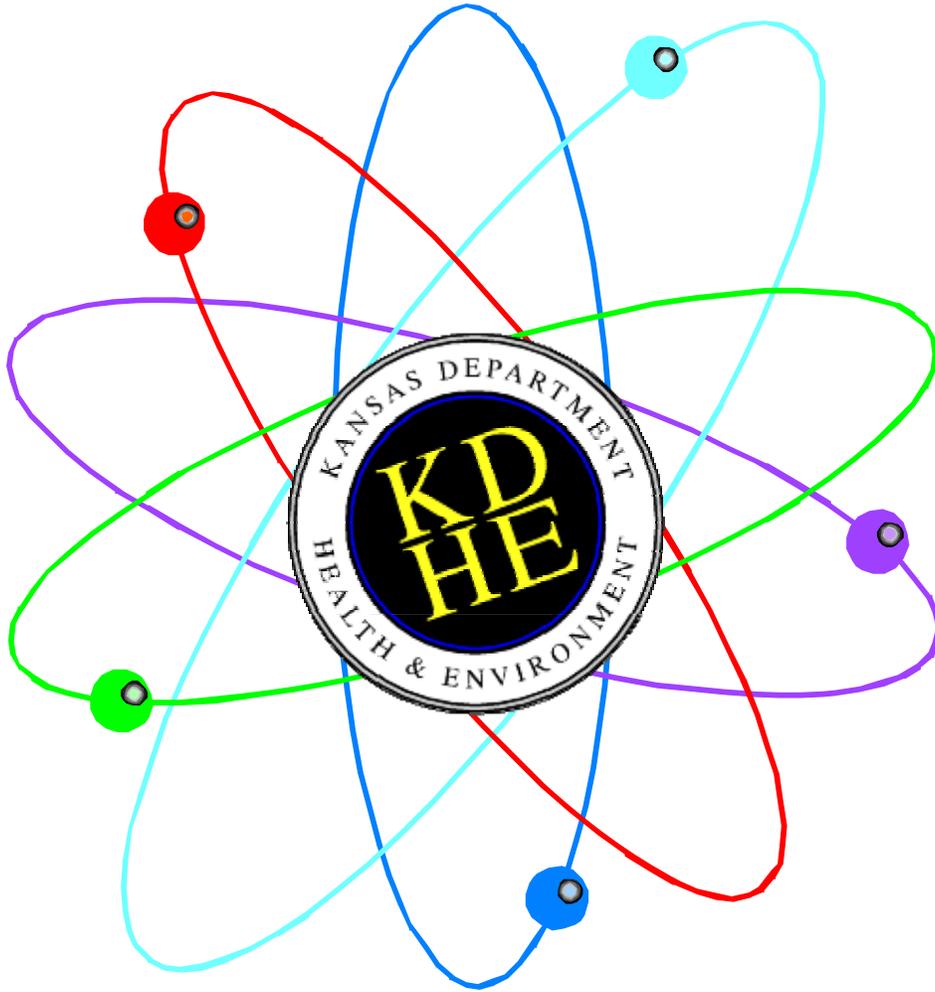


**Kansas Department of Health and Environment**  
Report of Radiological Environmental Monitoring of the Environs Surrounding  
**Wolf Creek Generating Station**



**July 2004-June 2005**  
**Division of Environment, Bureau of Air and Radiation**  
Radiation and Asbestos Control Section  
1000 SW Jackson St., Suite 310  
Topeka, Kansas 66612-1366

## 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, 2004 through June 30, 2005.

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 September 1985. The ERS program parallels (and partially overlaps) the WCNOC Radiological 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 2003 improvements in the efficiency and the quality of the program were identified. As a result, in July 2003 a revised program was approved and implemented by KDHE. The changes involved replacement of the Victoreen axial bulb thermoluminescent dosimeters for direct radiation monitoring with optically stimulated luminescence dosimetry obtained on contract from Landauer, Inc. 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.

The ERS program includes the following monitoring methods:

- Measurement of ambient external radiation levels using optically stimulated luminescence dosimetry
- 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.

A tabular summary of the WCGS environmental radiation surveillance program conducted during SFY 2005 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 OSLDs were processed by Landauer, Inc. under contract.

Wolf Creek Environmental Management 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, three 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, 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  $^{131}\text{I}$ ). 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 performed on two composite samples, one composed of the five particulate filters and the other of the five charcoal cartridges. Indication of  $^{131}\text{I}$  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 Landauer Luxel OSLDs. OSLDs are read by Landauer. OSLD readings are corrected for transit and handling exposure.

Thirty-one locations around the WCGS are monitored by KDHE, including three control locations greater than ten miles from WCGS. Two OSLDs are 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 TLDs and OSLDs quarterly. KDHE has collocated OSLDs with WCNOG at twelve 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 from John Redmond Reservoir. One sample is collected from the Coffey County Lake, monthly at the spillway. Samples are collected from the Neosho River near Leroy and the public fishing area on CCL, near the Makeup Discharge Structure (MUDS). 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. Samples are split with WCNOG.

## **Ground water**

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

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

## **Milk**

Milk samples were collected 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.

## **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 WCNOG.

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 WCNOG. Random soil samples were collected at 12 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 WCNOG. Fish collected at John Redmond Reservoir on the Neosho River are used for control samples. Sixteen fish for a total of ten species 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. No samples were available during SFY 2005.

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. 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 performed on all aquatic vegetation samples.

## **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 (pCi/m<sup>3</sup>), 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 μGy or 10<sup>-5</sup> 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 2005. Radionuclides detected in the environment surrounding WCGS during SFY 2005 include <sup>228</sup>Ac, <sup>7</sup>Be, <sup>60</sup>Co, <sup>137</sup>Cs, <sup>3</sup>H, <sup>40</sup>K, <sup>226</sup>Ra, <sup>125</sup>Sb and <sup>228</sup>Th. The isotopes <sup>228</sup>Ac, <sup>7</sup>Be, <sup>40</sup>K, <sup>226</sup>Ra, and <sup>228</sup>Th are naturally occurring radionuclides common in the environment. The isotopes <sup>137</sup>Cs and <sup>3</sup>H are fission products from WCGS nuclear reactor operation. The isotopes <sup>60</sup>Co and <sup>125</sup>Sb are activation products, also the result of WCGS nuclear reactor operation. A small background component of the <sup>3</sup>H (half-life = 12.3 y) and <sup>137</sup>Cs (half-life = 30.1 y) activity is attributable to previous nuclear weapons tests. Small amounts of <sup>3</sup>H are also produced naturally from cosmic ray interactions with water vapor in the upper atmosphere. Background levels of <sup>137</sup>Cs and <sup>3</sup>H are accounted for in control samples and in preoperational data. The fission and activation product

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

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 2005 was 17,737 pCi/l in February 2005. This maximum Coffey County Lake  $^3\text{H}$  concentration is 90% 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 2005 was 14,925 pCi/l, or 75% of 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 2005 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. Five trending samples and six random samples were analyzed.

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 2005 was 316 pCi/kg-dry  $^{137}\text{Cs}$  found at the EEA (WCBS-AR-1). The highest activation product activity observed during SFY 2005 was 264 pCi/kg-dry  $^{60}\text{Co}$ , also at the EEA. Seven trending samples and 17 random samples were analyzed.

Airborne sample analysis indicated that no radionuclides attributable to the operation of WCGS were present above the lower limits of detection during SFY 2005.

Sample analysis of terrestrial vegetation, soil, milk, grain, and vegetable samples collected in the environs of WCGS during SFY 2005 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 2005. Sample analysis of edible fish portions collected in the environs of WCGS during SFY 2005 indicated that no gamma emitters attributable to WCGS operation were present. Five edible fish samples collected during SFY 2005 were analyzed for  $^3\text{H}$  in tissue (fat and water). The highest  $^3\text{H}$  concentration in tissue was 13,949 pCi/kg-wet found in a white bass sample taken at the CCL Discharge Cove. Using an ICRP 30 dose conversion factor for ingestion ( $h_{E,50}$ ) of  $6.40 \times 10^{-8}$  mrem per pCi  $^3\text{H}$  ingested, a standard man consuming 21 kg/y of fish containing 66,589 pCi/kg  $^3\text{H}$  would receive a committed effective dose equivalent of 0.019 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, although the average OSLD readings were significantly lower than past KDHE and concurrent WCNOG TLD results. The grand yearly average of all sites was 54 mR/y,

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

corresponding to 6.5  $\mu\text{R}/\text{h}$ . KDHE will employ side by side TLDs for comparison at selected locations to determine if OSLD usage should be continued. 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 to 2. A summary of comparison data may be found in Table III. Data tables and maps are also attached.

**Table 1.** ERS Program summary report for SFY 2005

Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

Type of Sample	Number of Sampling Stations	Total Samples Collected
Air (particulate and iodine)	5	520
Direct Radiation	31	248
Surface Water	5	49
Ground Water	3	3
Sediments	4	7
Random Sediments	17	17
Milk	1	4
Aquatic Vegetation	5	5
Random Aquatic Vegetation	6	6
Fish	2	16
Game Animals/Domestic Meat	0	0
Soil	5	5
Random Soil	12	12
Terrestrial Vegetation	8	9
Random Terrestrial Vegetation	12	12
Total	116	913

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**Table II ERS Summary Statistics SFY 2005**

Description	Average	Standard deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR per 90 day quarter	25.3	5.5	0.5	15.0	35.2	124
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)	<350	*	*	<350	<350	12
Coffey County Lake (J1A/SP)	14925	501	151	10661	17737	12
Coffey County Lake (MUDS)	14781	496	143	10174	18071	11
Neosho River Near Leroy	<350	*	*	<350	<350	11
Ponds surrounding WCGS	<350	*	*	<350	<350	1
Ground water tritium ( <sup>3</sup> H), pCi/l (All Stations)	<350	*	*	<350	<350	3
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, 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	316 ± 18 <sup>137</sup> Cs (gamma)					
Coffey County Lake fish, wet	White Bass: 13949 ± 2081 <sup>3</sup> H (beta)					

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE III. ERS program data comparison<sup>a</sup> summary statistics SFY 2005.**

Description	Average	Standard Deviation	Standard error of the mean	Min	Max	N
TLD direct radiation, mR <sup>b</sup>	<u>25.1</u> (19.9)	<u>5.3</u> (2.5)	<u>0.8</u> (0.7)	<u>15.0</u> (14.7)	<u>35.5</u> (25.1)	48(48)
Airborne particulate filter and charcoal cartridge gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Environmental, Inc.) 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	Gamma isotopic analysis by both KDHE and WCNO (Environmental, Inc.) indicated 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.					
CCL <sup>c</sup> spillway, J-1A (SP)	14925 (13955)	501 (331)	151(100)	10661 (10697)	17737 (15907)	12
JRR <sup>d</sup> below dam (control), N-1 (MUSH)	<350 (<169)	*	*	*	*	12
Ground water <sup>3</sup> H, pCi/l	<350 (<167)	*	*	*	*	3
Surface and ground water gamma isotopic analysis	Gamma isotopic analysis by both KDHE and WCNO (Environmental, Inc.) indicated 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 Random Sample, 259 ± 17 <sup>137</sup> Cs (gamma)					
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 White Bass 13949 ± 2081 (7867 ± 206 <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.					
Soil, terrestrial vegetation	Gamma isotopic analysis by both KDHE and WCNO (Environmental, Inc.) indicated that no comparable gamma emitters attributable to Wolf Creek Generating Station operation were present above the lower limits of detection in any soil, shoreline sediments or terrestrial vegetation sample evaluated.					

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

<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.

Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

**Table IV** Data comparison summary by selected analysis SFY 2005

Analysis	Average Ratio of KDHE results to WCNOC results <sup>a</sup>	Comments
TLD Direct Radiation	0.65 N=48	12 collocated sites.
Surface Water <sup>3</sup> H	1.08 N=12	Coffey County lake spillway
Bottom sediment gamma isotopic	1.28 N=7	Comparison of <sup>137</sup> Cs results
Fish tritium ( <sup>3</sup> H) in tissue	1.4 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. Rejected results not compared.

<sup>a</sup> KDHE/WCNOC

Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

**DATA TABLES**

		<u>PAGE</u>
1.0	WEEKLY AIR PARTICULATE.....	15
2.0	QUARTERLY DIRECT RADIATION MONITORING.....	15
2.1	COLLOCATED QUARTERLY DIRECT RADIATION MONITORING.....	16
3.0	MONTHLY SURFACE WATER.....	17
4.0	ANNUAL SURFACE WATER (PONDS).....	17
5.0	ANNUAL GROUND WATER.....	18
6.0	SOIL.....	18
6.1	RANDOM SOIL.....	19
7.0	MILK.....	19
8.0	BOTTOM SEDIMENT.....	20
8.1	RANDOM BOTTOM SEDIMENT.....	20
9.0	SHORELINE SEDIMENT.....	21
9.1	RANDOM SHORELINE SEDIMENT.....	21
10.0	FISH.....	22
11.0	AQUATIC VEGETATION.....	22
11.1	RANDOM AQUATIC VEGETATION.....	23
12.0	TERRESTRIAL VEGETATION .....	24
12.1	RANDOM TERRESTRIAL VEGETATION. ....	25
13.0	KDHE RADIOCHEMISTRY LABORATORY EPA INTERCOMPARISON STUDIES.....	26
14.0	KDHE RADIOCHEMISTRY LABORATORY METHOD DETECTION LIMIT.....	27
15.0	WCNOC LOWER LIMIT OF DETECTION VALUES .....	29

**TABLE 1.0 Weekly Air Particulate/Iodine Monitoring**

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

Number of Samples	Average <sup>7</sup> Be Concentration	Average Iodine Concentration
52	0.11 ± 0.01	<0.03

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. **No radionuclides attributable to WCGS operation were detected.** See Map #1.0 for sample locations.

**TABLE 2.0** Wolf Creek quarterly **direct radiation** monitoring SFY 2005. Direct radiation monitoring results in mR. Exposures are normalized to a 90-day quarter. Results are expressed as the average of two OSLD readings per location. WCNOG 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	23.5	24.1	26.4	34.0
2. A-2, Sharpe	23.0	20.1	27.9	31.5
3. A-3, Forward Staging Area	19.5	19.1	27.4	30.0
4. B-1, East Sharpe	20.5	24.1	27.4	34.5
<b>5. B-2, Waverly Control</b>	22.0	22.1	28.4	34.5
6. C-1, near residence	21.0	20.1	26.9	28.0
7. D-1 (9), near residence	20.0	20.6	27.9	33.0
8. E-1, near residence	23.5	23.1	31.9	33.5
9. F-1, near residence	26.0	23.1	27.9	33.0
10. G-1 (14), WCNOG gate	19.5	22.1	30.4	35.5
11. H-0 (42), CCL baffle dike A	16.0	16.1	24.9	25.0
12. H-1, east of CCL dam	23.0	18.6	28.4	34.5
<b>13. H-2, LeRoy control</b>	23.0	20.6	26.9	34.5
14. J-1, near residence	20.0	20.6	28.9	31.0
15. K-1 (29), near residence	15.0	17.6	26.4	29.5
16. L-1 (27), near residence	18.0	22.6	25.9	33.5
17. L-2, Burlington	20.0	20.1	28.9	31.0
18. L-3, Coffey County Shop	19.5	20.6	27.9	29.5
19. M-1 (26), near residence	19.5	19.6	27.9	30.5
20. N-1, near pasture	23.0	22.6	28.4	33.5
21. P-0 (43), CCL baffle dike B	15.0	15.1	23.4	21.0
22. P-1, New Strawn	17.5	20.6	28.9	29.0
<b>23. P-2, Hartford Control</b>	18.0	20.6	28.4	32.0
24. P-3, CCL entrance	24.0	23.6	30.4	33.0
25. P-4 (46), CCL near MUDS	20.5	21.1	30.4	32.0
26. P-5, JRR public use area	18.5	22.6	29.4	32.0
27. Q-1, near residence	23.5	21.6	28.4	31.0
28. R-0 (41), Stringtown cemetery	19.5	23.6	29.9	33.5
29. R-1 (37), near residence	20.5	20.1	26.4	35.5
30. R-2 (44), CCL EEA	22.0	21.1	30.9	32.5
31. R-3, near Coffey County Airport	18.5	20.6	30.4	34.5

**TABLE 2.1** Wolf Creek collocated quarterly **direct radiation** monitoring SFY 2005. Direct radiation monitoring results in mR. WCNOG results are expressed as normalized 90-day quarter average ± two standard deviations of two dosimeters at each location (two TLD chips per badge are used for data evaluation). KDHE results are expressed as a normalized 90-day quarter average of two OSLDs at each location.

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

Location KDHE (WCNOC)	KDHE Monitoring period	KDHE	WCNOC
1. A-1 (1)	7/7/04-10/5/04	23.5	23.5 ± 1.3
	10/5/04-1/12/05	24.1	22.1 ± 1.4
	1/12/05-4/8/05	26.4	19.6 ± 0.9
	4/8/05-7/7/05	34.0	25.1 ± 2.8
2. D-1 (9)	7/7/04-10/5/04	20.0	19.7 ± 0.9
	10/5/04-1/12/05	20.6	21.5 ± 1.5
	1/12/05-4/8/05	27.9	18.1 ± 1.8
	4/8/05-7/7/05	33.0	20.2 ± 1.2
3. G-1 (14)	7/7/04-10/5/04	19.5	22.8 ± 1.5
	10/5/04-1/12/05	22.1	24.6 ± 2.1
	1/12/05-4/8/05	30.4	19.9 ± 2.5
	4/8/05-7/7/05	35.5	20.4 ± 0.3
4. H-0 (42)	7/7/04-10/5/04	16.0	16.2 ± 1.0
	10/5/04-1/12/05	16.1	16.2 ± 1.2
	1/12/05-4/8/05	24.9	13.7 ± 0.9
	4/8/05-7/7/05	25.0	17.3 ± 2.9
5. K-1 (29)	7/7/04-10/5/04	15.0	19.1 ± 0.5
	10/5/04-1/12/05	17.6	18.5 ± 1.1
	1/12/05-4/8/05	26.4	16.3 ± 1.0
	4/8/05-7/7/05	29.5	17.0 ± 0.6
6. L-1 (27)	7/7/04-10/5/04	18.0	22.5 ± 1.1
	10/5/04-1/12/05	22.6	21.4 ± 1.2
	1/12/05-4/8/05	25.9	19.0 ± 1.8
	4/8/05-7/7/05	33.5	20.8 ± 0.8
7. M-1 (26)	7/7/04-10/5/04	19.5	20.4 ± 0.9
	10/5/04-1/12/05	19.6	22.2 ± 4.5
	1/12/05-4/8/05	27.9	17.4 ± 1.0
	4/8/05-7/7/05	30.5	19.2 ± 2.2
8. P-0 (43)	7/7/04-10/5/04	15.0	15.3 ± 1
	10/5/04-1/12/05	15.1	15.3 ± 0.6
	1/12/05-4/8/05	23.4	14.8 ± 3.7
	4/8/05-7/7/05	21.0	14.7 ± 2.2
9. P-4 (46)	7/7/04-10/5/04	20.5	21.9 ± 1.7
	10/5/04-1/12/05	21.1	23.3 ± 3.2
	1/12/05-4/8/05	30.4	19.0 ± 0.9
	4/8/05-7/7/05	32.0	19.8 ± 1.0
10. R-0 (41)	7/7/04-10/5/04	19.5	22.8 ± 1.3
	10/5/04-1/12/05	23.6	21.8 ± 1.7
	1/12/05-4/8/05	29.9	20.6 ± 2.5
	4/8/05-7/7/05	33.5	21.2 ± 1.9
11. R-1 (37)	7/7/04-10/5/04	20.5	20.9 ± 0.6
	10/5/04-1/12/05	20.1	20.5 ± 1.2
	1/12/05-4/8/05	26.4	18.3 ± 1.5
	4/8/05-7/7/05	35.5	20.1 ± 0.6
12. R-2 (44)	7/7/04-10/5/04	22.0	21.6 ± 2
	10/5/04-1/12/05	21.1	21 ± 0.9
	1/12/05-4/8/05	30.9	19.0 ± 1.0
	4/8/05-7/7/05	32.5	19.8 ± 1.0

**TABLE 3.0** Wolf Creek monthly duplicate samples for waterborne radionuclides in **surface water** SFY 2005. Gamma isotopic analyses by both KDHE and WCNOC 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).

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

Date	J-1A (Spillway)		N-1 (JRR/MUSH) Control		P-1 MUDS	H-1 Neosho R.	
	KDHE	WCNOC	KDHE	WCNOC			
7/14/2004	10661± 504	10697 ± 296	<350	<159	7/21/2004	13769 ± 618	<350
8/12/2004	10801± 501	11547 ± 312	<350	<169	8/12/2004	11211 ± 506	<350
9/23/2004	12464± 504	13197 ± 327	<350	<162	9/8/2004	12239 ± 499	<350
10/14/2004	15713 ±491	14368 ± 340	<350	<162	10/27/2004	14946 ± 476	<350
11/12/2004	15695 ± 485	14745 ± 346	<350	<167	11/23/2004	16319 ± 503	<350
12/1/2004	15751± 496	13429 ± 331	<350	<164	12/28/2004	17593 ± 542	<350
1/13/2005	17226± 533	13878 ± 334	<350	<164	1/31/2005	17890 ± 524	<350
2/10/2005	17737± 523	15907 ± 354	<350	<166	2/25/2005	18071 ± 525	<350
3/10/2005	17718± 523	14970 ± 332	<350	<147	3/30/2005	15749 ± 466	<350
4/21/2005	15428±463	15313 ± 336	<350	<139	5/31/2005	14631 ± 458	<350
5/12/2005	15608± 472	15289 ± 335	<350	<140	6/23/2003	10174 ± 399	<350
6/9/2005	14303±454	14119 ± 336	<350	<169			

**TABLE 4.0** Wolf Creek annual samples for deposition of airborne radionuclides on **surface water (PONDS)** SFY 2005. 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. WCNOC sample location designations are denoted by parenthesis. *No radionuclides attributable to WCNOC operations were found above method detection limits.*

Location	Date	Tritium ( <sup>3</sup> H)
P-1, New Strawn City Lake	9/8/04	<350

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 5.0** Wolf Creek Annual samples for waterborne radionuclides in **ground water** SFY 2005. 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 radionuclides attributable to WCNOG operations were found above method detection limits.* See Map #1.0 for sample locations.

Date	L-1 (L49)	N-1 (C-10)	B-1 (B-12)
	KDHE (WCNOG)	KDHE (WCNOG)	KDHE (WCNOG)
	TRITIUM ( <sup>3</sup> H)		
11/17/04	<350 (<167)	<350 (<167)	<350 (<167)
	ALPHA + BETA		
11/17/04	14 ± 3.1	6 ± 3.0	6 ± 2.9

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

**TABLE 6.0** ERS annual samples for airborne radionuclide deposition on **soil** SFY 2005. 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 radionuclides attributable to WCNOG operations were observed above method detection limits.**

Isotope	A-1 Sector A Sharpe KDHE 7/20/04 0.5m <sup>2</sup>	E-1 Scott Valley Church (Control) 4/5/05 0.5m <sup>2</sup>	H-1 East of CCL Dam Near HCA H-1 4/5/05 0.5m <sup>2</sup>
<sup>228</sup> Ac*	1645 ± 40	1231 ± 31	1193 ± 34
<sup>137</sup> Cs	Not Detected	415 ± 23	536 ± 29
<sup>40</sup> K*	14696 ± 21.6	11851 ± 600	12215 ± 632
	P-1 (MUDS) 6/7/05 KDHE (WCNOG)	R-1 EEA 5/16/05 KDHE	
<sup>228</sup> Ac*	710 ± 23 (N/A)	1098 ± 24 (N/A)	
<sup>137</sup> Cs	20 ± 4 (<34.8)	485 ± 24 (557.5 ± 63.4)	
<sup>40</sup> K*	8208 ± 428 (9282.4 ± 926.0 )	11202 ± 556(11095.0 ± 962.8)	

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 6.1** ERS random samples for airborne radionuclide deposition in soil SFY 2005. 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 WCNO operations were found above method detection limits. See Map #7.0 for locations.

Location	Date	Isotope		
		<sup>137</sup> Cs	<sup>40</sup> K	
WCRS-1-N-278-9.8	16th & Fauna	7/12/2004	706 ± 33	15063 ± 711
WCRS-5-K-214-4.3	Kelley Park Burlington	9/1/2004	Not Detected	12654 ± 593
WCRS-4-N-267-3.4	Near JRR Dam	9/1/2004	43 ± 6	11744 ± 569
WCRS-1-K-201-5.0	10th and Native	12/3/2004	Not Detected	11103 ± 557
WCRS-1-R-333-3.9	18th and Native Rd	12/3/2004	275 ± 23	10586 ± 701
WCRS-1-H-153-6.2	9th and Shetland	12/3/2004	104 ± 8	15101 ± 710
WCRS-2-D-70-5.0	16th & Trefoil	2/24/2005	Not Detected	12688 ± 617
WCRS-1-C-036-1.5	Old 50 and Xeric	2/24/2005	391 ± 20	10284 ± 658
WCRS-1-M-239-1.5	14th Rd. W of CCL	3/16/2005	31 ± 6	10510 ± 747
WCRS-2-A-3-8.5	23rd Rd between Oxen and Planter	3/16/2005	13 ± 4	13358 ± 647
WCRS-1-Q-311-8.6	12 <sup>th</sup> and Wayside	5/23/2005	Not Detected	14344 ± 708
WCRS-2-L-224-6.8	10th & Kafir Rd	5/23/2005	208 ± 12	9842 ± 491

**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 2005. Sample is collected at Lebo, R-1 (Linsey Dairy). Lebo is a control location. 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 location. No isotopes attributable to WCNO operations were found above method detection limits.

Date	<sup>40</sup> K, natural KDHE
Lebo R-1 quarterly sample collection	
10/5/04	<88
12/1/04	<88
2/3/05	<88
5/31/05	<88

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 8.0** ERS annual samples for waterborne radioisotope concentration in **bottom sediments** SFY 2005. 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 11-5-04 KDHE (WCNOC)	John Redmond Reservoir <b>Control</b> 11/9/04 KDHE (WCNOC)
<sup>228</sup> Ac*	1088 ± 25(not reported)	1443 ± 46 (not reported)
<sup>137</sup> Cs	85 ± 7 (201.3 ± 34.9)	176 ± 25 (116 ± 30)
<sup>40</sup> K*	12241 ± 589 (12039 ± 723.1)	18191 ± 1108 (15269 ± 824.5)
		WCBS-AR-1 EEA 6/25/05 KDHE (WCNOC)
<sup>228</sup> Ac*		1146 ± 26 (not reported)
<sup>137</sup> Cs		78 ± 7(84 ± 50)
<sup>40</sup> K*		12873 ± 622 (12856 ± 1048)

**TABLE 8.1** Wolf Creek random samples for waterborne radioisotope concentration in **bottom sediments** SFY 2005. 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. See Map #3.0 for locations.

Location	Date	Isotope		
		<sup>137</sup> Cs	<sup>60</sup> Co	
WCRBS-7-H-166-2.9	CCL	9/27/2004	111 ± 7.5	23 ± 2.5
WCRBS-5-H-160-3.1	CCL	9/27/2004	112 ± 5.6	Not Detected
WCRBS-4-J-170-3.0	CCL	9/27/2004	147 ± 10.1	19 ± 2.8
WCRBS-1-N-269-1.5	CCL	9/27/2004	92 ± 5.7	29 ± 4
WCRBS-2-L-224-1.6	CCL	9/27/2004	13 ± 3.2	Not Detected
WCRBS-3-R-327-2.9	CCL	5/19/2005	59 ± 5.6	Not Detected
WCRBS-4-R-336-2.4	CCL	5/19/2005	103 ± 7.6	Not Detected
WCRBS-1-Q-320-2.1	CCL	5/19/2005	91 ± 6.2	16 ± 3.6
WCRBS-2-R-330-2.7	CCL	5/19/2005	Not Detected	Not Detected
WCRBS-R-1-329-1.0	CCL	5/16/2005	78 ± 6.8	Not Detected
WCBS-A-1	EEA	11/12/2004	316 ± 18	Not Detected

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 9.0** Wolf Creek annual samples for waterborne radioisotope concentration in **shoreline sediment** SFY 2005. 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	N-1 (JRR) John Redmond Reservoir (Control) 11-9-04 KDHE (WCNOC)	R-1 (EEA) Environmental Education Area 11-12-04 KDHE (WCNOC)	P-1 (MUDS) CCL Public Access Fishing Area 6-14-05 KDHE (WCNOC)
<sup>137</sup> Cs	176 ± 24.8 (<134)	19 ± 4.8	<8 (<35.9)
<sup>60</sup> Co	<11 (<12.3)	264 ± 15.4	<11 (<24.3)
<sup>40</sup> K*	8415 ± 416.9 (10666 ± 489.9)	12241 ± 589.3	11544 ± 553.3 (1805.4 ± 1065)
Isotope	Q-1 (DC) CCL Discharge Cove 11-5-04 KDHE (WCNOC)		
<sup>137</sup> Cs	176 ± 24.8 (<18.3)		
<sup>60</sup> Co	<56 (<11.3)		
<sup>40</sup> K*	8415 ± (11083.0 ± 486.8)		

**TABLE 9.1** Wolf Creek random samples for waterborne radioisotope concentration in **shoreline sediments** SFY 2005. 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-1-R-335-0.9	Stringtown Cemetery	7/27/2004	17 ± 4.4	Not Detected
WCRSS-1-H-157-3.0	E of Dam	7/27/2004	25 ± 4.7	Not Detected
WCRSS-L-1-220-4.1	Neosho River	4/5/2005	32 ± 5.4	Not Detected
WCRSS-1-K-197-6.0	Neosho River	5/10/2005	Not Detected	Not Detected
WCRSS-2-J-171-10.9	Neosho River	5/10/2005	Not Detected	Not Detected
WCRSS-1-R-340-3.0	CCL	6/24/2005	82 ± 6.5	Not Detected
WCRSS-2-J-182-4.8	Wolf Creek	6/24/2005	44 ± 5.4	Not Detected

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 10.0** Wolf Creek fish ingestion pathway duplicate samples for waterborne radioisotope bioaccumulation in fish SFY 2005. Sample results in pCi/kg-wet. Results reported at the 95% confidence level. 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  $^{239}\text{Np}$ . A Tritium ( $^3\text{H}$ ) in tissue analysis is done on all edible fish portions collected.  $^3\text{H}$  is a beta emitter. See Map #1.0 for sample locations. WCNOC sample location designations are denoted by parentheses. \*Indicates result is suspect, not included in data summaries. Tritium bioaccumulation in fish occurs at a factor of 0.9 pCi/g per pCi/L. The average CCL tritium level of 14,925 and no detectable tritium in JRR thus renders any result above MDA for fish from JRR or greater than 13,453 pCi/g for CCL fish suspect.

Location	Date	Description	$^3\text{H}$ KDHE (WCNOC)
N-1 (JRR) John Redmond Reservoir Below dam on Neosho River <b>Control</b>	11/9/04	FW Drum Channel Catfish Sm. Mouth Buffalo Common Carp	*3954 ± 1844 (<118) *5147 ± 1928 (<130) *3791 ± 2184 (<114) *4928 ± 2018 (<122)
Q-1 (DC) CCL Discharge Cove	10/22/04	Blue Catfish White Bass Sm. Mouth Buffalo Channel Catfish Wiper Lg. Mouth Buffalo Walleye	10472 ± 2145 (7678 ± 211) 13148 ± 2529 (5250 ± 164) *30765 ± 4264 (5847 ± 172) 9483 ± 2146 (7578 ± 206) 10052 ± 2227 (8660 ± 239) *20775 ± 3257 (6828 ± 209) 9283 ± 2081 (7942 ± 213)
Q-1 (DC) CCL Discharge Cove	5/27/05	Sm. Mouth Bass White Bass Channel Catfish FW Drum Common Carp	*22256 ± 2446 (8695 ± 235) 13949 ± 2081 (7867 ± 206) *66589 ± 4564 (9338 ± 257) *20939 ± 2577 (7710 ± 199) 10346 ± 2073 (9479 ± 235)

**TABLE 11.0** Wolf Creek samples for waterborne radioisotope bioaccumulation in aquatic vegetation SFY 2005. 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  $^7\text{Be}$ ,  $^{40}\text{K}$ ,  $^{51}\text{Cr}$ ,  $^{54}\text{Mn}$ ,  $^{58}\text{Co}$ ,  $^{59}\text{Fe}$ ,  $^{60}\text{Co}$ ,  $^{65}\text{Zn}$ ,  $^{67}\text{Ga}$ ,  $^{95}\text{Nb}$ ,  $^{95}\text{Zr}$ ,  $^{99}\text{Mo}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{103}\text{Ru}$ ,  $^{106}\text{Ru}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{111}\text{In}$ ,  $^{123}\text{I}$ ,  $^{125}\text{Sb}$ ,  $^{131}\text{I}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{140}\text{Ba}$ ,  $^{140}\text{La}$ ,  $^{141}\text{Ce}$ ,  $^{144}\text{Ce}$ ,  $^{169}\text{Yb}$ ,  $^{226}\text{Ra}$ ,  $^{228}\text{Ac}$ ,  $^{228}\text{Th}$ ,  $^{234}\text{Th}$ , and  $^{239}\text{Np}$ . The isotopes  $^{89}\text{Sr}$  and  $^{90}\text{Sr}$  are beta emitters. See Map #1.0 for sample location.

Location	Type	Date	$^7\text{Be}$	Isotope $^{40}\text{K}$	
WCAV-N-1	JRR Below the Dam	Cattails	6/24/05	908 ± 144	13587 ± 971
WCAV-J-1	Wolf Creek 11 <sup>th</sup> St. Bridge	Arrowhead	6/30/05	Not Detected	40253 ± 7696
WCAL-P-1	MUDS	Pondweed	6/14/05	12626 ± 913 (516.3 ± 193.3)	18857 ± 659 (2154 ± 384)
WCAV-Q-1	Coffey County Lake Discharge Cove	Algae	5/16/05	2044 ± 196	28529 ± 3010
WCAV R-1	EEA	Creeping Water Primrose	6/14/05	2848 ± 264 (1302 ± 263)	16194 ± 1412 (2517 ± 496)

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

**TABLE 11.1** Wolf Creek random samples for waterborne radioisotope bioaccumulation in **aquatic vegetation** SFY 2005. 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	<sup>40</sup> K
CCL Boat Ramps	8/31/2004	Algae	Not Detected	39356 ± 2561
0.25 mi s. of 16th near Xeric Rd	9/7/2004	Arrowhead	Not Detected	74640 ± 6368
CCL 38.20977 95.69571	9/27/2004	Pondweed	629 ± 215.8	13721 ± 2020
CCL 38.19725 95.67049	9/28/2004	Pondweed	560 ± 126.3	11815 ± 790.5
Near 11th & Quail	6/14/2005	Cattails	2021 ± 320.7	17341 ± 4152.1
CCL	6/25/2005	Cattails	1601 ± 301	17869 ± 1560

**TABLE 12.0** Wolf Creek trending samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2005. 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*

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

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)
WCFV-J-1 (NR-D2) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/6/04	Non-irrigated Corn	<100 (<112.8)	1632 ± 200 (2683 ± 376)
WCFV-J-2 (NR-D1) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/6/04	Irrigated Soybeans	<100 (<194.1)	2493 ± 81 (13737.0 ± 844.4)
WCFV-J-3 (NR-D2) Near Leroy, crops that may be irrigated with water from the Neosho River below the confluence with Wolf Creek	10/20/04	Irrigated Soybeans	<100 (<99.4)	15217±845 (15059 ± 630)
K-1 (NR-D1)	9/29/04	Non-irrigated Corn	<100 (<117.4)	13541 ± 328(2641.2 ± 370.7)
E-1 Scott Valley Church <b>Control</b>	7/20/04	Pasturage	1065 ± 152	14987 ± 987
A-1 Sector A, Sharpe/Pasture near Sharpe	7/20/04	Pasturage	8407 ± 610.9	15740 ± 1194.5
H-1 East of CCL dam, near WCA H-1	6/7/05	Pasturage	7691 ± 588.9	26105 ± 4279.8
P-1 (MUDS) CCL public access area, north side of parking lot, 10 m from shore	6/7/05	Plums	<100 (<111.5)	13230 ± 666.8 (2769 ± 303)
R-1 (EEA) CCL environmental education area	5/16/05	Pasturage	4187 ± 426 (868 ± 227)	27871 ± 4829.4 (7677 ± 471)

**TABLE 12.1** ERS random samples for airborne radionuclide deposition on **terrestrial vegetation** SFY 2005. Includes ingestion pathway sampling of garden vegetables. Sample results in pCi/kg-dry. Results reported at the 95% confidence level. *No isotopes attributable to*

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

WCNOC operation were found above method detection limits. 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  $^{239}\text{Np}$ . The isotopes  $^{89}\text{Sr}$  and  $^{90}\text{Sr}$  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	
			$^7\text{Be}$	$^{40}\text{K}$
12th & Reaper	7/20/2004	Brome hay	12461 ± 893.5	10080 ± 1349.7
6th & Juneberry	7/12/2004	Pasturage	6755 ± 522.7	12411 ± 1041
10th & Garner	8/31/2004	Red Milo	377 ± 75.4	3174 ± 602.1
17th & Quail	8/31/2004	Corn (Cob)	Not Detected	4190 ± 242.6
Near Kafir 0.5 mi. S of 17th	9/7/2004	Soybeans	1770 ± 277.4	19488 ± 1392
21st & Shetland Rd.	9/7/2004	White Milo	422 ± 94	3414 ± 760.4
1 mi. S. of CCL dam	9/24/2004	Pasturage	Not Detected	2663 ± 181.2
21st and Lynx	5/23/2005	Pasturage	2770 ± 270.2	19717 ± 1345.8
12th & Iris	5/23/2005	Pasturage	3824 ± 350.2	19348 ± 3449.3
Sharpe near air sampler	5/10/2005	pasturage	3194 ± 332.1	18578 ± 3561.5
17th & Wayside	6/9/2005	Wheat	1804 ± 151.5	3134 ± 1023.4
S. Burlington Residence	6/14/2005	Mint	8143 ± 693.8	16052 ± 1742.9

**Table 13.0** KDHE RADIOCHEMISTRY LABORATORY EPA INTERCOMPARISON STUDIES

Analysis	Date	Known Value ±	Expected	KHEL Average
----------	------	---------------	----------	--------------

Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

		Control Limit (pCi/l)	Precision	Results ± Uncertainty
Gross Alpha	8-17-04	57.0 ± 24.7	14.3	62.1 ± 1.1
	2-15-05	67.9 ± 30.3	17.0	71.8 ± 2.2
	5-17-05	37.0 ± 16.0	9.3	36.2 ± 2.0
Gross Beta	8-17-04	20.0 ± 8.7	5.0	19.8 ± 0.4
	2-15-05	51.1 ± 17.3	10.0	44.8 ± 1.6
	5-17-05	34.2 ± 8.7	5.0	19.8 ± 0.4
Tritium	11-15-04	20700 ± 3600	2070	21400 ± 177
	2-15-05	30200 ± 5200	3020	30600 ± 406
<sup>89</sup> Sr	2-15-05	29.4 ± 8.7	5.0	31.1 ± 2.1
	5-17-05	41.3 ± 8.7	5.0	44.6 ± 1.2
<sup>90</sup> Sr	2-15-05	24.4 ± 8.7	5.0	18.9 ± 0.4
	5-17-05	5.92 ± 8.7	5.0	5.33 ± 0.21
<sup>60</sup> Co	8-17-04	24.0 ± 8.7	5.0	24.7 ± 0.3
	11-15-04	11.7 ± 8.7	5.0	11.3 ± 0.5
	2-15-05	56.6 ± 8.7	5.0	55.3 ± 0.6
<sup>134</sup> Cs	8-17-04	24.0 ± 8.7	5.0	24.7 ± 0.3
	11-15-04	11.7 ± 8.7	5.0	11.3 ± 0.5
	2-15-05	56.6 ± 8.7	5.0	55.3 ± 0.6
± 1.8	8-17-04	193 ± 17	9.7	192 ± 3
	11-15-04	60.1 ± 8.7	5.0	63.4 ± 1.1
	2-15-05	64.9 ± 8.7	5.0	58.0
<sup>133</sup> Ba	8-17-04	193 ± 17	9.7	192 ± 3
	11-15-04	78.4 ± 13.6	7.8	84.6 ± 1.2
	2-15-05	53.4 ± 9.2	5.3	51.6 ± 1.0
<sup>65</sup> Zn	8-17-04	143 ± 25	14.3	142 ± 1.5
	11-15-04	50.9 ± 8.7	5.1	54.8 ± 3.2
	2-15-05	161 ± 28	16.1	168 ± 2.2
<sup>131</sup> I	8-17-05	9.29 ± 3.51	2.0	9.60 ± 0.4
	2-15-05	28.6 ± 5.2	3.0	29.3 ± 0.2
	5-17-05	15.5 ± 5.2	3.0	16.0

**TABLE 14.0** KHEL Radiochemistry Laboratory method detection limits SFY 2005. 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).

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

**GeLi [HPGe] detection system <sup>a</sup>**

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>.

**Table 14.0 continued.** KHEL Radiochemistry Laboratory method detection limits SFY 2005. Method detection limits of present analytical methods for selected radionuclides monitored by the KHEL Radiochemistry Laboratory. These limits are

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

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
Minimum Sample Size	200 ml		250 m <sup>3</sup>		Total
Minimum Counting Time	200 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	

**Table 15.0** Lower limit of detection (LLD) values for selected radionuclides for Wolf Creek environmental sample analysis<sup>a</sup>.

Analysis	Water	Airborne	Fish	Milk	Food	Sediment	Aquatic

**Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005**

	(pCi/l)	(pCi/m <sup>3</sup> )	(pCi/kg-wet)	(pCi/l)	Products <sup>b</sup> (pCi/kg-wet)	(pCi/kg-dry)	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 WCNO'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

$$LLD = 2.10x \left[ \frac{S_b}{E V Y \exp(-\lambda \Delta t)} \right]$$

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<sup>-1</sup>), 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.

## GRAPHS

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

**KDHE Air Particulate Be-7 Activity**

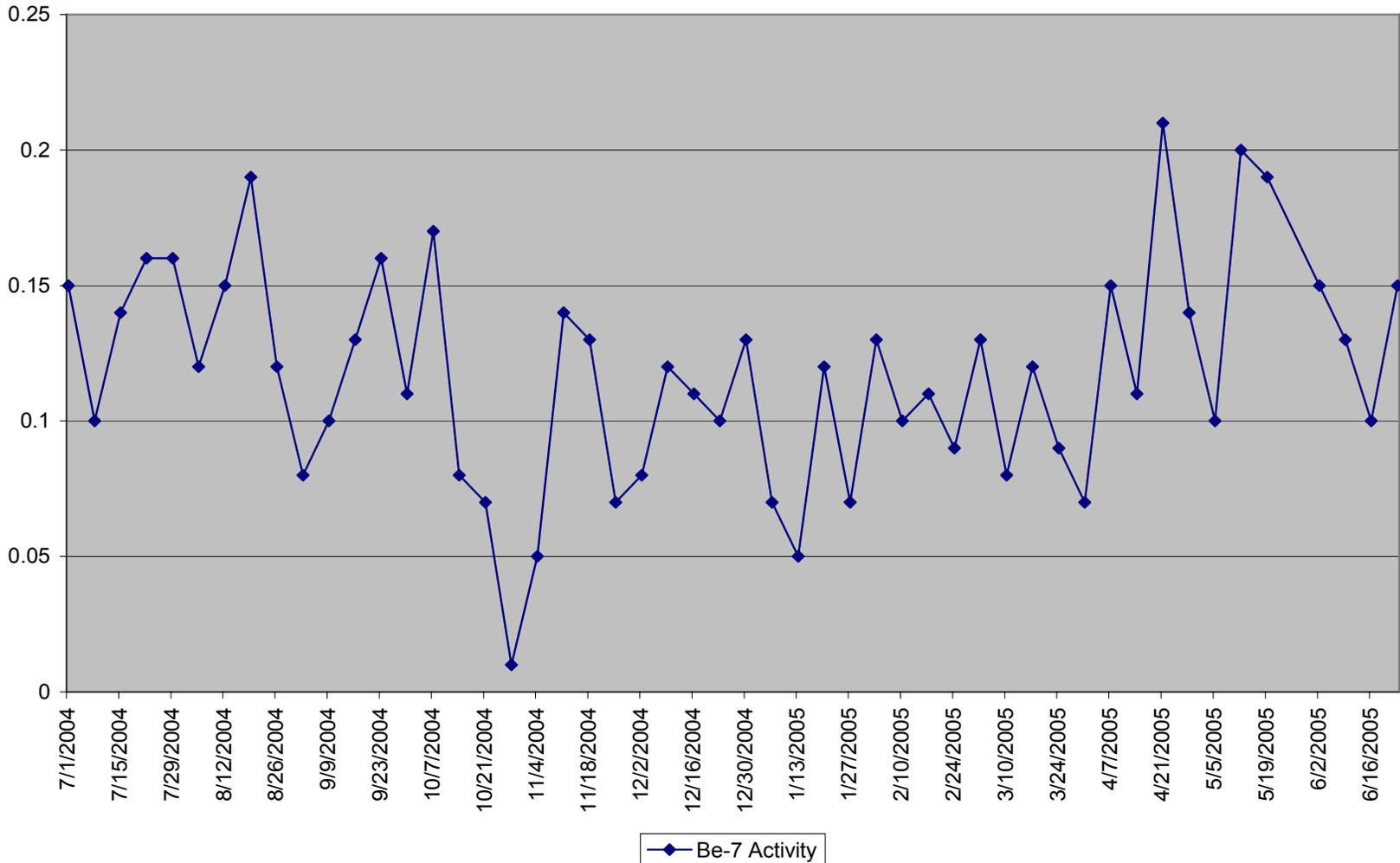


Chart 1.0 KDHE Air Particulate Be-7 Activity

**KDHE Quarterly TLD Averages by Sector  
mR/Hr**

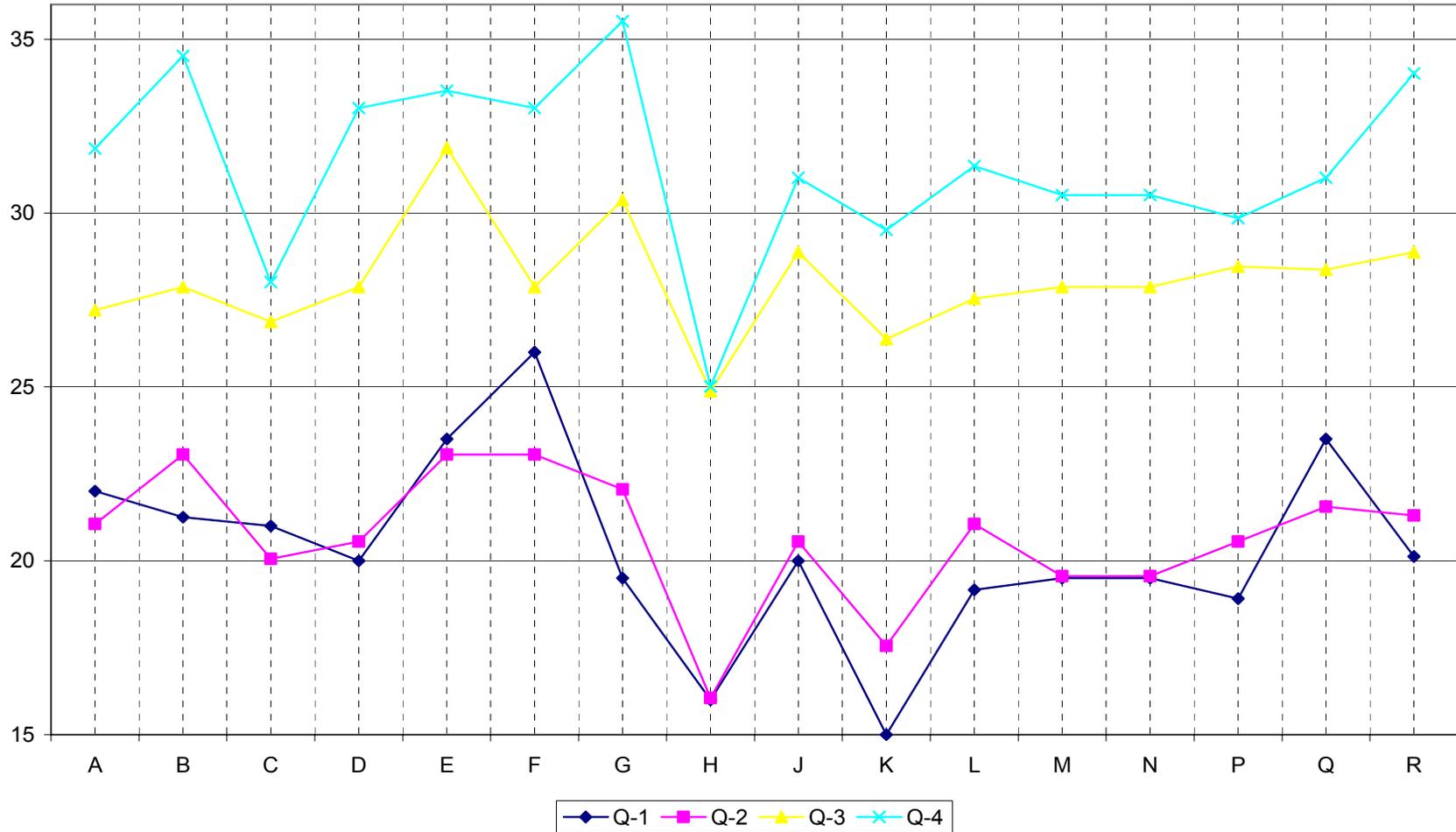


Chart 2.0 Quarterly Direct Radiation Results for all KDHE Direct Radiation Sites

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

**KDHE vs. WCNOC Direct Radiation**  
Average By Sector

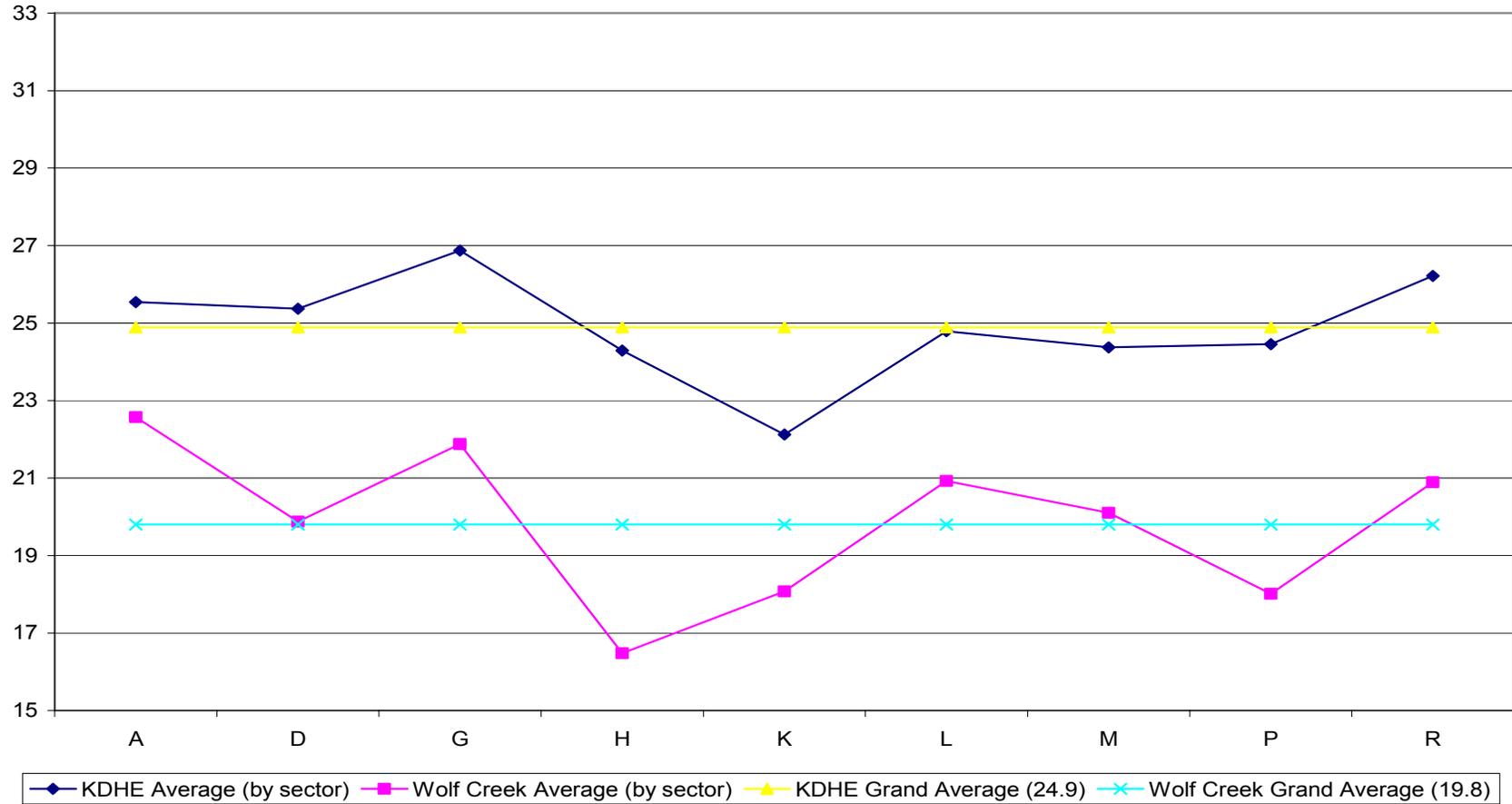
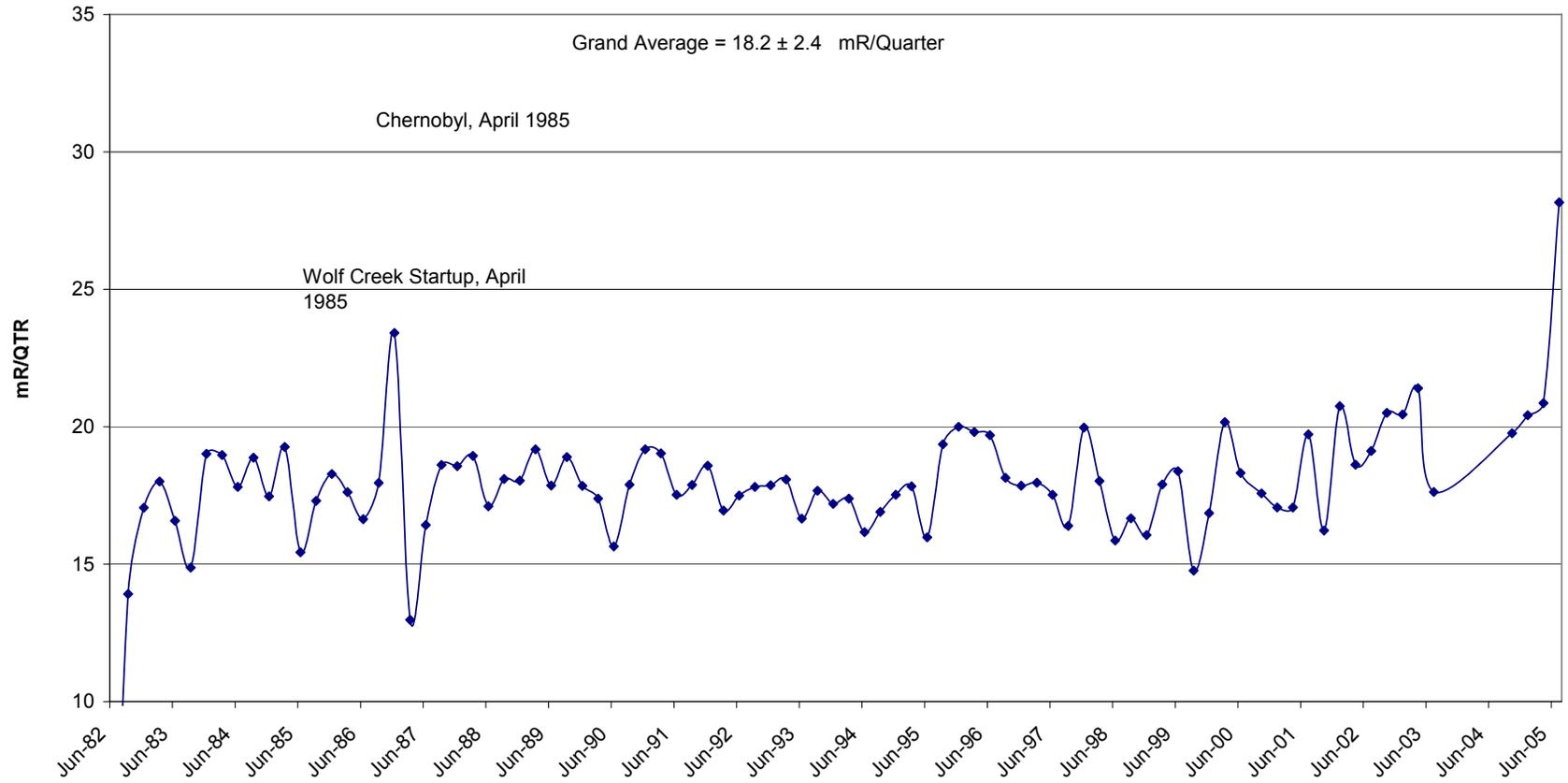


Chart 2.1 Comparison of WCNOC and KDHE Average Direct Radiation Readings

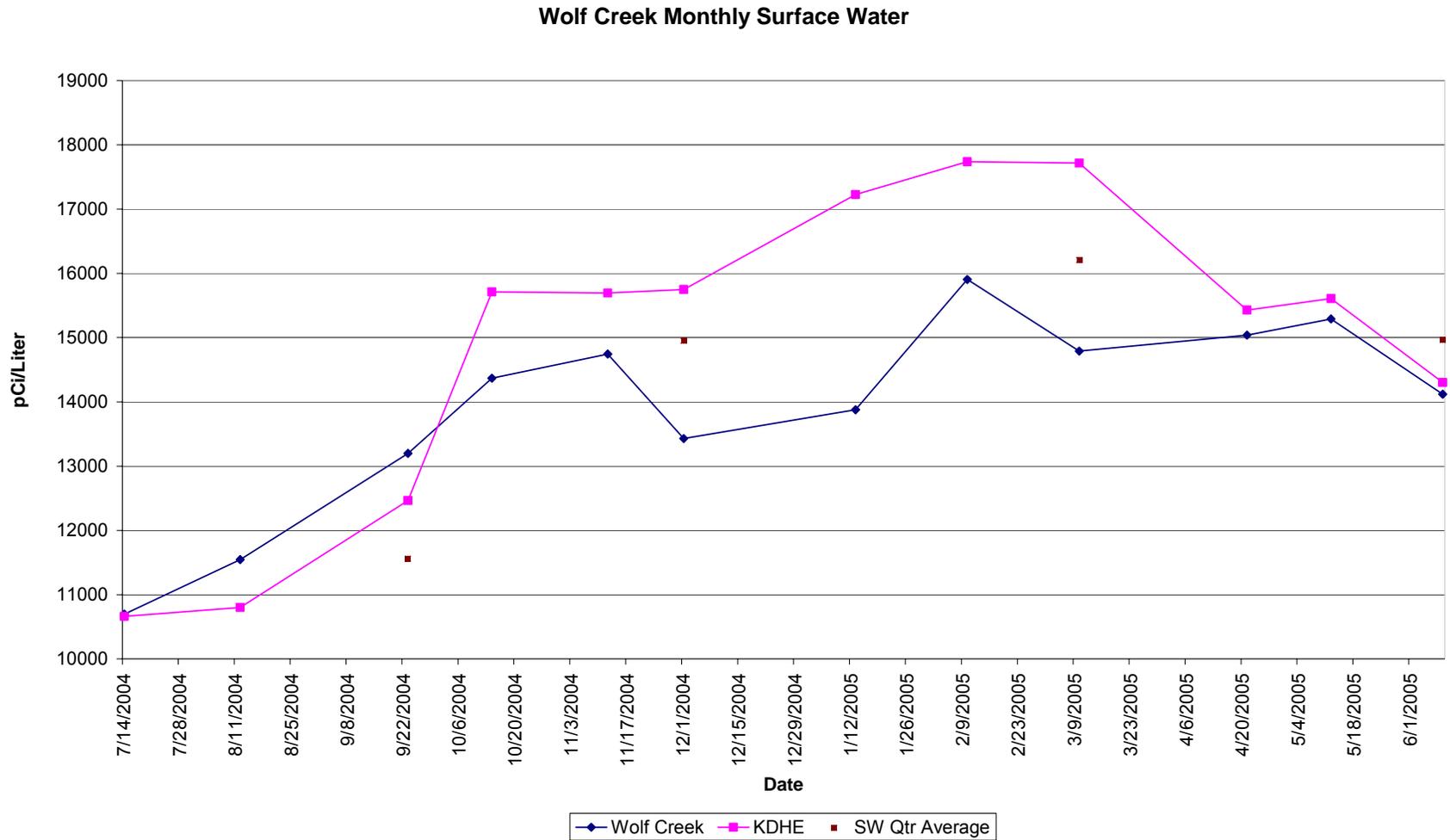
Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

Historical TLD Results



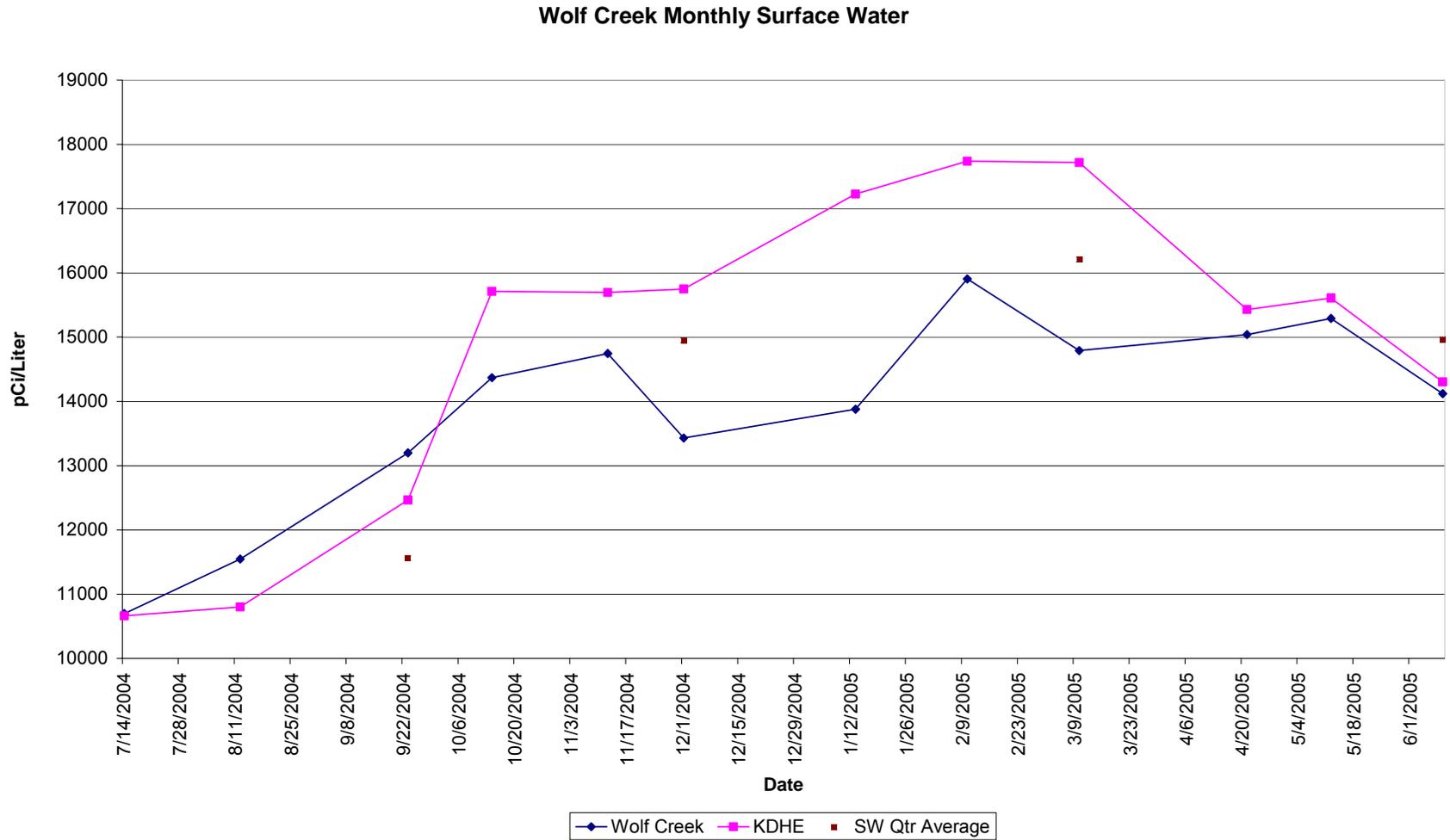
Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

Chart 2.3 KDHE Historical Direct Radiation Monitoring (TLD) Results



Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

Chart 3.0 Comparison of Monthly Surface Water Tritium Results



Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

Historic Surface Water Tritium

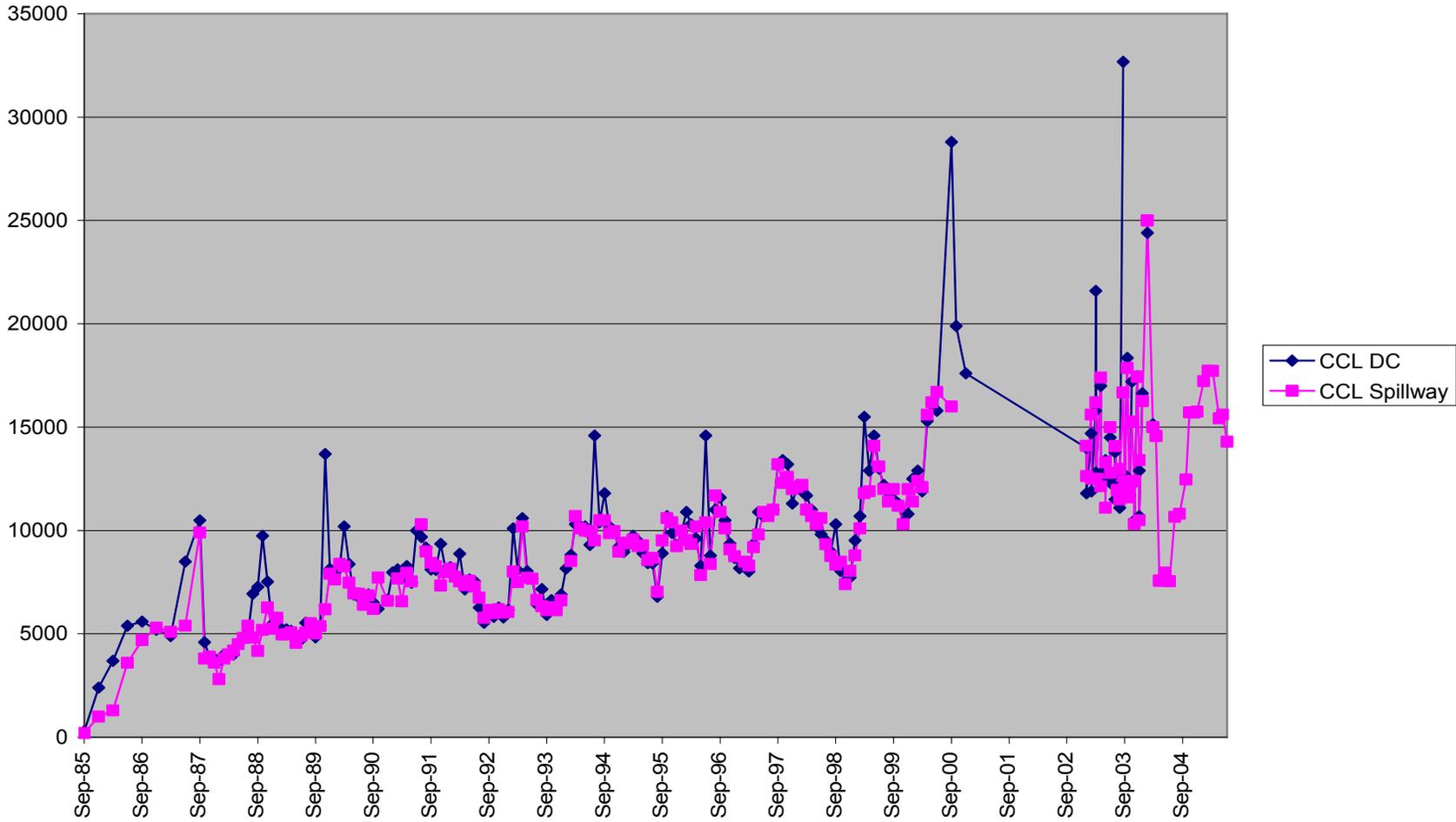


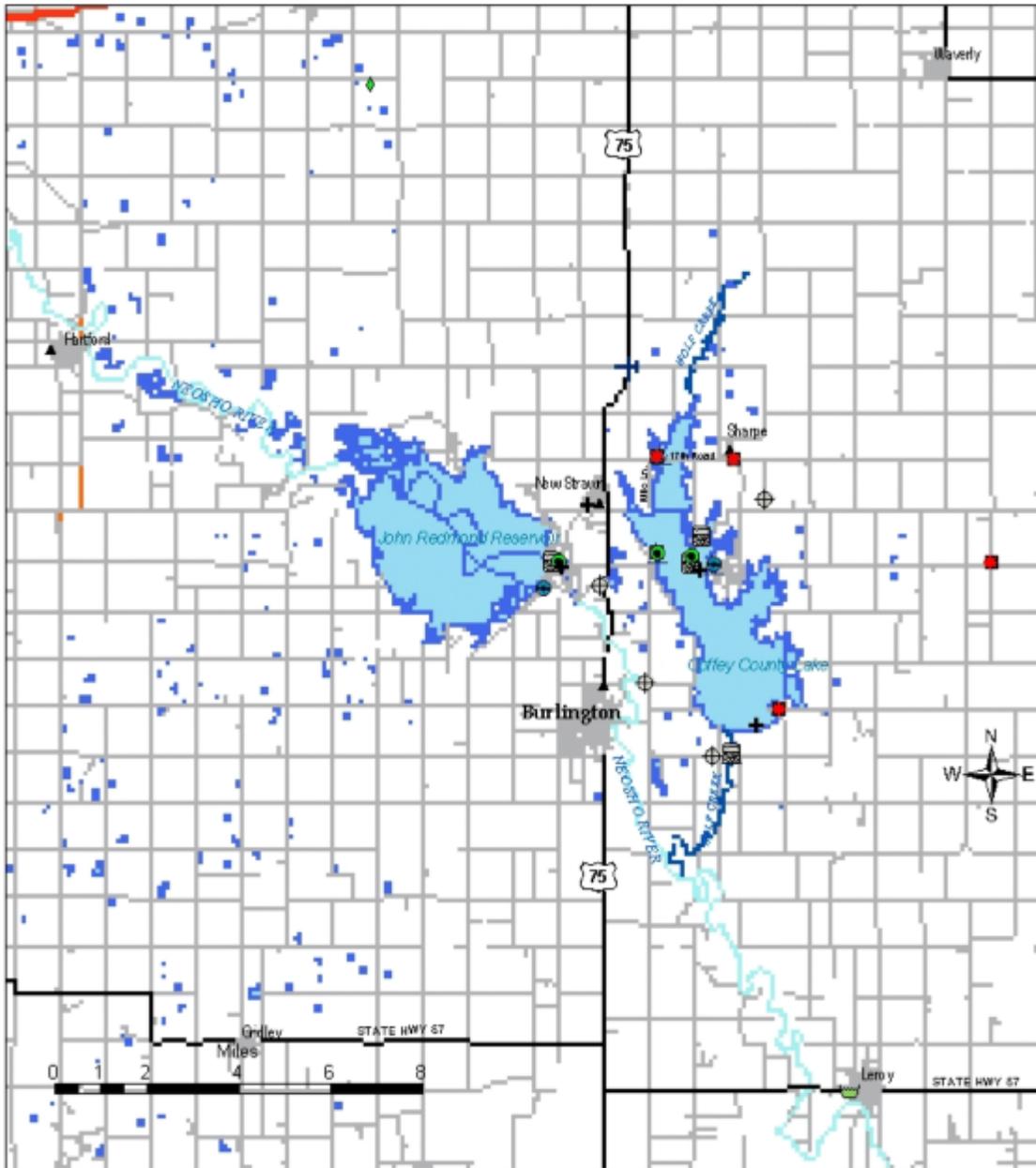
Chart 3.1 Historical KDHE Surface Water Tritium Results

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

Maps

	<u>Page</u>
1.0 Routine Sample Locations.....	38
2.0 KDHE OSLD Locations.....	39
3.0 Random Sample Locations.....	40

Kansas Department of Health and Environment  
 Environmental Radiation Surveillance Report  
 Wolf Creek Generating Station  
 SFY 2005

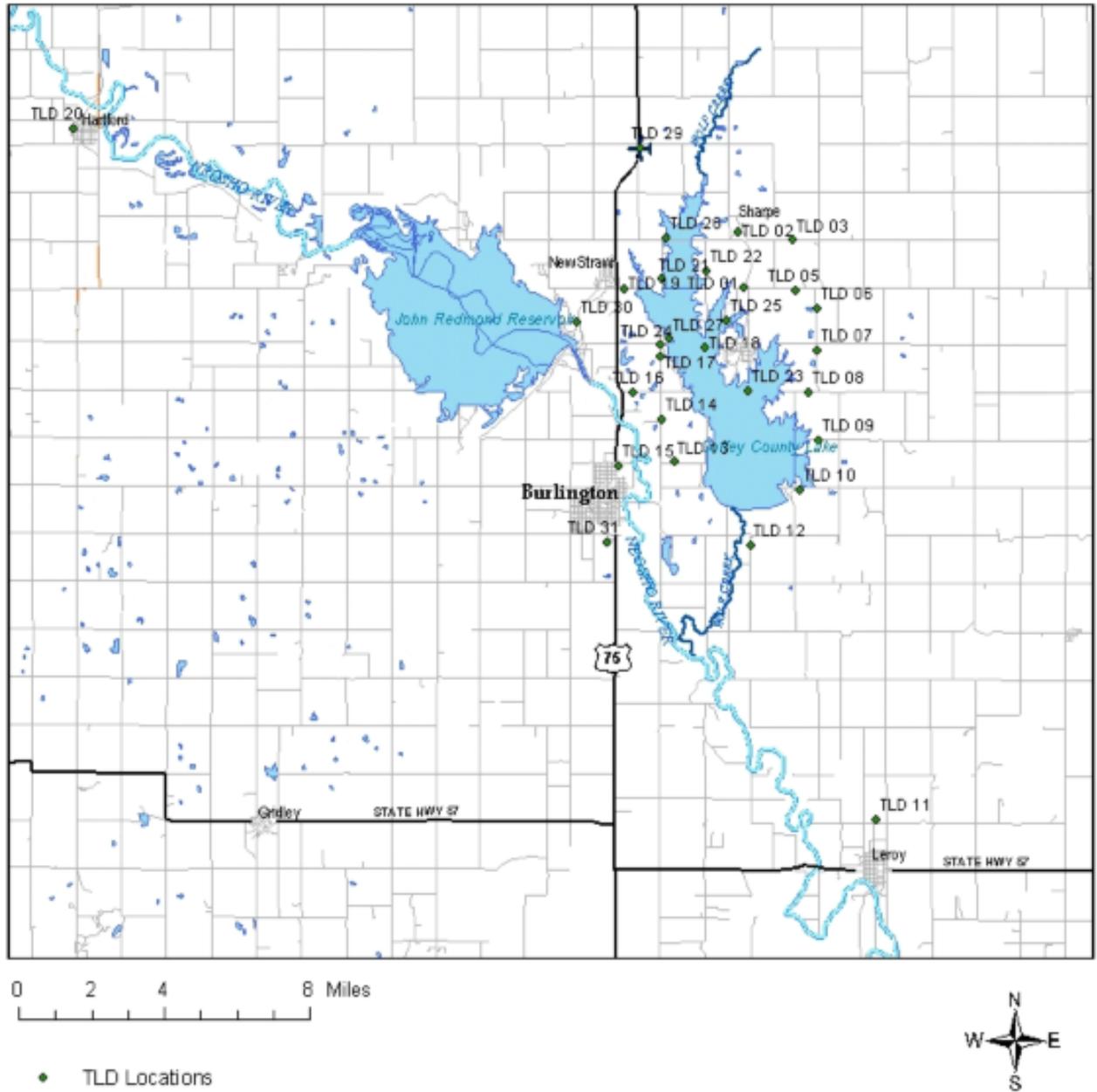


**Routine Sample Locations**

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

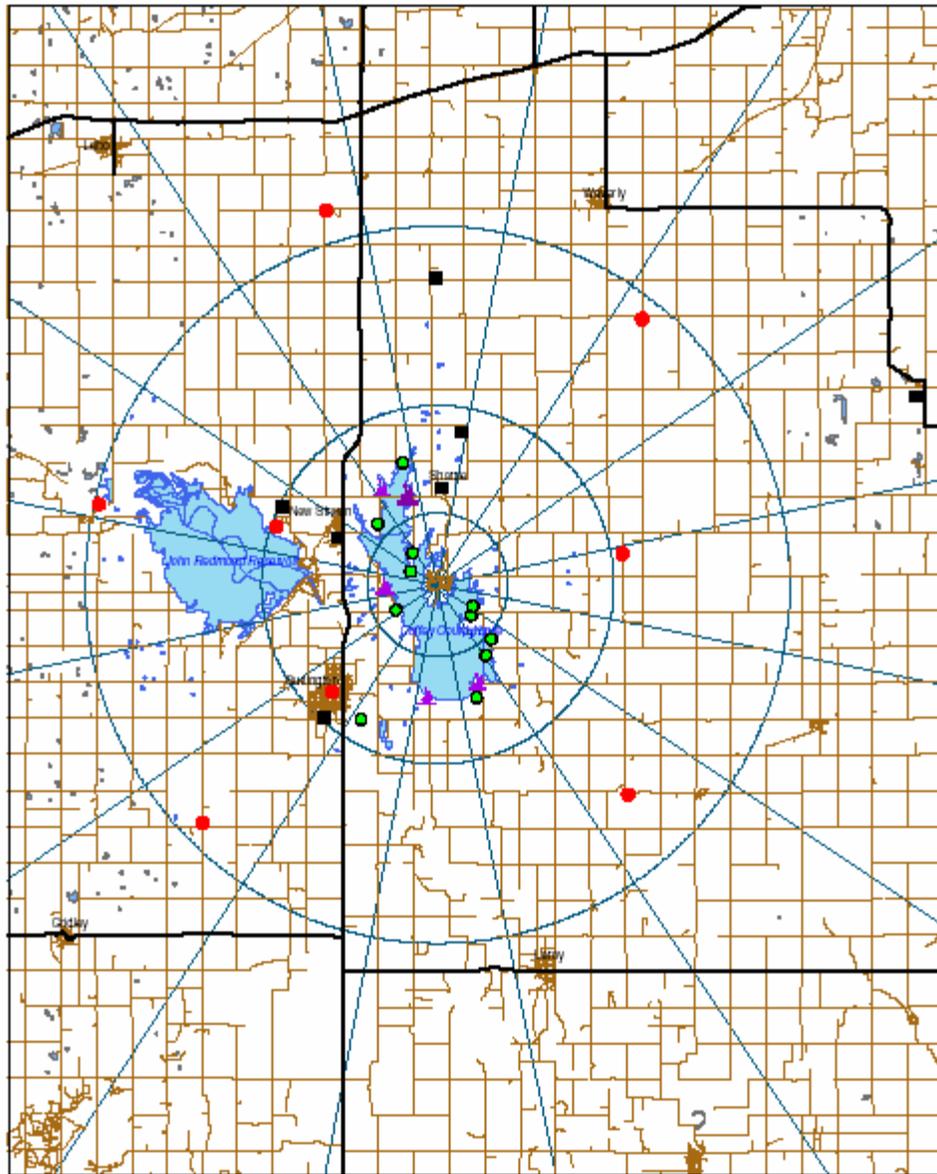
Map 1.0 Routine Sample Locations

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005

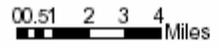


Map 2.0 KDHE OSLD (Shown as TLD) Locations

Kansas Department of Health and Environment  
Environmental Radiation Surveillance Report  
Wolf Creek Generating Station  
SFY 2005



**Random Sample Locations**



- Vegetation
- Soil
- Shoreline Sediment
- ▲ Aquatic Vegetation

Map 3.0 Random Sample Locations