total of 24 sediment samples were taken this fiscal year; (sixteen random and eight trending). The highest fission product activity in sediments during SFY 2003 was 622 pCi/kg-dry <sup>137</sup>Cs found in CCL near Stringtown Cemetery (WCBS-AR-2-329-1.0). It should be noted that the highest non-CCL bottom sediment sample contained a <sup>137</sup>Cs concentration of 145 pCi/kg-dry. The highest activation product activity observed during SFY 2003 was 323 pCi/kg-dry <sup>60</sup>Co also found in the same Coffey County Lake bottom sediment sample.

Airborne sample analysis indicated that no radionuclides attributable to the operation of WCGS were present above the lower limits of detection during SFY 2003.

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCGS during SFY 2003 indicated no radionuclides present attributable to the operation of WCGS.

Samples of seven species of fish were taken from the Coffey County Lake during SFY 2003. Sample analysis of edible fish portions collected in the environs of WCGS during SFY 2003 indicated that no gamma emitters attributable to WCGS operation were present. Five edible fish samples collected during SFY 2003 were analyzed for <sup>3</sup>H in tissue (fat and water). The highest <sup>3</sup>H concentration in tissue was 11,403 pCi/kg-wet found in a Smallmouth Buffalo sample taken at the CCL Discharge Cove. Using an ICRP 30 dose conversion factor for ingestion ( $h_{E,50}$ ) of 6.40E-08 mrem per pCi <sup>3</sup>H ingested, a standard man consuming 21 kg/y of fish containing 11,403 pCi/kg <sup>3</sup>H would receive a committed effective dose equivalent of 0.015 mrem. The projected dose equivalent is far below the 100 mrem/y regulatory limit for a member of the public.

Data from direct radiation monitoring sites revealed no significant changes from preoperational data. The grand yearly average of all sites was 81 mR/y, corresponding to 9  $\mu$ R/h. 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 average baffle dike direct radiation level for SFY 2003 was 58 mR/y; corresponding to 7  $\mu$ R/h. 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. No data are available for the Wolf Creek Environmental Education Area for the third quarter (January, February, March) as the result of theft of dosimeters from the holder.

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Summary statistics for SFY 2003, including data comparisons between KDHE and WCNOC are contained in tables I and II. The ratio of KDHE results to WCNOC results ranged from 1 to 5. A summary of comparison data may be found in Tables III and IV. Data tables, graphs, and maps are also attached.

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**Table 1.** ERS Program summary report for SFY 2004

Type of Sample	Number of Sampling Stations	Total Samples Collected
Air (particulate and iodine)	5	516
Direct Radiation	31	369
Surface Water	4	37
Ground Water	4	4
Drinking Water	1	12
Sediments	6	10
Random Sediments	16	16
Aquatic Vegetation	5	5
Random Aquatic Vegetation	6	7
Milk	1	5
Fish	2	14
Game Animals/Domestic Meat	0	2
Soil	5	5
Random Soil	10	10
Terrestrial Vegetation	7	9
Random Terrestrial Vegetation	10	13
Grand Total	113	1014

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**Table II. ERS Program summary statistics SFY 2004**

Description	Average	Standard deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR per 90 day quarter						
Airborne particulate and radioiodine cartridge 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 air particulate filter or radioiodine cartridge evaluated.					
Surface water tritium ( <sup>3</sup> H), pCi/l  John Redmond Reservoir, control (N-1/MUSH) Coffey County Lake (Q-1/DC) Coffey County Lake (J1A/SP) Ponds surrounding WCGS		*	*	<350 (<126)	<350(<163)	4
			3510 (3648)	10545(10852)	13763(13996)	12
		*	3472(3627)	10313(10871)	14081(14300)	12
			*	<350	<350	1
Drinking water tritium ( <sup>3</sup> H), pCi/l  LeRoy	<350	*	*	<350	<350	12
Ground water tritium ( <sup>3</sup> H), pCi/l (All Stations)	<350	*	*	<350	<350	4
Water sample 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, drinking water, or ground water sample evaluated.					
Gamma isotopic analysis of soil, milk, 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 bottom sediment, dry	323±19 <sup>60</sup> Co (gamma)					
Coffey County Lake fish, wet	Smallmouth Buffalo: 14018±1073 <sup>3</sup> H (beta)					
Maximum naturally occurring gamma activity, pCi/kg-dry						
WCFV-G-1, Garden in sector G, cabbage	37117± 4200 (dry)					
<p><sup>a</sup> Corresponds to 9 µR/h. ORNL/TM-7343 (1981) gives background radiation levels in Kansas ranging from 7 µR/h to 14 µR/h with an average background of 10±1 µR/h (N=6). Measurements were taken along I-70 from western Kansas to eastern Kansas.</p> <p><sup>b</sup> Total number of TLD readings evaluated (31 locations with 3 TLDs each read 4 times per year).</p>						

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**TABLE III. ERS program data comparison <sup>a</sup> summary statistics SFY 2003.**

Description	Average	Standard Deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR <sup>b</sup>	19.9	2.1	0.4	10.7	25.0	119
Airborne particulate filter and charcoal cartridge gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNOG (Teledyne) demonstrated that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any particulate filter or charcoal cartridge evaluated.					
Surface water tritium ( <sup>3</sup> H), pCi/l						
CCL discharge cove, Q-1 (DC)	12160(13444)	1087 (1111)	4053(3648)	10545 (10852)	13763 (14233)	12 (13)
CCL <sup>c</sup> spillway, J-1A (SP)	13896 (13016)	1951(1520)	4190 (3508)	11547 (10871)	14081 (14300)	12 (12)
JRR <sup>d</sup> below dam (control), N-1 (MUSH)	<350 (<149)	* (*)	* (*)	<350 (<181)	<350 (<126)	12 (12)
Ground water <sup>3</sup> H, pCi/l	<350 (<189 <sup>e</sup> )	* (*)	* (*)	<350 (<100)	<350 (<200)	4 (4)
LeRoy drinking water <sup>3</sup> H, H-1	<350 (<250 <sup>e</sup> )	* (*)	* (*)	<350 (<200)	<350 (<300)	16 (4)
Surface, ground, and drinking water gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNOG (Teledyne) showed that no gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any surface, ground, or drinking water sample evaluated.					
<b>Maximum activity by isotope attributable to WCGS operation, pCi/kg</b>						
Bottom sediment	Gamma emitter: CCL discharge cove, WCBS-AQ-1 (WCBS- 7819), 282±29 <sup>60</sup> Co-dry (228±44 <sup>60</sup> Co-dry)					
CCL fish	All results for fish indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present <i>above</i> the lower limits of detection. Beta emitter: Composite of Small mouth buffalo 14018±1073 <sup>3</sup> H-wet (7624.5±212 <sup>3</sup> H-wet), (Composite of White Crappie (8706±239 <sup>3</sup> H-wet) 4715±1,584 <sup>3</sup> H-wet)					
Shoreline Sediment	All results for shoreline sediments indicated that no gamma emitters attributable to Wolf Creek Generating Station operation were present <i>above</i> the lower limits of detection at co-located sites.					
Milk, soil, terrestrial vegetation	Gamma isotopic analysis by both KDHE and WCNOG (Teledyne) showed that no comparable gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any milk, soil, shoreline sediments or terrestrial vegetation sample evaluated.					
<b>Maximum naturally occurring gamma activity, pCi/kg</b>						
Sector G Garden cabbage sample, (WCFV-G-1) at 37117±4200 <sup>40</sup> K-dry, (3818.2 ± 348.1 <sup>40</sup> K-wet)						

<sup>a</sup> KDHE (WCNOG).

<sup>b</sup> mR per 90-day quarter.

<sup>c</sup> Coffey County Lake.

<sup>d</sup> John Redmond Reservoir.

<sup>e</sup> Average of MDA values.

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**Table IV** Data comparison summary by selected analysis SFY 2003

Analysis	Average Ratio of KDHE results to WCNOC results <sup>a</sup>	Comments
Air Particulate Filter Gamma Isotopic	1.42± 0.2 N=4	Isotope used for comparison was <sup>7</sup> Be (T <sub>1/2</sub> = 53 days). WCNOC composites filters by location for quarterly analysis, KDHE analyzes a five-filter composite across all locations. Comparison was made using quarterly averages.
TLD Direct Radiation	0.99 ± 0.13 N=53	14 collocated sites.
Surface Water <sup>3</sup> H	0.97± 0.07 N=24	Coffey County lake spillway and discharge canal
Bottom sediment gamma isotopic	1.14± 0.5 N=6	Isotopes used for the comparison were <sup>137</sup> Cs and <sup>40</sup> K
Terrestrial vegetation gamma isotopic- pasturage.	2.42 ± 0.5 N=1	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the sample compared was 3.6. Isotopes used for comparison were <sup>7</sup> Be and <sup>40</sup> K. When the WCNOC results are normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.67.
Terrestrial vegetation gamma isotopic- grains	1.34± 0.14 N=2	Isotope used for the comparison was <sup>40</sup> K.
Terrestrial vegetation gamma isotopic-garden vegetables.	6.45 N=1	The results for KDHE are reported as pCi/kg-dry while the WCNOC results are reported as pCi/kg-wet. The wet weight to dry weight ratio for the sample collected was 6.45. Isotope used for comparison was <sup>40</sup> K. When the WCNOC result is normalized to a dry-weight reporting basis, the KDHE/WCNOC ratio improves to 0.99.
Fish gamma isotopic	2.0± 0.6 N=11	The isotope used for comparison was <sup>40</sup> K.
Fish tritium ( <sup>3</sup> H) in tissue	1.3± 0.5 N=7	WCNOC samples are analyzed for tritium content in the water of the tissue while KDHE analyzes for the tritium content in the fat and water of the tissue.

<sup>a</sup> KDHE/WCNOC±SEM. The relative agreement is given by the absolute value of (1-(WCNOC/KDHE)×100%.)

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**TABLE 1.0** KDHE weekly samples for **airborne particulate radionuclides** SFY 2003. Gross beta-gamma field counts in ncpm (net counts per minute). *Weekly five-charcoal cartridge and five-particulate filter composite gamma isotopic analysis indicated that no gamma emitters attributable to Wolf Creek operation were present above the method detection limits. WCNOG sample location designations are denoted by parentheses.*

Date	A-1 (2) Sharpe	H-1(18) East of CCL dam	L-1 Burlington	P-1 (32) New Strawn	D-1 Harris control
07/03/02	431	297	271	274	353
07/11/02	247	216	196	229	256
07/18/02	305	309	366	293	230
07/25/02	847	455	515	367	759
08/01/02	347	349	294	308	340
08/08/02	401	364	394	335	413
08/16/02	204	225	152	194	213
08/22/02	247	210	203	241	270
08/28/02	848	592	575	674	751
09/05/02	400	445	339	364	729
09/13/02	775	615	642	606	450
09/19/02	81	283	359	288	222
09/26/02	545	525	637	580	557
10/03/02	491	425	525	545	486
10/10/02	353	349	549	422	349
10/17/02	399	440	362	381	347
10/24/02	503	385	357	406	257
11/02/02	290	227	340	264	293
11/08/02	407	396	512	512	441
11/16/02	306	296	305	362	295
11/21/02	431	417	528	466	428
11/29/02	469	427	529	385	536
12/06/02	360	354	353	389	312
12/13/02	319	289	324	382	365
12/20/02	336	338	475	338	474
12/27/02	647	488	616	525	*
01/04/03	340	330	370	330	*
01/10/03	321	281	310	290	*
01/17/03	600	600	500	500	*
01/24/03	320	240	330	305	325
02/01/03	615	530	770	560	1470
02/07/03	670	410	560	465	520
02/14/03	170	180	170	170	123
02/22/03	260	230	412	208	445
02/28/03	230	240	212	212	265
03/08/03	185	140	180	175	155
03/13/03	356	328	376	274	365
03/21/03	147	141	160	142	198
03/28/03	140	205	160	140	141
04/04/03	215	230	170	230	190
04/11/03	390	400	730	383	1360
04/18/03	95	57	169	58	223
04/25/03	155	163	134	186	180
05/02/03	323	279	253	332	280
05/09/03	195	150	186	220	210
05/16/03	248	227	250	216	304
05/23/03	217	206	248	204	427
05/30/03	336	345	390	341	574
06/06/03	269	197	169	236	416
06/13/03	187	167	158	154	254
06/19/03	602	617	742	626	1054
06/27/03	146	160	179	167	163

Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58/60</sup>Co, <sup>59</sup>Fe, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134/137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141/144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>234/228</sup>Th, and <sup>239</sup>Np. The naturally occurring radioisotope <sup>7</sup>Be was detected on the particulate filter composite samples (0.06 pCi/m<sup>3</sup> to 0.17 pCi/m<sup>3</sup> with a mean of 0.12±0.017 pCi/m<sup>3</sup>, N=50). See Map #1.0 for sample locations.

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**TABLE 2.0** Wolf Creek quarterly **direct radiation** monitoring SFY 2003. Direct radiation monitoring results in mR. Reported results include errors associated with correction factors. Exposures are normalized to a 90-day quarter. Results are expressed as the average of three TLD readings per location  $\pm$  total uncertainty ( $\pm_{\text{UNC}}$ ). <sup>a</sup> WCNOC sample location designations are denoted by parentheses. Sample locations are shown on Map #2.0.

Location	QTR 1	QTR 2	QTR 3	QTR 4
1. A-1 (1), North of WCGS	19.1 $\pm$ 1.0	19.7 $\pm$ 2.7	17.9 $\pm$ 1.5	19.7 $\pm$ 1.7
2. A-2, Sharpe	17.3 $\pm$ 1.2	22.6 $\pm$ 1.2	17.0 $\pm$ 0.9	17.0 $\pm$ 2.3
3. A-3, Forward Staging Area	21.0 $\pm$ 1.1	17.6 $\pm$ 1.3	16.3 $\pm$ 1.4	18.4 $\pm$ 1.7
4. B-1, East Sharpe	23.3 $\pm$ 1.8	19.4 $\pm$ 1.7	19.8 $\pm$ 1.1	20.4 $\pm$ 1.3
<b>5. B-2, Waverly Control</b>	22.5 $\pm$ 1.3	20.8 $\pm$ 1.8	19.9 $\pm$ 1.3	18.3 $\pm$ 1.1
6. C-1, near residence	21.2 $\pm$ 1.0	20.3 $\pm$ 1.0	17.7 $\pm$ 1.7	20.0 $\pm$ 1.4
7. D-1 (9), near residence	19.8 $\pm$ 1.9	21.4 $\pm$ 1.3	17.2 $\pm$ 1.2	20.3 $\pm$ 1.6
8. E-1, near residence	21.8 $\pm$ 1.2	21.6 $\pm$ 1.9	16.6 $\pm$ 0.9	18.2 $\pm$ 2.3
9. F-1, near residence	22.4 $\pm$ 1.6	23.6 $\pm$ 1.2	19.0 $\pm$ 1.0	22.9 $\pm$ 2.4
10. G-1 (14), WCNOC gate	21.6 $\pm$ 2.1	21.6 $\pm$ 1.6	18.8 $\pm$ 2.1	19.0 $\pm$ 1.9
11. H-0 (42), CCL baffle dike A	15.0 $\pm$ 1.0	19.1 $\pm$ 2.7	10.7 $\pm$ 1.2	14.2 $\pm$ 1.5
12. H-1, east of CCL dam	19.5 $\pm$ 1.8	20.8 $\pm$ 3.2	18.0 $\pm$ 1.1	19.6 $\pm$ 1.6
<b>13. H-2, LeRoy control</b>	20.5 $\pm$ 1.3	22.2 $\pm$ 1.4	14.5 $\pm$ 2.0	18.4 $\pm$ 1.0
14. J-1, near residence	19.1 $\pm$ 1.4	23.1 $\pm$ 1.0	15.5 $\pm$ 1.2	17.5 $\pm$ 0.9
15. K-1 (29), near residence	17.9 $\pm$ 0.9	17.3 $\pm$ 1.3	15.0 $\pm$ 1.5	19.0 $\pm$ 5.5
16. L-1 (27), near residence	19.1 $\pm$ 3.6	23.2 $\pm$ 1.6	17.7 $\pm$ 0.8	20.2 $\pm$ 1.2
17. L-2, Burlington	21.9 $\pm$ 1.0	21.2 $\pm$ 1.6	17.9 $\pm$ 0.8	17.9 $\pm$ 2.8
18. L-3, Coffey County Shop	19.9 $\pm$ 1.1	19.5 $\pm$ 1.7	18.5 $\pm$ 0.9	19.8 $\pm$ 1.4
19. M-1 (26), near residence	20.9 $\pm$ 1.1	20.7 $\pm$ 1.1	17.7 $\pm$ 1.2	18.8 $\pm$ 2.2
20. N-1, near pasture	20.3 $\pm$ 1.9	24.0 $\pm$ 1.6	18.2 $\pm$ 0.7	22.5 $\pm$ 1.5
21. P-0 (43), CCL baffle dike B	13.0 $\pm$ 1.0	18.6 $\pm$ 2.7	11.5 $\pm$ 0.9	13.0 $\pm$ 1.2
22. P-1, New Strawn	21.5 $\pm$ 1.7	21.9 $\pm$ 1.1	18.6 $\pm$ 0.8	22.9 $\pm$ 2.9
<b>23. P-2 (40), Hartford Control</b>	19.7 $\pm$ 1.7	19.1 $\pm$ 1.9	17.1 $\pm$ 1.3	19.1 $\pm$ 1.5
24. P-3 (45), CCL entrance	22.5 $\pm$ 1.1	24.0 $\pm$ 1.6	19.5 $\pm$ 1.3	22.9 $\pm$ 2.8
25. P-4 (46), CCL near MUDS	21.3 $\pm$ 1.3	21.7 $\pm$ 1.2	19.1 $\pm$ 1.2	22.2 $\pm$ 1.0
26. P-5, JRR public use area	22.7 $\pm$ 1.6	24.3 $\pm$ 2.1	20.2 $\pm$ 1.2	21.5 $\pm$ 1.1
27. Q-1, near residence	23.1 $\pm$ 1.5	24.4 $\pm$ 1.7	21.0 $\pm$ 1.2	23.8 $\pm$ 1.3
28. R-0 (41), Stringtown cemetery	25.0 $\pm$ 1.1	24.7 $\pm$ 1.4	21.6 $\pm$ 1.1	23.5 $\pm$ 1.6
29. R-1 (37), near residence	20.1 $\pm$ 1.9	22.2 $\pm$ 2.5	18.5 $\pm$ 1.5	22.0 $\pm$ 1.6
30. R-2 (44), CCL EEA	21.6 $\pm$ 1.0	21.4 $\pm$ 1.8	*	21.4 $\pm$ 2.1
31. R-3, near Coffey County Airpor	23.3 $\pm$ 1.5	23.1 $\pm$ 1.1	20.5 $\pm$ 1.6	22.2 $\pm$ 1.3

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**TABLE 2.1** Wolf Creek collocated quarterly **direct radiation** monitoring SFY 2003. Direct radiation monitoring results in mR.

WCNOC results are expressed as normalized 90-day quarter average  $\pm$  two standard deviations of two dosimeters at each location (three TLD chips per badge are used for data evaluation). KDHE results are expressed as a normalized 90-day quarter average  $\pm$  total uncertainty (one standard deviation) of three TLD bulb dosimeters at each location.

Location KDHE (WCNOC)	KDHE Monitoring period	KDHE	WCNOC
1. A-1 (1)	9/9/02-10/15/02	19.1 $\pm$ 1.0	22.5 $\pm$ 1.4
	10/15/02-1/9/03	19.7 $\pm$ 2.7	21.0 $\pm$ 1.4
	1/9/03-4/3/03	17.9 $\pm$ 1.5	23.4 $\pm$ 2.5
	4/3/03-7/10/03	19.7 $\pm$ 1.7	21.4 $\pm$ 1.3
2. D-1 (9)	9/9/02-10/15/02	21.8 $\pm$ 1.2	19.8 $\pm$ 1.1
	10/15/02-1/9/03	21.6 $\pm$ 1.9	18.8 $\pm$ 1.1
	1/9/03-4/3/03	16.6 $\pm$ 0.9	19.1 $\pm$ 1.2
	4/3/03-7/10/03	18.2 $\pm$ 2.3	18.8 $\pm$ 1.4
3. G-1 (14)	9/9/02-10/15/02	21.6 $\pm$ 2.1	22.1 $\pm$ 1.0
	10/15/02-1/9/03	21.6 $\pm$ 1.6	21.0 $\pm$ 1.1
	1/9/03-4/3/03	18.8 $\pm$ 2.1	21.5 $\pm$ 1.2
	4/3/03-7/10/03	19.0 $\pm$ 1.9	20.5 $\pm$ 0.8
4. H-0 (42)	9/9/02-10/15/02	15.0 $\pm$ 1.0	15.1 $\pm$ 1.0
	10/15/02-1/9/03	19.1 $\pm$ 2.7	16.7 $\pm$ 4.0
	1/9/03-4/3/03	10.7 $\pm$ 1.2	15.5 $\pm$ 1.5
	4/3/03-7/10/03	14.2 $\pm$ 1.5	16.2 $\pm$ 3.5
5. K-1 (29)	9/9/02-10/15/02	17.9 $\pm$ 0.9	17.7 $\pm$ 1.4
	10/15/02-1/9/03	17.3 $\pm$ 1.3	17.5 $\pm$ 0.8
	1/9/03-4/3/03	15.0 $\pm$ 1.5	20.1 $\pm$ 2.9
	4/3/03-7/10/03	19.0 $\pm$ 5.5	15.9 $\pm$ 0.5
6. L-1 (27)	9/9/02-10/15/02	19.1 $\pm$ 3.6	21.1 $\pm$ 1.3
	10/15/02-1/9/03	23.2 $\pm$ 1.6	20.7 $\pm$ 0.6
	1/9/03-4/3/03	17.7 $\pm$ 1.2	21.0 $\pm$ 1.2
	4/3/03-7/10/03	20.2 $\pm$ 1.2	19.3 $\pm$ 1.8
7. M-1 (26)	9/9/02-10/15/02	20.9 $\pm$ 1.1	20.7 $\pm$ 1.7
	10/15/02-1/9/03	20.7 $\pm$ 1.1	19.8 $\pm$ 0.9
	1/9/03-4/3/03	17.7 $\pm$ 0.8	22.0 $\pm$ 3.2
	4/3/03-7/10/03	18.8 $\pm$ 2.2	18.8 $\pm$ 1.1
8. P-0 (43)	9/9/02-10/15/02	13.0 $\pm$ 1.0	14.4 $\pm$ 1.1
	10/15/02-1/9/03	18.6 $\pm$ 2.7	14.5 $\pm$ 0.8
	1/9/03-4/3/03	11.5 $\pm$ 0.9	16.5 $\pm$ 4.2
	4/3/03-7/10/03	13.0 $\pm$ 1.2	13.9 $\pm$ 0.9
9. P-2 (40)	9/9/02-10/15/02	19.7 $\pm$ 1.7	18.2 $\pm$ 0.7
	10/15/02-1/9/03	19.1 $\pm$ 1.9	20.3 $\pm$ 0.6
	1/9/03-4/3/03	17.1 $\pm$ 1.3	19.7 $\pm$ 2.5
	4/3/03-7/10/03	19.1 $\pm$ 1.5	17.0 $\pm$ 0.7
10. P-3 (45)	9/9/02-10/15/02	22.5 $\pm$ 1.1	22.4 $\pm$ 1.2
	10/15/02-1/9/03	24.0 $\pm$ 1.6	21.8 $\pm$ 0.7
	1/9/03-4/3/03	19.5 $\pm$ 1.3	No data
	4/3/03-7/10/03	22.9 $\pm$ 2.8	No data
11. P-4 (46)	9/9/02-10/15/02	21.3 $\pm$ 1.3	20.4 $\pm$ 1.5
	10/15/02-1/9/03	21.7 $\pm$ 1.2	20.2 $\pm$ 1.5
	1/9/03-4/3/03	19.1 $\pm$ 1.2	22.0 $\pm$ 3.9
	4/3/03-7/10/03	22.2 $\pm$ 1.0	18.5 $\pm$ 1.8
12. R-0 (41)	9/9/02-10/15/02	25.0 $\pm$ 1.1	21.8 $\pm$ 1.7
	10/15/02-1/9/03	24.7 $\pm$ 1.4	21.7 $\pm$ 1.5
	1/9/03-4/3/03	21.6 $\pm$ 1.1	22.3 $\pm$ 3.6
	4/3/03-7/10/03	23.5 $\pm$ 1.6	20.5 $\pm$ 1.0
13. R-1 (37)	9/9/02-10/15/02	20.1 $\pm$ 1.9	20.0 $\pm$ 1.9
	10/15/02-1/9/03	22.2 $\pm$ 2.5	20.3 $\pm$ 1.6
	1/9/03-4/3/03	18.5 $\pm$ 1.5	22.3 $\pm$ 3.6
	4/3/03-7/10/03	22.0 $\pm$ 1.6	19.1 $\pm$ 1.3
14. R-2 (44)	9/9/02-10/15/02	21.6 $\pm$ 1.0	22.1 $\pm$ 1.6
	10/15/02-1/9/03	21.4 $\pm$ 1.8	22.2 $\pm$ 3.7
	1/9/03-4/3/03	*	21.3 $\pm$ 1.9
	4/3/03-7/10/03	21.4 $\pm$ 2.1	21.5 $\pm$ 4.1

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**TABLE 3.0** Wolf Creek monthly duplicate samples for waterborne radionuclides in **surface water** SFY 2003. Gamma isotopic analyses by both KDHE and WCNOG of surface water samples indicated that no gamma emitters attributable to WCGS operation were present above the lower limits of detection. Sample results in pCi/l tritium (<sup>3</sup>H). See Map #1.0 for sample locations.

Date	J-1A (Spillway)		Q-1 (Discharge Canal)		N-1 (JRR/MUSH) Control	
	KDHE	WCNOG	KDHE	WCNOG	KDHE	WCNOG
07/18/02	14081± 383	11112± 294	13763±380	10894±291	<350	<126
08/22/02	12980± 323	10871± 292	12089±350	10852±292	<350	<135
09/25/02	12000±400	13619±348	12000±400	13365±345	<350	<181
10/17/02	12182±361	12159± 320	11663±502	12271±321	<350	<146
11/21/02	10313± 480	12096± 322	10545±484	12279±324	<350	<142
12/19/02	10500± 500	12399± 320	10700±500	12341±319	<350	<159
01/30/03	12634±525	14300± 342	11800±500	13599±334	<350	<160
02/20/03	12500± 500	13377± 320	11900±518	14233±330	<350	<136
03/20/03	12500± 500	14117± 237	12800±500	13543±329	<350	<161
04/17/03	12131± 363	12954± 322	12344±365	12858±321	<350	<156
05/15/03	11100± 500	12372± 302	13400±500	13996±321	<350	<128
06/19/03	12782±423	11394± 305	12346±592	11409±305	<350	<163

**TABLE 4.0** Wolf Creek annual samples for deposition of airborne radionuclides on **surface water (PONDS)** SFY 2003. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. See Map #1.0 for sample locations. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were found above method detection limits.*

Location	Date	Tritium ( <sup>3</sup> H)
P-1, New Strawn City Lake	7/29/02	<350

**TABLE 5.0** Wolf Creek Annual samples for waterborne radionuclides in **ground water** SFY 2003. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were found above method detection limits.* See Map #1.0 for sample locations.

Date	J-1 (D65)	L-1 (L49)	N-1 (C-10)	B-1 (B-12)
	KDHE (WCNOG)	KDHE (WCNOG)	KDHE (WCNOG)	KDHE (WCNOG)
TRITIUM ( <sup>3</sup> H)				
8/22/02	<350 (<184)	<350 (<184)	<350 (<184)	<350 (<184)
ALPHA + BETA				
8/22/02	<5	<4	<9	5

<sup>a</sup> WCNOG results for tritium only.

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**TABLE 6.0** Wolf Creek ingestion pathway quarterly samples for waterborne radionuclides in **drinking water** SFY 2003. Sample results in pCi/l. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{51}\text{Cr}$ ,  $^{54}\text{Mn}$ ,  $^{58}\text{Co}$ ,  $^{59}\text{Fe}$ ,  $^{60}\text{Co}$ ,  $^{65}\text{Zn}$ ,  $^{67}\text{Ga}$ ,  $^{95}\text{Nb}$ ,  $^{95}\text{Zr}$ ,  $^{99}\text{Mo}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{103}\text{Ru}$ ,  $^{106}\text{Ru}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{111}\text{In}$ ,  $^{123}\text{I}$ ,  $^{125}\text{Sb}$ ,  $^{131}\text{I}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{140}\text{Ba}$ ,  $^{140}\text{La}$ ,  $^{141}\text{Ce}$ ,  $^{144}\text{Ce}$ ,  $^{169}\text{Yb}$ ,  $^{226}\text{Ra}$ ,  $^{228}\text{Ac}$ ,  $^{228}\text{Th}$ ,  $^{234}\text{Th}$ , and  $^{239}\text{Np}$ . See Map #1.0 for sample locations. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were found above method detection limits.*

LEROY DRINKING WATER		
DATE	GROSS BETA	TRITIUM
07/02/02	<5 (4.7±1.1)	<350
08/07/02	<5 (5.9±1.1)	<350
09/05/02	<5(4.6±1.1)	<350
10/02/02	7.0±2.0 (5.3±1.2)	<350
11/6/02	<5 (No Data)	<350
12/03/02	<5 (4.5±1.1)	<350
01/03/03	<5 (4.4±1.1)	<350
02/05/03	<5 (5.6±1.1)	<350
03/07/03	7.0± 2.0(4.6±1.2)	<350
04/02/03	7.0± 2.0 (5±1.3)	<350
05/06/03	(3.8±1.2)	<350
6/12/03	<5 (No Data)	<350

**TABLE 7.0** Wolf Creek ingestion pathway samples for radionuclide bioaccumulation in **milk** (from airborne radionuclide deposition on pasturage with subsequent ingestion by milk producing cattle) SFY 2003. Sample is collected at Lebo, R-1 (Linsey Dairy). Lebo is a control location. Sample results in pCi/□. Results reported at the 95% confidence level. Gamma isotopic analysis showed that no gamma emitters attributable to Wolf Creek operation were present above the lower limits of detection. Gamma emitting radionuclides routinely analyzed for include  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{51}\text{Cr}$ ,  $^{54}\text{Mn}$ ,  $^{58}\text{Co}$ ,  $^{59}\text{Fe}$ ,  $^{60}\text{Co}$ ,  $^{65}\text{Zn}$ ,  $^{67}\text{Ga}$ ,  $^{95}\text{Nb}$ ,  $^{95}\text{Zr}$ ,  $^{99}\text{Mo}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{103}\text{Ru}$ ,  $^{106}\text{Ru}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{111}\text{In}$ ,  $^{123}\text{I}$ ,  $^{125}\text{Sb}$ ,  $^{131}\text{I}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{140}\text{Ba}$ ,  $^{140}\text{La}$ ,  $^{141}\text{Ce}$ ,  $^{144}\text{Ce}$ ,  $^{169}\text{Yb}$ ,  $^{226}\text{Ra}$ ,  $^{228}\text{Ac}$ ,  $^{228}\text{Th}$ ,  $^{234}\text{Th}$ , and  $^{239}\text{Np}$ . See Map #1.0 for sample location. *No isotopes attributable to WCNOG operations were found above method detection limits.*

Date	$^{40}\text{K}$ , natural KDHE
Lebo R-1 quarterly sample collection	
8/1/02	1449
11/14/02	1258 <sup>1</sup>
3/27/03	2300
6/26/03	No Data <sup>2</sup>

1. Two samples obtained in Q2 SFY 03, October sample was not analyzed.
2. SFY Q4 sample disposed of by lab after iodine analysis prior to performance of gamma isotopic analysis.

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**TABLE 8.0** ERS annual samples for airborne radionuclide deposition on **soil** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. The presence of <sup>137</sup>Cs is not attributable to Wolf Creek operation unless accompanied by other reactor nuclides.

Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np.

The symbol \* indicates naturally occurring radionuclides. See Map #1.0 for sample location. WCNOG sample location designations are denoted by parenthesis. *No isotopes attributable to WCNOG operations were observed above method detection limits.*

Isotope	A-1 Sector A Sharpe KDHE 4/16/03 0.5m <sup>2</sup>	E-1 Scott Valley Church (Control) 5/15/03 0.5m <sup>2</sup>	H-1 East of CCL Dam Near HCA H-1 6/9/03 0.5m <sup>2</sup>
<sup>228</sup> Ac*	11590±60	1690±60	1200±50
<sup>137</sup> Cs	Not detected	90±10	Not detected
<sup>40</sup> K*	15000±4000	17000±1000	13000±1000
<sup>228</sup> Th*	3000±40000	3000±40000	3000±13000
	P-1 (MUDS) KDHE	R-1 EEA Public Access Area for fishing KDHE	
<sup>228</sup> Ac*	1150±50	1690±60	
<sup>137</sup> Cs	140±10	90±10	
<sup>40</sup> K*	12000±100	17000±1000	
<sup>228</sup> Th*	2000±200000	3000±40000	

**TABLE 8.1** ERS random samples for airborne radionuclide deposition in **soil** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>40</sup>K activity. *No isotopes attributable to WCNOG operations were found above method detection limits.* See Map #7.0 for locations.

Location	Date	<sup>137</sup> Cs	Isotope <sup>40</sup> K
WCRS-1-D-068-15 Harris Coop	9/5/02	422±32	11323±928
WCRS-02-L-220-4.8 Kelley Park, Burlington	4/16/03	<49	18000±2000
WCRS-03-P-290-4.9 Dove Roost Trail, Flint Hills Natl. Wildlife Refuge	5/2/03	1740±70	22000±2000
WCRS-04-L-238-3.7 Burlington Public Library	5/2/03	1500±70	19000±3000
WCRS-05-C-135-7.9 21 <sup>st</sup> Road and Trefoil Road, Coffey County	5/15/03	1730±60	17000±1000
WCRS-06-E-080-2.2 15 <sup>th</sup> Road and Reaper Road, Coffey County	5/15/03	1200±60	14000±2000
WCRS-07-L-220-9.6 8 <sup>th</sup> Road and Iris Road, Coffey County	5/15/03	1660±60	10300±800
WCRS-08-N-283-9.9 Jacobs Creek Boat Ramp	5/15/03	1470±60	22000±2000
WCRS-09-R-343-10.9 25 <sup>th</sup> Road and Lynx Road, Coffey County	6/3/03	1310±50	14000±1000
WCRS-10-G-141-8.8 22 <sup>nd</sup> Road and Shetland Road, Coffey County	6/3/03	1220±40	8900±900

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**TABLE 9.0** ERS annual samples for waterborne radioisotope concentration in **bottom sediments** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \* indicates naturally occurring radioisotopes. See Map #1.0 for sample location. WCNOC sample location designations are denoted by parentheses.

Isotope	WCBS-AQ-1 (DC)	WCBS-AN-1 (JRR)
	CCL discharge cove 11/14/02 KDHE (WCNOC)	John Redmond Reservoir <b>Control</b> (10/29/02) KDHE (WCNOC)
<sup>228</sup> Ac*	1280±50(not reported)	1924±95(not reported)
<sup>137</sup> Cs	250±20 (281± 59)	145±18(106± 35)
<sup>40</sup> K*	13000±1000 (14983± 886)	21500±7995(13515± 760)
<sup>226</sup> Ra*	<828 (not reported)	<828(not reported)
<sup>228</sup> Th*	2000±30000 (not reported)	2950±97617(not reported)
	WCBS-AR-1 EEA 6/24/03 KDHE (WCNOC)	
<sup>228</sup> Ac*	950±40 (not reported)	
<sup>137</sup> Cs	77±8(69± 34)	
<sup>40</sup> K*	12000±1000(12168± 1080)	
<sup>226</sup> Ra*	<828(not reported)	
<sup>228</sup> Th*	2000±20000(not reported)	

**TABLE 9.1** Wolf Creek random samples for waterborne radioisotope concentration in **bottom sediments** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>60</sup>Co activity. Strontium analysis is done on selected samples. See Map #3.0 for locations.

	Location	Date	Isotope	
			<sup>137</sup> Cs	<sup>60</sup> Co
WCRBS-R-1-341-0.8	Coffey County Lake Near Stringtown Cemetery	11/14/02	622±48	323±19
WCRBS-N-1-280-1.7	Public Access Boat Ramps	5/3/03	<49	<56
WCRBS-Q-1-129-0.8	Coffey County Lake, Western Edge	6/12/03	<49	<56

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**TABLE 10.0** Wolf Creek annual samples for waterborne radioisotope concentration in **shoreline sediment** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. The symbol \* indicates naturally occurring radioisotopes. See Map #1.0 for sample location. WCNOG sample location designations are denoted by parentheses.

Isotope	N-1 (JRR) John Redmond Reservoir (Control) 10/29/02 KDHE (WCNOG)	R-1 (EEA) Environmental Education Area 6/24/03 KDHE (WCNOG)	P-1 (MUDS) CCL Public Access Fishing Area 11/7/02 KDHE (WCNOG)
	Q-1 (DC) CCL Discharge Cove 5/23/03 KDHE (WCNOG)	J-1 Wolf Creek near Plant Discharge 6/13/03 KDHE	
<sup>228</sup> Ac*	1543±41	1260±50	1083±36
<sup>7</sup> Be*	579±57	NA	411±53
<sup>137</sup> Cs	<49	<49	58±7
<sup>60</sup> Co	<56	<56	56±5
<sup>40</sup> K*	14718±1200	12000±2000	8877±78
<sup>226</sup> Ra*	1124±518	<828	2598±391
<sup>89</sup> Sr	NA	NA	NA
<sup>90</sup> Sr	NA	NA	NA
<sup>228</sup> Ac*	1210±50		960± 30
<sup>7</sup> Be*	NA		NA
<sup>137</sup> Cs	<49		<49
<sup>60</sup> Co	<56		<56
<sup>40</sup> K*	13000±2000		10000±800
<sup>226</sup> Ra*	<828		<828
<sup>89</sup> Sr	NA		NA
<sup>90</sup> Sr	NA		NA

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**TABLE 10.1** Wolf Creek random samples for waterborne radioisotope concentration in **shoreline sediments** SFY 2003. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. This table reports only <sup>137</sup>Cs and <sup>60</sup>Co activity. Strontium analysis is performed on selected samples. See Map #3.0 for locations.

	Location	Date	<sup>137</sup> Cs	Isotope <sup>60</sup> Co
WCRSS-31-L-220-4.8	Neosho River at Burlington Kelley Park	4/16/03	<56	<49
WCRSS-1-A-350-3.8	0.5 mile east of EOF	5/6/03	<56	<49
WCRSS-2-J-180-3.0	East of Dam, 3 miles south of plant	5/6/03	<56	<49
WCRSS-1-F-113-1.5	1.5 Mi. SE of plant	5/7/03	<56	<49
WCRSS-5-H-156-18	Neosho River at Neosho Falls	5/15/03	<56	<49
WCRSS-1-M-237-1.5	14 <sup>th</sup> Rd. dead end 1.5 mi. west of Plant	5/28/03	<56	<49
WCRSS-8-H-165-11.5	Neosho River near Leroy @ K-57 Bridge	5/30/03	<56	<49
WCRSS-9-J-180-4.8	Wolf Creek at FAS 10 Bridge	5/30/03	<56	<49
WCRSS-Q-1-291-0.8	Coffey County Lake	6/12/03	<56	<49
WCRSS-G-1-145-2.3	Coffey County Lake	6/12/03	<56	<49
WCRSS-G-2-128-2.1	Coffey County Lake	6/12/03	<56	<49
WCRSS-H-1-160-3.0	Coffey County Lake	6/12/03	<56	<49
WCRSS-Q-2-318-2.4	Black Bear Bosin Area	6/12/03	<56	<49

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**TABLE 11.0** Wolf Creek fish ingestion pathway duplicate samples for waterborne radioisotope bioaccumulation in fish SFY 2003. Sample results in pCi/kg-wet. Results reported at the 95% confidence level. Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. A Tritium (<sup>3</sup>H) in tissue analysis is done on all edible fish portions collected. <sup>3</sup>H is a beta emitter. See Map #1.0 for sample locations. WCNOG sample location designations are denoted by parentheses.

Location	Date	Description	Isotope	
			<sup>40</sup> K, natural KDHE (WCNOG)	<sup>3</sup> H KDHE (WCNOG)
N-1 (JRR) John Redmond Reservoir Below dam on Neosho River  <b>Control</b>	10/29/02	Channel Catfish	3080± 316(3124± 303)	447± 933 (<116)
		Common Carp	2370± 553 (3055± 442)	1062± 846 (<136)
		Small Mouth Buffalo	2720± 249 (3404± 309)	829± 648(<116)
		Large Mouth Buffalo	2964± 333 (2725± 270)	2044± 910 (<114)
Q-1 (DC) CCL Discharge Cove	10/10/02	Channel Catfish	7424± 1396 (2805± 371)	7837± 880 (7949± 221)
		Common Carp	7613± 755 (3093± 642)	8668± 900 (7910± 223)
		White bass	7378± 662 (2727± 368)	9339± 950 (8075± 223)
		White Crappie	6531± 1046 (3112± 464)	4715± 485 (8706± 239)
		Walleye	7945± 794 (3391± 422)	11403± 1010 (6167± 180)
		Small Mouth Buffalo	6537± 1197 (1686± 401)	14018± 1073 (7625± 210)
		Large Mouth Buffalo	6468± 750 (2787± 284)	13958± 1080 (7830± 216)

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**TABLE 12.0** Wolf Creek samples for waterborne radioisotope bioaccumulation in **aquatic vegetation** SFY 2003. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. See Map #1.0 for sample location.

	Location	Type	Date	<sup>7</sup> Be	Isotope <sup>40</sup> K
WCAV-N-1	JRR Below the Dam	Filamentous Algae	9/5/02	323±51	10378±800
WCAV-J-1	Wolf Creek 11 <sup>th</sup> St. Bridge	Arrowhead Fern	9/13/02	1791±354	6035±4591
WCAV-P-1	MUDS	Pondweed	9/25/02	714±173	2931±428
WCAV R-1	EEA	Pondweed	6/23/03	1300±500	20000±10000

**TABLE 12.1** Wolf Creek random samples for waterborne radioisotope bioaccumulation in **aquatic vegetation** SFY 2003. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operations were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. See Map #8.0 for sample location.

	Location	Date	Description	Isotope <sup>7</sup> Be natural KDHE (WCNOC)	<sup>40</sup> K natural KDHE (WCNOC)
WCRRA-1-J-181-4.8	Wolf Creek 10th and Oxen Rd.	9/31/02	Arrowhead	584± 146	28759± 2340
WCRRA-01-335-2.8	0.5 Mi. E of EOF	5/6/03	Cattails	<35	27000± 5000
WCRAL-1-N-280-1.7	Public Access Boat Ramps	5/23/03	Algae	800± 200	12000± 1000
WCRAL-1-J-186-3.5	Behind CCL Blowdown structure	5/28/03	Algae	4100± 700	9000± 4000
WCRRA-3-J-181-4.8	Wolf Creek off FAS-10 bridge	5/30/03	Arrowhead	10000± 1000	5000± 2000
WCRAL-1-H-157-3.1	East of CCL Dam	6/9/03	Algae	2100± 500	20000± 10000
WCRRA-1-Q-324-13	Old HWY 50 and Garner Rd	6/23/03	Pondweed	1500± 300	20000± 2000
WCALR-1-R-332-3.0	EEA	6/26/03	Algae	<35	12000± 7000

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**TABLE 13.0** Wolf Creek trending samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2003. Includes ingestion pathway sampling of garden vegetables and sampling for waterborne radionuclide bioaccumulation in irrigated crops. Sample results in pCi/kg-dry (KDHE) and pCi/kg-wet (WCNOC). Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operation were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. See Map #1.0 for sample location. WCNOC sample location designations are denoted by parentheses.

Location	Date	Description	Isotope	
			<sup>7</sup> Be natural KDHE (WCNOC)	<sup>40</sup> K natural KDHE (WCNOC)
S-4 (WC Designation) Garden Near Hartford	7/17/02	Cabbage	2434± 381 (229± 134)	34347± 3328 (3818± 394)
C-1 Garden in Sector C	8/14/02	Mustard Greens	<35 (<198)	15856±1536 (3818± 394)
WCFV-J-1 (NRD2) Near LeRoy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	11/14/02	Corn	<35 (<109)	3660± 448 (2466± 375)
WCFV-J-2 (NRD2) Near LeRoy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	11/14/02	Soybeans	<35(<190)	15608± 1257 (12969± 875)
E-1 Scott Valley Church <b>Control</b>	5/15/03	Pasturage	200± 100	20000± 6000
A-1 Sector A, Sharpe/Pasture near Sharpe	6/9/03	Pasturage	7000± 900	13000± 1000
H-1 East of CCL dam, near WCA H-1	6/9/03	Pasturage	1400± 300	26000± 7000
P-1 (MUDS) CCL public access area, north side of parking lot, 10 m from shore	6/24/03	Pasturage	<35	8904± 3324
R-1 (EEA) CCL environmental education area	6/24/03	Pasturage	1800± 300 (865.1± 364.2)	24000± 4000 (8657± 698)

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**TABLE 13.1** ERS random samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2003. Includes ingestion pathway sampling of garden vegetables. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. *No isotopes attributable to WCNOC operation were found above method detection limits.* Gamma emitting radionuclides routinely analyzed for include <sup>7</sup>Be, <sup>40</sup>K, <sup>51</sup>Cr, <sup>54</sup>Mn, <sup>58</sup>Co, <sup>59</sup>Fe, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>67</sup>Ga, <sup>95</sup>Nb, <sup>95</sup>Zr, <sup>99</sup>Mo, <sup>99m</sup>Tc, <sup>103</sup>Ru, <sup>106</sup>Ru, <sup>110m</sup>Ag, <sup>111</sup>In, <sup>123</sup>I, <sup>125</sup>Sb, <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs, <sup>140</sup>Ba, <sup>140</sup>La, <sup>141</sup>Ce, <sup>144</sup>Ce, <sup>169</sup>Yb, <sup>226</sup>Ra, <sup>228</sup>Ac, <sup>228</sup>Th, <sup>234</sup>Th, and <sup>239</sup>Np. The isotopes <sup>89</sup>Sr and <sup>90</sup>Sr are beta emitters. Strontium analysis is done on selected samples. See Map #6.0 for sample location. WCNOC sample location designations are denoted by parentheses.

Location	Date	Description	Isotope	
			<sup>7</sup> Be KDHE (WCNOC)	<sup>40</sup> K KDHE (WCNOC)
Harris COOP	09/05/02	Pasturage	2175 ± 329	16946 ± 8710
Sharpe	09/13/02	Asparagus	3885 ± 519	13120 ± 9883
New Strawn Golf Course	09/25/02	Apples	<35	1589 ± 188
16th and Oxen Lane	10/16/02	Soybeans	<35	11945 ± 864
Junction US75 and 23rd rd.	04/16/03	Pasturage	9000 ± 1000	600 ± 900
Dove Roost Trail	05/02/03	Pasturage	9200 ± 900	4000 ± 1000
515 Cumberland, Burlington	05/02/03	Pasturage	3300± 500	23000 ± 9000
19th and Reaper	06/26/03	Pasturage	1500 ± 200	3000 ± 3000
Garden in Sector G	7/17/02	Cabbage	299± 48 (<177.7)	37117± 4200 (5758±579)
Garden, Sector A	7/17/02	Rhubarb	1544± 383	41404± 3759
Garden Near Hartford	8/14/02	Collard Greens	1119± 171	16693± 2755
Garden, Sector G	8/14/02	Mustard Greens	907 ± 179	17336± 2490

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**Table 14.0** KDHE RADIOCHEMISTRY LABORATORY EPA INTERCOMPARISON STUDIES

Analysis	Date	Known Value $\pm$ Control Limit (pCi/l)	Expected Precision	KHEL Average Results $\pm$ Uncertainty
Gross Alpha	1-23-03	103.0 $\pm$ 45.0	25.8	99.5 $\pm$ 1.04
	1-23-03	12.2 $\pm$ 8.7	5.0	9.7 $\pm$ 1.0
	4-16-03	37.6 $\pm$ 16.3	9.4	30.3 $\pm$ 2.1
	7-3-03	70.3 $\pm$ 30.7	17.6	67.5 $\pm$ 1.7
Gross Beta	1-23-03	330.0 $\pm$ 86.0	49.5	267.0 $\pm$ 14.3
	1-23-03	47.0 $\pm$ 8.7	5.0	47.8 $\pm$ 3.12
	4-16-03	8.6 $\pm$ 8.7	5.0	8.2 $\pm$ 1.4
	7-3-03	363 $\pm$ 94	55	305 $\pm$ 8.7
Tritium	1-23-03	10200 $\pm$ 1800	1020	9500 $\pm$ 541
	7-3-03	1250 $\pm$ 570	331	1480 $\pm$ 12.3
<sup>89</sup> Sr	11-28-02	29.0 $\pm$ 8.7	5.0	24.3 $\pm$ 0.95
	1-23-03	47.6 $\pm$ 8.7	5.0	48.3 $\pm$ 4.54
	4-16-03	15.9 $\pm$ 8.7	5.0	13.9 $\pm$ 1.6
	7-3-03	31.7 $\pm$ 8.7	5.0	26.0 $\pm$ 0.4
<sup>90</sup> Sr	11-18-02	36.4 $\pm$ 8.7	5.0	37.0 $\pm$ 1.1
	1-23-03	7.6 $\pm$ 8.7	5.0	8.5 $\pm$ 0.7
	4-16-03	9.0 $\pm$ 8.7	5.0	9.8 $\pm$ 1.0
	7-3-03	27.4 $\pm$ 8.7	5.0	28.7 $\pm$ 0.7
<sup>60</sup> Co	11-8-02	23.3 $\pm$ 8.7	5.0	24.7 $\pm$ 0.2
	1-23-03	104 $\pm$ 9	5.2	99 $\pm$ 0.5
	4-16-03	37.4 $\pm$ 8.7	5.0	39.4 $\pm$ 0.5
	7-3-03	63.8 $\pm$ 8.7	5.0	60.9 $\pm$ 2.5
<sup>134</sup> Cs	11-8-02	71.7 $\pm$ 8.7	5.0	73.4 $\pm$ 1.4
	1-23-03	55.5 $\pm$ 8.7	5.0	50.8 $\pm$ 1.0
	4-16-03	17.8 $\pm$ 8.7	5.0	17.7 $\pm$ 0.6
	7-3-03	75.7 $\pm$ 8.7	5.0	73.9 $\pm$ 0.6
<sup>137</sup> Cs	11-8-02	214 $\pm$ 19	10.7	233 $\pm$ 2.52
	1-23-03	117 $\pm$ 10	5.9	111 $\pm$ 2
	4-16-03	44.2 $\pm$ 8.7	5.0	46.5 $\pm$ 1.6
	7-3-03	150 $\pm$ 13	7.5	145 $\pm$ 3
<sup>133</sup> Ba	11-8-02	80.0 $\pm$ 13.6	8.0	82.7 $\pm$ 1.5
	4-16-03	19.5 $\pm$ 8.7	5.0	19.2 $\pm$ 1.0
<sup>65</sup> Zn	11-8-02	95.7 $\pm$ 16.3	9.7	96.3 $\pm$ 2.5
	4-16-03	60.3 $\pm$ 10.4	6.0	60.3 $\pm$ 1.0
<sup>131</sup> I	1-23-03	6.76 $\pm$ 3.44	2.0	6.80 $\pm$ 0.1
	7-3-03	20.8 $\pm$ 5.2	3.0	22.8 $\pm$ 0.7

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**TABLE 15.0** KHEL Radiochemistry Laboratory method detection limits SFY 2003. Listed below are method detection limits of present analytical methods for some of the radionuclides monitored by the 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).

<b>GeLi [HPGe] detection system<sup>a</sup></b>						
Environmental Sampling						
	Water and Milk	Filter	Wipe	Soil and Sediment	Biota	Vegetation and food products
Minimum sample size Minimum Counting Time Method Detection Limit	2000 ml 8 hr. pCi/l	1500 m <sup>3</sup> 3 hr. pCi/m <sup>3</sup>	Total 3Hr. pCi/wipe	.45 kg 15 hr. pCi/kg-dry	0.3 kg 15 hr. pCi/kg-wet	1 kg 15 hr pCi/kg-dry
<sup>7</sup> Be	64 [22]	0.03 [0.02]	****	346 [186]	231 [144]	35 [19]
<sup>40</sup> K	88 [39]	0.03 [0.02]	****	828 [654]	459 [262]	152 [72]
<sup>51</sup> Cr	52 [32]	0.01 [0.009]	5 [3]	35 [22]	41 [32]	55 [46]
<sup>54</sup> Mn	4 [2]	0.004 [0.003]	1 [0.7]	44 [11]	30 [15]	72 [24]
<sup>58</sup> Co	4 [2]	0.008 [0.002]	2 [1]	45 [23]	37 [20]	92 [36]
<sup>59</sup> Fe	8 [3]	0.01 [0.01]	3 [2]	51 [16]	41 [15]	97 [52]
<sup>60</sup> Co	11 [7]	0.01 [0.0053]	2.5 [1.7]	56 [35]	43 [26]	79 [50]
<sup>65</sup> Zn	8 [4]	0.01 [0.007]	****	48 [30]	38 [22]	93 [63]
<sup>95</sup> Nb	7 [3]	0.009 [0.007]	2.5 [1.4]	68 [30]	44 [26]	9 [4]
<sup>95</sup> Zr	6 [3]	0.01 [0.002]	0.5 [0.3]	35 [27]	27 [19]	84 [54]
<sup>99</sup> Mo	5 [3]	0.002 [0.0014]	1 [0.6]	73 [43]	33 [21]	****
<sup>103</sup> Ru	10 [7]	0.004 [0.003]	****	29 [20]	29 [21]	69 [47]
<sup>106</sup> Ru	55 [43]	0.07 [0.05]	1.5 [1]	269 [192]	43 [29]	96 [65]
<sup>110m</sup> Ag	4 [3]	0.006 [0.0002]	****	47 [33]	47 [34]	86 [55]
<sup>125</sup> Sb	35 [12]	0.02 [0.01]	****	97 [44]	96 [51]	15 [6]
<sup>131</sup> I	5 [3] (1) <sup>b</sup>	0.00027 [0.00027] <sup>c</sup>	1.5 [1]	33 [20]	37 [23]	45 [13]
<sup>134</sup> Cs	5 [3]	0.007 [0.004]	1.4 [1]	44 [29]	37 [24]	57 [39]
<sup>137</sup> Cs	7 [4]	0.006 [0.004]	1 [0.3]	49 [29]	32 [21]	80 [56]
<sup>140</sup> Ba	10 [6]	0.004 [0.003]	****	26 [17]	24 [15]	60 [39]
<sup>140</sup> La	9 [5]	0.01 [0.02]	****	28 [9]	34 [21]	13 [6]
<sup>141</sup> Ce	8 [3]	0.002 [0.001]	****	46 [23]	22 [13]	6 [3]
<sup>144</sup> Ce	35 [14]	0.013 [0.0096]	****	216 [103]	110 [70]	28 [14]
<sup>226</sup> Ra	116 [69]	0.05 [0.03]	****	828 [654]	323 [195]	90 [51]
<sup>228</sup> Ac	30 [18] 15 h	0.0127 [0.0099]	****	68 [33]	146 [87]	27 [12]
<sup>228</sup> Th	387 [142]	0.09 [0.06]	****	859 [317]	944 [356]	454 [167]
<sup>234</sup> Th	618 [87] 15 h	0.159 [0.0423]	****	1009 [378]	1300 [556]	570 [94]
<sup>235</sup> U	****	****	45 [30] 15 h	****	****	****
<sup>239</sup> Np	41 [33]	0.01 [0.009]	5 [3]	64 [44]	40 [30]	97 [71]

<sup>a</sup> GeLi = Germanium lithium; HPGe = High purity germanium.

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

<sup>c</sup> The MDL for <sup>131</sup>I when analyzing a charcoal cartridge is 0.03 [0.02] pCi/m<sup>3</sup> based upon a 250 m<sup>3</sup> sample volume. If the sample volume is increased to 1500 m<sup>3</sup>, the MDL is 0.002 [0.001] pCi/m<sup>3</sup>.

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**Table 15.0 continued.** KHEL Radiochemistry Laboratory method detection limits SFY 2003. 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).

Low Background Alpha and Beta Counting System					
	Water	Milk	Wipe Total	Soil and Sedimen 0.01kg	Vegetation and Food products 0.1 kg
Minimum Sample Size	1000 ml	1000 ml	200 min.	200 min.	200 min.
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
<sup>89</sup> Sr	1	2	3	200	500
<sup>90</sup> Sr	1	2	4	200	500
<sup>131</sup> I	1	****	****	****	****
<sup>228</sup> Ra	1.2	****	0.3	60	****
Gross Beta					
	Water	Filter	Wipe		
Minimum Sample Size	200 ml	250m <sup>3</sup>	Total		
Minimum Counting Time	200 min.	100 min.	100 min.		
Method Detection Limit	4 pCi/l	0.004 pCi/m <sup>3</sup>	2pCi/Wipe		
Gross Alpha					
	Water	Filter	Wipe	Soil and Sediment	
Minimum Sample Size	200 ml	250 m <sup>3</sup>	Total	0.001 kg	
Minimum Counting Time	200 min.	100 min.	100 min.	100 min.	
Method Detection Limit	1 pCi/l	0.0006 pCi/m	0.5 pi/Wipe	160 pCi/kg-dry	
Random Scintillation Counting System					
<sup>226</sup> 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 ( <sup>3</sup> H)		<sup>222</sup> Rn (Radon)		
	In water	In Tissue	In Water		
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		

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**Table 16.0** Lower limit of detection (LLD) values for selected radionuclides for Wolf Creek environmental sample analysis<sup>a</sup>.

Analysis	Water (pCi/l)	Airborne (pCi/m <sup>3</sup> )	Fish (pCi/kg-wet)	Milk (pCi/l)	Food Products <sup>b</sup> (pCi/kg-wet)	Sediment (pCi/kg-dry)	Aquatic Vegetation (pCi/kg-wet)
Gross Beta	4 (2)	0.01 (0.003)	*	*	*	*	*
<sup>3</sup> H	2000 <sup>c</sup> (1000)	*	(300)	*	*	*	*
<sup>54</sup> Mn	15	*	130	*	(40)	(30)	(40)
<sup>59</sup> Fe	30	*	260	*	*	*	*
<sup>58</sup> Co and <sup>60</sup> Co	15 (5)	*	130	*	(10)	(30)	(40)
<sup>65</sup> Zn	30	*	260	*	*	*	(10)
<sup>95</sup> Zr and <sup>95</sup> Nb	15	*	*	*	(10)	*	(40)
<sup>131</sup> I	1 <sup>d</sup> (0.5)	0.07 (0.007)	*	1 (0.3)	60	*	*
<sup>134</sup> Cs	15	0.05	130	15	60	150 (60)	(20)
<sup>137</sup> Cs	18	0.06	150	18	80 (10)	180 (60)	(10)
<sup>140</sup> Ba and <sup>140</sup> La	15	*	*	15	*	*	*
<sup>51</sup> Cr	*	*	*	*	*	*	(500)
<sup>125</sup> Sb	*	*	*	*	*	*	(50)
<sup>226</sup> Ra	*	*	*	*	(200)	(500)	(200)
<sup>228</sup> Th	*	*	*	*	(20)	(40)	(20)
<sup>7</sup> Be	*	(0.001)	*	*	(100)	(300)	(100)
<sup>40</sup> K	*	(0.002)	(500)	(100)	(500)	(500)	(500)

<sup>a</sup> This table is adapted from Table 5-3 of WCNOC's Offsite Dose Calculation Manual (ODCM). Values in parenthesis reflect typical LLDs achievable by offsite laboratories. This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the above nuclides, shall also be analyzed and reported. The LLD is defined as the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with

$$LLD = 2.10 \times \left[ \frac{S_b}{EY \exp(-\lambda \Delta t)} \right]$$

95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal. For a particular measurement system, which may include radio-chemical separation.

Where LLD is the *a priori* lower limit of detection (picoCuries per Unit mass or Volume),  $S_b$  is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute), E is the counting efficiency (counts per disintegration), V is the sample size (units of mass or volume), 2.10 is a conversion factor with units picoCurie per disintegration per minute (4.66/2.22 dpm/pCi), Y is the fractional radiochemical yield (when applicable),  $\lambda$  is the radioactive decay constant for the particular radionuclide ( $s^{-1}$ ), and  $\Delta t$  is the elapsed time between sample collection (or end of the sample collection period), and time of counting (s).

It should be recognized that the LLD is defined as an *a priori* (before the fact) limit representing the capability of a measurement system and not used as an *a posteriori* (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidable small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors shall be identified and described.

<sup>b</sup> Includes terrestrial vegetation.

<sup>c</sup> LLD for drinking water samples. If no drinking water pathway exists, a value of 3000 pCi/P may be used.

<sup>d</sup> LLD for drinking water samples. If no drinking water pathway exists, the LLD of gamma isotopic analysis may be used.

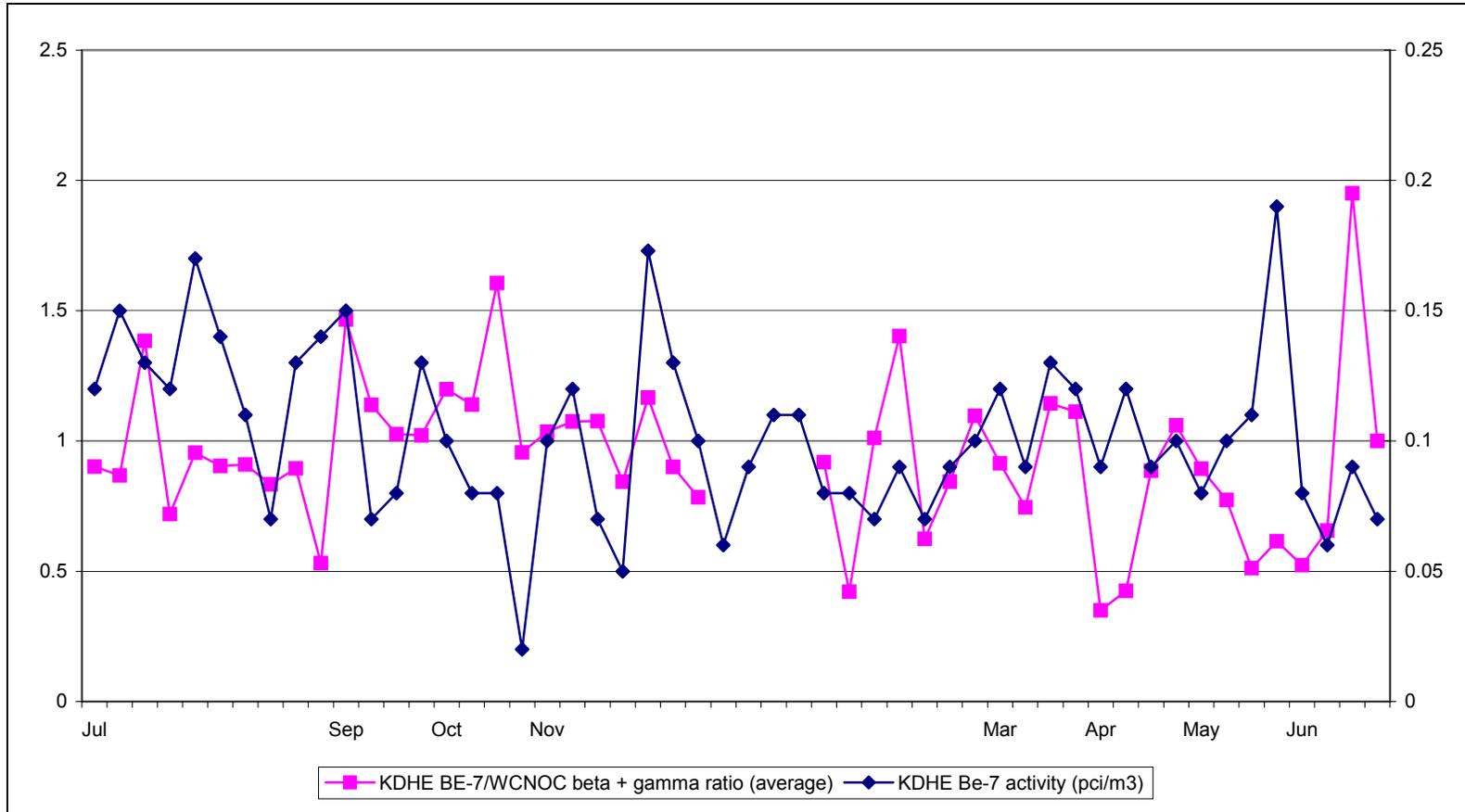
Note: If the above equation is used with an actual background count of a sample and a recently determined counting efficiency (using *a posteriori* values instead of assumed *a priori* values), the minimum detectable activity (MDA) may be calculated. Ideally, the MDA will be very close to the LLD. The LLD is a device to predict the detection capability of the counting system, while the MDA reflects the actual detection capability of a counting system. An MDA should be determined for each sample analyzed. The method detection limit (MDL) and MDA are equivalent.

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**Chart 1.0** Comparison of KDHE <sup>7</sup>Be activity to the ratio of KDHE <sup>7</sup>Be activity to WCNOC gross beta-gamma activity.

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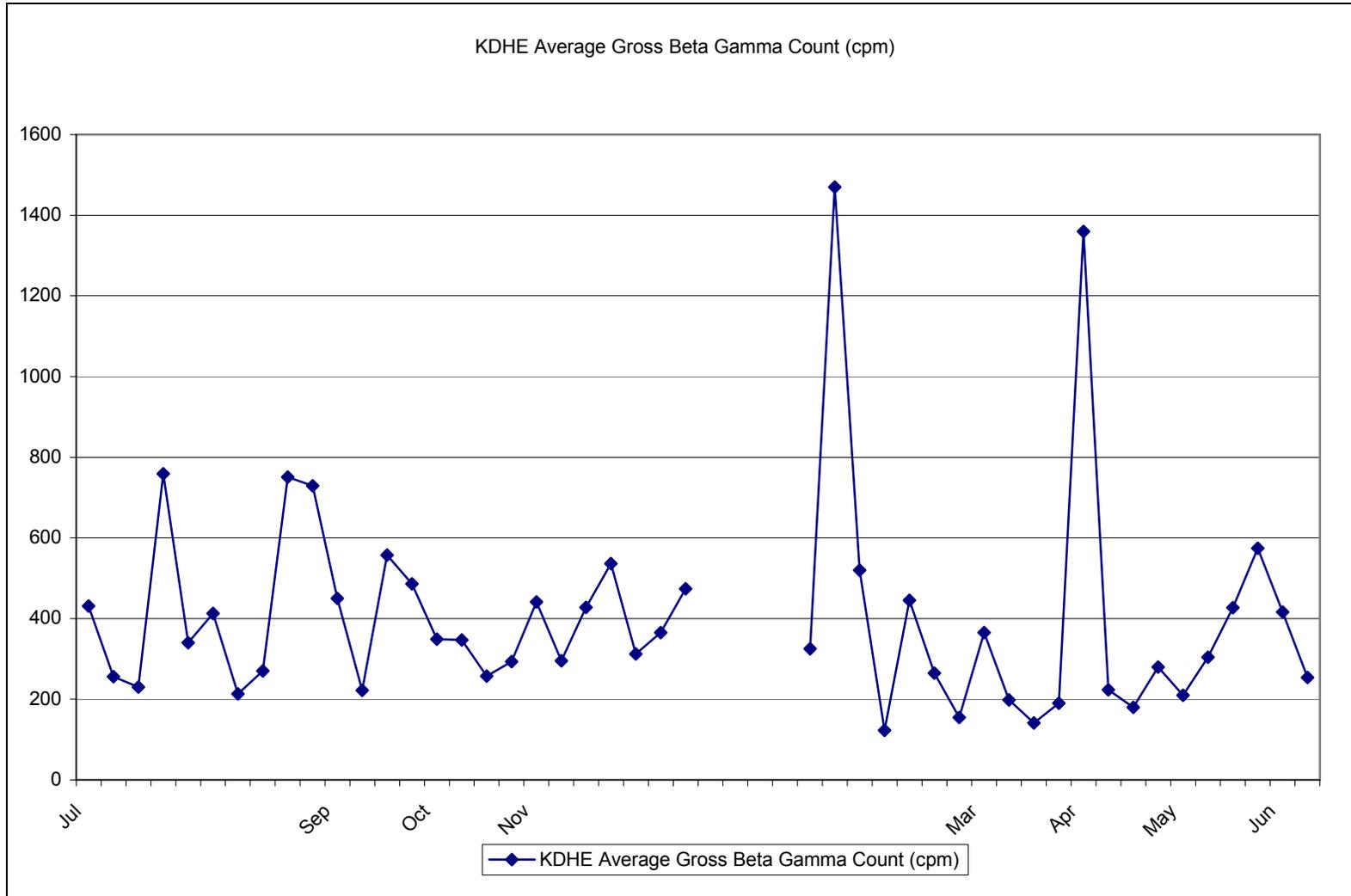


Chart 1.1 KDHE Average Gross Beta Count

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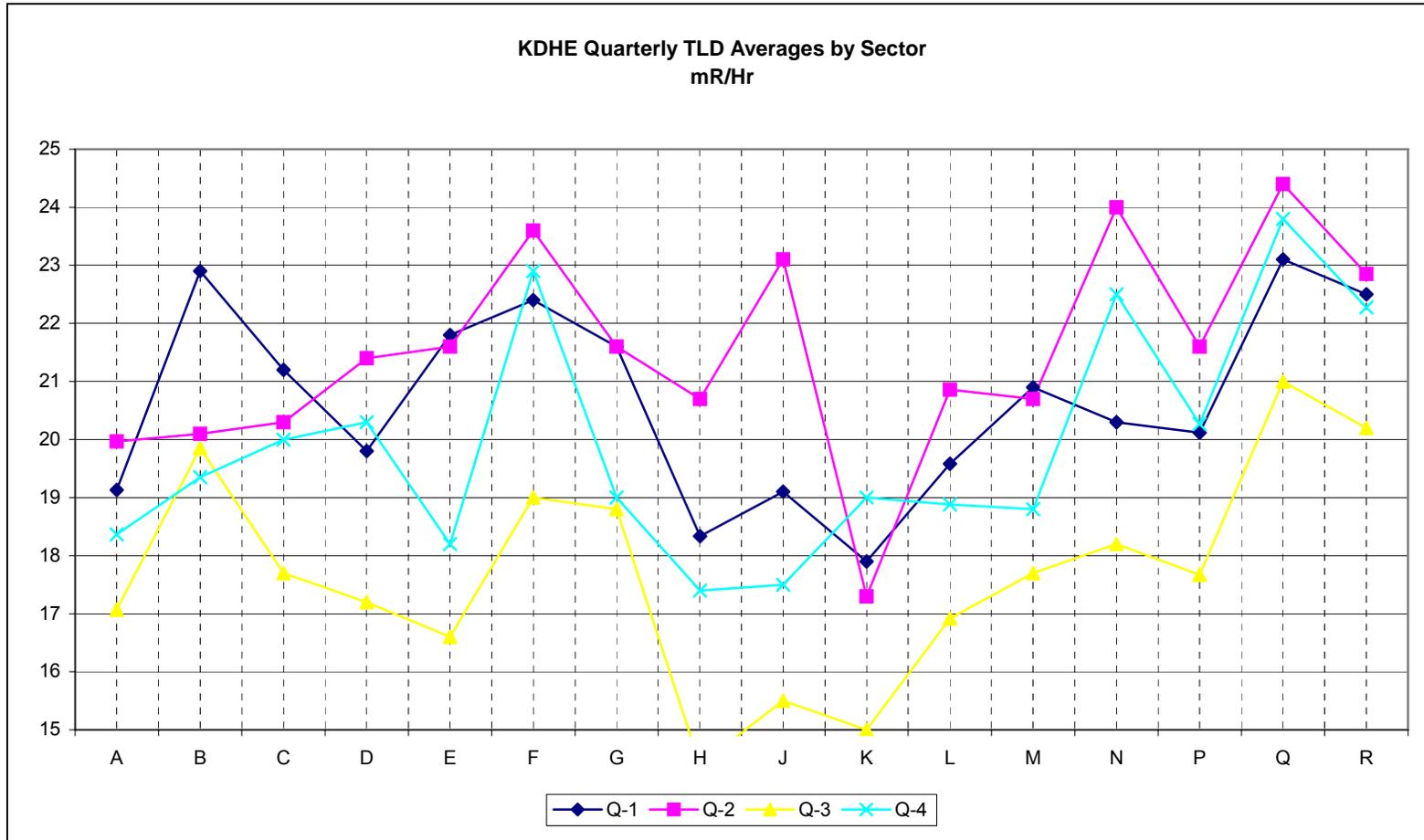
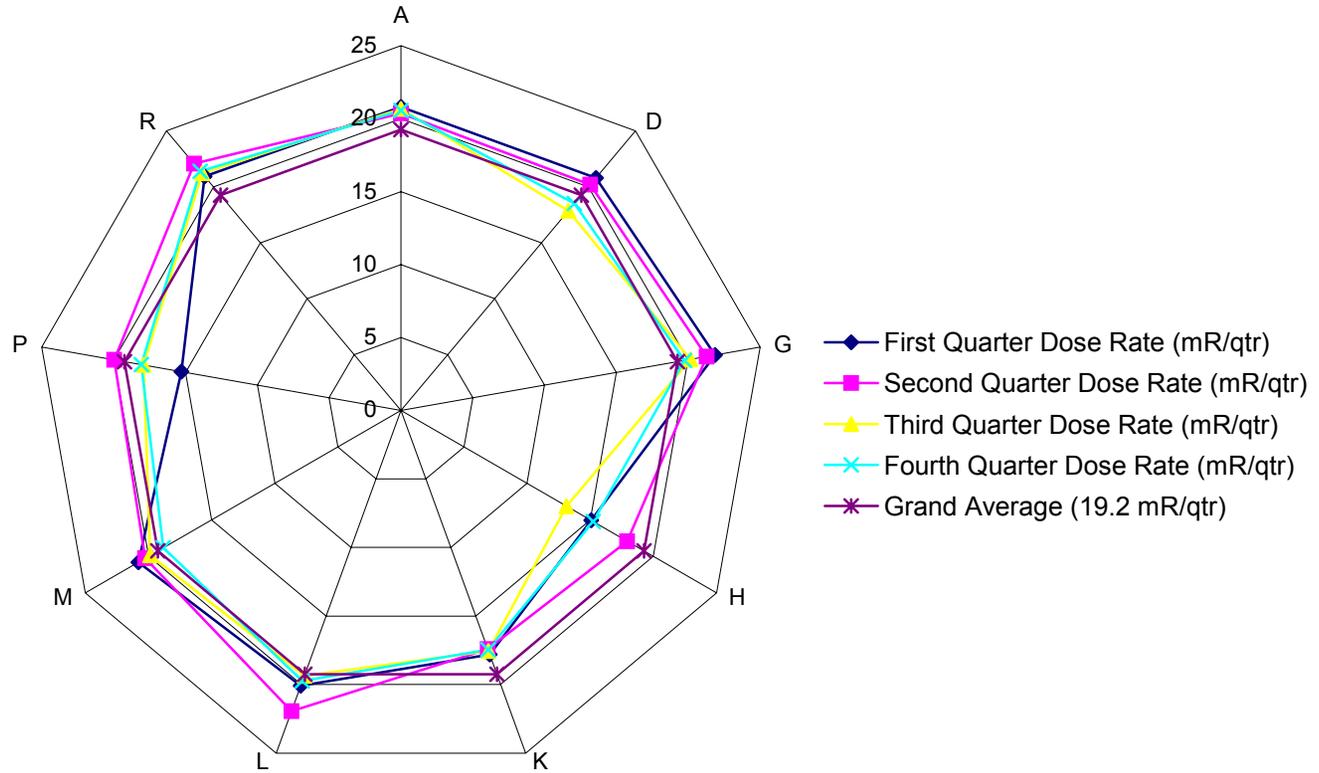


Chart 2.0 KDHE TLD Averages by Sector (All Stations)

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**Quarterly Direct Radiation Monitoring**  
 Collocated Sites (By Sector)



**Chart 2.1** Quarterly Direct Radiation Monitoring Results for Collocated TLD Sites

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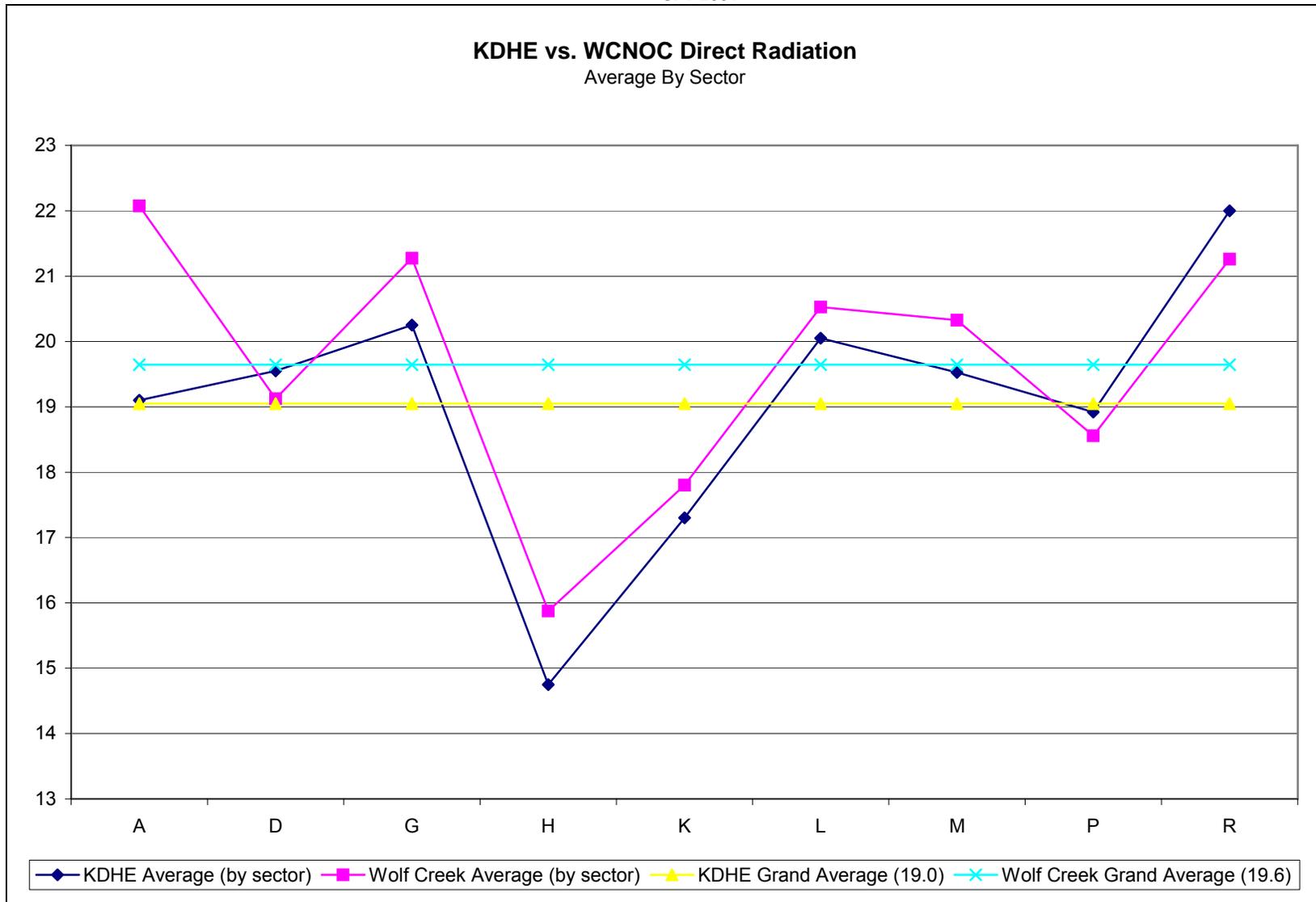


Chart 2.2 Comparison of KDHE and WCNOC Direct Radiation Results

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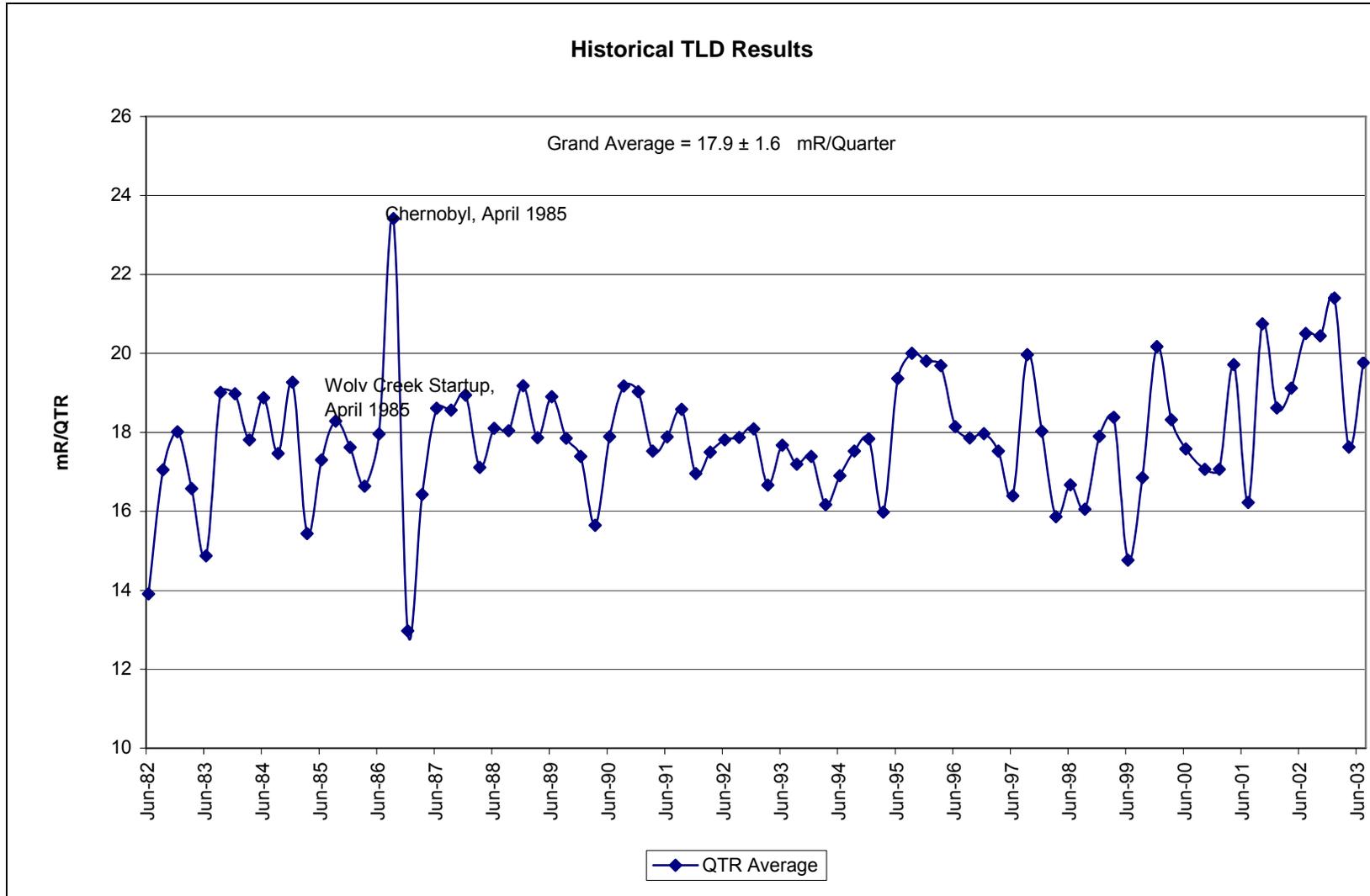
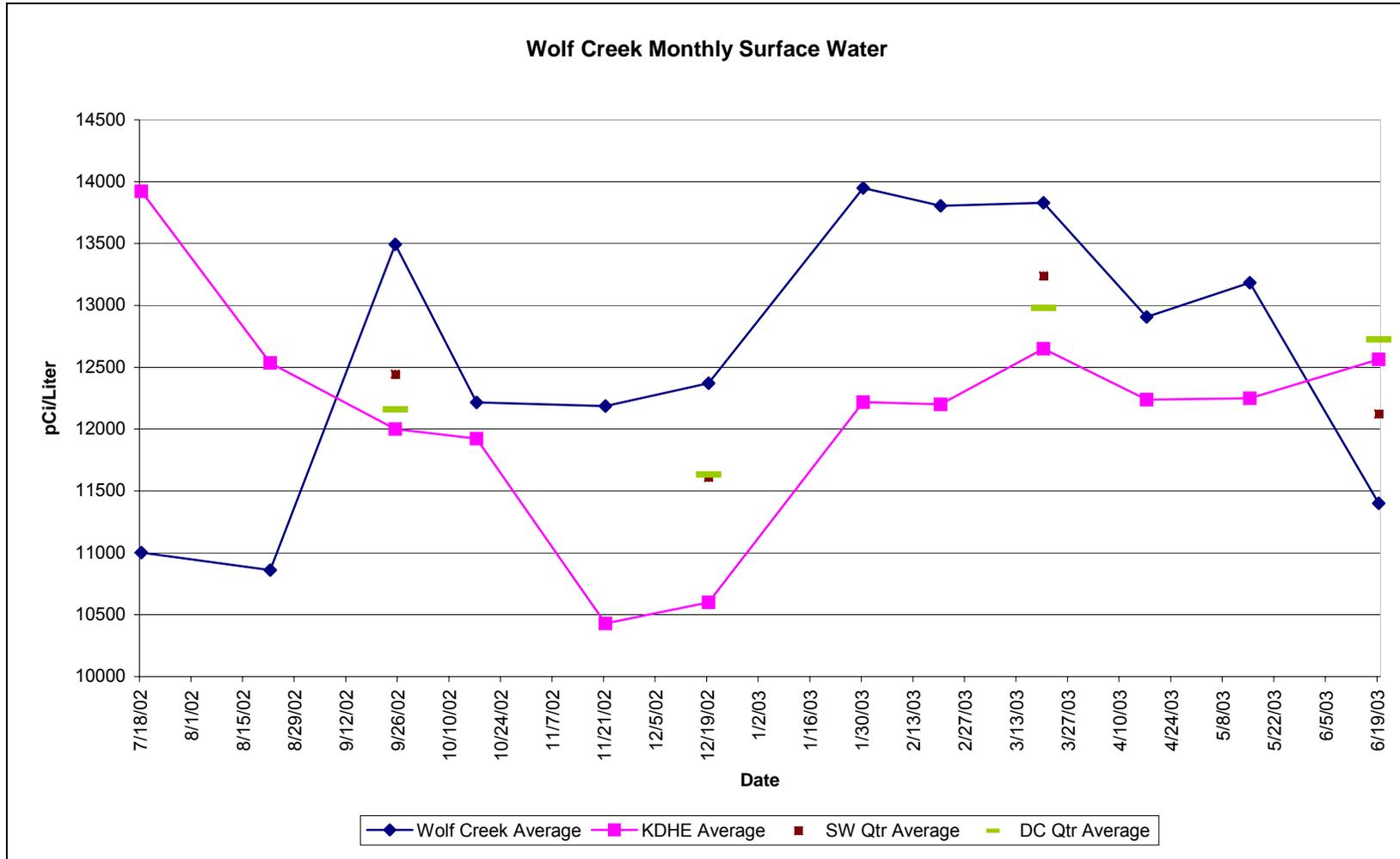


Chart 2.3 Historical Direct Radiation Monitoring Results

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**Chart 3.0** Comparison of Surface Water Tritium Levels

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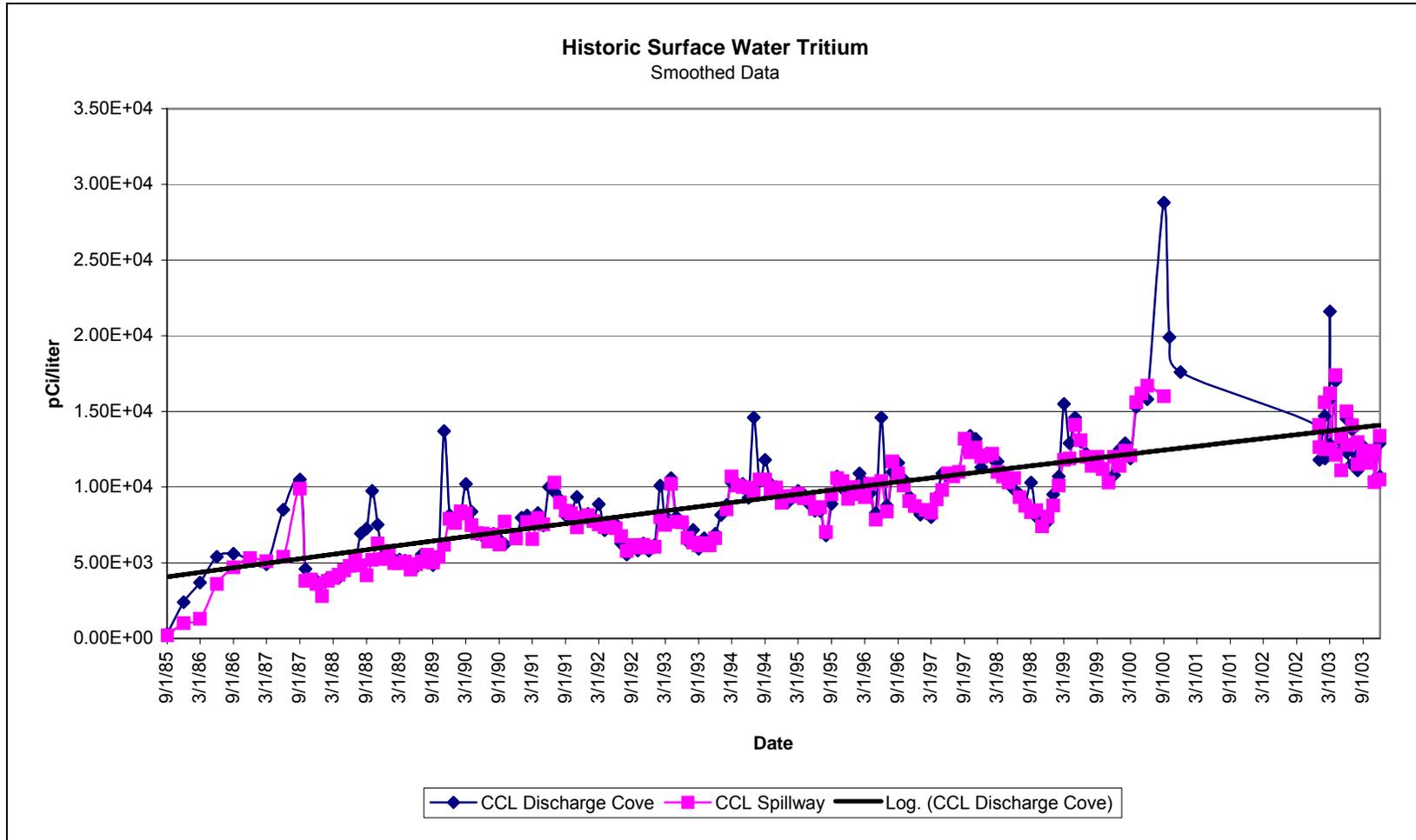


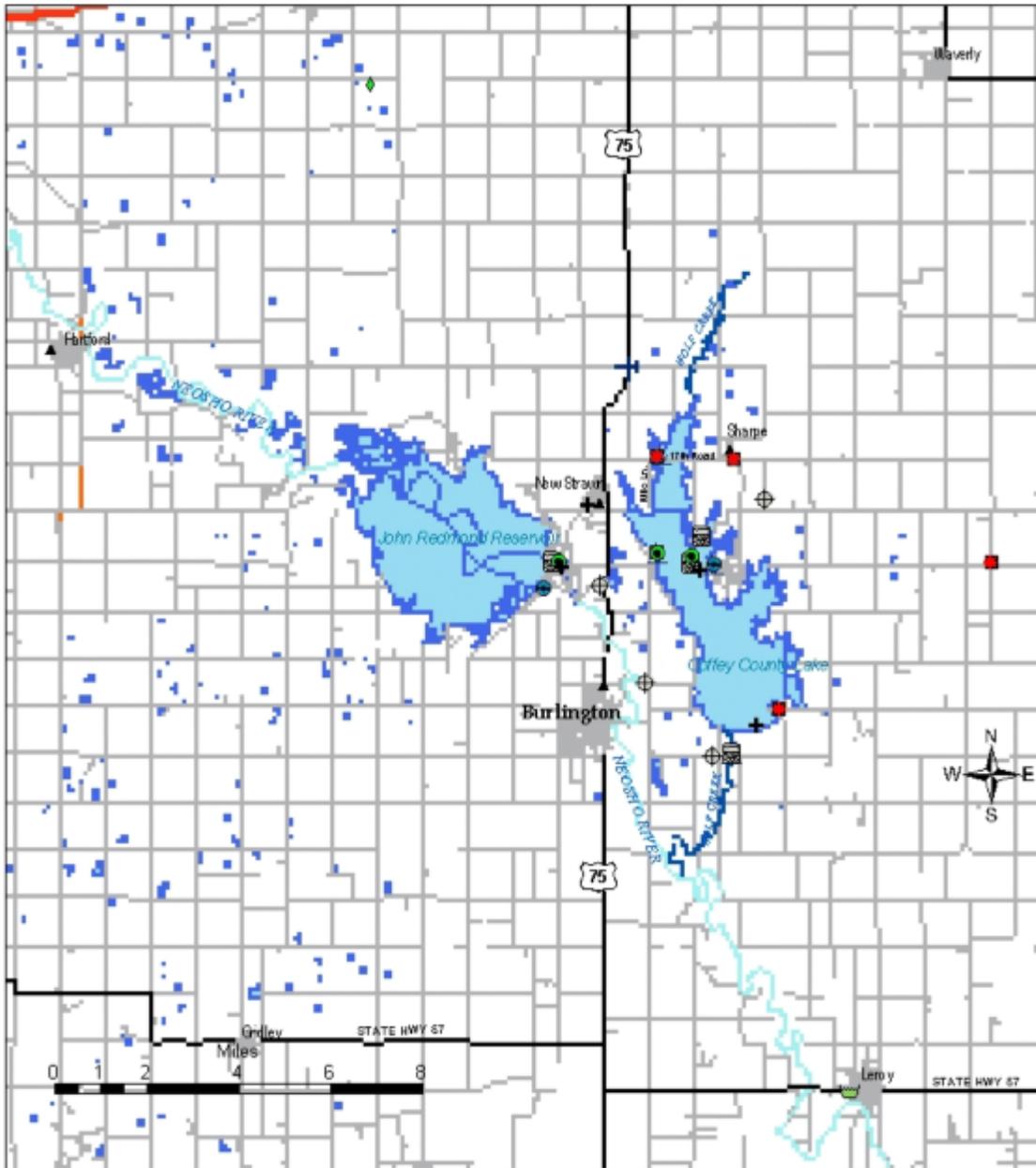
Chart 3.1 Historical Surface Water Tritium

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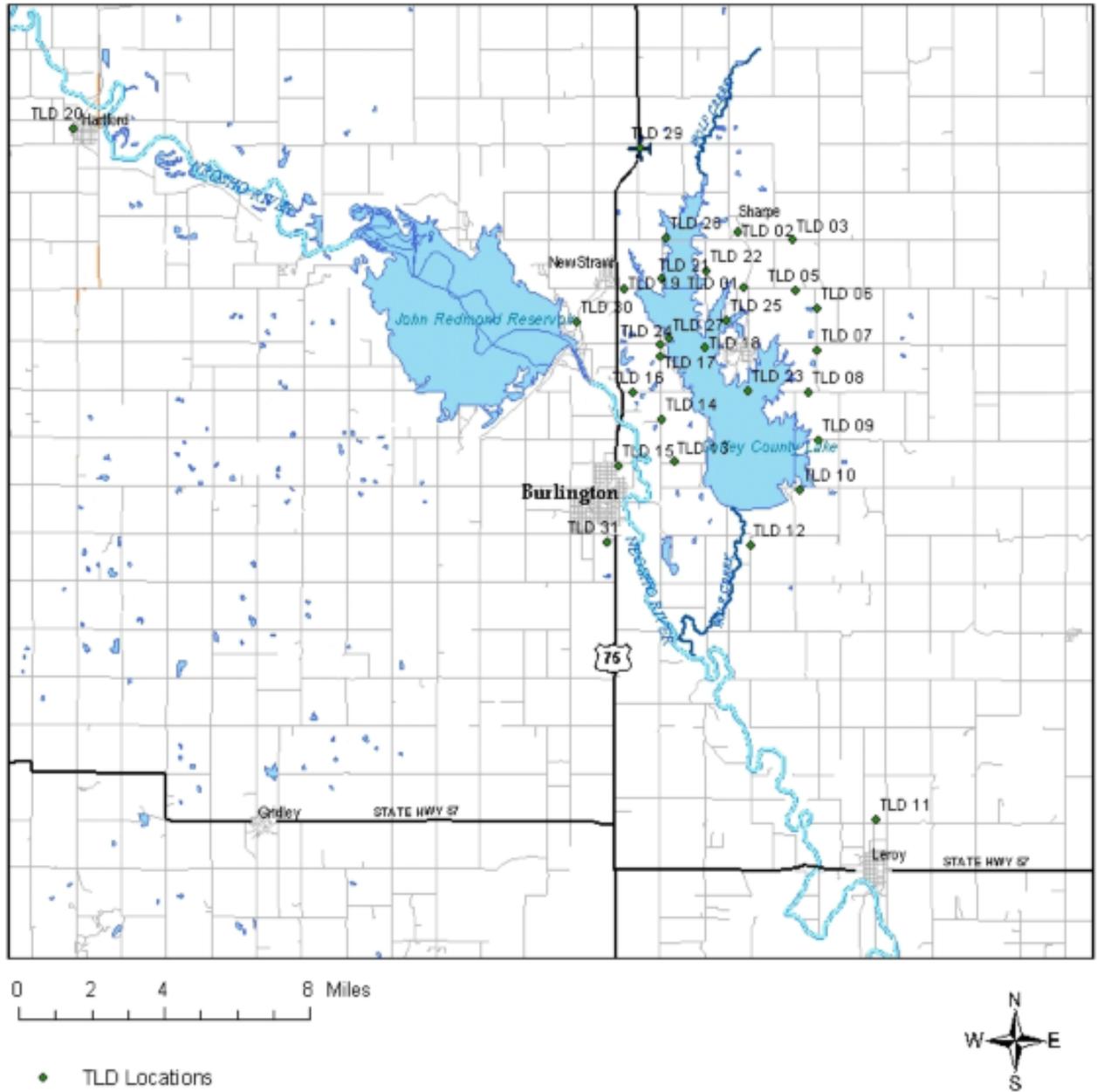


**Routine Sample Locations**

- |  |                    |  |                    |  |               |
|--|--------------------|--|--------------------|--|---------------|
|  | Aquatic Vegetation |  | Drinking Water     |  | Ground Water  |
|  | Air Monitor        |  | Fish               |  | Milk          |
|  | Bottom Sediment    |  | Vegetation         |  | Soil          |
|  |                    |  | Shoreline Sediment |  | Surface Water |

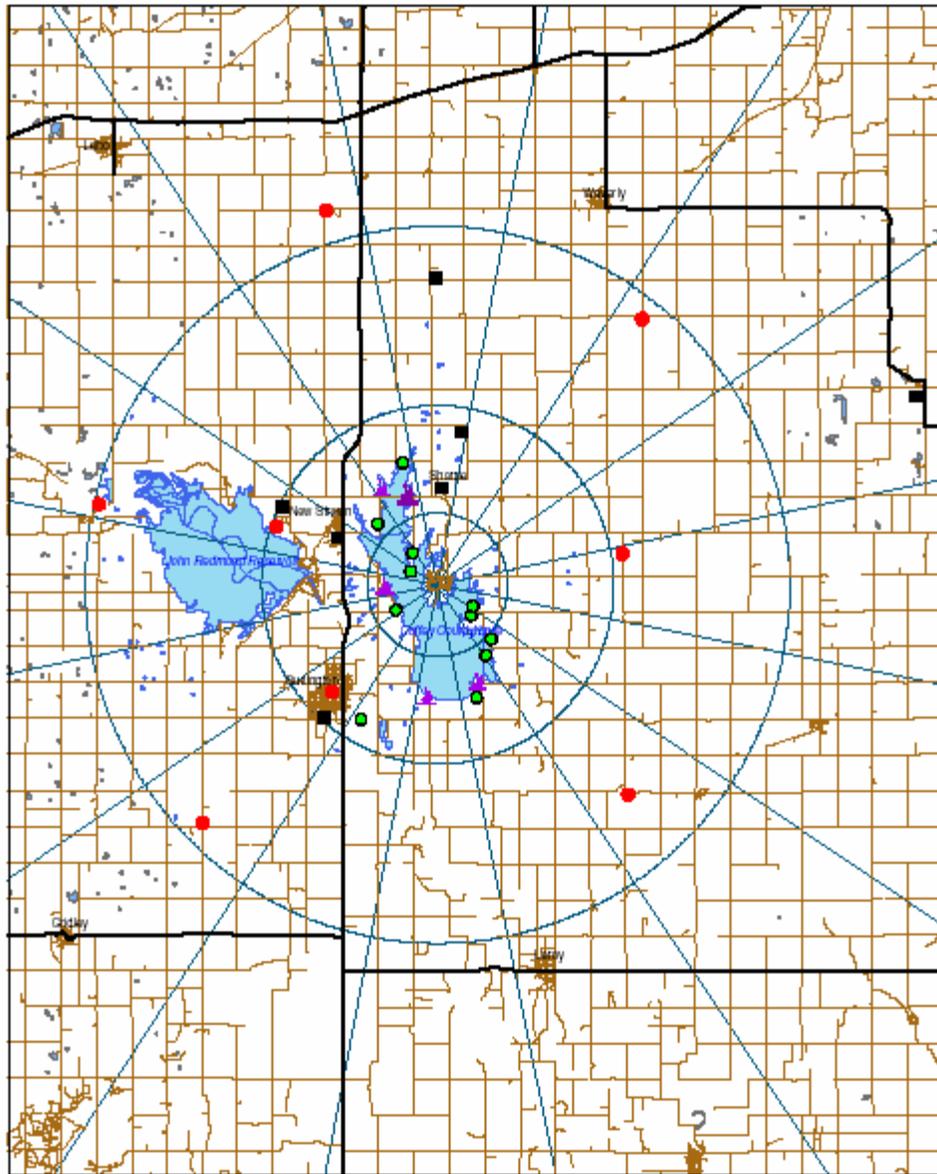
Map 1.0 Routine Sample Locations

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Map 2.0 KDHE TLD Locations

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**Random Sample Locations**



- Vegetation
- Soil
- Shoreline Sediment
- ▲ Aquatic Vegetation

Map 3.0 Random Sample Locations