South Carolina Department of Health and Environmental Control

Environmental Surveillance Oversight Program Data Report for 2010

Region 5 EQC
206 Beaufort Street NE,
Aiken, SC 29801
(803) 641-7670 Fax (803) 641-7675

D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

Region 5
Environmental Quality Control
Serving: Aiken, Allendale, Bamberg, Barnwell, Calhoun, and Orangeburg Counties
Promoting Health, Protecting the Environment

Introduction

The South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) supports and complements SCDHEC's comprehensive regulatory program at the Savannah River Site (SRS) by focusing on those activities not supported or covered through our normal regulatory framework. The primary function of the ESOP is to evaluate the effectiveness of SRS monitoring activities. To accomplish this function, the ESOP conducts non regulatory monitoring activities on and around the SRS, conducts evaluations of the SRS monitoring program and provides an independent source of information to the public pertaining to levels of contaminants in the environment from historical and current SRS operations.

This report includes a description of the ESOP's multi-media monitoring network and activities along with a summary of the findings of the ESOP from the 2010 calendar year monitoring period.

TOC

Table of Contents

Table of Contents

Table of Contents

List of Illustrations

Maps

Tables and Figures

TOC

List of Data Tables

Summary Data Tables

Statistical Summaries

TOC

List of Acronyms

8HLE	Eight half-lives elapsed
AEI	Average Exposed Individual
AGMN	Ambient Groundwater Monitoring Network
AGQMP	Ambient Groundwater Quality Monitoring Project
ANL	Argonne National Laboratory
AOC	Area of Concern
APW	Atmospheric Pathway
ATSDR	Agency for Toxic Substances and Disease Registry
AVG	Average
"B"	Background samples (>50 miles from SRS center point)
BDC	Beaver Dam Creek
BKG	Background
BNA	Base neutral/ acid extractable organics
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Resource Compensation and Liability Act
CDC	Centers for Disease Control
DER	Duplicate Error Ratio
DIL	Derived Intervention Level
DNRGW	Department of Natural Resources Groundwater Wells
DO	Dissolved Oxygen
DOE	Department of Energy
DOE-SR	Department of Energy - Savannah River
"E"	Perimeter samples (<50 miles from SRS center point, but outside SRS boundary)
EFIS	Environmental Facility Information System
EMS	Environmental Monitoring Section
EQC	Environmental Quality Control
ESOP	Environmental Surveillance and Oversight Program
ESV	Ecological Screening Value
ETF	Effluent Treatment Facility
FGR	Federal Guidance Report
FMB	Fourmile Branch
FT AMSL	Feet Above Mean Sea Level
FT BGS	Feet Below Ground Surface
GA	Georgia
GW	Groundwater
Hwy. 17	United States Highway 17
Hwy. 301	United States Highway 301
IAEA	International Atomic Energy Agency
IPC	Inner Perimeter of Counties, same as "E"
LLD	Lower Limit of Detection
LPW	Liquid Pathway
LTR	Lower Three Runs Creek
MAX	Single highest maximum detection
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
MDL	Minimum Detection Level
MEI	Maximum Exposed Individual
MFFF	Mixed Oxide Fuel Fabrication Facility
MOX	Mixed Oxide
N	Number
N/A	Not Applicable
ND	No Detection
NESHAP	National Emission Standards for Hazardous Air Pollutants
NORM	Naturally Occurring Radioactive Material
NRSW	Non-Radiological Surface Water

List of Acronyms

NS	Not Sampled or No Sample
NSBLD	New Savannah Bluff Lock & Dam
OPC	Outer Perimeter of Counties, same as “B”
ORWBG	Old Radiological Waste Burial Ground
PCB	Polychlorinated Biphenyl
PRG	Preliminary Remediation Goals
PWS	Public Water System
PWSGW	Public Water System Groundwater Wells
PWSRW	Public Water System River Water
QA/QC	Quality Assurance/Quality Control
R	Wet/Dry Ratio
RAC	Radiological Assessments Corporation
RCRA	Resource Conservation and Recovery Act
REMD	Radiological Environmental Monitoring Division
RSL	Regional Screening Level
RW	River Water
SC	South Carolina
SCAT	South Carolina Advanced Technology
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SD	Standard Deviation
SMSV	Sediment from Savannah River Study Area
SOP	Standard Operating Procedure
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
SS	Surface Soil
SSL	Soil Screening Level
STC	Steel Creek
STDEV	Standard Deviation
STEVENS	Stevens Creek
STOKES	Stokes Bluff Landing
SW	Surface Water
SWBL	Surface Water at Boat Landings
TEF	Tritium Extraction Facility
TKN	Total Kjeldahl Nitrogen
TLD	Thermoluminescent Dosimeter
TSP	Total Suspended Particulates
TSS	Total Suspended Solid
UNK	Unknown
US	United States
USDOE	United States Department of Energy
USDOI	United States Department of Interior
USEPA	United States Environmental Protection Agency
USFDA	United States Food and Drug Administration
USGS	United States Geological Survey
UTR	Upper Three Runs
VEGP	Vogtle Electric Generating Plant
VOC	Volatile Organic Carbon
WSRC	Washington Savannah River Company (formerly Westinghouse Savannah River Company)

TOC

List of Acronyms

UNITS OF MEASURE

C	temperature in Celsius
cm	centimeter
cps	**c**ounts per second
d	days
g/cm^3	grams per cubic centimeter
h	hours
hr/day	hours per day
hr/yr	hours per year
kg/yr	kilograms per year
L	Liter
L/hr	Liters per hour
L/yr	Liters per year
m	minutes or when attached to radionuclide identification means metastable
m^3/yr	cubic meters per year
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mrem	millirem
mrem/yr	millirem per year
ntu	nephelometric turbidity units
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
pCi/mL	Picocuries per milliliter
pCi/m^3	Picocuries per cubic meter
person-rem/y	Person-roentgen equivalent man per year
su	standard units
umhos/cm	specific conductance
±	Plus or minus. Refers to one standard deviation unless otherwise stated.
±**2**	Plus or minus two standard deviations, represents uncertainty in single detects.

TOC

List of Acronyms

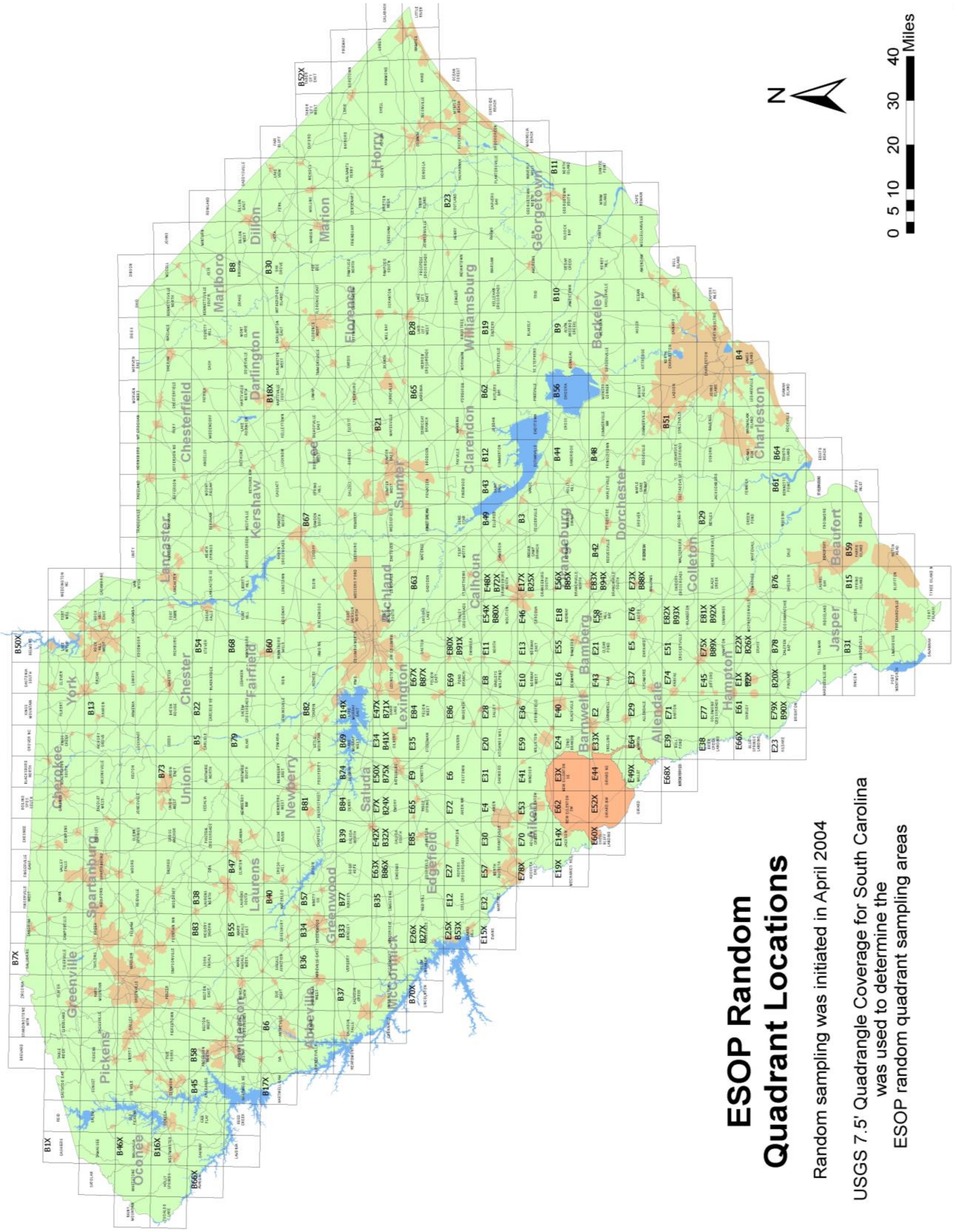
Radionuclides and Associated Half-Lives

Ac-228	Actinium-228	6.1 hours (h)
Am-241	Americium-241	432 years (y)
Be-7	Beryllium	53.4 days (d)
Ce-144	Cerium-144	284 d
Cs-134	Cesium-134	2.06 y
Cs-137	Cesium-137	30.1 y
Cm-244	Curium-244	18.1 y
Co-58	Cobalt-58	70.8 d
Co-60	Cobalt-60	5.27 y
Eu-152	Europium-152	13.6 y
Eu-154	Europium-154	8.8 y
Eu-155	Europium-155	4.96 y
H-3	Hydrogen-3 (tritium)	12.3 y
I-129	Iodine-129	1.57E7 y
I-131	Iodine-131	8.04 d
K-40	Potassium-40	1.27E9 y
Mn-54	Manganese-54	312.7 d
Na-22	Sodium-22	2.6 y
Pb-212	Lead-212	10.64 h
Pb-214	Lead-214	27 m
Pu-238	Plutonium-238	87.8 y
Pu-239	Plutonium-239	2.4E4 y
Pu-240	Plutonium-240	6.5E3 y
Ra-226	Radium-226	1.6E3 y
Ra-228	Radium-228	5.75 y
Ru-103	Ruthenium-103	39 d
Sb-125	Antimony-125	2.77 y
Sr-89	Strontium-89	50.6 d
Sr-90	Strontium-90	28.6 y
Tc-99	Technetium-99	2.13E5 y
Th-238	Thorium-238	1.9 y
Th-234	Thorium-234	24.1 d
U-234	Uranium-234	2.44E5 y
U-235	Uranium-235	7.03E8 y
U-238	Uranium-238	4.47E9 y
Zn-65	Zinc-65	244 d
Zr-95	Zirconium-95	64.0 d

TOC

Random Sampling Location Information

Map 1. Savannah River Site perimeter and South Carolina background random sampling locations chosen to date. Not all locations have been sampled.



Random Sampling Location Information

TOC

1.1 Radiological Atmospheric Monitoring

1.1.1 Summary

Atmospheric transport has a significant potential to impact the citizens of South Carolina from releases associated with activities at the Savannah River Site (SRS). This project provides independent quantitative monitoring of atmospheric radionuclide releases associated with SRS. It also provides monitoring of atmospheric media on a routine basis to measure radionuclide concentrations in the surrounding environment and to identify trends that may require further investigation. Radiological atmospheric monitoring sites were established to provide spatial coverage of the project area.

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) air monitoring capabilities in 2010 included eight air-monitoring stations with the capacity for sample collection using glass fiber filters, rain collection pans, silica gel columns, and 19 thermoluminescent dosimeters (TLDs). Five of the air-monitoring stations are on or within two miles of the SRS perimeter, New Ellenton (NEL), Jackson (JAK), Allendale Barricade (ABR), South Carolina Advanced Technology Park in Snelling (SCT), and Dark Horse at the Williston Barricade (DKH), one at the center of the site, Burial Grounds North (BGN), and two are within 25 miles of the site Aiken (AIK) and Allendale (ALN). Thirteen of the TLDs are on or near the site perimeter, one is in the center of the site, and five are within 25 miles of the site. Only perimeter air monitoring stations and TLDs are used for comparison. Refer to the map in Section 1.1.2 for specific monitoring locations.

The glass fiber filters were used to collect total suspended particulates (TSP). Particulates were screened weekly for gross alpha and gross beta-emitting activity. Precipitation, when present, was sampled and analyzed monthly for tritium. Silica gel distillates of atmospheric moisture were analyzed monthly for tritium. TLDs were collected and analyzed every quarter for ambient beta/gamma levels. SCDHEC emphasizes monitoring for radionuclides in atmospheric media around the SRS at potential public exposure locations.

SCDHEC data substantiated historically reported Department of Energy-Savannah River (DOE-SR) values for radionuclides in the ambient environment at or near the SRS boundary. Average DOE-SR atmospheric radiological monitoring results for gross alpha/beta in air, ambient beta/gamma, and tritium in precipitation at the SRS boundary were within two standard deviations of the SCDHEC reported average values. Variations in atmospheric radiological monitoring results between SCDHEC and DOE-SR are likely a result of differences in monitoring locations, local meteorological conditions, frequency of sampling, and number of locations. Reported differences are at regional background levels and present no difference with regard to the impact on public health.

In summary, no United States Environmental Protection Agency (USEPA) air standards were exceeded at the monitored locations and there were no elevations of radiological pollutant concentrations associated with SRS operations. Sampling results by SCDHEC indicate that SRS activities had a measurable but negligible impact on local air quality.

Results and Discussion

Total Suspended Particulates

Gross Alpha

During the 2010 sampling period, gross alpha activity ranged from Less Than the Lower Limit of Detection (<LLD) to 0.0071 picoCuries per cubic meter (pCi/m^3) at the site perimeter (NEL, JAK, ABR, SCT, and DKH). The maximum gross alpha detection was collected on April 6 at the SCT air station. Values in this range are typically associated with naturally occurring alpha-emitting radionuclides, primarily as decay products of radon, and are considered normal (Kathren 1984). According to the USEPA, (Rhonda Sears telephone conversation, September 17, 2005) if gross alpha counts are above 0.7 pCi/m^3, the filters are analyzed for specific radioisotopes. The SCDHEC average gross alpha radionuclide concentration in 2010 was 0.0021 (± 0.0007) pCi/m^3. The DOE-SR gross alpha average of 0.001 (±0.0004) pCi/m^3 is within two standard deviations of the SCDHEC gross alpha activity average (SRNS 2009). Section 1.1.3, Figure 1 shows average gross alpha activity for SRS perimeter locations and illustrates trending of gross alpha values for SCDHEC and DOE-SR.

Gross Beta

During the 2010 sampling period, the site perimeter (NEL, JAK, ABR, SCT, and DKH) gross beta concentrations ranged from 0.0018 to 0.0536 pCi/m^3. The maximum gross beta detection was collected on October 26 at the JAK air station. The average gross beta concentration reported by SCDHEC in 2010 was 0.0222 (± 0.0070) pCi/m^3. Values in this range are typically associated with naturally occurring beta-emitting radionuclides, primarily as decay products of radon (Kathren 1984). Small seasonal variations at each monitoring location have been consistent with historically reported SCDHEC values (SCDHEC 2007a). The USEPA Office of Radiation and Indoor Air uses gross beta counts as an indicator to determine if additional analyses will be performed. A gamma scan is conducted if the gross beta activity exceeds 1 pCi/m^3. This is the tiering of definitive analyses that is used for all total suspended particulate sampling associated with RadNet. RadNet is comprised of a nationwide network of sampling stations that identify trends in the accumulation of long-lived radionuclides in the environment (USEPA 2005). Over the past several years, SCDHEC has seen a slight decrease in gross beta while DOE-SR results have remained stable. Section 1.1.3 , Figure 2 shows average gross beta activity for the SRS perimeter locations and illustrates trending of gross beta values for SCDHEC and DOE-SR. The DOE-SR gross beta average of 0.0166 (± 0.0053) pCi/m^3 is within one standard deviation of the SCDHEC gross beta activity average (SRNS 2009). Section 1.1.3, Figures 6-14 show SCDHEC trending for 2010 for both gross alpha and gross beta.

Ambient Beta/Gamma

SCDHEC conducts ambient beta/gamma monitoring through the deployment of Thermoluminescent Dosimeters (TLD's) around the perimeter of the SRS. Ambient beta/gamma levels measured with TLDs are provided for all quarters of 2010. It should be noted that 4 millirem (mrem) are subtracted from the reported result for each TLD to account for the transcontinental flight from South Carolina to California and back (Walter 1995). The maximum ambient beta/gamma detection of 37 mrem was collected for the 1st quarter 2010 at the TNX boat ramp The SCDHEC average ambient beta/gamma activity for perimeter TLDs in 2010 was 86.77 (± 14.35) mrem. The DOE-SR average ambient beta/gamma activity was 78.07 (±10.79) mrem for 2010. The DOE-SR ambient/beta gamma average was within one standard deviation of the SCDHEC average. During the sampling period, SCDHEC external radiation levels at monitored locations were higher than levels reported by DOE-SR. Over the past six years, there have been no major increases or decreases in the average ambient beta/gamma activity reported by DOE-SR or SCDHEC. Section 1.1.3, Figure 3 shows trends at the SRS perimeter for averaged ambient beta/gamma values for DOE-SR and SCDHEC.

Tritium

Tritium continues to be the predominant radionuclide detected in the perimeter samples. During 2010, DOE-SR released approximately 40,500 Ci of tritium from SRS (SRNS 2009). Most of the tritium detected in SCDHEC perimeter samples may be attributed to the release of tritium from tritium facilities, separation areas, and from diffuse and fugitive sources (SRNS 2009).

Tritium In Air

Tritium in air values reported by SCDHEC are the result of using the historical means of calculating an air concentration of tritium based on the upper limit value of absolute humidity (11.5 grams of atmospheric moisture per cubic meter) in the geographic region (NCRP 1984). SCDHEC tritium results greater than the lower limit of detection (LLD) are then converted from picocuries per liter (pCi/L) to pCi/m^3 using the formula:

$$\frac{\text{pCi/L}}{1000} = \text{pCi/ml}(11.5) = \text{pCi/m}^3$$

Average DOE-SR tritium in air activity was higher than the SCDHEC measured activity but well within the same order-of-magnitude. These variations could be caused by different sampling locations, number of locations, or sample frequency.

Average tritium in air activity at the SRS perimeter reported by SCDHEC for 2010 was lower than reported in 2009 and has fluctuated over the last six years. DOE-SR also reported a decrease from 2009 to 2010. Section 1.1.3, Figure 4 illustrates trending of atmospheric tritium activity for SCDHEC and DOE-SR as measured and calculated at the SRS perimeter. Section 1.1.3, Figures 14-21 show trending for 2010 for SCDHEC.

The DOE-SR average measured value for tritium activity in air at the SRS perimeter was 12.08 (±4.80) pCi/m^3 (SRNS 2009). The SCDHEC average measured activity for tritium was 5.27 (± 2.57) pCi/m^3. The maximum tritium in air activity of 16.74 (±2.77) pCi/m^3 was collected at SCT air station, for the month of December 2010. The SCDHEC average for tritium activity was well below the USEPA equivalent yearly average standard of 21,000 pCi/m^3 for airborne tritium activity (ANL 2007a). DOE-SR average measured values for tritium in atmospheric moisture were higher than SCDHEC averaged measured values for the SRS perimeter (SRNS 2009). The DOE-SR average measured activity for tritium was within two standard deviations of the SCDHEC measured average. This difference may be attributed to a dilution that occurs when desiccants are used for collecting atmospheric moisture for tritium analysis. Prior to deployment in the field, silica-gel desiccant is dried to remove any moisture. However, a small percentage of water remains in the desiccant. This results in a slight dilution of the collected sample, which is reflected in the distillate. Another factor that may contribute to the lower SCDHEC air tritium values is that only two of the monitoring stations are exactly on the SRS perimeter (property line), while the other three points used for this comparison are located approximately two miles from the SRS property line.

Tritium In Precipitation

The maximum reported value for SCDHEC perimeter locations was 691.70 (± 104.78) pCi/L, collected at the NEL air station for the collection period of November 2010. The DOE-SR average measured value for tritium activity in precipitation at the SRS perimeter was 588.81 (±284.53) pCi/L (SRNS 2009). The SCDHEC average measured activity for tritium in precipitation was 359.98 (±153.13) pCi/L. The SCDHEC and DOE-SR averages for tritium activity were well below the EPA standard of 20,000 pCi/L in drinking water (USEPA 2002a). The DOE-SR averages for tritium activity were within one standard deviation of the SCDHEC average. Section 1.1.3, Figure 5 shows average tritium in precipitation activity for SRS perimeter locations and illustrates trending tritium in precipitation values for SCDHEC and DOE-SR. Section 1.1.3, Figures 22-29 show trending for 2010 for SCDHEC.

Conclusions/Recommendations

All SCDHEC data collected in 2010 confirmed historically reported DOE-SR values for gross alpha/beta, ambient beta/gamma and tritium in the environment at the SRS boundary with no anomalous data noted for any monitored parameters.

Due to the variability of environmental data and the frequency of collecting samples, DOE-SR gross alpha/beta in air, tritium in precipitation, tritium in air, and ambient beta/gamma averages were within two standard deviations of SCDHEC measured averages.

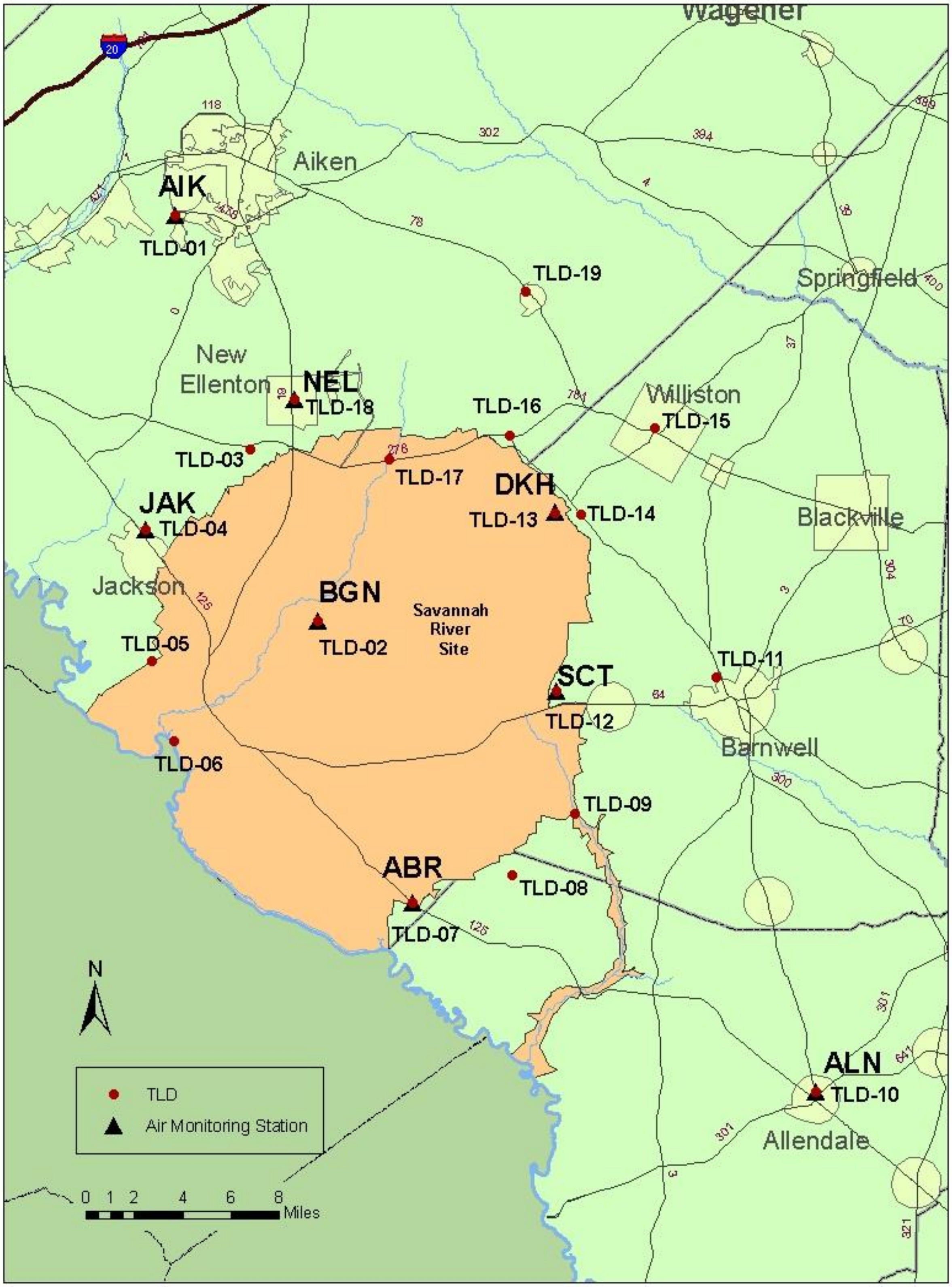
No EPA air standards were exceeded at the monitored locations and there were no elevations of radiological pollutant concentrations associated with SRS operations. Sampling results by SCDHEC indicate that SRS activities did have a measurable but negligible impact on local air quality.

Due to continued releases from site facilities (tritium facilities, separations areas, etc.) SCDHEC will continue to collect weekly TSP for gross alpha/beta, monthly for atmospheric and precipitation tritium, and quarterly ambient beta/gamma samples.

TOC

1.1.2

Map 2. Radiological Atmospheric Monitoring Locations



[TOC](#)

1.1.3 TABLES AND FIGURES

2010 Radiological Atmospheric Monitoring on and Adjacent to SRS
Table 1. SCDHEC and DOE-SR Sample Frequency Comparison

Figure 1. DOE-SR and SCDHEC Comparison of Average Gross Alpha For Total Suspended

Sample Frequency		
	SCDHEC	DOE-SR
Total Suspended Particulates	Weekly	Bi-weekly
Precipitation	Monthly	Bi-weekly
Atmospheric Moisture	Monthly	Monthly
Thermoluminscent Dosimeters	Quarterly	Quarterly

Particulates at the SRS Perimeter

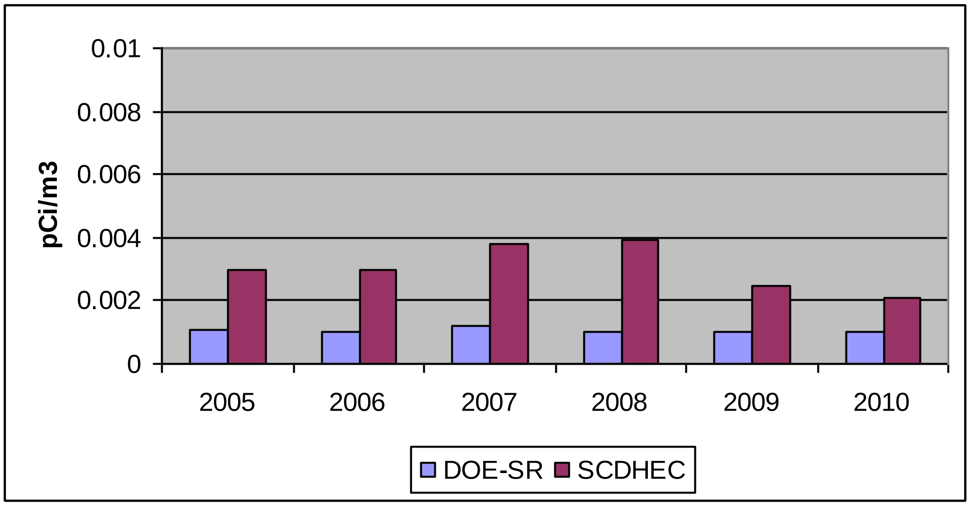


Figure 2. DOE-SR and SCDHEC Comparison of Average Gross Beta For Total Suspended Particulates at the SRS Perimeter

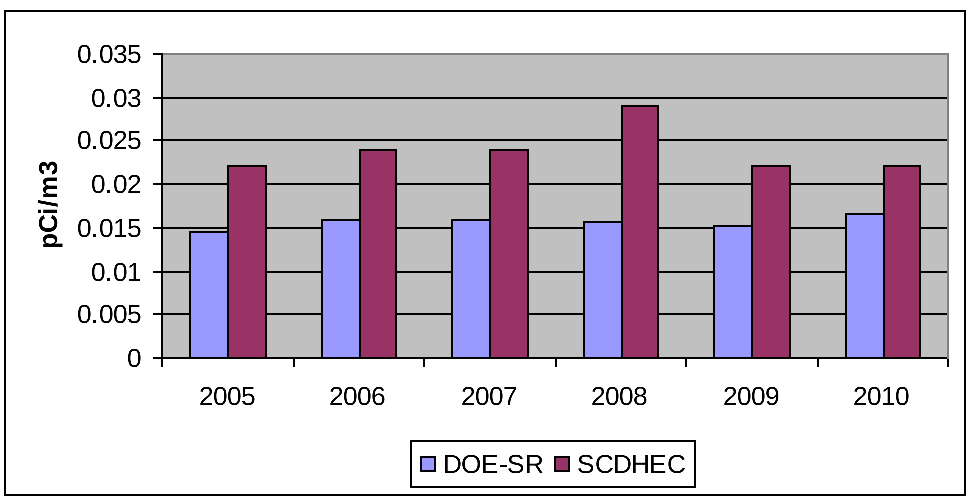


Figure 3. DOE-SR and SCDHEC Comparison of Ambient Beta/Gamma at the SRS Perimeter

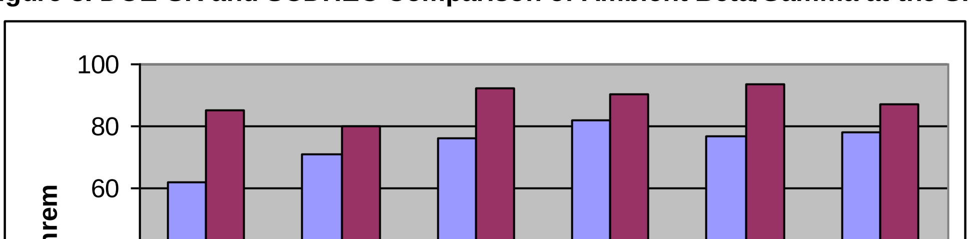


Figure 4. DOE-SR and SCDHEC Comparison of Average Tritium in Air at the SRS Perimeter

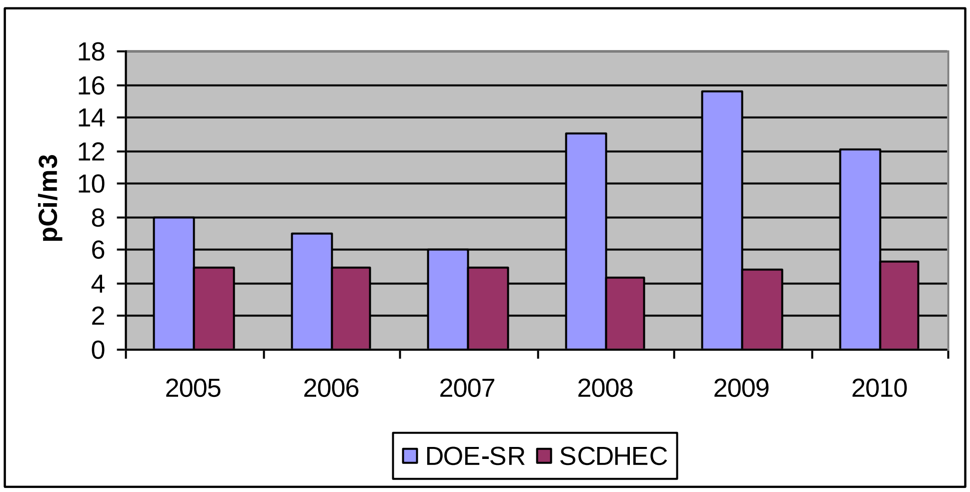


Figure 5. DOE-SR and SCDHEC Comparison of Average Tritium in Precipitation at the SRS Perimeter

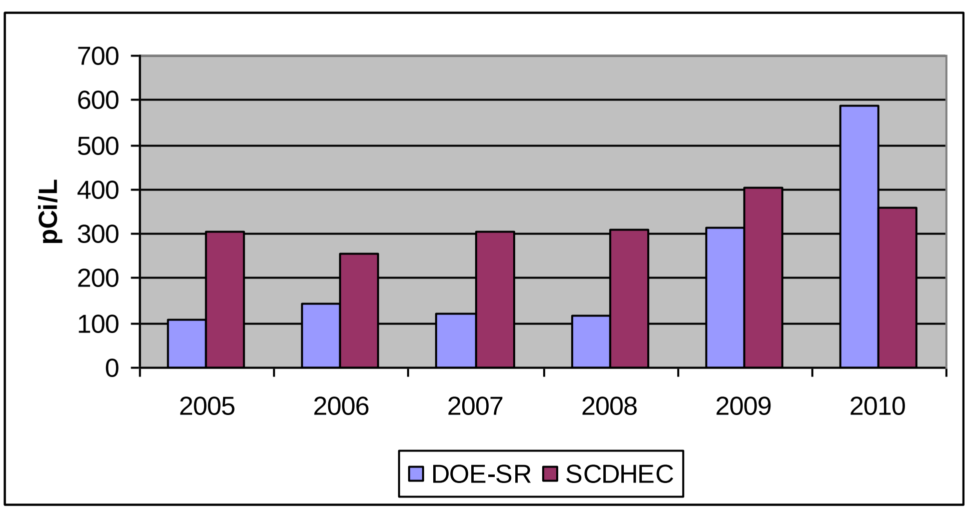


Figure 6. AIK Weekly Gross Alpha/Beta 2010

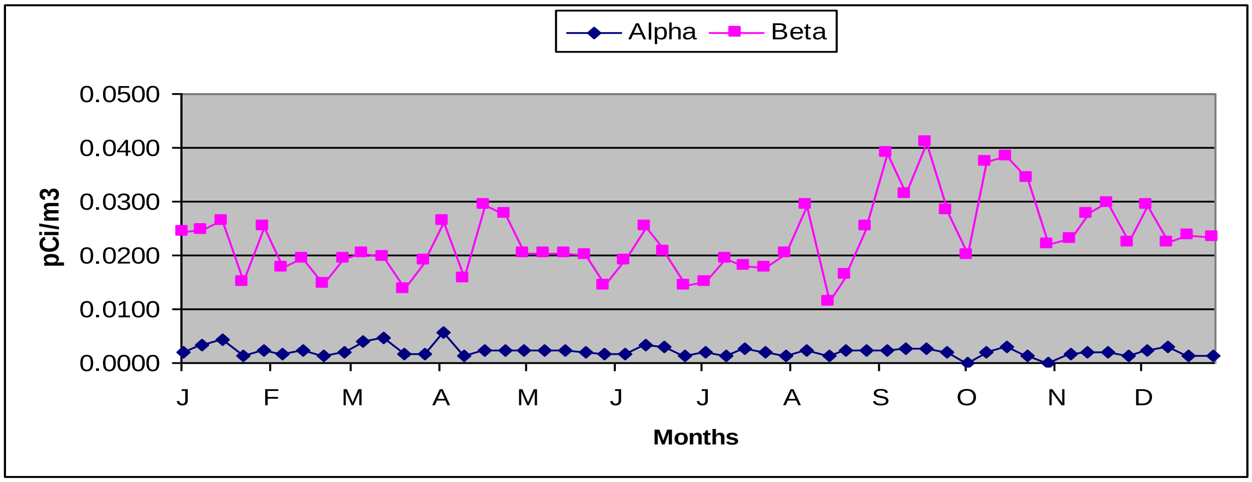


Figure 7. NEL Weekly Gross Alpha/Beta 2010

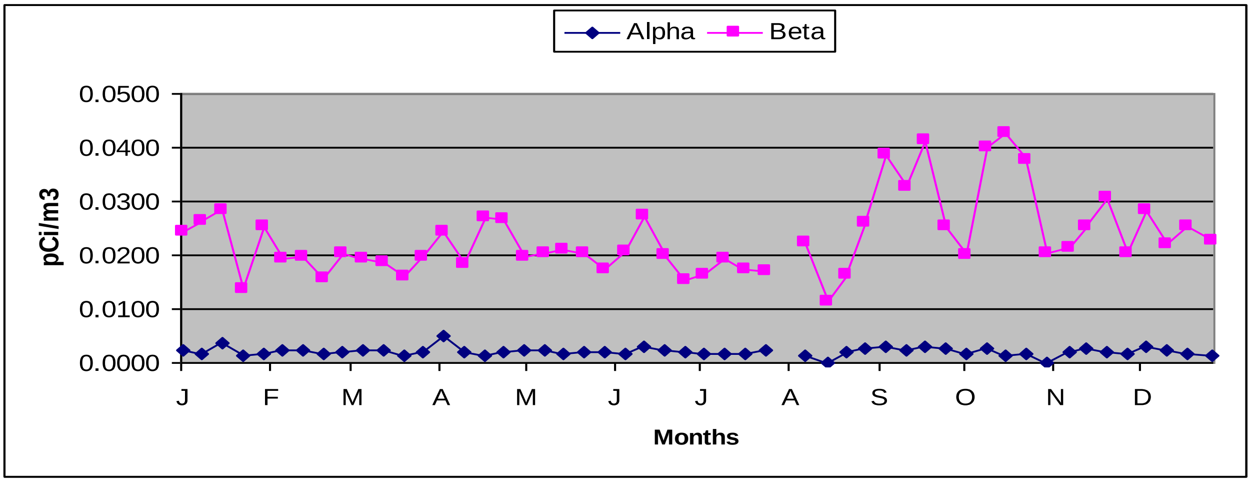
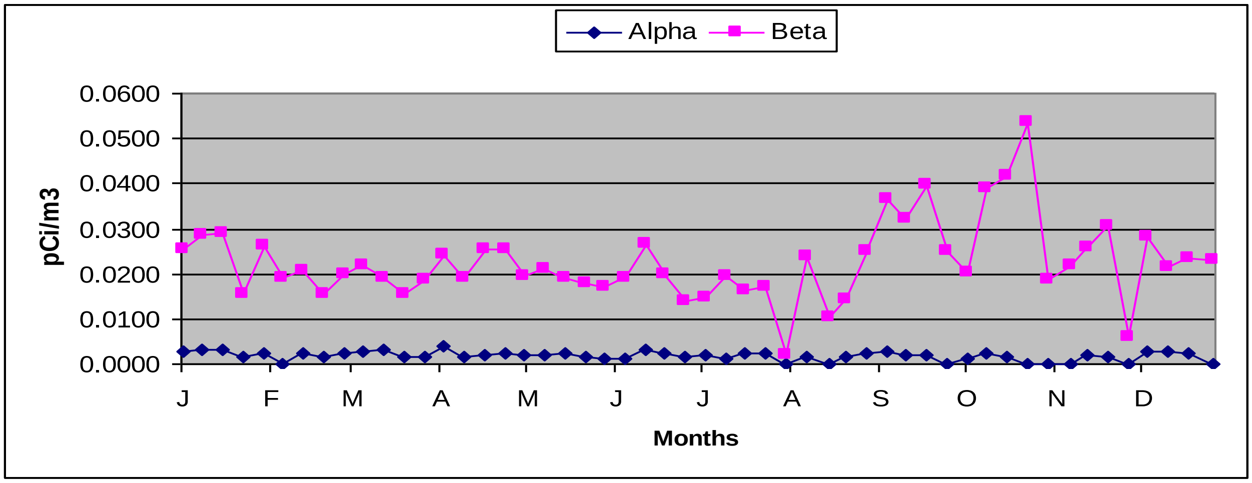


Figure 8. JAK Weekly Gross Alpha/Beta 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 9. BGN Weekly Gross Alpha/Beta 2010

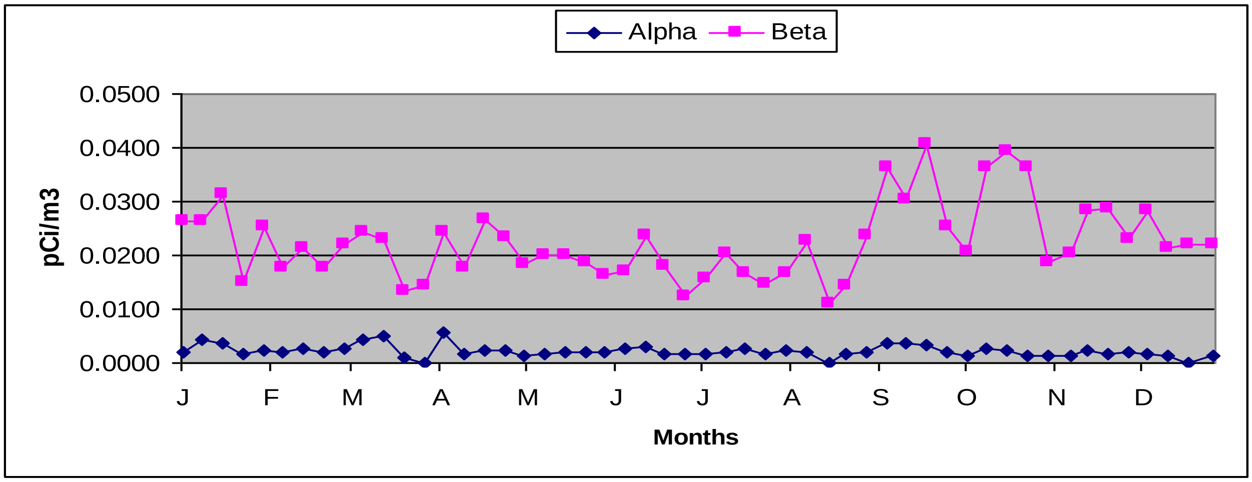


Figure 10. ABR Weekly Gross Alpha/Beta 2010

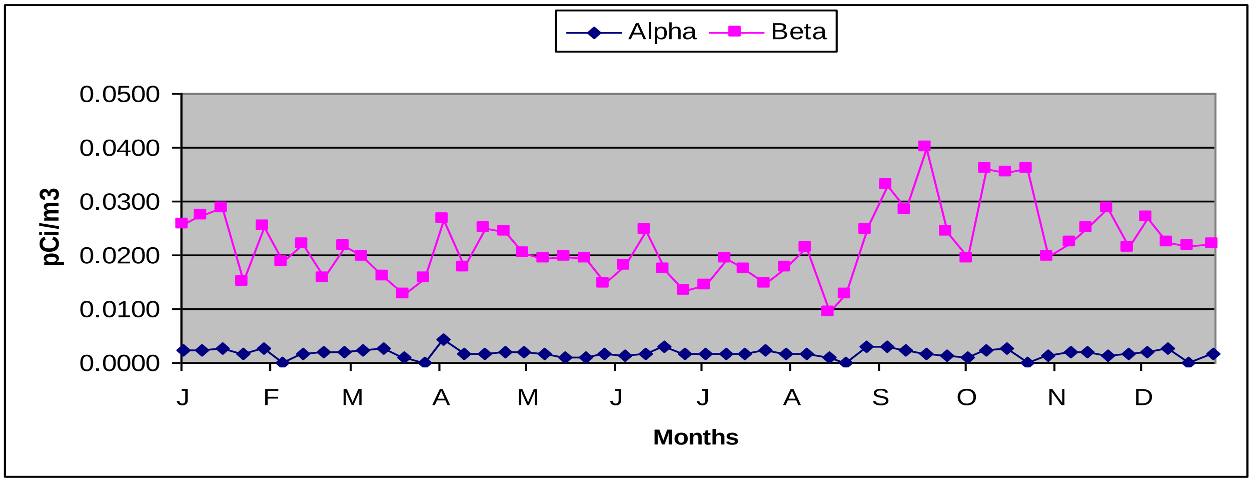
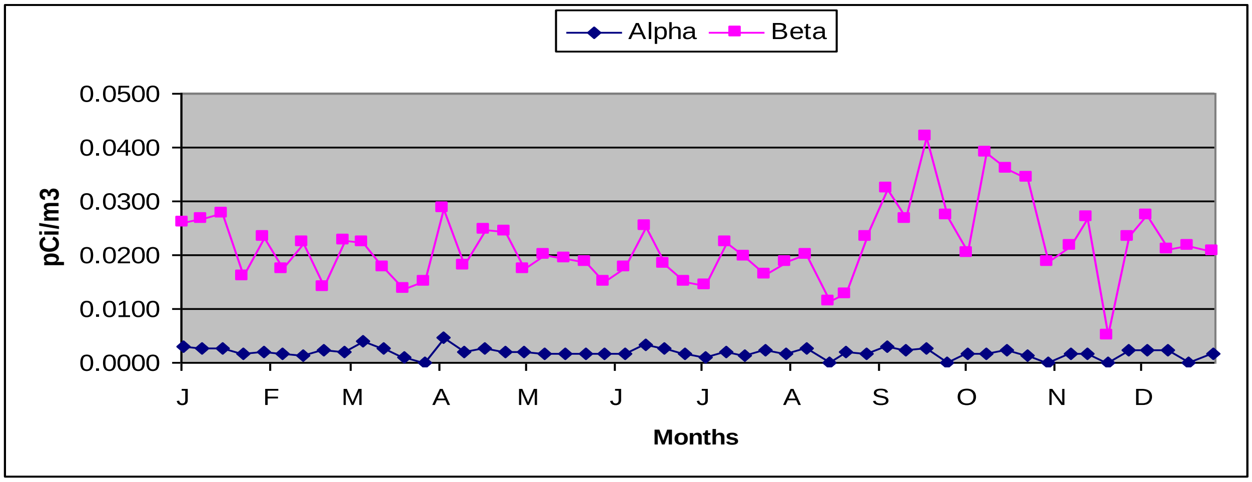


Figure 11. ALN Weekly Gross Alpha/Beta 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 12. SCT Weekly Gross Alpha/Beta Beta 2010

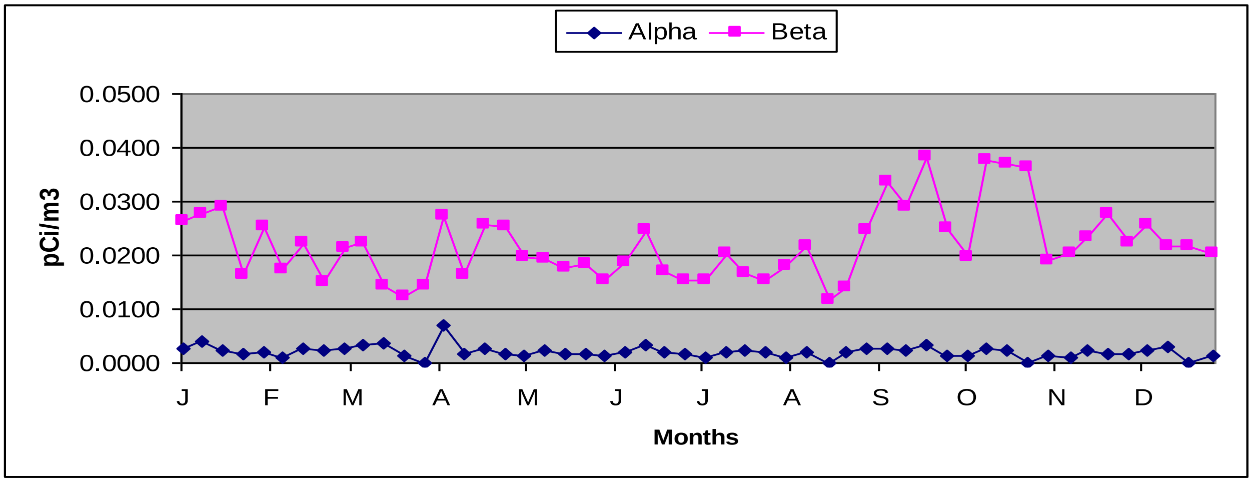
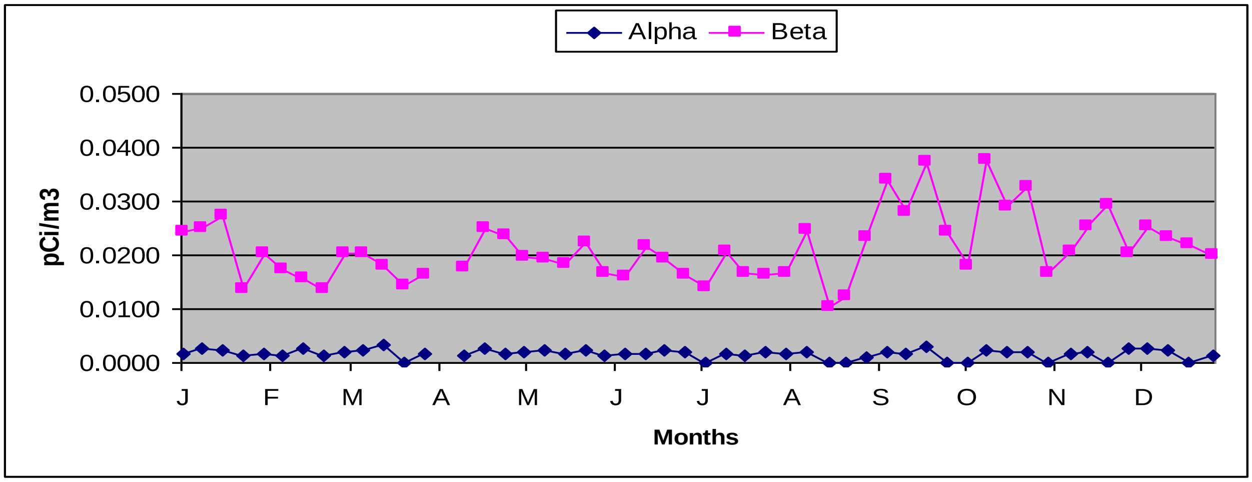


Figure 13. DKH Weekly Gross Alpha/Beta 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 14. AIK Monthly Tritium in Air 2010

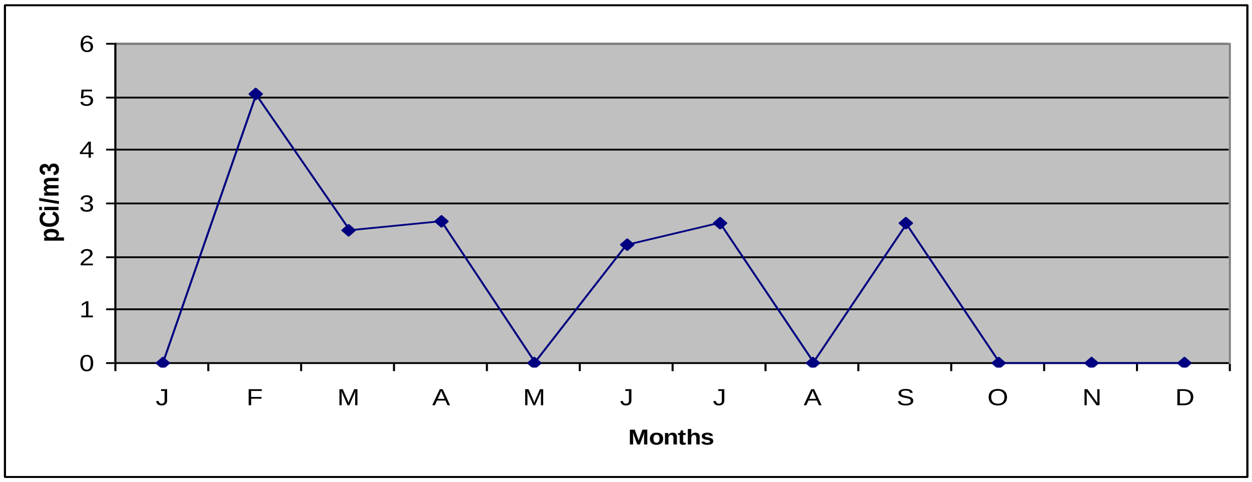


Figure 15. NEL Monthly Tritium in Air 2010

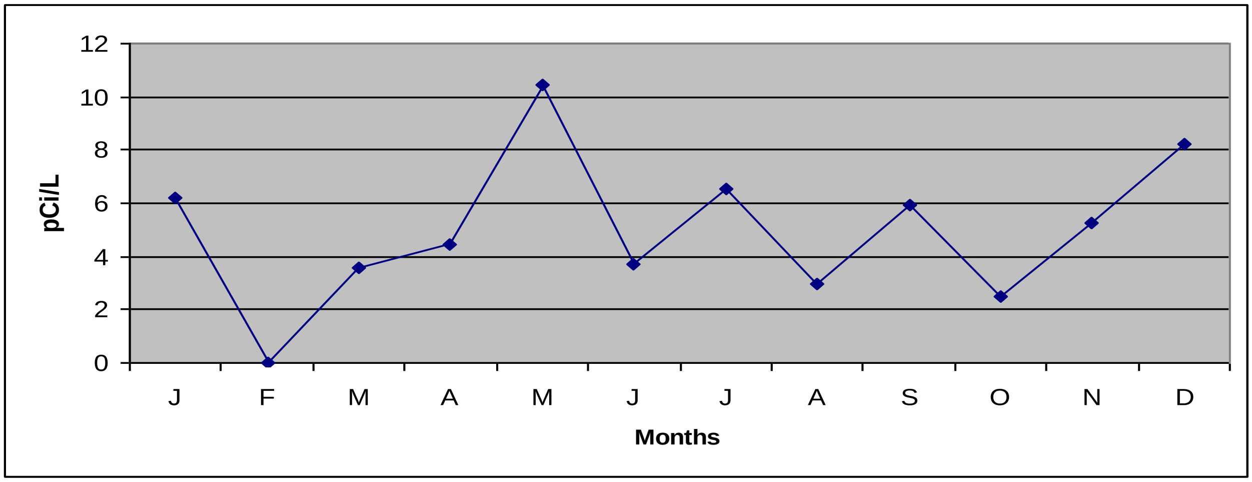
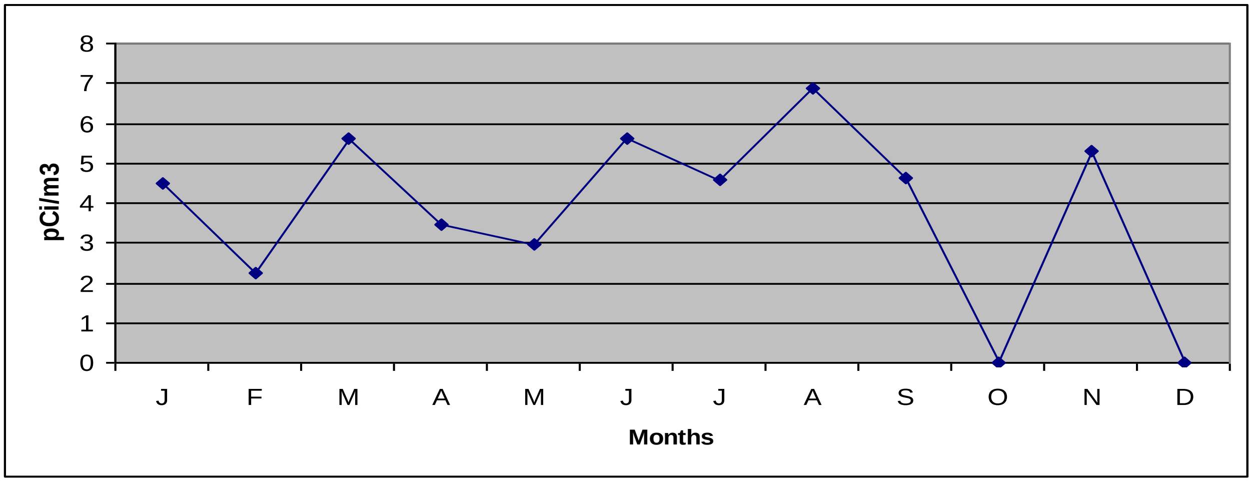


Figure 16. JAK Monthly Tritium in Air 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 17. BGN Monthly Tritium in Air 2010

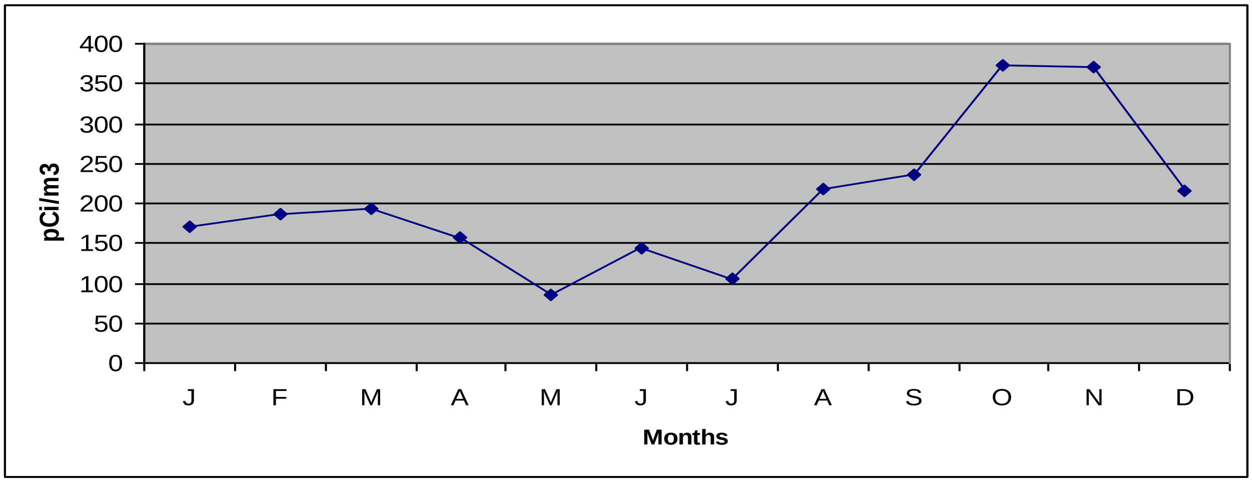


Figure 18. ABR Monthly Tritium in Air 2010

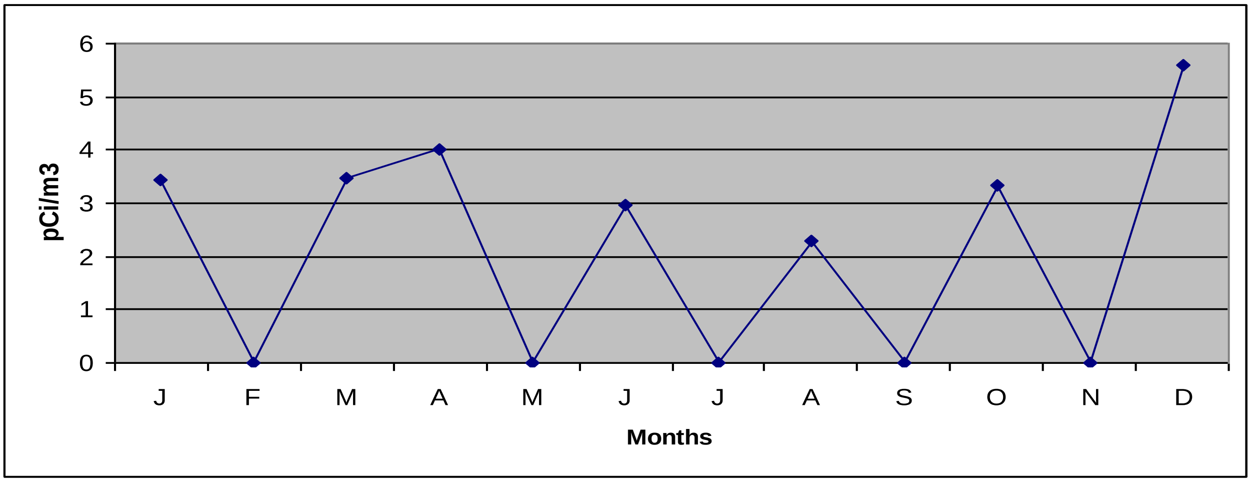
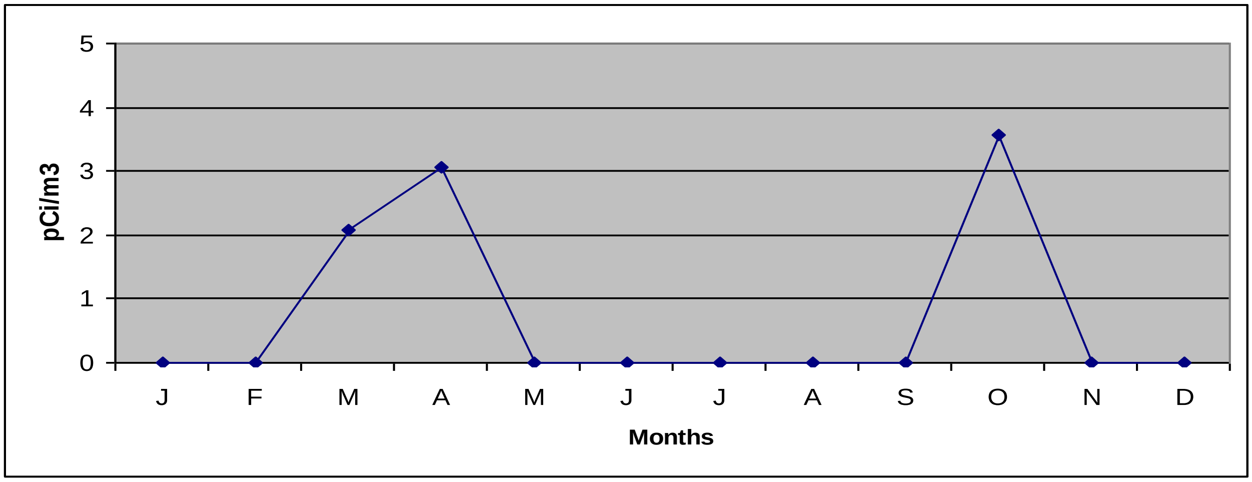


Figure 19. ALN Monthly Tritium in Air 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 20. SCT Monthly Tritium in Air 2010

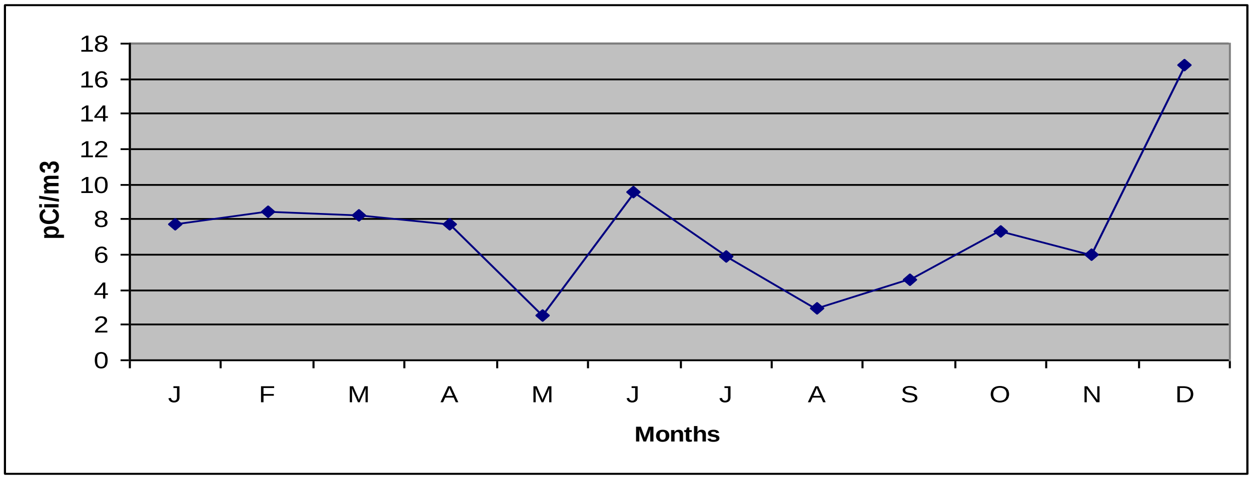
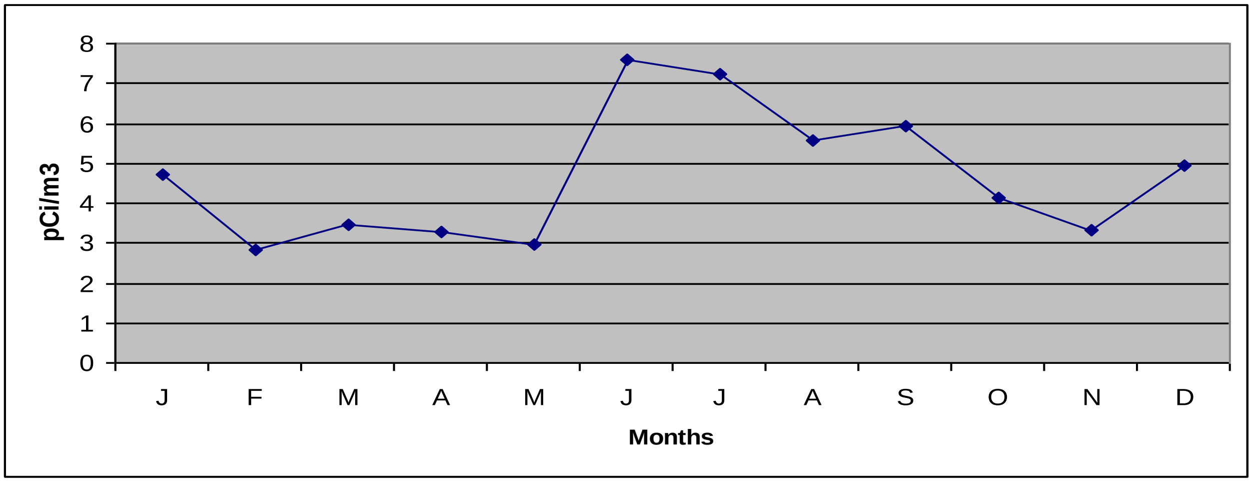


Figure 21. DKH Monthly Tritium in Air 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 22. AIK Monthly Tritium in Precipitation 2010

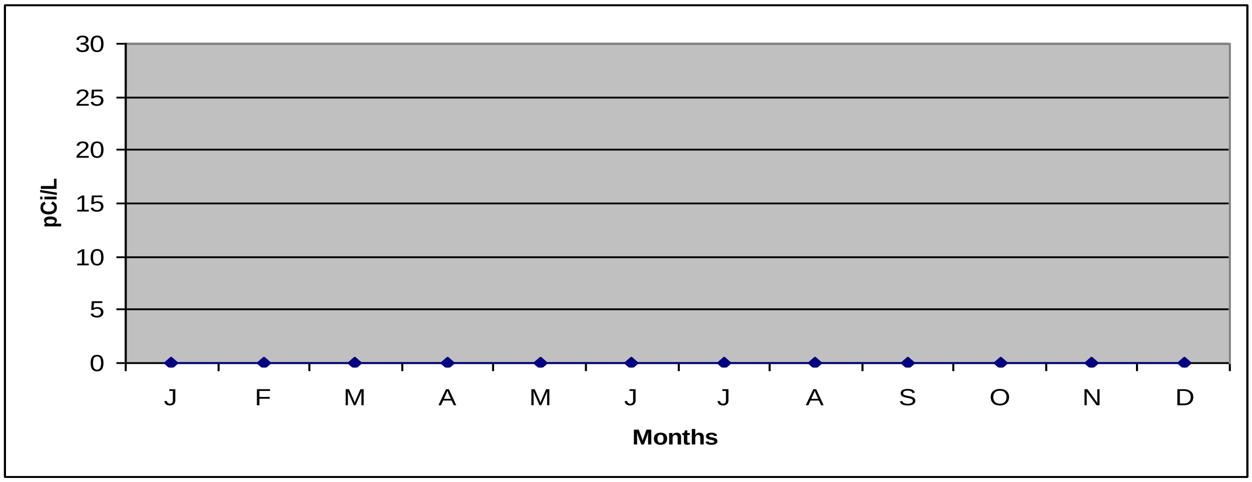


Figure 23. NEL Monthly Tritium in Precipitation 2010

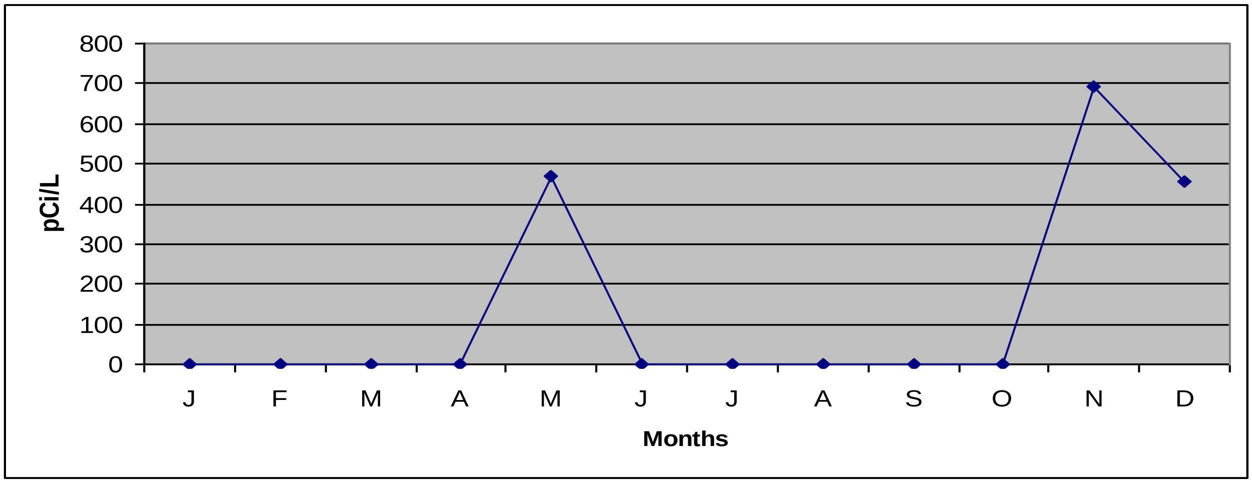
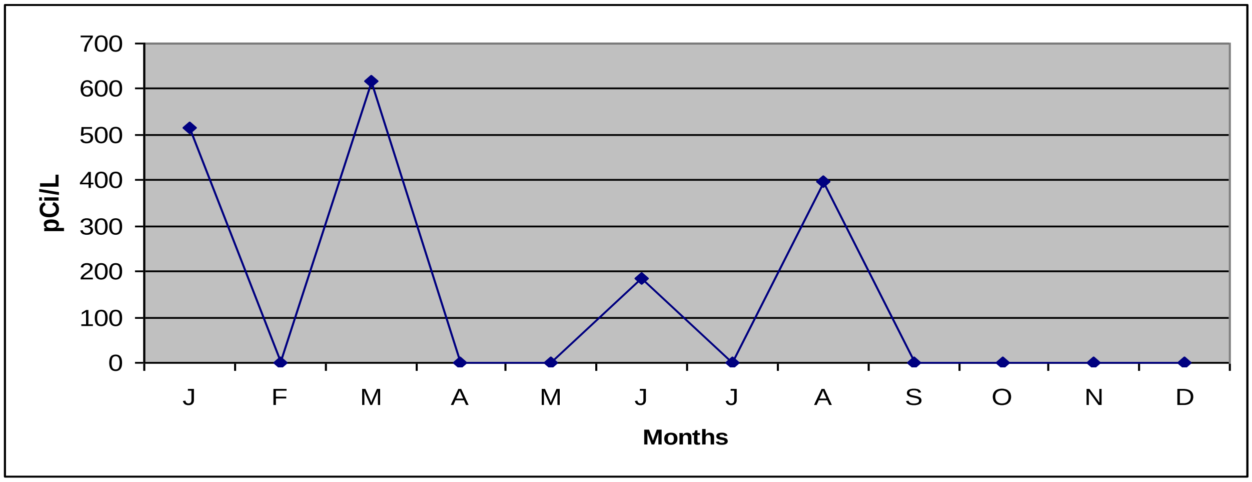


Figure 24. JAK Monthly Tritium in Precipitation 2010



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 25. BGN Monthly Tritium in Precipitation

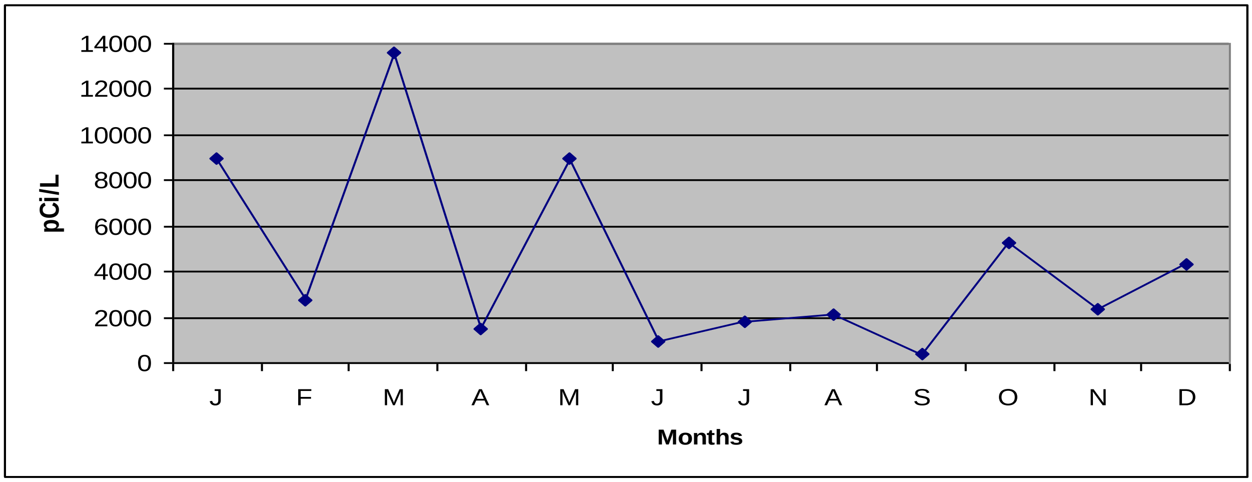


Figure 26. ABR Monthly Tritium in Precipitation

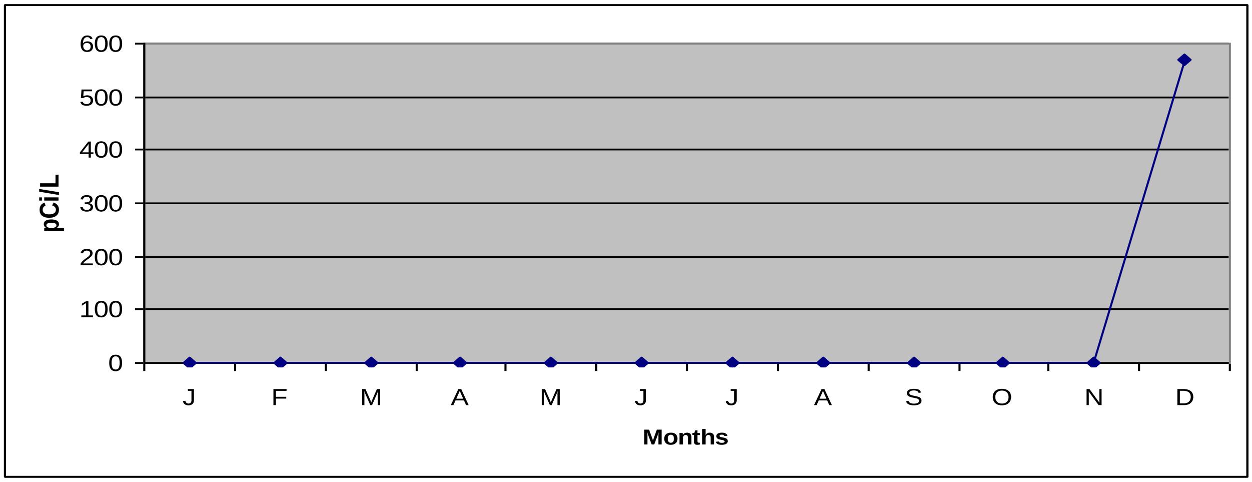
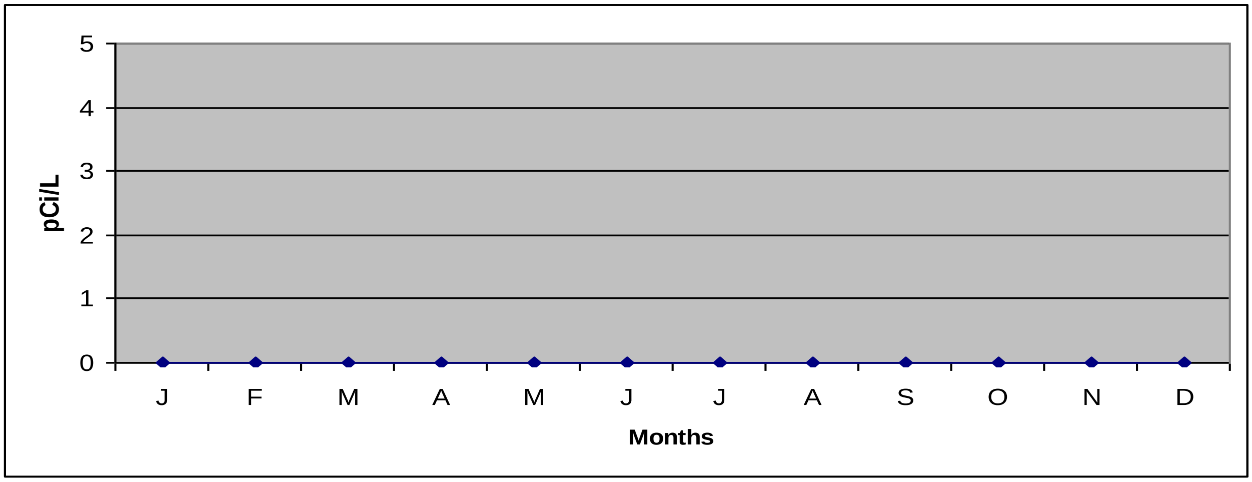


Figure 27. ALN Monthly Tritium in Precipitation



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

Figure 28. SCT Monthly Tritium in Precipitation

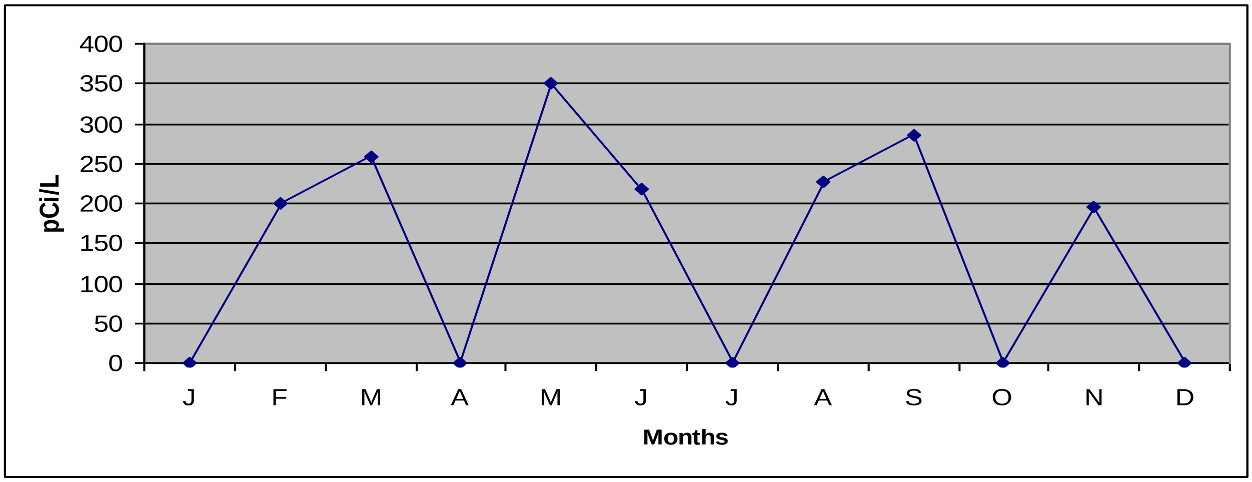
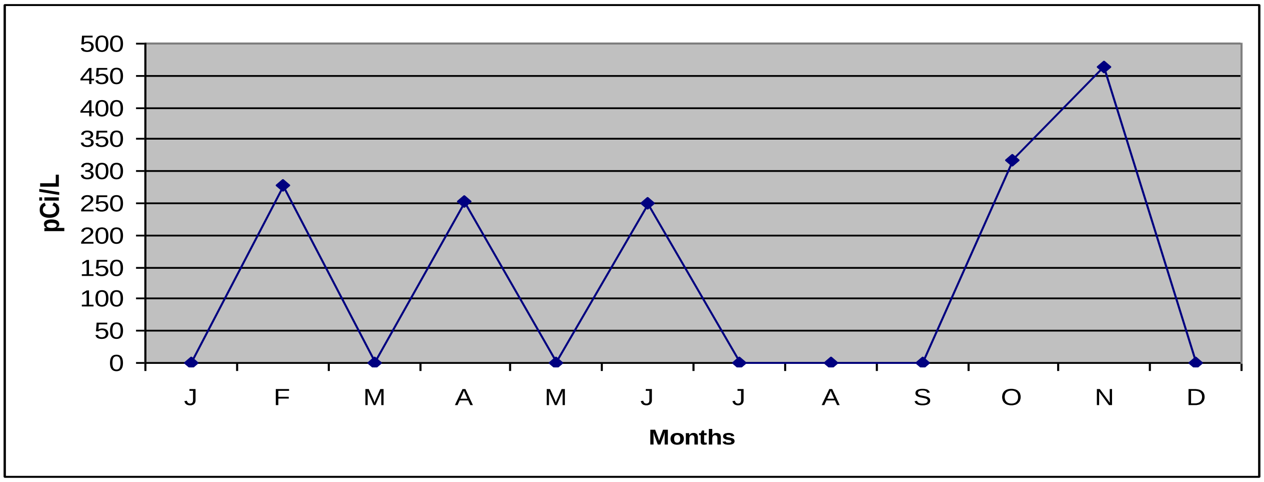


Figure 29. DKH Monthly Tritium in Precipitation



Note: Gaps in data indicate where no sample was available.
Samples that were less than the LLD are shown as 0.00.

TOC

1.1.4 DATA
2010 Radiological Atmospheric Monitoring on and Adjacent to SRS

2010 Quarterly TLD Beta/Gamma Data

2010 Air Station Data

Notes:
Blank Spaces -- No Sample Available
NA -- Not Applicable
< -- Less Than LLD

Quarterly TLD Beta/Gamma Summary 2010

Sample Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	20.00	15.00	24.00	15.00	74.00
Colocated with BGN Air Station	34.00	24.00	30.00	32.00	120.00
Green Pond (P)	22.00	18.00	23.00	21.00	84.00
Colocated with JAK Air Station (P)	33.00	17.00	21.00	16.00	87.00
Crackerneck Gate (P)	23.00	19.00	29.00	23.00	94.00
TNX Boat Ramp (P)	37.00	25.00	33.00	26.00	121.00
Colocated with ABR Air Station (P)	19.00	14.00	19.00	15.00	67.00
Junction of Millet Road and Round Tree Road (P)	24.00	21.00	24.00	23.00	92.00
Patterson Mill Road at Lower Three Runs Creek (P)	26.00	21.00	24.00	26.00	97.00
Colocated with ALN Air Station	23.00	17.00	22.00	18.00	80.00
Barnwell Airport	24.00	22.00	23.00	31.00	100.00
Colocated with SCT Air station (P)	28.00	17.00	24.00	20.00	89.00
Colocated with DKH Air station (P)	23.00	17.00	27.00	22.00	89.00
Bates Cemetery (P)	23.00	15.00	22.00	17.00	77.00
Williston Police Department	24.00	20.00	24.00	23.00	91.00
Junction of US 278 and SC 781 (P)	24.00	17.00		22.00	63.00
US 278 near Upper Three Runs Creek (P)	28.00	23.00		29.00	80.00
Colocated with NEL Air Station (P)	23.00	17.00	25.00	23.00	88.00
Winsor Post Office	23.00	17.00	25.00	18.00	83.00
Control TLD (Kept in Office)	27.00	21.00	28.00	25.00	101.00

Note: (P) indicates perimeter TLD

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Aiken Elementary Water Tower (AIK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m3	+- 2 sigma	pCi/m3	+- 2 sigma	pCi/m3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0019	0.0007	0.0245	0.0018				
01/12/10	0.0034	0.0009	0.0247	0.0017				
01/19/10	0.0042	0.0009	0.0263	0.0018				
01/26/10	0.0015	0.0007	0.0151	0.0015	<2.19	NA	<187	NA
02/02/10	0.0023	0.0008	0.0252	0.0018				
02/09/10	0.0016	0.0008	0.0176	0.0016				
02/16/10	0.0023	0.0008	0.0194	0.0016				
02/23/10	0.0014	0.0008	0.0147	0.0015	5.04	1.12	<193	NA
03/02/10	0.0020	0.0008	0.0193	0.0016				
03/09/10	0.0039	0.0010	0.0203	0.0017				
03/16/10	0.0045	0.0010	0.0198	0.0017				
03/23/10	0.0018	0.0007	0.0138	0.0015				
03/30/10	0.0017	0.0007	0.0191	0.0017	2.50	0.98	<179	NA
04/06/10	0.0055	0.0011	0.0262	0.0018				
04/13/10	0.0014	0.0007	0.0157	0.0015				
04/20/10	0.0024	0.0009	0.0292	0.0021				
04/27/10	0.0025	0.0008	0.0276	0.0019	2.65	1.00	<182	NA
05/04/10	0.0023	0.0007	0.0203	0.0017				
05/11/10	0.0022	0.0007	0.0204	0.0017				
05/18/10	0.0024	0.0008	0.0203	0.0017				
05/25/10	0.0019	0.0007	0.0201	0.0017	<2.14	NA	<184	NA
06/01/10	0.0015	0.0007	0.0144	0.0015				
06/08/10	0.0017	0.0007	0.0191	0.0017				
06/15/10	0.0033	0.0009	0.0255	0.0019				
06/22/10	0.0031	0.0009	0.0206	0.0017				
06/29/10	0.0014	0.0007	0.0145	0.0014	2.23	0.98	<179	NA
07/06/10	0.0019	0.0008	0.0151	0.0014				
07/13/10	0.0015	0.0008	0.0195	0.0016				
07/20/10	0.0026	0.0010	0.0181	0.0017				
07/27/10	0.0019	0.0008	0.0178	0.0017	2.62	1.16	<189	NA
08/03/10	0.0012	0.0008	0.0202	0.0017				
08/10/10	0.0023	0.0009	0.0294	0.0020				
08/18/10	0.0014	0.0008	0.0115	0.0013				
08/24/10	0.0022	0.0010	0.0164	0.0017				
08/31/10	0.0022	0.0009	0.0252	0.0019	<2.09	NA	<202	NA
09/07/10	0.0023	0.0010	0.0389	0.0022				
09/14/10	0.0025	0.0010	0.0314	0.0020				
09/21/10	0.0026	0.0010	0.0410	0.0023				
09/28/10	0.0021	0.0010	0.0285	0.0019	2.64	1.00	<180	NA
10/05/10	<0.0009	NA	0.0200	0.0016				
10/12/10	0.0021	0.0009	0.0375	0.0021				
10/19/10	0.0030	0.0011	0.0384	0.0022				
10/26/10	0.0014	0.0010	0.0343	0.0021	<2.17	NA	<291	NA
11/02/10	<0.0011	NA	0.0219	0.0017				
11/10/10	0.0016	0.0008	0.0230	0.0016				
11/16/10	0.0020	0.0011	0.0278	0.0021				
11/23/10	0.0021	0.0010	0.0297	0.0019	<2.65	NA	<182	NA
11/30/10	0.0013	0.0009	0.0224	0.0018				
12/07/10	0.0024	0.0010	0.0295	0.0020				
12/14/10	0.0030	0.0011	0.0225	0.0018				
12/21/10	0.0015	0.0010	0.0237	0.0018				
12/30/10	0.0014	0.0009	0.0232	0.0016	<3.67	NA	<277	NA

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	New Ellenton, SC (NEL)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0022	0.0008	0.0242	0.0018				
01/12/10	0.0017	0.0007	0.0262	0.0018				
01/19/10	0.0036	0.0009	0.0285	0.0019				
01/26/10	0.0013	0.0007	0.0138	0.0015	6.18	1.18	<187	NA
02/02/10	0.0017	0.0008	0.0255	0.0019				
02/09/10	0.0023	0.0009	0.0194	0.0017				
02/16/10	0.0022	0.0008	0.0196	0.0017				
02/23/10	0.0018	0.0009	0.0158	0.0016	<2.13	NA	<193	NA
03/02/10	0.0019	0.0008	0.0205	0.0017				
03/09/10	0.0025	0.0009	0.0192	0.0017				
03/16/10	0.0025	0.0009	0.0186	0.0017				
03/23/10	0.0013	0.0007	0.0160	0.0016				
03/30/10	0.0021	0.0008	0.0198	0.0018	3.54	1.03	<179	NA
04/06/10	0.0049	0.0011	0.0242	0.0019				
04/13/10	0.0021	0.0008	0.0185	0.0016				
04/20/10	0.0015	0.0007	0.0269	0.0019				
04/27/10	0.0021	0.0008	0.0266	0.0019	4.45	1.08	<182	NA
05/04/10	0.0022	0.0007	0.0197	0.0017				
05/11/10	0.0025	0.0007	0.0202	0.0017				
05/18/10	0.0016	0.0007	0.0211	0.0017				
05/25/10	0.0021	0.0007	0.0203	0.0017	10.46	1.31	467.47	95.55
06/01/10	0.0019	0.0007	0.0172	0.0016				
06/08/10	0.0016	0.0007	0.0206	0.0017				
06/15/10	0.0029	0.0008	0.0272	0.0019				
06/22/10	0.0023	0.0008	0.0200	0.0016				
06/29/10	0.0018	0.0008	0.0155	0.0015	3.69	1.04	<179	NA
07/06/10	0.0018	0.0008	0.0163	0.0015				
07/13/10	0.0018	0.0008	0.0195	0.0016				
07/20/10	0.0017	0.0009	0.0174	0.0016				
07/27/10	0.0024	0.0008	0.0170	0.0016	6.56	1.27	<189	NA
08/03/10								
08/10/10	0.0014	0.0007	0.0222	0.0016				
08/18/10	<0.0013	NA	0.0113	0.0013				
08/24/10	0.0022	0.0010	0.0163	0.0017				
08/31/10	0.0025	0.0009	0.0259	0.0019	2.94	1.04	<202	NA
09/07/10	0.0030	0.0010	0.0387	0.0022				
09/14/10	0.0023	0.0010	0.0327	0.0020				
09/21/10	0.0030	0.0011	0.0414	0.0022				
09/28/10	0.0028	0.0010	0.0254	0.0019	5.93	1.10	<180	NA
10/05/10	0.0018	0.0008	0.0199	0.0016				
10/12/10	0.0027	0.0010	0.0400	0.0022				
10/19/10	0.0013	0.0010	0.0426	0.0023				
10/26/10	0.0017	0.0010	0.0378	0.0022	2.50	1.03	<291	NA
11/02/10	<0.0011	NA	0.0202	0.0016				
11/10/10	0.0021	0.0008	0.0215	0.0015				
11/16/10	0.0027	0.0012	0.0254	0.0020				
11/23/10	0.0022	0.0010	0.0306	0.0019	5.29	1.25	691.70	104.78
11/30/10	0.0017	0.0009	0.0203	0.0017				
12/07/10	0.0031	0.0011	0.0284	0.0021				
12/14/10	0.0025	0.0011	0.0221	0.0019				
12/21/10	0.0017	0.0011	0.0252	0.0019				
12/30/10	0.0012	0.0007	0.0226	0.0014	8.20	2.20	455.74	202.70

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Jackson, SC (JAK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0026	0.0008	0.0254	0.0018				
01/12/10	0.0032	0.0009	0.0286	0.0019				
01/19/10	0.0032	0.0009	0.0289	0.0019				
01/26/10	0.0014	0.0007	0.0155	0.0016	4.50	1.11	513.49	100.23
02/02/10	0.0026	0.0008	0.0261	0.0018				
02/09/10	<0.0011	NA	0.0190	0.0016				
02/16/10	0.0022	0.0008	0.0207	0.0017				
02/23/10	0.0017	0.0008	0.0153	0.0015	2.23	1.00	<193	NA
03/02/10	0.0023	0.0008	0.0198	0.0017				
03/09/10	0.0029	0.0009	0.0217	0.0017				
03/16/10	0.0032	0.0009	0.0189	0.0017				
03/23/10	0.0014	0.0007	0.0154	0.0016				
03/30/10	0.0014	0.0007	0.0187	0.0017	5.61	1.10	618.89	101.97
04/06/10	0.0039	0.0009	0.0242	0.0018				
04/13/10	0.0017	0.0007	0.0190	0.0016				
04/20/10	0.0020	0.0008	0.0256	0.0018				
04/27/10	0.0024	0.0008	0.0254	0.0019	3.44	1.02	<182	NA
05/04/10	0.0021	0.0007	0.0195	0.0017				
05/11/10	0.0019	0.0007	0.0212	0.0017				
05/18/10	0.0024	0.0008	0.0189	0.0016				
05/25/10	0.0015	0.0006	0.0180	0.0016	2.95	1.03	<184	NA
06/01/10	0.0012	0.0006	0.0170	0.0015				
06/08/10	0.0013	0.0007	0.0191	0.0017				
06/15/10	0.0033	0.0009	0.0266	0.0019				
06/22/10	0.0026	0.0008	0.0198	0.0016				
06/29/10	0.0016	0.0007	0.0139	0.0014	5.63	1.12	185.47	84.16
07/06/10	0.0019	0.0008	0.0148	0.0015				
07/13/10	0.0012	0.0008	0.0195	0.0016				
07/20/10	0.0024	0.0009	0.0161	0.0015				
07/27/10	0.0026	0.0009	0.0169	0.0016	4.59	1.22	<189	NA
08/03/10	<0.0012	NA	0.0018	0.0016				
08/10/10	0.0017	0.0008	0.0237	0.0018				
08/18/10	<0.0012	NA	0.0102	0.0012				
08/24/10	0.0018	0.0009	0.0144	0.0016				
08/31/10	0.0024	0.0009	0.0252	0.0018	6.87	1.27	398.42	101.14
09/07/10	0.0027	0.0010	0.0365	0.0021				
09/14/10	0.0020	0.0009	0.0320	0.0020				
09/21/10	0.0020	0.0010	0.0398	0.0022				
09/28/10	<0.0011	NA	0.0251	0.0018	4.62	1.08	<180	NA
10/05/10	0.0011	0.0008	0.0202	0.0017				
10/12/10	0.0022	0.0010	0.0388	0.0022				
10/19/10	0.0017	0.0010	0.0417	0.0022				
10/26/10	<0.0022	NA	0.0536	0.0034	<2.17	NA	<291	NA
11/02/10	<0.0011	NA	0.0187	0.0016				
11/10/10	<0.0009	NA	0.0217	0.0015				
11/16/10	0.0020	0.0011	0.0259	0.0020				
11/23/10	0.0014	0.0009	0.0306	0.0019	5.29	1.25	<182	NA
11/30/10	<0.0011	NA	0.0061	0.0011				
12/07/10	0.0029	0.0010	0.0282	0.0019				
12/14/10	0.0026	0.0010	0.0213	0.0017				
12/21/10	0.0022	0.0010	0.0236	0.0017				
12/30/10	<0.0011	NA	0.0230	0.0015	<3.67	NA	<277	NA

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Burial Grounds North (BGN)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0020	0.0007	0.0263	0.0019				
01/12/10	0.0042	0.0010	0.0264	0.0018				
01/19/10	0.0037	0.0009	0.0312	0.0020				
01/26/10	0.0016	0.0007	0.0150	0.0015	171.31	4.01	8986.21	273.83
02/02/10	0.0024	0.0008	0.0252	0.0018				
02/09/10	0.0019	0.0008	0.0178	0.0016				
02/16/10	0.0026	0.0008	0.0212	0.0017				
02/23/10	0.0019	0.0009	0.0177	0.0016	185.56	4.19	2734.36	166.70
03/02/10	0.0025	0.0009	0.0221	0.0019				
03/09/10	0.0043	0.0010	0.0242	0.0018				
03/16/10	0.0050	0.0011	0.0230	0.0018				
03/23/10	0.0011	0.0006	0.0135	0.0014				
03/30/10	<0.0009	NA	0.0144	0.0014	192.76	4.22	13631.46	333.19
04/06/10	0.0056	0.0011	0.0245	0.0018				
04/13/10	0.0018	0.0008	0.0175	0.0016				
04/20/10	0.0022	0.0008	0.0266	0.0019				
04/27/10	0.0024	0.0008	0.0233	0.0018	157.71	3.79	1507.19	131.94
05/04/10	0.0015	0.0006	0.0184	0.0016				
05/11/10	0.0018	0.0007	0.0201	0.0017				
05/18/10	0.0019	0.0008	0.0199	0.0017				
05/25/10	0.0022	0.0007	0.0188	0.0016	84.53	2.87	8998.76	255.82
06/01/10	0.0019	0.0007	0.0165	0.0015				
06/08/10	0.0026	0.0008	0.0169	0.0016				
06/15/10	0.0031	0.0008	0.0236	0.0018				
06/22/10	0.0017	0.0007	0.0181	0.0016				
06/29/10	0.0018	0.0008	0.0123	0.0013	143.74	3.66	961.40	113.76
07/06/10	0.0016	0.0008	0.0157	0.0015				
07/13/10	0.0020	0.0009	0.0203	0.0017				
07/20/10	0.0028	0.0009	0.0166	0.0015				
07/27/10	0.0017	0.0007	0.0148	0.0014	104.98	3.32	1776.04	141.51
08/03/10	0.0022	0.0009	0.0167	0.0015				
08/10/10	0.0021	0.0009	0.0226	0.0017				
08/18/10	<0.0011	NA	0.0109	0.0012				
08/24/10	0.0018	0.0009	0.0142	0.0016				
08/31/10	0.0020	0.0008	0.0238	0.0017	218.76	4.67	2105.94	156.50
09/07/10	0.0038	0.0010	0.0364	0.0020				
09/14/10	0.0036	0.0011	0.0302	0.0020				
09/21/10	0.0035	0.0012	0.0406	0.0023				
09/28/10	0.0021	0.0011	0.0253	0.0020	236.05	4.34	400.72	93.64
10/05/10	0.0013	0.0009	0.0206	0.0018				
10/12/10	0.0026	0.0010	0.0364	0.0022				
10/19/10	0.0023	0.0011	0.0392	0.0022				
10/26/10	0.0015	0.0010	0.0364	0.0021	373.02	5.84	5269.05	406.11
11/02/10	0.0013	0.0008	0.0186	0.0016				
11/10/10	0.0012	0.0007	0.0202	0.0015				
11/16/10	0.0023	0.0011	0.0282	0.0020				
11/23/10	0.0017	0.0009	0.0286	0.0018	371.06	5.76	2365.79	153.47
11/30/10	0.0019	0.0009	0.0229	0.0017				
12/07/10	0.0018	0.0009	0.0284	0.0018				
12/14/10	0.0014	0.0008	0.0213	0.0017				
12/21/10	<0.0012	NA	0.0221	0.0016				
12/30/10	0.0013	0.0008	0.0221	0.0015	214.96	8.78	4329.49	366.05

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Allendale Barricade (ABR)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0022	0.0007	0.0256	0.0018				
01/12/10	0.0023	0.0008	0.0272	0.0018				
01/19/10	0.0028	0.0008	0.0288	0.0018				
01/26/10	0.0016	0.0007	0.0150	0.0015	3.45	1.07	<187	NA
02/02/10	0.0026	0.0008	0.0255	0.0018				
02/09/10	<0.0011	NA	0.0187	0.0016				
02/16/10	0.0016	0.0007	0.0219	0.0017				
02/23/10	0.0021	0.0008	0.0157	0.0015	<2.13	NA	<193	NA
03/02/10	0.0021	0.0008	0.0218	0.0017				
03/09/10	0.0022	0.0008	0.0198	0.0016				
03/16/10	0.0028	0.0008	0.0161	0.0014				
03/23/10	0.0010	0.0006	0.0127	0.0014				
03/30/10	<0.0010	NA	0.0158	0.0015	3.47	1.03	<179	NA
04/06/10	0.0043	0.0010	0.0267	0.0019				
04/13/10	0.0016	0.0007	0.0175	0.0016				
04/20/10	0.0015	0.0008	0.0249	0.0019				
04/27/10	0.0019	0.0008	0.0245	0.0019	4.00	1.06	<182	NA
05/04/10	0.0019	0.0007	0.0205	0.0016				
05/11/10	0.0018	0.0006	0.0193	0.0016				
05/18/10	0.0012	0.0007	0.0198	0.0016				
05/25/10	0.0012	0.0006	0.0193	0.0016	<2.14	NA	<184	NA
06/01/10	0.0017	0.0007	0.0146	0.0015				
06/08/10	0.0014	0.0007	0.0181	0.0016				
06/15/10	0.0018	0.0007	0.0246	0.0018				
06/22/10	0.0029	0.0009	0.0173	0.0016				
06/29/10	0.0015	0.0007	0.0134	0.0014	2.97	1.01	<179	NA
07/06/10	0.0016	0.0008	0.0145	0.0014				
07/13/10	0.0018	0.0008	0.0193	0.0016				
07/20/10	0.0016	0.0008	0.0173	0.0015				
07/27/10	0.0024	0.0008	0.0148	0.0015	<2.33	NA	<189	NA
08/03/10	0.0017	0.0008	0.0176	0.0015				
08/10/10	0.0017	0.0008	0.0213	0.0017				
08/18/10	0.0012	0.0008	0.0094	0.0012				
08/24/10	<0.0013	NA	0.0128	0.0015				
08/31/10	0.0031	0.0010	0.0247	0.0018	2.29	1.10	<202	NA
09/07/10	0.0029	0.0010	0.0330	0.0020				
09/14/10	0.0024	0.0010	0.0284	0.0019				
09/21/10	0.0016	0.0009	0.0399	0.0022				
09/28/10	0.0015	0.0009	0.0243	0.0018	<2.07	NA	<180	NA
10/05/10	0.0011	0.0007	0.0195	0.0016				
10/12/10	0.0023	0.0010	0.0361	0.0021				
10/19/10	0.0027	0.0011	0.0354	0.0021				
10/26/10	<0.0012	NA	0.0359	0.0021	3.33	1.07	<291	NA
11/02/10	0.0013	0.0008	0.0197	0.0016				
11/10/10	0.0021	0.0008	0.0224	0.0016				
11/16/10	0.0021	0.0011	0.0250	0.0019				
11/23/10	0.0013	0.0009	0.0286	0.0018	<2.65	NA	<182	NA
11/30/10	0.0015	0.0009	0.0214	0.0017				
12/07/10	0.0019	0.0009	0.0271	0.0018				
12/14/10	0.0026	0.0010	0.0223	0.0017				
12/21/10	<0.0012	NA	0.0216	0.0016				
12/30/10	0.0018	0.0008	0.0219	0.0015	5.58	2.59	569.67	159.26

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Allendale, SC (ALN)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0029	0.0008	0.0260	0.0018				
01/12/10	0.0026	0.0008	0.0267	0.0018				
01/19/10	0.0027	0.0008	0.0277	0.0018				
01/26/10	0.0018	0.0007	0.0159	0.0016	<2.19	NA	<187	NA
02/02/10	0.0020	0.0008	0.0235	0.0017				
02/09/10	0.0016	0.0008	0.0172	0.0016				
02/16/10	0.0014	0.0007	0.0222	0.0017				
02/23/10	0.0024	0.0009	0.0140	0.0015	<2.13	NA	<193	NA
03/02/10	0.0021	0.0008	0.0226	0.0018				
03/09/10	0.0040	0.0009	0.0222	0.0017				
03/16/10	0.0027	0.0008	0.0176	0.0015				
03/23/10	0.0009	0.0006	0.0138	0.0014				
03/30/10	<0.0009	NA	0.0150	0.0015	2.08	0.96	<179	NA
04/06/10	0.0046	0.0010	0.0286	0.0020				
04/13/10	0.0022	0.0008	0.0180	0.0016				
04/20/10	0.0026	0.0009	0.0247	0.0018				
04/27/10	0.0019	0.0007	0.0243	0.0018	3.06	1.02	<182	NA
05/04/10	0.0019	0.0007	0.0174	0.0016				
05/11/10	0.0017	0.0006	0.0201	0.0017				
05/18/10	0.0016	0.0007	0.0194	0.0016				
05/25/10	0.0015	0.0006	0.0187	0.0016	<2.14	NA	<184	NA
06/01/10	0.0015	0.0007	0.0150	0.0015				
06/08/10	0.0017	0.0007	0.0175	0.0016				
06/15/10	0.0035	0.0009	0.0253	0.0018				
06/22/10	0.0027	0.0009	0.0185	0.0016				
06/29/10	0.0016	0.0007	0.0149	0.0015	<2.08	NA	<179	NA
07/06/10	0.0011	0.0007	0.0145	0.0014				
07/13/10	0.0019	0.0009	0.0223	0.0017				
07/20/10	0.0015	0.0008	0.0196	0.0016				
07/27/10	0.0022	0.0008	0.0163	0.0015	<2.33	NA	<189	NA
08/03/10	0.0017	0.0008	0.0187	0.0016				
08/10/10	0.0028	0.0010	0.0201	0.0017				
08/18/10	<0.0012	NA	0.0114	0.0013				
08/24/10	0.0019	0.0010	0.0128	0.0016				
08/31/10	0.0017	0.0009	0.0234	0.0018	<2.09	NA	<202	NA
09/07/10	0.0031	0.0010	0.0325	0.0020				
09/14/10	0.0024	0.0010	0.0267	0.0019				
09/21/10	0.0026	0.0010	0.0420	0.0023				
09/28/10	<0.0011	NA	0.0275	0.0019	<2.07	NA	<180	NA
10/05/10	0.0016	0.0008	0.0203	0.0017				
10/12/10	0.0018	0.0009	0.0390	0.0022				
10/19/10	0.0025	0.0011	0.0361	0.0021				
10/26/10	0.0014	0.0010	0.0342	0.0021	3.57	1.07	<291	NA
11/02/10	<0.0011	NA	0.0187	0.0016				
11/10/10	0.0016	0.0008	0.0218	0.0015				
11/16/10	0.0016	0.0011	0.0271	0.0020				
11/23/10	<0.0012	NA	0.0049	0.0010	<2.65	NA	<182	NA
11/30/10	0.0024	0.0010	0.0235	0.0018				
12/07/10	0.0023	0.0009	0.0275	0.0018				
12/14/10	0.0024	0.0009	0.0211	0.0017				
12/21/10	<0.0012	NA	0.0218	0.0016				
12/30/10	0.0018	0.0008	0.0208	0.0014	<3.67	NA	<277	NA

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Snelling, SC South Carolina Advanced Technology Park (SCT)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0026	0.0008	0.0265	0.0018				
01/12/10	0.0039	0.0009	0.0277	0.0018				
01/19/10	0.0022	0.0007	0.0291	0.0019				
01/26/10	0.0016	0.0007	0.0165	0.0016	7.78	1.24	<187	NA
02/02/10	0.0021	0.0008	0.0253	0.0018				
02/09/10	0.0011	0.0007	0.0174	0.0016				
02/16/10	0.0026	0.0008	0.0223	0.0017				
02/23/10	0.0025	0.0009	0.0149	0.0015	8.41	1.25	200.82	89.86
03/02/10	0.0026	0.0008	0.0213	0.0017				
03/09/10	0.0034	0.0009	0.0224	0.0017				
03/16/10	0.0037	0.0009	0.0144	0.0014				
03/23/10	0.0015	0.0007	0.0122	0.0014				
03/30/10	<0.0009	NA	0.0144	0.0015	8.20	1.21	258.34	87.29
04/06/10	0.0071	0.0012	0.0273	0.0019				
04/13/10	0.0015	0.0007	0.0164	0.0015				
04/20/10	0.0028	0.0009	0.0256	0.0018				
04/27/10	0.0018	0.0007	0.0254	0.0019	7.68	1.20	<182	NA
05/04/10	0.0015	0.0006	0.0198	0.0017				
05/11/10	0.0023	0.0007	0.0193	0.0017				
05/18/10	0.0015	0.0007	0.0177	0.0015				
05/25/10	0.0015	0.0006	0.0182	0.0016	2.55	1.01	350.60	93.64
06/01/10	0.0012	0.0006	0.0154	0.0015				
06/08/10	0.0019	0.0007	0.0186	0.0016				
06/15/10	0.0035	0.0009	0.0246	0.0019				
06/22/10	0.0019	0.0007	0.0171	0.0015				
06/29/10	0.0016	0.0007	0.0152	0.0014	9.60	1.27	218.94	85.52
07/06/10	0.0010	0.0007	0.0154	0.0014				
07/13/10	0.0021	0.0009	0.0204	0.0017				
07/20/10	0.0023	0.0009	0.0166	0.0015				
07/27/10	0.0020	0.0008	0.0154	0.0015	5.91	1.22	<189	NA
08/03/10	0.0011	0.0007	0.0179	0.0016				
08/10/10	0.0019	0.0008	0.0217	0.0017				
08/18/10	<0.0011	NA	0.0116	0.0012				
08/24/10	0.0021	0.0010	0.0139	0.0016				
08/31/10	0.0026	0.0009	0.0247	0.0018	2.94	1.04	227.67	95.69
09/07/10	0.0028	0.0010	0.0336	0.0020				
09/14/10	0.0025	0.0010	0.0291	0.0019				
09/21/10	0.0033	0.0011	0.0384	0.0022				
09/28/10	0.0014	0.0009	0.0251	0.0018	4.62	1.08	286.23	85.13
10/05/10	0.0014	0.0008	0.0196	0.0016				
10/12/10	0.0028	0.0010	0.0376	0.0021				
10/19/10	0.0023	0.0011	0.0369	0.0021				
10/26/10	<0.0012	NA	0.0365	0.0021	7.29	1.22	<291	NA
11/02/10	0.0015	0.0009	0.0190	0.0016				
11/10/10	0.0011	0.0007	0.0203	0.0015				
11/16/10	0.0025	0.0011	0.0235	0.0019				
11/23/10	0.0016	0.0009	0.0277	0.0018	5.95	1.30	196.01	85.13
11/30/10	0.0017	0.0009	0.0225	0.0017				
12/07/10	0.0022	0.0009	0.0257	0.0018				
12/14/10	0.0031	0.0010	0.0216	0.0017				
12/21/10	<0.0012	NA	0.0217	0.0016				
12/30/10	0.0014	0.0008	0.0204	0.0014	16.74	2.77	<277	NA

Routine Radiological Atmospheric Monitoring Data, 2010

Sample Location:	Willsiton Barricade (DKH)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Rain	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/05/10	0.0016	0.0007	0.0244	0.0018				
01/12/10	0.0027	0.0008	0.0249	0.0017				
01/19/10	0.0023	0.0007	0.0275	0.0018				
01/26/10	0.0014	0.0007	0.0136	0.0015	4.72	1.12	<187	NA
02/02/10	0.0017	0.0007	0.0205	0.0017				
02/09/10	0.0013	0.0007	0.0174	0.0016				
02/16/10	0.0028	0.0012	0.0157	0.0022				
02/23/10	0.0015	0.0009	0.0137	0.0016	2.84	1.03	276.84	93.54
03/02/10	0.0020	0.0008	0.0204	0.0017				
03/09/10	0.0024	0.0008	0.0205	0.0016				
03/16/10	0.0033	0.0009	0.0179	0.0016				
03/23/10	<0.0009	NA	0.0145	0.0015				
03/30/10	0.0016	0.0007	0.0165	0.0016	3.46	1.03	<179	NA
04/06/10								
04/13/10	0.0014	0.0007	0.0175	0.0016				
04/20/10	0.0027	0.0009	0.0249	0.0018				
04/27/10	0.0018	0.0007	0.0238	0.0018	3.26	1.03	252.38	87.94
05/04/10	0.0019	0.0007	0.0197	0.0017				
05/11/10	0.0025	0.0007	0.0194	0.0017				
05/18/10	0.0017	0.0007	0.0184	0.0015				
05/25/10	0.0024	0.0007	0.0224	0.0017	2.98	1.03	<184	NA
06/01/10	0.0013	0.0006	0.0168	0.0015				
06/08/10	0.0016	0.0007	0.0160	0.0015				
06/15/10	0.0018	0.0007	0.0216	0.0017				
06/22/10	0.0023	0.0008	0.0193	0.0016				
06/29/10	0.0019	0.0008	0.0162	0.0015	7.59	1.20	251.27	87.18
07/06/10	<0.0010	NA	0.0141	0.0014				
07/13/10	0.0017	0.0008	0.0207	0.0017				
07/20/10	0.0014	0.0008	0.0167	0.0015				
07/27/10	0.0020	0.0008	0.0165	0.0015	7.22	1.32	<189	NA
08/03/10	0.0015	0.0008	0.0168	0.0015				
08/10/10	0.0022	0.0009	0.0247	0.0018				
08/18/10	<0.0012	NA	0.0102	0.0012				
08/24/10	<0.0013	NA	0.0123	0.0015				
08/31/10	0.0011	0.0007	0.0234	0.0017	5.56	1.16	<202	NA
09/07/10	0.0022	0.0009	0.0340	0.0020				
09/14/10	0.0016	0.0009	0.0281	0.0019				
09/21/10	0.0029	0.0011	0.0373	0.0021				
09/28/10	<0.00114	NA	0.0244	0.0018	5.93	1.10	<180	NA
10/05/10	<0.0009	NA	0.0181	0.0016				
10/12/10	0.0023	0.0010	0.0376	0.0021				
10/19/10	0.0021	0.0010	0.0290	0.0019				
10/26/10	0.0019	0.0010	0.0328	0.0020	4.13	1.10	316.72	180.18
11/02/10	<0.0011	NA	0.0168	0.0015				
11/10/10	0.0016	0.0008	0.0206	0.0015				
11/16/10	0.0020	0.0011	0.0252	0.0019				
11/23/10	<0.0011	NA	0.0293	0.0019	3.31	1.27	462.97	97.26
11/30/10	0.0025	0.0010	0.0202	0.0016				
12/07/10	0.0026	0.0009	0.0252	0.0017				
12/14/10	0.0023	0.0009	0.0234	0.0017				
12/21/10	<0.0012	NA	0.0221	0.0016				
12/30/10	0.0012	0.0008	0.0201	0.0014	4.92	2.46	<277	NA

TOC

1.1.5 SUMMARY STATISTICS

Note:
Avg—Average
Std Dev—Standard Deviation

Min—Minimum
Max—Maximum
N—Number of Samples
( )—Number of Detections

Yearly Average of Ambient TLD Beta/Gamma Summary 2010

Sample Location	Quarterly Avg	Std Dev	Min	Max	Median
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	18.50	4.36	15.00	24.00	17.50
Colocated with BGN Air Station	30.00	4.32	24.00	34.00	31.00
Green Pond (P)	21.00	2.16	18.00	23.00	21.50
Colocated with JAK Air Station (P)	21.75	7.80	16.00	33.00	19.00
Crackerneck Gate (P)	23.50	4.12	19.00	29.00	23.00
TNX Boat Ramp (P)	30.25	5.74	25.00	37.00	29.50
Colocated with ABR Air Station (P)	16.75	2.63	14.00	19.00	17.00
Junction of Millet Road and Round Tree Road (P)	23.00	1.41	21.00	24.00	23.50
Patterson Mill Road at Lower Three Runs Creek (P)	24.25	2.36	21.00	26.00	25.00
Colocated with ALN Air Station	20.00	2.94	17.00	23.00	20.00
Barnwell Airport	25.00	4.08	22.00	31.00	23.50
Colocated with SCT Air station (P)	22.25	4.79	17.00	28.00	22.00
Colocated with DKH Air station (P)	22.25	4.11	17.00	27.00	22.50
Bates Cemetery (P)	19.25	3.86	15.00	23.00	19.50
Williston Police Department	22.75	1.89	20.00	24.00	23.50
Junction of US 278 and SC 781 (P)	21.00	3.61	17.00	24.00	22.00
US 278 near Upper Three Runs Creek (P)	26.67	3.21	23.00	29.00	28.00
Colocated with NEL Air Station (P)	22.00	3.46	17.00	25.00	23.00
Winsor Post Office	20.75	3.86	17.00	25.00	20.50
Control TLD (Kept in Office)	25.25	3.10	21.00	28.00	26.00

Note: (P) indicates perimeter TLD

Summary Statistics

Statistical Review Of Radiological Monitoring at Aiken Elementary Water Tower (AIK)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52 (50)	52 (50)	12 (5)	12 (0)
Mean	0.0022	0.0231	2.95	No Detections
Std Dev	0.0009	0.0068	1.04	
Median	0.0021	0.0213	2.63	
Min	0.0012	0.0115	2.23	
Max	0.0055	0.0410	5.04	

Statistical Review Of Radiological Monitoring at New Ellenton, SC (NEL)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	51 (49)	51 (51)	12 (11)	12 (3)
Mean	0.0022	0.0233	5.43	538.30
Std Dev	0.0007	0.0071	2.40	132.98
Median	0.0021	0.0206	5.29	467.47
Min	0.0012	0.0113	2.50	455.74
Max	0.0049	0.0426	10.46	691.70

Statisical Review Of Radiological Monitoring at Jackson, SC (JAK)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(43)	52(52)	12(10)	12(4)
Mean	0.0022	0.0225	4.57	429.07
Std Dev	0.0007	0.0088	1.39	185.69
Median	0.0021	0.0210	4.60	455.96
Min	0.0011	0.0018	2.23	185.47
Max	0.0039	0.0536	6.87	618.89

Statisical Review Of Radiological Monitoring at Burial Grounds North, SRS (BGN)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(49)	52(52)	12(12)	12(12)
Mean	0.0023	0.0225	204.54	4422.20
Std Dev	0.0010	0.0069	90.06	4083.26
Median	0.0020	0.0217	189.16	2550.07
Min	0.0011	0.0109	84.53	400.72
Max	0.0056	0.0406	373.02	13631.46

Statistical Review Of Radiological Monitoring at Allendale Barricade (ABR)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(46)	52(52)	12(7)	12(1)
Mean	0.0020	0.0219	3.59	One Detection 569.67
Std Dev	0.0006	0.0065	1.02	
Median	0.0018	0.0214	3.45	
Min	0.0010	0.0094	2.29	
Max	0.0043	0.0399	5.58	

Summary Statistics

Statistical Review Of Radiological Monitoring at Allendale, SC (ALN)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(46)	52(52)	12(3)	12(0)
Mean	0.0021	0.0218	2.90	No Detections
Std Dev	0.0007	0.0069	0.76	
Median	0.0019	0.0210	3.06	
Min	0.0009	0.0049	2.08	
Max	0.0046	0.0420	3.57	

Statistical Review Of Raiological Monitoring at Snelling, SC (SCT)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(48)	52(52)	12(12)	12(7)
Mean	0.0022	0.0220	7.30	248.37
Std Dev	0.0010	0.0066	3.68	55.20
Median	0.0021	0.0209	7.49	227.67
Min	0.0010	0.0116	2.55	196.01
Max	0.0071	0.0384	16.74	350.60

Statistical Review Of Radiological Monitoring at Dark Horse (DKH)				
Analyte	Gross Alpha in Air	Gross Beta in Air	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	51(42)	51(51)	12(12)	12(5)
Mean	0.0020	0.0212	4.66	312.03
Std Dev	0.0005	0.0061	1.63	88.45
Median	0.0019	0.0204	4.42	276.84
Min	0.0011	0.0102	2.84	251.27
Max	0.0033	0.0376	7.59	462.97

TOC

2.1 Ambient Groundwater Monitoring Adjacent to SRS

2.1.1 Summary

The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) samples an ambient groundwater monitoring network adjacent to the Savannah River Site (SRS) to characterize groundwater quality in the area. This annual evaluation is conducted to determine possible offsite groundwater impacts due to operations conducted at the SRS. The well network consists of existing groundwater wells owned by neighboring municipalities, businesses, and members of the public. Radiological and nonradiological contaminants have historically been detected in some network, random background and random perimeter groundwater wells. ESOP provides this project report annually as an independent source of information concerning Department of Energy-Savannah River (DOE-SR) activities and the potential impacts of those activities to public health and the environment.

DOE-SR currently utilizes a regional monitoring network consisting of approximately 230 groundwater monitoring wells. These wells, which are not routinely sampled, are maintained and sampled by various agencies. These agencies include DOE-SR, SCDHEC, South Carolina Department of Natural Resources (SCDNR), and the United States Geological Survey (USGS). ESOP has identified and considered wells in this network for inclusion in the ESOP Ambient Groundwater Monitoring Network (AGMN). For a more detailed review of background information, please refer to “A Determination of Ambient Groundwater Quality Adjacent to Savannah River Site, Annual Report 1997" (SCDHEC 1999a).

The following items outline the objectives of the project, as well as the importance of sampling for radionuclides throughout the groundwater well network:

- Evaluate groundwater quality adjacent to SRS
- Compare results with historical data
- Determine any SRS contaminant migration offsite
- Expand current ambient water quality databases
- Provide the public with independently generated, region specific, groundwater quality information.

The study area is composed of a 10-mile perimeter extending from the SRS boundary, as well as random background and random perimeter locations found throughout the state of South Carolina. ESOP is currently involved in an ongoing statistical study, where random background (B locations) and random perimeter (E locations) are sampled around the perimeter of the SRS as well as throughout the entire state of South Carolina. These sample locations are selected at random using a designated quadrant system that extends throughout the state of South Carolina. These samples are collected from private groundwater wells. Map 3, Section 2.1.2 depicts the network groundwater well locations, the extent of the study area, and the wells sampled during the 2010 sampling event. ESOP evaluates five aquifer zones from the water table to confined aquifers more than 1400 feet deep (Table 1, Section 2.1.3).

The SCDHEC analytical laboratory data from the 2010 groundwater sampling event revealed limited contaminants present in the groundwater wells sampled. These groundwater wells, along with the extent of contaminants, will be detailed in Section 2.1.4 of this report. Due to the low concentrations and limited extent of the contaminants identified in these groundwater wells, it is likely the sources of these contaminants are a result of naturally occurring processes in the subsurface.

Results and Discussion

The 2010 groundwater sampling event was comprised of 20 wells. Fourteen of these wells are designated as network wells, and the remaining six wells are classified as background and perimeter wells (Map 3, Section 2.1.2). One additional network well (G06163) was scheduled for sampling, but the designated well pump was inoperable. Based on a review of the wet chemistry, metals, tritium, gross alpha, non-volatile beta, and gamma-emitting radioisotope analytical data provided by the SCDHEC analytical and radiological laboratories, various contaminants were detected in the 20 groundwater wells sampled.

Alpha activity was not detected at any of the groundwater well locations sampled during the 2010 sampling event. Beta activity was detected at two groundwater well locations, neither of which exceeded the maximum contaminant level (MCL) of 8 picocuries per liter (pCi/L). Tritium was detected at three groundwater well locations and one duplicate sample. All three locations with tritium detections are identified as network wells. These tritium detections are well below the MCL drinking water standard of 20,000 pCi/L (Figure 1).

Additional radiological samples (Plutonium and Uranium) were collected from the same background and perimeter locations during the 2010 groundwater sampling event. These samples were collected in an effort to help ESOP develop a baseline before the SRS MOX (Mixed Oxide) fuel fabrication facility becomes operational. Of the six sample locations (3 background and 3 perimeter) there was one detection for Pu-239/240 (GWB22), three detections for U-234 (GWB21, GWB22, and GWE22X), one detection for U-235 (GWB22), and three detections for U-238 (GWB21, GWB22, and GWB23) (Section 6.0). These activities were all slightly above the detection limit and well below the United States Environmental Protection Agency (USEPA) established MCL. The source of these contaminants can likely be attributable to the naturally occurring radiological decay series commonly found in the subsurface and atmospheric deposition.

The 2010 groundwater sampling event revealed additional contamination in several groundwater well locations. Lead was detected in three groundwater wells. Only one of these wells (GWD02011) yielded a lead concentration of 0.033 mg/L which exceeded the 0.015 milligrams per liter (mg/L) MCL established by the USEPA. Due to the elevated lead concentration found in this well, a sample was recollected and the laboratory result was non-detectable. The origins of this sample discrepancy are unknown. One or more of the following contaminants: nitrate/nitrite, copper, cadmium, and thallium were detected in 12 well locations. None of these contaminants exceeded the USEPA drinking water standard.

Due to the extent of the known groundwater contamination on the SRS, SCDHEC will continue to monitor groundwater quality to identify any future SRS offsite contaminant migration.

Radiological Parameter Results

The presence of naturally occurring radionuclides has been well documented in the groundwater regime across the state of South Carolina. Groundwater investigations performed by state and federal agencies such as SCDHEC, SCDNR and the USGS have confirmed the presence of these radionuclides.

Gross alpha was not detected in any of the 20 groundwater wells sampled during the 2010 event.

Non-volatile beta was detected in two of the 20 groundwater wells that were analyzed. Calculation of summary statistics revealed a non-volatile beta average of 6.56 pCi/L for the perimeter population and an average of 4.79 pCi/L for the groundwater network wells sampled during the 2010 event (Section 2.1.5). As the presence of naturally occurring radionuclides has been well documented in the groundwater regime across the state of South Carolina, the non-volatile beta activity found in these wells is likely due to the natural decay process of uranium deposits within the subsurface.

Tritium was detected in three network wells with an average activity of 260.00 (± 86.64) pCi/L. No tritium detections were found at any of the background or perimeter locations. The locations of these wells and their concentrations of tritium can be found in Section 2.1.4. None of these wells exceeded the 20,000 pCi/L MCL for tritium.

Due to the low concentrations of tritium detected in a limited number of groundwater wells, the source of the tritium is unclear. However, the most likely contributors of tritium in the study area are the SRS, Plant Vogtle (GA), Chem Nuclear, and natural atmospheric deposition. As stakeholder interests in tritium levels continue to rise (DOE 2006), tritium sampling will continue and be addressed in future project reports.

Gamma analysis was conducted on all groundwater samples for the 2010 sampling event. However, gamma activity was below the detection level for all samples collected.

Nonradiological Parameter Results

The presence of metals and other nonradiological contaminants in the environment can be attributed to man-made processes such as industrial manufacturing and/or the natural decay of deposits. However, a review of the following metal and nonradiological contaminants detected indicates their limited presence is most likely due to the erosion of natural deposits. Additionally, the position of these wells, as related to the location of SRS's centrally located process areas, supports the theory of natural occurrence. All analytical results can be found in Section 2.1.4.

Cadmium was detected in two groundwater monitoring wells. The calculated average for cadmium in these wells is 0.000315 mg/L. Although the concentrations of cadmium in these wells are detectable, both are well below the 0.005 mg/L MCL established by the USEPA.

Copper was detected at three groundwater well locations. The calculated average for copper in these wells is 0.031 mg/L. The USEPA has established an MCL for copper of 1.3 mg/L. Although the copper concentrations found in these groundwater wells are detectable, these concentrations are well below the USEPA established MCL.

Lead was detected in three groundwater monitoring wells yielding an average concentration of 0.014 mg/L. One of the groundwater wells revealed a lead concentration of 0.033 mg/L, which exceeds the USEPA established MCL of 0.015 mg/L. A repeat sample was collected at this location and the laboratory result was non-detectable. Although the lead concentrations found in these wells are detectable, the concentrations are still below the MCL and not considered to be a known human health risk.

Nitrate/Nitrite was detected at concentrations well below the 10 mg/L MCL in ten groundwater wells. Calculation revealed a nitrate/nitrite average of 0.99 mg/L of these 10 groundwater well locations. The presence of nitrate/nitrite is most likely due to the erosion of natural deposits and/or runoff from fertilizer use. Once in the soil, nitrate is mobile due to its water solubility characteristic, and therefore moves easily through the soil matrix at a speed comparable to groundwater flow velocity.

Thallium was detected in five groundwater monitoring wells. The calculated average for thallium in these wells is 0.00057 mg/L. Although the concentrations of thallium in these wells are detectable, these concentrations do not exceed the MCL of 0.002 mg/L established by the USEPA. As a result, these concentrations are not considered known human health risks.

ESOP and DOE-SR Data Comparison

Due to the fact DOE-SR collects groundwater samples from a separate onsite monitoring well network, direct SCDHEC offsite groundwater comparisons could not be made to their findings in the latest SRS Environmental Report for 2010. However, the 2010 SRS report identifies numerous areas of groundwater contamination throughout the SRS property. These areas of impacted groundwater include A Area, B Area, C Area, D Area, E Area, F Area, H Area, K Area, L Area, M Area, N Area, P Area, R Area, S Area, Sanitary Landfill, TNX, and CMP Pits. The extent of the contamination varies and the contaminants include chlorinated volatile organics, organics, metals, tritium, gross alpha, and beta radionuclides. SCDHEC groundwater contaminates detected in the 2010 sample event include tritium, non-volatile beta, and various metals. Due to the presence of the aforementioned contaminants in the groundwater on the SRS, the ESOP groundwater project will continue sampling for these contaminants in future sampling events.

Summary Statistics

During the 2010 groundwater sampling event, 20 wells were sampled. Of these 20 wells, six of the wells are classified as random background and random perimeter wells. The remaining 14 wells are classified as network wells. These wells are located on private property (either a private residence, public water system, or church) situated around the perimeter of the SRS as well as various locations throughout the state of South Carolina. The locations of the samples collected can be found in Map 3, Section 2.1.2.

Laboratory analytical data revealed a random perimeter non-volatile beta average of 6.56 pCi/L. Given the average is below the USEPA MCL of 8 pCi/L for non-volatile beta, the concentration found in this groundwater well is unlikely to pose health risks to humans.

Summary statistics from perimeter sampling revealed a Uranium 234 average of 0.10600 pCi/L. This average is a reflection of a single detection. This groundwater sampling location did not exceed the MCL established by the USEPA.

Random background statistics also revealed an average for each of the following: Pu-239/240 0.00808 pCi/L (single detection), U-234 0.14090 (± 0.06661) pCi/L, U-235 0.02890 pCi/L (single detection), and U-238 0.09213 (± 0.09264) pCi/L. These detections are considered low and none exceed the drinking water limits established by the USEPA.

Three network well locations (GWG02292, GWD02011, and GWG02154) revealed tritium activities of 198 pCi/L, 223 pCi/L, and 359 pCi/L respectively, yielding an average of 260.00 (± 86.64) pCi/L. Although these samples are slightly above the Lower Limit of Detection (LLD), they do not exceed the 20,000 pCi/L MCL established by the USEPA. These concentrations are not considered known concerns to human health.

Conclusions and Recommendations

A review of the 2010 analytical data revealed various but limited nonradiological and/or radiological constituents in all 20 groundwater wells sampled. Although several of the groundwater wells sampled during the 2010 sampling event revealed detectable concentrations, the data suggests the extent of the contaminants are isolated and likely the result of dissolved metals and radionuclides from naturally occurring geologic formations.

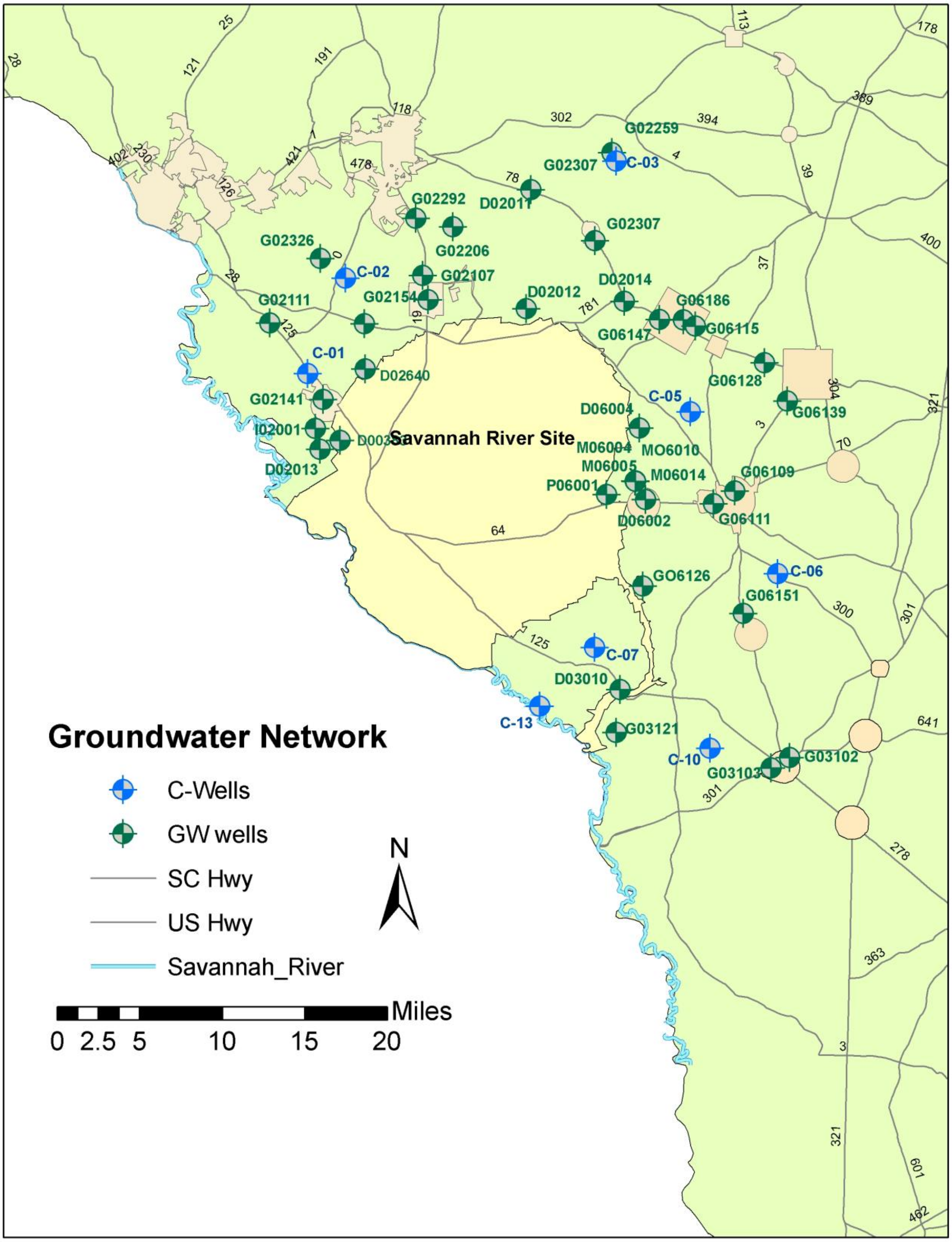
The AGQMP attempted to determine if constituents, other than naturally occurring, have impacted groundwater within the AGMN. The results of the 2010 groundwater sampling event indicate several nonradiological constituents and naturally occurring radionuclides are impacting groundwater quality in isolated regions throughout the groundwater monitoring well network. Independent monitoring of basic water quality parameters, metals, VOC's, tritium, gross alpha, non-volatile beta, and gamma-emitting radionuclides will continue throughout future annual groundwater investigations. In addition, statistical analysis of perimeter and background data along with evaluating DOE-SR groundwater monitoring data, will be performed. Continued groundwater monitoring will provide a better understanding of actual groundwater quality parameters, their extent, and trends. As a result, comparisons with historical data can be made. In addition, ESOP will provide SCDHEC's Bureau of Water with groundwater data to assist in their evaluation of the extent of naturally occurring radionuclides in the region.

During future DOE-SR groundwater sampling events, SCDHEC will request the opportunity to conduct split QA/QC (Quality Assurance/Quality Control) sampling. Split sampling at random well locations throughout the SRS groundwater well network will help provide SCDHEC further annual confirmation.

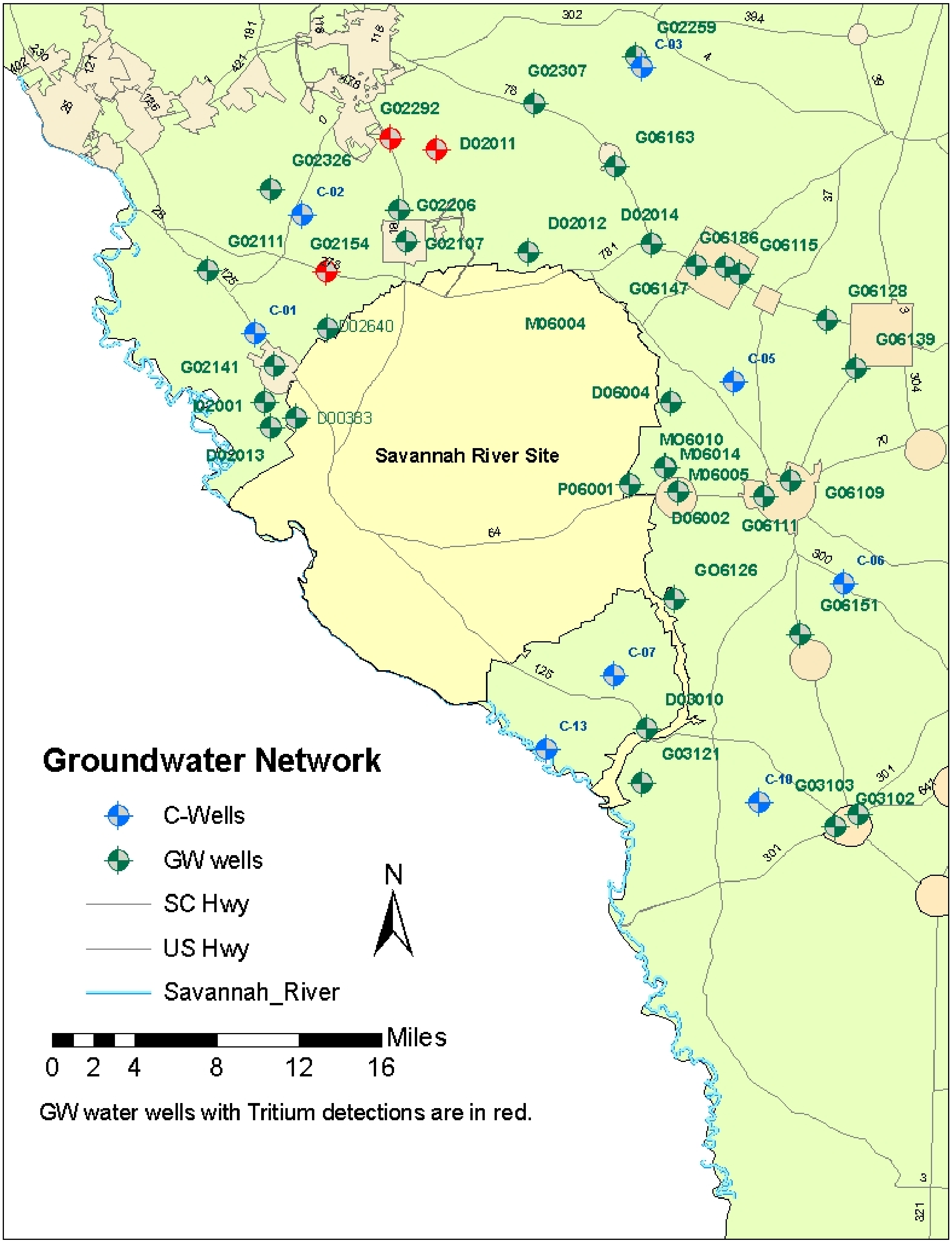
TOC

2.1.2 Maps

Map 3. Ambient Groundwater Quality Monitoring Well Network



Map 4. Tritium Detections



TOC

Tables and Figures

Ambient Groundwater Monitoring

Table 1. 2010 ESOP Groundwater Monitoring Well Data

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
G02292	Hunter's Glen	**2010**	unknown	210	SP
G02206	Oak Hill Subdivision	**2010**	445	240	SP
G02107	New Ellenton	**2010**	421	425	CB
G02259	Aiken State Park	**2010**	262	*	SP
G02154	Talatha Water District	**2010**	250	185	CB
G02141	Jackson	**2010**	225	105	SP
G02111	Beech Island Water District	**2010**	380	360	CB
G02326	ORA Site	**2010**	300	397	MB
D02014	Messer Well	**2010**	unknown	144	SP
G02307	Oakwood School	**2010**	428	404	CB
D02013	Cowden Plantation, Well 2	**2010**	124	*	SP
I02001	Cowden Plantation, Well 1	**2010**	132	*	CB
D02011	Mettlen Well	**2010**	400	180	SP
D02012	Windsome Plantation, House Well	**2010**	260	*	SP
G06109	Barnwell, Hwy. 3	2011	230	146	UTR
G06111	Barnwell, Rose St.	2011	220	166	UTR
G06128	Edisto Station	2011	322	360	GOR
G06147	Williston, Halford St.	2011	352	530	CB
G06139	Barnwell State Park	2011	248	163	UTR
D06002	Moore Well	2011	240	*	UTR
P06001	Allied General Nuclear, Well 1	2011	250	*	MB
D06004	J. Williams Well	2011	245	76.15	UTR
M06004	Chem Nuclear WO0061	2011	254.52	401	CB
M06014	Chem Nuclear WO0071	2011	255.33	250	GOR
M06010	Chem Nuclear WO0069	2011	254.28	145	UTR
D03010	Martin Post Office	2012	108	105	UTR
I03002	Williams Grocery	2012	138	*	UTR
G03102	Allendale, Water St.	2012	201	343	UTR
G03103	Allendale, Googe St.	2012	180	347	UTR
G03112	Allendale Welcome Center	2012	143	100	UTR
G06151	Chappels Labor Camp	2012	250	260	UTR
G03121	Clariant	2012	180	812	CB
G03115	Whitlock Combing	2012	166	800	CB
G06126	Starmet (Carolina Metals)	2012	200	323	GOR

Tables and Figures

Ambient Groundwater Monitoring

Table 1. (continued) ESOP Groundwater Monitoring Well Data, 2010

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M02101	SCDNR Cluster C-01, AIK-2378	2013	220.3	185	CB
M02102	SCDNR Cluster C-01, AIK-2379	2013	224.2	266	CB
M02103	SCDNR Cluster C-01, AIK-2380	2013	228.9	385	MB
M02104	SCDNR Cluster C-01, AIK-902	2013	231.9	511	MB
M02202	SCDNR Cluster C-02, AIK-825	2013	418.8	231	CB
M02203	SCDNR Cluster C-02, AIK-824	2013	418.6	365	CB
M02204	SCDNR Cluster C-02, AIK-818	2013	418.3	425	MB
M02205	SCDNR Cluster C-02, AIK-817	2013	418.9	535	MB
M02301	SCDNR Cluster C-03, AIK-849	2013	301.6	97	SP
M02302	SCDNR Cluster C-03, AIK-848	2013	299.7	131	CB
M02303	SCDNR Cluster C-03, AIK-847	2013	299	193	CB
M02304	SCDNR Cluster C-03, AIK-846	2013	297.8	255	CB
M02305	SCDNR Cluster C-03, AIK-845	2013	296.9	356	MB
M02306	SCDNR Cluster C-03, AIK-826	2013	294.9	500	MB
M06501	SCDNR Cluster C-05, BRN-360	2013	264.3	140	UTR
M06502	SCDNR Cluster C-05, BRN-359	2013	265.5	214	GOR
M06503	SCDNR Cluster C-05, BRN-367	2013	263.8	285	GOR
M06504	SCDNR Cluster C-05, BRN-368	2013	265.1	443	CB
M06505	SCDNR Cluster C-05, BRN-365	2013	263.5	539	CB
M06506	SCDNR Cluster C-05, BRN-366	2013	266.7	715	MB
M06507	SCDNR Cluster C-05, BRN-358	2013	265.6	847	MB
M03706	SCDNR Cluster C-07, ALL-368	2014	246.6	691	CB
M03707	SCDNR Cluster C-07, ALL-369	2014	242.1	800	CB
M03708	SCDNR Cluster C-07, ALL-370	2014	245.1	975	MB
M03709	SCDNR Cluster C-07, ALL-358	2014	243.1	1123	MB
M03131	SCDNR Cluster C-13, Artesian	2014	80	*	GOR
M03132	SCDNR Cluster C-13, ALL-378	2014	90	1060	MB
M03702	SCDNR Cluster C-07, ALL-364	2014	245.2	225	UTR
M03703	SCDNR Cluster C-07, ALL-365	2014	244.3	333	GOR
M03704	SCDNR Cluster C-07, ALL-366	2014	243.5	400	GOR
M03705	SCDNR Cluster C-07, ALL-367	2014	245.7	566	CB
M06601	SCDNR Cluster C-06, BRN-351	2014	207.3	95	UTR
M06602	SCDNR Cluster C-06, BRN-350	2014	207.4	170	UTR
M06603	SCDNR Cluster C-06, BRN-352	2014	207.1	293	GOR

Tables and Figures

Ambient Groundwater Monitoring

Table 1. (continued) ESOP Groundwater Monitoring Well Data, 2010

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M06604	SCDNR Cluster C-06, BRN-354	2014	207.6	411	GOR
M06605	SCDNR Cluster C-06, BRN-353	2014	207.7	588	CB
M06608	SCDNR Cluster C-06, BRN-349	2014	208.6	1045	MB
M03101	SCDNR Cluster C-10, ALL-347	2014	281.6	1423	MB
M03104	SCDNR Cluster C-10, ALL-374	2014	280.9	580	GOR
D02640	Green Pond Road	2014	*	222	*
D00383	Brown Road	2014	*	*	*

Notes:
1. * - Total depth/top of casing information unknown, Aquifer assigned based on owner information.
2. ft amsl – feet above mean sea level
3. ft bgs – feet below ground surface
4. UTR – Upper Three Runs, CB – Crouch Branch, SP – Steeds Pond, GOR – Gordon, MB- McQueen Branch

Tables and Figures

Ambient Groundwater Monitoring

Table 2. Summary of the Stratigraphy and Hydrostratigraphy of the Study Area

<table>
<tr><th>PERIOD/EPOCH</th><th>GROUP</th><th>FORMATION</th><th colspan="2">HYDROLOGIC UNIT</th></tr>
<tr><td>Middle Miocene</td><td>Cooper</td><td>Upland Unit</td><td colspan="2">Unsaturated Zone</td></tr>
<tr><td rowspan="6">Tertiary / Eocene</td><td rowspan="2">Barnwell</td><td>Tobacco Road</td><td rowspan="6">Steed Pond Aquifer</td><td rowspan="3">Upper Three Runs Aquifer (UTR)</td></tr>
<tr><td>Dry Branch/Clinchfield</td></tr>
<tr><td rowspan="3">Orangeburg</td><td>Tinker/Santee</td></tr>
<tr><td>Warley Hill</td><td>Gordon Confining Unit</td></tr>
<tr><td>Congaree</td><td rowspan="2">Gordon Aquifer (GOR)</td></tr>
<tr><td rowspan="3">Black Mingo</td><td>Fourmile</td></tr>
<tr><td rowspan="2">Tertiary / Paleocene</td><td>Snapp</td><td colspan="2" rowspan="2">Crouch Branch Confining Unit</td></tr>
<tr><td>Lang Syne/Sawdust Landing</td></tr>
<tr><td rowspan="3">Late Cretacious</td><td rowspan="3">Lumbee</td><td>Steel Creek</td><td colspan="2">Crouch Branch Aquifer</td></tr>
<tr><td>Black Creek</td><td colspan="2">McQueen Branch Confining Unit</td></tr>
<tr><td>Middendorf</td><td colspan="2">McQueen Branch Aquifer</td></tr>
<tr><td>Paleozoic or Precambrian</td><td></td><td>Cape Fear
Crystalline Basement</td><td colspan="2">Appleton Confining System
Piedmont Hydrogeologic Province</td></tr>
</table>

Tables and Figures

Ambient Groundwater Monitoring

Figure 1. 2010 Tritium Activity

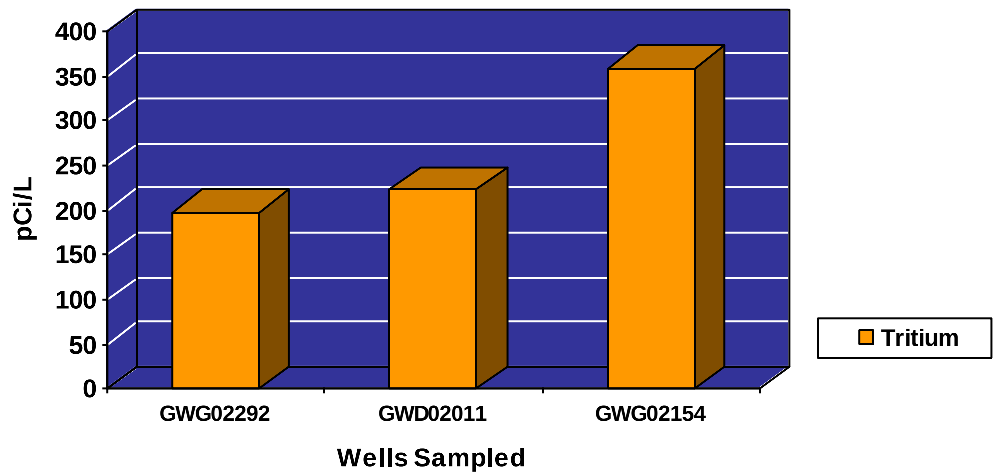
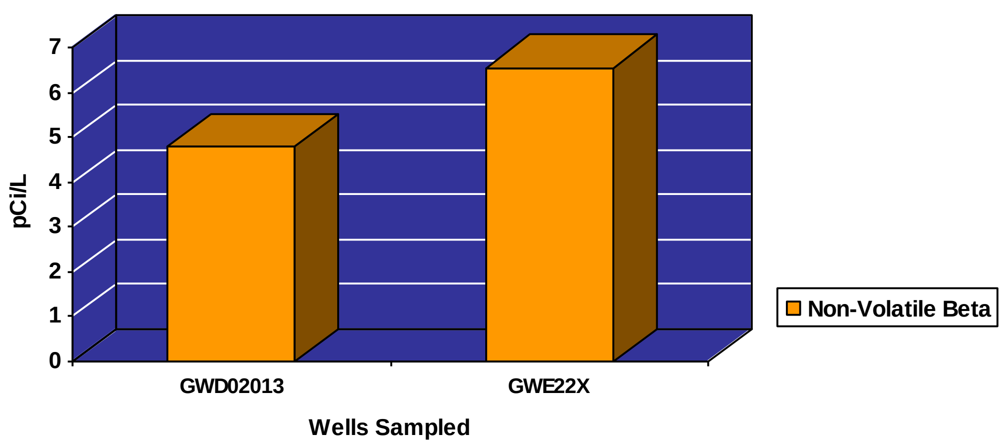


Figure 2. 2010 Non-Volatile Beta Activity



TOC

2.1.4 Data

Ambient Groundwater Monitoring

Notes:

1. Bold numbers with dark shaded boxes denotes a detection
2. LLD = Lower Limit of Detection
3. MDA = Minimum Detectable Activity
4. NA = Not Applicable

2.1.4 Data

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWG02107	GWG02292	GWFieldblank01	GWD02014	GWG02259	GWG02307
Collection Date	4/15/2010	4/15/2010	4/6/2010	4/6/2010	4/6/2010	4/6/2010
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	35.98	40.69	28.54	24.97	27.61	25.85
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA
Na-22 MDA	3.40	3.88	2.36	2.30	2.56	2.23
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA
K-40 MDA	94.50	96.82	49.64	48.43	42.77	45.70
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA
Mn-54 MDA	3.54	3.67	2.36	2.34	2.26	2.29
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-58 MDA	3.50	3.83	2.85	2.83	2.42	2.70
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	3.66	3.48	2.32	2.17	2.31	2.27
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA
Zn-65 MDA	6.61	7.25	5.26	4.90	4.79	4.86
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA
Y-88 MDA	3.87	3.40	2.45	2.65	2.05	2.48
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA
Zr-95 MDA	7.10	7.70	5.00	5.18	5.01	4.65
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA
Ru-103 MDA	4.73	4.66	3.35	3.49	3.35	3.74
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA
Sb-125 MDA	11.93	12.03	7.26	7.27	7.48	7.16
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	13.20	12.37	18.11	18.53	19.11	19.73
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-134 MDA	3.31	3.59	2.35	2.38	2.38	2.20
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	4.00	3.81	2.35	2.73	2.53	2.48
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA
Ce-144 MDA	39.74	40.51	26.33	26.03	25.28	26.30
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-152 MDA	13.28	13.28	8.21	8.48	8.39	8.12
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-154 MDA	9.49	10.87	6.59	6.37	6.57	6.22
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-155 MDA	22.51	22.79	12.16	13.29	12.18	12.81
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	9.78	9.99	6.26	6.99	5.65	6.41
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-214 MDA	10.37	10.26	6.60	7.00	6.22	6.33
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	125.00	121.50	68.62	81.11	79.68	80.45
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA
Ac-228 MDA	19.82	19.62	10.07	11.18	10.48	10.61
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	125.60	130.10	77.24	81.36	78.18	79.49
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	83.03	86.72	26.01	27.77	24.64	25.86

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWDuplicate01	GWD02012	GWG02326	GWD02011	GWD02013	GWG02142
Collection Date	4/6/2010	4/6/2010	4/14/2010	4/14/2010	4/14/2010	4/14/2010
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	27.11	28.10	26.00	26.36	25.62	26.57
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA
Na-22 MDA	2.08	2.46	2.22	2.30	2.16	2.07
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA
K-40 MDA	43.38	45.36	47.09	46.95	45.45	45.76
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA
Mn-54 MDA	2.55	2.26	2.10	2.43	2.26	2.43
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-58 MDA	2.77	2.72	2.60	2.45	2.52	2.88
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	2.03	2.21	2.19	2.07	2.16	2.28
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA
Zn-65 MDA	4.63	4.81	4.90	5.01	4.74	4.54
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA
Y-88 MDA	2.56	2.51	2.33	2.19	2.14	1.99
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA
Zr-95 MDA	5.35	5.22	4.96	4.52	4.76	4.94
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA
Ru-103 MDA	3.61	3.70	3.40	3.57	3.39	3.17
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA
Sb-125 MDA	7.28	6.95	7.36	6.60	7.33	7.17
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	18.61	26.81	14.40	14.64	13.42	13.15
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-134 MDA	2.42	2.15	2.32	2.39	2.18	2.46
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	2.49	2.68	2.57	2.63	2.34	2.41
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA
Ce-144 MDA	27.00	27.30	25.01	25.33	26.24	25.23
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-152 MDA	8.10	8.23	7.55	7.96	8.00	8.59
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-154 MDA	5.77	6.69	6.18	6.41	6.10	5.76
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-155 MDA	13.34	12.95	12.65	12.70	12.44	12.97
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	6.59	6.48	6.34	6.54	5.14	6.57
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-214 MDA	5.48	6.52	6.63	6.96	6.50	6.31
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	80.21	79.27	77.41	<7.955E+01	80.21	78.95
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA
Ac-228 MDA	9.27	9.73	10.76	10.49	10.16	10.90
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	76.98	79.79	77.52	79.85	78.58	76.33
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	26.15	28.32	27.81	27.84	26.03	25.49

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWI02001	GWG02154	GWDuplicate02	GWG02111	GWG02206	GWFieldblank02
Collection Date	4/14/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	24.53	26.68	27.62	25.32	25.91	27.74
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA
Na-22 MDA	2.35	2.33	1.93	2.47	1.71	2.37
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA
K-40 MDA	44.77	47.00	20.86	49.21	44.94	47.29
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA
Mn-54 MDA	2.21	2.43	2.35	2.32	2.48	2.42
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-58 MDA	2.62	2.69	2.78	2.59	2.66	2.56
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	1.75	2.10	2.13	2.19	2.32	2.02
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA
Zn-65 MDA	5.03	5.50	4.47	4.90	5.37	5.01
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA
Y-88 MDA	1.93	2.45	2.63	2.18	2.50	2.58
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA
Zr-95 MDA	4.60	4.89	4.60	5.06	5.05	4.93
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA
Ru-103 MDA	3.42	3.26	3.41	3.59	3.19	3.59
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA
Sb-125 MDA	6.84	7.71	7.63	7.20	6.94	7.92
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	13.14	16.33	15.96	16.61	16.57	15.06
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-134 MDA	2.24	2.51	2.34	2.35	2.33	2.34
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	2.49	2.26	2.67	2.72	2.41	2.33
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA
Ce-144 MDA	26.16	26.29	27.05	26.09	25.98	25.86
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-152 MDA	8.05	8.59	8.34	8.45	7.92	7.89
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-154 MDA	6.58	6.46	5.37	6.84	4.79	6.42
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-155 MDA	12.28	12.98	12.95	13.09	12.57	12.66
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	5.49	6.37	5.61	6.16	6.63	6.60
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-214 MDA	6.07	6.71	6.56	6.74	6.49	6.44
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	76.74	83.72	78.12	82.16	76.42	80.13
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA
Ac-228 MDA	9.79	10.53	10.08	10.61	9.74	9.66
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	76.44	78.76	76.18	81.87	76.62	79.08
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	26.17	26.20	26.65	26.30	26.44	26.05

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWB21	GWB22	GWB23	GWDuplicate03
Collection Date	9/7/2010	9/3/2010	9/2/2010	9/2/2010
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	29.50	29.80	31.50	30.60
Na-22 Activity	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA
Na-22 MDA	2.11	2.22	2.00	2.24
K-40 Activity	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA
K-40 MDA	44.60	44.30	45.10	43.70
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA
Mn-54 MDA	2.41	2.31	2.42	2.40
Co-58 Activity	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA
Co-58 MDA	2.71	2.85	2.77	2.92
Co-60 Activity	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA
Co-60 MDA	2.04	2.16	2.03	1.95
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA
Zn-65 MDA	4.13	5.01	4.91	4.69
Y-88 Activity	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA
Y-88 MDA	2.22	2.35	2.23	2.47
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA
Zr-95 MDA	4.89	5.78	5.11	5.43
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA
Ru-103 MDA	3.90	4.36	4.51	4.17
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA
Sb-125 MDA	7.11	7.19	6.94	7.10
I-131 Activity	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA
I-131 MDA	28.70	45.90	46.10	49.10
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA
Cs-134 MDA	2.22	2.46	2.28	2.20
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	2.39	2.23	2.63	2.31
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA
Ce-144 MDA	26.20	25.20	25.90	27.00
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA
Eu-152 MDA	7.90	7.78	8.30	7.75
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA
Eu-154 MDA	5.87	6.15	5.52	6.22
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA
Eu-155 MDA	12.30	12.60	12.10	12.30
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA
Pb-212 MDA	6.17	6.25	6.16	6.15
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA
Pb-214 MDA	6.07	6.23	5.86	6.26
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA
Ra-226 MDA	76.10	60.40	76.70	76.90
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA
Ac-228 MDA	10.50	10.40	10.20	8.92
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	77.90	78.90	79.10	77.20
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	24.70	23.40	24.30	24.50

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWE21	GWE22X	GWE24
Collection Date	8/31/2010	9/8/2010	9/8/2010
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	33.00	29.20	28.30
Na-22 Activity	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA
Na-22 MDA	2.09	2.10	2.06
K-40 Activity	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA
K-40 MDA	44.20	45.30	41.60
Mn-54 Activity	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA
Mn-54 MDA	2.19	2.22	2.32
Co-58 Activity	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA
Co-58 MDA	2.90	2.76	2.57
Co-60 Activity	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA
Co-60 MDA	2.15	1.96	1.99
Zn-65 Activity	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA
Zn-65 MDA	4.53	5.16	4.97
Y-88 Activity	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA
Y-88 MDA	2.14	2.27	2.61
Zr-95 Activity	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA
Zr-95 MDA	5.69	5.06	5.29
Ru-103 Activity	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA
Ru-103 MDA	4.49	4.00	3.84
Sb-125 Activity	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA
Sb-125 MDA	7.01	6.47	6.86
I-131 Activity	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA
I-131 MDA	55.10	31.40	30.40
Cs-134 Activity	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA
Cs-134 MDA	2.30	2.30	2.32
Cs-137 Activity	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA
Cs-137 MDA	2.48	2.27	2.35
Ce-144 Activity	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA
Ce-144 MDA	26.40	25.20	25.40
Eu-152 Activity	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA
Eu-152 MDA	7.27	7.69	7.46
Eu-154 Activity	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA
Eu-154 MDA	5.78	5.81	5.73
Eu-155 Activity	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA
Eu-155 MDA	12.80	11.90	12.10
Pb-212 Activity	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA
Pb-212 MDA	6.02	6.12	6.18
Pb-214 Activity	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA
Pb-214 MDA	6.26	6.34	5.72
Ra-226 Activity	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA
Ra-226 MDA	77.00	74.50	75.30
Ac-228 Activity	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA
Ac-228 MDA	10.30	10.40	10.80
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	75.70	76.50	74.60
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	25.10	24.10	23.70

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWFieldblank01	GWD02014	GWDuplicate01	GWG02259	GWG02307	GWD02012
Collection Date	4/6/2010	4/6/2010	4/6/2010	4/6/2010	4/6/2010	4/6/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Alpha LLD	3.14	5.46	5.49	3.31	4.87	3.55
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Beta LLD	3.83	3.92	3.92	3.84	3.90	3.85

Network Wells

Location Description	GWI02001	GWD02013	GWG02142	GWG02326	GWD02011	GWFieldblank02
Collection Date	4/14/2010	4/14/2010	4/14/2010	4/14/2010	4/14/2010	4/15/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Alpha LLD	3.32	3.30	4.44	3.33	3.41	3.15
Beta Activity	<LLD	**4.79**	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	2.15	N/A	N/A	N/A	N/A
Beta LLD	3.84	3.84	3.89	3.84	3.85	3.83

Network Wells

Location Description	GWG02154	GWDuplicate02	GWG02111	GWG02206	GWG02292	GWG02107
Collection Date	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Alpha LLD	3.46	3.42	4.36	3.65	4.56	2.90
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Beta LLD	3.85	3.85	3.89	3.86	3.89	4.11

Network Wells

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWB21	GWB22	GWB23	GWDuplicate03
Collection Date	**9/7/2010**	**9/3/2010**	**9/2/2010**	**9/2/2010**
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A	N/A
Alpha LLD	4.13	5.39	10.90	10.90
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	N/A	N/A	N/A	N/A
Beta LLD	2.91	2.95	6.73	6.73

Background Wells

Location Description	GWE21	GWE24	GWE22X
Collection Date	**8/31/2010**	**9/8/2010**	**9/8/2010**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	N/A	N/A	N/A
Alpha LLD	3.57	4.55	5.36
Beta Activity	<LLD	<LLD	**6.56**
Beta Confidence Interval	N/A	N/A	2.72
Beta LLD	2.89	2.92	3.99

Perimeter Wells

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWG02107	GWG02292	GWD02014	GWFieldblank01	GWG02259	GWG02307
Collection Date	4/15/2010	4/15/2010	4/6/2010	4/6/2010	4/6/2010	4/6/2010
Tritium Activity	<LLD	**198**	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	88	N/A	N/A	N/A	N/A
Tritium LLD	189	189	187	187	187	187

Location Description	GWD02012	GWI02001	GWD02013	GWDuplicate01	GWG02142	GWG02326
Collection Date	4/6/2010	4/14/2010	4/14/2010	4/6/2010	4/14/2010	4/14/2010
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	N/A	N/A	N/A	N/A	N/A
Tritium LLD	187	187	187	187	187	187

Location Description	GWD02011	GWG02111	GWG02206	GWFieldblank02	GWG02154	GWDuplicate02
Collection Date	4/14/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010	4/15/2010
Tritium Activity	**223**	<LLD	<LLD	<LLD	**359**	**231**
Tritium Confidence Interval	89	N/A	N/A	N/A	95	89
Tritium LLD	187	187	187	187	187	187

Network Wells

Location Description	GWB23	GWB21	GWB22	GWDuplicate03
Collection Date	9/2/2010	9/7/2010	9/3/2010	9/2/2010
Tritium Activity	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	N/A	N/A	N/A
Tritium LLD	191	191	191	191

Background Wells

Location Description	GWE21	GWE22X	GWE24
Collection Date	8/31/2010	9/8/2010	9/8/2010
Tritium Activity	<LLD	<LLD	<LLD
Tritium Confidence Interval	N/A	N/A	N/A
Tritium LLD	191	191	191

Perimeter Wells

Ambient Groundwater Data

2010 Radiological Data

Location Description	GWB21	GWB22	GWB23	GWDuplicate03
Collection Date	9/7/2010	9/3/2010	9/2/2010	9/2/2010
Pu-238	0.00000	0.00539	0.00530	-0.02060
Pu-238 Confidence Interval	0.00206	0.01320	0.01300	0.04750
Pu-238 MDA	0.02430	0.02490	0.02440	0.09450
Pu-239/240	0.00333	**0.00808**	0.01060	**0.01650**
Pu-239/240 Confidence Interval	0.01150	0.00938	0.01300	0.01660
Pu-239/240 MDA	0.02430	0.00714	0.01930	0.01090
U-234	**0.18800**	**0.09380**	0.06950	0.08060
U-234 Confidence Interval	0.10200	0.06740	0.07230	0.06920
U-234 MDA	0.07910	0.03110	0.11300	0.08220
U-235	0.00000	**0.02890**	0.01060	0.01570
U-235 Confidence Interval	0.00439	0.04110	0.05040	0.03150
U-235 MDA	0.04000	0.03830	0.12900	0.04160
U-238	**0.19900**	**0.04280**	**0.03460**	0.05920
U-238 Confidence Interval	0.10400	0.04770	0.04600	0.05780
U-238 MDA	0.07870	0.06240	0.06940	0.06770

Location Description	GWE21	GWE24	GWE22X
Collection Date	8/31/2010	9/8/2010	9/8/2010
Pu-238	0.00978	0.00532	0.00299
Pu-238 Confidence Interval	0.01200	0.01310	0.02460
Pu-238 MDA	0.01780	0.02450	0.04720
Pu-239/240	0.00733	0.01330	0.01110
Pu-239/240 Confidence Interval	0.01300	0.01610	0.01370
Pu-239/240 MDA	0.02250	0.02450	0.02030
U-234	0.07430	0.04050	**0.10600**
U-234 Confidence Interval	0.06780	0.05760	0.07880
U-234 MDA	0.09060	0.10600	0.08250
U-235	0.05090	0.02000	0.04720
U-235 Confidence Interval	0.06320	0.04490	0.06590
U-235 MDA	0.09870	0.09690	0.01150
U-238	-0.000188	0.02820	0.09750
U-238 Confidence Interval	0.004940	0.04370	0.07920
U-238 MDA	0.132000	0.07820	0.10200

Ambient Groundwater Data

2010 Nonradiological Data

Location Description	GWFieldblank	GWG02154	GWDup02	GWG02111	GWG02206	GWG02107	GWG02292
Collection Date	**4/15/2010**	**4/15/2010**	**4/15/2010**	**4/15/2010**	**4/15/2010**	**4/15/2010**	**4/15/2010**
Field Water Quality Data							
pH	N/A	4.10	N/A	6.47	6.94	5.50	6.80
Conductivity	N/A	0.146	N/A	0.105	0.126	0.016	0.110
Turbitity	N/A	0.00	N/A	0.00	3.00	3.00	0.00
Dissolved Oxygen	N/A	10.24	N/A	11.28	11.94	11.76	13.11
Temperature ©	N/A	18.60	N/A	20.80	20.30	22.20	21.00
Analyte							
Nitrate/Nitrite (mg/L)	<0.020	**2.2**	**2.3**	**1.9**	**0.22**	**0.24**	**3.0**
Barium (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Beryllium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	**0.038**
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**0.00050**	<0.00010
Lead (mg/L)	<0.0020	**0.0036**	**0.0033**	<0.0020	<0.0020	<0.0020	<0.0020
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thallium (mg/L)	<0.00050	<0.00050	**0.00063**	**0.00060**	**0.00056**	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500

Location Description	GWI02001	GWD02013	GWG02142	GWG02326	GWD02011	GWD02014	GWDup01
Collection Date	**4/14/2010**	**4/14/2010**	**4/14/2010**	**4/14/2010**	**4/14/2010**	**4/6/2010**	**4/6/2010**
Field Water Quality Data							
pH	4.27	4.19	8.63	5.14	4.57	5.76	N/A
Conductivity	0.153	0.049	0.440	0.014	0.020	0.259	N/A
Turbitity	0.00	0.00	1.00	6.00	0.00	0.00	N/A
Dissolved Oxygen	11.95	11.96	12.25	13.20	14.04	11.01	N/A
Temperature ©	19.80	20.20	21.30	20.90	20.60	20.60	N/A
Analyte							
Nitrate/Nitrite (mg/L)	**0.140**	<0.020	**0.440**	**0.045**	**0.860**	**0.900**	**0.900**
Barium (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Beryllium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Copper (mg/L)	<0.010	<0.010	<0.010	**0.021**	<0.010	<0.010	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium (mg/L)	<0.00010	**0.00013**	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Lead (mg/L)	<0.0020	<0.0020	<0.0020	**0.0046**	**0.033**	<0.0020	<0.0020
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Thallium (mg/L)	**0.00050**	**0.00056**	<0.00050	**0.00063**	<0.00050	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500	<0.00500

Ambient Groundwater Data

2010 Nonradiological Data

Location Description	GWG02259	GWG02307	GWD02012	GWFieldblank
Collection Date	**4/6/2010**	**4/6/2010**	**4/6/2010**	**4/6/2010**
Field Water Quality Data				
pH	4.48	5.16	5.02	N/A
Conductivity	0.023	0.046	0.081	N/A
Turbitity	1.00	0.00	0.00	N/A
Dissolved Oxygen	12.68	10.62	8.64	N/A
Temperature ©	19.90	20.80	20.40	N/A
Analyte				
Nitrate/Nitrite (mg/L)	<0.020	<0.020	<0.020	<0.020
Barium (mg/L)	<0.050	<0.050	<0.050	<0.050
Beryllium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
Copper (mg/L)	<0.010	**0.034**	<0.010	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
Cadmium (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
Lead (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020
Thallium (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500

TOC

2.1.5 Summary Statistics

Ambient Groundwater Monitoring

2010 Radiological Summary Statistics

Notes:
1. N/A = Not Applicable
2. LLD = Lower Limit of Detection

2.1.5 Summary Statistics

Ambient Groundwater Data

2010 Ambient Groundwater Monitoring Summary Statistics

Location Description	Well Designation	Pu239/240 (pCi/L)	U 234 (pCi/L)	U 235 (pCi/L)	U 238 (pCi/L)	Beta (pCi/L)
GWE22X	Perimeter Well	<MDA	**0.10600**	<MDA	<MDA	**6.56000**
GWB21	Background Well	<MDA	**0.18800**	<MDA	**0.19900**	<LLD
GWB22	Background Well	**0.00808**	**0.09380**	**0.02890**	**0.04280**	<LLD
GWB23	Background Well	<MDA	<MDA	<MDA	**0.03460**	<LLD

Random Background			
	Mean	**Std Dev.**	**Median**
Pu-239/240 (pCi/L)	0.00808	N/A	0.00808
U-234 (pCi/L)	0.14090	0.06661	0.14090
U-235 (pCi/L)	0.02890	N/A	0.02890
U-238 (pCi/L)	0.09213	0.09264	0.04280

Random Perimeter			
	Mean	**Std Dev.**	**Median**
Beta (pCi/L)	6.56000	N/A	6.56000
U-234 (pCi/L)	0.10600	N/A	0.10600

Ambient Groundwater Data

2010 Ambient Groundwater Monitoring Summary Statistics

Location Description	Alpha (pCi/L)	Beta (pCi/L)	Tritium (pCi/L)
GWD02013	<LLD	**4.79**	<LLD
GWG02292	<LLD	<LLD	**198**
GWD02011	<LLD	<LLD	**223**
GWG02154	<LLD	<LLD	**359**

Network Wells

Network Wells			
	Mean	Std Dev.	Median
Tritium (pCi/L)	260	86.64	223
Beta (pCi/L)	4.79	N/A	4.79

TOC

APPENDIX A

Regional Geology

The study area, including SRS, is located in west-central South Carolina. The regional geology is characterized as the Aiken Plateau of the Coastal Plain physiographic province. SRS is located approximately 20 miles southeast of the fall line of the Piedmont physiographic province. A thickening wedge of Cenozoic and Cretaceous sediment, which overlies Paleozoic crystalline basement rock and Triassic sedimentary rocks, underlies the area south of the fall line (Aadland et al 1995). The sediment, consisting of alternating sands and clays with Tertiary carbonates, thickens toward the southeast from zero at the fall line to more than 1,800 feet at the Allendale-Hampton County line. The sediment is about 1,100 feet thick beneath the central portion of SRS and dips toward the southeast at about 35 feet per mile. Table 2 , Section 2.1.3 summarizes the stratigraphy and hydrostratigraphy of the study area. For a more detailed review of regional geology and hydrogeology, refer to the 1997 Annual Report (SCDHEC 1999a).

2.2 Drinking Water Quality Monitoring

2.2.1 Summary

The Environmental Surveillance and Oversight Program (ESOP) Drinking Water Monitoring Project, as part of South Carolina Department of Health and Environmental Control (SCDHEC), evaluates drinking water quality in communities that could be impacted by Savannah River Site (SRS) operations. ESOP monitoring provides information to the public regarding the extent that radiological constituents may or may not have impacted community drinking water systems adjacent and downstream to the SRS. Additionally, ESOP provides analytical data from this project for comparison to published Department of Energy-Savannah River (DOE-SR) data. The project objectives are to collect monthly composite surface water samples from water treatment plants using the lower portion of the Savannah River, and to collect semi-annual grab samples from selected community drinking water systems within 30 miles from the center point of the SRS. SCDHEC analyzes samples for gross alpha, non-volatile beta, gamma-emitting radionuclides, and tritium.

The study area was established as a 30-mile radius circle centered in the SRS. Using SCDHEC geographical information system, 19 groundwater fed and four surface water fed community drinking water systems were selected (Map 4, Section 2.2.2). These systems serve approximately 281,000 customers with approximately 105,000 receiving their water from groundwater sources (Table 1, Section 2.2.3). None of the drinking water samples collected originated from the SRS drinking water system.

During 2010, DOE-SR collected water samples from four surface water background locations (North Augusta, Purrysburg, Beaufort and Savannah) that are colocated with the ESOP surface water fed drinking water systems. Currently, DOE-SR does not conduct drinking water sampling off-site from groundwater fed wells.

Historically, tritium has been the main environmental release due to operations at the SRS. Tritium was produced as a nuclear weapon enhancement component. The majority of tritium releases came from the production reactors and the separation areas (Till et al 2001). In addition to SRS activities, tritium can be attributed to releases from nuclear facilities within close proximity of the study area.

Man-made gamma-emitting radionuclides, such as iodine-131, cesium-137, and cobalt-60, were products of SRS activities. These radionuclides were produced by fission in reactor fuels and were primarily released in surface streams in the 1960s or into the atmosphere in the separation areas (WSRC 1998). There have been no detections of gamma-emitting radionuclides in water systems since ESOP began testing drinking water in 2002.

Results and Discussion

Surface Water System Fixed Network Results

<u>Tritium</u>

Tritium oxide, the form of most concern, is generally indistinguishable from normal water and can move rapidly through the environment in the same manner as water. Tritium is naturally present in surface waters at about 10 to 30 picocuries per liter (pCi/L) (ANL 2007a). The maximum contaminant level (MCL) developed by the United States Environmental Protection Agency (USEPA) for tritium in drinking water supplies is 20,000 pCi/L (ANL 2007a). Tritium continues to be the most abundant radionuclide detected in public drinking water in the study area. Detected in both groundwater and surface water systems, the ESOP tritium detectable average was 260 (± 42.43) pCi/L for groundwater systems and 298.23 (± 70.61) pCi/L for surface water systems. The DOE-SR detectable average for surface water systems was 243.00 (± 93.35) pCi/L. These tritium activities, however, were quite low when compared to the USEPA drinking water MCL of 20,000 pCi/L (USEPA 2002a).

The primary tritium releases originated from processes associated with the reactors (R, P, K, L, and C), separation facilities (F-area and H-area), the heavy water facility (D-area), and tritium recovery in the tritium facilities. The two main types of tritium releases come from direct releases from site facilities and migration from seepage basins in F-area and H-area, the burial ground, and the K-area containment basin. In the early operational years, almost 100% of the releases to streams were related to direct releases. After the cessation of operational activities, most releases were a result of migration from the seepage basins. Since the mid 1970s, migration and outcropping to streams have accounted for most of the SRS tritium released to surface water (Till et al. 2001).

Based on a review of the surface water data from the Savannah River, tritium was detected above the lower limit of detection (LLD) in approximately 67% of surface water composite samples. Detectable tritium activity in these samples yielded an average of 298.23 (± 70.61) pCi/L and ranged from 183 to 739 pCi/L. These tritium activities are measurable but not significant when compared with the 20,000 pCi/L USEPA MCL (USEPA 2002a). Of the 12 upstream North Augusta surface water composites, there were four detections above the LLD. Tritium activity in the North Augusta samples ranged from 183 to 231 pCi/L and averaged 202.00 (± 20.58) pCi/L. Of the 36 composite samples collected downstream from the SRS, 28 samples had a tritium activity slightly above the minimum detectable activity (MDA). The tritium activity in these three downstream intakes, Chelsea Plant, Purrysburg Plant, and City of Savannah had a range of 189 to 739 and averaged 330.30 (± 36.14) pCi/L. Figure 1 of Section 2.2.3 illustrates the trending data for surface water fed systems over the past five years.

Gamma-emitting Radionuclides

Gamma-emitting radionuclides of concern (Table 2, Section 2.2.3) were not detected above the MDA and have not been detected for any of the surface water samples collected by ESOP or DOE-SR since 2002.

Gross Alpha and Non-volatile Beta

Gross alpha-emitting radionuclides were released to liquid effluent from the reactor materials area (M-area), separations areas (F-area and H-area), and the reactor areas. The primary stream affected by the M-area releases was Tims Branch, which ultimately flows into Upper Three Runs. Fourmile Creek is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs (Till et al 2001). Gross beta-emitting radionuclides were released to liquid effluent from the separations areas (F-area and H-area). The aforementioned streams ultimately flow directly or indirectly into the Savannah River.

Gross alpha was detected at Chelsea B/J, City of Savannah, and Purrysburg with an average activity of 3.68 (± 1.26) pCi/L. Non-volatile beta was detected at three locations (Chelsea B/J, City of Savannah, and Purrysburg). These three locations revealed non-volatile beta detections that averaged 4.54 (± 0.25) pCi/L and ranged from 2.60 to 7.65 pCi/L. Speciation is not conducted for gross alpha or non-volatile beta unless there is detection above the USEPA MCL of 15 pCi/L or 8 pCi/L, respectively (USEPA 2002a). Alpha and beta activity is likely attributable to naturally occurring radionuclides.

(Figures 2 and 3, Section 2.2.3) illustrates the trends in gross alpha and non-volatile beta activities since the year 2006. Although there are several detections identified during the 2010 sampling event, none of these analytes have exceeded the EPA established MCL for each of these contaminants. As a result, these concentrations are not considered to be known health risks for humans.

Groundwater System Fixed Network Results

Tritium

Based on a review of the analytical data, only one of the 19 groundwater fed systems sampled had tritium activities above the LLD. This tritium detection located at the Talatha public water system yielded an average activity of 260 (± 42.43) pCi/L. This tritium activity is measurable but not significant when compared to the 20,000 pCi/L USEPA MCL (USEPA 2002a). Figure 1, Section 2.2.3 shows trending data from the past five years for the samples from groundwater fed systems that showed detections.

Gamma-emitting Radionuclides

Gamma-emitting radionuclides of concern were not detected above the MDA in any groundwater samples tested in nine years of testing by ESOP. As a result of the history on non-detections for gamma-emitting radionuclides, no summary statistics were calculated.

Gross Alpha and Non-volatile Beta

Gross alpha was detected in seven of the 19 groundwater systems (Aiken, Jackson, Breezy Hill, Montmorenci, Williston, South Carolina Advanced Technology (SCAT Park), and College Acres) tested in 2010. The range for gross alpha activity was 2.43 to 6.44 pCi/L with an average activity of 3.45 (± 0.99) pCi/L. All gross alpha samples were below the USEPA MCL of 15 pCi/L (USEPA 2002a). Speciation is not conducted for gross alpha unless there is a detection above the USEPA MCL of 15 pCi/L. Summary statistics for groundwater fed systems are located in Section 2.2.5. There were two detections for non-volatile beta located at the SCAT Park and Talatha water districts, which yielded an average activity of 4.13 (± 0.40) pCi/L. Although these concentrations are detectable, they are well below the EPA established MCL of 8 pCi/L.

The SCDHEC Drinking Water Monitoring Project continues to be an important source of essential data for assessing human health exposure pathways. SCDHEC will continue sampling to provide the public with an independent source of radiological data for drinking water systems within the SRS study area.

Due to the extent of the surface water contamination on the SRS and it's potential to migrate south/southwest and discharge to the Savannah River, SCDHEC will continue to monitor surface water quality to identify any future contaminant migration, which could potentially impact drinking water systems downstream from the SRS.

ESOP and DOE-SR Data Comparison

DOE-SR conducts monthly composite sampling at the four water treatment plants (North Augusta, Purrysburg, Beaufort and Savannah) that use Savannah River surface water to supply drinking water for the local population.

Based on the DOE-SR 2010 annual report, tritium in the three downstream water intakes averaged 287.67 (± 33.17) pCi/L ranging from 259.00 to 324.00 pCi/L while ESOP downstream detections averaged 330.30 (± 36.14) pCi/L ranging from 289.13 to 356.78 pCi/L. Figure 4 and Figure 5 illustrate DOE-SR finished water tritium detection averages over a five year time period. DOE-SR had an overall detected tritium average of 243.00 (± 93.35) pCi/L for all surface water samples collected in 2010. This was lower than the ESOP detected tritium average of 298.23 (± 70.61) pCi/L for the same period. The ESOP calculated average tritium activity for North Augusta is 202.00 (± 20.58) pCi/L. This average is lower than the averages for the other downstream locations due to the fact North Augusta is located upstream from the SRS (Table 3). All samples were within two standard deviations as well as being lower than the USEPA MCL of 20,000 pCi/L (USEPA 2002a). Tritium activity in 2010 is within two standard deviations of the running 5-year average. These activity levels are well below the USEPA MCL. Naturally occurring radionuclides may account for variability in tritium activities. Tritium continues to be the most abundant radionuclide in the Savannah River.

Gamma-emitting radionuclides were not detected in DOE-SR or ESOP samples in 2010. DOE-SR and ESOP detected non-volatile beta in surface water samples. The DOE-SR non-volatile beta average (for all four locations) of 1.98 (± 0.27) pCi/L was slightly less than the ESOP non-volatile beta average (for Chelsea B/J, City of Savannah, and Purrysburg) of 4.54 (± 0.25) pCi/L. DOE-SR reported an average gross alpha activity (for all four locations) of 0.13 (± 0.08) pCi/L. ESOP had surface water gross alpha detections at the Chelsea B/J, City of Savannah, and Purrysburg plants with an average of 3.68 (± 1.26) pCi/L. All detections were less than the established USEPA MCL for gross alpha and non-volatile beta in drinking water (USEPA 2002a).

Alphas (or betas) are not directly comparable due to the unknown nature (species) of the contributing alphas (or betas) in any two compared samples.

Conclusions and Recommendations

Tritium continues to be the most abundant radionuclide detected in public drinking water supplies potentially impacted by the SRS. Tritium was detected in both groundwater and surface water systems. However, these tritium activities are low considering the USEPA 20,000 pCi/L MCL for drinking water. Detections of gross alpha, non-volatile beta and gamma-emitting radionuclides of concern were all below their respective MCL's. Comparative analysis with

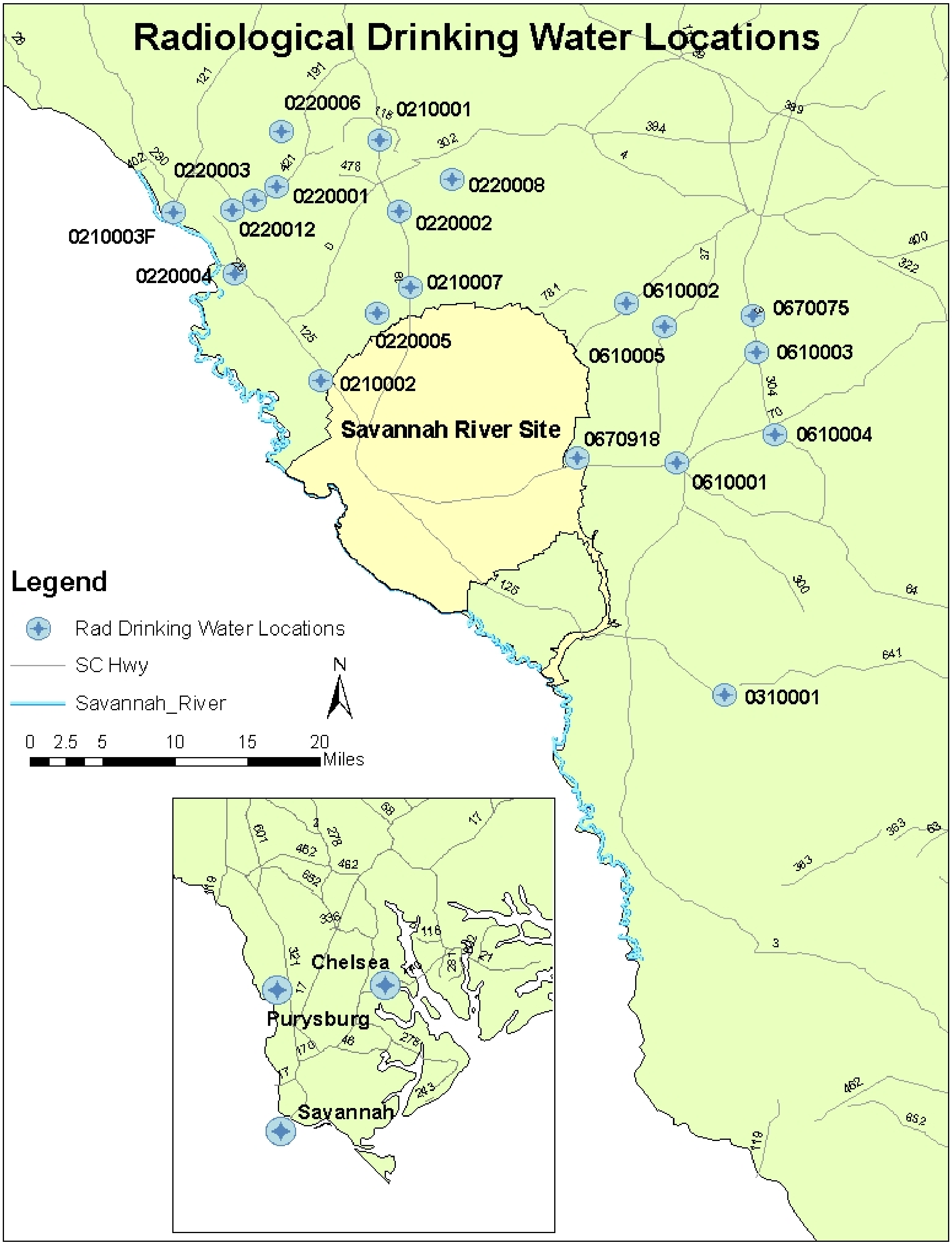
DOE-SR for groundwater systems cannot be performed because DOE-SR does not sample groundwater systems off the Savannah River Site.

SCDHEC will continue sampling drinking water systems to provide the public with an independent source of radiological data for surface water and groundwater fed water systems. Additional background samples will be taken in the future to give a better idea of what ambient radioactivity levels are present in South Carolina. The data from these samples will be used in statistical analysis with the routine samples.

TOC

2.2.2 Maps

Map 4. SCDHEC ESOP Drinking Water Network TOC



2.2.3 Tables and Figures

Drinking Water Quality Monitoring

Table 1. Drinking Water Systems Sampled by ESOP

System Number	System Name	Number of Taps	Population
0210001	Aiken	18,443	42,374
0210002	Jackson	1,309	3,602
0210007	New Ellenton	2,231	5,303
0220001	Langley Water District	367	838
0220002	College Acres Public Water District	529	1,350
0220003	Bath Water District	314	1,064
0220004	Beech Island	3,094	7,436
0220005	Talatha Water District	571	1,553
0220006	Breezy Hill Water District	5,080	12,495
0220008	Montmorenci Water District	1,396	3,428
0220012	Valley Public Service Authority	3,409	7,803
0310001	Allendale	1,521	4,052
0610001	Barnwell	2,494	6,727
0610002	Williston	1,650	3,307
0610003	Blackville	1,141	2,973
0610004	Hilda	131	466
0610005	Elko	150	462
0670075	Healing Springs	1	6*
0670918	SCAT Park	6	125
0210003F	North Augusta Surface Water	12,022	31,506
0720003F	Chelsea B/J Plant	44,227	133,353
0720004F	Purrysburg B/J Plant		
SAVF	City of Savannah (Industrial)	35	10,619
	TOTAL	100,121	280,842
	Approximate Groundwater	43,837	105,364
	Approximate Surface Water	56,284	175,478

***** This information is likely higher due to public access to the natural spring.
Note: Data was obtained from SC DHEC Environmental Facility Information Sytem database.

Tables and Figures

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Table 2. Gamma Analyte Table

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Yttrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Note: Units are reported in pCi/g.

Tables and Figures

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Table 3. DOE-SR and ESOP Data Comparisons

	ESOP Tritium	DOE-SR Tritium	ESOP Gross Alpha	DOE-SR Gross Alpha	ESOP NV Beta	DOE-SR NV Beta
North Augusta	202.00	109.00	N/A	0.18	N/A	1.61
Beaufort Jasper	289.13	259.00	4.90	0.22	4.62	2.17
Purrysburg	356.78	324.00	2.39	0.05	4.73	1.93
Savannah	345.00	280.00	3.74	0.07	4.26	2.19
Average	**298.23**	**243.00**	**3.68**	**0.13**	**4.54**	**1.98**

2.2.3 Tables and Figures

Drinking Water Quality Monitoring

Figure 1. ESOP Yearly Tritium Averages in Drinking Water Systems

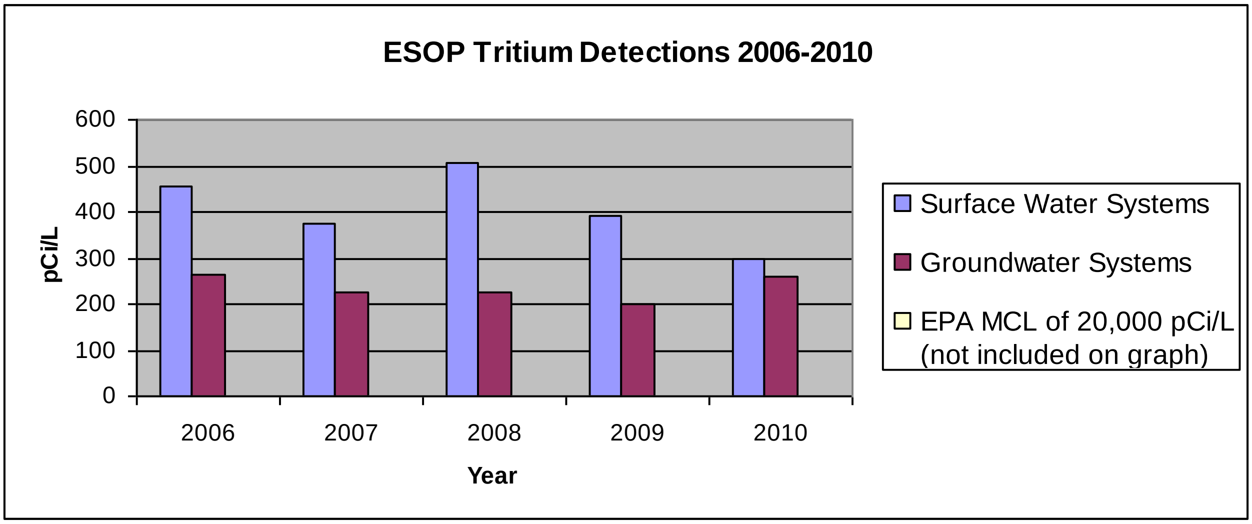
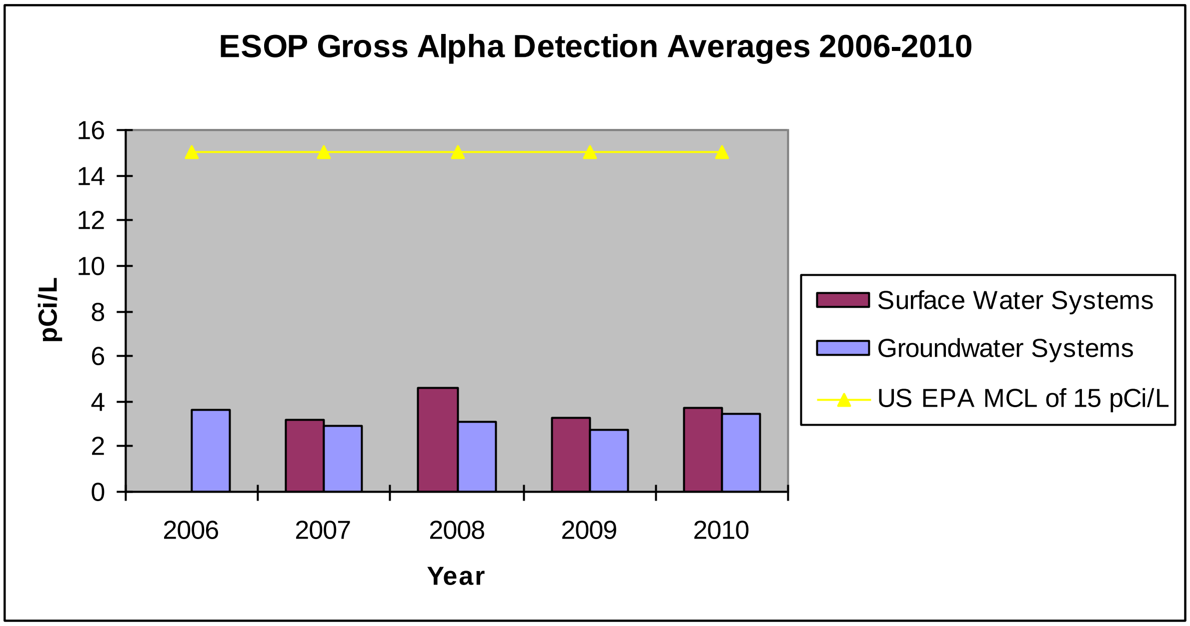


Figure 2. ESOP Yearly Gross Alpha Averages in Drinking Water Systems

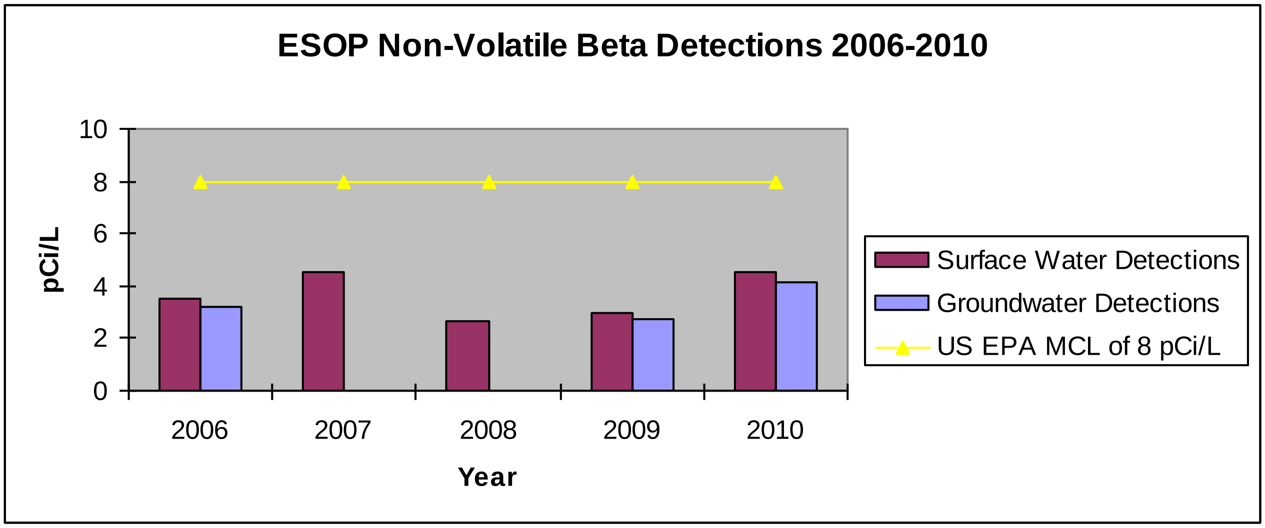


Note: Missing data for 2006 indicates no surface water detections were found for that year.

Tables and Figures

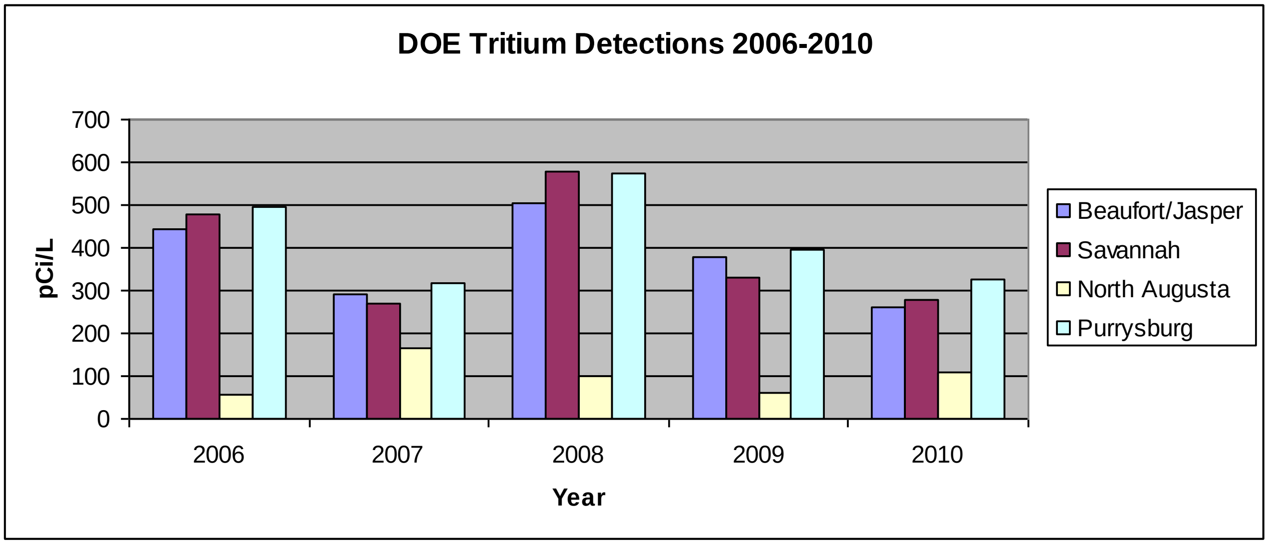
Drinking Water Quality Monitoring

Figure 3. ESOP Yearly Non-Volatile Beta Averages in Drinking Water Systems



Note: Missing data for 2007 and 2008 indicates no groundwater detections were found for those years.

Figure 4. DOE-SR Yearly Tritium Averages in Drinking Water

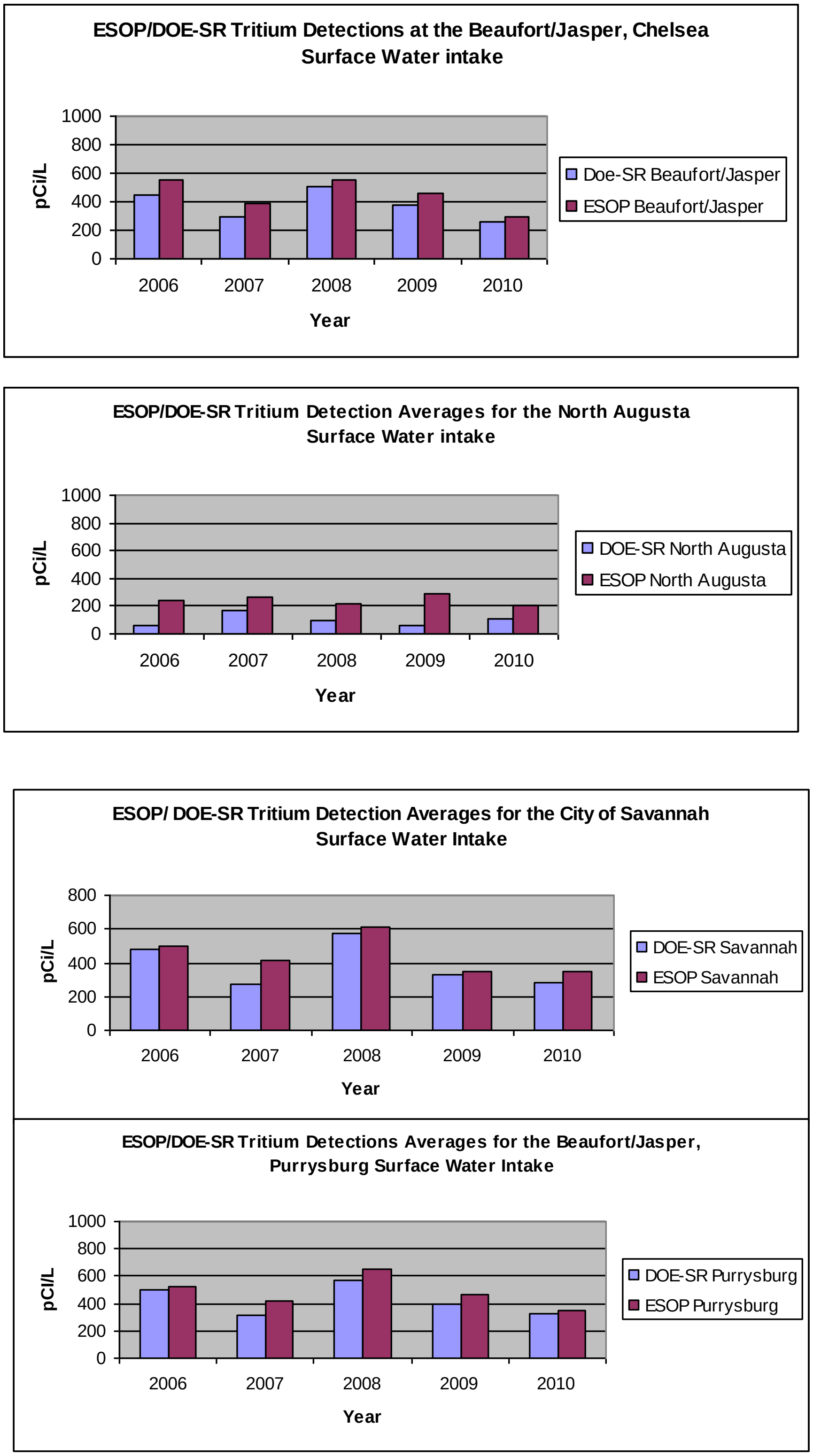


Note: Purrysburg was first collected as a new sampling location in 2006.

Tables and Figures

Drinking Water Quality Monitoring TOC

Figure 5. ESOP/DOE-SR Comparison of 2010 Averages of Tritium in Drinking Water



2.2.4 Data

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Notes:

4. Bold numbers denote detection.
5. A blank field following ±2 SIGMA occurs when the sample is <LLD.
6. LLD= Lower Limit of Detection
7. MDA= Minimum Detectable Activity
5. No Media = No Drinking Water Sample was Available in the Quadrant
6. NV = Non-volatile

Drinking Water Data
2010 Radiological Data for Surface Water Systems

Sample Number:		**DW0210003F**											
Sample Name:		**North Augusta Surface Water**											
Date:		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	3.17	3.08	2.53	2.53	1.60	1.61	3.10	3.10	2.90	2.75	2.97	2.96
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	3.81	3.80	4.09	4.08	3.57	3.57	3.75	3.75	2.41	2.49	2.59	2.59
Tritium	(pCi/L)	<LLD	<LLD	**194**	<LLD	<LLD	<LLD	**200**	<LLD	<LLD	**231**	<LLD	**183**
±2	(sigma)	N/A	N/A	85	N/A	N/A	N/A	96	N/A	N/A	N/A	N/A	83
	(LLD)	185	185	181	181	222	222	196	196	216	216	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	2.53	2.70	2.20	2.43	1.74	1.70	2.38	2.57	2.47	2.42	2.66	2.73

Sample Number:		**DW0720003F**											
Sample Name:		**Chelsea B/J Surface Water Canal Intake**											
Date:		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.88**	**3.38**	**8.45**	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.18	2.23	3.09	N/A
	(LLD)	3.45	3.43	2.78	2.84	1.80	1.88	3.61	3.59	2.79	2.75	3.42	3.37
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**4.62**	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.13	N/A	N/A
	(LLD)	3.82	3.82	4.10	4.10	3.58	3.59	3.78	3.78	2.97	3.07	2.62	2.62
Tritium	(pCi/L)	**223**	**189**	<LLD	<LLD	<LLD	<LLD	**200**	**199**	**290**	**231**	**387**	**594**
±2	(sigma)	88	87	N/A	N/A	N/A	N/A	86	86	98	94	91	100
	(LLD)	185	185	181	181	222	222	196	196	216	216	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	2.64	2.68	2.37	2.47	1.81	1.88	2.43	2.62	2.79	2.62	2.62	2.54

Sample Number:		**DWSAVF**											
Sample Name:		**City of Savannah Surface Water (Industrial)**											
Date:		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**3.74**	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.06	N/A	N/A
	(LLD)	3.26	2.61	2.74	1.89	1.85	3.73	2.77	2.80	3.37	2.19	3.26	3.27
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	**7.65**	<LLD	<LLD	<LLD	**2.60**	**3.60**	<LLD	**3.19**
±2	(sigma)	N/A	N/A	N/A	N/A	2.15	N/A	N/A	N/A	1.54	1.75	N/A	1.79
	(LLD)	3.81	4.09	4.10	3.59	3.59	3.78	2.43	2.43	2.13	2.43	2.61	2.61
Tritium	(pCi/L)	**414**	**236**	**234**	<LLD	**316**	**259**	**202**	**201**	**290**	**519**	**619**	**505**
±2	(sigma)	96	87	87	N/A	101	91	83	83	98	107	101	96
	(LLD)	185	181	181	222	222	196	174	174	216	216	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	2.51	2.40	2.24	1.74	1.87	2.41	2.44	2.24	2.62	2.64	2.63	2.73

Sample Number:		**DW0720004F**											
Sample Name:		**Purrysburg B/J Plant Surface Water SR Intake**											
Date:		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	**1.88**	<LLD	<LLD	**2.89**	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	1.32	N/A	N/A	1.85	N/A	N/A	N/A
	(LLD)	3.31	3.23	3.73	2.83	1.76	1.75	3.51	6.67	2.09	4.12	3.31	3.29
N-V Beta	(pCi/L)	<LLD	<LLD	**4.82**	<LLD	<LLD	<LLD	**4.66**	<LLD	**3.64**	**5.80**	<LLD	<LLD
±2	(sigma)	N/A	N/A	2.29	N/A	N/A	N/A	2.51	N/A	2.11	2.06	N/A	N/A
	(LLD)	3.81	3.81	4.15	4.10	3.58	3.58	3.77	3.88	3.15	2.74	2.62	2.61
Tritium	(pCi/L)	<LLD	**238**	**231**	**275**	<LLD	<LLD	**314**	**256**	**290**	**461**	**407**	**739**
±2	(sigma)	N/A	89	87	88	N/A	N/A	96	91	N/A	104	92	105
	(LLD)	185	185	181	181	222	222	196	196	216	216	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	2.73	2.69	2.41	2.57	1.59	1.81	2.54	2.50	2.59	2.60	2.58	2.64

Drinking Water Data
2010 Radiological Data for Groundwater Systems

System Number:	DW0210001		DW0210002		DW670075		DW0210007		DW0220001	
System Name:	Aiken		Jackson		Healing Springs		New Ellenton		Langley Water	
Date:	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10
Gross Alpha (pCi/L)	**2.88**	<LLD	**3.97**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	1.71	N/A	1.68	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	2.37	2.47	2.04	2.18	3.76	4.47	2.24	2.01	3.34	2.85
N-V Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	4.02	2.42	4.00	2.42	4.09	3.73	4.01	2.41	3.61	2.43
Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	188	208	188	208	188	189	188	208	179	208
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	2.34	3.06	2.39	2.68	2.34	2.39	2.55	2.65	1.72	2.60

System Number:	DW0220005		DW0220006		DW0220008		DW0220012		DW0310001	
System Name:	Talatha Water		Breezy Hill		Montmorenci		Valley PSA		Allendale	
Date:	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	**2.43**	**3.35**	**4.69**	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	1.87	1.74	2.22	N/A	N/A	N/A	N/A
(LLD)	2.24	2.05	2.84	2.28	2.29	2.28	4.81	3.78	4.19	4.03
N-V Beta (pCi/L)	<LLD	**4.41**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	1.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	4.01	2.41	3.59	2.42	4.02	2.42	3.66	2.68	4.11	2.68
Tritium (pCi/L)	**290**	**230**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	91	98	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	188	208	179	208	188	208	179	208	188	208
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	2.47	2.61	1.73	2.83	2.43	2.68	1.59	2.71	2.28	2.79

System Number:	DW0610004		DW0610001		DW0220003		DW0220002		DW0610002	
System Name:	Hilda		Barnwell		Bath Water Dist.		College Acres		Williston	
Date:	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.97**	<LLD	**2.69**	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	1.54	N/A	1.78	N/A
(LLD)	2.60	3.70	2.79	3.12	3.39	3.05	2.03	2.12	2.55	2.82
N-V Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	4.04	3.70	4.05	2.43	3.61	2.43	4.00	2.41	2.49	2.43
Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(LLD)	188	189	188	208	179	208	188	208	188	208
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
(MDA)	2.21	2.21	2.43	2.50	1.64	2.55	2.43	2.56	2.49	2.64

Drinking Water Data
2010 Radiological Data for Groundwater Systems

System Number:		DW0610005		DW0610003		DW0220004		DWDuplicate01		DWDuplicate02	
System Name:		Elko		Blackville		Beech Island					
Date:		Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10	Apr-10	Oct-10
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.68**	<LLD	**3.62**	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	1.67	N/A	1.95	N/A
	(LLD)	3.69	3.78	4.27	5.10	3.25	2.57	2.36	3.44	2.62	4.25
N-V Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	4.14	2.44	4.11	3.75	3.61	2.42	4.02	3.69	4.04	3.73
Tritium	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(LLD)	188	208	188	189	179	208	188	189	188	189
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(MDA)	2.28	2.63	2.08	2.38	1.74	2.52	2.42	2.24	2.30	2.44

System Number:		DW0670918	
System Name:		SCAT Park	
Date:		Apr-10	Oct-10
Gross Alpha	(pCi/L)	**3.95**	**6.44**
±2	(sigma)	1.58	2.26
	(LLD)	1.87	2.00
N-V Beta	(pCi/L)	<LLD	**3.84**
±2	(sigma)	N/A	1.80
	(LLD)	3.98	2.41
Tritium	(pCi/L)	<LLD	<LLD
±2	(sigma)	N/A	N/A
	(LLD)	188	208
Cesium-137	(pCi/L)	<MDA	<MDA
±2	(sigma)	N/A	N/A
	(MDA)	2.37	2.61

TOC

2.2.5 Summary Statistics

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

Notes:

3. N/A = Not Applicable
4. Min. = Minimum
5. Max. = Maximum
4. Num = Number of Detections
5. NV = Non-volatile

Summary Statistics
2010 Surface Water Fed Summary Statistics

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name	System Number	Median	Avg.	St. Dev.	Max	Min	Num
Chelsea B/J	DW0720003F	3.38	4.90	3.08	8.45	2.88	3
City of Savannah	SAVF	3.74	3.74	N/A	3.74	3.74	1
Purrysburg	DW0720004F	2.39	2.39	0.71	2.89	1.88	2
Yearly Average of Detectable gross alpha			**3.68**				
Standard Deviation			**1.26**				

Radionuclide:	Gross NV Beta (pCi/L)	Statistical Analysis					
System Name	System Number	Median	Avg.	St. Dev.	Max	Min	Num
Chelsea B/J	DW0720003F	4.62	4.62	N/A	4.62	4.62	1
City of Savannah	DWSAVF	3.40	4.26	2.30	7.65	2.60	4
Purrysburg	DW0720004F	4.74	4.73	0.88	5.80	3.64	4
Yearly Average of Detectable non-volatile (NV) beta			**4.54**				
Standard Deviation			**0.25**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name	System Number	Median	Avg.	St. Dev.	Max	Min	Num
North Augusta	DW0210003F	197.00	202.00	20.58	231	183	4
Chelsea B/J	DW0720003F	227.00	289.13	139.58	594	189	8
City of Savannah	DWSAVF	290.00	345.00	145.73	619	201	11
Purrysburg	DW0720004F	290.00	356.78	162.99	739	231	9
Yearly Average of Detectable Tritium			**298.23**				
Standard Deviation			**70.61**				

Summary Statistics
2010 Groundwater Fed Summary Statistics

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name	**System**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Aiken	**DW0210001**	2.88	2.88	N/A	2.88	2.88	1
Jackson	**DW0210002**	3.97	3.97	N/A	3.97	3.97	1
Breezy Hill	**DW0220006**	2.43	2.43	N/A	2.43	2.43	1
Montmorenci	**DW0220008**	4.02	4.02	0.95	4.69	3.35	2
Williston	**DW0610002**	2.69	2.69	N/A	2.69	2.69	1
SCAT Park	**DW0670918**	5.20	5.20	1.76	6.44	3.95	2
College Acres	**DW0220002**	2.97	2.97	N/A	2.97	2.97	1
Yearly Average of Detectable Gross Alpha			**3.45**				
Standard Deviation			**0.99**				

Radionuclide:	Gross NV Beta (pCi/L)	Statistical Analysis					
System Name	**System**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
SCAT Park	**DW0670918**	3.84	3.84	N/A	3.84	3.84	1
Talatha Water	**DW0220005**	4.41	4.41	N/A	4.41	4.41	1
Yearly Average of Detectable Gross NV Beta			**4.13**				
Standard Deviation			**0.40**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name	**System**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Talatha Water	**DW0220005**	260	260	42.43	290	230	2
Yearly Average of Detectable Tritium			**260.00**				
Standard Deviation			**42.43**				

TOC

2.3 Radiological Monitoring of Surface Water

2.3.1 Summary

The U.S. Atomic Energy Commission established the Savannah River Site (SRS) in 1950 to produce plutonium, tritium, and other materials for national defense and civilian purposes (Till et al. 2001). Due to the large number of materials that could potentially be released from SRS, the Centers for Disease Control and Prevention (CDC) performed a site assessment to determine the potential health effects of any released radionuclides to the offsite public. In 1992, CDC hired Radiological Assessments Corporation (known as Risk Assessment Corporation as of 1998) to perform screening procedures to determine the key radionuclides released to the environment. These screening methods indicated that the main radionuclides released to surface water were tritium (H3) and cesium-137 (Cs-137). Other radionuclides of interest are strontium-90 (Sr-90), cobalt-60 (Co-60), americium-241 (Am-241), and uranium (U). The five production reactors (R, K, P, L, and C) were the primary sources for these radionuclide releases directly to onsite streams. Additionally, effluent from the separation areas (F-Area and H-Area) was discharged into storage tanks and seepage basins, but not directly into streams. However, some releases from these areas occurred due to leaks in cooling coils, which contained water pumped from deep wells. The fuel fabrication area (M-Area), heavy water reprocessing facility (D-Area), and the administration area (A-Area) also contributed radionuclides to liquid discharge. Onsite streams affected by these releases are Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. All of these SRS streams are tributaries to the Savannah River (Till et al. 2001).

Tritium was one of the principle nuclear materials produced at SRS to multiply the firepower of plutonium in nuclear weapons (Till et al. 2001). The primary tritium releases originated from processes associated with the reactors, F-Area and H-Area, D-Area, and tritium recovery in the tritium facilities. The two main types of tritium releases come from direct site facility releases and migration from seepage basins in F-Area and H-Area, the burial ground, and the K-Area containment basin. In the early operational years, almost 100% of the releases to streams were related to direct releases. After the cessation of active reactor activities, most releases were a result of migration from the seepage basins. Since the mid 1970s, migration and outcropping to streams have accounted for most of the SRS tritium released to surface water (Zeigler et al. 1985, Murphy et al. 1991, Murphy and Carlton 1991). After 1988, the Effluent Treatment Facility (ETF) went into operation and the F-Area and H-Area basins were not used (CDC 2006). The primary purpose of ETF was to process low level radioactive wastewater from the separation areas (SRS 2008). Periodically, ETF has controlled tritium releases to Upper Three Runs Creek. Additionally, tritium occurs naturally from the cosmic interaction of radiation with atmospheric gases (USEPA 2008e) and also as a result of past nuclear testing (Till et al. 2001).

Most of the radiocesium at SRS was formed as a byproduct of the nuclear fuel and targets during operation of the five production reactors. Cesium-137 is an important radionuclide to monitor due to its 30 year half-life. Additionally, the biological behavior of Cs-137 is similar to potassium, which is essential to the function of living cells (USEPA 2008a). Therefore, the potential for Cs-137 uptake into humans is important considering the potential health effects. The streams that were largely affected by Cs-137 are Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek, with Steel Creek showing the highest activity (Till et al. 2001).

Alpha-emitting radionuclides were released to liquid effluent from M-Area, F-Area and H-Area, and the reactor areas. The primary stream affected by the M-area releases was Tims Branch, which ultimately flows into Upper Three Runs Creek. Fourmile Branch is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs Creek (Till et al. 2001).

Beta-emitting radionuclides were released to liquid effluent from F-Area, H-Area and the reactors. Fourmile Branch is the stream primarily affected by releases from the separations areas. Steel Creek, Pen Branch, and Lower Three Runs Creek were mainly affected by releases from the reactors. Strontium-90 is a main contributor of beta activity and came primarily from the reactors (Till et al. 2001).

The previously mentioned SRS surface water bodies, as well as the Savannah River, continue to be the focus for monitoring and surveillance activities of the Radiological Monitoring of Surface Water (RSW) project that is part of the South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP). Since the Savannah River is the primary drinking water source for downstream communities, it is important to ensure radionuclide concentrations in the river are well below limits considered safe for human consumption. Surface water samples are collected and analyzed for radionuclides, and the results are compared to Department of Energy-Savannah River (DOE-SR) data. DOE-SR conducts surveillance and monitoring activities for the following purposes: determining concentrations and migration of radionuclides in the aquatic environment, detecting and verifying accidental releases, characterizing concentration trends, and determining associated impacts on human health and the environment. ESOP supports DOE-SR's objectives to ensure the primary goal of drinking water safety is established and met. Project databases were expanded and data trends for radionuclides in streams are given (Section 2.3.3, Tables and Figures, Section 2.3.4, Data Tables, and Section 2.3.5, Summary Statistics). These activities will allow the RSW project to generate independent data that is shared with the public.

Section 2.3.3, Table 1 identifies sample ID, location, rationale, and frequency. The RSW Project continues to collect surface water samples from 13 specific locations within and outside of the SRS boundary as part of an ambient sampling network (Section 2.3.2, Map 5.). Seven of these locations use ISCO™ automatic water samplers to collect aliquots every 30 minutes to produce a composite. Grab samples are collected from the remaining six locations. Samples are collected three days per week (Monday, Wednesday, Friday) from the locations that have the automatic water samplers. Tritium, gross alpha, gross beta and gamma analyses are dependent on sample location and sampling frequency. Some locations were chosen because they are considered to be public access locations. The public access locations are downstream of SRS and provide a potential means for exposure to radionuclides.

Prior to 2009, quarterly samples were collected for tritium analysis from the five creeks that flow from SRS directly into the Savannah River (Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs Creek). Pen Branch is not sampled because the Savannah River Swamp interrupts the flow for this creek and there is no creek mouth access. In 2009, ESOP switched from quarterly to monthly sampling of these creek mouth locations. This modification was implemented to collect additional creek mouth data that would provide a better comparison to the weekly DOE-SR creek mouth sampling regimen.

An enhanced surface water monitoring program is implemented to provide downstream drinking water customers with advance notice of the potential for increased tritium levels in the Savannah River due to an SRS release. This early detection facet is possible because of the continuous monitoring of the six SRS streams that flow to the Savannah River. Samples for tritium analysis are collected from the seven locations with automatic water samplers. Additionally, a grab sample is collected from Johnson's Boat Landing (SV-2080) and US Highway 301 at the Savannah River (SV-118). Sampling devices at SV-118 consist of an ISCO™ composite sampler and a 24 bottle carousel sampler. The composite sampler is utilized to collect composite samples over a 48 hour period (Monday through Wednesday and Wednesday through Friday) or a 72 hour period (Friday through Monday). The carousel sampler provides hourly samples collected for the same respective time frame as the composite sampler. This gives ESOP a more accurate method for detecting potential tritium concentrations. Samples are analyzed at the Region 5 Environmental Quality Control (EQC) tritium laboratory on the day of collection and results from the tritium analysis are used to project tritium activity in the Savannah River. Results from the enhanced program are considered to be unofficial results and are used only for notification purposes. All RSW tritium analysis is conducted at the Region 5 EQC laboratory.

An additional component of the RSW Project is the Supplemental Surface Water Monitoring Program implemented in 2005. The purpose of this sampling program is to monitor any potential releases of gross alpha/beta emitting radionuclides primarily along Upper Three Runs and Fourmile Branch. Sample locations are established along Upper Three Runs Creek, McQueen Branch, and Fourmile Branch. The primary focus of this monitoring is the Saltstone facility, F-Area, and H-Area. The Saltstone facility is responsible for stabilizing and disposing of low-activity liquid radioactive waste produced on SRS (SRS 2009). Samples are collected on Monday, prepped the same day, and analyzed the next day as part of a quick scan early detection procedure. These samples are collected as unofficial results for notification purposes only.

ESOP began random sampling in 2004 to include more random coverage of perimeter samples (those within 50 miles of the SRS center point) and background samples (those greater than 50 miles from the SRS center point). This sampling program was implemented to allow future probabilistic comparisons of SRS perimeter and South Carolina (SC) background contaminant levels. These locations were randomly selected from a quadrant system established by the U.S. Department of Interior on a 7.5' topographical map of SC revision 10/92. Quadrants were established based on longitude and latitude limits (USDOI 1992). These quadrant locations are shown in Map 1. ESOP collected surface water samples in 2010 from three background sites.

During August of 2007, ESOP began collecting samples from a location at SC Highway 125 and Lower Three Runs Creek. This sampling was conducted in response to elevated tritium levels detected in groundwater samples near the Energy Solutions (formerly Chem-Nuclear) facility in Snelling, SC. The purpose of adding this location was to determine any potential tritium contributions to Lower Three Runs from Chem-Nuclear. This sampling location was moved to a location (Lower Three Runs Creek and Patterson Mill Road, SV-328) closer to the source during November of 2007. Samples were collected from this location during 2010.

Quarterly sampling for iodine-129 (I-129) and technetium-99 (Tc-99) was conducted at the ambient location on Fourmile Branch due to concerns that these are possible constituents related to effluent from the burial grounds.

The automatic water samplers located at SV-118 are powered by alternating current. This power source can be interrupted at times due to power outages most often associated with seasonal thunderstorms. Although this interruption of power typically is not frequent, only a partial sample may be collected in the composite sampler. Additionally, the sampling program in the carousel sampler may be halted, resulting in missed samples during a sampling event. Any missed composite samples are collected as grab samples.

RESULTS AND DISCUSSION

SCDHEC ESOP Surface Water Data

All monitoring data are in Section 2.3.4 and summary statistics are in Section 2.3.5. All established sampling locations are in Section 2.3.4, Table 1.

Tritium

In 2010, tritium activity was detected at all ambient locations where weekly samples were collected (Section 2.3.5, Summary Statistics). Average tritium activities at Jackson Boat Landing (SV-2010), TNX Boat Landing (SV-2012), Beaver Dam Creek (SV-2040), and Upper Three Runs Creek at United States Forestry Service (USFS) Rd E-2 (SV-2027), were lower than average tritium activities at the other ambient sample locations (Section 2.3.4, Table 1). The 2010 tritium average for these locations was 233 (±49) picocuries per liter (pCi/L) for SV-2012, 235 (± 44) for SV-2040 and 233 (±39) pCi/L for SV-2027. Fourmile Branch at USFS Rd. 13.2 (SV-2039) and Pen Branch at USFS Rd. 13.2 (SV-2047) continue to yield the highest levels of tritium activity. SV-2039 had an average tritium activity of 39,877 (±5,370) pCi/L and SV-2047 had an average tritium activity of 35,111 (±9,394) pCi/L. Tritium detected activity ranged from 182 pCi/L at SV-2040 to 56,149 pCi/L at SV-2039**.** Section 2.3.3, Figure 1 shows trending for 2006-2010 tritium averages.

Tritium activity in the Savannah River at the creek mouths of the five SRS streams was scheduled for monitoring on a monthly basis in 2010 (Section 2.3.5, Summary Statistics). Three samples were collected at Fourmile Branch (SV-2015): one from the creek mouth, one from 30 feet downstream of the creek mouth, and one from 150 feet downstream of the creek mouth. Samples were taken at these three intervals to show the effect of the mixing zone created by the Savannah River flow. Samples collected directly at the creek mouth of Fourmile Branch (SV-2015a) had the highest average tritium activity (30,376 (±13,495) pCi/L) of all creek mouth locations**.** Due to flooding and personnel issues, samples were not collected in February, October, November and December.

Three random background samples were collected during the first quarter in 2010. Tritium was not detected in any of these samples.

Since random sampling began in 2004, there have been only four detections out of 49 perimeter samples collected and four detections out of 69 background samples collected. For the period of 2004-2010, there was one tritium detection of 230 (±2SD 92) pCi/L in 2006, one detection of 265 (±2SD 91) pCi/L in 2007, and two detections averaging 635 pCi/L (±615). Furthermore, for the same time period, there were only three years where tritium was detected in background samples. There was one detection of 247 (±2SD 91) pCi/L in 2004, an average of 242 (±53) pCi/L for two detections in 2007, and the 2009 single detection of 192 (±2SD 84) pCi/L. The

2004-2010 tritium average for background and perimeter samples was 231 (±40) pCi/L and 436 (±427) pCi/L, respectively. The 2004-2010 background average 231 (±40) pCi/L is within one standard deviation of the 2004-2009 perimeter average 436 (±417) pCi/L and is much lower than the perimeter average.

Gamma

As part of a gamma spectroscopy analysis, samples were analyzed for gamma-emitting radionuclides (Section 2.3.4, Table 2) at the Radiological Environmental Monitoring Division (REMD) Laboratory in Columbia, SC. Cesium-137 was detected in a sample collected from SV-2053 (5.11 (±2SD 2.40) pCi/L) in October 2010 (Section 2.3.4, Data). Cesium-137 has been detected in samples collected from SV-2039 in 2003, 2005, 2006 and 2008, in addition to Lower Three Runs Creek at SRS Road B (SV-2053) in 2002 (SCDHEC 2003a, 2004b, 2006, 2007b, 2009a). Fourmile Branch and Lower Three Runs were affected by releases from reactor activities, so periodic Cs-137 detections are likely in samples collected from these locations. In 2008, Co-60 and Am-241 results were incorporated in the RSW project report for comparison purposes with SRS data. There were no detections for Co-60 and Am-241 in ambient samples collected in 2010. There was a single detection for lead-214 (Pb-214) of 12.73 (±2SD 5.50) pCi/L in a sample collected from Steel Creek Boat Landing (SV-2018) in February. Lead-214 has never been detected at this location and may be attributed to unspecified Naturally Occurring Radioactive Material (NORM). All other radionuclides from the gamma analysis were below detection. There were no detections of Cs-137 for the 49 perimeter and 69 background samples collected from 2004-2010 and no detections for Co-60 and Am-241 for 2010 random perimeter or background samples (SCDHEC 2005a, 2006, 2007b, 2008a, 2009a, 2010c).

Alpha

Alpha-emitting radionuclides were detected at all locations where monthly composite samples were collected with the exception of Jackson Boat Landing (SV-2010) (Section 2.3.5, Summary Statistics). All other sampling locations had at least one detection out of the 12 samples collected. Average activity over all locations ranged from a single detection of 1.78 pCi/L at SV-2047 to 14.80 pCi/L at SV-325. SV-325 had detections in all 12 samples collected. Historically, SV-325 yields detections for alpha activity (SCDHEC 2000, 2001c, 2002, 2003a, 2004b, 2005a, 2006, 2007b, 2008a, 2009a). Tims Branch, which flows into Upper Three Runs Creek, was the primary stream affected by M-Area releases (Till et al. 2001). This may contribute to the common occurrence of alpha detections at this location. The 2010 average alpha activity at SV-325 was below the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) for drinking water of 15 pCi/L (USEPA 2002b). Beginning in 2009, samples collected at this location exhibited particles of sediment and detritus usually associated with rain events. This increase in turbidity seems to be related to storm events. Samples with high turbidity can have potential interferences during alpha/beta analysis. Alpha particles, and to a lesser extent, beta particles, are attenuated by salts and solids dried onto a planchet (USEPA 2010c). Furthermore, samples submitted to the REMD underwent a shorter turnaround for analysis during this period. This could have resulted in the detection of short lived radionuclides that had not decayed sufficiently. A rerun of some of these samples resulted in lower activities, which may indicate the presence of short lived radionuclides. Samples collected during September and October had the highest alpha activities than samples collected in the other months of the year. This sampling location will be monitored during 2011, and will continue into the future on an as needed basis, to ensure that turbidity is not a concern in collected samples. Ambient monitoring average annual alpha trends for 2006-2010 are shown in Section 5.0, Figure 2. All averages were below the USEPA MCL of 15 pCi/L for gross alpha-emitting particles in drinking water (USEPA 2002b) including SV-325.

In 2010, average alpha detections were lower than in 2009. Six locations in 2010 (SV-2040, SV-2039, SV-2047, SV-2018, SV-118, SV-2053) had single detections while in 2009 there were only two locations with single detections (SV-2047, SV-2053). The highest alpha average for both years was collected at SV-325. This average decreased from 23.18 (±19.48) pCi/L in 2009 to 14.80 (±7.16) pCi/L in 2010.

Alpha-emitting radionuclides were detected in two random samples in 2010 (Section 2.3.4, Random Sample Alpha/Beta Data). These background samples collected in Orangeburg County (RWB49) and Williamsburg County (RWB62) yielded an average detection of 8.95 (±6.30) pCi/L.

Beta

Beta-emitting radionuclide activity was detected in five of nine locations where monthly composite samples were collected (Section 2.3.5, Summary Statistics). The average activity ranged from 5.58 (±1.03) pCi/L at SV-2040 to 6.72 (±1.84) pCi/L at SV-2039**.** Four Mile Creek was primarily affected by releases from the separations areas, so gross beta detections can be expected at this location. Ambient monitoring average annual beta trends for 2006-2010 are shown in Section 2.3.3, Figure 3. The USEPA screening MCL for gross beta-emitting particles for drinking water systems is 50 pCi/L (USEPA 2002b)**,** and all averages were below this limit. No beta-emitting radionuclides were detected in the four random samples collected in 2010 (Section 2.3.4, Random Sample Alpha/Beta Data).

Iodine-129 and Technetium-99

There were I-129 detections in all four quarterly samples collected from SV-2039 in 2010. These detections averaged 2.53 (±0.90) pCi/L. There was only one detection of Tc-99 (6.16 (±2.54) pCi/L) during fourth quarter (Section 2.3.4).

SCDHEC/DOE-SR DATA COMPARISON

Data from 2010 reported in this project were compared to DOE-SR reported results (Section 2.3.3, Tables 3, 4, 5). DOE-SR reports all values, including values that are negative and ones that are below detection. Therefore, DOE-SR reports an average for all locations derived from detections and nondetection values. The SCDHEC and DOE-SR colocated sampling sites were Upper Three Runs Creek and SC Highway 125, Fourmile Branch and USFS Road 12.2, Pen Branch and USFS Road 13.2, Steel Creek and SC Highway 125, Lower Three Runs Creek and SRS Road B, and US Highway 301 Bridge at the Savannah River.

Tritium

SCDHEC and DOE-SR had detections for tritium at all colocated sample locations (Section 2.3.3, Table 3). DOE-SR average tritium activities for all colocated sites were within one SD of SCDHEC average tritium activities. SCDHEC and DOE-SR samples indicate that Fourmile Branch (39,877 (±5,370) pCi/L and 40,333 (±4,879) pCi/L (SRNS 2011), respectively) and Pen

Branch (345,111 (±9,394) pCi/L and 35,642 (±8,822) pCi/L (SRNS 2011), respectively) have the highest tritium activity of all SRS streams**.** The 2010 SCDHEC and DOE-SR tritium results appear to be consistent with historically reported data values (Section 2.3.3, Figures 4-9) (SCDHEC 2000, 2001, 2002, 2003a, 2004b, 2005a, 2006, 2007b, 2008a, 2009a, 2010c, WSRC 2000a, 2001, 2002b, 2003a, 2004, 2005a, 2006, 2007, 2008, 2009, SRNS 2010-2011).

Gamma

DOE-SR reported a single detection of Cs-137 (9.32 pCi/L) (SRNS 2010) in January at Fourmile Branch. SCDHEC had a single Cs-137 detection of 5.11(±2.40) pCi/L at Lower Three Runs (SV-2053) in October 2010.

Alpha

SCDHEC detected gross alpha activity at all of the colocated sample locations with DOE-SR (Section 2.3.3, Table 4). DOE-SR average gross alpha activities were within one SD of the SCDHEC average gross alpha activities at Upper Three Runs Creek and Steel Creek. DOE-SR reported an average of 0.84 (±0.64) pCi/L at Pen Branch (SRNS 2010). SCDHEC had only one detection of 1.78 pCi/L at this location. Additionally, DOE-SR reported an average of 0.57 (±0.72) pCi/L at Lower Three Runs (SRNS 2010). SCDHEC had two detections averaging 6.26 (±4.38) pCi/L at this location. The DOE-SR average was within two SD of SCDHEC average gross alpha activity. SCDHEC and DOE-SR samples collected from Upper Three Runs Creek at SC Highway 125 exhibited the highest gross alpha average concentration (14.80 (±7.16) pCi/L and 8.32 (±3.63) pCi/L (SRNS 2010), respectively).

Beta

SCDHEC and DOE-SR detected gross beta activity at three of the six colocated sampling locations (Section 2.3.3, Table 5). SCDHEC did not detect gross beta activity at Pen Branch (SV-2047), Steel Creek (SV-327) or Lower Three Runs (SV-2053). DOE-SR average gross beta activities were within one SD of SCDHEC average gross beta activities at Four Mile Branch, two SD at Upper Three Runs, and more than three SD at the Hwy 301 Bridge. DOE-SR reported a monthly average, 1.07 (±0.57) pCi/L (SRNS 2010) at Pen Branch. DOE-SR samples collected from Fourmile Branch exhibited the highest gross beta average activities, 6.66 (±1.49) pCi/L (SRNS 2010). SCDHEC samples collected from Highway 301 had the highest average beta activity, 6.95 (±1.22) pCi/L.

CONCLUSIONS AND RECOMMENDATIONS

While tritium is detected at all public access locations, the results were below the EPA MCL annual average of 20,000 pCi/L for drinking water (USEPA 2002b). However, data generated from samples collected at the mouth of Fourmile Branch (SV-2015) indicate that the public could come into contact with tritium activity greater than the MCL at that location.

ESOP utilizes Minimum Detectable Activities (MDAs) in reporting radioactivity and does not report anything below MDA. DOE-SR, however, incorporates all values, including those below the MDA and negative numbers. This approach accounts for seemingly large differences between average values, which yield DOE-SR averages that are greater than three SDs from the

SCDHEC average. Also, differences could be attributed, in part, to the nature of the water medium and the specific point and time when the sample was collected.

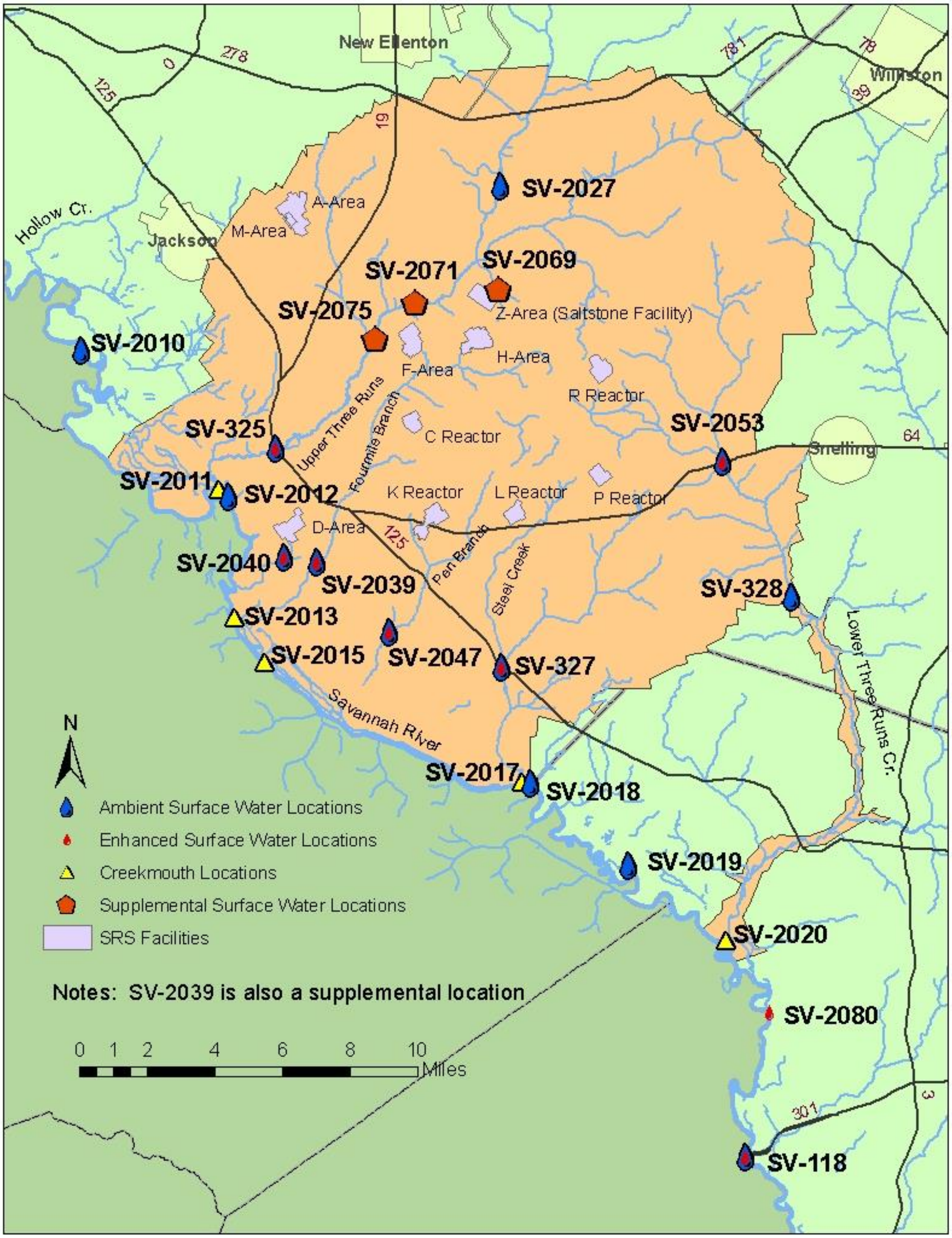
Differences in analytical results for tritium activity at sampling sites colocated with DOE-SR showed DOE-SR results were within one SD of SCDHEC results. Typically, ESOP samples do not exhibit Cs-137 on an annual basis. ESOP had a single detect of Cs-137 at Lower Three Runs (SV-2053) of 5.11 pCi/L (±2.40) which may be due to past reactor activities. ESOP only had one detection for gross alpha at Pen Branch. DOE-SR average gross beta activities were within one SD of SCDHEC average gross beta activities at Four Mile Branch, two SD at Upper Three Runs, and more than three SD at the Hwy 301 Bridge. ESOP and DOE-SR typically detect gross alpha emitting radionuclides from samples collected from the Upper Three Runs Creek location. Samples collected from this stream may continue to yield alpha detections due to past site operations in M-Area. ESOP had seven beta detections out of 12 samples and DOE-SR had 12 beta detections out of 12 samples for the sampling location at Fourmile Branch. These beta detections are most likely attributed to past activities that occurred in the separation areas (F-Area and H-Area). This sampling location historically yields multiple gross beta detections.

The ESOP RSW Project will continue to independently collect and analyze surface water on and adjacent to SRS. This monitoring effort will provide an improved understanding of radionuclide levels in SRS surface waters and valuable information relative to human health exposure pathways. The RSW project will periodically evaluate modifications of the monitoring activities to better accomplish the project's goals and objectives. Potential expansion of the RSW project may result in additional sampling locations being incorporated into the ambient or enhanced monitoring regimes. Furthermore, some historic locations may be removed due to the cessation of operational procedures at specific SRS facilities. This will only be considered if there is no potential for radionuclide exposure to the public at the specified location based on previously accumulated data. Monitoring will continue as long as there are activities at the SRS that create the potential for contamination entering the environment. Continued monitoring will provide an improved understanding of radionuclide activity in SRS surface waters and the Savannah River, which will provide valuable information to human health exposure pathways. This comparison of data results allows for independent data evaluation of DOE-SR monitoring activities.

TOC

2.3.2 Radiological Monitoring of Surface Water on and Adjacent to the SRS

Map 5. Surface Water Sampling Locations for 2009



TOC

2.3.3 Tables and Figures

Radiological Monitoring of Surface Water on and Adjacent to the SRS

Table 1. 2010 Surface Water Sampling Locations and Frequency

Ambient Monitoring Locations

ID	Location	Rationale	Frequency
SV-2010	Savannah River at RM 170.5 (Jackson Boat Landing)	Accessible to public; Above all SRS operations; Near Jackson population center; Upriver control; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-325	Upper Three Runs Creek at SC 125 (SRS Road A)	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2012	Savannah River at RM 170.5 (TNX Boat Landing)	Adjacent to SRS perimeter; River monitoring	Weekly H3
SV-2040	Beaver Dam Creek at D-Area	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2039	Fourmile Branch at Road A-13.2	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2047	Pen Branch at Road A-13.2	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-327	Steel Creek at SC 125 (SRS Road A)	Within SRS perimeter; Below SRS operations areas; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2018	Savannah River at RM 141 (Steel Creek Boat Landing)	Accessible to public; Adjacent to SRS perimeter; Below SRS operations and tributaries; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2019	Savannah River at RM 134.5 (Little Hell Boat Landing)	Accessible to public; Below SRS operations and tributaries; River monitoring	Weekly H3
SV-2080	Svannah River at RM 125 (Johnson's Boat Landing)	Accessible to public; Below SRS operations and tributaries; River monitoring	TriWeekly H3 Grab
SV-118	Savannah River at RM 118.8 (Highway 301 Bridge)	Accessible to public; Below SRS operations and tributaries; River monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-328	Lower Three Runs Creek at Patterson Mill Rd.	Within SRS perimeter; Below SRS operations areas and PAR pond; Tributary monitoring	Weekly H3
SV-2053	Lower Three Runs Creek at Road B	Within SRS perimeter; Below SRS operations areas and PAR pond; Tributary monitoring	Weekly H3 / Monthly AB, Gamma Composite
SV-2027	Upper Three Runs Creek at SRS Road 2-1	Within SRS perimeter; Upstream from SRS operations; Upstream control; Tributary monitoring	Weekly H3

Notes:
1. ID is Sampling Location Identification Code Number
2. RM is River Mile
3. H3 is Tritium
4. AB is Alpha/Beta
5. SV-2080 is an enhanced sampling location that is collected three times per week

Tables and Figures
Radiological Monitoring of Surface Water on and Adjacent to the SRS

Table 1. (Cont.)

Creek Mouth Locations

ID	Location	Rationale	Frequency
SV-2011	Upper Three Runs Creek Mouth at RM 157.4	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2013	Beaver Dam Creek Mouth at RM 152.3	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015a	Fourmile Branch at RM 150.6 (Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015b	Fourmile Branch at RM 150.6 (30 ' downstream from Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2015c	Fourmile Branch at RM 150.6 (150' downstream from Creek Mouth)	Accessible to public; Adjacent to SRS; Below SRS operations areas; Tributary monitoring	Monthly H3
SV-2017	Steel Creek Mouth at RM 141.5	Accessible to public; Adjacent to SRS; Downstream from SRS operations; Tributary monitoring	Monthly H3
SV-2020	Lower Three Runs Creek Mouth at RM 129.1	Accessible to public; Adjacent to SRS; Downstream from SRS operations; Tributary monitoring	Monthly H3

Supplemental Locations

ID	Location	Rationale	Frequency
SV-2069	McQueen Branch off Monroe Owens Rd.	Downstream from SRS operations; Z-Area	Weekly AB
SV-2071	Upper Three Runs Creek at Road C-4	Downstream from F- & H-Area HLW Tanks	Weekly AB
SV-2075	Upper Three Runs Creek at Road C	Downstream from F- & H-Area HLW Tanks	Weekly AB
SV-2039	Fourmile Branch at Road A-12.2	Downstream from F- & H-Area HLW Tanks	Weekly AB

Notes:
1. ID is Sampling Location Identification Code Number
2. RM is River Mile
3. H3 is Tritium
4. AB is Alpha/Beta

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 2. Radiological analytes for gamma spectroscopy analysis

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 3. 2010 Tritium Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	949	461	797	397	2,403	52	52
U3R-4 at Road A	1,020	484	NA	384	1,980	12	11
Fourmile Branch (SV-2039)	39,877	5,370	40,051	28,442	56,149	52	52
FM-6 at Road A-12.2	40,333	4,879	NA	34,100	48,600	12	12
Pen Branch (SV-2047)	35,111	9,394	37,769	15,031	53,146	52	52
PB-3 at Road 13.2	35,642	8,822	NA	20,400	48,600	12	12
Steel Creek (SV-327)	2,781	1,054	2,614	999	5,502	52	52
SC-4 Steel Creek at Road A	2,827	996	NA	1,540	4,300	12	12
Highway 301 Bridge (SV-118)	346	144	313	190	736	52	43
River Mile 118.8	349	179	NA	99	957	52	49
Lower Three Runs Creek at Patterson Mill Rd. (SV-328)	2,633	988	2,545	1,092	4,644	52	52
L3R-2 at Patterson Mill Rd	2,628	884	NA	995	3,890	12	12
Lower Three Runs Creek (SV-2053)	380	77	370	216	541	52	50
L3R-1A at Road B	429	165	NA	186	786	12	7

Notes:
1. Shaded areas represent SCDHEC data and unshaded areas represent DOE-SR data
2. DOE-SR data is from the SRS Environmental Data Report for 2009 (SRNS 2009)
3. NA is Not Applicable
4. DOE-SR sampling locations:
   U3R-4: Upper Three Runs at SC Highway 125
   FM-6: Fourmile Branch at USFS Road A-12.2
   PB-3: Pen Branch at USFS Road 13.2
   SC-4: Steel Creek at SC Highway 125
   L3R-2: Lower Three Runs at Patterson Mill Road
   L3R-1A: Lower Three Runs at SRS Road B

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Table 4. 2010 Alpha Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	14.80	7.16	13.6	6.07	29.8	12	12
U3R-4 at Road A	8.32	3.63	NA	3.59	13.3	12	12
Fourmile Branch (SV-2039)	*2.49	NA	NA	NA	NA	12	1
FM-6 at Road A-12.2	0.69	0.35	NA	0.24	1.36	12	5
Pen Branch (SV-2047)	***1.78**	**NA**	NA	NA	NA	12	1
PB-3 at Road 13.2	0.84	0.64	NA	0.00	1.73	12	5
Steel Creek (SV-327)	3.32	2.74	3.32	1.38	5.25	12	2
SC-4 Steel Creek at Road A	2.09	2.37	NA	0.00	8.38	12	9
Highway 301 Bridge (SV-118)	*10.70	NA	NA	NA	NA	12	1
River Mile 118.8	0.30	0.36	NA	-0.17	1.14	52	3
Lower Three Runs Creek (SV-2053)	**6.26**	**4.38**	6.26	3.16	9.36	12	2
L3R-1A at Road B	0.57	0.72	NA	0.00	2.1	12	3

Table 5. 2010 Beta Data Comparison for SCDHEC and DOE-SR Colocated Sampling Locations

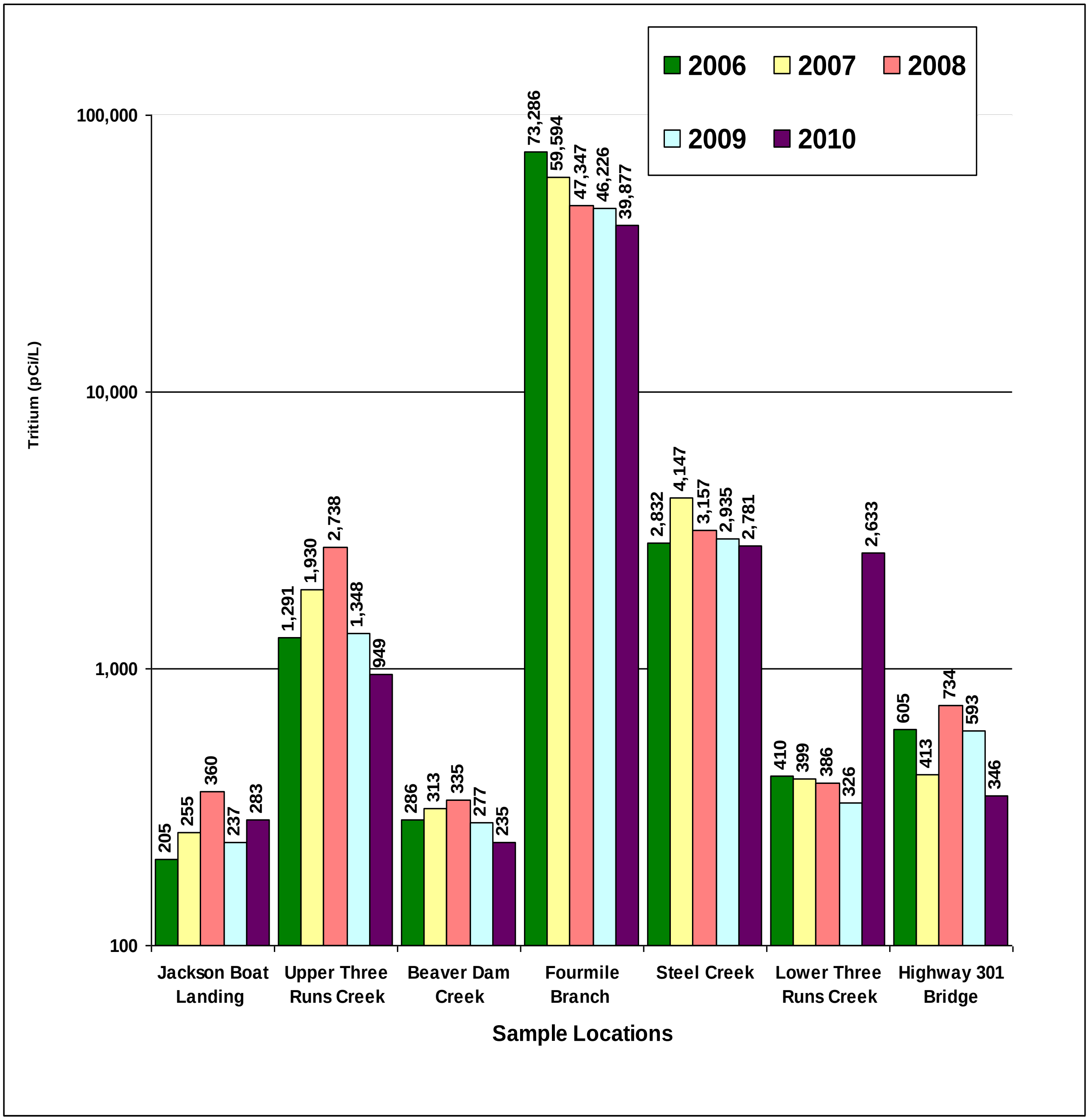
Sample Location	Average Concentration (pCi/L)	Standard Deviation (pCi/L)	Median (pCi/L)	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek (SV-325)	5.74	2.67	6.70	2.73	7.80	12	3
U3R-4 at Road A	2.90	2.01	NA	0.40	6.30	10	5
Fourmile Branch (SV-2039)	6.72	1.84	6.93	4.28	9.86	12	7
FM-6 at Road A-12.2	6.66	1.49	NA	5.00	9.97	12	12
Pen Branch (SV-2047)	**ND**	**ND**	NA	NA	NA	12	0
PB-3 at Road 13.2	1.07	0.57	NA	0.00	2	12	3
Steel Creek (SV-327)	ND	NA	NA	ND	ND	12	0
SC-4 Steel Creek at Road A	2.02	1.55	NA	0.50	6.27	12	11
Highway 301 Bridge (SV-118)	6.95	1.22	5.30	4.22	7.49	12	6
River Mile 118.8	2.35	0.68	NA	0.83	3.05	52	44
Lower Three Runs Creek (SV-2053)	ND	NA	NA	NA	NA	12	0
L3R-1A at Road B	2.17	0.70	NA	0.97	3.57	12	10

Notes:
1. Shaded areas represent SCDHEC data and unshaded areas represent DOE-SR data
2. DOE-SR data is from the SRS Environmental Data Report for 2010 (SRNS 2010)
3. NA is Not Applicable
4. ND is No Detects
5. NR is Not Reported
6. * denotes actual value and uncertainty (±2sd) for one detection for sampling location
7. DOE-SR sampling locations:
   U3R-4: Upper Three Runs at SC Highway 125
   FM-6: Fourmile Branch at USFS Road A-12.2
   PB-3: Pen Branch at USFS Road 13.2
   SC-4: Steel Creek at SC Highway 125
   L3R-2: Lower Three Runs at Patterson Mill Road
   L3R-1A: Lower Three Runs at SRS Road B

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

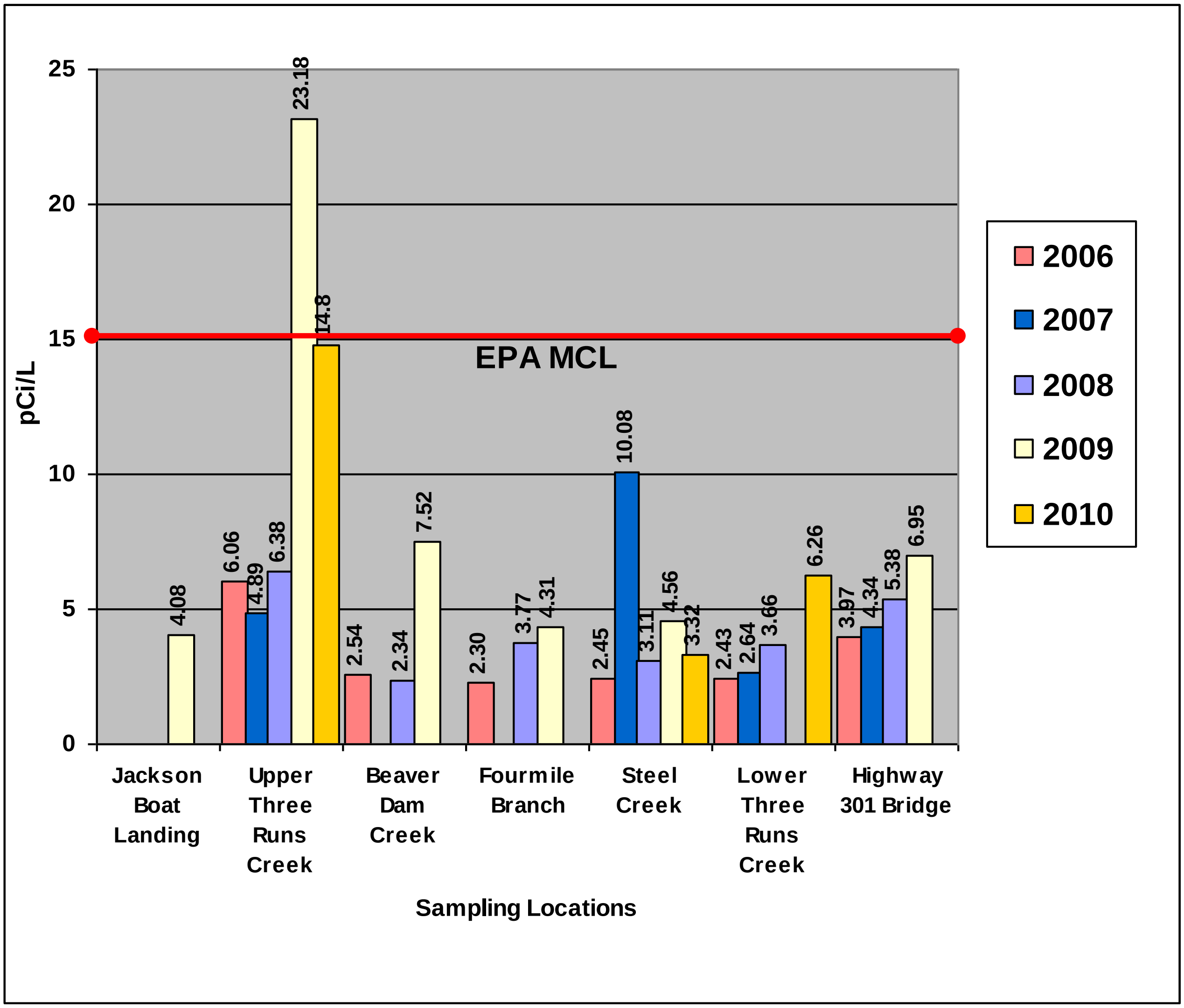
Figure 1. SCDHEC Average Tritium Trends for 2006-2010

Note: Jackson Boat Landing is a background location.



Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

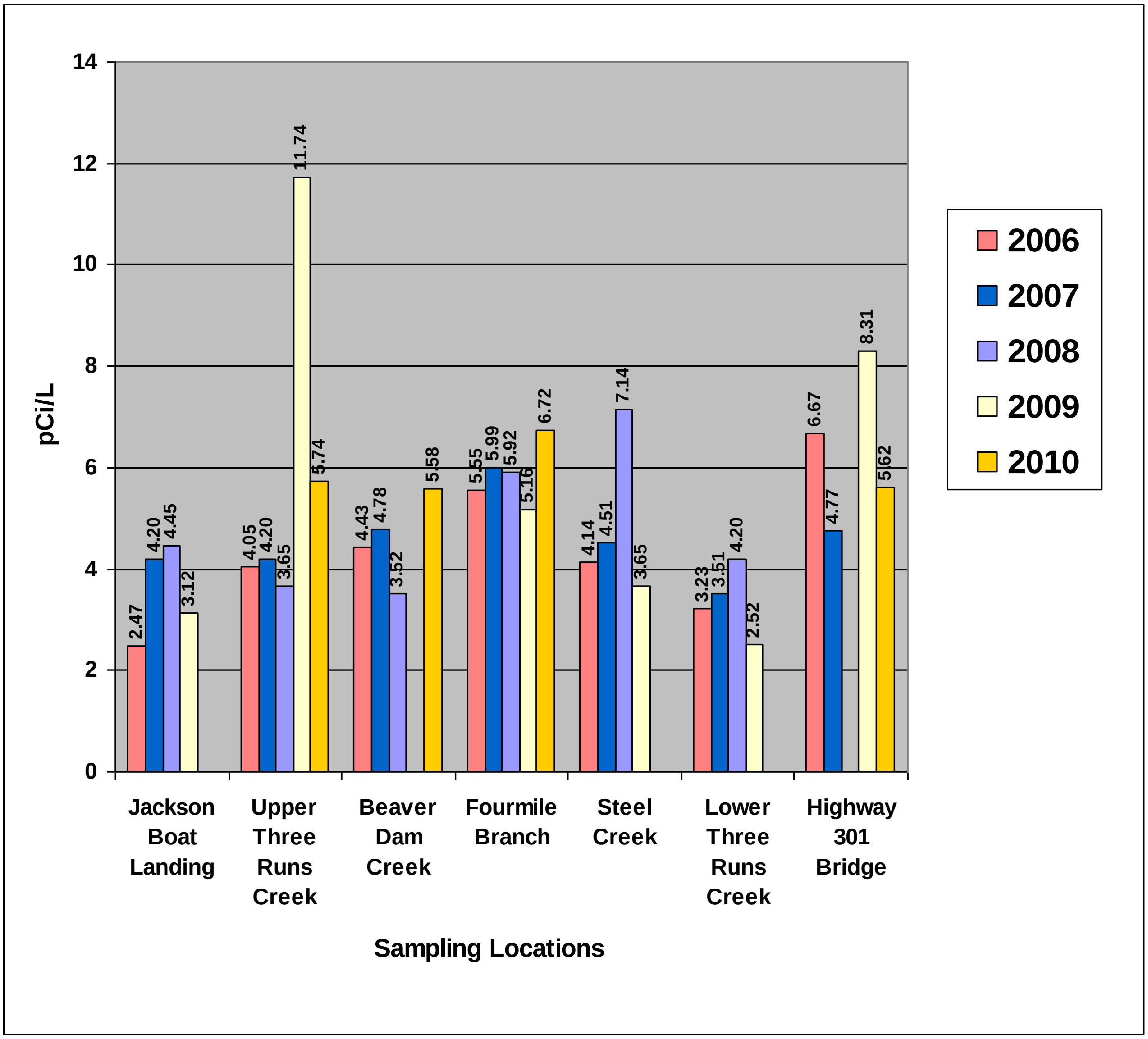
Figure 2. SCDHEC 2006-2010 Average Alpha Data



Notes:
1. No detections at Jackson Landing in 2006, 2007, 2008, and 2010
2. No detections at Beaver Dam Creek 2007
3. No detections at Fourmile Branch in 2007
4. No detections at Lower Three Runs Creek in 2009

Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

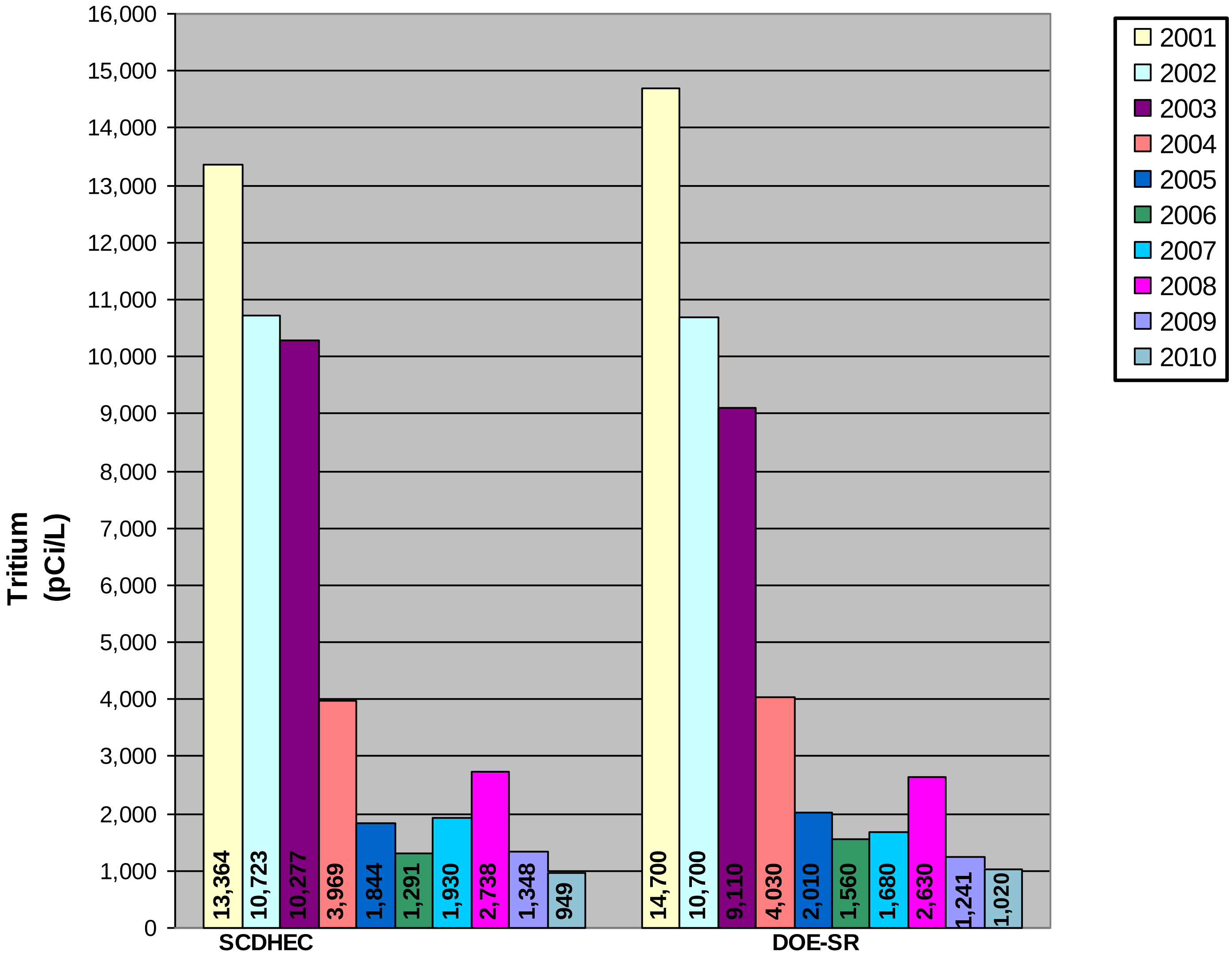
Figure 3. SCDHEC 2006-2010 Average Beta Data



Notes:
1. The EPA screening level MCL for gross beta particles is 50 pCi/L
2. No detections at Highway 301 in 2008
3. No detections at Beaver Dam Creek in 2009
4. No detections at Jackson Boat Landing, Steel Creek or Lower Three Runs in 2010

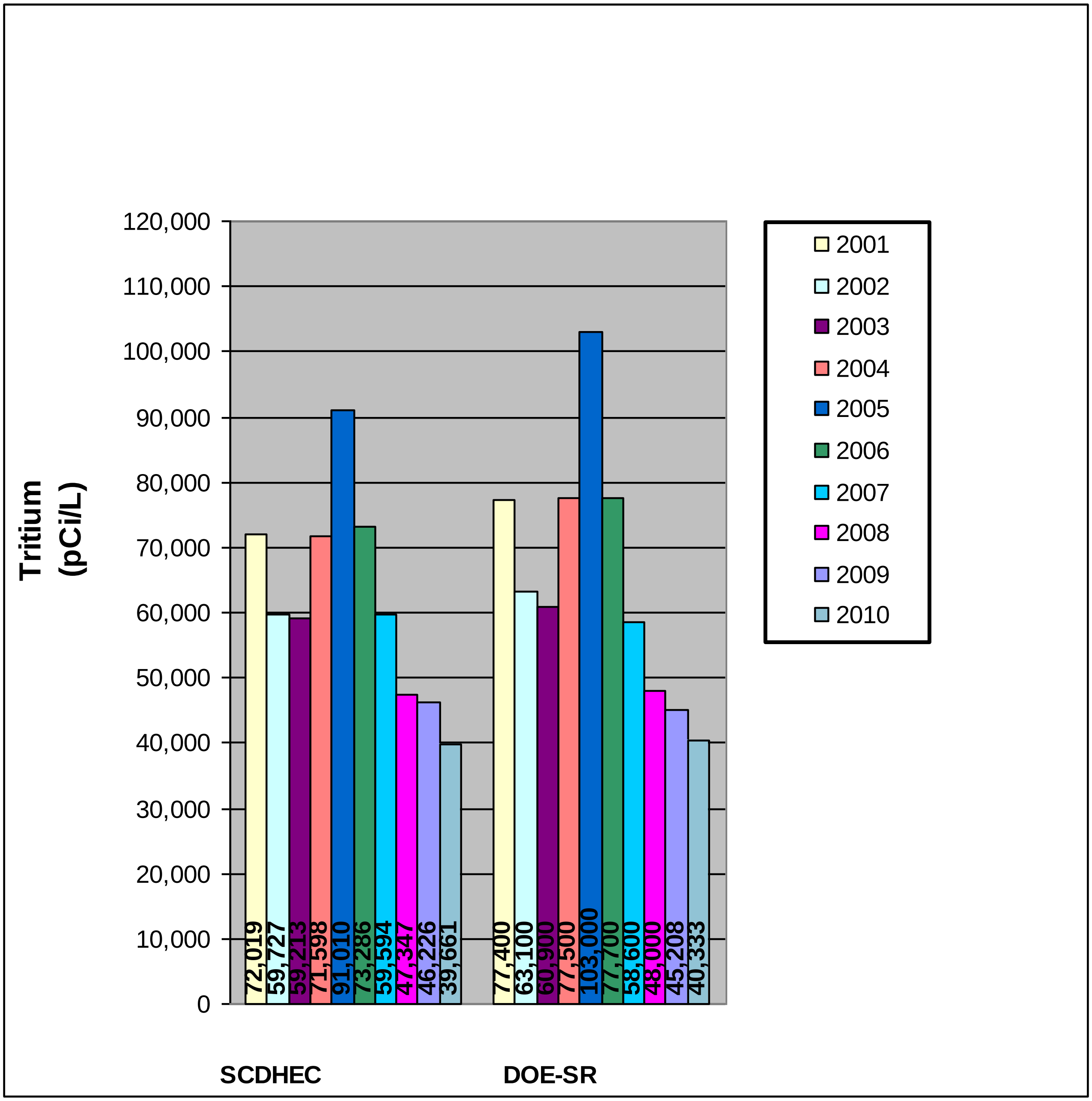
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 4. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at Upper Three Runs Creek and SC Highway 125



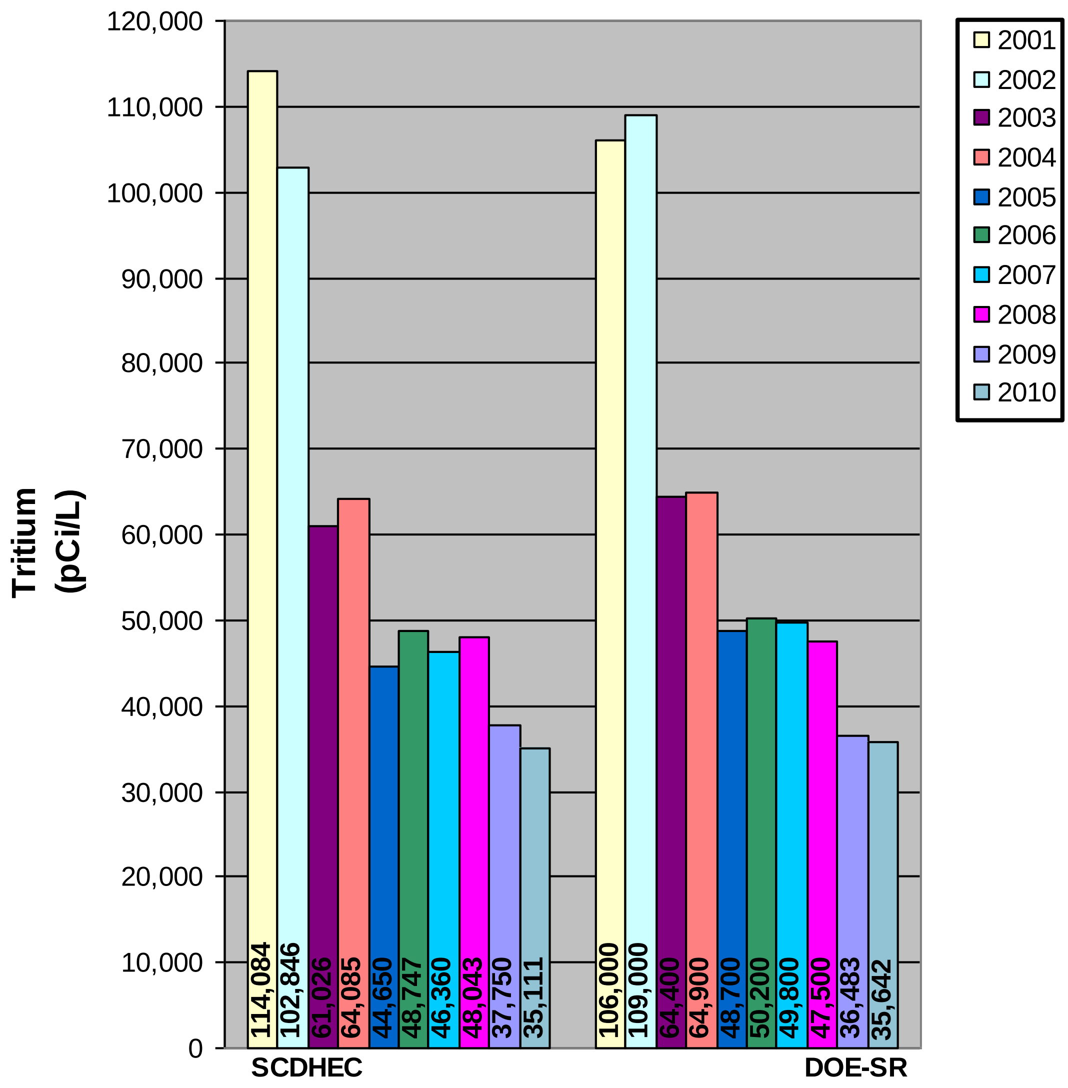
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 5. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at Fourmile Branch and USFS Road 12.2



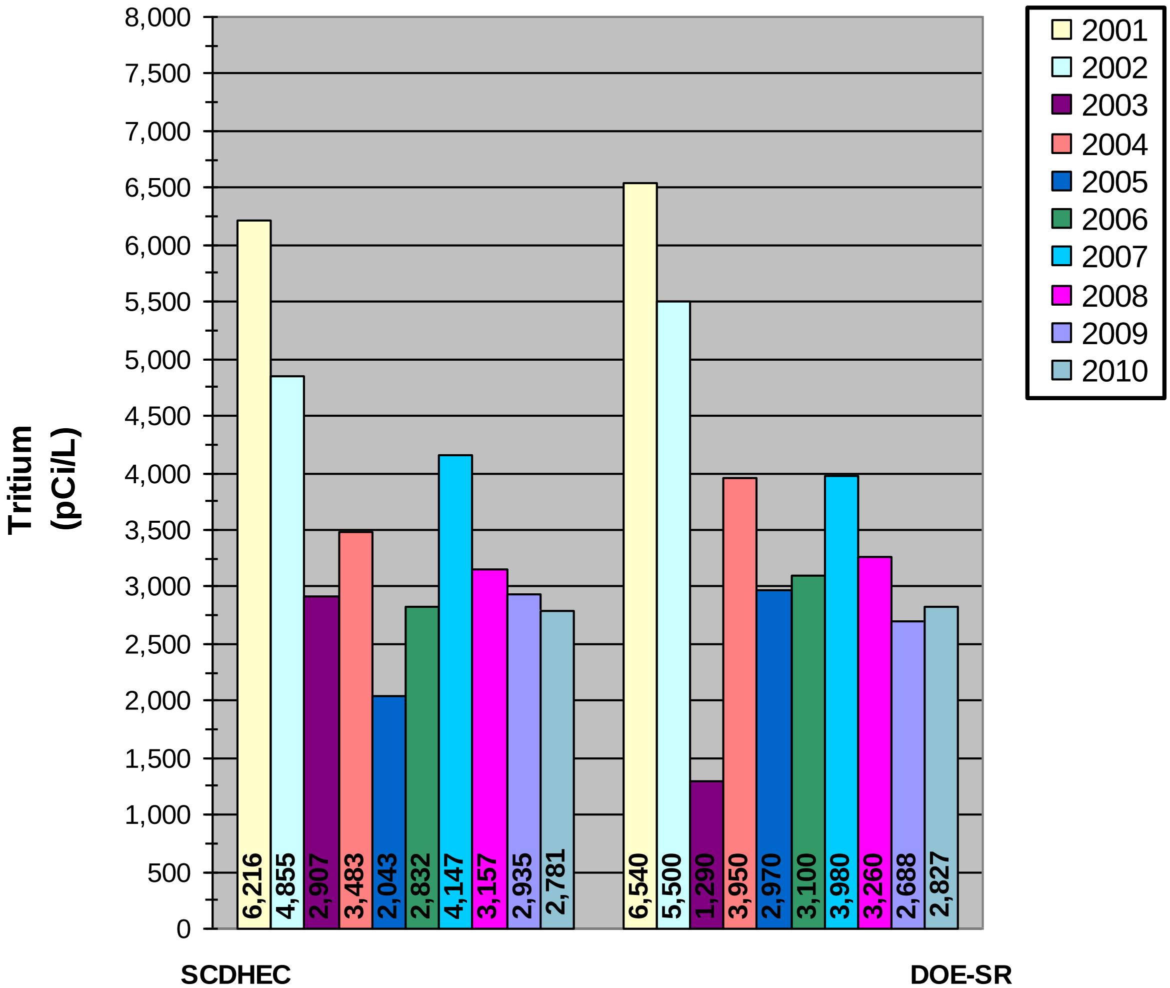
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 6. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at Pen Branch and USFS Road 13.2



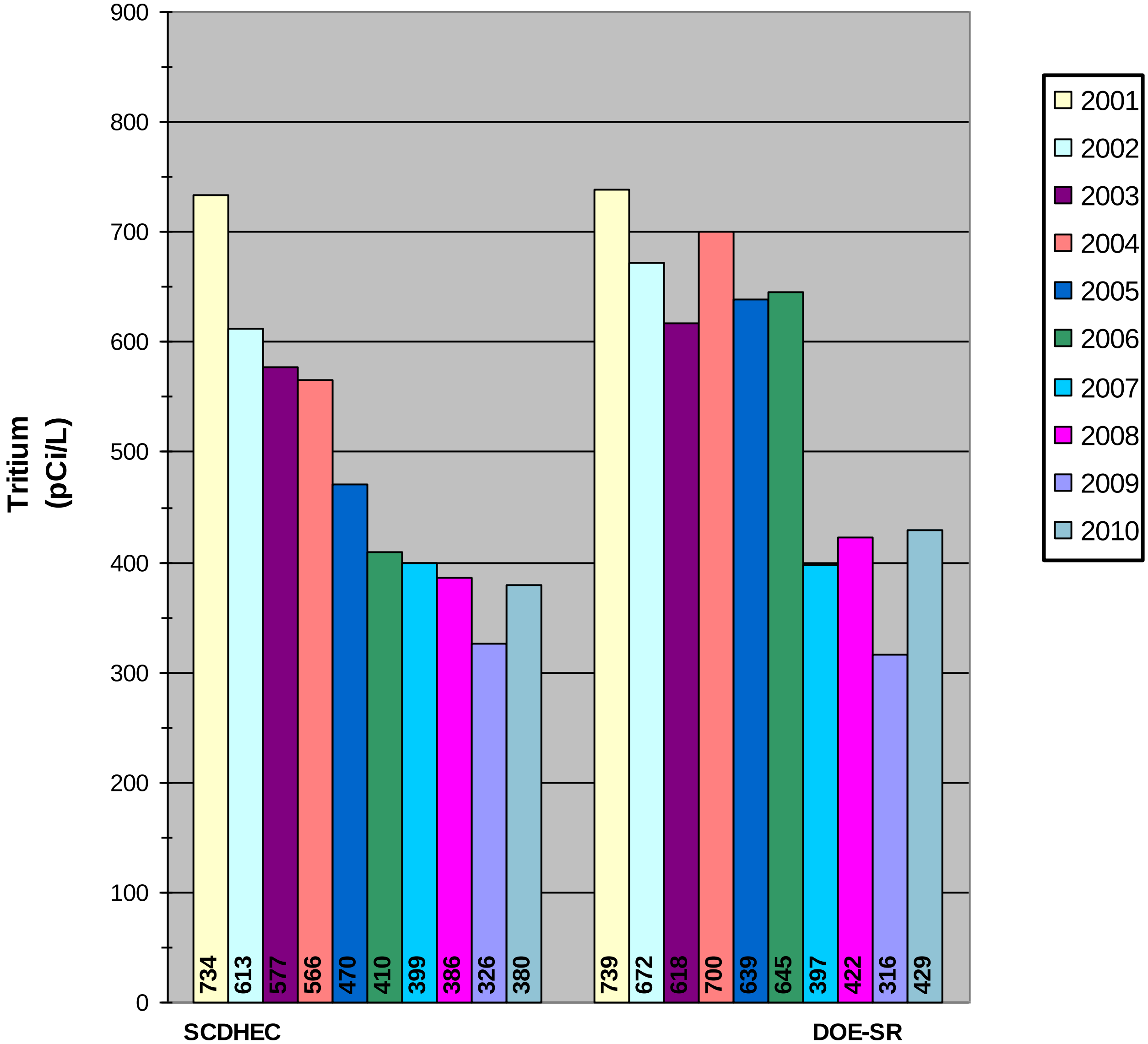
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 7. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at Steel Creek and SC Highway 125



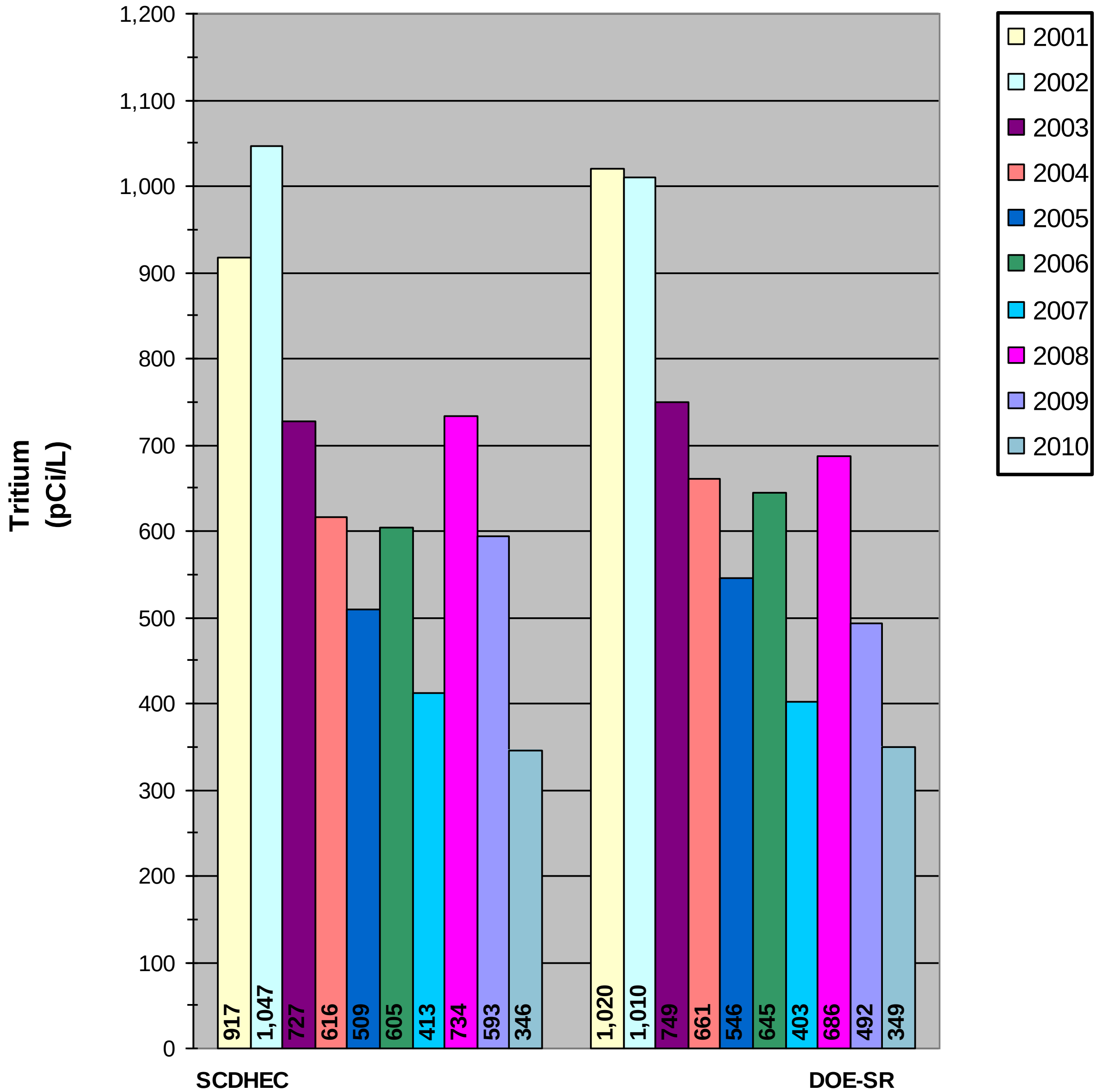
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 8. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at Lower Three Runs Creek and SRS Road B



Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS TOC

Figure 9. 2001-2010 Average Tritium Data Trends For SCDHEC and DOE-SR at the Savannah River and US Highway 301 Bridge



2.3.4 Data Tables

Radiological Monitoring of Surface Water On and Adjacent to the SRS

Notes:

1. Bold numbers indicate detections
2. "MDA" is Minimum Detectable Activity
3. "NA" is Non applicable
4. "NS" is No Sample
5. "LLD" is Lower Limit of Detection

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2010 Jackson Boat Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	<LLD	NA	190
	1/13/10	<LLD	NA	189
	1/20/10	**393**	**102**	**192**
	1/27/10	**349**	**95**	**178**
February	2/3/10	**206**	**92**	**190**
	2/10/10	**272**	**93**	**183**
	2/17/10	**363**	**98**	**186**
	2/24/10	**283**	**94**	**186**
March	3/3/10	<LLD	NA	191
	3/10/10	<LLD	NA	186
	3/17/10	**251**	**90**	**185**
	3/24/10	<LLD	NA	191
	3/31/10	**261**	**89**	**179**
April	4/7/10	<LLD	NA	186
	4/14/10	<LLD	NA	188
	4/21/10	<LLD	NA	186
	4/28/10	<LLD	NA	183
May	5/5/10	<LLD	NA	181
	5/12/10	<LLD	NA	189
	5/19/10	<LLD	NA	185
	5/26/10	<LLD	NA	186
June	6/2/10	<LLD	NA	184
	6/9/10	<LLD	NA	184
	6/16/10	<LLD	NA	180
	6/23/10	<LLD	NA	180
	6/30/10	<LLD	NA	222
July	7/7/10	<LLD	NA	181
	7/14/10	<LLD	NA	177
	7/21/10	<LLD	NA	178
	7/28/10	<LLD	NA	319
August	8/4/10	<LLD	NA	181
	8/11/10	<LLD	NA	210
	8/18/10	**282**	**106**	**216**
	8/25/10	<LLD	NA	216
September	9/1/10	<LLD	NA	216
	9/8/10	**254**	**91**	**196**
	9/15/10	<LLD	NA	195
	9/22/10	<LLD	NA	178
	9/29/10	<LLD	NA	192
October	10/6/10	<LLD	NA	212
	10/13/10	<LLD	NA	212
	10/20/10	<LLD	NA	192
	10/27/10	<LLD	NA	189
November	11/3/10	<LLD	NA	174
	11/10/10	**254**	**87**	**174**
	11/17/10	<LLD	NA	249
	11/24/10	<LLD	NA	178
December	12/1/10	<LLD	NA	195
	12/8/10	<LLD	NA	192
	12/15/10	**228**	**101**	**206**
	12/22/10	<LLD	NA	263
	12/29/10	<LLD	NA	210

SV-325 Upper Three Runs and SC Highway 125

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**774**	**112**	**190**
	1/13/10	**437**	**100**	**189**
	1/20/10	**707**	**111**	**192**
	1/27/10	**926**	**116**	**178**
February	2/3/10	**803**	**114**	**190**
	2/10/10	**771**	**110**	**183**
	2/17/10	**732**	**109**	**186**
	2/24/10	**700**	**108**	**186**
March	3/3/10	**777**	**112**	**191**
	3/10/10	**941**	**116**	**186**
	3/17/10	**711**	**111**	**185**
	3/24/10	**967**	**119**	**191**
	3/31/10	**1042**	**119**	**179**
April	4/7/10	**628**	**106**	**186**
	4/14/10	**945**	**117**	**188**
	4/21/10	**670**	**107**	**186**
	4/28/10	**643**	**105**	**183**
May	5/5/10	**690**	**106**	**181**
	5/12/10	**850**	**115**	**189**
	5/19/10	**684**	**107**	**185**
	5/26/10	**703**	**109**	**186**
June	6/2/10	**509**	**100**	**184**
	6/9/10	**1530**	**135**	**184**
	6/16/10	**995**	**118**	**180**
	6/23/10	**406**	**94**	**180**
	6/30/10	**826**	**123**	**222**
July	7/7/10	**625**	**103**	**181**
	7/14/10	**839**	**109**	**177**
	7/21/10	**792**	**108**	**178**
	7/28/10	**1666**	**260**	**319**
August	8/4/10	**560**	**102**	**181**
	8/11/10	**706**	**119**	**210**
	8/18/10	**1809**	**156**	**216**
	8/25/10	**1469**	**149**	**216**
September	9/1/10	**1300**	**136**	**216**
	9/8/10	**2403**	**163**	**196**
	9/15/10	**1721**	**146**	**195**
	9/22/10	**969**	**110**	**178**
	9/29/10	**910**	**114**	**192**
October	10/6/10	**895**	**121**	**212**
	10/13/10	**1184**	**132**	**212**
	10/20/10	**736**	**109**	**192**
	10/27/10	**594**	**101**	**189**
November	11/3/10	**480**	**98**	**174**
	11/10/10	**932**	**110**	**174**
	11/17/10	**1768**	**225**	**249**
	11/24/10	**2198**	**150**	**178**
December	12/1/10	**397**	**96**	**195**
	12/8/10	**1359**	**125**	**192**
	12/15/10	**1709**	**144**	**206**
	12/22/10	**425**	**135**	**263**
	12/29/10	**541**	**107**	**210**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2012 TNX Boat Landing D-Area SRS

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	<LLD	NA	190
	1/13/10	<LLD	NA	189
	1/20/10	<LLD	NA	192
	1/27/10	**215**	**87**	**178**
February	2/3/10	**309**	**95**	**190**
	2/10/10	<LLD	NA	183
	2/17/10	<LLD	NA	186
	2/24/10	**186**	**87**	**186**
March	3/3/10	<LLD	NA	191
	3/10/10	<LLD	NA	186
	3/17/10	<LLD	NA	185
	3/24/10	<LLD	NA	191
	3/31/10	**195**	**86**	**179**
April	4/7/10	<LLD	NA	186
	4/14/10	<LLD	NA	188
	4/21/10	**199**	**88**	**186**
	4/28/10	**202**	**87**	**183**
May	5/5/10	<LLD	NA	181
	5/12/10	**218**	**90**	**189**
	5/19/10	<LLD	NA	185
	5/26/10	<LLD	NA	186
June	6/2/10	<LLD	NA	184
	6/9/10	<LLD	NA	184
	6/16/10	**183**	**86**	**180**
	6/23/10	<LLD	NA	180
	6/30/10	<LLD	NA	222
July	7/7/10	**196**	**85**	**181**
	7/14/10	**254**	**87**	**177**
	7/21/10	<LLD	NA	178
	7/28/10	<LLD	NA	319
August	8/4/10	<LLD	NA	181
	8/11/10	<LLD	NA	210
	8/18/10	**339**	**110**	**216**
	8/25/10	<LLD	NA	216
September	9/1/10	<LLD	NA	216
	9/8/10	<LLD	NA	196
	9/15/10	<LLD	NA	195
	9/22/10	**228**	**83**	**178**
	9/29/10	<LLD	NA	192
October	10/6/10	**260**	**98**	**212**
	10/13/10	<LLD	NA	212
	10/20/10	<LLD	NA	192
	10/27/10	<LLD	NA	189
November	11/3/10	<LLD	NA	174
	11/10/10	**197**	**83**	**174**
	11/17/10	<LLD	NA	249
	11/24/10	<LLD	NA	178
December	12/1/10	<LLD	NA	195
	12/8/10	<LLD	NA	192
	12/15/10	**228**	**94**	**206**
	12/22/10	<LLD	NA	263
	12/29/10	**313**	**98**	**210**

SV-2040 Beaver Dam Creek D-Area

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	<LLD	NA	190
	1/13/10	<LLD	NA	189
	1/20/10	**193**	**90**	**192**
	1/27/10	**197**	**85**	**178**
February	2/3/10	<LLD	NA	190
	2/10/10	**207**	**88**	**183**
	2/17/10	**267**	**91**	**186**
	2/24/10	**236**	**89**	**186**
March	3/3/10	<LLD	NA	191
	3/10/10	<LLD	NA	186
	3/17/10	<LLD	NA	185
	3/24/10	<LLD	NA	191
	3/31/10	**276**	**98**	**179**
April	4/7/10	<LLD	NA	186
	4/14/10	<LLD	NA	188
	4/21/10	<LLD	NA	186
	4/28/10	<LLD	NA	183
May	5/5/10	<LLD	NA	181
	5/12/10	<LLD	NA	189
	5/19/10	**226**	**88**	**185**
	5/26/10	<LLD	NA	186
June	6/2/10	<LLD	NA	184
	6/9/10	**241**	**89**	**184**
	6/16/10	**182**	**86**	**180**
	6/23/10	<LLD	NA	180
	6/30/10	<LLD	NA	222
July	7/7/10	<LLD	NA	181
	7/14/10	<LLD	NA	177
	7/21/10	<LLD	NA	178
	7/28/10	<LLD	NA	319
August	8/4/10	<LLD	NA	181
	8/11/10	<LLD	NA	210
	8/18/10	**339**	**110**	**216**
	8/25/10	<LLD	NA	216
September	9/1/10	<LLD	NA	216
	9/8/10	**198**	**86**	**196**
	9/15/10	**198**	**91**	**195**
	9/22/10	<LLD	NA	178
	9/29/10	<LLD	NA	192
October	10/6/10	**318**	**102**	**212**
	10/13/10	**260**	**98**	**212**
	10/20/10	**283**	**89**	**192**
	10/27/10	<LLD	NA	189
November	11/3/10	**198**	**83**	**174**
	11/10/10	**198**	**83**	**174**
	11/17/10	<LLD	NA	249
	11/24/10	**227**	**85**	**178**
December	12/1/10	**227**	**89**	**195**
	12/8/10	<LLD	NA	192
	12/15/10	**228**	**94**	**206**
	12/22/10	<LLD	NA	263
	12/29/10	<LLD	NA	210

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2039 Four Mile Creek at USFS Rd. 13.2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**32550**	**512**	**190**
	1/13/10	**43154**	**589**	**189**
	1/20/10	**35909**	**543**	**192**
	1/27/10	**28442**	**484**	**178**
February	2/3/10	**33115**	**518**	**190**
	2/10/10	**31266**	**504**	**183**
	2/17/10	**35838**	**538**	**186**
	2/24/10	**37712**	**552**	**186**
March	3/3/10	**40203**	**565**	**191**
	3/10/10	**42663**	**583**	**186**
	3/17/10	**34113**	**526**	**185**
	3/24/10	**37898**	**554**	**191**
	3/31/10	**43625**	**597**	**179**
April	4/7/2010	**43737**	**595**	**186**
	4/14/10	**43416**	**595**	**188**
	4/21/10	**45717**	**609**	**186**
	4/28/10	**47031**	**613**	**183**
May	5/5/10	**45795**	**606**	**181**
	5/12/10	**44660**	**601**	**189**
	5/19/10	**47955**	**624**	**185**
	5/26/10	**46993**	**614**	**186**
June	6/2/10	**42564**	**586**	**184**
	6/9/10	**33899**	**526**	**184**
	6/16/10	**42422**	**581**	**180**
	6/23/10	**40042**	**520**	**180**
	6/30/10	**33906**	**550**	**222**
July	7/7/10	**33799**	**512**	**181**
	7/14/10	**38848**	**556**	**177**
	7/21/10	**42825**	**578**	**178**
	7/28/10	**41290**	**1132**	**319**
August	8/4/10	**36076**	**539**	**181**
	8/11/10	**37012**	**578**	**210**
	8/18/10	**37650**	**582**	**216**
	8/25/10	**33551**	**550**	**216**
September	9/1/10	**42271**	**612**	**216**
	9/8/10	**44689**	**623**	**196**
	9/15/10	**44216**	**620**	**195**
	9/22/10	**34711**	**490**	**178**
	9/29/10	**31789**	**476**	**192**
October	10/6/10	**40061**	**560**	**212**
	10/13/10	**43180**	**584**	**212**
	10/20/10	**36986**	**507**	**192**
	10/27/10	**36900**	**509**	**189**
November	11/3/10	**40745**	**536**	**174**
	11/10/10	**39906**	**529**	**174**
	11/17/10	**35819**	**890**	**249**
	11/24/10	**46295**	**603**	**178**
December	12/1/10	**40115**	**527**	**195**
	12/8/10	**38099**	**511**	**192**
	12/15/10	**48373**	**607**	**206**
	12/22/10	**37631**	**914**	**263**
	12/29/10	**56149**	**661**	**210**

SV-2047 Pen Branch at USFS Rd. 13.2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**21409**	**420**	**190**
	1/13/10	**26705**	**467**	**189**
	1/20/10	**20319**	**414**	**192**
	1/27/10	**15031**	**359**	**178**
February	2/3/10	**18045**	**392**	**190**
	2/10/10	**15574**	**363**	**183**
	2/17/10	**19223**	**399**	**186**
	2/24/10	**21950**	**426**	**186**
March	3/3/10	**24703**	**447**	**191**
	3/10/10	**26975**	**467**	**186**
	3/17/10	**18434**	**393**	**185**
	3/24/10	**22899**	**434**	**191**
	3/31/10	**29967**	**497**	**179**
April	4/7/2010	**34117**	**528**	**186**
	4/14/10	**37750**	**553**	**188**
	4/21/10	**44240**	**596**	**186**
	4/28/10	**42529**	**582**	**183**
May	5/5/10	**42302**	**582**	**181**
	5/12/10	**42283**	**584**	**189**
	5/19/10	**49916**	**625**	**185**
	5/26/10	**53146**	**649**	**186**
June	6/2/10	**46222**	**608**	**184**
	6/9/10	**38677**	**557**	**184**
	6/16/10	**49159**	**622**	**180**
	6/23/10	**37955**	**505**	**180**
	6/30/10	**30205**	**519**	**222**
July	7/7/10	**34130**	**514**	**181**
	7/14/10	**37585**	**543**	**177**
	7/21/10	**39094**	**557**	**178**
	7/28/10	**39245**	**1067**	**319**
August	8/4/10	**41658**	**574**	**181**
	8/11/10	**39440**	**591**	**210**
	8/18/10	**34428**	**555**	**216**
	8/25/10	**37787**	**582**	**216**
September	9/1/10	**40011**	**595**	**216**
	9/8/10	**40901**	**594**	**196**
	9/15/10	**47263**	**638**	**195**
	9/22/10	**36592**	**503**	**178**
	9/29/10	**33780**	**487**	**192**
October	10/6/10	**39945**	**561**	**212**
	10/13/10	**46819**	**605**	**212**
	10/20/10	**38629**	**517**	**192**
	10/27/10	**39049**	**519**	**189**
November	11/3/10	**35952**	**502**	**174**
	11/10/10	**38769**	**519**	**174**
	11/17/10	**32340**	**837**	**249**
	11/24/10	**40634**	**564**	**178**
December	12/1/10	**35632**	**495**	**195**
	12/8/10	**34759**	**491**	**192**
	12/15/10	**44499**	**589**	**206**
	12/22/10	**27154**	**764**	**263**
	12/29/10	**39928**	**557**	**210**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-327 Steel Creek at SC Highway 125

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**1924**	**147**	**190**
	1/13/10	**4168**	**198**	**189**
	1/20/10	**1842**	**146**	**192**
	1/27/10	**3761**	**190**	**178**
February	2/3/10	**4508**	**208**	**190**
	2/10/10	**3452**	**182**	**183**
	2/17/10	**2283**	**155**	**186**
	2/24/10	**2526**	**161**	**186**
March	3/3/10	**2565**	**162**	**191**
	3/10/10	**2609**	**163**	**186**
	3/17/10	**2194**	**156**	**185**
	3/24/10	**2423**	**160**	**191**
	3/31/10	**2618**	**163**	**179**
April	4/7/2010	**2542**	**162**	**186**
	4/14/10	**2920**	**172**	**188**
	4/21/10	**3380**	**181**	**186**
	4/28/10	**1618**	**136**	**183**
May	5/5/10	**1401**	**130**	**181**
	5/12/10	**1550**	**137**	**189**
	5/19/10	**1533**	**135**	**185**
	5/26/10	**1453**	**139**	**186**
June	6/2/10	**999**	**118**	**184**
	6/9/10	**1179**	**124**	**184**
	6/16/10	**1651**	**137**	**180**
	6/23/10	**1217**	**117**	**180**
	6/30/10	**1281**	**139**	**222**
July	7/7/10	**5438**	**216**	**181**
	7/14/10	**5502**	**219**	**177**
	7/21/10	**3276**	**176**	**178**
	7/28/10	**2893**	**307**	**319**
August	8/4/10	**2352**	**155**	**181**
	8/11/10	**2850**	**180**	**210**
	8/18/10	**2487**	**175**	**216**
	8/25/10	**2372**	**169**	**216**
September	9/1/10	**2600**	**177**	**216**
	9/8/10	**3194**	**181**	**196**
	9/15/10	**3753**	**194**	**195**
	9/22/10	**3819**	**176**	**178**
	9/29/10	**3412**	**171**	**192**
October	10/6/10	**3899**	**194**	**212**
	10/13/10	**4477**	**208**	**212**
	10/20/10	**4021**	**182**	**192**
	10/27/10	**3817**	**179**	**189**
November	11/3/10	**3472**	**171**	**174**
	11/10/10	**3360**	**170**	**174**
	11/17/10	**2738**	**262**	**249**
	11/24/10	**3467**	**181**	**178**
December	12/1/10	**2894**	**160**	**195**
	12/8/10	**2095**	**145**	**192**
	12/15/10	**2678**	**168**	**206**
	12/22/10	**1671**	**220**	**263**
	12/29/10	**2476**	**162**	**210**

SV-2018 Steel Creek Boat Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**5336**	**221**	**190**
	1/13/10	**972**	**119**	**189**
	1/20/10	**366**	**97**	**192**
	1/27/10	**4484**	**204**	**178**
February	2/3/10	**5379**	**224**	**190**
	2/10/10	**5384**	**223**	**183**
	2/17/10	**5160**	**218**	**186**
	2/24/10	**5219**	**219**	**186**
March	3/3/10	**552**	**105**	**191**
	3/10/10	**248**	**90**	**186**
	3/17/10	**625**	**106**	**185**
	3/24/10	**417**	**99**	**191**
	3/31/10	**248**	**88**	**179**
April	4/7/2010	**462**	**99**	**186**
	4/14/10	**356**	**95**	**188**
	4/21/10	**2345**	**157**	**186**
	4/28/10	**224**	**88**	**183**
May	5/5/10	<LLD	NA	181
	5/12/10	**260**	**92**	**189**
	5/19/10	**257**	**90**	**185**
	5/26/10	<LLD	NA	186
June	6/2/10	**745**	**108**	**184**
	6/9/10	**667**	**106**	**184**
	6/16/10	**229**	**88**	**180**
	6/23/10	**232**	**87**	**180**
	6/30/10	**654**	**119**	**222**
July	7/7/10	**379**	**93**	**181**
	7/14/10	**535**	**98**	**177**
	7/21/10	**263**	**87**	**178**
	7/28/10	<LLD	NA	319
August	8/4/10	**2352**	**155**	**181**
	8/11/10	**2850**	**180**	**210**
	8/18/10	**2487**	**175**	**216**
	8/25/10	**2372**	**169**	**216**
September	9/1/10	**282**	**101**	**216**
	9/8/10	**3194**	**181**	**196**
	9/15/10	**197**	**91**	**195**
	9/22/10	**3819**	**176**	**178**
	9/29/10	**3412**	**171**	**192**
October	10/6/10	**3899**	**194**	**212**
	10/13/10	**4477**	**208**	**212**
	10/20/10	**4021**	**182**	**192**
	10/27/10	**3817**	**179**	**189**
November	11/3/10	**3472**	**171**	**174**
	11/10/10	**3360**	**170**	**174**
	11/17/10	**2738**	**262**	**249**
	11/24/10	**3467**	**181**	**178**
December	12/1/10	**2894**	**160**	**195**
	12/8/10	**2095**	**145**	**192**
	12/15/10	**2678**	**168**	**206**
	12/22/10	**1671**	**220**	**263**
	12/29/10	**2476**	**162**	**210**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2019 Little Hell Landing

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	2564	164	190
	1/13/10	<LLD	NA	189
	1/20/10	318	96	192
	1/27/10	3809	191	178
February	2/3/10	3156	180	190
	2/10/10	2998	174	183
	2/17/10	2431	160	186
	2/24/10	2214	154	186
March	3/3/10	223	90	191
	3/10/10	394	96	186
	3/17/10	200	87	185
	3/24/10	203	91	191
	3/31/10	200	86	179
April	4/7/2010	276	92	186
	4/14/10	303	93	188
	4/21/10	186	88	186
	4/28/10	264	90	183
May	5/5/10	<LLD	NA	181
	5/12/10	<LLD	NA	189
	5/19/10	217	88	185
	5/26/10	226	89	186
June	6/2/10	188	86	184
	6/9/10	207	87	184
	6/16/10	<LLD	NA	180
	6/23/10	232	87	180
	6/30/10	313	101	222
July	7/7/10	323	91	181
	7/14/10	207	84	177
	7/21/10	199	83	178
	7/28/10	<LLD	NA	319
August	8/4/10	272	89	181
	8/11/10	<LLD	NA	210
	8/18/10	282	106	216
	8/25/10	<LLD	NA	216
September	9/1/10	226	97	216
	9/8/10	254	91	196
	9/15/10	197	91	195
	9/22/10	228	83	178
	9/29/10	<LLD	NA	192
October	10/6/10	375	106	212
	10/13/10	548	111	212
	10/20/10	792	107	192
	10/27/10	311	94	189
November	11/3/10	<LLD	NA	174
	11/10/10	197	83	174
	11/17/10	<LLD	NA	249
	11/24/10	258	86	178
December	12/1/10	397	96	195
	12/8/10	339	88	192
	12/15/10	341	102	206
	12/22/10	311	119	263
	12/29/10	<LLD	NA	210

SV-118 US Highway 301 Bridge

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	531	103	190
	1/13/10	504	102	189
	1/20/10	226	91	192
	1/27/10	324	91	178
February	2/3/10	242	92	190
	2/10/10	271	90	183
	2/17/10	300	92	186
	2/24/10	245	90	186
March	3/3/10	279	93	191
	3/10/10	634	105	186
	3/17/10	333	94	185
	3/24/10	319	95	191
	3/31/10	316	91	179
April	4/7/2010	405	97	186
	4/14/10	405	97	188
	4/21/10	<LLD	NA	186
	4/28/10	334	93	183
May	5/5/10	<LLD	NA	181
	5/12/10	228	91	189
	5/19/10	318	92	185
	5/26/10	190	88	186
June	6/2/10	<LLD	NA	184
	6/9/10	<LLD	NA	184
	6/16/10	696	107	180
	6/23/10	232	87	180
	6/30/10	313	101	222
July	7/7/10	379	93	181
	7/14/10	535	98	177
	7/21/10	263	87	178
	7/28/10	<LLD	NA	319
August	8/4/10	239	88	181
	8/11/10	<LLD	NA	210
	8/18/10	226	101	216
	8/25/10	226	101	216
September	9/1/10	283	101	216
	9/8/10	368	101	196
	9/15/10	198	91	195
	9/22/10	285	87	178
	9/29/10	227	92	192
October	10/6/10	722	116	212
	10/13/10	491	107	212
	10/20/10	736	103	192
	10/27/10	198	92	189
November	11/3/10	<LLD	NA	174
	11/10/10	197	83	174
	11/17/10	<LLD	NA	249
	11/24/10	258	86	178
December	12/1/10	397	96	195
	12/8/10	339	88	192
	12/15/10	341	102	206
	12/22/10	311	119	263
	12/29/10	<LLD	NA	210

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-328 Lower Three Runs at Patterson Mill Rd.

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**1519**	**135**	**190**
	1/13/10	**1798**	**143**	**189**
	1/20/10	**1320**	**130**	**192**
	1/27/10	**1249**	**124**	**178**
February	2/3/10	**1092**	**123**	**190**
	2/10/10	**1345**	**128**	**183**
	2/17/10	**1302**	**128**	**186**
	2/24/10	**1374**	**130**	**186**
March	3/3/10	**1362**	**131**	**191**
	3/10/10	**1624**	**137**	**186**
	3/17/10	**1178**	**124**	**185**
	3/24/10	**1502**	**135**	**191**
	3/31/10	**1744**	**140**	**179**
April	4/7/2010	**1939**	**146**	**186**
	4/14/10	**2409**	**159**	**188**
	4/21/10	**3003**	**172**	**186**
	4/28/10	**2303**	**155**	**183**
May	5/5/10	**2158**	**152**	**181**
	5/12/10	**3262**	**178**	**189**
	5/19/10	**3387**	**181**	**185**
	5/26/10	**3960**	**193**	**186**
June	6/2/10	**2357**	**157**	**184**
	6/9/10	**3114**	**174**	**184**
	6/16/10	**2810**	**168**	**180**
	6/23/10	**2431**	**147**	**180**
	6/30/10	**2303**	**166**	**222**
July	7/7/10	**3076**	**170**	**181**
	7/14/10	**3198**	**174**	**177**
	7/21/10	**4299**	**197**	**178**
	7/28/10	**4349**	**395**	**319**
August	8/4/10	**1699**	**139**	**181**
	8/11/10	**3017**	**188**	**210**
	8/18/10	**2202**	**166**	**216**
	8/25/10	**2539**	**172**	**216**
September	9/1/10	**3556**	**197**	**216**
	9/8/10	**4264**	**209**	**196**
	9/15/10	**4594**	**212**	**195**
	9/22/10	**4042**	**181**	**178**
	9/29/10	**1704**	**134**	**192**
October	10/6/10	**3606**	**186**	**212**
	10/13/10	**4644**	**207**	**212**
	10/20/10	**3338**	**169**	**192**
	10/27/10	**2683**	**157**	**189**
November	11/3/10	**2961**	**161**	**174**
	11/10/10	**3018**	**163**	**174**
	11/17/10	**2108**	**232**	**249**
	11/24/10	**3238**	**175**	**178**
December	12/1/10	**2551**	**156**	**195**
	12/8/10	**2827**	**158**	**192**
	12/15/10	**3585**	**186**	**206**
	12/22/10	**2460**	**244**	**263**
	12/29/10	**3496**	**186**	**210**

SV-2053 Lower Three Runs at SRS Rd. B

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	**436**	**99**	**190**
	1/13/10	**230**	**90**	**189**
	1/20/10	**447**	**100**	**192**
	1/27/10	**357**	**91**	**178**
February	2/3/10	**216**	**90**	**190**
	2/10/10	**243**	**88**	**183**
	2/17/10	<LLD	NA	186
	2/24/10	**257**	**90**	**186**
March	3/3/10	**326**	**94**	**191**
	3/10/10	**271**	**90**	**186**
	3/17/10	**398**	**95**	**185**
	3/24/10	**330**	**95**	**191**
	3/31/10	**511**	**98**	**179**
April	4/7/2010	**306**	**92**	**186**
	4/14/10	**274**	**91**	**188**
	4/21/10	**369**	**94**	**186**
	4/28/10	**370**	**93**	**183**
May	5/5/10	**392**	**94**	**181**
	5/12/10	**321**	**94**	**189**
	5/19/10	**442**	**97**	**185**
	5/26/10	**334**	**93**	**186**
June	6/2/10	**368**	**94**	**184**
	6/9/10	**373**	**94**	**184**
	6/16/10	**351**	**93**	**180**
	6/23/10	**348**	**89**	**180**
	6/30/10	**370**	**106**	**222**
July	7/7/10	**444**	**96**	**181**
	7/14/10	**371**	**91**	**177**
	7/21/10	**399**	**93**	**178**
	7/28/10	<LLD	NA	319
August	8/4/10	**383**	**94**	**181**
	8/11/10	**311**	**106**	**210**
	8/18/10	**396**	**115**	**216**
	8/25/10	**339**	**110**	**216**
September	9/1/10	**452**	**115**	**216**
	9/8/10	**481**	**101**	**196**
	9/15/10	**423**	**101**	**195**
	9/22/10	**456**	**94**	**178**
	9/29/10	**284**	**89**	**192**
October	10/6/10	**433**	**186**	**212**
	10/13/10	**433**	**207**	**212**
	10/20/10	**453**	**169**	**192**
	10/27/10	**368**	**157**	**189**
November	11/3/10	**367**	**161**	**174**
	11/10/10	**367**	**163**	**174**
	11/17/10	**342**	**232**	**249**
	11/24/10	**508**	**175**	**178**
December	12/1/10	**340**	**156**	**195**
	12/8/10	**509**	**158**	**192**
	12/15/10	**513**	**186**	**206**
	12/22/10	**425**	**244**	**263**
	12/29/10	**541**	**186**	**210**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Tritium Data

SV-2027 Upper Three Runs at USFS Rd. E-2

Month	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
January	1/6/10	<LLD	NA	190
	1/13/10	<LLD	NA	189
	1/20/10	**207**	**91**	**192**
	1/27/10	<LLD	NA	178
February	2/3/10	<LLD	NA	190
	2/10/10	<LLD	NA	183
	2/17/10	<LLD	NA	186
	2/24/10	**189**	**87**	**186**
March	3/3/10	<LLD	NA	191
	3/10/10	**194**	**87**	**186**
	3/17/10	<LLD	NA	185
	3/24/10	<LLD	NA	191
	3/31/10	<LLD	NA	179
April	4/7/2010	<LLD	NA	186
	4/14/10	<LLD	NA	188
	4/21/10	<LLD	NA	186
	4/28/10	<LLD	NA	183
May	5/5/10	**222**	**87**	**181**
	5/12/10	**194**	**89**	**189**
	5/19/10	**245**	**89**	**185**
	5/26/10	<LLD	NA	186
June	6/2/10	**204**	**87**	**184**
	6/9/10	**259**	**89**	**184**
	6/16/10	**207**	**87**	**180**
	6/23/10	<LLD	NA	180
	6/30/10	**256**	**106**	**222**
July	7/7/10	<LLD	NA	181
	7/14/10	**273**	**87**	**177**
	7/21/10	**319**	**90**	**178**
	7/28/10	**321**	**191**	**319**
August	8/4/10	**194**	**88**	**181**
	8/11/10	<LLD	NA	210
	8/18/10	**226**	**101**	**216**
	8/25/10	<LLD	NA	216
September	9/1/10	**226**	**106**	**216**
	9/8/10	<LLD	NA	196
	9/15/10	**197**	**91**	**195**
	9/22/10	**285**	**87**	**178**
	9/29/10	<LLD	NA	192
October	10/6/10	<LLD	NA	212
	10/13/10	<LLD	NA	212
	10/20/10	**227**	**92**	**192**
	10/27/10	<LLD	NA	189
November	11/3/10	**254**	**87**	**174**
	11/10/10	**197**	**83**	**174**
	11/17/10	<LLD	NA	249
	11/24/10	**200**	**84**	**178**
December	12/1/10	<LLD	NA	195
	12/8/10	<LLD	NA	192
	12/15/10	<LLD	NA	206
	12/22/10	<LLD	NA	263
	12/29/10	**256**	**101**	**210**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Gamma Data

SV-2010 Jackson Boat Landing

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.79	<MDA	NA	1.86	<MDA	NA	13.74
February	1/27/2010	2/24/2010	<MDA	NA	2.28	<MDA	NA	2.43	<MDA	NA	26.35
March	2/24/2010	3/31/2010	<MDA	NA	1.75	<MDA	NA	1.87	<MDA	NA	11.97
April	3/31/2010	4/28/2010	<MDA	NA	1.83	<MDA	NA	1.73	<MDA	NA	12.17
May	4/28/2010	5/26/2010	<MDA	NA	2.23	<MDA	NA	2.32	<MDA	NA	23.27
June	5/26/2010	6/30/2010	<MDA	NA	3.63	<MDA	NA	4.00	<MDA	NA	77.50
July	6/30/2010	7/28/2010	<MDA	NA	3.50	<MDA	NA	3.72	<MDA	NA	80.64
August	7/28/2010	8/25/2010	<MDA	NA	1.93	<MDA	NA	2.27	<MDA	NA	24.61
September	8/25/2010	9/29/2010	<MDA	NA	1.74	<MDA	NA	2.47	<MDA	NA	18.13
October	9/29/2010	10/27/2010	<MDA	NA	3.16	<MDA	NA	4.00	<MDA	NA	78.40
November	10/27/2010	12/1/2010	<MDA	NA	2.43	<MDA	NA	2.64	<MDA	NA	18.77
December	12/1/2010	12/29/2010	<MDA	NA	3.27	<MDA	NA	3.45	<MDA	NA	6.14

SV-325 Upper Three Runs at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.66	<MDA	NA	1.96	<MDA	NA	13.12
February	1/27/2010	2/24/2010	<MDA	NA	2.02	<MDA	NA	2.49	<MDA	NA	25.97
March	2/24/2010	3/31/2010	<MDA	NA	1.75	<MDA	NA	1.89	<MDA	NA	12.38
April	3/31/2010	4/28/2010	<MDA	NA	1.77	<MDA	NA	1.75	<MDA	NA	11.85
May	4/28/2010	5/26/2010	<MDA	NA	2.13	<MDA	NA	2.18	<MDA	NA	24.17
June	5/26/2010	6/30/2010	<MDA	NA	3.54	<MDA	NA	3.87	<MDA	NA	79.64
July	6/30/2010	7/28/2010	<MDA	NA	3.11	<MDA	NA	4.00	<MDA	NA	81.98
August	7/28/2010	8/25/2010	<MDA	NA	2.07	<MDA	NA	2.57	<MDA	NA	24.07
September	8/25/2010	9/29/2010	<MDA	NA	2.03	<MDA	NA	2.54	<MDA	NA	18.86
October	9/29/2010	10/27/2010	<MDA	NA	3.32	<MDA	NA	3.60	<MDA	NA	83.70
November	10/27/2010	12/1/2010	<MDA	NA	2.14	<MDA	NA	2.62	<MDA	NA	19.50
December	12/1/2010	12/29/2010	<MDA	NA	3.28	<MDA	NA	3.21	<MDA	NA	5.89

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.57	<MDA	NA	1.79	<MDA	NA	13.84
February	1/27/2010	2/24/2010	<MDA	NA	2.04	<MDA	NA	2.30	<MDA	NA	25.52
March	2/24/2010	3/31/2010	<MDA	NA	1.62	<MDA	NA	1.79	<MDA	NA	11.78
April	3/31/2010	4/28/2010	<MDA	NA	1.56	<MDA	NA	1.76	<MDA	NA	11.57
May	4/28/2010	5/26/2010	<MDA	NA	1.91	<MDA	NA	2.28	<MDA	NA	24.30
June	5/26/2010	6/30/2010	<MDA	NA	3.70	<MDA	NA	3.91	<MDA	NA	80.62
July	6/30/2010	7/28/2010	<MDA	NA	3.86	<MDA	NA	3.98	<MDA	NA	81.50
August	7/28/2010	8/25/2010	<MDA	NA	2.24	<MDA	NA	2.27	<MDA	NA	24.18
September	8/25/2010	9/29/2010	<MDA	NA	2.11	<MDA	NA	2.52	<MDA	NA	18.07
October	9/29/2010	10/27/2010	<MDA	NA	2.91	<MDA	NA	3.85	<MDA	NA	79.80
November	10/27/2010	12/1/2010	<MDA	NA	2.21	<MDA	NA	2.63	<MDA	NA	18.71
December	12/1/2010	12/29/2010	<MDA	NA	3.27	<MDA	NA	2.94	<MDA	NA	6.09

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Gamma Data

SV-2039 Four Mile Creek at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.70	<MDA	NA	1.92	<MDA	NA	13.50
February	1/27/2010	2/24/2010	<MDA	NA	2.05	<MDA	NA	2.66	<MDA	NA	25.88
March	2/24/2010	3/31/2010	<MDA	NA	1.71	<MDA	NA	2.17	<MDA	NA	11.89
April	3/31/2010	4/28/2010	<MDA	NA	1.64	<MDA	NA	2.15	<MDA	NA	11.61
May	4/28/2010	5/26/2010	<MDA	NA	2.03	<MDA	NA	2.83	<MDA	NA	25.29
June	5/26/2010	6/30/2010	<MDA	NA	3.10	<MDA	NA	3.98	<MDA	NA	77.62
July	6/30/2010	7/28/2010	<MDA	NA	2.79	<MDA	NA	3.97	<MDA	NA	76.58
August	7/28/2010	8/25/2010	<MDA	NA	2.20	<MDA	NA	2.95	<MDA	NA	24.76
September	8/25/2010	9/29/2010	<MDA	NA	2.18	<MDA	NA	3.09	<MDA	NA	18.27
October	9/29/2010	10/27/2010	<MDA	NA	3.33	<MDA	NA	3.98	<MDA	NA	79.60
November	10/27/2010	12/1/2010	<MDA	NA	2.05	<MDA	NA	2.71	<MDA	NA	19.04
December	12/1/2010	12/29/2010	<MDA	NA	3.28	<MDA	NA	3.38	<MDA	NA	6.16

SV-2047 Pen Branch at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.94	<MDA	NA	1.82	<MDA	NA	13.85
February	1/27/2010	2/24/2010	<MDA	NA	2.07	<MDA	NA	2.37	<MDA	NA	25.66
March	2/24/2010	3/31/2010	<MDA	NA	1.66	<MDA	NA	1.89	<MDA	NA	11.42
April	3/31/2010	4/28/2010	<MDA	NA	1.78	<MDA	NA	1.71	<MDA	NA	10.82
May	4/28/2010	5/26/2010	<MDA	NA	2.23	<MDA	NA	2.49	<MDA	NA	24.31
June	5/26/2010	6/30/2010	<MDA	NA	3.14	<MDA	NA	3.45	<MDA	NA	82.11
July	6/30/2010	7/28/2010	<MDA	NA	3.46	<MDA	NA	3.92	<MDA	NA	82.60
August	7/28/2010	8/25/2010	<MDA	NA	2.21	<MDA	NA	2.42	<MDA	NA	24.30
September	8/25/2010	9/29/2010	<MDA	NA	2.02	<MDA	NA	2.46	<MDA	NA	18.04
October	9/29/2010	10/27/2010	<MDA	NA	3.35	<MDA	NA	4.00	<MDA	NA	82.30
November	10/27/2010	12/1/2010	<MDA	NA	2.35	<MDA	NA	2.66	<MDA	NA	19.34
December	12/1/2010	12/29/2010	<MDA	NA	2.98	<MDA	NA	3.17	<MDA	NA	5.83

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.75	<MDA	NA	2.19	<MDA	NA	13.94
February	1/27/2010	2/24/2010	<MDA	NA	2.01	<MDA	NA	2.61	<MDA	NA	26.65
March	2/24/2010	3/31/2010	<MDA	NA	1.77	<MDA	NA	1.80	<MDA	NA	11.06
April	3/31/2010	4/28/2010	<MDA	NA	1.50	<MDA	NA	1.75	<MDA	NA	11.73
May	4/28/2010	5/26/2010	<MDA	NA	1.99	<MDA	NA	2.57	<MDA	NA	23.72
June	5/26/2010	6/30/2010	<MDA	NA	3.43	<MDA	NA	3.72	<MDA	NA	80.10
July	6/30/2010	7/28/2010	<MDA	NA	3.05	<MDA	NA	4.00	<MDA	NA	71.82
August	7/28/2010	8/25/2010	<MDA	NA	2.05	<MDA	NA	2.45	<MDA	NA	24.09
September	8/25/2010	9/29/2010	<MDA	NA	1.96	<MDA	NA	2.68	<MDA	NA	18.00
October	9/29/2010	10/27/2010	<MDA	NA	3.57	<MDA	NA	4.00	<MDA	NA	78.00
November	10/27/2010	12/1/2010	<MDA	NA	2.07	<MDA	NA	2.89	<MDA	NA	18.33
December	12/1/2010	12/29/2010	<MDA	NA	3.15	<MDA	NA	3.20	<MDA	NA	6.23

Radiological Monitoring of Surface Water On and Adjacent to the SRS Ambient Gamma Data

SV-2018 Steel Creek Boat Landing

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.75	<MDA	NA	1.97	<MDA	NA	13.89
February	1/27/2010	2/24/2010	<MDA	NA	2.07	<MDA	NA	2.53	<MDA	NA	26.50
March	2/24/2010	3/31/2010	<MDA	NA	1.60	<MDA	NA	1.92	<MDA	NA	11.39
April	3/31/2010	4/28/2010	<MDA	NA	1.55	<MDA	NA	1.73	<MDA	NA	11.76
May	4/28/2010	5/26/2010	<MDA	NA	3.28	<MDA	NA	3.91	<MDA	NA	79.80
June	5/26/2010	6/30/2010	<MDA	NA	3.67	<MDA	NA	3.71	<MDA	NA	83.87
July	6/30/2010	7/28/2010	<MDA	NA	3.74	<MDA	NA	3.90	<MDA	NA	82.36
August	7/28/2010	8/25/2010	<MDA	NA	2.16	<MDA	NA	2.18	<MDA	NA	24.61
September	8/25/2010	9/29/2010	<MDA	NA	2.08	<MDA	NA	2.44	<MDA	NA	18.08
October	9/29/2010	10/27/2010	<MDA	NA	3.23	<MDA	NA	3.89	<MDA	NA	80.30
November	10/27/2010	12/1/2010	<MDA	NA	2.10	<MDA	NA	2.79	<MDA	NA	19.62
December	12/1/2010	12/29/2010	<MDA	NA	3.16	<MDA	NA	3.36	<MDA	NA	5.82

SV-118 US Highway 301 at the Savannah River

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.68	<MDA	NA	1.70	<MDA	NA	13.99
February	1/27/2010	2/24/2010	<MDA	NA	2.13	<MDA	NA	2.47	<MDA	NA	26.85
March	2/24/2010	3/31/2010	<MDA	NA	1.56	<MDA	NA	1.90	<MDA	NA	10.77
April	3/31/2010	4/28/2010	<MDA	NA	1.62	<MDA	NA	1.80	<MDA	NA	11.66
May	4/28/2010	5/26/2010	<MDA	NA	1.97	<MDA	NA	2.29	<MDA	NA	23.93
June	5/26/2010	6/30/2010	<MDA	NA	3.48	<MDA	NA	3.91	<MDA	NA	79.87
July	6/30/2010	7/28/2010	<MDA	NA	3.37	<MDA	NA	3.99	<MDA	NA	82.24
August	7/28/2010	8/25/2010	<MDA	NA	1.98	<MDA	NA	2.46	<MDA	NA	25.20
September	8/25/2010	9/29/2010	<MDA	NA	1.82	<MDA	NA	2.62	<MDA	NA	18.44
October	9/29/2010	10/27/2010	<MDA	NA	3.40	<MDA	NA	3.91	<MDA	NA	76.00
November	10/27/2010	12/1/2010	<MDA	NA	2.21	<MDA	NA	2.86	<MDA	NA	18.93
December	12/1/2010	12/29/2010	<MDA	NA	3.04	<MDA	NA	3.11	<MDA	NA	5.69

SV-2053 Lower Three Runs at SRS Rd. B

Month	Sample Deployment Date	Collection Date	Co-60 Activity	Co-60 Confidence Interval	Co-60 MDA	Cs-137 Activity	Cs-137 Confidence Interval	Cs-137 MDA	Am-241 Activity	Am-241 Confidence Interval	Am-241 MDA
January	12/30/2009	1/27/2010	<MDA	NA	1.50	<MDA	NA	2.31	<MDA	NA	13.11
February	1/27/2010	2/24/2010	<MDA	NA	2.04	<MDA	NA	2.41	<MDA	NA	25.17
March	2/24/2010	3/31/2010	<MDA	NA	1.69	<MDA	NA	2.05	<MDA	NA	11.59
April	3/31/2010	4/28/2010	<MDA	NA	1.75	<MDA	NA	2.17	<MDA	NA	12.02
May	4/28/2010	5/26/2010	<MDA	NA	1.97	<MDA	NA	2.50	<MDA	NA	24.80
June	5/26/2010	6/30/2010	<MDA	NA	3.66	<MDA	NA	3.98	<MDA	NA	81.53
July	6/30/2010	7/28/2010	<MDA	NA	3.49	<MDA	NA	4.00	<MDA	NA	79.22
August	7/28/2010	8/25/2010	<MDA	NA	2.24	<MDA	NA	2.67	<MDA	NA	24.06
September	8/25/2010	9/29/2010	<MDA	NA	1.97	<MDA	NA	2.89	<MDA	NA	17.78
October	9/29/2010	10/27/2010	<MDA	NA	3.42	5.11	2.40	3.92	<MDA	NA	79.70
November	10/27/2010	12/1/2010	<MDA	NA	2.09	<MDA	NA	3.14	<MDA	NA	19.48
December	12/1/2010	12/29/2010	<MDA	NA	1.33	<MDA	NA	1.41	<MDA	NA	2.84

Note: SV-2018 had a Pb-214 detection of 12.73 (±2SD 5.50) pCi/L in the February monthly composite sample.

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2010 Jackson Boat Landing

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.22	<LLD	NA	3.91
February	1/27/2010	2/24/2010	<LLD	NA	3.29	<LLD	NA	4.10
March	2/24/2010	3/31/2010	<LLD	NA	1.11	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	<LLD	NA	1.76	<LLD	NA	2.48
June	5/26/2010	6/30/2010	<LLD	NA	3.95	<LLD	NA	3.82
July	6/30/2010	7/28/2010	<LLD	NA	3.05	<LLD	NA	3.83
August	7/28/2010	8/25/2010	<LLD	NA	3.22	<LLD	NA	3.85
September	8/25/2010	9/29/2010	<LLD	NA	3.86	<LLD	NA	4.09
October	9/29/2010	10/27/2010	<LLD	NA	3.60	<LLD	NA	3.70
November	10/27/2010	12/1/2010	<LLD	NA	2.99	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.71	<LLD	NA	4.17

SV-325 Upper Three Runs and SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	**8.32**	**2.51**	**3.23**	<LLD	NA	**4.10**
February	1/27/2010	2/24/2010	**14.4**	**2.87**	**2.73**	<LLD	NA	**3.91**
March	2/24/2010	3/31/2010	**12.7**	**2.27**	**1.13**	**2.73**	**1.45**	**2.31**
April	3/31/2010	4/28/2010	**6.07**	**2.10**	**2.71**	<LLD	NA	**3.58**
May	4/28/2010	5/26/2010	**16.70**	**2.74**	**1.82**	<LLD	NA	**2.48**
June	5/26/2010	6/30/2010	**14.6**	**3.39**	**4.09**	<LLD	NA	**3.82**
July	6/30/2010	7/28/2010	**9.53**	**3.09**	**3.02**	<LLD	NA	**3.82**
August	7/28/2010	8/25/2010	**11.20**	**3.47**	**3.39**	<LLD	NA	**3.86**
September	8/25/2010	9/29/2010	**29.80**	**5.91**	**4.87**	**6.70**	**2.95**	**4.14**
October	9/29/2010	10/27/2010	**27.10**	**5.47**	**4.45**	**7.80**	**2.79**	**3.73**
November	10/27/2010	12/1/2010	**10.70**	**2.92**	**2.75**	<LLD	NA	**2.65**
December	12/1/2010	12/29/2010	**16.50**	**3.81**	**3.39**	<LLD	NA	**4.15**

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.33	<LLD	NA	3.92
February	1/27/2010	2/24/2010	<LLD	NA	3.27	<LLD	NA	4.10
March	2/24/2010	3/31/2010	<LLD	NA	1.11	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.97	**6.31**	**2.10**	**3.59**
May	4/28/2010	5/26/2010	<LLD	NA	1.74	<LLD	NA	2.48
June	5/26/2010	6/30/2010	<LLD	NA	3.94	<LLD	NA	3.81
July	6/30/2010	7/28/2010	<LLD	NA	3.29	<LLD	NA	3.84
August	7/28/2010	8/25/2010	**5.45**	**2.93**	**3.53**	<LLD	NA	3.87
September	8/25/2010	9/29/2010	<LLD	NA	4.00	<LLD	NA	4.10
October	9/29/2010	10/27/2010	<LLD	NA	3.64	**4.85**	**2.47**	**3.70**
November	10/27/2010	12/1/2010	<LLD	NA	3.03	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.82	<LLD	NA	4.17

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2039 Four Mile Creek at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.14	<LLD	NA	3.90
February	1/27/2010	2/24/2010	<LLD	NA	3.08	<LLD	NA	4.09
March	2/24/2010	3/31/2010	**2.49**	**1.08**	**1.06**	**4.28**	**1.47**	**2.30**
April	3/31/2010	4/28/2010	<LLD	NA	2.79	**9.86**	**2.24**	**3.58**
May	4/28/2010	5/26/2010	<LLD	NA	1.72	<LLD	NA	2.47
June	5/26/2010	6/30/2010	<LLD	NA	3.74	**7.31**	**2.23**	**3.81**
July	6/30/2010	7/28/2010	<LLD	NA	2.97	**6.93**	**2.64**	**3.82**
August	7/28/2010	8/25/2010	<LLD	NA	3.26	<LLD	NA	3.85
September	8/25/2010	9/29/2010	<LLD	NA	3.55	7.31	2.80	4.07
October	9/29/2010	10/27/2010	<LLD	NA	3.35	6.53	2.56	3.69
November	10/27/2010	12/1/2010	<LLD	NA	2.92	<LLD	NA	2.65
December	12/1/2010	12/29/2010	<LLD	NA	3.57	4.80	2.73	4.16

SV-2047 Pen Branch at USFS Rd. A-13

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.30	<LLD	NA	3.91
February	1/27/2010	2/24/2010	<LLD	NA	3.19	<LLD	NA	4.10
March	2/24/2010	3/31/2010	**1.78**	**0.98**	**1.10**	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	<LLD	NA	1.81	<LLD	NA	2.48
June	5/26/2010	6/30/2010	<LLD	NA	3.96	<LLD	NA	3.82
July	6/30/2010	7/28/2010	<LLD	NA	3.00	<LLD	NA	3.82
August	7/28/2010	8/25/2010	<LLD	NA	3.56	<LLD	NA	3.87
September	8/25/2010	9/29/2010	<LLD	NA	3.86	<LLD	NA	4.09
October	9/29/2010	10/27/2010	<LLD	NA	3.54	<LLD	NA	3.70
November	10/27/2010	12/1/2010	<LLD	NA	2.95	<LLD	NA	2.65
December	12/1/2010	12/29/2010	<LLD	NA	3.72	<LLD	NA	4.17

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	3.91	<LLD	NA	4.13
February	1/27/2010	2/24/2010	<LLD	NA	3.34	<LLD	NA	4.11
March	2/24/2010	3/31/2010	**1.38**	**0.91**	**1.12**	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	**5.25**	**1.92**	**2.16**	<LLD	NA	2.52
June	5/26/2010	6/30/2010	<LLD	NA	5.40	<LLD	NA	3.86
July	6/30/2010	7/28/2010	<LLD	NA	3.72	<LLD	NA	3.86
August	7/28/2010	8/25/2010	<LLD	NA	3.23	<LLD	NA	3.85
September	8/25/2010	9/29/2010	<LLD	NA	4.23	<LLD	NA	4.11
October	9/29/2010	10/27/2010	<LLD	NA	3.73	<LLD	NA	3.71
November	10/27/2010	12/1/2010	<LLD	NA	2.99	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.74	<LLD	NA	4.17

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Ambient Alpha/Beta Data

SV-2018 Steel Creek Boat Landing

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.26	**6.35**	**2.23**	**3.91**
February	1/27/2010	2/24/2010	<LLD	NA	3.14	<LLD	NA	4.10
March	2/24/2010	3/31/2010	**1.94**	**1.02**	**1.12**	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	<LLD	NA	1.75	<LLD	NA	2.48
June	5/26/2010	6/30/2010	<LLD	NA	3.92	<LLD	NA	3.81
July	6/30/2010	7/28/2010	<LLD	NA	3.05	<LLD	NA	3.83
August	7/28/2010	8/25/2010	<LLD	NA	3.77	**6.11**	**2.65**	**3.88**
September	8/25/2010	9/29/2010	<LLD	NA	3.85	<LLD	NA	4.09
October	9/29/2010	10/27/2010	<LLD	NA	3.68	**4.71**	**2.48**	**3.70**
November	10/27/2010	12/1/2010	<LLD	NA	3.06	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.66	<LLD	NA	4.17

SV-118 US Highway 301 and Savannah River

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	<LLD	NA	2.31	<LLD	NA	3.91
February	1/27/2010	2/24/2010	<LLD	NA	3.17	<LLD	NA	4.10
March	2/24/2010	3/31/2010	<LLD	NA	1.11	<LLD	NA	2.31
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	<LLD	NA	1.96	<LLD	NA	2.50
June	5/26/2010	6/30/2010	<LLD	NA	4.34	**5.74**	**2.18**	**3.83**
July	6/30/2010	7/28/2010	<LLD	NA	3.04	**4.22**	**2.52**	**3.83**
August	7/28/2010	8/25/2010	<LLD	NA	3.77	**6.11**	**2.65**	**3.88**
September	8/25/2010	9/29/2010	<LLD	NA	5.68	**4.52**	**2.74**	**4.17**
October	9/29/2010	10/27/2010	**10.70**	**5.4**	**6.42**	**7.49**	**2.7**	**3.79**
November	10/27/2010	12/1/2010	<LLD	NA	3.26	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.77	**4.86**	**2.73**	**4.17**

SV-2053 Lower Three Runs and SRS Rd. B

Month	Sample Deployment Date	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
January	12/30/2009	1/27/2010	**3.16**	**1.67**	**2.33**	<LLD	NA	3.92
February	1/27/2010	2/24/2010	<LLD	NA	3.03	<LLD	NA	4.09
March	2/24/2010	3/31/2010	<LLD	NA	1.04	<LLD	NA	2.30
April	3/31/2010	4/28/2010	<LLD	NA	2.93	<LLD	NA	3.59
May	4/28/2010	5/26/2010	<LLD	NA	1.67	<LLD	NA	2.47
June	5/26/2010	6/30/2010	<LLD	NA	3.70	<LLD	NA	3.80
July	6/30/2010	7/28/2010	<LLD	NA	2.86	<LLD	NA	3.82
August	7/28/2010	8/25/2010	<LLD	NA	2.95	<LLD	NA	3.83
September	8/25/2010	9/29/2010	<LLD	NA	3.54	<LLD	NA	4.07
October	9/29/2010	10/27/2010	**9.36**	**3.17**	**3.36**	<LLD	NA	3.69
November	10/27/2010	12/1/2010	<LLD	NA	3.01	<LLD	NA	2.66
December	12/1/2010	12/29/2010	<LLD	NA	3.78	<LLD	NA	4.17

Radiological Monitoring of Surface Water On and Adjacent to the SRS Creek Mouth Data

SV-2011 Upper Three Runs

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	**619**	**106**	**182**
3/8/2010	**666**	**109**	**193**
4/12/2010	**606**	**102**	**175**
5/12/2010	**372**	**95**	**186**
6/22/2010	**383**	**95**	**184**
7/9/2010	**479**	**98**	**182**
8/6/10	**508**	**111**	**229**
9/3/10	**648**	**119**	**209**

SV-2013 Beaver Dam

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	<LLD	NA	182
3/8/2010	**248**	**93**	**193**
4/12/2010	**209**	**84**	**175**
5/12/2010	<LLD	NA	186
6/22/2010	<LLD	NA	184
7/9/2010	<LLD	NA	182
8/6/10	<LLD	NA	229
9/3/10	<LLD	NA	209

SV-2015a Four Mile Creek (Creek Mouth)

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	<LLD	NA	182
3/8/2010	**32999**	**518**	**193**
4/12/2010	**38457**	**564**	**175**
5/12/2010	**35942**	**543**	**186**
6/22/2010	**41615**	**577**	**184**
7/9/2010	**36694**	**544**	**182**
8/6/10	**2257**	**166**	**229**
9/3/10	**24668**	**469**	**209**

SV-2015b Four Mile Creek (30')

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	<LLD	NA	182
3/8/2010	<LLD	NA	193
4/12/2010	**9413**	**284**	**175**
5/12/2010	**15600**	**359**	**186**
6/22/2010	**15761**	**361**	**184**
7/9/2010	<LLD	NA	182
8/6/10	**4458**	**216**	**229**
9/3/10	<LLD	NA	209

SV-2015c Four Mile Creek (150')

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	**203**	**87**	**182**
3/8/2010	**1314**	**131**	**193**
4/12/2010	**1572**	**134**	**175**
5/12/2010	**3249**	**178**	**186**
6/22/2010	**9473**	**283**	**184**
7/9/2010	**2225**	**152**	**182**
8/6/10	**44357**	**635**	**229**
9/3/10	**5723**	**239**	**209**

SV-2017 Steel Creek

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	**411**	**96**	**182**
3/8/2010	**1804**	**146**	**193**
4/12/2010	**3772**	**197**	**175**
5/12/2010	**4054**	**202**	**186**
6/22/2010	**721**	**109**	**184**
7/9/2010	**5002**	**215**	**182**
8/6/10	**1749**	**156**	**229**
9/3/10	**479**	**115**	**209**

SV-2020 Lower Three Runs Creek

Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
1/20/2010	**199**	**87**	**182**
3/8/2010	**697**	**110**	**193**
4/12/2010	**990**	**116**	**175**
5/12/2010	**265**	**90**	**186**
6/22/2010	**2695**	**175**	**184**
7/9/2010	**1584**	**135**	**182**
8/6/10	**1016**	**131**	**229**
9/3/10	**1607**	**146**	**209**

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Random Sample Tritium Data
Background Locations (> 50 Miles from SRS)

Location Description	Collection Date	Tritium Activity	Tritium Confidence Interval	Tritium LLD
RW B62	3/30/2010	<LLD	NA	182
RW B43	3/30/2010	<LLD	NA	182
RW B49	3/30/2010	<LLD	NA	182

Random Sample Gamma Data
Background Locations (> 50 Miles from SRS)

Location Description	Collection Date	Co-60 Activity (pCi/L)	Confidence Interval (pCi/L)	Co-60 MDA (pCi/L)	Cs-137 Activity (pCi/L)	Cs-137 Confidence Interval (pCi/L)	Cs-137 MDA pCi/L)	Am-241 Activity (pCi/L)	Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
RW B62	3/30/2010	<MDA	NA	3.44	<MDA	NA	3.99	<MDA	NA	78.12
RW B43	3/30/2010	<MDA	NA	3.63	<MDA	NA	3.99	<MDA	NA	77.70
RW B49	3/30/2010	<MDA	NA	3.70	<MDA	NA	3.96	<MDA	NA	77.22
RW DUP1	3/30/2010	<MDA	NA	3.32	<MDA	NA	3.87	<MDA	NA	87.18

Random Sample Alpha/Beta Data
Background Locations (>50 Miles from SRS)

Location Description	Collection Date	Alpha Activity	Alpha Confidence Interval	Alpha LLD	Beta Activity	Beta Confidence Interval	Beta LLD
RW B62	3/30/2010	**13.4**	**2.74**	**2.65**	<LLD	NA	3.91
RW B43	3/30/2010	<LLD	NA	2.89	<LLD	NA	3.92
RW B49	3/30/2010	**4.49**	**2.12**	**3.02**	<LLD	NA	3.93
RW DUP1	3/30/2010	<LLD	NA	2.66	<LLD	NA	3.91

Quarterly Iodine-129 and Technetium-99 Data for Fourmile Branch (SV-2039).

Collection Date	Iodine-129 Activity (pCi/L)	Iodine-129 Confidence Interval (pCi/L)	Iodine-129 MDA (pCi/L)	Technetium-99 Activity (pCi/L)	Technetium-99 Confidence Interval (pCi/L)	Technetium-99 MDA (pCi/L)
02/22/10	3.00	1.52	3.12	<MDA	NA	5.69
04/30/10	3.29	1.91	3.05	<MDA	NA	5.15
9/30/2010	2.57	1.35	2.62	<MDA	NA	1.42
12/13/2010	1.24	1.43	3.11	6.16	2.54	4.05

TOC

2.3.5 Summary Statistics

Radiological Monitoring of Surface Water On and Adjacent to the SRS

Notes:
1) "pCi/L" is "picocuries per Liter"
2) "ND" is "No Detection"
3) "NA" is "Not Applicable"
4) "NS" is "No Sample"
5) "*" Denotes actual value and uncertainty (± 2sd) for one detection for sampling location

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Summary Statistics

Tritium Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	283	56	266	206	393	52	12
Upper Three Runs Creek (SV-325)	949	461	797	397	2,403	52	52
TNX Boat Landing (SV-2012)	233	49	216	183	339	52	16
Beaver Dam Creek (SV-2040)	235	44	227	182	339	52	20
Fourmile Branch (SV-2039)	39,877	5,370	40,051	28,442	56,149	52	52
Pen Branch (SV-2047)	35,111	9,394	37,769	15,031	53,146	52	52
Steel Creek (SV-327)	2,781	1,054	2,614	999	5,502	52	52
Steel Creek Boat Landing (SV-2018)	2,123	1,764	2,345	197	5,384	52	49
Little Hell Landing (SV-2019)	663	951	276	186	3,809	52	41
Highway 301 Bridge (SV-118)	346	144	313	190	736	52	43
Patterson Mill Rd. (SV-328)	2,633	988	2,545	1,092	4,644	52	52
Lower Three Runs Creek (SV-2053)	380	77	370	216	541	52	50
Upper Three Runs Creek (SV-2027)	233	39	226	189	321	52	23

Tritium Data for Creek Mouth Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Upper Three Runs Creek Creek Mouth (SV-2011)	535	117	557	372	666	8	8
Beaver Dam Creek Creek Mouth (SV-2013)	228	27	228	209	248	8	2
Fourmile Branch Creek Mouth (SV-2015 a)	30,376	13,495	35,942	2,257	41,615	8	7
Fourmile Branch (SV-2015 b) 30' downstream from Creek Mouth	11,308	5,440	12,506	4,458	15,761	8	4
Fourmile Branch (SV-2015 c) 150' downstream from Creek Mouth	8,514	14,783	2,737	203	44,357	8	8
Steel Creek Creek Mouth (SV-2017)	2,249	1,791	1,777	411	5,002	8	8
Lower Three Runs Creek Creek Mouth (SV-2020)	1,148	885	990	199	2,695	8	8

Tritium Data for Random Samples

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Random Perimeter (<50 Miles)	NA	NA	NA	NA	NA	NS	NA
Random Background (>50 Miles)	ND	ND	ND	ND	ND	3	0

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Summary Statistics

Alpha Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	ND	NA	NA	NA	NA	12	0
Upper Three Runs Creek (SV-325)	14.80	7.16	13.55	6.07	29.8	12	12
Beaver Dam Creek (SV-2040)	5.45 *	2.93 *	NA	NA	NA	12	1
Fourmile Branch Creek (SV-2039)	2.49 *	1.08 *	NA	NA	NA	12	1
Pen Branch (SV-2047)	1.78 *	0.98 *	NA	NA	NA	12	1
Steel Creek (SV-327)	3.32	2.74	3.32	1.38	5.25	12	2
Steel Creek Boat Landing (SV-2018)	1.94 *	1.02 *	NA	NA	NA	12	1
Highway 301 Bridge (SV-118)	10.70 *	5.40 *	NA	NA	NA	12	1
Lower Three Runs Creek (SV-2053)	6.26	4.38	6.26	3.16	9.36	12	2

Alpha Data for Random Samples

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Random Perimeter (< 50 Miles)	NA	NA	NA	NA	NA	NS	NA
Random Background (> 50 Miles)	8.95	6.30	8.95	4.49	13.40	3	2

Beta Data for Ambient Monitoring Locations

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Jackson Landing (SV-2010)	ND	NA	NA	NA	NA	12	0
Upper Three Runs Creek (SV-325)	5.74	2.67	6.70	2.73	7.8	12	3
Beaver Dam Creek (SV-2040)	5.58	1.03	5.58	4.85	6.31	12	2
Fourmile Branch (SV-2039)	6.72	1.84	6.93	4.28	9.9	12	7
Pen Branch (SV-2047)	NA	NA	NA	NA	NA	12	0
Steel Creek (SV-327)	NA	NA	NA	NA	NA	12	0
Steel Creek Boat Landing (SV-2018)	5.72	0.89	6.11	4.71	6.35	12	3
Highway 301 Bridge (SV-118)	5.62	1.22	5.30	4.22	7.49	12	5
Lower Three Runs Creek (SV-2053)	NA	NA	NA	NA	NA	12	0

Beta Data for Random Samples

Sample Location	Average Concentration (pCi/L)	Standard Deviation	Median	Minimum Concentration (pCi/L)	Maximum Concentration (pCi/L)	Number of Samples	Number of Detects
Random Perimeter (< 50 Miles)	NA	NA	NA	NA	NA	NS	NA
Random Background (> 50 Miles)	ND	ND	ND	ND	ND	3	0

Note: There were only two gamma detections in the ambient monitoring locations. Cs-137 was detected in the October sample at SV-2053 of 5.11 (±2SD 2.40) pCi/L. There was one detection for Pb-214 of 12.73 (±2SD 5.50) pCi/L. There were no gamma detections in the random background samples.

TOC

2.4 Nonradiological Monitoring of Ambient Surface Water

2.4.1 PROJECT SUMMARY

The streams located on the Savannah River Site (SRS) receive a wide variety of permitted point source discharges and nonpoint source run-off from on-site facilities and operations. These discharges specifically include, but are not limited to, industrial storm water, utility water, treated industrial and sanitary wastewater, and run-off from land disturbing activities. Data from SRS Environmental Reports and South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance Oversight Program (ESOP) is used to monitor the ambient water quality of streams on SRS. The Freshwaters Standard guidelines used are stated in SCDHEC's Water Classifications and Standards (Regulation 61-68) (SCDHEC 2008b).

The SCDHEC assessed the surface water quality for nonradiological parameters in 2010 at SRS by sampling the on-site streams for inorganic and organic contaminants. Specific parameters were analyzed monthly, bi-annually and annually. Sampling locations were strategically chosen to monitor ambient surface water conditions and detect the nonradiological impact from the Department of Energy – Savannah River (DOE-SR) operations.

Streams were tested for the following parameters on a monthly interval: pH, temperature, dissolved oxygen (DO), alkalinity, turbidity, biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, ammonium, nitrite, nitrate, total phosphorous, total kjeldahl nitrogen (TKN), chromium (Cr), iron (Fe), and mercury (Hg). Additionally, in June 2010 SCDHEC began sampling cadmium (Cd), copper (Cu), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn) on a monthly basis. Volatile organic carbons (VOC) were sampled bi-annually, and pesticides and polychlorinated biphenyls (PCB) were sampled annually. These are standard parameters used to sample streams around South Carolina (SCDHEC 2011a). In all, a total of 2769 different analyses were performed with 135 of these exceeding the state or EPA standards. Data from SCDHEC surface water locations were compared to DOE-SR data where sample points were collocated (SCDHEC 2011b).

RESULTS AND DISCUSSION

<u>pH Results</u>

SCDHEC field personnel recorded pH at each sample location during each sampling event. All surface water data can be found in Section 2.4.4. The freshwater pH standard for South Carolina is between 6.0 and 8.5 standard units (su) (SCDHEC 2008b). All sample location yearly averages met this standard, although there were six individual measurements that were outside of the standard. The streams encountered at SRS are typical of southeastern streams characterized as blackwater. A blackwater stream is a stream with a deep, slow moving channel that flows through forested swamps and wetlands. Decaying vegetation in the water results in the leaching of tannins from the vegetation resulting in transparent, acidic water that is darkly stained resembling tea or coffee. Low pH is typical for black water streams such as those sampled at SRS (USGS 2000). See Section 2.4.3, Figure 1 for a comparison of SCDHEC and DOE-SR data for collocated samples; there were no notable differences (SRNS 2011).

Dissolved Oxygen Results

Dissolved oxygen measurements were recorded at each sample location as part of each sampling event. South Carolina freshwater DO Standard is a daily average no less than 5.0 milligrams per Liter (mg/L) with a minimum of 4.0 mg/L (SCDHEC 2008b). All yearly averages and individual analysis met this requirement. See Section 2.4.3, Figure 2 for a comparison of SCDHEC and DOE-SR data for collocated samples; there were no notable differences (SRNS 2011).

Fecal Coliform Results

SCDHEC field personnel collected surface water samples for fecal coliform analysis at each location during each sampling event. According to the South Carolina freshwater fecal coliform standard, five consecutive stream samples during any 30-day period shall not exceed a geometric mean of 200 colonies/100 milliliters (mL), nor shall more than ten percent of total samples during any 30-day period exceed 400 colonies/100 mL (SCDHEC 2008b). SCDHEC's ESOP does not collect samples every day of the month, however no yearly average was above 400 colonies/100mL. Independent from the ESOP monitoring program, SCDHEC Bureau of Water has placed location RWSV-325 on the state Section 303(d) List of impaired waters due to fecal coliform bacteria (SCDHEC 2010e). DOE-SR did not collect samples for fecal coliform in 2010, therefore no comparison was made.

Nitrate/Nitrite Results

There is no official South Carolina freshwater standard for nitrate/nitrite levels; however, the federally established drinking water standard is used to determine ambient water quality in freshwater stream for nitrate/nitrite. All 2010 sample results for nitrate/nitrite were below the United States Environmental Protection Agency (USEPA) drinking water standard of 10 mg/L and 1 mg/L, respectively (USEPA 2003). Drinking water standards are designed to protect the public from consumption and are a conservative measurement for freshwater streams, yet all data meets this criterion. See Section 2.4.3, Figure 3 for a comparison of SCDHEC and DOE-SR data for collocated samples; there were no notable differences (SRNS 2011).

Alkalinity Results

Alkalinity is important for fish and other aquatic life in freshwater systems because it buffers pH changes that occur naturally as a result of photosynthetic activity of the chlorophyll-bearing vegetation. Components of alkalinity, such as carbonate and bicarbonate, will incorporate some toxic heavy metals and reduce their toxicity. For these reasons, the National Technical Advisory Committee recommends a minimum alkalinity of 20 mg/L and that natural alkalinity not be reduced by more than 25 percent (NAS 1974). The use of the 25 percent reduction avoids the problem of establishing standards on waters where natural alkalinity is at or below 20 mg/L. Waters having insufficient alkalinity do not have to be supplemented with artificially added materials to increase the alkalinity. Alkalinity resulting from naturally occurring materials, such as carbonate and bicarbonate, is not considered a health hazard in drinking water supplies, and naturally occurring maximum levels up to approximately 400 mg/L, as calcium carbonate, are not considered a problem to human health (NAS 1974). Several SCDHEC sampling locations had yearly averages that were below the recommended level: SV-324 (5.3 (±1.2) mg/L), SV-325 (3.0 (±0.86) mg/L), SV-2027 (0.97 (±0.49) mg/L), SV-2039 (16 (±5.0) mg/L), SV-2047 (19

(±5.7) mg/L) and SV-2061 (5.5 (±1.8) mg/L). This may be due to the presence of naturally low buffering chemicals in the streams. DOE-SR did not sample for alkalinity in 2010, therefore no comparison was made.

Turbidity Results

The freshwater quality standard for turbidity in South Carolina streams is not to exceed 50 nephelometric turbidity units (NTU) provided existing uses are maintained (SCDHEC 2008b). All SCDHEC monitored streams were below the standard for this parameter. DOE-SR did not sample for turbidity in 2010, therefore no comparison was made.

Metals Results

In June 2010, SCDHEC began sampling cadmium (Cd), copper (Cu), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn) on a monthly basis in addition to the routinely sampled metals chromium (Cr), iron (Fe), and mercury (Hg). Chromium, nickel and mercury were not detected above the lower limit of detection (LLD) for any samples in 2010; therefore all SCDHEC monitored streams have met the standards for each of these parameters. DOE-SR detected chromium and nickel in some collocated samples at levels below both the SCDHEC detection limits and the SC freshwater quality standards (SRNS 2011). In addition, DOE-SR detected mercury in all the collocated samples in June and/or December of 2010. Mercury was not detected by SCDHEC possibly due to different sampling times or weather conditions (SRNS 2011).

The freshwater quality standard for zinc in South Carolina streams is not to exceed 0.037 mg/L (SCDHEC 2008b). All the samples collected in 2010 were below the standard for this parameter. All DOE-SR detections at collocated samples were also below the standard for this parameter (SRNS 2011).

The freshwater quality standard for cadmium in South Carolina streams is not to exceed 0.0001 mg/L (SCDHEC 2008b). Three SCDHEC sampled streams had cadmium averages that were above the standard; SV-324 (0.00032 (±0.00020) mg/L), SV-327 (0.00013 (one detection) mg/L), and SV-328 (0.00026 (one detection) mg/L). All three of these locations are downstream of various SRS operations. DOE-SR did not detect cadmium above the detection limit of 0.0001 mg/L in any samples for 2010; see Section 2.4.3, Figure 4 for a comparison of SCDHEC and DOE-SR data for collocated samples (SRNS 2011).

The freshwater quality standard for lead in South Carolina streams is not to exceed 0.00054 mg/L (SCDHEC 2008b). All nine SCDHEC sampled streams had lead averages that were above the standard; SV-175 (0.0037 (±0.0011) mg/L), SV-324 (0.0038 (±0.0010) mg/L), SV-325 (0.0036 (±0.0013) mg/L), SV-327 (0.0034 (±0.00092) mg/L), SV-328 (0.0035 (±0.0016) mg/L), SV-2027 (0.0033 (±0.00044) mg/L), SV-2039 (0.0042 (±0.0011) mg/L), SV-2047 (0.0040 (±0.0011) mg/L), and SV-2061 (0.0033 (±0.0013) mg/L). These nine samples include locations above and below SRS operations. DOE-SR did not detect lead above the detection limit of 0.002 mg/L in any samples for 2010; see Section 2.4.3, Figure 5 for a comparison of SCDHEC and DOE-SR data for collocated samples (SRNS 2011).

The freshwater quality standard for copper in South Carolina streams is not to exceed 0.0029 mg/L (SCDHEC 2008b). One SCDHEC sampled stream had copper that was above the standard, SV-327 (0.014 (one detection) mg/L). DOE-SR detected copper in all 2010 collocated samples at levels below the SCDHEC detection limit of 0.010 mg/L. DOE-SR did not detect copper above 0.010 mg/L in any collocated samples for 2010; see Section 2.4.3, Figure 6 for a comparison of the SCDHEC and DOE-SR data (SRNS 2011).

Iron and manganese are naturally occurring and do not have state freshwater standards. The USEPA recommended limit for iron in freshwater streams is 1 mg/L (USEPA 2008b). One SCDHEC sampled stream had iron that was above the recommended limit, SV-324 (3.0 (±1.3) mg/L). See Section 2.4.3, Figure 7 and Figure 8 for a comparison of SCDHEC and DOE-SR data for collocated samples; there were no notable differences (SRNS 2011).

VOC Results

SCDHEC field personnel collected surface water samples for VOC at each location semiannually. VOC were not detected above the LLD for any samples in 2010. Statistical analysis was not done for these parameters due to the lack of numerical data. DOE-SR results are comparable to SCDHEC's results with no VOC detected (SRNS 2011).

PCB and Pesticide Results

SCDHEC field personnel collected surface water samples for PCB and pesticides at each location annually. PCB and pesticides were not detected above the LLD for any samples in 2010. Statistical analysis was not done for these parameters due to the lack of numerical data. DOE-SR results are comparable to SCDHEC's results with no PCB or pesticides detected (SRNS 2011).

Other Parameters

Samples were also analyzed for other parameters; including, but not limited to ammonium, total phosphorous, and total suspended solids. The results indicate that the SRS streams met the applicable freshwater standards (SCDHEC 2008b). All surface water data are located in Section 2.4.4. Surface water statistical analyses can be found in Section 2.4.5. There were no notable differences between the SCDHEC and DOE-SR surface water data for these other parameters (SRNS 2011).

SCDHEC and DOE-SR Data Comparison

The following SCDHEC sampling locations were collocated with DOE-SR sampling locations: SV-324, SV-325, SV- 327, SV-328, SV-2039, and SV-2047 (SRNS 2011) (Section 2.4.2, Map 6). Section 2.4.3, Table 1 defines the geographic locations of the SCDHEC sampling locations and Section 2.4.3, Table 2 defines the sampling schedule for SCDHEC. Section 2.4.3, Table 3 defines the geographic locations of all the DOE-SR sampling locations. Comparisons were made with the collocated sampling locations to see if there were any significant statistical differences in parameters: pH (Section 2.4.3, Figure 1); dissolved oxygen (Section 2.4.3, Figure 2); nitrate/nitrite (Section 2.4.3, Figure 3); cadmium (Section 2.4.3, Figure 4); lead (Section 2.4.3, Figure 5); copper (Section 2.4.3, Figure 6); iron (Section 2.4.3, Figure 7); manganese (Section 2.4.3, Figure 8). All data less than lower limit of detections (<LLD) were left out of the graphs for lack of numerical data. Discrepancies in data between DOE-SR and SCDHEC may be attributed to differences in sample collection date and time, sample preservation, and lab

analysis. Differences in calculations, such as the yearly averages used in the figures mentioned above, may also attribute to dissimilarity. SCDHEC does not include non-detections when calculating this average.

CONCLUSION/ RECOMMENDATIONS

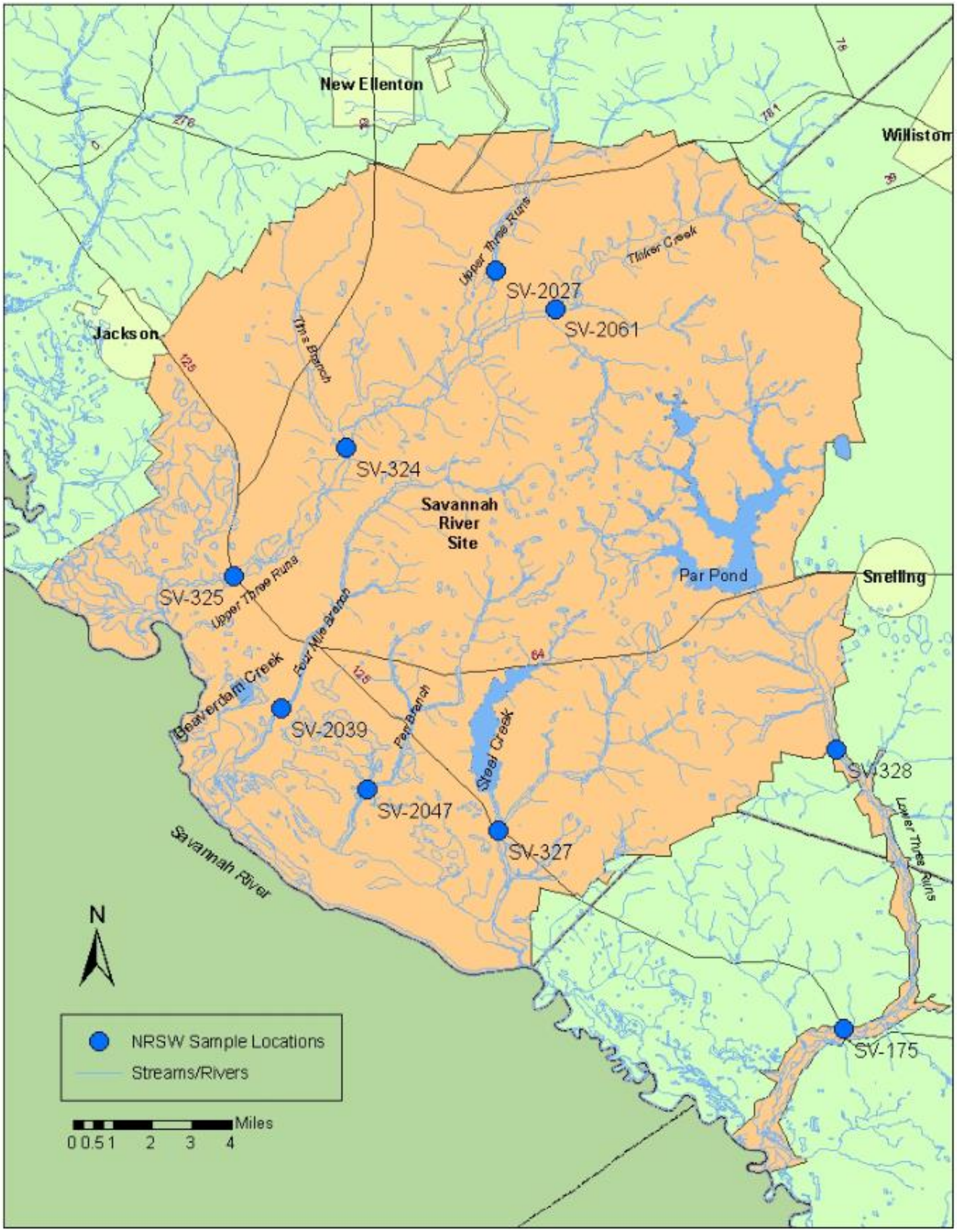
The parameters identified that were above or below USEPA or SCDHEC standards or recommended levels for particular streams will continue to be monitored to establish trends that may warrant further investigation. SCDHEC will also continue to sample on a monthly basis for the six metals that were added to the routine parameters in June of 2010. Several of these metals had individual and yearly averages above the SC freshwater quality standards. SCDHEC will continue to monitor these metals to determine if further investigation is needed.

SCDHEC will continue the nonradiological independent monitoring and surveillance of SRS surface water to evaluate water quality. Monitoring is required because of continued land disturbance from accelerated clean-up, new facility construction, logging, and new missions. The locations, numbers of samples, sample frequencies and monitoring parameters are reviewed and modified annually to maximize available resources and address SRS mission changes.

TOC

2.4.2 MAP TOC

Map 6. Nonradiological Surface Water (NRSW) Monitoring Sample Locations



2.4.3 TABLES AND FIGURES

Table 1. SCDHEC Surface Water Sample Locations

Sample Location	Location Description	Location Rationale
NWSV-2027	Upper Three Runs at Road 2-1	Background sample
NWSV-2061	Upper Three Runs at Road 2-1	Background sample
NWSV-324	Tims Branch at Road C	Downstream from M- & A-Areas
NWSV-325	Upper Three Runs at Road A	Downstream from F-Area
NWSV-2039	Fourmile Branch at Road A-13.2	Downstream from F- and H-Areas
NWSV-2047	Pen Branch at Road A-13.2	Downstream from K-Area
NWSV-327	Steel Creek at Road A	Downstream from L-Lake
NWSV-175	Lower Three Runs at Highway 125	Downstream from Par Pond
NWSV-328	Lower Three Runs at Patterson Mill Road	Downstream from Par Pond

Table 2. Water Quality Parameter Analyses for SCDHEC

Laboratory	Frequency	Parameter
Aiken	Monthly	Turbidity, Alkalinity, Biochemical Oxygen Demand (BOD 5), Fecal Coliform, and Total Suspended Solids.
Columbia Lab	Monthly	Ammonia, Nitrate/Nitrite, Total Phosphorus, Total Kjeldahl Nitrogen (TKN), and Metals.
	Semi-annually	Volatile Organic Compounds (VOCs).
	Annually	Pesticide Scan and Polychlorinated Biphenyls (PCBs).
Field	Monthly	Temperature, pH, and Dissolved Oxygen (DO).

Table 3. DOE-SR Surface Water Sample Locations

SRS Stream Locations * = colocated with DHEC locations	Savannah River Locations
Tinker Creek near Northeast Site Boundary	River Mile 160
*Tims Branch at Road C	River Mile 150.4
Upper Three Runs at Road 1-A	River Mile 141.5
*Upper Three Runs at Road A	River Mile 129.1
Beaver Dam Creek at D-Area	River Mile 118.8
Four Mile Creek at Road E	
Four Mile Creek at Road C	
*Four Mile Creek adjacent to D-Area	
*Pen Branch at Road A-13.2	
*Steel Creek at Road A	
*Lower Three Runs at Patterson Mill Rd.	

Tables and Figures

Figure 1. pH Comparison

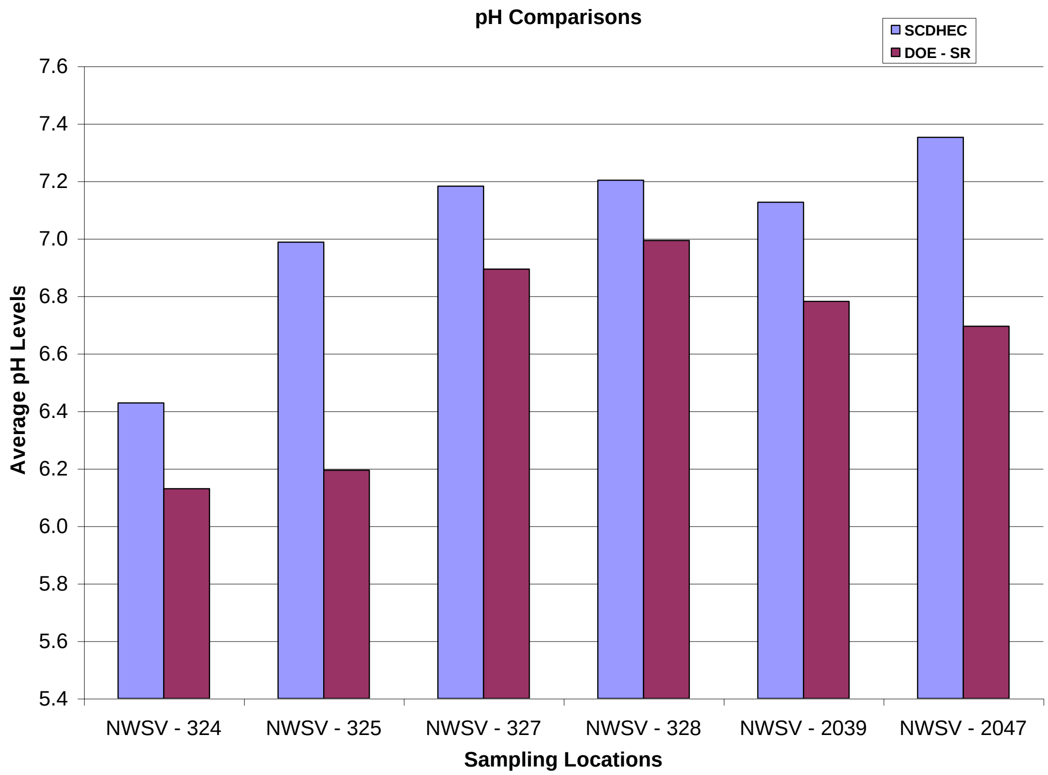
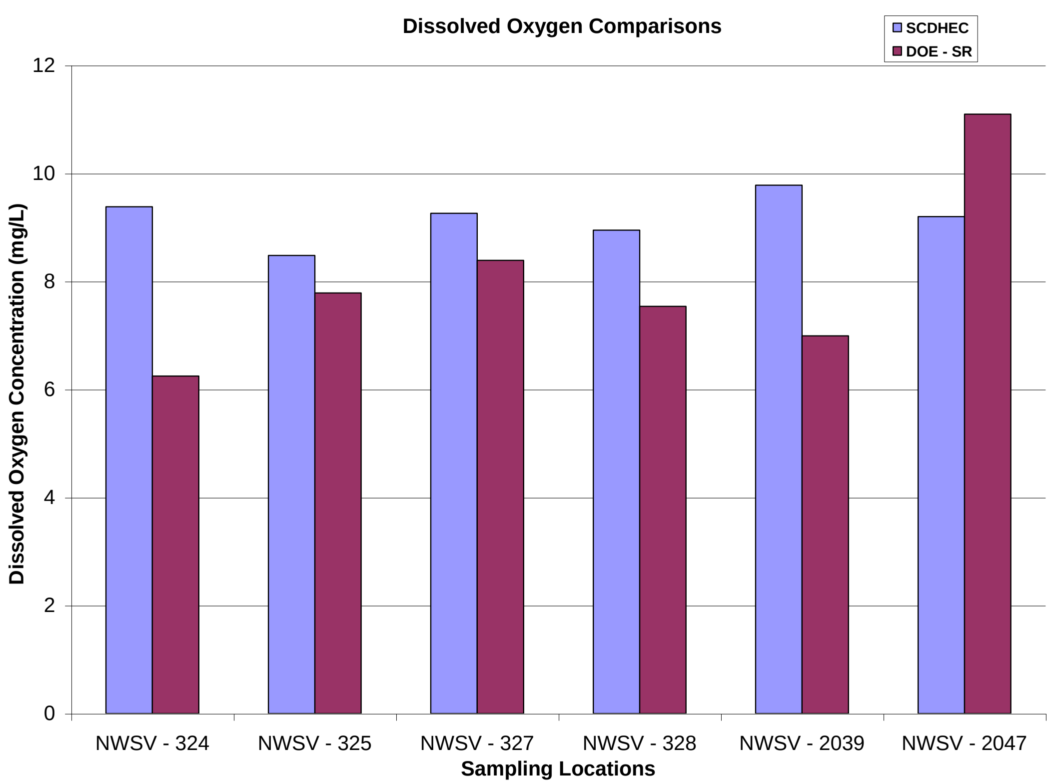


Figure 2. DO Comparison



Tables and Figures

Figure 3. Nitrate/Nitrite Comparison

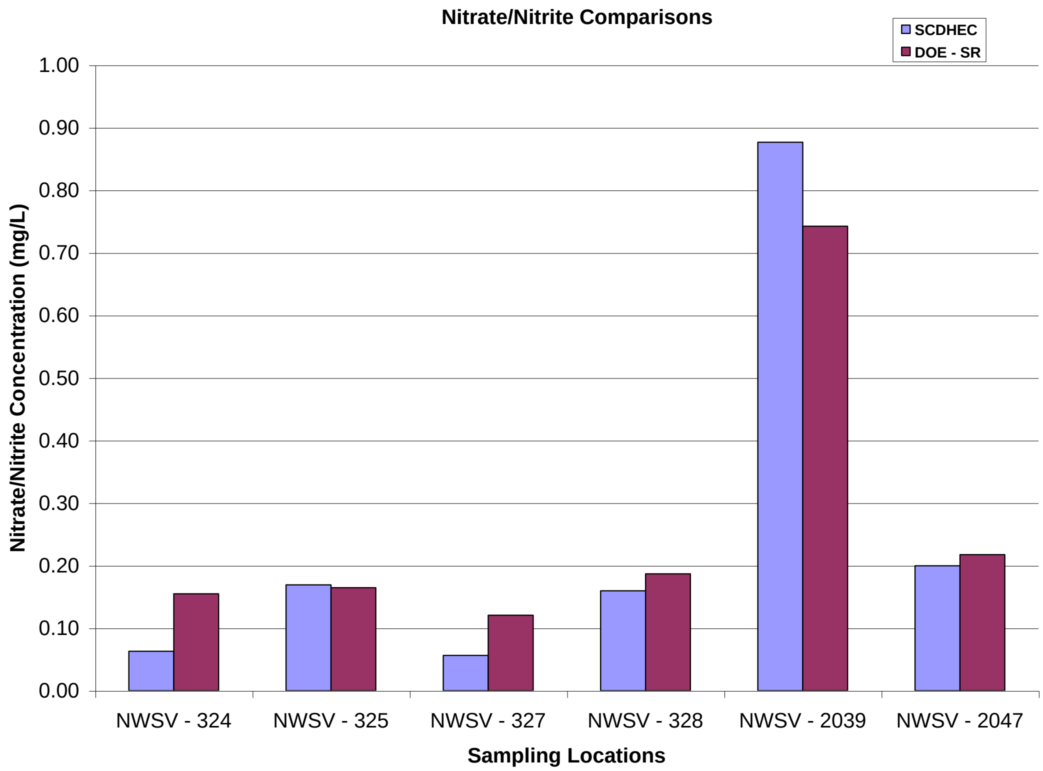
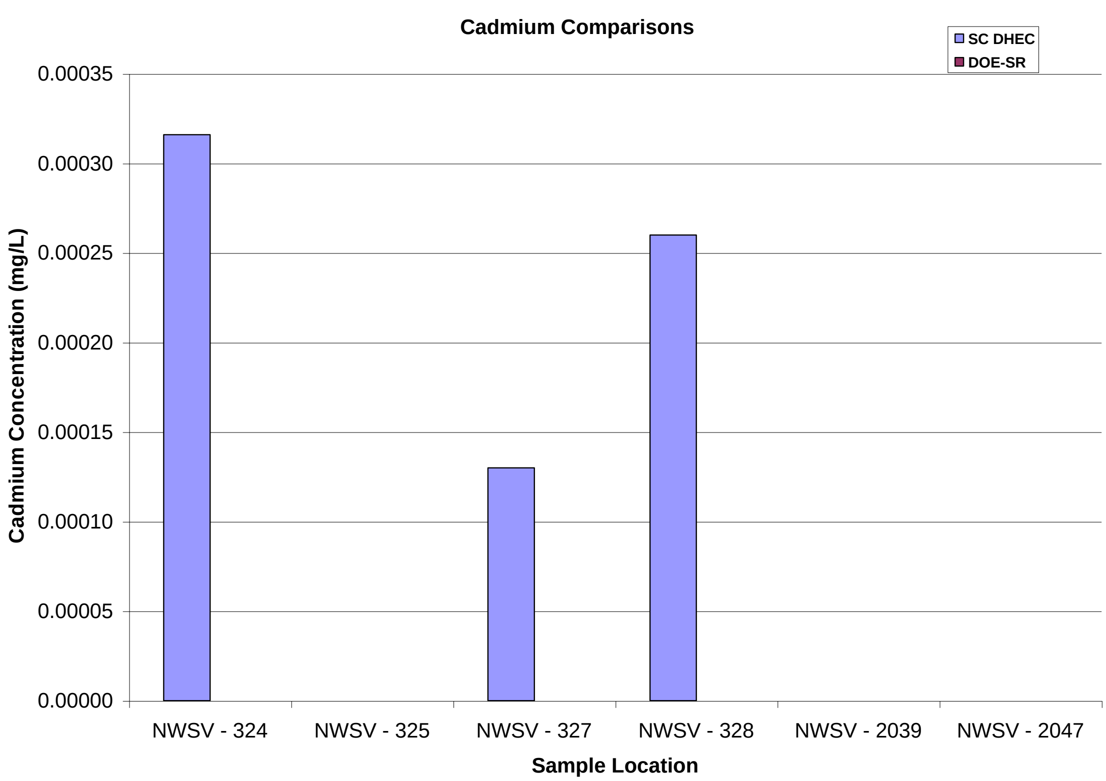


Figure 4. Cadmium Comparison



Tables and Figures

Figure 5. Lead Comparison

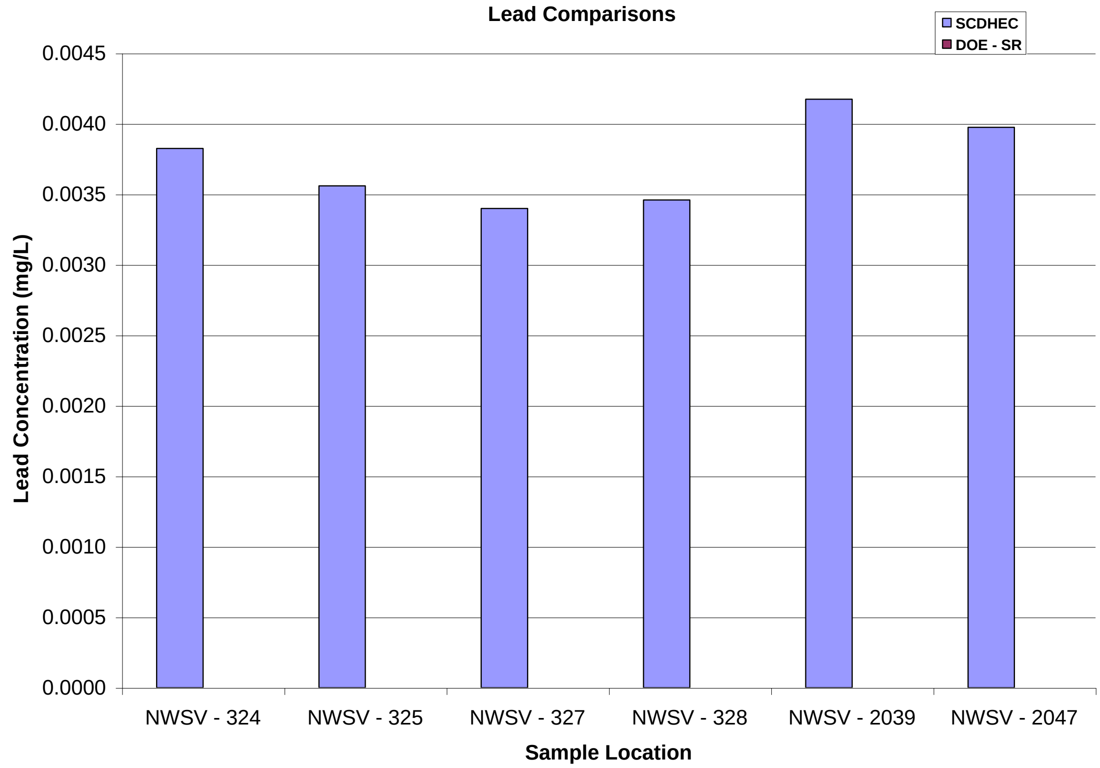


Figure 6. Copper Comparison

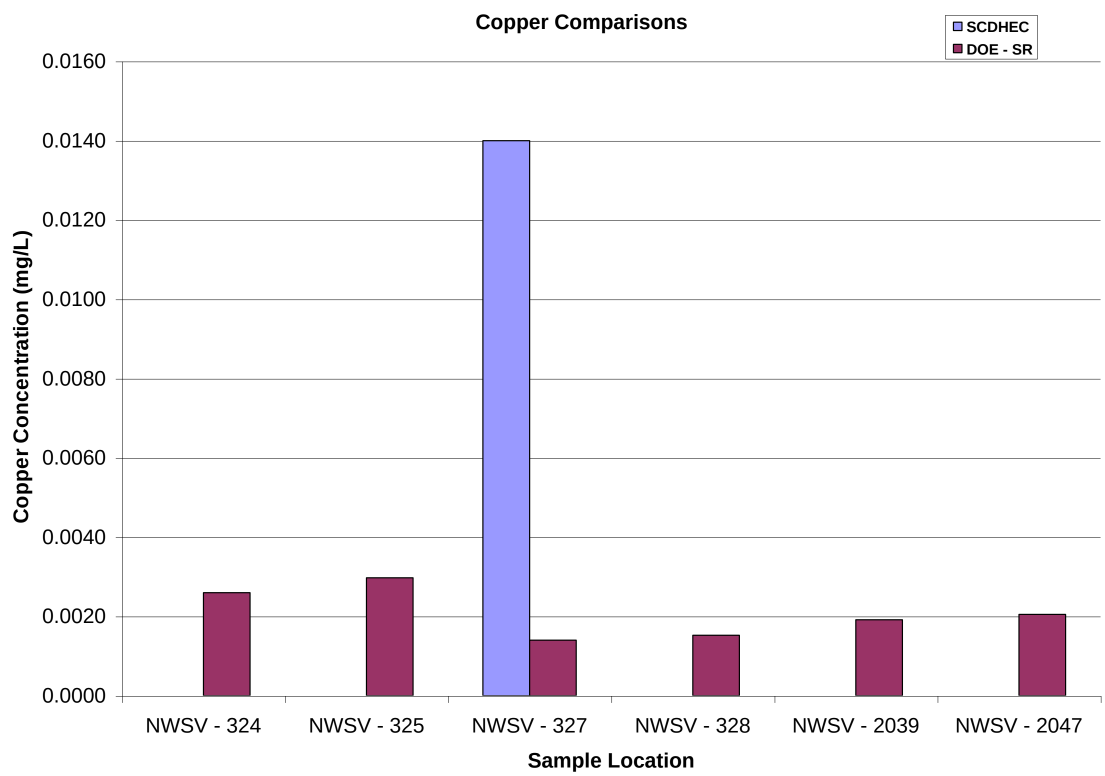


Figure 7. Iron Comparison

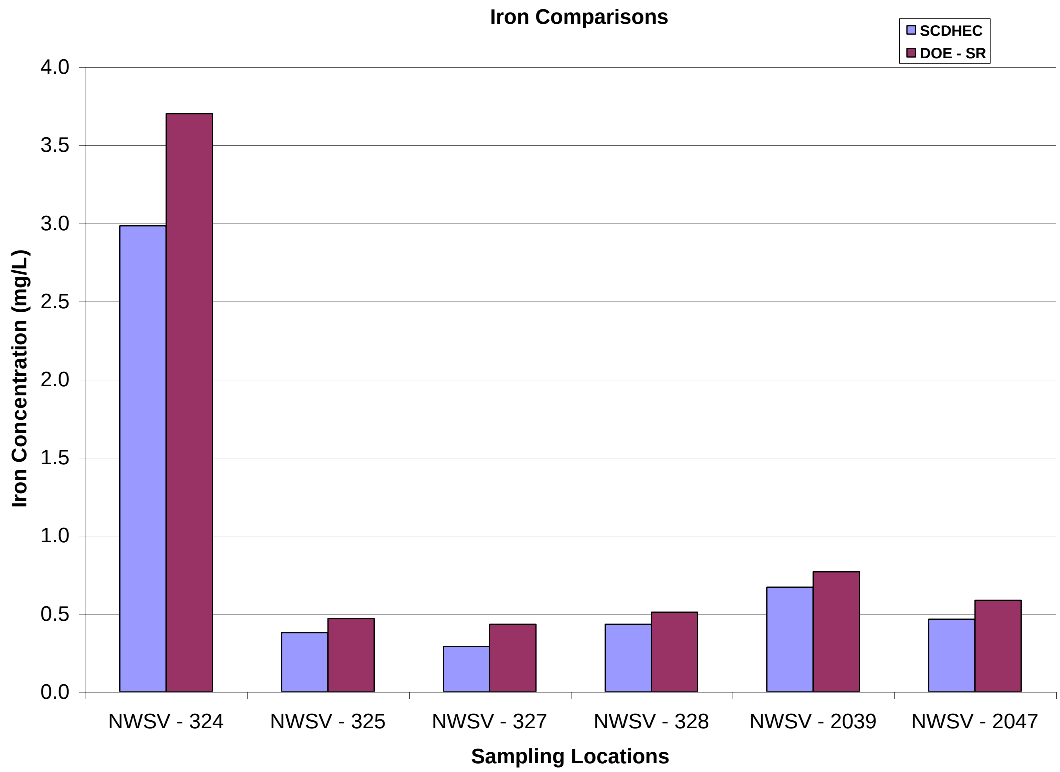
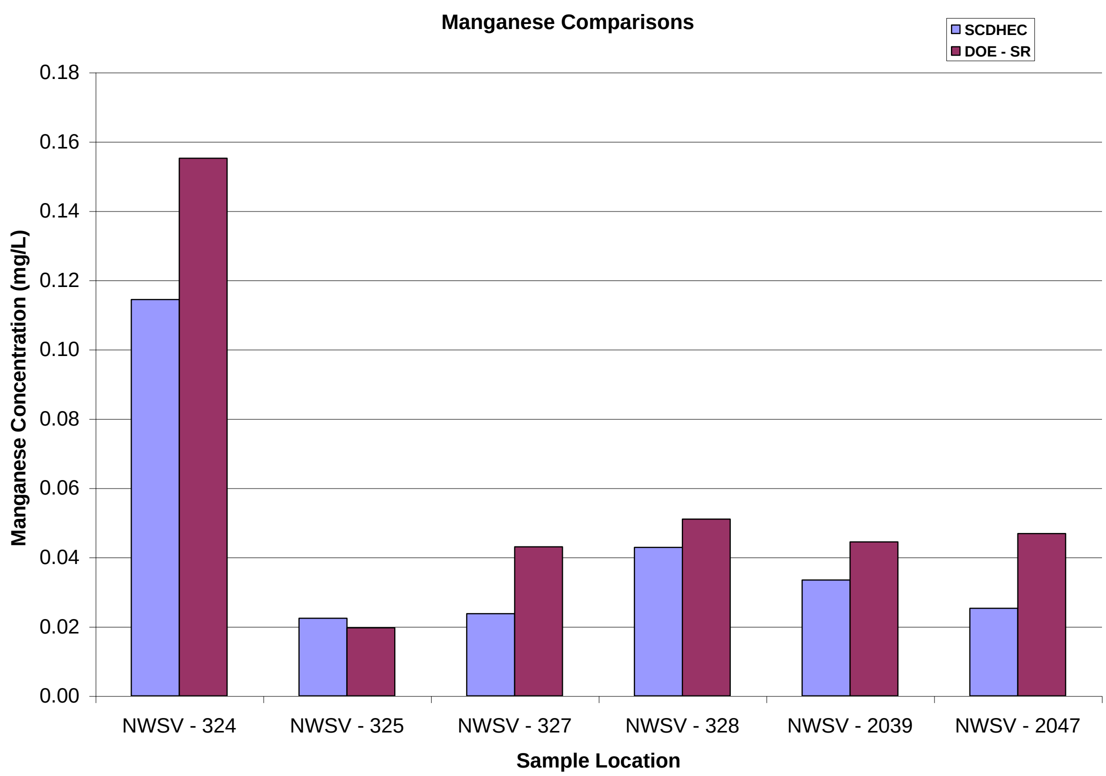


Figure 8. Manganese Comparison



2.4.4 DATA

Nonradiological Monitoring of Ambient Surface Water

Notes:

1. Empty Cells displayed in tables represent time frames that were unable to be sampled due to adjustments to the project structure in the middle of the year, due to access to sampling locations or due to bi-annual sampling criteria.
2. AE = Analytical Error
3. EST = Estimated Amount
4. Sample location NWSV-175 was discontinued in September 2010.

DATA TABLES

NWSV-175	Upper Three Runs at Road 2-1					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.62	7.67	7.04	6.91	7.65	7.08
DO	12.14	12.08	9.18	6.96	7.76	7.35
Water Temp	3.53	8.07	12.63	19.68	18.89	22.43
Alkalinity	30	16	31	25	45	25
Turbidity	1.9	3.1	1.9	3.0	5.2	7.3
BOD	<2.0	<2.0	<2.0	<2.0	AE	<2.0
TSS	1.2	2.0	2.1	2.6	5.7	8.8
Fecal Coliform	160	190	120	230	200	720
TKN	0.13	0.24	0.36	0.24	0.28	0.52
Ammonia	<0.050	<0.050	0.059	0.11	0.091	<0.050
Nitrate/Nitrite	0.035	0.048	<0.020	0.040	0.12	0.074
Total Phosphorus	0.02	<0.020	0.063	0.036	0.046	0.060
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.25	0.32	0.30	0.57	0.50	0.63
Lead						0.0029
Manganese						0.048
Nickel						<0.020
Zinc						<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-175	Upper Three Runs at Road 2-1					
	July	**August**	**September[4]**	**October[4]**	**November[4]**	**December[4]**
pH	7.29	6.89				
DO	7.23	6.50				
Water Temp	22.77	24.98				
Alkalinity	41	40				
Turbidity	3.1	2.8				
BOD	<2.0	<2.0				
TSS	2.8	3.6				
Fecal Coliform	120	94				
TKN	0.19	<0.10				
Ammonia	0.055	<0.050				
Nitrate/Nitrite	0.15	0.11				
Total Phosphorus	0.045	0.046				
Cadmium	<0.00010	<0.00010				
Chromium	<0.0050	<0.0050				
Copper	<0.010	<0.010				
Iron	0.45	0.49				
Lead	<0.0020	0.0044				
Manganese	0.036	0.040				
Nickel	<0.020	<0.020				
Zinc	<0.010	<0.010				
Mercury	<0.00020	<0.00020				

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-324	Tims Branch at Road C					
	January	**February**	**March**	**April**	**May**	**June**
pH	6.51	7.14	6.30	6.27	6.31	6.01
DO	11.81	15.32	10.30	8.12	7.94	8.07
Water Temp	3.45	8.49	10.31	19.46	20.20	22.85
Alkalinity	4.0	3.6	4.1	7.0	7.4	6.3
Turbidity	4.9	4.8	6.7	10	12	8.4
BOD	<2.0	<2.0	<2.0	2.1	AE	2.4
TSS	3.7	3.7	5.0	9.1	10	9.4
Fecal Coliform	<5	73	77	100	67	170
TKN	0.27	0.12	0.21	0.49	0.41	0.54
Ammonia	0.066	<0.050	<0.050	0.13	0.20	0.15
Nitrate/Nitrite	0.071	0.065	<0.020	<0.020	0.028	0.026
Total Phosphorus	0.026	0.026	0.03	0.073	0.083	0.078
Cadmium						0.00012
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	1.1	1.3	1.2	3.3	3.8	3.8
Lead						0.0031
Manganese						0.12
Nickle						<0.020
Zinc						<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-324	Tims Branch at Road C					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.01	**5.97**	6.40	6.73	6.67	6.82
DO	7.00	6.18	7.93	7.96	9.61	12.34
Water Temp	24.45	25.84	20.68	15.30	14.50	4.41
Alkalinity	5.6	6.2	5.5	4.4	4.7	4.5
Turbidity	11	13	9.6	6.0	4.3	4.6
BOD	<2.0	<2.0	2.6	<2.0	<2.0	<2.0
TSS	8.7	11	10	AE	6.7	3.5
Fecal Coliform	20 EST	95	190	30 EST	100	30 EST
TKN	0.46	1.0	0.46	0.34	0.46	0.59
Ammonia	0.14	0.14	0.14	<0.050	0.055	0.10
Nitrate/Nitrite	0.073	<0.020	0.11	0.068	0.067	0.060
Total Phosphorus	0.083	0.068	0.062	0.045	0.060	0.044
Cadmium	0.00023	0.00050	0.00055	<0.00010	0.00018	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	4.0	4.6	4.6	2.6	2.9	2.6
Lead	<0.0020	0.0047	0.0047	<0.0020	0.0028	<0.0020
Manganese	0.14	0.17	0.21	0.051	0.056	0.054
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-325	Upper Three Runs at Road A					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.30	7.48	6.76	6.99	7.01	6.05
DO	11.18	11.19	8.88	7.94	7.02	7.57
Water Temp	4.90	9.21	12.87	19.20	18.50	21.63
Alkalinity	2.0	1.7	3.2	3.9	3.4	1.6
Turbidity	2.0	2.8	2.2	5.1	5.9	8.2
BOD	<2.0	<2.0	<2.0	2.1	AE	3.6
TSS	0.80	1.6	2.9	4.0	6.4	7.0
Fecal Coliform	55 EST	25 EST	40	86	80	>600
TKN	0.12	<0.10	0.12	0.14	0.11	0.67
Ammonia	<0.050	<0.050	<0.050	0.058	<0.050	0.080
Nitrate/Nitrite	0.16	0.11	0.12	0.091	0.16	0.27
Total Phosphorus	<0.020	<0.020	0.047	0.041	0.043	0.052
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.21	0.35	0.26	0.48	0.43	0.69
Lead						0.0030
Manganese						0.055
Nickle						<0.020
Zinc						0.028
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-325	Upper Three Runs at Road A					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.82	6.59	6.90	7.11	7.13	7.71
DO	6.58	6.58	7.54	7.38	8.43	11.49
Water Temp	21.90	23.58	19.78	15.24	14.60	5.92
Alkalinity	2.6	2.6	3.5	3.7	4.1	3.5
Turbidity	4.2	6.6	4.1	2.7	1.6	2.0
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	5.6	5.8	5.8	AE	1.5	1.4
Fecal Coliform	200	100	220	110	120	100
TKN	<0.10	0.48	<0.10	0.78	0.30	0.32
Ammonia	0.060	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.17	0.18	0.25	0.16	0.14	0.22
Total Phosphorus	0.045	0.042	0.029	<0.020	0.033	0.024
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.45	0.56	0.41	0.21	0.22	0.26
Lead	<0.0020	0.0050	0.0047	<0.0020	0.0031	0.0020
Manganese	0.015	0.015	0.016	<0.010	<0.010	0.011
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-327	Steel Creek at Road A					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.63	7.66	7.16	6.91	7.49	6.83
DO	10.95	12.02	13.20	8.60	7.26	8.44
Water Temp	7.03	9.11	11.30	17.39	19.03	21.39
Alkalinity	22	17	20	23	20	16
Turbidity	1.6	2.1	2.2	3.8	8.1	3.7
BOD	<2.0	<2.0	<2.0	<2.0	AE	<2.0
TSS	1.1	2.2	2.3	3.0	11	8.3
Fecal Coliform	45	47	67	70	120	230
TKN	<0.10	0.18	0.12	0.15	0.29	0.26
Ammonia	0.057	<0.050	<0.050	0.071	0.086	0.065
Nitrate/Nitrite	0.025	0.042	0.029	0.033	0.084	0.072
Total Phosphorus	<0.020	<0.020	<0.020	<0.020	0.036	0.033
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.12	0.21	0.27	0.48	0.52	0.55
Lead						0.0042
Manganese						0.050
Nickle						<0.020
Zinc						<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-327	Steel Creek at Road A					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.14	6.93	6.83	6.87	7.19	7.55
DO	6.57	6.75	7.86	8.06	9.12	12.29
Water Temp	27.13	24.71	22.67	17.94	16.37	5.11
Alkalinity	25	22	25	26	12	25
Turbidity	2.3	2.9	1.9	1.8	1.5	1.7
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.2	2.3	2.5	AE	0.90	1.3
Fecal Coliform	40 EST	98	130	150	140	110
TKN	0.36	<0.10	<0.10	0.30	0.41	0.46
Ammonia	0.056	0.081	<0.050	<0.050	0.058	<0.050
Nitrate/Nitrite	0.15	0.076	0.041	0.034	0.032	0.060
Total Phosphorus	0.024	0.024	<0.020	<0.020	0.031	0.020
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00013
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	0.014	<0.010	<0.010
Iron	0.21	0.31	0.20	0.17	0.20	0.23
Lead	<0.0020	0.0024	0.0036	<0.0020	<0.0020	<0.0020
Manganese	0.023	0.024	0.016	0.014	0.017	0.022
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl’s.

DATA TABLES

NWSV-328	Lower Three Runs at Patterson Mill Road					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.58	7.67	7.05	6.78	7.53	7.03
DO	11.44	12.70	9.85	7.31	7.82	7.80
Water Temp	6.64	8.68	12.73	18.73	19.13	21.96
Alkalinity	31	23	32	34	4.3	39
Turbidity	1.7	2.2	1.4	4.0	3.4	4.9
BOD	<2.0	<2.0	<2.0	<2.0	AE	<2.0
TSS	1.5	2.2	1.7	4.4	5.4	8.1
Fecal Coliform	260	160	150	140	220	250
TKN	0.12	0.32	0.12	0.27	0.20	0.28
Ammonia	<0.050	<0.050	<0.050	0.095	0.065	0.074
Nitrate/Nitrite	0.95	0.023	<0.020	0.026	0.085	0.091
Total Phosphorus	<0.020	<0.020	0.047	0.03	0.035	0.047
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.19	0.21	0.26	0.41	0.38	0.62
Lead						0.0031
Manganese						0.068
Nickle						<0.020
Zinc						<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-328	Lower Three Runs at Patterson Mill Road					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.97	6.95	7.04	6.92	7.28	7.64
DO	6.97	6.48	8.02	8.30	8.96	11.73
Water Temp	23.33	25.22	19.73	15.59	14.85	5.68
Alkalinity	39	36	52	49	52	51
Turbidity	2.1	2.5	1.6	1.5	1.1	1.3
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.6	5.1	2.0	AE	<0.50	0.88
Fecal Coliform	150	390	220	120 EST	160 EST	220
TKN	0.12	0.84	0.20	0.15	0.39	0.40
Ammonia	0.053	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.11	0.10	0.11	0.092	0.069	0.10
Total Phosphorus	0.041	0.036	0.030	0.027	0.021	0.025
Cadmium	0.00026	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.45	0.41	0.48	0.79	0.73	0.25
Lead	<0.0020	0.0028	0.0061	0.0020	0.0033	<0.0020
Manganese	0.047	0.040	0.035	0.045	0.029	0.036
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-2027	Upper Three Runs at Road 2-1					
	January	**February**	**March**	**April**	**May**	**June**
pH	6.40	6.63	6.25	6.07	**5.84**	**5.93**
DO	10.27	12.25	8.97	8.40	8.12	8.51
Water Temp	8.01	11.61	14.37	18.51	18.62	20.48
Alkalinity	<1.0	<1.0	1.0	1.3	0.0	<1.0
Turbidity	1.7	2.0	2.3	2.7	3.1	3.4
BOD	<2.0	<2.0	<2.0	<2.0	AE	<2.0
TSS	1.6	1.7	2.1	3.0	4.9	5.3
Fecal Coliform	50 EST	40 EST	110	52	210	190
TKN	0.10	<0.10	<0.10	0.27	0.41	0.20
Ammonia	<0.050	<0.050	<0.050	0.050	0.063	0.084
Nitrate/Nitrite	0.29	0.25	0.31	0.23	1.6	0.25
Total Phosphorus	<0.020	<0.020	0.042	<0.020	0.021	0.026
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.14	0.18	0.20	0.27	0.26	0.38
Lead						0.0030
Manganese						<0.010
Nickle						<0.020
Zinc						<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2027	Upper Three Runs at Road 2-1					
	July	**August**	**September**	**October**	**November**	**December**
pH	**5.40**	**5.43**	6.23	6.38	6.08	7.05
DO	7.56	7.04	8.19	7.83	9.24	11.27
Water Temp	20.95	21.83	19.04	15.88	15.60	8.01
Alkalinity	<1.0	<1.0	<1.0	1.1	1.3	1.1
Turbidity	2.4	3.6	2.5	1.9	2.0	1.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	3.1	4.6	4.9	AE	1.6	1.8
Fecal Coliform	77	170	73	240	330	200
TKN	0.14	0.26	<0.10	<0.10	0.36	0.47
Ammonia	0.051	<0.050	0.056	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.28	0.30	0.27	0.28	0.25	0.33
Total Phosphorus	0.024	<0.020	<0.020	<0.020	0.023	<0.020
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.28	0.34	0.31	0.20	0.21	0.17
Lead	<0.0020	0.0038	0.0036	<0.0020	0.0029	<0.0020
Manganese	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	0.012	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-2039	Fourmile Branch at Road A-13.2					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.50	7.73	7.13	6.96	7.11	6.46
DO	13.06	12.40	13.17	8.69	8.30	8.04
Water Temp	3.31	8.33	10.03	18.92	19.64	22.38
Alkalinity	8.2	8.5	12	16	21	11
Turbidity	2.7	3.8	2.0	6.5	5.9	9.1
BOD	<2.0	<2.0	<2.0	<2.0	AE	<2.0
TSS	0.80	1.6	1.2	4.2	4.1	5.4
Fecal Coliform	23 EST	20 EST	45	170	140	290
TKN	0.24	0.19	0.16	0.26	0.34	0.36
Ammonia	<0.050	<0.050	<0.050	0.086	0.058	0.079
Nitrate/Nitrite	1.3	0.98	1.0	0.58	1.0	0.73
Total Phosphorus	0.054	0.06	0.058	0.12	0.16	0.15
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.38	0.50	0.40	1.0	0.87	1.5
Lead						0.0040
Manganese						0.061
Nickle						<0.020
Zinc						0.012
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2039	Fourmile Branch at Road A-13.2					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.06	6.82	6.96	6.90	7.20	7.69
DO	7.26	6.87	8.12	8.56	10.08	12.84
Water Temp	22.96	24.84	20.09	15.12	14.46	3.81
Alkalinity	17	20	22	16	22	14
Turbidity	2.4	3.5	2.2	2.3	2.1	2.0
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	1.8	2.8	1.7	AE	0.80	1.5
Fecal Coliform	160	83	88	200	140	120
TKN	0.24	0.69	0.20	0.22	0.43	0.64
Ammonia	0.14	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.30	0.51	1.1	0.98	0.64	1.4
Total Phosphorus	0.11	0.13	0.092	0.093	0.095	0.079
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.70	0.92	0.45	0.32	0.40	0.59
Lead	<0.0020	0.0044	0.0055	<0.0020	0.0028	<0.0020
Manganese	0.035	0.045	0.028	0.023	0.019	0.023
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

NWSV-2047	Pen Branch at Road A-13.2					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.41	**8.24**	7.39	7.38	7.36	6.84
DO	12.08	12.30	13.11	8.84	8.65	8.74
Water Temp	3.93	8.35	10.30	18.03	19.34	21.61
Alkalinity	12	7.9	15	23	21	14
Turbidity	2.9	4.1	2.8	4.3	7.8	8.2
BOD	2.0	<2.0	<2.0	3.0	AE	<2.0
TSS	0.90	2.5	2.0	3.5	9.4	6.9
Fecal Coliform	63	86	120	57	130	220
TKN	0.24	0.34	0.17	0.26	0.18	0.29
Ammonia	0.056	<0.050	<0.050	0.087	0.080	0.081
Nitrate/Nitrite	0.16	0.088	0.31	0.077	0.22	0.28
Total Phosphorus	<0.020	<0.020	0.020	0.031	0.045	0.044
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.28	0.43	0.30	0.64	0.86	0.82
Lead						0.0028
Manganese						0.048
Nickle						<0.020
Zinc						0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2047	Pen Branch at Road A-13.2					
	July	**August**	**September**	**October**	**November**	**December**
pH	7.20	7.04	7.06	7.04	7.30	7.97
DO	7.81	7.36	8.69	8.86	9.96	4.01
Water Temp	22.90	24.65	20.08	15.37	14.67	12.96
Alkalinity	23	21	25	24	25	23
Turbidity	2.7	2.8	2.0	3.8	1.9	2.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	1.8	2.2	1.5	AE	0.90	1.4
Fecal Coliform	220	94	63	120	140	110
TKN	0.24	0.56	<0.10	<0.10	0.37	0.46
Ammonia	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.33	0.18	0.18	0.22	0.16	0.19
Total Phosphorus	0.036	0.034	0.025	0.027	0.034	0.028
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.58	0.46	0.30	0.28	0.26	0.36
Lead	<0.0020	0.0043	0.0054	<0.0020	0.0034	<0.0020
Manganese	0.026	0.028	0.020	0.020	0.014	0.021
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

DATA TABLES

TOC

NWSV-2061	Upper Three Runs at Road 2-1					
	January	**February**	**March**	**April**	**May**	**June**
pH	7.30	7.05	6.85	6.44	**5.78**	6.02
DO	11.59	12.50	8.10	8.82	8.32	8.12
Water Temp	4.18	9.09	12.43	19.27	19.69	22.47
Alkalinity	3.2	<1.0	8.8	6.6	6.0	3.2
Turbidity	2.1	3.1	1.1	6.5	7.5	6.8
BOD	<2.0	<2.0	<2.0	3.2	AE	2.5
TSS	2.0	2.4	1.6	6.6	9.8	9.2
Fecal Coliform	100	69	10 EST	77	160	310
TKN	0.20	0.10	0.27	0.16	0.18	0.50
Ammonia	<0.050	<0.050	AE	0.052	0.077	0.087
Nitrate/Nitrite	0.044	0.035	0.034	<0.020	0.053	0.084
Total Phosphorus	0.028	0.03	0.074	0.063	0.080	0.087
Cadmium						<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper						<0.010
Iron	0.21	0.28	0.22	0.50	0.52	0.79
Lead						0.0026
Manganese						0.040
Nickle						<0.020
Zinc						0.014
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

NWSV-2061	Upper Three Runs at Road 2-1					
	July	**August**	**September**	**October**	**November**	**December**
pH	6.40	6.29	6.48	6.72	6.77	7.51
DO	7.55	6.74	8.36	8.56	9.88	12.50
Water Temp	23.04	24.78	20.24	15.32	15.01	5.17
Alkalinity	4.9	3.2	5.4	6.5	6.8	5.5
Turbidity	4.2	5.2	2.4	2.3	1.8	2.4
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TSS	4.0	5.2	4.6	AE	1.8	2.8
Fecal Coliform	130	120	>200	220	260	430
TKN	0.19	0.32	0.18	0.14	0.37	0.52
Ammonia	0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate/Nitrite	0.063	0.23	0.054	0.025	0.042	0.16
Total Phosphorus	0.084	0.094	0.068	0.037	0.053	0.039
Cadmium	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Chromium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron	0.54	0.70	0.44	0.22	0.26	0.27
Lead	<0.0020	0.0045	0.0050	0.0020	0.0025	<0.0020
Manganese	0.018	0.025	0.018	<0.010	0.013	0.020
Nickle	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc	<0.010	<0.010	<0.010	0.010	<0.010	0.011
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

There were no detections in any 2010 samples above the LLD for volatile organic carbons, pesticides, or polychlorinated biphenyl's.

2.4.5 SUMMARY STATISTICS

Nonradiological Monitoring of Ambient Surface Water

Notes:

1. N/A = Not Applicable
2. AVG = Average
3. STDEV = Standard Deviation
4. N = Number

SUMMARY STATISTICS

Sample Location	NWSV-175	Upper Three Runs at Road 2-1					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.27	0.34	7.19	6.89	7.67	8
	DO	8.65	2.27	7.56	6.50	12.14	8
	Water Temp	16.62	7.71	19.29	3.53	24.98	8
Lab Parameters	Alkalinity	32	9.8	31	16	45	8
	Turbidity	3.5	1.8	3.1	1.9	7.3	8
	BOD	<2.0	N/A	N/A	N/A	N/A	0
	TSS	3.6	2.5	2.7	1.2	8.8	8
	Fecal Coliform	229	204	175	94	720	8
	TKN	0.28	0.13	0.24	0.13	0.52	7
	Ammonia	0.079	0.026	0.075	0.055	0.11	4
	Nitrate/Nitrite	0.082	0.045	0.074	0.035	0.15	7
	Total Phosphorus	0.045	0.014	0.046	0.02	0.063	7
	Cadmium	<0.00010	N/A	N/A	N/A	N/A	0
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.44	0.14	0.47	0.25	0.63	8
	Lead	0.0037	0.0011	0.0037	0.0029	0.0044	2
	Manganese	0.041	0.0061	0.040	0.036	0.048	3
	Nickel	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	<0.010	N/A	N/A	N/A	N/A	0
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

Sample Location	NWSV-324	Tims Branch at Road C					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.43	0.36	6.36	5.97	7.14	12
	DO	9.38	2.63	8.10	6.18	15.32	12
	Water Temp	15.83	7.69	17.38	3.45	25.84	12
Lab Parameters	Alkalinity	5.3	1.2	5.1	3.6	7.4	12
	Turbidity	7.9	3.1	7.6	4.3	13	12
	BOD	2.4	0.25	2.4	2.1	2.6	3
	TSS	7.3	2.9	8.7	3.5	11	11
	Fecal Coliform	87	54	77	20	190	11
	TKN	0.45	0.22	0.46	0.12	1.0	12
	Ammonia	0.12	0.045	0.14	0.055	0.20	9
	Nitrate/Nitrite	0.063	0.025	0.067	0.026	0.11	9
	Total Phosphorus	0.057	0.022	0.061	0.026	0.083	12
	Cadmium	0.00032	0.00020	0.00023	0.00012	0.00055	5
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	3.0	1.3	3.1	1.1	4.6	12
	Lead	0.0038	0.0010	0.0039	0.0028	0.0047	4
	Manganese	0.11	0.063	0.12	0.051	0.21	7
	Nickel	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	0.010	N/A	0.010	0.010	0.010	1
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

SUMMARY STATISTICS

Sample Location	NWSV-325	Upper Three Runs at Road A					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.99	0.43	7.00	6.05	7.71	12
	DO	8.48	1.82	7.76	6.58	11.49	12
	Water Temp	15.61	6.30	16.87	4.90	23.58	12
Lab Parameters	Alkalinity	3.0	0.86	3.3	1.6	4.1	12
	Turbidity	4.0	2.1	3.5	1.6	8.2	12
	BOD	2.9	1.1	2.9	2.1	3.6	2
	TSS	3.9	2.3	4.0	0.80	7.0	11
	Fecal Coliform	103	61	100	25	220	11
	TKN	0.34	0.25	0.30	0.11	0.78	9
	Ammonia	0.066	0.012	0.060	0.058	0.080	3
	Nitrate/Nitrite	0.17	0.054	0.16	0.091	0.27	12
	Total Phosphorus	0.040	0.009	0.042	0.024	0.052	9
	Cadmium	<0.00010	N/A	N/A	N/A	N/A	0
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.38	0.15	0.38	0.21	0.69	12
	Lead	0.0036	0.0013	0.0031	0.0020	0.0050	5
	Manganese	0.022	0.018	0.015	0.011	0.055	5
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	0.019	0.013	0.019	0.010	0.028	2
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

Sample Location	NWSV-327	Steel Creek at Road A					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.18	0.32	7.15	6.83	7.66	12
	DO	9.26	2.28	8.52	6.57	13.20	12
	Water Temp	16.60	7.09	17.67	5.11	27.13	12
Lab Parameters	Alkalinity	21	4.3	22	12	26	12
	Turbidity	2.8	1.8	2.2	1.5	8.1	12
	BOD	<2.0	N/A	N/A	N/A	N/A	0
	TSS	3.5	3.2	2.3	0.90	11	11
	Fecal Coliform	104	55	104	40	230	12
	TKN	0.28	0.12	0.29	0.12	0.46	9
	Ammonia	0.068	0.012	0.065	0.056	0.086	7
	Nitrate/Nitrite	0.057	0.036	0.042	0.025	0.150	12
	Total Phosphorus	0.028	0.0062	0.028	0.020	0.036	6
	Cadmium	0.00013	N/A	0.00013	0.00013	0.00013	1
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	0.014	N/A	0.014	0.014	0.014	1
	Iron	0.29	0.15	0.22	0.12	0.55	12
	Lead	0.0034	0.00092	0.0036	0.0024	0.0042	3
	Manganese	0.024	0.012	0.022	0.014	0.050	7
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	<0.010	N/A	N/A	N/A	N/A	0
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

SUMMARY STATISTICS

Sample Location	NWSV-328	Lower Three Runs at Patterson Mill Road					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.20	0.32	7.05	6.78	7.67	12
	DO	8.95	2.03	8.16	6.48	12.70	12
	Water Temp	16.02	6.50	17.16	5.68	25.22	12
Lab Parameters	Alkalinity	37	14	38	4.3	52	12
	Turbidity	2.3	1.2	1.9	1.1	4.9	12
	BOD	<2.0	N/A	N/A	0	0	0
	TSS	3.5	2.3	2.9	0.88	8.1	10
	Fecal Coliform	203	75	190	120	390	12
	TKN	0.28	0.20	0.24	0.12	0.84	12
	Ammonia	0.072	0.018	0.070	0.053	0.095	4
	Nitrate/Nitrite	0.16	0.26	0.092	0.023	0.95	11
	Total Phosphorus	0.034	0.0090	0.033	0.021	0.047	10
	Cadmium	0.00026	N/A	0.00026	0.00026	0.00026	1
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.43	0.20	0.41	0.19	0.79	12
	Lead	0.0035	0.0016	0.0031	0.0020	0.0061	5
	Manganese	0.043	0.013	0.040	0.029	0.068	7
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	<0.010	N/A	N/A	N/A	N/A	0
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

Sample Location	NWSV-2027	Upper Three Runs at Road 2-1					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	6.14	0.47	6.16	5.40	7.05	12
	DO	8.97	1.56	8.46	7.04	12.25	12
	Water Temp	16.08	4.77	17.20	8.01	21.83	12
Lab Parameters	Alkalinity	0.97	0.49	1.1	0.0	1.3	6
	Turbidity	2.4	0.68	2.4	1.4	3.6	12
	BOD	<2.0	N/A	N/A	N/A	N/A	0
	TSS	3.1	1.5	3.0	1.6	5.3	11
	Fecal Coliform	145	92	140	40	330	12
	TKN	0.28	0.13	0.27	0.10	0.47	8
	Ammonia	0.061	0.014	0.056	0.050	0.084	5
	Nitrate/Nitrite	0.39	0.38	0.28	0.23	1.6	12
	Total Phosphorus	0.027	0.0085	0.024	0.021	0.042	5
	Cadmium	<0.00010	N/A	N/A	N/A	N/A	0
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.25	0.074	0.24	0.14	0.38	12
	Lead	0.0033	0.00044	0.0033	0.0029	0.0038	4
	Manganese	<0.010	N/A	N/A	N/A	N/A	0
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	0.012	N/A	0.012	0.012	0.012	1
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

SUMMARY STATISTICS

Sample Location	NWSV-2039	Fourmile Branch at Road A-13.2					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.13	0.37	7.09	6.46	7.73	12
	DO	9.78	2.41	8.63	6.87	13.17	12
	Water Temp	15.32	7.43	17.02	3.31	24.84	12
Lab Parameters	Alkalinity	16	5.0	16	8.2	22	12
	Turbidity	3.7	2.3	2.6	2.0	9.1	12
	BOD	<2.0	N/A	N/A	N/A	N/A	0
	TSS	2.4	1.6	1.7	0.80	5.4	11
	Fecal Coliform	123	78	130	20	290	12
	TKN	0.33	0.17	0.25	0.16	0.69	12
	Ammonia	0.091	0.035	0.083	0.058	0.14	4
	Nitrate/Nitrite	0.88	0.33	0.98	0.30	1.4	12
	Total Phosphorus	0.10	0.035	0.094	0.054	0.16	12
	Cadmium	<0.00010	N/A	N/A	N/A	N/A	0
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.67	0.35	0.55	0.32	1.5	12
	Lead	0.0042	0.0011	0.0042	0.0028	0.0055	4
	Manganese	0.033	0.015	0.028	0.019	0.061	7
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	0.011	0.0014	0.011	0.010	0.012	2
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

Sample Location	NWSV-2047	Pen Branch at Road A-13.2					
Statistical Analysis		AVG	STDEV	Median	Min	Max	N
Field Parameters	pH	7.35	0.40	7.33	6.84	8.24	12
	DO	9.20	2.47	8.79	4.01	13.11	12
	Water Temp	16.02	6.28	16.70	3.93	24.65	12
Lab Parameters	Alkalinity	19	5.7	22	7.9	25	12
	Turbidity	3.8	2.1	2.9	1.9	8.2	12
	BOD	2.5	0.71	2.5	2.0	3.0	2
	TSS	3.0	2.7	2.0	0.90	9.4	11
	Fecal Coliform	119	55	115	57	220	12
	TKN	0.31	0.12	0.28	0.17	0.56	10
	Ammonia	0.076	0.014	0.081	0.056	0.087	4
	Nitrate/Nitrite	0.20	0.079	0.19	0.077	0.33	12
	Total Phosphorus	0.032	0.0080	0.033	0.020	0.045	10
	Cadmium	<0.00010	N/A	N/A	N/A	N/A	0
	Chromium	<0.0050	N/A	N/A	N/A	N/A	0
	Copper	<0.010	N/A	N/A	N/A	N/A	0
	Iron	0.46	0.21	0.40	0.26	0.86	12
	Lead	0.0040	0.0011	0.0039	0.0028	0.0054	4
	Manganese	0.025	0.011	0.021	0.014	0.048	7
	Nickle	<0.020	N/A	N/A	N/A	N/A	0
	Zinc	0.01	N/A	0.01	0.01	0.01	1
	Mercury	<0.00020	N/A	N/A	N/A	N/A	0

TOC

2.5 Radiological and Nonradiological Monitoring of Sediments

2.5.1 Summary

The accumulation of radiological and nonradiological contaminants in sediment can have direct impacts on aquatic organisms that can result in human exposure. Point source and nonpoint source pollutants impact water bodies through direct discharge, atmospheric fallout, or through runoff. These accumulated contaminants may become resuspended in streams and rivers. Contaminants dispersed downstream potentially impact drinking water supplies and fish consumed by the public. The high mobility of sediments is a complicated issue as stream flow changes can redistribute contaminants or bury them as part of the natural sedimentation process. Patterns of sediment contamination are strongly affected by hydrologic factors and the physical and chemical characterization of the sediment (USEPA 1987).

The United States Atomic Energy Commission established the Savannah River Site (SRS) in 1950 to produce plutonium, tritium, and other materials for national defense and civilian purposes (Till et al. 2001). SRS streams receive surface water runoff and water from permitted discharges. Stormwater basins may receive runoff and atmospheric fallout from diffuse and fugitive sources (USDOE 1995). Cesium-137 (Cs-137) contamination due to accidental releases of nuclear materials from past operations occurs along the entire length of Lower Three Runs (LTR) and Steel Creek on SRS, and the private property of Creek Plantation. LTR and Steel Creek watersheds represent a possible pathway for release of contamination from SRS activities to both on-site and off-site receptors in the environment (WSRC 2002). Flooding and dam releases from Par Pond and L-Lake scour creek bottoms that may result in the resuspension of contaminated sediments. SRS is within the Savannah River watershed, with five major SRS streams feeding into the Savannah River. Dispersal of any contaminants from these SRS streams has the potential to impact the publically accessible Savannah River.

Cesium-137 is an artificially produced fission product. Atmospheric Cs-137 was released from the separation areas and was a key radionuclide released to water and air, mainly from F-Area and H-Area (CDC 2006). The liquid releases were also from the reactors as a result of leaking fuel elements in the 1950s and 1960s (WSRC 1998). The largest single source of Cs-137 was fallout from atmospheric nuclear weapons tests in the 1950s and 1960s, which dispersed and deposited Cs-137 world-wide. However, much of the Cs-137 from testing has now decayed. Due to its half-life of 30 years, Cs-137 has an impact on the SRS environment. Additionally, the biological behavior of Cs-137 is similar to potassium, which is essential to the function of living cells (USEPA 2009a). Therefore, the potential for Cs-137 uptake into humans is important considering the potential health effects.

Americium-241 (Am-241) is a man-made transuranic nuclide produced during the fission process. With a half-life of 432 years, this nuclide may be a legacy of past nuclear fallout events. However, previous studies indicate that Am-241 was released in significant quantities from the SRS (Till et. al. 2001). Along with Cs-137, Am-241 was released to the air from SRS (CDC 2006).

Alpha-emitting radionuclides were released to liquid effluent from M-Area, F-Area and H-Area, and the reactor areas. The primary stream affected by the M-Area releases was Tims Branch, which ultimately flows into Upper Three Runs Creek. Fourmile Branch is the stream most affected by releases coming from the separation areas. Releases from the reactor areas affected all streams with the exception of Upper Three Runs Creek (Till et al. 2001).

Beta-emitting radionuclides were released to liquid effluent from F-Area, H-Area, and the reactors. Fourmile Branch is the stream primarily affected by releases from the separations areas. Steel Creek, Pen Branch, and Lower Three Runs Creek were mainly affected by releases from the reactors. Strontium-90 (Sr-90) is a main contributor of beta activity and came primarily from the reactors (Till et al. 2001).

Plutonium releases at SRS occurred primarily through the discharge of liquid effluent. Plutonium was manufactured on SRS in H-Area for fuel rods and in F-Area for targets (Till et al. 2001). Iodine-129 (I-129) is a fission product of reactor fuel that has a very long (~16 million year) half-life. Most releases occurred during fuel processing (Till et al. 2001). Technetium-99 (Tc-99) was produced in SRS production reactors as a fission byproduct of uranium and plutonium. This radionuclide was released to the environment from the separation areas ventilation systems, the aqueous environment from liquid waste in waste tanks, and the Solid Waste Disposal Facility (WSRC 1993a). Technetium-99 has also been released to the environment from atmospheric weapons tests, nuclear reactor airborne emissions, nuclear fuel reprocessing plant airborne emissions, and facilities that treat or store radioactive waste (USEPA 2009b). Although historical fallout from weapons testing has been the most important man-made contributor to radioactive contamination of the global environment, there are other anthropogenic sources, such as SRS operations. Also, some radionuclides occur naturally in the environment. Separating radioactivity contributed by releases from the SRS from weapons fallout is difficult for some radioisotopes (Till et al. 2001)

Barium has been a constituent of the H-Area Hazardous Waste Management Facility (WSRC 1993b). Cadmium enters the atmosphere through fuel and coal combustion (Till et al. 2001). Chromium solutions were used at the SRS as corrosion inhibitors. Chromium was a part of wastewater solutions resulting from dissolving stainless steel. It was also used in cleaning solutions in the separation areas (Till et al. 2001). Copper, while naturally occurring, can also be released to the environment through the combustion of wood, coal, and oil (Alloway 1995). These mechanisms are possible sources of elevated copper in the sediments. Atmospheric emissions of lead from SRS occurred through coal and fuel combustion (Till et al. 2001). Lead can deposit in sediment, where it has a long residence time when compared to other pollutants (Alloway 1995). Manganese has been released in the separations area head end processes and discharged to liquid waste tanks. It is also a byproduct of coal burning (Till et al. 2001). Mercury in sediment may be attributed to atmospheric fallout. SRS facilities such as F-Area and H-Area, tritium facilities, waste tanks, and the coal-fired power plants have emitted mercury to the atmosphere (Till et al. 2001). Nickel was released to Tims Branch from M-Area processes (Till et al. 2001). Upper Three Runs creek is the receptor of effluent from Tims Branch. Zinc was released in relatively small amounts to the separations area seepage basins as well as the M-Area seepage basin (Till et al. 2001). Although DDT was banned in the United States in 1972, releases of this long lived pesticide from waste sites may continue to contaminate the environment (ATSDR 1997).

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) provides independent evaluation of the Department of Energy-Savannah River (DOE-SR) environmental monitoring programs.

ESOP personnel independently evaluated sediment samples for radionuclide and nonradionuclide contaminant concentrations in SRS streams, SRS stormwater basins, creek mouths along the boundary of SRS, the Savannah River, and publically accessible sites in the SRS vicinity. Background locations are sampled to compare ambient levels of radionuclides from offsite locations to determine potential impacts due to SRS operations. Sediment samples on SRS are routinely split with DOE-SR in order to compare results.

The ESOP ambient sediment monitoring project changed in 2007 to include more random coverage of perimeter sediments (those within 50 miles of the SRS center point, but outside the SRS boundary) and background sediments (those greater than 50 miles from the SRS center point) within the boundaries of the state of South Carolina. This sampling program was implemented to allow statistical comparisons of the SRS perimeter and South Carolina background contaminant levels in sediment. The United States Geological Survey 7.5' Quadrangle Coverage for South Carolina (USDOI 1992) was used to determine the ESOP random quadrant sampling areas.

ESOP sampled 16 locations at SRS in 2010 with the cooperation of DOE-SR personnel. SRS sediment sampling locations are illustrated in Section 2.5.2, Map 1. Split samples were collected from eight stream locations on SRS and from three stormwater basins. These locations are not publically accessible. Creek mouth sediment samples at five publicly accessible locations along the Savannah River were also co-sampled (Section 2.5.3, Table 1). ESOP independently sampled three random background sediments (Section 2.5.3, Table 2 and Section 2.5.2, Map 2).

All SRS split samples were analyzed for gross alpha, gross beta, gamma, and metals, as well as organic and inorganic constituents. All samples collected from random background locations were analyzed for gross alpha, gross beta, and gamma. Additionally, isotopic analysis was conducted on one SRS streams and one stormwater basin. Evaluation of radiological and nonradiological contaminants in sediment is necessary to detect any impact from DOE-SR operations beyond historically impacted areas. Radionuclide detections in sediment are typically the result of accumulation over many years and do not represent yearly depositions.

The continuation of sediment sampling and analysis, along with trending of data, is necessary to closely monitor SRS sediments. The potential for contaminants to impact the environment of SRS along with the publicly accessible creek mouths and the Savannah River warrants these long-term monitoring efforts.

RESULTS AND DISCUSSION

Radiological Parameter Results

SCDHEC 2010 radiological data can be found in Section 2.5.4 and statistical data can be found in Section 2.5.5.

Gamma spectroscopy led to detections of man-made radionuclides. Cesium-137 activity trends highest at the stormwater basins, followed by SRS streams and publicly accessible SRS creek mouths. Figure 1 in Section 2.5.3 illustrates Cs-137 activity in sediment samples collected from SRS stormwater basins, SRS streams, SRS creek mouths and random background locations.

Cesium-137 was detected at four of the five publicly accessible SRS creek mouth locations (Section 2.5.3, Figure 2). Cesium-137 was detected in three on-site non-publicly accessible SRS stream sediment samples at an average of 0.54 (± 0.79) picocuries per gram (pCi/g) and ranged from 0.07 to 1.45 pCi/g. The highest detection was located at Four Mile Creek at Highway 125 (SV-2049). Z Basin is the only stormwater basins that had a detection of Cs-137 at 9.0 pCi/g.

Samples collected from four of the five publicly accessible SRS creek mouths had Cs-137 detections averaging 0.42 (± 0.45) pCi/g and ranged from 0.04 pCi/g at Upper Three Runs creek mouth (SV-2011) to 0.92 pCi/g at Lower Three Runs creek mouth (SV-2020).

There were detections of actinium-228, potassium-40, lead-212, lead-214, radium-226, and thorium-234. These are Naturally Occurring Radioactive Material (NORM) decay products that may account for these detections. All other gamma-emitting radionuclides had no detections above their respective minimum detectable activity (MDA).

Gross alpha activity was detected in three on-site non-publicly accessible SRS stream samples locations averaging 17.20 (±10.22) pCi/g and ranging from 11.10 to 29.00 pCi/g. The highest detection was located at Upper Three Runs (SV-2027). Gross alpha activity was detected in two of the three SRS basin sample locations averaging 13.7 (±4.2) pCi/g and ranging from 10.7 pCi/g to 16.7 pCi/g. The highest detection was located at Z Basin. There were no gross alpha detections from samples collected from the SRS creek mouths or the random background locations (Section 2.5.3 Figure 3).

Gross non-volatile beta was detected in three on-site SRS stream locations averaging 13.1 (±1.57) pCi/g. Activities ranged from 11.7 pCi/g to 14.8 pCi/g. The highest detection was located at Upper Three Runs (SV-2027). Four out of the five creek mouth locations had gross non-volatile beta detections averaging 29.9 (±5.25). Activities ranged from 27.2 pCi/g to 37.5 pCi/g. The highest detection was located at Beaver Dam creek mouth (SV-2013). Gross non-volatile beta was detected in all of the SRS stormwater basins averaging 27.4 (±13.3). The highest detection was located at Z Basin. Activities ranged from13.5 pCi/g to 40.10 pCi/g (Section 2.5.3 Figure 3).

There was a gross-beta detection of 15.7 pCi/g from a random background sample location B49 in Calhoun County.
Isotopic analysis of Pu-238, Pu-239/240, U-234, and U-235 was performed on samples from McQueen Branch at Monroe Owens Road (SV-2069) and Z-Basin.

Plutonium-238 and Pu-239/240 were detected at the Z Basin sampling location. Samples collected at Z-Basin had Pu-238 activities of 0.021 pCi/g. Plutonium-239/240 was detected at both SV-2069 and Z Basin locations. Samples collected at Z-Basin had Pu-239/40 activities of 0.0062 pCi/g and SV-2069 had Pu-239/40 activity of 0.0067 pCi/g. Uranium-234 was detected at both locations. Samples collected at Z-Basin had U-234 activities of 1.36 pCi/g and SV-2069 had U-234 activity of 0.129 pCi/g. Uranium-235 was detected at both locations. Samples collected at Z-Basin had U-235 activities of 0.082 pCi/g and SV-2069 had U-235 activity of 0.015 pCi/g.

Sediments were evaluated for gross alpha and gross non-volatile beta as well as a suite of 24 gamma-emitting radionuclides. Selected samples were also analyzed for Plutonium-238 (Pu-

238), Plutonium-239/240 (Pu-239/240), Uranium-234 (U-234), and Uranium-235 (U-235). A complete list of gamma-emitting radionuclides that SCDHEC analyzed for in 2010 can be found in Section 2.5.3, Table 3.

Nonradiological Parameter Results

A United States Environmental Protection Agency (USEPA) Target Analyte List of nine metals was analyzed in all of the SRS stream locations and the stormwater basins in 2010. These samples were also analyzed for organic pesticides, herbicides, polychlorinated biphenols (PCBs), and organic base neutral/acid analysis (BNA). A complete list of all nonradiological analytes can be found in Section 2.5.3, Table 4 and 5. Metals data can be found in Section 2.5.3, Figure 5. Comparisons were made to the Ecological Screening Value (ESV) for sediment which does not represent remediation goals or cleanup levels, but is used to identify constituents of potential concern (WSRC 2005). The South Carolina state averages are from "Elements in South Carolina Inferred Background Soil and Stream Sediment Samples" (Canova 1999).

Barium was detected above the South Carolina state average of 20 mg/kg in only two of the eight stream samples collected. The SRS stream average was 19.0 mg/kg with a minimum of 5.3 mg/kg at SV-2055 and a maximum of 41 mg/kg at SV-2027. The stormwater basin average was 33 mg/kg with a minimum of 7.8 mg/kg at E-006 and a maximum of 71 mg/kg at Z-Basin.

Cadmium was found above the South Carolina state average of 0.6 mg/kg in only one of the eight stream samples collected (1.1 mg/kg at SV-2048). The stormwater basin average was 3.7 mg/kg with a minimum of 2.6 mg/kg at E-006 and a maximum of 71 mg/kg at Z-Basin.

Chromium was detected in the majority of the samples and was above the South Carolina state average of 36 mg/kg in only one sample. The SRS stream average was 3.5 mg/kg with a minimum of 1.6 mg/kg at SV-2055 and a maximum of 6.6 mg/kg at SV-2027. The stormwater basin average was 27.5 mg/kg with a minimum of 16 mg/kg at E-006 and a maximum of 49 mg/kg at Z-Basin

All 2010 samples were below the ESV of 18.7 mg/kg for copper. The SRS Stream average was 1. 8 mg/kg with a minimum of 1.30 mg/kg at SV-2048 and a maximum of 3.2 mg/kg at SV-2027. The stormwater average was 11.8 mg/kg with a minimum of 3.4 mg/kg at E-006 and a maximum of 25 mg/kg at Z-Basin.

Lead was detected in only one of the SRS stream samples with a detection of 5.5 mg/kg at SV-2048. All stormwater basins yielded detections for lead. The average was 16.0 mg/kg with a minimum of 11.0 mg/kg at E-006 and a maximum of 24.9 mg/kg at Z-Basin.

Manganese was detected in all SRS stream and stormwater basin samples. SRS stream samples had an average of 103.95 mg/kg with a minimum of 6.6 mg/kg at SV-2027 and a maximum of 680.0 mg/kg at SV-2048. The stormwater basin average was 92 mg/kg with a minimum of 27 mg/kg at E-006 and a maximum of 110 at E-004.

There was no mercury detected in any sample collected in 2010.

Nickel was detected in only two of the SRS stream samples. The SRS stream average was 2.2 mg/kg with a minimum of 2.2 mg/kg at SV-2055 and a maximum of 2.3 mg/kg at SV-2027. The stormwater basin average was 3.9 mg/kg with a minimum of 2.7 mg/kg at E-001 and a maximum of 6.6 mg/kg at E-005.

Zinc was detected in seven of the eight SRS stream samples. The SRS stream average was 7.5 mg/kg with a minimum of 2.2 mg/kg at SV-2055 and a maximum of 17 mg/kg at SV-2049. The stormwater basin average was 137.5 mg/kg with a minimum of 7.0 mg/kg at E-006 and maximum of 420 mg/kg at Z-Basin. Metal data results can be found in Section 2.5.3, Figure 5.

There were no detections of pesticides, herbicides, polychlorinated biphenols, and organic base neutral/acids in any of the 2010 sediment samples.

SCDHEC nonradiological sediment data can be found in Section 2.5.4 and nonradiological statistical data can be found in Section 2.5.5.

SCDHEC and DOE-SR Data Comparison

Radiological data comparison of 2010 sediment samples from SCDHEC and DOE-SR resulted in similar findings. SCDHEC Cs-137 data from the SRS creek mouths were trended for 2006-2010 (Section 2.5.3, Figure 4). Average Cs-137 levels increased from 2007 to 2009. The 2010 average was only slightly lower than the previous year. Due to flooding disturbances in sediments and other media characteristics, variability in sediment samples can be anticipated.

DOE-SR and SCDHEC split eight SRS stream sediment and three stormwater basin sediment samples in 2010. All SCDHEC samples were analyzed for gross alpha- and gross beta-emitting particles and gamma-emitting radionuclides. Select samples (SMSV-2069 and SM-Z Basin) were also analyzed for Pu-238, Pu-239/40 and U-234 and U-235.

Both agencies detected Cs-137 concentrations in SRS streams, SRS creek mouths and SRS stormwater basins. DOE-SR highest Cs-137 concentration (105 pCi/g) was detected in sediment from R-Canal (100-R Location) which is not accessible to the public. When averaging all the SRS on-site stream sediment samples, SCDHEC found 0.54 (± .79) pCi/g Cs-137 while DOE-SR found 16.7 pCi/g. When the Cs-137 concentration at R-Canal (100-R Location) is removed from the SRS on site stream average, the mean Cs-137 SRS on site stream concentration decreases to 6.9 pCi/g .The publically accessible Savannah River and SRS creek mouths averaged 0.42 (±.45) pCi/g in the SCDHEC data. DOE-SR detected Cs-137 above the minimum detectable concentration (MDC) at 5 locations along the Savanah River and creek mouths at an average of 0.23 pCi/g. Cs-137 was only detected at one of the three basins sampled by SCDHEC. The Z-Basin Cs-137 sample concentration was 9.0 pCi/g. The DOE-SR on site stormwater basins results ranged from less than MDC to a maximum Cs-137 concentration of 9.1 pCi/g at the Z-Area Basin. Analytical results of Cs-137 for DOE-SR Savannah River and SRS creek mouths and stormwater basins are within one standard deviation of the data from SCDHEC. Figures 6 and 7 in Section 2.5.3 illustrate the findings.

SCDHEC had no detections of Am-241 in sediment samples collected in 2010. The on site DOE-SR stream sediments Am-241 detections ranged from less than MDC to 0.0543 pCi/g at R-Canal (100-R Location). DOE-SR detected Am-241 (0.0027 pCi/g) in only one of the Savannah River and SRS creek mouths samples above MDC. The average MDA for the 2010 SCDHEC sediment samples was 0.182 pCi/g, which is much higher than the DOE-SR MDC of 0.0039 pCi/g (SRNS 2009). Since DOE-SR has a much lower MDC, this may explain why the SCDHEC data does not report more detections above the MDA. Also, values less than the MDC are included in the DOE-SR data (SRNS 2011). Only detections are averaged from the SCDHEC data.

DOE-SR had three detections of Pu-238 above the MDC in the Savannah River and SRS creek mouths sediment samples at an average of 0.006 pCi/g. SCDHEC detected Pu-238 at the Z storm water basin sampling location (0.021 pCi/g). DOE-SR Pu-238 detections in the on-site stream sediment samples which averaged 0.13 pCi/g. The DOE-SR on site stormwater basins detections averaged 0.017 pCi/g for Pu-238. The average MDC for the 2010 SCDHEC sediment samples was 0.0157 pCi/g, which is higher than the DOE-SR representative MDC of 0.0029 pCi/g (SRNS 2011).

DOE-SR detected Pu-239 in one sample in the Savannah River and SRS creek mouths above the MDC. DOE-SR had 11 detections in on-site stream sediment samples above MDC which averaged 0.039 pCi/g. Plutonium-239/240 was analyzed by SCDHEC in one stormwater basin location (SM-Z Basin) and was detected at 0.006 pCi/g. DOE-SR on site stormwater basins results ranged from less than MDC to a maximum Pu-239 concentration of 0.646 pCi/g at Pond 400. The MDC for the 2010 SCDHEC sediment samples was 0.0169 pCi/g, which is higher than the DOE-SR representative MDC of 0.0028 pCi/g (SRNS 2011).

CONCLUSIONS AND RECOMMENDATIONS

The creek mouths of SRS are a conduit for the dispersal of radionuclides into publically accessible water. Cesium-137 was found in the sediment within several creek mouths at their confluences with the Savannah River.

Cesium-137 is the most abundant anthropogenic radionuclide found in the sediment samples. Cesium-137 levels of 2010 from all the samples collected outside of SRS boundaries are within the expected range consistent with previous SCDHEC background data and may be attributed, in part, to fallout from past nuclear events in the 1950s and 1960s. The highest level of Cs-137 from all 2010 sediment samples occurred in the on-site sample collected from Z-Basin. Four of the publically accessible creek mouths of the SRS streams had Cs-137 activity, which was higher than average when compared to background levels. The publically accessible SRS creek mouths exhibited lower Cs-137 activity in 2010 than in 2009 with the exception of Lower Three Runs creek mouth.

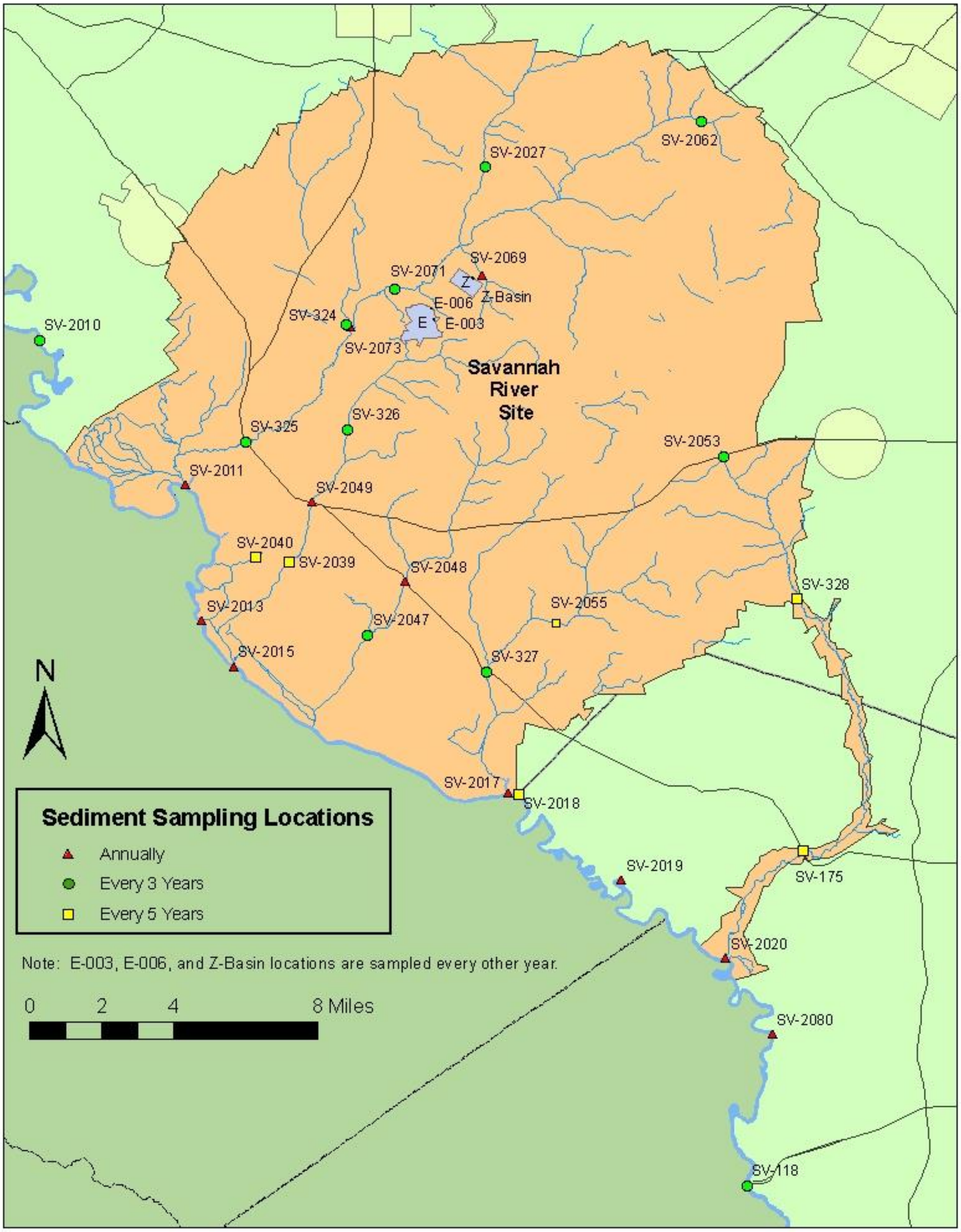
Metals in sediment can be naturally occurring or a result of man-made processes such as those used in SRS operations, which have released elevated amounts into streams on the SRS. Re-distribution of sediment from flooding can mobilize contaminants to downstream locations. Geological factors in the Savannah River basin contribute to the levels of metals through erosion and sediment deposition. Comparisons to background levels are used to determine the anthropogenic contribution. All 2010 samples were below the ESV for chromium and lead. The only non-publicly accessible SRS stream location in 2010 that had ESV exceedances for cadmium was SV-2048. The non-publicly accessible SRS stormwater basin average for metals in 2010 had ESV exceedances for barium, cadmium and zinc.

SRS sediments should continue to be monitored due to current releases and the potential for future discharges from SRS operations, legacy wastes, and clean up activities. Year to year data comparisons are difficult to interpret due to the nature of sediment. Differences among samples may be due to the fraction of clays that most effectively retain radionuclides. There is also difficulty in replicating the exact sampling point due to the movement of sediment. Monitoring of on-site sediments is of great importance as streams are a migration route for radionuclides to enter waters and sediment outside of the SRS boundary. ESOP will continue independent monitoring of SRS and Savannah River sediments and will periodically evaluate modification of the monitoring activities to better accomplish project goals and objectives. Continued monitoring will provide an improved understanding of radionuclide and non-radionuclide levels in SRS sediments and the Savannah River which will impart valuable information to human health exposure pathways. Trending of data over multiple years demonstrates whether radionuclide concentrations in the SRS area are declining due to radioactive decay or possibly increasing due to disturbances on SRS. The comparison of data results allows for independent data evaluation of DOE-SR monitoring activities. To compare the environmental monitoring programs of ESOP and DOE-SR, the sediment samples from SRS will be collected in cooperation with DOE-SR personnel. Each program will then independently analyze the samples for radiological and nonradiological parameters and results will be compared in the 2010 ESOP Data Report. Cooperation between DOE-SR and SCDHEC provides credibility and confidence in the information being provided to the public.

TOC

2.5.2 Radiological and Nonradiological Monitoring of Sediments

Map 1. SRS Sediment Sampling Locations



[TOC](#)

2.5.3 Tables and Figures

Radiological and Nonradiological Monitoring of Sediments

Table 1. Locations of SRS Sediment Samples

2010 ESOP Sediment Sample Locations on SRS		
Sample Location	**Location Description**	**Stream Abbr.**
SV-324	Tims Branch at Road C.	TB
SV-325	Upper Three Runs @ SC 125 (SRS Road A)	UTR
SV-2011	Upper Three Runs mouth @ RM 157.4	UTR
SV-2013	Beaver Dam Creek mouth @ RM 152.3	BDC
SV-2015	Fourmile Branch creek mouth @ RM 150.6	FMB
SV-2017	Steel Creek mouth @ RM 141.5	SC
SV-2020	Lower Three Runs mouth @ RM 129.1	LTR
SV-2048	Pen Branch @ Road 125	PB
SV-2049	Fourmile Branch @ Road 125	FMB
SV-2027	Upper Three Runs @ SRS Road 2-1	UTR
SV-2069	McQueen Branch off Monroe Owens Road.	McQ
SV-2055	Meyers Branch at Road 9	MB
SV-2073	Upper Three Runs off Road C.	UTR
SME-003	E-003E Area stormwater basin	
SME-006	E-006 E Area stormwater basin	
SME-Z BASIN	Stormwater basin in N.E. perimeter of Z Area	

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 2. Random Quadrant Locations

2010 Random Background Sediment Sampling Locations			
Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.			**Geological**
Quad	**7.5' Quad Name**	**Latitude by Lat and Longitude by Long**	**Region**
B43	Bradley	3400 by 3407.5 and -8207.5 by -8215	PM
B49	Greenwood	3407.5 by 3415 and -8207.5 by -8215	PM
B62	Limestone	3352.5 by 3400 and -8200 by -8207.5	PM

Notes:
1. The randomly selected quadrants are from a United States Department of Interior 7.5 Minute Topographic Map Printed by the South Carolina Land Resources Commission, Rv 10/92.
2. **"X"** in any designated ID represents the presence of an exclusion zone of either a state border, 50 mi. limit bisector line that splits the quad area into an environmental side and a background side, or occurrence of background random pick area within 10 miles of a nuclear facility.
3. "**E**" means this is a pick selected for SRS perimeter (outside SRS from center point 33 deg. 15' 00" & -81 deg. 37' 30"). Public dose outside of SRS and within 10 mi. of a reactor are not excluded for "E" samples.
4. "**B**" means this is a South Carolina background pick outside of the 50 mile limit from SRS center point. Ten mile exclusion zone in "B" quads is used to reduce influence of any local reactor on SC background.
5. Parenthesis info by quad name identifies type of exclusion (NCX is North Carolina, GAX is Georgia, NRX is nuclear reactor, SRS is Savannah River Site exclusion zone border).
6. Purpose of random sampling is to compare public dose within 50 miles of SRS to a S. C. background.
7. Geological Regions are Blue Ridge (BR), Piedmont (PM), Upper & Lower Coastal Plain (U&LCP). Quadrants split by geological regions are assigned to the upper most region in the quadrant.

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 3. Gamma Analytes

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Antimony-125	Sb-125
Berylium-7	Be-7
Cobalt-58	Co-58
Cobalt-60	Co-60
Cerium-144	Ce-144
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Lead-212	Pb-212
Lead-214	Pb-214
Manganese-54	Mn-54
Potassium-40	K-40
Radium-226	Ra-226
Ruthenium-103	Ru-103
Sodium-22	Na-22
Thorium-234	Th-234
Yttrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Note: Units are reported in pCi/g.

Table 4. Inorganic Metal Analytes

Analyte	Abbreviation	MDL	ESV
Barium	Ba	5.0	20
Cadmium	Cd	1.0	0.6
Chromium	Cr	1.0	36
Copper	Cu	1.0	18.7
Lead	Pb	5.0	30.2
Manganese	Mn	1.0	630
Mercury	Hg	0.10	0.13
Nickel	Ni	2.0	15.9
Zinc	Zn	1.0	98

Note: Units are reported in mg/kg.

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Table 5. Nonradiological Analytes

Organic Pesticide Analysis	MDL
Aldrin	0.0020
alpha-BHC	0.0020
beta-BHC	0.0020
Chlordane	0.015
delta-BHC	0.0020
Dieldrin	0.0020
Endosulfan I	0.0020
Endosulfan II	0.0020
Endosulfan Sulfate	0.0020
Endrin	0.0020
Endrin aldehyde	0.0020
Heptachlor	0.0020
Heptachlor epoxide	0.0020
Lindane	0.0020
p,p'-DDD	0.0020
p,p'-DDE	0.0020
p,p'-DDT	0.0020

PCB Analysis	MDL
PCB 1016	0.015
PCB 1221	0.030
PCB 1232	0.015
PCB 1242	0.015
PCB 1248	0.015
PCB 1254	0.015
PCB 1260	0.015
Toxaphene	0.070

Herbicides in Sediment
2,4-D
2,4,5-T
2.4.5-TP

Organic Base Neutral/Acid Analysis (MDL = 0.30)

1,2,4-trichlorobenzene	4-chlorophenyl phenyl ether	Dibenzofuran
1,2-dichlorobenzene	4-methylphenol	Diethyl phthalate
1,3-dichlorobenzene	4-nitroaniline	Dimethyl phthalate
1,4-dichlorobenzene	4-nitrophenol	Di-n-butylphthalate
2,4,5-trichlorophenol	Acenaphthene	Di-n-octylphthalate
2,4,6-trichlorophenol	Acenaphthylene	Fluoranthene
2,4-dichlorophenol	Aniline	Fluorene
2,4-dimethyl phenol	Anthracene	Hexachlorobenzene
2,4-Dinitrophenol	Azobenzene	Hexachlorobutadiene
2,4-dinitrotoluene	Benzo(a)anthracene	Hexachlorocyclopentadiene
2,6-dinitrotoluene	Benzo(a)pyrene	Hexachloroethane
2-chloronaphthalene	Benzo(b)fluoranthene	Indeno(1,2,3-cd)pyrene
2-chlorophenol	Benzo(ghi)perylene	Isophorone
2-methyl naphthalene	Benzo(k)fluoranthene	Naphthalene
2-methyl-4,6-dinitrophenol	Benzoic acid	Nitrobenzene
2-methylphenol	Benzyl alcohol	N-nitrosodimethylamine
2-nitroaniline	Bis(2-chloroethoxy)methane	N-nitrosodi-n-propylamine
2-nitrophenol	Bis(2-chloroethyl)ether	N-nitrosodiphenylamine
3,3'-dichlorobenzidine	Bis(2-chloroisopropyl)ether	Pentachlorophenol
3-nitroaniline	Bis(2-ethylhexyl)phthalate	Phenanthrene
4-bromophenyl phenyl ether	Butylbenzyl phthalate	Phenol
4-chloro-3 methyl phenol	Chrysene	Pyrene
4-chloroaniline	Dibenzo(a,h)anthracene	

Note: Results reported in mg/kg

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Figure 1. Comparisons of Cs-137 Activity Among Sample Groups

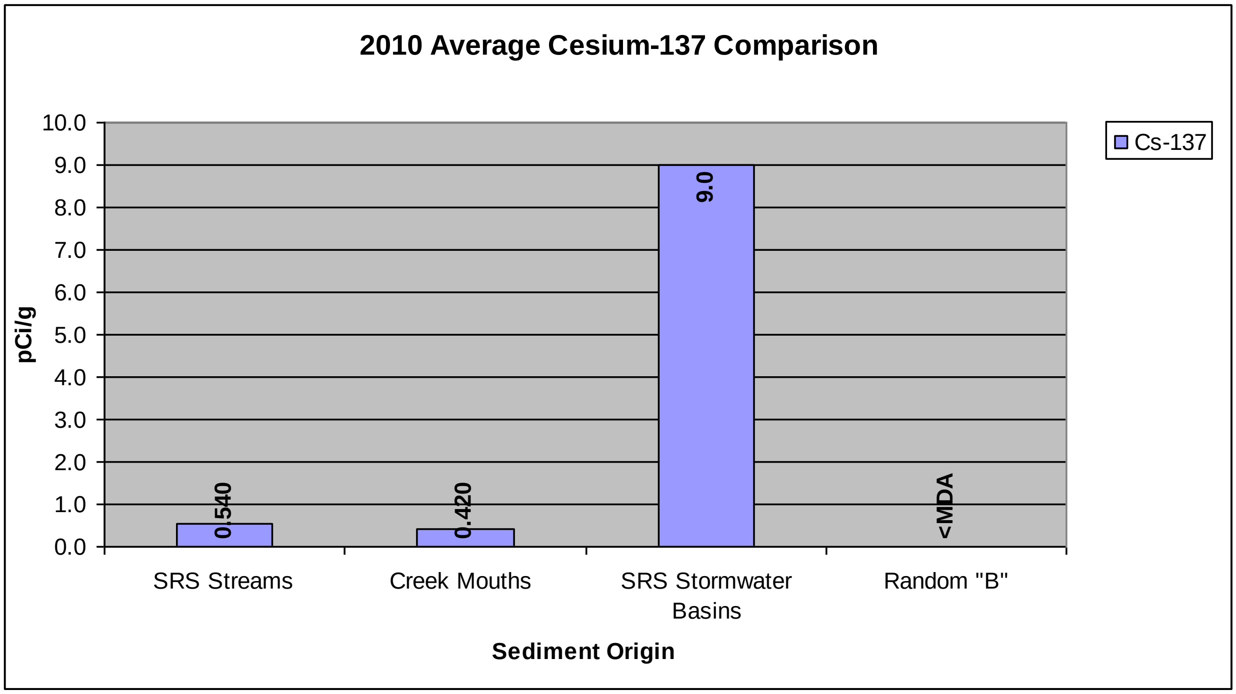
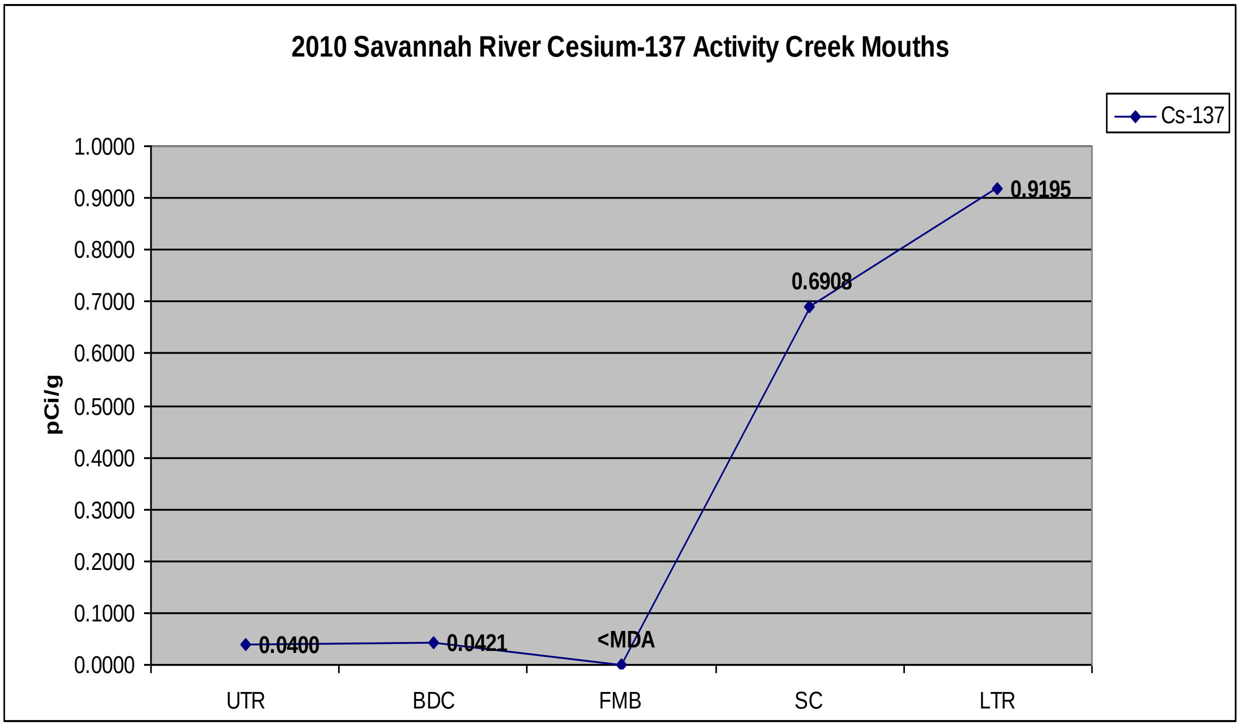


Figure 2. Cesium-137 Activity in Savannah River Sediment Samples



Tables and Figures

Radiological and Nonradiological Monitoring of Sediments

Figure 3. Comparisons of Gross-Alpha and Non-volatile Beta Activity Among Sample Groups

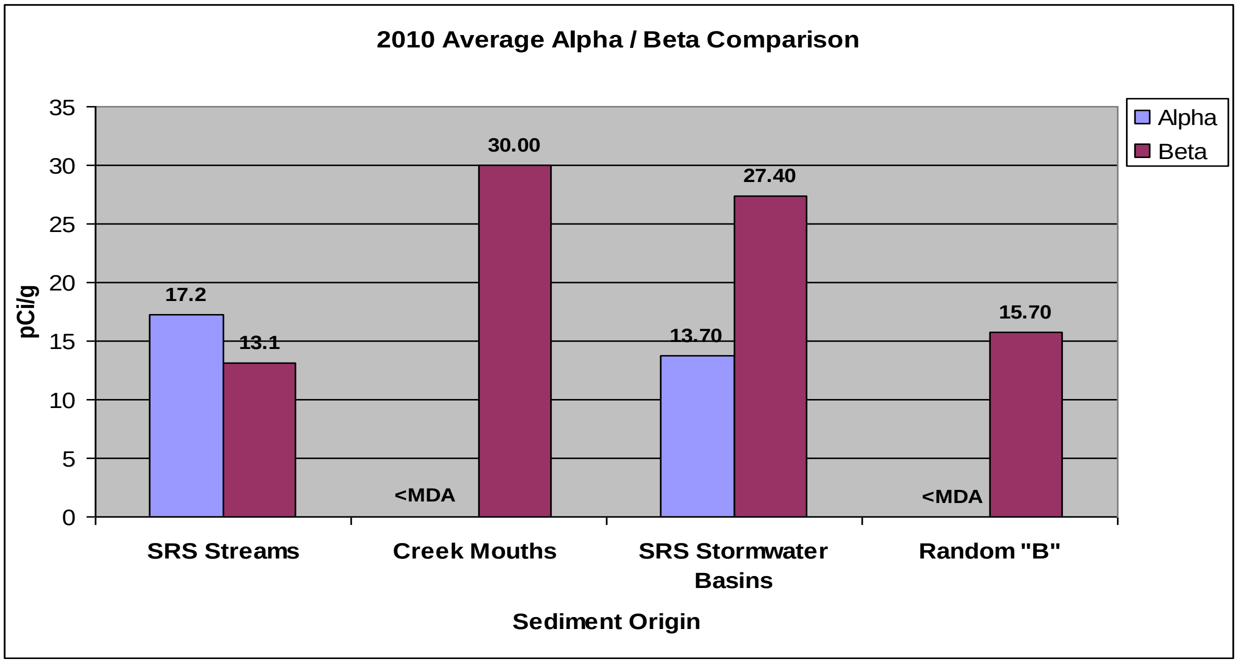
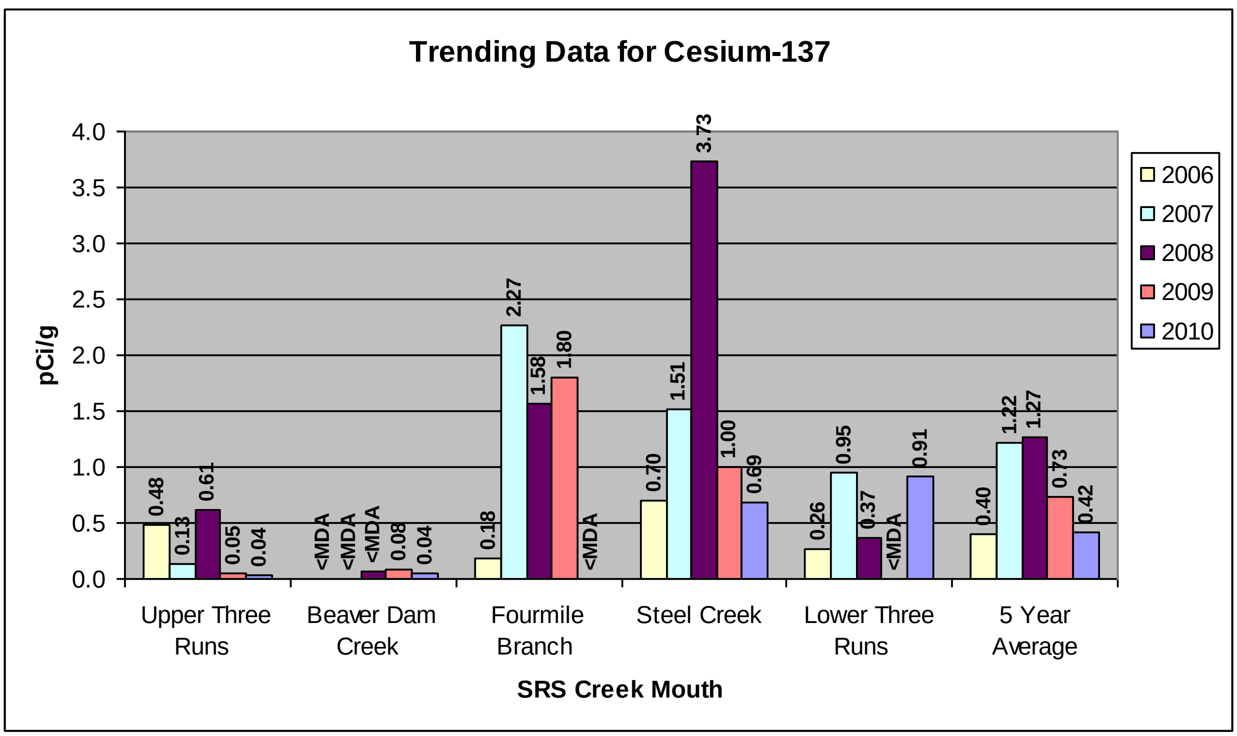


Figure 4. Trending Data for Cs-137 in SRS Creek Mouth Samples



Radiological and Nonradiological Monitoring of Sediments
Figure 5. Comparisons of Metal Concentrations Among Sample Groups

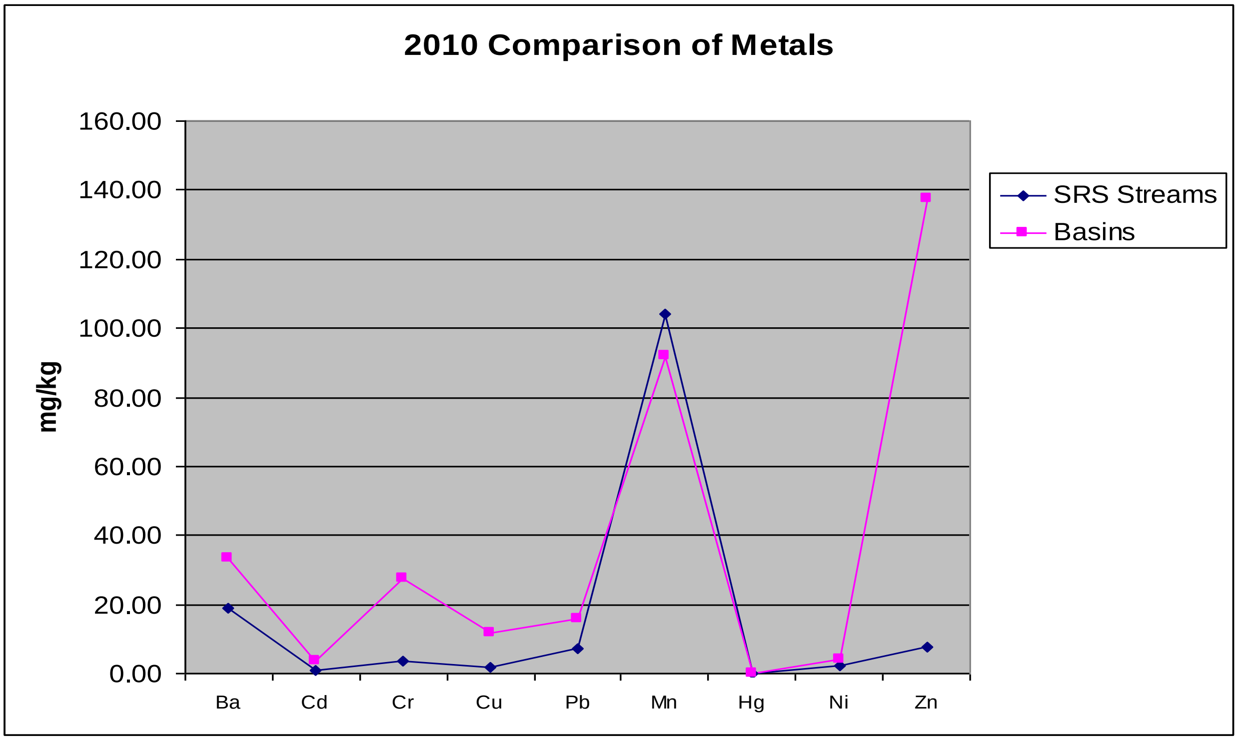
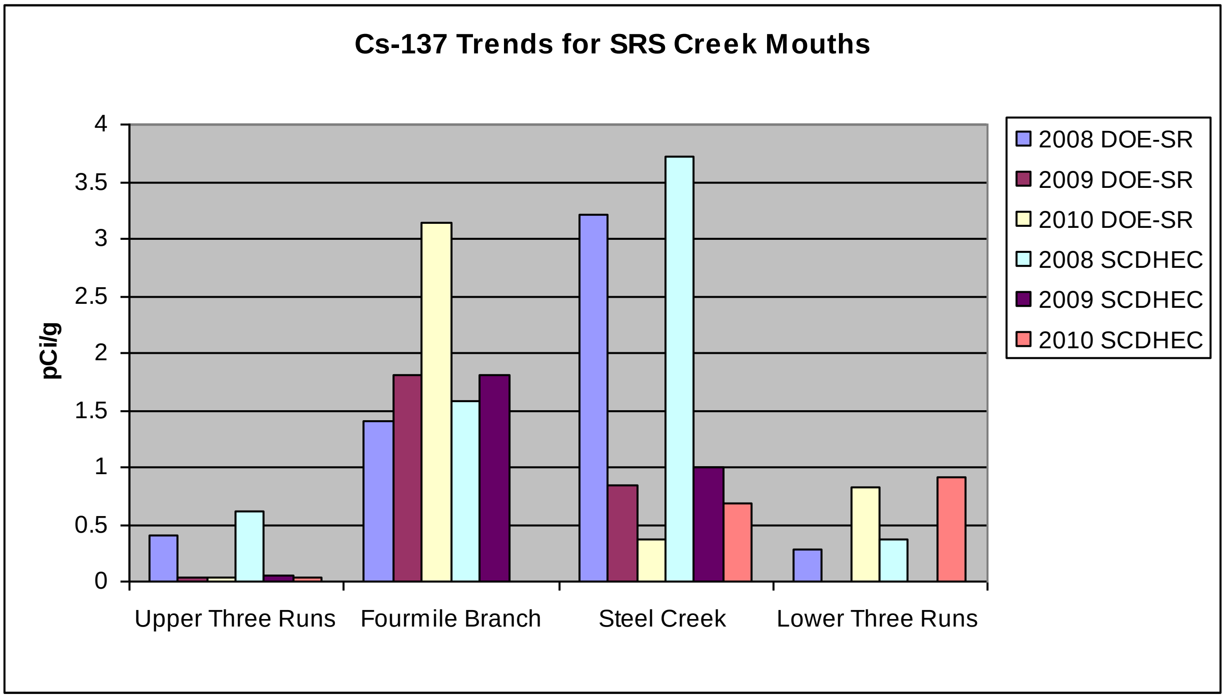


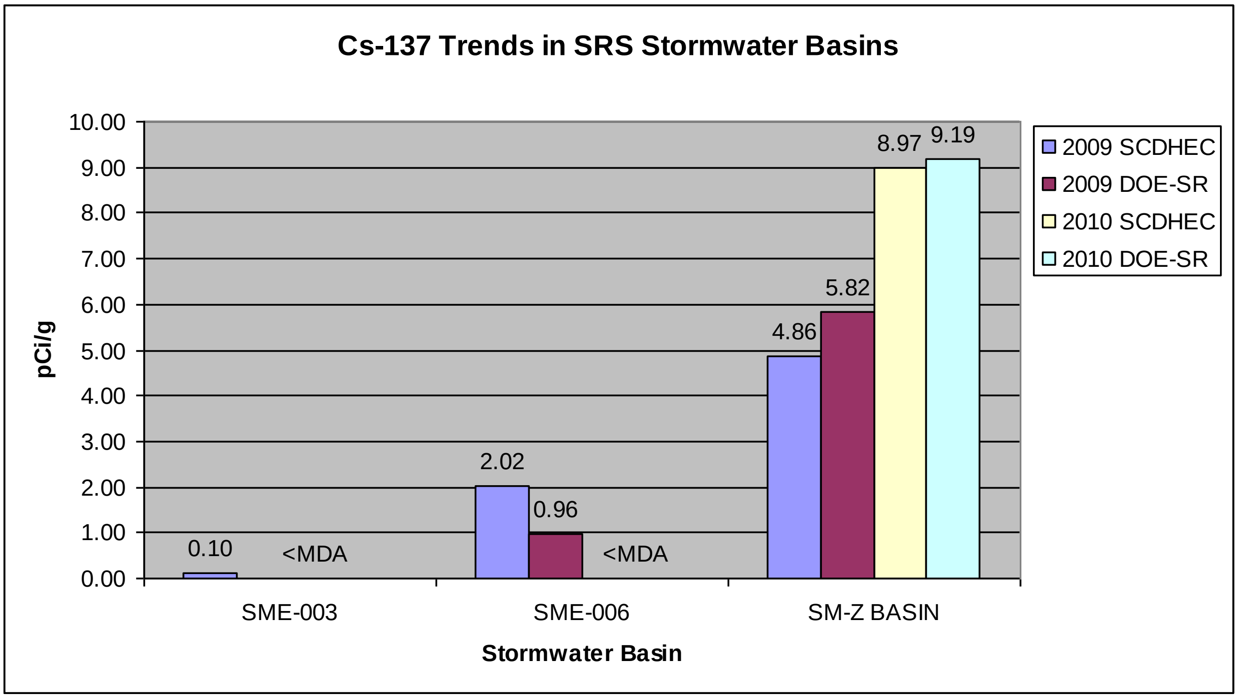
Figure 6. Cesium-137 in Savannah River Creek Mouths – SCDHEC Comparison to DOE-SR Data



Note: Neither DOE-SR and SCDHEC detected Cs-137 in the Lower Three Runs samples in 2009

Tables and Figures
Radiological and Nonradiological Monitoring of Sediments

Figure 7. Cesium-137 in SRS Stormwater Basins – SCDHEC Comparison to DOE-SR Data



Note: DOE-SR did not detect Cs-137 in E-003 in 2009. Neither DOE-SR and SCDHEC detected Cs-137 in E-006 and E-003 samples in 2010

TOC

2.5.4 Data

Radiological and Nonradiological Monitoring of Sediments

Notes:

8. Bold numbers denotes a detection.
9. A blank field following ±2 SIGMA occurs when the sample is <LLD.
10. LLD= Lower Limit of Detection
11. MDA= Minimum Detectable Activity

2010 Radiological Data for Savannah River and Creek Mouths Accessible to the Public

Radiological and Nonradiological Monitoring of Sediments Data

Location Description	SMSV-2011	SMSV-2013	SMSV-2015	SMSV-2017	SMSV-2020
Collection Date	5/12/2010	5/12/2010	5/12/2010	5/12/2010	5/12/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA	NA
Alpha LLD	10.6	10.9	10.1	13	12.8
Beta Activity	<LLD	**37.5**	**25.7**	**29.4**	**27.2**
Beta Confidence Interval	NA	**8.41**	**7.3**	**7.68**	**7.44**
Beta LLD	8.75	**8.96**	**8.49**	**8.67**	**8.54**
K-40 Activity	**1.883**	**16.11**	**14.52**	**17.63**	**16.44**
K-40 Confidence Interval	**0.32**	**1.146**	**1.055**	**1.245**	**1.179**
K-40 MDA	**0.131**	**0.193**	**0.1871**	**0.1913**	**0.1977**
Cs-137 Activity	**0.041**	**0.0421**	<MDA	**0.6908**	**0.9195**
Cs-137 Confidence Interval	**0.0165**	**0.0204**	NA	**0.0633**	**0.0826**
Cs-137 MDA	**0.0193**	**0.0249**	0.0262	**0.0278**	**0.0257**
Pb-212 Activity	**0.5334**	**2.173**	**3.371**	**1.515**	**1.901**
Pb-212 Confidence Interval	**0.0627**	**0.188**	**0.2756**	**0.14**	**0.1678**
Pb-212 MDA	**0.0368**	**0.0533**	**0.0571**	**0.0492**	**0.0537**
Pb-214 Activity	**1.237**	**1.734**	**2.059**	**1.538**	**1.784**
Pb-214 Confidence Interval	**0.0724**	**0.1043**	**0.1191**	**0.0925**	**0.1**
Pb-214 MDA	**0.0391**	**0.0566**	**0.0596**	**0.0545**	**0.0566**
Ra-226 Activity	**2.837**	**2.88**	**3.622**	**2.779**	**3.227**
Ra-226 Confidence Interval	**0.6367**	**0.7948**	**0.8007**	**0.7151**	**0.7782**
Ra-226 MDA	**0.4612**	**0.6973**	**0.7447**	**0.6249**	**0.6785**
Ac-228 Activity	**0.6952**	**2.318**	**3.573**	**1.501**	**1.763**
Ac-228 Confidence Interval	**0.0704**	**0.1391**	**0.189**	**0.1145**	**0.1249**
Ac-228 MDA	**0.0584**	**0.0858**	**0.0878**	**0.0861**	**0.0846**

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2010 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2027	SMSV-2069	SMSV-2055	SMSV-2049
Collection Date	3/10/2010	3/10/2010	3/10/2010	3/10/2010
Alpha Activity	**29**	<LLD	<LLD	**11.1**
Alpha Confidence Interval	**12.4**	NA	NA	**9.2**
Alpha LLD	**10.6**	10.3	10.5	**10.5**
Beta Activity	**14.8**	<LLD	<LLD	<LLD
Beta Confidence Interval	**7.73**	NA	NA	NA
Beta LLD	**10.7**	10.5	10.6	10.6
K-40 Activity	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA
K-40 MDA	0.3766	0.2142	0.5613	0.2354
Cs-137 Activity	<MDA	<MDA	<MDA	**1.454**
Cs-137 Confidence Interval	NA	NA	NA	**0.1167**
Cs-137 MDA	0.0471	0.027	0.0343	**0.032**
Pb-212 Activity	**3.997**	**0.6221**	**1.04**	**0.8636**
Pb-212 Confidence Interval	**0.3364**	**0.0679**	**0.1045**	**0.0926**
Pb-212 MDA	**0.0946**	**0.0467**	**0.0591**	**0.0614**
Pb-214 Activity	**7.089**	**0.5989**	**0.8259**	**1.047**
Pb-214 Confidence Interval	**0.326**	**0.0587**	**0.0767**	**0.0893**
Pb-214 MDA	**0.1042**	**0.0519**	**0.0666**	**0.0655**
Ra-226 Activity	**13.06**	<MDA	<MDA	**2.197**
Ra-226 Confidence Interval	**1.489**	NA	NA	**0.9234**
Ra-226 MDA	**1.252**	0.5662	0.7393	**0.7585**
Ac-228 Activity	**3.818**	**0.5696**	**1.086**	**0.8265**
Ac-228 Confidence Interval	**0.2201**	**0.0757**	**0.0997**	**0.1014**
Ac-228 MDA	**0.147**	**0.0736**	**0.0945**	**0.1024**

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2010 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2048	SM SV-324	SM SV-2073	SM SV-325
Collection Date	3/10/2010	3/17/2010	3/17/2010	3/17/2010
Alpha Activity	<LLD	<LLD	<LLD	**11.5**
Alpha Confidence Interval	NA	NA	NA	**9.62**
Alpha LLD	10.4	10.7	10.6	**11**
Beta Activity	<LLD	<LLD	**11.7**	**12.8**
Beta Confidence Interval	NA	NA	**6.4**	**6.67**
Beta LLD	10.6	8.78	**8.72**	**8.99**
K-40 Activity	**0.829**	<MDA	<MDA	<MDA
K-40 Confidence Interval	**0.4121**	NA	NA	NA
K-40 MDA	**0.2606**	0.6207	0.258	0.2605
Cs-137 Activity	**0.0727**	<MDA	<MDA	**0.0842**
Cs-137 Confidence Interval	**0.0292**	NA	NA	**0.0337**
Cs-137 MDA	**0.0395**	0.0322	0.032	**0.0335**
Pb-212 Activity	**2.009**	**2.253**	**1.273**	**1.537**
Pb-212 Confidence Interval	**0.1811**	**0.1882**	**0.1264**	**0.1448**
Pb-212 MDA	**0.0673**	**0.0689**	**0.0703**	**0.0644**
Pb-214 Activity	**1.415**	**1.249**	**2.611**	**2.16**
Pb-214 Confidence Interval	**0.1046**	**0.0938**	**0.1414**	**0.1252**
Pb-214 MDA	**0.0727**	**0.0742**	**0.0718**	**0.0739**
Ra-226 Activity	**2.686**	<MDA	**5.436**	**3.644**
Ra-226 Confidence Interval	**0.89**	NA	**0.9646**	**0.9698**
Ra-226 MDA	**0.8377**	0.8806	**0.8526**	**0.8303**
Ac-228 Activity	**2.012**	**2.223**	**1.574**	**1.492**
Ac-228 Confidence Interval	**0.1448**	**0.1489**	**0.1295**	**0.1268**
Ac-228 MDA	**0.1084**	**0.1059**	**0.1091**	**0.1067**

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2010 Radiological Data for SRS Stormwater Basins That Are Not Publicly Accessible

Location Description	SM Z-BASIN	SM E-003	SM E-006
Collection Date	3/10/2010	3/17/2010	3/17/2010
Alpha Activity	**16.7**	**10.7**	<LLD
Alpha Confidence Interval	**10.7**	**9.3**	NA
Alpha LLD	**10.7**	**10.4**	10.4
Beta Activity	**40.1**	**28.7**	**13.5**
Beta Confidence Interval	**8.5**	**7.63**	**6.45**
Beta LLD	**8.78**	**8.64**	**8.64**
Be-7 Activity	<MDA	**3.494**	<MDA
Be-7 Confidence Interval	NA	**0.9385**	NA
Be-7 MDA	1.452	**0.8112**	0.7357
K-40 Activity	**5.012**	**8.82**	**2.656**
K-40 Confidence Interval	**0.6764**	**0.8228**	**0.4674**
K-40 MDA	**0.2688**	**0.263**	**0.218**
Cs-137 Activity	**8.972**	<MDA	<MDA
Cs-137 Confidence Interval	**0.6005**	NA	NA
Cs-137 MDA	**0.046**	0.0351	0.0329
Pb-212 Activity	**3.062**	**2.73**	**1.795**
Pb-212 Confidence Interval	**0.265**	**0.2311**	**0.1635**
Pb-212 MDA	**0.0941**	**0.0705**	**0.0649**
Pb-214 Activity	**2.012**	**2.01**	**1.21**
Pb-214 Confidence Interval	**0.1479**	**0.1214**	**0.1008**
Pb-214 MDA	**0.1145**	**0.0724**	**0.0696**
Ra-226 Activity	**4.226**	**4.197**	**2.768**
Ra-226 Confidence Interval	**1.134**	**0.9433**	**0.8738**
Ra-226 MDA	**1.187**	**0.8771**	**0.7904**
Ac-228 Activity	**3.169**	**2.704**	**1.724**
Ac-228 Confidence Interval	**0.199**	**0.1642**	**0.1345**
Ac-228 MDA	**0.1255**	**0.1174**	**0.1038**

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2010 Radiological Data for Random Background "B" Samples > 50 miles from the SRS Center Point

Location Description	SM B62	SM B43	SM B49
Collection Date	3/30/2010	3/30/2010	3/30/2010
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	13.1	12.9	12.6
Beta Activity	<LLD	<LLD	**15.7**
Beta Confidence Interval	NA	NA	**7.24**
Beta LLD	10.2	10.1	**9.94**
K-40 Activity	**9.73**	**17.94**	**22.52**
K-40 Confidence Interval	**0.79**	**1.29**	**1.5**
K-40 MDA	**0.27**	**0.24**	**0.15**
Cs-137 Activity	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA
Cs-137 MDA	0.038	0.037	0.026
Pb-212 Activity	**5.894**	**2.292**	**0.599**
Pb-212 Confidence Interval	**0.438**	**0.199**	**0.064**
Pb-212 MDA	**0.066**	**0.058**	**0.039**
Pb-214 Activity	**3.386**	**1.069**	**0.451**
Pb-214 Confidence Interval	**0.163**	**0.079**	**0.048**
Pb-214 MDA	**0.069**	**0.066**	**0.045**
Ra-226 Activity	**6.045**	**1.992**	**1.296**
Ra-226 Confidence Interval	**0.99**	**0.68**	**0.516**
Ra-226 MDA	**0.814**	**0.705**	**0.468**
Ac-228 Activity	**6.248**	**2.335**	<MDA
Ac-228 Confidence Interval	**0.241**	**0.137**	NA
Ac-228 MDA	**0.11**	**0.109**	0.174

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

Radiological and Nonradiological Monitoring of Sediments Data

2010 Radiological Isotopic Data

Location Description	SM Z-BASIN	SM SV-2069
Collection Date	3/10/2010	3/1/2010
Pu-238 Activity	0.0215	<MDA
Pu-238 Confidence Interval	0.0105	NA
Pu-238 MDA	0.007	0.0057
Pu-239/240 Activity	0.0063	0.0067
Pu-239/240 Confidence Interval	0.0056	0.0051
Pu-239/240 MDA	0.0059	0.0047
U-234 Activity	1.36	0.129
U-234 Confidence Interval	0.25	0.0329
U-234 MDA	0.0116	0.0037
U-235 Activity	0.0824	0.0153
U-235 Confidence Interval	0.0329	0.0104
U-235 MDA	0.0143	0.0045

Note: Units are in pCi/g

Radiological and Nonradiological Monitoring of Sediments Data

2010 Nonradiological Data for Savannah River Site Streams and Stormwater Basins That Are Not Publicly Accessible

Location Description	SMSV-324	SMSV-2073	SMSV-325	SMSV-2027
Collection Date	3/17/2010	3/17/2010	3/17/2010	3/10/2010
Barium in Sediment	<5.0	**16**	**10**	**41**
Cadmium in Sediment	<1.0	<1.0	<1.0	<1.0
Chromium in Sediment	<1.0	**3.1**	**1.8**	**6.6**
Copper in Sediment	<1.0	<1.0	<1.0	**3.2**
Lead in Sediment	<5.0	<5.0	<5.0	**8.8**
Manganese in Sediment	**16**	**26**	**14**	**6.6**
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10
Nickel in Sediment	<2.0	<2.0	<2.0	**2.3**
Zinc in Sediment	<1.0	**5**	**4.1**	**8.8**
Location Description	**SMSV-2069**	**SMSV-2055**	**SVSV-2049**	**SMSV-2048**
Collection Date	**3/10/2010**	**3/10/2010**	**3/10/2010**	**3/10/2010**
Barium in Sediment	**7.9**	**5.3**	**17**	**36**
Cadmium in Sediment	<1.0	<1.0	<1.0	**1.1**
Chromium in Sediment	**1.8**	**1.6**	**3.7**	**5.7**
Copper in Sediment	**1.2**	<1.0	**1.6**	**1.3**
Lead in Sediment	<5.0	<5.0	<5.0	**5.5**
Manganese in Sediment	**15**	**24**	**50**	**680**
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10
Nickel in Sediment	<2.0	<2.0	<2.0	**2.2**
Zinc in Sediment	**3.9**	**2.2**	**17**	**12**
Location Description	**SME-003**	**SME-006**	**SM-Z BASIN**	
Collection Date	**3/17/2010**	**3/17/2010**	**3/10/2010**	
Barium in Sediment	**33**	**7.8**	**71**	
Cadmium in Sediment	**5.5**	**2.6**	**3.1**	
Chromium in Sediment	**22**	**16**	**49**	
Copper in Sediment	**11**	**3.4**	**25**	
Lead in Sediment	**13**	**11**	**24**	
Manganese in Sediment	**170**	**27**	**61**	
Mercury in Sediment	<0.10	<0.10	<0.10	
Nickel in Sediment	**5.8**	<2.0	**4**	
Zinc in Sediment	**82**	**7**	**420**	

Note: Units are in mg/kg.

TOC

2.5.5 Summary Statistics

Radiological and Nonradiological Monitoring of Sediments

Notes:

6. N/A = Not Applicable
7. Min. – Minimum
8. Max. = Maximum

2010 Summary Statistics – SCDHEC Radiological Data
Non-Publicly Accessible SRS Streams

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number	Number of Detections
Alpha	17.2	10.2	11.5	11.1	29	8	3
Beta	13.1	1.6	12.8	11.7	14.8	8	3
K-40	0.8	N/A	0.8	0.8	0.8	8	1
Cs-137	0.54	0.79	0.08	0.07	1.45	8	3
Pb-212	1.7	1.1	1.4	0.6	4	8	8
Pb-214	2.1	2.1	1.3	0.6	7.1	8	8
Ra-226	5.4	4.5	3.6	2.2	13.1	8	5
Ac-228	1.7	1	1.5	0.6	3.8	8	8

2010 Summary Statistics – SCDHEC Radiological Data
Publicly Accessible SRS Creek Mouths and Savannah River Sediment

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	5	0
Beta	30	5.3	28.3	25.7	37.5	5	4
K-40	13.3	6.5	16.1	1.9	17.6	5	5
Cs-137	0.42	0.45	0.36	0.04	0.92	5	4
Pb-212	1.9	1.03	1.9	0.53	3.37	5	5
Pb-214	1.67	0.31	1.73	1.24	2.06	5	5
Ra-226	3.07	0.36	2.88	2.78	3.62	5	5
Ac-228	1.97	1.07	1.76	0.7	3.57	5	5

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Ru-103, Sb-125, I-131, Cs-134, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

2010 Summary Statistics – SCDHEC Radiological Data
Non-Publicly Accessible SRS Stormwater Basins

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	13.7	4.2	13.7	10.7	16.7	3	2
Beta	27.4	13.3	28.7	13.5	40.1	3	3
K-40	5.5	3.1	5	2.7	8.8	3	3
Cs-137	9	N/A	9	9	9	3	1
Pb-212	2.5	0.7	2.7	1.8	3.1	3	3
Pb-214	1.7	0.5	2	1.2	2	3	3
Ra-226	3.7	0.8	4.2	2.8	4.2	3	3
Ac-228	2.5	0.7	2.7	1.7	3.2	3	3

Note: Units are in pCi/g. There were no detections in any 2009 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Ru-103, Sb-125, I-131, Cs-134, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235. There was one Be-7 detection in sample collected from one stormwater basin (Z-Basin).

2010 Summary Statistics – SCDHEC Radiological Data
Nonrandom Background Samples

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	3	0
Beta	15.7	N/A	15.7	15.7	15.7	3	1
K-40	16.7	6.4	17.9	9.7	22.5	3	3
Cs-137	N/A	N/A	N/A	N/A	N/A	3	0
Pb-212	2.9	2.7	2.3	0.6	5.9	3	3
Pb-214	1.6	1.5	1	0.45	3.38	3	3
Ra-226	3.1	2.5	1.9	1.2	6	3	3
Ac-228	4.3	2.8	4.3	2.3	6.2	3	2

Note: Units are in pCi/g. There were no detections in any 2010 sediment sample above the MDA for: Na-22, Co-58, Co-60, Zn-65, Y-88, Ru-103, Sb-125, I-131, Cs-134, Eu-152, and Eu-154. Mn-54 not reported due to interference from Ac-228. Eu-155 not reported due to interference from Ac-228 or U-235.

2010 Summary Statistics – SCDHEC Sediment Metals Data
Non-Publicly Accessible SRS Streams

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Barium	19	14	16	5.3	41	8	7
Cadmium	1.1	N/A	1.1	1.1	1.1	8	1
Chromium	3.5	2	3.1	1.6	6.6	8	7
Copper	1.8	0.9	1.5	1.2	3.2	8	4
Lead	7.2	2.3	7.2	5.5	8.8	8	2
Manganese	104	233	20	6.6	680	8	8
Mercury	N/A	N/A	N/A	N/A	N/A	8	0
Nickel	2.3	0.1	2.3	2.2	2.3	8	2
Zinc	7.6	5.3	5	2.2	17	8	7

Note: Units are in mg/kg.

2010 Summary Statistics-SCDHEC Sediment Metals Data
Non-Publicly Accessible SRS Stormwater Basins

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Barium	37.27	31.8	33	7.8	71	3	3
Cadmium	3.73	1.55	3.1	2.6	5.5	3	3
Chromium	29	17.58	22	16	49	3	3
Copper	13.13	10.96	11	3.4	25	3	3
Lead	16	7	13	11	24	3	3
Manganese	86	74.71	61	27	170	3	3
Mercury	N/A	N/A	N/A	N/A	N/A	3	0
Nickel	4.9	1.27	4.9	2	5.8	3	2
Zinc	169.67	220.01	82	7	420	3	3

Note: Units are in mg/kg

TOC

3.1 Radiological Surface Soil Monitoring

3.1.1 Summary

Surface soil is an important medium that can be contaminated by radionuclides and metals, and transported to other ecological systems. Plants absorb contaminants from soil that in turn introduce contaminants to the food chain. Radionuclides and metals in soil can leach into groundwater and possibly emerge into surface water, thus potentially contaminating aquatic systems (Corey 1980). Air and water are subject to a much greater mixing than soil; therefore, dilution of metal load does not occur in soil as in air or water. As a result, the accumulation of metals in surface soils is often more intense on both local and global scales than in the other components of the biosphere (Alloway 1995). The re-suspension and subsequent airborne contamination of materials, due to cleanup processes and prescribed burns, facilitates the movement of contaminants to areas outside of the Savannah River Site (SRS) boundary.

The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) provides independent evaluation of the Department of Energy – Savannah River (DOE-SR) environmental monitoring programs. ESOP personnel independently evaluated surface soils from ground surface to a 12 inch depth for gross alpha and gross non-volatile beta and select gamma-emitting radionuclides, as well as specific metals of concern at SRS. These soil samples were collected to determine if SRS activities might have impacted areas outside of the site boundary. Radionuclide detections in soil are the result of accumulation over many years and do not represent yearly depositions.

The ESOP surface soil monitoring project changed in 2004 to include more random coverage of perimeter soils (those within 50 miles of the SRS center point, but outside the SRS boundary) and background soils (those greater than 50 miles from the SRS center point) within the boundaries of the state of South Carolina. This sampling program was implemented to allow statistical comparisons of the SRS perimeter and South Carolina background contaminant levels in soils. The United States Geological Survey (USGS) 7.5' Quadrangle Coverage for South Carolina (USDOI 1992) was used to determine the ESOP random quadrant sampling areas. Refer to Section 3.1.3, Table 1 and Section 3.1.2, Map 1 for random sampling locations. ESOP initiated the random sampling system to determine if elevated levels of contaminants are attributable to SRS activities. Perimeter and background averages were used to determine if SCDHEC data were comparable to radiological data from DOE-SR. Since DOE-SR environmental monitoring division does not report metals data for surface soil, no direct data comparisons can be made. Assessment of radiological and nonradiological contaminants in surface soil is necessary to detect any impact from DOE-SR operations beyond the historically impacted areas within the SRS boundaries. In addition to samples collected near the perimeter of SRS, publicly accessible boat landings were included in the sampling regime in 2007 to exemplify areas where direct contact to surface soil by the public often occurs.

ESOP collected samples in 2010 from three random perimeter sites within the 50-mile radius of the SRS center point and three random background sites outside of the 50-mile SRS center point radius. Twelve nonrandom samples were collected from SRS perimeter locations. Thirteen riverbank samples were collected from publicly accessible boat landings. Nonrandom SRS perimeter sampling locations are depicted on Map 2 of Section 3.1.2. A list of all nonrandom sampling locations is in Section 3.1.2, Table 2. The majority of all the samples had detectable amounts of cesium-137 (Cs-137), an anthropogenic radionuclide, that were consistent with levels attributed to atmospheric fallout from past nuclear weapons testing. The background average was the highest, being slightly higher than the other locations collected around SRS. Cesium-137 activity in 2010 was slightly lower but, coincide with levels detected by ESOP in the past. There were no surface soil samples collected in 2010 that were above the United States Environmental Protection Agency (USEPA) Preliminary Remediation Goals (PRGs) or the USEPA Regional Screening Levels (RSLs) (USEPA 2010). Furthermore, there were no riverbank soil samples in 2010 that exceeded the radiological USEPA Soil Screening Levels (SSLs). SSLs are more conservative screening values which are utilized when soil is in close proximity to groundwater (e.g. near rivers and sometimes near surface water bodies). USEPA PRGs are generic/default screening values for radioactive contamination in soil. USEPA RSLs are generic/default values for the toxicity of chemical contaminants in soil. The PRGs, RSLs and SSLs of select radionuclides and metals sampled by SCDHEC are listed in Section 3.1.3, Tables 6, 7 and 8.

There were no gross alpha-emitting radionuclides detected in any of the samples collected in 2010. Gross non-volatile beta was detected among all sample types.

Results for all metal analytes were below the USEPA RSLs. Metals data has been trended over time and the samples collected near the SRS perimeter are similar to those collected randomly throughout South Carolina.

Data comparison of 2010 surface soil data from SCDHEC and DOE-SR resulted in similar findings. Both data sets report average Cs-137 levels higher outside the 50 mile radius of SRS than within the SRS perimeter. SCDHEC data from 2010 show a slightly decreased average level of Cs-137 from the 2009 data. DOE-SR reports in 2010 that Cs-137 concentrations are consistent with historical results. Metals data could not be compared to SCDHEC results since the SRS environmental monitoring division does not analyze nonradiological contaminants.

RESULTS AND DISCUSSION

Radiological Parameter Results

All radiological data can be found in Section 3.1.4 and statistical data can be found in Section in 3.1.5.

Surface soils were evaluated for gross alpha and gross non-volatile beta as well as a suite of 24 gamma-emitting radionuclides. Radioisotopes were detected not only in samples collected on SRS, but in background samples as well. The USEPA PRGs are used as a screening tool that corresponds to certain levels of human health risk in regards to radioactivity in soil (USEPA 2010). The conservative PRGs, correspond to a risk for chronic soil ingestion for a residential scenario and a one in one million (1E-06) increased cancer risk. Uranium has both a PRG and an RSL because it is both carcinogenic and toxic (USEPA 2010). In 2010, ESOP analyzed for all of the radioisotopes listed in Section 3.1.3, Table 4.

Cesium-137 is a man-made fission product. Atmospheric Cs-137 was released from the separation areas and was a key radionuclide released to water and air, mainly from F- and H-areas (CDC 2006). Cesium-137 was detected in all 12 SRS nonrandom perimeter samples at an average of 0.13 (±0.06) picocuries per gram (pCi/g) and ranged from 0.05 to 0.26 pCi/g. The highest detection was located at SSJAK10 in Aiken County. Twelve of the 13 riverbank soil samples had Cs-137 detections at an average of 0.18 (±0.16) pCi/g. The samples ranged from 0.06 to 0.65 pCi/g. The highest detection of all samples was at Burton's Ferry Boat Landing (SS301SC001).

Analysis for Cs-137 in riverbank soils collected at the public boat landings show that samples in 2010 had Cs-137 levels consistent with levels attributed to atmospheric fallout from past nuclear weapons testing. Results are depicted in Section 3.1.3, Figure 1.

All of the random perimeter and background samples had Cs-137 detections. The random SRS perimeter sample detection average was 0.17 (±0.01) pCi/g. The random background samples had detections averaging 0.31 (±0.06) pCi/g. Cesium-137, on average, was highest in the random background samples followed by public boat landings soils. The results are depicted in Section in Section 3.1.3, Figure 2.

In addition, potassium-40, lead-212, lead-214, radium-226, and actinium-228 were the only other gamma-emitting radionuclides detected among surface soil samples. These are Naturally Occurring Radioactive Material (NORM) decay products that may account for these detections. All other gamma-emitting radionuclides had no detections above their respective Minimum Detectable Activity (MDA).

Gross alpha-emitting radionuclides were released to the air at SRS primarily from M-area, the reactor areas, and the separations facilities (CDC 2006). Analyses were conducted on gross alpha-emitting radionuclides in surface soil samples collected during 2010. There were no detections of gross alpha-emitting radionuclides in any of the soil samples collected in 2010.

Gross beta-emitting radionuclides were released from the separations areas on the SRS (CDC 2006). Gross beta was detected in seven SRS nonrandom perimeter samples at an average of 11.2 (±1.6) pCi/g and ranged from 9.2 to 14.2 pCi/g. The highest detection was in soil collected at SSJAK10 in Aiken County. Four riverbank boat landing soil samples had detections for gross beta-emitting radionuclides. The riverbank landing average was 21.9 (±6.9) pCi/g, and the values ranged from 11.80 to 27.7 pCi/g. Johnson's Boat Landing (SS JL001) yielded the highest riverbank soil detection. One random perimeter (E74) sample collected in Allendale County had a detection of 30.7 pCi/g. Two random background samples (B75 and B73) had gross beta detections averaging 26.9 (±13.9) pCi/g. The highest gross beta random background sample (B75) was collected in Beaufort County (36.8 pCi/g). Results are depicted in Figures 3 and 4 of Section 3.1.3.

Nonradiological Parameter Results

Data for all metals detected can be found in Section 3.1.4. The statistical data tables are found in Section 3.1.5.

Nine metals were analyzed in 12 nonrandom surface soil samples collected in 2010. A complete list of all nonradiological analytes can be found in Section 3.1.3, Table 5. Findings were compared to the USEPA RSLs that are used as a screening tool, corresponding to certain levels of human health risk in soils (USEPA 2010). All sample results were below the conservative generic/default USEPA RSLs, corresponding to a risk for chronic soil ingestion for a residential scenario. ESOP 2010 samples had detections of barium, cadmium, chromium, copper, lead, manganese, nickel, and zinc. There were no detections above the Minimum Detection Limit (MDL) for mercury. The following discussion of individual analytes will be limited to those of potential concern due to SRS operations.

Barium has been a constituent of the H-Area Hazardous Waste Management Facility (WSRC 1993). Barium was detected in all 12 SRS nonrandom perimeter samples at an average of 19.8 milligrams per kilogram (mg/kg) and ranged from 5.3 to 60 mg/kg. The highest detection was located at SSALN10 in Allendale County. All samples were well below the RSL of 15,000 mg/kg and also below the South Carolina (SC) average of 38 mg/kg (Canova 1999).

Chromium solutions were used at the SRS as corrosive inhibitors. Chromium was a part of wastewater solutions resulting from dissolving stainless steel. It was also used in cleaning solutions in the separation areas (Till et al. 2001). Disposal of fly ash on land is a contributor of both chromium and nickel to soils (Alloway 1995). Chromium was detected in 11 SRS nonrandom perimeter samples at an average of 4.28 milligrams per kilogram (mg/kg) and ranged from 1.4 to 17.0 mg/kg. The highest detection was located in SSAIK0210 in Aiken County. For comparison, the most conservative RSL screening level (ChromiumVI) is 230 mg/kg. The SC average for total chromium in soil is 16 mg/kg (Canova 1999).

Copper, while naturally occurring, can also be released to the environment through the combustion of wood, coal and oil (Alloway 1995). These mechanisms are possible sources of elevated copper in surface soils. Copper was detected in five SRS nonrandom perimeter samples at an average of 4.28 mg/kg and ranged from 1.1 to 14 mg/kg. The highest detection was located in SSALN10 in Allendale County. All samples were below the RSL of 3,100 mg/kg . The SC average for copper in soil is 9 mg/kg (Canova 1999).

Atmospheric emissions of lead from SRS occurred through coal and fuel combustion (Till et al. 2001). Depositions of lead in soil have a long resonance time. Lead tends to accumulate in soil where its bioavailability can exist far into the future (Alloway 1995). Lead was detected in 10 SRS nonrandom perimeter samples at an average of 14 mg/kg and ranged from 5.6 to 60 mg/kg. The highest detection was located at SSALN10 in Allendale County. For comparison, the RSL is 400 mg/kg and the state average for lead in soil is 16 mg/kg (Canova 1999).

Manganese has been released in the separations area head end processes and discharged to liquid waste tanks. It is also a byproduct of coal burning (Till et al. 2001). Manganese was detected in all 12 SRS nonrandom perimeter samples at an average of 88 mg/kg and ranged from 10 to 370 mg/kg. The highest detection was located at SSJAK10 in Aiken County. Four samples exceeded the state average of 100 mg/kg (Canova 1999), and all were below the RSL of 1,800 mg/kg.

The largest anthropogenic source of nickel globally is the burning of fuels and coal combustion (Alloway 1995). At SRS, nickel was directly released through M-area effluent from the plating rinse tanks and through site use of diesel generators (Till et al. 2001). Nickel was detected in two SRS nonrandom perimeter samples at an average of 3.3 mg/kg and ranged from 3.2 to 3.3 mg/kg. The highest detection was SSALN10 in Allendale County. There were no samples above the state average of 6 mg/kg (Canova 1999), and all samples were below the RSL of 1,500 mg/kg.

Zinc was released in relatively small amounts to the separations area seepage basins as well as the M-area seepage basin (Till et al. 2001). Zinc was detected in all 12 SRS nonrandom perimeter samples at an average of 8.2 mg/kg and ranged from 1.4 to 55 mg/kg. The highest detection was located at SSALN10 in Allendale County. The RSL is 23,000 mg/kg. All samples except SS ALN 11 (55 mg/kg) were also below the state average of 23 mg/kg (Canova 1999).

SRS facilities, such as F-and H-area, tritium facilities, waste tanks and the coal-fired power plants, have emitted mercury to the atmosphere (Till et al. 2001). Atmospheric fallout contributes to mercury findings in surface soil. None of the surface soil samples collected in 2010 yielded detections above the MDL of 0.1 mg/kg for mercury. The RSL for mercury is 5.6 mg/kg.

Cadmium enters the atmosphere through fuel and coal combustion (Till et al. 2001). Only one of the surface soil samples collected in 2010 yielded detections above the MDL of 1.0 mg/kg for cadmium. The lone cadmium detection of 1.7 mg/kg was located at SSAIK0210 in Aiken County. The RSL for cadmium in soil is 70 mg/kg.

SCDHEC and DOE-SR Data Comparison

Cesium-137, cobalt-60 (Co-60) and Americium-241 (Am-241) were the only gamma-emitting radionuclides for which SCDHEC and DOE-SR shared analytical results. DOE-SR did not have any detections of Co-60 above the MDA. DOE-SR did detect Am-241 in one perimeter location at 0.004 pCi/g as well as Am-241 in a 25 mile perimeter location at 0.005 pCi/g. Since SCDHEC did not have any detections of Co-60 or Am-241 above the MDA, only the Cs-137 detections are compared. DOE-SR did not analyze for alpha or beta- emitting radionuclides, nor did they analyze for metals. Samples varied by location and in number. DOE-SR collected 12 samples near the SRS perimeter and three samples within 25 miles. ESOP collected 12 nonrandom SRS perimeter samples. ESOP also sampled three background locations greater than 50 miles from SRS. DOE-SR sampled one background location 100 miles from SRS at Savannah Georgia. Samples were collected from a variety of soil types. This should be taken into consideration in regards to data interpretation. Comparative data can be found in Section 3.1.3, Tables 9 and 10.

Cesium-137 was detected by both DOE-SR and SCDHEC. Cesium-137 was detected above the Minimum Detectable Concentration (MDC) in all 12 DOE-SR perimeter samples. SCDHEC detected Cs-137 in all of the 12 nonrandom perimeter SCDHEC samples. Cesium-137 was detected in both the DOE-SR background location and the SCDHEC background locations. For the 2010 samples, the SCDHEC nonrandom perimeter average for Cs-137 was 0.13 (± 0.06) pCi/g. The average for all the SCDHEC background samples was 0.31 (± 0.06) pCi/g. The DOE-SR Cs-137 average for all SRS perimeter samples was 0.153 pCi/g, and 0.173 pCi/g for those locations within 25 miles of SRS. The DOE-SR 100 mile background Cs-137 activity was 0.164 pCi/g (SRNS 2011). The DOE-SR data average for Cs-137 activity falls within one standard deviation of the SCDHEC data.

Cesium-137 was the only consistently analyzed parameter over past years. Trending data for Cs-137 in SRS perimeter samples is in Section 3.1.3, Figure 5. SCDHEC has trended Cs-137 since 2003 (SCDHEC 2004-2010). Data shows that SCDHEC average levels of Cs-137 in surface soils held steady from 2004 to 2005. There were slightly higher levels in 2006 and even higher levels in 2007. Results from 2008 through 2010 each show a decline year to year. DOE-SR data shows steady levels from 2003-2004, slightly higher in 2005 and 2006, and the lowest average in 2007 before higer levels were detected in 2008 (WSRC 2004, 2005c, 2006-2008). The 2010 DOE-SR data show an increase from 2009. This contradicts the SCDHEC data. The results found by both SCDHEC and DOE-SR are influenced by the number of samples used to determine the average and by collecting samples from different locations. The average level of Cs-137 in surface soil can vary due to the highly variable nature of soils. Radiocesium bioavailability in soil is influenced by soil properties such as clay content, pH, organic matter, and soil microflora (Absalom et al. 2001). The increase of Cs-137 activity in the SCDHEC samples in 2006 through 2008 could be due to the 2006 addition of samples in closer proximity to the boundary of SRS, specifically in the Steel Creek floodplain. In the previous years only random samples within 50 miles of the SRS center point were sampled to determine the yearly average. In 2007, the addition of sampling at public boat landings was initiated. Excursions outside normally expected levels, contributed through unplanned Cs-137 releases, occurred at boat landings just downstream of SRS specifically in the Steel Creek floodplain area, driving the average higher. These areas have historically been impacted by SRS operations and higher than background results are to be expected. These yielded higher averages in 2006, 2007, and 2008. DOE-SR does not collect samples at these locations.

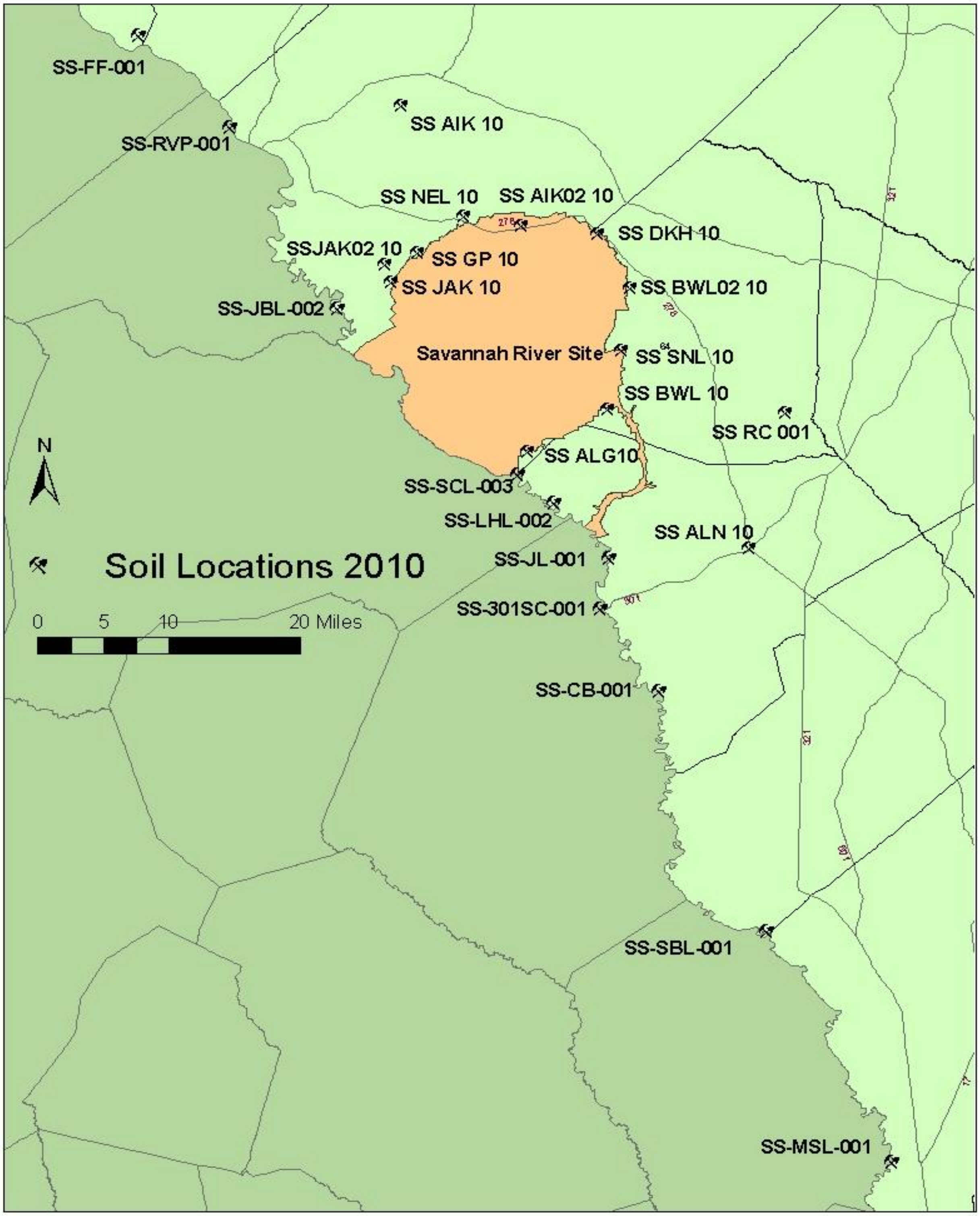
CONCLUSIONS AND RECOMMENDATIONS

ESOP will continue independent monitoring of SRS perimeter surface soil and will periodically evaluate modification of the monitoring activities to better accomplish project goals and objectives. Monitoring will continue as long as there are activities at the SRS that create the potential for contamination entering the environment. Continued monitoring will provide an improved understanding of radionuclide and non-radionuclide activity in SRS perimeter surface soils and the surrounding areas. Additional monitoring will impart valuable information to human health exposure pathways. Trending of data over multiple years will give a more definitive answer as to whether radionuclide concentrations in the SRS area are declining due to radioactive decay or possibly increasing due to disturbances on SRS. The comparison of data results allows for independent data verification of DOE-SR monitoring activities. Cooperation between DOE-SR and SCDHEC provides credibility and confidence in the information being provided to the public.

In 2011, SCDHEC will continue to monitor the surface soil along the perimeter of SRS for radionuclides. Riverbank soil samples will be collected from the publicly accessible Savannah River watershed boat landings where human exposure is likely. The SCDHEC data at this time does not show there is an impact of elevated metal concentrations to areas outside of SRS. However, continued monitoring along the perimeter of SRS is still necessary due to the potential impact of SRS site operations to the surrounding environments. Possible atmospheric releases due to burning and soil disturbance at SRS could elevate metals in the surrounding area. Only through continued monitoring will this be determined. If perimeter samples show elevated metals levels, additional samples will be evaluated.

3.1.2

Map 2. SRS Perimeter Surface Soil Monitoring Locations



TOC

3.1.3 Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 1. Random Soil Samples Collected in 2010

2010 Random Surface Soil Sampling Locations Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.			**Geological**
Quad	**7.5' Quad Name**	**Latitude by Lat and Longitude by Long**	**Region**
B73	Union East	3437.5 by 3445 and -8130 by -8137.5	PM
B77	Kirksey	3400 by 3407.5 and -8200 by -8207.5	PM
B75X	Batesburg	3352.5 by 3400 and -8130 by -8137.5	PM
Random Quadrants Within SRS Perimeter or "E" Quadrants			**Geological**
Quad	**7.5' Quad Name**	**Latitude by Lat and Longitude by Long**	**Region**
E71	Barton	3252.5 by 3300 and -8115 by -8122.5	LCP
E74	Fairfax	3252.5 by 3300 and -8107.5 by -9115	LCP
E75X	Hampton (50 mi.)	3245 by 3252.5 and -8100 by -8107.5	LCP

1. The randomly selected quadrants are from a United States Department of Interior 7.5 Minute Topographic Map Printed by the South Carolina Land Resources Commission, Rv 10/92.
2. "**X**" in any designated ID represents the presence of an **exclusion zone** of either a state border, 50 mi. limit bisector line that splits the quad area into an environmental side and a background side, or occurrence of background random pick area within 10 miles of a nuclear facility.
3. "**E**" means this is a pick selected for SRS perimeter (outside SRS from center point 33 deg. 15' 00" & -81deg. 37' 30"). Public dose outside of SRS and within 10 mi. of a reactor are not excluded for "E" sar
4. "**B**" means this is a South Carolina background pick outside of the 50 mile limit from SRS center point. Ten mile exclusion zone in "B" quads is used to reduce influence of any local reactor on SC background.
5. Parenthesis info by quad name identifies type of exclusion (NCX is North Carolina, GAX is Georgia, NRX is nuclear reactor, SRS is Savannah River Site exclusion zone border).
6. Purpose of random sampling is to compare public dose within 50 miles of SRS to a S. C. background.
7. Geological Regions are Blue Ridge (BR), Piedmont (PM), Upper & Lower Coastal Plain (U&LCP). Quadrants split by geological regions are assigned to the upper most region in the quadrant.

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 2. Nonrandom Soil Samples Collected in 2010

SAMPLE ID	LOCATION	COUNTY
SS ALG 10	Allendale Gate	Allendale
SS SNL 10	Snelling Gate	Barnwell
SS DKH 10	Darkhorse	Barnwell
SS ALN 10	Allendale	Allendale
SS GP 10	Green Pond	Aiken
SS JAK 10	Jackson	Aiken
SS AIK 10	Aiken	Aiken
SS JAK02 10	Jackson	Aiken
SS NEL 10	New Ellenton	Aiken
SS BWL 10	Co-located at VEG site BWL-004	Barnwell
SS AIK02 10	Boggy Gut Road	Aiken
SS BWL02 10	Co-located at VEG site BWL-002	Barnwell

Table 3. Riverbank Soil Samples Collected in 2010

SAMPLE ID	COUNTY
SS PRA 001	McCormick
SS FF 001	McCormick
SS JBL 002	Aiken
SS SCL 002	Barnwell
SS LHL 002	Allendale
SS BH121 SR	Saluda
SS BH395 SR	Saluda
SS BH194 SR	Saluda
SS SBL 001	Hampton
SS CB 001	Allendale
SS RC 001	Barnwell
SS 301SC 001	Allendale
SS JL 001	Allendale

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 4. Radiological Analytes

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Note: Units are reported in pCi/g.

Table 5. Nonradiological Analytes

Analyte	Abbreviation	MDL
Barium	Ba	5.0
Cadmium	Cd	1.0
Chromium	Cr	1.0
Copper	Cu	1.0
Mercury	Hg	0.10
Manganese	Mn	1.0
Nickel	Ni	2.0
Lead	Pb	5.0
Zinc	Zn	1.0

Note: Units are reported in mg/kg.

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 6. Preliminary Remediation Goals of Anthropogenic Radionuclides Samples by SCDHEC

Radionuclide	Abbreviation	PRG
Americium-241	Am-241	**3.75 pCi/g**
Cesium-137	Cs-137	**25.4 pCi/g**
Cobalt-60	Co-60	**79.2 pCi/g**
Iodine-131	I-131	**5940 pCi/g**

Table 7. Regional Screening Levels of Metals sampled by SCDHEC

Analyte	Abbreviation	RSL
Barium	Ba	**15,000 mg/kg**
Cadmium	Cd	**70 mg/kg**
Chromium	Cr	**230 mg/kg**
Copper	Cu	**3,100 mg/kg**
Mercury	Hg	**400 mg/kg**
Manganese	Mn	**1,800 mg/kg**
Nickel	Ni	**1,500 mg/kg**
Lead	Pb	**400 mg/kg**
Zinc	Zn	**23,000 mg/kg**

Table 8. Soil Screening Levels of Anthropogenic Radionuclides Samples by SCDHEC

Radionuclide	Abbreviation	SSL
Americium-241	Am-241	**0.088 pCi/g**
Cesium-137	Cs-137	**0.492 pCi/g**
Cobalt-60	Co-60	**0.081 pCi/g**
Iodine-131	I-131	**5.05 pCi/g**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 9. Cs-137 Surface Soil Data Comparison: Nonrandom Perimeter SCDHEC and DOE-SR Perimeter Surface Soil Samples

SCDHEC

Sample ID	County	Cs-137
SS ALG 10	Allendale	0.09
SS SNL 10	Barnwell	0.19
SS DKH 10	Barnwell	0.15
SS ALN 10	Allendale	0.16
SS GP 10	Aiken	0.05
SS JAK 10	Aiken	0.26
SS AIK 10	Aiken	0.09
SS JAK02 10	Aiken	0.1
SS NEL 10	Aiken	0.19
SS BWL 10	Barnwell	0.13
SS AIK02 10	Aiken	0.05
SS BWL02 10	Barnwell	0.14
AVG		**0.13**
MEDIAN		**0.13**
STD		**0.06**

DOE-SR

SRS Perimeter	Cs-137
Allendale Gate	0.04
Barnwell Gate	0.23
D-Area	0.08
Darkhorse @ Williston	0.22
East Talatha	0.05
Green Pond	0.04
Highway 21/167	0.22
Jackson	0.27
Patterson Mill Road	0.04
Talatha Gate	0.38
West Jackson	0.21
Windsor Road	0.06
AVG	**0.15**
MEDIAN	**0.14**
STD	**0.11**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 10. Cs-137 Surface Soil Data Comparison: SCDHEC and DOE-SR Surface Soil Samples Collected > 50 miles from the SRS Center Point.

SCDHEC

Sample ID	County	Cs-137
B73	Union	0.29
B77	Greenwood	0.38
B75X	Saluda	0.26
AVG		**0.31**
Median		**0.29**
STD		**0.06**

DOE-SR

Sample ID	Sample	Cs-137
100-Mile Radius	Savannah, GA	**0.16**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Figure 1. Cesium-137 Levels in Savannah River Riverbank Surface Soil Samples
Note: Graph depicts samples in order of location along the Savannah River. The most upstream sample is on the left and the most downstream sample is on the right of the graph.

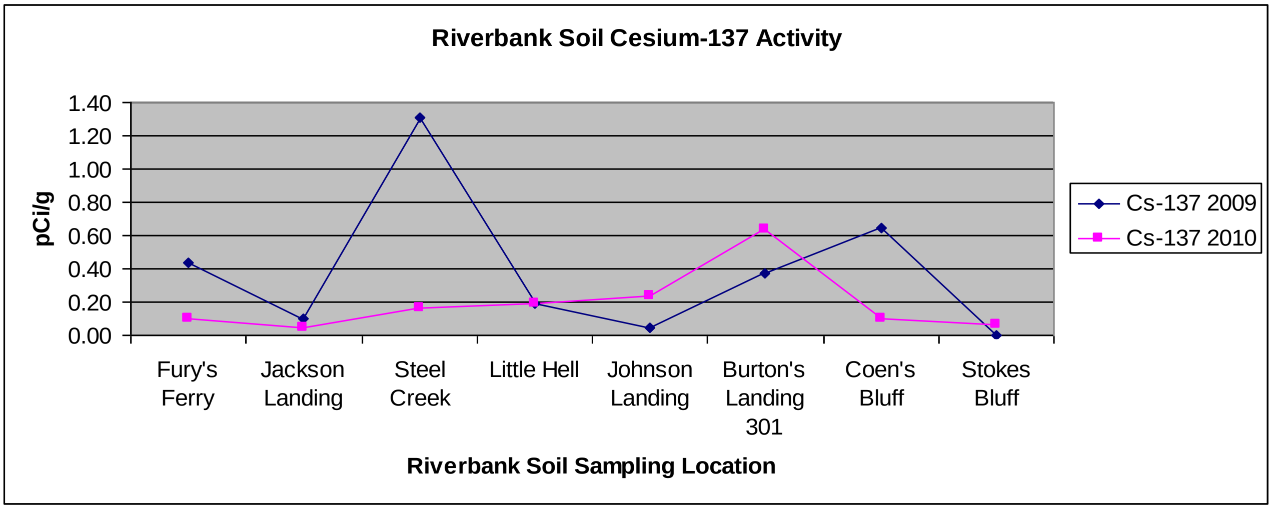
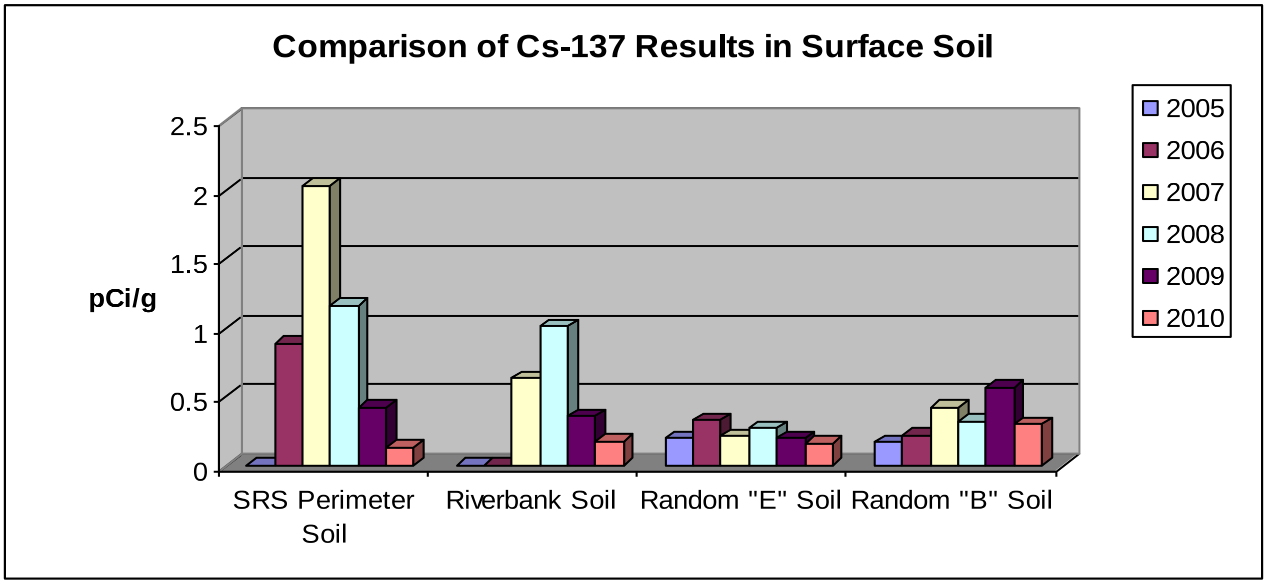


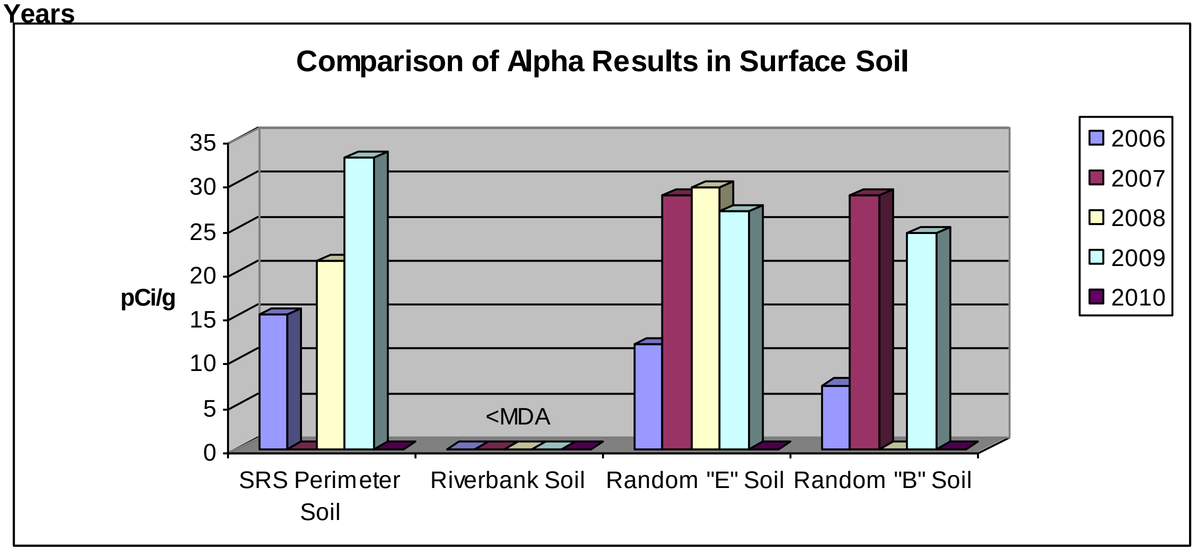
Figure 2. Trending Data for Cesium-137 by Yearly Averages of 2005-2010 and Individual Years



Note: There were no samples collected from the SRS perimeter in 2005. There were no samples collected from riverbank soil from 2005-2006.

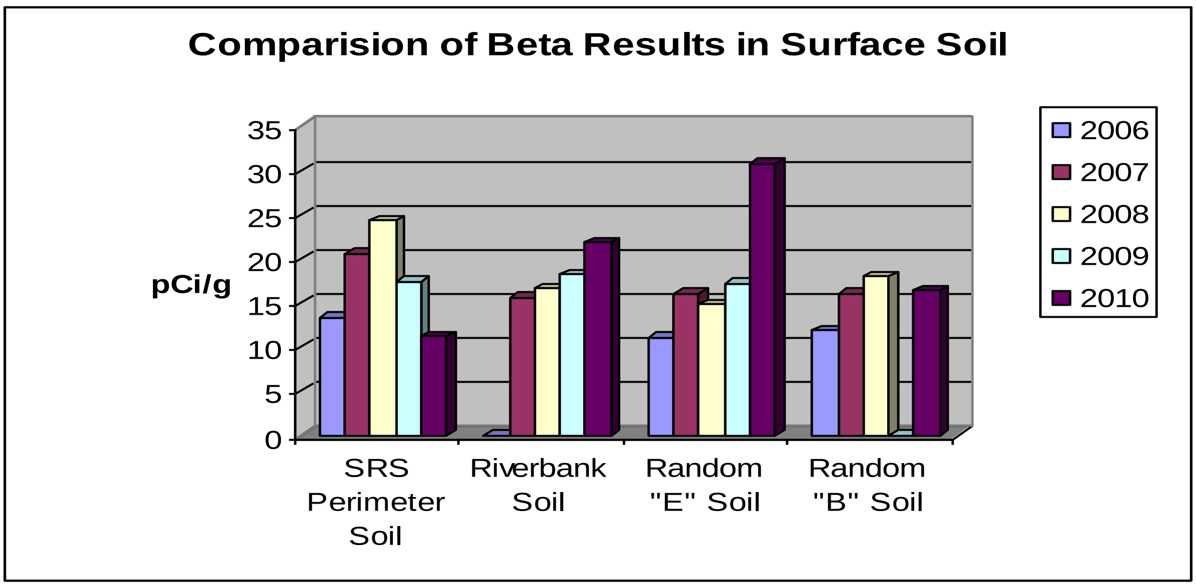
Tables and Figures
Surface Soil Monitoring Adjacent to SRS

Figure 3. Trending Data for Alpha Detections by Yearly Averages of 2006-2010 and Individual Years



Note: There were no alpha detections in any of the soil samples collected in 2010. There were no alpha detections in any of the perimeter soil samples collected in 2007 and there were no alpha detections in "B" samples collected in 2008.

Figure 4. Trending Data for Beta Detections by Yearly Averages of 2006-2010 and Individual Years

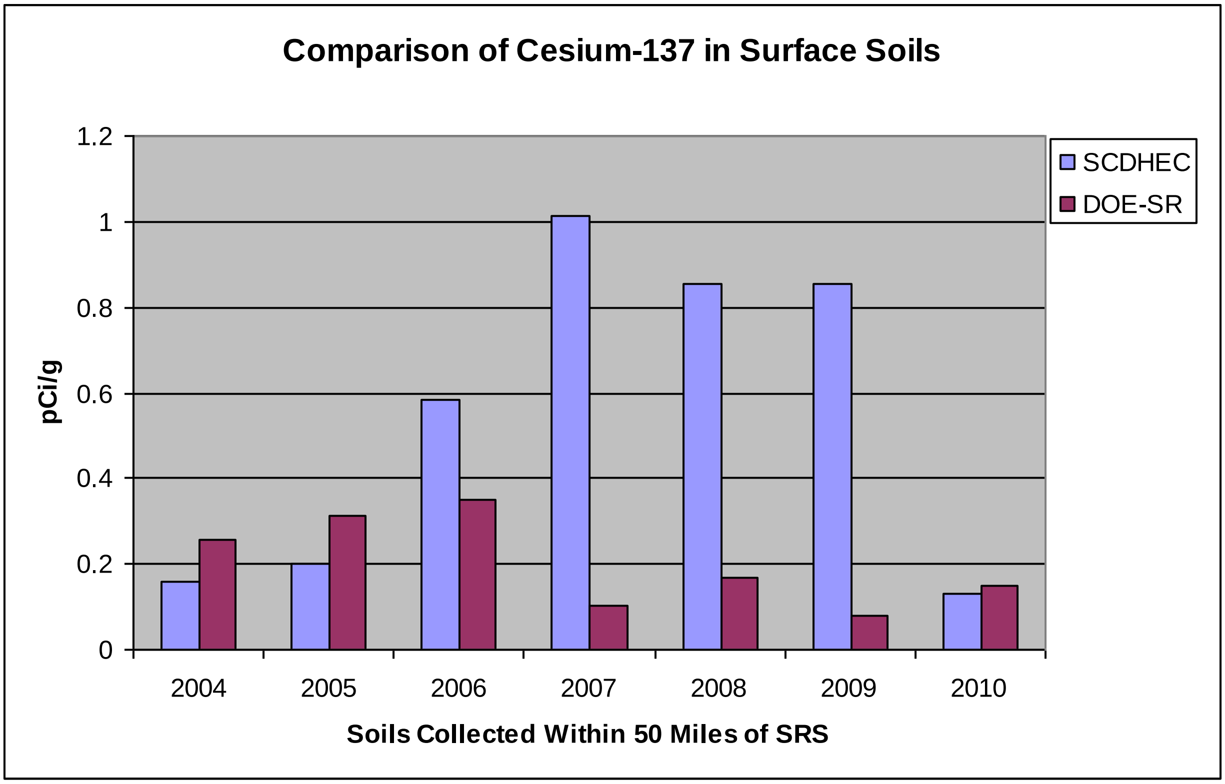


Note: There were no samples collected from riverbank soil from 2005-2006. Only one detection found in the random "E" soil samples. There were no beta detections in any of the "B" soil samples collected in 2009

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Figure 5. SCDHEC and DOE-SR Trending Data for Cesium-137 from 2004-2010



TOC

3.1.4 Data

Surface Soil Monitoring Adjacent to SRS

Notes:

12. LLD= Lower Limit of Detection
13. MDA= Minimum Detectable Activity
14. SS= Surface soil

Surface Soil Monitoring Adjacent to SRS

2010 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SSALN10	SSALG10	SSBWG10	SSDKH10
Collection Date	9/30/2010	9/30/2010	9/30/2010	9/30/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.6	10.5	10.5	10.6
Beta Activity	**11.4**	**9.25**	<LLD	<LLD
Beta Confidence Interval	**6.29**	**6.07**	NA	NA
Beta LLD	**8.73**	**8.68**	8.69	8.77
K-40 Activity	**2.74**	**0.55**	**0.72**	**0.53**
K-40 Confidence Interval	**0.35**	**0.18**	**0.18**	**0.18**
K-40 MDA	**0.16**	**0.12**	**0.11**	**0.13**
Cs-137 Activity	**0.16**	**0.09**	**0.14**	**0.15**
Cs-137 Confidence Interval	**0.02**	**0.02**	**0.02**	**0.02**
Cs-137 MDA	**0.02**	**0.01**	**0.02**	**0.02**
Pb-212 Activity	**1.78**	**0.42**	**0.75**	**1.3**
Pb-212 Confidence Interval	**0.15**	**0.05**	**0.07**	**0.11**
Pb-212 MDA	**0.05**	**0.03**	**0.04**	**0.04**
Pb-214 Activity	**1.47**	**0.41**	**0.63**	**0.88**
Pb-214 Confidence Interval	**0.09**	**0.04**	**0.05**	**0.06**
Pb-214 MDA	**0.05**	**0.03**	**0.04**	**0.04**
Ra-226 Activity	**2.71**	**0.78**	**1.5**	**1.38**
Ra-226 Confidence Interval	**0.62**	**0.39**	**0.42**	**0.44**
Ra-226 MDA	**0.65**	**0.41**	**0.44**	**0.51**
Ac-228 Activity	**1.9**	**0.48**	**0.81**	**1.29**
Ac-228 Confidence Interval	**0.11**	**0.05**	**0.06**	**0.08**
Ac-228 MDA	**0.08**	**0.05**	**0.05**	**0.06**

Note: Units are in pCi/g.
There were no detections in any 2010 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SSGP10	SSJAK10	SSAIK10	SSJAK02 10
Collection Date	9/30/2010	9/30/2010	12/2/2010	12/2/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.6	10.5	10.3	14.7
Beta Activity	**10.6**	**14.2**	<LLD	<LLD
Beta Confidence Interval	**6.25**	**6.54**	NA	NA
Beta LLD	**8.73**	**8.67**	8.57	8.5
K-40 Activity	<MDA	**2.78**	**0.5**	**0.9**
K-40 Confidence Interval	NA	**0.31**	**0.17**	**0.21**
K-40 MDA	0.12	**0.14**	**0.11**	**0.13**
Cs-137 Activity	**0.05**	**0.26**	**0.09**	**0.1**
Cs-137 Confidence Interval	**0.02**	**0.03**	**0.02**	**0.02**
Cs-137 MDA	**0.02**	**0.02**	**0.01**	**0.02**
Pb-212 Activity	**0.64**	**1.08**	**0.38**	**0.58**
Pb-212 Confidence Interval	**0.06**	**0.1**	**0.04**	**0.06**
Pb-212 MDA	**0.04**	**0.05**	**0.03**	**0.04**
Pb-214 Activity	**0.48**	**1.04**	**0.32**	**0.73**
Pb-214 Confidence Interval	**0.04**	**0.07**	**0.04**	**0.05**
Pb-214 MDA	**0.04**	**0.05**	**0.04**	**0.04**
Ra-226 Activity	<MDA	**1.73**	**0.75**	**1.1**
Ra-226 Confidence Interval	NA	**0.52**	**0.36**	**0.4**
Ra-226 MDA	0.44	**0.59**	**0.41**	**0.48**
Ac-228 Activity	**0.66**	**1.1**	**0.43**	**0.6**
Ac-228 Confidence Interval	**0.06**	**0.08**	**0.05**	**0.06**
Ac-228 MDA	**0.05**	**0.07**	**0.05**	**0.06**

Note: Units are in pCi/g.
There were no detections in any 2010 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SSAIK02 10	SSNEL10	SSBWL02 10	SSBWL10
Collection Date	12/2/2010	12/2/2010	12/6/2010	12/6/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	10.4	10.3	10.2	10.2
Beta Activity	**11.4**	**11.4**	**10.1**	<LLD
Beta Confidence Interval	**6.31**	**6.19**	**6.07**	NA
Beta LLD	**8.63**	**8.56**	**8.51**	8.54
K-40 Activity	**2.5**	**0.45**	**0.41**	**0.58**
K-40 Confidence Interval	**0.37**	**0.18**	**0.15**	**0.16**
K-40 MDA	**0.19**	**0.13**	**0.11**	**0.11**
Cs-137 Activity	**0.05**	**0.19**	**0.14**	**0.13**
Cs-137 Confidence Interval	**0.02**	**0.02**	**0.02**	**0.02**
Cs-137 MDA	**0.03**	**0.02**	**0.02**	**0.02**
Pb-212 Activity	**2.13**	**2.13**	**0.85**	**0.55**
Pb-212 Confidence Interval	**0.18**	**0.18**	**0.08**	**0.05**
Pb-212 MDA	**0.06**	**0.06**	**0.04**	**0.03**
Pb-214 Activity	**1.81**	**0.67**	**0.67**	**0.52**
Pb-214 Confidence Interval	**0.1**	**0.05**	**0.05**	**0.04**
Pb-214 MDA	**0.06**	**0.04**	**0.04**	**0.04**
Ra-226 Activity	**3.51**	**1.25**	**1.07**	**0.99**
Ra-226 Confidence Interval	**0.75**	**0.41**	**0.39**	**0.41**
Ra-226 MDA	**0.74**	**0.45**	**0.46**	**0.42**
Ac-228 Activity	**2.07**	**0.82**	**0.79**	**0.59**
Ac-228 Confidence Interval	**0.13**	**0.06**	**0.06**	**0.06**
Ac-228 MDA	**0.09**	**0.05**	**0.05**	**0.05**

Note: Units are in pCi/g.
There were no detections in any 2010 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

Location Description	**SSLHL002**	**SSBH121SR**	**SSBH395SR**	**SSBH194BC**
Collection Date	**2/9/2010**	**3/17/2010**	**3/17/2010**	**3/17/2010**
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	14.4	14	13.8	14.2
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA
Beta LLD	10.5	10.2	10.2	10.4
K-40 Activity	**7.2**	**13.4**	**3.7**	**6.9**
K-40 Confidence Interval	**0.71**	**1.1**	**0.54**	**0.71**
K-40 MDA	**0.23**	**0.22**	**0.24**	**0.22**
Cs-137 Activity	**0.2**	<MDA	**0.23**	**0.11**
Cs-137 Confidence Interval	**0.03**	NA	**0.04**	**0.03**
Cs-137 MDA	**0.02**	0.02	**0.03**	**0.03**
Pb-212 Activity	**0.45**	**0.14**	**1.33**	**0.76**
Pb-212 Confidence Interval	**0.06**	**0.07**	**0.12**	**0.08**
Pb-212 MDA	**0.06**	**0.05**	**0.06**	**0.05**
Pb-214 Activity	**0.59**	**0.47**	**1.11**	**0.67**
Pb-214 Confidence Interval	**0.07**	**0.06**	**0.09**	**0.07**
Pb-214 MDA	**0.06**	**0.06**	**0.06**	**0.07**
Ra-226 Activity	<MDA	**1.26**	**2.54**	**1.86**
Ra-226 Confidence Interval	NA	**0.61**	**0.9**	**0.65**
Ra-226 MDA	0.67	**0.66**	**0.76**	**0.71**
Ac-228 Activity	<MDA	<MDA	1.26	**0.77**
Ac-228 Confidence Interval	NA	NA	0.12	**0.09**
Ac-228 MDA	0.18	0.16	0.1	**0.1**

Note: Units are in pCi/g.
There were no detections in any 2010 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

Location Description	SSPRA001	SSFF001	SSJBL002	SSSCL002
Collection Date	1/28/2010	1/28/2010	1/28/2010	2/9/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	14.1	14.7	13.8	14.4
Beta Activity	<LLD	**23.5**	<LLD	<LLD
Beta Confidence Interval	NA	**8.1**	NA	NA
Beta LLD	10.3	**10.6**	10.2	10.5
K-40 Activity	**12.4**	**18.8**	**3.2**	**2.7**
K-40 Confidence Interval	**1.06**	**1.46**	**0.57**	**0.46**
K-40 MDA	**0.22**	**0.26**	**0.292**	**0.19**
Cs-137 Activity	**0.15**	**0.1**	**0.06**	**0.16**
Cs-137 Confidence Interval	**0.03**	**0.03**	**0.03**	**0.03**
Cs-137 MDA	**0.03**	**0.03**	**0.03**	**0.03**
Pb-212 Activity	**1.25**	**1.26**	**1.33**	**0.98**
Pb-212 Confidence Interval	**0.12**	**0.12**	**0.13**	**0.1**
Pb-212 MDA	**0.06**	**0.06**	**0.06**	**0.06**
Pb-214 Activity	**0.81**	**1.08**	**1.43**	**1.06**
Pb-214 Confidence Interval	**0.08**	**0.09**	**0.09**	**0.08**
Pb-214 MDA	**0.07**	**0.07**	**0.07**	**0.07**
Ra-226 Activity	**2.52**	**1.96**	**2.99**	**2.68**
Ra-226 Confidence Interval	**0.82**	**0.84**	**0.82**	**0.75**
Ra-226 MDA	**0.77**	**0.82**	**0.79**	**0.72**
Ac-228 Activity	**1.22**	**1.24**	**1.44**	**0.9**
Ac-228 Confidence Interval	**0.12**	**0.12**	**0.17**	**0.11**
Ac-228 MDA	**0.11**	**0.12**	**0.11**	**0.1**

Note: Units are in pCi/g.
There were no detections in any 2010 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Beta and Gamma Detections for Public Boat Landing Riverbank Soil Samples

Location Description	SSLHL002	SSBH121SR	SSBH395SR	SSBH194BC
Collection Date	2/9/2010	3/17/2010	3/17/2010	3/17/2010
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	14.4	14	13.8	14.2
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA
Beta LLD	10.5	10.2	10.2	10.4
K-40 Activity	**7.2**	**13.4**	**3.7**	**6.9**
K-40 Confidence Interval	**0.71**	**1.1**	**0.54**	**0.71**
K-40 MDA	**0.23**	**0.22**	**0.24**	**0.22**
Cs-137 Activity	**0.2**	<MDA	**0.23**	**0.11**
Cs-137 Confidence Interval	**0.03**	NA	**0.04**	**0.03**
Cs-137 MDA	**0.02**	0.02	**0.03**	**0.03**
Pb-212 Activity	**0.45**	**0.14**	**1.33**	**0.76**
Pb-212 Confidence Interval	**0.06**	**0.07**	**0.12**	**0.08**
Pb-212 MDA	**0.06**	**0.05**	**0.06**	**0.05**
Pb-214 Activity	**0.59**	**0.47**	**1.11**	**0.67**
Pb-214 Confidence Interval	**0.07**	**0.06**	**0.09**	**0.07**
Pb-214 MDA	**0.06**	**0.06**	**0.06**	**0.07**
Ra-226 Activity	<MDA	**1.26**	**2.54**	**1.86**
Ra-226 Confidence Interval	NA	**0.61**	**0.9**	**0.65**
Ra-226 MDA	0.67	**0.66**	**0.76**	**0.71**
Ac-228 Activity	<MDA	<MDA	1.26	**0.77**
Ac-228 Confidence Interval	NA	NA	0.12	**0.09**
Ac-228 MDA	0.18	0.16	0.1	**0.1**

Note: Units are in pCi/g.
There were no detections in any 2010 boat landing surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Alpha, Beta and Gamma Detections for Random Perimeter "E" (<50 miles) Surface Soil Samples

Location Description	**SSE71**	**SSE74**	**SSE75**
Collection Date	**12/6/2010**	**12/6/2010**	**12/6/2010**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	12.8	13.4	13
Beta Activity	<LLD	**30.7**	<LLD
Beta Confidence Interval	NA	**8.72**	NA
Beta LLD	10.3	**10.7**	10.5
K-40 Activity	**0.75**	**1.1**	**2.86**
K-40 Confidence Interval	**0.33**	**0.43**	**0.5**
K-40 MDA	**0.2**	**0.27**	**0.22**
Cs-137 Activity	**0.17**	**0.17**	**0.15**
Cs-137 Confidence Interval	**0.03**	**0.04**	**0.03**
Cs-137 MDA	**0.03**	**0.04**	**0.03**
Pb-212 Activity	**0.87**	**2.02**	**1**
Pb-212 Confidence Interval	**0.09**	**0.18**	**0.09**
Pb-212 MDA	**0.05**	**0.07**	**0.05**
Pb-214 Activity	**0.8**	**2.07**	**1.08**
Pb-214 Confidence Interval	**0.07**	**0.13**	**0.08**
Pb-214 MDA	**0.06**	**0.09**	**0.06**
Ra-226 Activity	**1.42**	**4.08**	<MDA
Ra-226 Confidence Interval	**0.67**	**1.04**	NA
Ra-226 MDA	**0.66**	**0.97**	**0.7**
Ac-228 Activity	**0.84**	**1.97**	**0.92**
Ac-228 Confidence Interval	**0.09**	**0.15**	**0.1**
Ac-228 MDA	**0.11**	**0.09**	**0.14**

Note: Units are in pCi/g.
There were no detections in any 2010 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Alpha, Beta and Gamma Detections for Random Background "B" (>50 miles) Surface Soil Samples

Location Description	SSB75	SSB77	SSB73
Collection Date	12/7/2010	12/7/2010	12/7/2010
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	12.9	13.1	12.8
Beta Activity	**36.8**	<LLD	**17.1**
Beta Confidence Interval	**8.85**	NA	**7.53**
Beta LLD	**10.4**	10.5	**10.3**
K-40 Activity	**1.9**	**2.26**	**18.7**
K-40 Confidence Interval	**1.46**	**0.42**	**1.42**
K-40 MDA	**0.26**	**0.21**	**0.26**
Cs-137 Activity	**0.26**	**0.38**	**0.29**
Cs-137 Confidence Interval	**0.04**	**0.05**	**0.04**
Cs-137 MDA	**0.03**	**0.03**	**0.04**
Pb-212 Activity	**1.4**	**0.39**	**1.34**
Pb-212 Confidence Interval	**0.13**	**0.05**	**0.06**
Pb-212 MDA	**0.06**	**0.05**	**0.06**
Pb-214 Activity	**1.36**	**0.45**	**1.22**
Pb-214 Confidence Interval	**0.09**	**0.06**	**0.09**
Pb-214 MDA	**0.07**	**0.06**	**0.07**
Ra-226 Activity	**2.91**	<MDA	**2.6**
Ra-226 Confidence Interval	**0.96**	NA	**0.87**
Ra-226 MDA	**0.8**	0.65	**0.77**
Ac-228 Activity	**1.43**	<MDA	**1.46**
Ac-228 Confidence Interval	**0.13**	NA	**0.12**
Ac-228 MDA	**0.11**	0.16	**0.11**

Note: Units are in pCi/g.

There were no detections in any 2010 surface soil samples above the MDA for: Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Ce-144, Eu-152, Eu-154, Eu-155, and Am-241.

Surface Soil Monitoring Adjacent to SRS

2010 Metals Detections for Nonrandom Perimeter Surface Soil Samples

Location Description	SSALN10	SSALG10	SSBWG10	SSDKH10
Collection Date	**9/30/2010**	**9/30/2010**	**9/30/2010**	**9/30/2010**
Analyte				
Barium in Soil	**60**	**19**	**11**	**11**
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	**11**	**1.8**	**2.3**	**2.2**
Copper in Soil	**14**	**1.1**	<1.0	<1.0
Lead in Soil	**60**	**15**	**5.7**	**6.6**
Manganese in Soil	**67**	**110**	**27**	**60**
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Nickel in Soil	**3.3**	<2.0	<2.0	<2.0
Zinc in Soil	**55**	**3**	**2.1**	**3.5**

Location Description	SSGP10	SSJAK10	SSAIK10	SSJAK0210
Collection Date	**9/30/2010**	**9/30/2010**	**12/2/2010**	**12/2/2010**
Analyte				
Barium in Soil	**6.3**	**28**	**5.3**	**16**
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	**3.4**	**2.1**	<1.0	**2.2**
Copper in Soil	<1.0	**1.7**	<1.0	**1.1**
Lead in Soil	**5.6**	**11**	<5.0	**6**
Manganese in Soil	**41**	**370**	**10**	**110**
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Nickel in Soil	<2.0	<2.0	<2.0	<2.0
Zinc in Soil	**2.7**	**2.6**	**1.4**	**8.5**

Location Description	SSAIK0210	SSNEL10	SSBWL0210	SSBWL10
Collection Date	**12/2/2010**	**12/2/2010**	**12/6/2010**	**12/6/2010**
Analyte				
Barium in Soil	**47**	**12**	**11**	**11**
Cadmium in Soil	**1.7**	<1.0	<1.0	<1.0
Chromium in Soil	**17**	**2.1**	**1.6**	**1.4**
Copper in Soil	**3.5**	<1.0	<1.0	<1.0
Lead in Soil	**11**	**7.7**	<5.0	**12**
Manganese in Soil	**160**	**15**	**39**	**47**
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Nickel in Soil	**3.2**	<2.0	<2.0	<2.0
Zinc in Soil	**12**	**3.7**	**1.8**	**2.2**

Note: Units are in mg/kg.

TOC

3.1.5 Summary Statistics

Surface Soil Monitoring Adjacent to SRS

9. Notes: N/A = Not Applicable

Surface Soil Monitoring Adjacent to SRS

2010 Summary Statistics – SCDHEC Surface Soil Metals Data
Nonrandom Perimeter Samples

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Barium	19.8	17	11.5	5.3	60	12	12
Cadmium	N/A	N/A	1.7	1.7	1.7	12	1
Chromium	4.3	5	2.2	1.4	17	12	11
Copper	4.3	5.5	1.7	1.1	14	12	5
Lead	14	16.5	9.4	5.6	60	12	10
Manganese	88	99.2	53.5	10	370	12	12
Mercury	N/A	N/A	N/A	N/A	N/A	12	0
Zinc	8.2	15	2.9	1.4	55	12	12
Nickel	3.3	0.07	3.2	3.2	3.3	12	2

Note: Units are in mg/kg.

2010 Summary Statistics – SCDHEC Surface Soil Radiological Data
Nonrandom Perimeter Samples

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	12	0
Beta	11.2	1.6	11.4	9.3	14.2	12	7
K-40	1.2	0.99	0.58	0.41	2.8	12	11
Cs-137	0.13	0.06	0.13	0.05	0.26	12	12
Pb-212	1	0.64	0.8	0.38	2.1	12	12
Pb-214	0.8	0.44	0.67	0.32	1.81	12	12
Ra-226	1.5	0.86	1.3	0.75	3.5	12	11
Ac-228	0.96	0.54	0.8	0.43	2	12	12

Note: Units are in pCi/g.

2010 Summary Statistics – SCDHEC Surface Soil Radiological Data
Public Boat Landings

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	13	0
Beta	21.9	6.9	23.9	11.8	27.7	13	4
K-40	9.7	6	7.3	2.7	18.8	13	12
Cs-137	0.18	0.16	0.14	0.06	0.65	13	12
Pb-212	1.1	0.49	1.26	0.15	1.67	13	13
Pb-214	1.04	0.39	1.08	0.47	1.6	13	13
Ra-226	2.57	0.66	2.63	1.26	3.38	13	11
Ac-228	1.3	0.31	1.26	0.74	1.72	13	10

Note: Units are in pCi/g.

Surface Soil Monitoring Adjacent to SRS Summary Statistics

2010 Summary Statistics – SCDHEC Surface Soil Radiological Data
Random Perimeter "E" Samples and Background "B" Samples

Analyte	AVG:	Standard Deviation	Median	Minimum	Maximum	Total Number Sampled	Number of Detections
Alpha	N/A	N/A	N/A	N/A	N/A	6	0
Beta	28.2	10.1	30.7	17.1	36.8	6	3
K-40	4.6	6.9	2.1	0.8	18.7	6	6
Cs-137	0.24	0.09	0.22	0.15	0.38	6	6
Pb-212	1.2	0.6	1.2	0.4	2	6	6
Pb-214	1.2	0.5	1.2	0.5	2.1	6	6
Ra-226	2.8	1.1	2.8	1.4	4.1	6	4
Ac-228	1.3	0.5	1.4	0.8	2	6	5

Note: Units are in pCi/g.

TOC

3.2 Radiological Monitoring of Terrestrial Vegetation Related to the Savannah River Site

3.2.1 Summary

Terrestrial vegetation can be contaminated externally by direct deposition of airborne materials, water runoff, and precipitation that contains radioactivity. Vegetation can also be contaminated internally by uptake of radionuclides through the roots. Contaminated vegetation can be transported by physical means and, if eaten by animals, this radioactivity can enter the food chain. As with all ionizing radiation, exposure to tritium and cesium-137 (Cs-137) can increase the risk of developing cancer.

The Department of Energy-Savannah River (DOE-SR) contracts for the collection and analysis of terrestrial vegetation, primarily Bermuda grass, to determine concentrations of radionuclides (SRNS 2011). The samples are obtained from twelve locations at the Savannah River Site (SRS) perimeter. The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) monitors for the presence of radionuclides in vegetation around SRS, collecting leaves from broad-leafed evergreen trees and shrubs, such as wax myrtle (*Myrica cerifera*), laurel oak (*Quercus laurifolia*), or Carolina laurelcherry (*Prunus caroliniana*).

In 2010 ESOP conducted independent vegetation monitoring at 17 locations along the perimeter of SRS as well as three former SRS monitoring locations 25 miles from the center of SRS. Sampling was performed on a quarterly basis with samples obtained in February, March, June, September, and December. ESOP and DOE-SR perimeter stations sampled in 2010 are shown in Section 3.2.2.

Samples from all 17 perimeter stations exhibited tritium levels greater than the Lower Limit of Detection (LLD), with the highest activity found on the eastern side of SRS. Vegetation was collected for gamma analysis at nine perimeter locations. Cesium-137 (Cs-137) was detected at all but two of these locations, with the highest activities from stations on the northern side of SRS. Cs-137 levels were consistent with historical values while tritium levels appear to have increased, particularly at AKN-002 and BWL-009.

In addition to routine sampling, six vegetation samples were obtained to provide a baseline before startup of the Mixed Oxide Facility (MOX) at SRS, three from within 50 miles of the SRS

centerpoint and three from greater than 50 miles from the SRS centerpoint. All of the samples were analyzed for plutonium-238 (Pu-238), plutonium-239/240 (Pu-239/240), uranium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238).

Tables and figures depicting average sample results as well as comparisons with SRS data are in Section 3.2.3. Sample results for Cs-137 and tritium are given in Section 3.2.4; summary statistics are in Section 3.2.5.

Results and Discussion

Results from vegetation analyses are included in Section 3.2.4; summary statistics are presented in Section 3.2.5. Cobalt-60 (Co-60) and Americium-241 (Am-241) were not detected during 2010. Cs-137 and tritium were detected at several locations in all four quarters of the year.

Tritium in Vegetation

Tritium is a naturally occurring radioisotope of hydrogen that is normally found in very low concentrations (USEPA 2007 a). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases on SRS include both atmospheric and liquid contributions (SRNS 2011). Although the United States Environmental Protection Agency (USEPA) has not established a Maximum Contaminant Level (MCL) for tritium in solid media (e.g. vegetation), the MCL for drinking water has been set at 20,000 picocuries per liter (pCi/L) (USEPA 2008 a).

Tritium was detected in vegetation from all of the 17 perimeter sites sampled in 2010. The highest tritium levels detected during 2010 for each quarter were:

- Quarter 1 (February): BWL-002 at 3824 pCi/L (wax myrtle)
- Quarter 2 (June): AKN-005 at 899 pCi/L (laurel oak)
- Quarter 3 (September): AKN-002 at 2472 pCi/L (wax myrtle)
- Quarter 4 (December): BWL-002 at 1179 pCi/L (wax myrtle)

Tritium levels at each of the three 25-mile radius stations were less than the LLD.

Two of the four highest quarterly tritium detections in 2010 were from BWL-002, located on the eastern side of SRS. AKN-002 and AKN-005 are on the west and north sides of SRS, respectively. This represents a departure from years past that tended to show the highest activity levels on SRS' west side (Figures 1 and 2; SCDHEC 2010 c). The reason for this departure is unclear but could be due to such factors as wind direction or rainfall on a given sampling day or during the days preceding it. Samples were also collected at three stations located 25 miles from the SRS centerpoint; all tritium results were <LLD.

Tritium analysis results from SCDHEC and DOE-SR sampling are presented in Section 3.2.3, Table 1. However, differences between the two programs in sampling dates, the vegetation sampled, and analysis methods should be considered during comparison. Data comparison of associated locations from the two programs was conducted by converting from pCi/g to pCi/L, using a dry/wet weight ratio of 0.3 furnished by DOE-SR, using the formula:

$$pCi/L = [pCi/g \times (1/0.3)] / (1 - 0.3) \times 1g/mL \times 1000mL/L.$$

The two colocations at Patterson Mill Road and the Allendale Gate showed differing levels of tritium activity. The Patterson Mill Road DOE-SR sample showed a tritium activity level of

<MDC while the corresponding ESOP sample, BWL-004, showed tritium activity at 493 pCi/L. Colocated samples at the Allendale Gate both showed tritium activity, with the DOE-SR sample showing 381 pCi/L and the ESOP sample, BWL-006, showing 397 pCi/L (SRNS 2011).

The DOE-SR program detected tritium from nine perimeter stations that had comparable ESOP locations in 2010 (SRNS 2011); ESOP detected tritium at eight comparable locations. The DOE-SR average, 341 (± 154) pCi/L, was within one standard deviation of the ESOP average, 1073 (± 1239) pCi/L, however these numbers are somewhat misleading. In a distribution of numbers with a large outlier (i.e. the ESOP tritium data), the median is the better measure of central tendency because that outlier skews the mean value; the DOE-SR median value was 333 pCi/L and the ESOP median value was 487 pCi/L.

Furthermore, when the ESOP detection of 3824 pCi/L at BWL-002 isn't included in the calculations the ESOP average, standard deviation, and median fall to 680 pCi/L, 592 pCi/L, and 481 pCi/L respectively. These numbers are much more in line with the DOE-SR data. All measures of central tendency and standard deviation were calculated using detections only. Additionally, if an ESOP location corresponded to more than one DOE-SR location, the result was used only once.

Gamma in Vegetation

The naturally occurring isotopes potassium-40 (K-40) and beryllium-7 (Be-7) were detected from all stations where gamma samples were collected in 2010. The lead (Pb) isotopes Pb-212 and Pb-214 were also detected, but not from all locations. Because these are naturally occurring isotopes the results will not be discussed in this section, but are presented in Section 3.2.4.

Cesium-137 is a man-made fission product and was a constituent of air and water releases on SRS, mainly from F and H-Areas. Liquid releases also occurred from the production reactors as a result of leaking fuel elements in the 1950s and 1960s (WSRC 1999 a).

Cesium-137 was detected at seven of the nine perimeter stations sampled in 2010, and five of these stations produced Cs-137 results greater than the Minimum Detectable Activity (MDA) in all four quarters (Section 3.2.4). AKN-008 exhibited the highest Cs-137 activity in all four quarters: 0.38 pCi/g in March, 0.62 pCi/g in June, 0.64 pCi/g in September, and 0.44 pCi/g in December. AKN-008 is located off Highway 278 on the north end of SRS.

Results of analysis for Cs-137 at four of nine perimeter sampling locations followed what appear to be downward trends in 2010 (Figure 3; SCDHEC 2010 c). AKN-001 has shown a decrease in average activity every year since 2007; AKN-003 has decreased from 2009 levels and AKN-005 and AKN-006 since have decreased since 2006. Stations AKN-002 and BWL-004 showed no change from 2009 levels.

Contrary to recent trends (Figure 3; SCDHEC 2010 c), sampling locations AKN-008, ALD-001, and BWL-006 each showed an average Cs-137 activity increase relative to 2009. ALD-001 showed the largest increase, going from 0.15 pCi/g to 0.20 pCi/g. AKN-008, located on the north side of SRS, showed the highest average Cs-137 activity during 2010, at 0.52 pCi/g, an increase of 0.02 pCi/g from 2009. Although each of these activity increases is likely due to local wind or rainfall variations, next year's results will merit close scrutiny to determine whether an upward trend is developing.

Gamma analysis results for Cs-137 from ESOP and DOE-SR sampling in 2010 are presented in Section 3.2.3, Table 2. The Patterson Mill Road/BWL-004 colocation showed similar results: 0.08 (±0.03) pCi/g and 0.11 (±0.02) pCi/g (SRNS 2011). The Allendale Gate/BWL-006 colocation exhibited dissimilar results: 0.70 (±0.06) pCi/g and 0.23 (±0.06) pCi/g. Differences in analysis and sampling methods may account for this disparity.

For the other DOE-SR stations, the closest ESOP stations were selected for comparison, except for the DOE-SR Highway 21/167 detection of 0.28 (±0.06) pCi/g (SRNS 2011). This gamma sampling location does not have a corresponding ESOP sampling location and any attempted comparison would be invalid. For this reason, it was not used for calculating the DOE-SR mean, median, and standard deviation.

DOE-SR detected Cs-137 at 10 of 11 sampling stations that had a comparable ESOP location or collocation. ESOP had detections at 7 of 11 comparable locations, although some ESOP locations correspond with more than one DOE-SR location. When this is taken into account, ESOP detected CS-137 at five of eight comparable locations. There were additional Cs-137 detections at ALD-001. However, DOE-SR does not have a sampling location nearby so no comparison can be made.

Average Cs-137 levels at the Table 2 locations were also compared, using only detections to calculate the mean, median, and standard deviation. If an ESOP station corresponded to more than one DOE-SR station, BWL-004 for example, the result was used only once for calculations. The DOE-SR average 0.151 (±0.200) pCi/g (SRNS 2011) was within one standard deviation of the ESOP average 0.224 (±0.104) pCi/g. Taken in total, the DOE-SR and ESOP data are similar.

MOX Baseline Samples

Six samples taken from South Carolina locations were analyzed for Pu-238, Pu-239/240, U-234, U-235, and U-238. U-234 and U-238 were detected at all six locations and U-235 at four locations. This was not unexpected as these three radioisotopes are naturally occurring radioactive material. The transuranics Pu-238 and Pu-239 were detected in three and one locations, respectively. The highest Pu-238 detection came from the town of St. Matthews, at .0012 pCi/g; the Pu-239 detection also came from St. Matthews, at .0005 pCi/g.

St. Matthews is approximately 60 miles northeast of SRS. Pu has been dispersed throughout the environment from weapons tests, the reentry of satellites that utilized Pu-238 power sources, Chernobyl, and releases from various nuclear materials production facilities (USEPA 2011). However, the ultimate sources of these detections are unknown.

Conclusions and Recommendations

ESOP conducted independent vegetation monitoring in 2010 at 17 locations around the perimeter of SRS and three locations 25 miles from the center of SRS. Tritium was detected in vegetation from all 17 of the perimeter stations, but none of the 25-mile stations. In contrast to recent years, the highest activity samples were generally obtained from the north and east sides of SRS.

ESOP data supports the DOE-SR conclusion that elevated tritium levels at the site perimeter are due to atmospheric releases from SRS, although Plant Vogtle, a commercial nuclear power plant across the Savannah River from SRS, may also have an effect. Tritium levels decrease with increasing distance from SRS facilities.

A comparison of ESOP and DOE-SR tritium data was performed. Tritium was detected at both colocations; by ESOP at the Patterson Mill/BWL-004 location and by both DOE-SR and ESOP at the Allendale Gate/BWL-006 location (SRNS 2011). DOE-SR and ESOP detected tritium from nine perimeter stations (Section 3.2.3, Table 1) with comparable locations. While the DOE-SR and ESOP tritium data sets appear to be dissimilar, having significantly different means due to a relatively high detection at BWL-002, a comparison of the median values shows similar results that are within one standard deviation of each other.

There are differences in analysis and sampling methods between the programs (e.g., ESOP collects leaves from trees, whereas DOE-SR conducts annual grass collections). Perhaps reconciling ESOP and DOE-SR methods would provide better comparability of data. Additionally, DOE-SR data are reported in pCi/g without denoting whether this activity relates to a gram of water or a gram of wet vegetation. ESOP recommends that DOE-SR report tritium activity in a different manner, such as pCi/ml as in previous reports, to reflect the tritium activity in the water extracted from the sample.

A comparison of DOE-SR data and ESOP Cs-137 data was also performed. DOE-SR and ESOP data were similar, within one standard deviation of each other. For the most part, Cs-137 activity followed the overall trends seen in recent years, the exception being BWL-006, which decreased from 2008 to 2009 but increased from 2009 to 2010. Six of these locations showed either decreasing or static activity. However, three locations showed increases relative to 2009 levels and warrant future scrutiny to determine whether an upward trend is developing.

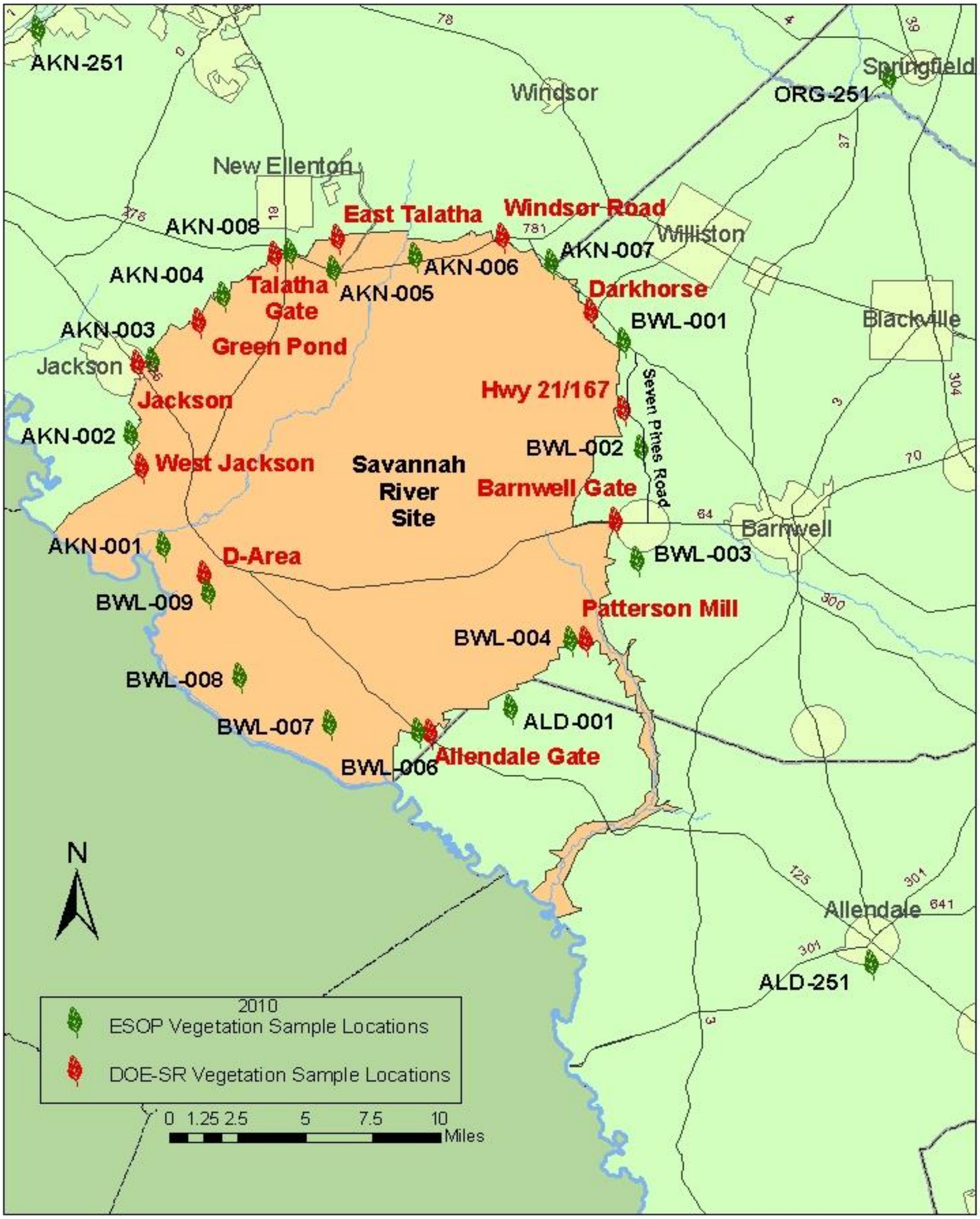
It is unclear why these sites have higher cesium levels, as they are not located near SRS facilities, or in areas known to be affected by past releases. A review of the deposition plume from the 1955 Teapot Hornet test (Till et al. 2001) showed the highest radiation levels were not associated with the areas where ESOP finds the highest Cs-137 levels in vegetation.

TOC

3.2.2 Radiological Monitoring of Terrestrial Vegetation

Map 1. ESOP and DOE-SR Radiological Vegetation Sampling Locations, 2010

3.2.3 Tables and Figures



[TOC](#)

Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

Figure 1. Tritium in Vegetation at SRS Perimeter, 2006-2010

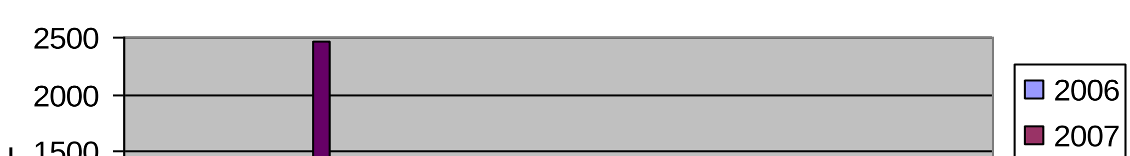
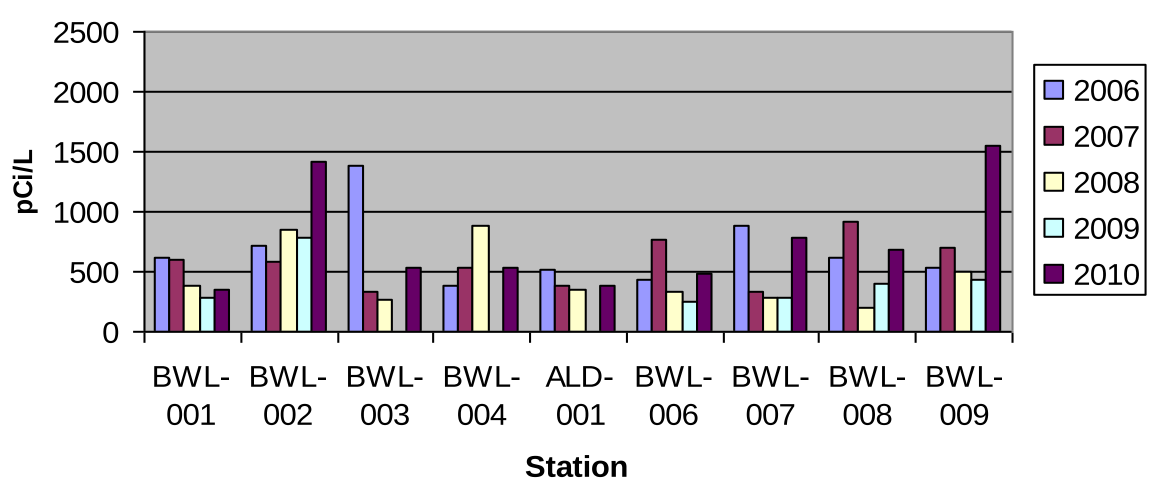


Figure 2. Tritium in Vegetation at SRS Perimeter, 2006-2010

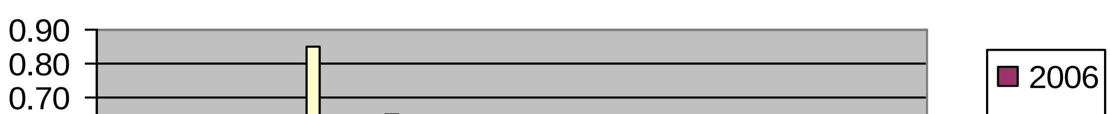


Notes:
(1) These graphs depict the average of all detections for calendar years 2006-2010 by sampling station.
(2) 2009 was the first year AKN-008 was sampled for tritium.
(3) Missing bars indicate an average that was less than the lower limit of detection.

Tables and Figures

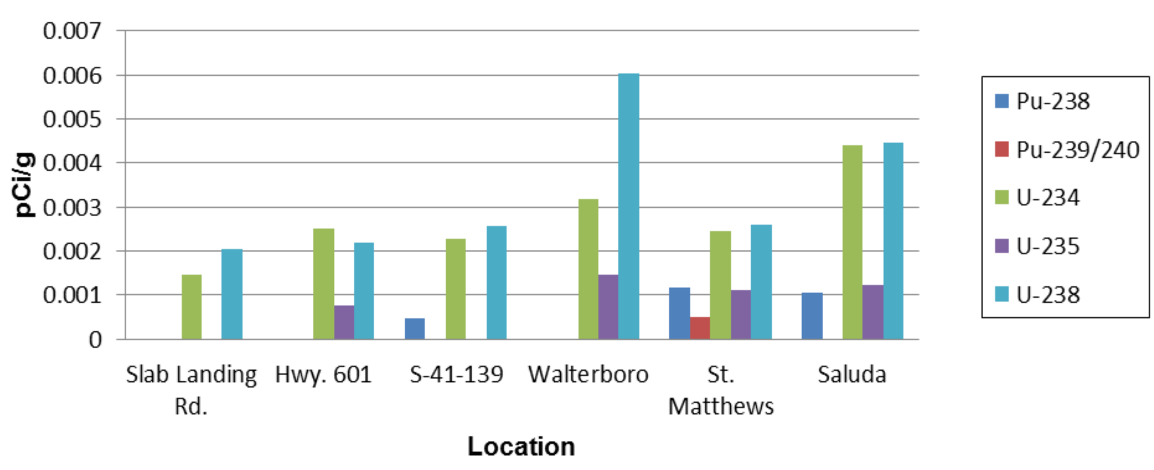
Radiological Monitoring of Terrestrial Vegetation

Figure 3: Average Cs-137 at SRS Perimeter, 2006-2010



Note:
This graph depicts the average of all detections for calendar years 2006-2010 by sampling station. Missing bars indicate an average that was less than the minimum detectable activity.

Figure 4: MOX Startup Study



Note:
Missing bars represent levels that were less than minimum detectable activity.

Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

Table 1. Comparison of Tritium Analyses, DOE-SR and ESOP Data, 2010

DOE-SR DATA (WSRC 2010)		Tritium			ESOP Data	Tritium		
Station	Date	pCi/g	Confidence Interval	pCi/L	Station	Date	pCi/L	Confidence Interval
D-Area	4/13/2010	0.12	0.02	571	BWL-009 b	3/12/2010	1966	144
West Jackson	4/13/2010	0.06	0.02	258	AKN-002 b	2/23/2010	<LLD	
Jackson	4/13/2010	0.07	0.02	333	AKN-003 b	3/19/2010	805	111
Green Pond	4/13/2010	0.05	0.02	238	AKN-004 b	3/19/2010	268	90
Talatha Gate	4/14/2010	0.12	0.02	571	AKN-005 b	3/18/2010	<LLD	
East Talatha	4/27/2010	<MDC			AKN-006 b	3/18/2010	<LLD	
Windsor Road	4/14/2010	0.04	0.02	190	AKN-007 b	2/23/2010	481	99
Darkhorse	4/14/2010	<MDC			BWL-001 b	2/23/2010	352	95
Highway 21/167	4/27/2010	0.08	0.02	381	BWL-002 b	2/23/2010	3824	189
Barnwell Gate	4/13/2010	0.03	0.01	143	BWL-004b	3/5/2010	493	100
Patterson Mill Road	4/13/2010	<MDC			BWL-004 c	3/5/2010	493	100
Allendale Gate	4/13/2010	0.05	0.02	381	BWL-006 c	3/5/2010	397	96

Average	341	**Average**	1073
Std Dev	154	**Std Dev**	1239
Median	333	**Median**	487

<MDC denotes less than the SRNS Minimum Detectable Concentration
<LLD denotes less than reported Lower Limit of Detection
Without BWL-002, the ESOP average is 680 pCi/L, the standard deviation is 592 pCi/L, and the median is 481 pCi/l
b Comparable ESOP location c Colocation

Table 2. Comparison of Cs-137 Analyses, DOE-SR and ESOP Data, 2010

DOE-SR DATA		Cs-137		ESOP DATA		Cs-137	
Location	Date	pCi/g (dry)	Confidence Interval	Station	Date	pCi/g (fresh)	Confidence Interval
D-Area	4/13/2010	0.08	0.03	AKN-001[a]	3/29/2010	<MDA	
West Jackson	4/13/2010	0.05	0.04	AKN-002[a]	2/23/2010	<MDA	
Jackson	4/13/2010	0.04	0.03	AKN-003[a]	3/19/2010	0.15	0.02
Green Pond	4/13/2010	<MDC		AKN-003[a]	3/19/2010	0.15	0.02
Talatha Gate	4/13/2010	0.06	0.04	AKN-008[a]	3/18/2010	0.38	0.04
East Talatha	4/27/2010	0.23	0.05	AKN-005[a]	3/18/2010	0.25	0.03
Windsor Road	4/14/2010	0.11	0.05	AKN-006[a]	3/18/2010	<MDA	
Darkhorse	4/14/2010	0.08	0.04	AKN-006[a]	3/18/2010	<MDA	
Barnwell Gate	4/13/2010	0.08	0.03	BWL-004[a]	3/5/2010	0.11	0.02
Patterson Mill Road[b]	4/13/2010	0.08	0.03	BWL-004[b]	3/5/2010	0.11	0.02
Allendale Gate[b]	4/13/2010	0.70	0.06	BWL-006[b]	3/5/2010	0.23	0.06

Average	0.151	**Average**	0.224
Std Dev	0.200	**Std Dev**	0.104
Median	0.080	**Median**	0.23

<MDC denotes less than the WSRC Minimum Detectable Concentration
<LLD denotes less than reported Lower Limit of Detection
[a] **Comparable ESOP location** [b] **Colocation**

TOC

3.2.4 Data

Radiological Monitoring of Terrestrial Vegetation

Notes:

1. pCi/L - picocuries per liter
2. pCi/g - picocuries per gram
3. LLD - Lower Limit of Detection
4. MDA - Minimum Detectable Activity

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2010 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/19/10	06/18/10	09/24/10	12/30/10
VG AKN-001	Tritium Activity	406	319	<LLD	625
VG AKN-001	Tritium Confidence Interval	96	89	NA	112
VG AKN-001	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/23/10	06/04/10	09/24/10	12/16/10
VG AKN-002	Tritium Activity	<LLD	<LLD	2472	<LLD
VG AKN-002	Tritium Confidence Interval	NA	NA	162	NA
VG AKN-002	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/19/10	06/18/10	09/28/10	12/30/10
VG AKN-003	Tritium Activity	805	435	785	<LLD
VG AKN-003	Tritium Confidence Interval	111	92	114	NA
VG AKN-003	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/19/10	06/18/10	09/28/10	12/30/10
VG AKN-004	Tritium Activity	268	493	320	292
VG AKN-004	Tritium Confidence Interval	90	96	102	100
VG AKN-004	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/18/10	06/18/10	09/28/10	12/23/10
VG AKN-005	Tritium Activity	<LLD	899	<LLD	404
VG AKN-005	Tritium Confidence Interval	NA	110	NA	105
VG AKN-005	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/18/10	06/11/10	09/28/10	12/23/10
VG AKN-006	Tritium Activity	<LLD	<LLD	262	274
VG AKN-006	Tritium Confidence Interval	NA	NA	98	100
VG AKN-006	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/23/10	06/04/10	09/23/10	12/16/10
VG AKN-007	Tritium Activity	481	320	669	853
VG AKN-007	Tritium Confidence Interval	99	89	113	119
VG AKN-007	Tritium LLD	187	186	212	213

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2010 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/18/10	06/18/10	09/28/10	12/23/10
VG AKN-008	Tritium Activity	<LLD	667	436	384
VG AKN-008	Tritium Confidence Interval	NA	101	104	103
VG AKN-008	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/23/10	06/04/10	09/23/10	12/23/10
VG BWL-001	Tritium Activity	352	204	<LLD	477
VG BWL-001	Tritium Confidence Interval	95	87	NA	107
VG BWL-001	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/23/10	06/04/10	09/23/10	12/16/10
VG BWL-002	Tritium Activity	3824	320	320	1179
VG BWL-002	Tritium Confidence Interval	189	89	102	129
VG BWL-002	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/05/10	06/04/10	09/23/10	12/16/10
VG BWL-003	Tritium Activity	<LLD	<LLD	378	700
VG BWL-003	Tritium Confidence Interval	NA	NA	106	115
VG BWL-003	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/05/10	06/04/10	09/24/10	12/23/10
VG BWL-004	Tritium Activity	493	<LLD	785	304
VG BWL-004	Tritium Confidence Interval	100	NA	114	101
VG BWL-004	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/05/10	06/11/10	09/24/10	12/30/10
VG ALD-001	Tritium Activity	441	320	<LLD	366
VG ALD-001	Tritium Confidence Interval	97	89	NA	104
VG ALD-001	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/05/10	06/11/10	09/24/10	12/30/10
VG BWL-006	Tritium Activity	397	436	494	627
VG BWL-006	Tritium Confidence Interval	96	92	107	112
VG BWL-006	Tritium LLD	187	186	212	213

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2010 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/12/10	06/11/10	09/24/10	12/23/10
VG BWL-007	Tritium Activity	<LLD	494	<LLD	1076
VG BWL-007	Tritium Confidence Interval	NA	96	NA	126
VG BWL-007	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/12/10	06/11/10	09/24/10	12/30/10
VG BWL-008	Tritium Activity	361	726	727	940
VG BWL-008	Tritium Confidence Interval	94	105	116	121
VG BWL-008	Tritium LLD	187	186	212	213

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/12/10	06/11/10	09/24/10	12/30/10
VG BWL-009	Tritium Activity	1966	823	2214	1173
VG BWL-009	Tritium Confidence Interval	144	118	150	127
VG BWL-009	Tritium LLD	183	208	182	209

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/05/10	05/19/10	09/23/10	12/16/10
VG AKN-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG AKN-251	Tritium Confidence Interval	NA	NA	NA	NA
VG AKN-251	Tritium LLD	183	208	182	209

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	03/12/10	05/28/10	09/23/10	12/16/10
VG ORG-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG ORG-251	Tritium Confidence Interval	NA	NA	NA	NA
VG ORG-251	Tritium LLD	183	208	182	209

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/23/10	05/28/10	09/23/10	12/16/10
VG ALD-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG ALD-251	Tritium Confidence Interval	NA	NA	NA	NA
VG ALD-251	Tritium LLD	183	208	182	209

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2010 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	03/29/10	06/18/10	09/24/10	12/30/10
VGAKN-001	Be-7 Activity	3.149	1.165	1.500	1.193
VGAKN-001	Be-7 Confidence Interval	0.448	0.326	0.370	0.328
VGAKN-001	Be-7 MDA	0.290	0.270	0.310	0.344
VGAKN-001	K-40 Activity	1.523	2.941	2.300	2.121
VGAKN-001	K-40 Confidence Interval	0.261	0.342	0.290	0.300
VGAKN-001	K-40 MDA	0.109	0.114	0.120	0.116
VGAKN-001	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Co-60 MDA	0.014	0.015	0.010	0.015
VGAKN-001	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Cs-137 MDA	0.016	0.016	0.010	0.016
VGAKN-001	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Pb-212 MDA	0.036	0.029	0.030	0.028
VGAKN-001	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Pb-214 MDA	0.040	0.038	0.040	0.043
VGAKN-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Am-241 MDA	0.116	0.117	0.110	0.115

	Results (pCi/g) fresh weight	02/23/10	06/04/10	09/24/10	12/16/10
VGAKN-002	Be-7 Activity	3.358	0.962	1.180	1.492
VGAKN-002	Be-7 Confidence Interval	0.686	0.357	0.316	0.567
VGAKN-002	Be-7 MDA	0.513	0.310	0.320	0.508
VGAKN-002	K-40 Activity	2.180	4.065	3.430	1.946
VGAKN-002	K-40 Confidence Interval	0.371	0.400	0.386	0.285
VGAKN-002	K-40 MDA	0.158	0.121	0.140	0.151
VGAKN-002	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Co-60 MDA	0.018	0.014	0.014	0.015
VGAKN-002	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Cs-137 MDA	0.020	0.016	0.017	0.017
VGAKN-002	Pb-212 Activity	0.098	<MDA	0.082	<MDA
VGAKN-002	Pb-212 Confidence Interval	0.030	NA	0.026	NA
VGAKN-002	Pb-212 MDA	0.035	0.035	0.030	0.037
VGAKN-002	Pb-214 Activity	0.404	0.165	0.284	0.235
VGAKN-002	Pb-214 Confidence Interval	0.045	0.032	0.037	0.036
VGAKN-002	Pb-214 MDA	0.040	0.034	0.033	0.033
VGAKN-002	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Am-241 MDA	0.155	0.123	0.132	0.120

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2010 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	03/19/10	06/18/10	09/28/10	12/30/10
VGAKN-003	Be-7 Activity	3.225	1.185	1.880	1.492
VGAKN-003	Be-7 Confidence Interval	0.489	0.320	0.357	0.567
VGAKN-003	Be-7 MDA	0.320	0.282	0.266	0.508
VGAKN-003	K-40 Activity	1.724	2.128	1.660	1.946
VGAKN-003	K-40 Confidence Interval	0.263	0.307	0.268	0.285
VGAKN-003	K-40 MDA	0.135	0.119	0.132	0.151
VGAKN-003	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Co-60 MDA	0.013	0.014	0.013	0.015
VGAKN-003	Cs-137 Activity	0.153	0.064	0.113	<MDA
VGAKN-003	Cs-137 Confidence Interval	0.022	0.016	0.025	NA
VGAKN-003	Cs-137 MDA	0.014	0.016	0.016	0.017
VGAKN-003	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Pb-212 MDA	0.034	0.034	0.033	0.037
VGAKN-003	Pb-214 Activity	<MDA	<MDA	<MDA	0.235
VGAKN-003	Pb-214 Confidence Interval	NA	NA	NA	0.036
VGAKN-003	Pb-214 MDA	0.039	0.040	0.040	0.033
VGAKN-003	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Am-241 MDA	0.116	0.110	0.120	0.120

	Results (pCi/g) fresh weight	03/18/10	06/18/10	09/28/10	12/23/10
VGAKN-005	Be-7 Activity	2.962	1.069	1.880	1.046
VGAKN-005	Be-7 Confidence Interval	0.463	0.315	0.357	0.502
VGAKN-005	Be-7 MDA	0.302	0.313	0.266	0.545
VGAKN-005	K-40 Activity	1.839	2.203	1.660	1.704
VGAKN-005	K-40 Confidence Interval	0.266	0.305	0.268	0.256
VGAKN-005	K-40 MDA	0.119	0.129	0.132	0.127
VGAKN-005	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Co-60 MDA	0.016	0.016	0.013	0.014
VGAKN-005	Cs-137 Activity	0.251	0.560	0.113	0.285
VGAKN-005	Cs-137 Confidence Interval	0.032	0.052	0.025	0.034
VGAKN-005	Cs-137 MDA	0.016	0.017	0.016	0.016
VGAKN-005	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Pb-212 MDA	0.034	0.035	0.033	0.032
VGAKN-005	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Pb-214 MDA	0.037	0.038	0.040	0.038
VGAKN-005	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Am-241 MDA	0.114	0.110	0.119	0.121

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2010 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	03/18/10	06/11/10	09/28/10	12/23/10
VGAKN-006	Be-7 Activity	3.106	0.719	1.780	2.062
VGAKN-006	Be-7 Confidence Interval	0.458	0.303	0.379	0.472
VGAKN-006	Be-7 MDA	0.275	0.307	0.309	0.463
VGAKN-006	K-40 Activity	1.386	2.574	1.700	0.900
VGAKN-006	K-40 Confidence Interval	0.256	0.327	0.272	0.205
VGAKN-006	K-40 MDA	0.130	0.122	0.137	0.103
VGAKN-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Co-60 MDA	0.014	0.013	0.015	0.012
VGAKN-006	Cs-137 Activity	<MDA	0.080	0.063	0.024
VGAKN-006	Cs-137 Confidence Interval	NA	0.020	0.017	0.012
VGAKN-006	Cs-137 MDA	0.014	0.015	0.015	0.014
VGAKN-006	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Pb-212 MDA	0.033	0.032	0.035	0.032
VGAKN-006	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Pb-214 MDA	0.040	0.036	0.043	0.037
VGAKN-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Am-241 MDA	0.111	0.118	0.126	0.105

	Results (pCi/g) fresh weight	03/18/10	06/18/10	09/28/10	12/23/10
VGAKN-008	Be-7 Activity	3.562	<MDA	1.960	1.305
VGAKN-008	Be-7 Confidence Interval	0.471	NA	0.419	0.598
VGAKN-008	Be-7 MDA	0.311	0.342	0.337	0.547
VGAKN-008	K-40 Activity	1.943	2.083	1.810	1.491
VGAKN-008	K-40 Confidence Interval	0.265	0.305	0.296	0.271
VGAKN-008	K-40 MDA	0.107	0.144	0.120	0.119
VGAKN-008	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Co-60 MDA	0.012	0.015	0.013	0.014
VGAKN-008	Cs-137 Activity	0.384	0.620	0.639	0.437
VGAKN-008	Cs-137 Confidence Interval	0.038	0.057	0.058	0.043
VGAKN-008	Cs-137 MDA	0.015	0.016	0.016	0.015
VGAKN-008	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Pb-212 MDA	0.033	0.033	0.035	0.034
VGAKN-008	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Pb-214 MDA	0.038	0.039	0.039	0.037
VGAKN-008	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Am-241 MDA	0.113	0.119	0.124	0.112

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2010 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	03/05/10	06/04/10	09/24/10	12/23/10
VGBWL-004	Be-7 Activity	2.998	0.894	0.631	1.163
VGBWL-004	Be-7 Confidence Interval	0.469	0.361	0.304	0.469
VGBWL-004	Be-7 MDA	0.356	0.349	0.331	0.477
VGBWL-004	K-40 Activity	1.881	1.662	2.490	1.854
VGBWL-004	K-40 Confidence Interval	0.284	0.264	0.321	0.269
VGBWL-004	K-40 MDA	0.126	0.128	0.133	0.118
VGBWL-004	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Co-60 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Co-60 MDA	0.014	0.015	0.015	0.014
VGBWL-004	Cs-137 Activity	0.110	0.145	0.198	0.065
VGBWL-004	Cs-137 Confidence Interval	0.020	0.024	0.028	0.020
VGBWL-004	Cs-137 MDA	0.014	0.016	0.016	0.015
VGBWL-004	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Pb-212 MDA	0.033	0.034	0.036	0.029
VGBWL-004	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Pb-214 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Pb-214 MDA	0.038	0.037	0.035	0.037
VGBWL-004	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Am-241 MDA	0.112	0.113	0.119	0.115

	Results (pCi/g) fresh weight	03/05/10	06/11/10	09/24/10	12/30/10
VGALD-001	Be-7 Activity	2.516	1.160	2.370	<MDA
VGALD-001	Be-7 Confidence Interval	0.481	0.370	0.459	NA
VGALD-001	Be-7 MDA	0.388	0.354	0.354	0.448
VGALD-001	K-40 Activity	1.600	2.488	2.360	2.115
VGALD-001	K-40 Confidence Interval	0.280	0.326	0.325	0.293
VGALD-001	K-40 MDA	0.120	0.145	0.126	0.117
VGALD-001	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Co-60 Confidence Interval	NA	NA	NA	NA
VGALD-001	Co-60 MDA	0.014	0.014	0.014	0.013
VGALD-001	Cs-137 Activity	0.142	0.330	0.141	<MDA
VGALD-001	Cs-137 Confidence Interval	0.023	0.037	0.021	NA
VGALD-001	Cs-137 MDA	0.014	0.016	0.016	0.016
VGALD-001	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Pb-212 Confidence Interval	NA	NA	NA	NA
VGALD-001	Pb-212 MDA	0.033	0.030	0.038	0.035
VGALD-001	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Pb-214 Confidence Interval	NA	NA	NA	NA
VGALD-001	Pb-214 MDA	0.035	0.038	0.044	0.030
VGALD-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGALD-001	Am-241 MDA	0.112	0.120	0.121	0.108

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2010 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	03/05/10	06/11/10	09/24/10	12/30/10
VGBWL-006	Be-7 Activity	2.307	<MDA	1.140	<MDA
VGBWL-006	Be-7 Confidence Interval	0.445	NA	0.321	NA
VGBWL-006	Be-7 MDA	0.405	0.323	0.354	0.450
VGBWL-006	K-40 Activity	1.687	1.979	1.810	1.720
VGBWL-006	K-40 Confidence Interval	0.271	0.277	0.276	0.283
VGBWL-006	K-40 MDA	0.132	0.127	0.118	0.142
VGBWL-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Co-60 MDA	0.015	0.014	0.013	0.016
VGBWL-006	Cs-137 Activity	0.227	0.180	0.448	0.258
VGBWL-006	Cs-137 Confidence Interval	0.028	0.026	0.045	0.031
VGBWL-006	Cs-137 MDA	0.015	0.016	0.017	0.014
VGBWL-006	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-212 MDA	0.034	0.025	0.035	0.033
VGBWL-006	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-214 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-214 MDA	0.038	0.036	0.042	0.036
VGBWL-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Am-241 MDA	0.125	0.117	0.116	0.115

TOC

3.2.5 Summary Statistics

Radiological Monitoring of Terrestrial Vegetation Data

Notes:

1. pCi/L - picocuries per liter
2. pCi/g - picocuries per gram
3. N denotes number of samples
4. Std Dev – standard deviation
5. LLD - Lower Limit of Detection
6. MDA - Minimum Detectable Activity

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2010 Vegetation Tritium Summary

Tritium Levels (pCi/L) in Vegetation from SRS Perimeter Stations, 2010						
Station	**N (ND)**	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
AKN-001	3 (1)	450	99	406	624	319
AKN-002	1 (3)	2472	N/A	2472	2472	2472
AKN-003	3 (1)	675	106	785	805	435
AKN-004	4 (0)	343	97	306	493	268
AKN-005	2 (2)	652	108	652	899	404
AKN-006	2 (2)	268	99	268	274	262
AKN-007	4 (0)	581	105	575	853	320
AKN-008	3 (1)	496	103	436	667	384
BWL-001	3 (1)	344	96	352	477	204
BWL-002	4 (0)	1471	127	750	3824	320
BWL-003	2 (2)	539	111	539	700	378
BWL-004	3 (1)	527	105	493	304	<LLD
ALD-001	3 (1)	376	97	366	320	<LLD
BWL-006	4 (0)	257	102	465	627	397
BWL-007	2 (2)	785	111	785	1076	494
BWL-008	4 (0)	689	109	727	940	360
BWL-009	4 (0)	430	288	1570	1966	823
AKN-251	0 (4)	N/A	N/A	N/A	<LLD	<LLD
ALD-251	0 (4)	N/A	N/A	N/A	<LLD	<LLD
ORG-251	0 (4)	N/A	N/A	N/A	<LLD	<LLD

Note: All measures of central tendency exclude non-detections.

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2010 Vegetation Cesium-137 Summary

Cesium-137 Levels (pCi/g-fresh) in SRS Perimeter Vegetation Samples, 2010						
Station	**N (ND)**	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
AKN-001	0 (4)	N/A	N/A	N/A	<LLD	<LLD
AKN-002	0 (4)	N/A	N/A	N/A	<LLD	<LLD
AKN-003	3 (1)	0.11	0.02	0.11	0.15	0.06
AKN-005	4 (0)	0.30	0.04	0.27	0.56	0.11
AKN-006	3 (1)	0.06	0.02	0.06	0.08	0.02
AKN-008	4 (0)	0.52	0.05	0.53	0.64	0.38
BWL-004	4 (0)	0.13	0.02	0.13	0.20	0.07
ALD-001	3 (1)	0.20	0.03	0.14	0.33	0.14
BWL-006	4 (0)	0.28	0.03	0.24	0.45	0.18

Cs-137 Levels (pCi/g) in SRS Perimeter Vegetation Samples, 2010					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
25 (11)	0.23	0.03	0.14	0.34	0.14

Note: All averages exclude non-detections.

TOC

3.3 Radiological Monitoring of Edible Vegetation

3.3.1 Summary

Radionuclide uptake by vegetation may occur by direct absorption into the plant through the foliage or roots, and grazing animal dose exposure occurs primarily by ingestion of the contaminated plant (Kathren 1984). Plant uptake of radionuclides depends upon many factors including species, tissue type, soil-water-plant relationships, soil type, and the chemical nature of the radionuclide in the soil (Hanlon 2004). "Sampling and analyzing native vegetation can provide information about the presence and movement of radionuclides in the environment" (LLNL 1997).

The Radiological Monitoring of Edible Vegetation Project is a component of the South Carolina Department of Health and Environmental Control's (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) that monitors edible food from perimeter and background locations around the Savannah River Site (SRS). SCDHEC ESOP monitoring addresses public concerns pertaining to SRS operations through independent monitoring of radionuclide activities in edible vegetation and fungi found around the perimeter of SRS. Edible vegetation was collected based solely on availability, and was directly dependent upon the growing season. Farmers, gardeners, and/or businesses surrounding the perimeter of SRS occasionally contribute some domestically grown crops, and wild edible vegetation including fungi are collected to monitor potential consumer exposures. Typical domestic crops collected include squash, corn, cucumbers, etc., and typical wild food sources include pokeberry leaves, hog plums, winged sumac berries, and edible fungi used as salads, greens, pies, condiments and teas (Section 3.3.4 Data). Edible fungi were added in 2010 to address exposure for the wild mushroom consumer due to the evidence for bioconcentration of cesium-137 (Cs-137) in some fungi and historical detections on SRS (Botsch 1999, Du Pont 1984).

Tritium is naturally present as a very small percentage of hydrogen in water, both liquid and vapor (ANL 2007a). Historically, the main sources of tritium releases from the SRS operations were the reactor areas, the chemical separation facilities, and the tritium packaging areas. Tritium releases on the SRS include both atmospheric and liquid contributions (SRNS 2011). Tritiated water is more hazardous biologically than tritium gas and reacts chemically in living cells the same as nonradioactive water (CDC SRSHES 1997).

Since 1988, when the last heavy water reactor at SRS was shut down, the tritium supply was re-established using the new Tritium Extraction Facility (TEF). This facility's mission is to transfer new tritium gas to the nation's tritium inventory (WSRC 2006). Adjacent to the SRS, the Southern Nuclear Operating Company operates the Vogtle Electric Generating Plant (VEGP) located in Burke County, GA. Permitted tritium releases coming from the VEGP are a result of spent fuel pools during power operation, during reactor operation by the fission process, and from fuel assemblies mainly during reactor operation and shortly after shutdown (Federal Register 1968).

Tritium and a suite of 24 gamma radionuclides were analyzed by SCDHEC in 2010 plus 5 older fungi samples for plutonium-238 (Pu-238), Pu-239/240, uranium-234 (U-234), U-235, and U-238 baselines (Section 3.3.4 Data and Appendix tables). Section 4.0, Map 1 shows the inner perimeter of counties (IPC) adjacent to the SRS boundary, and the outer perimeter of counties (OPC) that make up the study area of concern (AOC). The AOC was sampled for edible vegetation and fungi and compared to their respective South Carolina backgrounds (SCbkg). Fungi and green plant vegetation comparisons are kept separate since edible fungi are typically saprophytic and do not contain chlorophyll. Fungi and woody vegetation have a relatively large absorptive surface area compared to annual plants, i.e., fungal mycelia mats or green plant root systems and leafy areas have much larger surface areas for uptake of radionuclides deposited in past years. Both woody edible plants and fungi have a greater potential than annual plants for concentrating some radionuclides deposited over many years, whereas annual plants tend to uptake more recent depositions due to a decreased time for the leaching away of recent deposits from the absorptive surface to deeper layers. Radionuclide uptake over large areas is expected to be greater for plants with larger surface areas above ground through direct absorption or increased transpiration. Thus, the available absorptive surface area and competing or limiting factors, such as soil chemistry interactions, affect uptake (Hanlon 2004).

The SCDHEC AOC detections are separated into IPC versus OPC detections to establish depositional pattern trends. These radionuclide detections are also broken down into various food types to determine the trends of exposure within different food groups. First, the "all plant food" category radionuclide concentration in the AOC is compared with that in the SCbkg. All detections are then broken down into domestic versus wild food categories, crops typically planted as annuals versus those resulting from perennial or woody crops, and the data section shows all detections by the specific sample type (e.g., mustard, onion, bolete), and in some cases genus/species if known. These comparisons establish the trends of radionuclide exposure within the local vegetation and fungi consumables.

SCDHEC detected activities above the minimum detectable concentrations for the following vegetation in 2010: tritium (H-3) in fruits, tea leaves, and fungi; potassium-40 (K-40) in fruits, greens, tea leaves, and fungi; lead-214 (Pb-214) in fruits, greens, and fungi; lead-212 (Pb-212) in fungi; and beryllium-7 (Be-7) in fungi.

The DOE-SR annually collects and analyzes terrestrial food products to determine the presence of certain alpha, beta, and gamma-emitting radionuclides that include tritium, strontium, plutonium, uranium, americium, curium, technetium, and neptunium species. The DOE-SR collected cabbage in 2010 within each of four quadrants and from a location approximately 25 miles from SRS. The gamma-emitting radionuclide detections in 2010 in edible vegetation included Cs-137 in collards, cabbage, and fruit. Tritium, Sr-89,90 and U-238 were detected in collards, cabbage, and fruit. Uranium -234 was detected in collards, cabbage, and fruit. Uranium-235 and Technetium-99 was detected only in collards and cabbage. Plutonium-239 was detected only in cabbage. Most detections were northeast and/or northwest of SRS (SRNS 2011).

SCDHEC wild-type vegetation monitoring increased in 2010, and now includes edible fungi since previous data indicated that the higher dose exposures occurred from consuming some woody perennials (e.g., wild plums), and certain edible fungi (e.g., bolete mushrooms) favored by wild mushroom and plant consumers. Split sample comparisons with DOE-SR are occasionally conducted to compare method results, but increasing the variety of vegetation sampled is more likely to find previously unknown dose exposure.

RESULTS AND DISCUSSION

The International Atomic Energy Agency (IAEA 2009) has established guideline levels for radionuclides in foods (gamma-, beta-, and alpha-emitters) for general consumption. The appendix section shows the radionuclides of concern, the guideline level and their conversion to pCi/g for data comparison (Appendices Section 3.3.3). IAEA emphasizes the cumulative radioactivity limits for food (beta-emitters, alpha-emitters, and gamma-emitters), but are not individual limits for each speciated radionuclide.

The US Food and Drug Administration (USFDA 2005) also has guidance levels for radionuclide activity concentration (Strontium-90, Iodine-131, Cesium134+Cesium137, Plutonium-238 +Plutonium-239+Americium-241, Ruthenium-103+Ruthenium-106), called derived intervention levels (DILs), which USFDA has adopted to help determine whether domestic food in interstate commerce or food offered for import into the United States presents a safety concern (Appendices Section 3.3.3). A DIL for tritium is not addressed by the USFDA. The USFDA's guidance documents do not establish legally enforceable responsibilities. Instead, guidances should be viewed only as recommendations, unless specific regulatory or statutory requirements are cited.

References to plants in general refers to the edible parts of green vegetation and fungi in this report. Otherwise more specific terms are used to indicate a category or specific type of green plant or fungi. The edible fungi collected are primarily heterotrophic (consume preformed organic matter) and saprophytic (digest and consume dead plant and animal matter), but not parasitic (consume living matter). Lichens are symbionts (benefit nutritionally) whose form (thallus) is altered by the associated organism (e.g., algae). The collected edible fungi produce spores outside of a structure (mushroom basidia) or within a structure (mushroom asci and lichens) (Moore-Landecker 1972). Herein, plants or green vegetation are distinguished from fungi, and edible vegetation refers to both.

Section 4.0, Map 1 depicts the counties around the perimeter of SRS and the USGS 7.5-minute quadrants that overlay those counties. All of the detects described herein are well below the IAEA guidelines for the specific radionuclide in food (Appendix).

2010 Tritium

There were only 16 tritium detections out of 37 sample scans (AOC and SCbkg) of vegetation and fungi collected by SCDHEC in 2010 (Section 3.3.3, Table 1). Tritium was detected in all three IPC counties (AKN, BWL, ALD) bordering SRS, but not in any of the outer (BMB, ORG, LEX, EDF, SAL, HMP) counties of the AOC or in the SCbkg. Aerial deposition detections for tritium tend to be close to SRS sources (SRNS 2011). The AOC 2010 IPC tritium detections averaged 354 pCi/L (±35) with a median of 367 pCi/L and a maximum of 1000 pCi/L (Section 3.3.3 Table 1a). Any tritum aerial releases reaching the upper atmosphere would disperse over larger areas with increased distances resulting in reduced concentrations and unlikely detections at a distance based on the low levels found in vegetation at the SRS boundary. The primary mechanisms for aerial tritium depositions were wind and/or rain. Fifteen of the 16 tritium detections in vegetation occurred in the Aiken and Barnwell county areas indicating the primary drift depositional pattern was to the north or northeast of the SRS in 2010 for sampled areas. Unsampled areas to the southwest were in Georgia. The observed levels of tritium were well below the IAEA Radionuclides Guidelines for Food, and the more restrictive USFDA DILs for each Radionuclide Group for Food in Domestic Commerce and Food Offered for Import (Appendices Section 3.3.3).

Fourteen out of 16 tritum AOC detections occurred in plant fruit (biological, not dietary definition) and one in a wild tea leaf source, and one lichen thallus (Section 3.3.3 Table 1c). Two wild plant fruits were usable as tea sources (winged sumac berries). Tritium detections in domestically grown vegetation (4 of 13) in the AOC averaged 283 pCi/L (± 85), and median of 278 pCi/L, and included grapes (highest was 370 pCi/L), corn (281 pCi/L), and pears (200 pCi/L) (Section 3.3.3 Table 1d). Tritium detections (12 of 24) in wild plant food averaged 398 pCi/L (±150) with a median of 392 pCi/L (Section 3.3.3 Table 1e). The maximum of 1000 pCi/L occurred in Winged Sumac drupes (Section 3.3.3 Table 1e). Wild hog plums were second highest in tritium (717 pCi/L), Yaupon leaf third (428 pCi/L), lichen fourth (314 pCi/L), and persimmons fifth (257 pCi/L). Note that the woody perennials (shrubs, trees, and vines) tend to have higher tritium detections than annual crops possibly due to their exposure to more than one season of deposited tritium, and a generally larger absorptive surface area compared to annual crops (Section 3.3.3 Tables 1d,e). The higher tritium detections occurred in woody vegetation such as Winged Sumac, Yaupon leaf, and plums compared to a less than lower limit of detection (<LLD) or nondetections in domestic annual species such as collards, cabbage, and wild mustard (Section 3.3.3 Table 1c). Summary Table 1a shows all samples for tritium including four for background tritium (Section 3.3.4 Data Table 1). See the Summary Statistics section for tritium backgrounds by vegetation categories and other radionuclide detections (Summary Statistics Section 3.3.5).

2010 Gammas

South Carolina gamma background detections included six edible vegetation samples (Section 3.3.3 Table 2) plus one edible fungi sample, and 4 nonedible fungi (Section 3.3.3 Table 4b). The nonedible fungi resulted from the midyear assignment of fungi to the edible vegetation project, and as a comparison of edible versus nonedible fungi radionuclide detection concentrations (Section 3.3.3 Tables 4b, 6b). However, the 2004-2010 summary statistics (green vegetation and fungi) for nonNORM radionuclides serve as large data bases for monitoring changes in the plant food radionuclide environment around SRS (Section 3.3.5, Table 8). The AOC gamma samples included 42 green vegetation samples, 19 edible fungi samples, and four nonedible fungi (Section 3.3.3 Table 4a, 6b). The edible vegetation samples, and edible and nonedible fungi samples were analyzed for a suite of 24 gamma-emitting radionuclides. Only potassium-40 (K-40) and lead-214 (Pb-214) were detected in edible green vegetation in 2010, and beryllium-7 (Be-7), K-40, cesium-137 (Cs-137), Pb-212, and Pb-214 were detected in edible and inedible fungi. Section 3.3.3 Tables 3a through 4b show the radionuclide summary statistics for different categories of edible green vegetation and fungi.

A comparison was made between the gamma radionuclides found in edible green vegetation (K-40, Pb-214) versus edible fungi (Be-7, K-40, Cs-137, Pb-212, and Pb-214) (Section 3.3.5, Tables 2a,2b). Tritium activity concentration was slightly higher in green plants, whereas Cs-137, Be-7, K-40, Pb-212, and Pb-214 were much higher in fungi. Note Section 3.3.3 Tables 2 and 5, and compare the average, median, and maximums for the counties, IPC, OPC, and SCbkg. Potassium-40 and Pb-214 were highest in Barnwell county, and the detection statistics decreased from the IPC to the OPC area to the SCbkg except for K-40 in the SCbkg (Section 3.3.3 Table 5). The county statistic basis for green plants shows the same trend except for Pb-214 being higher in the SCbkg (Section 3.3.3 Table 2). All gamma backgrounds came from McCormick and Laurens counties or the Piedmont Region where cretaceous geology dominates the surface soils. Potassium-40 activity is heavily influenced by fertilizers, and Pb-214 is part of the naturally occurring uranium decay products prevalent in saprolitic rock found in Fall Line fracture areas. Also, a fertilizer production plant in Augusta, Georgia may contribute atmospheric depositions to the AOC. South Carolina backgrounds from coastal areas exhibit lower overall radionuclide activity in surface soils and would influence the edible vegetation concentration uptake and background statistics (SCDHEC 2010).

The gamma radionuclides in green plants and edible fungi vary by specific type of vegetation and food use groups (Section 3.3.3, Tables 3a-4b). Most food types or food use groups detections were K-40 and Pb-214 in 2010. However, edible fungi appears to be the exception adding Be-7, Cs-137, and Pb-212. The Cs-137 activity adds radionuclide exposure above the naturally occurring radioactive material (NORM) due to historical depositions from atomic bomb tests fallout during the 1950-1980 period, and Cs-137 detections occurred primarily in certain edible fungi such as boletes (Botsch 1999, Yoshida 1998). Comparison of wild versus domestic food types sampled showed a higher K-40 activity in domestic crops and annual crops versus wild type and perennial crops (Section 3.3.3 Table 4a). This was probably due to the use of fertilizers. Higher K-40 in fungi, perennials, and wild edible vegetation occurred in SCbkgs (Section 3.3.3 Table 4b). This trend also occurred for Pb-214 in some SCbkgs, and may be related to the geology of the surface soils and influence on uptake of those radionuclides (Rommelt 1990, Seel 1995). Section 3.3.3 Table 5 shows the gamma trends by county, IPC, and OPC area basis. The only nonNORM gamma radionuclide detection, Cs-137, was much higher in the IPC than in the OPC (IPC average 4.92 pCi/g versus 0.10 in the OPC), and occurred only in fungi.

However, these concentrations are not necessarily due to SRS operations since these relatively low concentrations may be a result of past atomic test fallout depositions and fungal bioconcentration of the radionuclide. These low level bioconcentrations are not above the health risk guidelines (Appendices Section 3.3.3).

Naturally Occurring Radionuclides

Lead-212, Pb-214, Be-7, and K-40 are all NORM in the environment. Lead-214 and K-40 were the only detections in green plant samples collected in 2010 (Section 3.3.4 Data). Lead occurs everywhere in the environment with concentrations in U.S. soil typically ranging from less than 10 to 30 milligrams of lead per kilogram of soil (mg/kg) (ANL 2007a). Concentrations in sandy soil particles are estimated to be 270 times higher than in the water in pore spaces; binding even more tightly to clay and loam soils, with concentration ratios of about 500 to more than 16,000 times. Reported concentrations of lead in various foods range from 0.002 to 0.65 mg/kg with higher levels generally found in vegetables. The typical concentration of lead in plants to that in the soil on which they grow is estimated at roughly four percent.

Lead-214 was detected in one persimmon and one lichen sample, and Pb-212 was also found in a lichen sample in 2010. Section 3.3.3 Table 2 shows that green plant Pb-214 was higher in the IPC than in the OPC, but both were less than the SCbkg. The trend in edible fungi was the same, higher in the IPC, for both Pb-212 and Pb-214, and the SCbkg was lower than the IPC (Section

3.3.3 Table 5). Thus, lead uptake in fungi appeared higher than in green plants overall (Section 3.3.3 Tables 2,5).

Potassium occurs in the earth's crust, oceans, and organic material. Potassium binds preferentially to soil, with the concentration associated with sandy soil particles estimated to be 15 times higher than in the pore spaces between soil particles; it binds more tightly to loam and clay soil, so those concentration ratios are higher (above 50). Together with nitrogen and phosphorous, potassium is a major soil fertilizer, and levels of potassium-40 (K-40) in soils are strongly influenced by fertilizer use. It is estimated that about 3,000 curies (Ci) of K-40 are added annually to U.S. soils (ANL 2007a). Potassium behaves in the environment the same as other potassium isotopes and is assimilated into the tissues of all plants and animals through normal biological processes. Milk contains about 2000 pCi/L of natural K-40. Potassium-40 was detected in nearly all food samples collected around the perimeter of the SRS with concentrations ranging up to a maximum detection of 18.10 pCi/g (sunflower). Potassium-40 was found in wild plums, persimmons, winged and smooth sumac fruit, bolete mushrooms, chanterelle mushrooms, lichens, oyster mushrooms, *Lactarius indigo* mushroom, Yaupon leaves, grapes, pears, and peaches (Section 3.3.4 Data). Fertilizers and cretaceous geology are the suspected factors affecting K-40 distribution in the AOC, while all SCbkgs came from the Piedmont Region.

Beryllium-7 occurs naturally in the earth's crust. The concentration generally ranges from 1 to 15 milligrams per kilogram (mg/kg), which is the same as parts per million (ppm). The average concentration of naturally occurring beryllium in U.S. soils is 0.6 ppm and levels typically range from near zero in nondetections to 40 ppm. Concentrations in sandy soil are estimated to be up to 250 times higher than in the water within the pore space between the soil particles, and with much higher concentration ratios in loam and clay soils. Beryllium is naturally present in some foods and has a median concentration of 22.5 micrograms/kilograms (ug/kg) reported across 38 different food types, ranging from less than 0.1 to 2,200 ug/kg in kidney beans (for example). The major source of environmental releases from human activities is combustion of coal and fuel oil (ANL 2007b). Beryllium-7 was less than the MDA for all green vegetation samples collected, and was detected only in edible fungi (Section 3.3.3 Table 3a).

Cesium-137

Cesium-137 is an alkali metal which is chemically and metabolically similar to potassium. If ingested, it is distributed relatively uniformly throughout the whole body, including bone marrow (Federal Radiation Council 1965). The largest source of Cs-137 in the environment was fallout from atmospheric nuclear weapons tests in the 1950's and 1960's that dispersed and deposited Cs-137 worldwide; however, much of that has now decayed (USEPA 2007a) to <MDA detection limit.

Pathways through plant foods are relatively unimportant as cesium is poorly absorbed by vegetation from the soil. Cesium is relatively uniformly distributed throughout all portions of the plant and generally does not tend to concentrate in the edible portions. Grains, however, do tend to have relatively high concentrations. Fruits and root vegetables, which have a high water content, tend to have low concentrations of cesium (Kathren 1984). Some fungi appear to bioconcentrate cesium and contribute to radioactive exposure in the mushroom consumer (Botsch 1999).

Cesium-137 is a major radionuclide in spent nuclear fuel, high level radioactive waste resulting from the processing of spent nuclear fuel, and radioactive wastes associated with the operation of nuclear reactors and fuel reprocessing plants. Radioactive cesium is present in soil around the world largely as a result of fallout from past atmospheric nuclear weapons tests. The concentration of Cs-137 in surface soil from fallout ranges from about 0.1 to 1 pico curies per gram (pCi/g), averaging less than 0.4 pCi/g. Cesium is generally one of the less mobile radioactive metals in the environment. Cesium preferentially adheres quite well to the soil organic layer, and the concentration associated with sandy soil particles is estimated to be 280 times higher than in interstitial water; concentration ratios are much higher in clay and loam soils. Thus, cesium is generally not a major contaminant in groundwater at DOE sites or other locations (ANL 2007a).

All of the detected radionuclides except Cs-137 originate in NORM. NORM radionuclides are the source of most public exposure and are considered background due to their natural and abundant occurrence in nature. Only some wild mushroom samples in 2010 would add radiation exposure to the individual consumer above NORM background due to the detection of Cs-137, which is bioconcentrated by some mushrooms (Botsch 1999). The Cs-137 detections were generally <1 pCi/g except for boletes, chanterelles, and one lactarius species (Data Section 3.3.4). These detections reflect bioconcentrations over several years rather than a yearly depositional dose. These edible mushrooms are the fruiting bodies of long-lived organisms (large mycelia mats), which are primarily saprophytes on dead or dying vegetation. Thus, Cs-137 uptake by these fungi may be a reflection of the interactions between soil chemistry, the food host biochemistry, and the fungi. Cesium-137 tends to bind with organic material in the forest floor and is available to resident organisms before leaching to a confining layer such as clays (Linkov 1999). Many non-NORM radionuclides were distributed worldwide due to atomic tests primarily in the 1950's and 1960's, and the present detectable levels in soils today cannot be assigned to a single source (Aracnet 1957, RADNET 2006).

Other non-NORM

Five fungi collected in 2010 were analyzed for the plutonium series. There was one Pu-238 detection equal to the MDA in a golden chanterelle mushroom from the Steel Creek landing floodplain area in Allendale county, and one Pu-239/240 detection in a *Lactarius indigo* collection from highway 278 near the SRS border in Barnwell county (Section 3.3.4 Table 14). Both were potentially false positives illustrated by the lack of detection confirmation by the EVO11c duplicate.

Plutonium-238 and Pu-239 come from different nuclear production modes at SRS. Plutonium species have large ingestion and inhalation dose exposure factors (WSRC 1997). Five older edible fungi samples (from 2008) and one older inedible fungi sample (2005) were also sent to a contract laboratory for speciation of plutonium (Pu-238, Pu-239/240) and uranium (U-234, U-235, and U-238) as a potential basis for these radionuclides in fungi before the DOE-SR mixed oxide facility (MOX) goes into operation (Section 3.3.4 Table 13). Some AOC Pu-239/240, U-234, U-235, and U-238 detections in bolete fungi were greater than the background detections for bolete mushrooms (Section 3.3.4 Table 13). Plutonium-238 was <MDA in all samples except for a detection in the E41NR22 duplicate that was not confirmed by the original sample. Trace detections (D# is detection number) averaged greater than the bolete fungi SCbkg for Pu-

239/240 (D#4), U-234 (D#6), U-235 (D#3), and U-238 (D#6) (Section 3.3.3 Table 7). Uranium-234 and U-238 are part of the same natural decay series present in the environment. Uranium-235 comes from Pu-239 decay and is part of the naturally occurring actinium decay series. All are present in any uranium containing sample, at least transiently, whether metal, compound, ore, or mineral. One onion sample was analyzed for total strontium and was <MDA (Section 3.3.4 Data Table 4).

Plutonium-239, U-235/238, Sr-90, Cs-137, and tritium are listed in the maximum exposed individual (MEI) risk comparisons for the years 1954 to 1995 atmospheric and liquid releases at SRS (WSRC 1997). All will remain of importance on a percentage of risk basis in the future.

ESOP and DOE-SR Data Comparison

Comparison is based on the reports tables and data sections and the SRNS Environmental Report 2011. The only nuclide detection common to vegetation sampled by both programs (greens, fruit, and cabbage) was tritium. SCDHEC reports only the activity concentration in the extracted water (pCi/L) greater than the MDA. The detections marked significant and reported by DOE-SR were averaged for comparison to SCDHEC detections on a similar basis (SRNS 2011). Application of the DOE-SR general dry/wet weight ratio used for vegetation allows a general comparison in terms of pCi/L of tritium for DOE-SR tritium data.

$$\{[pCi/g \times (1/0.3)]/(1-0.3)\} \times (1g/1ml) \times (1000ml/1Liter) = pCi/L$$ (SCDHEC 2010)

Tritium in SCDHEC fruit averaged 294 (± 85 pCi/L) with a median of 279 compared to the DOE-SR single detection of 291, which was within one standard deviation of the SCDHEC average. Tritium in SCDHEC greens and cabbage were all <MDA (MDA average 202 ± 16 pCi/L) compared to the DOE-SR tritium in greens average of 202 (± 23 pCi/L) with a median of 198, and 276 (± 108 pCi/L) with a median of 314 pCi/L in cabbage. The SCDHEC 2010 tritium MDA average was within the DOE-SR average first standard deviation for cabbage. SCDHEC and DOE-SR appeared to detect approximately the same levels of tritium in comparable vegetation within the average's first standard deviation, and the concentration activities were far less than USFDA food guidance levels of concern (USFDA 2005).

There were not any comparable significant gamma detections in vegetation for the two programs in similar media. However, Cs-137 in SCDHEC collected fruit averaged <MDA compared to the DOE-SR single detection of 0.0059 pCi/g. Additional single detections found in fruit by DOE-SR included Sr-89,90 (0.00311 pCi/g) (<MDA in a SCDHEC sample), U-234 (0.000221 pCi/g), and U-238 (0.000192 pCi/g).

The significant gamma detection statistics for DOE-SR collected greens were: Cs-137 (0.0325 ±0.0062 pCi/g), Sr-89,90 (0.0954 ±0.0486 pCi/g), U-234 (0.0344 ±0.0159 pCi/g), U-235 (0.00247 pCi/g, one result), U-238 (0.00529 ±0.00311 pCi/g), and Tc-99 (0.6025 ±0.2187 pCi/g). The significant gamma detection statistics for DOE-SR collected cabbage were: Cs-137 (0.0843 pCi/g, one result), Sr-89,90 (0.0716 ±0.0206 pCi/g), U-234 (0.0503 ±0.0479 pCi/g), U-235 (0.00336 pCi/g ±0.00245 pCi/g), U-238 (0.0552 ±0.0523 pCi/g), Tc-99 (0.2375 ±0.0403 pCi/g), and a single result for Pu-239 (0.00103 pCi/g). This single Pu-239 detection was very close to the average Pu-239 detection above background found by SCDHEC (averaged 0.001413 pCi/g, standard deviation 0.001090, and median 0.001090 pCi/g) in bolete fungi in 2008 (Section

3.3.3 Table 7). The SCDHEC uranium and plutonium speciation in 2010 was for fungi. Only Pu-239/240 was slightly higher in SCDHEC fungi than in DOE-SR edible green plants in 2010, but SCDHEC Pu-239/240, U-234, U-235, and U-238 in fungi were all higher than the fungi SCbkg (Section 3.3.3 Table 7). The SCDHEC average MDA for the various gamma radionuclides was not as low as the DOE-SR respective MDA, and accounts for the few lower level detections found by DOE-SR.

CONCLUSIONS AND RECOMMENDATIONS

Detected radionuclide concentrations found in edible vegetation sampled around SRS are well below the IAEA and USFDA standards for these emitters. Tritium continues to be the prevailing analyte across all edible green vegetation. However, Cs-137 dominates non-NORM radionuclide exposure for the wild mushroom consumer. Fungi collected in 2008 and 2010 were analyzed in 2010 by an independent laboratory for the plutonium and uranium series to establish a baseline reference in wild edible fungi near the SRS. The trace Pu-240, U-234, U-235, and U-238 radionuclides found in fungi are part of naturally occurring decay series, but does represent increased exposure for the wild mushroom consumer.

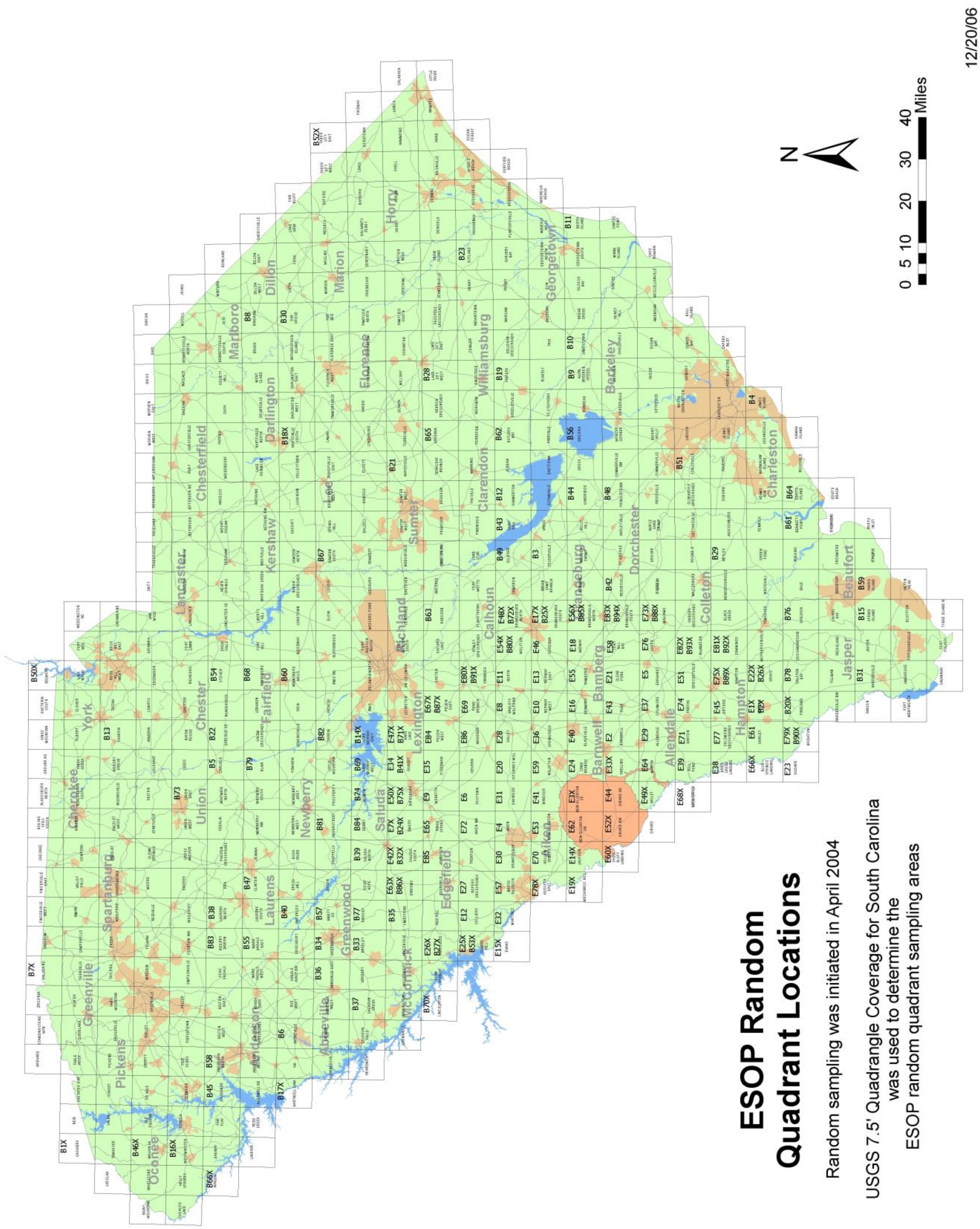
The highest tritium sample (1000 pCi/L) occurred in a water extract from a winged sumac fruit, which is far below the 20,000 pCi/L USEPA limit for tritium in water. The DOE-SR comparable vegetation tritium results were within one standard deviation of the SCDHEC averages. Cesium-137 levels in certain edible fungi species, primarily *Cantharelles* and *Boletus* species, add exposure for the wild mushroom consumer, whether animal or human. The highest Cs-137 occurred in a golden chanterelle mushroom (30.70 pCi/g), and was the main contributor to exposure for the wild mushroom consumer. This highest Cs-137 detection occurred in a ditch subject to flooding backwaters from SRS near Steel Creek landing. All edible vegetation in 2010, except fungi, contained only typical NORM gamma radionuclides. DOE-SR found a few additional low-level gamma radionuclide detections due to a lower MDA for Sr-89/90, Tc-99, and Pu-239.

SCDHEC and the Department of Energy-Savannah River (DOE-SR) have different sampling schemes. The DOE-SR has annual participants in quadrants at 0-10 miles from the perimeter of the SRS and one quadrant at 25 miles. SCDHEC annual participants vary, but the 2010 vegetation collections were generally within 10 miles of the SRS border, and backgrounds were generally along a 50-mile perimeter with one annual background participant in Laurens county. The SCDHEC will continue to establish relationships with annual contributors around the perimeter of the SRS, but has added emphasis in sampling a broader selection of edible vegetation, especially woody species and fungi, in an attempt to detect any previously unknown radionuclide contamination exposure. ESOP plans to continue to collect wild plants in addition to normal garden vegetation and edible wild fungi to help identify the maximally exposed individual in 2011.

TOC

3.3.2 2010 Radiological Monitoring of Edible Vegetation [TOC]

Map 1. Sample Locations By County Lines or 7.5 Minute Quadrants



3.3.3 Tables and Figures

2010 Radiological Monitoring of Edible Vegetation

Table 1a. Tritium (pCi/L) in Edible Vegetation and Fungi in SRS Perimeter Counties, Year 2010

Location	Avg	SD	Median	Max	D#	N#
SCbkg	<LLD	NA	<LLD	<LLD	0	4
AKN	367	178	274	717	7	16
ALD	314	NA	314	314	1	5
BWL	381	260	270	1000	8	10
EDF	<LLD	NA	<LLD	<LLD	0	3
BMB	<LLD	NA	<LLD	<LLD	0	1
SAL	<LLD	NA	<LLD	<LLD	0	2
Tritium was detected in the inner boundary of counties around SRS, but not in the outer boundary of counties within the area of concern (AOC).						
AOC Inner Perimeter Counties		AOC Outer Perimeter Counties			SCbkg	
Avg	354	NA	<LLD	NA	<LLD	
SD	35	NA	NA	NA	NA	
Median	367	NA	<LLD	NA	<LLD	
Max	1000	NA	<LLD	NA	<LLD	
D#	16	NA	0	NA	0	
N#	31	NA	6	NA	4	
Tritium concentrations were higher than the SCbkg only in the inner AOC counties around SRS. The depositional trend was highest close to the SRS boundary and in Barnwell and Aiken counties.						

Notes:

1 - D# is number of detections and N# is number of samples.

2 - The area of concern (AOC) included an inner perimeter of counties (IPC) adjacent to SRS and outer perimeter of counties (OPC) occur outside of the inner ring of counties around SRS, but within the 50-mile perimeter.

3 - Most tritium detections occurred in the Aiken and Barnwell county areas indicating the primary depositional pattern was north to northeast of SRS.

4 - See Table of Acronyms for other abbreviations.

Table 1b. Tritium (pCi/L) in Edible Vegetation in AOC Food Groups, 2010

Food Use Group	Avg	SD	Median	Max	D#	N#
Fruits	294	85	279	717	12	25
Greens	<LLD	NA	<LLD	<LLD	0	5
Teas	528	142	528	1000	3	5
Fungi	314	NA	314	314	1	2
All AOC EV, includes Fungi	371	211	278	1000	16	37
All SCbkg EV, no fungi	<LLD	NA	<LLD	<LLD	0	4

Notes:

1 - The term fruit is applied in a biological sense, i.e., corn or soybeans is the fruit of the plant. The plant part consumed is either the fruit/seed, leaf/stalk/flower as greens, and tubers/bulbs. Teas are applied to any plant part used primarily as an extraction in water.

2 - Tritium was detected only in perennial fruit sources and fungi, not annuals.

3 - Mushrooms are the fruit of the fungi collected, and are separated out as lacking chlorophyll. The alga component of a lichen thallus (body) does contain chlorophyll.

4 - These food groups contain domestic and wild food samples.

5 - AOC is the area of concern outside the SRS boundary and inside a 50-mile perimeter. The AOC contains an inner perimeter of counties (IPC) adjacent to SRS and outside perimeter of counties (OPC) within the 50-mile perimeter.

Table 1c. Tritium (pCi/L) in AOC Edible Vegetation and Fungi, 2010

Food Type	Avg	SD	Median	Max	D#	N#
Watermelon	<LLD	NA	<LLD	<LLD	0	1
Collards	<LLD	NA	<LLD	<LLD	0	3
Peaches	<LLD	NA	<LLD	<LLD	0	2
Bear's Head Fungus	<LLD	NA	<LLD	<LLD	0	1
Cabbage	<LLD	NA	<LLD	<LLD	0	1
Wild Mustard	<LLD	NA	<LLD	<LLD	0	1
Winged Sumac (Drupe)	628	526	628	1000	2	3
Wild Yaupon (Leaf)	428	88	174	428	1	1
Wild Plums	392	180	344	717	6	13
Grapes	370	94	186	370	1	1
Lichen Fungus	314	NA	314	314	1	2
Corn	278	5	278	281	2	4
Wild Persimmons	228	40	228	257	2	3
Pears	200	87	186	200	1	1
Avg	355	Average of tritium across food types.				
SD	136	Standard deviation around average.				
Median	342	Central tendency across area of concern (AOC).				
D#	16	Total tritium detections across AOC.				
N#	37	Total tritium samples across AOC.				
SCbkg	<LLD	NA	<LLD	<LLD	0	4

Notes: See list of acronyms for abbreviation definitions.

1 - Tea sources were winged sumac drupes and wild yaupon berry leaf.

Table 1d. Tritium (pCi/L) in AOC Domestic Edible Vegetation, 2010

Domestic Food	Avg	SD	Median	Max	D#	N#	A/P
Watermelon	<LLD	NA	<LLD	<LLD	0	1	A
Collards	<LLD	NA	<LLD	<LLD	0	3	A
Peaches	<LLD	NA	<LLD	<LLD	0	2	P
Cabbage	<LLD	NA	<LLD	<LLD	0	1	A
Grapes	370	94	186	370	1	1	P
Corn	278	5	278	281	2	4	A
Pears	200	87	186	200	1	1	P
Domestic Food		**Annual Crops**			**Perennial Crops**		
Avg	283	Avg		278	Avg		289
SD	86	SD		5	SD		126
Median	278	Median		278	Median		289
D#	4	D#		2	D#		2
N#	13	N#		9	N#		4

Notes: See list of acronyms for definitions.

1 - Tritium detections frequency and central tendencies in perennial crops were higher than annuals.

2 - Collected as an annual (A) or perennial (P) planting.

Table 1e. Tritium (pCi/L) in AOC Wild Edible Vegetation, 2010

Wild Food	Avg	SD	Median	Max	D#	N#
Bear's Head Fungus	<LLD	NA	<LLD	<LLD	0	1
Wild Mustard	<LLD	NA	<LLD	<LLD	0	1
Winged Sumac	628	526	628	1000	2	4
Yaupon Leaf	428	88	174	428	1	1
Plums	392	180	344	717	6	13
Lichen	314	NA	314	314	1	1
Persimmons	228	40	228	257	2	3
ALL Wild Food		**Wild Greens/Leaf**		**Wild Fruit**	**Wild Fungi/Lichen**	
Avg	398	428		416	314	
SD	150	88		201	NA	
Median	392	174		392	314	
D#	12	1		10	1	
N#	24	2		20	2	

Notes: See list of acronyms for definitions.

1 - Among either wild or domestic crops the woody perennials tend to have higher tritium detections, The generally long-lived (woody) plants and fungal mycelia have a large absorptive or exposure area. Thus, the generally higher tritium absorption among trees and shrubs is expected (leaves and fruits).

2 - Also tritium in wild food types (Perennials) was higher than in domestic food types (Annuals).

Table 2. Gamma (pCi/g) in Edible Vegetation in SRS Perimeter Counties Excluding Fungi, 2010

SCBkg	Avg	SD	Median	Max	D#	N#	K-40 AVG	Pb-214 AVG
K-40	3.52	1.28	3.47	5.11	6	7	3.52	
Pb-214	0.76	0.91	0.76	1.41	2	7		0.76
AKN	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	2.64	1.31	1.99	4.89	10	10	2.64	
Pb-214	0.10	NA	0.10	0.10	1	10		0.10
ALD	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	2.38	0.31	2.32	2.72	5	5	2.38	
Pb-214	0.10	NA	0.10	0.10	1	5		0.10
BWL	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	5.59	5.58	2.70	18.10	20	20	5.59	
Pb-214	0.38	0.20	0.43	0.55	4	20		0.38
BMB	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	4.26	NA	4.26	4.26	1	1	4.26	
EDF	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	3.87	0.79	3.87	4.26	2	2	3.87	
Pb-214	0.07	NA	0.07	1.30	1	2		0.07
MCM	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	2.45	NA	2.45	2.45	1	1	2.45	
SAL	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**Avg**	**Avg**
K-40	2.79	0.74	2.79	3.31	2	3	2.79	
Inner Perimeter Counties (IPC) AKN, BWL, ALD				IPC Minus SCbkg		**No SCbkg Subtraction**		
County Basis	**K-40**	**Pb-214**		**K-40**	**Pb-214**	**ALL AOC County Basis**		
AVG	3.54	0.19		**0.02**	-0.57	**Statistics**		
Outer Perimeter Counties (OPC) BMB, EDF, MCM, SAL				OPC Minus SCbkg			**K-40**	**Pb-214**
AVG	3.34	0.07		**K-40**	**Pb-214**	**AVG**	**3.56**	**0.16**
SCbkg				-0.18	-0.69	**SD**	1.26	0.14
AVG	3.52	0.76				**Median**	**3.33**	**0.10**

Notes:

1 - Potassium-40 and Pb-214 were highest in Barnwell (BWL) county, but less than the SCbkg.
K-40 and Pb-214 were slightly higher in the IPC compared to the OPC.

2 - Compare the higher county basis radionuclide result to the IPC and OPC basis results.
BWL K-40 AVG detection was twice the background followed by BMB and EDF.

3 - K-40 was higher in the IPC than the OPC.

4 - Pb-214 was <SCbkg in the IPC and OPC.

5 - The K-40 distribution may be related to a fertllizer production facility in Augusta and dominance in wind direction toward BWL and AKN or from southwest to northeast of SRS or soil types and applied fertilizers.

6 - The Pb-214 dominance in the SCbkg appear potentially related to soil types containing saprolitic granite.

7 - The 'ALL AOC County Basis' statistics uses the county averages as the data input.

Table 3a. Area of Concern (AOC) Edible Vegetation Gamma in Food Use Groups

Category	Statistics (pCi/g)	AVG	SD	Median	Max	D#	N#
Fruit/seed	K-40	3.49	4.07	2.29	18.10	33	33
	Pb-214	<u>0.29</u>	0.23	<u>0.26</u>	<u>0.55</u>	4	33
Greens/bulbs	K-40	<u>5.02</u>	2.69	<u>4.42</u>	<u>10.94</u>	7	7
	Pb-214	0.08	0.02	0.08	0.10	2	7
Teas/condiments	K-40	4.11	2.31	4.11	5.74	2	2
Fungi	Be-7	**4.38**	0.44	**4.21**	**4.88**	3	19
	K-40	**24.43**	11.72	**23.20**	**47.30**	16	19
	Cs-137	**4.39**	7.77	**1.19**	**30.70**	17	19
	Pb-212	**0.39**	0.01	**0.39**	**0.40**	2	19
	Pb-214	**0.45**	0.24	**0.36**	**0.85**	5	19

Table 3b. South Carolina Background (SCbkg) Edible Vegetation Gamma in Food Use Groups

Category	Statistics (pCi/g)	AVG	SD	Median	Max	D#	N#
Fruit/seed	K-40	2.30	0.20	2.49	2.30	2	2
	Pb-214	0.12	NA	0.12	0.12	1	2
Greens/bulbs	K-40	<u>4.76</u>	0.50	<u>4.76</u>	<u>5.11</u>	2	3
	Pb-214	<u>1.41</u>	NA	<u>1.41</u>	<u>1.41</u>	1	3
Teas/condiments	K-40	3.50	1.36	3.50	4.46	2	2
Fungi (Oysters)	K-40	**25.48**	NA	**25.48**	**25.48**	1	1

Table 3c. Edible Plants AOC minus SCbkg or Gamma>SCbkg, 2010

Category	Statistics (pCi/g)	AVG	SD	Median	Max	D#	N#
Fruit/seed	K-40	<u>1.19</u>	NA	-0.20	<u>15.80</u>	31	31
	Pb-214	0.17	NA	<u>0.14</u>	<u>0.43</u>	3	31
Greens/bulbs	K-40	0.27	NA	-0.33	5.83	5	4
	Pb-214	-1.33	NA	-1.33	-1.31	1	4
Teas/condiments	K-40	0.62	NA	<u>0.62</u>	**1.29**	0	0
Fungi	Be-7	**4.38**	NA	**4.21**	**4.88**	3	19
	K-40	-1.05	NA	-2.28	**21.82**	15	18
	Cs-137	**4.39**	NA	**1.19**	**30.70**	17	19
	Pb-212	**0.39**	NA	**0.39**	**0.40**	2	19
	Pb-214	**0.45**	NA	**0.36**	**0.85**	5	19

Notes:

1 - Bolded numbers indicate the highest food use group statistic for that radionuclide (mostly in fungi).

2 - Underlined numbers indicate the second highest food use group statistic for the indicated radionuclide. Greens/bulbs had the highest statistics for K-40 (fertilizers), and fruit/seed for Pb-214 (woody plants).

3 - The same trends listed in notes 1 & 2 occurred in the SCbkg except for Pb-214 (Greens/bulbs).

4 - Radionuclide activities > SCbkg (Table 3c) may be a more relevant comparison, and indicated that fungi dominate the statistics > SCbkg for all radionuclide detections except K-40 (Avg, Median). Among the edible vegetation>SCbkg excluding fungi the fruit/seed category (woody perennials mostly) dominate the avg and max for K-40 and Pb-214.

5 - The clear domination of some radionuclides in fungi over other edible vegetation may be related to bioconcentration in some cases (Cs-137) or large absorptive area (mycelia mat and woody root systems), and soil chemistry/plant biochemistry interactions.

6 - N# refers only to the sample group and may not be equal to the total sample number. D# is the number of detections for that radionuclide found in samples with other detections.

Table 4a. Edible Vegetation Categories in Area of Concern (AOC), Gamma Detections (pCi/g), 2010

GreenEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**Avg AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
K-40	**3.77**	3.80	**2.47**	18.10	42	42	0.25	-1.00	12.99
Pb-214	**0.22**	0.21	**0.10**	0.55	6	42	<SCbkg	<SCbkg	<SCbkg
Fungi	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**	**AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
Be-7	4.38	0.44	4.21	4.88	3	19	**4.38**	**4.21**	**4.88**
K-40	24.43	11.72	23.20	47.30	16	19	<SCbkg	<SCbkg	<SCbkg
Cs-137	4.39	7.77	1.19	30.70	17	19	**4.39**	**1.19**	**30.70**
Pb-212	0.39	0.01	0.39	0.40	2	19	**0.39**	**0.39**	**0.40**
Pb-214	0.45	0.24	0.36	0.85	5	19	**0.45**	**0.36**	**0.85**
DomesticEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
K-40	5.36	5.36	2.75	18.10	18	19	1.83	<SCbkg	12.99
Pb-214	0.25	0.22	0.10	0.55	5	19	<SCbkg	<SCbkg	<SCbkg
WildEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
K-40	2.55	0.96	2.38	5.74	23	23	<SCbkg	<SCbkg	1.28
Pb-214	0.10	**NA**	0.10	0.10	1	23	0.10	0.10	0.10
Annual Crops	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
K-40	5.70	5.37	3.31	18.10	17	18	2.17	**-0.11**	12.99
Pb-214	0.25	0.22	0.10	0.55	5	18	<SCbkg	<SCbkg	<SCbkg
Perennials	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**	**AOC-SCBkg**	**Median AOC-SCBkg**	**Max-SCbkg**
K-40	2.43	0.95	2.32	5.74	24	24	<SCbkg	<SCbkg	1.28
Pb-214	0.10	**NA**	0.10	0.10	1	24	0.10	0.10	0.10

Table 4b. Edible Vegetation Categories in South Carolina Background (SCBkg), Gamma (pCi/g), 2010

GreenEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**S#**
K-40	3.52	1.28	3.47	5.11	6	7
Pb-214	0.76	0.91	0.76	1.41	2	7
Fungi	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
K-40	25.48	NA	25.48	25.48	1	1
DomesticEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
K-40	3.53	1.45	3.42	5.11	4	5
Pb-214	0.76	0.91	0.76	1.41	2	5
WildEV	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
K-40	3.50	1.36	3.50	4.46	2	2
Annual Crops	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
K-40	3.53	1.45	3.42	5.11	4	5
Pb-214	0.76	0.91	0.76	1.41	2	5
Perennials	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
K-40	3.50	1.36	3.50	4.46	2	2

Notes:

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

2 - Fungi dominate the average, median, and maximum statistics for all detections except K-40 (annual crops, potentially high due to commonly applied fertilizers).

3 - Potassium-40 was highest in green edible vegetation for the domestic and annual crop categories where fertilizer application was common.

4 - Lead-214 was highest among perennials that were mostly large woody root systems.

5 - N# refers to sample category detections. S# includes samples with no detections.

6 - The only sample to have no radionuclide detections was a SCbkg onion sample.

7 - No nonNORM radionuclides were detected in any green plant samples, but were detected in fungi.

Table 5. Edible Fungi Gamma (pCi/g) Summary in SRS Perimeter Areas, 2010

IPC	Region	Avg	SD	Median	Max	D#	N#
K-40	AKN	30.18	8.47	31.60	38.85	5	5
K-40	ALD	25.18	17.92	24.20	47.30	4	7
K-40	BWL	22.47	6.64	23.15	29.40	6	6
Statistics	IPC	25.94	3.91	25.94	47.30	15	18
BMB	OPC	4.43	NA	4.43	4.43	1	1
K-40	SCbkg	25.50	NA	25.50	25.50	1	1
IPC	**Region**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Cs-137	AKN	1.65	1.75	0.24	4.66	5	5
Cs-137	ALD	7.35	13.20	0.71	30.70	5	7
Cs-137	BWL	4.92	5.56	1.65	15.80	6	6
Statistics	IPC	4.64	2.86	4.64	30.70	16	18
BMB	OPC	0.10	NA	0.10	0.10	1	1
Cs-137	SCbkg	<MDA	NA	<MDA	<MDA	0	1
IPC	**Region**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Pb-212	AKN	0.40	NA	0.40	0.40	1	5
Pb-212	ALD	0.39	NA	0.39	0.39	1	7
Statistics	IPC	0.39	0.01	0.39	0.40	2	12
BMB	OPC	<MDA	NA	<MDA	<MDA	0	1
Pb-212	SCbkg	<MDA	NA	<MDA	<MDA	0	1
IPC	**Region**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Pb-214	AKN	0.38	0.12	0.38	0.47	2	5
Pb-214	ALD	0.49	0.31	0.36	0.85	3	7
Statistics	IPC	0.44	0.08	0.44	0.85	5	12
BMB	OPC	<MDA	NA	<MDA	<MDA	0	1
Pb-214	SCbkg	<MDA	NA	<MDA	<MDA	0	1
IPC	**Region**	**Avg**	**SD**	**Median**	**Max**	**D#**	**N#**
Be-7	ALD	4.38	0.44	4.21	4.88	3	7
Be-7	SCbkg	<MDA	NA	<MDA	<MDA	0	1

Notes:

1 - There is a decrease in concentration from the IPC to OPC to SCbkg except for K-40.

2 - Aiken (AIK) and Barnwell (BWL) had the highest statistics for K-40 and Cs-137. Cesium can replace potassium in some plants uptake.

3 - Lead-212 and Pb-214 were only slightly higher in Aiken county edible plants.

4 - D# is the specific radionuclide number of detections out of the number of samples with any detections, and not the total sample number.

Table 6a. Edible Fungi Gamma (pCi/g) Detections in the AOC, 2010

Fungus	Date	ID	Cs-137	Be-7	K-40	Pb-212	Pb-214
Boletes	8/10/2010	EV019	1.59	<MDA	19.94	<MDA	<MDA
Boletes	8/26/2010	VGNR95	4.66	<MDA	23	<MDA	<MDA
Boletes	8/26/2010	VGNR95B	5.30	<MDA	26.5	<MDA	<MDA
Boletes	8/26/2010	VGNR96	1.19	<MDA	22.9	<MDA	<MDA
Boletes	8/26/2010	VGNR97	1.10	<MDA	23.4	<MDA	<MDA
Boletes	8/26/2010	VGNR98	3.44	<MDA	29.4	<MDA	<MDA
Boletes	9/7/2010	VGNR100	2.61	<MDA	22.6	<MDA	<MDA
Chanterelle[1]	6/29/2010	VGNR82	0.39	<MDA	3.5	<MDA	<MDA
Chanterelle[1]	6/29/2010	VGNR85	0.61	<MDA	31.6	0.40	0.47
Chanterelle[1]	6/29/2010	VGNR86	30.70	<MDA	47.3	<MDA	<MDA
Chanterelle[1]	6/29/2010	VGNR91	4.85	<MDA	29.9	<MDA	<MDA
Lactarius[3]	9/13/2010	EV011C	15.80	<MDA	10.01	<MDA	<MDA
Lichen	11/23/2010	EV012	0.24	4.06	<MDA	<MDA	<MDA
Lichen	12/21/2010	EV028	<MDA	4.88	<MDA	0.39	0.36
Oyster	12/21/2010	EV027	0.25	<MDA	5.003	<MDA	0.85
Puffball	1/28/2010	VGNR70	<MDA	4.21	<MDA	<MDA	0.27
Chicken[2]	6/29/2010	EV018	0.99	<MDA	38.85	<MDA	<MDA
Chicken[2]	6/29/2010	VGNR88	0.71	<MDA	18.5	<MDA	<MDA
Chicken[2]	9/13/2010	EV012B	0.10	<MDA	4.425	<MDA	<MDA

Notes:

1 - Chanterelles were mostly golden chanterelles, *Cantharellus cibarius* .

2 - Red sulfur shelf, also known as the chicken mushroom, *Laetiporus sulfureus* .

3 - Indigo Milk Cap, *Lactarius indigo* .

Table 6b. Nonedible Fungi, 2010

AOC Nonedible Fungi, 2010.						
Leather Types	**AVG**	**SD**	**Median**	**Max**	**D#**	**S#**
Be-7	3.83	NA	3.83	3.83	1	4
K-40	4.33	1.88	4.52	6.11	3	4
Cs-137	1.02	0.71	1.30	1.55	3	4
SCbkg for Nonedible Fungi, 2010.						
Leather Types	**AVG**	**SD**	**Median**	**Max**	**D#**	**S#**
Be-7	3.49	0.96	3.08	4.92	4	4
K-40	2.38	0.63	2.34	3.10	4	4
Cs-137	0.21	0.01	0.21	0.22	2	4
Pb-212	0.18	NA	0.18	0.18	1	4
Pb-214	0.17	NA	0.17	0.17	1	4

Notes: All other gamma (pCi/g) were <MDA for the respective radionuclide.

1 - All other gamma analyses for the respective food group were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

2 - Activity concentrations in pCi/g.

Table 7. Plutonium and Uranium Species in Bolete Fungi, 2008.

SRS Perimeter Study Area of Concern (AOC)				SCbkg
Radionuclide (pCi/g)	AVG	SD	Median	AVG
Pu-239/240	**0.001413**	0.00099211	0.001090	<MDA
U-234	**0.012745**	0.00892824	0.010924	**0.005868**
U-235	**0.00112313**	0.00025214	0.0009887	<MDA
U-238	**0.01340125**	0.00897063	0.0115875	**0.007719**
AOC Average Minus South Carolina Background (SCbkg)				
Pu-239/240	**0.001413**			
U-234	**0.006877**			
U-235	**0.00112313**			
U-238	**0.005682**			

Notes:
1 - <MDA assigned value of zero in subtraction.
2 - Independent lab analysis of dried specimens.
3 - Fungi collected in 2008 were analyzed in 2010 for survey.

TOC

3.3.4 Data

2010 Radiological Monitoring of Edible Vegetation

Notes:

15. Bold numbers denote detections.
16. A blank field following ±2 SIGMA occurs when the sample is <LLD or <MDA.
17. LLD= Lower Limit of Detection, MDA=Minimum Detectable Activity
18. MDA= Minimum Detectable Activity
19. * More than 8 half lives had elapsed
20. NA - Denotes not applicable.
10. All units are in pCi/g. D# is number of detections
21. D# is number of detections
22. N# is number of samples
23. pCi/L – all tritium values
24. pCi/g – all other radionuclide (gamma) values

Data Table 1. Tritium (pCi/L) Detections in AOC and SCbkg Edible Plants

ID	EV001	EV002	EV003	EV004	EV005	EV006	EV007	EV008
Collection Date	9/9/10	9/9/10	9/13/10	9/13/10	9/13/10	9/13/10	9/7/10	9/8/10
Type	**persimmon**	**pear**	**Rhus spp.**	**Rhus spp.**	**persimmon**	**grapes**	**watermelon**	**persimmon**
Activity	**<LLD**	**200**	**256**	**<LLD**	**199**	**370**	**<LLD**	**257**
Confidence Interval	NA	87	85	NA	87	94	NA	85
LLD	186	186	186	186	186	186	186	186
ID	**EV011**	**EV024**	**EV028**	**EV029**	**EV033**	**EVBWL-02**	**EVBWL03**	
Collection Date	9/9/10	12/21/10	12/21/10	12/21/10	12/28/10	5/17/10	7/14/10	
Type	**Rhus spp.**	**Hericium spp.**	**lichen**	**Rhus spp.**	**Yaupon**	**plum**	**corn**	
Activity	**<LLD**	**<LLD**	**314**	**1000**	**428**	**258**	**<LLD**	
Confidence Interval	NA	NA	85	109	88	106	NA	
LLD	186	174	174	174	174	210	188	
ID	**EVJAK-01**	**EVJAK-02**	**EVJAK03**	**EVE5910**	**EVALN-01**	**EVALN-02**	**EVBWL-01**	
Collection Date	5/12/10	5/12/10	7/14/10	6/29/10	5/17/10	5/13/10	5/13/10	
Type	**plum**	**plum**	**corn**	**corn**	**plum**	**plum**	**plum**	
Activity	**430**	**258**	**274**	**<LLD**	**<LLD**	**<LLD**	**<LLD**	
Confidence Interval	110	97	91	NA	NA	NA	NA	
LLD	210	210	188	223	210	210	210	
ID	**EVNEW-01**	**EVNEW-02**	**EVSAL10A**	**EVSAL10B**	**EVSNL-01**	**EVSNL-02**	**EVE14B**	
Collection Date	5/12/10	5/13/10	5/28/10	5/28/10	5/17/10	5/13/10	1/19/10	
Type	**plum**	**plum**	**plum**	**peach**	**plum**	**plum**	**collard**	
Activity	**258**	**717**	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**	
Confidence Interval	97	115	NA	NA	NA	NA	NA	
LLD	210	210	223	223	210	210	187	
ID	**EVAKNBK**	**EVAKN-01**	**EVAKN-02A**	**EVAKN-02B**	**EVTRT**	**EVE65B1**	**EVE5310**	**EVE6410**
Collection Date	5/28/10	5/13/10	5/12/10	5/12/10	2/25/10	3/26/10	1/19/10	7/14/10
Type	**peach**	**plum**	**plum**	**cabbage**	**collard**	**mustard**	**collard**	**corn**
Activity	**<LLD**	**430**	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**281**
Confidence Interval	NA	110	NA	NA	NA	NA	NA	91
LLD	223	210	210	210	187	177	187	188
Tritium Backgrounds								
ID	**EV032**	**EV009**	**EV010**	**EVSMB2**				
Collection Date	12/28/2010	9/9/2010	9/9/2010	4/20/2010				
Type	**garlic**	**Rhus spp.**	**Rhus spp.**	**onion**				
Activity	**<LLD**	**<LLD**	**<LLD**	**<LLD**				
Confidence Interval	NA	NA	NA	NA				
LLD	174	186	186	177				

Notes:

1 - LLD is lower limit of detection.

2 - ID is identification in logbook.

3 - Rhus spp. Is winged/smooth sumac species drupes used in teas.

4 - Hericium spp. Is bear's head fungus.

5 - Lichen is reindeer spp.

6 - Yaupon leaf is a source of caffeine tea.

Data Table 2. Gamma Data (pCi/g) Radionuclide Detections in Wild Plum Fruit

ID	EVAKN-01	EVAKN-02A	EVJAK-01	EVJAK-02	EVNEW-01
Collection Date	05/13/10	05/12/10	05/12/10	05/12/10	05/12/10
County	AKN	AKN	AKN	AKN	AKN
K-40 Activity	**1.969**	**1.609**	**1.816**	**1.358**	**1.589**
K-40 Confidence Interval	0.532	0.527	0.493	0.449	0.469
K-40 MDA	0.249	0.258	0.205	0.206	0.243
ID	EVBWL-01	EVBWL-02	EVSNL-01	EVSNL-02	NA
Collection Date	5/13/10	5/17/10	5/17/10	5/13/10	NA
County	BWL	BWL	BWL	BWL	NA
K-40 Activity	**1.939**	**2.265**	**2.380**	**2.072**	NA
K-40 Confidence Interval	0.470	0.531	0.564	0.509	NA
K-40 MDA	0.235	0.222	0.191	0.231	NA
ID	EVSAL10A	EVNEW-02	EVALN-01	EVALN-02	NA
Collection Date	05/28/10	05/13/10	05/17/10	05/13/10	NA
County	SAL	ALN	ALN	ALN	NA
K-40 Activity	**2.264**	**2.622**	**1.946**	**2.720**	NA
K-40 Confidence Interval	0.535	0.516	0.518	0.515	NA
K-40 MDA	0.217	0.261	0.251	0.219	NA

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 3. Gamma (pCi/g) Radionuclide Detections in Wild Persimmon Fruit

Persimmons	EV001	EV005	EV008/NR101	EV011B
Collection Date	**9/9/2010**	**9/13/2010**	**9/8/2010**	**9/30/2010**
County	**BWL**	**AKN**	**BWL**	**BWL**
K-40 Activity	**2.73E+00**	**2.93E+00**	**2.74E+00**	**1.92E+00**
K-40 Confidence Interval	3.39E-01	3.50E-01	3.36E-01	2.98E-01
K-40 MDA	1.38E-01	1.09E-01	1.10E-01	1.10E-01
Pb-214 Activity	**MDA**	**MDA**	**9.61E-02**	**MDA**
Pb-214 Confidence Interval	NA	NA	2.88E-02	NA
Pb-214 MDA	4.34E-02	3.92E-02	3.36E-02	3.94E-02

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 4. All Gamma Backgrounds for Edible Green Vegetation and Edible Fungi (FG)

ID	EV009	EV010	EV020	EV021	EV022	EV023	EV030	EVSMB2
Collected	9/9/2010	9/9/2010	12/11/2010	12/11/2010	12/11/2010	12/11/2010	12/20/2010	04/20/10
Type	**Winged Sumac**	**Winged Sumac**	**Lettuce**	**Mustard**	**Tomatoes**	**Tomatoes**	**Oysters(FG)**	**Onions**
Location	MCM	MCM	LRNS	LRNS	LRNS	LRNS	LRNS	CAL
K-40 Activity	**2.53E+00**	**4.46E+00**	**5.11E+00**	**4.40E+00**	**2.45E+00**	**2.16E+00**	**2.55E+01**	<MDA
C. I.	5.40E-01	7.24E-01	1.32E+00	1.18E+00	3.84E-01	4.91E-01	2.03E+00	NA
K-40 MDA	2.22E-01	3.04E-01	5.89E-01	5.78E-01	1.59E-01	1.90E-01	4.46E-01	0.2304
Pb-214 Activity	<MDA	<MDA	<MDA	**1.41E+00**	**1.19E-01**	<MDA	<MDA	<MDA
C. I.	NA	NA	NA	1.52E-01	3.29E-02	NA	NA	NA
Pb-214 MDA	7.27E-02	9.72E-02	1.88E-01	1.45E-01	3.60E-02	5.33E-02	1.43E-01	0.07244

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - C. I. is concidence interval.
4 - Individual backgrounds are applied to specific food use categories.
5 - See microsoft Access tables for all other <LLD data.
6 - One onion sample, EVSMB2, analyzed for total strontium was <MDA (2.64E-02 pCi/g).

Data Table 5. Gamma Radionuclide Detections (pCi/g) in Greens

ID	EVTRT	EVE5310	EVE14B	EVAKN-02B	EV014	EVE65B1
Collected	**2/25/2010**	**1/19/2010**	**1/19/2010**	**5/12/2010**	**11/23/2010**	**3/26/2010**
Type	**Collards**	**Collards**	**Collards**	**Cabbage**	**Cabbage**	**Mustards**
Location	**EDF**	**AKN**	**AKN**	**AKN**	**BWL**	**EDF**
K-40 Activity	**4.42**	**4.89**	**3.54**	**4.69**	**3.35**	**3.31**
K-40 Confidence Interval	0.50	0.51	0.38	0.61	0.53	0.53
K-40 MDA	0.15	0.13	0.12	0.23	0.19	0.21
Pb-214 Activity	**0.07**	<MDA	**0.10**	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	0.03	NA	0.03	NA	NA	NA
Pb-214 MDA	0.03	0.04	0.03	0.07	0.05	0.07

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 6. Gamma Radionuclide Detections (pCi/g) in Domestic Fruit

ID	EVSAL10B	EVAKNBK	EV002	EV006	EV007
Collected	5/28/2010	5/28/10	9/9/2010	9/13/2010	9/7/2010
Type	**peaches**	**peaches**	**pears**	**grapes**	**watermelons**
Location	SAL	SAL	BWL	BWL	ALD
K-40	2.427	2.02	**1.16E+00**	**2.64E+00**	**2.29E+00**
Confidence Interval	0.499	0.50	2.44E-01	3.39E-01	2.96E-01
MDA	0.223	0.26	1.07E-01	1.10E-01	1.11E-01
Pb-214	<MDA	<MDA	<MDA	<MDA	**9.73E-02**
Confidence Interval	NA	NA	NA	NA	3.70E-02
MDA	0.066	0.08	4.13E-02	4.41E-02	3.57E-02

1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 7. Gamma Radionuclide Detections (pCi/g) in Seed Food Sources

ID	EV017	EV013	EV013B	EVBWL03	EVJAK03	EVE5910	EVE6410
Collected	11/23/2010	11/23/2010	11/23/2010	7/14/2010	7/14/2010	6/29/2010	7/14/2010
Type	**Sunflower**	**Soybean**	**Soybeans**	**Corn**	**Corn**	**Corn**	**Corn**
Location	BWL	BWL	BWL	BWL	AKN	ALD	BWL
K-40 Activity	**18.10**	**15.10**	**14.67**	**2.87**	**2.01**	**2.32**	**1.80**
K-40 Confidence Interval	1.83	1.29	1.42	0.41	0.36	0.52	0.33
K-40 MDA	0.64	0.31	0.26	0.20	0.17	0.21	0.22
Pb-214 Activity	**0.55**	**0.43**	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	0.16	0.07	NA	NA	NA	NA	NA
Pb-214 MDA	0.16	0.08	0.08	0.06	0.05	0.07	0.05

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 8. Gamma Radionuclide Detections (pCi/g) in Tea and Spice Sources

ID	EV015	EV016	EV031	EV033	EV003	EV004	EV011
Collected	11/23/10	11/23/10	12/28/10	12/28/10	9/13/10	9/13/10	9/9/10
Type	**Green Sweet Peppers**	**Sweet Sorgum**	**Garlic**	**YauponLeaf**	**Winged Sumac Berry**		
Location	BWL	BWL	BWL	BWL	BWL	BMB	MCM
K-40 Activity	**1.47**	**2.48**	**10.94**	**5.74**	**2.67**	**4.26**	**2.45**
K-40 Confidence Interval	0.43	0.66	2.10	2.42	0.62	0.69	0.54
K-40 MDA	0.19	0.33	0.85	1.25	0.30	0.22	0.22

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 9. Gamma Radionuclide Detections (pCi/g) in Bolete Mushrooms, 2010

Bolete Mushrooms	EV019	VGNR95	VGNR95B	VGNR96	VGNR97	VGNR98	VGNR100
Collected	8/10/2010	8/26/2010	8/26/2010	8/26/2010	8/26/2010	8/26/2010	9/7/2010
County	**AKN**	**AKN**	**BWL**	**BWL**	**BWL**	**BWL**	**BWL**
K-40 Activity	**19.94**	**23.00**	**26.50**	**22.90**	**23.40**	**29.40**	**22.60**
K-40 Confidence Interval	1.66	2.54	2.95	2.97	2.79	3.51	2.31
K-40 MDA	0.39	0.76	1.01	0.92	0.99	1.04	0.55
Cs-137 Activity	**1.59**	**4.66**	**5.38**	**1.19**	**1.10**	**3.44**	**2.61**
Cs-137 Confidence Interval	0.13	0.36	0.41	0.18	0.16	0.34	0.23
Cs-137 MDA	0.04	0.10	0.12	0.13	0.12	0.15	0.08
Pb-214 Activity	**0.30**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Pb-214 Confidence Interval	0.08	NA	NA	NA	NA	NA	NA
Pb-214 MDA	0.09	0.23	0.30	0.29	0.27	0.34	0.19

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 10. Gamma Radionuclide Detections (pCi/g) in Chanterelle and Red Sulfur Mushrooms

ID	VGNR82	VGNR85	VGNR86	VGNR91	EV012B	EV018	VGNR88
Collected Date	6/29/2010	6/29/2010	6/29/2010	6/29/2010	9/13/2010	6/29/2010	6/29/2010
Type	**Golden Chanterelle Mushrooms**				**Red Sulfur (Chicken) Mushrooms**		
Location	AKN	AKN	ALD	ALD	BMB	AKN	ALD
K-40 Activity	**37.50**	**31.60**	**47.30**	**29.90**	**4.43**	**38.85**	**18.50**
K-40 Confidence Interval	4.03	2.35	5.20	2.88	0.93	2.99	2.38
K-40 MDA	1.16	0.38	1.52	0.69	0.31	0.46	0.85
Cs-137 Activity	**0.39**	**0.61**	**30.70**	**4.85**	**0.10**	**0.99**	**0.71**
Cs-137 Confidence Interval	0.15	0.08	2.02	0.37	0.04	0.11	0.14
Cs-137 MDA	0.13	0.04	0.21	0.10	0.05	0.06	0.10
Pb-212 Activity	<MDA	**0.40**	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	0.07	NA	NA	NA	NA	NA
Pb-212 MDA	0.24	0.06	0.40	0.17	0.09	0.11	0.19
Pb-214 Activity	<MDA	**0.47**	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	0.07	NA	NA	NA	NA	NA
Pb-214 MDA	0.32	0.08	0.57	0.19	0.13	0.14	0.23

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 11. Gamma Radionuclide Detections (pCi/g) in Other Fungi

ID	EV011C	EV027	VGNR70	EV012	EV028
CollectDate	9/13/2010	12/21/2010	1/28/2010	11/23/2010	12/21/2010
Type	Lactarius Indigo	Oyster Mushrooms	Puffballs	Reindeer Lichen	
Location	BWL	ALD	ALD	ALD	AKN
Be-7 Activity	**<MDA**	**<MDA**	**4.21**	**4.06**	4.88
Be-7 Confidence Interval	**NA**	**NA**	1.81	2.03	0.85
Be-7 MDA	3.70	1.77	1.49	1.83	0.72
K-40 Activity	**10.01**	**5.00**	**<MDA**	**<MDA**	**<MDA**
K-40 Confidence Interval	1.25	2.26	**NA**	**NA**	**NA**
K-40 MDA	0.46	1.16	0.47	3.01	0.46
Cs-137 Activity	**15.80**	**0.25**	**<MDA**	**0.24**	**<MDA**
Cs-137 Confidence Interval	1.01	0.12	**NA**	0.09	**NA**
Cs-137 MDA	0.06	0.15	0.06	0.11	0.06
Pb-212 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.39**
Pb-212 Confidence Interval	**NA**	**NA**	**NA**	**NA**	0.09
Pb-212 MDA	0.13	0.22	0.11	0.22	0.10
Pb-214 Activity	**<MDA**	**0.85**	**0.27**	**<MDA**	**0.36**
Pb-214 Confidence Interval	**NA**	0.24	0.10	**NA**	0.11
Pb-214 MDA	0.18	0.27	0.11	0.29	0.12

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - See microsoft Access tables for all other <LLD data.

Data Table 12. Nonedible Leather Type Fungi Backgrounds and AOC Detections

Study Areas	SCbkg				AOC			
ID	**VGNR69**	**VGNR74**	**VGNR75**	**VGNR76**	**VGNR71**	**VGNR72**	**VGNR73**	**VGNR90**
Collected	1/28/2010	3/17/2010	3/17/2010	3/17/2010	1/28/2010	2/9/2010	2/9/2010	6/29/2010
Type	**Leather**	**Leather**	**Leather**	**Leather**	**Leather**	**Leather**	**Leather**	**Leather**
Location	**MCM**	**SAL**	**SAL**	**SAL**	**AKN**	**ALD**	**ALD**	**BWL**
Be-7 Activity	**4.916**	**3.128**	**3.038**	**2.859**	**<MDA**	**3.827**	**<MDA**	**<MDA**
Be-7 Confidence Interval	2.169	0.597	1.135	0.7632	NA	1.881	NA	NA
Be-7 MDA	1.978	0.5571	0.9389	0.746	2.81	1.982	2.388	1.87
K-40 Activity	**2.693**	**3.096**	**1.991**	**1.72**	**6.113**	**<MDA**	**4.515**	**2.36**
K-40 Confidence Interval	1.14	0.701	0.9837	0.7679	1.47	NA	1.409	0.961
K-40 MDA	0.5809	0.3175	0.5152	0.3868	0.5827	0.6777	0.6936	0.5
Cs-137 Activity	**0.2021**	**<MDA**	**0.2181**	**<MDA**	**0.2218**	**1.551**	**<MDA**	**1.3**
Cs-137 Confidence Interval	0.09335	NA	0.07684	NA	0.1038	0.1727	NA	0.142
Cs-137 MDA	0.07717	0.03999	0.06559	0.05118	0.08942	0.08352	0.09128	0.0645
Pb-212 Activity	**<MDA**	**0.1769**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Pb-212 Confidence Interval	NA	0.06132	NA	NA	NA	NA	NA	NA
Pb-212 MDA	0.1324	0.06865	0.1349	0.09948	0.1764	0.1691	0.1595	0.128
Pb-214 Activity	**<MDA**	**0.1666**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Pb-214 Confidence Interval	NA	0.06774	NA	NA	NA	NA	NA	NA
Pb-214 MDA	0.1863	0.0762	0.1469	0.124	0.2195	0.215	0.2175	0.161

Notes:
1 - All other gamma were <MDA from survey: Be-7, Na-22, K-40, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, Pb-212, Pb-214, Ra-226, Ac-228, U/Th-238, Am-241.
2 - See Acronyms and Radionuclides Appendix for abbreviation definitions.
3 - Cesium-137 higher detections in AOC versus SCbkg confirms the same pattern for nonNORM as in edible fungi.
4 - See microsoft Access tables for all other <LLD data.

Data Table 13. Select Fungi Reanalyzed in 2010 for Uranium and Plutonium Species

Location	**B24**	**B8NR34**	**E24NR21**	**E24NR26**	**E24NR36**	**E41NR22**	**E41NR22 Dup**
Lab Sample ID	10-05022-04	10-05022-05	10-05022-06	10-05022-07	10-05022-08	10-05022-09	10-05022-03
Collection Date	10/17/05	10/1/08	8/3/08	8/22/08	9/7/08	8/5/08	8/5/08
COC #	4708	4708	4708	4708	4708	4708	4708
Fungi Type	Gill/leather	boletes	boletes	boletes	boletes	boletes	boletes
Pu-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	0.00139*[7]
Pu-238 CSU	0.001432	0.000658	0.000406	0.000564	0.000548	0.000431	0.000611
Pu-238 MDA	0.002892	0.000959	0.000675	0.001150	0.001001	0.000752	0.000625
Pu-239/240 Activity	<MDA	<MDA	**0.001455**	**0.000670**	**0.000725**	**0.002801**	**0.002180**
Pu-239/240 CSU	0.001075	0.000381	0.000563	0.000449	0.000444	0.000779	0.000706
Pu-239/240 MDA	0.001461	0.000900	0.000487	0.000538	0.000506	0.000447	0.000477
U-234 Activity	**0.002392**	**0.005868**	**0.015410**	**0.006438**	**0.004932**	**0.024200**	**0.023700**
U-234 CSU	0.000911	0.002668	0.002406	0.001663	0.001179	0.003712	0.003560
U-234 MDA	0.000718	0.002850	0.000373	0.001120	0.000728	0.000152	0.000819
U-235 Activity	<MDA	<MDA	**0.000967**	**0.000989**	<MDA	**0.001414**	**0.001250**
U-235 CSU	0.000573	0.001590	0.000516	0.000738	0.000362	0.000682	0.000711
U-235 MDA	0.001079	0.002174	0.000533	0.000937	0.000609	0.000509	0.000835
U-238 Activity	**0.003535**	**0.007719**	**0.017060**	**0.006040**	**0.006115**	**0.024390**	**0.022300**
U-238 CSU	0.001106	0.002642	0.002597	0.001554	0.001312	0.003746	0.003380
U-238 MDA	0.000715	0.000511	0.000108	0.000844	0.000548	0.000670	0.000674

Notes: Eberline Data
1 - CSU=combined standard uncertainty or 2-sigma.
2 - CU=counting uncertainty
3 - Bolded numbers are detections >MDA.
4 - "B" in column heading denotes SC background and "E" denotes environmental perimeter study area of concern (AOC).
5 - These samples were selected for reanalysis based on higher Cs-137 detections.
6 - The underlined AOC detections were greater than the B8 bolete background.
7 - Note that the duplicate detection was suspect compared to the original sample.

Data Table 14. Select Fungi Analyzed in 2010 for Plutonium Species

Location	**EV011c**	**EVo11c Dup**	**VGNR86**	**VGNR91**	**VGNR95**	**VGNR95b**
Lab Sample ID	11-08102-04	11-08102-04	11-08102-05	11-08102-06	11-08102-07	11-08102-08
Collection Date	9/13/10	9/13/10	6/29/10	6/30/10	8/26/10	8/26/10
COC #	6311	6311	6311	6311	6311	6311
Fungi Type	Lactarius	Lactarius	Chanterelles	Chanterelles	Boletes	Boletes
Pu-238 Activity	0.0358*[5]	<MDA	0.00501*[6]	<MDA	<MDA	<MDA
Pu-238 CSU	0.012400	0.002410	0.004380	0.005760	0.007670	0.004030
Pu-238 MDA	0.005510	0.004130	0.005010	0.010100	0.009450	0.006130
Pu-239/240 Activity	0.0567*[5]	<MDA	<MDA	<MDA	<MDA	<MDA
Pu-239/240 CSU	0.016100	0.003770	0.002380	0.003490	0.006330	0.004030
Pu-239/240 MDA	0.004510	0.004130	0.004090	0.008270	0.007730	0.006120

Notes: Eberline Data
1 - CSU=combined standard uncertainty or 2-sigma.
2 - CU=counting uncertainty
3 - Bolded numbers are detections equal to or >MDA.
4 - *Lactarius Indigo* and *Cantharelles cibarius* .
5 - Note that this detection was suspect since the duplicate did not confirm the detection.
6 - No duplicate confirmation of suspect data equivalent to the MDA.

TOC

3.3.5 Summary Statistics

2010 Radiological Monitoring of Edible Vegetation

Notes:

1. S# is total sample number. N# will sometimes equal S#.
11. N/A = Not Applicable
12. Min. – Minimum
13. Max. = Maximum
14. * more than 8 half lives had elapsed
15. D# is number of detections
16. N# is number of samples in group
17. pCi/L – all tritium values
18. pCi/g – all other radionuclide (gamma) values

Summary Statistics Table 1a. AOC Edible Vegetation and Fungi Tritium (pCi/L), 2010

Food Type	AVG	SD	Median	Max	Detects	N#
Watermelon	<LLD	NA	<LLD	<LLD	0	1
Collards	<LLD	NA	<LLD	<LLD	0	3
Peaches	<LLD	NA	<LLD	<LLD	0	2
Bear's Head Fungus	<LLD	NA	<LLD	<LLD	0	1
Cabbage	<LLD	NA	<LLD	<LLD	0	1
Wild Mustard	<LLD	NA	<LLD	<LLD	0	1
Winged Sumac (Berry)	628	526	628	1000	2	4
Wild Yaupon (Leaf)	428	88	174	428	1	1
Wild Plums	392	180	344	717	6	13
Grapes	370	94	186	370	1	1
Lichen Fungus	314	NA	314	314	1	1
Corn	278	5	278	281	2	4
Wild Persimmons	228	40	228	257	2	3
Pears	200	87	186	200	1	1
AVG	355	Average of tritium across food types.				
SD	136					
Median	342	Central tendency across AOC.				
Detects	16	Total tritium detections across AOC.				
S#	37	Total tritium samples across area of concern (AOC).				
SCbkg	<LLD	NA	<LLD	<LLD	0	4

Table 1b. South Carolina Background (SCbkg) for Tritium in Edible Vegetation, 2010.

Food Type	AVG	SD	Median	Maximum	D#	N#
Onion and Garlic	<LLD	NA	<LLD	<LLD	0	2
Drupes[1]	<LLD	NA	<LLD	<LLD	0	2

Notes:
1. Winged Sumac drupes.
2. No tritium in fungi background.
3 - N# refers to sample number by group reference, and S# refers to the total sample number.
4 - Food group and county tritium summaries are already covered in section 5.0, tables 1a, 1b.

Summary Statistics Table 2a. AOC Edible Plant Radionuclide Detections 'Without' Fungi, 2010

pCi/g	H-3	Cs-137	Sr-89/90	Be-7	K-40	Pb-212	Pb-214
AVG	0.374	<MDA	<MDA	<MDA	3.774	<MDA	0.223
SD	0.218	<MDA	<MDA	<MDA	3.803	<MDA	0.21
Median	0.274	<MDA	<MDA	<MDA	2.466	<MDA	0.099
Maximum	1.000	<MDA	<MDA	<MDA	18.1	<MDA	0.552
D#	15	0	0	0	42	0	6
N#	35	42	42	42	42	42	42

Table 2b. Summary Statistics for AOC 'Edible Fungi' Radionuclide Detections, 2010

pCi/g	H-3	Cs-137	Sr-89/90	Be-7	K-40	Pb-212	Pb-214
AVG	0.314	4.3877	<MDA	4.3817	24.4268	0.39335	0.4487
SD	NA	7.7659	<MDA	0.4353	11.724	0.01082	0.2355
Median	0.314	1.19	<MDA	4.208	23.2	0.39335	0.3597
Maximum	0.314	30.7	<MDA	4.877	47.3	0.401	0.8475
D#	1	17	0	3	16	2	5
N#	2	19	19	19	19	19	19

Notes:
1 - AOC green vegetation (plants) versus fungi.
2 - Sample basis statistics.
3 - Tritium (H-3) is slightly higher in green plants, whereas Cs-137, Be-7, K-40, Pb-212, and Pb-214 are much higher in fungi.
4 - Combining tables 2a and 2b will give table 1c tritium statistics in tables and figures.
5 - N# refers to sample number by group reference, and S# refers to the total sample number.
6 - Gamma summaries by counties and region, radionuclide, and food groups are already covered in section 5.0.
7 - This summary is by radionuclides for the edible plant or green vegetation versus fungi.
8 - Herein 'vegetation' without a qualifier refers to all samples, both plant and fungi kingdoms.

Table 3. 2010 Edible Vegetation South Carolina *Background* Detections Summary Statistics

Food Type	Radionuclide	AVG	SD	Median	Max	D#	N#
Leafy Greens	K-40	4.755	0.502	4.755	5.110	2	3
Leafy Greens	Pb-214	1.410	NA	1.410	1.410	1	3
Leafy Greens	H-3	<LLD	NA	<LLD	<LLD	0	2
Teas	K-40	3.495	1.360	3.495	4.457	2	2
Teas	H-3	<LLD	NA	<LLD	<LLD	0	2
Fruit (Tomatoes)	K-40	2.305	0.203	2.305	2.448	2	2
Fruit (Tomatoes)	Pb-214	0.119	NA	0.119	0.119	1	2
Fungi (Oysters)	K-40	25.480	NA	25.480	25.480	1	1
All EV	K-40	6.656	8.382	4.400	25.480	7	8
All EV	Pb-214	0.765	0.913	0.765	1.410	2	8
All EV	H-3	<LLD	NA	<LLD	<LLD	0	4

Notes:
1 - Detections in tea sources were from winged sumac drupes and Yaupon leaf.
2 - Categories combine wild and domestic species.
3 - All in pCi/g.
4 - Leafy greens includes onions, which had no detections.
5 - All EV means green plants plus fungi.
6 - N# refers to sample number by group reference, and S# refers to total sample numbers. The All EV rows N# is equivalent to S#.

Summary Statistics Table 4. Nonedible and Edible Fungi Background Summary Statistics

AOC Nonedible Fungi, 2010.						
Leather Types	**AVG**	**SD**	**Median**	**Maximum**	**D#**	**N#**
Be-7	3.83	NA	3.83	3.83	1	4
K-40	4.33	1.88	4.52	6.11	3	4
Cs-137	1.02	0.71	1.30	1.55	3	4
SCbkg for Nonedible Fungi, 2010.						
Leather Types	**AVG**	**SD**	**Median**	**Maximum**	**D#**	**N#**
Be-7	3.49	0.96	3.08	4.92	4	4
K-40	2.38	0.63	2.34	3.10	4	4
Cs-137	0.21	0.01	0.21	0.22	2	4
Pb-212	0.18	NA	0.18	0.18	1	4
Pb-214	0.17	NA	0.17	0.17	1	4
AOC Edible Fungi, 2010.						
pCi/g	**AVG**	**SD**	**Median**	**Maximum**	**D#**	**N#**
Be-7	4.38	0.44	4.21	4.88	3	19
K-40	24.43	11.72	23.20	47.30	16	19
Cs-137	4.39	7.77	1.19	30.70	17	19
Pb-212	0.39	0.01	0.39	0.40	2	19
Pb-214	0.45	0.24	0.36	0.85	5	19
H-3	0.31	NA	0.31	0.31	1	2
Oyster, Edible Fungi Background, 2010.						
Oyster	**AVG**	**SD**	**Median**	**Maximum**	**D#**	**N#**
K-40	25.48	NA	25.48	25.48	1	1

Notes:

1 - Be-7, K-40, and Cs-137 were higher in the AOC versus SCbkg in both nonedible and edible fungi. However, edible fungi were higher than inedible fungi for detected radionuclides.

2 - K-40 was the only radionuclide detection for the edible oyster mushroom found in the background, and was over ten times higher in the edible versus inedibles. This large difference in K-40 uptake may be related to the species, and soil or host substrate chemistry.

3 - The widely varying statistics across species,substrates, and soil sources for fungi indicate additional study is needed in all three areas within very specific parameters.

4 - All other gamma analyses were <MDA. Gamma analyses included Be-7, Na-22, Mn-54, Co-58, Co-60, Zn-65, Y-88, Zr-95, Ru-103, Sb-125, I-131, Cs-134, Cs-137, Ce-144,Eu-152, Eu-154, Eu-155, Ra-226, Ac-228, U/Th-238, K-40, Pb-212, Pb-214, and Am-241.

Summary Statistics Tables 5 a,b. 2004-2010 nonNORM Detections in Edible Vegetation

Table 5a. 2004-2010 AOC Summary Statistics for All Edible Vegetation Including Fungi			
pCi/g	H-3	Cs-137	Sr-89/90
AVG	0.31	4.39	0.18
SD	0.16	7.77	0.18
Median	0.26	1.19	0.08
Max	1.00	30.70	0.62
D# out of 200.	55	17	10
Table 5b. 2004-2010 AOC Summary Statistics for All Edible Vegetation Excluding Fungi			
pCi/g	H-3	Cs-137	Sr-89/90
AVG	0.31	<MDA	0.18
SD	0.16	NA	0.18
Median	0.26	<MDA	0.08
Max	1.00	<MDA	0.62
D# out of 181.	54	0	10

Notes:
1 - Edible plants have lower detection statistics when fungi are excluded for radionuclides in common.
2 - These statistics include only edible fungi collected in 2010 as part of the edible vegetation project, and not fungi previously collected for the nonedible vegetation project, 2004-09.
3 - This comparison shows that most tritium detections occurred in edible green plants and most gamma detections occurred in fungi to date. Edible fungi were not sampled for Sr-89/90 in 2010.

Summary Statistics Tables 6 a,b. 2004-2010 NORM Detections in Edible Vegetation

Table 6a. 2004-2010 AOC Summary Statistics for All Edible Vegetation Including Fungi				
pCi/g	Be-7	K-40	Pb-212	Pb-214
AVG	4.38	9.47	0.39	0.39
SD	0.44	11.55	0.01	0.01
Median	4.21	2.90	0.39	0.39
Max	4.88	47.30	0.40	0.40
D# out of 200	3	58	2	2
Table 6b. 2004-2010 AOC Summary Statistics for All Edible Vegetation Excluding Fungi				
pCi/g	Be-7	K-40	Pb-212	Pb-214
AVG	<MDA	3.77	<MDA	0.22
SD	<MDA	3.80	<MDA	0.21
Median	<MDA	2.47	<MDA	0.10
Max	<MDA	18.10	<MDA	0.55
D# out of 181	54	42	10	6

Notes:
1 - Edible plants have lower detection statistics when fungi are excluded for radionuclides in common.
2 - These statistics include only edible fungi collected in 2010 as part of the edible vegetation project, and not fungi previously collected for the nonedible vegetation project, 2004-09.

Summary Statistics Table 7. 2004-2010 Background Detections in Edible Vegetation

pCi/g	Including Fungi		Excluding Fungi	
Type	K-40	Pb-214	K-40	Pb-214
AVG	6.656	0.800	3.518	0.800
SD	8.382	0.863	1.278	0.863
Median	4.400	0.800	3.465	0.800
Max	25.480	1.410	5.110	1.410
D#	7	2	6	2
N#	8	8	7	7

Notes:
1 - Fungi detections increase the South Carolina background statistics also.

TOC

Table 8. Radionuclides in Edible Fungi versus ALL Fungi 2004-2010

SCbkg Edible Fungi 2004-2010							
	AVG	SD	Median	MAX	D#	N#	Freq
Be-7	7.27	2.84	6.71	14.97	12	20	0.600
K-40	13.36	11.03	9.87	30.53	14	20	0.700
Cs-137	1.40	4.96	0.14	20.00	16	20	0.800
Pb-212	0.29	0.11	0.29	0.46	9	20	0.450
Pb-214	0.41	0.31	0.33	1.12	10	20	0.500
Edibles were mostly boletes and chanterells.							
SCbkg All Fungi 2004-2010							
	AVG	SD	Median	MAX	D#	N#	Freq
Be-7	5.54	3.32	4.98	14.97	28	80	0.350
K-40	7.27	8.28	3.99	36.85	58	80	0.725
Cs-137	0.83	0.91	0.47	4.16	50	80	0.625
Pb-212	0.26	0.12	0.27	0.46	18	80	0.225
Pb-214	0.38	0.24	0.29	1.12	37	80	0.463
Ra-226	2.99	NA	2.99	2.99	1	79	0.013
AOC Radionuclides in Edible versus All Fungi.							
Area of Concern Radionuclies in Edible Fungi 2004-2010							
	AVG	SD	Median	MAX	D#	N#	FreqDet
Be-7	6.07	2.00	5.66	8.63	6	54	0.111
K-40	19.53	9.64	18.57	47.30	48	54	0.889
Cs-137	3.14	5.00	1.59	30.70	51	54	0.944
Pb-212	0.31	0.13	0.34	0.47	11	54	0.204
Pb-214	0.55	0.38	0.42	1.69	17	54	0.315
Edibles were mostly boletes and chanterells.							
Area of Concern Radionuclides in All Fungi 2004-2010							
	AVG	SD	Median	MAX	D#	N#	Freq
Be-7	4.97	3.51	4.13	20.00	30	154	0.195
K-40	12.42	11.32	7.86	63.40	125	154	0.812
Cs-137	2.31	4.23	1.02	30.70	126	154	0.818
Pb-212	0.32	0.21	0.33	0.83	22	154	0.143
Pb-214	0.60	0.64	0.37	3.50	67	154	0.435
Ra-226	6.69	3.01	6.48	10.91	7	154	0.045
Ac-228	2.34	NA	2.34	2.34	1	154	0.006

Notes:
1 - These statistics would change with the proportions and types of fungi collected.
2 - The Area of Concern extends from the boundary of SRS to a 50-mile perimeter.
3 - The South Carolina (SCbkg) is outside of the 50-mile perimeter.
4 - These statistics combine the fungi collected in the edible and nonedible projects.
5 - Note that only K-40, Cs-137, Pb-212, and Pb-214 are higher in the AOC edible fungi than the SCbkg.
6 - The same radionuclides plus the addition of Ra-226 and Ac-228 were greater in the AOC for all fungi.
7 - Also, the highest frequency of detections tend to occur either in the K-40 or Cs-137 radionuclides.

TOC

Appendix Table 1a.

Radioisotope	Abbreviation
Actinium-228	Ac-228
Americium-241	Am-241
Berylium-7	Be-7
Cerium-144	Ce-144
Cobalt-58	Co-58
Cobalt-60	Co-60
Cesium-134	Cs-134
Cesium-137	Cs-137
Europium-152	Eu-152
Europium-154	Eu-154
Europium-155	Eu-155
Iodine-131	I-131
Potassium-40	K-40
Manganese-54	Mn-54
Sodium-22	Na-22
Lead-212	Pb-212
Lead-214	Pb-214
Radium-226	Ra-226
Ruthenium-103	Ru-103
Antimony-125	Sb-125
Thorium-234	Th-234
Ytrium-88	Y-88
Zinc-65	Zn-65
Zirconium-95	Zr-95

Appendix Table 1 b. International Atomic Energy Agency Radionuclides Guidelines for Food

Radionuclides in Foods		Guideline Levels	
Radionuclides	Units	kBq/kg	pCi/g
Pu-238, Pu-239, Pu-240, Am-241		1	0.27
Sr-90, Ru-106, I-129, I-131, U-235		100	2.7
S-35, Co-60, Sr-89, Ru-103, Cs-134, Cs-137, Ce-144, Ir-192		1000	27
H-3, C-14, Tc-99		10000	270

Appendix Table 1c.

USFDA Derived Intervention Levels (DILS) for Each Radionuclide Group for Food in Domestic Commerce and Food Offered for Import		Guideline Levels	
Radionuclide Group	Units	Bq/kg	pCi/g
Strontium-90		160	4.32
Iodine-131		170	4.59
Cesium-134 + Cesium-137		1200	32.4
Plutonium-238 + Plutonium-239 + Am-241		2	0.054
Ruthenium-103 + Ruthenium-106		$((C_3/6800) + (C_6/450)) < 1$	

Notes:
1 - For spices use a dilution factor of 10.
2 - C3 and C6 refer to concentrations of Ru-103 and Ru-106.

TOC

3.4 Radiological Monitoring of Dairy Milk

3.4.1 PROJECT SUMMARY

Operations at the Savannah River Site (SRS) have resulted in the potential for radiological constituents to be released to the surrounding environment. Milk from dairies around the SRS are routinely analyzed for levels of radioactivity that could impact human health. This project provides radiological dairy milk monitoring of selected cow dairies within a 50-mile radius of the SRS in South Carolina (SC). This project also provides analytical data for comparison to published Department of Energy-Savannah River (DOE-SR) data.

Consumption of milk products containing radioactive materials can be an important human exposure pathway to radioactivity. When an atmospheric release occurs, radionuclides can be deposited on pastures and ingested by grazing dairy cows. The cows would then release a portion of the radioactivity into the milk that is consumed by humans (CDC 2001). Radioactive strontium is a calcium analogue and may show a tendency to accumulate in bones and teeth (Kathren 1984).

Plants and animals assimilate different radioisotopes based on the chemistry and not on the radioactive nature of the components. Cesium-137 (Cs-137) is less readily taken up by plant roots than strontium-90 (Sr-90), but the opposite is true for direct absorption from foliar (leaf) deposits. Cesium-137 is transferred rapidly from pasture grass to the muscles of animals. Strontium-90 is an isotope that can bioconcentrate in bones when there is a deficiency of calcium in the diet of the individual. This pathway is of particular importance in the case of infants and children because they are more likely to drink large quantities of milk and they are actively developing bones and teeth (Kathren 1984). Irrigation of a pasture with contaminated groundwater or uptake by plants from contaminated soil can provide alternate modes of release and contribution to this exposure pathway. Iodine-131 (I-131) is rapidly transferred to milk and accumulates in the thyroid of humans. Cobalt-60 (Co-60) is unlikely to bioaccumulate, but it can be absorbed in the blood and tissues before it is slowly eliminated (USEPA 2002d). Most of the Co-60 contamination came exclusively from the SRS from the period 1968 to 1984 when Co-60 was used as a heat source for a thermoelectric generator (WSRC 1998). Tritium (H-3) is a radioisotope of hydrogen that produces beta particles, and therefore can impact anything containing water or hydrocarbons. Tritium exists everywhere in the environment**,** and its volatility quickly achieves equilibrium in the environment and the body (Larson 1958). Therefore, tritium targets the whole body**.**

During 2010, DOE-SR collected samples from six dairy locations, four of which are located in South Carolina (SRNS 2011). DOE-SR milk samples are collected quarterly within a 25-mile radius of the SRS. Only four of the dairies that DOE-SR sampled are located in South Carolina and the remaining two are located in Georgia. The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) collected milk at six cow dairy locations within the state to provide an independent source of data on radionuclide concentrations of concern in milk (Section 3.4.3, Table 1). Of the six SCDHEC samples four of them are environmental (E) samples within a 50-mile perimeter of an SRS center point and two are background (B) samples beyond the 50 mile perimeter.

SCDHEC personnel collected unpasteurized milk samples on a quarterly basis in 2010. Cow milk samples from each quarter were analyzed for tritium, strontium-89/90 (Sr-89/90), and select gamma-emitting radionuclides, specifically I-131, Cs-137, and Co-60. SCDHEC samples for total strontium (Sr-89/90), instead of just Sr-90, due to prefered laboratory techniques. In order to provide a conservative result, it is assumed that the total strontium detected is in the form of Sr-90.

SCDHEC did not detect any anthropogenic gamma-emitting or tritium radionuclides in any of the 24 milk samples collected during 2010. Strontium-89/90 was detected in three samples collected from perimeter locations and in two samples collected from background locations in 2010 (Section 3.4.4, 2010 Strontium Milk Data table). The source of the strontium is likely due to historical atmospheric nuclear weapons testing. Strontium has slow long-term fallout properties and a long half-life (Larson 1958). None of the Sr-89/90 detections in 2010 exceeded the United States Environmental Protection Agency (USEPA) drinking water Maximum Contaminant Level (MCL) of 8 picocuries per liter (pCi/L) for Sr-90 (USEPA 2002c).

DOE-SR did not detect tritium in any milk samples collected in 2010. Cesium-137 was detected in one milk sample from Barnwell, SC. DOE-SR also had two detections of Sr-89/90 in milk samples from Denmark, SC and McBean, GA (SRNS 2011).

During 2010, concentrations of radionuclides of concern in milk did not deviate from historically expected levels as measured by DOE-SR and SCDHEC. SCDHEC will continue to monitor dairies for radionuclides that have the potential to impact human health.

RESULTS AND DISCUSSION

Tritium Results

Historically tritium has been the main product of operations at SRS, produced as a nuclear weapon enhancement component. The majority of tritium released was in the production reactors and separation areas (CDC 2001). Cow milk tritium contributions come not only from atmospheric depositions, but from food sources and groundwater wells also. Over 99% of tritium occurs as tritiated water and groundwater. Background test wells (SCDHEC 2003b) have tritium contributions (atomic legacy source likely) that are higher than the range found in milk. Tritium averages are lower in milk because of plant uptake factors, intrinsic transfer factors, bioelimination factors, and the variation in distributions of atmospheric depositions.

No SCDHEC perimeter milk sample collected during 2010 exhibited tritium activity above the Lower Limit of Detection (LLD) of 213 pCi/L. This was consistent with the 2009 results, where no perimeter milk sample exhibited tritium activity above the LLD of 207 pCi/L (SCDHEC 2010d). Figure 1 of Section 3.4.3 illustrates average tritium detections for the last ten years SCDHEC has sampled milk. All tritium detections have been below the USEPA drinking water MCL of 20,000 pCi/L for tritium. DOE-SR did not detect tritium in any milk samples for 2010 (SRNS 2011). No summary statistics were calculated for tritium as all results were below the Minimum Detectable Activity (MDA). The tritium results for all milk samples collected by SCDHEC are given in Section 3.4.4. These radionuclide contributions to cow milk come from the SRS, other nuclear facilities, and legacy contamination from the cold war period (CDC 2001).

Gamma-Emitting Radionuclides Results

The gamma-emitting radionuclides I-131, Cs-137, and Co-60 are man-made radioactive elements that can impact public health and were all products of SRS activities. These radionuclides were produced by fission in reactor fuels, and they were primarily released in surface streams in the 1960s or into the atmosphere in the separation areas (CDC 2001; WSRC 1998). SCDHEC tested for I-131, Cs-137, and Co-60 in all milk samples collected in 2010. All analytical results for these radionuclides were below the sample MDA. These results were consistent with 2009 results (SCDHEC 2010d). All analytical results for gamma-emitting radionuclides are located in Section 3.4.4. No summary statistics were calculated for these radionuclides as all results were below the MDA. DOE-SR detected a gamma-emitting radionuclide from one sample in 2010; the sample collected in Barnwell, SC exhibited a Cs-137 activity of 3.97 pCi/L (SRNS 2011).

Strontium-89/90 Results and Statistics

Strontium is present around the world due to nuclear weapons atmospheric testing in the 1950s and 1960s (CDC 2001). Since strontium has slow fallout from the atmosphere and a 29-year half-life, it is still present in the environment; however, concentrations are low and continue to decrease over time (USEPA 2002c; Larson 1958). SRS operations have also released strontium into the environment through normal site operations and equipment failure. Strontium was a product of fission in SRS reactors, and was subsequently released in the F-area and H-area (WSRC 1998).

Samples were collected quarterly in 2010 for Sr-89/90 analysis (Section 3.4.4). Five SCDHEC milk samples collected in 2010 exhibited strontium activities above the MDA. The range for these detections was 0.22 pCi/L to 0.47 pCi/L, with the minimum detection in a sample from Johnston, SC, and the maximum detection in a sample from Bowman, SC. These detections averaged 0.37 (± 0.11) pCi/L (Section 3.4.5). This average is below the USEPA established MCL of 8 pCi/L for Sr-90 in drinking water (USEPA 2002c). This average is a decrease from 2009, when the strontium average was 0.73 (± 0.37) pCi/L (SCDHEC 2010d). Figure 2 (Section 3.4.3) shows the trend for SCDHEC strontium detections for the last ten years. All strontium detections have been below the USEPA established MCL of 8 pCi/L for Sr-90 since testing initiated in 1998. DOE-SR detected Sr-89/90 in two samples from locations in Denmark, SC and McBean, GA. The detection activities were 1.40 pCi/L and 1.36 pCi/L, with the higher activity in the sample from Barnwell, SC (SRNS 2011).

Statistical analysis was limited to a comparison of averages of all E samples collected within 50-mile perimeter and all B samples, as shown in Section 3.4.5. Two of the five DHEC samples above the MDA were from background locations. The result was a negligible effect of Sr-90 in milk from dairies with close proximity to the SRS (Section 3.4.5, E minus B).

CONCLUSIONS AND RECOMMENDATIONS

The DOE-SR uses all analytical results, including below Minimum Detectable Concentration (MDC), to compute averages. SCDHEC uses only detections to compute averages. Consequently, dairy milk analytical data comparisons between SCDHEC and DOE-SR were not conducted. An evaluation of average concentrations by sampling location is included in Section 3.4.5.

A large portion of the radiological activity observed in milk samples can be attributed to fallout from past nuclear testing. Also, radionuclides within soil and plants can potentially be redistributed as a result of farming practices and prescribed burns. SCDHEC will continue to monitor tritium, gamma-emitting radionuclides that can affect human health, and strontium in cow milk to ensure the safety of milk consumption by the public.

The dairies in the ESOP South Carolina study area and background locations appear to be stable with no indication of closing in the foreseeable future. ESOP has had no indication of any new dairies opening within the study area. Additional dairy sources will be added to the network if and when they become available.

TOC

3.4.2 Radiological Monitoring of Dairy Milk Map

Map 11. 2010 SCDHEC Radiological Monitoring Locations for Dairy Milk

TOC

3.4.3 Tables and Figures

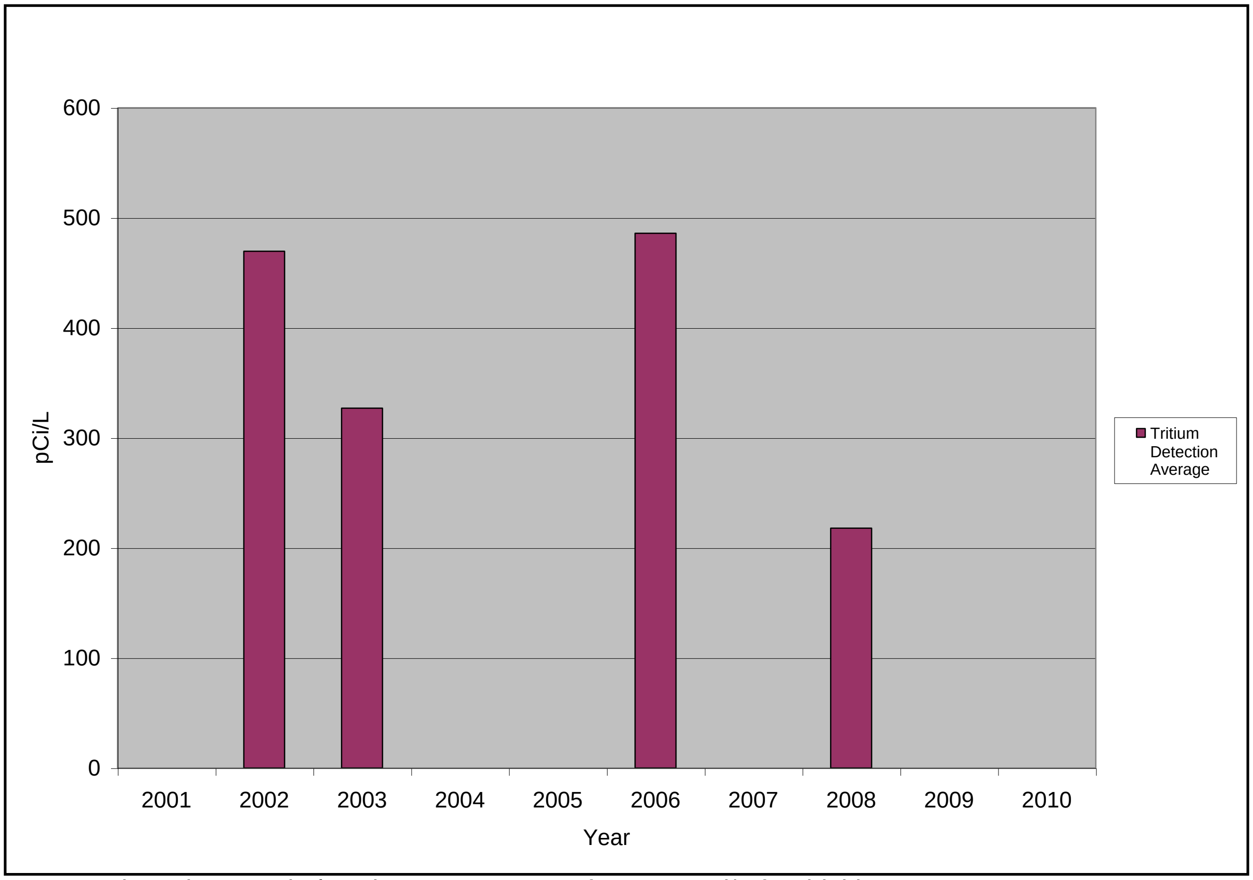
Radiological Monitoring of Dairy Milk

Table 1. 2010 SCDHEC and DOE-SR Dairy Milk Sampling Locations

2010 SCDHEC and DOE-SR Dairy Milk Sampling Locations	
SCDHEC Cow Dairy Locations	**DOE-SR Cow Dairy Locations**
Denmark, SC, MK-17	Barnwell: SC Dairy
Leesville, SC, MK-10	Denmark: SC
Johnston, SC, MK-8	Ehrhardt Road: Govan: SC Dairy
Govan, SC, MK-22	HWY 23 Girard: GA Dairy
Bowman, SC*, MK-30	Hwy 23: McBean GA Dairy
Darlington, SC*, MK-99	Partridge Rd: Govan: SC Dairy

*Background Locations

Figure 1. Average Tritium Detections in SCDHEC Milk, 2001-2010

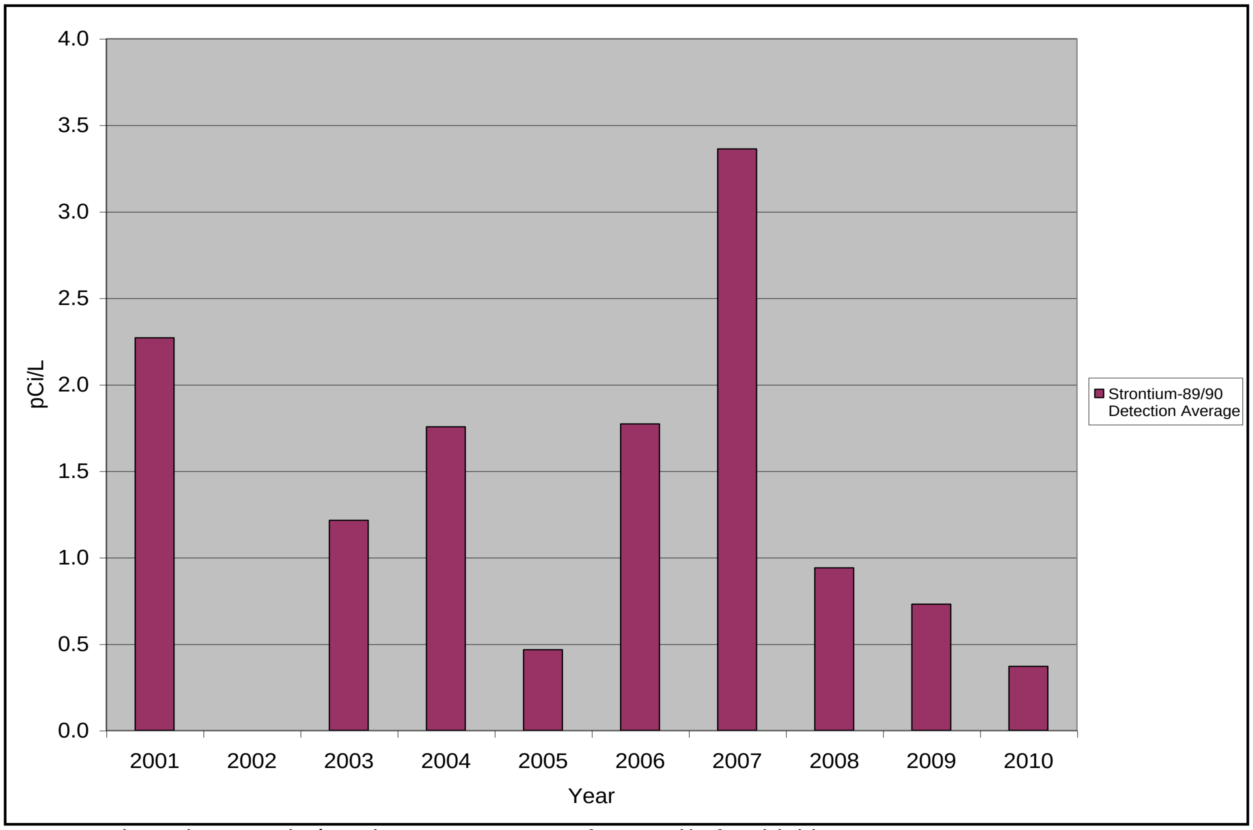


Average detections are below the USEPA MCL of 20,000 pCi/L for drinking water.
No detections above the MDA were observed in 2001, 2004, 2005, 2007, 2009 and 2010.

Tables and Figures

Radiological Monitoring of Dairy Milk

Figure 2. Strontium-89/90 Detection Averages, 2001-2010



Average detections are below the USEPA MCL of 8.0 pCi/L for drinking water.
No detections above the MDA were observed in 2002.

TOC

3.4.4 Data

Radiological Monitoring of Dairy Milk

Notes:

25. LLD - Lower Limit of Detection
26. MDA - Minimum Detectable Activity
27. MDC - Minimum Detectable Concentration
28. SC - South Carolina
29. * Indicates a background sampling location

Radiological Monitoring Of Dairy Milk Data
2010 Tritium and Gamma-emitting Milk Data

Sample Location		MK-8 Johnston, SC			
Collection Date		2/8/2010	4/20/2010	9/6/2010	11/29/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	210	224	210	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.57	2.32	2.46	2.60
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	117.80	22.15	14.94	10.53
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.70	2.29	2.41	2.69

Radiological Monitoring of Dairy Milk Data

2010 Tritium and Gamma-emitting Milk Data

Sample Location		MK-10 Leesville, SC			
Collection Date		2/8/2010	4/20/2010	9/7/2010	11/29/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	212	224	209	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.47	2.09	2.20	2.39
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	169.40	20.25	14.16	10.20
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.70	2.05	2.42	2.70

Sample Location		MK-17 Denmark, SC			
Collection Date		2/10/2010	4/19/2010	9/3/2010	11/30/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	210	223	210	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	3.06	2.03	2.13	3.67
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	118.80	22.42	24.62	16.32
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.67	2.14	2.52	4.82

Sample Location		MK-22 Govan, SC			
Collection Date		2/10/2010	4/19/2010	9/3/2010	12/1/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	211	224	208	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.59	2.14	2.32	2.49
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	122.20	29.31	27.19	9.43
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.70	2.09	2.69	2.70

Sample Location		MK-30 Bowman, SC*			
Collection Date		2/9/2010	4/22/2010	9/3/2010	11/30/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	209	223	209	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.54	2.23	2.66	3.73
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	195.20	22.36	28.03	16.97
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.70	2.09	2.67	4.09

Sample Location		MK-99 Darlington, SC*			
Collection Date		2/9/2010	4/22/2010	9/6/2010	11/30/2010
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	208	223	207	210
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.61	2.12	2.33	3.39
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	198.70	32.72	28.10	21.60
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.66	2.20	2.62	3.33

Radiological Monitoring of Dairy Milk Data

2010 Strontium Milk Data

Units are in picocuries per Liter (pCi/L)

Sample Location	MK-8 Johnston, SC			
Collection Date	2/8/2010	4/20/2010	9/6/2010	11/29/2010
Sr - 89/90 (pCi/L)	<MDA	<MDA	<MDA	**0.224**
+/- 2 sigma				0.098
MDA	0.459	0.580	0.371	0.212

Sample Location	MK-10 Leesville, SC			
Collection Date	2/8/2010	4/20/2010	9/7/2010	11/29/2010
Sr - 89/90 (pCi/L)	<MDA	<MDA	<MDA	<MDA
+/- 2 sigma				
MDA	0.484	0.634	0.338	0.239

Sample Location	MK-17 Denmark, SC			
Collection Date	2/10/2010	4/19/2010	9/3/2010	11/30/2010
Sr - 89/90 (pCi/L)	**0.462**	<MDA	<MDA	**0.359**
+/- 2 sigma	0.121			0.138
MDA	0.412	0.655	0.373	0.192

Sample Location	MK-22 Govan, SC			
Collection Date	2/10/2010	4/19/2010	9/3/2010	12/1/2010
Sr - 89/90 (pCi/L)	<MDA	<MDA	<MDA	<MDA
+/- 2 sigma				
MDA	0.391	0.715	0.368	0.237

Sample Location	MK-30 Bowman, SC*			
Collection Date	2/9/2010	4/22/2010	9/3/2010	11/30/2010
Sr - 89/90 (pCi/L)	**0.469**	<MDA	<MDA	<MDA
+/- 2 sigma	0.132			
MDA	0.456	0.742	0.427	0.246

Sample Location	MK-99 Darlington, SC*			
Collection Date	2/9/2010	4/22/2010	9/6/2010	11/30/2010
Sr - 89/90 (pCi/L)	<MDA	<MDA	<MDA	**0.377**
+/- 2 sigma				0.146
MDA	0.445	0.713	0.309	0.213

TOC

3.4.5 Summary Statistics

Radiological Monitoring of Dairy Milk Data

Notes:

19. N - Number
20. Avg. - Average
21. St. Dev. - Standard Deviation
22. Min. - Minimum
23. Max. - Maximum
24. Statistics calculated for detections only
25. Non-detect denotes <MDA
26. N/A - Not Applicable

Radiological Monitoring of Dairy Milk Data

2010 Strontium Summary Statistics for all Milk Sample Detections
Units are in picocuries per liter (pCi/L)

Radionuclide:		Strontium-89/90					
Statistical Analysis:		**N**	**Avg.**	**St. Dev.**	**Median**	**Min**	**Max**
Sample Locations	**MK-8**	1 (4)	0.224	N/A	0.224	0.224	0.224
	MK-10	0 (4)	<MDA	N/A	N/A	N/A	N/A
	MK-17	2 (4)	0.411	0.073	0.411	0.359	0.462
	MK-22	0 (4)	<MDA	N/A	N/A	N/A	N/A
	MK-30	1 (4)	0.469	N/A	0.469	0.469	0.469
	MK-99	1 (4)	0.377	N/A	0.377	0.377	0.377
Yearly Average of Detectable Sr-89/90			0.370				
Standard Deviation			0.105				
Median			0.394				

Radionuclide:		Strontium-89/90					
Statistical Analysis:		**N**	**Avg.**	**St. Dev.**	**Median**	**Min**	**Max**
Perimeter Locations:	**MK-8**	1 (4)	0.224	N/A	0.224	0.224	0.224
	MK-10	0 (4)	<MDA	N/A	N/A	N/A	N/A
	MK-17	2 (4)	0.411	0.073	0.411	0.359	0.462
	MK-22	0 (4)	<MDA	N/A	N/A	N/A	N/A
Yearly Average of Detectable Sr-89/90			0.317				
Standard Deviation			0.132				
Median			0.317				

Radionuclide:		Strontium-89/90					
Statistical Analysis:		**N**	**Avg.**	**St. Dev.**	**Median**	**Min**	**Max**
Background Locations:	**MK-30**	1 (4)	0.469	N/A	0.470	0.470	0.470
	MK-99	1 (4)	0.377	N/A	0.380	0.380	0.380
Yearly Average of Detectable Sr-89/90			0.423				
Standard Deviation			0.065				
Median			0.423				

Non-detections () excluded from computations

2010 Strontium Summary Statistics Comparison of Perimeter and Background Locations
Units are in picocuries per liter (pCi/L)

Sr-89/90	Perimeter Locations (E) (<50 Miles)			Background Locations (B) (>50 Miles)			E minus B	
	Average	**Std. Dev.**	**Median**	**Average**	**Std. Dev.**	**Median**	**Average**	**Median**
	0.317	0.132	0.317	0.423	0.065	0.423	-0.106	-0.106

TOC

4.1 Radiological Fish Monitoring

4.1.1 Summary

The Department of Energy-Savannah River (DOE-SR) has historically monitored the uptake of radionuclides in fish. However, DOE-SR reported results were not routinely evaluated by an independent monitoring source. Because of the size, scope, and complexity of the activities at the Savannah River Site (SRS), the Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) was tasked with providing a non-regulatory independent monitoring and surveillance program at the SRS.

Radiocesium, released from 1954-1975, has been reported by DOE-SR as one of the most significant radionuclides related to human exposure (WSRC 1997). At SRS, the majority of liquid releases of cesium-137 (Cs-137) were due to leaking fuel rods in the 1950s and 1960s. Fuel rods were stored in basins, and Cs-137 was released to SRS streams when the basins were purged. In the early 1970s, physical and administrative controls were implemented to control the releases of most fission and activation products. During subsequent years, tritium, which cannot be filtered from effluent streams, became more significant than cesium (WSRC 1999a).

ESOP conducts fish monitoring for radionuclide activity in an effort to determine the magnitude, extent, and trends of radionuclide levels. Largemouth bass (*Micropterus salmoides)* and catfish (*Ameiurus catus* or *Ictalurus punctatus*) were collected from nine sample locations on the Savannah River, and a background station established on the Edisto River between Colleton and Charleston counties. Studies have shown these species bioaccumulate measurable amounts of radionuclides (Cummins 1994; USEPA 2000b). Red drum (*Sciaenops ocellatus*) and flounder (*Cynoscion nebulosus*) were collected near Savannah, Georgia. Stations sampled in 2010 are shown in Section 4.1.2, and location descriptions can be found in the Monitoring of Fish in the Savannah River Quality Assurance Project Plan, (SCDHEC 2010a).

Fish were collected using boat-mounted electrofishing equipment. Samples were collected at five stations where creeks from the SRS meet the Savannah River (Upper Three runs Creek SV-2011, Beaver Dam Creek SV-2013, Fourmile Branch SV-2015, Steel Creek SV-2017, Lower Three Runs Creek SV-2020). Samples were also collected from the Edisto River as a background location (MD-119), one Savannah River station upstream of the SRS (SV-2028), and four stations downstream of the SRS (Highway 301 SV-118, Stokes Bluff SV-355, Highway 17 fresh water SV-2090, Highway 17 saltwater SV-2091). All these locations are accessible to the public. Typically, five fish of each species were collected at each sample location. Analysis of right-side fillets from each fish for mercury and selected metals was initiated in 2010. The remainder for each species was separated into edible and non-edible portions, and the portions were combined into homogeneous composites for radionuclide analyses. Edible composites were analyzed for gamma-emitting isotopes and tritium. Non-edible composites were analyzed for gamma-emitters and strontium. Detailed procedures can be found in the Quality Assurance Project Plan (SCDHEC 2010a).

Four locations did not produce samples with detectable tritium activity in 2010: the background location on the Edisto River, Upper Three Runs Creek, Four Mile Branch, and Steel Creek. All other locations adjacent to and downstream of SRS exhibited detectable tritium activity. Four locations did not exhibit Cs-137 activity: upstream near Augusta, Highway 301, and the freshwater and saltwater locations near Savannah, Georgia, downstream of SRS. Activities of strontium-89,90 (Sr-89,90) were reported from all locations.

The DOE-SR also conducts fish monitoring to assess the environmental effects of current and historical releases of radionuclides. SCDHEC data were compared to DOE-SR reported results. Dissimilarities in these results could be attributed to the natural variation of radionuclide levels. Although there are differences between reported values, the data is consistent with historically reported data. In the past, samples have been collected and split between SCDHEC and DOE-SR for analyses, and no great variations in the data results were found. This would potentially rule out methodology differences and substantiate that differences result from the variability in samples analyzed by the two programs.

Independent monitoring of radionuclides, metals, and mercury in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. The information provided will assist in advising, informing, and protecting the people at risk, and in comparing current and historical data.

RESULTS AND DISCUSSION

The following radionuclides were not detected above the minimum detectable activity (MDA) in 2010: beryllium-7 (Be-7), sodium-22 (Na-22), manganese-54 (Mn-54), cobalt-58 (Co-58), cobalt-60 (Co-60), zinc-65 (Zn-65), yttrium-88 (Y-88), zirconium-95 (Zr-95), ruthenium-103 (Ru-103), antimony-125 (Sb-125), iodine-131(I-131), cesium-134 (Cs-134), cerium-144 (Ce-144), europium-152 (Eu-152), europium-154 (Eu-154), europium-155 (Eu-155), radium-226 (Ra-226), actinium-228 (Ac-228), uranium/thorium-238 (U/Th-238), and americium-241 (Am-241).

Fish collections were conducted from April through December of 2010. A minimum of three fish species were caught at all river locations. Largemouth bass were collected from all Savannah River locations and the Edisto River background site. Channel catfish were collected at five Savannah River locations; three white catfish were collected at three river locations. Three channel catfish were collected from the Edisto River. Three red drum and three flounder were collected from the saltwater location.

A total of 91 fish were collected. Forty-six composites and one individual fish sample were processed in 2010. The SCDHEC Region 5 tritium laboratory analyzed aliquots from all edible samples. Edible and non-edible samples were sent to the SCDHEC Radiological Environmental Monitoring Division in Columbia, South Carolina for radiological analysis of gamma-emitting radionuclides. Portions of some non-edible samples were sent to Eberline Services for strontium analysis. Graphic presentations of 2010 and 2006-2010 activity levels of tritium, cesium-137 (Cs-137), and strontium-89,90 (Sr-89,90) are reported in Section 4.1.3. Activity levels of Cs-137 for all samples and SCDHEC historical data from 2006 – 2010 are reported in Section 4.1.4. Summary statistics are presented in Section 4.1.5. Tritium results represent the activity level in the water distilled from the fish tissue. Cesium and strontium results represent the activity level in the wet sample itself.

Tritium Results

Tritium is a naturally occurring radioisotope, although in very low concentrations (USEPA 2007a). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases at SRS include both atmospheric and liquid contributions (SRNS 2010b). Although the United States Environmental Protection Agency (USEPA) has not established a Maximum Contaminant Level (MCL) for tritium in solid media (e.g. fish, vegetation), the MCL for drinking water has been set at 20,000 picocuries per liter (pCi/L) (USEPA 2008a).

Activity levels of tritium were analyzed in 18 edible composites. Six of the ten freshwater stations exhibited detectable tritium activity in 2010 (Section 4.1.3, Figure 1a); the saltwater sampling location (SV-2091) produced detections in both species sampled. The Edisto River background location did not produce tritium activity. The uppermost Savannah River location near the New Savannah Bluff Lock and Dam (NSBLD, SV-2028) and the location near Upper Three Runs (SV-2011) also had no tritium activity. All stations downstream of Upper Three Creek exhibited tritium activity.

Four of seven bass samples from the Savannah River exhibited detectable tritium activity, with an average of 792 (± 934) pCi/L. The composite from the Beaver Dam Creek location (SV-2011) had the highest reported tritium activity, 1870 pCi/L. Two of seven Savannah River catfish samples exhibited tritium activity, with an average of 395 (± 45) pCi/L. The highest tritium level observed in the catfish composites, 427 pCi/L was from the Stokes Bluff location.

With the exception of the Beaver Dam Creek location, samples from downstream of SRS exhibited little tritium activity in 2010. The 2010 data are generally similar to SCDHEC historically reported data (Section 4.1.3, Figures 1b and 1c; SCDHEC 2010a). Although results can be quite variable between years, tritium levels tend to be highest at locations adjacent to SRS (creek mouth stations) and decrease with distance downstream. Tritium has been detected upstream of SRS only occasionally, and at low levels.

Gamma Results

The naturally occurring isotope of potassium-40 (K-40) was detected from all stations where gamma samples were collected in 2010. The lead isotopes Pb-212 and Pb-214 were also detected, but not from all locations. Because these are naturally occurring isotopes, the results will not be discussed in this report.

Cesium-137 is a man-made fission product, and was a constituent of air and water releases on SRS, mainly from F- and H-Areas. Liquid releases also occurred from the production reactors as a result of leaking fuel elements in the 1950s and 1960s, and reactor basin purges were discharged to SRS streams, including Fourmile Branch, Steel Creek, and Lower Three Runs (WSRC 1999a).

Activity levels of Cs-137 were analyzed in 22 edible and non-edible portions of bass, catfish, red drum, and flounder composites. The NSBLD, Hwy 301, and the Hwy. 17 freshwater and saltwater locations did not exhibit Cs-137 activity in any sample (Section 4.1.3, Figure 2a and 3a).

Five of nine edible bass composites from Savannah River locations exhibited detectable levels of Cs-137, ranging from 0.030 to 0.280 (pCi/g), with an average of 0.160 (± 0.11) pCi/g (Section 4.1.3, Figure 2a). The sample from the Four Mile Branch location had the highest reported activity level. Cesium-137 levels reported above the MDA were observed in edible bass composites from all five-creek mouth locations adjacent to SRS and one of three locations downstream of the SRS. Cesium-137 activity was detected in non-edible bass composites from three creek mouth locations but no downstream location. The background location on the Edisto River exhibited detectable Cs-137 activity in both the edible and non-edible samples.

Only one edible catfish composite exhibited a detectable Cs-137 level of 0.042 pCi/g (Section 4.1.3, Figure 3a). Only one non-edible catfish composite produced detectable Cs-137 level of 0.10 pCi/g. The Lower Three Runs location (SV-2020) exhibited the highest activity for the non-edible samples.

Consistent with historically reported SCDHEC data, higher levels of Cs-137 were reported from locations adjacent to the SRS, especially Steel Creek and Lower Three Runs (Section 4.1.3, Figure 2b and 2c, 3b and 3c) (SCDHEC 2009b). Higher activity levels in samples from these locations are not unexpected based on historical releases to these streams and the Savannah River swamp, and the Cs-137 contamination still present.

Strontium Results

ESOP contracted with a private laboratory for Sr-89,90 analysis of fish samples in 2010. Strontium-89 and -90 are present around the world as a result of fallout from past atmospheric nuclear weapons tests (MII 2008). Strontium-90 behaves like calcium in the body, and tends to deposit in bone and bone marrow. Internal exposure is linked to several forms of cancer (USEPA 2007a).

Portions of 23 non-edible composites were selected for Sr-89,90 analysis in 2010. All locations produced detectable strontium activity, including the background station (Section 4.1.3, Figure 4a). Sr-89,90 levels reported are for wet results, from analysis of fresh fish tissue. Averages noted below are for Savannah River freshwater species only, excluding the Edisto River location.

Levels of Sr-89,90, in bass, ranged from 0.032 to 0.091 pCi/g, with an average of 0.051 (± 0.019) pCi/g. The sample from the Hwy. 17 location had the highest activity level. Strontium levels in catfish samples ranged from 0.020 to 0.049 pCi/g, with an average of 0.033 (± 0.011) pCi/g. The Hwy. 301 exhibited the highest activity. For comparison, the USEPA has established an MCL of 8 pCi/L in public drinking water for Sr-90 (USEPA 2008a).

Section 4.1.3, Figures 4b and 4c show historically reported SCDHEC data for Sr-89,90 (SCDHEC 2010a). The data from 2006-2007 represents calculated wet results using a dry/wet conversion ratio from the actual dry analyses. The 2008, 2009, and 2010 data were reported as wet results by the contract laboratory that year. Results are highly variable, but Sr-89,90 appears to be widespread.

Individual Fish Analyses

Larger, older fish may bioaccumulate more contaminants over time (USEPA 2000). In the past, ESOP has analyzed and compared data from large fish versus the composites they were a part of in order to ascertain the impact a large fish might have on a composite sample. However, largely due to a change in the processing technique to also collect tissue for mercury and metals analyses (SCDHEC 2010a), this procedure was not performed in 2010.

Mercury and Metals Analyses

In 2010 ESOP initiated analysis of edible fish samples for mercury and selected metals. A total of 91 samples were analyzed. The metals antimony, arsenic, cadmium, and manganese were selected for analysis for direct comparison to DOE-SR data. Samples were also analyzed for chromium, copper, lead, nickel, and zinc, a suite of analyses already established by SCDHEC sampling programs in Columbia, South Carolina.

Mercury is a naturally occurring element that is found in air, water and soil. It exists in several forms: elemental or metallic mercury, inorganic mercury compounds, and organic mercury compounds. Coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States, accounting for over 50 percent of all domestic human-caused mercury emissions. EPA has estimated that about one quarter of U.S. emissions from coal-burning power plants are deposited within the contiguous U.S. and the remainder enters the global cycle. Current estimates are that less than half of all mercury deposition within the U.S. comes from U.S. sources (USEPA 2010b).

Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change it into methylmercury, a highly toxic form that builds up in fish, shellfish and animals that eat fish. Fish and shellfish are the main sources of methylmercury exposure to humans. Methylmercury builds up more in some types of fish and shellfish than others. The levels of methylmercury in fish and shellfish depend on what they eat, how long they live and how high they are in the food chain.

Mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. Research shows that most people's fish consumption does not cause a health concern. However, it has been demonstrated that high levels of methylmercury in the bloodstream of unborn babies and young children may harm the developing nervous system, making the child less able to think and learn (USEPA 2010b).

Mercury was detected in fish, primarily bass, from all locations except the upstream-most Savannah River location near Augusta, Georgia (Section 4.1.4). Samples from the background location on the Edisto River exhibited detectable mercury in all four bass samples. Mercury was detected in two of three catfish samples from the Edisto River.

Mercury was detected in 30 of 40 bass samples from eight of nine Savannah River locations, ranging from 0.11 to 1.4 milligrams per kilogram (mg/kg), with an average of 0.33 (± 0.26) mg/kg (Section 4.1.3, Figure 5). The Steel Creek location exhibited the highest mercury concentration in an individual fish and the highest average among the locations sampled. Samples from the Stokes Bluff location well downstream of SRS exhibited detectable mercury in all four bass samples collected.

Only seven of 39 Savannah River catfish samples, from three locations, exhibited detectable mercury concentrations, ranging from 0.10 to 0.75 mg/kg, with an average of 0.17 (± 0.03) mg/kg (Section 4.1.3, Figure 5). The Hwy. 17 location had the highest average mercury concentration.

The following metals were not detected in any samples in 2010: antimony, arsenic, cadmium, lead, and nickel. Chromium was detected in only one sample, manganese in eight. Copper was detected in 78 samples locations. Zinc was detected in all 91 samples analyzed.

SCDHEC and DOE-SR Data Comparison

SCDHEC bass and catfish data collected for this project in 2010 were compared to DOE-SR reported information (SRNS 2010). Data comparison summaries are located in Section 4.1.4. One difference between the two programs is that ESOP analyzes one composite type from each species for each location, whereas the DOE-SR program analyzes three composite types per location. Therefore, a single composite for an ESOP location was compared to the average of the three DOE-SR composites reported, although DOE-SR uses results below the Minimum Detectable Concentration (MDC) when calculating averages.

ESOP and DOE-SR detected tritium in fish from five of nine Savannah River freshwater locations. ESOP largemouth bass samples from five locations and DOE-SR bass samples from three locations exhibited tritium activity. ESOP detected tritium in catfish samples from two sites, DOE-SR from three. Cesium-137 was detected in edible fish from most locations by both programs in 2010. Cesium-137 results for edible bass and catfish from ESOP and DOE-SR were less than 1.00 pCi/g. Strontium-89,90 was detected at all locations by both programs, although all values were less than 1.00 pCi/g. (SRNS 2010).

Average results of tritium, Cs-137, and Sr-89,90 analyses were used for direct comparisons of data between the two programs. Averages were calculated using only detections, including from separate DOE-SR composite analyses. For tritium in bass and catfish, DOE-SR results were within one standard deviation of the ESOP results. For Cs-137 in bass samples, DOE-SR results were within one standard deviation of the ESOP results. For Cs-137 in catfish samples, DOE-SR results were within six standard deviations of the ESOP results, although it is noteworthy that most samples were below the minimum detectable concentration. DOE-SR and ESOP results for bass and catfish were five standard deviations apart for Sr-89,90, but the detections were at very low levels, averaging 0.09 pCi/g for DOE-SR and 0.05 pCi/g for ESOP.

Mercury was the only metal detected by both programs, DOE-SR results were within one standard deviation of the ESOP results. Although sample sizes from each program were different average mercury concentrations for both organizations were essentially the same for catfish and largemouth bass samples.

CONCLUSIONS AND RECOMMENDATIONS

A review of SCDHEC data indicates that DOE-SR operations have impacted fish. Higher levels of radionuclides are found in Savannah River fish collected adjacent to and downstream of SRS compared to upstream. Previous studies have shown that tritium and cesium in the SRS environment from historical and continuing releases can be manifested in the SRS biota (Cummins 1994; WSRC 1997). Fish from background locations tend not to exhibit detectable levels of man-made radionuclides, except for Sr-89,90, which is present worldwide from past nuclear weapons testing (USEPA 2007a).
SCDHEC project data was compared to DOE-SR reported information (SRNS 2010). Based on standard deviations, tritium, Cs-137, Sr-89,90, and mercury data were generally similar and at or near the minimum detectable concentration. Differences in results could be due to the natural

variation of contaminant levels in individual fish. Both programs detected Sr-89,90, and mercury at all locations.

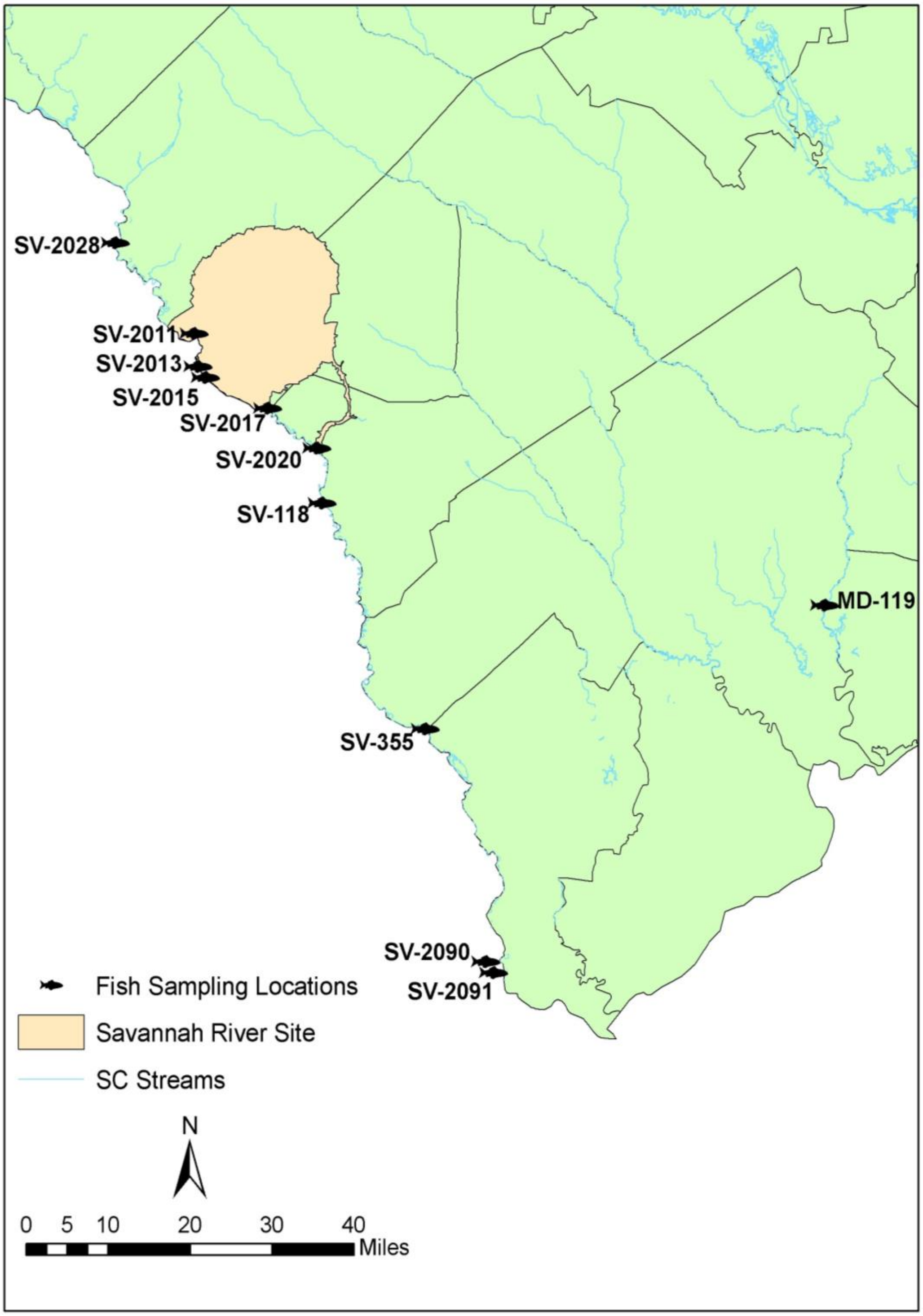
Independent monitoring of radionuclide levels in Savannah River fish will continue along with evaluating the DOE-SR Radiological Fish Monitoring Program. Continued monitoring will provide a better understanding of actual radionuclide levels, their extent, and trends. Several important benefits can be realized as a result. Foremost is the ability for the SCDHEC Bureau of Water and the Division of Health Hazard Evaluation to further evaluate the potential human health risk associated with consumption of Savannah River fish. SCDHEC will be able to better advise, inform, and protect those people at risk. Although Cs-137 and Sr-89,90 are found in some Savannah River fish, the levels are low and have decreased over time. If the public follows the SCDHEC mercury advisories for consumption of fish from the river, the health risk from these radioactive elements is very low (SCDHEC 2010b). Another benefit will be the ability to compare this data with historical data. Data comparison will also be part of the further evaluation of the DOE-SR program. This independent evaluation will provide credibility and confidence in the DOE-SR data and its uses.

Future analyses of the target species will continue to include mercury and selected metals analyses. This will augment the existing data on Savannah River fish, provide information for human health assessment, and provide another basis for comparison of results with DOE-SR data.

TOC

4.1.2

Map 14. Radiological Fish Monitoring, Sampling Locations, 2010



TOC

4.1.3 Tables and Figures
Radiological Fish Monitoring

Figure 1a. Tritium in Fish Composites, 2010

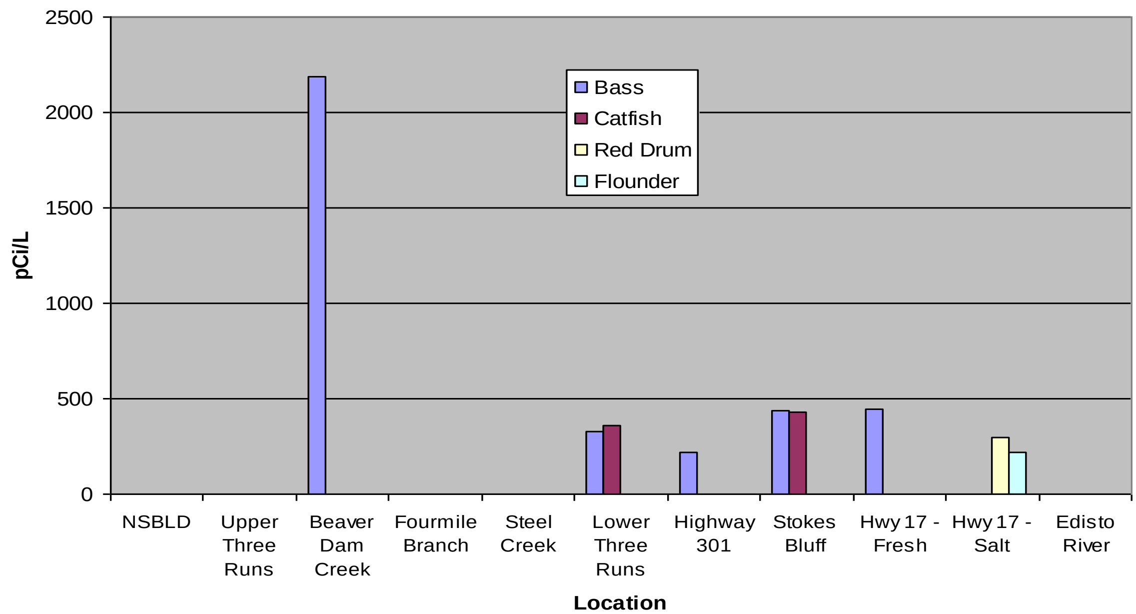
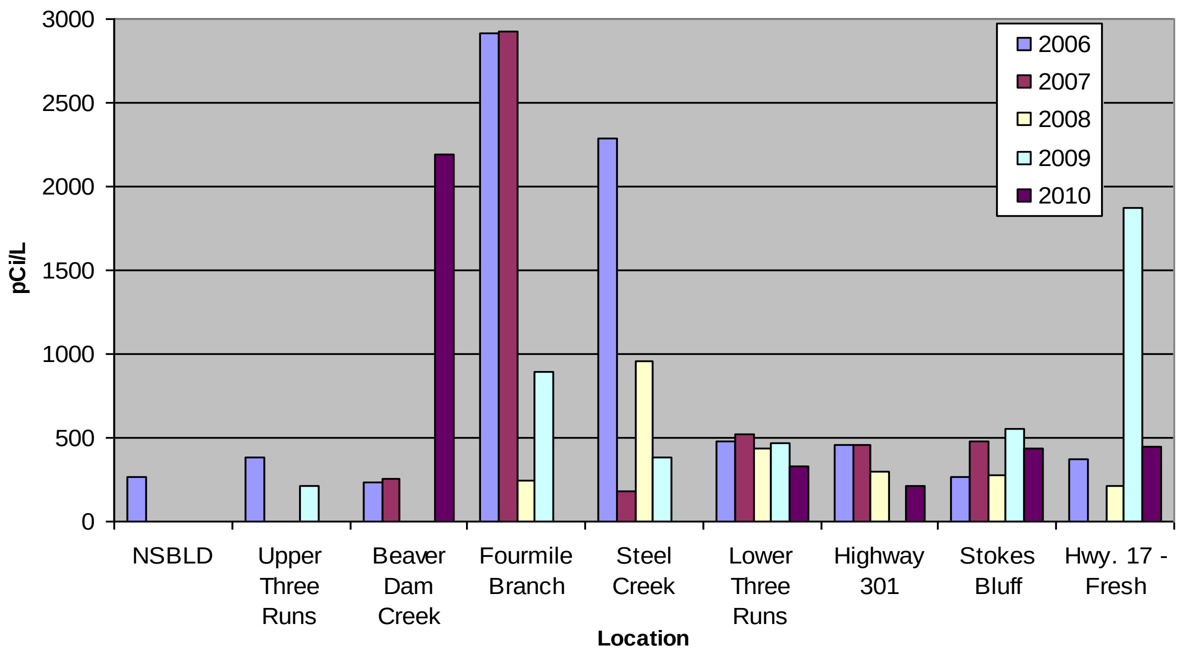
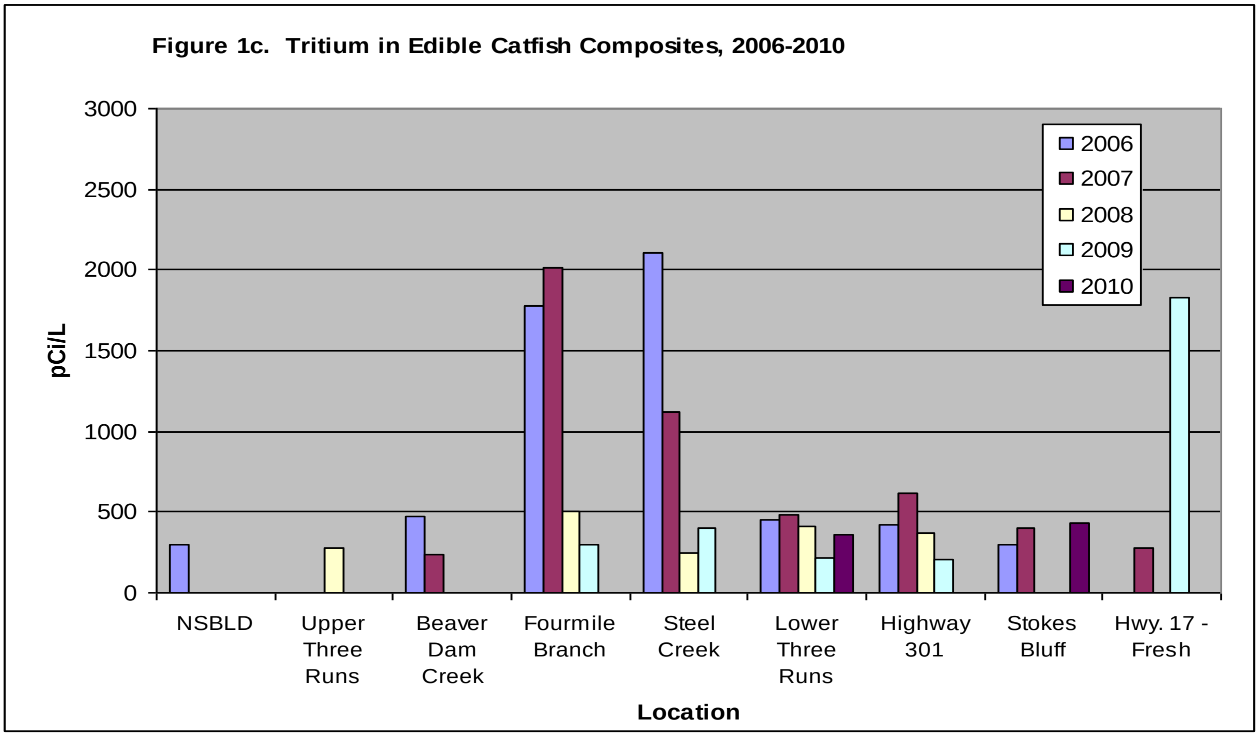


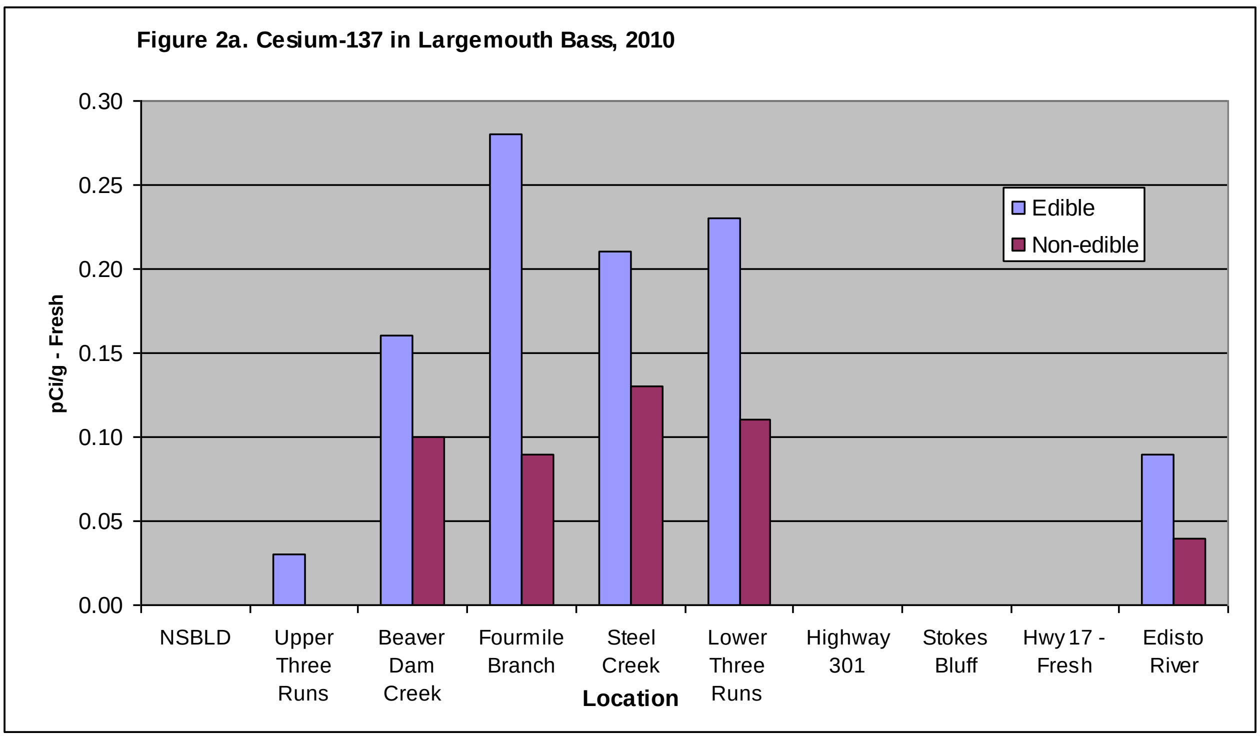
Figure 1b. Tritium in Edible Bass Composites, 2006-2010



Note: Sampling at the Hwy. 17 location started in 2006

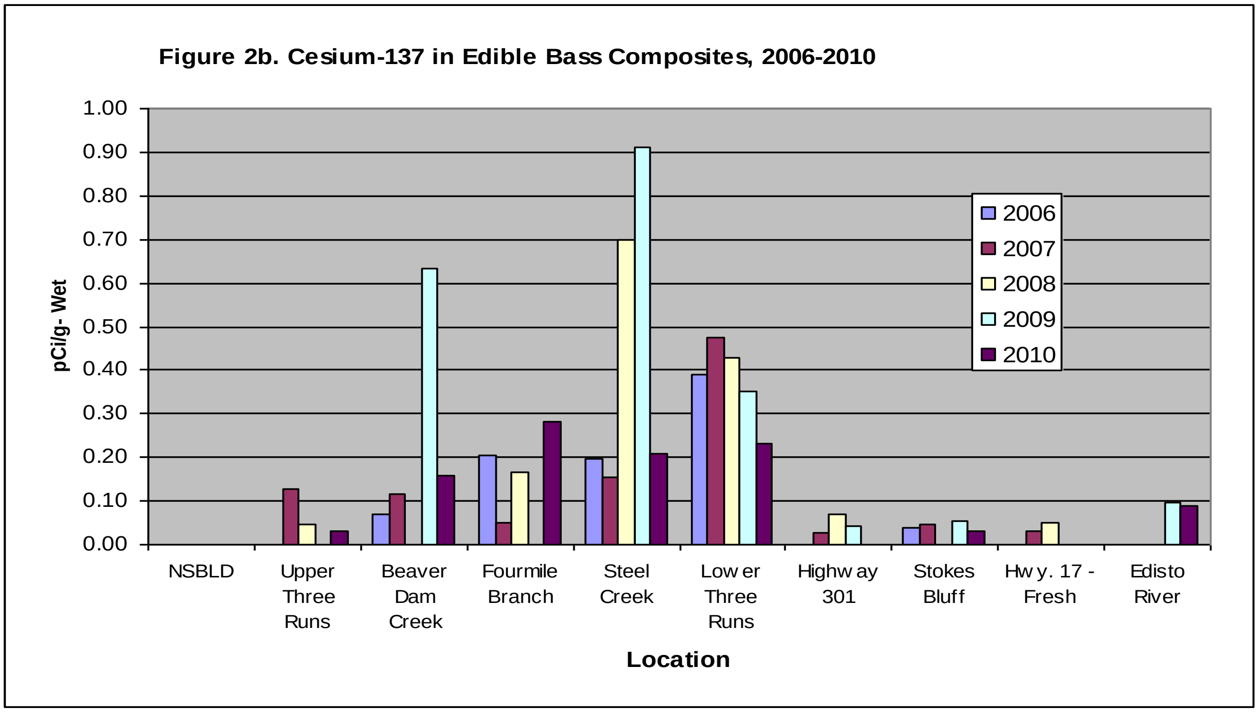
Tables and Figures
Radiological Fish Monitoring



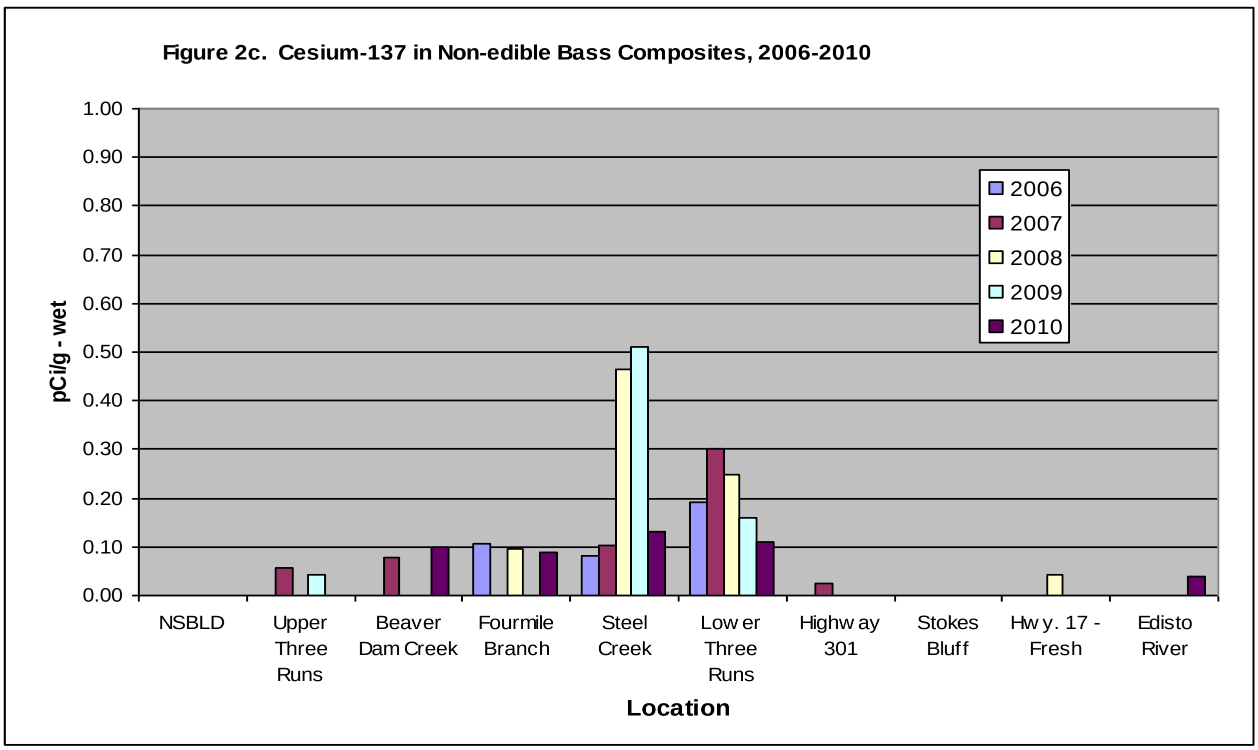


Note Cs-137 activity not detected in non-edible pickerel

Tables and Figures
Radiological Fish Monitoring



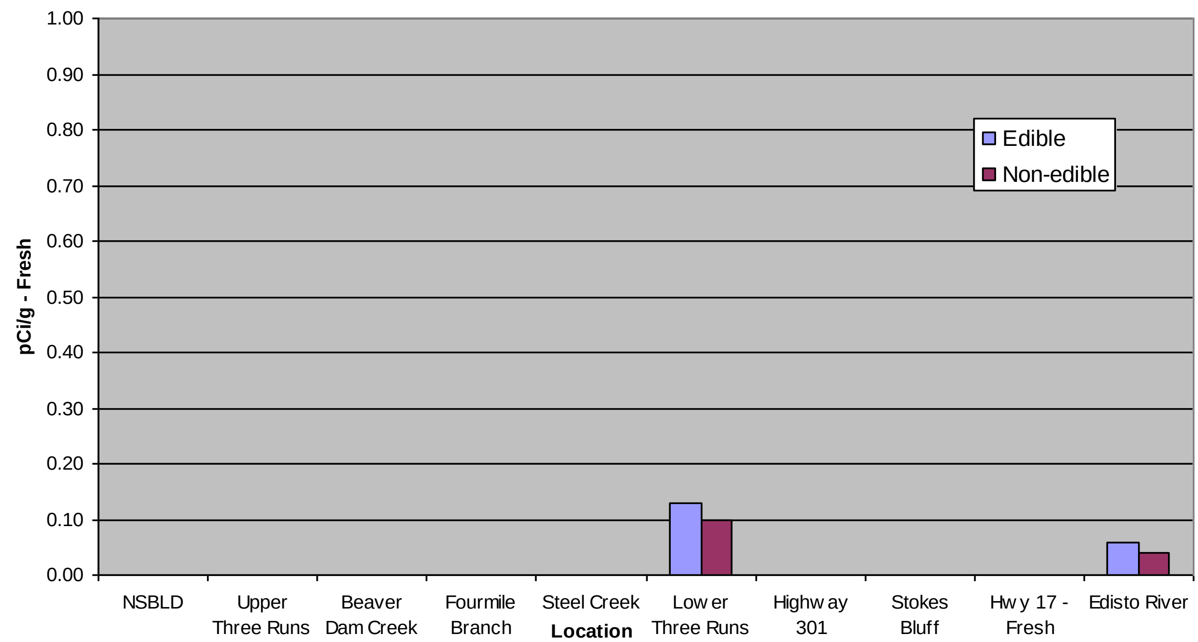
Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009



Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

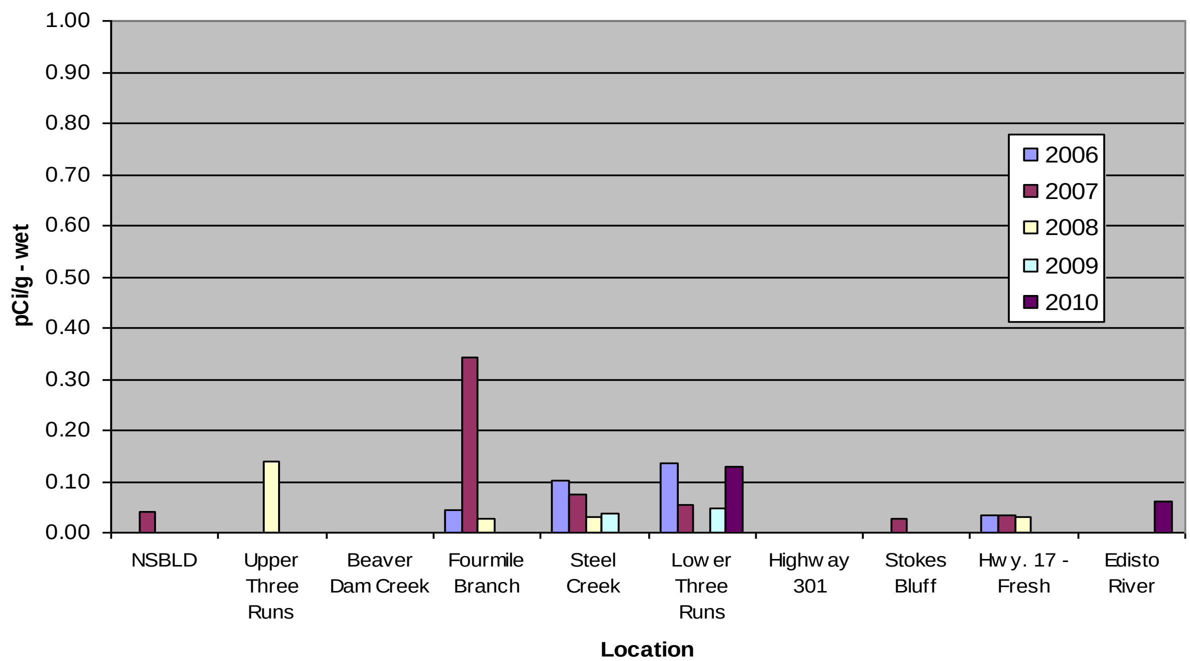
Tables and Figures
Radiological Fish Monitoring

Figure 3a. Cesium-137 in Catfish, 2010



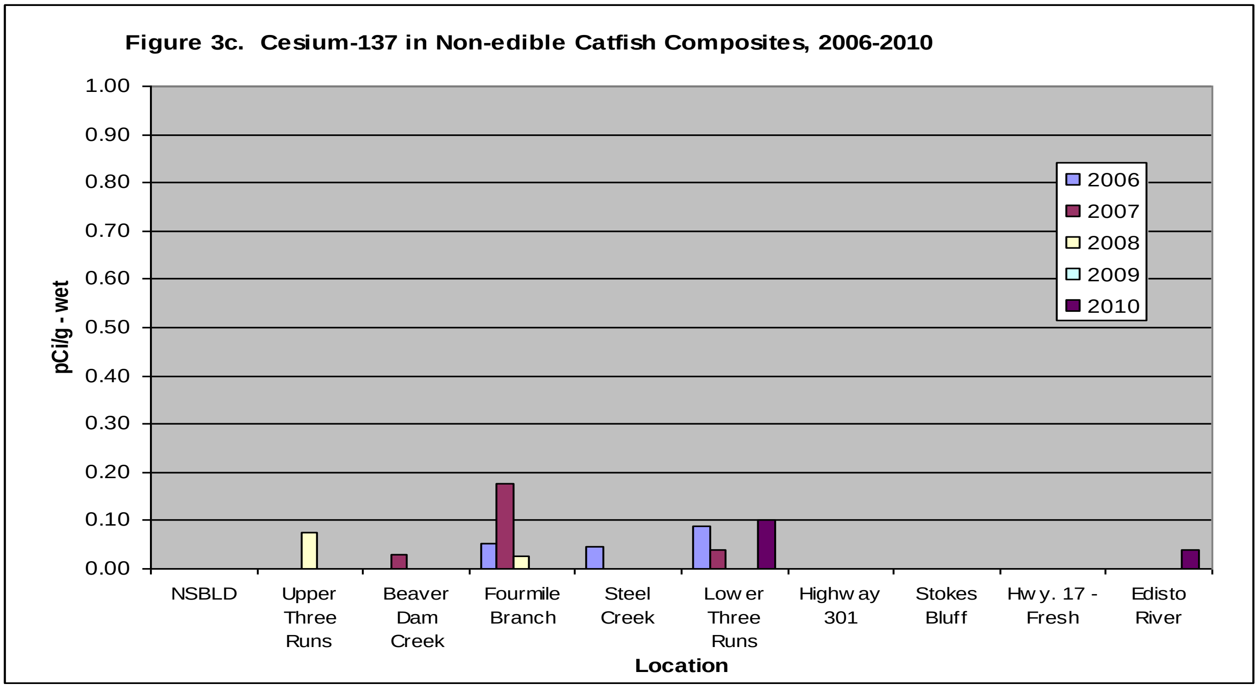
Note: No catfish collected from Stevens Creek

Figure 3b. Cesium-137 in Edible Catfish Composites, 2006-2010

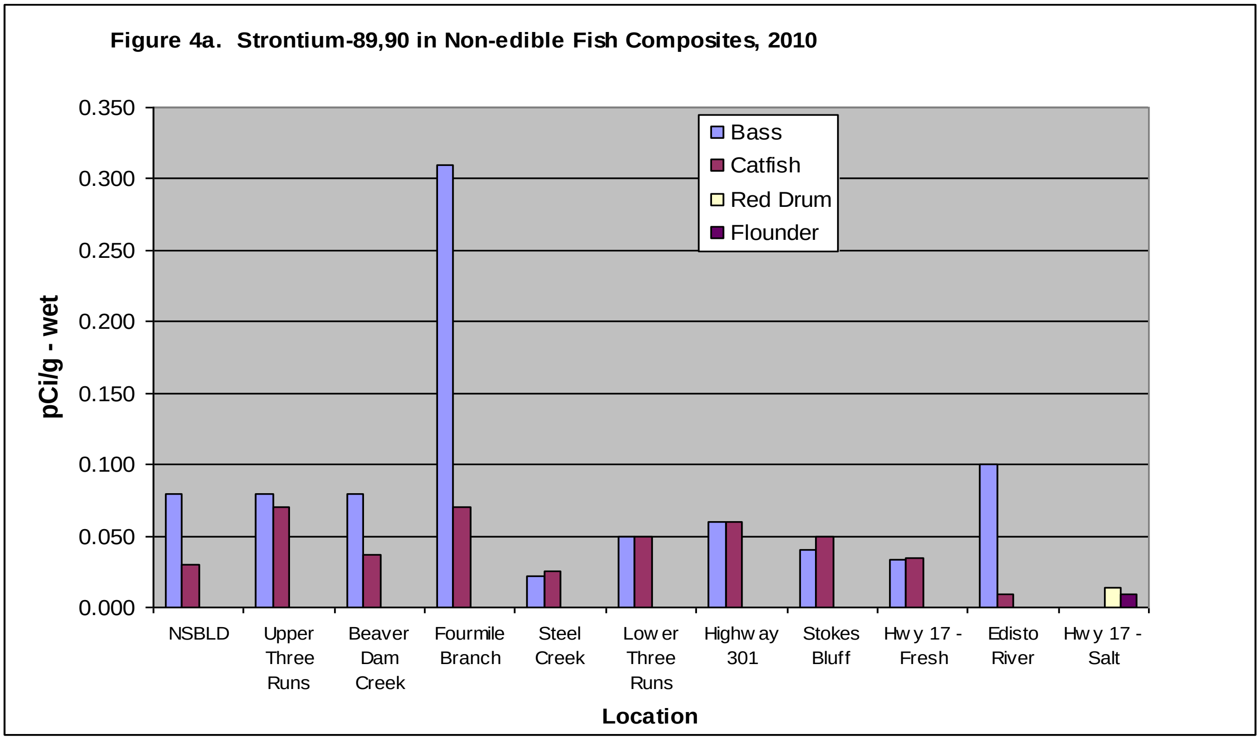


Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

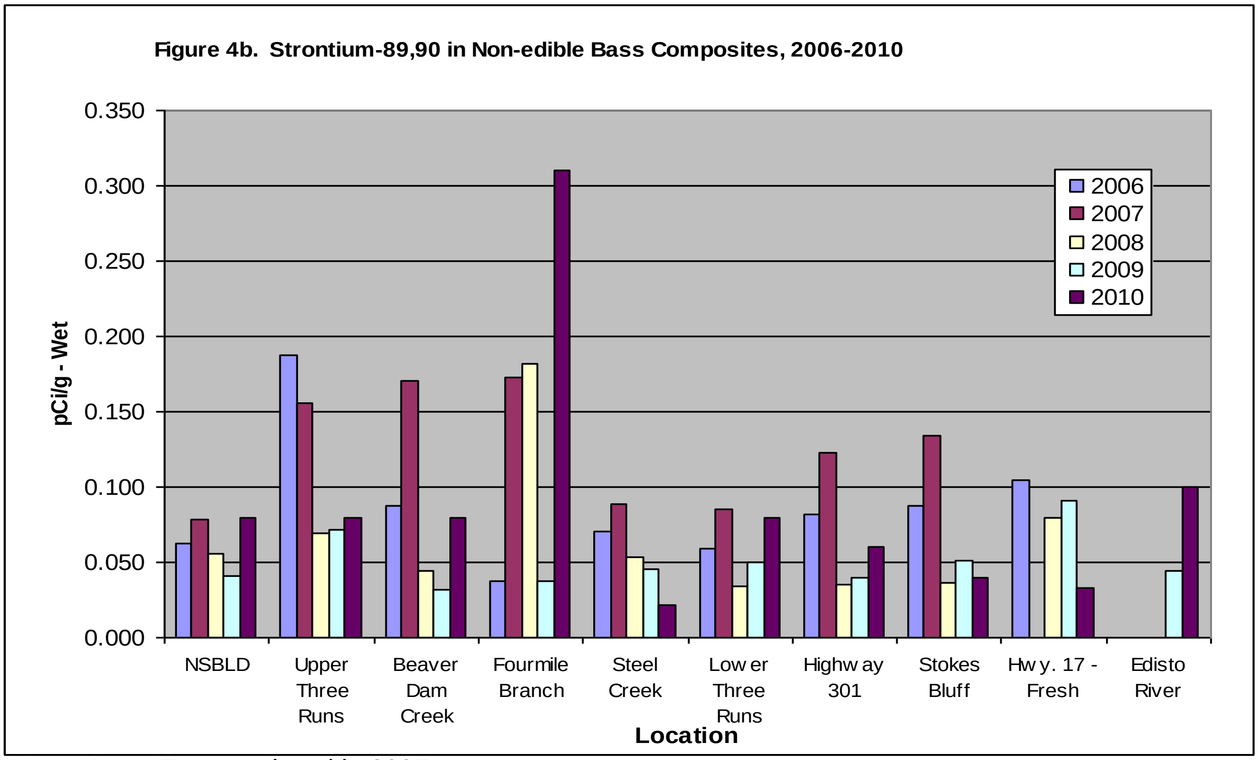
Tables and Figures
Radiological Fish Monitoring



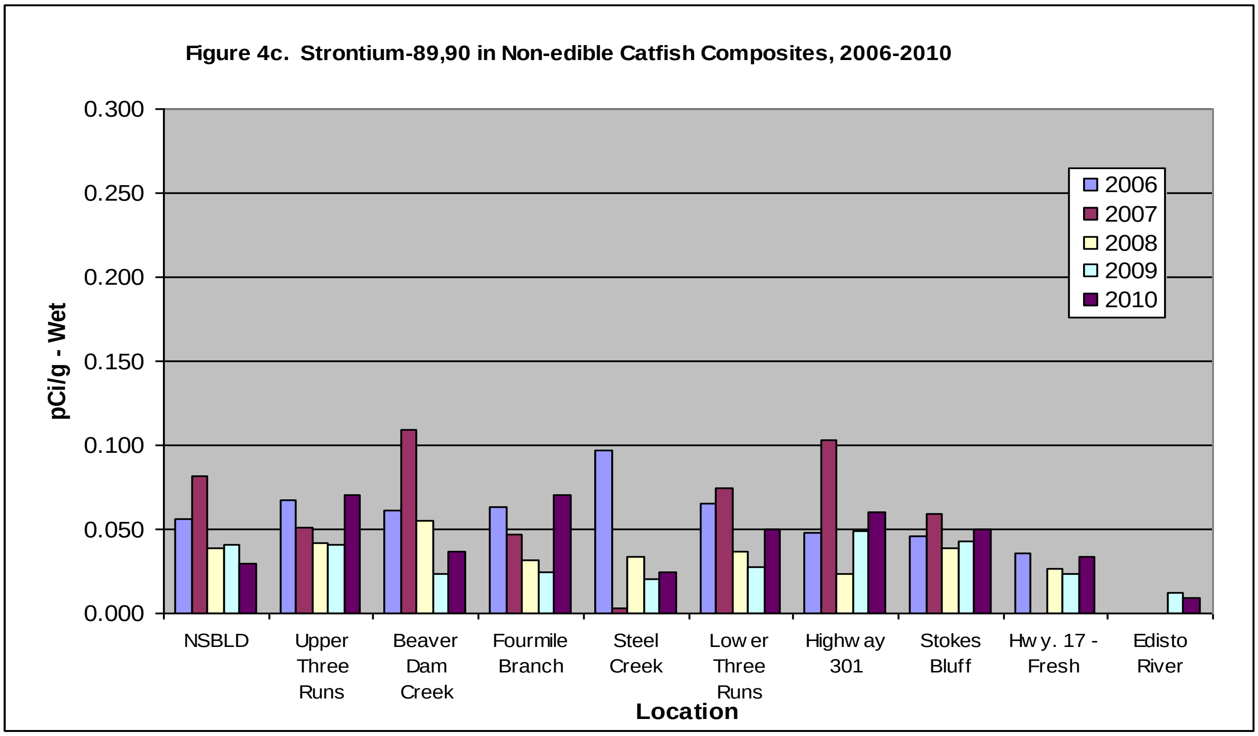
Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009



Tables and Figures
Radiological Fish Monitoring

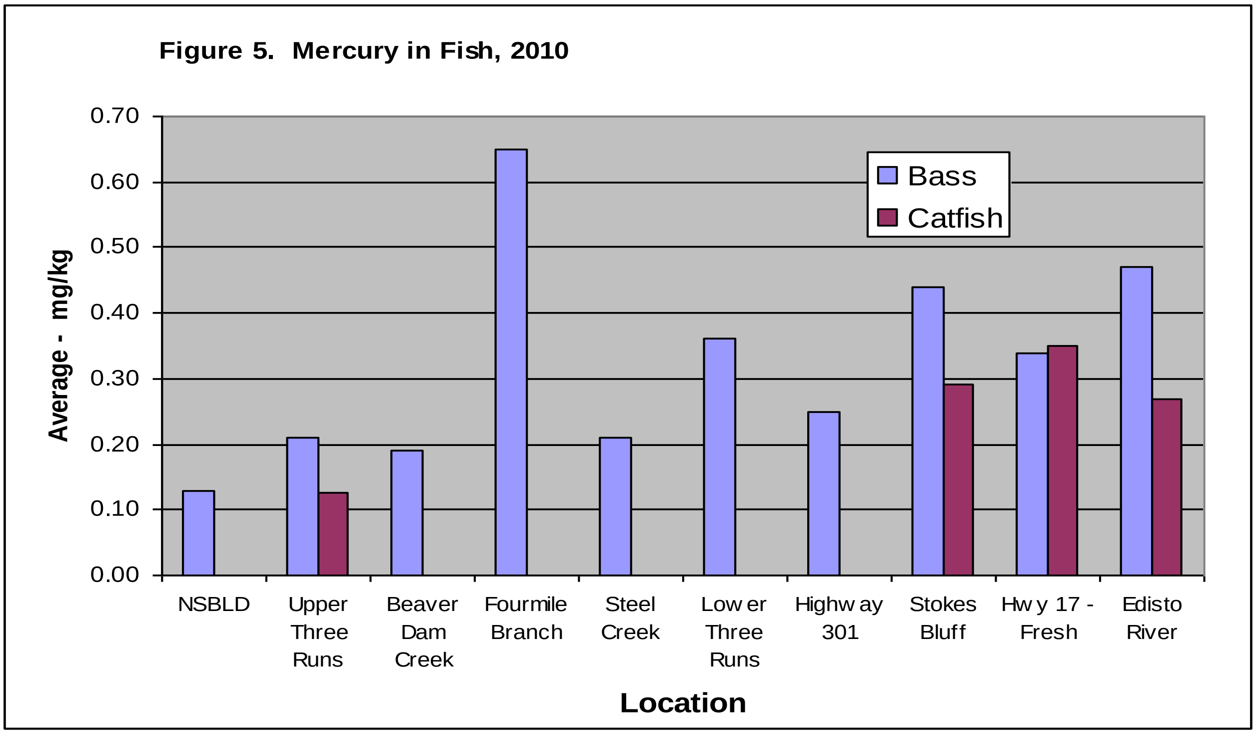


Note: Hwy. 17 not analyzed in 2007



Note: Hwy. 17 not analyzed in 2007

Tables and Figures
Fish Monitoring Associated with the Savannah River Site



[TOC](#)

4.1.4 Data

Fish Monitoring Associated with the Savannah River Site

Notes:

1. FM denotes Fish Monitoring project
2. LLD - Lower Limit of Detection
3. MDA - Minimum Detectable Activity
4. MDC - Minimum Detectable Concentration

5. NSBLD - New Savannah Bluff Lock & Dam
6. Hwy. 301 - Savannah River at U.S. Highway 301
7. Hwy. 17 - Savannah River at U.S. Highway 17

Radiological Monitoring of Fish

2010 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Upper Three Runs Bass	FMSV-2011A	Tritium Activity	7/7/2010	<LLD
	FMSV-2011A	Tritium Confidence Interval	7/7/2010	NA
	FMSV-2011A	Tritium LLD	7/7/2010	181
Upper Three Runs Catfish	FMSV-2011C	Tritium Activity	7/7/2010	<LLD
	FMSV-2011C	Tritium Confidence Interval	7/7/2010	NA
	FMSV-2011C	Tritium LLD	7/7/2010	181
Beaver Dam Creek Bass	FMSV-2013A	Tritium Activity	10/22/2010	2187
	FMSV-2013A	Tritium Confidence Interval	10/22/2010	148
	FMSV-2013A	Tritium LLD	10/22/2010	181
Beaver Dam Creek Catfish	FMSV-2013C	Tritium Activity	10/22/2010	<LLD
	FMSV-2013C	Tritium Confidence Interval	10/22/2010	NA
	FMSV-2013C	Tritium LLD	10/22/2010	181
Fourmile Branch Bass	FMSV-2015A	Tritium Activity	9/8/2010	<LLD
	FMSV-2015A	Tritium Confidence Interval	9/8/2010	NA
	FMSV-2015A	Tritium LLD	9/8/2010	181
Steel Creek Bass	FMSV-2017A	Tritium Activity	6/23/2010	<LLD
	FMSV-2017A	Tritium Confidence Interval	6/23/2010	NA
	FMSV-2017A	Tritium LLD	6/23/2010	181

Radiological Monitoring of Fish

2010 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Lower Three Runs Bass	FMSV-2020A	Tritium Activity	7/8/2010	329
	FMSV-2020A	Tritium Confidence Interval	7/8/2010	90
	FMSV-2020A	Tritium LLD	7/8/2010	181
Lower Three Runs Catfish	FMSV-2020C	Tritium Activity	7/8/2010	363
	FMSV-2020C	Tritium Confidence Interval	7/8/2010	91
	FMSV-2020C	Tritium LLD	7/8/2010	181
Hwy. 301 Bass	FMSV-118A	Tritium Activity	7/15/2010	218
	FMSV-118A	Tritium Confidence Interval	7/15/2010	85
	FMSV-118A	Tritium LLD	7/15/2010	181
Hwy. 301 Catfish	FMSV-118C	Tritium Activity	7/15/2010	<LLD
	FMSV-118C	Tritium Confidence Interval	7/15/2010	NA
	FMSV-118C	Tritium LLD	7/15/2010	181
Stokes Bluff Bass	FMSV-355A	Tritium Activity	7/20/2010	434
	FMSV-355A	Tritium Confidence Interval	7/20/2010	94
	FMSV-355A	Tritium LLD	7/20/2010	181
Stokes Bluff Catfish	FMSV-355C	Tritium Activity	7/20/2010	427
	FMSV-355C	Tritium Confidence Interval	7/20/2010	84
	FMSV-355C	Tritium LLD	7/20/2010	181

Radiological Monitoring of Fish

2010 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Hwy. 17 Freshwater Bass	FMSV-2090A	Tritium Activity	11/2/2010	447
	FMSV-2090A	Tritium Confidence Interval	11/2/2010	113
	FMSV-2090A	Tritium LLD	11/2/2010	229
Hwy. 17 Freshwater Catfish	FMSV-2090C	Tritium Activity	11/2/2010	<LLD
	FMSV-2090C	Tritium Confidence Interval	11/2/2010	NA
	FMSV-2090C	Tritium LLD	11/2/2010	229
Hwy. 17 Saltwater Red drum	FMSV-2091G	Tritium Activity	10/13/2010	300
	FMSV-2091G	Tritium Confidence Interval	10/13/2010	89
	FMSV-2091G	Tritium LLD	10/13/2010	181
Hwy. 17 Saltwater Flounder	FMSV-2091I	Tritium Activity	11/2/2010	221
	FMSV-2091I	Tritium Confidence Interval	11/2/2010	85
	FMSV-2091I	Tritium LLD	11/2/2010	181
Edisto River Bass	FMSV-119A	Tritium Activity	6/22/2010	<LLD
	FMSV-119A	Tritium Confidence Interval	6/22/2010	NA
	FMSV-119A	Tritium LLD	6/22/2010	181
Edisto River Catfish	FMSV-119C	Tritium Activity	6/22/2010	<LLD
	FMSV-119C	Tritium Confidence Interval	6/22/2010	NA
	FMSV-119C	Tritium LLD	6/22/2010	181

Radiological Monitoring of Fish

2010 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff	FMSV-2028A	Cs-137 Activity	5/25/2010	<MDA
Lock & Dam	FMSV-2028A	Cs-137 Confidence Interval	5/25/2010	NA
Bass	FMSV-2028A	Cs-137 MDA	5/25/2010	0.02
New Sav. Bluff	FMSV-2028C	Cs-137 Activity	5/25/2010	<MDA
Lock & Dam	FMSV-2028C	Cs-137 Confidence Interval	5/25/2010	NA
Catfish	FMSV-2028C	Cs-137 MDA	5/25/2010	0.01
Upper	FMSV-2011A	Cs-137 Activity	7/7/2010	0.03
Three Runs	FMSV-2011A	Cs-137 Confidence Interval	7/7/2010	0.01
Bass	FMSV-2011A	Cs-137 MDA	7/7/2010	0.01
Upper	FMSV-2011C	Cs-137 Activity	7/7/2010	<MDA
Three Runs	FMSV-2011C	Cs-137 Confidence Interval	7/7/2010	NA
Catfish	FMSV-2011C	Cs-137 MDA	7/7/2010	0.02
Beaver	FMSV-2013A	Cs-137 Activity	10/22/2010	0.16
Dam Creek	FMSV-2013A	Cs-137 Confidence Interval	10/22/2010	0.03
Bass	FMSV-2013A	Cs-137 MDA	10/22/2010	0.03
Beaver	FMSV-2013C	Cs-137 Activity	10/22/2010	<MDA
Dam Creek	FMSV-2013C	Cs-137 Confidence Interval	10/22/2010	NA
Catfish	FMSV-2013C	Cs-137 MDA	10/22/2010	0.03
Fourmile	FMSV-2015A	Cs-137 Activity	9/8/2010	0.28
Branch	FMSV-2015A	Cs-137 Confidence Interval	9/8/2010	0.04
Bass	FMSV-2015A	Cs-137 MDA	9/8/2010	0.02
Fourmile	FMSV-2015C	Cs-137 Activity	6/22/2010	<MDA
Branch	FMSV-2015C	Cs-137 Confidence Interval	6/22/2010	NA
Catfish	FMSV-2015C	Cs-137 MDA	6/22/2010	0.04

Radiological Monitoring of Fish

2010 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel	FMSV-2017A	Cs-137 Activity	10/19/2010	0.21
Creek	FMSV-2017A	Cs-137 Confidence Interval	10/19/2010	0.03
Bass	FMSV-2017A	Cs-137 MDA	10/19/2010	0.03
Steel	FMSV-2017C	Cs-137 Activity	10/19/2010	<MDA
Creek	FMSV-2017C	Cs-137 Confidence Interval	10/19/2010	NA
Catfish	FMSV-2017C	Cs-137 MDA	10/19/2010	0.03
Lower	FMSV-2020A	Cs-137 Activity	7/8/2010	0.23
Three Runs	FMSV-2020A	Cs-137 Confidence Interval	7/8/2010	0.03
Bass	FMSV-2020A	Cs-137 MDA	7/8/2010	0.01
Lower	FMSV-2020C	Cs-137 Activity	7/8/2010	0.13
Three Runs	FMSV-2020C	Cs-137 Confidence Interval	7/8/2010	0.02
Catfish	FMSV-2020C	Cs-137 MDA	7/8/2010	0.02
Hwy. 301	FMSV-118A	Cs-137 Activity	7/15/2010	<MDA
Bass	FMSV-118A	Cs-137 Confidence Interval	7/15/2010	NA
	FMSV-118A	Cs-137 MDA	7/15/2010	0.01
Hwy. 301	FMSV-118C	Cs-137 Activity	7/15/2010	<MDA
Catfish	FMSV-118C	Cs-137 Confidence Interval	7/15/2010	NA
	FMSV-118C	Cs-137 MDA	7/15/2010	0.01
Stokes	FMSV-355A	Cs-137 Activity	7/20/2010	0.03
Bluff	FMSV-355A	Cs-137 Confidence Interval	7/20/2010	0.02
Bass	FMSV-355A	Cs-137 MDA	7/20/2010	0.01
Stokes	FMSV-355C	Cs-137 Activity	7/20/2010	<MDA
Bluff	FMSV-355C	Cs-137 Confidence Interval	7/20/2010	NA
Catfish	FMSV-355C	Cs-137 MDA	7/20/2010	0.01

Radiological Monitoring of Fish

2010 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17 Freshwater Bass	FMSV-2090A	Cs-137 Activity	11/2/2010	<MDA
	FMSV-2090A	Cs-137 Confidence Interval	11/2/2010	NA
	FMSV-2090A	Cs-137 MDA	11/2/2010	0.02
Hwy. 17 Freshwater Catfish	FMSV-2090C	Cs-137 Activity	10/13/2010	<MDA
	FMSV-2090C	Cs-137 Confidence Interval	10/13/2010	NA
	FMSV-2090C	Cs-137 MDA	10/13/2010	0.03
Edisto River Bass	FMMD-119A	Cs-137 Activity	6/10/2010	0.09
	FMMD-119A	Cs-137 Confidence Interval	6/10/2010	0.03
	FMMD-119A	Cs-137 MDA	6/10/2010	0.03
Edisto River Catfish	FMMD-119C	Cs-137 Activity	12/15/2010	0.06
	FMMD-119C	Cs-137 Confidence Interval	12/15/2010	0.02
	FMMD-119C	Cs-137 MDA	12/15/2010	0.02
Hwy. 17 Saltwater Red drum	FMSV-2091A	Cs-137 Activity	10/13/2010	<MDA
	FMSV-2091A	Cs-137 Confidence Interval	10/13/2010	NA
	FMSV-2091A	Cs-137 MDA	10/13/2010	0.02
Hwy. 17 Saltwater Flounder	FMSV-2091C	Cs-137 Activity	11/2/2010	<MDA
	FMSV-2091C	Cs-137 Confidence Interval	11/2/2010	NA
	FMSV-2091C	Cs-137 MDA	11/2/2010	0.02

Radiological Monitoring of Fish

2010 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff Lock & Dam Bass	FMSV-2028B	Cs-137 Activity	5/25/2010	<MDA
	FMSV-2028B	Cs-137 Confidence Interval	5/25/2010	NA
	FMSV-2028B	Cs-137 MDA	5/25/2010	0.01
New Sav. Bluff Lock & Dam Catfish	FMSV-2028D	Cs-137 Activity	5/25/2010	<MDA
	FMSV-2028D	Cs-137 Confidence Interval	5/25/2010	NA
	FMSV-2028D	Cs-137 MDA	5/25/2010	0.01
Upper Three Runs Bass	FMSV-2011B	Cs-137 Activity	7/7/2010	<MDA
	FMSV-2011B	Cs-137 Confidence Interval	7/7/2010	NA
	FMSV-2011B	Cs-137 MDA	7/7/2010	0.02
Upper Three Runs Catfish	FMSV-2011D	Cs-137 Activity	6/4/2010	<MDA
	FMSV-2011D	Cs-137 Confidence Interval	6/4/2010	NA
	FMSV-2011D	Cs-137 MDA	6/4/2010	0.02
Beaver Dam Creek Bass	FMSV-2013B	Cs-137 Activity	10/22/2010	0.10
	FMSV-2013B	Cs-137 Confidence Interval	10/22/2010	0.03
	FMSV-2013B	Cs-137 MDA	10/22/2010	0.02
Beaver Dam Creek Catfish	FMSV-2013D	Cs-137 Activity	10/22/2010	<MDA
	FMSV-2013D	Cs-137 Confidence Interval	10/22/2010	NA
	FMSV-2013D	Cs-137 MDA	10/22/2010	0.02
Fourmile Branch Bass	FMSV-2015B	Cs-137 Activity	9/8/2010	0.09
	FMSV-2015B	Cs-137 Confidence Interval	9/8/2010	0.03
	FMSV-2015B	Cs-137 MDA	9/8/2010	0.02
Fourmile Branch Catfish	FMSV-2015D	Cs-137 Activity	6/22/2010	<MDA
	FMSV-2015D	Cs-137 Confidence Interval	6/22/2010	NA
	FMSV-2015D	Cs-137 MDA	6/22/2010	0.02

Radiological Monitoring of Fish
2010 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel	FMSV-2017B	Cs-137 Activity	10/19/2010	0.13
Creek	FMSV-2017B	Cs-137 Confidence Interval	10/19/2010	0.03
Bass	FMSV-2017B	Cs-137 MDA	10/19/2010	0.02
Steel	FMSV-2017D	Cs-137 Activity	10/19/2010	<MDA
Creek	FMSV-2017D	Cs-137 Confidence Interval	10/19/2010	NA
Catfish	FMSV-2017D	Cs-137 MDA	10/19/2010	0.03
Lower	FMSV-2020B	Cs-137 Activity	7/8/2010	0.11
Three Runs	FMSV-2020B	Cs-137 Confidence Interval	7/8/2010	0.02
Bass	FMSV-2020B	Cs-137 MDA	7/8/2010	0.02
Lower	FMSV-2020D	Cs-137 Activity	7/8/2010	0.10
Three Runs	FMSV-2020D	Cs-137 Confidence Interval	7/8/2010	0.02
Catfish	FMSV-2020D	Cs-137 MDA	7/8/2010	0.01
Hwy. 301	FMSV-118B	Cs-137 Activity	7/15/2010	<MDA
Bass	FMSV-118B	Cs-137 Confidence Interval	7/15/2010	NA
	FMSV-118B	Cs-137 MDA	7/15/2010	0.01
Hwy. 301	FMSV-118D	Cs-137 Activity	7/15/2010	<MDA
Catfish	FMSV-118D	Cs-137 Confidence Interval	7/15/2010	NA
	FMSV-118D	Cs-137 MDA	7/15/2010	0.01
Stokes	FMSV-355B	Cs-137 Activity	7/20/2010	<MDA
Bluff	FMSV-355B	Cs-137 Confidence Interval	7/20/2010	NA
Bass	FMSV-355B	Cs-137 MDA	7/20/2010	0.01
Stokes	FMSV-355D	Cs-137 Activity	7/20/2010	<MDA
Bluff	FMSV-355D	Cs-137 Confidence Interval	7/20/2010	NA
Catfish	FMSV-355D	Cs-137 MDA	7/20/2010	0.01

Radiological Monitoring of Fish
2010 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17	FMSV-2090B	Cs-137 Activity	11/2/2010	<MDA
Freshwater	FMSV-2090B	Cs-137 Confidence Interval	11/2/2010	NA
Bass	FMSV-2090B	Cs-137 MDA	11/2/2010	0.02
Hwy. 17	FMSV-2090D	Cs-137 Activity	10/13/2010	<MDA
Freshwater	FMSV-2090D	Cs-137 Confidence Interval	10/13/2010	NA
Catfish	FMSV-2090D	Cs-137 MDA	10/13/2010	0.02
Edisto	FMMD-119B	Cs-137 Activity	6/10/2010	0.04
River	FMMD-119B	Cs-137 Confidence Interval	6/10/2010	0.02
Bass	FMMD-119B	Cs-137 MDA	6/10/2010	0.02
Edisto	FMMD-119D	Cs-137 Activity	12/15/2010	0.04
River	FMMD-119D	Cs-137 Confidence Interval	12/15/2010	0.02
Catfish	FMMD-119D	Cs-137 MDA	12/15/2010	0.02
Hwy. 17	FMSV-2091B	Cs-137 Activity	10/13/2010	<MDA
Saltwater	FMSV-2091B	Cs-137 Confidence Interval	10/13/2010	NA
Red drum	FMSV-2091B	Cs-137 MDA	10/13/2010	0.02
Hwy. 17	FMSV-2091D	Cs-137 Activity	11/2/2010	<MDA
Saltwater	FMSV-2091D	Cs-137 Confidence Interval	11/2/2010	NA
Flounder	FMSV-2091D	Cs-137 MDA	11/2/2010	0.02

Radiological Monitoring of Fish
2010 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff Lock & Dam Bass	FMSV-2028B	Strontium-89,90	5/25/2010	0.080
	FMSV-2028B	Strontium Uncertainty	5/25/2010	0.010
	FMSV-2028B	Strontium MDA	5/25/2010	0.020
New Sav. Bluff Lock & Dam Catfish	FMSV-2028D	Strontium-89,90	5/25/2010	0.030
	FMSV-2028D	Strontium Uncertainty	5/25/2010	0.010
	FMSV-2028D	Strontium MDA	5/25/2010	0.020
Upper Three Runs Bass	FMSV-2011B	Strontium-89,90	7/7/2010	0.080
	FMSV-2011B	Strontium Uncertainty	7/7/2010	0.010
	FMSV-2011B	Strontium MDA	7/7/2010	0.020
Upper Three Runs Catfish	FMSV-2011D	Strontium-89,90	7/7/2010	0.070
	FMSV-2011D	Strontium Uncertainty	7/7/2010	0.010
	FMSV-2011D	Strontium MDA	7/7/2010	0.020
Beaver Dam Creek Bass	FMSV-2013B	Strontium-89,90	10/22/2010	0.080
	FMSV-2013B	Strontium Uncertainty	10/22/2010	0.028
	FMSV-2013B	Strontium MDA	10/22/2010	0.005
Beaver Dam Creek Catfish	FMSV-2013D	Strontium-89,90	10/22/2010	0.037
	FMSV-2013D	Strontium Uncertainty	10/22/2010	0.013
	FMSV-2013D	Strontium MDA	10/22/2010	0.004
Fourmile Branch Bass	FMSV-2015B	Strontium-89,90	9/8/2010	0.310
	FMSV-2015B	Strontium Uncertainty	9/8/2010	0.020
	FMSV-2015B	Strontium MDA	9/8/2010	0.020
Fourmile Branch Catfish	FMSV-2015D	Strontium-89,90	6/22/2010	0.070
	FMSV-2015D	Strontium Uncertainty	6/22/2010	0.010
	FMSV-2015D	Strontium MDA	6/22/2010	0.020

Radiological Monitoring of Fish
2010 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel Creek Bass	FMSV-2017B	Strontium-89,90	10/19/2010	0.022
	FMSV-2017B	Strontium Uncertainty	10/19/2010	0.008
	FMSV-2017B	Strontium MDA	10/19/2010	0.004
Steel Creek Catfish	FMSV-2017D	Strontium-89,90	10/19/2010	0.025
	FMSV-2017D	Strontium Uncertainty	10/19/2010	0.009
	FMSV-2017D	Strontium MDA	10/19/2010	0.004
Lower Three Runs Bass	FMSV-2020B	Strontium-89,90	7/8/2010	0.080
	FMSV-2020B	Strontium Uncertainty	7/8/2010	0.010
	FMSV-2020B	Strontium MDA	7/8/2010	0.020
Lower Three Runs Catfish	FMSV-2020D	Strontium-89,90	7/8/2010	0.050
	FMSV-2020D	Strontium Uncertainty	7/8/2010	0.010
	FMSV-2020D	Strontium MDA	7/8/2010	0.020
Hwy. 301 Bass	FMSV-118B	Strontium-89,90	7/15/2010	0.060
	FMSV-118B	Strontium Uncertainty	7/15/2010	0.010
	FMSV-118B	Strontium MDA	7/15/2010	0.030
Hwy. 301 Catfish	FMSV-118D	Strontium-89,90	7/15/2010	0.060
	FMSV-118D	Strontium Uncertainty	7/15/2010	0.010
	FMSV-118D	Strontium MDA	7/15/2010	0.020
Stokes Bluff Bass	FMSV-355B	Strontium-89,90	7/20/2010	0.040
	FMSV-355B	Strontium Uncertainty	7/20/2010	0.010
	FMSV-355B	Strontium MDA	7/20/2010	0.030
Stokes Bluff Catfish	FMSV-355D	Strontium-89,90	7/20/2010	0.050
	FMSV-355D	Strontium Uncertainty	7/20/2010	0.010
	FMSV-355D	Strontium MDA	7/20/2010	0.020

Radiological Monitoring of Fish
2010 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17	FMSV-2090B	Strontium-89,90	11/2/2010	0.033
Freshwater	FMSV-2090B	Strontium Uncertainty	11/2/2010	0.011
Bass	FMSV-2090B	Strontium MDA	11/2/2010	0.003
Hwy. 17	FMSV-2090D	Strontium-89,90	10/13/2010	0.034
Freshwater	FMSV-2090D	Strontium Uncertainty	10/13/2010	0.012
Catfish	FMSV-2090D	Strontium MDA	10/13/2010	0.005
Edisto	FMMD-119B	Strontium-89,90	6/10/2010	0.100
River	FMMD-119B	Strontium Uncertainty	6/10/2010	0.010
Bass	FMMD-119B	Strontium MDA	6/10/2010	0.020
Edisto	FMMD-119D	Strontium-89,90	12/15/2010	0.009
River	FMMD-119D	Strontium Uncertainty	12/15/2010	0.003
Catfish	FMMD-119D	Strontium MDA	12/15/2010	0.003
Hwy. 17	FMSV-2091H	Strontium-89,90	10/13/2010	0.014
Saltwater	FMSV-2091H	Strontium Uncertainty	10/13/2010	0.005
Red drum	FMSV-2091H	Strontium MDA	10/13/2010	0.003
Hwy. 17	FMSV-2091J	Strontium-89,90	11/2/2010	0.009
Saltwater	FMSV-2091J	Strontium Uncertainty	11/2/2010	0.003
Flounder	FMSV-2091J	Strontium MDA	11/2/2010	0.004

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2006-2010

Year			NSBLD	UTR	BDC	FMB	STC
	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Tritium (pCi/L)	NS	ND	2187	ND	ND
2009			ND	209	ND	893	383
2008			ND	ND	ND	240	954
2007			ND	ND	359	2,930	183
2006			269	385	232	2,920	2,287

Year			LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Tritium (pCi/L)	329	218	434	447	ND
2009			468	ND	550	1870	ND
2008			436	301	279	215	NS
2007			518	396	477	ND	NS
2006			474	454	265	368	NS

Year			NSBLD	UTR	BDC	FMB	STC
	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	0.03	0.160	0.28	0.210
2009			ND	ND	0.634	ND	0.910
2008			ND	0.047	ND	0.167	0.700
2007			ND	0.129	0.117	0.052	0.155
2006			ND	ND	0.069	0.206	0.198

Year			LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Cs-137 (pCi/g wet)	0.230	ND	0.030	ND	0.090
2009			0.353	0.041	0.053	ND	0.097
2008			0.427	0.071	ND	0.050	NS
2007			0.473	0.027	0.045	0.031	NS
2006			0.391	ND	0.039	ND	NS

Notes:
ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled
NR - Not Reported
NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam creek
FMB - Fourmile Branch
STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto river

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2006-2010

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	0.100	0.090	0.130
2009			ND	0.042	ND	ND	0.512
2008			ND	ND	ND	0.094	0.463
2007			ND	0.057	0.079	ND	0.102
2006			ND	ND	ND	0.107	0.081

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Cs-137 (pCi/g wet)	0.110	ND	ND	ND	0.040
2009			0.160	ND	ND	ND	0.066
2008			0.248	ND	ND	0.041	NS
2007			0.303	0.026	ND	ND	NS
2006			0.192	ND	ND	ND	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Sr-89,90 (pCi/g Wet)	0.080	0.080	0.080	0.310	0.022
2009			0.041	0.072	0.032	0.038	0.045
2008			0.056	0.069	0.044	0.182	0.053
2007			0.078	0.156	0.170	0.173	0.089
2006			0.063	0.187	0.087	0.038	0.070

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Bass	Bass	Bass	Bass	Bass
2010	Radionuclide	Sr-89,90 (pCi/g Wet)	0.080	0.060	0.040	0.033	0.100
2009			0.050	0.040	0.051	0.091	0.044
2008			0.034	0.035	0.036	0.080	NS
2007			0.085	0.123	0.134	NA	NS
2006			0.059	0.082	0.088	0.105	NS

Notes:
ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled
NR - Not Reported
NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam creek
FMB - Fourmile Branch
STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto river

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2006-2010

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Tritium (pCi/L)	NS	ND	ND	NS	NS
2009			ND	ND	ND	298	405
2008			ND	278	ND	507	247
2007			ND	ND	233	2,010	1,120
2006			302	ND	469	1779	2104

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Bass
2010	Radionuclide	Tritium (pCi/L)	363	ND	427	ND	ND
2009			216	205	ND	1832	ND
2008			406	373	ND	ND	NS
2007			484	621	396	273	NS
2006			451	423	296	ND	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND	ND	ND
2009			ND	ND	ND	ND	0.036
2008			ND	0.138	ND	0.026	0.032
2007			0.041	ND	ND	0.342	0.075
2006			ND	ND	ND	0.043	0.101

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Edible	Edible	Edible	Edible	Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Cs-137 (pCi/g wet)	0.130	ND	ND	ND	0.090
2009			0.048	ND	ND	ND	ND
2008			ND	ND	ND	0.032	NS
2007			0.053	ND	0.028	0.035	NS
2006			0.135	ND	ND	0.035	NS

Notes:
ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled
NR - Not Reported
NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam creek
FMB - Fourmile Branch
STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto river

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2006-2010

	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND	ND	ND
2009			ND	ND	ND	ND	ND
2008			ND	0.075	ND	0.027	ND
2007			ND	ND	0.028	0.178	ND
2006			ND	ND	ND	0.051	0.045

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Cs-137 (pCi/g wet)	0.100	ND	ND	ND	0.040
2009			ND	ND	ND	ND	ND
2008			ND	ND	ND	ND	NS
2007			0.039	ND	ND	ND	NS
2006			0.088	ND	ND	ND	NS

Year	Sample Location		NSBLD	UTR	BDC	FMB	STC
	Sample Station		SV-2028	SV-2011	SV-2013	SV-2015	SV-2017
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-Edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Sr-89,90 (pCi/g Wet)	0.030	0.070	0.037	0.070	0.025
2009			0.041	0.041	0.023	0.025	0.020
2008			0.039	0.042	0.055	0.032	0.034
2007			0.082	0.051	0.109	0.047	0.003
2006			0.056	0.067	0.061	0.063	0.097

Year	Sample Location		LTR	Hwy. 301	Stokes	Hwy. 17	Edisto R.
	Sample Station		SV-2020	SV-118	SV-355	SV-2090	MD-119
	Sample Cut		Non-Edible	Non-Edible	Non-Edible	Non-Edible	Non-edible
	Species		Catfish	Catfish	Catfish	Catfish	Catfish
2010	Radionuclide	Sr-89,90 (pCi/g Wet)	0.050	0.060	0.050	0.034	0.090
2009			0.048	0.049	0.043	0.023	0.012
2008			0.037	0.023	0.039	0.027	NS
2007			0.074	0.103	0.059	NA	NS
2006			0.065	0.048	0.046	0.036	NS

Notes:

ND - Non-Detect
NS - Not Sampled
NA - Not Analyzed
NR - Not Reported

NSBLD - New Sav. Bluff Lock & Dam
UTR - Upper Three Runs
BDC - Beaver Dam creek
FMB - Fourmile Branch

STC - Steel Creek
LTR - Lower Three Runs
Stokes - Stokes Bluff
Edisto R. - Edisto river

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2006-2010

Year				
	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Edible	Edible
	Species		Red drum	Flounder
2010	Radionuclide	Tritium (pCi/L)	300	221
2009			378	414
2008			ND	ND
2007			ND	ND
2006			223	296

Year				
	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Edible	Edible
	Species		Red drum	Flounder
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	ND
2009			ND	ND
2008			ND	ND
2007			ND	ND
2006			ND	ND

Year				
	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible
	Species		Red drum	Flounder
2010	Radionuclide	Cs-137 (pCi/g wet)	ND	ND
2009			ND	ND
2008			ND	ND
2007			NA	NA
2006			ND	ND

Year				
	Sample Location		Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible
	Species		Red drum	Flounder
2010	Radionuclide	Sr-89,90 (pCi/g Wet)	0.140	0.009
2009			0.017	0.004
2008			0.010	ND
2007			NA	NA
2006			0.015	ND

Notes: ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled

Fish Monitoring Data
2010 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
New Sav. Bluff Lock & Dam Bass	FMSV-2028A-1	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028A-2	Mercury in Fish	5/25/2010	0.13
	FMSV-2028A-3	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028A-4	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028A-5	Mercury in Fish	5/25/2010	<0.10
New Sav. Bluff Lock & Dam Catfish	FMSV-2028C-1	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028C-2	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028C-3	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028C-4	Mercury in Fish	5/25/2010	<0.10
	FMSV-2028C-5	Mercury in Fish	5/25/2010	<0.10
Upper Three Runs Bass	FMSV-2011A-1	Mercury in Fish	7/7/2010	0.12
	FMSV-2011A-2	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011A-3	Mercury in Fish	7/7/2010	0.30
	FMSV-2011A-4	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011A-5	Mercury in Fish	7/7/2010	<0.10
Upper Three Runs Catfish	FMSV-2011C-1	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011C-2	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011C-3	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011C-4	Mercury in Fish	7/7/2010	<0.10
	FMSV-2011C-5	Mercury in Fish	7/7/2010	0.15
Beaver Dam Creek Bass	FMSV-2013A-1	Mercury in Fish	10/22/2010	0.11
	FMSV-2013A-2	Mercury in Fish	10/22/2010	0.21
	FMSV-2013A-3	Mercury in Fish	10/22/2010	0.26
Beaver Dam Creek Catfish	FMSV-2013C-1	Mercury in Fish	10/22/2010	<0.10
	FMSV-2013C-2	Mercury in Fish	10/22/2010	<0.10
	FMSV-2013C-3	Mercury in Fish	10/22/2010	<0.10

Fish Monitoring Data
2010 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Fourmile Branch Bass	FMSV-2015A-1	Mercury in Fish	9/8/2010	1.4
	FMSV-2015A-2	Mercury in Fish	9/8/2010	0.28
	FMSV-2015A-3	Mercury in Fish	9/8/2010	0.29
Fourmile Branch Catfish	FMSV-2015C-1	Mercury in Fish	6/22/2010	<0.10
	FMSV-2015C-2	Mercury in Fish	6/22/2010	<0.10
	FMSV-2015C-3	Mercury in Fish	6/22/2010	<0.10
Steel Creek Bass	FMSV-2017A-1	Mercury in Fish	10/19/2010	0.16
	FMSV-2017A-2	Mercury in Fish	10/19/2010	0.31
	FMSV-2017A-3	Mercury in Fish	10/19/2010	0.15
	FMSV-2017A-4	Mercury in Fish	10/19/2010	0.21
Steel Creek Catfish	FMSV-2017C-1	Mercury in Fish	10/19/2010	<0.10
	FMSV-2017C-2	Mercury in Fish	10/19/2010	<0.10
	FMSV-2017C-3	Mercury in Fish	10/19/2010	<0.10
	FMSV-2017C-4	Mercury in Fish	10/19/2010	<0.10
	FMSV-2017C-5	Mercury in Fish	10/19/2010	<0.10
Lower Three Runs Bass	FMSV-2020A-1	Mercury in Fish	7/8/2010	0.51
	FMSV-2020A-2	Mercury in Fish	7/8/2010	0.15
	FMSV-2020A-3	Mercury in Fish	7/8/2010	0.12
	FMSV-2020A-4	Mercury in Fish	7/8/2010	<0.10
	FMSV-2020A-5	Mercury in Fish	7/8/2010	0.67
Lower Three Runs Catfish	FMSV-2020C-1	Mercury in Fish	7/8/2010	<0.10
	FMSV-2020C-2	Mercury in Fish	7/8/2010	<0.10
	FMSV-2020C-3	Mercury in Fish	7/8/2010	<0.10
	FMSV-2020C-4	Mercury in Fish	7/8/2010	<0.10
	FMSV-2020C-5	Mercury in Fish	7/8/2010	<0.10

Fish Monitoring Data
2010 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Hwy. 301 Bass	FMSV-118A-1	Mercury in Fish	7/15/2010	0.23
	FMSV-118A-2	Mercury in Fish	7/15/2010	0.22
	FMSV-118A-3	Mercury in Fish	7/15/2010	0.39
	FMSV-118A-4	Mercury in Fish	7/15/2010	0.28
	FMSV-118A-5	Mercury in Fish	7/15/2010	0.12
Hwy. 301 Catfish	FMSV-118C-1	Mercury in Fish	7/15/2010	<0.10
	FMSV-118C-2	Mercury in Fish	7/15/2010	<0.10
	FMSV-118C-3	Mercury in Fish	7/15/2010	<0.10
	FMSV-118C-4	Mercury in Fish	7/15/2010	<0.10
	FMSV-118C-5	Mercury in Fish	7/15/2010	<0.10
Stokes Bluff Bass	FMSV-355A-1	Mercury in Fish	7/20/2010	0.42
	FMSV-355A-2	Mercury in Fish	7/20/2010	0.67
	FMSV-355A-3	Mercury in Fish	7/20/2010	0.25
	FMSV-355A-4	Mercury in Fish	7/20/2010	0.67
	FMSV-355A-5	Mercury in Fish	7/20/2010	0.17
Stokes Bluff Catfish	FMSV-355C-1	Mercury in Fish	7/20/2010	<0.10
	FMSV-355C-2	Mercury in Fish	7/20/2010	0.44
	FMSV-355C-3	Mercury in Fish	7/20/2010	<0.10
	FMSV-355C-4	Mercury in Fish	7/20/2010	0.13
	FMSV-355C-5	Mercury in Fish	7/20/2010	<0.10
Hwy. 17 Bass	FMSV-2090A-1	Mercury in Fish	11/2/2010	0.45
	FMSV-2090A-2	Mercury in Fish	11/2/2010	0.16
	FMSV-2090A-3	Mercury in Fish	11/2/2010	0.42
Hwy. 17 Catfish	FMSV-2090C-1	Mercury in Fish	10/13/2010	0.75
	FMSV-2090C-2	Mercury in Fish	10/13/2010	0.11
	FMSV-2090C-3	Mercury in Fish	10/13/2010	0.20

Fish Monitoring Data
2010 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Hwy. 17 Red Drum	FMSV-2091A-1	Mercury in Fish	10/13/2010	<0.10
	FMSV-2091A-2	Mercury in Fish	10/13/2010	<0.10
	FMSV-2091A-3	Mercury in Fish	10/13/2010	<0.10
	FMSV-2091A-4	Mercury in Fish	10/13/2010	<0.10
Hwy. 17 Flounder	FMSV-2091C-1	Mercury in Fish	11/2/2010	<0.10
	FMSV-2091C-2	Mercury in Fish	11/2/2010	<0.10
	FMSV-2091C-3	Mercury in Fish	11/2/2010	<0.10
	FMSV-2091C-4	Mercury in Fish	11/2/2010	<0.10
Edisto River Bass	FMMD-119A-1	Mercury in Fish	6/10/2010	0.66
	FMMD-119A-2	Mercury in Fish	6/10/2010	0.28
	FMMD-119A-3	Mercury in Fish	6/10/2010	0.52
	FMMD-119A-4	Mercury in Fish	6/10/2010	0.42
Edisto River Catfish	FMMD-119C-1	Mercury in Fish	12/15/2010	0.11
	FMMD-119C-2	Mercury in Fish	12/15/2010	<0.10
	FMMD-119C-3	Mercury in Fish	12/15/2010	0.43

Fish Monitoring Data
2010 SCDHEC and DOE-SR Data Comparison

Table 1 Tritium Activity Levels in Edible Bass pCi/g[1]			
Location	Agency	# of samples	Result
NSBLD	ESOP	NS	NA
	DOE-SR	3	0.08
Upper Three Runs	ESOP	1	<LLD
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	2187.00
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	<LLD
	DOE-SR	3	0.13
Steel Creek	ESOP	1	<LLD
	DOE-SR	3	<MDC
Lower Three Runs	ESOP	1	329
	DOE-SR	3	0.07
Hwy. 301	ESOP	1	218
	DOE-SR	3	<MDC
Stokes Bluff	ESOP	1	434
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	447
	DOE-SR	3	<MDC
Average[2]	ESOP	5	723
	DOE-SR	3	0.093
Standard Deviation[2]	ESOP	5	824
	DOE-SR	3	0.032

Table 2 Tritium Activity Levels in Edible Catfish pCi/g[1]			
Location	Agency	# of samples	Result
NSBLD	ESOP	NS	NA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<LLD
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	<LLD
	DOE-SR	3	0.11
Fourmile Branch	ESOP	NS	NA
	DOE-SR	3	<MDC
Steel Creek	ESOP	NS	NA
	DOE-SR	3	0.26
Lower Three Runs	ESOP	1	393
	DOE-SR	3	0.08
Hwy. 301	ESOP	1	<LLD
	DOE-SR	3	<MDC
Stokes Bluff	ESOP	1	427
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<LLD
	DOE-SR	3	<MDC
Average[2]	ESOP	2	0.591
	DOE-SR	3	0.150
Standard Deviation[2]	ESOP	2	0.698
	DOE-SR	3	0.096

Notes:
[1]ESOP - per gram of water in fish tissue
DOE-SR data from SRNS 2011
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only
N/A - Not Applicable
NS - No Sample

Fish Monitoring Data
2010 SCDHEC and DOE-SR Data Comparison

Table 3
Cesium-137 Activity Levels in Edible Bass
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	0.03
	DOE-SR	3	0.05*
Beaver Dam Creek	ESOP	1	0.16
	DOE-SR	3	0.05*
Fourmile Branch	ESOP	1	0.28
	DOE-SR	3	.05**
Steel Creek	ESOP	1	0.21
	DOE-SR	3	0.15
Lower Three Runs	ESOP	1	0.23
	DOE-SR	3	0.06
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.04
Stokes Bluff	ESOP	1	0.03
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	6	0.16
	DOE-SR	6	0.05
Standard Deviation[2]	ESOP	6	0.11
	DOE-SR	6	0.01

Table 4
Cesium-137 Activity Levels in Edible Catfish
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.02*
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	<MDA
	DOE-SR	3	0.10
Lower Three Runs	ESOP	1	0.13
	DOE-SR	3	0.07
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.03
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	0.03**
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	.04*
Average[2]	ESOP	1	0.13
	DOE-SR	6	0.05
Standard Deviation[2]	ESOP	1	NA
	DOE-SR	6	0.03

Notes: DOE-SR data from SRNS 2011
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring
2010 SCDHEC and DOE-SR Data Comparison

Table 5 Cesium-137 Activity Levels in Non-edible Bass pCi/g			
Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.03**
Beaver Dam Creek	ESOP	1	0.10
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	0.09
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	0.13
	DOE-SR	3	0.11
Lower Three Runs	ESOP	1	0.11
	DOE-SR	3	<MDC
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	<MDC
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	4	0.12
	DOE-SR	2	0.07
Standard Deviation[2]	ESOP	4	0.01
	DOE-SR	2	0.06

Table 6 Cesium-137 Activity Levels in Non-edible Catfish pCi/g			
Location	Agency	# of samples	Result
NSBLD	ESOP	1	<MDA
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<MDA
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	<MDA
	DOE-SR	3	0.07
Lower Three Runs	ESOP	1	0.10
	DOE-SR	3	0.04
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.01
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	0	N/A
	DOE-SR	3	#DIV/0!
Standard Deviation[2]	ESOP	0	N/A
	DOE-SR	3	#DIV/0!

Notes:
DOE-SR data from SRNS 2011
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring Data
2010 SCDHEC and DOE-SR Data Comparison

Table 7
Strontium-89,90 Activity Levels in Non-edible Bass
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	0.08
	DOE-SR	3	0.11
Upper Three Runs	ESOP	1	0.08
	DOE-SR	3	0.10
Beaver Dam Creek	ESOP	1	0.08
	DOE-SR	3	0.09
Fourmile Branch	ESOP	1	0.31
	DOE-SR	3	0.13
Steel Creek	ESOP	1	0.02
	DOE-SR	3	0.01
Lower Three Runs	ESOP	1	0.08
	DOE-SR	3	0.05
Hwy. 301	ESOP	1	0.06
	DOE-SR	3	0.11
Stokes Bluff	ESOP	1	0.05
	DOE-SR	3	0.12
Hwy. 17	ESOP	1	0.03
	DOE-SR	3	0.01
Average[2]	ESOP	9	0.09
	DOE-SR	9	0.08
Standard Deviation[2]	ESOP	9	0.09
	DOE-SR	9	0.05

Table 8
Strontium-89,90 Activity Levels in Non-edible Catfish
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	0.03
	DOE-SR	3	0.06
Upper Three Runs	ESOP	1	0.07
	DOE-SR	3	0.01
Beaver Dam Creek	ESOP	1	0.04
	DOE-SR	3	0.01
Fourmile Branch	ESOP	1	0.07
	DOE-SR	3	0.05
Steel Creek	ESOP	1	0.03
	DOE-SR	3	0.09
Lower Three Runs	ESOP	1	0.05
	DOE-SR	3	0.06
Hwy. 301	ESOP	1	0.06
	DOE-SR	3	0.09
Stokes Bluff	ESOP	1	0.04
	DOE-SR	3	0.08
Hwy. 17	ESOP	1	0.03
	DOE-SR	3	0.07
Average[2]	ESOP	9	0.05
	DOE-SR	9	0.06
Standard Deviation[2]	ESOP	9	0.02
	DOE-SR	9	0.03

Notes: DOE-SR data from SRNS 2011
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring Data
2010 SCDHEC and DOE-SR Data Comparison

Table 9
Mercury Levels in Edible Bass
mg/kg

Location	Agency	# of samples	Result
NSBLD	ESOP	5 (1)	0.13
	DOE-SR	15(15)	0.20
Upper Three Runs	ESOP	5 (2)	0.21
	DOE-SR	15(15)	0.28
Beaver Dam Creek	ESOP	3 (3)	0.19
	DOE-SR	15(15)	0.35
Fourmile Branch	ESOP	3 (3)	0.65
	DOE-SR	15(15)	0.51
Steel Creek	ESOP	4 (4)	0.21
	DOE-SR	15(15)	0.55
Lower Three Runs	ESOP	5 (4)	0.36
	DOE-SR	15(15)	0.33
Hwy. 301	ESOP	5 (5)	0.25
	DOE-SR	15(15)	0.41
Stokes Bluff	ESOP	5 (5)	0.44
	DOE-SR	15(15)	0.73
Hwy. 17	ESOP	3 (3)	0.34
	DOE-SR	15(15)	0.25
Average[2]	ESOP	38 (30)	0.38
	DOE-SR	135(135)	0.40
Standard Deviation[2]	ESOP	38 (30)	0.32
	DOE-SR	135(135)	0.17

Table 10
Mercury Levels in Edible Catfish
mg/kg

Location	Agency	# of samples	Result
NSBLD	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.14
Upper Three Runs	ESOP	5 (0)	0.13
	DOE-SR	15(15)	0.12
Beaver Dam Creek	ESOP	3 (0)	<PQL
	DOE-SR	15(15)	0.13
Fourmile Branch	ESOP	3 (0)	<PQL
	DOE-SR	15(15)	0.11
Steel Creek	ESOP	5 (0)	<PQL
	DOE-SR	11(11)	0.22
Lower Three Runs	ESOP	5 (0)	<PQL
	DOE-SR	19(19)	0.15
Hwy. 301	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.23
Stokes Bluff	ESOP	5 (2)	0.29
	DOE-SR	15(15)	0.33
Hwy. 17	ESOP	3 (0)	<PQL
	DOE-SR	15(15)	0.28
Average[2]	ESOP	39 (2)	0.17
	DOE-SR	135(135)	0.19
Standard Deviation[2]	ESOP	39 (2)	0.03
	DOE-SR	135(135)	0.08

Notes:
DOE-SR data from SRNS 2011
( ) denotes number of detections
Results are averages, unless ( ) = 1
* includes one result below MDC
** includes two results below MDC

PQL - Practical Quantitation Limit
mg/kg - milligrams per kilogram
DOE-SR results converted from ug/g (microgram per gram)

TOC

4.1.5 Summary Statistics

Radiological Fish Monitoring

Notes:
1. N - denotes number of samples
2. Tritium results(pCi/L) represent the activity level in the water distilled from the fish tissue.
3. Cs-137 results (pCi/g) represent the activity level in natural fish tissue.
4. Strontium results (pCi/g) represent the activity level in an aliquot of wet fish tissue.

2010 Fish Monitoring Summary Statistics

Tritium Levels (pCi/L) in Savannah River Fish, 2010

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	4 (3)	792	934	382	2187	218
Catfish	2 (5)	395	45	395	427	363

Non-detections (ND) excluded from computations
Tritium reported as activity in the water extracted from fish tissue

Cesium-137 Levels (pCi/g - Wet) in Savannah River Fish, 2010

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	5 (4)	0.16	0.11	0.19	0.28	0.03
Catfish	1 (8)	0.13	N/A	0.13	0.13	0.13
Non-edible	**N (ND)**	**Average**	**Standard Deviation**	**Median**	**Maximum**	**Minimum**
Bass	3 (6)	0.11	0.02	0.11	0.13	0.09
Catfish	1 (8)	0.10	N/A	0.10	0.10	0.10

Non-detections (ND) excluded from computations
Non-edible pickerel not analyzed

Strontium-89,90 Levels (pCi/g - Wet) in Savannah River Fish, 2010

Non-edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	9 (0)	0.083	0.088	0.060	0.310	0.022
Catfish	9 (0)	0.047	0.017	0.050	0.070	0.025

Mercury Levels (mg/kg) in Savannah River Fish, 2010

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	30 (8)	0.33	0.26	0.26	1.40	0.11
Catfish	7 (32)	0.27	0.24	0.15	0.75	0.10

Non-detections (ND) excluded from computations

TOC

4.2 Radiological Game Animal Monitoring Adjacent to SRS

4.2.1 PROJECT SUMMARY

Since the initiation of nuclear testing, concern has grown over the accumulation of radionuclides in the environment. The Savannah River Site (SRS) has historically been a nuclear weapons material production, separation, and research facility located along the Savannah River within Aiken, Allendale, and Barnwell counties in South Carolina. The operation of production reactors, waste storage sites, and other nuclear facilities at SRS has resulted in the release of cesium-137 (Cs-137) to the environment for the past 50 years. Routine operations at the SRS have released Cs-137 to the regional environment surrounding the SRS. The most significant releases occurred during the early years of site operation when Cs-137 was released to seepage basins and site streams. The SRS facilities that have documented Cs-137 releases are the production reactors, separation areas, liquid waste facilities, solid waste disposal facility, central shops, heavy water rework facility, and the Savannah River National Laboratory. A number of other facilities handled material containing Cs-137, but releases, if any, are not documented. As part of the environmental monitoring program, the Department of Energy - Savannah River (DOE-SR) investigates a variety of mammalian species for the presence of contaminants. White-tailed deer and feral hogs have shown the highest potential of the mammalian species for a human exposure pathway from Cs-137 (Haselow 1991).

DOE-SR has annual hunts open to members of the general public to control the site's deer and feral hog population and to reduce animal/vehicle accidents. Before any animal is released to a hunter, SRS personnel monitor Cs-137 levels for exposure limit considerations, to ensure established administrative dose limits are not exceeded. DOE-SR does not collect game animal samples within the South Carolina Department of Health and Environmental Control (SCDHEC) study area, and off-site hunter doses are based on DOE-SR models. Therefore, no direct comparisons could be made between SCDHEC and DOE-SR data. The SCDHEC Critical Pathway Dose report addresses dose based on collected samples and is compared to DOE-SR modeled dose for off-site hunters.

The precise ranging behavior of individual deer and hogs on the SRS is unknown. White-tailed deer and feral hogs have access to a number of contaminated areas on the SRS and are a vector for the redistribution of contaminants, primarily Cs-137, to off-site locations. Consumption of these wildlife species can result in the transfer of contaminants to humans. Cesium-137 is of concern because of the 30 year half-life, its availability to game animals, and associated health risk to humans. (Haselow 1991).

Cesium-137 is readily incorporated into the human body because of its similarity to potassium-40 (K-40) in physiological processes (Davis 1963). Cesium-137 concentrates in animal skeletal muscles, which are selectively consumed by hunters (Brisbin 1975). Cesium-137 emits both beta and gamma radiation, contributing to both internal and external radiation exposure, which may be associated with gastrointestinal, genetic, hemopoietic, and central nervous system damage (Bond 1965). Because of these concerns, Cs-137 will be the only isotope discussed in this report.

The Environmental Surveillance and Oversight Program (ESOP) of the SCDHEC conducts independent non-regulatory oversight of game animal monitoring activities at the SRS. The game animal project addresses concerns of potentially contaminated white-tailed deer and feral hogs migrating off the SRS and can provide valuable information concerning the potential off-site exposure to Cs-137 by analyzing samples collected off-site. SCDHEC analyzed muscle tissue collected in 2010 for Cs-137 from 30 deer and four hogs collected from area hunters via hunting clubs, plantations, and Crackerneck Wildlife Management Area within a five-mile study area adjacent to the SRS (Map 15, Section 4.2.2). Additionally, five deer tissue samples were collected and analyzed from a background location 55 miles east of the SRS in Bamberg County, South Carolina. Sample size, location, and collection dates were dependent on the participating hunters.

RESULTS AND DISCUSSION

Cesium-137

Cesium-137 and the naturally occurring isotopes K-40 and lead-214 (Pb-214) were the only isotopes detected in game samples collected in 2010. Naturally occurring isotopes will not be discussed in this report. Cesium-137 concentrations from deer collected in the SRS perimeter study area are shown in Section 5.0 Figure 2. Analytical results are listed under each zone in Section 4.2.4.

ESOP and DOE-SR Data Comparison

Cesium-137 activities from the 30 SCDHEC perimeter deer samples ranged from less than the MDA (<MDA) to 9.96 pCi/g, with an average of 1.02 (± 1.93) pCi/g (Section 4.2.5). Cesium-137 activities from the four SCDHEC perimeter hog samples ranged from <MDA to 2.49 pCi/g with an average of 1.33 (± 1.23) pCi/g (Section 4.2.5). All SCDHEC hunt zone averages were within one standard deviation of the overall perimeter average. Results from the five background samples (Section 4.2.4) ranged from 0.05 pCi/g to 1.63 pCi/g, with an average of 0.46 (± 0.66) pCi/g. DOE-SR reported an approximate field measurement range of 1.00 pCi/g to 2.99 pCi/g with an average of 1.00 pCi/g from 502 deer and 1.00 pCi/g from 102 feral hogs harvested on the SRS in 2010 (SRNS 2011). The DOE-SR field average was within one standard deviation of the SCDHEC average. Average perimeter, background, and DOE-SR on-site Cs-137 levels for the past five years (Section 4.2.5) are indicated in Figure 1 (Section 4.2.3).

Statistical Analysis

The 2010 perimeter Cs-137 average result, 1.02 pCi/g, is within one standard deviation of the background average 0.46 (± 0.66) pCi/g. The 2006 to 2010 DOE-SR yearly on-site Cs-137 average activity,1.78 (± 0.71) pCi/g, is within three standard deviations of the SCDHEC off-site average of 0.91 (± 0.26) pCi/g (Section 4.2.5) (SRNS 2009, SRNS 2010, SRNS 2011, WSRC 2007 and WSRC 2008) The five-year Cs-137 averages between SCDHEC and DOE-SR may differ for various reasons. The DOE-SR data is acquired in the field by using a portable sodium iodide detector while SCDHEC data are analytical results. Also, the SCDHEC data presents a challenge for direct comparisons to DOE-SR data because the perimeter area is heavily baited with corn. Therefore, the uptake of Cs-137 by these animals will be reduced based on the increased K-40 levels in the corn from fertilizers (Heckman 1992).

CONCLUSIONS AND RECOMMENDATIONS

Historic SRS operations released known Cs-137 contamination to Steel Creek, Par Pond, and Lower Three Runs, their floodplains, and the Savannah River swamp, all of which impact hunt zones four, five, six and seven. Although a portion of the Cs-137 was deposited on the SRS from site operations, levels found in the study area and background location are likely results of above ground nuclear weapons testing (Haselow 1991). DOE-SR does not collect game animal samples within the SCDHEC study area, and off-site hunter doses are based on DOE-SR models from animals collected on SRS. Further research may be needed to help determine why elevated Cs-137 activities are found in other hunt units.

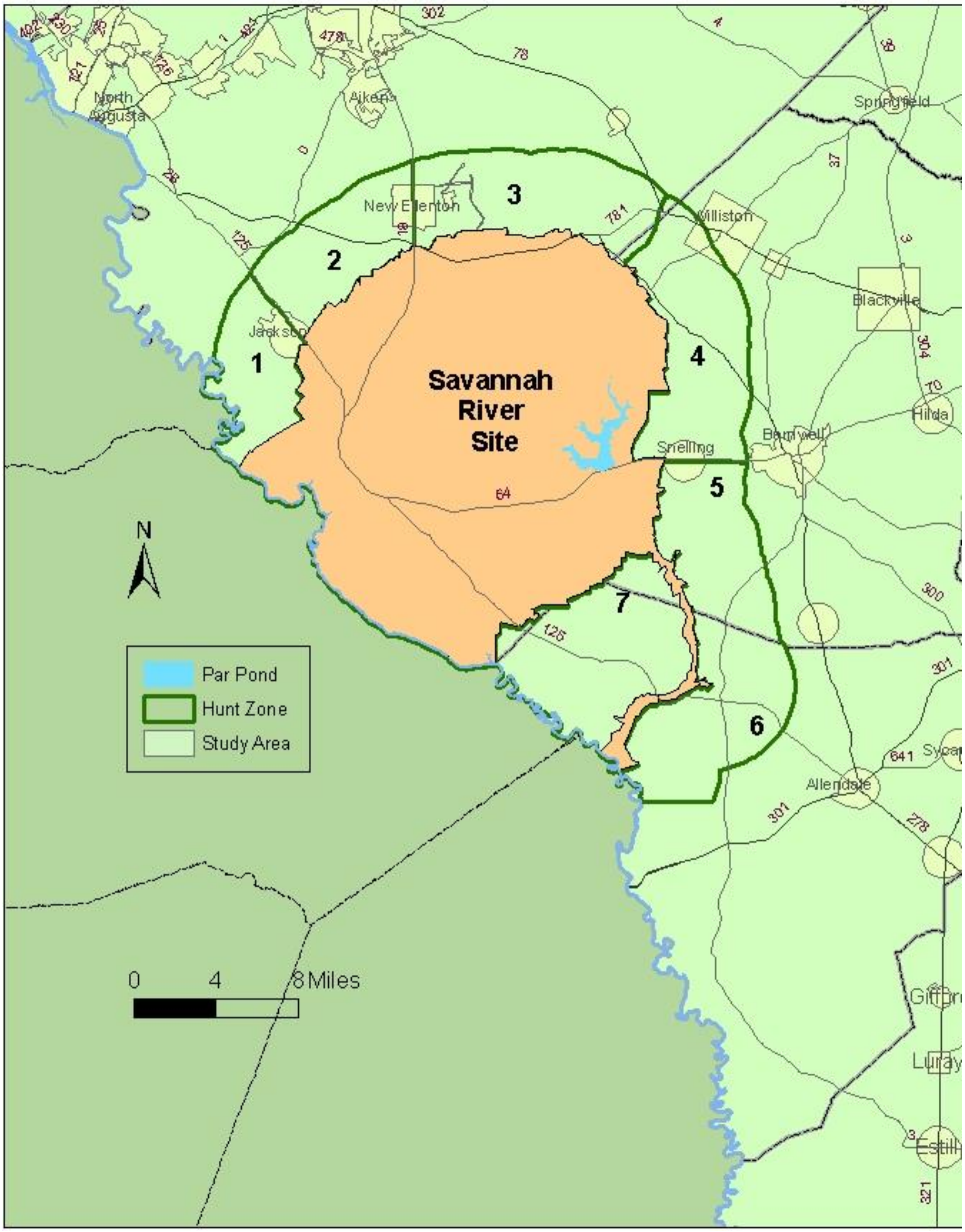
Age, sex, body weight, soil type, diet and collection location may affect the Cs-137 activities found in white-tailed deer and hogs (Haselow 1991). The differences in average activities indicated in Figure 1 (Section 4.2.3) are probably a combination of one or more of the above factors. A hunter consuming deer from SRS, the study area, or background locations would most likely ingest a portion of the activity associated with these animals. Refer to the ESOP Critical Pathway Dose report for a better understanding of the contamination found in game versus other food sources.

SCDHEC is currently working with the United States Environmental Protection Agency, DOE-SR, and Eastern Illinois University in an effort to achieve background levels for SRS deer. Investigators from Eastern Illinois University are using SCDHEC game animal data for a comparison of Cs-137 body burdens in SRS deer. ESOP will continue to work with all involved parties until a scientific determination of SRS background levels are determined. Also, ESOP will continue to monitor Cs-137 levels in deer and hogs within the established study area and background locations to assess trends and human health impacts.

TOC

4.2.2

Map. 15 Cesium-137 Ranges In Game Animals Adjacent to SRS, 2010

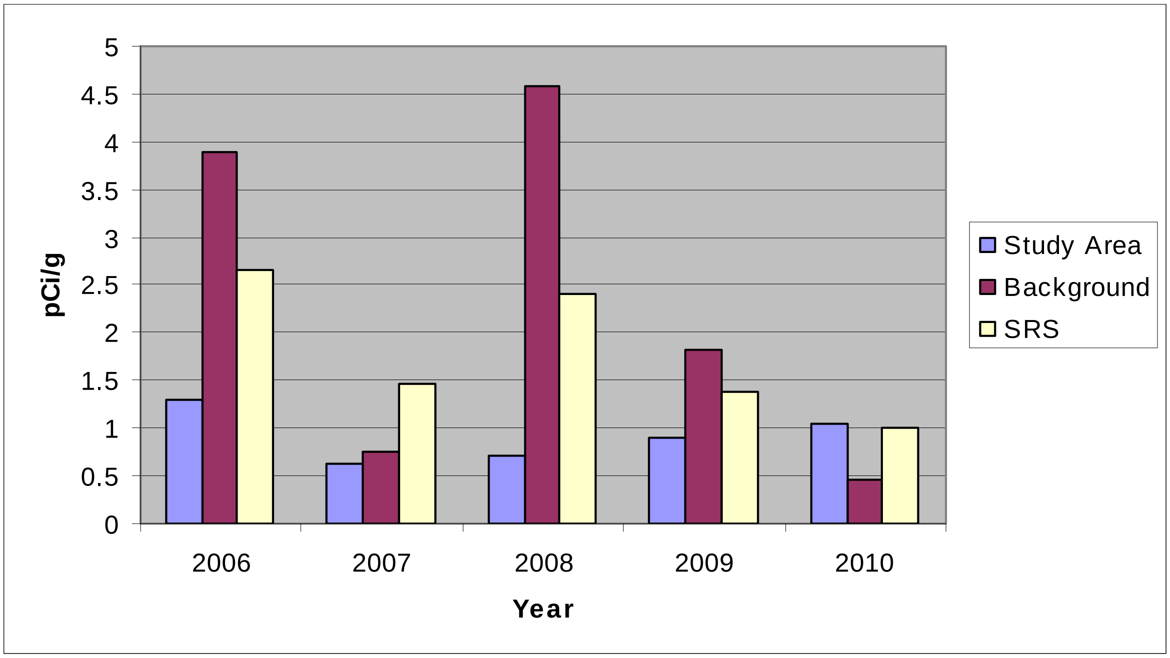


TOC

4.2.3 Tables and Figures

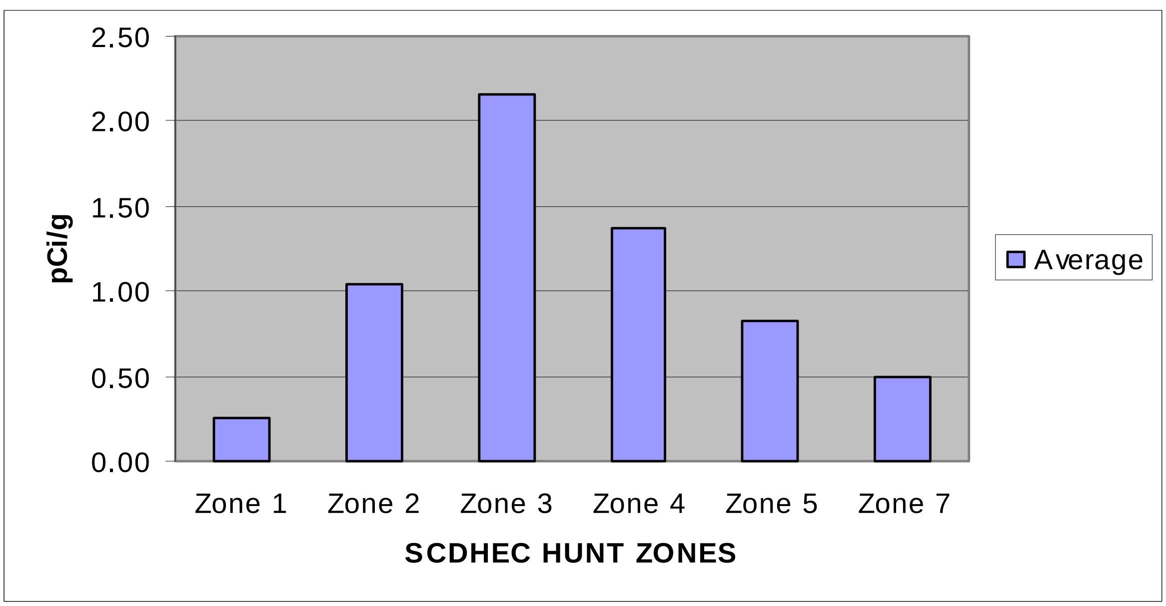
Radiological Game Animal Monitoring Adjacent to SRS

Figure 1. Average Cs-137 Concentration In Deer, 2006-2010



Background Locations
2006 - 2009 - Carolina Sandhills National Wildlife Refuge
2010 - Bamberg County

Figure 2. SCDHEC Hunt Zone Average Cs-137 Concentration In Deer, 2010



TOC

4.2.4 Data

Radiological Game Animal Monitoring Adjacent to SRS

Notes:

30. MDA - Minimum Detectable Activity
31. Sig - Sigma

Radiological Game Animal Monitoring Adjacent to SRS Project Data

2010 Perimeter Cs-137 Data

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/15/2010	10/15/2010	10/15/2010	10/15/2010	10/15/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Doe	Buck	Doe
Weight	Pounds	50	50	120	60	105
Cesium-137	(pCi/g) wet	0.24	0.22	0.11	0.13	0.57
Uncertainty	(+/- 2sig)	0.04	0.03	0.02	0.03	0.06
MDA	(pCi/g) wet	0.02	0.03	0.02	0.02	0.02

Sample Location		Zone-2	Zone-2	Zone-2	Zone-2	Zone-2
Sample Date		9/17/2010	9/17/2010	9/17/2010	9/17/2010	12/1/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Doe
Weight	Pounds	145	130	140	130	90
Cesium-137	(pCi/g) wet	<MDA	<MDA	<MDA	0.58	1.5
Uncertainty	(+/- 2sig)	NA	NA	NA	0.06	0.14
MDA	(pCi/g) wet	0.03	0.03	0.03	0.03	0.02

Sample Location		Zone-3	Zone-3	Zone-3	Zone-3	Zone-3
Sample Date		9/15/2010	12/2/2010	12/2/2010	12/2/2010	12/2/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Doe	Doe	Doe	Doe	Buck
Weight	Pounds	100	80	85	120	140
Cesium-137	(pCi/g) wet	0.31	9.96	0.15	0.32	0.08
Uncertainty	(+/- 2sig)	0.05	0.70	0.04	0.04	0.04
MDA	(pCi/g) wet	0.03	0.03	0.03	0.03	0.03

Sample Location		Zone-4	Zone-4	Zone-4	Zone-4	Zone-4
Sample Date		9/18/2010	11/10/2010	11/10/2010	11/10/2010	11/10/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Doe	Buck	Buck
Weight	Pounds	190	120	80	155	150
Cesium-137	(pCi/g) wet	2.68	0.72	0.59	0.29	2.55
Uncertainty	(+/- 2sig)	0.20	0.08	0.06	0.04	0.23
MDA	(pCi/g) wet	0.03	0.02	0.02	0.02	0.02

Sample Location		Zone-5	Zone-5	Zone-5	Zone-5	Zone-5
Sample Date		9/17/2010	9/17/2010	9/17/2010	9/15/2010	11/20/2010
Species		Hog	Hog	Hog	Deer	Deer
Sex		Boar	Sow	Sow	Buck	Buck
Weight	Pounds	65	55	85	120	140
Cesium-137	(pCi/g) wet	1.26	<MDA	2.49	0.50	0.32
Uncertainty	(+/- 2sig)	0.11	NA	0.19	0.06	0.04
MDA	(pCi/g) wet	0.03	0.04	0.03	0.03	0.02

Sample Location		Zone-5	Zone-5	Zone-5	Zone-5
Sample Date		11/20/2010	11/20/2010	11/20/2010	12/31/2010
Species		Deer	Deer	Deer	Hog
Sex		Buck	Buck	Doe	Sow
Weight	Pounds	135	55	95	150
Cesium-137	(pCi/g) wet	0.62	1.98	0.72	0.25
Uncertainty	(+/- 2sig)	0.07	0.18	0.08	0.03
MDA	(pCi/g) wet	0.03	0.02	0.02	0.02

Sample Location		Zone-7	Zone-7	Zone-7	Zone-7	Zone-7
Sample Date		11/17/2010	11/17/2010	12/15/2010	12/15/2010	12/15/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Buck
Weight	Pounds	140	130	85	100	80
Cesium-137	(pCi/g) wet	0.11	0.32	1.49	0.34	0.21
Uncertainty	(+/- 2sig)	0.03	0.04	0.12	0.05	0.03
MDA	(pCi/g) wet	0.02	0.02	0.03	0.02	0.02

Radiological Game Animal Monitoring Adjacent to SRS Project Data

2010 Background Data

Sample Location		**Background**	**Background**	**Background**	**Background**	**Background**
Sample Date		12/1/2010	12/1/2010	12/1/2010	12/1/2010	12/1/2010
Species		Deer	Deer	Deer	Deer	Deer
Sex		Doe	Buck	Buck	Doe	Doe
Weight	Pounds	115	175	140	90	85
Cesium-137	(pCi/g) wet	0.05	0.18	0.17	0.27	1.63
Uncertainty	(+/- 2sig)	0.02	0.03	0.03	0.04	0.13
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.03

TOC

4.2.5 Summary Statistics

Radiological Game Animal Monitoring Adjacent to SRS

Notes:

27. N - Number of Samples
28. Std.Dev. - Standard Deviation
29. Min - Minimum
30. Max - Maximum
31. MDA - Minimum Detectable Activity
32. Average, Std.Dev., and Median calculated using detections only
    NA - Not Available

Radiological Game Animal Monitoring Adjacent to SRS Summary Statistics

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected in 2010

	N	Average	Std. Dev.	Median	Min.	Max
Study Area Deer	30	1.02	1.93	0.34	<MDA	9.96
Study Area Hogs	4	1.33	1.23	1.26	<MDA	2.49
Background Deer	5	0.46	0.66	0.18	0.05	1.63

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected in 2010 SCDHEC Hunt Zones

Hunt Zone	N	Average	Std. Dev.	Median	Min.	Max
Zone 1	5	0.25	0.19	0.22	0.11	0.57
Zone 2	5	1.04	0.65	1.04	<MDA	1.50
Zone 3	5	2.16	4.36	0.31	0.08	9.96
Zone 4	5	1.36	1.15	0.72	0.29	2.68
Zone 5 Deer	5	0.83	0.66	0.62	0.32	1.98
Zone 5 Hogs	4	1.33	1.23	1.26	<MDA	2.49
Zone 7	5	0.49	0.56	0.32	0.11	1.49

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected from 2006 - 2010

	Year	N	Average	Std.Dev	Median	Min.	Max.
Study Area	2006	68	1.29	1.05	0.85	< MDA	3.90
Background	2006	60	3.90	1.38	3.86	1.17	7.02
SRS	2006	324	2.65	NA	NA	1.00	9.05
Study Area	2007	65	0.62	0.61	0.36	< MDA	3.30
Background	2007	20	0.75	0.58	0.57	0.15	2.09
SRS	2007	388	1.46	NA	NA	1.00	8.70
Study Area	2008	51	0.72	0.83	0.38	<MDA	4.60
Background	2008	10	4.59	2.45	4.11	1.91	10.59
SRS	2008	432	2.40	NA	NA	1.00	12.65
Study Area Deer	2009	47	0.89	0.81	0.63	<MDA	3.13
Study Area Hogs	2009	7	0.05	0.01	0.05	<MDA	0.05
Background	2009	12	1.81	0.88	1.58	0.77	3.60
SRS Deer	2009	396	1.38	NA	NA	1.00	9.17
SRS Hogs	2009	78	1.06	NA	NA	1.00	2.78
Study Area Deer	2010	30	1.02	1.93	0.34	<MDA	9.96
Study Area Hogs	2010	4	1.33	1.23	1.26	<MDA	2.49
Background	2010	5	0.46	0.66	0.18	0.05	1.63
SRS Deer	2010	502	1.00	NA	NA	1.00	2.99
SRS Hogs	2010	107	1.00	NA	NA	1.00	2.14
Study Area Deer	2006 -2010	261	0.91	0.26	0.89	< MDA	9.96
Study Area Hogs	2009 -2010	11	0.69	0.91	0.69	<MDA	2.49
Background Deer	2006 -2010	107	2.45	1.70	0.58	0.05	10.59
SRS Deer	2006 -2010	2042	1.78	0.71	1.46	1.00	12.65
SRS Hogs	2009 -2010	185	1.03	0.04	1.03	1	2.49

Background Locations
2006-2009 – Carolina Sandhills National Wildlife Refuge
2010-Bamberg County

TOC

5.1 2010 Critical Pathway Dose Report

5.1.1 Summary

The Environmental Surveillance and Oversight Program (ESOP) of the South Carolina Department of Health and Environmental Control (SCDHEC) monitored the Savannah River Site (SRS) and perimeter areas under an Agreement in Principle with the United States Department of Energy (USDOE). Atmospheric pathway (APW) and liquid pathway (LPW) discharges from the SRS were monitored by the Department of Energy – Savannah River (DOE-SR) contractor Savannah River Nuclear Solutions (SRNS), environmental monitoring section. DOE-SR and SCDHEC used data from these monitoring activities to calculate the potential radiation dose in millirem (mrem) to the surrounding public (WSRC 1999-2009, SRNS 2010-11 and SCDHEC 1999-2010). SCDHEC implemented a Radionuclide Dose Calculation Project and a Critical Pathway Project to calculate the potential exposure or dose to the public within 50 miles of an SRS center-point. Historical missions and data in previous years reports, primarily the SRS Environmental Reports (1999-2007), the Risk Assessment Corporation report (Till 2001) and the Centers for Disease Control study (CDC 2004) helped to establish the SCDHEC (1999-2010) Critical Pathway Dose report basis. Radionuclide dose potential exposure to the public was calculated by SCDHEC from radionuclide concentration activities found in various media that may impact the public (Section 5.1.3). A comparison of similar SCDHEC and DOE-SR media resulted in an evaluation of both programs based on averages and standard deviations (Results and Discussion). Summary statistics (Section 5.1.4) and tables and figures (Section 5.1.2) illustrate the trends and central tendencies in the critical pathway dose. The critical pathway dose is now calculated on a non-scenario, scenario, and individual optional scenario (Section 5.1.2) basis allowing readers to select scenarios or specific exposures that may impact their individual lifestyle choices.

It is important for the reader to note the differences in DOE-SR and SCDHEC critical pathway dose estimations. Some DOE-SR dose calculations use computer models based on estimates of known *releases within* the report *year* based on source term data. SCDHEC estimates are based solely on field sample data that allow calculation of an average exposed individual (AEI) dose per radionuclide per media above background and represents *accumulated* dose *over several years*. Also, SCDHEC calculates a single highest maximum (MAX) dose per radionuclide per media that may result in exposure throughout the year as if that maximum is somehow stored and used throughout the year. For example, a one time filling of a water cistern from the Savannah River water. The MAX calculation represents an upper limit estimate of potential accumulated exposure that may not have been detected. The AEI data represents the typical dose levels above background and the MAX data represents the extreme data points or one time dose extreme that occurs sometime during the year. The MAX data is assigned to the maximally exposed individual (MEI), considered by SCDHEC as a survivalist who is exposed to all media. The health of the public and environment are protected when all of these estimates are below established protective dose standards or limits for the various pathways of exposure.

The 2010 non-scenario media calculations were represented on an AEI basis and on a MAX or upper limit basis of potential exposure per media per radionuclide above the average background (Section 5.1.2, Table 1a). The non-scenario table (1a) summarizes all SCDHEC detections by media on an AEI and MAX detect basis without assigning any result to an exposure scenario. The MAX (16.114 mrem in 2010) basis provides a radiation exposure limit based on the single highest potential dose detections. Typical exposures on a non-scenario basis should be closer to the AEI media total (2.794 mrem in 2010). Individual exposures may be far less than the AEI due to the lack of contact by an individual with all media collected. An alternate possibility existed that all potential exposure was not detected, but was allowed for by the MAX calculation and the added DOE-SR release estimates greater than SCDHEC dose detections detected (Section 5.1.2, Tables 1 and 3).

The SCDHEC plus DOE-SR total (31.726 mrem) for applicable MAX assigned to the MEI is based on the total of the highest possible exposure from environmental media (MAX column) Section 5.1.2 Table 1, plus all other dose modeled or detected by DOE-SR that has the potential to impact the public (Section 5.1.2, Table 3).

Four basic AEI and two MAX scenarios were developed based on selecting media results from Section 5.1.2 Table 1a that applied only to the hypothetical scenario. The media selections per scenario are defined under the 2010 Scenario heading. These scenarios calculate a dose relative to public exposure activities in 2010 (Section 5.1.2, Table 2) and averaged over the period 1999-2010:

1) Public scenario - 0.008 mrem in 2010 and averaged 0.086 (± 0.059) mrem with a median of 0.082 mrem;
2) Farmer scenario – 0.020 mrem in 2010 and averaged 0.114 (± 0.112) mrem with a median of 0.071 mrem;
3) Average Sportsman scenario – 1.946 mrem in 2010 and averaged 1.463 (± 1.386) mrem with a median of 1.118 mrem;
4) Average Survivalist scenario – 2.794 mrem in 2010 and averaged 1.620 (± 1.425) mrem with a median of 1.277 mrem;
5) MAX Sportsman scenario – 10.254 mrem in 2010 and averaged 11.310 (± 9.973) mrem with a median of 9.711 mrem; and
6) MAX Survivalist scenario – 16.114 mrem in 2010 and averaged 9.844 (± 5.567) mrem with a median of 9.299 mrem.

The MAX Survivalist scenario annual dose was the highest in any year and the 1999-2010 average was temporarily lower than the MAX Sportsman average only because it was a new scenario that started in 2008. The annual MAX survivalist will always be higher than the MAX Sportsman since it adds media to the sportsman dose that may be encountered by the survivalist.

The radionuclide dose that was not naturally occurring (nonNORM) had contributions from 1999 through 2010 and was 20.906 mrem from cesium-137 (Cs-137), 3.75 mrem from all strontium–89/90 (Sr-89/90), and 3.076 mrem from tritium (H-3) (Section 5.1.4, Table 1). These SCDHEC field collections represent accumulated dose over many years and not yearly dose releases, which was one of the main reasons for differences in dose estimations by SCDHEC and DOE-SR (see Dose Critique in Results and Discussion. The SCDHEC and DOE-SR dose estimates were very close due to the correlation between Cs-137 detections in collected media that dominated the dose detections, and not due to a correlation between the annual release versus accumulations over past years. The following comparisons to annual DOE-SR standard limits are not applicable since dose found in media represents many years dose, but the comparison is made to show that even the accumulated dose in the environment is less than the annual DOE-SR standard release limits.

The SCDHEC 2010 conservative estimate for All-Sources AEI exposures from APW (2.597 mrem) and LPW (0.224 mrem, mostly tritium) accumulations were within the respective, 10 mrem and 4 mrem, annual DOE release limits (Section 5.1.2, Table 1). An upper bound MEI (excluding NORM detections) accumulated dose potential (31.726 mrem) calculated from the combined data of DOE-SR and SCDHEC was within the 100-mrem annual release limit (SRNS 2011).

RESULTS AND DISCUSSION

The SCDHEC MEI is a subsistence and survivalist type of individual who resides in the downriver swamp area below all SRS contributions to the Savannah River, visits the entire 50-mile perimeter study area, and receives the MEI dose based on the single highest detection per radionuclide per media collected in the environment. Section 5.1.3 contains the dose data tables from which most tables and figures are derived. The 2010 data and dose results are discussed under the following headings in this section: the 2010 non-scenario basis, the 2010 scenario basis, the 2010 individual optional personal scenario, the 2010 added dose basis, the DOE-SR and SCDHEC comparisons, critical pathways summary, 1999-2010 statistical summary, and dose critique. The statistical summary covers the 1999-2010 period, whereas other headings discuss only 2010 data except for critical pathways and some DOE-SR comparisons.

The critical pathways were analyzed both on a millirem (mrem) basis and percentage (%) of dose basis. Percentages denote relative importance whereas mrem denote potential exposure levels. The dose critique attempts to indicate the limits of this dose estimate and why any DOE-SR and SCDHEC estimates may or may not be similar.

The 2010 Non-Scenario Basis

The non-scenario table (1a) in Section 5.1.2 summarized all SCDHEC detections by media on an AEI and MAX detection basis without assigning any result to an exposure scenario. The 2010 non-scenario average media results were added to past years results to establish the 1999-2010 media statistics summary Table 2 in Section 5.1.4. The 2010 non-scenario media calculations were represented on an AEI and MAX basis per media above their respective radionuclide average backgrounds (Section 5.1.2, Table 1a). The six scenarios used only the non-scenario media result that applied to that hypothetical persons exposure. The optional personal scenario shows how an individual can select only the media exposure data that applied to them for a personal dose estimate. Thus, the statistics for the non-scenario, scenario, and personal scenario could be very different. Radiation exposures to the single highest detection greater than background from each radionuclide exposure per media were assigned to the SCDHEC MEI. This SCDHEC MEI (16.114 mrem) basis provides an offsite radiation exposure limit based on the single highest potential dose detections. However, the true MEI may be higher, since not all dose potential can be collected and measured. This was the reason for calculating the MEI based on the single highest detection per radionuclide per media at protective maximum exposure rates. This MEI dose was due mostly to single maximum food detections (from MAX column of Section 5.1.2 Table 1a that were theoretically consumed by one individual (the highest dose potential from deer, fish, vegetables or mushrooms, etc.). Typical exposures on a non-scenario basis should be less than the AEI media totals in Table 1a, since a single individual could not be at all locations where and when all maximums occurred and sustain that exposure at a constant rate throughout the year. However, the MAX dose exposure was possible if the media containing the MAX dose was somehow stored and used by the MEI over the entire year. The MAX total perimeter dose will always be assigned to the maximum survivalist dose (SCDHEC MEI).

Only specific radionuclide (speciated) doses were included in the estimated dose for 2010. The use of detections only in determining AEI dose above background per radionuclide per media, the calculation of dose based on the MAX detection for each radionuclide/media, and conservative consumption references provided a protective dose estimate. Each media radionuclide dose above background, excluding naturally occurring radioactive material, (NORM) was considered as part of a different critical pathway lifestyle with contributions through the inhalation, ingestion, and direct exposure routes. The typical perimeter average dose exposure greater than background without regard to lifestyle (as if the individual were exsposed to all media collected) was represented on an AEI (2.794 mrem) basis (Section 5.1.2, Table 1a). Refer to the scenario basis for typical potential exposures by lifestyle. The SRS perimeter study area total exposure may be viewed either on an AEI (2.794 mrem) or MAX detection (16.114 mrem) basis that excludes probable NORM.

The SCDHEC MEI grand total (31.726 mrem) that includes added dose from DOE-SR (15.612 mrem) was based on the total of all SCDHEC MAX (16.114 mrem) detections (Section 5.1.2 Table 1a, MAX column) plus any additional exposure estimates by DOE-SR (Section 5.1.2, Table 3). These two elevated dose bases (AEI and MAX) were used because they were measured and protective without the inclusion of screening value assumptions for alpha and beta. The assumption of all alpha as plutonium-239 (Pu-239) and all beta as strontium-90 (Sr-90) may double the calculated dose without evidence for that assumption in speciated data, and was discontinued in 2008 and replaced by calculating a MAX dose potential from the single highest detection per radionuclide per media.

The All-Sources Dose

The All-Sources dose comes from a DOE-SR reference, which indicates direct annual releases to the atmospheric and liquid pathways. All other dose sources are atypical in that the general public is usually not impacted, e.g., dose measured in an animal is the result of dose releases over more than one year and exposure to more than one source. An All-Sources Dose Upper Bound and a Perimeter Dose total are given in Section 5.1.2, Table 1b for the AEI and MAX column totals. The All-Sources Dose Upper Bound totals for AEI (2.821 mrem) and MAX (16.156 mrem) are not the applicable totals, because each drinking water source dose would require proportioning of consumption rates, if there were more than one drinking water source. Therefore, only one drinking water source (the highest) was calculated as the sole source for the entire year. The All-Sources Upper Bound dose total is not an achievable dose based on temporal and location conflicts, a 100% consumption factor used for all water sources, and single MAX detections treated as if they occurred at unvarying concentration activities throughout the entire year. The Perimeter Dose MEI total is an applicable dose potential estimate (16.114 mrem) that uses the single highest media drinking water dose plus swimming ingestion potential.

The Perimeter Dose

Since only one drinking water maximum could be added to the final perimeter dose total, the highest dose source was used at 100% (underlined in Section 5.1.2, Table 1a, drinking water or

DW Ingestion) instead of proportioning each water source. The AEI air inhalation (0.001 mrem), food ingestion (2.768 mrem), and direct exposure (0.000 mrem) totals were added to the highest drinking water dose (0.020 mrem from rainwater) and the swimming ingestion dose (0.005 mrem) to obtain the 2010 Perimeter Dose AEI results (2.794 mrem). The 2010 MAX perimeter dose potential used the same logic except for using the surface water at boat landings for the sportsman and survivalist in place of the rainwater dose, and resulted in 0.007 mrem for air inhalation, 15.842 mrem for food ingestion, 0.239 mrem for water ingestion, 0.026 mrem for a swimming ingestion dose, and 0.000 mrem direct exposure for a total MAX perimeter dose of 16.114 mrem (Section 5.1.2, Tables 1 and 4). The theoretical assumption was that a single MEI always received the maximum dose potential despite the high improbability. The AEI and MAX applicable Perimeter Dose totals used only the single highest drinking water source (underlined in Section 5.1.2, Table 1a) on an AEI and MAX basis, respectively. Note the first occurrence of different water source contributions (AEI of 0.020 mrem from rainwater and MAX of 0.239 mrem from consuming surface water at boat landings) as the drinking water high source dose. This was due to subtraction of a higher background for surface water (283 pCi/L) versus rainwater (<MDL), but the higher detection did occur in surface water as usual.

The SCDHEC MAX non-scenario perimeter total was simply all available dose based on the single highest detections per media at maximum consumption rates for a period of one year (16.114 mrem). The perimeter AEI dose total (the typical available dose) was 2.794 mrem in 2010 and no individual dose potential should exceed the MAX dose total (16.114 mrem) on a non-scenario basis. The exception was the addition of DOE-SR additional dose potential not measured by SCDHEC (mostly from onsite deer) that was included in a combined SCDHEC and DOE-SR MEI estimate, which should capture the upper bound for any nondetected dose. A personal scenario different from those described above can be calculated by the reader (see the 2010 Optional Personal Scenario Basis section). Note the 2.794 mrem AEI perimeter dose was approximately the same dose attributable to a single coast-to-coast airplane flight, while the 16.114 mrem perimeter MAX dose would add the NORM dose from living in a brick house for two years (SCDHEC 2006b). Also, compare this dose to the AEI NORM dose exposure for people living in the southeastern region of the United States (300 mrem) (Section 5.1.2, Figure 2, SCDHEC 2006b). The authors of a recent study concluded that if there are harmful health effects at or below 100 mrem, they are “certainly very small” (Manzoli 2004). The nonNORM totals for the 2010 AEI (2.794 mrem) and MAX (16.114 mrem) dose detections (mostly wild food sources) in 2010 (Section 5.1.2 Table 1a) were far less than the 1998 food protective action guideline of 500 mrem to the whole body (USDHHS 1998).

The 2010 Scenario Basis

The basic scenario results for 1999-2010 are given in the summary statistics, Section 5.1.2, Table 2. The alpha-beta dose assumptions are now replaced by observed maximum detections (single highest detections per radionuclide per media) that provide a measured (not assigned) upper bound of potential dose and protective buffer for public dose calculations. See the Results and Discussion section for the six SCDHEC scenario results for 2010. Even the AEI totals were very conservative estimates of potential dose and should be greater than any actual or typical dose per individual. The DOE-SR hunter would add onsite dose to the Sportsman and Survivalist dose, if they killed and ate onsite harvested deer.

Four critical pathway basic scenarios (Public, Farmer, Sportsman, and Survivalist) calculated in 2010 as estimates for the typical dose potential were based on averages for lifestyle activities that resulted in media exposures above background (Section 5.1.2, Table 2). Two additional scenarios, the MAX Sportsman and MAX Survivalist, define the upper bound of dose for SCDHEC detections in media. The notes below Section 5.1.2, Table 2 explain which data were included in each scenario. The 2010 scenario average results were 0.008 mrem of potential dose for the general public who uses only public water systems and local garden vegetables, 0.020 mrem for the farmer that plows up land and drinks wellwater, 1.946 mrem for the average sportsman, and 2.794 mrem for the average survivalist that also eats local wild mushrooms. One drinking water dose was assigned per scenario and incidental ingestion of water while swimming was added for the worst case exposure at creek mouths for the sportsman and survivalist categories. The AEI Survivalist scenario dose (2.794 mrem) was equal to the total of all perimeter AEI dose (the survivalist is exposed to all dose by definition except for a limitation to one drinking water source, the highest water dose). The MAX Survivalist Scenario dose (16.114 mrem) was based on the total of all dose detection maximums in the MAX column of Section 5.1.2 Table 1a except for a limitation to one drinking water source (the highest dose source in that column). Note that the rainwater dose was highest (due to a subtraction of zero for the background) for the AEI column, and the surface water at boat landings was highest for the MAX column. The MAX Survivalist dose was greater than the MAX Sportsman dose due primarily to the addition of the highest edible fungi dose (5.603 mrem) to the Sportsman dose. The MAX Survivalist dose was equal to the MAX Perimeter dose (16.114 mrem), and was the MEI based on SCDHEC data alone. The reader should not assume that the AEI or MEI dose data applied to them except on an optional individual personal scenario basis (dose adjustment) that is described under the next heading.

The 2010 Optional Individual Personal Scenario

Both AEI and MAX media calculations are categorized into two primary exposure pathways (atmospheric and liquid pathways) that were subdivided into other more specialized exposure routes (inhalation, ingestion, and direct exposure) by media. The statistical results are given under the critical pathway heading and summary statistics section.

The public can estimate their potential dose based on activities that involve exposure to one or more media not covered by the given scenarios, provided their personal scenario dose calculation does not exceed 16.114 mrem for offsite exposure. If a lifestyle is different from one of the given scenarios, each individual can add one or more MAX column media dose detections (Section 5.1.2, Table 1a) to the perimeter AEI column dose total and subtract the corresponding media AEI column dose to calculate their own maximum dose potential.

For example, a member of the general public who received deer meat for consumption, but did not hunt, may add the deer maximum (7.522 mrem) to the Perimeter AEI Dose total (2.794 mrem) and then subtract the corresponding media AEI dose average for deer (0.617 mrem) to obtain a dose of 9.699 mrem. Thus, by adding deer meat from the local area to the general diet, the non-scenario dose potential would increase from 2.794 mrem (AEI) to a maximum of 9.699 mrem for the worst-case deer consumption personal scenario. However, the probability that this person would receive all the deer meat (may consume more than one deer) from the hunter with the highest deer dose, and consume all of the edible portion is low. This would be a specific personal dose potential versus the highest MAX overall dose detections of 16.114 mrem (MEI) based on all SCDHEC data.

Likewise, if someone consumed wild edible mushrooms in 2010, then a maximum of 5.603 mrems could be added and subtract the corresponding AEI dose (0.848 mrem) to obtain their potential maximum dose exposure of 7.549 mrem.

Any dose observed by DOE-SR (onsite deer dose, e.g.) that was not sampled by SCDHEC may also be added to the optional total dose, if applicable to the individual (Section 5.1.2, Table 3). An onsite deer hunter could add 12.37 mrem of potential dose (SRNS 2011, Table 6-4). The grand total for any personal scenario dose calculated from this data cannot exceed the SCDHEC plus DOE-SR upper bound (31.726 mrem) given in Section 5.1.2 of Table 3 (refer to the following 2010 Added Dose Basis section).

The SCDHEC AEI dose determination was the best estimate for a typical exposure versus the atypical MAX dose basis, if the individual was exposed to all media listed in Section 5.1.2, Table 1a. The scenario basis and the individual optional scenario provided the best individual estimate based on scenarios or actual media exposure. Also, the scenario medians were potentially more relevant to typical central tendency exposures over the 1999-2010 period than averages. The individual seeking to calculate their most accurate personal dose estimate should use the Section 5.1.3 Data and add up only the radionuclide dose in specific media they encountered within the year.

The 2010 Added Dose Basis

Section 5.1.2, Table 3 includes data from Table 6-4 data of the SRS Environmental Report (SRNS 2011) that can be added to give a total combined SCDHEC plus DOE-SR onsite and offsite dose potential of 31.726 mrem for the Upper Bound MEI estimate. This addition of dose detections greater than SCDHEC detections from other environmental programs helped to extend the MEI potential dose limit on a definable basis.

A consumption factor of 3.65 kg/yr was used to calculate dose for edible fungi in 2010 (Botsch 1999). Therefore, the potential dose above background from consuming wild mushrooms was added for the wild mushroom consumer and the SCDHEC MEI (survivalist). The 2010 edible fungi dose maximum (5.603 mrem) was well below the 1998 food protective action guideline of 500 mrem to the whole body (USDHHS 1998).

DOE-SR and SCDHEC 2010 Comparisons

The 2010 SCDHEC MEI represented a potential exposure based on single highest detections per radionuclide per media, and was a survivalist type of individual who received most of the dose exposure through wild game and wild mushroom consumer pathways. The SCDHEC MAX and AEI estimates were inflated (see Dose Critique heading) and represented a potential dose accumulated over several years in environmental samples. The SCDHEC AEI dose was more relevant to actual potential exposure than the MAX or total MEI dose (low probability), and the calculation factors were conservative also. The addition of and comparison to DOE-SR dose estimates may be directly relevant (onsite deer also represented accumulated dose), while other detections (backgrounds) may be from yearly release estimates or measurements that do not necessarily result in depositions within the 50-mile study area. Also, some DOE-SR radionuclide releases cannot be measured and DOE-SR must use computer modeling to generate a theoretical exposure based on known releases. The DOE-SR dose was potentially inflated due to the treatment of unknown alpha as Pu-239 and unknown beta as Sr-90. The SCDHEC Public Scenario basis (0.008 mrem) was the most relevant dose estimate for the general public in 2010. The upper limit and certain data (wild food, e.g.) should not be included in the general public dose, but added to the survivalist and/or sportsman dose instead.

DOE-SR yearly radionuclide releases were not directly comparable to field measurements that included accumulated dose from past releases. Most comparisons were based on Table 6-4 of the Savannah River Site Environmental Report for 2010 (SRNS 2011). This comparison assisted in evaluating the 2010 DOE-SR environmental monitoring program and the SCDHEC ESOP environmental monitoring program. The SCDHEC media dose detections within the study area represented accumulated and decayed dose from all area sources including historical (atomic bomb test fallout, Chernobyl, domestic). No detected dose by SCDHEC was strictly assignable to DOE-SR alone, but was considered of potential DOE-SR origin if within the 50-mile study area and greater than background.

The relatively close agreement of the 2010 MEI total estimates (SCDHEC 16.114 mrem, DOE-SR 16.36 mrem) between the two monitoring programs that included atypical exposure pathways was due primarily to Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway and not to correlations between annual releases and detected dose in media (Section 5.1.2, Table 1a, and SRNS 2011 Table 6-4).

SCDHEC and DOE-SR Atmospheric Pathway Comparison

The potential dose to the MEI from the SRS atmospheric releases was reviewed in the SRS Environmental Report for 2010 (SRNS 2011). The National Emission Standards for Hazardous Air Pollutants (NESHAP) for all radionuclide air pollutants (diffuse and fugitive) in 2010 was 0.04 mrem for the MEI effective dose equivalent, and the total estimated atmospheric release dose was 0.04 mrem. This was due to increased tritium and plutonium diffuse and fugitive releases in 2010. This was 0.4 % of the 10 mrem/yr DOE Order 5400.5 air pathway standard. The atmospheric pathway contributed accumulated dose to the individual through the inhalation, ingestion, and direct exposure routes. Rainwater contamination from atmospheric releases of tritium (SCDHEC 0.02 mrem) would directly impact water cisterns used for drinking water.

Not all SRS dose releases resulted in depositions within the sample area. This was evidenced by the inhalation pathway detections noted in the following paragraph that were far less than SRS releases. Atmospheric releases, when deposited outside of the study area are greatly diluted with distance from the originator and by weather factors. Also, many years of cumulative dose depositions contributed to the SCDHEC dose detections in any given year and made potential dose releases by DOE-SR (an annual estimate) not directly comparable to SCDHEC field detections. The detected exposure in millirems was a more meaningful indicator of dose to the public versus percentages that establish rank.

Unknown variables caused fluctuation in the annual deer dose, but weather and related forage availability may have played a role, especially in bioconcentrators (e.g., mushrooms). Deer tracks among bolete fungi that were mostly missing the caps with scattered pieces nearby were observed in 2008 at an Audubon preserve. The highest known bioconcentrators from some literature references for Cs-137 were mostly bolete fungi that fruit primarily in August and September (Botsch 1999, Kalac 2001). Deer and other animals that consumed boletes could potentially receive the highest dose from boletes no later than October (bolete mushrooms generally occur from June through September). The highest observed Cs-137 concentration (30.70 pCi/g) was found in a *Cantharellus cibarius* group in a ditch bank near Steel Creek landing.

Four comparable SCDHEC and DOE-SR media pathway dose results (air, liquid, soil, food) were totaled and compared for 2010 in Section 5.1.2, Table 5. SCDHEC detected far less air inhalation dose (0.007 mrem MAX) than the estimated potential dose by DOE-SR releases (0.050 mrem MAXDOSE-SR), because all releases were not detected and were not necessarily deposited within the study area. The air pathway data difference between SCDHEC and DOE-SR was due to dose based primarily on field measurements versus actual atmospheric releases and dose modeling, respectively. Few atmospheric releases resulted in dose detections offsite of SRS within the 50-mile study area perimeter. The DOE-SR pathways most affected by contributions from atmospheric releases in 2010 were the terrestrial sportsman food pathway (12.92 mrem), the hunter soil exposure pathway (2.90 mrem), and the airborne contributions to the goat milk pathway alone (0.0588 mrem)(Table 6-4 and the MAXDOSE-SR Data Table 6-22 or MEI Dose Using Goat Milk Pathway data, SRNS 2011). This airborne dose in combination with the low dose contributions from the MEI liquid pathway (0.059 mrem) is clear evidence of bioaccumulation of dose in the sportsman pathway (Data Table 6-12, MEI Dose – Liquid Pathways, SRNS 2011), because this annual dose level would require several years to achieve the dose found in wild food sources (deer, hog, fish, mushrooms, vegetation).

SCDHEC MAX atmospheric pathway maximum dose detections in 2010 came mostly from the sportsman food and edible mushrooms. See the Food Pathway Comparison section that follows. Inhalation (0.007 mrem) had the smallest dose detections, terrestrial food (15.258 mrem) was highest, and dose from riverbank soil shine was minor (<0.000 mrem)(Section 5.1.2, Table 1a). SCDHEC only monitors offsite dose, and terrestrial food did not include an onsite (within SRS boundary) hunter dose (deer and hog) (12.40 mrem Table 6-4, SRNS 2011)(Section 5.1.2 Table 1a, SCDHEC). SCDHEC hog samples maximum dose was 2.120 mrem in 2010. SCDHEC monitored edible fungi (5.603 mrem) and DOE-SR did not (Section 5.1.2, Table 1a). Animals with large body mass and vegetation with large absorptive areas (leaf, root, or mycelia) tended to contain the largest dose for particular radionuclides (Cs-137, e.g.) (Section 5.1.3 Data).
A comparison of atmospheric dose maximums (air, soil, and food pathways) in similar media that were monitored by both DOE-SR and SCDHEC programs gave totals of 4.101 mrem and 10.246 mrem, respectively (Section 5.1.2, Table 5). The sportsman scenario includes fish (covered under the liquid pathway), but most sportsman dose was related to the atmospheric pathway. The prime difference between the two estimates was due to backgrounds and offsite deer and hog dose estimates (9.642 mrem above background for SCDHEC versus 3.45 mrem for DOE-SR). SCDHEC offsite deer and hog dose was measured, whereas DOE-SR offsite deer and hog dose was a hypothetical calculation based on onsite measurements. The Bowman deer background dose was 0.450 mrem in 2010. The higher background in the McBee area compared to the previous background areas may be due to natural factors such as the abundance of mushrooms (bioconcentrators of Cs-137) consumed by deer during the high background years, legacy spot depositions of Cs-137 in the area by fallout from nuclear weapons testing primarily in the 1950-1970 period, or a variation in weather patterns that affect atmospheric depositions at a distance from potential sources. Section 5.1.2 Figure 8 shows a decreasing dose trend in deer

and hunter dose. This may indicate that maximums in the deer Cs-137 activity concentration were a result of the legacy dose local maximums and their respective decay rates. If no further releases were added to the Cs-137 population, then future years should show a continuing decline toward the offsite deer AEI dose average of 0.306 mrem or less due to further decay (Section 5.1.4 Table 2).

Most of the dose estimate from either DOE-SR or SCDHEC was due to atmospheric deposits and bioaccumulation. Approximately 96.88 % (15.85/16.46 mrem x 100%) of the DOE-SR 2010 dose in Table 6-4 came primarily from the sportsman hunter subpathway within the atmospheric pathway (SRNS 2011). Subtracting the fungi dose (not collected by DOE-SR) contribution from the SCDHEC total leaves 10.511 mrem. The SCDHEC sportsman hunter subpathway within the 2010 atmospheric pathway accumulated MAX dose was 91.73 % (9.642/10.511 mrem x 100%) of the detected dose in the atmospheric pathway excluding fungi (Section 5.1.2, Table 1). The major dose difference occurred in deer. The DOE-SR MEI estimate was 12.4 mrem from onsite deer and 3.27 mrem in hypothetical offsite deer, and was 7.522 mrem in SCDHEC offsite deer. SCDHEC deer samples were close to the SRS, and based on SRS onsite deer dose, exhibited contamination possibly from crossing over into the SRS. The same logical consideration appeared possible for comparisons of DOE-SR (onsite hunter dose of 12.4 mrem included hogs versus offsite projected dose of 0.18 mrem) and SCDHEC (2.120 mrem) offsite hog samples. That is, hogs harvested near the SRS could contain contamination from onsite travel and food consumption within the SRS. However, the DOE-SR offsite hog dose was hypothetical (0.18 mrem). Both of the DOE-SR hog and deer offsite hypothetical dose calculations appear low since even the SCDHEC AEI dose was higher (hogs 1.104 mrem, deer 0.617 mrem). However, this may be due to the difference in averaging in nondetections versus using only detections in dose calculations. Dose accumulations in offsite fungi were near deer MAX contamination levels, but DOE-SR did not collect fungi on or off the SRS, and program comparisons of Cs-137 in fungi on and offsite were not possible. Overall, the approximate DOE-SR atmospheric dose accumulation (12.95 mrem) was higher than the SCDHEC atmospheric less fungi dose accumulation (9.662 mrem). All atmospheric releases would not result in media contamination within the study area due to weather dispersion factors, plus the offsite dose samples were subject to many years of accumulated dose. Also, historical dose accumulation has many potential sources. Any dose cross-contaminations from the liquid pathway were minor in comparison to atmospheric depositions (Table 6-12, SRNS 2011).

This relatively close agreement (within one standard deviation) on the MEI calculations between the two monitoring programs was due primarily to Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway, and not to a correlation between releases and detected dose in media. Both total MEI estimates were very similar despite the differences in dose factors and monitoring method considerations. Despite the contributions from bioaccumulation over several years versus annual release estimates, both environmental program MEI estimates added together indicated that the upper bound of the combined MEIs (31.726 mrem) in 2010 was far less than the 100-mrem (not applicable except on an annual release basis) DOE-SR Order 5400.5 dose release standard. Comparisons to DOE-SR annual dose release limits are not strictly applicable, but serve to illustrate that accumulated dose in the environment is less than any single years release dose estimate.

The MAX limit of available exposure or upper bound for the 2010 MEI air dose excluding atypical exposure pathways (the sportsman and survivalist dose) was based on exposure to the total of the single highest maximums (SCDHEC data) for air inhalation (0.007 mrem), local vegetables (0.013 mrem) and milk production (0.000 mrem) for a total of 0.020 mrem of accumulated dose. Note that the atmospheric accumulated dose is well under the DOE-SR yearly air limit for dose releases to the public of 10 mrem/yr. (Section 5.1.2, Table 1 and Section 5.1.3 Data). Atypical annual atmospheric exposures were included by DOE order 5400.5 under the 100-mrem total annual limit. The addition of an upper bound (ALL-Sources) dose calculation illustrated the MEI APW including atypical exposures could not be greater than 15.290 mrem based on SCDHEC sampled media MAX detections, and not greater than 2.597 mrem for the AEI APW (Section 5.1.2 Table 1b). Note that atmospheric pathway field samples contained depositions accumulated over many years mostly in sportsman media and wild edible vegetation and fungi sources.

SCDHEC detected sportsman soil exposure dose (0.000 mrem), based on riverbank and forest soils, was far less than the estimated DOE-SR swamp soil dose (2.90 mrem) (Section 5.1.2, Table 1a) (Table 6-4 SRNS 2011). Again, DOE-SR calculations were based on an annual dose potential, whereas SCDHEC data results measured accumulated dose in sampled media (not directly comparable). However, note the SCDHEC accumulated dose estimates were less than the annual release estimates of DOE-SR, which indicated that most of the dose releases either stayed on SRS or were carried far away by weather atmospherics and dispersed.

The SCDHEC order of MAX detected radionuclide dose in the 2010 atmospheric pathway excluding assigned NORM was Cs-137 in deer (7.522 mrem), Cs-137 in fungi (5.603 mrem), Cs-137 in hogs (2.120 mrem), tritium in vegetables (0.013 mrem), and tritium in air (0.007 mrem), and <0.01mrem for all others (Section 5.1.3, Data Tables). The bioconcentrated radionuclides, primarily Cs-137 and H-3 in the food pathway, were the major contributors to the atmospheric pathway dose. The MAX dose from the atmospheric pathway (15.258 mrem/yr) was less than that from living in a block house for two years (7 mrem/yr), and taking one coast-to-coast flight (2.5 mrem) (Section 5.1.2 Figure 2, SCDHEC 2006b).

SCDHEC and DOE-SR Liquid Pathway Comparison

A comparison of liquid ingestion media (e.g., river water) categories with DOE-SR gave different maximums. The SCDHEC survivalist that saved Savannah River water to a cistern on the highest tritium release date received the highest liquid potential dose consumption at Steel Creek Boat Landing for tritium (0.239 mrem) in 2010 (Section 5.1.2, Table 1a). It is possible to collect a tank full of water (observed) at any location and transport it to a personal cistern or well. Calculation of this maximum yearly dose based on the single highest sample, however improbable, served to illustrate that the survivalist (an atypical scenario) should not receive a higher dose due to tritium than 0.239 mrem from untreated Savannah River water in 2010. The SCDHEC comparable drinking water maximum detection for the typical public exposure was 0.017 mrem (wellwater). The drinking water dose was greatly reduced at Savannah, Chelsea, and Purrysburg downriver locations (DOE-SR 0.02 mrem). Both atypical and typical liquid pathway exposures were well below the 4 mrem/yr DOE 5400.5 drinking water pathway annual standard (SRNS 2011). Compare the accumulated potential Survivalist (SCDHEC) maximum (0.239 mrem) to the annual release calculation of 0.03 mrem in 2010 for the DOE-SR drinking water maximum (which included plant Vogtle contributions) from source term data. However, the swamp dwelling survivalist was unlikely to pull a tanker to Steel Creek Landing and save that dose to a tank, well, or cistern on that date, and drink only that water for the rest of the year.

Even the highest incidental ingestion dose of tritium in water from swimming at Fourmile Creek mouth would add only 0.03 mrem.

The SCDHEC fish dose MAX value was 0.584 mrem and the DOE-SR total offsite fisherman dose was 0.40 mrem (Table 6-4 SRNS 2011). SCDHEC determined the fish dose based on the sum of the highest dose per radionuclide in all fish and not per fish species, since the survivalist was assumed to eat all fish. Most of the difference was a consumption factor of 48.2 kg/yr for the SCDHEC survivalist versus 19 kg/yr for the DOE-SR typical fisherman. The MAX liquid pathway dose potential (0.849 mrem) was due primarily to Cs-137 in fish (highest in bass at Fourmile Creek)(Section 5.1.3, Data Tables). The SCDHEC AEI liquid dose (0.197 mrem) applied to the average potential exposure versus the highly improbable MAX based on a single highest (0.849 mrem) detection (Section 5.1.2, Table 1b). Ingestion or dose uptake after bioconcentration of Cs-137 in fish was the dominant route of exposure to the public via the food pathway that was of liquid pathway origin.

The DOE-SR potential dose contributions via a theoretical irrigation pathway (vegetable, milk, meat - 0.1 mrem) is almost double that of the typical liquid pathways (fish, water, shoreline, swimming, and boating – 0.059 mrem). The main liquid dose release contributors were Cs-137 (48%), tritium (18%), unknown alpha (25%), I-129 (4%), nonvolatile beta (3%), Sr-90 and Pu-238 (1% each), and the rest were all <1% each (Tables 6-12 and 6-16 SRNS 2011). The DOE-SR liquid releases percent of dose potential in 2010 was 61 % for fish consumption, 39 % for water consumption, and <1 % each for the shoreline, swimming, and boating.

The SCDHEC nonsportsman MAX dose in public water supply groundwater (PWSGW Wells) was tritium (0.000 mrem) (Section 5.1.2, Table 1a). The private well dose was potentially higher at 0.017 mrem (DNRGW Wells). The DOE-SR measured dose at the downstream water supply locations of Chelsea, Purrysburg, and Savannah I&D were all 0.02 mrem (SRNS 2011 Table 6-2). Private groundwater well dose (SCDHEC 0.017 mrem) was lower. Weather also played a role in that tributary streams floodwater can greatly dilute radionuclide concentrations in the Savannah River at any given time at tributary and downstream locations.

The SCDHEC order of MAX detected radionuclide dose in the 2010 liquid pathway excluding assigned NORM was Cs-137 in bass fish (0.458 mrem), tritium in Steel Creek boat landing water (0.239 mrem), Sr-89/90 in bass (0.121 mrem), incidental tritium ingestion from swimming in the Savannah River Fourmile stream creekmouth location (0.026 mrem), tritium in private groundwater wells (0.017 mrem), tritium in bass (0.005 mrem), and <0.01mrem for all others (Section 5.1.3, Data Tables). The bioconcentrated radionuclides, primarily Cs-137 and Sr-89/90 in the food pathway, were the major contributors to the liquid pathway dose. The MAX dose from the liquid pathway (0.849 mrem/yr) was far less than that from watching TV (1 mrem/yr) in 2010 (Section 5.1.2 Figure 2, SCDHEC 2006b).

<u>All-Pathway SCDHEC and DOE-SR Comparison</u>

The DOE-SR MEI All-Pathway yearly dose (0.11 mrem) basically represented combining typical exposures from the airborne and liquid pathways for the general public who were not subject to increased exposure from other activities (e.g., not farmer, sportsman, or survivalist). While consumption of PWS water at downstream locations was typically <0.02 mrem, the survivalist who used boiled swamp water at Steel Creek Landing for drinking water could receive a much higher dose (0.239 mrem SCDHEC). The SCDHEC general public liquid plus air MAX potential dose in 2010 (0.02 mrem) was less than that received from taking one coast-to-coast flight (2.5 mrem) (Section 5.1.2 Figure 2, SCDHEC 2006b).

The DOE-SR All-Pathway potential has not exceeded 0.28 mrem in the last twelve years and has an overall downward trend since 1999 (did not include the atypical exposure pathways for hunter, fisherman, and wild mushroom consumer (SCDHEC Section 5.1.2 Table 7).

The Food Pathway SCDHEC and DOE-SR Comparison

The food pathway was previously covered on an atmospheric or liquid contributor comparison basis. This section only adds comments related to their combined statistics for a total sportsman dose comparison. DOE-SR radionuclide annual releases were generally not directly comparable to SCDHEC accumulated dose detections in food media, since some media may contain or bioconcentrate several years of dose releases. The food pathway has contributions from the liquid (primarily fish) and the atmospheric pathway (primarily wild game and plant food sources).

The 2010 DOE-SR media contributing dose to the food pathway from highest annual release estimates were: onsite deer (12.37 mrem), offsite deer (0.37 mrem), offsite hog (0.18 mrem), vegetation (0.086 mrem), goat milk (0.0146 mrem), meat (0.0042 mrem), and fish (0.22 mrem) pathways for a total of 13.245 mrem in 2010 (SRNS 2011). The onsite deer dose is included in the comparison since many SCDHEC offsite deer were close to and probably traveled within site boundaries.

The 2010 SCDHEC MAX potential food dose included: offsite deer (7.522 mrem), offsite hogs (2.120 mrem), edible mushrooms (5.603 mrem), fish (0.584 mrem), and other edible vegetation (0.013 mrem) for a total of 15.842 mrem. However, the total is only 10.239 mrem if the edible mushrooms are excluded, which DOE-SR did not collect. If this comparison is limited only to the hunter dose, the comparison is more relevant. The likelihood of wild edible mushroom consumption by animals or humans is a major factor in dose exposure.

Compare the SCDHEC comparable food (excludes mushrooms) maximum dose total (10.239 mrem) to the DOE-SR maximum food dose total (13.272 mrem) in 2010. The DOE-SR total was based on doses for hypothetical offsite MEI deer consumption (0.37 mrem), offsite hog (0.18 mrem), and irrigation pathways (0.100 mrem), plus creek mouth fisherman (0.22 mrem) and goat milk pathways (0.032 mrem) for a total of 0.902 mrem of potential food dose, plus onsite deer (12.37 mrem) (SRNS 2011 Table 6-4, and SCDHEC Section 4.0, Table 5). Dose differences were attributable to consumption factor differences, temporal and location factors, the number of deer (and hogs) eaten by the respective MEI hunter and resultant dose, and the inclusion of Sr-89/90 in fish bone for the SCDHEC survivalist.

The food difference between the two agency averages was primarily dependent upon the highest deer or hog dose in previous years, but the hog and fish rankings were displaced by mushrooms in 2010 for SCDHEC data (Section 5.1.2, Table 1a). Compare the 2010 SCDHEC MAX dose for milk (0.000 mrem for cow milk) and edible vegetation (0.013 mrem) to the DOE-SR 0.0146 mrem in goat milk and 0.0172 mrem in vegetation (SRNS 2011) MEI dose (MAXDOSE-SR Goat Milk Pathway). A hypothetical calculation from DOE-SR increases the dose on an irrigation pathway basis to 0.086 mrem for vegetables and 0.10 mrem for milk. Most of this higher dose estimate was due to technetium-99 (Tc-99) and iodine-129 (I-129) estimates due to their longer half-lifes versus H-3, Cs-137, and Sr-90. Both of these radionuclides will play a more dominate role in long term dose calculations as the present dominate radionuclide contributors to dose (H-3, Cs-137, Sr-90) undergo decay, provided there are no further contributions.

The reader should keep in mind that the MAX calculation potential applied only if that MAX dose was somehow stored and delivered to the MEI as the sole source of that media throughout the year (e.g., the MEI who received the single highest dose from cow or goat milk, dried it into a powder perhaps, stored it on that day, and consumed it throughout the year). Thus, the reason for concluding that the SCDHEC MEI based on the single highest dose per radionuclide per media was of extremely low probability and that the SCDHEC AEI represents the most probable dose basis for any scenario. Tritium bioaccumulation potential has far less impact on the SCDHEC AEI or MEI dose than Cs-137 and Sr-89/90.

SCDHEC adds the single highest media detected dose (nonscenario basis) as a protective upper bound limit for the potential worst-case minority (survivalist). The survivalist may consume all of the maximally contaminated deer, hog, fish, mushrooms, and farm crops due to his location near SRS (and potential as a poacher or onsite hunter dose), which is most of the MEI dose or 98.31 % (Section 5.1.2, Table 1a) (Section 5.1.2, Table 4). Compare these MAX or MEI percentages to the AEI percentages for the food pathway (99.07 %). The food pathway was clearly the dominate dose pathway whether on a MAX or AEI basis.

DOE-SR found that terrestrial food products had the following detections: Cs-137 and Sr-89,90 in collards, cabbage, fruit, and milk; Uranium-234 (U-234) in collards, cabbage, fruit, and beef; U-235 in collards and cabbage; U-238 in collards, cabbage, and beef; Plutonium-239 (Pu-239) in cabbage; Curium-244 (Cm-244) in beef; Tc-99 in cabbage, collards, and beef; and tritium (H-3) in cabbage, collards, fruit, and beef (SRNS 2011).

SCDHEC detected tritium in winged sumac berries (tea source), wild yaupon leaf (tea source), wild plums, grapes, lichen fungi, corn, wild persimmons, and pears. Cesium-137 MAX detections were found in the following fungi: several *Boletus* species (5.38 pCi/g), *Cantharellus cibarius* (30.7 pCi/g), *Lactarius indigo* (15.8 pCi/g), *Cladonia rangiferina* (0.242 pCi/g), *Pleurotus ostreatus* (0.251 pCi/g), and *Laetiporus sulphureus* (0.987 pCi/g). Only tritium and Cs-137 detections were potentially not of natural origin and contributed dose to the MEI. These edible mushrooms contributed a potential dose to the minority wild mushroom consumer, whether animal or human. Although reindeer lichen (*Cladonia rangiferina*) and other lichens are not a particularly desirable food even with proper preparation, lichens tend to store elemental levels contained in ambient air and serve as an effective biomonitor of atmospheric quality and plays a significant role in reindeer Cs-137 contaminant levels and in their predators (Halonen 1993).

The combined SCDHEC and DOE-SR MEI dose potential (31.726 mrem) confirmed that any scenario or individual was not exposed to a dose greater than the DOE-SR annual dose limit of 100 mrem/yr., especially since this total represented accumulated dose over many years and not just one year. DOE-SR monitored individual hunters on the SRS to ensure that they did not exceed the DOE 100 mrem standard (SRNS 2011). Both SCDHEC and DOE-SR programs sampled predominantly the same dose contributors despite differences in locations, methods, and analyses. Section 5.1.2, Table 8 statistics derived from DOE-SR release dose estimates revealed that the overall dose to the onsite hunter (12.37 mrem) was similar to the SCDHEC offsite MAX deer and hog dose (9.640 mrem) in 2010 (SRNS 2011).

The dose detected in comparable media by SCDHEC came from previous years dose accumulations or bioconcentrations of legacy dose (which may or may not have come from DOE-SR) plus the annual release.

Critical Pathways 2010 Summary

All SCDHEC dose detections occurred in one of the following pathways: atmospheric, liquid, food or ingestion, inhalation, direct exposure, public water supply, and the nonpotable drinking water. Most of the critical pathways were discussed in detail under the section "DOE-SR and SCDHEC Comparisons". The following discussion is limited to percentage comparisons of critical pathways in 2010 to denote their relative importance to overall dose exposure (Section 5.1.2 Table 1a and Section 5.1.3 Data). The 1999-2010 Statistics Summary section covers the overall media trends. The AEI data represented the typical dose levels above background or yearly dose and the MAX data represented the extreme data points or one time dose extreme that occurred sometime during the year. The MAX dose is very conservative since it is based on a single high detection as if it was stored and constantly used throughout the year.

The Atmospheric Pathway 2010 Summary

The SCDHEC 2010 atmospheric pathway contributed dose to the individual through the inhalation of air and resuspended soil, ingestion of food and game, and direct exposure routes. The SCDHEC MAX column contributions to the MEI APW were 94.731% of the MEI total and was dominant compared to the LPW (5.269%) on a single highest detection exposure basis (Section 5.1.2 Table 1b). The SCDHEC AEI column contributions to the total AEI (more typical of actual exposure potential) were 92.949% APW and 7.051% LPW. Food ingestion was 99.069% of the SCDHEC detected AEI non-NORM dose, drinking water ingestion was 0.895%, inhalation was 0.036%, and direct exposure was less than 0.000% (Section 5.1.2 Table 1a). .

Most of the 2010 total (atmospheric and liquid) food pathway dose was clearly due to all food sources on an AEI (99.07%) or MAX (98.31%) basis (Section 5.1.2 Table 1a, 4). The MAX% is less here than the AEI% due to gains in nonfood dose on a MAX basis. Exposure from all 2010 AEI food detections subject to the atmospheric pathways (2.576 mrem) was substantial at 92.20% of the AEI perimeter dose (Section 5.1.2 Table 1a) and 99.23% of the APW dose (2.596 mrem). Addition of the rainwater dose (also atmospheric) and air inhalation dose completes the observed APW AEI dose. The APW MAX dose total (15.290 mrem) and APW food dose total (15.258 mrem) were 94.89% (perimeter dose 16.114 mrem) and 99.79% (15.290 mrem APW), respectively.

However, the atmospheric Cs-137 maximum in 2010 occurred in deer (7.522 mrem) as 46.68% of MAX perimeter dose, and 94.69% of the atmospheric pathway. Strontium-89/90 and tritium (0.02 mrem) were near 0.00% in the atmospheric pathway (Section 5.1.3 Data). The highest MAX detections occurred in the APW, and the APW was always dominant in any year on a MAX basis, which represented the potential extremes. Most exposure occurred as a result of the ingestion of wild food sources containing Cs-137 (MAX deer, hog, vegetation and mushrooms) in any pathway (Section 5.1.3 Data).

The SCDHEC APW All-Sources limit or upper bound (MAX column) for the atmospheric dose accumulated potential in Section 5.1.2 Table 1b was based on exposure to the single highest media maximums (15.290 mrem) irrespective of applicability, and was not directly comparable to the DOE-SR annual atmospheric dose limit.

The Liquid Pathway 2010 Summary

The 2010 liquid pathway contributed dose to the individual through the ingestion of fish, water (public water supplies, groundwater, surface water), direct exposure routes, and the inhalation (e.g., resuspension of dried riverbank sediment) and swimming ingestion pathways, but was never dominant. Riverbank sediments were an example of a media that can impact both atmospheric (through inhalation of resuspensed dry sediments) and liquid pathways (through ingestion and direct contact), dependent on how the exposure occurred.

The SCDHEC 2010 perimeter AEI detected dose potential from the LPW was 7.051% (Section 5.1.2, Table 1b). This AEI liquid dose was due mostly to fish consumption or food dose from the Savannah River, and the MAX dose basis was even smaller (5.269% of MAX dose). The highest detected dose for the liquid pathway in 2010 on an AEI (7.051%) and MAX (5.269%) dose basis (Section 5.1.3, Data) was much less than the atmospheric pathway percentages (92.949% AEI, 94.731 % MAX). Thus, fish dose was less dominant on an AEI and MAX basis compared to terrestrial food sources (see deer, hog, and wild mushroom dose in food section). The SCDHEC MEI (the survivalist MAX dose total) ate all fish and the dose was assigned based on the highest detections per radionuclide and not on a fish-type basis, since the survivalist ate all fish. However, all liquid pathway MAX in 2010 occurred in largemouth bass due to Cs-137 (2.84%), Sr-89/90 (0.75%), and tritium (0.03%). Thus, Cs-137 was the dominant source of exposure on an APW and LPW basis in food from the liquid pathway.

The Food Pathway

The food pathway was covered under the atmospheric pathway except for these few additional observations. The 2010 SCDHEC AEI versus MAX food pathway dose order was hog, fungi, deer, and fish versus deer, fungi, hog, and fish, respectively (Section 5.1.2 Table 1). Note that deer switches position (1^{st} or 3^{rd}) with hog dependent on the dose basis used (AEI or MAX). These orders for primary media affected by the atmospheric and liquid pathways can vary greatly depending on the backgrounds collected in any particular year (see the Statistics Section for the overall trend). Most of the potential food dose was Cs-137 first, Sr-89/90 second, and tritium third (Section 5.1.3 Data) on an AEI or MAX basis. The radionclide order responsible for dose remained the same whether on an AEI or MAX basis. However, tritium replaces Sr-89/90, if the basis is expanded to include water sources. The 2010 food dose was 99.069 % of the AEI and 98.312 % of MAX perimeter potential dose (Section 5.1.2 Tables 1,6). The survivalist and sportsman food categories compared to the general public food sources were the dominate sources of exposure whether on an AEI or MAX basis (Section 5.1.2 Table 1).

1999-2010 Statistics

The 2010 data were covered under the previous headings. Only the 1999-2010 statistics are summarized under this heading. Section 5.1.4 Table 1 summarizes *all potential dose detected* regardless of applicability, and Table 2 summarizes only media dose relevant (assigned) to the AEI and MAX basis calculations.

This critical pathway basis of comparison for SCDHEC detected dose results from accumulated releases of radionuclides that were deposited outside of SRS and within 50-miles of the SRS center-point. These tables and figures illustrate the dominance of the atmospheric pathway dose (60.470%) over the liquid pathway (39.530%) and emphasizes the AEI dose basis (Section 5.1.4 Table 3). The food subpathway (89.617% of dose) was the dominant route of exposure, the nonpotable drinking water supply was second (4.979%), the direct exposure pathway third (2.657%), the public water supply pathway fourth (2.420%), and the inhalation pathway least (0.327%).
Cesium-137 (71.78% of *all* AEI dose detections) accounted for most accumulated dose detections in all media for the period 1999-2010, and occurred primarily as a result of exposure to wild food sources (Section 5.1.4 Tables 1 and 2). Total strontium (3.75% of *all* AEI dose) was second, and tritum ingestion (3.08%) third. All other potential non-NORM radionuclides were less than 1% of the dose exposure for the period 1999-2010. The potential NORM radionuclide dose detections came primarily from radium-226 (Ra-226) and uranium-238 (U-238).

The 12-year (1999-2010) media statistics can be found in Section 5.1.4, Tables 1, 2 and 3. The offsite hunter MAX and AEI statistics are only for game animal totals, and all other statistics are on a single media basis. Section 5.1.4 Table 2 medians, which reduce the influence of the extremes, should provide the most relevant central tendency for environmental media exposure estimates over the period 1999-2010 (Gilbert 1987), and the median is still protective since the statistics are based on detections only. The dominant sources of exposure on an AEI median basis were hog (0.970 mrem), fungi (0.730 mrem), fish (0.440 mrem), and deer (0.080 mrem) (Section 5.1.4 Table 2). The MAX categories change the median order and indicate the dose potential that exists in exposure to extremes (deer (7.520 mrem), hog (2.120 mrem), edible fungi (1.767 mrem), and fish (1.766 mrem). Notice that deer meat consumption represents the most variable rank in this comparison of AEI to MAX detections. Refer to Section 5.1.4 Table 2 for the statistics of relatively minor dose that occurred in other media. The highest dose potential in water media would come from consuming water from the Savannah River at boat landings (SWBL) (median 0.045 mrem). The next highest media minor dose came from edible vegetation and/or soil (both medians were 0.010 mrem). The SCDHEC milk dose (median 0.003 mrem) is potentially the result of annual inhalation dose by cows or depositions on annual food crops, whereas the air filter dose (median 0.002 mrem) represents mostly inhalaton and relates directly to annual releases. See Section 5.1.4 Table 2 for the AEI average and standard deviation of each media, which illustrate the potential variation in dose.

Section 5.1.2 Table 6 illustrates the 1999-2010 DOE-SR Percent of Total Dose potential to the MEI for the atmospheric and liquid pathways based on annual releases. The greatest potential dose exists in the inhalation, vegetation, fish, and water pathways when atypical dose, e.g. sportsman or survivalist dose, is not included. Section 5.1.2 Table 7 illustrates that the dominant dose (mrem) exposure for the overall DOE-SR MEI 1999-2010 on a median basis is from the sportsman pathway (onsite hunter 14.80 mrem, offsite hunter 8.70 mrem, offsite fisherman 0.57 mrem) versus the All-Pathway typical exposure (0.17 mrem). SCDHEC data from dose accumulations in all media shows that dose exposure is dominated by the wild food (deer, hog, fish, fungi) pathway for the period 1999-2010 (Section 5.1.2 Figures 4, 5, 6, 7, 8). The

SCDHEC recent addition of edible fungi (mushroom MAX dose was 5.603 mrem in 2010) and other edible native plants shifts the emphasis of maximum exposure to include the atypical survivalist who takes advantage of all food sources. Section 5.1.2 Figure 8 shows the close agreement between DOE-SR and SCDHEC sportsman media, and that the overall trend in sportsman media dose was declining. DOE-SR did not collect fungi and few wild-type edible vegetation species during 1999-2010. Most of the SCDHEC dose in wild-type vegetation came from bolete and chanterelle mushrooms, and woody edible plant sources (not annuals). Annual plant or seasonally absorbed dose would tend to emphasize the effect of annual releases. Perennial plants, the edible parts of woody shrubs and trees, and long-lived fungi mycelia resident in the soil and older plants would tend to show the effects of any dose accumulations or bioconcentrations over many years. This accumulated dose is then passed on to the consumer of those sources. The data seems to indicate that the true MEI is primarily a survivalist who is also a sportsman.

Note from Section 5.1.4 Table 2, 1999-2010 MAX basis statistics, the prime contributors to outliers in dose occurred in deer (7.706 (±5.894) mrem, median 7.520 mrem), hog (4.704 (±7.064) mrem, median 2.120 mrem), edible fungi (2.885 (±2.366) mrem, median 1.767 mrem), and fish (2.122 (±1.531) mrem, median 1.766 mrem). Note the change in order averages if on an AEI basis: hog, fungi, fish, and deer. The order changes again on a total dose detection basis: fish, hog, deer, fungi. Also, if the median represents the true central tendency (minimizes the extremes of detections), the order changes back to: hog, fungi, fish, and deer. The hunter AEI based (0.764 (±1.445) mrem, median 0.091 mrem) and hunter MAX based statistics (9.024 (±10.036) mrem, median 8.000 mrem) combine the game animal dose. The AEI dose median indicates that the central tendency can be drastically lower than indicated by the average or maximum detections. The only median higher than the average occurred in the edible mushrooms (fungi), and the highest detections also occurred in the fungi (all Cs-137). This conforms with the Chernobly highest environmental dose occurring in individuals who consistently ate wild mushrooms (Botsch 1999).

Section 5.1.2 Table 4, 1999-2010 food statistics, indicated that sportsman (fish, deer, hog) media (1.298 (±1.438) mrem, median 0.960 mrem), and the typical wild mushroom consumer (fungi 0.628 (±0.285) mrem, median 0.730 mrem) contained more dose even on an AEI basis than the local area nonsportsman public food dose (0.052 (±0.062) mrem, median 0.030 mrem. Section 5.1.2 Table 7 and Figure 8 show the 1999-2010 trends for the offsite hunter and fisherman. Compare the DOE-SR offsite fisherman average dose of 0.68 (±0.40) mrem with a median of 0.57 mrem to the SCDHEC fisherman average dose of 0.535 (±0.302) mrem with a median of 0.440 mrem that did not include a soil exposure contribution (Section 5.1.2 Table 7 and Section 5.1.4 Table 2). The fisherman soil average contribution included by DOE-SR was typically 0.28 mrem/yr, and if subtracted, still left an average fish dose agreement between the two programs within the first standard deviation (SRNS 2011 Table 6-4). The DOE-SR offsite hunter dose (Section 5.1.2 Table 7) included hogs and averaged 7.61 (±5.41) mrem with a median of 8.70 mrem compared to the SCDHEC MAX hunter dose (Section 5.1.4 Table 2)average of 9.024 (±10.036) mrem with a median of 8.000 mrem. The differences were attritutable to the individual hunter who was the MEI, and the DOE-SR offsite hunter estimate based on onsite hunter dose. Compare both to the SCDHEC AEI hunter dose average of 0.764 (±1.445) mrem with a median of 0.091 mrem, which was based on an overall average dose instead of a single hunter maximum. Thus, the SCDHEC hunter who was not the MEI would receive far less dose on average, and the typical dose should be closer to the median (0.091mrem) because nondetections were not part of the dose estimate calculations.

The 1999-2010 average dose per radionuclide (Section 5.1.4 Table 1) for all detections regardless of assignment gave the following central tendency statistics (average, standard deviation, median) over all media collected: Cs-137 (0.510 (±0.818) mrem, median 0.265 mrem for N#41), Sr-89/90 (0.062 (±0.084) mrem, median 0.016 mrem for N#14), and H-3 (tritium) (0.012 (±0.013) mrem, median 0.008 mrem for N#72). Note that N# for SCDHEC data is the same as the number of detections used in dose calculations. The scenario statistics given below were different due to the inclusion of other media as part of the scenario dose. Section 5.1.4 Table 2 gives individual media statistics for assigned dose to the MEI.

Four basic AEI scenarios were developed based on SCDHEC data alone, which calculated a dose relative to public exposure activities (Section 5.1.2, Table 2).
The basic scenario results for 1999-2010 were:

- the general public 0.086 mrem average, ± one standard deviation of (0.059), with a median of 0.082 mrem;
- the farmer, 0.114 (± 0.112) mrem with a median of 0.071 mrem;
- the average sportsman, 1.463 (± 1.386) mrem with a median of 1.118 mrem.
- the average survivalist (as a minority group) was added in 2008 and included edible fungi consumption; the average survivalist was 1.620 (± 1.425) mrem with a median of 1.277 mrem (2008-2010 statistics).

Two MAX scenarios based on the single highest detection per media were the maximally exposed sportsman, 11.310 (± 9.973) mrem with a median of 9.711 mrem, and the maximally exposed survivalist, 9.844 (± 5.567) mrem with a median of 9.299 mrem (Section 5.1.2 Table 2). The MAX Survivalist was lower than the MAX Sportsman because of the averaging of three years of data versus 12 years, respectively. The MAX Survivalist by definition adds dose for additional nonsportsman media to the MAX Sportsman in any single year unless no dose results occur in the added media that year.

The hunter maximum doses are trending toward lower dose levels whether from onsite or offsite deer (Section 5.1.2, Figure 8). Also, the SCDHEC offsite hunter MAX (deer plus hogs) dose averaged 9.024 (± 10.036 mrem) with a median of 8.000 mrem from 2000 to 2010, whereas the hunter AEI dose averaged 0.764 (± 1.445 mrem) with a median of 0.091 mrem (Section 5.1.4, Table 2).

Dose Critique

The median may be a more applicable reference for deciding the central tendency in environmental data when media sample numbers are relatively large in size. Random sampling in most SCDHEC media revealed that the environmental data detections are aymmetric and skewed to the left (most detections are low and near the origin) and the median of the population probably tends to be larger than the true mean (Gilbert 1987). Most sampling resulted in less than a minimum detectable activity (MDA) and were not included in the above statistics that used detections only. The use of detections only in statistics was protective, but distorts the true central tendency, which was the primary basis for concluding that the median was probably closer to the actual central tendency.

The DOE-SR study area shows a gradual downward exposure trend due to inactive SRS reactors and natural radioactive decay and dispersal processes. This trend can change based on new DOE-SR missions or outside influences from global atmospheric sources.

All dose was summarized by average, standard deviation, and median. The median may be a better indicator of the central tendency in environmental media dose compared to average dose for large sample numbers due to:

1) the decrease in influence by the extremes;
2) the added conservancy present in selected dose factors;
3) the addition of dose based on single highest detections such as hog and deer worst-case game animal consumption;
4) the use of "detections only" for statistical analyses when many sample results were less than the detection limit;
5) the assignment of the higher dose to dual radionuclide determinations (e.g., the assignment of dose based on Sr-90 when the detection is for Sr-89/90);
6) the use of 0.00 mrem as background subtraction for <MDA data averages;
7) and the influence or potential of false positives (WSRC 2003a).

The NORM averages and maximums were not included in the dose estimates since this dose was part of the 300-mrem expected NORM for the study area. The yearly dose averages greater than background were based on SCDHEC detections only and are inflated since most sample results were less than the MDA. The justification for using detections only was to allow for undetected radionuclides and media. The justification for selecting higher source consumption levels was due to the consideration of the SCDHEC MEI as a survivalist type who consumed natural media at a greater than typical rate. The basis for both considerations was to be protective of the public and environment. The inclusion of alpha and beta assumed dose in the past was excessive and not supported by media radionuclide species detections. The inclusion of calculations based on a single highest maximum detection for each radionuclide/media was a more definable basis for establishing an upper bound rather than the dose assumption of unknown alpha as plutonium-239 (Pu-239) and unknown beta as Sr-90.

The SCDHEC 2007 Critical Pathway Dose Report noted that 38.50 % of the dose was assigned and represents a potential dose overestimate that may in fact be NORM detections. Also, only 44.25% of the detected dose above background was potentially from SRS, if all NORM potentials were excluded. The SCDHEC dose calculations since then were still protective due to the use of detections only in determining dose, the calculation of a maximum dose for the MEI based on a single maximum detection for each radionuclide/media, and the use of very conservative consumption rates.

The AEI was given prominence as protective for general dose considerations, and the reader should be aware that the AEI dose estimate was conservative or biased high due to the use of 'detections only' in calculations and the use of very conservative consumption rates for the SCDHEC AEI. For example, the omission of <MDA assignments from calculations would raise any calculated number to a higher value. Alternatively, <MDA actually represents an undetermined low number that may be zero or any number up to the given MDA value for that analysis. All detected dose above background was assigned either to the AEI, MAX (for the MEI), or NORM dose dependent on assignable cause that was based on knowledge of environmental sources, media, and locations (Section 5.1.2, Table 1a,b and Section 5 Data). For

example, the potential dose for resuspended soils was not assignable as farmer inhalation, if not detected by air samplers (see atmospheric pathway section). The SCDHEC MEI was primarily a sportsman scenario because most potential dose was found in game animals and fish. However, the wild mushroom consumer potential dose would add significant additional dose to the survivalist. The MEI would consume the single highest maximum activity/isotope/media and defined a limit of potential dose based on detections only. This was done since SCDHEC sampling was limited and did not necessarily include the true yearly MEI exposure (due to undetected dose and/or dose accumulations) for the exceptional individual who may receive the MEI dose resident in the 50-mile perimeter study area. Thus, the dose limiting factors were biased high to be protective of the public and the environment, but realistic or limiting in that only measured radionuclide specific values were used.

Specific radionuclide (speciated) doses were used in the estimated dose for 2010 except for the dose assignments of total strontium as Sr-90. The use of detections only, the calculation of dose based on a single maximum for each radionuclide/media, and high consumption levels provide an elevated dose basis that is protective without the inclusion of screening value assumptions for alpha and beta. SCDHEC field detection dose accumulations over many years and DOE-SR yearly releases were not directly comparable and yet the potential MEIs calculated from both programs were close primarily due to the dominance of Cs-137 in the wild food pathway.

This project used dose instead of risk so that direct comparisons of dose magnitude can be made with similar media data published in the SRS Environmental Reports. Both the USEPA and SCDHEC use risk calculations when determining clean-up levels at Comprehensive Environmental Resource Compensation and Liability Act (CERCLA) and Resource Conservation Recovery Act (RCRA) sites. DOE-SR modeled radionuclide releases for a particular year were not directly comparable to SCDHEC yearly-detected dose in some media due to accumulation or biomagnification factors that may occur over many years.

CONCLUSIONS AND RECOMMENDATIONS

The survivalist MEI scenario should include all potential dose as a worst-case scenario. The SCDHEC detected worst-case dose potential that excluded the South Carolina background and probable NORM was 16.114 mrem in 2010. The SCDHEC MEI total potential dose was based on the single highest maximum detections/radionuclide/media in 2010 that included edible fungi, and was less than the dose typically received by living in a block house for two years (7 mrem/yr) and making one coast-to-coast flight (2.5 mrem) (Section 5.1.2, Figure 2). Additional dose added primarily from DOE-SR onsite estimates for sportsmen increased the combined onsite and offsite dose potential to 31.726 mrem for the combined MEI. This improbable combined MEI potential accumulated dose confirmed that the DOE-SR 100-mrem annual dose release standard to the public was not exceeded in 2010 despite contributions from other years dose and bioaccumulations (Section 5.1.2, Table 3). The relatively close agreement of the 2010 SCDHEC MEI (16.114 mrem) and 2010 DOE-SR MEI (16.43 mrem) environmental monitoring program estimates was due primarily to the Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway and not to a correlation between annual releases and detected dose in media. However, a very conservative estimate by SCDHEC of the average DOE-SR perimeter dose potential above background was only 2.794 mrem in 2010 (Section 5.1.2, Table 1).

The SCDHEC 2010 All-Sources MAX dose estimates relative to the All-Pathway DOE standard atmospheric (0.025 mrem from rainwater) and liquid (0.239 mrem) pathways excluding the atypical dose pathways, were well within the respective 10 mrem, and 4 mrem DOE Order 5400.5 limits (Section 5.1.2, Table 1) despite dose additions from other years inherent in field collected media. The All-Pathway DOE atmospheric and liquid estimates exclude atypical dose, which was captured under the total MEI estimate for comparison to the DOE defined dose limit for all annual dose releases to the public (100 mrem/yr). Inhalation was 0.036 % of the dose to the critical pathway, ingestion was 99.964 %, and direct exposure was <0.000 % in 2010 (Section 5.1.2, Table 1).

Four dose scenario estimates were updated based on SCDHEC data from 1999 through 2010 as an AEI dose above background. The medians were viewed as the best representation of the central tendency over the period 1999-2010, and were still protective estimates (see Dose Critique Section). The average sportsman who was not the MEI was exposed to 1.946 mrem of dose in 2010 and averaged 1.463 (±1.386) mrem with a median of 1.118 mrem for 1999-2010. The farmer, who was not a hunter, but inhaled, ingested, or received direct exposure from soil, received a dose of 0.020 mrem in 2010 and averaged 0.114 (±0.112) mrem with a median of 0.071 mrem. A minority category, the survivalist, who was a wild mushroom consumer (new in 2008), received an average dose of 2.794 mrem in 2010 and averaged 1.620 (±1.425) mrem with a median of 1.277 mrem. The general public who ate some wild or domestic vegetation (e.g., plums and grapes), but was not a sportsman or wild mushroom consumer, and was not exposed to swamp soils, received less than 0.008 mrem of dose in 2010 and averaged 0.086 (±0.059) mrem with a median of 0.082 mrem (Section 5.1.2, Table 2). The general public dose was the dose that applied to most people within the study area and was a conservative and protective estimate (Results and Discussion Dose Critique).

Most of the 1999-2010 AEI dose was the result of atmospheric pathway deposits (60.47 % or 12.218 mrem total) and the balance was from the liquid pathway route (39.53 % or 7.988 mrem total) (Section 5.1.4, Table 3). The wild food ingestion subpathway contained mostly Cs-137 and contributed 89.62 % or 18.108 mrem of dose from 1999 through 2010 primarily through the fish, hog, deer, and wild mushroom ingested dose pathways. The second highest dose subpathway was due to the nonpotable drinking water subpathway consumption (4.98 % or 1.006 mrem), primarily from tritium in ingested Savannah River water by sportsmen at boat landings near SRS. The direct exposure subpathway was the third major pathway (2.66 % of dose or 0.537 mrem), primarily from Cs-137 in Savannah River bank soil at public boat landings. Public water supply sources were fourth (2.42 % or 0.489 mrem) due to tritium, and inhalation was fifth (0.33 % or 0.066 mrem), primarily from tritium.

The dose rank comparison for all MEI assigned dose detections from 1999 through 2010 (Section 5.1.4 Table 1) elevated the strontium dose to second place versus 2010 data alone (third place). Relative to all dose detections including NORM, Cs-137 (71.78%) and total strontium (3.75%) were the main contributors of dose through the wild food pathway, and tritium (3.08%) was the primary contributor of dose through the atmospheric and liquid pathways. The dominant dose order for strontium and tritium tends to change annually between 2^{nd} and 3^{rd} place for MEI assigned dose, but Cs-137 was always the main contributor to dose. Radium-226 made up the bulk of detected dose assigned to the NORM detections.

ESOP has increased sampling near the perimeter of SRS and in closer proximity to SRS tank farms, basins and seepage areas to ensure an early warning for any contaminant making its way to the SRS streams. New media sampling will be added in the future if needed. Edible fungi sampling was started in 2008 to address the concern for Cs-137 bioconcentration in edible mushrooms, and a wider variety of woody edible vegetation sources were added in 2010.

Potential atmospheric and liquid release concerns that may play a relatively larger role in the dose to the surrounding public in the future may include the following:

- releases of americium-241 (Am-241), plutonium and uranium radionuclides from the Mixed Oxide Fuel Fabrication Facility (MFFF) through the air and surface water environmental mediums (Compagnie Generale des Martieres Nucleaires or Cogema, Duke, Stone, & Webster 1998);
- a high concentration of tritium predicted by computer models migrating from the Old Radioactive Waste Burial Ground (ORWBG) to Upper Three Runs (WSRC 2001) and/or the Savannah River;
- and radionuclides such as carbon-14 (C-14), iodine-129 (I-129), neptunium-237 (Np-237) and technetium-99 (Tc-99) may be an ORWBG contaminant to monitor in the future because of their long half-lives.

These findings indicated that monitoring of the potential accumulations and bioconcentrations of dose should continue, especially within the sportsman food and wild edible food source subpathways, in addition to the primary inhalation, ingestion, and direct exposure routes from the atmospheric and liquid pathways. The down-gradient wells, surface water, sediments, plants, and animals should be carefully monitored for any signs of the contaminants that are present at tank farms, basins, and seepage areas. Early detection is paramount to protecting the public and the environment if a release to offsite streams or groundwater occurs. SCDHEC will continue to monitor the SRS and adjacent area for the primary radionuclide contributors to dose potentially associated with DOE-SR operations.

TOC

5.1.2 Tables and Figures

2010 Critical Pathway Dose Report

Table 1a. 2010 SCDHEC Non-Scenario Dose (mrem/yr) Estimates for Pathways, Exposure Routes, and Media

Pathways	Routes	Media	AEI[1]	MAX[2]	MAX minus AEI[3]
APW[4]	Inhalation	Air	*0.001*	*0.007*	0.006
APW	Inhalation	Resuspended Soil	*0.000*	*0.000*	0.000
LPW[4]	Inhalation	Resuspended Riverbank Sediment	*0.000*	*0.000*	0.000
AEI **%**	0.036	**Air Inhalation Totals**	**0.001**	**0.007**	0.006
LPW	Ingestion	Fish[5]	*0.192*	*0.584*	0.392
APW	Ingestion	Deer	*0.617*	*7.522*	6.905
APW	Ingestion	Hog	*1.104*	*2.120*	1.016
APW	Ingestion	Vegetable	*0.007*	*0.013*	0.006
APW	Ingestion	Milk	*0.000*	*0.000*	0.000
APW	Ingestion	Soil	*0.000*	*0.000*	0.000
LPW	Ingestion	Riverbank Sediments	*0.000*	*0.000*	0.000
APW	Ingestion	Edible Fungi	*0.848*	*5.603*	4.755
AEI **%**	99.069	**Food Ingestion Dose Totals**	**2.768**	**15.842**	13.074
LPW	Ingestion	PWS River Water	NS	NS	NS
LPW	Ingestion	PWS Wells	*0.000*	*0.000*	0.000
LPW	Ingestion	DNR GW Wells	*0.012*	*0.017*	0.005
LPW	Ingestion	SR Water at Boat Landings	*0.015*	*0.239*	0.224
APW	Ingestion	Rainwater	*0.020*	*0.025*	0.005
LPW	Ingestion	Swimming Ingestion	*0.005*	*0.026*	0.021
AEI **%**	underlined (0.895)%	**All DW Ingestion Dose Totals**	**0.052**	**0.307**	0.255
APW	Direct	Submersion (Cloud)	NS	NS	NS
APW	Direct	Absorption (Skin)	NS	NS	NS
LPW	Direct	Immersion (Swimming)	*0.000*	*0.000*	0.000
LPW	Direct	Sediment Wading (Skin)	*0.000*	*0.000*	0.000
APW	Direct	Ground Direct Exposure (Shine)	*0.000*	*0.000*	0.000
LPW	Direct	Boating	*0.000*	*0.000*	0.000
LPW	Direct	Riverbank (Shine)	*0.000*	*0.000*	0.000
LPW	Direct	Swamp Dweller Surface Water Shine	*0.000*	*0.000*	0.000
AEI **%**	0.000	**All Direct Exposure Dose Totals**	**0.000**	**0.000**	0.000
All-Sources[6] Dose (Upper Bound of Detections) Totals			2.821	16.156	13.335
Perimeter[7] Dose (Applicable Media Only Totals Underlined[8]) Totals			***2.794***	***16.114***	13.320
See Table 1b for critical pathway summary and notes.					

Tables and Figures
2010 Critical Pathway Dose Report

Table 1b. 2010 SCDHEC Non-Scenario Dose (mrem/yr) Estimates for Pathways, Exposure Routes, and Media (cont.)				
Examples of maximum dose substitutions for calculating a personal media exposure average result.				
Examples of adding	Replace Avg Deer with Max Deer	**9.699**	2.794 plus difference 6.905	
maximums to avg dose	Replace Avg Fish with Max Fish	**3.186**	2.794 plus difference 0.392	
Perimeter[8] Dose Detections Applicable to MEI				
Critical Pathway Summary of MEI Perimeter[8] Dose (mrem)		**AEI[1]**	**MAX[2]**	**MAX minus AEI[3]**
The Atmospheric Pathway Perimeter Totals (**APW**)		2.597	15.265	12.668
The Liquid Pathway Perimeter Totals (**LPW**)		0.197	0.849	0.652
Perimeter[8] Critical Pathways Percent Contributions (%)		**AEI**	**MAX**	**MAX minus AEI[3]**
Atmospheric (**APW**) Pathway		**APW%**	**APW%**	
Percentage Totals for Perimeter Dose		92.949	94.731	1.782
Liquid (**LPW**) Pathway		**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose		7.051	5.269	-1.782
All-Sources[6] Dose (Upper Bound of Detections) Detections				
Critical Pathway Summary (mrem)		**AEI[1]**	**MAX[2]**	**MAX minus AEI[3]**
The Atmospheric Pathway Totals (**APW**) From All-Sources[6]		2.597	15.290	12.693
The Liquid Pathway Totals (**LPW**) From All-Sources[6]		0.224	0.866	0.642
ALL-Sources Critical Pathways Percent Contributions (%)		**AEI**	**MAX**	**MAX minus AEI[3]**
Atmospheric (**APW**) Pathway		**APW%**	**APW%**	
Percentage Totals for Perimeter Dose From All-Sources		92.060	94.640	2.580
Liquid (**LPW**) Pathway		**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose From All-Sources		7.940	5.360	-2.580

Table 1 Notes:
1 - AEI is the average radionuclide activity concentrations (dose) above background excluding **NORM**.
2 - MAX is the single highest (maximum) radionuclide activity concentration (dose) above background excluding NORM.
3 - Difference of values in AEI and MAX (highest single dose) columns.
4 - APW is the atmospheric pathway media and LPW is the liquid pathway media.
5 - Fish dose totals are based on the highest dose detection/radionuclide instead of fish species.
6 - All-sources refers to all detected dose except NORM without qualification as to its' applicability.
7 - Perimeter refers to the study area which is outside of DOE-SR boundaries and within 50-miles of an SRS center-point.
8 - The underlined DW ingestion total and AEI % comes from the total of the doses that are underlined. The maximum consumption rate can only be used with one drinking water (DW) source (highest underlined).
9 - Nonspecific screening level detections of alpha, beta, and beta-gamma (TLD) were replaced by the MAX estimate.
10 - cont. = continued.

Tables and Figures
Table 2. Dose Scenario Estimates

Scenarios in Millirem of Exposure	**2010**	**1999-2010**		
	Avg.	**Avg.**	**SD**	**Median**
Public[1]	0.008	0.086	0.059	0.082
Farmer[2]	0.020	0.114	0.112	0.071
Average Sportsman[3]	1.946	1.463	1.386	1.118
Average Survivalist[4]	2.794	1.620	1.425	1.277
MAX Sportsman[5]	10.254	11.310	9.973	9.711
MAX Survivalist[6]	16.114	9.844	5.567	9.299

Notes:
1 – The nonsportsman public who is exposed only to the milk, air, edible vegetation, and the highest public water supply AEI dose.
2 – The farmer scenario replaces the public water river supply dose with the highest AEI well water, or rainwater dose and adds the sediments and soil dose to the public dose. The farmer is treated as a nonsportsman.
3 – The average sportsman adds the average game (deer, fish, hog) dose to the farmer dose and uses the highest AEI public, private, or river water source dose (underlined in Table 1).
4 – The average survivalist adds the AEI fungi dose, and swamp dweller dose to the sportsman dose.
5 – The MAX sportsman is based on the average sportsman but receives the highest single dose from all game (deer, hog, fish). Note that the MAX sportsman does not add other nonsportsman category maximums.
6 - The MAX survivalist adds all remaining maximums in place of the AEI dose (started in 2008). The exception is that only one drinking water maximum can be used. Equals the perimeter MAX dose total.
7 - Scenario results are not directly comparable to non-scenario results due to specified media/scenario except for the MAX Survivalist who receives the perimeter nonscenario dose or SCDHEC MEI.

2010 Critical Pathway Dose Report

Table 3. 2010 MEI All-Pathway and Survivalist Potential Dose Comparisons to DOE-SR (mrem)

Pathway	Media Comparison Additional Dose	DOE-SR [1]	SCDHEC [2]	Add to SCDHEC [3]
All-Pathway	Liquid (DW underlined Table 1) plus Airborne [4]	0.11	0.246	0.000
Sportsman	Onsite Hunter	12.37	**NS**	12.370
	Creek Mouth Fish	0.22	0.584	0.000
	Offsite Hog	0.18	2.120	0.000
	Offsite Deer	0.37	7.522	0.000
	Hunter Soil Exposure [5]	2.90	0.000	2.900
	Fisherman Soil Exposure [6]	0.28	0.000	0.280
	Other Pathway [7]	0.10	0.039	0.062
Mushroom Consumer	Edible Fungi [8]	**NS**	5.603	0.000
Totals	**SCDHEC MEI**	NA	**16.114**	NA
	Total Difference to be added for MEI	NA	**15.612**	15.612
	SCDHEC plus DOE-SR MEI Additions [9]	NA	**31.726**	NA

Notes:
1 - DOE-SR data primarily from Table 6-4 and 6-16 (SRNS 2011).
2 - SCDHEC Maximums or single highest detection basis for all media per route of exposure (Table 1).
3 - MEI all-source 2010 dose additions. Some DOE-SR offsite dose is based on computer modeling.
4 - Air inhalation plus LPW water source ingestion (highest Savannah River water).
5 - APW soil sources were from Creek Plantation (DOE-SR) and other soil and sediment (SCDHEC).
6 - LPW soil and sediment sources (location differences).
7 - Highest Air/Liquid/Irrigation/milk, vegetable, and recreational swimming ingestion sources
8 - Edible fungi dose from Cs-137 bioconcentration was highest in *Cantharellus* and *Boletus* spp.
9 - Biased high primarily due to single maximums (SCDHEC), assigned dose (DOE-SR), and released dose basis.
Not all released dose results in local exposure, and explains why field measurements do not detect all dose released.

Table 4. Sportsman versus Nonsportsman Food Comparison

2010		1999-2010 mrem			
2010 AEI Food Categories	**Total mrem**	**Media**	**Avg.**	**SD**	**Median**
Sportsman	1.913	Fish,Deer,Hog	1.298	1.438	0.960
Nonsportsman Public Food	0.007	Veg and Milk	0.052	0.062	0.030
Fungi	0.848	Fungi	0.628	0.285	0.730
AEI All-Food Ttl[1]	**2.768**				
MAX Wild Food Ttl	**15.829**	**Fish,Deer,Hog,Fungi**	**11.867**	**9.982**	**10.135**
Substitute MAX Deer for AEI Deer[2]	9.699	**2010 Food**		**MAX**	**% of MEI[3]**
Substitute MAX Fish for AEI Fish[2]	3.186	Fungi Only		5.603	34.771
Substitute MAX Fungi for AEI Fungi[2]	7.549	Sportsman (fish, deer, hog)		10.226	63.460
		Public (vegetables and milk)		0.013	0.081
All Food MAX Totals[1]				**15.842**	**98.312**

Notes:
1 - The AEI All-Food totals and statistics are based on the AEI values from Section 4.0, Table 1.
2 - Examples of adding a single highest maximum in place of the AEI value.
3 - % of MEI is on a MAX basis percent of the MAX Perimeter dose (16.334 mrem).

Table 5. Variability in SCDHEC and DOE-SR Media Dose Pathway Maximums, 2010

Environmental Monitors - 2010	SCDHEC				DOE-SR[1]			
Pathways - - - - - - - Media and mrem Dose[2]	Air	Liquid	Soil	Food	Air	Liquid	Soil	Food
Water		0.239				0.060		
Inhalation	0.007				0.050			
Combined Soil[3]			0.000				3.180	
Swimming		0.026				0.000		
Boating		0.000				0.000		
Milk (cow or goat)				0.000				0.015
Edible Vegetation				0.013				0.086
Creek Mouth Fish				0.584				0.220
Offsite Deer				7.522				0.370
Offsite Hog				2.120				0.180
Totals	0.007	0.265	0.000	10.239	0.050	0.060	3.180	0.871
Avg	0.007	0.088	0.000	2.048	0.050	0.020	3.180	0.174
SD	NA	0.131	NA	3.180	NA	0.035	NA	0.136
Median	0.007	0.026	0.000	0.299	0.050	0.000	3.180	0.153
2010 MEI Comparison	Media				Summary Statistics			
Program Totals	Air	Liquid	Soil	Food	Totals	Avg[4]	SD[5]	Median
SCDHEC	0.007	***0.265***	0.000	***10.239***	10.511	**2.628**	5.076	0.136
DOE-SR	***0.050***	0.060	***3.180***	0.871	4.161	**1.040**	1.477	0.465
Combined average	0.029	0.163	1.590	5.555	7.336	1.834	NA	0.301
and standard deviation	0.030	0.145	2.249	6.624	4.490	1.123	NA	NA
% of standard[6]	**0.500**	**6.625**	Highest media totals across programs (italics).				*13.734*	is <100 mrem

Notes:

1. Used DOE-SR maximum source estimates of dose to the MEI from liquid, goat, irrigation, and sportsman pathways of the Savannah River Site Environmental Report for 2010, SRNS-STI-2011-00059.
2. Some media are not directly comparable due to annual release estimates versus field accumulations over several years. However, the highest field measurements tend to correlate since they represent accumulations.
3. The combined soil reflects dose from surface and riverbank soil (SCDHEC), swamp and Steel Creek soils (DOE-SR).
4. Avg is average.
5. SD is standard deviation.
6. % is percent of EPA and DOE annual air (10 mrem), liquid (4 mrem), and annual release standards using highest result (underlined), SCDHEC or DOE-SR. That is, sum of highest dose detections from either program is <annual standards. Table 3 confirms this for the total MEI estimated onsite and offsite dose is less than 31.726 mrem regardless of applicability
7. Highest comparable media result across SCDHEC and DOE-SR programs totaled is 13.734 mrem (bold italics).

2010 Critical Pathway Dose Report

Table 6. 1999-2010 DOE-SR Percent of Total Dose to the MEI for Atmospheric and Liquid Releases

MEI from Atmospheric Releases (MAXIGASP-SR Code) Percent of Total Dose												
DOE-SR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plume	0.1	0.4	0.5	0.2	0.4	0.0	0.0	0.0	0.0	0.00	0.0	0.0
Ground	1.0	1.7	0.7	2.1	1.7	1.6	2.3	6.4	3.8	0.30	3.2	2.7
Inhalation	48.3	45.7	42.6	41.0	33.5	43.4	42.7	41.6	41.1	43.20	41.1	47.0
Vegetation	44.4	41.9	44.1	44.5	51.9	39.4	40.7	46.3	39.6	39.32	38.7	32.2
Cow Milk	4.6	7.3	9.0	9.1	9.6	11.3	10.3	1.5	10.9	12.34	12.2	17.4
Meat	1.7	2.9	3.2	3.2	2.9	4.4	4.0	4.3	4.6	4.84	4.7	0.7

Cow Milk Pathway % Dose			
1999-2010	Avg	SD	Median
Plume	0.1	0.2	0.0
Ground	2.3	1.6	1.9
Inhalation	42.6	3.7	42.7
Vegetation	41.9	4.9	41.3
Cow Milk	9.6	4.0	9.9
Meat	3.5	1.3	3.6

MEI from Liquid Releases Percent of Total Dose												
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fish	61.0	45.8	40.2	42.5	55.4	47.0	59.0	59.0	51.0	43.0	64.0	61.0
Water	38.5	53.9	59.5	57.2	44.2	53.0	41.0	41.0	49.0	57.0	36.0	39.0
Shoreline	0.4	0.3	0.3	0.3	0.4	<1	<1	<1	<1	<1	<1	<1
Swimming	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1	<1
Boating	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1	<1

Potential MEI % Dose from the Liquid Releases			
1999-2010	Avg	SD	Median
Fish	52.4	8.5	53.2
Water	47.4	8.4	46.6
Shoreline	0.3	0.1	0.3
Swimming	0.0	0.0	0.0
Boating	0.0	0.0	0.0

Notes:
1 - See the list of acronyms for abbreviation definitions.
2 - Data accumulated from the DOE-SR SRS Environmental Reports for the listed years.

Table 7. 1999-2010 DOE-SR Committed Dose (mrem) for MEI and Sportsman Pathways (DOE-SR)

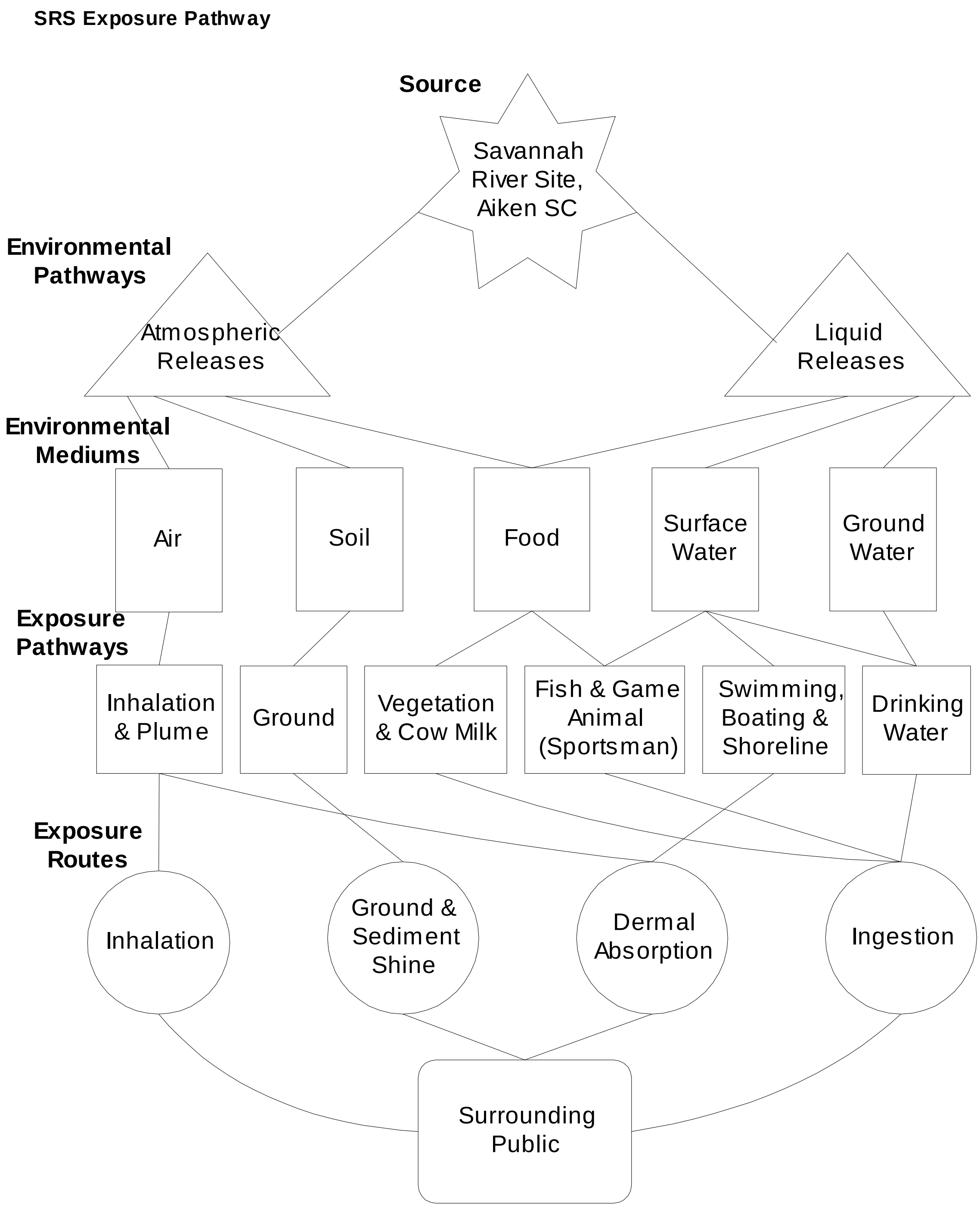
Path / Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
All Pathway	0.28	0.18	0.18	0.18	0.19	0.15	0.13	0.20	0.10	0.12	0.12	0.11
Onsite Hunter	77.00	63.00	14.00	39.50	15.60	70.80	8.80	22.00	9.00	13.00	8.4	12.37
Offsite Hunter	9.10	10.10	0.53	12.15	1.20	17.30	8.30	9.60	4.80	13.40	4.44	0.37
Offsite Fisherman	0.61	1.18	1.74	0.62	0.66	0.71	0.52	0.52	0.50	0.37	0.38	0.40

	Statistics		
1999-2010	Avg	SD	Median
All Pathway	0.16	0.05	0.17
Onsite Hunter	29.46	26.17	14.80
Offsite Hunter	7.61	5.41	8.70
Offsite Fisherman	0.68	0.40	0.57

Notes:
1 - See the list of acronyms for abbreviation definitions.
2 - Data accumulated from the DOE-SR SRS Environmental Reports for the listed years.
3. The offisite hunter includes deer and hog (when available) for this total.
4. The DOE-SR All-Pathway dose is for the liquid and airborne pathways excluding the sportsman dose.

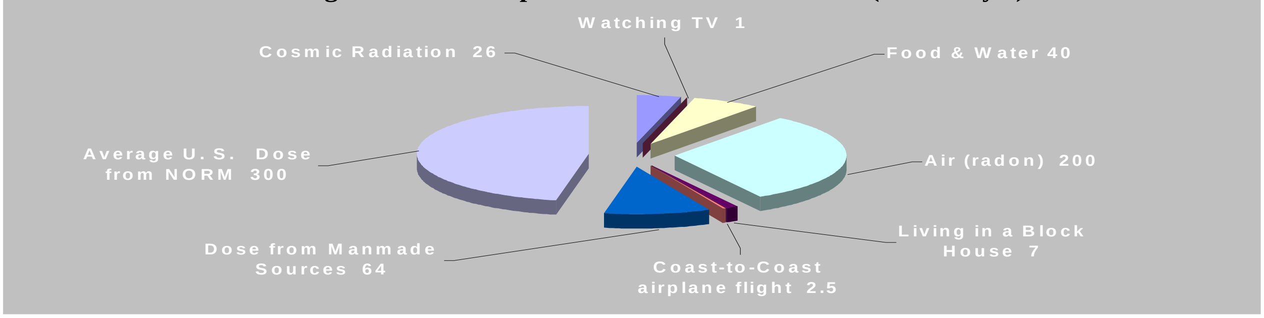
Tables and Figures
2010 Critical Pathway Dose Report

Figure 1. DOE-SR Critical Pathways and Dose Media



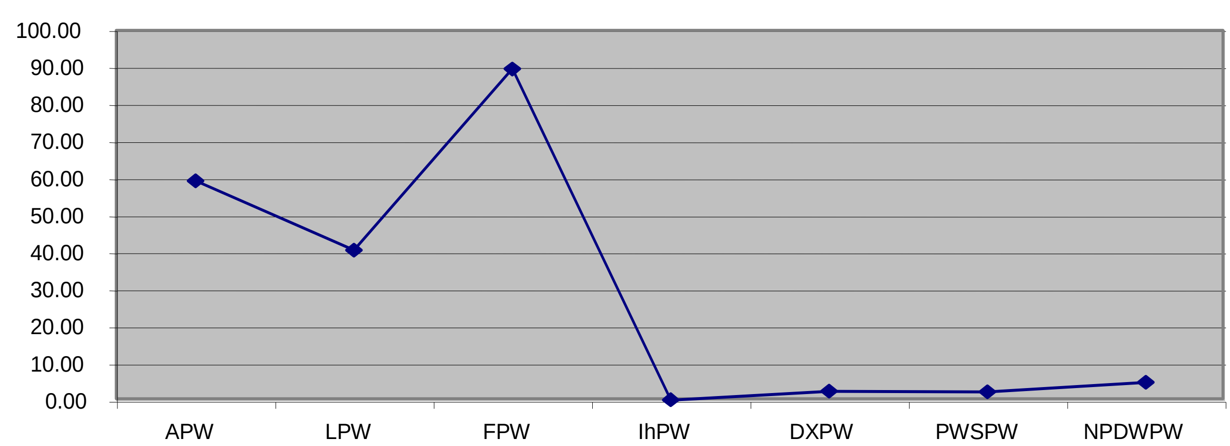
Tables and Figures
2010 Critical Pathway Dose Report

Figure 2. Comparison of Dose Levels (mrem/yr)



Notes:
1 – The average naturally occurring radioactive material (NORM) is 300 mrem/yr.
2 – Pie sections are relative to each other and not to percent of total.

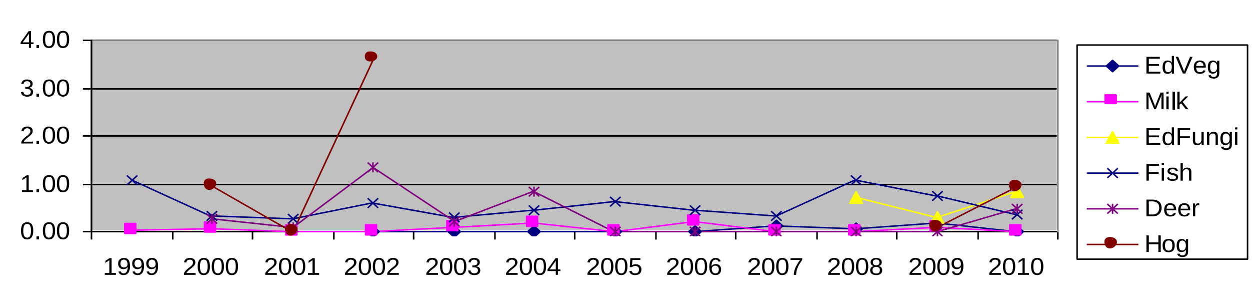
Figure 3. 1999-2010 Critical Pathways Comparison (%)



1 - Does not include alpha, beta, or beta-gamma since they are nonspecific screening values.
2 – APW is the atmospheric pathway inhalation plus deposition dose.
3 – LPW is the liquid pathway or water dose.
4 – FPWis the food subpathway.
5 – IhPW is the inhalation subpathway.
6 – DXPW is the direct exposure subpathway.
7 – PWSPW is the public water systems drinking water subpathway.
8 – NpDWPW is the nonpotable or untreated drinking water subpathway.
9 - Figure 3 is based on Section 6.0 Table 3.

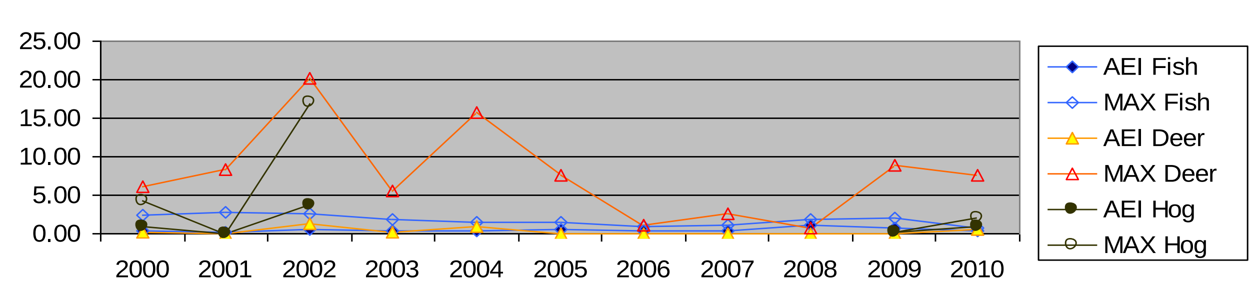
Tables and Figures
2010 Critical Pathway Dose Report

Figure 4. 1999-2010 AEI Food Media Trends (mrem)



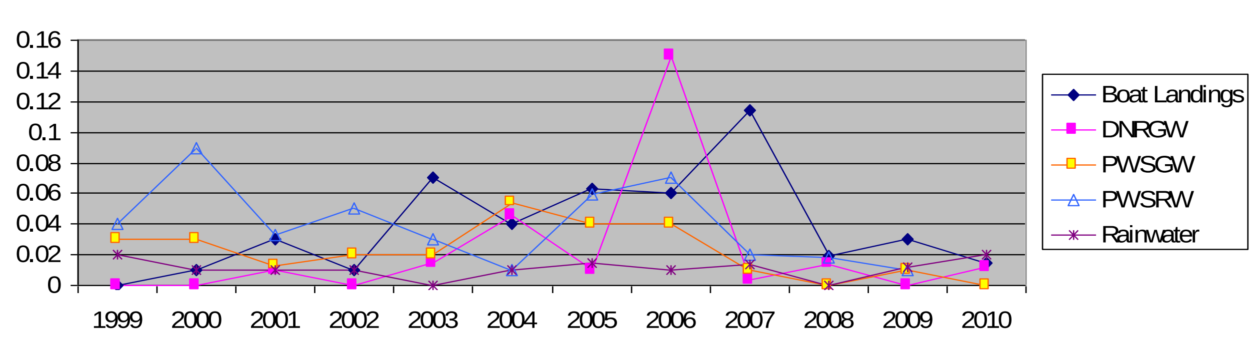
Note:
Average dose in foods are typically 1 mrem or less.

Figure 5. 1999-2010 AEI Versus MAX Dose Trends in Sportsman Food Media (mrem)



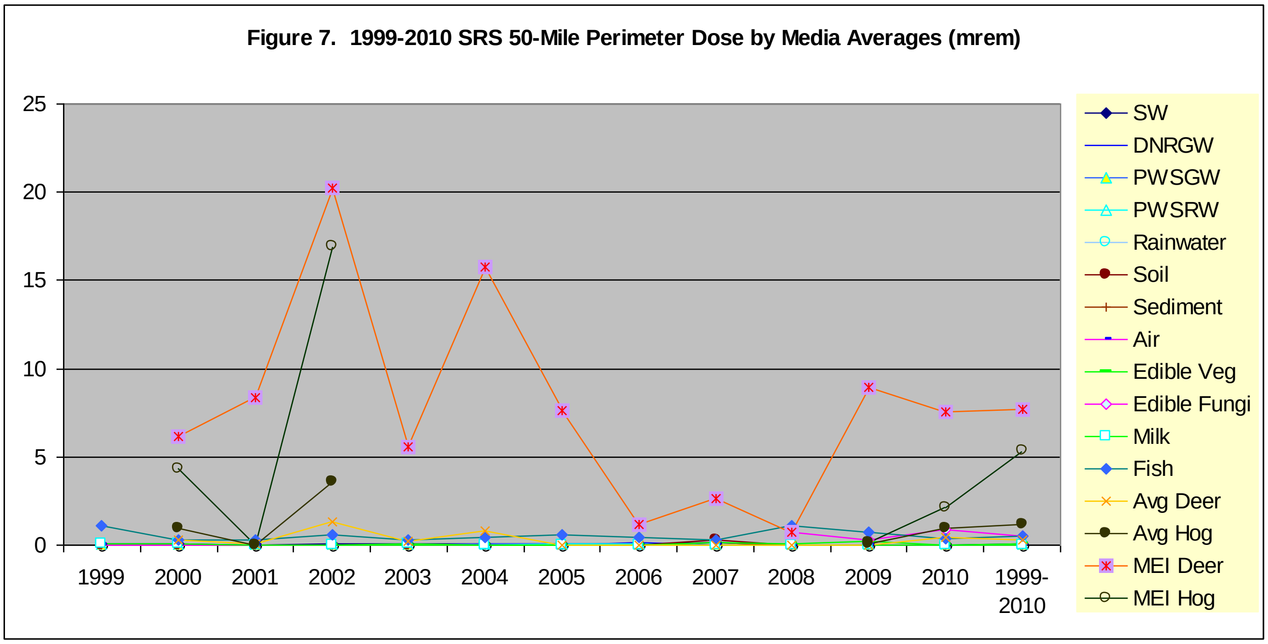
Note:
The storage of a single MAX dose consumed throughout the year can increase exposure up to 20 fold.

Figure 6. 1999-2010 AEI Dose Trends in Water Sources (mrem)

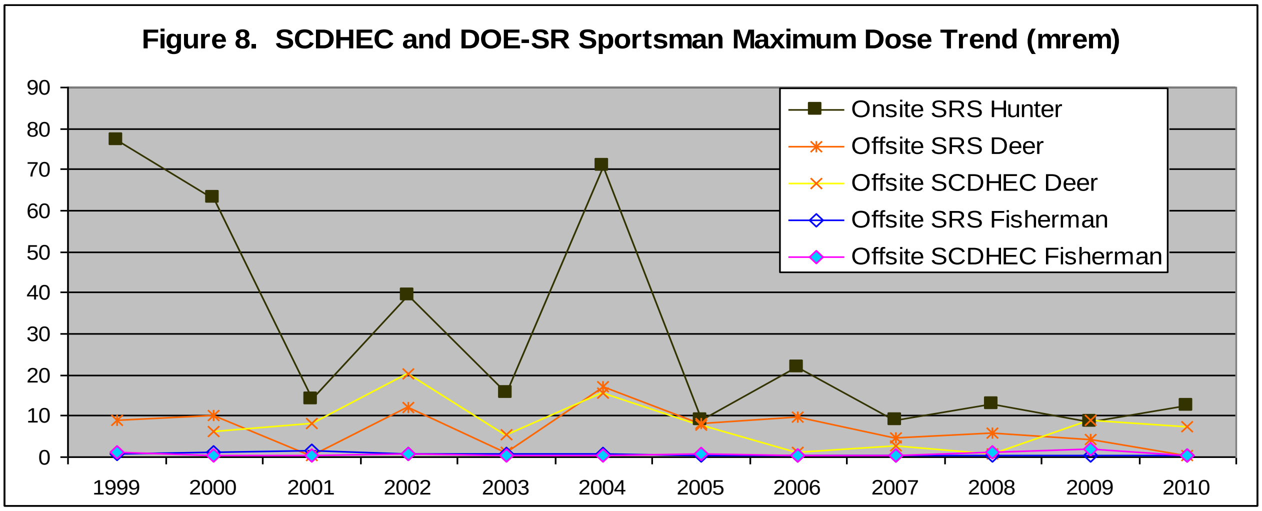


Note:
Water media dose exposure occurs primarily from Savannah River surface water near SRS.

Tables and Figures
2010 Critical Pathway Dose Report



Note:
The dominant dose exposure comes from wild food media.



Note:
Sportsman media maximum dose trends are declining.

TOC

5.1.3 Data

2010 Critical Pathway Dose Report

Notes:

1 – The following "Average Dose" data tables subtract an average background activity from the average activity of the listed radionuclide found in a media.

2 – The "Single Highest Dose" data tables subtract the same average background from the single highest maximum for a particular radionuclide found in a media.

3 – The resultant net activity is multiplied by a consumption rate and dose factors from USEPA FGR sources to obtain the dose result for a particular radionuclide and media source. The 2006 Dose Report and 2007 Critical Pathway Dose plan explain how these calculations result in a dose estimate in millirems per year.

4 – The last column/page gives the resultant dose that was assigned to the maximum exposed individual.

5 – Alpha, beta, and beta-gamma dose is no longer included since these are screening values with assigned dose for calculating an upper bound. The maximum dose from the single highest detected dose per radionuclide per media replaces this upper bound calculation with an actual detected radionuclide factor instead of an assigned substitute factor.

6 – See the list of acronyms, radionuclides, and units for abbreviation definitions.

7 - Section 5.1.2, Table 1 places the dose from media sources into applicable critical pathway categories. There are many crossover pathways; for example liquid dose can result in both direct exposure to the

swimmer and water ingestion. Specific knowledge of the science, radionuclides, media, locations, and supporting media are required to properly assign dose as NORM or nonNORM. Only nonNORM dose is included in these tables.

8 – Calculations by SCDHEC are to three decimal places in millirem determinations and rounded as needed for appropriate comparisons to DOE-SR data.

9 – NORM activity is not included since total yearly NORM detections are far less than the 300 mrem average background.

10 – Edibility of wild plants is based on Porcher (1863, 2001) and fungi on Lincoff (1981).

2010 Average Dose Detections in Food Media

Average Basis		AVG	Bkg	Net	MCR	Dose	Summaries		MEI
Project Media		**Activity**	**Activity**	**Activity**		**mrem**	**Fish**		**Dose**
Potential Dose from Fish Ingestion							**Average**	**Totals**	**NonNORM**
Fish	**Isotope**	**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**per Isotope**	**per Isotope**	**Basis**
Edible Bass	**H-3**	0.792	0.447	**0.345**	48.2	**0.001**	**H-3**	**H-3**	**0.001**
	Cs-137	0.157	0.090	**0.067**	48.2	**0.161**	0.001	0.002	
	Sr-89/90	0.083	0.100	**0.000**	48.2	0.000			
	Bass nonNORM dose average					0.054	**Cs-137**	**Cs-137**	**0.169**
Edible Catfish	**H-3**	0.395	0.000	**0.395**	48.2	**0.001**	0.165	0.329	
	Cs-137	0.130	0.060	**0.070**	48.2	**0.169**	**Sr-89/90**	**Sr-89/90**	**0.022**
	Sr-89/90	0.047	0.009	**0.038**	48.2	**0.022**	0.011	0.022	
	Catfish nonNORM dose average					0.064			
	Fish Total of Highest Dose per Radionuclide							**0.192**	
Potential Dose from Milk Ingestion									**0.000**
Cow		**pCi/L**	**pCi/L**	**pCi/L**	**kg/yr**	**mrem**	**nonNORM in Cow Milk**		
	H-3	0.000	0.000	**0.000**	230.0	**0.000**	**H-3**		
	Sr-89/90	0.347	0.425	**0.000**	230.0	**0.000**	**0.000**		
							Sr-89/90	**Cow Ttl**	
	Cow milk nonNORM dose avg					**0.000**	**0.000**	**0.000**	
Potential Dose From Game									**1.721**
Game Animal		**Study Area Average**		**Bkg Average**				**Game Ttl**	
Ingestion		**mrem**		**mrem**		**mrem**		**1.721**	
Avg Deer	**Cs-137**	**1.065**		0.448		**0.617**			
Avg Hog	**Cs-137**	**1.104**		0.000		**1.104**			
	Game Animal nonNORM dose average					0.861			
Potential Dose from NonNorm in Edible Vegetation									**0.007**
Edible Vegetation	**Isotope**	**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**nonNORM in Plants**		
Leafy	**H-3**	**0.428**	0.000	0.428	73.0	**0.002**	**Avg**	**Totals**	
Leafy Vegetables nonNORM Average						0.002	**H-3**	**H-3**	
Fruit	**H-3**	**0.294**	0.000	0.294	276.0	**0.005**	0.004	0.004	
Fruit nonNORM Average						0.005			
Edible	**Cs-137**	**4.647**	**0.000**	4.647	3.65	**0.848**	**nonNORM in Fungi**		**0.848**
Fungi	**H-3**	**0.314**	0.000	0.314	3.65	0.000	**All**	**All**	
Fungi nonNORM Average						0.424	0.424	0.848	
							Total nonNORM dose		**2.768**
							AEI Food Detected Dose		2.768

Table notes:

1 - Bold **number** denotes NonNORM isotope or radionuclide detections.

2 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.

3 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.

4 - Some edible fungi were not identified to species level. Most boletes are edible and other edible fungi potential dose was added only as a special case representing a minority consumer of wild mushrooms.

5 - <LLD and <MDA are entered as a zero average nondetection and biases the result high and protective.

2010 Single Highest Dose Detections in Food Media

Maximum Potential Exposure		**AVG**	**Bkg**	**Net**	**MCR**	**Dose**	**Summaries**		**MEI**
Project Media		**Activity**	**Activity**	**Activity**		**mrem**	**Fish**		**Dose**
Potential Dose from Fish Ingestion							**Average**	**Totals**	**NonNORM**
Fish	**Isotope**	**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**per Isotope**	**per Isotope**	**Basis**
Edible Bass	**H-3**	2.187	0.447	**1.740**	48.2	**0.005**	**H-3**	**H-3**	**0.005**
	Cs-137	0.280	0.090	**0.190**	48.2	**0.458**	0.003	0.007	
	Sr-89/90	0.310	0.100	**0.210**	48.2	**0.121**			
	Bass non-NORM dose average					0.232	**Cs-137**	**Cs-137**	**0.458**
Edible Catfish	**H-3**	0.427	0.000	**0.427**	48.2	**0.001**	0.313	0.627	
	Cs-137	0.130	0.060	**0.070**	48.2	**0.169**	**Sr-89/90**	**Sr-89/90**	**0.121**
	Sr-89/90	0.070	0.009	**0.061**	48.2	**0.035**	0.078	0.156	
	Catfish non-NORM dose average					0.085			
Potential Dose from Milk Ingestion									**0.000**
Cow		**pCi/L**	**pCi/L**	**pCi/L**	**kg/yr**	**mrem**	**H-3**		
	H-3	**<MDA**	**<MDA**	**0.000**	230.0	**0.000**	**0.000**		
	Sr-89/90	**0.460**	**0.425**	**0.035**	230.0	**0.000**	**Sr-89/90**	**Cow Ttl**	
	Cow milk nonNORM dose avg					**0.000**	**0.000**	**0.000**	
Potential Dose From Game									**9.642**
Game Animal		**Study Area Average**		**Bkg Average**			**Hunter Game Ttl**		
Ingestion		**mrem**		**mrem**		**mrem**	**9.642**		
MAX Deer	**Cs-137**	**7.970**		**0.448**		**7.522**	Based on 1 deer,1 hunter		
MAX Hog	**Cs-137**	**2.120**		**0.000**		**2.120**	Based on 1 hog,1 hunter		
Hunter MEI						**9.642**	Based on 1 deer+1 hog		
Deer & Hog	**Game Animal nonNORM dose average**					**4.821**			
Potential Dose from NonNorm in Edible Vegetation									**0.013**
Edible Vegetat	**Isotope**	**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**nonNORM in Plants**		
Leafy	**H-3**	**0.428**	0.000	0.428	73.0	**0.002**	**Avg**	**Totals**	
Leafy Vegetables nonNORM Average						0.002	**H-3**	**H-3**	
Fruit	**H-3**	**0.628**	0.000	0.628	276.0	**0.011**	0.007	0.013	
Fruit nonNORM Average						0.011	**nonNORM in Fungi**		**5.603**
Edible	**Cs-137**	**30.700**	0.000	30.700	3.65	**5.603**	**All**	**All**	
Mushrooms	**H-3**	**0.314**	0.000	0.314	3.65	0.000	2.801	5.603	
Fungi nonNORM Average						2.801			
							Total nonNORM dose		**15.842**
							Maximum Detected Dose		15.842

Table notes:
1 - Bold denotes NonNORM isotope or radionuclide activity.
2 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.
3 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.
4 - Some edible fungi were not identified to species level. Most boletes are edible and other edible fungi potential dose was added only as a special case representing a minority consumer of wild mushrooms.
5- The maximum detected dose potential is assigned to the maximally exposed individual (MEI).

2010 Average Dose Detections in Water Media

Average Basis		Avg	Bkg	Net	MCR	Dose	Exposure Group		MEI
Project Media		Activity	Activity	Activity		mrem			Dose
Sources	Radionuclide Ingestion From Surface Water (SW) and Wells							Totals	(mrem)
PWSRW(DW)	Isotope	pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM……		*1
SW	**H-3**	NC	NC	**NC**	730	**NC**			
Savannah River Public Water Supplies (PWS) Drinking Water (DW)									
See SW below for comparable Savannah River Values									
Downstream river water near Savannah would be <SW values below due to tributary dilutions.									
PWSGW(DW)		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM……		
GW	**H-3**	0.000	0.000	**0.000**	730	**0.000**			
Public Water Supplies with Groundwater (GW) Sources								0.000	
PWS Average Dose from Random plus nonRandom Wells.									
DNRGW		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM……		
GW	**H-3**	260	0	**260**	730	**0.012**			
DNR Monitoring Wells (comparable to local untreated private wells)								0.000	
Pu-238/239/240, U-234/235/238 were all <BKG.									
Nonpotable		pCi/L	pCi/L	pCi/L	L/yr	mrem	NonNORM……		
SW	**H-3**	606	283	**323**	730	**0.015**			
Survivalist Ingestion at Savannah River Boat Landings								0.000	
Average Dose from Random plus nonRandom Samples.									
Rainwater	**H-3**	419	0	**419**	730	**0.020**	NonNORM……		0.020
Nonpotable Average Dose Potential from Rainwater Cisterns									
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)									
Surface Water		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM……		0.005
Ingestion	**H-3**	8224	283	**7941**	91	**0.005**			
Ingestion while swimming at Savannah River Site Creek Mouths									
Surface Water		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM……		0.000
Immersion	**H-3**	8224	283	**7941**	91	0.000			
Direct exposure to the skin while swimming at SRS Creek Mouths.									
Average Dose from Skin Exposure to Creek Water						0.000			
Surface Water		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM……		0.000
Boating	**H-3**	8224	283	**7941**	192	0.000			
Direct exposure from SRS Creek Mouth Water while Boating									
Boating Average Dose from Skin Exposure to Creek Water						0.000			
Surface Water		pCi/L	pCi/L	pCi/L	hrs/yr	mrem	NonNORM……		0.000
Resident	**H-3**	8224	283	**7941**	4380	0.000			
Swamp House or Houseboat Dose Exposure to Water									
Swamp Resident Average Dose from Skin Exposure to Creek Water						0.000			
Sediment Random plus Nonrandom at Creek Mouths									
Skin exposure from wading on sediments to 1 cm depth at SRS creek mouths.									
Sediment Dose		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM……		0.000
Creek Mouths	**Cs-137**	0.423	0.000	**0.423**	91	0.000			
							AEI nonNORM		0.024
							all AEI Water Dose		0.052

Table notes: *1 for NC means not collected in 2010.

1 - Bold denotes nonNORM isotope or radionuclide activity.

2 - NC means not collected in 2010.

3 - SW is surface water, GW is groundwater, DW is drinking water, RW is river water, PWS is public water supply, DNR is Department of Natural Resources.

4 - pCi/g is pico curies per gram, pCi/L is pico curies per liter, hrs/yr is hours per year, mrem is millirem.

5 - Only one water consumption dose can be assigned (the highest) at the maximum rate of consumption.

2010 Single Highest Dose Detections in Water Media

Maximum Basis		**MAX**	**Bkg**	**Net**	**MCR**	**Dose**	**Exposure Group**		**MEI**
Project Media		**Activity**	**Activity**	**Activity**		**mrem**			**Dose**
	Radionuclide Ingestion From Surface Water and Wells								
Sources	**Ingestion**							Totals	**(mrem)**
PWSRW(DW)	**Isotope**	**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM......**		***1**
SW	**H-3**	NC	NC	NC	730	NC			
Savannah River Public Water Supplies (PWS) Drinking Water (DW)									
PWSRW(DW) Public Water Supplies from Savannah River Water (RW)									
Includes RW from Chelsea, Beaufort Jasper, and City of Savannah minus North Augusta background.									
PWSGW(DW) Ingestion		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM......**		
GW	**H-3**	<MDA	<MDA	**<MDA**	730	**<MDA**			
Public Water Supplies with Groundwater (GW) Sources								**0.000**	
PWSGW(DW) Public Water Supplies from Wells.									
DNRGW		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM......**		
GW	**H-3**	359.000	0.000	**359.000**	730	**0.017**			
DNR Monitoring Wells (comparable to local untreated private wells)								**0.017**	
Pu-238/239/240, U-234/235/238 were all <BKG.									
Nonpotable		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM......**		**0.239**
SW	**H-3**	5384.000	283.000	5101.000	730	**0.239**			
Survivalist Ingestion at Savannah River Boat Landings									
Cooking with or ingesting Savannah River Water									
Rainwater	**H-3**	538.770	0.000	**538.770**	730	**0.025**	**NonNORM......**		
Nonpotable Average Dose Potential from Rainwater and Boat Landings.						0.025		**0.025**	
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)									
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM......**		**0.026**
Ingestion	**H-3**	44357.000	283.000	**44074.000**	91	**0.026**			
Ingestion while swimming at Savannah River Creek Mouths									
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM......**		**0.000**
Immersion	**H-3**	44357.000	283.000	**44074.000**	91	0.000			
Direct exposure to the skin while swimming at SRS Creek Mouths[6]									
Average Dose from Skin Exposure to Creek Water						0.000			
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM......**		**0.000**
Boating	**H-3**	44357.000	283.000	**5101.000**	192	0.000			
Direct exposure from SRS Creek Mouth Water while Boating[5]									
Boating Average Dose from Skin Exposure to Creek Water						0.000			
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM......**		**0.000**
Resident	**H-3**	44357.000	283.000	**44074.000**	4380	0.000			
Swamp House or Houseboat Dose Exposure to Water[5]									
Swamp Resident Average Dose from Skin Exposure to Creek Water						0.000			
Sediment Random plus Nonrandom at Streams and Creek Mouths									
Sediment Dose		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**nonNORM**		**0.000**
Creek Mouths	**Cs-137**	**0.920**	**0.000**	**0.920**	91	**0.000**			
							MEI nonNORM		**0.264**
							all MAX Water Dose		0.306

Table notes: *1 for NA means not collected in 2010.

1 - Bold denotes nonNORM isotope or radionuclide activity.
2 - NC means not collected in 2010.
3 - SW is surface water, GW is groundwater, DW is drinking water, RW is river water, PWS is public water supply, DNR is Department of Natural Resources.
4 - pCi/g is pico curies per gram, pCi/L is pico curies per liter, hrs/yr is hours per year, mrem is millirem.
5 - Electron dose equivalent for boating activities is zero. This changes for other emissions and respective reduction factors.
6 - Skin immersion dose coefficient for tritium is zero. Other radionuclides do have dose coefficients for skin.
7 - Only one water consumption dose can be assigned (the highest) at the maximum rate of consumption.

2010 Average Dose Detections in Soil and Air Media

Average Basis		Avg	Bkg	Net	MCR	Dose	Exposure Group		MEI
Project Media		Activity	Activity	Activity		mrem	NORM or nonNORM		Dose
Sources	Isotopes								Total
Surface Soil & Riverbank Soil Random plus Nonrandom Sample Detections									
Surface Soil (SS)		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	**mrem**	**NonNORM......**		**0.000**
Ingestion	**Cs-137**	0.137	0.312	0.000	100	0.000	**Avg**	**Totals**	
							0.000	**0.000**	
Represents potential dose from ingesting resuspended farm soil in plants.									
Surface Soil **Ingestion** Average Dose **All** Isotopes									
Riverbank Soil (RS)		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	mrem	**NonNORM......**		**0.000**
Boat	**Cs-137**	0.224	0.130	**0.094**	100	0.000	**Avg**	**Totals**	
Landings							**0.000**	**0.000**	
Riverbank Soil Ingestion Avg Dose **All** Isotopes at Boat Landings.									
All Soil Ingestion Dose (Surface Soil plus Riverbank Soil)									
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM......**		**0.000**
Direct	**Cs-137**	0.137	0.312	**0.000**	4380	0.000	**Avg**	**Totals**	
Exposure							**0.000**	**0.000**	
Surface Soil Direct Exposure Average Dose All Isotopes									
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM......**		**0.000**
Direct	**Cs-137**	0.224	0.130	**0.094**	4380	0.000			
Exposure									
Riverbank Soil Average Direct Exposure **All** Isotopes									
All Soil Direct Exposure (Surface Soil plus Riverbank)									
Soil Resuspension and Air Inhalation Dose									
Surface Soil Resusp		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM......**		**0.000**
	Cs-137	**0.137**	**0.312**	**0.000**	8000	0.000	**Avg**	**Totals**	
							0.000	**0.000**	
Surface Soil Resuspension All Inhalation Avg Dose									
Riverbank Soil Resu		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM......**		**0.000**
	Cs-137	0.224	0.130	**0.094**	8000	0.000			
Riverbank Soil Resuspension All Inhalation Avg Dose									
All Soil Resuspension (Surface Soil plus Riverbank)									
Air Inhalation		**pCi/m3**	**pCi/m3**	**pCi/m3**	**m3/yr**	**mrem**	**NonNORM......**		**0.001**
Inhalation	**H-3**	**4.750**	2.930	**2.900**	8000	**0.001**	**Avg**	**Totals**	
							0.001	0.001	
							nonNORM total		**0.001**
							AEI Detected Dose		**0.001**

Table notes:

1 - Bold number denotes NonNORM isotope or radionuclide activity.

2 - NORM activity not included.

2010 Single Highest Dose Detections in Soil and Air Media

Maximum Basis		MAX	Bkg	Net	MCR	Dose	Exposure Group		MEI
Project Media		Activity	Activity	Activity		mrem			Dose
Sources	Isotope						Avgs	Totals	Total
Surface Soil (SS) & Riverbank Soil (RbS) Random and Nonrandom Sample Detections									
Surface Soil		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM......		0.000
Ingestion	Cs-137	0.256	0.312	0.000	100	0.000	Avg	Totals	
							0.000	0.000	
Upturned Soil NORM plus nonNORM Ingestion Dose									
Riverbank Soil		pCi/g	pCi/g	pCi/g	mg/day	mrem	NonNORM......		0.000
Ingestion	Cs-137	0.228	0.130	0.099	100	0.000	0.000	0.000	
Sportsman/Recreational potential riverbank soil dose at public boat landings.									
Surface Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	onNORM......		0.000
Direct	Cs-137	0.256	0.312	0.000	4380	0.000	Avg	Totals	
Exposure							0.000	0.000	
Farming Potential Dose From Surface Soils									
Riverbank Soil		pCi/g	pCi/g	pCi/g	hrs/yr	mrem	NonNORM......		0.000
Direct	Cs-137	0.228	0.130	0.099	4380	0.000	0.000	0.000	
Exposure									
Soil Resuspension and Inhalation Dose									
Surface Soil		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM......		0.000
Inhalation	Cs-137	0.256	0.312	-0.056	8000	0.000			
Riverbank Soil		pCi/g	pCi/g	pCi/g	m3/yr	mrem	NonNORM......		0.000
Inhalation	Cs-137	0.228	0.130	0.099	8000	0.000			
Air Inhalation		pCi/m3	pCi/m3	pCi/m3	Avg	mrem	NonNORM......		0.007
Inhalation	H-3	16.740	2.930	13.810	8000	0.007			
Notes:							Total nonNORM		0.007
1 - all <MDA non-detect results are assigned as zeros.							MAX Detected Dose		0.007

TOC

5.1.4 Summary Statistics
2010 Critical Pathway Dose Report

Summary Statistics
2010 Critical Pathway Dose Report

Table 1. Average Dose Rank by Radionuclide Categories (Millirems and Percentages)

1999-2010	Sum	%	Avg	SD	Median	Max	N#	2010	Sum	%	Avg	SD	Median	Max	N#
Totals	29.126	100.00	1.565	NA	0.917	7.549	171	Totals	3.027	100.00	0.785	0.356	0.791	1.191	14
Cs-137	20.906	71.78	0.510	0.818	0.265	4.770	41	Cs-137	2.898	95.738	0.725	0.330	0.733	1.104	4
Ra-226	5.084	17.46	0.462	0.517	0.189	1.390	11	H-3	0.067	2.213	0.010	0.010	0.007	0.025	7
H-3	0.896	3.08	0.012	0.013	0.008	0.057	72	Ra-226	0.040	1.321	0.040	NA	0.040	0.040	1
Sr-89/90	0.870	2.99	0.062	0.084	0.016	0.231	14	Sr-89/90	0.022	0.727	0.011	0.016	0.011	0.022	2
U-238	0.443	1.52	0.055	0.128	0.008	0.372	8	Sr-89	0.000	0.000	NA	NA	NA	0.000	0
Sr-89	0.209	0.72	0.052	0.078	0.019	0.169	4	Sr-90	0.000	0.000	NA	NA	NA	0.000	0
Ra-228	0.185	0.64	0.093	0.018	0.093	0.105	2	U-234	0.000	0.000	NA	NA	NA	0.000	0
U-234	0.177	0.61	0.089	0.084	0.089	0.148	2	U-235	0.000	0.000	NA	NA	NA	0.000	0
Eu-155	0.119	0.41	0.060	0.074	0.060	0.112	2	U-238	0.000	0.000	NA	NA	NA	0.000	0
Zn-65	0.073	0.25	0.073	NA	0.073	0.073	1	Ra-228	0.000	0.000	NA	NA	NA	0.000	0
Th-234	0.057	0.20	0.029	0.023	0.029	0.045	2	Pu-239/240	0.000	0.000	NA	NA	NA	0.000	0
U-235	0.047	0.16	0.016	0.005	0.017	0.020	3	Am-243	0.000	0.000	NA	NA	NA	0.000	0
Am-241	0.040	0.14	0.040	NA	0.040	0.040	1	Pu-238	0.000	0.000	NA	NA	NA	0.000	0
Sr-90	0.012	0.04	0.006	0.004	0.006	0.009	2	Pu-239	0.000	0.000	NA	NA	NA	0.000	0
Am-243	0.003	0.01	0.003	NA	0.003	0.003	1	Ac-228	0.000	0.000	NA	NA	NA	0.000	0
Pu-239/240	0.002	0.01	0.001	0.000	0.001	0.001	2	Ce-144	0.000	0.000	NA	NA	NA	0.000	0
Zr-95	0.002	0.01	0.002	NA	0.002	0.002	1	Tc-99	0.000	0.000	NA	NA	NA	0.000	0
Pu-238	0.001	0.00	0.001	NA	0.001	0.001	1	Eu-155	0.000	0.000	NA	NA	NA	0.000	0
Tc-99	0.001	0.00	0.001	NA	0.001	0.001	1	Zn-65	0.000	0.000	NA	NA	NA	0.000	0

Notes:

1 - N# represents media category detection values and not individual detections (e.g., farm & riverbank soil).

2 - This table is not directly comparable with other tables for the summary is based on media categories potentially comparable to DOE-SR atmospheric, liquid, diffuse, and fugitive releases related to potential dose.

3 - Some detection categories are potential NORM (e.g., Ra-226) and not comparable to Section 4.0 Table 1.

Summary Statistics
2010 Critical Pathway Dose Report

TOC

Table 3. 1999-2010 AEI Critical Pathways, Subpathways, and Potential Exposure Summary

Critical Pathways Dose Totals 1999-2010		Millirems	% of Total
Atmospheric Pathway (APW)[1]		12.218	60.470
Liquid Pathway (LPW)[2]		7.988	39.530
Subpathways	Food or Ingestion (FPW)[3]	18.108	89.617
	Inhalation (IhPW)[4]	0.066	0.327
	Direct Exposure (DXPW)[5]	0.537	2.657
	Public Water Supply (PWSPW)[6]	0.489	2.420
	Nonpotable Drinking Water (NPDWPW)[7]	1.006	4.979

Notes:
1 – APW is the atmospheric pathway inhalation plus deposition dose.
2 – LPW is the liquid pathway or water dose.
3 – FPW is the food subpathway.
4 – IhPW is the inhalation subpathway.
5 – DXPW is the direct exposure subpathway.
6 – PWSPW is the public water systems drinking water subpathway.
7 – NPDWPW is the nonpotable or untreated drinking water subpathway.
8 - Does not include alpha, beta, or beta-gamma since they are nonspecific screening values.

Table 2. The 1999-2010 AEI Media Statistics and MAX Special Categories Dose

Media	Totals	AEI % Basis	Avg.	SD	Median	N#yrs
SWBL	0.624	3.09	0.052	0.029	0.045	12
DNRGW (2003-2010)	0.251	1.24	0.031	0.050	0.013	8
PWSGW	0.186	0.92	0.016	0.019	0.010	12
PWSRW	0.303	1.50	0.028	0.020	0.020	12
Rainwater	0.131	0.65	0.011	0.006	0.010	12
Swimming	0.024	0.12	0.002	0.003	0.000	12
Soil	0.354	1.75	0.029	0.073	0.010	12
Sediment	0.183	0.91	0.015	0.049	0.000	12
Air	0.066	0.33	0.006	0.006	0.002	12
Edible Vegetation (2002-2010)	0.408	2.02	0.045	0.069	0.010	9
Milk	0.213	1.05	0.018	0.030	0.003	12
Avg Edible Fungi (2008-2010)	1.884	9.32	0.628	0.285	0.730	3
Avg Fish[2] (1999-2010)	6.417	31.76	0.535	0.302	0.440	12
Avg Deer[2] (2000-2010)	3.367	16.66	0.306	0.447	0.080	11
Avg Hog[2] (2000-2002,2009-2010)	5.795	28.68	1.159	1.463	0.970	5
Totals	**20.206**	**100.00**	NA	NA	NA	NA
MAX Deer[2]	84.765	NA	7.706	5.894	7.520	11
MAX Hog[2]	23.520	NA	4.704	7.064	2.120	5
MAX Fish[2]	25.465	NA	2.122	1.531	1.766	12
MAX Fungi	8.655	NA	2.885	2.366	1.767	3
Offsite Hunter Max	108.285	NA	9.024	10.036	8.000	11
Offsite Hunter AEI	9.162	NA	0.764	1.445	0.091	11

Note:
1 - Note that the 20.206 mrem total excluded some detections included as potential NORM in the Table 1 total.

References

Aadland, R. K., J. A. Gellici, P. A. Thayer 1995. Hydrogeologic Framework of West Central South Carolina. South Carolina Department of Natural Resources, WRD Report 5.

Absalom, J.P.; Young, S.D.; Crout N.M.J.; Sanchez A.; Wright, S.M.; Smolders, E.; Nisbet, A.F. and Gillett A.G. 2001. Predicting the Transfer of Radiocaesium from Organic Soils to Plants Using Soil Characteristics. Journal of Environment Radioactivity, vol. 52, no. 1, p. 31-43.

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. ToxFaqs TM for Di-n-octylphthalate (DNOP). ATSDR Division of Toxicology, Atlanta, GA. http://www.atsdr.cdc.gov/tfacts95.html

Alloway, B.J. 1995. Heavy Metals in Soils. Great Britain, St Edmundsbury Press, Suffolk.

Aracnet. 1957. Off-Site Radioactive Fallout, Operation Plumbbob, Atomic Cloud Track Maps, 1957. Radioactive Fallout: Operation Plumbbob 1957, http://www.aracnet.com/~histgaz/atomi/fallout.htm

Argonne National Laboratory (ANL). 2007a. Health-Based Radionuclide Concentrations in Drinking Water and Air. Human Health Fact Sheet.

ANL. 2007b. Radiological and Chemical fact Sheets to Support Health risk Analyses for Contaminated Areas. www.evs.anl.gov/pub/doc/ANL_ContaminantFactSheets_All_070418.pdf.

Bond, V.P., T.M. Fliedner, and J.O. Archambeau. 1965. Mammalian Radiation Lethality. Academic Press, New York, p. 340.

Botsch. 1999. Investigation of the Radiation Exposure of Inhabitants of Contaminated Areas in Northern Ukraine. Center for Radiation Protection and Radioecology, University of Hanover, Germany and the State Agroecological Academie of Ukraine, Ukraine.

Brisbin, I. Lehr, Jr., and M.H. Smith. 1975. Radiocesium Concentrations in Whole-Body Homogenates and Several Body Compartments of Naturally Contaminated White-tailed Deer. In Mineral Cycling in the Southeastern Ecosystems, ERDA Symposium Series, CONF-740513, National Technical Information Service, Springfield, Virginia, p. 542.

Canova, J.L. 1999. Elements in South Carolina Inferred Background Soil and Stream Sediment Samples. South Carolina Geology, 1999, v.41, p.11-25.

Centers for Disease Control (CDC). 1997. SRS Health Effects Subcommittee (SRSHES). Dose Reconstruction News. “Estimating the Atmospheric Tritium Source Term at SRS: A Progress Report”, Vol II #3.

References

CDC. 2001. Savannah River Site Environmental Dose Reconstruction Project. Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval Evaluation of Materials Released from the Savannah River Site. 1-CDC-SRS-1999-Final. Risk Assessment Corporation, No. 200-95-0904.

CDC. 2004. "Draft for Public Comment" of Phase III Savannah River Site (SRS) Dose Reconstruction Project for the SRS Health Effects Subcommittee. Radiation Studies Branch, National Center for Environmental Health, Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services.

CDC. 2006. Phase III of the SRS dose reconstruction project. Available from URL http://www.cdc.gov/nceh/radiation/Savannah/docs/TOCs.pdf

Corey, J.C. 1980. Transport of Radionuclides Through Soil and Groundwater. E. I. DuPont de Nemours and Company, Savannah River Plant, Aiken, SCDP-MS-80-95.

Cummins, C.L. 1994. Radiological Bioconcentration Factors for Aquatic, Terrestrial, and Wetland Ecosystems at the Savannah River Site (U). Prepared for the United States Department of Energy, Savannah River Site. Aiken, South Carolina.

Davis, J.J. 1963. Cesium and its Relationships to Potassium in Ecology, in Radioecology. Colorado State University, Fort Collins, Colorado, pp. 539-556.

Du Pont. 1984. United States Department of Energy, Savannah River Plant Environmental Report For 1984, DPSPU 85-30-1. Health Protection Department of E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

Duke, Cogema, Stone & Webster. 1998. Mixed Oxide Fuel Fabrication Facility Environmental Report. Charlotte, North Carolina. Docket Number 070-03098/

Federal Radiation Council. 1965. Revised Fallout Estimates for 1964-1965 and Verification of the 1963 Prediction. http://www.epa.gov/radiation/docs/federal/frc_rpt6.

Federal Register. 1968. www.gpoaccess.gov/fr/.

Gilbert. 1987. Statistical Methods For Environmental Pollution Monitoring, Richard O. Gilbert. Pacific Northwest National Laboratory. John Wiley & Sons, Inc. 1987, ISBN 0-471-28878-0.

Hanlon, Edward A. 2004. Naturally Occurring Radionuclides in Agricultural Products, December 2004, University of Florida, Institute of Agricultural and Food Sciences (IAFS), Florida Cooperative Extension Service.

References

Haselow, L.A. 1991. The Relationship of Radiocesium and Potassium In The Nutritional Ecology of White-tailed Deer From the Savannah River Site. Masters Thesis, Purdue University, p. 1.

Heckman J.R., E.J. Kamprath. 1992. Potassium Accumulation and Corn Yield Related to Potassium Fertilizer Rate and Placement. P141-149

Hurst, R.W. Isotopic Tracers in Groundwater Hydrology. Retrieved from http://swhydro.arizona.edu/archive/V2_N1/feature2.pdf

International Atomic Energy Agency (IAEA). 2009. http://www.iaea.org/trc/radio-nuclides.htm

Kalac, 2001. A Review of Edible Mushroom Activity**.** Food Chemistry 75 (2001) 29-35. www.elsevier.com/locate/foodchem

Kathren, R.L. 1984. Radioactivity in the Environment: Sources, Distribution, and Surveillance. Harwood Academic Publishers, New York, New York.

Larson, B.L. and K. E. Ebner. 1958. Significance of Strontium-90 in Milk. A Review. Journal of Diary Science. 41(12): 1647-1662.

Lawrence Livermore National Laboratory (LLNL). 1997. Site Annual Environmental Report, UCRL-50027-97, Oakland, California.

Lincoff. 1981. National Audubon Society Field Guide to North American Mushrooms. National Audubon Society Field Guides. Gary Lincoff. Knopf Publishers 1981.

Linkov and W. R. Schell (eds.). 1999. Contaminated Forests: Recent Developments in Risk Identification and Future Perspectives, Kluewer, Amsterdam.

Manzoli L, Romano F, Schioppa F, D'Ovidio C, Lodi V, and Pirone GM. 2004. Current Epidemiological Evidence Regarding the Health Effects of Low-Dose Ionizing Radiation. Sanita Pubbl. 2004, Jan-Apr, 60 (1-2), 81-102.

Mineral Information Institute (MII). 2008. www.mii.org/Minerals/photostrontium

Moore-Landecker. 1972. Fundamentals of the Fungi. Prentice-Hall, Inc., Englewood Cliffs, N.J. ISBN:0-13-339267-8.

Murphy, C.E., Jr., L.R. Bauer, D.W. Hayes, W.L. Marter, C.C. Zeigler, D.E. Stephenson, D.D. Hoel, and D.H. Hamby. 1991. Tritium in the Savannah River Site Environment. WSRC-RP-9-0-424-1 Rev. 1. SRS Phase II Database MJC1994051310.

References

Murphy, C.E., Jr. and W.H. Carlton. 1991. Tritium in the Savannah River Environment Addendum to WSRC-RP-9-0-424-1, Rev. 1. SRS Phase II Database MJC1994051311.

National Academy of Sciences (NAS). 1974. National Academy of Engineering. Water quality criteria, 1972. U.S. Government Printing Office, Washington, D.C.

National Council on Radiation Protection and Measures (NCRP). 1984. Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment. NCRP Report No. 76, Bethesda, MD.

Pacific Northwest Laboratory (PNL). 2004. 8.8 Food and Farm Products Monitoring, Hanford Site Environmental Report for Calendar Year , DE-AC05-76RL01830, Department of Energy-Hanford Site, Richland, Washington.

Porcher. 1863. Resources of the Southern Fields and Forests, Medical, Economical, and Agricultural. Being also a Medical Botany of the Confederate States; With Practical Information on the Useful Properties of the Trees, Plants, and Shrubs. Francis Peyre Porcher. Charleston. Evans & Cogswell 1863.

Porcher. 2001. A Guide to the Wildflowers of South Carolina. Richard Dwight Porcher and Douglas Alan Rayner. University of South Carolina Press. ISBN 1-57003-438-9.

RADNET. 2006. Information about source points of anthropogenic radioactivity, A Freedom of Nuclear Information Resource, http://www.davistownmuseum.org/cbm/, Chernobyl Plume: Country-by-Country.

Rommelt, R., Hiersche, L., Schaller, G., and Wirth, E. 1990. Influence of soil fungi (Basidiomycetes) on the migration of Cs134 + 137 and Sr90 in coniferous forest soil. In: Transfer of Radionuclides in Natural and Semi-Natural Environments (eds. G. Desmet, P. Nassimbeni and M. Belli), Elsevier Applied Science, London, New York.

Savannah River Nuclear Solutions, LLC (SRNS). 2009. Savannah River Site Environmental Report for 2008. Savannah River Site, Aiken, South Carolina. SRNS-STI-2009-00190

SRNS. 2010. Savannah River Site Environmental Report for 2010. Savannah River Site Aiken, SC. SRNS-SRT-2010-00175.

SRNS. 2011. Savannah River Site Environmental Report for 2011. Savannah River Site. Aiken, SC. SRNS-STI-2011-00059.

References

Savannah River Site (SRS). 2008. Historical History Web Interface http://www.srs.gov/general/about/history1.htm

SRS. 2009. Savannah River Site Web Interface. http://www.srs.gov/general/programs/solidification/index.htm

Sears, Rhonda. 2005. USEPA National Air and Radiation Environmental Laboratory. Montgomery, AL. Telephone Conversation September 17, 2005.

Seel, J. F., Whicker, F. W., and Adriano, D. C. 1995. Uptake of Cs-137 in Vegetable Crops Grown on a Contaminated Lakebed, 1995 Health Physics Society manuscript.

SCDHEC. 1999a. Determination of Ambient Groundwater Quality Adjacent to the Savannah River Site. Annual Report, 1997. Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 1999b. Standard Operating Procedures for the Environmental Surveillance and Oversight Program, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2000. South Carolina Department of Health and Environmental Control 1999 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2001a. Environmental Surveillance and Oversight Program Field Monitoring Procedures, Bureau of Environmental Services Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2001b. Standard Operating Procedures for the Environmental Surveillance and Oversight Program, Bureau of Environmental Services Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2001c. South Carolina Department of Health and Environmental Control 2000 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2002. South Carolina Department of Health and Environmental Control 2001 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2003a. South Carolina Department of Health and Environmental Control 2002 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

References

SCDHEC. 2003b. 2002 Radiological Monitoring of Milk from Dairies Surrounding the Savannah River Site. Bureau of Environmental Services, Environmental Surveillance and Oversight Program.

SCDHEC. 2004a. 2003 Radiological Atmospheric Monitoring Project Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2004b. South Carolina Department of Health and Environmental Control 2003 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2005a. South Carolina Department of Health and Environmental Control 2004 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2005b. Standard Operating Procedures for the Environmental Surveillance and Oversight Program, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2006a. South Carolina Department of Health and Environmental Control 2005 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2006b. South Carolina Department of Health and Environmental Control Internet Site. http://www.scdhec.gov/environment/water/radium.html.

SCDHEC. 2007a. 2006 Radiological Atmospheric Monitoring Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2007b. South Carolina Department of Health and Environmental Control 2006 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2008a. 2007 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2008b. Water Classifications and Standards (Regulation 61-68), Bureau of Water Pollution Control, Division of Water Quality Assessment and Enforcement, Columbia, South Carolina.

SCDHEC. 2008c. 2007 Critical Pathway Dose Project Plan, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

References

SCDHEC. 2009a. 2008 Environmental Data Report, Bureau or Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2009b. 2008 Monitoring of Fish Associated with the Savannah River Site, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2010a. Monitoring of Fish in the Savannah River Quality Assurance Project Plan, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2010b. 2010 South Carolina Fish Consumption Advisories. Division of Health Hazard Evaluation, Columbia, South Carolina.

SCDHEC. 2010c. South Carolina Department of Health and Environmental Control 2009 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2010d. 2009 Radiological Monitoring of Dairy Milk, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, SC.

SCDHEC. 2010e. State of South Carolina Section 303(d) List for 2010, Bureau of Water, Columbia, South Carolina.

SCDHEC. 2011a. State of South Carolina Monitoring Strategy, Technical Report No. 01J-11, Bureau of Water, Water Quality Monitoring Section, Columbia, South Carolina.

SCDHEC. 2011b. Nonradiological Ambient Surface Water Quality Monitoring Project Plan, Bureau of Environmental Services - Environmental Surveillance and Oversight Program. Aiken, South Carolina.

Till, J.E., et al. 2001. Savannah River Site Environmental Dose Reconstruction Project, Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval, Evaluation of Materials Released From the Savannah River Site. RAC Report No. 1-CDC-SRS-1999-Final. Risk Assessment Corporation (RAC).

United States Department of Energy (USDOE). 1995. SRS Waste Management Final Environmental Impact Statement. Doc. No. DOE/EIS-0217 http://www.eh.doe.gov/nepa/eis/eis0217/eis0217_toc.html

USDOE. 2006. Stakeholder Sensitivity To Tritium Releases. Retrieved May 22, 2007 from http://hss.energy.gov/CSA/csp/advisory/SAd_2006-04.pdf

United States Department of Health and Human Services (USDHHS) 1998. Accidental Radioactive Contamination of Human Food and Animal Feeds:

Recommendations for State and Local Agencies. Radiation Programs Branch, Food and Drug Administration, Center for Devices and Radiological Health, Rockville, Maryland.

United States Department of Interior (USDOI). 1992. 7.5 Minute Topographic Geologic Survey Map of South Carolina. South Carolina Land Resources Commission RV 10/92

United States Environmental Protection Agency (USEPA). 1987. An Overview of Sediment Quality in the United States, EPA-905/9-88-002, Office of Water Regulations and Standards, Washington, DC and Region 5, Chicago, IL.

USEPA. 2000. Guidance For Assessing Chemical Contaminant Data for use in Fish Advisories, Vol. 1.

USEPA. 2002a. National Primary Drinking Water Regulations. Title 40, Chapter 1, Part 141.

USEPA. 2002b. List of Drinking Water Contaminants & MCLs. EPA 816-F-02-013 July 2002.

USEPA. 2002c. EPA Facts About Strontium-90. http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/strontium.pdf

USEPA. 2002d. EPA Facts About Cobalt-60 www.epa.gov/superfund/health/contaminants/radiation/pdfs/cobalt.pdf

USEPA. 2003. National Primary Drinking Water Standards, EPA-816-F-03-016. Office of Water, Washington DC

USEPA. 2005. Office of Radiation and Indoor Air, Environmental Radiation Data, Report 123 July - September, Montgomery, AL.

USEPA. 2007a. US EPA Information. www.epa.gov/radiation/radionuclides.

USEPA. 2007b. Statistical Software ProUCL 4.00.04 Developed by Lockheed Martin for the USEPA Technical Support Center, Las Vegas, Nevada. http://www.epa.gov/nerlesd1/tsc/software.

USEPA. 2008a. National Primary Drinking Water Regulations; Radionuclides; Final Rule. Updated October 2008.

USEPA. 2008b. National Recommended Water Quality Criteria, EPA-Section 304(a) Clean Water Act.

USEPA. 2009a. EPA Facts about Cesium.

http://www.epa.gov/rpdweb00/radionuclides/cesium.html

USEPA. 2009b. EPA Facts about Technetium-99. http://www.epa.gov/rpdweb00/radionuclides/technetium.html

USEPA. 2009c. http://www.epa.gov/safewater/contaminants/index.html

USEPA. 2009d. Preliminary Remediation Goals for Radionuclides. http://epa-prgs.ornl.gov/radionuclides/download.res_soil_rad_prg_august_2010.xls

USEPA. 2009e. USEPA Website http://www.epa.gov/radiation/radionuclied/tritium.html#where

USEPA. 2010a. Regional Screening Levels for Chemical Contaminants. http://www.epa.gov/reg3hwmd/risk/human/rb-concentratino_table/generic_tables/index.htm

USEPA. 2010b. USEPA Information. www.epa.gov/mercury/

USEPA. 2011. Plutonium. http://www.epa.gov/radiation/radionuclides/plutonium.html

United States Food and Drug Administration (USFDA). 2005. www.fda.gov/Food/FoodSafety/FoodContaminantsAdulteration/ChemicalContaminants/Radionuclides

United States Geological Survey (USGS). 2000. Water Quality in the Santee River Basin and Coastal Drainages, North and South Carolina, 1995-1998: U.S Geological Survey Circular 1206, 32p., http://pubs.water.usgs.gov/circ1206/

Walter, A. E., 1995. America the Powerless, Facing our Nuclear Energy Dilemma, Library of Congress Card Number: 95-080187.

Westinghouse Savannah River Company (WSRC). 1993a. Assessment of Technetium In the Savannah River Site Environment. Carlton, W.H., Denham, M., Evans, A.G., Aiken, South Carolina. WSRC-TR-93-217.

WSRC. 1993b. Final Record of Decision Remedial Alternative Selection for H-Area Hazardous Waste Management Facility. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-RP-93-1043.

WSRC. 1997. Assessment of SRS Radiological Liquid and Airborne Contaminants and Pathways. Jannik, G.T., Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-970152.

WSRC. 1998. Assessment of Radionuclides in The Savannah River Site Environment-Summary (U), Environmental Protection Department, Environmental Monitoring Section, Aiken, South Carolina. WSRC-TR-98-00162

References

WSRC. 1999a. Radionuclides in the Savannah River Site Environment. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-MS-99-00667.

WSRC. 1999b. Savannah River Site Environmental Report for 1998. Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company Aiken, South Carolina. WSRC-TR-99-00299.

WSRC. 2000a. Savannah River Site Environmental Data for 1999, Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company Aiken, South Carolina. WSRC-TR-99-00301.

WSRC. 2000b. Savannah River Site Environmental Report for 1999. Environmental Monitoring Section, Environmental Protection Department, Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-99-00299.

WSRC. 2001. Savannah River Site Environmental Data for 2000, WSRC-TR-2000-00329, Environmental Monitoring Section, Environmental Protection Department, Aiken, South Carolina.

WSRC. 2002a. Savannah River Site Environmental Report for 2001. Environmental Monitoring Section, Environmental Protection Department. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2001-00474.

WSRC. 2002b. Viability of Sodium Iodide Detector Field Measurements and X-Ray Florescence Measurements for Recognition of Benchmark Exceedances in the Steel Creek Integrator Operable Unit. Westinghouse Savannah River Company, Aiken, South Carolina.

WSRC. 2003a. Savannah River Site Environmental Report for 2002. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2003-00026

WSRC. 2003b. Radiological False Positives in Environmental Soil and Groundwater Data From Commercial Laboratories. Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-MS-2003-00565.

WSRC. 2004. Savannah River Site Environmental Report for 2003. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2004-00015.

WSRC. 2005a. Savannah River Site Environmental Report for 2004. Environmental Monitoring & Analysis, Environmental Services Section, Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2005-00005.

WSRC. 2005b. Ecological Screening Values for Surface Water, Sediment, and Soil:

2005 Update, Friday, G.P., Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina.WSRC-TR-2004-00227.

WSRC. 2005c. Scoping Summary for the Savannah River and Floodplain Swamp Integrator Operable Unit. Westinghouse Savannah River Company, Aiken, South Carolina. ERD-EN-2205-0163.

WSRC. 2006. Savannah River Site Environmental Report for 2005. Savannah River Site, Aiken, South Carolina. WSRC-TR-2006-00007

WSRC. 2007. Savannah River Site Environmental Report for 2006. Washington Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-2007-00008.

WSRC. 2008. Savannah River Site Environmental Report for 2007. Washington Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-STI-2008-00057.

WSRC. 2009. Savannah River Site Environmental Report for 2008. Washington Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-STI-2009-00190.

World-Nuclear Organization. March 2009. www.world-nuclear.org/info/info30.html

Yoshida, S., and Muramatsu, Y., 1998. Concentrations of Alkali and Alkaline Earth Elements in Mushrooms and Plants Collected in a Japanese Pine Forest, and Their Relationship with Cs-137. J. Environ. Radioactivity 41, 183-205.

Zeigler, C.C, I.B. Lawrimore, and W.E. O'Rear. 1985. Environmental Monitoring at the Savannah River Plant, Annual Report 1984. DPSPU-85-302. Health Protection Department, Savannah River Plant, Du Pont. SRS Phase II Database MJC1994051722

TOC