South Carolina Department of Health and Environmental Control

Environmental Surveillance Oversight Program
Data Report for 2009

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

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

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 2009 calendar year monitoring period.

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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
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 (Random quadrants outside of the 50-mile perimeter)
BNA	Base neutral/ acid extractable organics
BOD	Biochemical Oxygen Demand
CDC	Centers for Disease Control
CI	Confidence Interval (2 Sigma)
DNRGW	Department of Natural Resources Groundwater Wells
DO	Dissolved Oxygen
DOE	Department of Energy
DOE-SR	Department of Energy - Savannah River
DW	Drinking Water
"E"	Perimeter samples (<50 miles from SRS center point, but outside SRS boundary)
EFIS	Environmental Facility Information System
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
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
N/A	Not Applicable
NaI	Sodium Iodide
NH_3	Ammonia
NH_4	Ammonium
NO_2	Nitrite
NO_3	Nitrate
NORM	Naturally Occurring Radioactive Material
NS	Not Sampled or No Sample
NSBLD	New Savannah Bluff Lock & Dam
PCB	Polychlorinated Biphenyl
PRG	Preliminary Remediation Goals

List of Acronyms

PWS	Public Water System
PWSGW	Public Water System Groundwater Wells
PWSRW	Public Water System River Water
QA/QC	Quality Assurance/Quality Control
RAC	Radiological Assessments Corporation
REMD	Radiological Environmental Monitoring Division
RSL	Regional Screening Level
RW	River Water
SA	Study Area
SC	South Carolina
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SD	Standard Deviation
SOP	Standard Operating Procedure
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
SS	Surface Soil
SSL	Soil Screening Level
STC	Steel Creek
STEVENS	Stevens Creek
STOKES	Stokes Bluff Landing
SW	Surface Water
SWBL	Surface Water at Boat Landings
TAL	Target Analyte List (metals)
TEF	Tritium Extraction Facility
TKN	Total Kjeldahl Nitrogen
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
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)

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List of Acronyms

UNITS OF MEASURE

C	temperature in Celsius
cm	centimeter
cps	counts 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.

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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**

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Random Sampling Location Information 2004-2009

Random Quadrant Locations for Environmental Perimeter Samples Collected from 2004 - 2009

DOE-SR Environmental Perimeter Random Quadrants Within SRS Perimeter or "E" Quadrants Quad	7.5' Quad Name	Quadrant (Quad) Limits Latitude by Lat and Longitude by Long	Geological Region
E1X&B2X	Furman (50mi.)	3237.5 by 3245 and -8107.5 by -8115	LCP
E2	Barnwell	3307.5 by 3315 and -8115 by -8122.5	UCP
E3X	New Ellenton, SE (SRSX)	3315 by 3322.5 and -8130 by -8137.5	UCP
E4	Aiken	3330 by 3337.5 and -8137.5 by -8145	UCP
E5	Ehrhardt	3300 by 3307.5 and -8100 by -8107.5	LCP
E6	Foxtown	3337.5 by 3345 and -8130 by -8137.5	UCP
E7X&B24X	Emory (50mi.)	3352.5 by 3400 and -8137.5 by -8145	PM
E8	HarleysMillPond	3330 by 3337.5 and -8107.5 by -8115	UCP
E9	Monetta	3345 by 3352.5 and -8130 by -8137.5	UCP
E10	Norway West	3322.5 by 3330 and -8107.5 by -8115	UCP
E11	North	3330 by 3337.5 and -8100 by -8107.5	UCP
E12	Colliers	3337.5 by 3345 and -8200 by -8207.5	PM
E13	Norway East	3325.5 by 3330 and -8100 by -8107.5	UCP
E14X	Jackson (NRX/SRS)	3315 by 3322.5 and -8145 by -8152.5	UCP
E15X	Evans (GAX)	3330 by 3337.5 and -8207.5 by -8215	PM
E16	Denmark	3315 by 3322.5 and -8107.5 by -8115	UCP
E17X&B25X	Orangeburg S. (50mi.)	3322.5 by 3330 and -8045 by -8052.5	UCP
E18	Midway	3315 by 3322.5 and -8052.5 by -8100	LCP
E19X	Mechanics Hill (GAX)	3315 by 3322.5 and -8152.5 by -8200	UCP
E20	Kitchens Mill	3330 by 3337.5 and -8122.5 by -8130	UCP
E21	Clear Pond	3307.5 by 3315and -8100 by -8107.5	LCP
E22X&B26X	Grays (50mi.)	3237.5 by 3245 and -8100 by -8107.5	LCP
E23X	Kildaire(GAX)	3230 by 3237.5 and -8122.5 by -8130	LCP
E24X	Long Branch(SRS)	3315 by 3322.5 and -8122.5 by -8130	UCP
E25X&B53X	Clarks Hill(GAX)	3337.5 by 3345 and -8207.5 by -8215	PM
E26X&B27X	Parksville (50mi.)	3345 by 3352.5 and -8207.5 by -8215	PM
E27	Roper's Crossroads	3337.5 by 3345 and -8152.5 by -8200	PM
E28	Salley	3330 by 3337.5 and -8115 by -8122.5	UCP
E29	Allendale	3300 by 3307.5 and -8115 by -8122.5	LCP
E30	Graniteville	3330 by 3337.5 and -8145 by -8152.5	UCP
E31	Oakwood	3330 by 3337.5 and -8130 by -8137.5	UCP
E32X	Martinez(GAX)	3330 by 3337.5 and -8200 by -8207.5	PM
E33X	Snellings (SRS)	3307.5 by 3315 and -8122.5 by -8130	UCP
E34X&B41X	Gilbert (50mi.)	3352.5 by 3400 and -8122.5 by -8130	PM
E35	Steedman	3345 by 3352.5 and -8122.5 by -8130	UCP
E36	Springfield	3322.5 by 3330 and -8115 by -8122.5	UCP
E37	Sycamore	3300 by 3307.5 and -8107.5 by -8115	LCP
E38X	Brier Creek Island(GAX)	3245 by 3252.5.5 and -8122.5 by -8130	LCP
E39X	Bull Pond(GAX)	3252.5 by 3300 and -8122.5 by -8130	LCP
E40	Blackville	3315 by 3322.5 and -8115 by -8122.5	UCP
E41	Windsor	3322.5 by 3330 and -8130 by -8137.5	UCP
E42X&B32X	Saluda South (50mi.)	3352.5 by 3400 and -8145 by -8152.5	PM
E43	Olar	3307.5 by 3315 and -8107.5 by -8115	LCP

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Random Sampling Location Information 2004-2009

Random Quadrant Locations for Environmental Perimeter Samples Collected from 2004 - 2009

DOE-SR Environmental Perimeter Random Quadrants Within SRS Perimeter or "E" Quadrants Quad	7.5' Quad Name	Quadrant (Quad) Limits Latitude by Lat and Longitude by Long	Geological Region
E44	Girard NE	3307.5 by 3315 and -8130 by -8137.5	UCP
E45	Gifford	3245 by 3252.5 and -8107.5 by -8115	LCP
E46	Cordova	3322.5 by 3330 and -8052.5 by -8100	UCP
E47X&B71	Barr Lake	3352.5 by 3400 and -8115 by -8122.5	UCP
E48X&B72X	Orangeburg N.(50mi.)	3330 by 3337.5 and -8045 by -8052.5	UCP
E49X	Millett (GAX)(NRX)	3300 by 3307.5 and -8030 by -8037.5	UCP
E50X&B75X	Batesburg(50mi.)	3352.5 by 3400 and -8130 by -8137.5	PM
E51	Crocketville	3252.5 by 3300 and -8100 by -8107.5	LCP
E52X	Girard NW(GAX)	3307.5 by 3315 and -8137.5 and -8145	UCP
E53	New Ellenton	3322.5 by 3330 and -8137.5 by -8145	UCP
E54X&B80X	Wolfton(50mi.)	3330 by 3337.5 and -8052.5 by -8100	UCP
E55	Bamburg	3315 by 3322.5 and -8100 by -8107.5	UCP
E56X&B85X	Branchville North(50mi.)	3315 by 3322.5 and -8045 by -8052.5	LCP
E57	North Augusta	3330 by 3337.5 and -8152.5 by -8200	UCP
E58	Tony Hill Bay	3307.5 by 3315 and -8052.5 by -8100	LCP
E59	Williston	3322.5 by 3330 and -8122.5 by -8130	UCP
E60X	Shell Bluff Landing(GAX)	3307.5 by 3315 and -8145 by -8152.5	UCP
E61	Shirley	3237.5 by 3245 and -8115 by -8122.5	LCP
E62	New Ellenton SW	3315 by 3322.5 and -8137.5 by -8145	UCP
E63X&B86X	Owdoms(50mi.)	3352.5 by 3400 and -8152.5 by -8200	PM
E64	Martin	3300 by 3307.5 and -8122.5 by -8130	LCP
E65	Ridge Spring	3345 by 3352.5 and -8137.5 by -8145	UCP
E66X	Blue Springs Landing(GAX)	3237.5 by 3245 and -8122.5 by -8130	LCP
E67X&B87X	Pelion East(50mi.)	3345 by 3352.5 and -8107.5 by -8115	UCP
E68X	Burtons Ferry Landing(GAX)	3252.5 by 3300 and -8130 by -8137.5	LCP
E69	Pond Branch	3337.5 by 3345 and -8107.5 by -8115	UCP
E70	Hollow Creek	3322.5 by 3330 and -8145 by -8152.5	UCP
E71	Barton	3252.5 by 3300 and -8115 by -8122.5	LCP
E72	Aiken NW	3337.5 by 3345 and -8137.5 by -8145	UCP
E73X&B88X	Williams(50mi.)	3300 by 3307.5 and -8045 by -8052.5	LCP
E74	Fairfax	3252.5 by 3300 and -8107.5 by -9115	LCP
E75X&B89X	Hampton(50mi.)	3245 by 3252.5 and -8100 by -8107.5	LCP
E76	Lodge	3300 by 3307.5 and -8052.5 by -8100	LCP
E77	Solomons Crossroads	3245 by 3252.5 and -8115 by -8122.5	LCP
E78X	Augusta East(GAX)	3322.5 by 3330 and -8152.5 by -8200	UCP
E79X&B90X	Brighton (50mi.)	3230 by 3237.5 and -8115 by -8122.5	LCP
E80X&B91X	Swansea(50mi.)	3337.5 by 3345 and -8100 by -8107.5	UCP
E81X&B92X	Cummings (50mi.)	3245 by 3252.5 and -8052.5 by -8100	LCP
E82X&B93X	Islandton (50mi.)	3252.5 by 3300 and -8052.5 by -8100	LCP
E83X&B94X	Branchville South (50mi.)	3307.5 by 3315 and -8045 by -8052.5	LCP
E84	Pelion West	3345 by 3352.5 and -8115 by -8122.5	UCP
E85	Johnston	3345 by 3352.5 and -8145 by -8152.5	PM
E86	Wagener	3337.5 by 3345 and -8115 by -8122.5	UCP

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Random Sampling Location Information 2004-2009

Random Quadrant Locations for SC Background Samples Collected from 2004 - 2009

South Carolina Background Random Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants. Quad	 7.5' Quad Name	Quadrant (Quad) Limits Latitude by Lat and Longitude by Long	 Geological Region
B1X	Cashiers (NCX)	3500 by 3507.5 and -8300 by -8307.5	BR
B2X&E1X	Furman (50mi.)	3237.5 by 3245 and -8107.5 by -8115	LCP
B3	Felderville	3322.5 by 3330 and -8030 by -8037.5	LCP
B4	James Is.	3237.5 by 3245 and -7952.5 by -8000	PM
B5	Carlisle	3430 by 3437.5 and -8122.5 by -8130	LCP
B6	Antreville	3415 by 3422.5 and -8230 by -8237.5	PM
B7X	Saluda (NCX)	3507.5 by 3515 and -8215 by -8222.5	BR
B8	Bingham	3422.5 by 3430 and -7930 by -7937.5	UCP
B9	Alvin	3315 by 3322.5 and -7945 by -7952.5	LCP
B10	Jamestown	3315 by 3322.5 and -7937.5 by -7945	LCP
B11	North Is.	3315 by 3322.5 and -7907.5 by -7915	LCP
B12	Summerton	3330 by 3337.5 and -8015 by -8022.5	LCP
B13	Sharon	3452.5 by 3500 and -8115 by -8122.5	PM
B14X	Lake Murray E (NRX)	3400 by 3407.5 and -8115 by -8122.5	PM
B15	Spring Is.	3215 by 3222.5 and -8045 by -8052.5	LCP
B16X	Westminster (NRX)	3437.5 by 3445 and -8300 by -8307.5	PM
B17X	Hartwell Dam (GAX)	3415 by 3422.5 and -8245 by -8252.5	PM
B18X	Hartsville South (NRX)	3415 by 3422.5 and -8000 by -8007.5	UCP
B19	Salters	3330 by 3337.5 and -7945 by -7952.5	LCP
B20X	Pineland(GAX)	3230 by 3237.5 and -8107.5 by -8115	LCP
B21	Mayesville	3352.5 by 3400 and -8007.5 by -8015	LCP
B22	Carlisle SE	3430 by 3437.5 and -8115 by -8122.5	PM
B23	Outland	3337.5 by 3345 and -7915 by -7922.5	LCP
B24X&E7X	Emory (50mi.)	3352.5 by 3400 and -8137.5 by -8145	PM
B25X&E17X	Orangeburg S. (50mi.)	3322.5 by 3330 and -8045 by -8052.5	LCP
B26X&E22X	Grays (50mi.)	3237.5 by 3245 and -8100 by -8107.5	LCP
B27X&E26X	Parksville (50mi.)	3345 by 3352.5 and -8207.5 by -8215	PM
B28	Lake City West	3345 by 3352.5 and -7945 by -7952.5	LCP
B29	Neyles	3245 by 3252.5 and -8030 by -8037.5	LCP
B30	Oak Grove	3415 by 3422.5 and -7930 by -7937.5	LCP
B31X	Hardeeville(GAX)	3215 by 3222.5 and -8100 by -8107.5	LCP
B32X&E42X	Saluda South (50mi.)	3352.5 by 3400 and -8145 by -8152.5	PM
B33	Bradley	3400 by 3407.5 and -8207.5 by -8215	PM
B34	Greenwood	3407.5 by 3415 and -8207.5 by -8215	PM
B35	Limestone	3352.5.5 by 3400 and -8200 by -8207.5	PM
B36	Abbeville East	3407.5 by 3415 and -8215 by -8222.5	PM
B37	Calhoun Creek	3400 by 3407.5 and -8222.5 by -8230	PM
B38	Laurens North	3430 by 3437.5 and -8200 by -8207.5	PM
B39	Saluda North	3400 by 3407.5 and -8145 by -8152.5	PM
B40	Waterloo	3415 by 3422.5 and -8200 by -8207.5	PM
B41X&E34X	Gilbert (50mi.)	3352.5 by 3400 and -8122.5 by -8130	PM
B42	Reevesville	3307.5 by 3315 and -8037.5 by -8045	LCP
B43	Saint Paul	3330 by 3337.5 and -8022.5 by -8030	LCP
B44	Sandridge	3315 by 3322.5 and -8015 by -8022.5	LCP
B45	La France	3430 by 3437.5 and -8245 by -8252.5	PM
B46X	Walhalla(50mi.)	3445 by 3452.5 and -8300 by -8307.5	BR
B47	Clinton	3422.5 by 3430 and -8152.5 by -8200	PM

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Random Sampling Location Information 2004-2009

Random Quadrant Locations for SC Background Samples Collected from 2004 - 2009

South Carolina Background Random Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants. Quad	7.5' Quad Name	Quadrant (Quad) Limits Latitude by Lat and Longitude by Long	Geological Region
B48	Pringletown	3307.5 by 3315 and -8015 by -8022.5	LCP
B49	Elloree	3330 by 3337.5 and -8030 by -8037.5	LCP
B50X	Belmont(NCX)	3507.5 by 3515 and -8100 by -8107.5	PM
B51	Stallsville	3252.5 by 3300 and -8007.5 by -8015	LCP
B52X	Tabor City East(NCX)	3407.5 by 3415 and -7945 by -7952.5	LCP
B53X&E25X	Clarks Hill(GAX)	3337.5 by 3345 and -8207.5 by -8215	PM
B54	Stover	3430 by 3437.5 and -8100 by -8107.5	PM
B55	Ware Shoals East	3422.5 by 3430 and -8207.5 by -8015	PM
B56	Chicora	3315 by 3322.5 and -8000 by -8007.5	LCP
B57	Ninety Six	3407.5 by 3415 and -8200 by -8207.5	PM
B58	Anderson North	3430 by 3437.5 and -8237.5 by -8245	PM
B59	Parris Island	3215 by 3222.5 and -8037.5 by -8045	LCP
B60	Winnsboro Mills	3415 by 3422.5 and -8100 by -8107.5	PM
B61	Bennetts Point	3230 by 3237.5 and -8022.5 by -8030	LCP
B62	Butlers Sav	3330 by 3337.5 and -8000 by -8007.5	LCP
B63	Gadsden	3345 by 3352.5 and -8045 by -8052.5	UCP
B64	Edisto Island	3230 by 3237.5 and -8015 by -8022.5	LCP
B65	Sardinia	3345 by 3352.5 and -8000 by -8007.5	LCP
B66X	Avalon(GAX)	3430 by 3437.5 and -8307.5 by -8315	PM
B67	Camden South	3407.5 by 3415 and -8030 by -8037.5	UCP
B68	Winnsboro	3422.5 by n3430 and -8100 by -8107.5	PM
B69	Lake Murray West	3400 by 3407.5 and -8122.5 by -8130	PM
B70X	Lincolnton(GAX)	3345 by 3352.5 and -8222.5 by -8230	PM
B71X&E47X	Barr Lake (50mi.)	3352.5 by 3400 and -8115 by -8122.5	UCP
B72X&E48X	Orangeburg N.(50mi.)	3330 by 3337.5 and -8045 by -8052.5	UCP
B73	Union East	3437.5 by 3445 and -8130 by -8137.5	PM
B74	Delmar	3400 by 3407.5 and -8130 by -8137.5	PM
B75X&E50X	Batesburg	3352.5 by 3400 and -8130 by -8137.5	PM
B76	Sheldon	3230 by 3237.5 and -8045 by -8052.5	LCP
B77	Kirksey	3400 by 3407.5 and -8200 by -8207.5	PM
B78	Calfpen Bay	3230 by 3237.5 and -8100 by -8107.5	LCP
B79	Blair	3422.5 by 3430 and -8122.5 by -8130	PM
B80X&E54X	Wolfton	3330 by 3337.5 and -8052.5 by -8100	UCP
B81	Silverstreet	3407.5 by 3415 and -8137.5 by -8145	PM
B82	Chapin	3407.5 by 3415 and -8115 by -8122.5	PM
B83	Hickory Tavern	3430 by 3437.5 and -8207.5 by -8215	PM
B84	Denny	3400 by 3407.5 and -8137.5 by -8145	PM
B85X&E56X	Branchville North	3315 by 3322.5 and -8045 by -8052.5	LCP
B86X&E63X	Owdoms	3352.5 by 3400 and -8152.5 by -8200	PM
B87X&E67X	Pelion East	3345 by 3352.5 and -8107.5 by -8115	UCP
B88X&E73X	Williams	3300 by 3307.5 and -8045 by -8052.5	LCP
B89X&E75X	Hampton	3245 by 3252.5 and -8100 by -8107.5	LCP
B90X&E79X	Brighton (50mi.)(GAX)	3230 by 3237.5 and -8115 by -8122.5	LCP
B91X&E80X	Swansea(50mi.)	3337.5 by 3345 and -8100 by -8107.5	UCP
B92X&E81X	Cummings (50mi.)	3245 by 3252.5 and -8052.5 by -8100	LCP
B93X&E82X	Islandton (50mi.)	3252.5 by 3300 and -8052.5 by -8100	LCP
B94X&E83X	Branchville South (50mi.)	3307.5 by 3315 and -8045 by -8052.5	LCP

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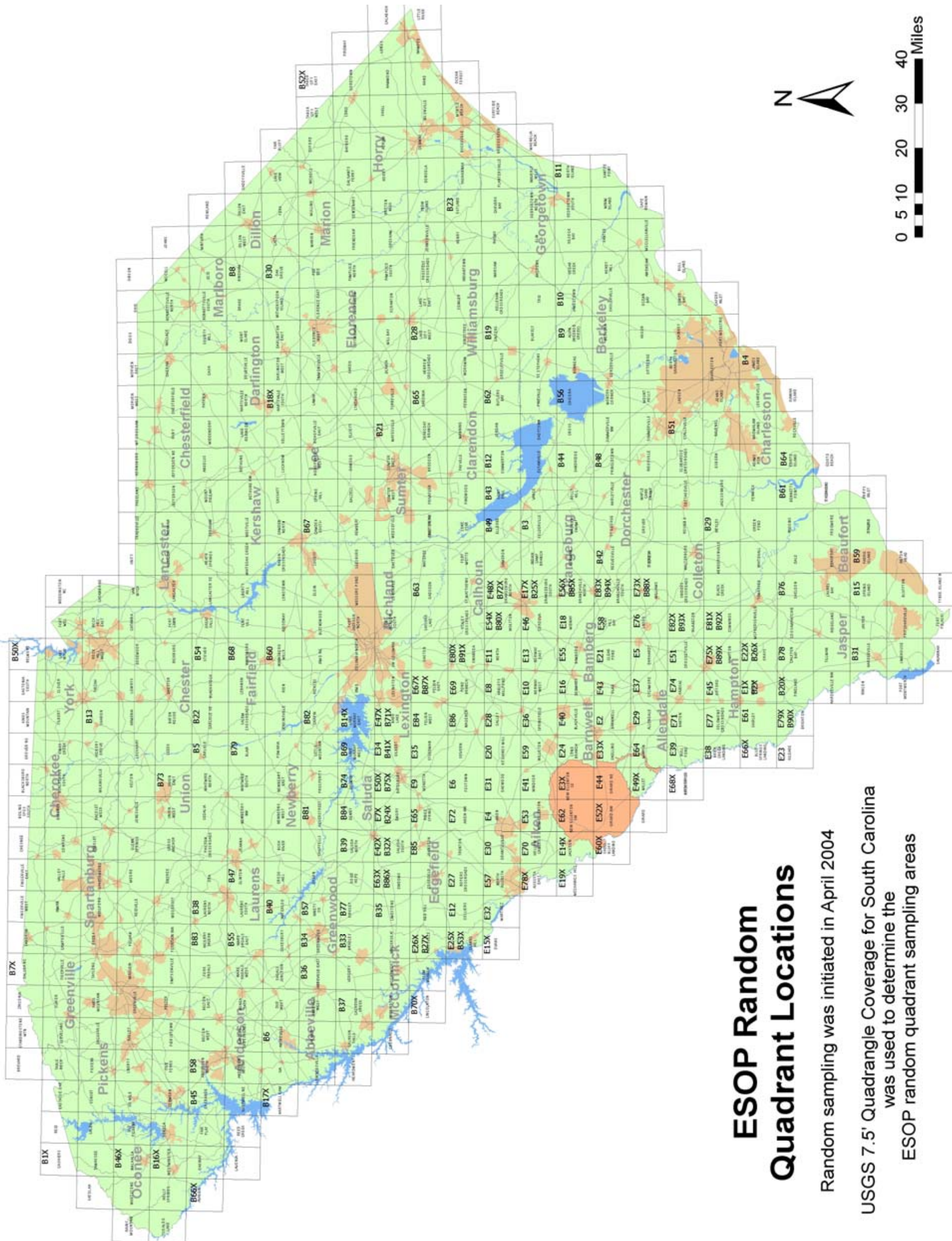
Random Sampling Location Information 2004-2009

Random Quadrant Information for Samples Collected from 2004 - 2009

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" 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 Coastal Plain (UCP), and Lower Coastal Plain (LCP).
8. Quadrants split by geological regions are assigned to the upper most region in the quadrant.

Random Sampling Location Information 2004-2009

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



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 2009 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 summary statistics. Refer to the map in Section 4.0 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. Also, first quarter particulates were composited and analyzed for specific radionuclides (uranium-234 (U-234), -235 (U-235), -238 (U-238), and plutonium-239 (Pu-239)). 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 2009 sampling period, gross alpha activity ranged from 0.0009 to 0.0129 picoCuries per cubic meter (pCi/m^3) at the site perimeter (NEL, JAK, ABR, SCT, and DKH). The maximum was collected on February 10 at the Snelling, South Carolina (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 2009 was 0.0025 (± 0.0014) pCi/m^3. The DOE-SR gross alpha average of 0.0010 (± 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 2009 sampling period, the site perimeter (NEL, JAK, ABR, SCT, and DKH) gross beta concentrations ranged from 0.0029 to 0.0402 pCi/m^3. The maximum was collected on February 10 at the Snelling, South Carolina (SCT) air station. The average gross beta concentration reported by SCDHEC in 2009 was 0.0220(± 0.0054) 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 2007). 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 six years, SCDHEC has seen a slight increase 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 0.0151 (±0.0033) pCi/m^3 is within two standard deviations of the SCDHEC gross beta activity average (SRNS 2009). Section 1.1.3, Figures 6-14 show trending for 2009 for both gross alpha and gross beta.

Radiochemical Particulates

First Quarter glass fiber filters were analyzed for U-234, U-235, U-238, and Pu-238. All analytical results were at or below the Minimum Detectable Activity (MDA), and in line with DOE-SR reported values. The data is presented in Section 1.1.4.

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 2009. It should be noted that 4 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 SCDHEC average ambient beta/gamma activity for perimeter TLDs in 2009 was 93.23 (±11.95) mrem. The DOE-SR average ambient beta/gamma activity was 76.54 (±9.45) mrem for 2009. The DOE-SR ambient/beta gamma average was within two standard deviations 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 2009, DOE-SR released approximately 36900 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).

<u>Tritium In Air</u>

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:

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

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 2009 was slightly higher than reported in 2008 and has fluctuated over the last six years. DOE-SR also reported an increase from 2008 to 2009. 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 15-23 show trending for 2009 for SCDHEC.

The DOE-SR average measured value for tritium activity in air at the SRS perimeter was 15.59 (±9.6) pCi/m^3 (SRNS 2009). The SCDHEC average measured activity for tritium was 4.83 (± 2.14) pCi/m^3. The maximum tritium in air activity of 6.92(±1.27) pCi/m^3 was collected at the Darkhorse air station, inside the Williston barricade, for the month of August 2009. 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 2007). 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 561 (±102) pCi/L, collected in New Ellenton, South Carolina for the collection period of July 2009. The DOE-SR average measured value for tritium activity in precipitation at the SRS perimeter was 314.89 (±727.02) pCi/L (SRNS 2009). The SCDHEC average measured activity for tritium in precipitation was 402.07 (±250.25) 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 2002). 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 24-32 show trending for 2009 for SCDHEC.

3.0 Conclusions/Recommendations

All SCDHEC data collected in 2009 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 deviation of SCDHEC measured averages.

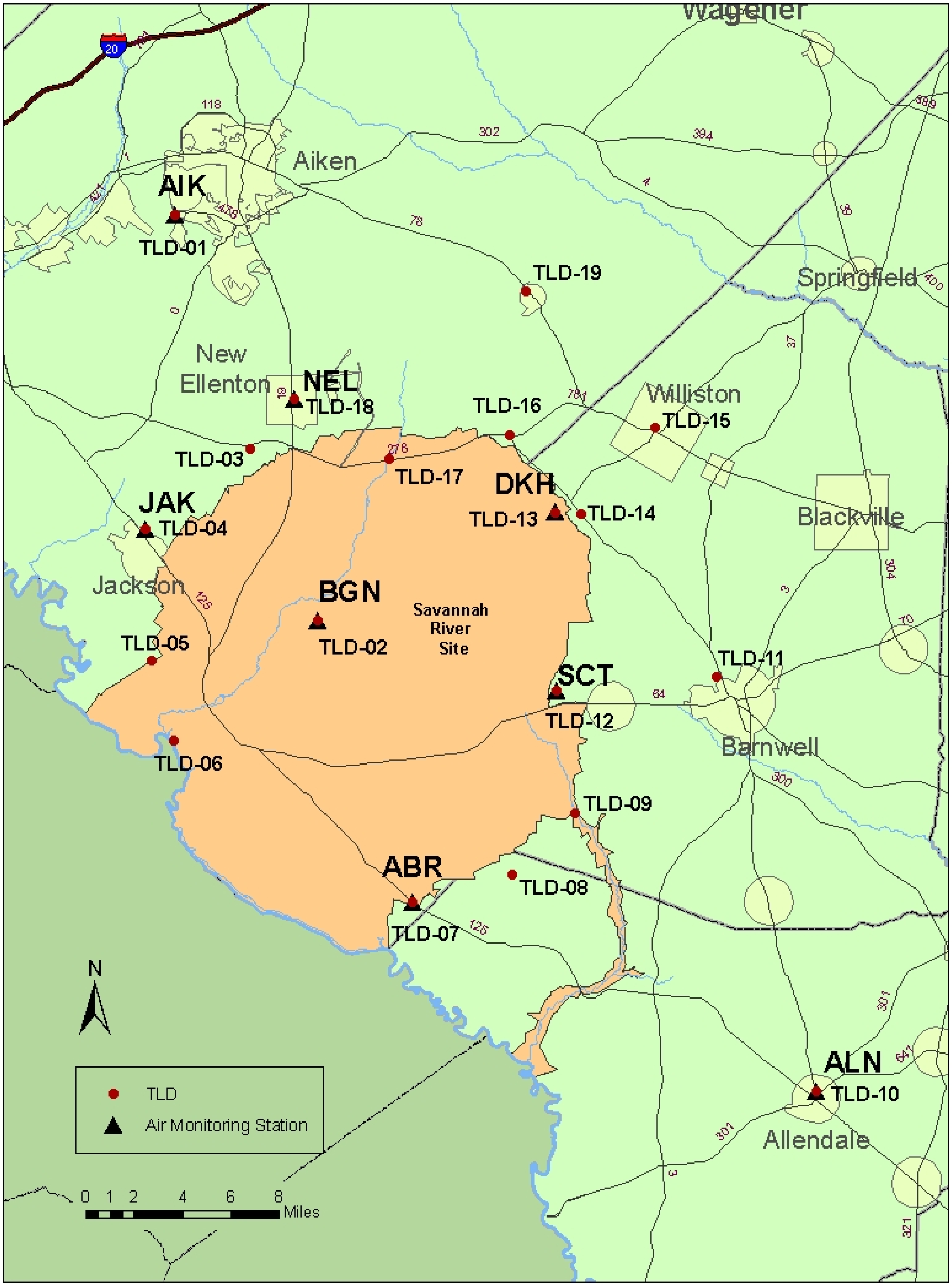
No EPA air standards were exceeded at the monitored locations and there were no elevations of radiological pollutant concentrations associated with SRS operations. Sampling results by SCDHEC indicate that SRS activities did have a measurable but negligible impact on local air quality.

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

2009 Radiological Atmospheric Monitoring
Table 1. SCDHEC and DOE-SR Sample Frequency Comparison

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

Figure 1. DOE-SR and SCDHEC Comparison of Average Gross Alpha For Total Suspended Particulates at the SRS Perimeter

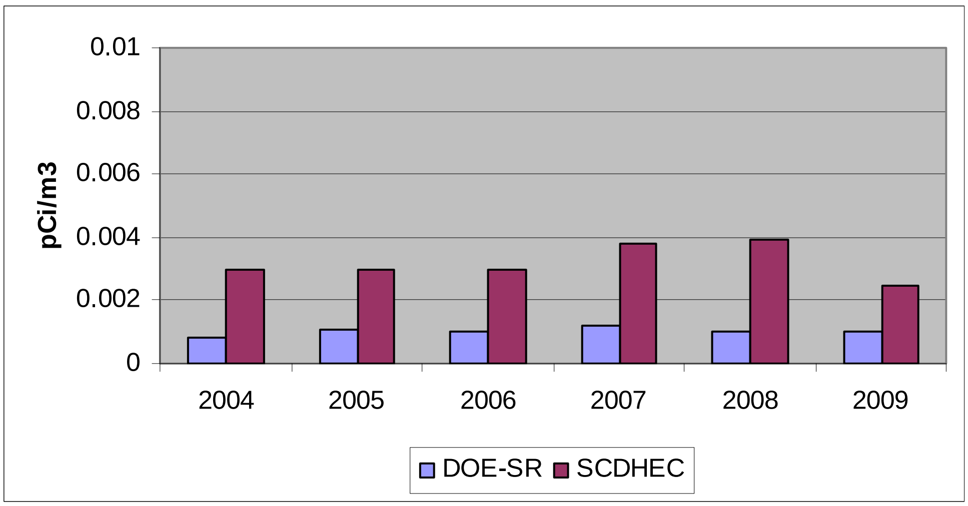


Figure 2. DOE-SR and SCDHEC Comparison of Average Gross Beta For Total Suspended Particulates at the SRS Perimeter

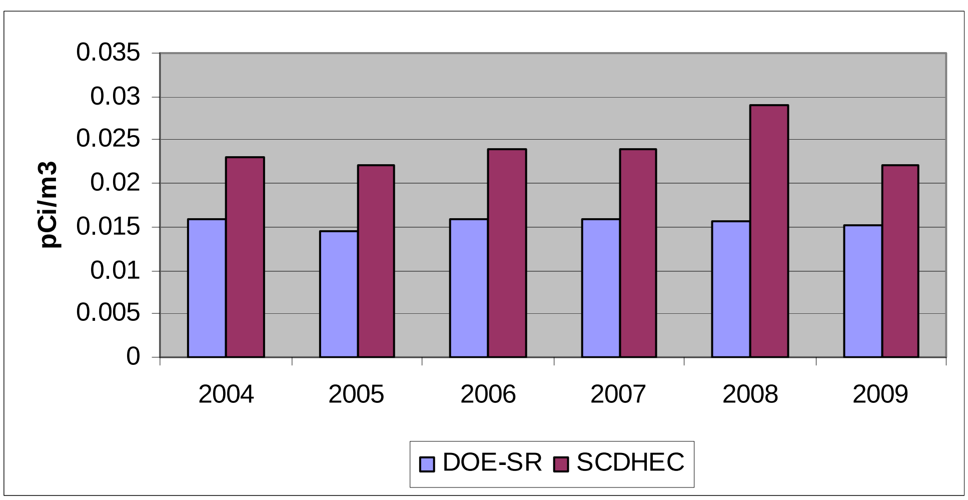


Figure 3. DOE-SR and SCDHEC Comparison of Ambient Beta/Gamma at the SRS Perimeter

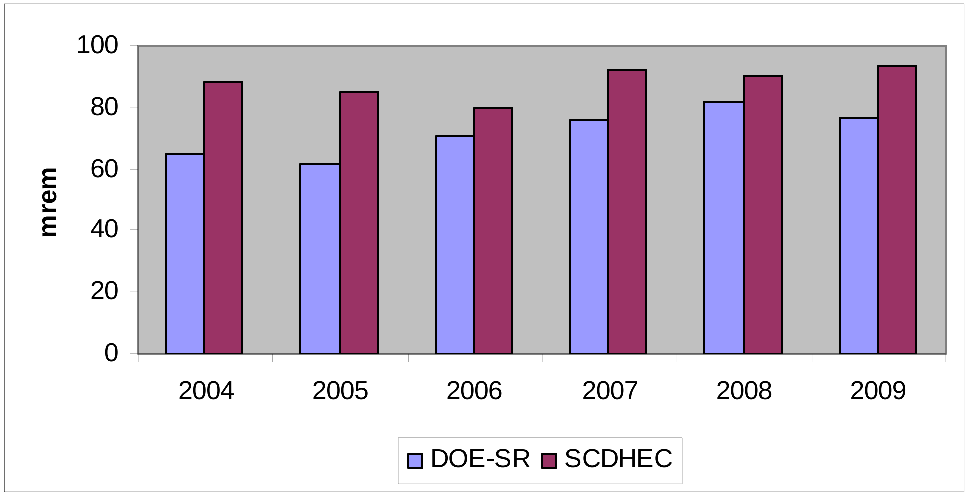


Figure 4. DOE-SR and SCDHEC Comparison of Average Tritium in Air at the SRS Perimeter

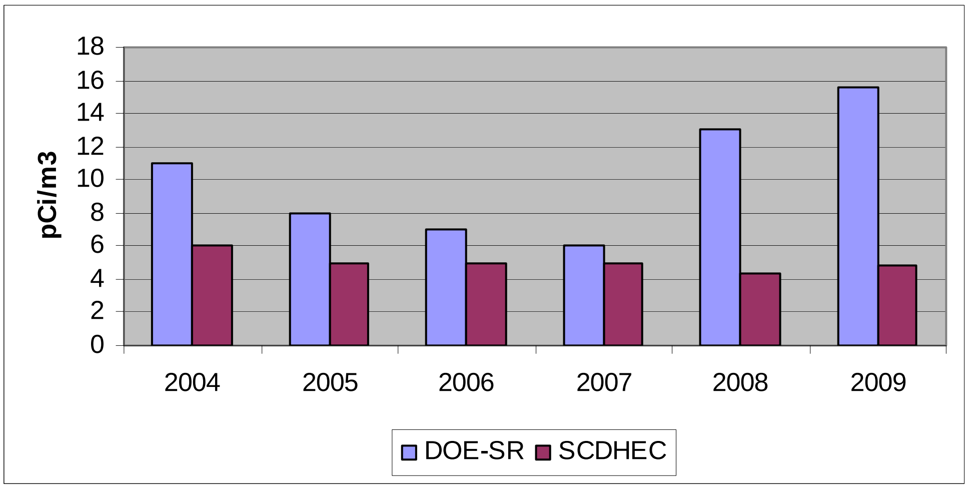


Figure 5. DOE-SR and SCDHEC Comparison of Average Tritium in Precipitation at the SRS Perimeter

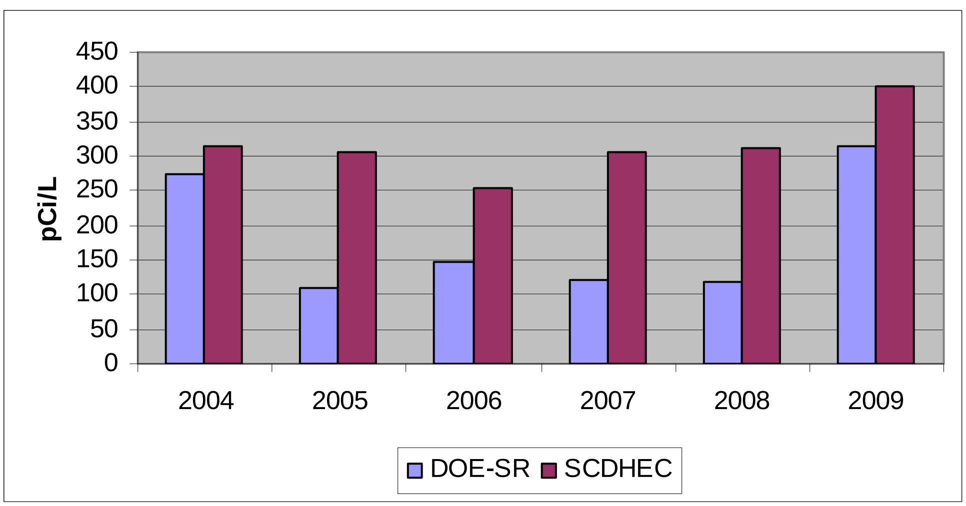


Figure 6. AIK Weekly Gross Alpha/Beta 2009

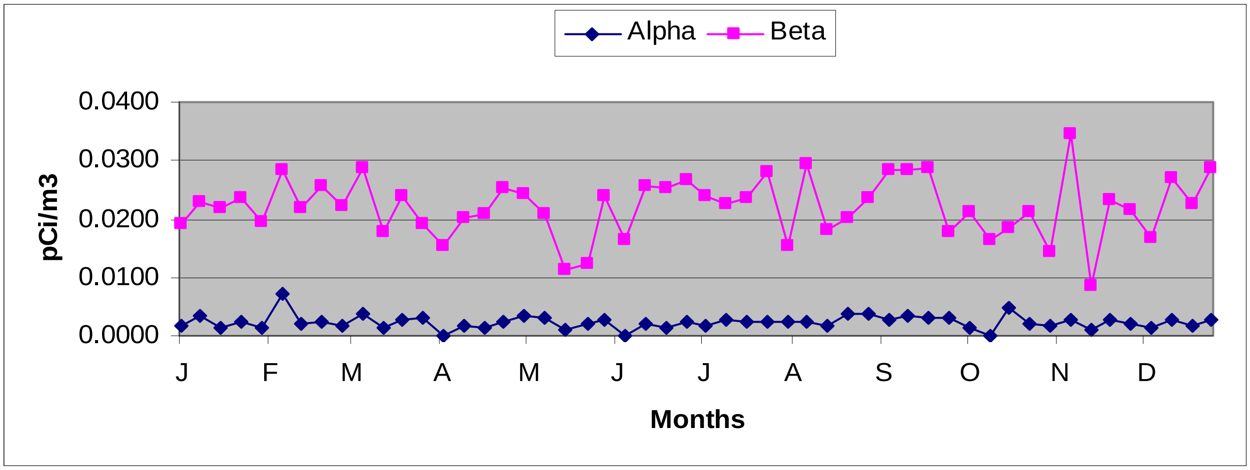


Figure 7. NEL Weekly Gross Alpha/Beta 2009

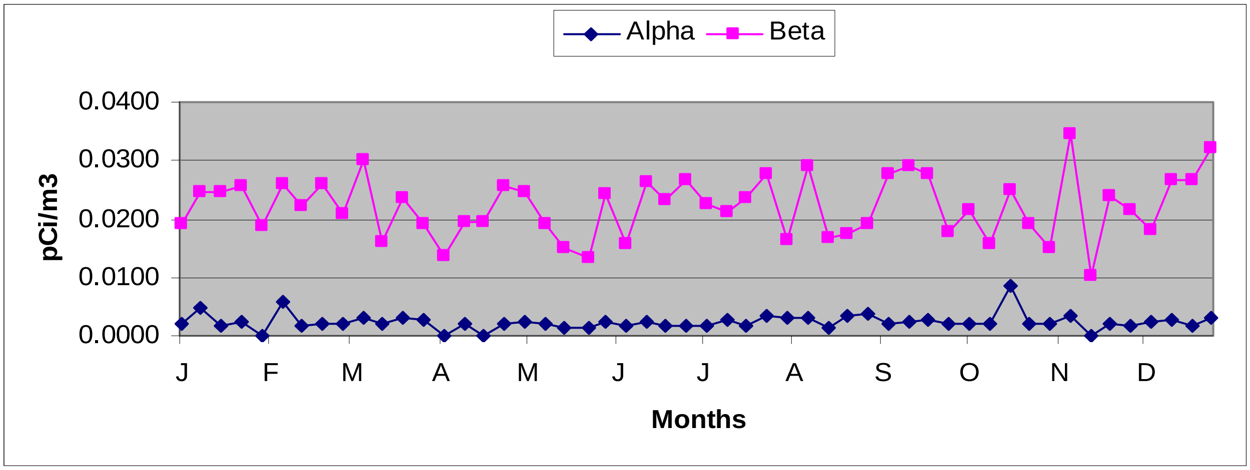
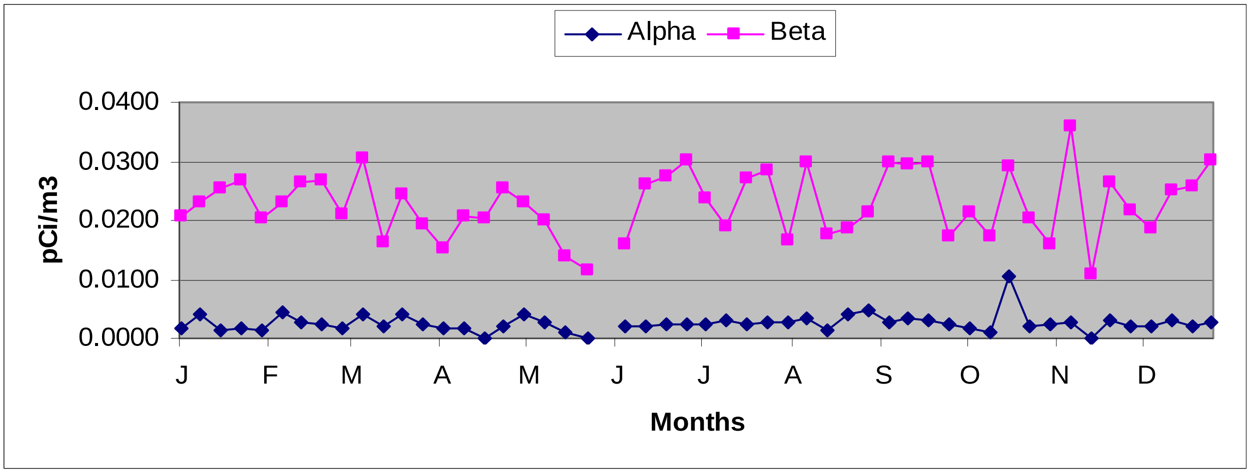


Figure 8. JAK Weekly Gross Alpha/Beta 2009



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 2009

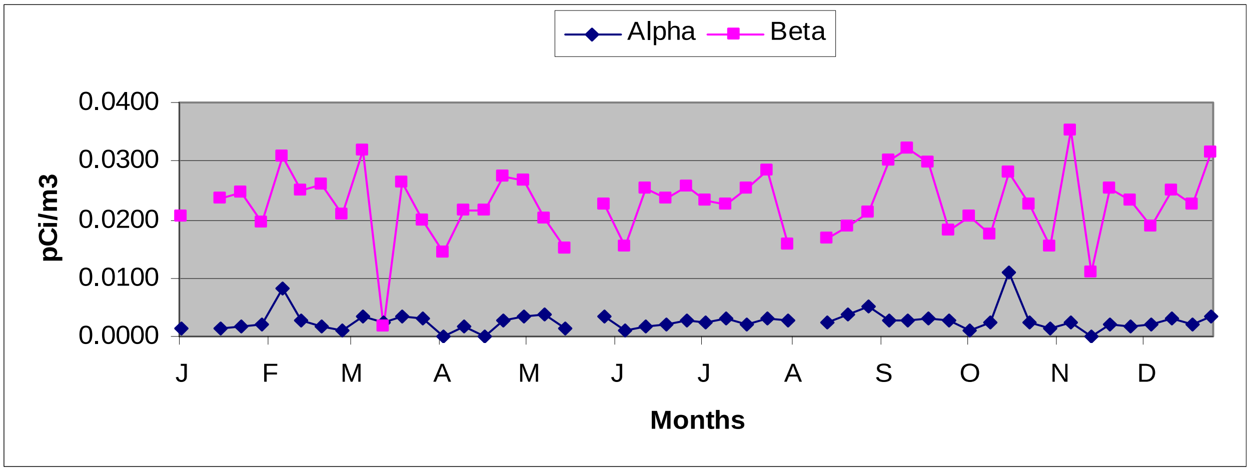


Figure 10. ABR Weekly Gross Alpha/Beta 2009

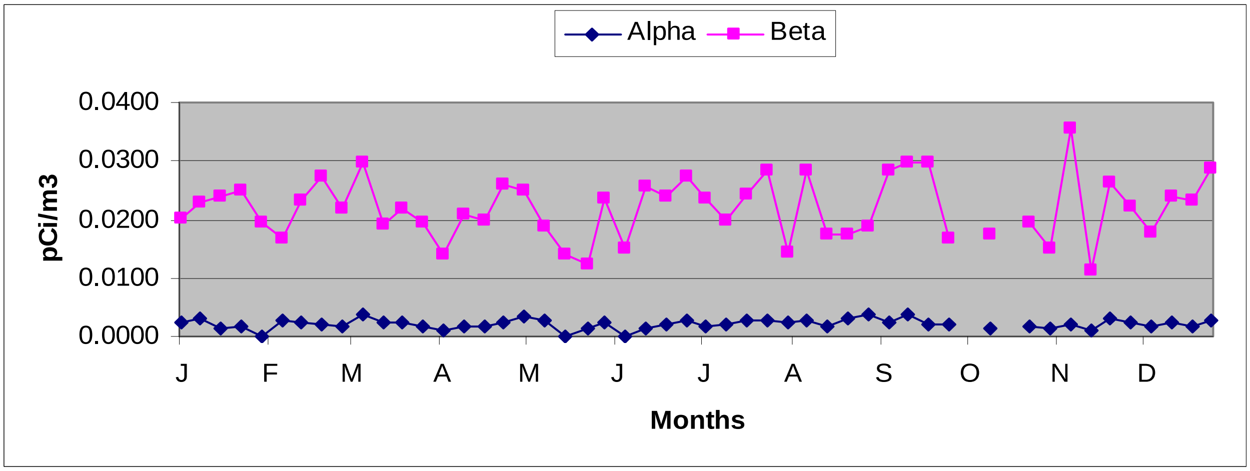
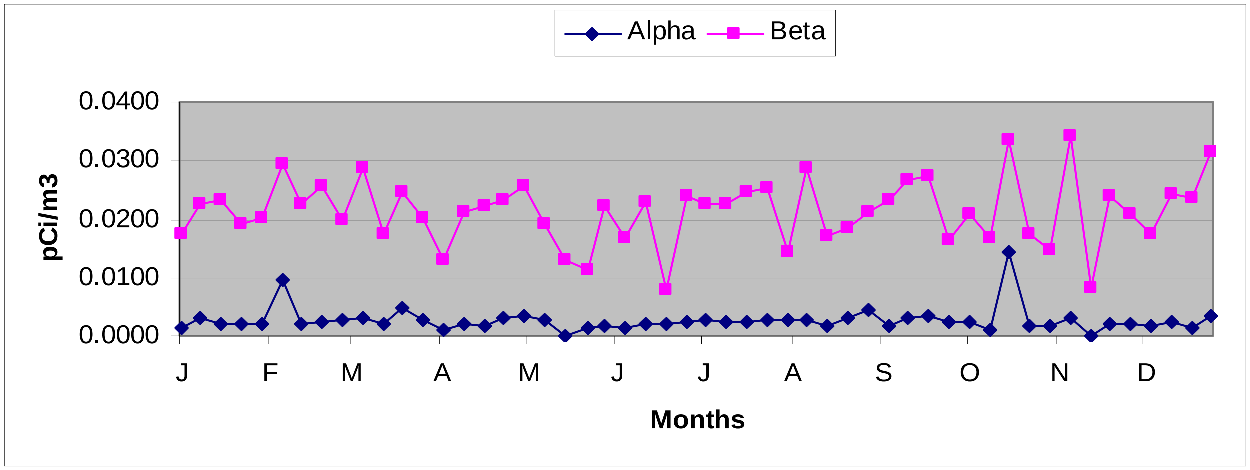


Figure 11. ALN Weekly Gross Alpha/Beta 2009



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 2009

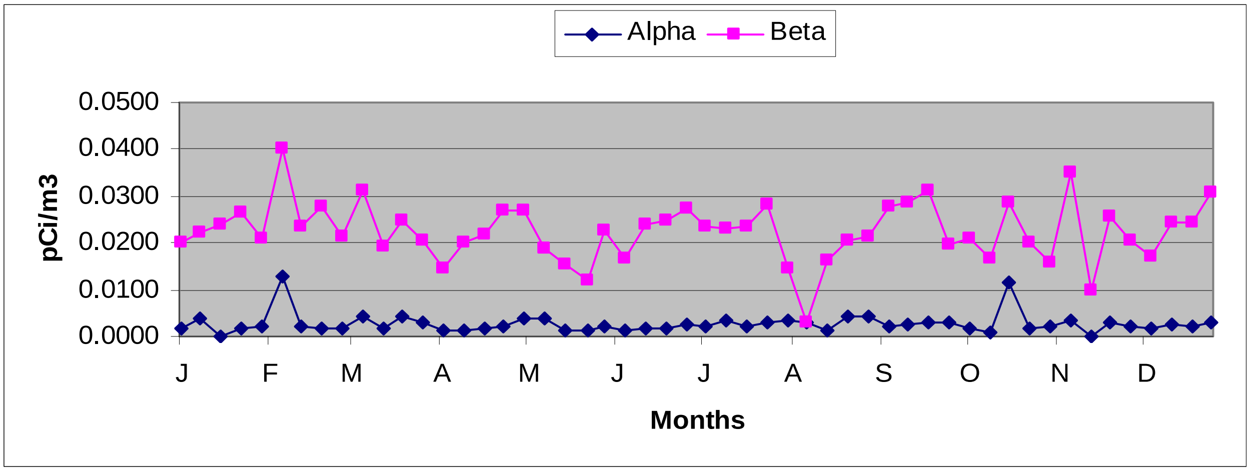
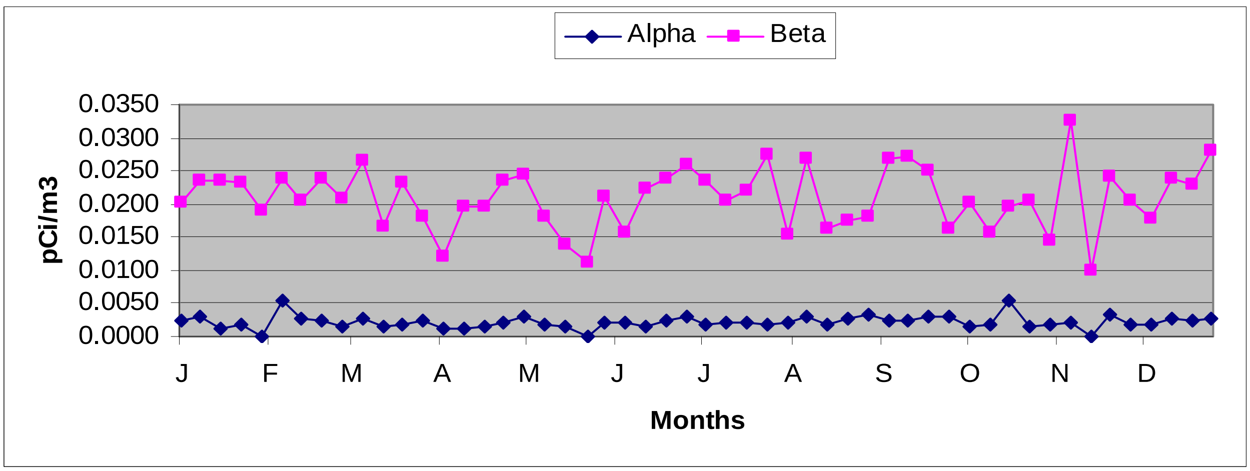


Figure 13. DKH Weekly Gross Alpha/Beta 2009



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 2009

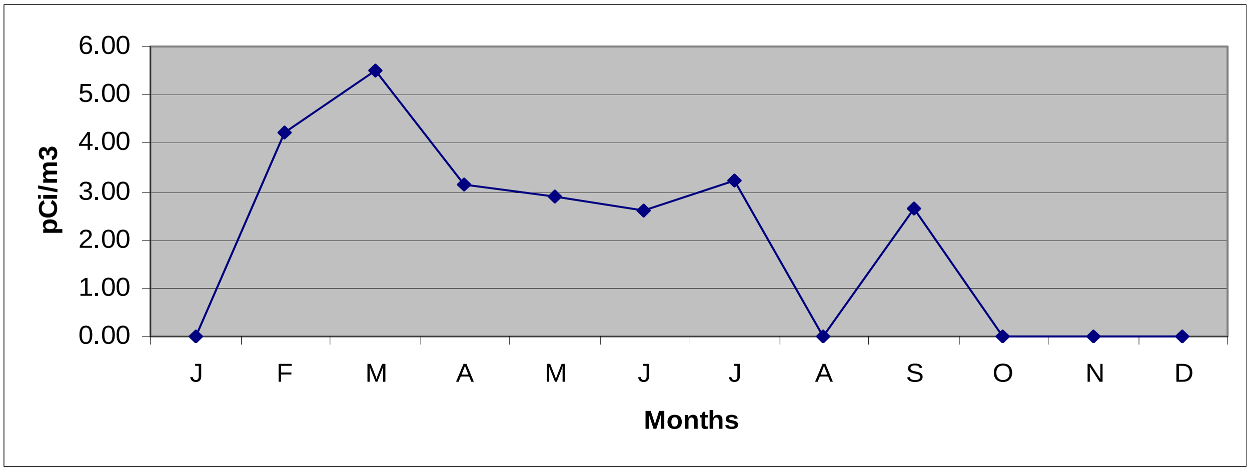


Figure 15. NEL Monthly Tritium in Air 2009

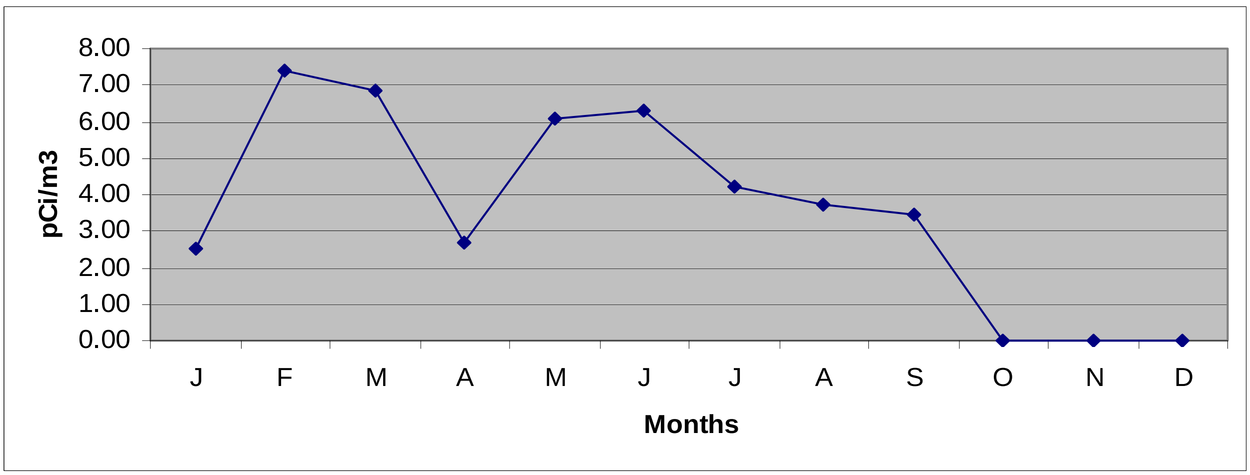
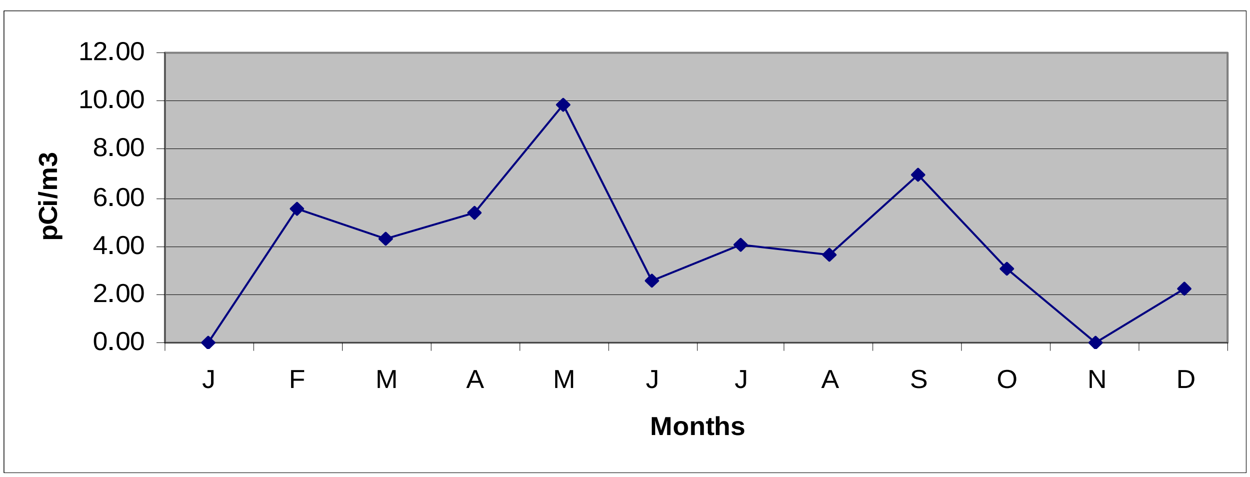


Figure 16. JAK Monthly Tritium in Air 2009



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 2009

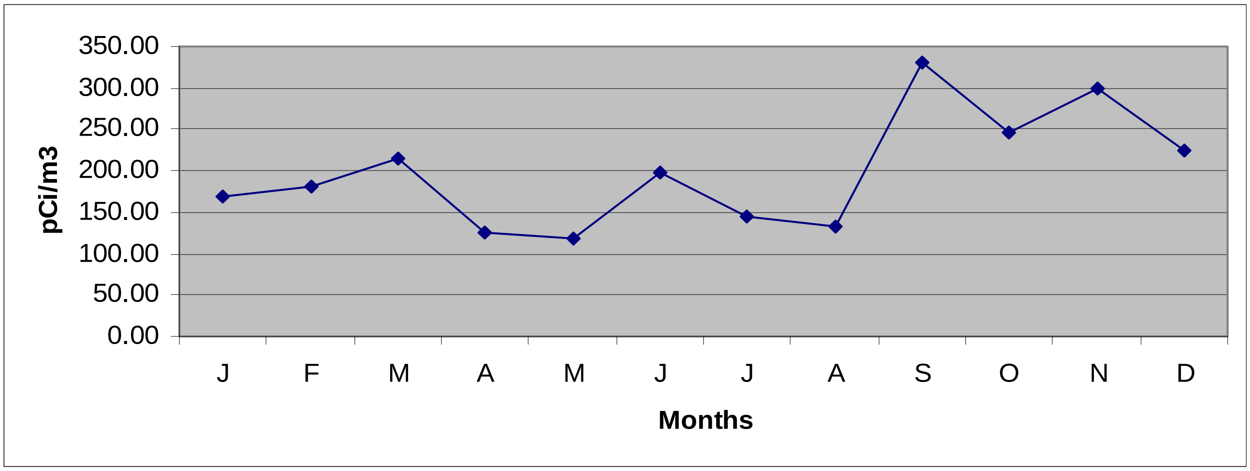


Figure 18. ABR Monthly Tritium in Air 2009

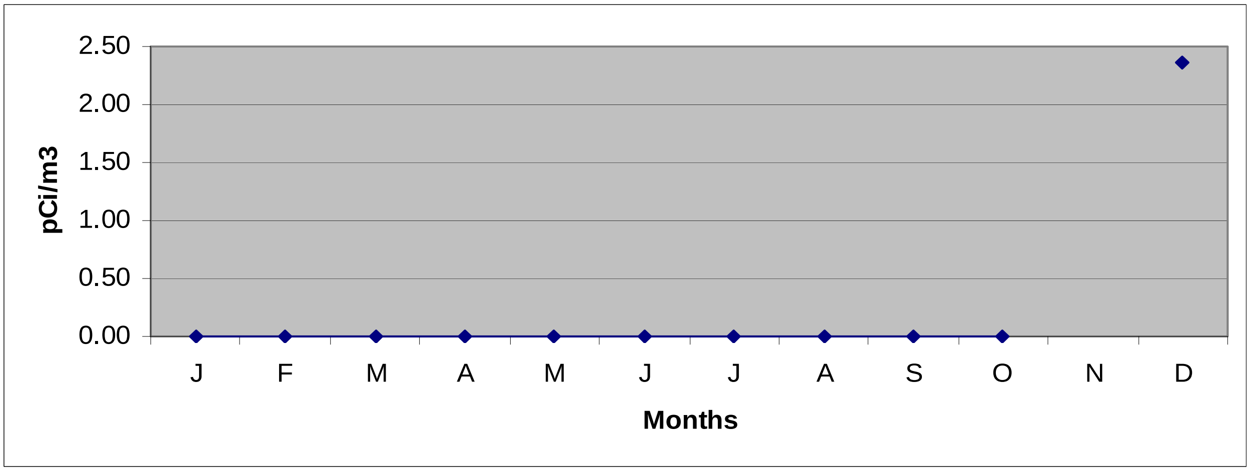
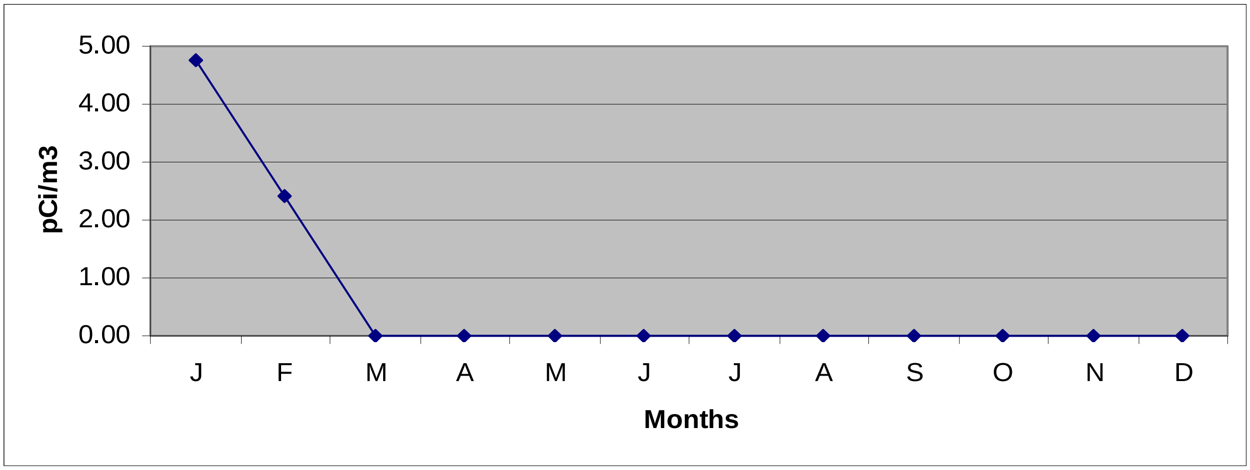


Figure 19. ALN Monthly Tritium in Air 2009



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 2009

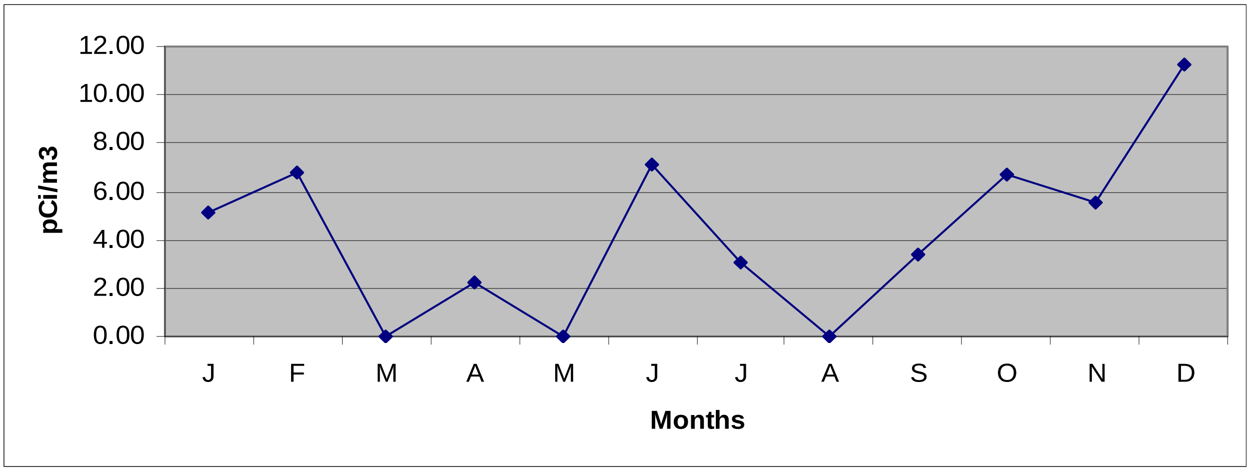
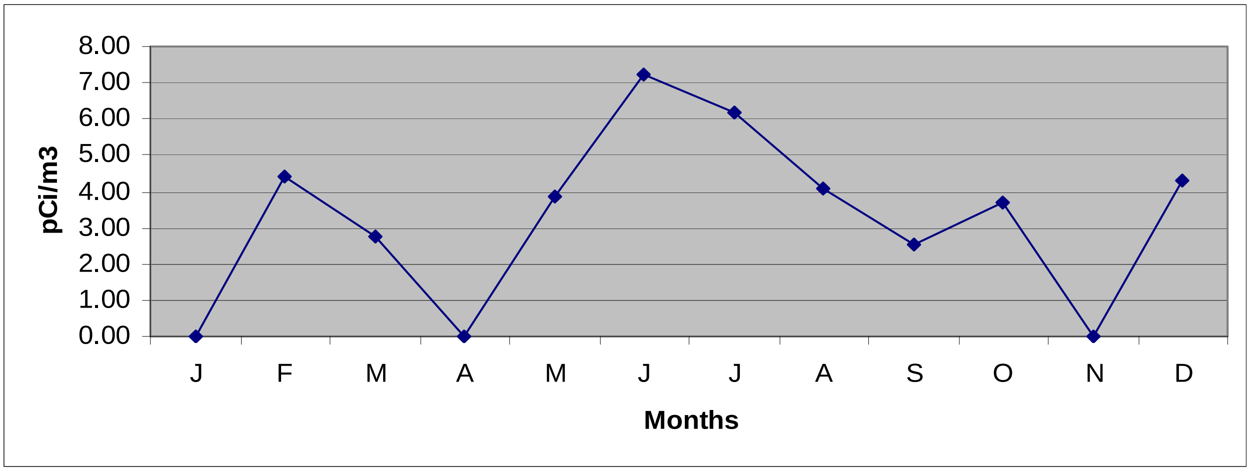


Figure 21. DKH Monthly Tritium in Air 2009



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 2009

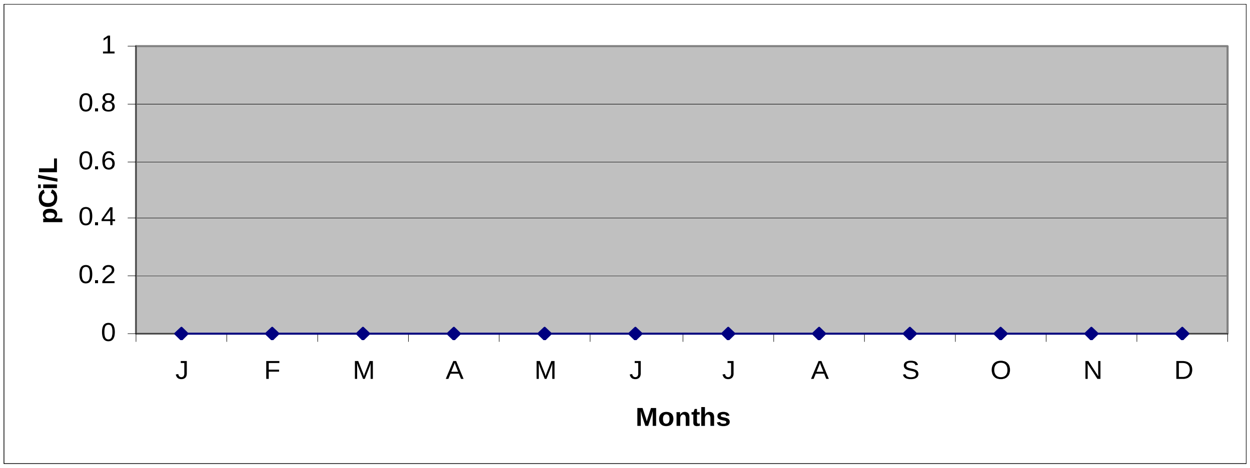


Figure 23. NEL Monthly Tritium in Precipitation 2009

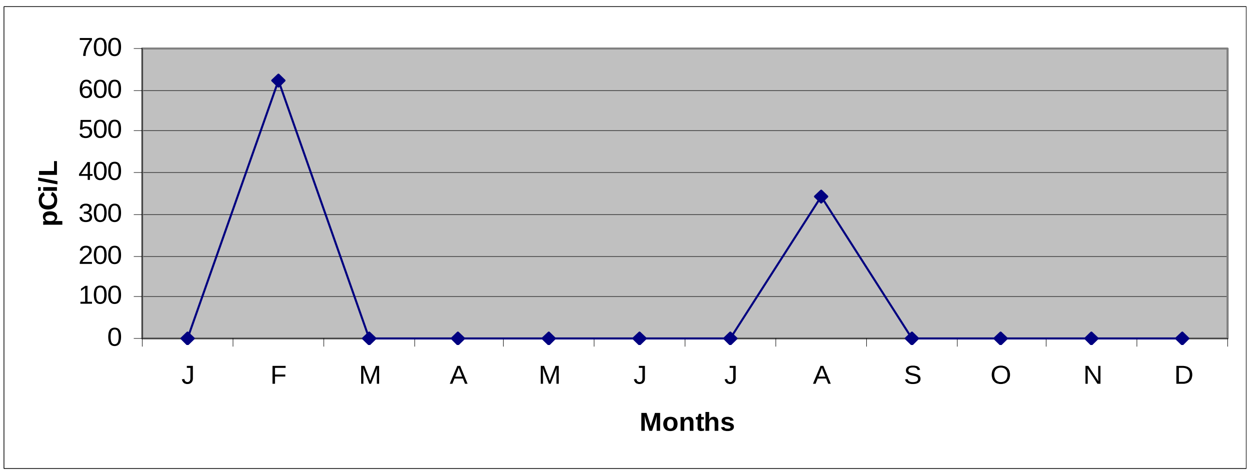
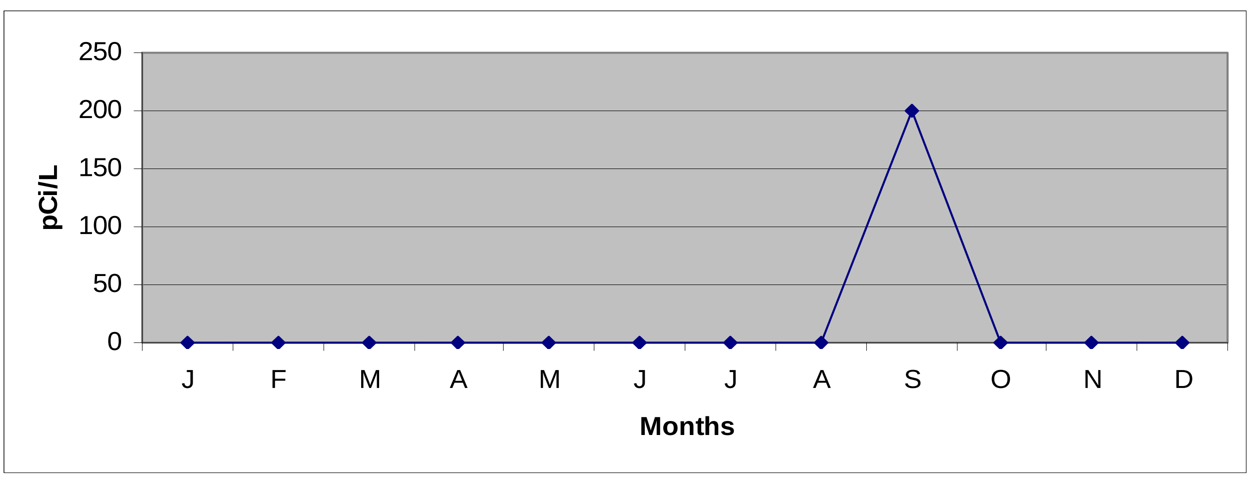


Figure 24. JAK Monthly Tritium in Precipitation 2009



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

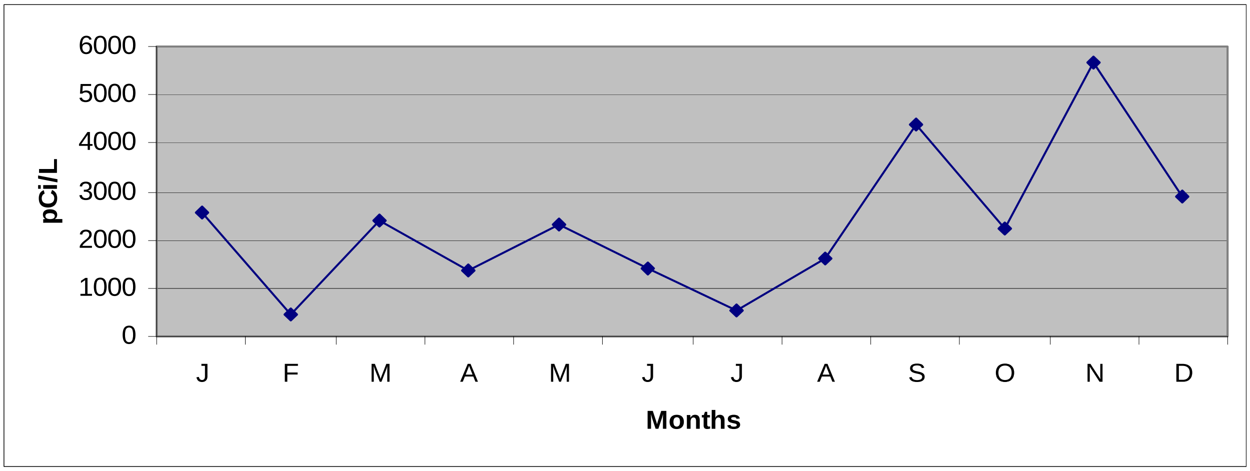


Figure 26. ABR Monthly Tritium in Precipitation

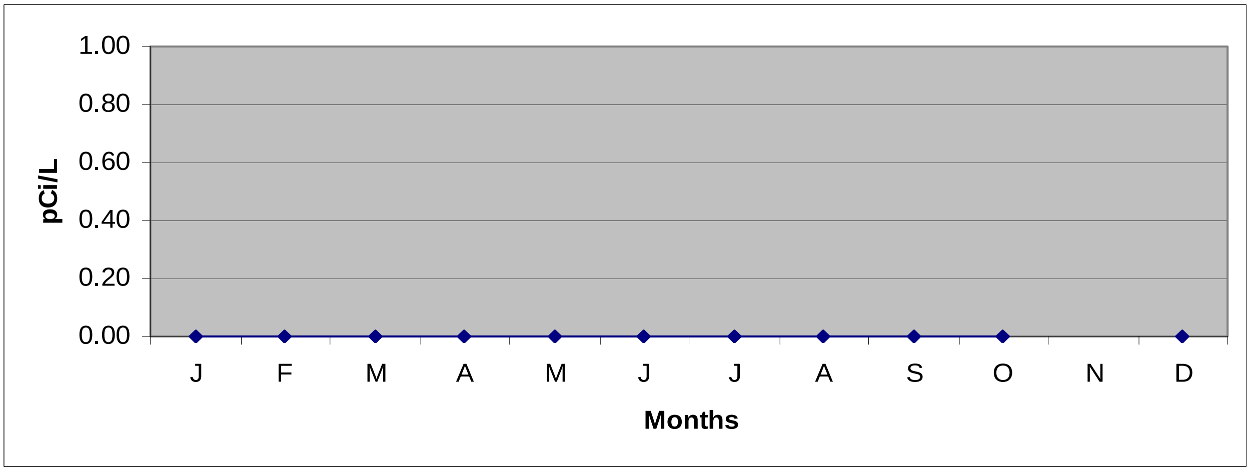
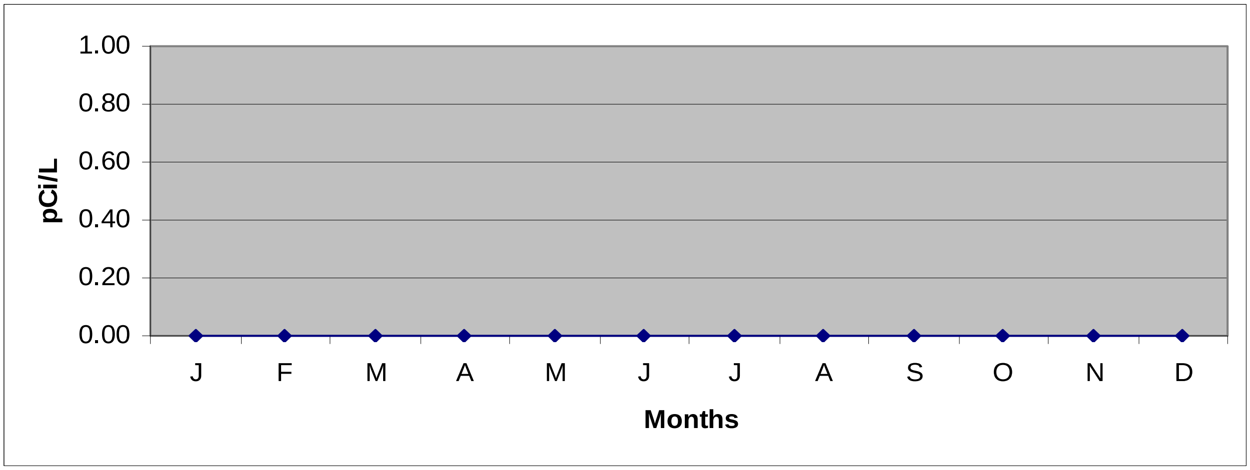


Figure 27. ALN Monthly Tritium in Precipitation



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

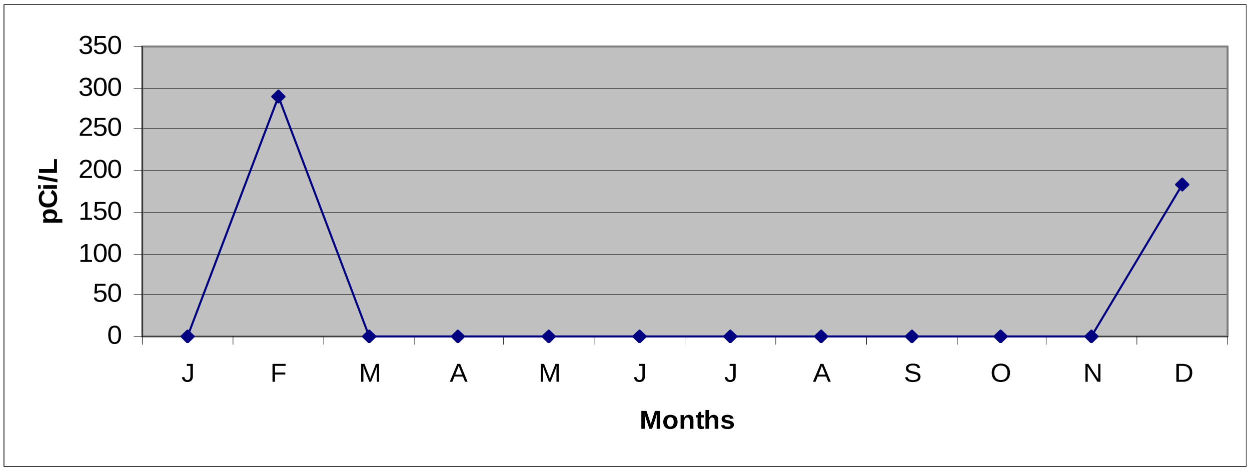
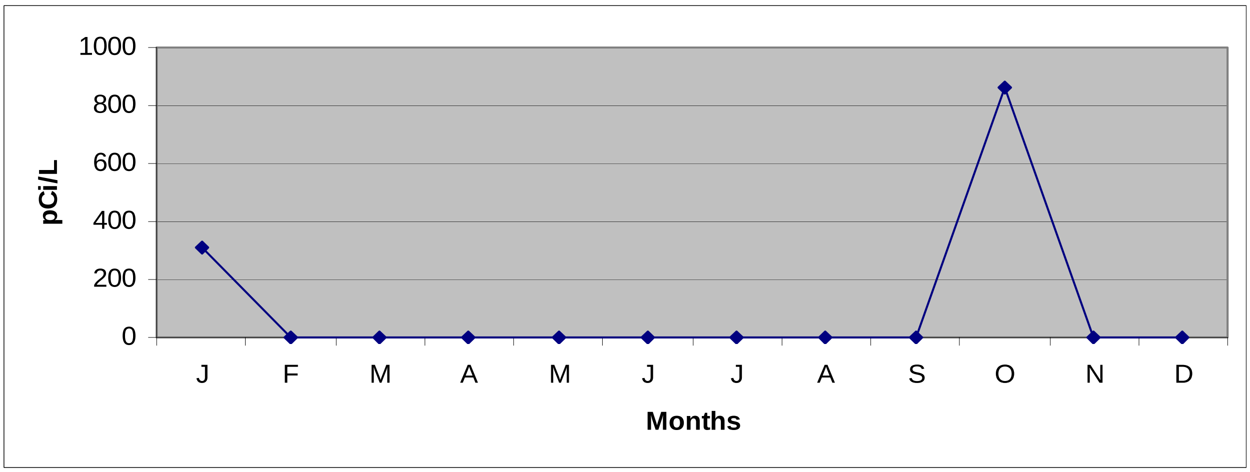


Figure 29. DKH Monthly Tritium in Precipitation



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
Radiological Atmospheric Monitoring

Notes:
Blank Spaces -- No Sample Available
N/A -- Not Applicable
LLD -- Lower Limit of Detection
< -- Less Than LLD
MDA -- Minimum Detectable Activity

Quarterly TLD Beta/Gamma Summary 2009

Sample Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	23.00	16.00	19.00	17.00	75.00
Colocated with BGN Air Station	40.00	34.00	45.00	44.00	163.00
Green Pond	27.00	19.00	23.00	23.00	92.00
Colocated with JAK Air Station	22.00	17.00	19.00	20.00	78.00
Crackerneck Gate	28.00	19.00	21.00	25.00	93.00
TNX Boat Ramp	27.00	25.00	28.00	26.00	106.00
Colocated with ABR Air Station	23.00	17.00	19.00	17.00	76.00
Junction of Millet Road and Round Tree Road	29.00	18.00	29.00	26.00	102.00
Patterson Mill Road at Lower Three Runs Creek	31.00	25.00	26.00	27.00	109.00
Colocated with ALN Air Station	25.00	17.00	23.00	23.00	88.00
Barnwell Airport	24.00	21.00	22.00	23.00	90.00
Colocated with SCT Air station	25.00	19.00	22.00	22.00	88.00
Colocated with DKH Air station	27.00	20.00	23.00	22.00	92.00
Bates Cemetery	22.00	18.00	20.00	19.00	79.00
Williston Police Department	28.00	22.00	25.00	27.00	102.00
Junction of US 278 and SC 781	29.00	20.00	23.00	23.00	95.00
US 278 near Upper Three Runs Creek	34.00	25.00	25.00	30.00	114.00
Colocated with NEL Air Station	24.00	20.00	22.00	22.00	88.00
Winsor Post Office	27.00	19.00	23.00	24.00	93.00
Control TLD (Kept in Office)	16.00	11.00	16.00	12.00	55.00

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Aiken Elementary Water Tower (AIK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0016	0.0007	0.0193	0.0017				
01/13/09	0.0034	0.0009	0.0229	0.0018				
01/20/09	0.0012	0.0008	0.0220	0.0017				
01/27/09	0.0023	0.0008	0.0236	0.0018	<2.42	N/A	<210	N/A
02/03/09	0.0014	0.0008	0.0195	0.0017				
02/10/09	0.0071	0.0011	0.0283	0.0019				
02/17/09	0.0022	0.0008	0.0218	0.0018				
02/24/09	0.0024	0.0009	0.0258	0.0020	4.23	1.09	<188	NA
03/03/09	0.0019	0.0008	0.0221	0.0018				
03/10/09	0.0036	0.0010	0.0288	0.0020				
03/17/09	0.0013	0.0007	0.0179	0.0017				
03/24/09	0.0029	0.0009	0.0241	0.0019				
03/31/09	0.0030	0.0009	0.0193	0.0018	5.49	1.14	<186	NA
04/07/09	<0.0011	N/A	0.0154	0.0016				
04/14/09	0.0016	0.0008	0.0201	0.0018				
04/21/09	0.0014	0.0009	0.0210	0.0018				
04/28/09	0.0025	0.0008	0.0252	0.0019	3.13	1.04	<251	NA
05/05/09	0.0034	0.0009	0.0243	0.0019				
05/12/09	0.0030	0.0009	0.0210	0.0018				
05/19/09	0.0009	0.0006	0.0112	0.0012				
05/27/09	0.0019	0.0007	0.0123	0.0013	2.91	1.03	<189	NA
06/02/09	0.0028	0.0009	0.0238	0.0021				
06/09/09	<0.0009	N/A	0.0164	0.0016				
06/16/09	0.0021	0.0008	0.0255	0.0020				
06/23/09	0.0014	0.0007	0.0254	0.0019				
06/30/09	0.0023	0.0008	0.0267	0.0020	2.60	0.99	<195	NA
07/07/09	0.0016	0.0007	0.0241	0.0019				
07/14/09	0.0026	0.0008	0.0224	0.0017				
07/21/09	0.0022	0.0008	0.0236	0.0019				
07/28/09	0.0024	0.0008	0.0280	0.0019	3.22	1.00	<181	NA
08/04/09	0.0025	0.0008	0.0153	0.0016				
08/11/09	0.0025	0.0008	0.0294	0.0020				
08/18/09	0.0018	0.0008	0.0180	0.0017				
08/25/09	0.0037	0.0009	0.0203	0.0018	<2.05	NA	<195	NA
09/01/09	0.0039	0.0010	0.0235	0.0018				
09/08/09	0.0029	0.0009	0.0285	0.0019				
09/15/09	0.0033	0.0009	0.0285	0.0019				
09/22/09	0.0031	0.0008	0.0287	0.0019				
09/29/09	0.0029	0.0008	0.0177	0.0016	2.66	0.99	<191	NA
10/06/09	0.0012	0.0006	0.0212	0.0017				
10/13/09	<0.0009	NA	0.0163	0.0015				
10/20/09	0.0049	0.0010	0.0185	0.0016				
10/27/09	0.0020	0.0007	0.0212	0.0017	<2.31	NA	<216	NA
11/03/09	0.0017	0.0006	0.0144	0.0015				
11/10/09	0.0029	0.0009	0.0345	0.0021				
11/17/09	0.0011	0.0006	0.0086	0.0012				
11/24/09	0.0028	0.0008	0.0234	0.0018	<2.26	NA	<198	NA
12/01/09	0.0021	0.0007	0.0215	0.0017				
12/08/09	0.0015	0.0006	0.0169	0.0015				
12/15/09	0.0029	0.0008	0.0271	0.0018				
12/22/09	0.0017	0.0007	0.0227	0.0017				
12/29/09	0.0028	0.0008	0.0288	0.0019	<2.18	NA	<181	NA

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	New Ellenton, SC (NEL)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0019	0.0008	0.0192	0.0019				
01/13/09	0.0047	0.0011	0.0246	0.0020				
01/20/09	0.0017	0.0008	0.0246	0.0018				
01/27/09	0.0023	0.0009	0.0258	0.0019	2.51	1.12	<210	N/A
02/03/09	<0.0012	NA	0.0187	0.0017				
02/10/09	0.0057	0.0010	0.0261	0.0018				
02/17/09	0.0019	0.0008	0.0222	0.0017				
02/24/09	0.0021	0.0009	0.0260	0.0019	7.40	1.22	623	105
03/03/09	0.0019	0.0008	0.0210	0.0018				
03/10/09	0.0032	0.0009	0.0301	0.0021				
03/17/09	0.0019	0.0008	0.0162	0.0016				
03/24/09	0.0032	0.0009	0.0235	0.0018				
03/31/09	0.0029	0.0008	0.0190	0.0017	6.84	1.19	<186	NA
04/07/09	<0.0011	N/A	0.0138	0.0016				
04/14/09	0.0020	0.0008	0.0194	0.0017				
04/21/09	<0.0013	N/A	0.0196	0.0018				
04/28/09	0.0021	0.0008	0.0255	0.0019	2.70	1.03	<251	NA
05/05/09	0.0026	0.0009	0.0245	0.0019				
05/12/09	0.0022	0.0008	0.0191	0.0017				
05/19/09	0.0012	0.0008	0.0152	0.0016				
05/27/09	0.0015	0.0007	0.0132	0.0014	6.11	1.16	<189	NA
06/02/09	0.0026	0.0009	0.0244	0.0021				
06/09/09	0.0016	0.0007	0.0156	0.0016				
06/16/09	0.0025	0.0009	0.0262	0.0020				
06/23/09	0.0019	0.0008	0.0231	0.0019				
06/30/09	0.0018	0.0008	0.0265	0.0020	6.27	1.15	<195	NA
07/07/09	0.0017	0.0008	0.0224	0.0019				
07/14/09	0.0027	0.0008	0.0211	0.0016				
07/21/09	0.0018	0.0008	0.0237	0.0019				
07/28/09	0.0035	0.0010	0.0278	0.0020	4.24	1.04	<181	NA
08/04/09	0.0031	0.0009	0.0164	0.0016				
08/11/09	0.0030	0.0009	0.0291	0.0020				
08/18/09	0.0015	0.0007	0.0166	0.0016				
08/25/09	0.0035	0.0009	0.0173	0.0017	3.70	1.02	341	96
09/01/09	0.0039	0.0010	0.0192	0.0018				
09/08/09	0.0022	0.0008	0.0278	0.0020				
09/15/09	0.0025	0.0008	0.0289	0.0020				
09/22/09	0.0026	0.0008	0.0276	0.0020				
09/29/09	0.0021	0.0007	0.0178	0.0016	3.48	1.03	<191	NA
10/06/09	0.0021	0.0008	0.0214	0.0018				
10/13/09	0.0021	0.0008	0.0158	0.0016				
10/20/09	0.0085	0.0013	0.0248	0.0018				
10/27/09	0.0020	0.0007	0.0192	0.0017	<2.31	NA	<216	NA
11/03/09	0.0019	0.0007	0.0152	0.0016				
11/10/09	0.0034	0.0010	0.0344	0.0021				
11/17/09	<0.0009	NA	0.0102	0.0013				
11/24/09	0.0021	0.0008	0.0238	0.0018	<2.26	NA	<198	NA
12/01/09	0.0018	0.0007	0.0217	0.0017				
12/08/09	0.0022	0.0007	0.0181	0.0016				
12/15/09	0.0026	0.0008	0.0265	0.0019				
12/22/09	0.0016	0.0007	0.0268	0.0019				
12/29/09	0.0029	0.0008	0.0323	0.0021	<2.18	NA	<181	NA

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Jackson, SC (JAK)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0018	0.0007	0.0208	0.0018				
01/13/09	0.0040	0.0009	0.0230	0.0018				
01/20/09	0.0014	0.0008	0.0253	0.0018				
01/27/09	0.0018	0.0008	0.0267	0.0019	<2.41	N/A	<210	N/A
02/03/09	0.0013	0.0008	0.0202	0.0017				
02/10/09	0.0043	0.0009	0.0231	0.0017				
02/17/09	0.0028	0.0009	0.0265	0.0020				
02/24/09	0.0022	0.0009	0.0267	0.0020	5.55	1.15	<188	NA
03/03/09	0.0018	0.0008	0.0210	0.0018				
03/10/09	0.0042	0.0010	0.0304	0.0021				
03/17/09	0.0020	0.0008	0.0164	0.0016				
03/24/09	0.0040	0.0010	0.0245	0.0019				
03/31/09	0.0024	0.0008	0.0193	0.0018	4.34	1.09	<186	NA
04/07/09	0.0017	0.0008	0.0153	0.0016				
04/14/09	0.0018	0.0008	0.0208	0.0018				
04/21/09	<0.0013	N/A	0.0202	0.0018				
04/28/09	0.0019	0.0008	0.0255	0.0019	5.41	1.14	<251	NA
05/05/09	0.0042	0.0010	0.0231	0.0018				
05/12/09	0.0026	0.0009	0.0201	0.0017				
05/19/09	0.0012	0.0007	0.0138	0.0015				
05/27/09	<0.0011	N/A	0.0114	0.0015	9.89	1.30	<189	NA
06/02/09								
06/09/09	0.0019	0.0008	0.0161	0.0016				
06/16/09	0.0020	0.0008	0.0260	0.0020				
06/23/09	0.0025	0.0009	0.0275	0.0021				
06/30/09	0.0025	0.0008	0.0302	0.0021	2.52	0.99	<195	NA
07/07/09	0.0024	0.0008	0.0236	0.0019				
07/14/09	0.0030	0.0008	0.0189	0.0015				
07/21/09	0.0025	0.0009	0.0272	0.0020				
07/28/09	0.0028	0.0009	0.0286	0.0020	4.09	1.03	<181	NA
08/04/09	0.0026	0.0008	0.0165	0.0017				
08/11/09	0.0035	0.0009	0.0300	0.0021				
08/18/09	0.0015	0.0007	0.0177	0.0017				
08/25/09	0.0041	0.0010	0.0185	0.0017	3.61	1.03	<195	NA
09/01/09	0.0046	0.0010	0.0214	0.0018				
09/08/09	0.0027	0.0009	0.0297	0.0020				
09/15/09	0.0033	0.0009	0.0296	0.0020				
09/22/09	0.0029	0.0008	0.0298	0.0020				
09/29/09	0.0025	0.0008	0.0174	0.0016	6.95	1.17	200	89
10/06/09	0.0017	0.0007	0.0213	0.0017				
10/13/09	0.0012	0.0007	0.0173	0.0016				
10/20/09	0.0104	0.0014	0.0293	0.0019				
10/27/09	0.0021	0.0007	0.0205	0.0017	3.06	1.10	<216	NA
11/03/09	0.0023	0.0007	0.0158	0.0016				
11/10/09	0.0026	0.0009	0.0361	0.0021				
11/17/09	<0.0009	NA	0.0108	0.0013				
11/24/09	0.0030	0.0008	0.0264	0.0019	<2.26	NA	<198	NA
12/01/09	0.0021	0.0008	0.0216	0.0017				
12/08/09	0.0020	0.0007	0.0188	0.0016				
12/15/09	0.0032	0.0009	0.0252	0.0018				
12/22/09	0.0020	0.0008	0.0256	0.0018				
12/29/09	0.0028	0.0008	0.0302	0.0020	2.23	1.02	<181	NA

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Burial Grounds North (BGN)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0015	0.0007	0.0206	0.0018				
01/13/09								
01/20/09	0.0013	0.0008	0.0237	0.0018				
01/27/09	0.0017	0.0008	0.0247	0.0019	168.87	4.03	2554	159
02/03/09	0.0022	0.0009	0.0196	0.0018				
02/10/09	0.0081	0.0013	0.0308	0.0020				
02/17/09	0.0028	0.0009	0.0251	0.0020				
02/24/09	0.0016	0.0008	0.0261	0.0019	181.54	4.13	443	98
03/03/09	0.0012	0.0007	0.0208	0.0017				
03/10/09	0.0034	0.0010	0.0317	0.0022				
03/17/09	0.0022	0.0008	0.0018	0.0017				
03/24/09	0.0035	0.0010	0.0262	0.0020				
03/31/09	0.0032	0.0009	0.0197	0.0018	213.90	4.45	2394	156
04/07/09	<0.0011	N/A	0.0143	0.0016				
04/14/09	0.0017	0.0008	0.0217	0.0019				
04/21/09	<0.0014	N/A	0.0214	0.0019				
04/28/09	0.0027	0.0008	0.0274	0.0019	125.39	3.45	1381	147
05/05/09	0.0036	0.0009	0.0266	0.0019				
05/12/09	0.0037	0.0009	0.0201	0.0017				
05/19/09	0.0013	0.0007	0.0151	0.0015				
05/27/09					117.53	3.35	2322	155
06/02/09	0.0034	0.0010	0.0225	0.0020				
06/09/09	0.0012	0.0007	0.0153	0.0015				
06/16/09	0.0016	0.0007	0.0253	0.0019				
06/23/09	0.0022	0.0008	0.0235	0.0018				
06/30/09	0.0029	0.0009	0.0258	0.0020	198.34	4.28	1402	131
07/07/09	0.0022	0.0008	0.0232	0.0019				
07/14/09	0.0031	0.0008	0.0225	0.0017				
07/21/09	0.0021	0.0008	0.0253	0.0019				
07/28/09	0.0031	0.0009	0.0283	0.0019	144.33	3.68	536	99
08/04/09	0.0026	0.0008	0.0158	0.0016				
08/11/09								
08/18/09	0.0022	0.0008	0.0167	0.0016				
08/25/09	0.0036	0.0009	0.0188	0.0017	131.85	3.53	1604	138
09/01/09	0.0052	0.0011	0.0212	0.0018				
09/08/09	0.0027	0.0009	0.0300	0.0020				
09/15/09	0.0027	0.0008	0.0321	0.0021				
09/22/09	0.0032	0.0009	0.0297	0.0020				
09/29/09	0.0028	0.0008	0.0182	0.0016	330.42	5.49	4397	201
10/06/09	0.0010	0.0006	0.0204	0.0017				
10/13/09	0.0023	0.0008	0.0174	0.0016				
10/20/09	0.0111	0.0014	0.0280	0.0019				
10/27/09	0.0026	0.0008	0.0225	0.0018	245.66	4.77	2222	159
11/03/09	0.0014	0.0006	0.0155	0.0016				
11/10/09	0.0024	0.0009	0.0353	0.0021				
11/17/09	<0.0009	NA	0.0110	0.0013				
11/24/09	0.0021	0.0008	0.0252	0.0018	299.75	5.24	5684	226
12/01/09	0.0019	0.0007	0.0232	0.0018				
12/08/09	0.0020	0.0007	0.0187	0.0016				
12/15/09	0.0030	0.0009	0.0248	0.0018				
12/22/09	0.0020	0.0008	0.0225	0.0017				
12/29/09	0.0033	0.0009	0.0316	0.0020	224.58	4.56	2908	167

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Allendale Barricade (ABR)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0025	0.0008	0.0203	0.0017				
01/13/09	0.0032	0.0009	0.0230	0.0018				
01/20/09	0.0013	0.0008	0.0239	0.0018				
01/27/09	0.0018	0.0008	0.0250	0.0019	<2.41	N/A	<210	N/A
02/03/09	<0.0012	NA	0.0194	0.0017				
02/10/09	0.0026	0.0008	0.0166	0.0015				
02/17/09	0.0022	0.0008	0.0233	0.0018				
02/24/09	0.0021	0.0008	0.0272	0.0019	<2.16	NA	<188	NA
03/03/09	0.0019	0.0008	0.0219	0.0018				
03/10/09	0.0038	0.0010	0.0296	0.0020				
03/17/09	0.0025	0.0008	0.0190	0.0017				
03/24/09	0.0024	0.0009	0.0218	0.0018				
03/31/09	0.0018	0.0007	0.0196	0.0017	<2.14	NA	<186	NA
04/07/09	0.0012	0.0007	0.0140	0.0016				
04/14/09	0.0016	0.0008	0.0209	0.0018				
04/21/09	0.0017	0.0009	0.0198	0.0018				
04/28/09	0.0023	0.0008	0.0261	0.0019	<2.18	NA	<251	NA
05/05/09	0.0035	0.0009	0.0250	0.0019				
05/12/09	0.0026	0.0009	0.0188	0.0017				
05/19/09	<0.0011	N/A	0.0139	0.0015				
05/27/09	0.0014	0.0006	0.0122	0.0013	<2.14	NA	<189	NA
06/02/09	0.0025	0.0009	0.0235	0.0021				
06/09/09	<0.0009	N/A	0.0152	0.0016				
06/16/09	0.0015	0.0008	0.0257	0.0020				
06/23/09	0.0020	0.0008	0.0241	0.0019				
06/30/09	0.0026	0.0009	0.0275	0.0021	<2.09	NA	<195	NA
07/07/09	0.0016	0.0008	0.0235	0.0019				
07/14/09	0.0022	0.0007	0.0197	0.0016				
07/21/09	0.0026	0.0009	0.0243	0.0019				
07/28/09	0.0026	0.0009	0.0283	0.0020	<2.01	NA	<181	NA
08/04/09	0.0025	0.0008	0.0144	0.0016				
08/11/09	0.0028	0.0009	0.0285	0.0020				
08/18/09	0.0019	0.0008	0.0174	0.0017				
08/25/09	0.0030	0.0008	0.0176	0.0017	<2.04	NA	<195	NA
09/01/09	0.0038	0.0010	0.0187	0.0018				
09/08/09	0.0025	0.0008	0.0284	0.0019				
09/15/09	0.0036	0.0009	0.0297	0.0020				
09/22/09	0.0021	0.0007	0.0299	0.0020				
09/29/09	0.0020	0.0007	0.0166	0.0016	<2.05	NA	<191	NA
10/06/09								
10/13/09	0.0015	0.0007	0.0176	0.0016				
10/20/09								
10/27/09	0.0017	0.0006	0.0196	0.0016	<2.31	NA	<216	NA
11/03/09	0.0015	0.0006	0.0149	0.0015				
11/10/09	0.0022	0.0008	0.0355	0.0021				
11/17/09	0.0009	0.0006	0.0114	0.0013				
11/24/09	0.0032	0.0009	0.0263	0.0019				
12/01/09	0.0023	0.0008	0.0221	0.0017				
12/08/09	0.0016	0.0006	0.0179	0.0016				
12/15/09	0.0024	0.0008	0.0241	0.0018				
12/22/09	0.0015	0.0007	0.0231	0.0017				
12/29/09	0.0029	0.0008	0.0287	0.0019	2.36	1.02	<181	NA

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Allendale, SC (ALN)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0015	0.0007	0.0176	0.0016				
01/13/09	0.0031	0.0008	0.0227	0.0018				
01/20/09	0.0022	0.0008	0.0233	0.0017				
01/27/09	0.0021	0.0008	0.0193	0.0017	4.75	1.21	<210	N/A
02/03/09	0.0020	0.0008	0.0203	0.0017				
02/10/09	0.0096	0.0012	0.0294	0.0018				
02/17/09	0.0021	0.0008	0.0226	0.0018				
02/24/09	0.0023	0.0008	0.0258	0.0019	2.40	1.02	<188	NA
03/03/09	0.0026	0.0009	0.0199	0.0017				
03/10/09	0.0031	0.0009	0.0286	0.0020				
03/17/09	0.0021	0.0008	0.0176	0.0017				
03/24/09	0.0046	0.0011	0.0246	0.0019				
03/31/09	0.0026	0.0008	0.0201	0.0018	<2.14	NA	<186	NA
04/07/09	0.0011	0.0007	0.0130	0.0015				
04/14/09	0.0021	0.0008	0.0211	0.0018				
04/21/09	0.0016	0.0009	0.0222	0.0019				
04/28/09	0.0031	0.0009	0.0234	0.0018	<2.18	NA	<251	NA
05/05/09	0.0035	0.0009	0.0258	0.0019				
05/12/09	0.0027	0.0009	0.0191	0.0017				
05/19/09	<0.0011	N/A	0.0131	0.0014				
05/27/09	0.0015	0.0006	0.0114	0.0012	<2.14	NA	<189	NA
06/02/09	0.0019	0.0008	0.0222	0.0020				
06/09/09	0.0015	0.0007	0.0168	0.0016				
06/16/09	0.0021	0.0008	0.0229	0.0182				
06/23/09	0.0022	0.0007	0.0080	0.0010				
06/30/09	0.0024	0.0008	0.0241	0.0019	<182	NA	<195	NA
07/07/09	0.0026	0.0008	0.0227	0.0018				
07/14/09	0.0024	0.0007	0.0225	0.0017				
07/21/09	0.0024	0.0008	0.0247	0.0019				
07/28/09	0.0028	0.0009	0.0254	0.0019	<2.01	NA	<181	NA
08/04/09	0.0026	0.0008	0.0142	0.0015				
08/11/09	0.0029	0.0008	0.0287	0.0020				
08/18/09	0.0017	0.0007	0.0170	0.0016				
08/25/09	0.0032	0.0008	0.0184	0.0017	<2.04	NA	<195	NA
09/01/09	0.0046	0.0011	0.0213	0.0019				
09/08/09	0.0019	0.0007	0.0234	0.0017				
09/15/09	0.0030	0.0009	0.0265	0.0020				
09/22/09	0.0035	0.0009	0.0274	0.0020				
09/29/09	0.0025	0.0008	0.0165	0.0016	<2.05	NA	<191	NA
10/06/09	0.0024	0.0008	0.0210	0.0018				
10/13/09	0.0011	0.0007	0.0169	0.0017				
10/20/09	0.0145	0.0016	0.0334	0.0021				
10/27/09	0.0018	0.0007	0.0175	0.0016	<2.31	NA	<216	NA
11/03/09	0.0016	0.0006	0.0146	0.0014				
11/10/09	0.0030	0.0008	0.0341	0.0020				
11/17/09	<0.0009	NA	0.0083	0.0012				
11/24/09	0.0021	0.0007	0.0238	0.0018	<2.26	NA	<198	NA
12/01/09	0.0022	0.0007	0.0210	0.0017				
12/08/09	0.0018	0.0006	0.0175	0.0015				
12/15/09	0.0023	0.0008	0.0242	0.0018				
12/22/09	0.0014	0.0007	0.0235	0.0017				
12/29/09	0.0033	0.0008	0.0314	0.0020	<2.18	NA	<181	NA

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Snelling, SC South Carolina Advanced Technology Park (SCT)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m3	+- 2 sigma	pCi/m3	+- 2 sigma	pCi/m3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0015	0.0007	0.0200	0.0017				
01/13/09	0.0038	0.0009	0.0223	0.0018				
01/20/09	<0.0011	NA	0.0240	0.0018				
01/27/09	0.0017	0.0008	0.0263	0.0019	5.14	1.22	<210	N/A
02/03/09	0.0020	0.0009	0.0209	0.0018				
02/10/09	0.0129	0.0015	0.0402	0.0022				
02/17/09	0.0022	0.0008	0.0237	0.0018				
02/24/09	0.0017	0.0008	0.0278	0.0020	6.82	1.20	290	92
03/03/09	0.0015	0.0008	0.0215	0.0018				
03/10/09	0.0043	0.0011	0.0310	0.0022				
03/17/09	0.0017	0.0008	0.0191	0.0018				
03/24/09	0.0043	0.0011	0.0250	0.0019				
03/31/09	0.0029	0.0009	0.0206	0.0018	<2.14	NA	<186	NA
04/07/09	0.0014	0.0008	0.0144	0.0016				
04/14/09	0.0012	0.0008	0.0200	0.0018				
04/21/09	0.0017	0.0009	0.0218	0.0019				
04/28/09	0.0021	0.0008	0.0271	0.0020	2.27	1.01	<251	NA
05/05/09	0.0039	0.0010	0.0269	0.0020				
05/12/09	0.0038	0.0010	0.0189	0.0017				
05/19/09	0.0011	0.0007	0.0152	0.0015				
05/27/09	0.0013	0.0006	0.0120	0.0013	<2.14	NA	<189	NA
06/02/09	0.0023	0.0009	0.0227	0.0020				
06/09/09	0.0013	0.0007	0.0168	0.0016				
06/16/09	0.0017	0.0008	0.0240	0.0019				
06/23/09	0.0018	0.0008	0.0248	0.0019				
06/30/09	0.0026	0.0009	0.0272	0.0020	7.10	1.18	<195	NA
07/07/09	0.0021	0.0008	0.0236	0.0019				
07/14/09	0.0036	0.0009	0.0229	0.0017				
07/21/09	0.0022	0.0008	0.0236	0.0019				
07/28/09	0.0030	0.0009	0.0284	0.0020	3.05	0.99	<181	NA
08/04/09	0.0036	0.0009	0.0147	0.0016				
08/11/09	0.0029	0.0009	0.0029	0.0020				
08/18/09	0.0013	0.0007	0.0164	0.0016				
08/25/09	0.0044	0.0010	0.0205	0.0018	<2.04	NA	<195	NA
09/01/09	0.0042	0.0010	0.0213	0.0018				
09/08/09	0.0023	0.0008	0.0279	0.0019				
09/15/09	0.0027	0.0008	0.0287	0.0019				
09/22/09	0.0029	0.0008	0.0312	0.0020				
09/29/09	0.0028	0.0008	0.0195	0.0017	3.39	1.02	<191	NA
10/06/09	0.0017	0.0007	0.0209	0.0017				
10/13/09	0.0011	0.0007	0.0167	0.0016				
10/20/09	0.0115	0.0014	0.0286	0.0019				
10/27/09	0.0019	0.0007	0.0199	0.0017	6.72	1.24	<216	NA
11/03/09	0.0024	0.0007	0.0160	0.0016				
11/10/09	0.0034	0.0009	0.0351	0.0021				
11/17/09	<0.0009	NA	0.0098	0.0013				
11/24/09	0.0028	0.0008	0.0258	0.0018	5.53	1.18	<198	NA
12/01/09	0.0020	0.0007	0.0203	0.0016				
12/08/09	0.0017	0.0006	0.0172	0.0015				
12/15/09	0.0026	0.0008	0.0242	0.0018				
12/22/09	0.0020	0.0008	0.0242	0.0017				
12/29/09	0.0030	0.0008	0.0307	0.0020	11.28	1.35	184	85

Routine Radiological Atmospheric Monitoring Data, 2009

Sample Location:	Williston Barricade (DKH)							
Date	Gross Alpha in Air		Gross Beta in Air		Tritium in Air		Tritium in Precipitation	
	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/m^3	+- 2 sigma	pCi/L	+- 2 sigma
01/06/09	0.0023	0.0008	0.0201	0.0018				
01/13/09	0.0030	0.0009	0.0235	0.0019				
01/20/09	0.0013	0.0008	0.0235	0.0018				
01/27/09	0.0018	0.0008	0.0232	0.0018	<2.41	N/A	312	101
02/03/09	<0.0012	NA	0.0190	0.0017				
02/10/09	0.0053	0.0010	0.0238	0.0018				
02/17/09	0.0028	0.0012	0.0205	0.0023				
02/24/09	0.0024	0.0009	0.0237	0.0018	4.39	1.10	<188	NA
03/03/09	0.0017	0.0007	0.0209	0.0017				
03/10/09	0.0029	0.0009	0.0267	0.0019				
03/17/09	0.0014	0.0007	0.0165	0.0016				
03/24/09	0.0017	0.0008	0.0231	0.0018				
03/31/09	0.0025	0.0008	0.0182	0.0017	2.76	1.02	<186	NA
04/07/09	0.0013	0.0007	0.0121	0.0015				
04/14/09	0.0012	0.0007	0.0196	0.0017				
04/21/09	0.0014	0.0008	0.0196	0.0017				
04/28/09	0.0020	0.0008	0.0236	0.0018	<2.18	NA	<251	NA
05/05/09	0.0029	0.0009	0.0244	0.0019				
05/12/09	0.0020	0.0008	0.0182	0.0017				
05/19/09	0.0014	0.0008	0.0140	0.0015				
05/27/09	<0.0009	N/A	0.0111	0.0012	3.88	1.07	<189	NA
06/02/09	0.0022	0.0008	0.0210	0.0020				
06/09/09	0.0020	0.0008	0.0158	0.0016				
06/16/09	0.0015	0.0007	0.0224	0.0018				
06/23/09	0.0023	0.0008	0.0239	0.0019				
06/30/09	0.0031	0.0009	0.0260	0.0020	7.20	1.18	<195	NA
07/07/09	0.0018	0.0008	0.0234	0.0019				
07/14/09	0.0021	0.0007	0.0204	0.0016				
07/21/09	0.0021	0.0008	0.0220	0.0018				
07/28/09	0.0019	0.0008	0.0276	0.0019	6.17	1.12	<181	NA
08/04/09	0.0021	0.0007	0.0154	0.0016				
08/11/09	0.0031	0.0009	0.0270	0.0020				
08/18/09	0.0018	0.0008	0.0162	0.0016				
08/25/09	0.0027	0.0008	0.0175	0.0017	4.09	1.04	<195	NA
09/01/09	0.0032	0.0009	0.0182	0.0017				
09/08/09	0.0025	0.0008	0.0270	0.0019				
09/15/09	0.0026	0.0008	0.0272	0.0019				
09/22/09	0.0029	0.0008	0.0249	0.0018				
09/29/09	0.0031	0.0008	0.0163	0.0016	2.53	0.99	<191	NA
10/06/09	0.0015	0.0007	0.0203	0.0017				
10/13/09	0.0018	0.0008	0.0158	0.0015				
10/20/09	0.0053	0.0010	0.0197	0.0016				
10/27/09	0.0014	0.0006	0.0204	0.0017	3.69	1.13	865	122
11/03/09	0.0017	0.0006	0.0146	0.0015				
11/10/09	0.0021	0.0008	0.0325	0.0020				
11/17/09	<0.0008	NA	0.0101	0.0013				
11/24/09	0.0034	0.0009	0.0240	0.0018	<2.26	NA	<198	NA
12/01/09	0.0018	0.0007	0.0204	0.0016				
12/08/09	0.0017	0.0006	0.0178	0.0016				
12/15/09	0.0028	0.0008	0.0239	0.0018				
12/22/09	0.0025	0.0008	0.0228	0.0017				
12/29/09	0.0027	0.0008	0.0280	0.0019	4.30	1.11	<181	NA

2009 First Quarter Radiochemical Particulate Data Summary

Sample Location: **Aiken (AIK)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides (pCi/m3)	U-234 Activity	0.00009	0.00005
	+- 2 sigma	0.00006	
	U-235 Activity	<MDA	0.00004
	+- 2 sigma	N/A	
	U-238 Activity	0.00011	0.00006
	+- 2 sigma	0.00004	
	Pu-238 Activity	<MDA	0.00004
	+- 2 sigma	N/A	

Sample Location: **New Ellenton (NEL)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides (pCi/m3)	U-234	0.00010	0.00003
	+- 2 sigma	0.00004	
	U-235	<MDA	0.00002
	+- 2 sigma	N/A	
	U-238	0.00005	0.00002
	+- 2 sigma	0.00003	
	Pu-238	<MDA	0.00002
	+- 2 sigma	N/A	

Sample Location: **Jackson (JAK)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides (pCi/m3)	U-234	0.00009	0.00003
	+- 2 sigma	0.00009	
	U-235	0.00001	0.00001
	+- 2 sigma	0.00001	
	U-238	0.00006	0.00002
	+- 2 sigma	0.00003	
	Pu-238	<MDA	0.00003
	+- 2 sigma	N/A	

Sample Location: **Burial Grounds North (BGN)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides (pCi/m3)	U-234	0.00006	0.00002
	+- 2 sigma	0.00003	
	U-235	<MDA	0.00003
	+- 2 sigma	N/A	
	U-238	0.00009	0.00004
	+- 2 sigma	0.00002	
	Pu-238	<MDA	0.00002
	+- 2 sigma	N/A	

2009 First Quarter Radiochemical Particulate Data Summary

Sample Location: **Allendale Barricade (ABR)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides	U-234	0.00007	<MDA
(pCi/m3)	+- 2 sigma	0.00003	
	U-235	<MDA	0.00002
	+- 2 sigma	N/A	
	U-238	0.00004	0.00003
	+- 2 sigma	0.00003	
	Pu-238	<MDA	0.00002
	+- 2 sigma	N/A	

Sample Location: **Allendale (ALN)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides	U-234	0.00008	0.00002
(pCi/m3)	+- 2 sigma	0.00004	
	U-235	<MDA	0.00001
	+- 2 sigma	N/A	
	U-238	0.00007	0.00002
	+- 2 sigma	0.00003	
	Pu-238	<MDA	0.00002
	+- 2 sigma	N/A	

Sample Location: **Snelling (SCT)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides	U-234	0.00009	0.00001
(pCi/m3)	+- 2 sigma	0.00004	
	U-235	<MDA	0.00001
	+- 2 sigma	N/A	
	U-238	0.00008	0.00003
	+- 2 sigma	0.00004	
	Pu-238	<MDA	0.00001
	+- 2 sigma	N/A	

Sample Location: **Williston Barricade (DKH)**

Sample Batch:		1st Quarter 2009	MDA
Radionuclides	U-234	0.00006	0.00002
(pCi/m3)	+- 2 sigma	0.00003	
	U-235	<MDA	0.00002
	+- 2 sigma	N/A	
	U-238	0.00006	0.00001
	+- 2 sigma	0.00003	
	Pu-238	<MDA	0.00002
	+- 2 sigma	N/A	

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1.1.5 SUMMARY STATISTICS
Radiological Atmospheric Monitoring

Note:
Avg—Average
Std Dev—Standard Deviation
Min—Minimum
Max—Maximum
N—Number of Samples
( )—Number of Samples Below LLD

Yearly Average of Ambient TLD Beta/Gamma Summary 2009

Sample Location	Quarterly Avg	Std Dev	Min	Max	Median
	mrem	mrem	mrem	mrem	mrem
Colocated with AIK Air Station	18.75	3.10	16.00	23.00	18.00
Colocated with BGN Air Station	40.75	4.99	34.00	45.00	42.00
Green Pond	23.00	3.27	19.00	27.00	23.00
Colocated with JAK Air Station	19.50	2.08	17.00	22.00	19.50
Crackerneck Gate	23.25	4.03	19.00	28.00	23.00
TNX Boat Ramp	26.50	1.29	25.00	28.00	26.50
Colocated with ABR Air Station	19.00	2.83	17.00	23.00	18.00
Junction of Millet Road and Round Tree Road	25.50	5.20	18.00	29.00	27.50
Patterson Mill Road at Lower Three Runs Creek	27.25	2.63	25.00	31.00	26.50
Colocated with ALN Air Station	22.00	3.46	17.00	25.00	23.00
Barnwell Airport	22.50	1.29	21.00	24.00	22.50
Colocated with SCT Air station	22.00	2.45	19.00	25.00	22.00
Colocated with DKH Air station	23.00	2.94	20.00	27.00	22.50
Bates Cemetery	19.75	1.71	18.00	22.00	19.50
Williston Police Department	25.50	2.65	22.00	28.00	26.00
Junction of US 278 and SC 781	23.75	3.77	20.00	29.00	23.00
US 278 near Upper Three Runs Creek	28.50	4.36	25.00	34.00	27.50
Colocated with NEL Air Station	22.00	1.63	20.00	24.00	22.00
Winsor Post Office	23.25	3.30	19.00	27.00	23.50
Control TLD (Kept in Office)	13.75	2.63	11.00	16.00	14.00

Summary Statistics

Statistical Review Of Radiological Monitoring at Aiken Elementary Water Tower (AIK)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(3)	52(0)	12(5)	12(12)
Mean	0.0025	0.0221	3.46	No Detections
Std Dev	0.0011	0.0052	1.05	
Median	0.0024	0.0223	3.13	
Min	0.0009	0.0086	2.60	
Max	0.0071	0.0345	5.49	

Statistical Review Of Radiological Monitoring at New Ellenton, SC (NEL)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(4)	52(0)	12(3)	12(10)
Mean	0.0026	0.0221	4.81	481.94
Std Dev	0.0012	0.0052	1.86	199.75
Median	0.0022	0.0223	4.24	481.94
Min	0.0012	0.0102	2.51	340.70
Max	0.0085	0.0344	7.40	623.19

Statisical Review Of Radiological Monitoring at Jackson, SC (JAK)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	51(3)	51(0)	12(2)	12(11)
Mean	0.0027	0.0228	4.76	One detection of 200.29
Std Dev	0.0014	0.0055	2.32	
Median	0.0025	0.0230	4.21	
Min	0.0012	0.0108	2.23	
Max	0.0104	0.0361	9.89	

Statisical Review Of Radiological Monitoring at Burial Grounds North, SRS (BGN)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	49(3)	49(0)	12(0)	12(0)
Mean	0.0028	0.0226	198.51	2320.60
Std Dev	0.0017	0.0061	68.25	1507.29
Median	0.0025	0.0225	189.94	2271.95
Min	0.0010	0.0018	117.53	443.11
Max	0.0111	0.0353	330.42	5684.29

Statistical Review Of Radiological Monitoring at Allendale Barricade (ABR)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	50(3)	50(0)	11(10)	11(11)
Mean	0.0023	0.0219	One detection of 2.36	No detections
Std Dev	0.0007	0.0053		
Median	0.0022	0.0220		
Min	0.0009	0.0114		
Max	0.0038	0.0355		

Summary Statistics

Statistical Review Of Radiological Monitoring at Allendale, SC (ALN)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(2)	52(0)	12(10)	12(12)
Mean	0.0028	0.0214	3.58	No detections
Std Dev	0.0021	0.0056	1.66	
Median	0.0024	0.0222	3.58	
Min	0.0011	0.0080	2.40	
Max	0.0145	0.0341	4.75	

Statistical Review Of Raiological Monitoring at Snelling, SC (SCT)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(2)	52(0)	12(3)	12(10)
Mean	0.0028	0.0224	5.70	237.05
Std Dev	0.0022	0.0063	2.74	75.29
Median	0.0022	0.0225	5.53	237.05
Min	0.0011	0.0029	2.27	183.81
Max	0.0129	0.0402	11.28	290.29

Statistical Review Of Radiological Monitoring at Dark Horse (DKH)				
Analyte	Gross Alpha	Gross Beta	Tritium in Air	Tritium in Rain
Units	pCi/m3	pCi/m3	pCi/m3	pCi/L
N	52(3)	52(0)	12(3)	12(10)
Mean	0.0023	0.0209	4.33	588.12
Std Dev	0.0009	0.0046	1.50	391.16
Median	0.0021	0.0207	4.09	588.12
Min	0.0012	0.0101	2.53	311.52
Max	0.0053	0.0325	7.20	864.71

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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 well network consists of existing groundwater wells owned by neighboring municipalities, businesses, and members of the public. Radiological and non-radiological 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 1999).

The ESOP Ambient Groundwater Quality Monitoring Project (AGQMP) evaluates ambient groundwater quality adjacent to SRS. This annual evaluation is conducted to determine possible offsite groundwater impacts due to operations conducted at SRS. 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 residential groundwater wells. This study provides ESOP an opportunity to determine if there has been any impact to the environment as a result of SRS activities. Map 3 in Section 2.1.2 depicts the network groundwater well locations and the approximate extent of the study area. The wells sampled in 2009 are depicted in Section 2.1.2, Map 3. ESOP evaluates five aquifer zones from the water table to confined aquifers more than 1400 feet deep (Section 2.1.3, Table 2). The SCDHEC analytical laboratory data from the 2009 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 2009 groundwater sampling event was comprised of 39 wells. Eighteen of these wells are designated as C wells (cluster wells surrounding SRS) and two are classified as network wells (Section 2.1.2, Map 3). The remaining 19 are classified as background and perimeter wells. Three additional C wells were scheduled for sampling, but the designated well pumps are 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 39 groundwater wells sampled.

Alpha activity was detected at 13 monitoring well locations, none of which exceeded the United States Environmental Protection Agency (USEPA) established Maximum Contaminant Level (MCL) of 15 picocuries per liter (pCi/L). Beta activity was detected at nine monitoring well locations, none of which exceeded the MCL of 8 pCi/L. Tritium was detected at five groundwater well locations. These locations with tritium detections are identified as one background, two perimeter and two network wells. These slightly elevated detections of tritium are well below the MCL drinking water standard of 20,000 pCi/L.

The 2009 groundwater sampling event revealed additional contamination in other groundwater well locations. Lead was detected at a concentration of 0.010 milligrams per liter (mg/L) at groundwater well M03703. The concentration of lead (0.010 mg/L) found in this well is below the 0.015 mg/L MCL established by the USEPA. At least one of the following contaminants (aluminum, manganese, and zinc) was detected in 23 monitoring well locations. None of these concentrations exceeded the USEPA secondary drinking water standard. The USEPA has not established a primary drinking water standard for aluminum, manganese and zinc, as they are not considered to be a known health risk to humans.

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 detected in 13 of the 39 groundwater wells analyzed. None of the 13 gross alpha detections exceeded the MCL. The concentrations of gross alpha detected in these 13 groundwater wells are most likely due to the natural decay process of uranium deposits within the subsurface. Calculation of summary statistics revealed a gross alpha average of 4.74 (± 3.18) pCi/L for the background population and an average of 3.30 (± 2.12) pCi/L for the groundwater network wells sampled during the 2009 event. These calculations reveal a gross alpha average for the network wells that is less than the average background concentration. Non-volatile beta was detected in nine of the 39 groundwater wells that were analyzed. As the presence of naturally occurring radionuclides has been well documented in the groundwater regime across the state of South Carolina, the concentration of non-volatile beta in this well is likely due to the natural decay process of uranium deposits within the subsurface. Calculation of summary statistics revealed a non-volatile beta average of 4.81 (± 3.10) pCi/L for the background population and an average of 3.98 (± 0.70) pCi/L for the groundwater network wells sampled during the 2009 event. These calculations reveal a non-volatile beta average for the network wells that is less than the average background concentration.

Tritium was detected in one background well (303 pCi/L), two perimeter wells (239.50 (± 65.76) pCi/L) and two network wells (309 (± 52.32) pCi/L). 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. As stakeholder interests in tritium levels continue to rise (DOE 2006), tritium sampling will continue and be addressed in future project reports.

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.

Gamma analysis was conducted on all groundwater samples for the 2009 sampling event. However, all gamma activity was below the detection level for all samples collected.

Nonradiological Parameter Results

The presence of metals and other non-radiological 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 non-radiological contaminants detected indicates their limited presence is most likely due to the erosion of natural deposits. In addition, the position of these wells as related to the location of SRS's centrally located process areas supports the theory of natural occurrence.

Aluminum was detected in three groundwater monitoring wells. The calculated average for aluminum in these wells is 0.12 mg/L. Although the concentrations of aluminum in these wells are detectable, there is currently no primary drinking water standard for aluminum established by the USEPA. The USEPA secondary drinking water standard for aluminum is currently set between 0.05 mg/L and 0.20 mg/L.

Barium was detected at 11 groundwater well locations. The calculated average for barium in these wells is 0.11 mg/L. The USEPA has established an MCL for barium of 2.0 mg/L. Although the barium concentrations found in these groundwater wells are detectable, these concentrations are well below the USEPA established MCL.

Manganese was detected in 12 groundwater monitoring wells. The calculated average for manganese in these wells is 0.03 mg/L. The USEPA has established a secondary drinking water standard MCL for manganese at 0.05 mg/L. Although the manganese concentrations found in these groundwater wells is detectable, these concentrations do not exceed the secondary drinking water standard MCL.

Fluoride was detected in seven groundwater monitoring wells. The calculated average for fluoride in these wells is 0.12 mg/L. Although the concentrations of fluoride in these wells are slightly elevated, these concentrations are well below the USEPA established MCL for fluoride currently set at 4.0 mg/L.

Lead was detected in one groundwater monitoring well (M03703) at a concentration of 0.010 mg/L. The USEPA has established an MCL for lead at 0.015 mg/L. Although the lead concentration found in this well is detectable, it is still below the MCL and not considered to be a known human health risk.

Zinc was detected in 13 groundwater monitoring wells. The calculated average for zinc in these wells is 1.05 mg/L. Although the concentrations of zinc in these wells are slightly elevated, there is currently no primary drinking water standard for zinc established by the USEPA. The USEPA secondary drinking water standard for zinc is currently set at 5.0 mg/L. As a result, these concentrations are not considered to be known human health risks.

ESOP and DOE-SR Data Comparison

Due to the fact DOE-SR collects groundwater samples from a separate monitoring well network, direct comparisons could not be made to their findings in the latest SRS Environmental Report for 2009. However, the 2009 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. 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 2009 groundwater sampling event, 19 wells were sampled. Of the 19 wells sampled, 10 of the wells are classified as random background wells and the remaining nine wells are classified as random perimeter wells. These wells are located on private property (either a private residence or a 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 the random quadrant map. Laboratory analytical data revealed a background gross alpha average of 4.74 (± 3.18) pCi/L and a beta average of 4.81 (± 3.10) pCi/L. Given the average is well below the USEPA MCL of 15 pCi/L for alpha and 8 pCi/L for beta, the concentrations found in these groundwater wells are unlikely to pose health risks to humans.

Summary statistics from the perimeter sampling revealed an alpha average of 6.04 (± 4.83) pCi/L. This average is a reflection of six detections. None of these groundwater sampling locations exceeded the 8 pCi/L MCL established by the USEPA.

Two random perimeter locations (GWE11 and GWE14X) revealed tritium activity of 193 pCi/L and 286 pCi/L respectively yielding an average of 239.5 (± 65.76) 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. As a result, these concentrations are not considered immediate concerns to human health. One random background location (GWB9) revealed a tritium concentration of 303 pCi/L. This concentration is not considered to be a known health risk to humans as it is well below the 20,000 pCi/L MCL. Concentrations of tritium typically seen at these low activities are generally considered to be a result of natural background.

Conclusions and Recommendations

A review of the 2009 analytical data revealed various but limited nonradiological and/or radiological constituents in all 39 groundwater wells sampled. Although several of the groundwater wells sampled during the 2009 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 2009 groundwater sampling event indicate several non-radiological 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 continue to 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.

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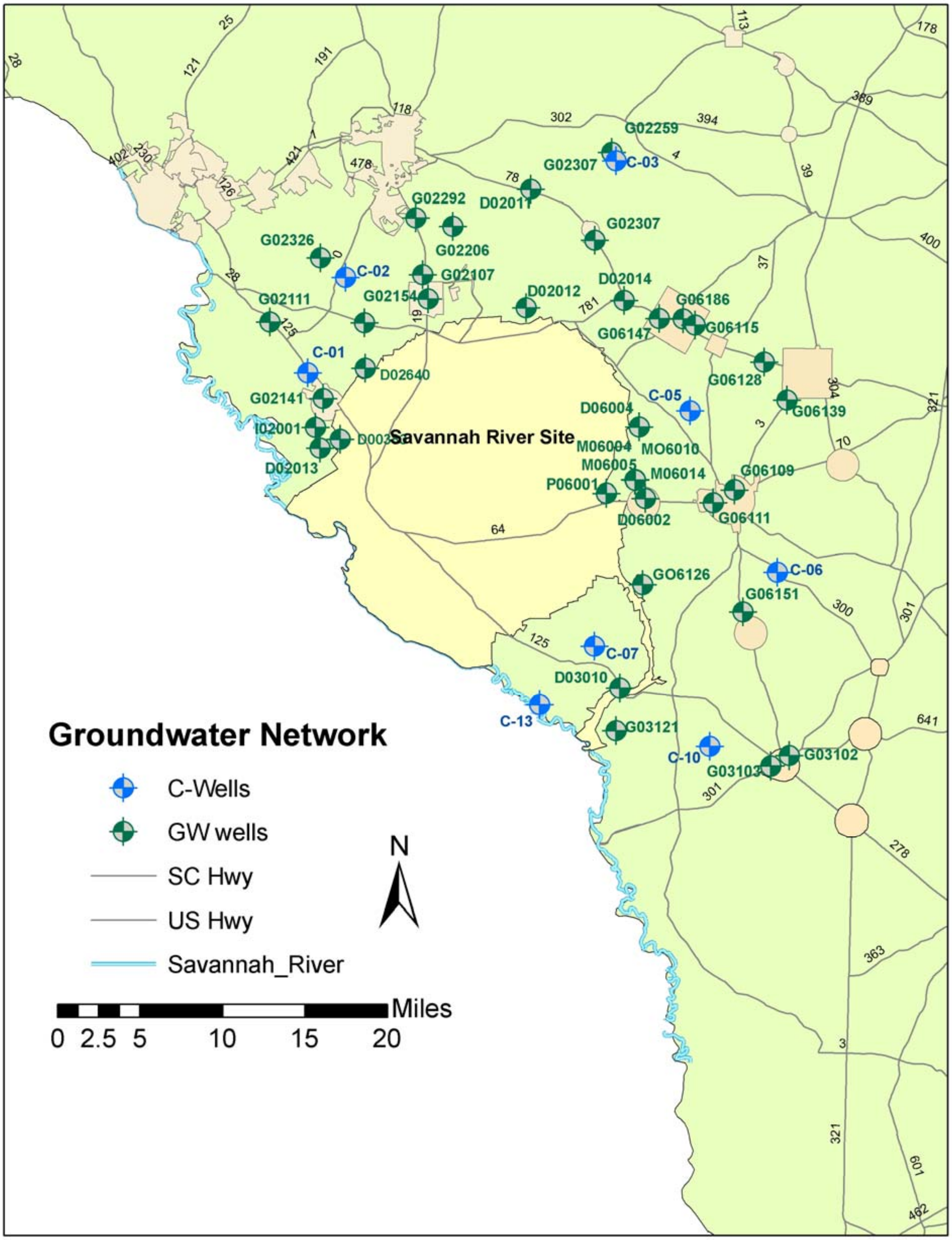
2.1.2 MAPS [TOC]

Map 3. Ambient Groundwater Quality Monitoring Well Network



2.1.3 Tables and Figures

Ambient Groundwater Monitoring

Table 1. 2009 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	2005	unknown	210	SP
G02206	Oak Hill Subdivision	2005	445	240	SP
G02107	New Ellenton	2005	421	425	CB
G06163	Mitchum MHP	2005	365	117	SP
G02259	Aiken State Park	2005	262	*	SP
G02154	Talatha Water District	2005	250	185	CB
G02141	Jackson	2005	225	105	SP
G02111	Beech Island Water District	2005	380	360	CB
G02326	ORA Site	2005	300	397	MB
D02014	Messer Well	2005	unknown	144	SP
G02307	Oakwood School	2005	428	404	CB
D02013	Cowden Plantation, Well 2	2005	124	*	SP
I02001	Cowden Plantation, Well 1	2005	132	*	CB
D02011	Mettlen Well	2005	400	180	SP
D02012	Windsome Plantation, House Well	2005	260	*	SP
G06109	Barnwell, Hwy. 3	2006	230	146	UTR
G06111	Barnwell, Rose St.	2006	220	166	UTR
G06128	Edisto Station	2006	322	360	GOR
G06147	Williston, Halford St.	2006	352	530	CB
G06113	Williston, Dewey Ct.	2006	353	125	UTR
G06115	Williston, Industrial Park	2006	360	685	MB
G06139	Barnwell State Park	2006	248	163	UTR
D06002	Moore Well	2006	240	*	UTR
P06001	Allied General Nuclear, Well 1	2006	250	*	MB
D06004	J. Williams Well	2006	245	76.15	UTR
M06004	Chem Nuclear WO0061	2006	254.52	401	CB
M06014	Chem Nuclear WO0071	2006	255.33	250	GOR
M06005	Chem Nuclear WO0067	2006	254.76	46.79	UTR
M06010	Chem Nuclear WO0069	2006	254.28	145	UTR
D03010	Martin Post Office	2007	108	105	UTR
I03002	Williams Grocery	2007	138	*	UTR
G03102	Allendale, Water St.	2007	201	343	UTR
G03103	Allendale, Googe St.	2007	180	347	UTR
G03112	Allendale Welcome Center	2007	143	100	UTR
G06151	Chappels Labor Camp	2007	250	260	UTR
G03121	Clariant	2007	180	812	CB
G03115	Whitlock Combing	2007	166	800	CB
G06126	Starmet (Carolina Metals)	2007	200	323	GOR

Tables and Figures

Ambient Groundwater Monitoring

Table 1. (continued) 2009 ESOP Groundwater Monitoring Well Data

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M02101	SCDNR Cluster C-01, AIK-2378	2008	220.3	185	CB
M02102	SCDNR Cluster C-01, AIK-2379	2008	224.2	266	CB
M02103	SCDNR Cluster C-01, AIK-2380	2008	228.9	385	MB
M02104	SCDNR Cluster C-01, AIK-902	2008	231.9	511	MB
M02202	SCDNR Cluster C-02, AIK-825	2008	418.8	231	CB
M02203	SCDNR Cluster C-02, AIK-824	2008	418.6	365	CB
M02204	SCDNR Cluster C-02, AIK-818	2008	418.3	425	MB
M02205	SCDNR Cluster C-02, AIK-817	2008	418.9	535	MB
M02301	SCDNR Cluster C-03, AIK-849	2008	301.6	97	SP
M02302	SCDNR Cluster C-03, AIK-848	2008	299.7	131	CB
M02303	SCDNR Cluster C-03, AIK-847	2008	299	193	CB
M02304	SCDNR Cluster C-03, AIK-846	2008	297.8	255	CB
M02305	SCDNR Cluster C-03, AIK-845	2008	296.9	356	MB
M02306	SCDNR Cluster C-03, AIK-826	2008	294.9	500	MB
M06501	SCDNR Cluster C-05, BRN-360	2008	264.3	140	UTR
M06502	SCDNR Cluster C-05, BRN-359	2008	265.5	214	GOR
M06503	SCDNR Cluster C-05, BRN-367	2008	263.8	285	GOR
M06504	SCDNR Cluster C-05, BRN-368	2008	265.1	443	CB
M06505	SCDNR Cluster C-05, BRN-365	2008	263.5	539	CB
M06506	SCDNR Cluster C-05, BRN-366	2008	266.7	715	MB
M06507	SCDNR Cluster C-05, BRN-358	2008	265.6	847	MB
M03706	SCDNR Cluster C-07, ALL-368	**2009**	246.6	691	CB
M03707	SCDNR Cluster C-07, ALL-369	**2009**	242.1	800	CB
M03708	SCDNR Cluster C-07, ALL-370	**2009**	245.1	975	MB
M03709	SCDNR Cluster C-07, ALL-358	**2009**	243.1	1123	MB
M03131	SCDNR Cluster C-13, Artesian	**2009**	80	*	GOR
M03132	SCDNR Cluster C-13, ALL-378	**2009**	90	1060	MB
M03701	SCDNR Cluster C-07, ALL-363	**2009**	246.1	105	UTR
M03702	SCDNR Cluster C-07, ALL-364	**2009**	245.2	225	UTR
M03703	SCDNR Cluster C-07, ALL-365	**2009**	244.3	333	GOR
M03704	SCDNR Cluster C-07, ALL-366	**2009**	243.5	400	GOR
M03705	SCDNR Cluster C-07, ALL-367	**2009**	245.7	566	CB
M06601	SCDNR Cluster C-06, BRN-351	**2009**	207.3	95	UTR
M06602	SCDNR Cluster C-06, BRN-350	**2009**	207.4	170	UTR
M06603	SCDNR Cluster C-06, BRN-352	**2009**	207.1	293	GOR

Tables and Figures

Ambient Groundwater Monitoring

Table 1. (continued) 2009 ESOP Groundwater Monitoring Well Data

Well No.	Well Name	Sample Year	Top of Casing Elevation (ft amsl)	Total Depth (ft bgs)	Aquifer
M06604	SCDNR Cluster C-06, BRN-354	**2009**	207.6	411	GOR
M06605	SCDNR Cluster C-06, BRN-353	**2009**	207.7	588	CB
M06608	SCDNR Cluster C-06, BRN-349	**2009**	208.6	1045	MB
M03101	SCDNR Cluster C-10, ALL-347	**2009**	281.6	1423	MB
M03102	SCDNR Cluster C-10, ALL-372	**2009**	282	155	UTR
M03103	SCDNR Cluster C-10, ALL-371	**2009**	282.2	217	UTR
M03104	SCDNR Cluster C-10, ALL-374	**2009**	280.9	580	GOR
D02640	Green Pond Road	**2009**	*	222	*
D00383	Brown Road	**2009**	*	*	*

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

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

Tables and Figures

Ambient Groundwater Monitoring

Figure 1. 2009 Gross Alpha Concentrations

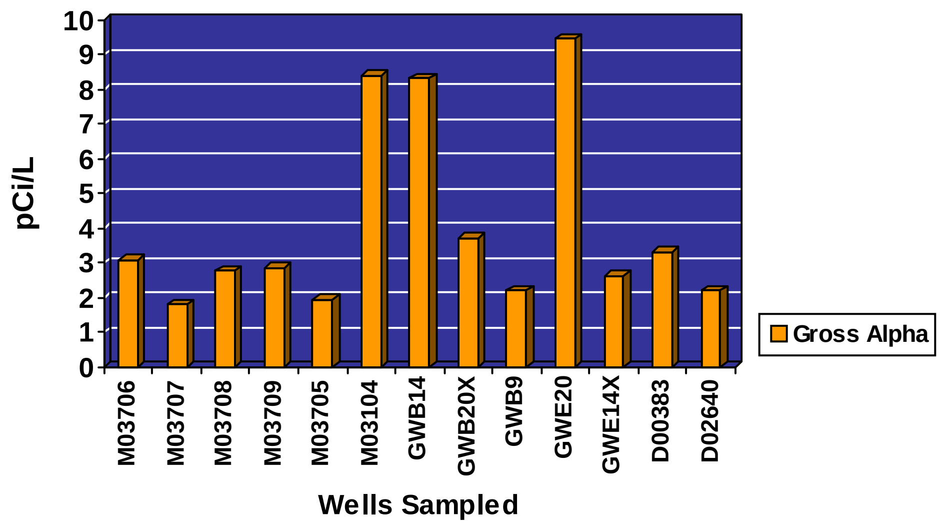
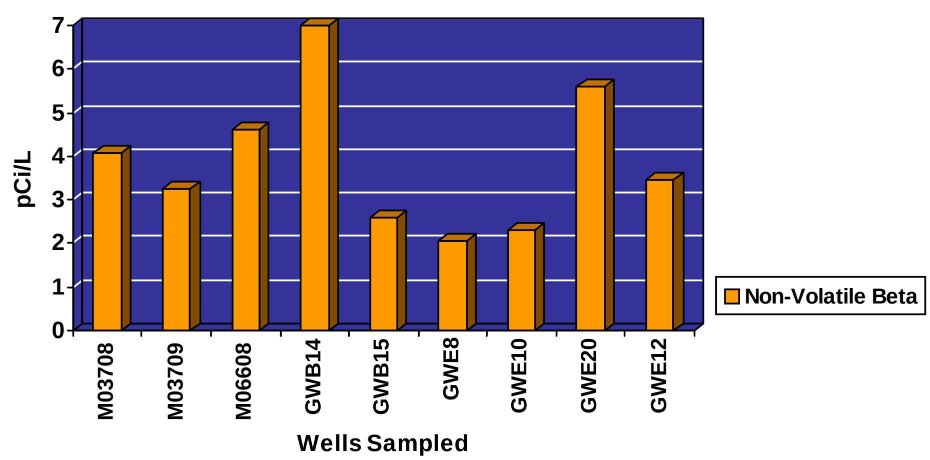


Figure 2. 2009 Non-Volatile Beta Concentrations



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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

2009 Radiological Data

Location Description	M06601	M06602	M06603	M06604	M06605	M06608	M03101	Trip Blank
Collection Date	2/12/2009	2/12/2009	2/9/2009	2/9/2009	2/4/2009	2/3/2009	2/17/2009	2/3/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Be-7 MDA	16.99	16.98	19.28	19.30	22.47	21.54	18.06	21.36
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Na-22 MDA	1.48	1.84	1.49	1.57	1.55	1.45	1.81	1.70
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
K-40 MDA	27.95	28.75	30.27	30.14	27.11	28.69	28.80	28.83
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Mn-54 MDA	1.72	1.65	1.58	1.69	1.84	1.67	1.68	1.56
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-58 MDA	1.93	1.77	1.79	1.66	1.80	2.17	1.84	2.01
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-60 MDA	1.74	1.52	1.39	1.63	1.52	1.64	1.46	1.61
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zn-65 MDA	3.71	3.60	3.78	3.59	3.78	3.57	3.53	3.54
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Y-88 MDA	1.45	1.99	2.15	1.84	2.05	2.10	1.74	2.23
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zr-95 MDA	3.32	3.77	3.74	3.48	3.72	3.50	3.48	3.85
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ru-103 MDA	2.26	2.16	2.69	2.43	2.83	3.15	2.67	3.11
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Sb-125 MDA	5.15	4.99	4.95	5.01	5.10	4.70	5.26	4.98
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
I-131 MDA	10.02	10.82	11.25	12.51	24.52	33.61	10.51	34.06
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-134 MDA	1.72	1.65	1.51	1.75	1.68	1.72	1.66	1.64
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-137 MDA	1.87	1.87	1.52	1.82	1.74	1.91	1.74	1.81
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ce-144 MDA	15.28	15.00	15.07	15.01	15.15	16.11	15.32	15.40
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-152 MDA	5.23	5.81	5.41	5.58	5.76	5.13	5.12	5.50
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-154 MDA	3.81	4.04	4.02	3.72	3.91	3.86	3.95	3.83
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-155 MDA	6.96	7.15	7.02	6.99	7.34	7.14	7.18	6.82
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-212 MDA	3.70	3.84	3.70	3.95	3.83	3.53	3.64	3.54
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-214 MDA	4.57	5.03	4.52	4.84	4.66	4.35	4.47	4.38
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ra-226 MDA	56.89	55.39	53.28	40.71	55.10	54.94	55.41	55.68
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ac-228 MDA	8.46	8.33	8.25	8.50	7.89	7.89	8.06	8.30
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	51.19	50.60	51.01	51.09	49.73	50.61	50.48	51.06
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Am-241 MDA	11.91	12.79	11.68	12.18	12.64	12.47	13.11	13.07

Ambient Groundwater Data

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Location Description	Duplicate 01	M03104	M03709	M03708	M03707	M03706	M03702	M03705
Collection Date	2/3/2009	2/25/2009	3/3/2009	3/10/2009	3/17/2009	3/18/2009	3/24/2009	3/24/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Be-7 MDA	23.08	41.79	38.94	39.18	36.72	33.11	35.07	35.47
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Na-22 MDA	1.65	2.12	2.15	1.94	1.96	2.18	1.98	2.03
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
K-40 MDA	30.82	47.54	44.72	15.56	44.84	47.10	43.57	45.45
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Mn-54 MDA	1.60	2.14	2.11	2.25	2.46	2.30	2.25	2.35
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-58 MDA	1.99	3.86	3.31	3.19	3.38	3.08	2.60	2.96
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-60 MDA	1.83	2.05	2.05	2.05	1.95	1.90	2.03	1.94
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zn-65 MDA	3.19	4.68	4.45	4.33	4.49	5.00	5.10	4.89
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Y-88 MDA	1.96	2.81	2.22	2.35	2.65	3.12	2.68	2.54
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zr-95 MDA	3.93	7.20	6.02	5.95	6.17	6.95	6.34	5.49
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ru-103 MDA	2.99	6.81	6.14	6.09	5.51	5.31	4.57	4.73
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Sb-125 MDA	4.86	7.11	6.98	6.64	7.23	7.21	7.24	6.55
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
I-131 MDA	37.60	575.60	349.10	314.60	170.50	175.40	109.10	113.10
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-134 MDA	1.65	2.18	2.32	2.26	2.13	2.32	2.03	2.33
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-137 MDA	1.72	2.32	2.11	2.15	2.17	2.33	2.16	2.43
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ce-144 MDA	15.39	26.63	25.77	26.15	26.46	25.73	25.86	25.94
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-152 MDA	5.43	7.85	7.20	7.57	7.41	7.24	7.20	7.33
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-154 MDA	4.08	5.81	5.91	5.28	5.41	5.98	5.45	5.59
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-155 MDA	6.94	12.48	11.73	12.16	12.30	12.16	12.14	12.66
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-212 MDA	3.78	4.83	5.86	5.97	6.17	5.06	5.75	5.95
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-214 MDA	4.39	5.86	5.32	5.62	5.67	5.45	5.71	5.48
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ra-226 MDA	55.44	72.47	74.52	75.18	75.33	75.19	74.96	75.58
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ac-228 MDA	7.83	9.56	9.76	9.50	10.02	10.12	9.95	10.07
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	52.52	76.27	73.04	73.84	76.52	76.92	75.97	76.06
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Am-241 MDA	11.99	23.42	22.13	21.36	23.73	22.60	23.72	25.27

Ambient Groundwater Data

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Location Description	M03131	M03132	M03703	M03704	Duplicate 02	Trip Blank 02	D00383	D02640
Collection Date	4/8/2009	4/8/2009	4/7/2009	4/7/2009	4/7/2009	4/8/2009	5/27/2009	5/27/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Be-7 MDA	36.25	37.67	37.04	43.65	43.37	41.50	38.21	35.91
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Na-22 MDA	3.50	3.46	3.01	2.96	3.13	2.90	3.53	3.50
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
K-40 MDA	43.87	51.30	27.72	49.56	43.35	51.31	87.25	90.77
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Mn-54 MDA	3.09	2.90	2.97	3.21	3.32	3.01	3.38	3.37
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-58 MDA	4.26	4.26	4.51	4.41	4.21	4.58	3.47	4.05
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Co-60 MDA	3.39	2.75	2.91	3.25	3.14	2.57	3.34	3.00
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zn-65 MDA	6.53	6.69	5.62	5.69	6.28	5.63	6.21	7.25
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Y-88 MDA	3.50	3.82	3.74	3.78	3.74	3.46	3.37	3.02
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Zr-95 MDA	6.61	8.19	7.66	6.85	7.70	8.17	6.31	6.77
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ru-103 MDA	5.00	6.16	5.49	6.14	6.94	6.51	4.22	4.40
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Sb-125 MDA	7.67	8.90	8.63	8.80	9.32	8.63	11.56	11.10
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
I-131 MDA	70.06	86.12	101.20	94.46	121.10	120.50	12.58	12.16
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-134 MDA	2.91	2.81	2.73	2.86	2.77	2.79	3.46	3.26
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Cs-137 MDA	3.44	3.60	3.40	3.27	3.37	3.12	3.82	3.99
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ce-144 MDA	22.35	22.51	22.72	22.76	22.66	22.38	37.85	37.58
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-152 MDA	7.98	7.99	8.24	8.09	7.67	7.66	12.08	12.03
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-154 MDA	5.50	5.69	5.74	5.40	5.41	5.47	9.93	9.78
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Eu-155 MDA	8.02	8.45	8.44	8.04	8.02	7.54	22.51	21.36
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-212 MDA	5.11	6.45	5.81	6.52	6.24	6.25	9.05	9.32
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Pb-214 MDA	6.49	7.14	6.77	6.91	6.76	6.27	10.01	10.17
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ra-226 MDA	81.70	79.06	80.87	81.54	78.13	76.63	111.60	111.60
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Ac-228 MDA	11.72	12.17	13.32	12.98	12.31	12.18	16.96	17.37
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
U/Th-238 MDA	58.66	60.54	60.65	58.03	59.17	57.07	133.40	125.00
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA	NA	NA
Am-241 MDA	6.69	7.46	6.80	6.62	7.38	6.84	77.78	75.63

Ambient Groundwater Data

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Location Description	GWB17	GWB14	GWB12	GWB15	GWB20X
Collection Date	1/27/2009	2/3/2009	5/26/2009	11/5/2009	12/14/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	20.82	21.26	38.62	75.69	46.64
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	1.66	2.00	3.56	2.39	2.20
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA
K-40 MDA	28.91	30.73	87.61	43.76	45.58
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	1.74	1.68	3.23	2.72	2.73
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	2.39	1.94	3.26	5.58	3.92
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	1.49	1.62	3.42	2.28	2.18
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	3.99	3.68	7.24	6.31	5.77
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	2.39	2.26	3.99	4.42	3.27
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	4.15	3.66	6.15	10.84	8.01
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	3.04	2.77	4.84	12.47	7.83
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	4.75	5.07	10.85	8.20	7.10
I-131 Activity	<MDA	<MDA	<MDA	No Data	No Data
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	32.45	19.76	12.94	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	1.75	1.73	3.47	2.41	2.33
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	1.70	1.77	3.69	2.24	2.41
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	15.64	16.08	38.38	30.62	28.21
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	5.73	5.77	12.08	7.79	8.15
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	3.91	4.11	9.93	6.39	5.94
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	7.06	7.07	21.73	12.78	12.83
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	3.77	4.00	9.33	6.32	6.46
Pb-214 Activity	<MDA	**10.87**	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	4.07	NA	NA	NA
Pb-214 MDA	4.57	4.00	11.02	6.40	6.16
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	56.41	56.23	111.10	76.95	77.76
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	8.22	8.72	16.01	10.72	10.04
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	50.78	50.04	127.10	77.71	77.01
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	11.88	12.57	75.84	26.64	25.93

Ambient Groundwater Data

2009 Radiological Data

Location Description	GWB8	GWB9	GWB18	GWB13	GWB19
Collection Date	**12/10/2009**	**12/9/2009**	**12/10/2009**	**12/16/2009**	**12/14/2009**
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	51.32	56.11	55.30	51.22	53.59
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	2.37	1.79	2.09	2.11	2.11
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA
K-40 MDA	45.94	47.06	41.71	44.49	44.86
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	2.61	2.74	2.45	2.39	2.61
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	4.44	4.54	4.52	4.60	3.94
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	2.03	2.39	2.43	2.49	2.19
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	5.50	5.64	5.54	5.40	6.23
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	3.17	3.18	3.63	3.09	3.15
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	8.52	8.74	8.44	8.38	8.68
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	9.08	9.06	9.30	8.22	8.80
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	7.78	7.54	7.56	7.45	7.61
I-131 Activity	No Data	No Data	No Data	No Data	No Data
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	NA	NA	NA	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	2.37	2.46	2.37	2.42	2.35
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	2.60	2.37	2.43	2.41	2.49
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	29.76	29.60	30.49	29.15	28.32
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	8.24	7.70	8.25	7.86	8.28
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	6.39	4.85	5.66	5.74	5.73
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	12.77	12.84	12.90	13.03	13.38
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	6.29	6.35	6.26	6.30	6.75
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	6.16	6.33	5.90	6.33	6.30
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	78.15	78.51	78.72	77.44	77.96
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	9.88	11.36	9.72	10.46	11.09
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	75.66	79.60	78.58	78.89	77.56
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	27.09	27.03	26.94	26.23	26.70

Ambient Groundwater Data

2009 Radiological Data

Location Description	GWE8	GWE11	GWE10	GWE20	GWDuplicate03	GWE16
Collection Date	11/12/2009	11/12/2009	11/12/2009	11/19/2009	11/19/2009	11/19/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	64.41	70.52	64.96	61.97	63.59	65.26
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA	NA
Na-22 MDA	2.31	2.45	2.21	2.24	2.17	2.41
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA	NA
K-40 MDA	40.46	45.61	18.55	44.57	44.93	45.36
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA	NA
Mn-54 MDA	2.56	2.52	2.61	2.86	2.64	2.56
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-58 MDA	4.54	5.63	4.92	5.12	5.64	4.61
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	2.05	2.17	2.25	2.35	2.11	2.37
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA	NA
Zn-65 MDA	5.61	5.78	6.04	6.60	6.27	5.53
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA	NA
Y-88 MDA	3.94	3.43	3.85	3.13	4.01	3.56
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA	NA
Zr-95 MDA	9.93	9.12	8.92	9.02	9.42	10.47
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA
Ru-103 MDA	11.53	11.79	11.65	11.67	10.59	11.17
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA	NA
Sb-125 MDA	7.96	7.32	8.03	7.66	7.25	7.58
I-131 Activity	No Data	No Data	No Data	No Data	No Data	No Data
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	NA	NA	NA	NA	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-134 MDA	2.41	2.53	2.50	2.52	2.30	2.51
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	2.28	2.41	2.71	2.61	2.49	2.56
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA	NA
Ce-144 MDA	30.82	30.67	30.93	31.10	31.12	30.08
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-152 MDA	7.87	8.14	8.56	8.81	8.22	8.21
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-154 MDA	6.21	6.56	5.93	6.07	5.85	6.44
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA	NA
Eu-155 MDA	12.92	12.82	12.97	13.35	13.38	12.64
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	5.49	6.54	6.57	6.48	6.65	6.23
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-214 MDA	5.85	6.20	6.11	6.99	6.96	6.32
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	76.88	77.10	81.57	81.81	79.23	76.48
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA
Ac-228 MDA	10.39	9.55	10.24	12.74	12.33	10.06
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	80.06	76.47	76.54	82.88	77.57	80.26
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	26.10	25.88	25.97	25.93	27.05	24.43

Ambient Groundwater Data

2009 Radiological Data

Location Description	GWE12	GWE7X	GWE14X	GWE18	GWDuplicate04
Collection Date	12/1/2009	12/3/2009	12/1/2009	12/3/2009	12/10/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	60.04	60.19	63.72	60.05	55.03
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	2.20	2.20	2.57	2.32	2.44
K-40 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
K-40 Confidence Interval	NA	NA	NA	NA	NA
K-40 MDA	50.64	48.72	49.05	45.09	44.83
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	2.48	2.68	2.55	2.69	2.74
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	5.04	4.53	4.72	4.74	4.41
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	2.08	2.32	2.27	2.04	2.10
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	5.76	5.19	5.35	5.26	6.12
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	3.73	3.62	3.66	3.88	3.38
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	9.75	9.20	9.67	9.41	8.44
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	11.16	10.62	11.38	9.99	9.40
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	6.82	7.85	7.97	7.31	7.24
I-131 Activity	No Data	No Data	No Data	No Data	No Data
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	NA	NA	NA	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	2.37	2.54	2.34	2.48	2.41
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	2.44	2.37	2.51	2.26	2.57
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	29.58	30.58	30.63	30.75	29.95
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	8.19	8.21	8.43	8.07	8.73
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	5.93	5.96	6.95	6.41	6.59
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	13.06	12.43	12.90	13.26	12.82
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	6.35	6.65	6.65	6.31	6.40
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	6.11	6.19	6.25	5.90	6.48
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	80.59	78.22	78.41	78.61	79.47
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	10.69	10.14	11.26	9.82	10.16
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	78.58	76.85	77.99	76.45	76.90
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	27.11	27.13	27.20	26.55	25.50

Ambient Groundwater Data

2009 Radiological Data

Location Description	M03706	M03707	M03708	M03709	M03131	M03132
Collection Date	3/18/2009	3/17/2009	3/10/2009	3/3/2009	4/8/2009	4/8/2009
Alpha Activity	3.09	1.82	2.77	2.87	<LLD	<LLD
Alpha Confidence Interval	1.26	1.06	1.20	1.17	NA	NA
Alpha LLD	1.19	1.22	1.18	1.10	4.86	2.56
Beta Activity	<LLD	<LLD	4.09	3.24	<LLD	<LLD
Beta Confidence Interval	NA	NA	1.54	1.48	NA	NA
Beta LLD	2.52	2.53	2.52	2.49	3.84	3.66

Network Wells

Location Description	M03702	M03703	M03704	M03705	M06601	M06602
Collection Date	3/24/2009	4/7/2009	4/7/2009	3/24/2009	2/12/2009	2/12/2009
Alpha Activity	<LLD	<LLD	<LLD	1.96	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	1.08	NA	NA
Alpha LLD	1.59	5.38	4.51	1.22	2.58	4.52
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA	NA	NA
Beta LLD	2.60	3.87	3.24	2.52	4.03	4.24

Network Wells

Location Description	M06603	M06604	M06605	M06608	M03101	M03104
Collection Date	2/9/2009	2/9/2009	2/4/2009	2/3/2009	2/17/2009	2/25/2009
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD	8.38
Alpha Confidence Interval	NA	NA	NA	NA	NA	2.53
Alpha LLD	5.51	4.75	3.25	3.23	3.31	1.93
Beta Activity	<LLD	<LLD	<LLD	4.62	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	2.09	NA	NA
Beta LLD	4.30	4.25	4.12	3.73	4.13	2.63

Network Wells

Location Description	Trip Blank 1	Duplicate 1	Trip Blank 2	Duplicate 2
Collection Date	2/3/2009	2/3/2009	4/8/2009	4/7/2009
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	2.38	2.93	1.81	5.45
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA
Beta LLD	4.00	4.08	3.53	3.88

Network Wells

Location Description	D00383	D02640
Collection Date	5/27/2009	5/27/2009
Alpha Activity	3.32	2.20
Alpha Confidence Interval	1.30	1.14
Alpha LLD	1.51	1.51
Beta Activity	<LLD	<LLD
Beta Confidence Interval	NA	NA
Beta LLD	2.28	2.28

Network Wells

Ambient Groundwater Data

2009 Radiological Data

Location Description	GWB12	GWB17	GWB14	GWB15	GWB20X	GWB8
Collection Date	5/26/2009	1/27/2009	2/3/2009	11/5/2009	12/14/2009	12/10/2009
Alpha Activity	<LLD	<LLD	**8.31**	<LLD	**3.71**	<LLD
Alpha Confidence Interval	NA	NA	3.57	NA	2.07	NA
Alpha LLD	2.03	3.11	5.15	3.61	2.88	1.76
Beta Activity	<LLD	<LLD	**7.00**	**2.61**	<LLD	<LLD
Beta Confidence Interval	NA	NA	2.28	1.22	NA	NA
Beta LLD	2.37	4.11	3.88	1.96	2.21	2.13

Background Wells

Location Description	GWDuplicate 04	GWB13	GWB19	GWB9	GWB18
Collection Date	12/10/2009	12/16/2009	12/14/2009	12/9/2009	12/10/2009
Alpha Activity	<LLD	<LLD	<LLD	**2.21**	<LLD
Alpha Confidence Interval	NA	NA	NA	1.35	NA
Alpha LLD	1.76	2.07	2.22E+00	1.94	1.90
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA	NA
Beta LLD	2.13	2.16	2.17	2.15	2.15

Background Wells

Location Description	GWE11	GWE8	GWE10	GWE20	GWDuplicate03
Collection Date	11/12/2009	11/12/2009	11/12/2009	11/19/2009	11/19/2009
Alpha Activity	<LLD	<LLD	<LLD	**9.45**	**8.11**
Alpha Confidence Interval	NA	NA	NA	2.05	1.92
Alpha LLD	1.87	1.64	1.63	1.75	1.75
Beta Activity	<LLD	**2.04**	**2.30**	**5.59**	**5.42**
Beta Confidence Interval	NA	1.13	1.15	1.54	1.52
Beta LLD	1.88	1.86	1.86	2.13	2.13

Perimeter Wells

Location Description	GWE16	GWE12	GWE7X	GWE14X	GWE18
Collection Date	11/19/2009	12/1/2009	12/3/2009	12/1/2009	12/3/2009
Alpha Activity	<LLD	<LLD	<LLD	**2.62**	<LLD
Alpha Confidence Interval	NA	NA	NA	1.25	NA
Alpha LLD	2.43	2.54	2.11	1.65	2.47
Beta Activity	<LLD	**3.47**	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	1.38	NA	NA	NA
Beta LLD	2.19	2.19	2.17	2.12	2.19

Perimeter Wells

Ambient Groundwater Data

2009 Radiological Data

Location Description	M03131	M03132	M03703	M03704	M03101	M03104
Collection Date	4/8/2009	4/8/2009	4/7/2009	4/7/2009	2/17/09	2/25/2009
Tritium Activity	<248	<248	<248	<248	<185	<183
Tritium Confidence Interval	NA	NA	NA	NA	NA	NA
Tritium LLD	248	248	248	248	185	183

Location Description	M03709	M03708	M03707	M03706	M03705	M03702
Collection Date	3/3/2009	3/10/2009	3/17/2009	3/18/2009	3/24/2009	3/24/2009
Tritium Activity	<183	<183	<183	<183	<183	<183
Tritium Confidence Interval	NA	NA	NA	NA	NA	NA
Tritium LLD	183	183	183	183	183	183

Location Description	M06601	M06602	M06603	M06604	M06605	M06608
Collection Date	2/12/2009	2/12/09	2/9/09	2/9/09	2/4/09	2/3/09
Tritium Activity	<185	<185	<185	<185	<185	<185
Tritium Confidence Interval	NA	NA	NA	NA	NA	NA
Tritium LLD	185	185	185	185	185	185

Location Description	Trip Blank 1	Duplicate 1	Trip Blank 2	Duplicate 2
Collection Date	2/3/09	2/3/2009	4/8/2009	4/7/2009
Tritium Activity	**192**	<185	<248	<248
Tritium Confidence Interval	86	NA	NA	NA
Tritium LLD	185	185	248	248

C Wells

Location Description	GWB12	GWB17	GWB14	GWDuplicate04
Collection Date	5/26/2009	1/27/2009	2/3/2009	12/10/2009
Tritium Activity	<190	<185	<185	<191
Tritium Confidence Interval	NA	NA	NA	NA
Tritium LLD	190	185	185	191

Location Description	GWB18	GWB8	GWB13	GWB9
Collection Date	12/10/2009	12/10/2009	12/16/2009	12/9/2009
Tritium Activity	<191	<191	<191	**303**
Tritium Confidence Interval	NA	NA	NA	93
Tritium LLD	191	191	191	191

Location Description	GWB19	GWB20X	GWB15
Collection Date	12/14/2009	12/14/2009	11/5/2009
Tritium Activity	<191	<191	<185
Tritium Confidence Interval	NA	NA	NA
Tritium LLD	191	191	185

Background Wells

Ambient Groundwater Data

2009 Radiological Data

Location Description	GWE8	GWE11	GWE10	GWE20
Collection Date	11/12/2009	11/12/2009	11/12/2009	11/19/2009
Tritium Activity	<185	**193**	<185	<185
Tritium Confidence Interval	NA	86	NA	NA
Tritium LLD	185	185	185	185

Location Description	GWDuplicate03	GWE16	GWE12	GWE14X
Collection Date	11/19/2009	11/19/2009	12/1/2009	12/1/2009
Tritium Activity	<185	<185	<185	**286**
Tritium Confidence Interval	NA	NA	NA	90
Tritium LLD	185	185	185	185

Location Description	GWE7X	GWE18
Collection Date	12/3/2009	12/3/2009
Tritium Activity	<185	<185
Tritium Confidence Interval	NA	NA
Tritium LLD	185	185

Perimeter Wells

Location Description	D00383	D02640
Collection Date	5/27/2009	5/27/2009
Tritium Activity	**272**	**346**
Tritium Confidence Interval	92	94
Tritium LLD	190	190

Network Wells

Ambient Groundwater Data

2009 Nonradiological Data

Location Description	M06601	M06602	M06603	M06604	M06605	M06608	M03101
Collection Date	**2/12/2009**	**2/12/2009**	**2/9/2009**	**2/9/2009**	**2/4/2009**	**2/3/2009**	**2/17/2009**
Field Water Quality Data							
pH	5.06	4.27	6.33	5.25	5.21	5.32	7.32
Conductivity	0.020	0.158	0.207	0.162	0.087	0.074	0.103
Turbitity	0.00	4.00	0.00	0.00	0.00	0.00	3.00
Dissolved Oxygen	6.78	5.40	-1.24	-0.07	-0.27	-0.91	0.59
Temperature ©	19.30	19.40	20.10	20.20	19.40	22.40	25.40
Analyte							
Alkalinity (mg/L)	6.200	95.000	110.000	83.000	33.000	22.000	42.000
Phenolphthalein Alkalinity (mg/L)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hardness (mg/L)	7.000	78.000	96.000	67.000	33.000	13.000	3.800
Specific Conductivity (UMHOS)	27.000	180.000	230.000	180.000	96.000	78.000	120.000
Total Dissolved Solids (mg/L)	28.000	110.000	160.000	140.000	67.000	57.000	92.000
Total Organic Carbon (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	No data	<2.0
Chloride (mg/L)	2.500	4.400	2.100	2.000	1.600	1.400	15.000
Fluoride (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrite (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate/Nitrite (mg/L)	0.280	0.069	<0.020	No data	<0.020	<0.020	<0.020
Ammonia (mg/L)	<0.050	<0.050	<0.050	No data	<0.050	<0.050	<0.050
Total Kjeldahl Nitrogen (mg/L)	<0.10	<0.10	<0.10	<0.10	0.150	0.200	3.400
Ortho Phosphate (mg/L)	<0.020	<0.020	0.035	0.023	0.073	0.039	0.021
Sulfate (mg/L)	<5.0	<5.0	5.900	5.900	11.000	12.000	11.000
Aluminum (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.130**
Barium (mg/L)	<0.050	<0.050	<0.050	<0.050	**0.120**	**0.069**	<0.050
Boron (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (mg/L)	2.500	30.000	37.000	25.000	12.000	4.600	1.000
Cobalt (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (mg/L)	0.025	0.110	0.060	0.360	0.600	0.510	0.051
Magnesium (mg/L)	0.190	0.660	1.000	1.200	0.650	0.400	0.320
Manganese (mg/L)	<0.010	<0.010	**0.037**	**0.044**	**0.019**	**0.019**	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Nickel (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Potassium (mg/L)	<1.0	<1.0	1.600	1.800	2.200	4.200	2.200
Silicon (mg/L)	3.200	5.100	12.000	12.000	6.000	6.700	10.000
Silver (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Sodium (mg/L)	1.000	1.700	1.600	1.400	1.200	1.500	19.000
Vanadium (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc (mg/L)	<0.010	<0.010	<0.010	**0.070**	**0.990**	**1.000**	**0.270**
pH (SU)	6.000	7.900	7.900	7.500	7.100	6.900	7.800
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Cadmium (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Thallium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Vinyl Chloride (mg/L)	<0.00500	<0.00500	<0.00500	<0.0050	<0.0050	<0.0050	<0.00500
Trichloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.0050	<0.0050	<0.0050	<0.00500
Tetrachloroethene (mg/L)	<0.00500	<0.00500	<0.00500	<0.0050	<0.0050	<0.0050	<0.00500

Ambient Groundwater Data

2009 Nonradiological Data

Location Description	Trip Blank 1	Duplicate 1	M03104	M03709	M03708	M03707	M03706
Collection Date	2/3/2009	2/3/2009	2/25/2009	3/3/2009	3/10/2009	3/17/2009	3/18/2009
Field Water Quality Data							
pH	No data	No data	5.43	6.78	4.40	6.01	5.91
Conductivity	No data	No data	0.237	0.066	0.081	0.158	0.145
Turbidity	No data	No data	0.00	0.00	4.00	0.00	0.00
Dissolved Oxygen	No data	No data	-1.60	1.18	-1.46	2.11	1.54
Temperature ©	No data	No data	21.20	22.40	19.50	21.80	21.60
Analyte							
Alkalinity (mg/L)	<1.0	22.000	120.000	16.000	36.000	35.000	31.000
Phenolphthalein Alkalinity (mg/L)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hardness (mg/L)	<1.0	15.000	110.000	10.000	26.000	28.000	31.000
Specific Conductivity (UMHOS)	0.670	80.000	270.000	73.000	99.000	100.000	93.000
Total Dissolved Solids (mg/L)	3.500	67.000	180.000	54.000	78.000	75.000	62.000
Total Organic Carbon (mg/L)	No data	No data	<2.0	<2.0	<2.0	<2.0	<2.0
Chloride (mg/L)	<1.0	1.300	5.100	1.300	1.300	2.100	2.400
Fluoride (mg/L)	<0.10	<0.10	**0.110**	**0.100**	**0.150**	<0.10	<0.10
Nitrite (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate/Nitrite (mg/L)	<0.020	<0.020	<0.020	No data	<0.020	<0.020	<0.020
Ammonia (mg/L)	<0.050	0.082	<0.050	<0.050	<0.050	0.060	<0.050
Total Kjeldahl Nitrogen (mg/L)	0.150	0.200	No data	<0.10	<0.10	<0.10	0.100
Ortho Phosphate (mg/L)	<0.020	0.032	<0.020	<0.020	0.052	0.082	0.077
Sulfate (mg/L)	<5.0	12.000	9.000	12.000	12.000	10.000	10.000
Aluminum (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Barium (mg/L)	<0.050	**0.083**	<0.050	**0.097**	**0.130**	**0.078**	**0.071**
Boron (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Calcium (mg/L)	<0.050	5.400	39.000	2.800	7.600	9.000	11.000
Cobalt (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (mg/L)	<0.020	0.570	0.370	0.900	0.540	0.380	0.690
Magnesium (mg/L)	<0.050	0.470	3.200	0.760	1.800	1.300	0.930
Manganese (mg/L)	<0.010	**0.022**	**0.017**	**0.032**	**0.036**	**0.016**	**0.024**
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Nickel (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Potassium (mg/L)	<1.0	5.000	3.200	4.900	6.400	3.400	2.000
Silicon (mg/L)	<0.050	6.700	No data	No data	6.400	7.400	6.300
Silver (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Sodium (mg/L)	0.140	1.800	2.600	3.300	2.900	1.600	1.400
Vanadium (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc (mg/L)	<0.010	**1.100**	**0.012**	**4.300**	**1.200**	**2.100**	**1.500**
pH (SU)	5.000	6.900	8.000	6.900	7.100	6.700	6.800
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Cadmium (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.004	<0.0030
Thallium (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Vinyl Chloride (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Trichloroethene (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tetrachloroethene (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Ambient Groundwater Data

2009 Nonradiological Data

Location Description	M03702	M03705	M03131	M03132	M03703	M03704	Duplicate 2
Collection Date	**3/24/2009**	**3/24/2009**	**4/8/2009**	**4/8/2009**	**4/7/2009**	**4/7/2009**	**4/7/2009**
Field Water Quality Data							
pH	6.99	5.71	No data	No data	10.18	7.45	No data
Conductivity	0.253	0.153	No data	No data	1.150	0.346	No data
Turbitity	1.00	0.00	No data	No data	2.00	0.00	No data
Dissolved Oxygen	7.16	1.34	No data	No data	3.77	0.93	No data
Temperature ©	19.60	21.00	No data	No data	19.70	19.70	No data
Analyte							
Alkalinity (mg/L)	83	34	99	43	44	110	38
Phenolphthalein Alkalinity (mg/L)	0	0	0	0	5	0	10
Hardness (mg/L)	78	36	87	6.7	110	110	120
Specific Conductivity (UMHOS)	170	100	220	120	99	240	93
Total Dissolved Solids (mg/L)	110	78	150	77	66	150	65
Total Organic Carbon (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Chloride (mg/L)	2.2	2.1	2.2	1.9	1.9	0.1	No data
Fluoride (mg/L)	<0.10	**0.12**	**0.13**	<0.10	**0.1**	**0.1**	<0.10
Nitrite (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate/Nitrite (mg/L)	0.055	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Ammonia (mg/L)	<0.050	<0.050	<0.050	No data	0.058	<0.050	0.086
Total Kjeldahl Nitrogen (mg/L)	0.62	<0.10	No data	No data	<0.10	<0.10	<0.10
Ortho Phosphate (mg/L)	<0.020	0.044	<0.020	<0.020	<0.020	<0.020	<0.020
Sulfate (mg/L)	<5.0	11	11	0.17	8.8	9.9	8.2
Aluminum (mg/L)	<0.10	<0.10	<0.10	<0.050	**0.16**	**0.056**	**0.2**
Barium (mg/L)	<0.050	**0.088**	**0.1**	**0.17**	**0.094**	**0.2**	**0.11**
Boron (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chromium (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050
Calcium (mg/L)	30	13	32	2	40	39	45
Cobalt (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Iron (mg/L)	<0.020	1	0.36	0.053	0.021	0.24	0.048
Magnesium (mg/L)	0.67	0.94	1.7	0.42	1.6	2.9	1.5
Manganese (mg/L)	<0.010	**0.028**	**0.04**	<0.010	<0.010	**0.026**	<0.010
Mercury (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Nickel (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Potassium (mg/L)	<1.0	2.4	2.1	3.4	4.2	2.2	4.5
Silicon (mg/L)	6.2	6.8	12	6.4	9	12	8.7
Silver (mg/L)	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Sodium (mg/L)	1.3	1.4	1.9	17	3.9	2	4.2
Vanadium (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Zinc (mg/L)	**0.21**	**1.7**	<0.010	<0.010	**0.2**	**0.035**	**0.24**
pH (SU)	8	6.6	7.8	8.2	9	8	9.4
Selenium (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Cadmium (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	No data	<0.00010
Arsenic (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Lead (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	**0.010**	<0.0050	**0.012**
Antimony (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Thallium (mg/L)	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.00050	<0.00050
Vinyl Chloride (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Trichloroethene (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tetrachloroethene (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Ambient Groundwater Data

2009 Nonradiological Data

Location Description	Trip Blank 2	D00383	D02640
Collection Date	4/8/2009	5/27/2009	5/27/2009
Field Water Quality Data			
pH	No data	No data	No data
Conductivity	No data	No data	No data
Turbitity	No data	No data	No data
Dissolved Oxygen	No data	No data	No data
Temperature ©	No data	No data	No data
Analyte			
Alkalinity (mg/L)	<1.0	No data	No Data
Phenolphthalein Alkalinity (mg/L)	0	No data	No data
Hardness (mg/L)	<1.0	No data	No data
Specific Conductivity (UMHOS)	0.64	No data	No data
Total Dissolved Solids (mg/L)	<10	No data	No data
Total Organic Carbon (mg/L)	<2.0	No data	No data
Chloride (mg/L)	<1.0	No data	No data
Fluoride (mg/L)	<0.10	No data	No data
Nitrite (mg/L)	<0.020	No data	No data
Nitrate/Nitrite (mg/L)	<0.020	No data	No data
Ammonia (mg/L)	<0.050	No data	No data
Total Kjeldahl Nitrogen (mg/L)	No data	No data	No data
Ortho Phosphate (mg/L)	<0.020	No data	No data
Sulfate (mg/L)	<5.0	No data	No data
Aluminum (mg/L)	<0.050	No data	No data
Barium (mg/L)	<0.050	No data	No data
Boron (mg/L)	<0.10	No data	No data
Chromium (mg/L)	<0.0050	No data	No data
Calcium (mg/L)	0.11	No data	No data
Cobalt (mg/L)	<0.020	No data	No data
Copper (mg/L)	<0.010	No data	No data
Iron (mg/L)	<0.020	No data	No data
Magnesium (mg/L)	0.014	No data	No data
Manganese (mg/L)	<0.010	No data	No data
Mercury (mg/L)	<0.00020	No data	No data
Nickel (mg/L)	<0.020	No data	No data
Potassium (mg/L)	<1.0	No data	No data
Silicon (mg/L)	<0.050	No data	No data
Silver (mg/L)	<0.030	No data	No data
Sodium (mg/L)	0.17	No data	No data
Vanadium (mg/L)	<0.020	No data	No data
Zinc (mg/L)	<0.010	No data	No data
pH (SU)	5.2	No data	No data
Selenium (mg/L)	<0.0020	No data	No data
Cadmium (mg/L)	<0.00010	No data	No data
Arsenic (mg/L)	<0.0050	No data	No data
Lead (mg/L)	<0.0050	No data	No data
Antimony (mg/L)	<0.0030	No data	No data
Thallium (mg/L)	<0.00050	No data	No data
Vinyl Chloride (mg/L)	<0.0050	<0.00500	<0.00500
Trichloroethene (mg/L)	<0.0050	<0.00500	<0.00500
Tetrachloroethene (mg/L)	<0.0050	<0.00500	<0.00500

TOC

2.1.5 Summary Statistics

Ambient Groundwater Monitoring

Notes:

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

Summary Statistics
Ambient Groundwater Data
2009 Ambient Groundwater Monitoring Summary Statistics

Location Description	Description	Alpha (pCi/L)	Beta (pCi/L)	Tritium (pCi/L)
GWE11	Random Perimeter	<1.87	<1.88	**193**
GWE14X	Random Perimeter	**2.62**	<2.12	**286**
GWE20	Random Perimeter	**9.45**	**5.59**	<185
GWE8	Random Perimeter	<1.64	**2.04**	<185
GWE10	Random Perimeter	<1.63	**2.30**	<185
GWE12	Random Perimeter	<2.54	**3.47**	<185
GWB9	Random Background	**2.21**	<2.15	**303**
GWB14	Random Background	**8.31**	**7.00**	<185
GWB20X	Random Background	**3.71**	<2.21	<191
GWB15	Random Background	<3.61	**2.61**	<185

Random Background			
	Mean	Std Dev.	Median
Alpha (pCi/L)	4.74	3.18	3.71
Beta (pCi/L)	4.81	3.10	4.81
Tritium (pCi/L)	303	N/A	303

Random Perimeter			
	Mean	Std Dev.	Median
Alpha (pCi/L)	6.04	4.83	6.04
Beta (pCi/L)	3.35	1.62	2.89
Tritium (pCi/L)	239.5	65.76	239.5

Ambient Groundwater Data
2009 Ambient Groundwater Monitoring Summary Statistics

Location Description	Alpha (pCi/L)	Beta (pCi/L)	Tritium (pCi/L)
M03706	**3.09**	<LLD	<LLD
M03707	**1.82**	<LLD	<LLD
M03708	**2.77**	**4.09**	<LLD
M03709	**2.87**	**3.24**	<LLD
M03705	**1.96**	<LLD	<LLD
M03104	**8.38**	<LLD	<LLD
M06608	<LLD	**4.62**	<LLD
D00383	**3.32**	<LLD	**272**
D02640	**2.20**	<LLD	**346**
Trip Blank1	<LLD	<LLD	**192**

C Wells and Network Wells			
	Mean	Std Dev.	Median
Alpha (pCi/L)	3.30	2.12	2.82
Beta (pCi/L)	3.98	0.70	4.09
Tritium (pCi/L)	309	52.33	309

TOC

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 provides assurance to the public that radiological constituents have not 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 of 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, 18 groundwater fed and four surface water fed community drinking water systems were selected (Section 2.2.2, Map 4). These systems serve approximately 281,000 customers with approximately 100,000 receiving their water from groundwater sources (Section 2.2.3, Table 1). None of the drinking water samples collected originated from the SRS drinking water system.

During 2009, DOE-SR collected water samples from four surface water locations (North Augusta, Purrysburg, Beaufort and Savannah) that are colocated with the ESOP surface water fed drinking water systems.

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. They 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. Currently, DOE-SR does not conduct drinking water sampling off-site from groundwater fed wells.

Results and Discussion

Surface Water System Fixed Network Results

Tritium

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 2007). 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 2007). 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 202 pCi/L for groundwater systems and 390.65 pCi/L for surface water systems. The DOE-SR detectable average for surface water systems was 291.15 (± 156.98) pCi/L. These tritium activities, however, were quite low when compared to the USEPA drinking water MCL of 20,000 pCi/L (USEPA 2002).

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 70% of surface water composite samples. Detectable tritium activity in these samples yielded an average of 390.65 (± 80.93) pCi/L and ranged from 186 to 906 pCi/L. These tritium activities are measurable but not significant when compared with the 20,000 pCi/L USEPA MCL (USEPA 2002). Of the 12 upstream North Augusta surface water composites, there were two detections above the LLD. Tritium activity in the North Augusta samples ranged from 186 to 391 pCi/L and averaged 288.50 (± 144.96) pCi/L. Of the 36 composite samples collected down stream from SRS, 32 samples had a tritium activity slightly above the MDA. The tritium activity in these three downstream intakes, Chelsea Plant, Purrysburg Plant, and City of Savannah had a range of 192 to 906 and averaged 424.69 (± 64.51) 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 (Section 2.2.3, Table 2) were not detected above the minimum detectable activity (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 stream primarily affected by these releases was Fourmile Creek (Till et al. 2001). The aforementioned streams ultimately flow directly or indirectly into the Savannah River.

Gross alpha was detected at Purrysburg in July 2009 with an activity of 3.30 pCi/L. Non-volatile beta was detected a three locations (Chelsea, Savannah and Purrysburg). These three locations revealed non-volatile beta detections that averaged 2.99 (± 1.04) pCi/L and ranged from 2.13 to 4.12 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 2002). Alpha and beta activity is likely attributable to naturally occurring radionuclides.

Section 2.2.3 (Figures 1, 2 and 3) illustrate the trends in tritium, gross alpha and non-volatile beta concentrations since the year 2005. Although there are several detections identified during the 2009 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 18 groundwater fed systems sampled had tritium activities above the LLD. This tritium detection located at the Elko public water system yielded an activity of 202 pCi/L. This tritium activity is measurable but not significant when compared to the 20,000 pCi/L USEPA MCL (USEPA 2002). Figure 1 in 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 eight 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 two of the 18 groundwater systems (Jackson and College Acres) tested in 2009. The range for gross alpha activity was 2.12 to 4.46 pCi/L with an average activity of 2.80 (± 0.96) pCi/L. All gross alpha samples were below the USEPA MCL of 15 pCi/L (USEPA 2002). 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 was a single detection for non-volatile beta located at the Bath water district and yielded an activity of 2.74 pCi/L. Although this concentration is detectable, it is 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.

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 2009 annual report, tritium in the three downstream water intakes averaged 368.33 (± 34.99) pCi/L ranging from 329.0 to 396.0 pCi/L while ESOP downstream detections averaged 424.70 (± 64.52) pCi/L ranging from 350.27 to 464.72 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 291.15 (± 156.99) pCi/L for all surface water samples collected in 2009. This was lower than the ESOP detected tritium average of 390.65 (± 80.93) pCi/L for the same period. The ESOP calculated average tritium activity for North Augusta is 288.50 pCi/L. This average is lower than the averages for the other down stream locations due to the fact North Augusta is located up stream from the SRS (Table 3). All samples were within one standard deviation as well as being lower than the USEPA MCL of 20,000 pCi/L (USEPA 2002). Tritium continues to be the most abundant radionuclide in the Savannah River. Tritium activity in 2009 is within one standard deviation of the running 5 year average. These activity levels are well below the USEPA MCL.

Gamma-emitting radionuclides were not detected in DOE-SR or ESOP samples in 2009. DOE-SR and ESOP detected non-volatile beta in surface water samples. The DOE-SR non-volatile beta average (for all four locations) of 2.20 (± 0.19) pCi/L was slightly less than the single ESOP detection of 4.12 pCi/L located at the city of Savannah. DOE-SR reported an average gross alpha activity (for all four locations) of 0.08 (± 0.07) pCi/L. ESOP had a single surface water gross alpha detection at the Purrysburg plant of 3.30 pCi/L. Naturally occurring radionuclides may account for variability in tritium activities. All detections were less than the established USEPA MCL for gross alpha and non-volatile beta in drinking water (USEPA 2002).

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 SRS. Tritium was detected in both groundwater and surface water systems. However, these tritium activities were 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 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.

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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 Served
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*
0210003F	North Augusta Surface Water	12,022	31,506
0720003F	Chelsea B/J Plant Surface Water canal intake	44,227	133,353
0720004F	Purrysburg B/J Plant Surface Water SR intake		
SAVF	City of Savannah Surface Water (Industrial)	35	10,619
	TOTAL	100,115	280,717
	Approx. Groundwater	43,831	105,239
	Approx. Surface water	56,284	175,478

*This number is likely higher due to public access to the natural spring.
Information Updated June 2008

Note: Information was updated August 2009. Data was obtained from SC DHEC EFIS 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	288.50	59.60	<MDA	0.06	<MDA	2.03
Beaufort Jasper	459.10	380.00	<MDA	0.05	2.34	2.31
Purrysburg	464.72	396.00	3.30	0.03	2.58	2.04
Savannah	350.27	329.00	<MDA	0.19	4.04	2.41
Average	390.65	291.15	3.30	0.08	2.99	2.20

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2.2.3 Tables and Figures

Drinking Water Quality Monitoring

Figure 1. ESOP Yearly Tritium Averages in Drinking Water Systems

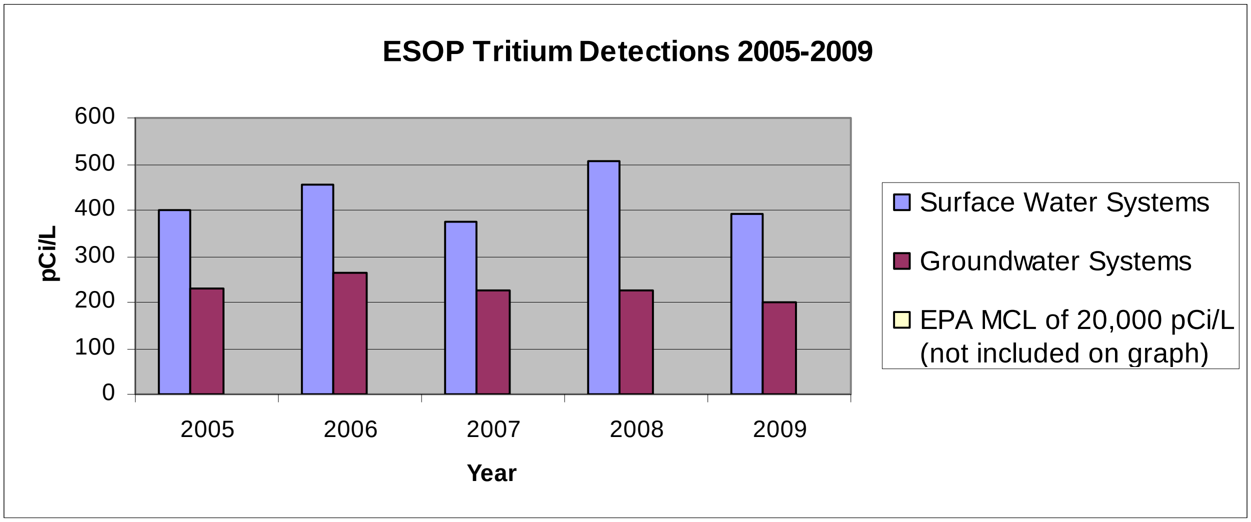
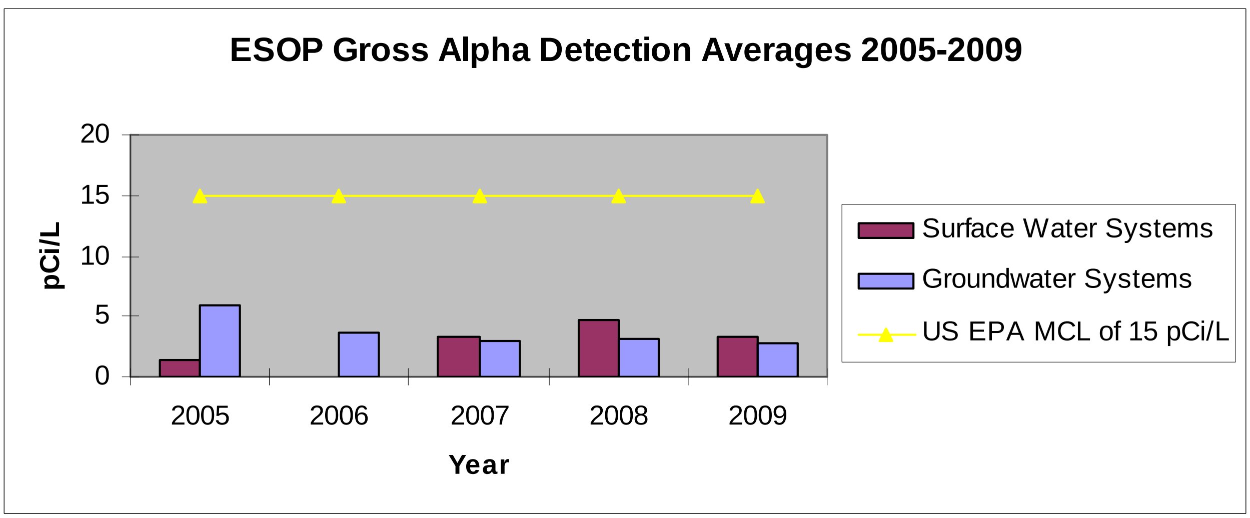


Figure 2. ESOP Yearly Gross Alpha Averages in Drinking Water Systems

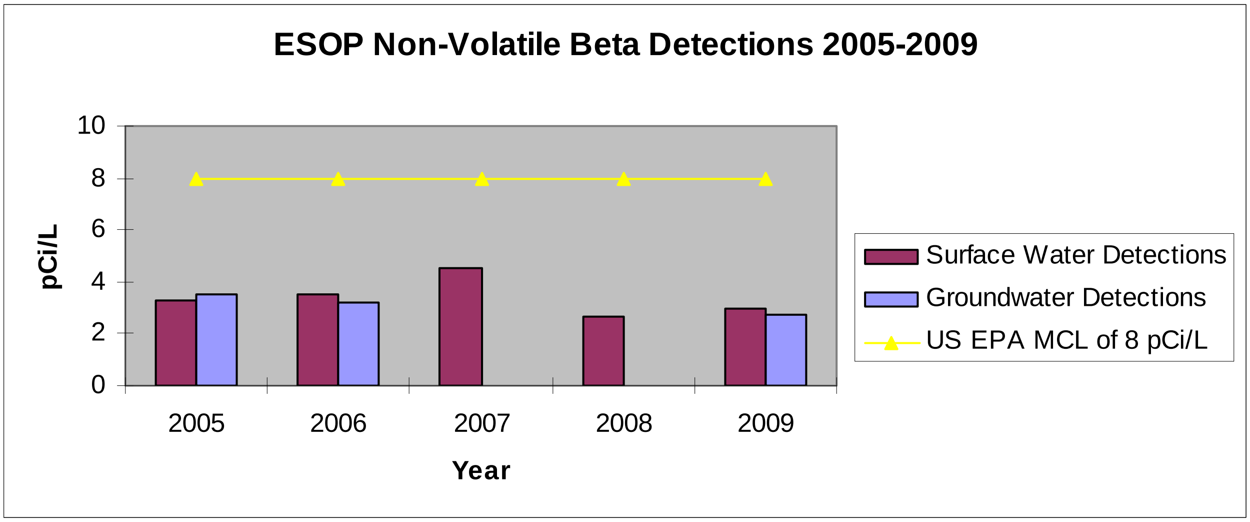


Note: Missing data for 2006 indicates no surface water detections were found for that year.

Tables and Figures

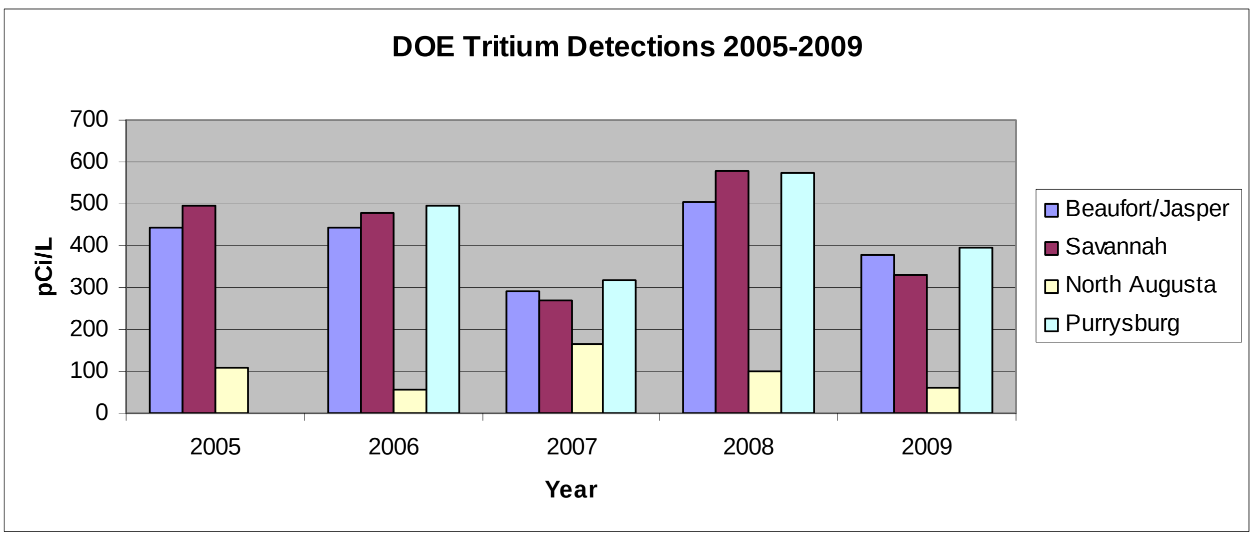
Drinking Water Quality Monitoring

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

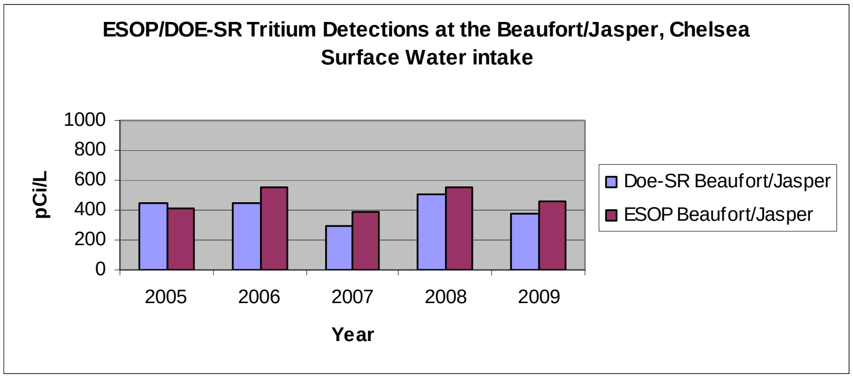


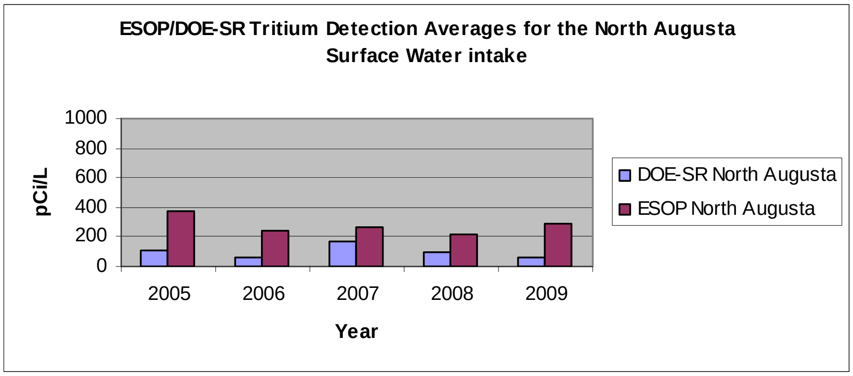
Note: Purrysburg was first collected as a new sampling location in 2006.

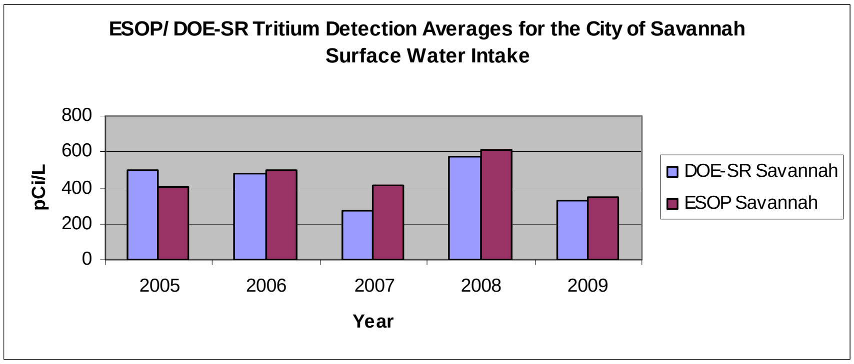
Tables and Figures

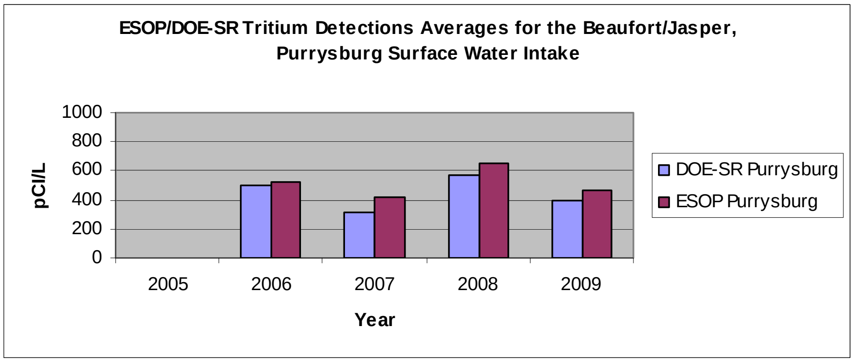
Drinking Water Quality Monitoring

Figure 5. ESOP/DOE-SR Comparison of 2009 Averages of Tritium in Drinking Water









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2.2.4 Data

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

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

Drinking Water Data
2009 Radiological Data for Surface Water Systems

Sample Number:		DW0210003F											
Sample Name:		North Augusta Surface Water											
Date:		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(LLD)	2.36	2.35	1.77	1.77	2.57	2.45	3.26	3.36	1.85	1.87	3.36	3.39
NV Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(LLD)	2.79	2.79	2.34	2.34	2.59	2.58	4.01	4.02	1.88	1.88	3.79	3.79
Tritium	(pCi/L)	**186**	**391**	<206	<206	<180	<180	<184	<184	<185	<185	<177	<177
±2	(sigma)	85	94	NA	NA	85	94	NA	NA	NA	NA	NA	NA
	(LLD)	182	182	206	206	180	180	184	184	185	185	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(MDA)	2.33	3.70	1.95	1.78	2.50	2.48	2.27	2.26	3.99	3.98	3.99	3.99

Sample Number:		DW0720003F											
Sample Name:		Chelsea B/J Surface Water Canal Intake											
Date:		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(LLD)	2.61	2.66	1.92	1.91	2.75	2.78	4.04	3.76	2.06	2.11	3.93	3.89
NV Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.34**	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	1.17	NA	NA	NA
	(LLD)	2.83	2.83	2.36	2.36	2.61	2.62	4.06	4.04	1.90	1.90	3.82	3.82
Tritium	(pCi/L)	**481**	**395**	<206	<206	**464**	**262**	**527**	**440**	**674**	**585**	**489**	**274**
±2	(sigma)	97	94	NA	NA	97	94	100	97	105	102	96	87
	(LLD)	182	182	206	206	180	180	184	184	185	185	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(MDA)	2.47	3.36	1.76	1.91	2.50	2.51	2.44	2.56	3.99	3.99	3.98	3.99

Sample Number:		DWSAVF											
Sample Name:		City of Savannah Surface Water (Industrial)											
Date:		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(LLD)	3.57	1.25	2.89	2.21	2.22	2.99	3.96	2.14	2.14	3.39	3.02	3.56
NV Beta	(pCi/L)	<LLD	<LLD	**3.93**	<LLD	<LLD	**4.12**	<LLD	**4.06**	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	2.03	NA	NA	2.01	NA	1.98	NA	NA	NA	NA
	(LLD)	4.16	2.53	3.69	2.56	2.56	3.61	4.05	3.55	3.55	3.71	3.69	3.80
Tritium	(pCi/L)	<182	**197**	**252**	**246**	**192**	**318**	**610**	**520**	**445**	**515**	**250**	**308**
±2	(sigma)	NA	87	95	89	90	90	103	102	99	100	89	89
	(LLD)	182	182	200	193	193	179	184	192	192	185	185	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(MDA)	1.91	3.80	1.66	3.98	3.99	2.51	2.46	2.02	1.94	4.00	3.99	3.99

Sample Number:		DW0720004F											
Sample Name:		Purrysburg B/J Plant Surface Water SR Intake											
Date:		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Gross Alpha	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**3.30**	<LLD	<LLD	<LLD	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	1.67	NA	NA	NA	NA	NA
	(LLD)	2.64	2.63	1.82	1.87	2.60	2.77	2.02	3.44	1.97	2.00	3.64	3.64
NV Beta	(pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.13**	**3.02**	<LLD	<LLD
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	1.14	1.22	NA	NA
	(LLD)	2.83	2.83	2.34	2.35	2.60	2.61	3.54	4.03	1.89	1.89	3.81	3.81
Tritium	(pCi/L)	**542**	**525**	**287**	<206	**267**	**301**	**649**	**570**	**906**	**460**	**251**	**354**
±2	(sigma)	99	100	98	NA	NA	87	105	102	114	97	86	91
	(LLD)	182	182	206	206	180	180	184	184	185	185	177	177
Cesium-137	(pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2	(sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	(MDA)	2.45	3.73	1.68	1.66	2.30	2.42	2.38	2.35	3.99	3.99	3.98	3.98

Drinking Water Data

2009 Radiological Data for Groundwater Systems TOC

System Number:	DW0210001		DW0210002		DW670075		DW0210007		DW0220001	
System Name:	Aiken		Jackson		Healing Springs		New Ellenton		Langley Water	
Date:	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09
Gross Alpha (pCi/L)	<LLD	<LLD	**2.12**	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	1.24	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.56	2.52	1.75	2.32	2.53	2.97	2.02	2.65	2.66	2.79
NV Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.50	2.54	2.33	2.53	2.43	2.37	2.60	2.55	2.51	2.56
Tritium (pCi/L)	<177	<232	<177	<232	<177	<182	<177	<232	<177	<232
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	177	232	177	232	177	182	177	232	177	232
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(MDA)	2.87	2.60	3.39	2.52	3.62	1.99	3.17	2.51	2.90	2.60

System Number:	DW0220005		DW0220006		DW0220008		DW0220012		DW0310001	
System Name:	Talatha Water		Breezy Hill		Montmorenci		Valley PSA		Allendale	
Date:	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.51	2.42	2.50	3.29	3.60	2.46	3.38	3.48	3.17	4.27
NV Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.49	2.54	2.49	4.05	2.53	2.54	2.58	2.60	2.47	2.62
Tritium (pCi/L)	<177	<232	<177	<232	<177	<232	<177	<232	<177	<232
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	177	232	177	232	177	232	177	232	177	232
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(MDA)	3.23	2.61	3.44	2.46	2.29	2.59	3.36	2.52	3.52	2.41

System Number:	DW0610004		DW0610001		DW0220003		DW0220002		DW0610002	
System Name:	Hilda		Barnwell		Bath Water Dist.		College Acres		Williston	
Date:	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	**2.50**	**4.46**	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	1.32	1.81	NA	NA
(LLD)	1.95	2.55	2.17	3.22	3.43	2.05	1.84	2.51	2.09	3.61
NV Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	**2.74**	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	1.31	NA	NA	NA	NA
(LLD)	2.36	2.55	2.39	2.59	2.58	2.16	2.57	2.54	2.38	4.07
Tritium (pCi/L)	<177	<232	<177	<232	<177	<232	<177	<232	<177	<232
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	177	232	177	232	177	232	177	232	177	232
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(MDA)	3.25	2.40	3.10	2.52	3.24	2.47	2.46	2.56	3.12	2.55

System Number:	DW0610005		DW0610003		DW0220004		DWDuplicate 01		DWDuplicate 02	
System Name:	Elko		Blackville		Beech Island					
Date:	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09	Apr-09	Nov-09
Gross Alpha (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.31	2.75	2.97	4.08	2.37	2.47	3.41	2.80	3.47	2.13
NV Beta (pCi/L)	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	2.41	2.36	2.46	2.62	2.48	2.54	2.58	2.36	2.58	2.31
Tritium (pCi/L)	<177	**202**	<177	<232	<177	<232	<177	<182	<177	<182
±2 (sigma)	NA	86	NA	NA	NA	NA	NA	NA	NA	NA
(LLD)	177	182	177	232	177	232	177	182	177	182
Cesium-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
±2 (sigma)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(MDA)	3.59	1.74	3.35	2.30	3.27	2.21	2.41	1.86	2.39	1.89

2.2.5 Summary Statistics

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site

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

Summary Statistics

2009 Surface Water Fed Summary Statistics TOC

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Purrysburg	**DW0720004F**	3.30	3.30	N/A	3.30	3.30	1
Yearly Average of Detectable gross alpha			**3.30**				
Standard Deviation			**N/A**				

Radionuclide:	Gross NV Beta (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Chelsea B/J SW	**DW0720003F**	2.34	2.34	N/A	2.34	2.34	1
Purrysburg B/J SW	**DW0720004F**	2.58	2.58	0.63	3.02	2.13	2
City of Savannah	**DWSAVF**	4.06	4.04	0.10	4.12	3.93	3
Yearly Average of Detectable non-volatile (NV) beta			**2.99**				
Standard Deviation			**1.04**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
North Augusta SW	**DW0210003F**	288.50	288.50	144.96	391	186	2
Chelsea B/J SW	**DW0720003F**	472.50	459.10	127.20	674	262	10
City of Savannah	**DWSAVF**	308.00	350.27	146.40	610	192	11
Purrysburg B/J SW	**DW0720004F**	460.00	464.72	201.20	906	251	11
Yearly Average of Detectable Tritium			**390.65**				
Standard Deviation			**80.93**				

Radiological Monitoring of Drinking Water Adjacent to the Savannah River Site
Groundwater Fed Summary Statistics

Radionuclide:	Gross Alpha (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Jackson	**DW0210002**	2.12	2.12	N/A	2.12	2.12	1
College Acres	**DW0220002**	3.48	3.48	1.39	4.46	2.50	2
Yearly Average of Detectable gross alpha			**2.80**				
Standard Deviation			**0.96**				

Radionuclide:	Gross NV Beta (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Bath Water District	**DW0220003**	2.74	2.74	N/A	2.74	2.74	1
Yearly Average of Detectable gross alpha			**2.74**				
Standard Deviation			**N/A**				

Radionuclide:	Tritium (pCi/L)	Statistical Analysis					
System Name:	**System Number:**	**Median**	**Avg.**	**St. Dev.**	**Max**	**Min**	**Num**
Elko	**DW0610005**	202	202	N/A	202	202	1
Yearly Average of Detectable Tritium			**202**				
Standard Deviation			**N/A**				

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 into site streams. The fuel fabrication area (M-Area), heavy water reprocessing facility (D-Area), and the administration area (A-Area) also contributed radionuclides to liquid effluent. 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 was 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 2008a) 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 2008b). 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 has conducted 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 5.0, Tables and Figures, Section 6.0, Data Tables, and Section 7.0, Summary Statistics). These activities will allow the RSW project to generate independent data that can be shared with the public.

Section 5.0, 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 4.0, Map 1.). 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 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 flow for this creek is interrupted by the Savannah River Swamp 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 ongoing 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) on the Savannah River. The primary sampling location for the enhanced monitoring program is located at United States (US) Highway 301 and the Savannah River (SV-118). Sampling devices at this location 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 the program a more accurate timeline 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.

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 Section 4.0, Map 2. ESOP collected surface water samples in 2009 from four perimeter sites and 13 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 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 2009.

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.

RESULTS AND DISCUSSION

SCDHEC ESOP Surface Water Data

All monitoring data are in Section 6.0 and summary statistics are in Section 7.0. All sampling locations are in Section 5.0, Table 1.

Tritium

In 2009, tritium activity was detected at all ambient locations where weekly samples were collected (Section 7.0, Summary Statistics). Average tritium activity in upstream background ambient locations (Jackson Boat Landing, SV-2010 and Upper Three Runs Creek at USFS Rd E-2, SV-2027) was lower than average tritium activity at the other ambient sample locations. The 2009 tritium average for the two background ambient locations was 237 (±51) picocuries per liter (pCi/L) for SV-2010 and 240 (±51) 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 (Section 7.0, Summary Statistics). SV-2039 had an average tritium activity of 46,226 (±7,613) pCi/L and SV-2047 had an average tritium activity of 37,750 (±12,315) pCi/L. Tritium activity ranged from 237 (± 51) pCi/L at SV-2010 to 46,226 (± 7,613) pCi/L at SV-2039. Section 5.0, Figure 1 shows trending for 2005-2009 tritium averages. All sampling locations showed a decrease in average tritium activity from 2008 to 2009.

Tritium activity in the Savannah River at the confluences of the five SRS streams was scheduled for monitoring on a monthly basis in 2009 (Section 7.0, 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 (43,526 (±9,628) pCi/L) of all creek mouth locations.

Seventeen random background and perimeter samples were collected during the first and fourth quarter in 2009. Tritium was detected in only one random background sample in 2009 (Section 6.0, Random Sample Data). This sample was collected in Berkley County (RWB56) and yielded a detection of 192 (±2 Standard Deviations (SD) 84) pCi/L.

Since random sampling began in 2004, there have been only four detections out of 49 perimeter samples collected and four detections out of 66 background samples collected. For the period of 2004-2009, there were only two years where tritium was detected in perimeter samples. There was one detection of 230 (±2SD 92) pCi/L in 2006 and one detection of 265 (±2SD 91) pCi/L in 2007. 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 2004-2009 tritium average for background and perimeter samples was 231 (±40) pCi/L and 436 (±427) pCi/L, respectively. The 2004-2009 background average is within one standard deviation of the 2004-2008 perimeter average and is much lower than the perimeter average.

Gamma

As part of a gamma spectroscopy analysis, samples were analyzed for gamma-emitting radionuclides (Section 5.0, Table 2) at the Radiological Environmental Monitoring Division (REMD) Laboratory in Columbia, SC. Cesium-137 was detected in a sample collected from SV-2039 (4.85 (±2SD 2.02) pCi/L) in November 2009 (Section 7.0, Summary Statistics). 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 2003, 2004, 2006, 2007, 2009). Fourmile Branch was affected by releases from reactor activities, so periodic Cs-137 detections are likely in samples collected from this location. 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 2009. There was a single detection for lead-214 (Pb-214) of 22.71 (±2SD 4.68) pCi/L in a sample collected from Upper Three Runs Creek at SC Highway 125 (SV-325) in August. 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 66 background samples collected from 2004-2009 and no detections for Co-60 and Am-241 for 2009 random samples (SCDHEC 2005-2009).

Alpha

Alpha-emitting radionuclides were detected at all locations where monthly composite samples were collected with the exception of Steel Creek Boat Landing (SV-2018) (Section 7.0, Summary Statistics). The sampling locations at SV-2047 and Lower Three Runs at SRS Rd. B (SV-2053) had one detection out of 12 samples (3.33 (±2SD 1.69) pCi/L and 2.49 (±2SD 1.45) pCi/L, respectively). Average activity for the other locations ranged from 4.31 (±3.83) pCi/L at SV-2039 to 23.18 (±19.48) pCi/L at SV-325. SV-325 had detections for 11 of 12 samples collected. Historically, SV-325 yields detections for alpha activity (SCDHEC 2000, 2001c, 2002-2009). Tims Branch, which flows into Upper Three Runs Creek, was the primary stream affected by M-Area releases (Till et al. 2001). This may account for the common occurrence of alpha detections at this location. The 2009 average alpha activity at SV-325 was well above the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) of 15 pCi/L (USEPA 2002). There is a high standard deviation associated with this average that indicates a broad range of alpha activity occurring in samples collected from this location during the year. During a five month period (June to October), alpha activities ranged from 30.3 (±4.16) pCi/L to 58.4 (±6.63) pCi/L. The increase in alpha detections may be explained by a sudden increase in turbidity at the sampling location. Samples collected at this location exhibited larger particles of sediment and detritus. This increase in turbidity could be related to storm events that occurred during this time frame. 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 2010). 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. To counteract the issue of turbidity, the sampling line at SV-325 was modified using two inch PVC pipe to prevent the strainer from sitting on the bottom of the creek. Samples collected during November and December had lower alpha activities than samples collected from June to October. This sampling location will be monitored during 2010 to ensure that turbidity is not a concern in collected samples.

Ambient monitoring average annual alpha trends for 2005-2009 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 2002) with the exception of SV-325. Average alpha activity in 2009 was higher than average activity in 2008 at all locations that had more than one detection. SV-2053 had only one detection in 2009 (2.49 (±2SD 1.45) pCi/L), which was lower than the 2008 average of 3.66 (±2.74) pCi/L.

Alpha-emitting radionuclides were detected in one random sample in 2009 (Section 6.0, Random Sample Alpha/Beta Data). This sample was a background sample collected in Richland County (RWB63) and yielded a detection of 1.81 (±2SD 1.13) pCi/L. This sample represents one detection out of 13 background samples collected. There were no detections for gross alpha in perimeter samples collected in 2009. For the entire sampling period of 2004-2009, there were only four detections out of 66 background samples and seven out of 49 perimeter samples (SCDHEC 2005-2009). The 2004-2009 alpha average for background and perimeter samples was 2.50 (±1.05) pCi/L and 3.92 (±2.28) pCi/L, respectively. The 2004-2009 background average is within one standard deviation of the 2004-2009 perimeter average and is slightly lower than the perimeter average. These few alpha detections could be attributed to unspecified NORM.

Beta

Beta-emitting radionuclide activity was detected in eight of nine locations where monthly composite samples were collected, with no detections at Beaver Dam Creek in D-Area (SV-2040) (Section 7.0, Summary Statistics). There was one location (SV-2047) that had only one detection out of 12 samples collected (4.58 (±1.51) pCi/L). For the other locations with multiple detections, the average activity ranged from 3.12 (±1.10) pCi/L at SV-2010 to 11.74 (±6.50) pCi/L at SV-325. The sampling location at SV-2039 yielded 11 detections out of 12 samples collected with an average of 5.16 (±1.51). Fourmile Branch was primarily affected by releases from the separations areas, so gross beta detections can be expected at this location. The high average recorded for SV-325 could be related to the same issues reported in the alpha section pertaining to this location.

Ambient monitoring average annual beta trends for 2005-2009 are shown in Section 5.0, Figure 3. The USEPA screening MCL for gross beta-emitting particles for drinking water systems is 50 pCi/L (USEPA 2002), and all averages were below this limit. Average beta activity in 2009 was lower than the 2008 average beta activity at all locations except SV-325. There was only one detection (5.38 (±1.29) pCi/L) at SV-118 in 2008. The 2009 average at this location was higher than the 2008 single detection. There were no detections at Beaver Dam Creek (SV-2040).

Beta-emitting radionuclides were detected in five random samples collected in 2009 (Section 6.0, Random Sample Alpha/Beta Data). One random perimeter sample collected in Orangeburg County (RWE48) yielded a detection of 2.62 (±2SD 1.33) pCi/L. Four background samples yielded an average of 3.71 (±2.41) pCi/L (Section 7.0, Summary Statistics, Beta Data for Random Samples) For the sampling period of 2004-2009, there were 13 detections out of 66 background samples collected and six detections out of 49 perimeter samples collected (SCDHEC 2005-2009). The 2004-2009 beta average for background and perimeter samples was 3.80 (±1.45) pCi/L and 5.35(±2.02) pCi/L, respectively. The 2004-2009 background average is within one standard deviation of the 2004-2009 perimeter average and is slightly lower than the perimeter average. These few beta detections could be attributed to unspecified NORM.

Iodine-129 and Technetium-99

Samples collected during the first quarter of 2009 had detections for I-129 (2.28 (±1.35) pCi/L) and Tc-99 (4.21 (±1.92) pCi/L) (Section 6.0). Samples collected from the other three quarters in 2009 were below detection limits.

SCDHEC/DOE-SR DATA COMPARISON

Data from 2009 reported in this project were compared to DOE-SR reported results (Section 5.0, 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 ESOP and DOE-SR colocated sampling sites were Upper Three Runs Creek and SC Highway 125, Fourmile Branch and United States Forestry Service (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 5.0, 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 (46,226 (±7,613) pCi/L and 45,208 (±7,512) pCi/L (SRNS 2009), respectively) and Pen Branch (37,750 (±12,315) pCi/L and 36,483 (±11,820) pCi/L (SRNS 2009), respectively) have the highest tritium activity of all SRS streams. The 2009 SCDHEC and DOE-SR tritium results appear to be consistent with historically reported data values (Section 5.0, Figures 4-9) (SCDHEC 2000-2007, WSRC 2000-2008, SRNS 2009).

Gamma

DOE-SR detected Cs-137 (9.30 (±2SD 3.45) at Pen Branch and reported a nondetection average of .256 (±.650) pCi/L (SRNS 2009) at this location. SCDHEC did not detect Cs-137 at this location. SCDHEC had one Cs-137 detection (4.85 (±2SD 2.20) pCi/L) at Fourmile Branch in November, 2009. DOE-SR had a nondetection average of 1.62 (±.625) at this location. The DOE-SR average is within two SD of the SCDHEC single detection.

Alpha

SCDHEC detected gross alpha activity at all of the colocated sample locations with DOE-SR (Section 5.0, Table 4). DOE-SR average gross alpha activities were within one SD of the SCDHEC average gross alpha activities at Upper Three Runs Creek, Fourmile Branch, and Steel Creek. The DOE-SR average gross alpha activity was within two SD of the SCDHEC average gross alpha activity at Highway 301. DOE-SR reported an average of 1.49 (±1.34) pCi/L at Pen Branch (SRNS 2009). SCDHEC had only one detection, 3.33 (±2SD 1.69) pCi/L, at this location. Additionally, DOE-SR reported an average of 0.77 (±0.70) pCi/L at Lower Three Runs (SRNS 2009). SCDHEC had only one detection, 2.49 (±2SD 1.45) pCi/L, at this location. The DOE-SR average was within 2SD of the SCDHEC single detection at both locations. SCDHEC and DOE-SR samples collected from Upper Three Runs Creek at SC Highway 125 exhibited the highest gross alpha average concentration (23.18 (±19.48) pCi/L and 8.96 (±4.96) pCi/L (SRNS 2009), respectively).

Beta

SCDHEC and DOE-SR detected gross beta activity at all of the colocated sampling locations (Section 5.0, Table 5). DOE-SR average gross beta activities were within one SD of SCDHEC average gross beta activities at Upper Three Runs Creek, Pen Branch, and Highway 301 Bridge. DOE-SR average beta activities were within two SD of SCDHEC average beta activities at Fourmile Branch and Lower Three Runs. The DOE-SR average beta activity was within three SD of the SCDHEC average beta activity at Steel Creek. DOE-SR reported a monthly average, 3.07 (±4.70) pCi/L (SRNS 2009), at Pen Branch. SCDHEC had only one detection, 4.58 (±2SD 1.51), at this location. The DOE-SR average was within one SD of the SCDHEC single detection at Pen Branch. DOE-SR samples collected from Fourmile Branch exhibited the highest gross beta average activities, 7.78 (±0.86) pCi/L (SRNS 2009). SCDHEC samples collected from Highway 301 had the highest average beta activity, 8.31 (±6.86) pCi/L. However, this average is highly influenced by a single detection of 21.2 pCi/L. Removing this value gives an average of 5.73 (±3.01) pCi/L, which is closer to historical values (Section 5.0, Figure 3). Furthermore, this would make the SCDHEC Fourmile Branch average the highest reported average. SCDHEC and DOE-SR collectively reports Fourmile Branch as having the highest beta activity average over the past five years (SCDHEC 2005, 2006, 2007, 2008, 2010). It should be noted that it is difficult to compare gross beta analyses due to the unknown nature of the contributing betas in collected samples.

CONCLUSIONS AND RECOMMENDATIONS

All tritium results for the public access locations downstream from SRS were below the EPA MCL annual average of 20,000 pCi/L for drinking water (USEPA 2002). 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 yields 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. The single Cs-137 detection within the particular sample from Fourmile Branch at USFS Rd. 13.2 (SV-2039) may be attributed to sediment disturbance due to storm events. Also, a comparison of gross alpha data identified DOE-SR results within one SD of SCDHEC results at three locations (Upper Three Runs Creek, Fourmile Branch, and Steel Creek) and within two SDs at three locations (Pen Branch, Highway 301, and Lower Three Runs Creek). ESOP only had one detection for gross alpha at Pen Branch and Lower Three Runs Creek. DOE-SR gross beta average activities were within one SD at three locations (Upper Three Runs Creek, Pen Branch, and Highway 301). DOE-SR average beta activities were within two SD at two locations (Fourmile Branch and Lower Three Runs) and three SD at one location (Steel Creek). 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 only had one detection for gross beta at Pen Branch. ESOP had 11 detections out of 12 samples and DOE-SR had 12 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.

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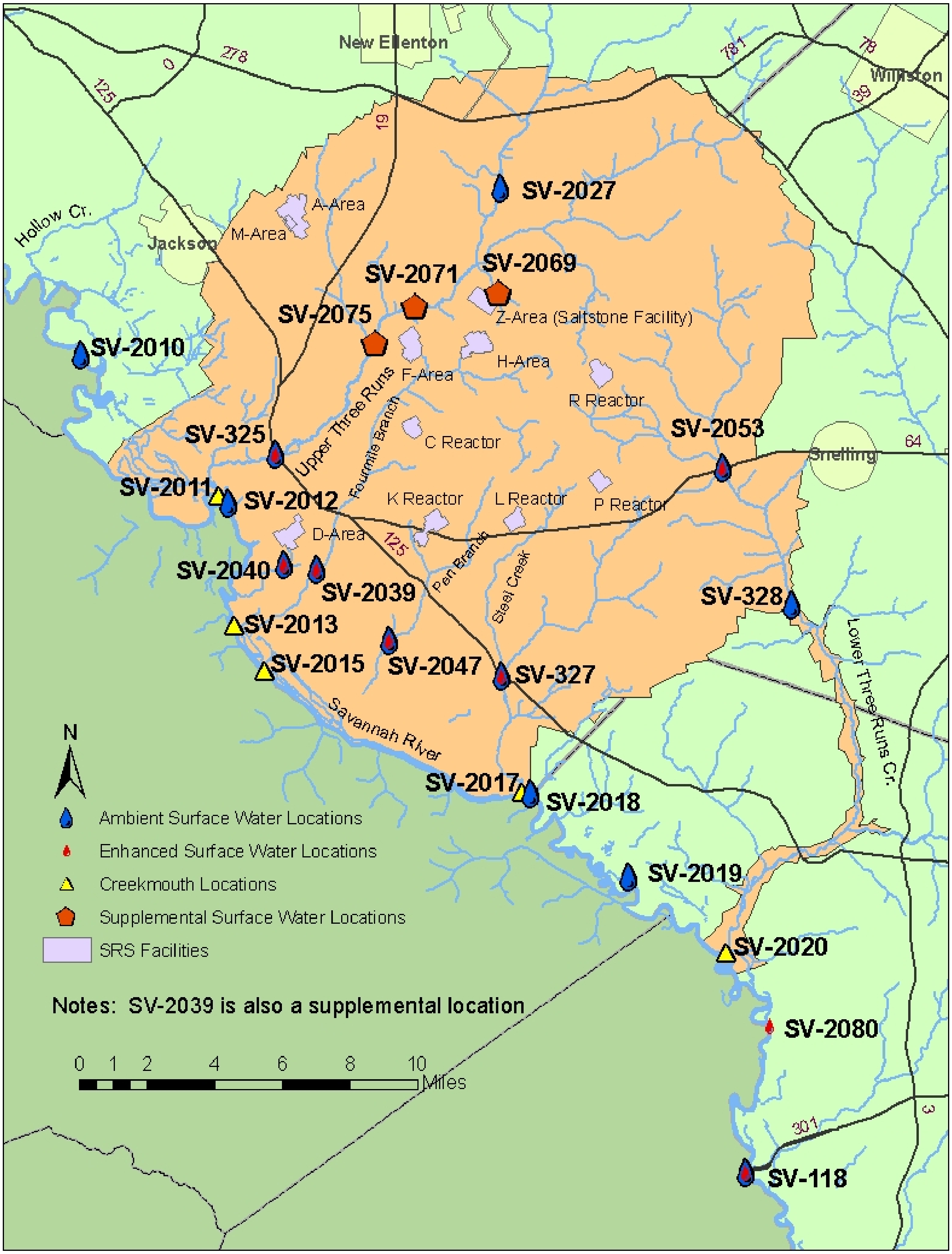
2.3.2 Radiological Monitoring of Surface Water on and Adjacent to the SRS

Map 5. Surface Water Sampling Locations for 2009



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2.3.3 Tables and Figures

Radiological Monitoring of Surface Water on and Adjacent to the SRS

Table 1. 2009 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 (Jackson 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. 2008 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)	1,348	628	1,302	393	3,087	52	49
U3R-4 at Road A	1,241	448	NA	641	2,290	12	12
Fourmile Branch (SV-2039)	46,226	7,613	46,417	25,532	61,849	52	52
FM-6 at Road A-12.2	45,208	7,512	NA	33,500	59,500	12	12
Pen Branch (SV-2047)	37,750	12,315	35,279	13,502	57,145	52	52
PB-3 at Road 13.2	36,483	11,820	NA	20,000	54,600	12	12
Steel Creek (SV-327)	2,935	825	3,019	1,556	4,382	52	52
SC-4 Steel Creek at Road A	2,688	835	NA	1,320	3,810	12	12
Highway 301 Bridge (SV-118)	593	409	443	204	1,991	52	39
River Mile 118.8	492	305	NA	114	405	52	51
Lower Three Runs Creek at Patterson Mill Rd. (SV-328)	2,259	976	1,990	302	4,183	52	52
L3R-2 at Patterson Mill Rd	2,338	812	NA	1,080	3,970	12	12
Lower Three Runs Creek (SV-2053)	326	60	325	216	458	52	44
L3R-1A at Road B	316	197	NA	37	668	12	5

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. 2008 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)	23.18	19.48	15.4	4.48	58.4	12	11
U3R-4 at Road A	8.96	4.96	NA	3.00	18.5	12	12
Fourmile Branch (SV-2039)	4.31	3.83	2.14	2.06	8.74	12	3
FM-6 at Road A-12.2	0.64	0.70	NA	0.04	2.51	12	12
Pen Branch (SV-2047)	**3.33***	**1.69***	NA	NA	NA	12	1
PB-3 at Road 13.2	1.49	1.34	NA	0.25	4.35	12	5
Steel Creek (SV-327)	4.56	1.79	3.58	2.81	6.93	12	5
SC-4 Steel Creek at Road A	3.71	5.28	NA	0.81	19.6	12	12
Highway 301 Bridge (SV-118)	6.95	3.99	6.09	3.45	11.3	12	3
River Mile 118.8	0.30	0.36	NA	-0.17	1.14	52	3
Lower Three Runs Creek (SV-2053)	**2.49***	**1.45***	NA	NA	NA	12	1
L3R-1A at Road B	0.77	0.70	NA	0.05	2.6	12	3

Table 5. 2008 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)	3.12	1.10	3.12	2.34	3.90	12	2
U3R-4 at Road A	3.63	1.91	NA	1.29	7.84	12	7
Fourmile Branch (SV-2039)	5.16	1.51	5.11	3.24	8.36	12	11
FM-6 at Road A-12.2	7.78	0.86	NA	6.24	8.95	12	12
Pen Branch (SV-2047)	**4.58***	**1.51***	NA	NA	NA	12	1
PB-3 at Road 13.2	3.07	4.70	NA	0.13	18	12	7
Steel Creek (SV-327)	3.65	0.47	3.65	3.31	3.98	12	2
SC-4 Steel Creek at Road A	2.52	2.89	NA	0.78	11.2	12	11
Highway 301 Bridge (SV-118)	8.31	6.86	7.06	2.57	21.2	12	6
River Mile 118.8	2.41	0.75	NA	1.66	4.38	52	48
Lower Three Runs Creek (SV-2053)	2.52	0.12	2.52	2.43	2.60	12	2
L3R-1A at Road B	2.30	0.75	NA	0.68	3.46	12	11

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. 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

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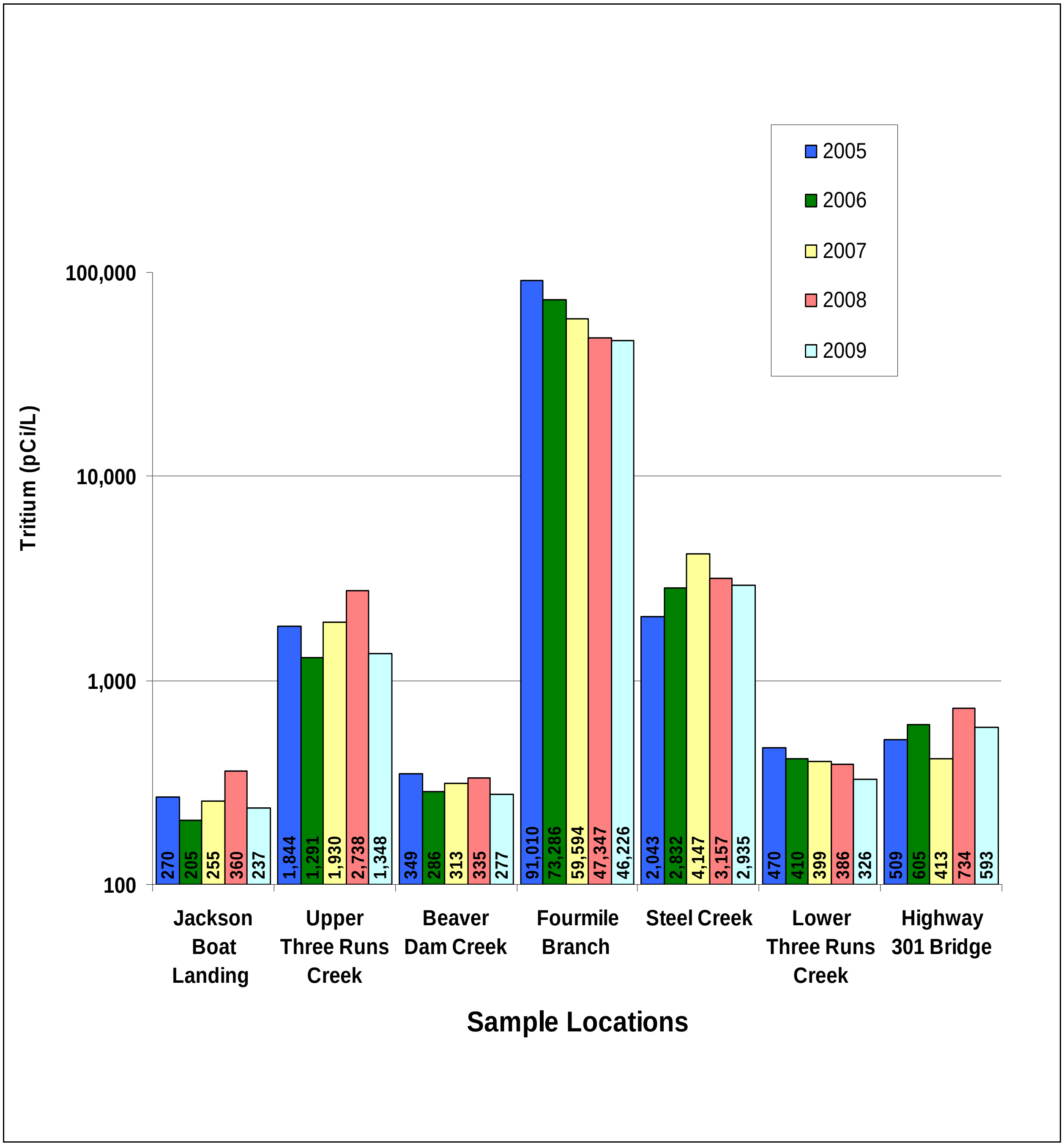
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 1. SCDHEC Average Tritium Trends for 2005-2009 (SCDHEC 2006-2009).



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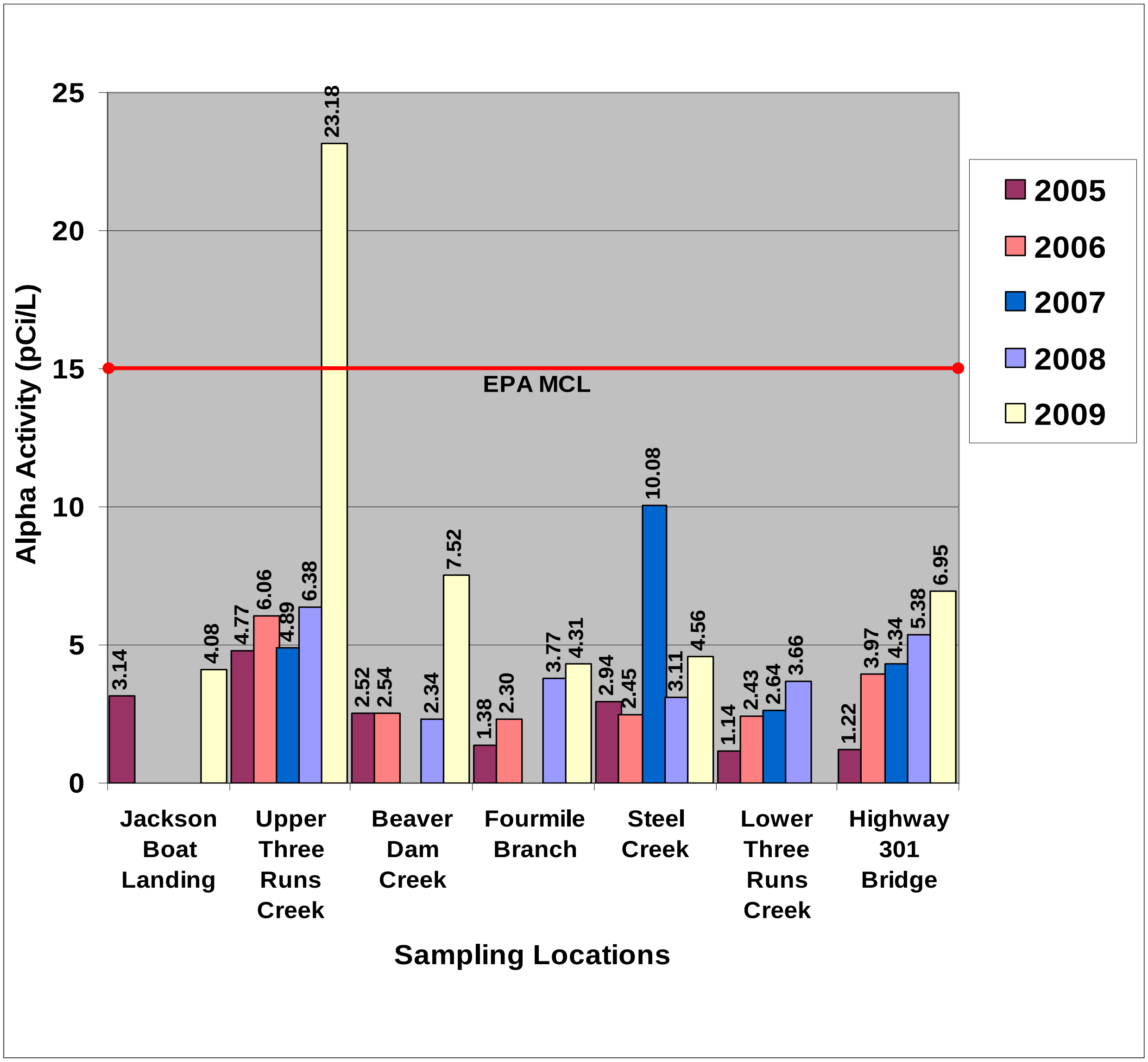
Radiological Monitoring of Surface Water On and Adjacent to the SRS

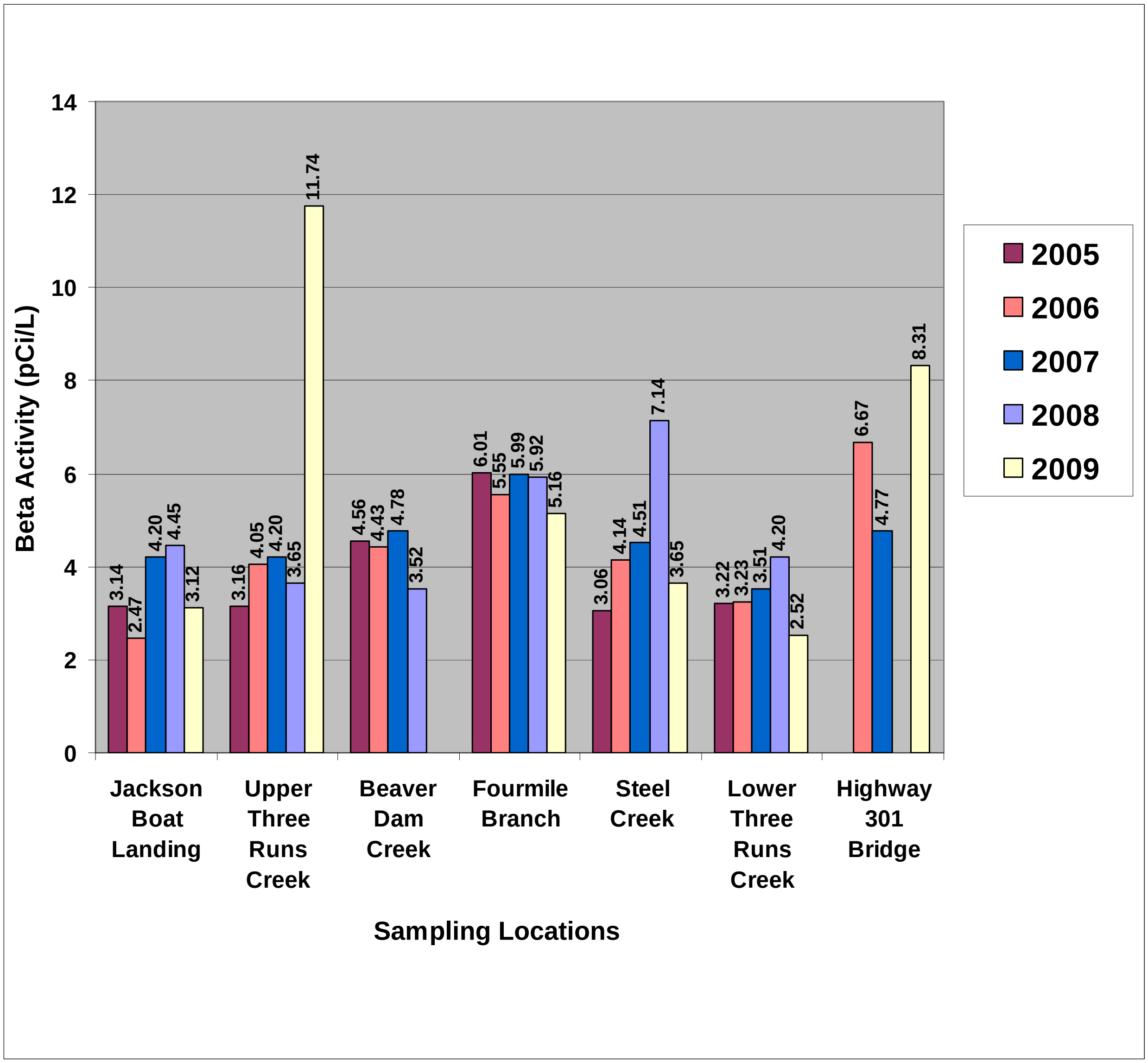
Figure 2. SCDHEC 2005-2009 Average Alpha Data (SCDHEC 2006-2009)



Notes:
1. No detections at Jackson Landing in 2006, 2007, and 2008
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

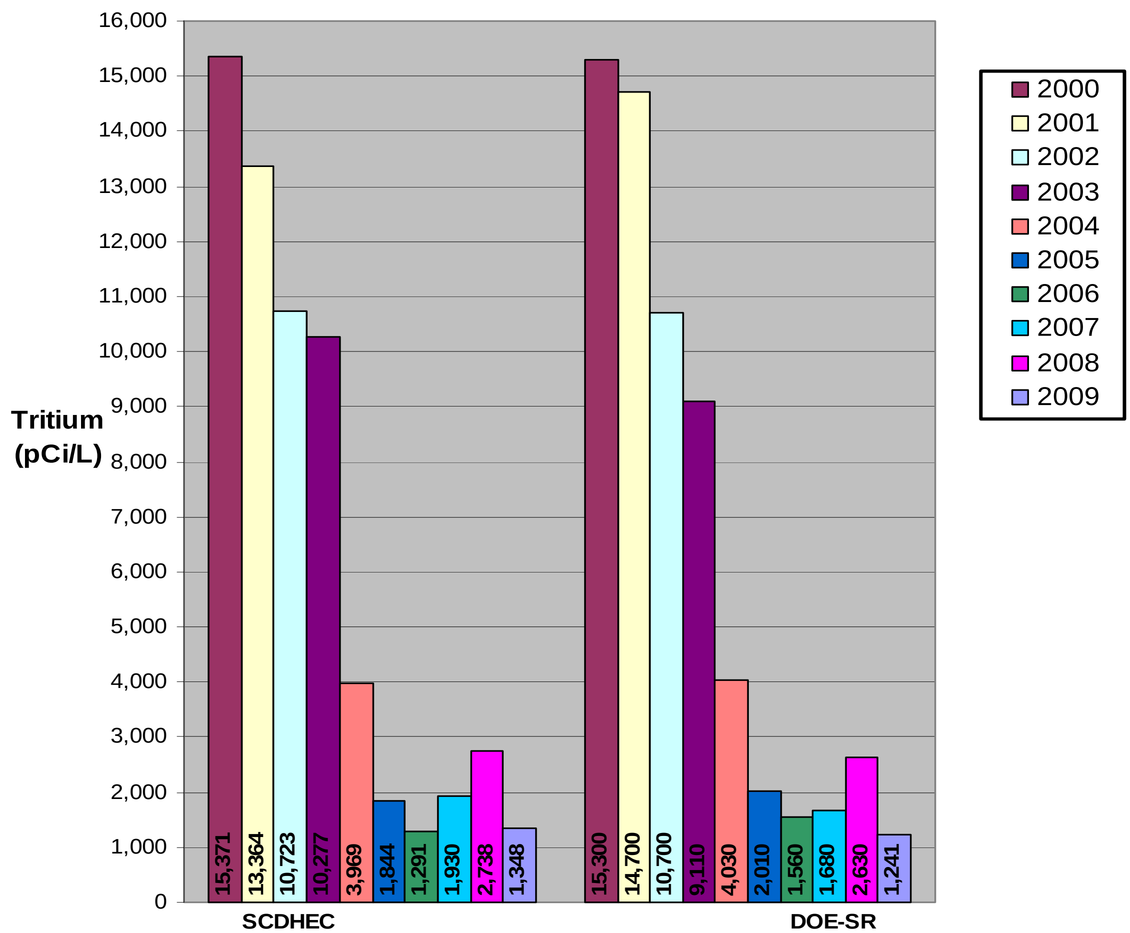
Figure 3. SCDHEC 2005-2009 Average Beta Data (SCDHEC 2006-2009)



Notes:
1. The EPA screening level MCL for gross beta particles is 50 pCi/L
2. No detections at Highway 301 in 2005 and 2008
3. No detections at Beaver Dam Creek in 2009

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

Figure 4. Average Tritium Data Trends For SCDHEC and DOE-SR at Upper Three Runs Creek and SC Highway 125 (WSRC 2000-2008, SRNS 2009, SCDHEC 2000-2008).



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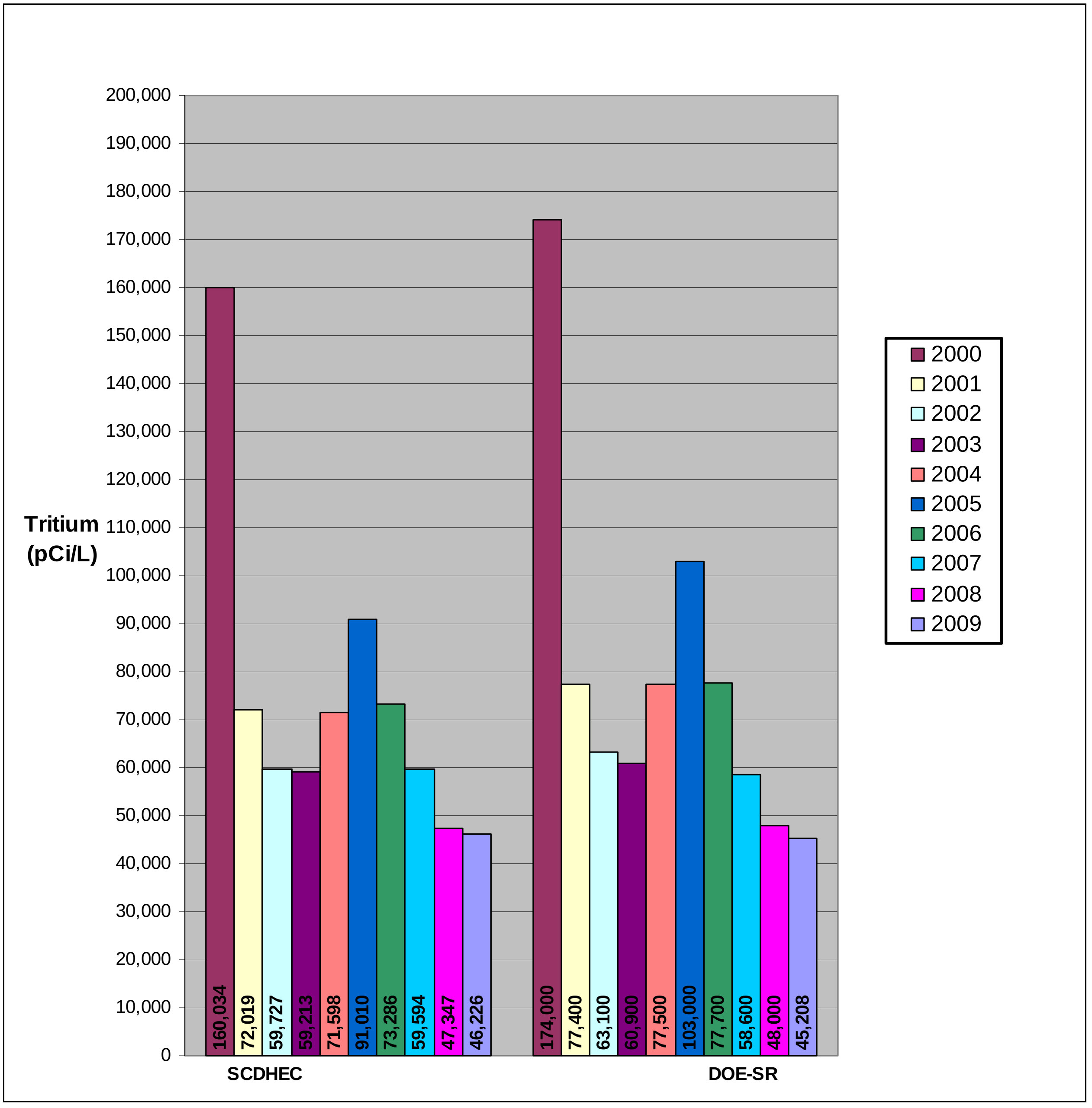
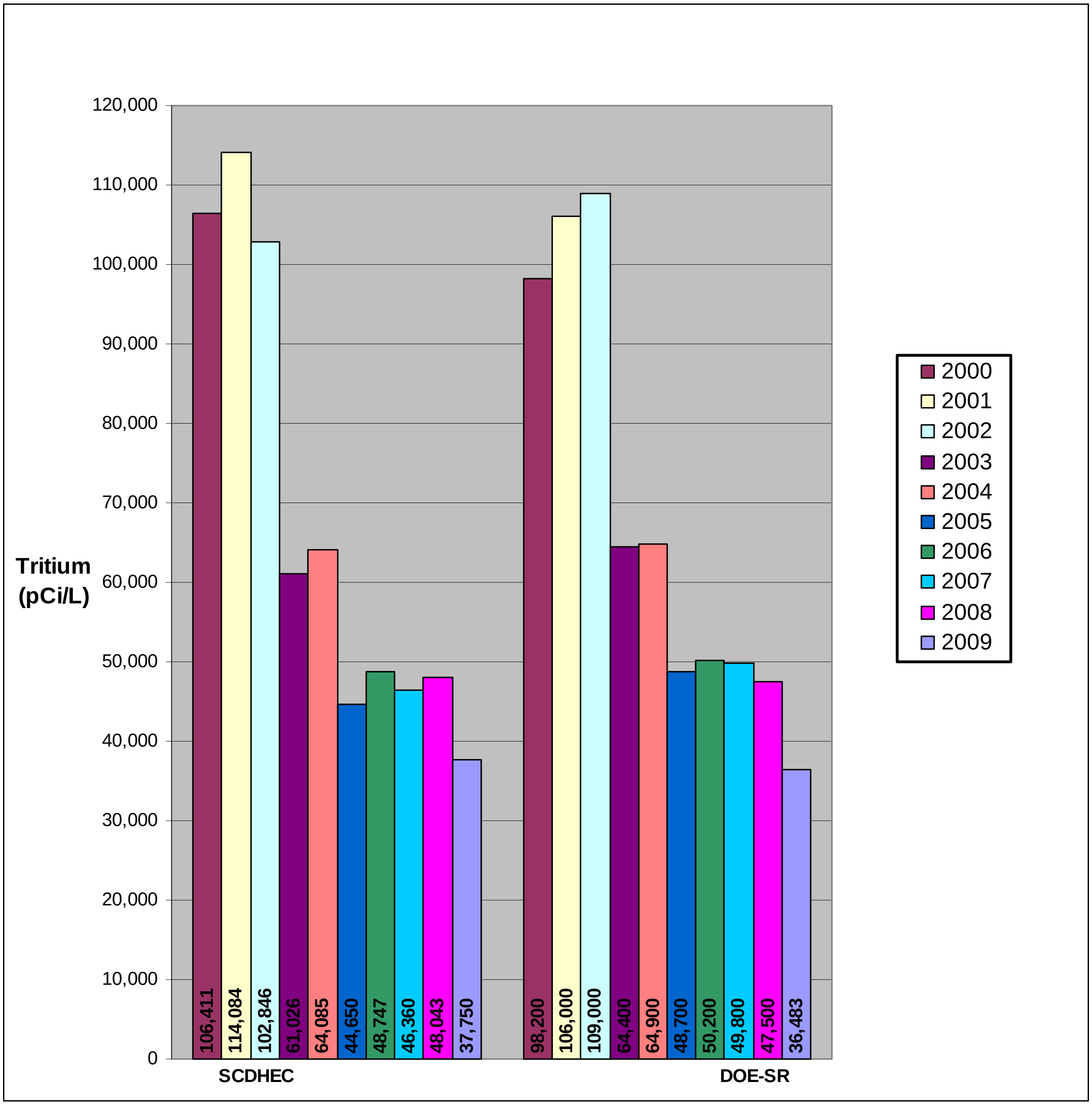
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 5. Average Tritium Data Trends For SCDHEC and DOE-SR at Fourmile Branch and USFS Road 12.2 (WSRC 2000-2008, SRNS 2009, SCDHEC 2000-2008).



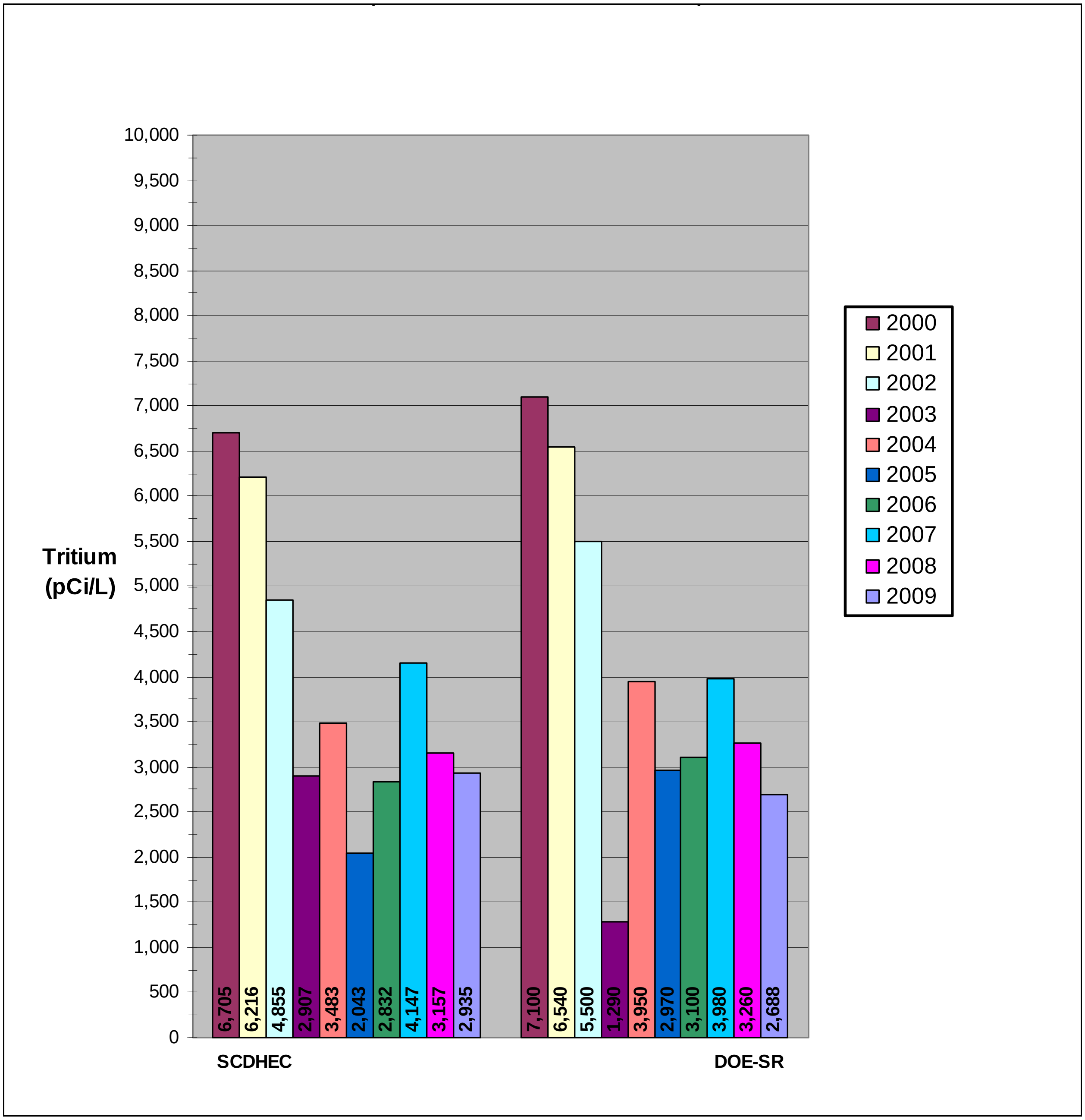
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 6. Average Tritium Data Trends For SCDHEC and DOE-SR at Pen Branch and USFS Road 13.2 (WSRC 2000-2008, SRNS 2009, SCDHEC 2000-2008).



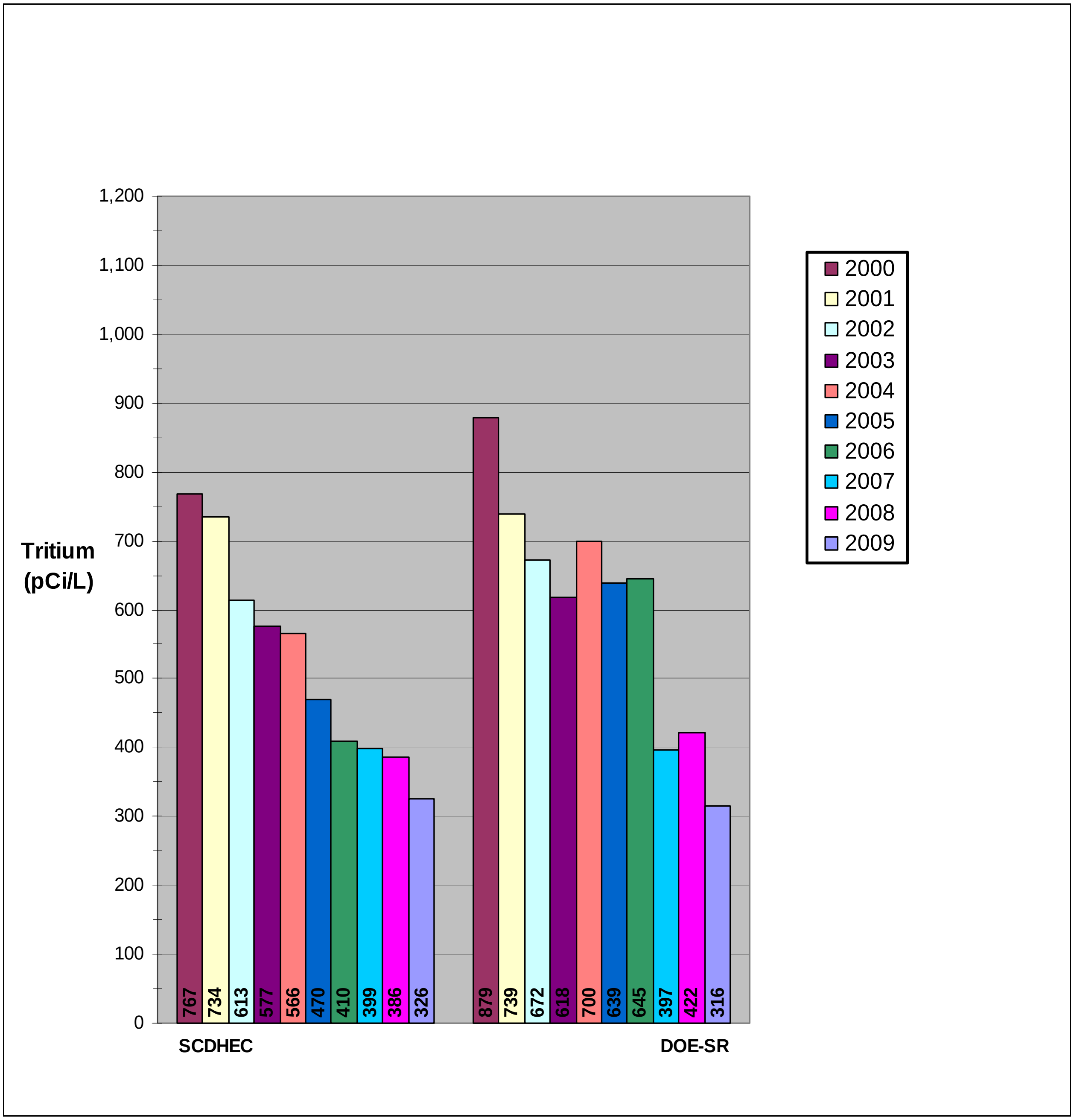
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 7. Average Tritium Data Trends For SCDHEC and DOE-SR at Steel Creek and SC Highway 125 (WSRC 2000-2008, SRNS 2009, SCDHEC 2000-2008).



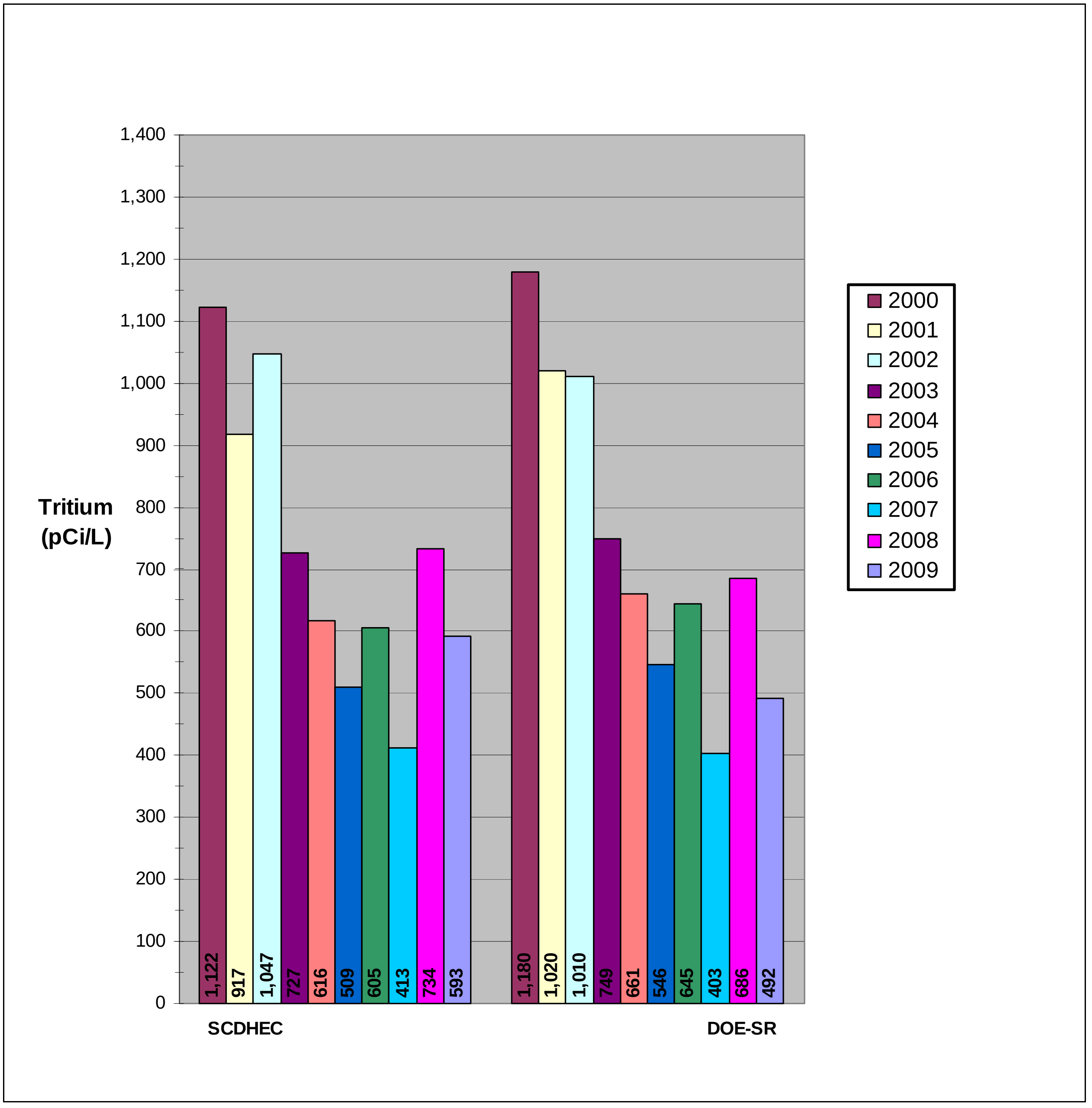
Tables and Figures
Radiological Monitoring of Surface Water On and Adjacent to the SRS

Figure 8. Average Tritium Data Trends For SCDHEC and DOE-SR at Lower Three Runs Creek and SRS Road B (WSRC 2000-2008, SRNS 2009 SCDHEC 2000-2008).



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

Figure 9. Average Tritium Data Trends For SCDHEC and DOE-SR at the Savannah River and US Highway 301 Bridge (WSRC 2000-2008, SRNS 2009, SCDHEC 2000-2008).



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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 (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	<LLD	NA	186
	1/14/2009	**174**	**82**	**173**
	1/21/2009	<LLD	NA	197
	1/28/2009	**237**	**88**	**182**
February	2/4/2009	<LLD	NA	203
	2/11/2009	<LLD	NA	190
	2/18/2009	**201**	**88**	**188**
	2/25/2009	**234**	**89**	**183**
March	3/4/2009	<LLD	NA	198
	3/11/2009	<LLD	NA	193
	3/18/2009	<LLD	NA	185
	3/25/2009	<LLD	NA	185
April	4/1/2009	<LLD	NA	180
	4/8/2009	<LLD	NA	188
	4/15/2009	**223**	**91**	**191**
	4/22/2009	<LLD	NA	186
	4/29/2009	<LLD	NA	188
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	<LLD	NA	202
	5/27/2009	<LLD	NA	181
June	6/3/2009	<LLD	NA	194
	6/10/2009	<LLD	NA	184
	6/17/2009	<LLD	NA	188
	6/24/2009	<LLD	NA	198
July	7/1/2009	**206**	**87**	**183**
	7/8/2009	<LLD	NA	183
	7/15/2009	<LLD	NA	183
	7/22/2009	<LLD	NA	183
	7/29/2009	<LLD	NA	178
August	8/5/2009	<LLD	NA	174
	8/12/2009	**234**	**88**	**183**
	8/19/2009	<LLD	NA	182
	8/26/2009	<LLD	NA	179
September	9/3/2009	**341**	**87**	**167**
	9/9/2009	**197**	**84**	**178**
	9/16/2009	<LLD	NA	190
	9/23/2009	<LLD	NA	179
	9/30/2009	**286**	**87**	**174**
October	10/7/2009	**241**	**87**	**179**
	10/14/2009	<LLD	NA	185
	10/21/2009	<LLD	NA	185
	10/28/2009	<LLD	NA	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	<LLD	NA	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	**208**	**89**	**189**
	12/9/2009	<LLD	NA	199
	12/16/2009	**348**	**97**	**180**
	12/23/2009	**239**	**95**	**190**
	12/30/2009	**187**	**92**	**186**

SV-325 Upper Three Runs and SC Highway 125

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	**545**	**103**	**186**
	1/14/2009	**1021**	**116**	**173**
	1/21/2009	**2169**	**155**	**197**
	1/28/2009	**1251**	**126**	**182**
February	2/4/2009	**1210**	**130**	**203**
	2/11/2009	**1591**	**138**	**190**
	2/18/2009	**824**	**113**	**188**
	2/25/2009	**1682**	**139**	**183**
March	3/4/2009	**1913**	**148**	**198**
	3/11/2009	**2560**	**163**	**193**
	3/18/2009	**1682**	**139**	**185**
	3/25/2009	**2514**	**161**	**185**
April	4/1/2009	**1551**	**134**	**180**
	4/8/2009	**2071**	**151**	**188**
	4/15/2009	**2059**	**151**	**191**
	4/22/2009	**2037**	**149**	**186**
	4/29/2009	**1437**	**131**	**188**
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	**792**	**116**	**202**
	5/27/2009	**771**	**109**	**181**
June	6/3/2009	**1397**	**132**	**194**
	6/10/2009	**1712**	**139**	**184**
	6/17/2009	**2057**	**149**	**188**
	6/24/2009	**699**	**111**	**198**
July	7/1/2009	**1715**	**139**	**183**
	7/8/2009	**1988**	**147**	**183**
	7/15/2009	**1886**	**145**	**183**
	7/22/2009	**3087**	**174**	**183**
	7/29/2009	**1460**	**130**	**178**
August	8/5/2009	**648**	**102**	**174**
	8/12/2009	**514**	**100**	**183**
	8/19/2009	**393**	**94**	**182**
	8/26/2009	**565**	**106**	**179**
September	9/3/2009	**1352**	**125**	**167**
	9/9/2009	**1885**	**143**	**178**
	9/16/2009	**1590**	**136**	**190**
	9/23/2009	**1086**	**119**	**179**
	9/30/2009	**759**	**106**	**174**
October	10/7/2009	**1079**	**119**	**179**
	10/14/2009	**991**	**118**	**185**
	10/21/2009	**826**	**113**	**185**
	10/28/2009	**997**	**117**	**184**
November	11/4/2009	<LLD	NA	292
	11/11/2009	**648**	**113**	**206**
	11/18/2009	**564**	**105**	**194**
	11/25/2009	**596**	**109**	**199**
December	12/2/2009	**993**	**120**	**189**
	12/9/2009	**1830**	**148**	**199**
	12/16/2009	**1302**	**128**	**180**
	12/23/2009	**672**	**109**	**190**
	12/30/2009	**1058**	**123**	**186**

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 (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	206	88	186
	1/14/2009	389	92	173
	1/21/2009	<LLD	NA	197
	1/28/2009	254	89	182
February	2/4/2009	<LLD	NA	203
	2/11/2009	<LLD	NA	190
	2/18/2009	336	94	188
	2/25/2009	326	93	183
March	3/4/2009	289	96	198
	3/11/2009	249	93	193
	3/18/2009	198	87	185
	3/25/2009	303	92	185
April	4/1/2009	277	90	180
	4/8/2009	305	94	188
	4/15/2009	<LLD	NA	191
	4/22/2009	650	106	186
	4/29/2009	<LLD	NA	188
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	<LLD	NA	202
	5/27/2009	<LLD	NA	181
June	6/3/2009	<LLD	NA	194
	6/10/2009	194	87	184
	6/17/2009	283	92	188
	6/24/2009	<LLD	NA	198
July	7/1/2009	<LLD	NA	183
	7/8/2009	<LLD	NA	183
	7/15/2009	<LLD	NA	183
	7/22/2009	<LLD	NA	183
	7/29/2009	218	85	178
August	8/5/2009	277	87	174
	8/12/2009	219	87	183
	8/19/2009	<LLD	NA	182
	8/26/2009	<LLD	NA	179
September	9/3/2009	231	82	167
	9/9/2009	207	85	178
	9/16/2009	<LLD	NA	190
	9/23/2009	186	84	179
	9/30/2009	194	83	174
October	10/7/2009	234	86	179
	10/14/2009	269	90	185
	10/21/2009	<LLD	NA	185
	10/28/2009	236	88	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	292	100	206
	11/18/2009	<LLD	NA	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	236	90	189
	12/9/2009	343	99	199
	12/16/2009	270	89	180
	12/23/2009	<LLD	NA	190
	12/30/2009	230	89	186

SV-2040 Beaver Dam Creek D-Area

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	379	96	186
	1/14/2009	274	86	173
	1/21/2009	<LLD	NA	197
	1/28/2009	317	91	182
February	2/4/2009	<LLD	NA	203
	2/11/2009	273	92	190
	2/18/2009	268	91	188
	2/25/2009	301	91	183
March	3/4/2009	<LLD	NA	198
	3/11/2009	294	95	193
	3/18/2009	<LLD	NA	185
	3/25/2009	379	95	185
April	4/1/2009	251	88	180
	4/8/2009	256	91	188
	4/15/2009	<LLD	NA	191
	4/22/2009	209	88	186
	4/29/2009	228	89	188
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	<LLD	NA	202
	5/27/2009	<LLD	NA	181
June	6/3/2009	<LLD	NA	194
	6/10/2009	408	95	184
	6/17/2009	<LLD	NA	188
	6/24/2009	<LLD	NA	198
July	7/1/2009	251	89	183
	7/8/2009	236	88	183
	7/15/2009	<LLD	NA	183
	7/22/2009	<LLD	NA	183
	7/29/2009	330	90	178
August	8/5/2009	<LLD	NA	174
	8/12/2009	<LLD	NA	183
	8/19/2009	<LLD	NA	182
	8/26/2009	218	86	179
September	9/3/2009	228	82	167
	9/9/2009	212	85	178
	9/16/2009	197	89	190
	9/23/2009	<LLD	NA	179
	9/30/2009	212	84	174
October	10/7/2009	295	89	179
	10/14/2009	350	94	185
	10/21/2009	<LLD	NA	185
	10/28/2009	301	92	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	<LLD	NA	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	289	93	189
	12/9/2009	204	93	199
	12/16/2009	349	92	180
	12/23/2009	<LLD	NA	190
	12/30/2009	259	91	186

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

SV-2039 Fourmile Branch at USFS Rd. 13.2

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	57804	680	186
	1/14/2009	54761	662	173
	1/21/2009	57773	679	197
	1/28/2009	55983	667	182
February	2/4/2009	59343	691	203
	2/11/2009	61307	701	190
	2/18/2009	61849	705	188
	2/25/2009	59188	690	183
March	3/4/2009	47544	617	198
	3/11/2009	50771	630	193
	3/18/2009	51950	640	185
	3/25/2009	52862	647	185
April	4/1/2009	49701	627	180
	4/8/2009	36220	540	188
	4/15/2009	41128	573	191
	4/22/2009	42733	580	186
	4/29/2009	52192	637	188
May	5/6/2009	50011	631	248
	5/13/2009	41185	573	210
	5/20/2009	45949	603	202
	5/27/2009	39787	557	181
June	6/3/2009	46610	607	194
	6/10/2009	43122	584	184
	6/17/2009	46940	608	188
	6/24/2009	46639	608	198
July	7/1/2009	46223	604	184
	7/8/2009	41038	573	183
	7/15/2009	41446	576	183
	7/22/2009	47004	612	183
	7/29/2009	45516	600	178
August	8/5/2009	42261	580	174
	8/12/2009	37362	547	183
	8/19/2009	36715	543	182
	8/26/2009	40825	569	179
September	9/3/2009	43590	588	167
	9/9/2009	44580	591	178
	9/16/2009	41684	574	190
	9/23/2009	35241	533	179
	9/30/2009	39251	561	174
October	10/7/2009	42549	583	179
	10/14/2009	49654	630	185
	10/21/2009	41962	582	185
	10/28/2009	49815	626	184
November	11/4/2009	53781	665	292
	11/11/2009	49589	633	206
	11/18/2009	47664	618	194
	11/25/2009	47438	619	199
December	12/2/2009	50169	634	189
	12/9/2009	39233	565	199
	12/16/2009	35845	542	180
	12/23/2009	34441	529	190
	12/30/2009	25532	458	186

SV-2047 Pen Branch at USFS Rd. 13.2

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	33642	514	177
	1/14/2009	33167	519	173
	1/21/2009	34880	531	197
	1/28/2009	32924	513	182
February	2/4/2009	35540	536	203
	2/11/2009	36677	544	190
	2/18/2009	35018	528	188
	2/25/2009	35765	536	183
March	3/4/2009	30471	498	198
	3/11/2009	32490	508	193
	3/18/2009	30199	491	185
	3/25/2009	32420	509	185
April	4/1/2009	29919	491	180
	4/8/2009	19181	399	188
	4/15/2009	21148	417	191
	4/22/2009	25732	456	186
	4/29/2009	32530	505	188
May	5/6/2009	31536	506	248
	5/13/2009	23736	442	210
	5/20/2009	23885	441	202
	5/27/2009	25612	454	181
June	6/3/2009	31004	499	194
	6/10/2009	30913	497	184
	6/17/2009	36545	537	188
	6/24/2009	13502	334	198
July	7/1/2009	24500	440	183
	7/8/2009	38649	556	183
	7/15/2009	43716	589	183
	7/22/2009	49272	625	183
	7/29/2009	47305	611	178
August	8/5/2009	51126	633	174
	8/12/2009	43209	587	183
	8/19/2009	47824	611	182
	8/26/2009	52392	644	179
September	9/3/2009	56166	666	167
	9/9/2009	54824	657	178
	9/16/2009	56910	669	190
	9/23/2009	45679	595	179
	9/30/2009	51912	641	174
October	10/7/2009	56298	668	179
	10/14/2009	57145	673	185
	10/21/2009	52643	648	185
	10/28/2009	56315	664	184
November	11/4/2009	52625	654	292
	11/11/2009	53732	658	206
	11/18/2009	51674	641	194
	11/25/2009	42399	583	199
December	12/2/2009	42814	588	189
	12/9/2009	27456	475	199
	12/16/2009	22671	433	180
	12/23/2009	19295	401	190
	12/30/2009	16013	368	186

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 (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	**2208**	**154**	**186**
	1/14/2009	**2025**	**146**	**173**
	1/21/2009	**2256**	**157**	**197**
	1/28/2009	**1892**	**144**	**182**
February	2/4/2009	**2010**	**152**	**203**
	2/11/2009	**2460**	**161**	**190**
	2/18/2009	**2439**	**160**	**188**
	2/25/2009	**2376**	**158**	**183**
March	3/4/2009	**1922**	**148**	**198**
	3/11/2009	**2175**	**152**	**193**
	3/18/2009	**1853**	**143**	**185**
	3/25/2009	**1875**	**144**	**185**
April	4/1/2009	**1917**	**144**	**180**
	4/8/2009	**1556**	**136**	**188**
	4/15/2009	**2843**	**169**	**191**
	4/22/2009	**3250**	**177**	**186**
	4/29/2009	**4013**	**192**	**188**
May	5/6/2009	**2462**	**174**	**248**
	5/13/2009	**2247**	**160**	**210**
	5/20/2009	**2099**	**154**	**202**
	5/27/2009	**3423**	**180**	**181**
June	6/3/2009	**3979**	**194**	**194**
	6/10/2009	**2835**	**167**	**184**
	6/17/2009	**3650**	**185**	**188**
	6/24/2009	**3255**	**180**	**198**
July	7/1/2009	**4037**	**192**	**183**
	7/8/2009	**3952**	**191**	**183**
	7/15/2009	**3732**	**187**	**183**
	7/22/2009	**4205**	**197**	**183**
	7/29/2009	**4073**	**193**	**178**
August	8/5/2009	**3123**	**172**	**174**
	8/12/2009	**3668**	**186**	**183**
	8/19/2009	**3383**	**179**	**182**
	8/26/2009	**4033**	**192**	**179**
September	9/3/2009	**4002**	**190**	**167**
	9/9/2009	**4382**	**198**	**178**
	9/16/2009	**4211**	**201**	**190**
	9/23/2009	**3467**	**179**	**179**
	9/30/2009	**3651**	**184**	**174**
October	10/7/2009	**3576**	**183**	**179**
	10/14/2009	**3369**	**180**	**185**
	10/21/2009	**3221**	**179**	**185**
	10/28/2009	**3523**	**182**	**184**
November	11/4/2009	**1858**	**174**	**292**
	11/11/2009	**3090**	**179**	**206**
	11/18/2009	**2997**	**173**	**194**
	11/25/2009	**2599**	**165**	**199**
December	12/2/2009	**3042**	**173**	**189**
	12/9/2009	**1989**	**151**	**199**
	12/16/2009	**2278**	**154**	**180**
	12/23/2009	**2273**	**157**	**190**
	12/30/2009	**1844**	**144**	**186**

SV-2018 Steel Creek Boat Landing

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	**810**	**112**	**186**
	1/14/2009	**542**	**98**	**173**
	1/21/2009	**1007**	**122**	**197**
	1/28/2009	**696**	**105**	**182**
February	2/4/2009	**704**	**113**	**203**
	2/11/2009	**1369**	**131**	**190**
	2/18/2009	**596**	**105**	**188**
	2/25/2009	**515**	**101**	**183**
March	3/4/2009	<LLD	NA	198
	3/11/2009	**870**	**116**	**193**
	3/18/2009	<LLD	NA	185
	3/25/2009	**865**	**114**	**185**
April	4/1/2009	**1395**	**133**	**180**
	4/8/2009	**1095**	**124**	**188**
	4/15/2009	**818**	**114**	**191**
	4/22/2009	**592**	**104**	**186**
	4/29/2009	**476**	**99**	**188**
May	5/6/2009	**264**	**115**	**248**
	5/13/2009	**525**	**110**	**210**
	5/20/2009	**324**	**99**	**202**
	5/27/2009	**1196**	**123**	**181**
June	6/3/2009	**970**	**120**	**194**
	6/10/2009	**581**	**103**	**184**
	6/17/2009	**346**	**94**	**188**
	6/24/2009	**348**	**99**	**198**
July	7/1/2009	**426**	**96**	**183**
	7/8/2009	**348**	**93**	**183**
	7/15/2009	**297**	**91**	**183**
	7/22/2009	**277**	**90**	**183**
	7/29/2009	<LLD	NA	178
August	8/5/2009	<LLD	NA	174
	8/12/2009	<LLD	NA	183
	8/19/2009	**207**	**86**	**182**
	8/26/2009	**1914**	**144**	**179**
September	9/3/2009	**1012**	**113**	**167**
	9/9/2009	**571**	**100**	**178**
	9/16/2009	**5768**	**227**	**190**
	9/23/2009	**441**	**95**	**179**
	9/30/2009	**385**	**91**	**174**
October	10/7/2009	**306**	**89**	**179**
	10/14/2009	**357**	**94**	**185**
	10/21/2009	**295**	**93**	**185**
	10/28/2009	**348**	**93**	**184**
November	11/4/2009	<LLD	NA	292
	11/11/2009	**256**	**98**	**206**
	11/18/2009	**287**	**94**	**194**
	11/25/2009	**4807**	**214**	**199**
December	12/2/2009	**1159**	**125**	**189**
	12/9/2009	**2246**	**158**	**199**
	12/16/2009	**7153**	**251**	**180**
	12/23/2009	**6545**	**243**	**190**
	12/30/2009	**5122**	**219**	**186**

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

SV-2019 Little Hell Landing

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	**276**	**91**	**186**
	1/14/2009	<LLD	NA	173
	1/21/2009	**233**	**94**	**197**
	1/28/2009	**206**	**86**	**182**
February	2/4/2009	<LLD	NA	203
	2/11/2009	<LLD	NA	190
	2/18/2009	<LLD	NA	188
	2/25/2009	<LLD	NA	183
March	3/4/2009	<LLD	NA	198
	3/11/2009	<LLD	NA	193
	3/18/2009	**1207**	**125**	**185**
	3/25/2009	**369**	**95**	**185**
April	4/1/2009	<LLD	NA	180
	4/8/2009	<LLD	NA	188
	4/15/2009	**206**	**89**	**191**
	4/22/2009	**282**	**91**	**186**
	4/29/2009	**276**	**91**	**188**
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	<LLD	NA	202
	5/27/2009	**246**	**88**	**181**
June	6/3/2009	**267**	**93**	**194**
	6/10/2009	**227**	**88**	**184**
	6/17/2009	**260**	**91**	**188**
	6/24/2009	<LLD	NA	198
July	7/1/2009	**512**	**100**	**183**
	7/8/2009	**304**	**90**	**183**
	7/15/2009	**1117**	**121**	**183**
	7/22/2009	**846**	**112**	**183**
	7/29/2009	**267**	**88**	**178**
August	8/5/2009	**827**	**108**	**174**
	8/12/2009	**312**	**92**	**183**
	8/19/2009	**436**	**96**	**182**
	8/26/2009	**378**	**93**	**179**
September	9/3/2009	**741**	**103**	**167**
	9/9/2009	**718**	**106**	**178**
	9/16/2009	**322**	**94**	**190**
	9/23/2009	**489**	**97**	**179**
	9/30/2009	**594**	**100**	**174**
October	10/7/2009	**675**	**104**	**179**
	10/14/2009	**370**	**95**	**185**
	10/21/2009	**236**	**90**	**185**
	10/28/2009	<LLD	NA	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	<LLD	NA	194
	11/25/2009	**1913**	**151**	**199**
December	12/2/2009	<LLD	NA	189
	12/9/2009	**296**	**97**	**199**
	12/16/2009	**2682**	**165**	**180**
	12/23/2009	**3419**	**184**	**190**
	12/30/2009	**4765**	**213**	**186**

SV-118 US Highway 301 Bridge

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	**499**	**101**	**186**
	1/14/2009	**463**	**94**	**173**
	1/21/2009	**596**	**108**	**197**
	1/28/2009	**635**	**103**	**182**
February	2/4/2009	**260**	**96**	**203**
	2/11/2009	**314**	**93**	**190**
	2/18/2009	**204**	**89**	**188**
	2/25/2009	**443**	**98**	**183**
March	3/4/2009	**225**	**94**	**198**
	3/11/2009	**565**	**106**	**193**
	3/18/2009	**423**	**97**	**185**
	3/25/2009	**378**	**95**	**185**
April	4/1/2009	**424**	**97**	**180**
	4/8/2009	**340**	**95**	**188**
	4/15/2009	**966**	**120**	**191**
	4/22/2009	**523**	**101**	**186**
	4/29/2009	**402**	**96**	**188**
May	5/6/2009	<LLD	NA	248
	5/13/2009	**334**	**103**	**210**
	5/20/2009	**375**	**101**	**202**
	5/27/2009	**474**	**97**	**181**
June	6/3/2009	**330**	**96**	**194**
	6/10/2009	**425**	**96**	**184**
	6/17/2009	**209**	**88**	**188**
	6/24/2009	**376**	**100**	**198**
July	7/1/2009	**578**	**102**	**183**
	7/8/2009	**1455**	**132**	**183**
	7/15/2009	**1991**	**147**	**183**
	7/22/2009	**1112**	**121**	**183**
	7/29/2009	**363**	**92**	**178**
August	8/5/2009	**571**	**99**	**174**
	8/12/2009	**532**	**101**	**183**
	8/19/2009	**869**	**113**	**182**
	8/26/2009	**494**	**98**	**179**
September	9/3/2009	**1691**	**135**	**167**
	9/9/2009	**1052**	**117**	**178**
	9/16/2009	**345**	**95**	**190**
	9/23/2009	**1182**	**121**	**179**
	9/30/2009	**439**	**96**	**174**
October	10/7/2009	**269**	**88**	**179**
	10/14/2009	**490**	**99**	**185**
	10/21/2009	**408**	**98**	**185**
	10/28/2009	**232**	**89**	**184**
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	<LLD	NA	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	**340**	**95**	**189**
	12/9/2009	<LLD	NA	199
	12/16/2009	**376**	**94**	**180**
	12/23/2009	**207**	**90**	**190**
	12/30/2009	**284**	**92**	**186**

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 (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	1320	129	186
	1/14/2009	1714	136	173
	1/21/2009	1764	144	197
	1/28/2009	1909	143	182
February	2/4/2009	1758	146	203
	2/11/2009	2174	153	190
	2/18/2009	2148	151	188
	2/25/2009	2419	158	183
March	3/4/2009	1432	134	198
	3/11/2009	1843	144	193
	3/18/2009	1436	131	185
	3/25/2009	1867	143	185
April	4/1/2009	1733	139	180
	4/8/2009	1592	137	188
	4/15/2009	1093	124	191
	4/22/2009	1645	137	186
	4/29/2009	2373	156	188
May	5/6/2009	561	125	248
	5/13/2009	1825	149	210
	5/20/2009	1515	138	202
	5/27/2009	1969	145	181
June	6/3/2009	1463	135	194
	6/10/2009	2214	152	184
	6/17/2009	2359	156	188
	6/24/2009	1640	140	198
July	7/1/2009	2970	170	183
	7/8/2009	2011	146	183
	7/15/2009	3416	180	183
	7/22/2009	2839	167	183
	7/29/2009	3985	191	178
August	8/5/2009	3489	180	174
	8/12/2009	3049	173	183
	8/19/2009	3291	178	182
	8/26/2009	3823	189	179
September	9/3/2009	3756	185	167
	9/9/2009	4183	195	178
	9/16/2009	3841	191	190
	9/23/2009	3376	178	179
	9/30/2009	3814	188	174
October	10/7/2009	3311	177	179
	10/14/2009	3186	177	185
	10/21/2009	3337	181	185
	10/28/2009	3073	173	184
November	11/4/2009	2071	178	292
	11/11/2009	302	103	206
	11/18/2009	321	98	194
	11/25/2009	2832	171	199
December	12/2/2009	1572	137	189
	12/9/2009	1590	140	199
	12/16/2009	1551	134	180
	12/23/2009	1549	136	190
	12/30/2009	1182	124	186

SV-2053 Lower Three Runs at SRS Rd. B

Month	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	267	91	186
	1/14/2009	387	90	173
	1/21/2009	253	94	197
	1/28/2009	216	86	182
February	2/4/2009	258	96	203
	2/11/2009	453	99	190
	2/18/2009	315	93	188
	2/25/2009	387	95	183
March	3/4/2009	<LLD	NA	198
	3/11/2009	285	93	193
	3/18/2009	294	91	185
	3/25/2009	309	92	185
April	4/1/2009	337	91	180
	4/15/2009	392	98	191
	4/22/2009	333	93	186
	4/22/2009	333	93	186
	4/29/2009	288	91	188
May	5/6/2009	<LLD	NA	248
	5/13/2009	236	98	210
	5/20/2009	<LLD	NA	202
	5/27/2009	305	90	181
June	6/3/2009	<LLD	NA	194
	6/10/2009	282	90	184
	6/17/2009	339	93	188
	6/24/2009	<LLD	NA	198
July	7/1/2009	284	90	183
	7/8/2009	274	89	183
	7/15/2009	330	92	183
	7/22/2009	282	90	183
	7/29/2009	282	88	178
August	8/5/2009	327	88	174
	8/12/2009	276	90	183
	8/19/2009	454	97	182
	8/26/2009	356	92	179
September	9/3/2009	443	93	167
	9/9/2009	458	95	178
	9/16/2009	305	94	190
	9/23/2009	348	92	179
	9/30/2009	359	90	174
October	10/7/2009	326	90	179
	10/14/2009	431	97	185
	10/21/2009	350	99	185
	10/28/2009	351	93	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	279	94	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	340	94	189
	12/9/2009	313	97	199
	12/16/2009	349	92	180
	12/23/2009	223	90	190
	12/30/2009	325	93	186

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 (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
January	1/7/2009	302	93	186
	1/14/2009	379	90	173
	1/21/2009	<LLD	NA	197
	1/28/2009	191	85	182
February	2/4/2009	<LLD	NA	203
	2/11/2009	205	89	190
	2/18/2009	<LLD	NA	188
	2/25/2009	208	87	183
March	3/4/2009	214	92	198
	3/11/2009	<LLD	NA	193
	3/18/2009	<LLD	NA	185
	3/25/2009	<LLD	NA	185
April	4/1/2009	274	88	180
	4/15/2009	233	94	191
	4/22/2009	214	88	186
	4/22/2009	214	88	186
	4/29/2009	<LLD	NA	188
May	5/6/2009	<LLD	NA	248
	5/13/2009	<LLD	NA	210
	5/20/2009	<LLD	NA	202
	5/27/2009	244	88	181
June	6/3/2009	<LLD	NA	194
	6/10/2009	<LLD	NA	184
	6/17/2009	<LLD	NA	188
	6/24/2009	<LLD	NA	198
July	7/1/2009	229	88	183
	7/8/2009	<LLD	NA	183
	7/15/2009	<LLD	NA	183
	7/22/2009	<LLD	NA	183
	7/29/2009	209	85	178
August	8/5/2009	272	86	174
	8/12/2009	183	86	183
	8/19/2009	230	87	182
	8/26/2009	198	85	179
September	9/3/2009	226	81	167
	9/9/2009	235	85	178
	9/16/2009	204	89	190
	9/23/2009	<LLD	NA	179
	9/30/2009	225	84	174
October	10/7/2009	<LLD	NA	179
	10/14/2009	228	89	185
	10/21/2009	<LLD	NA	185
	10/28/2009	235	89	184
November	11/4/2009	<LLD	NA	292
	11/11/2009	<LLD	NA	206
	11/18/2009	<LLD	NA	194
	11/25/2009	<LLD	NA	199
December	12/2/2009	<LLD	NA	189
	12/9/2009	376	101	199
	12/16/2009	302	90	180
	12/23/2009	<LLD	NA	190
	12/30/2009	205	88	186

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 (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	0.88	<MDA	NA	0.93	<MDA	NA	9.84
February	1/28/2009	2/25/2009	<MDA	NA	2.88	<MDA	NA	3.42	<MDA	NA	6.75
March	2/25/2009	3/25/2009	<MDA	NA	2.34	<MDA	NA	2.38	<MDA	NA	24.35
April	3/25/2009	4/29/2009	<MDA	NA	3.11	<MDA	NA	3.47	<MDA	NA	77.01
May	4/29/2009	5/27/2009	<MDA	NA	1.47	<MDA	NA	1.90	<MDA	NA	11.98
June	5/27/2009	6/24/2009	NS	NS	NS	NS	NS	NS	NS	NS	NS
July	6/24/2009	7/29/2009	<MDA	NA	2.27	<MDA	NA	2.46	<MDA	NA	25.59
August	7/29/2009	8/26/2009	<MDA	NA	1.64	<MDA	NA	1.72	<MDA	NA	13.49
September	8/26/2009	9/30/2009	<MDA	NA	1.61	<MDA	NA	1.60	<MDA	NA	12.87
October	9/30/2009	10/28/2009	<MDA	NA	1.76	<MDA	NA	1.59	<MDA	NA	13.26
November	10/28/2009	11/25/2009	<MDA	NA	1.76	<MDA	NA	2.02	<MDA	NA	13.97
December	11/25/2009	12/30/2009	<MDA	NA	2.17	<MDA	NA	2.35	<MDA	NA	27.97

SV-325 Upper Three Runs at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	2.07	<MDA	NA	2.32	<MDA	NA	22.64
February	1/28/2009	2/25/2009	<MDA	NA	2.88	<MDA	NA	3.41	<MDA	NA	6.85
March	2/25/2009	3/25/2009	<MDA	NA	1.75	<MDA	NA	2.01	<MDA	NA	23.82
April	3/25/2009	4/29/2009	<MDA	NA	3.29	<MDA	NA	3.43	<MDA	NA	74.25
May	4/29/2009	5/27/2009	<MDA	NA	1.64	<MDA	NA	1.74	<MDA	NA	12.63
June	5/27/2009	6/24/2009	<MDA	NA	2.05	<MDA	NA	2.69	<MDA	NA	26.31
July	6/24/2009	7/29/2009	<MDA	NA	2.30	<MDA	NA	2.75	<MDA	NA	26.21
August	7/29/2009	8/26/2009	<MDA	NA	1.76	<MDA	NA	1.99	<MDA	NA	15.88
September	8/26/2009	9/30/2009	<MDA	NA	1.72	<MDA	NA	2.30	<MDA	NA	14.20
October	9/30/2009	10/28/2009	<MDA	NA	1.69	<MDA	NA	1.93	<MDA	NA	13.49
November	10/28/2009	11/25/2009	<MDA	NA	1.76	<MDA	NA	1.98	<MDA	NA	13.81
December	11/25/2009	12/30/2009	<MDA	NA	2.26	<MDA	NA	2.50	<MDA	NA	25.44

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	2.02	<MDA	NA	2.25	<MDA	NA	22.28
February	1/28/2009	2/25/2009	<MDA	NA	3.03	<MDA	NA	3.87	<MDA	NA	6.89
March	2/25/2009	3/25/2009	<MDA	NA	2.04	<MDA	NA	2.22	<MDA	NA	22.48
April	3/25/2009	4/29/2009	<MDA	NA	3.14	<MDA	NA	3.79	<MDA	NA	71.13
May	4/29/2009	5/27/2009	<MDA	NA	1.79	<MDA	NA	1.73	<MDA	NA	12.22
June	5/27/2009	6/24/2009	<MDA	NA	2.25	<MDA	NA	2.79	<MDA	NA	26.55
July	6/24/2009	7/29/2009	<MDA	NA	1.93	<MDA	NA	2.18	<MDA	NA	25.92
August	7/29/2009	8/26/2009	<MDA	NA	1.57	<MDA	NA	1.75	<MDA	NA	13.88
September	8/26/2009	9/30/2009	<MDA	NA	1.45	<MDA	NA	1.82	<MDA	NA	13.43
October	9/30/2009	10/28/2009	<MDA	NA	1.72	<MDA	NA	1.98	<MDA	NA	12.75
November	10/28/2009	11/25/2009	<MDA	NA	1.60	<MDA	NA	1.68	<MDA	NA	14.06
December	11/25/2009	12/30/2009	<MDA	NA	1.97	<MDA	NA	2.67	<MDA	NA	26.97

Note: SV-325 had a Pb-214 detection of 22.71 (±2SD 4.68) pCi/L in the August monthly composite sample.

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 (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	1.93	<MDA	NA	2.35	<MDA	NA	22.49
February	1/28/2009	2/25/2009	<MDA	NA	3.51	<MDA	NA	3.78	<MDA	NA	6.86
March	2/25/2009	3/25/2009	<MDA	NA	2.08	<MDA	NA	2.81	<MDA	NA	25.58
April	3/25/2009	4/29/2009	<MDA	NA	3.26	<MDA	NA	3.99	<MDA	NA	72.89
May	4/29/2009	5/27/2009	<MDA	NA	1.77	<MDA	NA	2.19	<MDA	NA	12.24
June	5/27/2009	6/24/2009	<MDA	NA	2.20	<MDA	NA	2.86	<MDA	NA	25.33
July	6/24/2009	7/29/2009	<MDA	NA	2.21	<MDA	NA	2.37	<MDA	NA	25.32
August	7/29/2009	8/26/2009	<MDA	NA	1.46	<MDA	NA	2.30	<MDA	NA	13.33
September	8/26/2009	9/30/2009	<MDA	NA	1.50	<MDA	NA	2.24	<MDA	NA	13.37
October	9/30/2009	10/28/2009	<MDA	NA	1.89	<MDA	NA	2.27	<MDA	NA	13.11
November	10/28/2009	11/25/2009	<MDA	NA	1.63	**4.85**	**2.02**	**1.89**	<MDA	NA	14.25
December	11/25/2009	12/30/2009	<MDA	NA	2.24	<MDA	NA	2.29	<MDA	NA	25.98

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

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	2.19	<MDA	NA	2.26	<MDA	NA	22.97
February	1/28/2009	2/25/2009	<MDA	NA	2.89	<MDA	NA	3.30	<MDA	NA	7.09
March	2/25/2009	3/25/2009	<MDA	NA	1.76	<MDA	NA	2.71	<MDA	NA	24.54
April	3/25/2009	4/29/2009	<MDA	NA	3.05	<MDA	NA	3.46	<MDA	NA	77.98
May	4/29/2009	5/27/2009	<MDA	NA	1.81	<MDA	NA	1.70	<MDA	NA	12.90
June	5/27/2009	6/24/2009	<MDA	NA	1.83	<MDA	NA	2.62	<MDA	NA	26.54
July	6/24/2009	7/29/2009	<MDA	NA	2.13	<MDA	NA	2.49	<MDA	NA	25.38
August	7/29/2009	8/26/2009	<MDA	NA	1.64	<MDA	NA	1.94	<MDA	NA	13.40
September	8/26/2009	9/30/2009	<MDA	NA	1.68	<MDA	NA	1.79	<MDA	NA	13.20
October	9/30/2009	10/28/2009	<MDA	NA	1.78	<MDA	NA	1.84	<MDA	NA	13.13
November	10/28/2009	11/25/2009	<MDA	NA	1.63	<MDA	NA	1.92	<MDA	NA	13.29
December	11/25/2009	12/30/2009	<MDA	NA	1.98	<MDA	NA	2.61	<MDA	NA	26.90

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	2.10	<MDA	NA	2.24	<MDA	NA	24.03
February	1/28/2009	2/25/2009	<MDA	NA	3.36	<MDA	NA	3.65	<MDA	NA	6.97
March	2/25/2009	3/25/2009	<MDA	NA	2.16	<MDA	NA	2.49	<MDA	NA	24.28
April	3/25/2009	4/29/2009	<MDA	NA	3.36	<MDA	NA	3.99	<MDA	NA	65.39
May	4/29/2009	5/27/2009	<MDA	NA	1.69	<MDA	NA	2.16	<MDA	NA	12.49
June	5/27/2009	6/24/2009	<MDA	NA	2.34	<MDA	NA	2.89	<MDA	NA	25.74
July	6/24/2009	7/29/2009	<MDA	NA	2.17	<MDA	NA	2.62	<MDA	NA	26.61
August	7/29/2009	8/26/2009	<MDA	NA	1.46	<MDA	NA	2.07	<MDA	NA	13.74
September	8/26/2009	9/30/2009	<MDA	NA	1.77	<MDA	NA	1.98	<MDA	NA	11.79
October	9/30/2009	10/28/2009	<MDA	NA	1.88	<MDA	NA	2.17	<MDA	NA	14.07
November	10/28/2009	11/25/2009	<MDA	NA	1.87	<MDA	NA	2.21	<MDA	NA	13.35
December	11/25/2009	12/30/2009	<MDA	NA	2.31	<MDA	NA	2.45	<MDA	NA	26.92

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 (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	2.08	<MDA	NA	2.30	<MDA	NA	22.50
February	1/28/2009	2/25/2009	<MDA	NA	3.06	<MDA	NA	3.23	<MDA	NA	6.70
March	2/25/2009	3/25/2009	<MDA	NA	2.03	<MDA	NA	2.37	<MDA	NA	24.28
April	3/25/2009	4/29/2009	<MDA	NA	2.78	<MDA	NA	3.49	<MDA	NA	75.71
May	4/29/2009	5/27/2009	<MDA	NA	1.83	<MDA	NA	1.86	<MDA	NA	11.51
June	5/27/2009	6/24/2009	<MDA	NA	2.10	<MDA	NA	2.57	<MDA	NA	24.93
July	6/24/2009	7/29/2009	<MDA	NA	2.15	<MDA	NA	2.61	<MDA	NA	25.26
August	7/29/2009	8/26/2009	<MDA	NA	1.71	<MDA	NA	1.87	<MDA	NA	12.66
September	8/26/2009	9/30/2009	<MDA	NA	1.64	<MDA	NA	2.10	<MDA	NA	13.75
October	9/30/2009	10/28/2009	<MDA	NA	1.75	<MDA	NA	1.83	<MDA	NA	13.31
November	10/28/2009	11/25/2009	<MDA	NA	1.73	<MDA	NA	2.06	<MDA	NA	13.46
December	11/25/2009	12/30/2009	<MDA	NA	2.29	<MDA	NA	2.56	<MDA	NA	25.92

SV-118 US Highway 301 at the Savannah River

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	1.93	<MDA	NA	2.54	<MDA	NA	24.24
February	1/28/2009	2/25/2009	<MDA	NA	3.55	<MDA	NA	2.91	<MDA	NA	6.92
March	2/25/2009	3/25/2009	<MDA	NA	2.05	<MDA	NA	2.21	<MDA	NA	23.66
April	3/25/2009	4/29/2009	<MDA	NA	2.64	<MDA	NA	3.63	<MDA	NA	76.40
May	4/29/2009	5/27/2009	<MDA	NA	1.72	<MDA	NA	1.91	<MDA	NA	11.98
June	5/27/2009	6/24/2009	<MDA	NA	2.11	<MDA	NA	2.39	<MDA	NA	25.12
July	6/24/2009	7/29/2009	<MDA	NA	1.94	<MDA	NA	2.57	<MDA	NA	26.57
August	7/29/2009	8/26/2009	<MDA	NA	1.72	<MDA	NA	1.50	<MDA	NA	12.40
September	8/26/2009	9/30/2009	<MDA	NA	1.67	<MDA	NA	1.76	<MDA	NA	12.72
October	9/30/2009	10/28/2009	<MDA	NA	1.80	<MDA	NA	1.76	<MDA	NA	13.13
November	10/28/2009	11/25/2009	<MDA	NA	1.71	<MDA	NA	1.70	<MDA	NA	13.08
December	11/25/2009	12/30/2009	<MDA	NA	2.41	<MDA	NA	2.61	<MDA	NA	26.84

SV-2053 Lower Three Runs at SRS Rd. B

Month	Sample Deployment Date	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
Janurary	12/31/2008	1/28/2009	<MDA	NA	1.95	<MDA	NA	2.18	<MDA	NA	23.04
February	1/28/2009	2/25/2009	<MDA	NA	2.80	<MDA	NA	3.50	<MDA	NA	6.99
March	2/25/2009	3/25/2009	<MDA	NA	1.97	<MDA	NA	2.59	<MDA	NA	24.23
April	3/25/2009	4/29/2009	<MDA	NA	3.02	<MDA	NA	3.98	<MDA	NA	73.83
May	4/29/2009	5/27/2009	<MDA	NA	1.52	<MDA	NA	2.15	<MDA	NA	12.46
June	5/27/2009	6/24/2009	<MDA	NA	2.15	<MDA	NA	2.61	<MDA	NA	25.82
July	6/24/2009	7/29/2009	<MDA	NA	2.42	<MDA	NA	2.51	<MDA	NA	24.91
August	7/29/2009	8/26/2009	<MDA	NA	1.75	<MDA	NA	2.02	<MDA	NA	13.11
September	8/26/2009	9/30/2009	<MDA	NA	1.68	<MDA	NA	1.76	<MDA	NA	12.77
October	9/30/2009	10/28/2009	<MDA	NA	1.51	<MDA	NA	2.39	<MDA	NA	12.80
November	10/28/2009	11/25/2009	<MDA	NA	1.73	<MDA	NA	2.38	<MDA	NA	14.26
December	11/25/2009	12/30/2009	<MDA	NA	2.00	<MDA	NA	2.82	<MDA	NA	25.94

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 (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	3.04	<LLD	NA	2.46
February	1/28/2009	2/25/2009	<LLD	NA	2.25	<LLD	NA	2.35
March	2/25/2009	3/25/2009	**2.00**	**1.05**	**1.15**	<LLD	NA	2.51
April	3/25/2009	4/29/2009	<LLD	NA	2.18	**2.34**	**1.33**	**2.30**
May	4/29/2009	5/27/2009	<LLD	NA	1.78	<LLD	NA	2.34
June	5/27/2009	6/24/2009	NS	NS	NS	NS	NS	NS
July	6/24/2009	7/29/2009	<LLD	NA	2.98	**3.90**	**2.05**	**3.73**
August	7/29/2009	8/26/2009	<LLD	NA	3.79	<LLD	NA	4.06
September	8/26/2009	9/30/2009	**6.16**	**2.46**	**3.36**	<LLD	NA	4.02
October	9/30/2009	10/28/2009	<LLD	NA	2.23	<LLD	NA	2.32
November	10/28/2009	11/25/2009	<LLD	NA	2.32	<LLD	NA	2.34
December	11/25/2009	12/30/2009	<LLD	NA	2.95	<LLD	NA	3.65

SV-325 Upper Three Runs and SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	2.63	<LLD	NA	2.41
February	1/28/2009	2/25/2009	**4.77**	**1.63**	**2.03**	<LLD	NA	2.31
March	2/25/2009	3/25/2009	**5.18**	**1.45**	**1.04**	<LLD	NA	2.47
April	3/25/2009	4/29/2009	**8.79**	**2.08**	**2.02**	<LLD	NA	2.28
May	4/29/2009	5/27/2009	**11.3**	**2.23**	**1.70**	**5.55**	**1.76**	**2.73**
June	5/27/2009	6/24/2009	**30.3**	**4.16**	**3.13**	**7.88**	**2.48**	**4.11**
July	6/24/2009	7/29/2009	**38.8**	**4.60**	**1.98**	**16.4**	**2.58**	**3.54**
August	7/29/2009	8/26/2009	**52.0**	**7.53**	**5.26**	**21.0**	**3.45**	**4.12**
September	8/26/2009	9/30/2009	**58.4**	**6.63**	**4.31**	**17.7**	**2.85**	**4.07**
October	9/30/2009	10/28/2009	**25.6**	**3.53**	**2.43**	**8.91**	**1.87**	**2.34**
November	10/28/2009	11/25/2009	**15.4**	**2.99**	**2.73**	**4.72**	**2.12**	**3.67**
December	11/25/2009	12/30/2009	**4.48**	**1.92**	**2.69**	<LLD	NA	3.64

SV-2040 Beaver Dam Creek

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	3.08	<LLD	NA	2.46
February	1/28/2009	2/25/2009	**3.44**	**1.64**	**2.31**	<LLD	NA	2.35
March	2/25/2009	3/25/2009	<LLD	NA	3.62	<LLD	NA	2.54
April	3/25/2009	4/29/2009	<LLD	NA	2.11	<LLD	NA	2.29
May	4/29/2009	5/27/2009	<LLD	NA	1.79	<LLD	NA	2.75
June	5/27/2009	6/24/2009	<LLD	NA	2.05	<LLD	NA	2.54
July	6/24/2009	7/29/2009	<LLD	NA	3.07	<LLD	NA	3.73
August	7/29/2009	8/26/2009	<LLD	NA	3.96	<LLD	NA	4.07
September	8/26/2009	9/30/2009	<LLD	NA	4.07	<LLD	NA	4.06
October	9/30/2009	10/28/2009	**11.60**	**2.44**	**2.28**	<LLD	NA	2.32
November	10/28/2009	11/25/2009	<LLD	NA	2.43	<LLD	NA	2.35
December	11/25/2009	12/30/2009	<LLD	NA	3.12	<LLD	NA	3.67

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 (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	2.76	**5.11**	**1.56**	**2.43**
February	1/28/2009	2/25/2009	<LLD	NA	2.14	**5.19**	**1.53**	**2.33**
March	2/25/2009	3/25/2009	**8.74**	**2.47**	**3.43**	**3.45**	**1.57**	**2.52**
April	3/25/2009	4/29/2009	**2.14**	**1.32**	**1.97**	**4.31**	**1.46**	**2.27**
May	4/29/2009	5/27/2009	<LLD	NA	1.68	**3.24**	**1.57**	**2.72**
June	5/27/2009	6/24/2009	**2.06**	**1.30**	**1.92**	**3.89**	**1.53**	**2.51**
July	6/24/2009	7/29/2009	<LLD	NA	3.14	**8.36**	**2.24**	**3.74**
August	7/29/2009	8/26/2009	<LLD	NA	3.60	**5.62**	**2.60**	**4.04**
September	8/26/2009	9/30/2009	<LLD	NA	3.33	<LLD	NA	4.02
October	9/30/2009	10/28/2009	<LLD	NA	2.12	4.76	1.50	2.31
November	10/28/2009	11/25/2009	<LLD	NA	2.29	**6.25**	**1.58**	**2.34**
December	11/25/2009	12/30/2009	<LLD	NA	2.85	**6.54**	**2.13**	**3.65**

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

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	2.92	<LLD	NA	2.44
February	1/28/2009	2/25/2009	<LLD	NA	2.25	**4.58**	**1.51**	**2.35**
March	2/25/2009	3/25/2009	<LLD	NA	3.65	<LLD	NA	2.54
April	3/25/2009	4/29/2009	<LLD	NA	2.11	<LLD	NA	2.29
May	4/29/2009	5/27/2009	<LLD	NA	1.87	<LLD	NA	2.76
June	5/27/2009	6/24/2009	**3.33**	**1.69**	**2.33**	<LLD	NA	2.57
July	6/24/2009	7/29/2009	<LLD	NA	3.04	<LLD	NA	3.73
August	7/29/2009	8/26/2009	<LLD	NA	3.81	<LLD	NA	4.06
September	8/26/2009	9/30/2009	<LLD	NA	3.39	<LLD	NA	4.02
October	9/30/2009	10/28/2009	<LLD	NA	2.26	<LLD	NA	2.32
November	10/28/2009	11/25/2009	<LLD	NA	2.38	<LLD	NA	2.35
December	11/25/2009	12/30/2009	<LLD	NA	3.08	<LLD	NA	3.66

SV-327 Steel Creek at SC Highway 125

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	2.93	<LLD	NA	2.45
February	1/28/2009	2/25/2009	<LLD	NA	2.28	<LLD	NA	2.35
March	2/25/2009	3/25/2009	<LLD	NA	3.88	<LLD	NA	2.56
April	3/25/2009	4/29/2009	<LLD	NA	2.09	<LLD	NA	2.29
May	4/29/2009	5/27/2009	**3.58**	**1.67**	**2.10**	<LLD	NA	2.80
June	5/27/2009	6/24/2009	**6.93**	**2.21**	**2.48**	<LLD	NA	2.59
July	6/24/2009	7/29/2009	<LLD	NA	3.55	<LLD	NA	3.76
August	7/29/2009	8/26/2009	<LLD	NA	4.27	<LLD	NA	4.08
September	8/26/2009	9/30/2009	<LLD	NA	3.82	<LLD	NA	4.05
October	9/30/2009	10/28/2009	**3.49**	**1.94**	**2.84**	**3.98**	**1.49**	**2.36**
November	10/28/2009	11/25/2009	**2.81**	**1.71**	**2.67**	**3.31**	**1.43**	**2.37**
December	11/25/2009	12/30/2009	**5.99**	**2.51**	**3.48**	<LLD	NA	3.69

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 (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	3.01	<LLD	NA	2.45
February	1/28/2009	2/25/2009	<LLD	NA	2.27	<LLD	NA	2.35
March	2/25/2009	3/25/2009	<LLD	NA	3.73	<LLD	NA	2.55
April	3/25/2009	4/29/2009	<LLD	NA	2.12	<LLD	NA	2.30
May	4/29/2009	5/27/2009	<LLD	NA	1.84	<LLD	NA	2.76
June	5/27/2009	6/24/2009	<LLD	NA	2.06	<LLD	NA	2.54
July	6/24/2009	7/29/2009	<LLD	NA	3.00	4.44	2.08	3.73
August	7/29/2009	8/26/2009	<LLD	NA	3.86	<LLD	NA	4.06
September	8/26/2009	9/30/2009	<LLD	NA	3.36	<LLD	NA	4.02
October	9/30/2009	10/28/2009	<LLD	NA	2.26	<LLD	NA	2.32
November	10/28/2009	11/25/2009	<LLD	NA	2.40	**2.56**	**1.36**	**2.35**
December	11/25/2009	12/30/2009	<LLD	NA	2.99	<LLD	NA	3.66

SV-118 US Highway 301 and Savannah River

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	3.25	<LLD	NA	2.48
February	1/28/2009	2/25/2009	<LLD	NA	2.40	**2.57**	**1.38**	**2.37**
March	2/25/2009	3/25/2009	<LLD	NA	3.74	<LLD	NA	2.55
April	3/25/2009	4/29/2009	<LLD	NA	2.17	<LLD	NA	2.30
May	4/29/2009	5/27/2009	<LLD	NA	1.88	<LLD	NA	2.76
June	5/27/2009	6/24/2009	**6.09**	**2.38**	**2.94**	<LLD	NA	2.63
July	6/24/2009	7/29/2009	**3.45**	**2.19**	**3.41**	**9.16**	**2.29**	**3.75**
August	7/29/2009	8/26/2009	<LLD	NA	5.10	**8.16**	**2.78**	**4.12**
September	8/26/2009	9/30/2009	<LLD	NA	4.35	<LLD	NA	4.07
October	9/30/2009	10/28/2009	**11.30**	**2.93**	**3.11**	**21.20**	**2.35**	**2.37**
November	10/28/2009	11/25/2009	<LLD	NA	2.40	**2.82**	**1.38**	**2.35**
December	11/25/2009	12/30/2009	<LLD	NA	2.98	**5.95**	**2.11**	**3.66**

SV-2053 Lower Three Runs and SRS Rd. B

Month	Sample Deployment Date	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
Janurary	12/31/2008	1/28/2009	<LLD	NA	2.73	<LLD	NA	2.42
February	1/28/2009	2/25/2009	<LLD	NA	2.07	<LLD	NA	2.32
March	2/25/2009	3/25/2009	<LLD	NA	3.80	<LLD	NA	2.55
April	3/25/2009	4/29/2009	<LLD	NA	1.93	<LLD	NA	2.27
May	4/29/2009	5/27/2009	<LLD	NA	1.64	<LLD	NA	2.71
June	5/27/2009	6/24/2009	<LLD	NA	1.88	<LLD	NA	2.51
July	6/24/2009	7/29/2009	<LLD	NA	2.68	<LLD	NA	3.70
August	7/29/2009	8/26/2009	<LLD	NA	3.43	<LLD	NA	4.03
September	8/26/2009	9/30/2009	<LLD	NA	3.04	<LLD	NA	4.00
October	9/30/2009	10/28/2009	**2.49**	**1.45**	**2.14**	**2.60**	**1.38**	**2.31**
November	10/28/2009	11/25/2009	<LLD	NA	2.22	**2.43**	**1.34**	**2.33**
December	11/25/2009	12/30/2009	<LLD	NA	2.78	<LLD	NA	3.64

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

Creek Mouth Locations

SV-2011 Upper Three Runs

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	<LLD	NA	219
2/20/09	603	106	188
3/11/09	633	105	182
4/15/2009	627	106	187
5/20/2009	441	105	202
6/8/2009	570	103	185
7/6/2009	455	97	180
8/3/2009	411	97	185
9/14/2009	3958	192	186
10/26/2009	471	99	189
11/9/2009	448	104	201

SV-2013 Beaver Dam

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	<LLD	NA	219
2/20/09	188	88	188
3/11/09	272	90	182
4/15/2009	275	92	187
5/20/2009	<LLD	NA	202
6/8/2009	<LLD	NA	185
7/6/2009	<LLD	NA	180
8/3/2009	<LLD	NA	185
9/14/2009	582	103	186
10/26/2009	241	90	189
11/9/2009	<LLD	NA	201

SV-2015a Fourmile Branch (Creek Mouth)

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	56174	672	219
2/20/09	60258	691	188
3/11/09	42387	587	182
4/15/2009	29125	481	187
5/20/2009	32242	512	202
6/8/2009	35754	534	185
7/6/2009	42180	582	180
8/3/2009	39853	567	185
9/14/2009	51827	567	186
10/26/2009	42969	581	189
11/9/2009	46018	605	201

SV-2015b Fourmile Branch (30')

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	25872	459	219
2/20/09	36445	542	188
3/11/09	31185	511	182
4/15/2009	28582	478	187
5/20/2009	5603	226	202
6/8/2009	24849	447	185
7/6/2009	13157	331	180
8/3/2009	17347	379	185
9/14/2009	13276	329	186
10/26/2009	3177	175	189
11/9/2009	3546	187	201

SV-2015c Fourmile Branch (150')

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	12031	320	219
2/20/09	48643	623	188
3/11/09	17190	378	182
4/15/2009	22980	431	187
5/20/2009	10270	297	202
6/8/2009	10140	291	185
7/6/2009	15617	358	180
8/3/2009	23753	441	185
9/14/2009	6159	231	186
10/26/2009	11326	305	189
11/9/2009	3732	191	201

SV-2017 Steel Creek

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	5671	238	219
2/20/09	5709	229	188
3/11/09	6763	261	182
4/15/2009	4632	214	187
5/20/2009	4884	223	202
6/8/2009	4342	209	185
7/6/2009	4873	213	180
8/3/2009	2841	169	185
9/14/2009	2695	164	186
10/26/2009	1661	138	189
11/9/2009	2779	170	201

SV-2020 Lower Three Runs Creek

Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
1/28/09	<LLD	NA	219
2/20/09	6418	244	188
3/11/09	852	113	182
4/15/2009	353	96	187
5/20/2009	409	105	202
6/8/2009	734	109	185
7/6/2009	1424	130	180
8/3/2009	1066	121	185
9/14/2009	1551	135	186
10/26/2009	1272	126	189
11/9/2009	1094	125	201

Notes: No Boat Run conducted in December due to Savannah River flooding

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

Location Description	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
RW E48	2/19/2009	<LLD	NA	191
RW E49	6/23/2009	<LLD	NA	187
RW E40	6/23/2009	<LLD	NA	187
RW E64	6/23/2009	<LLD	NA	187

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

Location Description	Collection Date	Tritium Activity (pCi/L)	Tritium Confidence Interval (pCi/L)	Tritium LLD (pCi/L)
RW B63	2/19/2009	<LLD	NA	191
RW B65	2/19/2009	<LLD	NA	191
RW B72	2/19/2009	<LLD	NA	191
RW B47	3/3/2009	<LLD	NA	191
RW B38	3/3/2009	<LLD	NA	191
RW B55	3/3/2009	<LLD	NA	191
RW B40	3/3/2009	<LLD	NA	191
RW B57	3/3/2009	<LLD	NA	191
RW B51	10/22/2009	<LLD	NA	179
RW B56	10/22/2009	**192**	**84**	**179**
RW B44	10/22/2009	<LLD	NA	179
RW B48	10/22/2009	<LLD	NA	179
RW B42	10/22/2009	<LLD	NA	179

Random Sample Gamma Data
Perimeter Locations (< 50 Miles from SRS)

Location Description	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
RWE48	2/19/2009	<MDA	NA	2.12	<MDA	NA	2.22	<MDA	NA	22.83
RWE49	6/23/2009	<MDA	NA	3.54	<MDA	NA	3.99	<MDA	NA	86.24
RWE40	6/23/2009	<MDA	NA	3.06	<MDA	NA	3.99	<MDA	NA	83.98

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

Location Description	Collection Date	Co-60 Activity (pCi/L)	Co-60 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)	Am-241 Confidence Interval (pCi/L)	Am-241 MDA (pCi/L)
RWB63	2/19/2009	<MDA	NA	1.88	<MDA	NA	2.00	<MDA	NA	23.50
RWB65	2/19/2009	<MDA	NA	1.94	<MDA	NA	2.33	<MDA	NA	23.14
RWB72	2/19/2009	<MDA	NA	1.88	<MDA	NA	2.46	<MDA	NA	23.56
RWB47	3/3/2009	<MDA	NA	1.94	<MDA	NA	2.29	<MDA	NA	23.77
RWB38	3/3/2009	<MDA	NA	1.79	<MDA	NA	2.35	<MDA	NA	24.19
RWB55	3/3/2009	<MDA	NA	1.93	<MDA	NA	2.30	<MDA	NA	22.92
RWB40	3/3/2009	<MDA	NA	1.95	<MDA	NA	2.31	<MDA	NA	23.60
RWB57	3/3/2009	<MDA	NA	2.15	<MDA	NA	2.33	<MDA	NA	23.70
RWB56	10/22/2009	<MDA	NA	1.76	<MDA	NA	1.82	<MDA	NA	13.34
RWB44	10/22/2009	<MDA	NA	1.52	<MDA	NA	1.91	<MDA	NA	13.10
RWB48	10/22/2009	<MDA	NA	1.56	<MDA	NA	1.84	<MDA	NA	13.12
RWB42	10/22/2009	<MDA	NA	1.77	<MDA	NA	1.80	<MDA	NA	12.26

Radiological Monitoring of Surface Water On and Adjacent to the SRS
Random Sample Alpha/Beta Data
Perimeter Locations (< 50 Miles from SRS)

Location Description	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
RWE48	2/19/2009	<LLD	NA	2.75	**2.62**	**1.33**	**2.19**
RWE49	6/23/2009	<LLD	NA	1.81	<LLD	NA	2.49
RWE40	6/23/2009	<LLD	NA	2.09	<LLD	NA	2.54

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

Location Description	Collection Date	Alpha Activity (pCi/L)	Alpha Confidence Interval (pCi/L)	Alpha LLD (pCi/L)	Beta Activity (pCi/L)	Beta Confidence Interval (pCi/L)	Beta LLD (pCi/L)
RWB63	2/19/2009	**1.81**	**1.13**	**1.59**	<LLD	NA	2.70
RWB65	2/19/2009	<LLD	NA	2.76	<LLD	NA	2.19
RWB72	2/19/2009	<LLD	NA	2.88	<LLD	NA	2.20
RWB47	3/3/2009	<LLD	NA	2.72	<LLD	NA	2.19
RWB38	3/3/2009	<LLD	NA	2.60	**2.95**	**1.34**	**2.17**
RWB55	3/3/2009	<LLD	NA	2.86	**2.22**	**1.30**	**2.20**
RWB40	3/3/2009	<LLD	NA	2.93	<LLD	NA	2.21
RWB57	3/3/2009	<LLD	NA	2.91	**2.39**	**1.31**	**2.20**
RWB56	10/22/2009	<LLD	NA	2.41	<LLD	NA	2.40
RWB44	10/22/2009	<LLD	NA	4.95	<LLD	NA	2.50
RWB48	10/22/2009	<LLD	NA	3.49	**7.29**	**1.71**	**2.46**
RWB42	10/22/2009	<LLD	NA	3.46	<LLD	NA	2.46

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)
03/02/2009	**2.28**	**1.35**	**1.07**	**4.21**	**1.92**	**3.15**
5/25/2009	<MDA	NA	3.02	<MDA	NA	5.15
8/21/2009	<MDA	NA	2.70	<MDA	NA	5.24
12/15/2009	<MDA	NA	4.19	<MDA	NA	5.36

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7.0 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) “*” 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)	237	51	234	174	348	52	15
Upper Three Runs Creek (SV-325)	1,348	628	1,302	393	3,087	52	49
TNX Boat Landing (SV-2012)	273	88	254	186	650	52	29
Beaver Dam Creek (SV-2040)	277	58	270	197	408	52	28
Fourmile Branch (SV-2039)	46,226	7,613	46,417	25,532	61,849	52	52
Pen Branch (SV-2047)	37,750	12,315	35,279	13,502	57,145	52	52
Steel Creek (SV-327)	2,935	825	3,019	1,556	4,382	52	52
Steel Creek Boat Landing (SV-2018)	1,249	1,716	587	207	7,153	52	46
Little Hell Landing (SV-2019)	773	1,002	369	206	4,765	52	34
Highway 301 Bridge (SV-118)	593	409	443	204	1,991	52	39
Lower Three Runs Creek and Patterson Mill Rd. (SV-328)	2,259	976	1,990	302	4,183	52	52
Lower Three Runs Creek (SV-2053)	326	60	325	216	458	52	44
Upper Three Runs Creek (SV-2027)	240	51	227	183	379	52	26

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)	862	1,091	520	411	3,958	11	10
Beaver Dam Creek Creek Mouth (SV-2013)	312	155	272	188	582	11	5
Fourmile Branch Creek Mouth (SV-2015)	43,526	9,628	42,387	29,125	60,258	11	11
Fourmile Branch (SV-2015) 30' downstream from Creek Mouth	18,458	11,667	17,347	3,177	36,445	11	11
Fourmile Branch (SV-2015) 150' downstream from Creek Mouth	16,531	12,349	12,031	3,732	48,643	11	11
Steel Creek Creek Mouth (SV-2017)	4,259	1,571	4,632	1,661	6,763	11	11
Lower Three Runs Creek Creek Mouth (SV-2020)	1,517	1,767	1,080	353	6,418	11	10

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	4	0
Random Background (>50 Miles)	192*	84*	NA	NA	NA	13	1

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)	4.08	2.94	4.08	2.00	6.16	12	2
Upper Three Runs Creek (SV-325)	23.18	19.48	15.40	4.48	58.4	12	11
Beaver Dam Creek (SV-2040)	7.52	5.77	7.52	3.44	11.60	12	2
Fourmile Branch Creek (SV-2039)	4.31	3.83	2.14	2.06	8.74	12	3
Pen Branch (SV-2047)	3.33*	1.69*	NA	NA	NA	12	1
Steel Creek (SV-327)	4.56	1.79	3.58	2.81	6.93	12	5
Steel Creek Boat Landing (SV-2018)	ND	NA	NA	NA	NA	12	0
Highway 301 Bridge (SV-118)	6.95	3.99	6.09	3.45	11.30	12	3
Lower Three Runs Creek (SV-2053)	2.49*	1.45*	NA	NA	NA	12	1

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)	ND	NA	NA	NA	NA	3	0
Random Background (> 50 Miles)	1.18*	1.13*	NA	NA	NA	12	1

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)	3.12	1.10	3.12	2.34	3.90	12	2
Upper Three Runs Creek (SV-325)	11.74	6.50	8.91	4.72	21.0	12	7
Beaver Dam Creek (SV-2040)	ND	NA	NA	NA	NA	12	0
Fourmile Branch (SV-2039)	5.16	1.51	5.11	3.24	8.4	12	11
Pen Branch (SV-2047)	4.58*	1.51*	NA	NA	NA	12	1
Steel Creek (SV-327)	3.65	0.47	3.65	3.31	3.98	12	2
Steel Creek Boat Landing (SV-2018)	3.50	1.33	3.50	2.56	4.44	12	2
Highway 301 Bridge (SV-118)	8.31	6.86	7.06	2.57	21.20	12	6
Lower Three Runs Creek (SV-2053)	2.52	0.12	2.52	2.43	2.60	12	2

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)	2.62*	1.33*	NA	NA	NA	3	1
Random Background (> 50 Miles)	3.71	2.41	2.67	2.22	7.29	12	4

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2.4 Non-Radiological Monitoring of Surface On and Adjacent To The SRS

2.4.1 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's (ESOP) monitoring indicate that SRS surface waters meet the Freshwaters Standard guidelines stated in SCDHEC's Water Classifications and Standards (Regulation 61-68), (SCDHEC 2008).

The SCDHEC assessed the surface water quality for nonradiological parameters in 2009 at SRS by sampling the on-site streams for inorganic and organic contaminants. Specific parameters were analyzed monthly and bi-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.

Water quality on the SRS for nonradiological parameters meets the Freshwaters Standard for South Carolina streams. Streams are tested for these 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, and Total Kjeldahl Nitrogen (TKN). Cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), zinc (Zn), total organic carbon (TOC), volatile organic carbons (VOC's), pesticides and polychlorinated biphenyl's (PCB's) were sampled bi-annually. In all, a total of 2656 different analyses were performed and only 39 of these exceed the state or EPA standards, although the yearly averages remained within these standards. These are some of the same parameters used to sample streams around South Carolina (SCDHEC 2005). Data from SCDHEC surface water locations were compared to DOE-SR data where sample points were colocated (SCDHEC 2006) (WSRC 2008b). There were no notable differences between the SCDHEC and DOE-SR surface water data.

RESULTS AND DISCUSSION

pH Results

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 2008). All sample location yearly averages met this standard, although there were 12 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 Figure 1, Section 2.4.3 for a comparison of SCDHEC and DOE-SR data.

Dissolved Oxygen Results

Dissolved oxygen measurements were recorded at each sample location as part of each sampling event. Freshwaters DO Standard for South Carolina Streams are to have a daily average no less than 5.0 milligrams per Liter (mg/L) with a minimum of 4.0 mg/L (SCDHEC 2007). All sample locations met this requirement. See Figure 2, Section 2.4.3 for comparison data between SCDHEC and DOE-SR.

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 of (SCDHEC 2008). Since SCDHEC does not collect samples every day of the month, this standard cannot accurately be used to analyze the results for this parameter. However, none of the locations had an average that exceed the standard.

Nitrate/Nitrite

There are no official South Carolina freshwater standards for nitrate/nitrite levels; however, there are federally established drinking water standards. All 2009 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 figure 3, Section 2.4.3 for comparison data between SCDHEC and DOE-SR environmental monitoring programs.

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 recommended 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 sufficient 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 measurements that were below the recommended level SV-324 (3.3 (±0.92) mg/L), SV-325 (2.09 (±0.97) mg/L), SV-2027 (1.20 mg/L), SV-2039 (18.08 (±5.38) mg/L), and SV-2047 (19.08 (±2.47) mg/L). This may be due to naturally low occurring buffering chemicals in the streams.

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 2008). All SCDHEC monitored streams were in compliance with this parameter.

Total Phosphorus

The freshwater quality standard for total phosphorus in the Piedmont and Southeastern Plains of South Carolina are to be less than or equal to 0.06 mg/L (SCDHEC 2008). SV-2039 (0.09 (±0.04) mg/L) was the only location that had total phosphorus levels that were above the state standard. See Figure 4, Section 2.4.3 for a comparison of SCDHEC and DOE-SR data.

Iron Results

The USEPA recommended limit for iron in freshwater streams is 1 mg/L (USEPA 2008). One SCDHEC sampled stream had iron that was above the recommended limit, SV-324 (4.8 mg/L). See Figure 5, Section 2.4.3 for comparison data between SCDHEC and DOE-SR environmental monitoring programs.

Other Parameters

Samples were also analyzed for other parameters; including, but not limited to metals, mercury, TOC, VOC's, and pesticides. The results indicate that the SRS streams met the applicable freshwater standards (SCDHEC 2006). All surface water data are located in Section 2.4.4. Surface water statistical analyses can be found in Section 2.4.5.

SCDHEC and DOE-SR Data Comparison

The following SCDHEC sampling locations were colocated with DOE-SR sampling locations: SV-2027, SV-325, SV- 327, SV-328, SV-2047, SV-324, and SV-2039 (Section 4.0, Map 1). Table 1, Section 2.4.3, defines the geographic locations of the SCDHEC sampling locations and Table 2 in Section 2.4.3 defines the sampling schedule for surface streams at DOE-SR. Comparisons were made with the colocated sampling locations to see if there were any significant statistical differences: pH (Figure 1, Section 2.4.3); dissolved oxygen (Figure 2, Section 2.4.3); nitrate/nitrite (Figure 3, Section 2.4.3); total phosphorous (Figure 4, Section 2.4.3); iron (Figure 5, Section 2.4.3). All colocated stations had data within one standard deviation. All data less than lower limit of detections (<LLD) were left out of the graphs for lack of numerical data. Small discrepancies in data between DOE-SR and SCDHEC can be attributed to differences in sample collection date and time, sample preservation, and lab analysis.

CONCLUSION/ RECOMMENDATIONS

SRS streams are not influenced significantly, according to the data collected, from any industrial process to raise concerns above SCDHEC Fresh Water Stream Standards set for surface water quality (SCDHEC 2008) (USEPA 2008).

The parameters identified that were above or below USEPA or SCDHEC standards or recommended levels for particular streams will be further evaluated to determine the cause.

SCDHEC will continue the nonradiological independent monitoring and surveillance of SRS surface water to verify and validate water quality. Continued monitoring is required because of increased 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.

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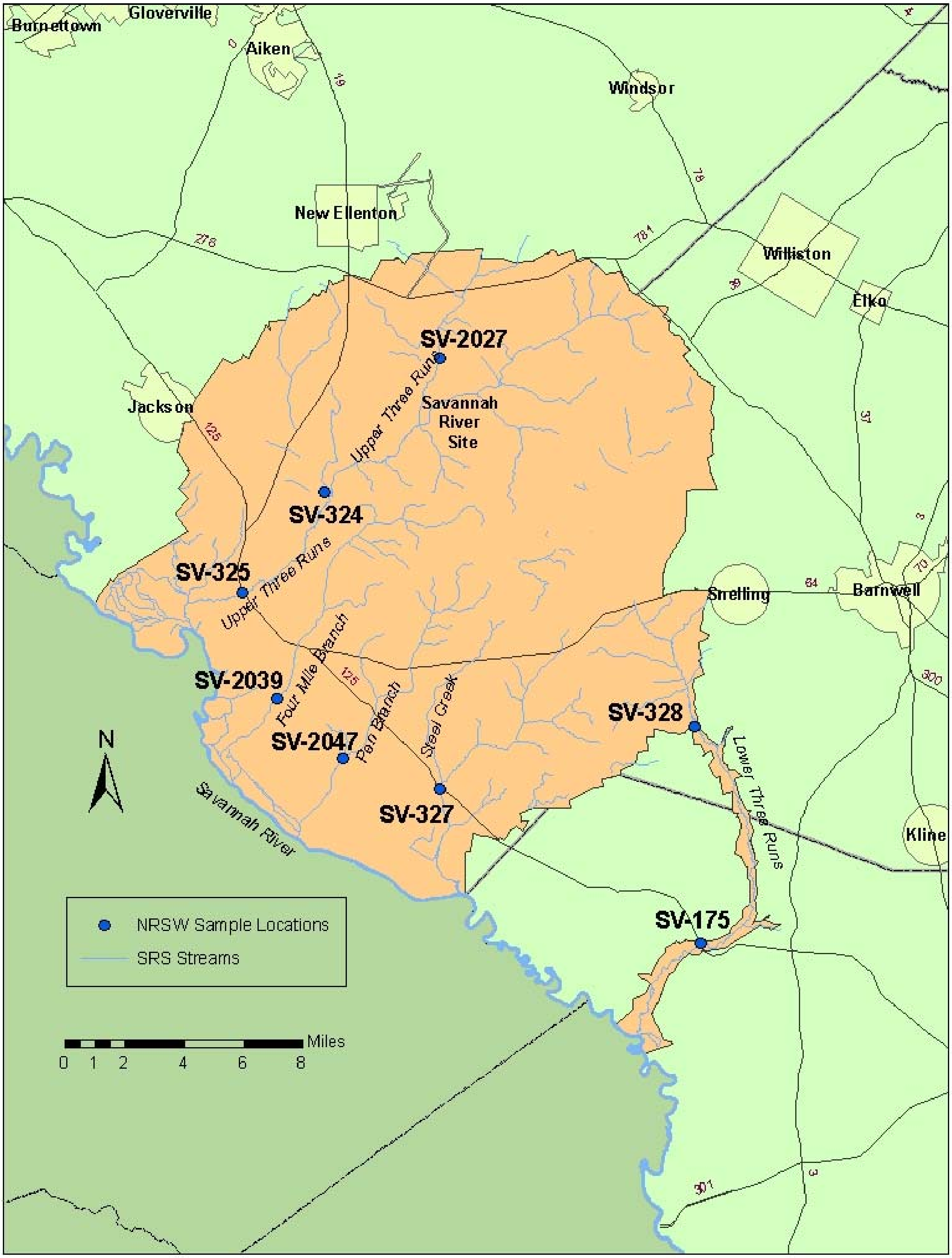
2.4.2

Map 6. Non-Radiological Surface Water Monitoring Locations TOC



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-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, and Total Kjeldahl Nitrogen (TKN).
	Semi-annually	Metals, Total Organic Carbon (TOC), and Volatile Organic Compounds (VOCs).
	Annually	Pesticide Scan, Polychlorinated Biphenyls (PCBs), Base Neutral Acid Extractable (BNA).
Field	Monthly	Temperature, pH, and Dissolved Oxygen (DO).

Table 3. DOE-SR Surface Water Sample Locations	
SRS Stream Locations * = colocated with ESOP site	**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

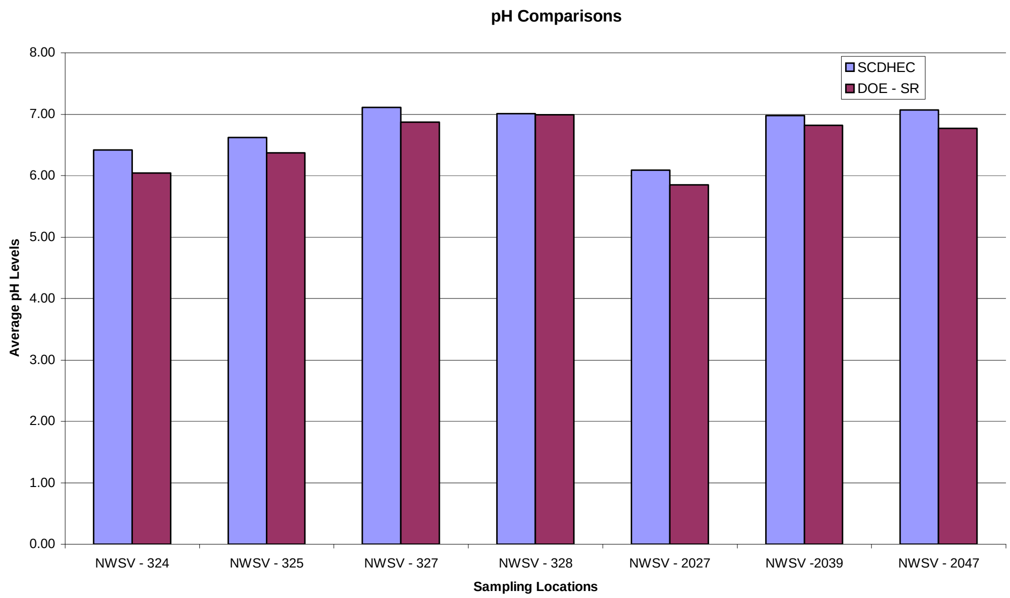
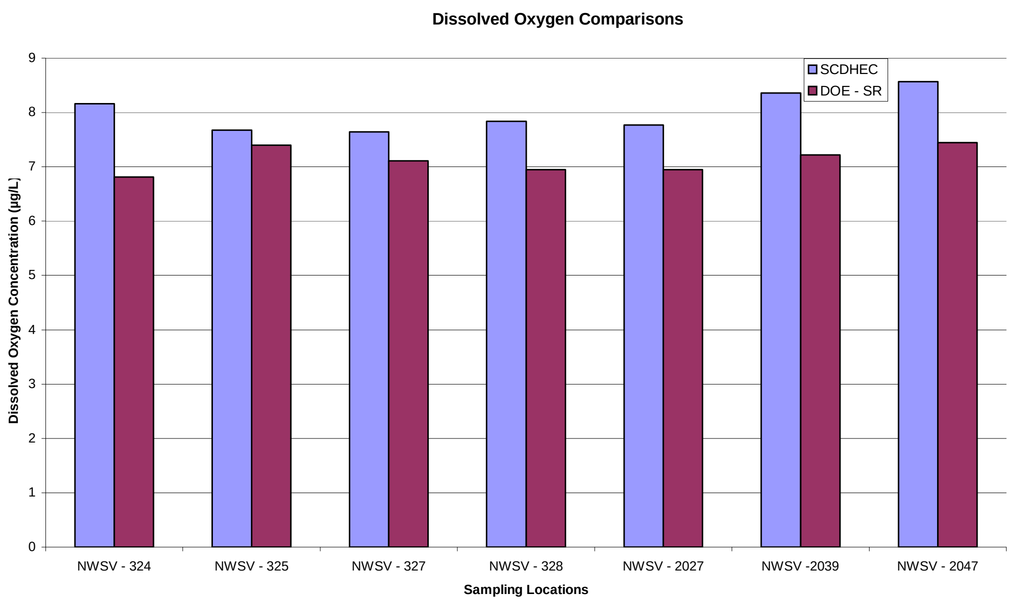


Figure 2

DO Comparison



Tables and Figures
Figure 3
Nitrate/Nitrite Comparison

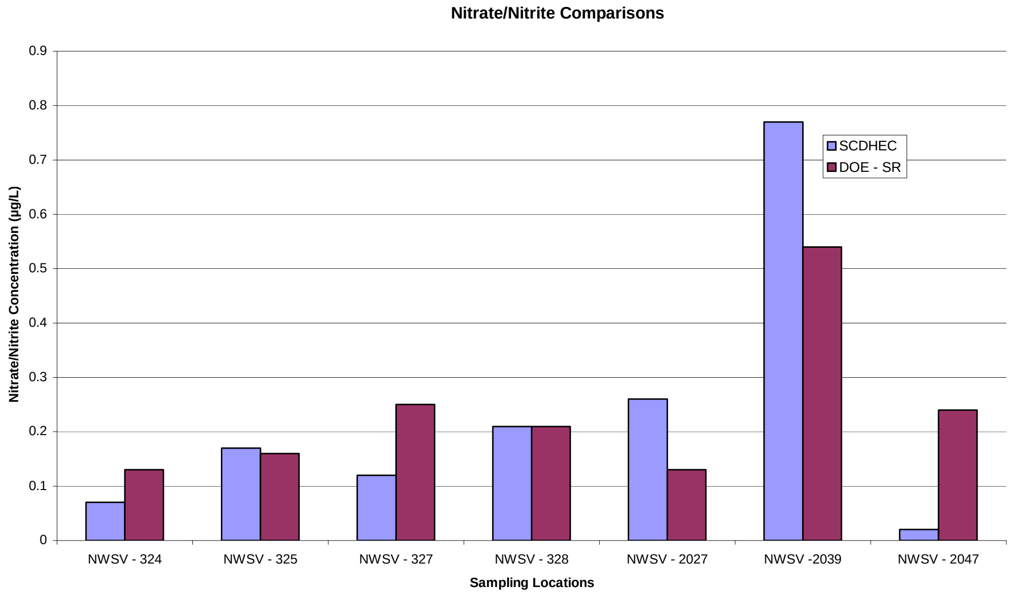
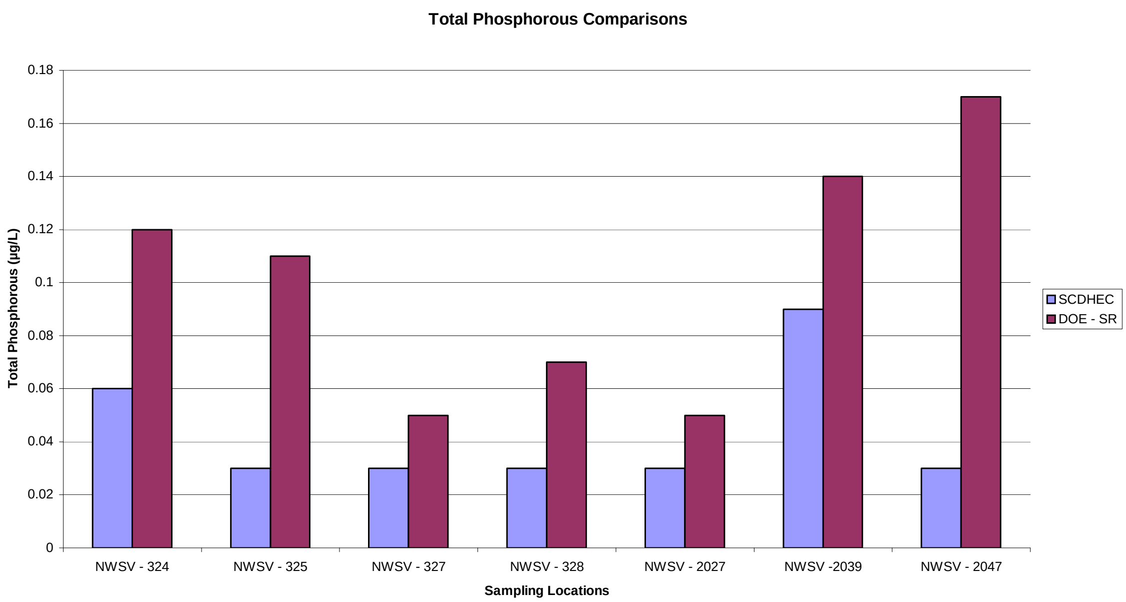
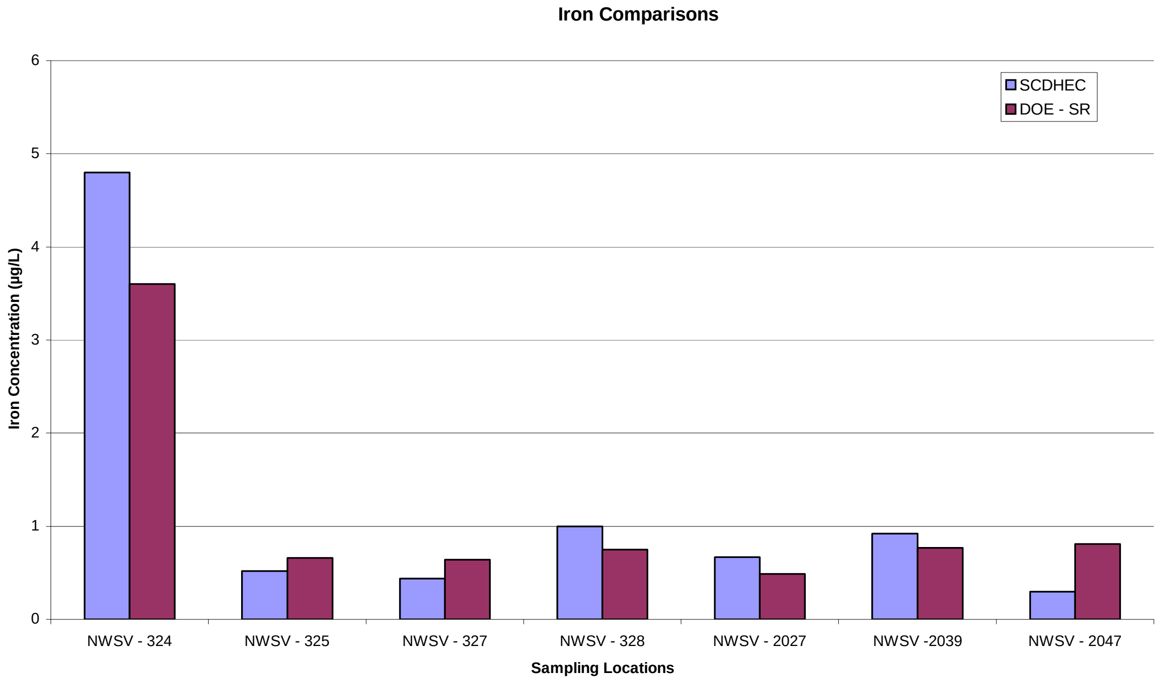


Figure 4
Total Phosphorus Comparison



Tables and Figures
Figure 5
Iron Comparison



[TOC](#)

2.4.4 DATA

Nonradiological Monitoring of Surface Water

Notes:

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.

AE = Analytical Error

EST = Estimated amount

NTU = Nephelometric Turbidity Units

NO_2 = Nitrite

NO_3 = Nitrate

NH3 = Ammonia

NH4 = Ammonium

DATA TABLES

NWSV-175	Lower Three Runs at Highway 125											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	7.09	7.03	7.7	6.6	7.4	7.17	6.56	6.28	7.4	7.45	7.19	8.12
DO	9.85	8.37	7.14	5.71	7.44	6.1	6.29	6.2	6.06	7.29	10.12	8.37
Water Temperature	7.8	14.2	14.1	16.04	18.66	24.05	23.46	23.06	21.21	18.43	16.92	9.59
Alkalinity	38	44	25	27	33	18	30	47	47	48	49	35
Turbidity	2.2	2.3	5.9	3.4		8.9	6.2	4.1	3.1	4.7	1.6	2.1
BOD	<2.0	2.5	<2.0	<2.0	<2.0	2.4	<2.0	<2.0	<2.0	2.1	<2.0	<2.0
TKN	0.23	0.33	0.51	0.4	0.44	0.35	0.42	<0.10	<0.10	0.37	0.19	0.29
NH3 / NH4	0.054	<0.050	0.076	0.051	0.074	0.096	0.091	<0.050	0.063	<0.050	0.069	<0.050
NO3 / NO2	0.091	0.037	0.029	0.057	0.074	5.5	0.069	0.1	0.1	0.059	0.18	<0.020
Total Phosphorus	0.025	0.032	0.023	0.02	0.046	0.054	0.046	0.039	0.031	0.051	0.036	0.03
Fecal Coliform	140	190	450	100	180	530	200	80 EST	180	920	140	210
TSS	1.1	1.6	3.9	3	5.6	11	5.8	3.7	2.7	9.2	0.8	2
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				5.3	AE					
Cadmium		AE				0.0001	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.76	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.081	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.031	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-324	Tims Branch and Road C											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	5.96	5.92	7.25	6.6	5.74	6.02	5.7	5.65	6.92	7.3	7.29	6.72
DO	10.43	9.56	8.55	8.61	7.00	7.02	7.03	6.54	6.22	7.74	10.26	9.01
Water Temperature	8.27	12.57	13.31	16.31	18.44	23.67	22.88	23.78	22.11	18.98	14.78	9.83
Alkalinity	1.8	2	2.8	4	3.6	4.5	2.3	3.2	3.4	3.4	4.2	4.4
Turbidity	4.6	7.5	8.3	6	9.5	13	9.5	17	8.2	7.1	5.3	3.8
BOD	<2.0	<2.0	<2.0	4.2	<2.0	<2.0	<2.0	2	<2.0	3.1	<2.0	<2.0
TKN	0.23	0.32	0.48	0.47	0.7	0.79	0.94	0.38	0.34	0.6	0.84	0.39
NH3 / NH4	0.1	0.14	0.07	0.11	0.13	0.13	0.15	0.13	0.097	0.11	<0.050	0.082
NO3 / NO2	0.088	0.025	0.071	0.05	0.053	0.08	0.033	<0.020	0.2	0.023	<0.020	<0.020
Total Phosphorus	0.034	0.044	0.028	0.032	0.057	0.029	0.082	0.14	0.052	0.075	0.068	0.039
Fecal Coliform	20 EST	2 EST	15	19	61	38	170	160 EST	200	520	150	110
TSS	2.8	5.8	5.8	6.6	12	11	11	33	9.6	8.8	7.9	4.5
Chromium	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				10	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				4.8	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.26	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.012	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-325	Upper Three Runs and Road A											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	6.31	6.55	7.16	5.93	6.18	6.18	6.04	6.12	7.28	7.17	6.73	7.8
DO	9.55	9.11	7.95	7.66	6.58	7.17	6.48	6.35	4.41	7.55	10.43	8.97
Water Temperature	9.11	13.31	14.37	16.48	18.57	22.87	22.41	22.47	20.96	18.47	14.75	10.36
Alkalinity	1.7	1.9	<1.0	2.2	1.8	1.7	<1.0	2.7	0	2.5	3.8	2.6
Turbidity	2.3	2.6	5.2	4.1	6.8	4.8	6.9	5.8	4.6	14	3.3	2.4
BOD	<2.0	<2.0	<2.0	2.5	<2.0	<2.0	<2.0	<2.0	<2.0	4.2	<2.0	<2.0
TKN	0.19	0.22	0.3	<0.10	0.17	0.37	0.82	<0.10	<0.10	0.54	0.26	0.21
NH3 / NH4	0.058	0.067	0.082	<0.050	<0.050	0.053	0.069	<0.050	<0.050	<0.050	0.056	<0.050
NO3 / NO2	0.19	0.13	0.084	0.12	0.15	0.22	0.15	0.3	0.25	0.15	0.18	0.1
Total Phosphorus	0.02	0.028	<0.020	<0.020	0.034	<0.020	0.043	0.037	0.022	0.054	0.04	0.028
Fecal Coliform	150	37	180	38	300	87	120	35 EST	170	1300 EST	320	100
TSS	1.8	3.2	4.9	5.1	9.2	6.4	7.4	5.7	5.2	13	3.6	1.9
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				2.5	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.52	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.018	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.011	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-327	Steel Creek at Road A											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	7.26	7.06	7.72	6.67	6.97	6.82	6.51	6.21	7.27	7.59	7.52	7.73
DO	10.08	8.45	8.81	8.13	6.8	6.15	7.07	6.64	6.14	7.21	7.99	8.23
Water Temperature	6.69	12.88	13.02	16.02	18.02	26.12	24.04	24.51	22.94	19.16	16.49	10.79
Alkalinity	22	23	17	20	20	22	21	17	26	22	25	22
Turbidity	2.2	2.6	4.1	3.6	6.8	3.2	4.6	2.9	2.2	4.7	2.2	1.9
BOD	<2.0	<2.0	<2.0	2.6	3.7	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TKN	<0.10	0.26	0.4	0.27	0.25	0.24	0.28	0.22	<0.10	0.48	0.42	0.24
NH3 / NH4	<0.050	0.11	0.068	0.06	0.058	0.06	0.071	<0.050	0.072	0.065	0.059	<0.050
NO3 / NO2	0.064	0.042	0.051	0.03	0.076	0.072	0.085	0.54	0.095	0.26	0.028	0.037
Total Phosphorus	<0.020	<0.020	<0.020	<0.020	0.032	<0.020	0.02	0.025	<0.020	0.028	0.028	<0.020
Fecal Coliform	110	66	86	110	110	45 EST	83	65 EST	210	240	160	60
TSS	1.2	2.4	4.4	4.2	9.3	3.8	6.8	2.8	2	6.6	1.4	1.8
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.005	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				3.3	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.44	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.042	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				<0.010	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-328	Lower Three Runs at Patterson Mill Road											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	7.09	7.11	7.77	6.88	7.22	7.06	6.59	6.28	6.2	7.43	6.63	7.82
DO	9.85	8.65	8.58	7.97	6.84	6.25	6.6	6.94	7.21	7.35	9.66	8.19
Water Temperature	7.8	14.11	13.58	15.72	18.23	23.73	23.16	21.08	6.76	17.93	18.94	11.11
Alkalinity	40	51	30	33	35	33	38	47	54	44	50	42
Turbidity	1.6	2.4	2.6	2.4	2.6	11	3.8	3.3	2.8	3.2	2	2
BOD	<2.0	<2.0	<2.0	2.6	<2.0	2.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TKN	0.21	0.42	0.44	0.27	0.17	0.26	0.26	<0.10	<0.10	0.42	0.28	0.3
NH3 / NH4	0.052	<0.050	0.071	<0.050	0.057	<0.050	0.05	0.084	<0.050	0.06	0.056	<0.050
NO3 / NO2	0.08	0.05	1.3	0.042	0.056	0.19	0.073	0.075	0.17	0.08	0.36	0.025
Total Phosphorus	0.021	0.032	<0.020	<0.020	0.039	0.057	0.032	0.03	0.024	0.038	0.038	0.031
Fecal Coliform	110 EST	160	140	74	120	560	190	170	230	450	400	300
TSS	1.4	2.8	3.4	3.8	6.2	20	5.8	4.2	3.6	6.7	1.5	1.4
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	0.0069	<0.005	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				4.9	AE					
Cadmium		AE				0.0005	AE					
Copper		AE				<0.010	AE					
Iron		AE				1	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.13	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.014	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-2027	Upper Three Runs at Road 2-1											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	5.6	5.87	6.8	6.53	5.22	5.31	6.23	5.74	6.75	5.35	7.34	6.3
DO	9.27	8.47	7.83	8.8	7.32	7.5	7.32	6.99	6.46	7.08	8.32	7.89
Water Temperature	10.15	13.83	13.31	16.01	17.37	21.1	20.73	21.13	20.45	18.28	15.57	12.32
Alkalinity	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2
Turbidity	1.5	1.8	2.5	1.7	3.1	2.2	3.3	2.5	2	8.5	1.4	1.1
BOD	<2.0	<2.0	<2.0	<2.0	2.3	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TKN	0.23	0.23	0.21	<0.10	0.23	0.16	0.4	<0.10	<0.10	0.56	0.16	0.27
NH3 / NH4	0.078	<0.050	<0.050	<0.050	<0.050	<0.050	0.057	<0.050	<0.050	0.057	<0.050	<0.050
NO3 / NO2	0.3	0.26	0.25	0.28	0.21	0.26	0.29	0.24	0.26	0.23	0.28	0.27
Total Phosphorus	0.041	<0.020	<0.020	<0.020	<0.020	<0.020	0.046	<0.020	<0.020	0.027	0.022	<0.020
Fecal Coliform	140	25 EST	62	33	130	43	65	43	110	1400 EST	160	50 EST
TSS	2.2	2.1	2.8	2.7	4.4	3.4	3.9	3.2	2.9	6.8	2	1.8
Chromium	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0052	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				<2.0	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.67	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.066	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.012	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-2039	Fourmile Branch at Road A-13.2											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	7.16	7.01	7.61	6.71	6.9	6.7	6.4	6.36	7.27	7.27	6.85	7.49
DO	11.14	9.91	8.66	8.62	7.38	7.16	7.25	7.06	6.84	7.45	10.21	8.69
Water Temperature	6.07	12.78	13.33	16.12	17.26	24.7	23.15	23.41	21.53	18.56	15.05	9.68
Alkalinity	15	17	15	15	21	22	15	18	32	14	21	12
Turbidity	2.6	1.8	5	3	3.2	2.8	3.7	2.6	1.3	8.5	2.9	3.7
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	2.1	<2.0	<2.0	<2.0	2.6	<2.0	<2.0
TKN	0.33	0.33	0.47	0.11	0.35	0.51	0.32	<0.10	<0.10	0.86	0.37	0.28
NH3 / NH4	<0.050	0.066	0.076	<0.050	<0.050	0.058	0.072	<0.050	<0.050	<0.050	0.1	<0.050
NO3 / NO2	1.4	1.2	0.92	0.69	0.63	0.38	0.46	0.24	0.38	1.7	0.54	0.75
Total Phosphorus	0.079	0.067	0.043	0.04	0.084	0.048	0.12	0.086	0.07	0.2	0.11	0.08
Fecal Coliform	55 EST	50 EST	47	60	52	17 EST	73	52	100	1200 EST	120	35 EST
TSS	2.2	2.5	4.4	2.6	2	2.8	2.6	1.5	1	18	2.5	2.6
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				4.5	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.92	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				0.04	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				<0.010	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

DATA TABLES

NWSV-2047	Pen Branch at Road A-13.2											
	January	February	March	April	May	June	July	August	September	October	November	December
pH	6.72	7.38	7.51	6.53	6.77	6.82	6.67	6.42	7.39	7.53	6.86	8.19
DO	11.29	10.86	8.9	8.8	7.46	7.17	7.65	7.15	6.72	8.04	10.02	8.83
Water Temperature	6.11	12.65	13.13	16.01	16.87	25.91	23.06	23.44	21.71	18.36	15.69	10.14
Alkalinity	20	21	16	21	18	18	21	21	14	20	22	17
Turbidity	4	2.3	7.9	3.7	6.6	12	4.5	4.3	2	6.5	3.1	3
BOD	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
TKN	0.1	0.28	0.43	0.12	0.4	0.35	0.23	0.17	<0.10	0.24	0.21	0.36
NH3 / NH4	<0.050	<0.050	0.07	<0.050	<0.050	<0.050	0.056	<0.050	0.055	0.069	0.058	0.052
NO3 / NO2	0.21	0.049	0.15	0.13	0.12	0.31	0.17	0.46	0.17	0.14	0.17	0.32
Total Phosphorus	0.025	0.03	0.02	<0.020	0.048	0.045	0.036	0.033	<0.020	0.034	0.032	0.026
Fecal Coliform	60 EST	60 EST	130	90	100	17 EST	65	73	57	280	120	80
TSS	1.8	3.3	6.4	5.1	6.4	17	3.6	1.9	1.5	11	2.3	1.9
Chromium	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
TOC		AE				4.2	AE					
Cadmium		AE				<0.00010	AE					
Copper		AE				<0.010	AE					
Iron		AE				0.3	AE					
Lead		AE				<0.0020	AE					
Manganese		AE				<0.010	AE					
Nickel		AE				<0.020	AE					
Zinc		AE				0.03	AE					
Acetone		<0.0500					<0.0500					
Chloromethane		<0.00500					<0.00500					
Vinyl chloride		<0.00500					<0.00500					
Bromomethane		<0.00500					<0.00500					
Chloroethane		<0.00500					<0.00500					
1,1-Dichloroethene		<0.00500					<0.00500					
Carbon Disulfide		<0.00500					<0.00500					
Dichloromethane		<0.00500					<0.00500					
trans-1,2-Dichloroethene		<0.00500					<0.00500					
1,1-Dichloroethane		<0.00500					<0.00500					
2-Butanone		<0.00500					<0.00500					
cis-1,2-Dichloroethylene		<0.00500					<0.00500					
Chloroform		<0.00500					<0.00500					
1,1,1-Trichloroethane		<0.00500					<0.00500					
Carbon tetrachloride		<0.00500					<0.00500					
Benzene		<0.00500					<0.00500					
1,2-Dichloroethane		<0.00500					<0.00500					
Trichloroethene		<0.00500					<0.00500					
1,2-Dichloropropane		<0.00500					<0.00500					
Bromodichloromethane		<0.00500					<0.00500					
2-Hexanone		<0.00500					<0.00500					
cis-1,3-Dichloropropene		<0.00500					<0.00500					
Toluene		<0.00500					<0.00500					
trans-1,3-Dichloropropene		<0.00500					<0.00500					
1,1,2-Trichloroethane		<0.00500					<0.00500					
4-Methyl-2-Pentanone		<0.00500					<0.00500					
Tetrachloroethene		<0.00500					<0.00500					
Dibromochloromethane		<0.00500					<0.00500					
Chlorobenzene		<0.00500					<0.00500					
Ethyl benzene		<0.00500					<0.00500					
m,p-Xylenes		<0.0100					<0.0100					
o-Xylene		<0.00500					<0.00500					
Styrene		<0.00500					<0.00500					
Bromoform		<0.00500					<0.00500					
1,1,2,2-Tetrachloroethane		<0.00500					<0.00500					

TOC

2.4.5 SUMMARY STATISTICS

Summary Statistics for Nonradiological Monitoring of Ambient Surface Water at SRS

Notes:

1. <LLD = Lower Level of Detection
2. N/A = Not Applicable
3. STDEV = Standard Deviation

SUMMARY STATISTICS

Sample Location	NWSV-175	Lower Three Runs at Highway 125					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	7.17	0.51	7.18	6.28	8.12	12
	DO	7.41	1.49	7.22	5.71	10.12	12
	Water Temperature	17.29	5.28	17.68	7.8	24.05	12
	Alkalinity	36.75	10.39	36.5	18	49	12
	Turbidity	4.05	2.23	3.4	1.6	8.9	11
	BOD	2.33	0.21	2.4	2.1	2.5	3
	TKN	0.35	0.10	0.36	0.19	0.51	10
	NH3 / NH4	0.07	0.02	0.0715	0.051	0.096	8
	NO3 / NO2	0.57	1.63	0.074	0.029	5.5	11
	Total Phosphorus	0.04	0.01	0.034	0.02	0.054	12
	Fecal Coliform	276.67	243.44	185	80	920	12
	TSS	4.20	3.20	3.35	0.8	11	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	5.30	N/A	5.3	5.3	5.3	1
	Cadmium	0.0001	N/A	0.0001	0.0001	0.0001	1
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.76	N/A	0.76	0.76	0.76	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.08	N/A	0.081	0.081	0.081	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.03	N/A	0.031	0.031	0.031	1

Sample Location	NWSV-324	Tims Branch and Road C					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	6.42	0.66	6.31	5.65	7.3	12
	DO	8.16	1.45	8.15	6.22	10.43	12
	Water Temperature	17.08	5.42	17.38	8.27	23.78	12
	Alkalinity	3.3	0.92	3.4	1.8	4.5	12
	Turbidity	8.32	3.70	7.85	3.8	17	12
	BOD	3.10	1.10	3.1	2	4.2	3
	TKN	0.54	0.23	0.475	0.23	0.94	12
	NH3 / NH4	0.11	0.02	0.11	0.07	0.15	11
	NO3 / NO2	0.07	0.05	0.053	0.023	0.2	9
	Total Phosphorus	0.06	0.03	0.048	0.028	0.14	12
	Fecal Coliform	122.08	143.59	85.5	2	520	12
	TSS	9.90	7.80	8.35	2.8	33	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	10.00	N/A	10	10	10	1
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	4.80	N/A	4.8	4.8	4.8	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.26	N/A	0.26	0.26	0.26	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.01	N/A	0.012	0.012	0.012	1

SUMMARY STATISTICS

Sample Location	NWSV-325	Upper Three Runs and Road A					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	6.62	0.60	6.43	5.93	7.8	12
	DO	7.68	1.66	7.61	4.41	10.43	12
	Water Temperature	17.01	4.73	17.48	9.11	22.87	12
	Alkalinity	2.09	0.97	2.05	0	3.8	10
	Turbidity	5.23	3.19	4.7	2.3	14	12
	BOD	3.35	1.20	3.35	2.5	4.2	2
	TKN	0.34	0.21	0.26	0.17	0.82	9
	NH3 / NH4	0.06	0.01	0.0625	0.053	0.082	6
	NO3 / NO2	0.17	0.06	0.15	0.084	0.3	12
	Total Phosphorus	0.03	0.01	0.034	0.02	0.054	9
	Fecal Coliform	236.42	347.91	135	35	1300	12
	TSS	5.62	3.17	5.15	1.8	13	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	2.50	N/A	2.5	2.5	2.5	1
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.52	N/A	0.52	0.52	0.52	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.02	N/A	0.018	0.018	0.018	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.01	N/A	0.011	0.011	0.011	1

Sample Location	NWSV-327	Steel Creek at Road A					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	7.11	0.49	7.16	6.21	7.73	12
	DO	7.64	1.18	7.60	6.14	10.08	12
	Water Temperature	17.56	6.07	17.26	6.69	26.12	12
	Alkalinity	21.42	2.71	22.00	17	26	12
	Turbidity	3.42	1.44	3.05	1.9	6.8	12
	BOD	3.15	0.78	3.15	2.6	3.7	2
	TKN	0.31	0.09	0.27	0.22	0.48	10
	NH3 / NH4	0.07	0.02	0.07	0.058	0.11	9
	NO3 / NO2	0.12	0.15	0.07	0.028	0.54	12
	Total Phosphorus	0.03	0.00	0.03	0.02	0.032	5
	Fecal Coliform	112.08	61.30	98.00	45	240	12
	TSS	3.89	2.53	3.30	1.2	9.3	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	3.3	N/A	3.30	3.3	3.3	1
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.44	N/A	0.44	0.44	0.44	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.04	N/A	0.042	0.042	0.042	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	N/A	N/A	N/A	N/A	N/A	0

SUMMARY STATISTICS

Sample Location	NWSV-328	Lower Three Runs at Patterson Mill Road					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	7.01	0.52	7.08	6.2	7.82	12
	DO	7.84	1.18	7.66	6.25	9.85	12
	Water Temperature	16.01	5.56	16.83	6.76	23.73	12
	Alkalinity	41.42	7.91	41.00	30	54	12
	Turbidity	3.31	2.50	2.60	1.6	11	12
	BOD	2.60	0.00	2.60	2.6	2.6	2
	TKN	0.30	0.09	0.28	0.17	0.44	10
	NH3 / NH4	0.06	0.01	0.06	0.05	0.084	7
	NO3 / NO2	0.21	0.36	0.08	0.025	1.3	12
	Total Phosphorus	0.03	0.01	0.03	0.021	0.057	10
	Fecal Coliform	242.00	153.27	180.00	74	560	12
	TSS	5.07	5.04	3.70	1.4	20	12
	Chromium	0.01	N/A	0.01	0.0069	0.0069	1
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	4.90	N/A	4.90	4.9	4.9	1
	Cadmium	0.0005	N/A	0.0005	0.0005	0.0005	1
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	1.00	N/A	1.00	1	1	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.13	N/A	0.13	0.13	0.13	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.01	N/A	0.01	0.014	0.014	1

Sample Location	NWSV-2027	Upper Three Runs at Road 2-1					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	6.09	0.68	6.05	5.22	7.34	12
	DO	7.77	0.82	7.67	6.46	9.27	12
	Water Temperature	16.69	3.76	16.69	10.15	21.13	12
	Alkalinity	1.20	N/A	1.20	1.2	1.2	1
	Turbidity	2.63	1.96	2.10	1.1	8.5	12
	BOD	2.30	N/A	2.30	2.3	2.3	1
	TKN	0.27	0.13	0.23	0.16	0.56	9
	NH3 / NH4	0.06	0.01	0.06	0.057	0.078	3
	NO3 / NO2	0.26	0.03	0.26	0.21	0.3	12
	Total Phosphorus	0.03	0.01	0.03	0.022	0.046	4
	Fecal Coliform	188.42	384.25	63.50	25	1400	12
	TSS	3.18	1.38	2.85	1.8	6.8	12
	Chromium	0.01	N/A	0.01	0.0052	0.0052	1
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	N/A	N/A	N/A	N/A	N/A	0
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.67	N/A	0.67	0.67	0.67	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.07	N/A	0.07	0.066	0.066	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.01	N/A	0.01	0.012	0.012	1

SUMMARY STATISTICS TOC

Sample Location	NWSV-2039	Fourmile Branch at Road A-13.2					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	6.98	0.40	6.96	6.36	7.61	12
	DO	8.36	1.42	8.04	6.84	11.14	12
	Water Temperature	16.80	5.80	16.69	6.07	24.7	12
	Alkalinity	18.08	5.38	16.00	12	32	12
	Turbidity	3.43	1.85	2.95	1.3	8.5	12
	BOD	2.35	0.35	2.35	2.1	2.6	2
	TKN	0.39	0.20	0.34	0.11	0.86	10
	NH3 / NH4	0.07	0.02	0.07	0.058	0.1	5
	NO3 / NO2	0.77	0.45	0.66	0.24	1.7	12
	Total Phosphorus	0.09	0.04	0.08	0.04	0.2	12
	Fecal Coliform	155.08	330.20	53.50	17	1200	12
	TSS	3.73	4.57	2.55	1	18	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	4.50	N/A	4.50	4.5	4.5	1
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.92	N/A	0.92	0.92	0.92	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	0.04	N/A	0.04	0.04	0.04	1
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	N/A	N/A	N/A	N/A	N/A	0

Sample Location	NWSV-2047	Pen Branch at Road A-13.2					
		AVG	STDEV	Median	Min	Max	n
Monthly Parameters	pH	7.07	0.53	6.84	6.42	8.19	12
	DO	8.57	1.50	8.42	6.72	11.29	12
	Water Temperature	16.92	5.91	16.44	6.11	25.91	12
	Alkalinity	19.08	2.47	20.00	14	22	12
	Turbidity	4.99	2.85	4.15	2	12	12
	BOD	N/A	N/A	N/A	N/A	N/A	0
	TKN	0.26	0.11	0.24	0.1	0.43	11
	NH3 / NH4	0.06	0.01	0.06	0.052	0.07	6
	NO3 / NO2	0.20	0.11	0.17	0.049	0.46	12
	Total Phosphorus	0.03	0.01	0.03	0.02	0.048	10
	Fecal Coliform	94.33	65.86	76.50	17	280	12
	TSS	5.18	4.65	3.45	1.5	17	12
	Chromium	N/A	N/A	N/A	N/A	N/A	0
	Mercury	N/A	N/A	N/A	N/A	N/A	0
Quarterly Parameters	TOC	4.2	N/A	4.2	4.2	4.2	1
	Cadmium	N/A	N/A	N/A	N/A	N/A	0
	Copper	N/A	N/A	N/A	N/A	N/A	0
	Iron	0.3	N/A	0.3	0.3	0.3	1
	Lead	N/A	N/A	N/A	N/A	N/A	0
	Manganese	N/A	N/A	N/A	N/A	N/A	0
	Nickel	N/A	N/A	N/A	N/A	N/A	0
	Zinc	0.03	N/A	0.03	0.03	0.03	1

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 movement 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 publicly 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 it’s 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 publicly 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 17 locations at SRS in 2009 with the cooperation of DOE-SR personnel. SRS sediment sampling locations are illustrated in Section 4.0, Map 1. Split samples were collected from seven stream locations on SRS and from four stormwater basins. These locations are not publicly accessible. Samples were collected from three separate area locations along Upper Three Runs Creek and SRS Road C (SV-2071) and upper Three Runs Creek and Road C-4 (SV-2073). This triplicate sampling at each location was conducted to determine if radionuclide concentrations decreased at different intervals on a downstream gradient. Creek mouth sediment samples at five publicly accessible locations along the Savannah River, as well as one location upstream of SRS, were also co-sampled (Section 2.5.3, Table 1). ESOP independently sampled four random perimeter sediments and six random background sediments (Section 2.5.3, Table 2). Additional sediment samples from ten publicly accessible boat landings along the Savannah River were collected. Seven of the landings chosen were downstream of SRS and three were chosen upstream as background samples (Section 2.5.3, Table 3). These sites were selected due to public exposure to sediments through sporting and recreational activities. Additional sampling was conducted at potential public exposure locations along tributaries of Lower Three Runs Creek in Allendale County and Barnwell County (Section 2.5.3, Table 4).

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 locations, boat landings, and Lower Three Runs tributary locations were analyzed for gross alpha, gross beta, and gamma only. Isotopic analysis was conducted on three 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 the result of accumulation over many years and do not represent yearly depositions.

In addition to sediment analysis, ESOP measured Cs-137 levels with a portable sodium iodide (NaI) detector in two of the three transects developed in 2007. A third transect was inaccessible due to extensive storm damage in 2008 and 2009. A comparison of yearly in-situ Cs-137 measurements using a portable NaI detector will be necessary in order to trend Cs-137 in-situ data.

Offsite sampling was to be initiated as part of a monitoring program prior to the beginning of operations at the Mixed Oxide Fuel Fabrication Facility (MFFF) on SRS. These preliminary results will provide background data that can be compared to additional samples that are collected after MFFF operations begin. Plutonium and uranium speciation will be performed on three samples each from within the 50-mile perimeter of SRS and the SC background area (near the 50 mile perimeter) to establish baseline data prior to MFFF operation.

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 and the publicly accessible Savannah River warrants these monitoring efforts.

RESULTS AND DISCUSSION

Radiological Parameter Results

SCDHEC 2009 radiological data can be found in Section 6.0 and statistical data can be found in Section 7.0.

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 I-129, Tc-99, Plutonium-238 (Pu-238), Plutonium-239/240 (Pu-239/240), Uranium-234 (U-234), Uranium-235 (U-235), and Uranium-238 (U-238). A complete list of gamma-emitting radionuclides that SCDHEC analyzed for in 2009 can be found in Section 2.5.3, Table 5.

Gamma spectroscopy led to detections of man-made radionuclides. On average, Cs-137 levels were highest in samples collected from SRS stormwater basins, followed by the creek mouth samples and on-site SRS streams (Section 2.5.3, Figure 1). Savannah River sediments collected upstream and downstream of SRS had similar Cs-137 levels with elevated concentrations occurring at several creek mouths along the SRS boundary (Section 2.5.3, Figure 2). There were no detections for Cs-137 in any random sample or samples collected from the LTR tributaries (Section 2.5.3, Figure 1). Cesium was detected in five on-site non-publicly accessible SRS stream sediment samples at an average of 0.504 (± 0.528) picocuries per gram (pCi/g) and ranged from 0.136 to 1.362 pCi/g. The highest detection was located at Lower Three Runs at Patterson Mill Rd (SV-328). All four of the stormwater basins sampled had detections with an average of 1.78 (± 2.24) pCi/g and ranging from 0.103 pCi/g (E-002) to 4.86 pCi/g (Z Basin).

Samples collected from four of the five publicly accessible creek mouths had Cs-137 detections averaging 0.733 (± 0.840) pCi/g and ranged from 0.048 pCi/g at Upper Three Runs creek mouth (SV-2011) to 1.80 pCi/g at Steel Creek creek mouth (SV-2017). Four of the boat landings detected Cs-137 at an average of 0.472 (± 0.595) pCi/g and ranged from 0.046 pCi/g at Johnson's Boat Landing (SV-2080) to 1.345 pCi/g at Little Hell Landing (SV-2019).

The samples from the Savannah River and creek mouths along the SRS boundary show that elevated Cs-137 occurs in several SRS creek mouths, but returns to lower levels immediately downstream of SRS. Figure 2 in Section 2.5.3 illustrates Cs-137 activity in sediment samples collected from public boat landings upstream and downstream of SRS as well as the creek mouths of SRS.

Americium-241 was detected in only one sample in 2009 (SME-002, 0.211 (±0.096) pCi/g)).

Results for europium-155 and manganese-54 could not be reported due to interference from the naturally occurring actinium-228 in the gamma spectroscopy. These radiological false positives occur because a naturally occurring nuclide, or combination of nuclides, may cause gamma instrument software to report a false positive of a reactor product (WSRC 2003).

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 was detected in the three samples collected from Upper Three Runs Creek. One of the three samples collected from SV-2071 had a detection of 26.1 (±17.0 2SD) pCi/g. Two of three samples from SV-2073 had detections (40.7 (±19.8 2SD) pCi/g and 38.4 (±18.6 2SD) pCi/g). There were two detections from the stormwater basins E-002 (39.5 (±19.2 2SD) pCi/g) and Z-Basin (22.3 (±15.6 2SD) pCi/g). Two of the Lower Three Runs tributary locations, LTRT2 and LTRT3, had detections of 17.5 (±12.5 2SD) pCi/g and 19.4 (±13.8 2SD) pCi/g, respectively. There were no detections from samples collected from the creek mouths or the boat landings.

One random perimeter sample (E41 in Aiken County) had a detection of 24.0 (±15.7 2SD) pCi/g. There were no detections in any random background samples collected.

Gross non-volatile beta was detected in seven on-site SRS stream locations. Activities ranged from 11.8 (±5.46 2SD) pCi/g to 25.7 (±6.05 2SD) pCi/g. These detections occurred in samples collected from SV-2073. Two creek mouth locations, SV-2015 (9.82 (±15.8 2SD) pCi/g) and SV-2017 (15.8 (±5.42 2SD) pCi/g), had detections. Two stormwater basins, E-002 (11.9 (±5.32) pCi/g) and Z-Basin (9.24 (±4.43 2 SD) pCi/g) had detections. Five boat landings had detections. Activities ranged from 10.4 (± 5.38 2SD) at SBL002 to 17.0 (± 5.81 2SD) at LHL002. There were no gross beta detections from samples collected from the Lower Three Runs tributaries.

There were no gross-beta detections from the random perimeter samples although there were three detections among the background samples. Activities ranged from 11.1 (±4.96 2SD) pCi/g at B38 in Laurens County to 17.3 (±5.43 2SD) pCi/g at B40 in Laurens County.

Isotopic analysis of Pu-238, Pu-239/240, U-234, U-235, and U-238 was performed on samples from McQueen Branch at Monroe Owens Road (SV-2069), Fourmile Branch at SC Highway 125 (SV-2049), SV-2071, SV-2073, and Z-Basin. Additional isotopic analysis of Tc-99 and I-129 was performed on samples from SV-2069 and Z-Area basin.

Plutonium-238 and Pu-239/240 were detected at all locations except Z Basin. Samples collected from SV-2071 had the highest and lowest Pu-238 activities (0.010 (± 0.005 2SD) pCi/g to 0.292 (±0.046 2SD) pCi/g). Plutonium-239/240 was detected at seven locations with a minimum of 0.003 (±0.003 2SD) pCi/g at SV-2071 and a maximum of 0.218 (±0.046 2SD) pCi/g at SV-2073. Uranium-234 was detected at all locations and ranged from a minimum of 0.179 (±0.042 2SD) pCi/g at SV-2049 to a maximum of 2.76 (±0.350 2SD) pCi/g at SV-2073. Uranium-235 was detected at seven locations and ranged from 0.012 (±0.013 2SD) pCi/g at SV-2049 to 0.272

(±0.088 2 SD) at SV-2069. Uranium-238 was detected at all locations with a minimum of 0.206 (±0.044 2SD) at SV-2071 and a maximum of 3.515 (±0.438 2SD) pCi/g at SV-2073. No Tc-99 or I-129 was detected in any sample.

Samples collected for MFFF baseline monitoring had detections for Pu-238, Pu-239/240, U-234, U-235, and U238. A random sample from B27 did not have a detection for Pu-239/240. These results will be used for future comparisons after MFFF operations have begun.

Nonradiological Parameter Results

A United States Environmental Protection Agency (USEPA) Target Analyte List of 24 metals was analyzed in all of the SRS stream locations, the creek mouth locations, and the stormwater basins in 2009. 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 6. 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).

While many samples exceeded the ESV, most metals found in SRS stream sediments were lower than those found in the creek mouths on the Savannah River. A graph depicting the metal averages for all sample types can be found in Section 2.5.3, Figure 6.

All chromium, copper, lead, manganese, and nickel were below the ESV. All samples were below the ESV for zinc with the exception of the stormwater basin SME-002 and SM Z-Basin. The ESV for barium and cadmium was exceeded in the average of detections for all sample locations. The ESV for mercury was exceeded only in basin samples.

Barium was detected above the South Carolina state average of 20 in nearly all samples collected. The SRS stream average was 27.92 (±20.50) mg/kg with a minimum of 6.3 mg/kg at SV-2048 and a maximum of 61 mg/kg at SV-2069. The creek mouth average was 43.3 (±22.4) mg/kg with a minimum of 17 mg/kg at SV-2011 and a maximum of 72 mg/kg at SV-2015. The stormwater basin average was 55 (±23.9) mg/kg with a minimum of 38 mg/kg at E-001 and a maximum of 90 mg/kg at E-005.

Cadmium was found above the South Carolina state average of 0.6 mg/kg in nearly all the samples collected. There was only one detection out of 12 samples collected for the SRS stream locations (2.1 mg/kg at SV-2069). The creek mouth average was 1.88 (±0.58) mg/kg with a minimum of 1.2 mg/kg at SV-2020 and a maximum of 2.6 mg/kg at SV-2013. The stormwater basin average was 3.75 (±1.68) mg/kg with a minimum of 2.0 mg/kg at E-001 and a maximum of 5.6 mg/kg at E-005

Chromium was detected in the majority of the samples and was above the South Carolina state average of 36 mg/kg in only a few samples. The SRS stream average was 5.22 (±5.12 mg/kg) with a minimum of 1.1 mg/kg at SV-2062 and a maximum of 19 mg/kg at SV-2069. The creek mouth average was 7.25 (±3.79) mg/kg with a minimum of 2.70 mg/kg at SV-2011 and a maximum of 13 mg/kg at SV-2010. The stormwater basin average was 27.75 (±12.95) mg/kg with a minimum of 17 mg/kg at E-002 and a maximum of 43 mg/kg at Z-Basin

All 2009 samples were below the ESV of 18.7 mg/kg for copper. The SRS Stream average was 7.78 (±12.87) mg/kg with a minimum of 1.30 mg/kg at SV-2071 and a maximum of 34 mg/kg at SV-2069. The creek mouth average was 3.73 (±2.39) mg/kg with a minimum of 1.1 mg/kg at SV-2011 and a maximum of 6.9 mg/kg at SV-2013. The stormwater average was 8.58 (±4.05) mg/kg with a minimum of 4.10 mg/kg at E-001 and a maximum of 12 mg/kg at Z-Basin and E-002.

Lead was detected in only one out of 11 SRS stream samples with a detection of 7.1 mg/kg at SV-2069. There were two detections out of six creek mouth samples. The detections were 5.9 mg/kg at both SV-2010 and SV-2013. All stormwater basins yielded detections for lead. The average was 9.60 (±3.26) mg/kg with a minimum of 6.30 mg/kg at E-001 and a maximum of 14 mg/kg at E-005.

Manganese was detected in all SRS stream, creek mouth, and stormwater basin samples. SRS stream samples had an average of 47.06 (±41.83) mg/kg with a minimum of 7.70 mg/kg at SV-2062 and a maximum of 160 mg/kg at SV-2069. Creek mouth samples had an average of 213 (±94.8) mg/kg with a minimum of 110 mg/kg at SV-2011 and a maximum of 340 mg/kg at SV-2010. The stormwater basin average was 102 (±81.34) mg/kg with a minimum of 40 mg/kg at Z-Basin and a maximum of 220 at E-002.

There was no mercury detected in any sample collected in 2009.

Nickel was detected in five of 11 SRS stream samples. The SRS stream average was 5.58 (±2.11) mg/kg with a minimum of 2.8 mg/kg at SV-2071 and a maximum of 7.7 mg/kg at SV-2073. The creek mouth average was 4.10 (±2.01) mg/kg with a minimum of 2.2 mg/kg at SV-2020 and a maximum of 7.1 mg/kg at SV-2013. The stormwater basin average was 5.23 (±1.82) 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 nine of 11 SRS stream samples and in all creek mouth and stormwater basin samples. The SRS stream average was 13.32 (±12.98) mg/kg with a minimum of 2.5 mg/kg at SV-328 and a maximum of 46 mg/kg at SV-2069. The creek mouth average was 17.3 (±8.42) mg/kg with a minimum of 6.9 mg/kg at SV-2011 and a maximum of 28 mg/kg at SV-2015. The stormwater basin average was 109.25 (±103.08) mg/kg with a minimum of 21 mg/kg at E-001 and maximum of 230 mg/kg at E-002.

SCDHEC nonradiological sediment data can be found in Section 2.5.4 and nonradiological statistical data can be found in Section 2.5.5. A statistical summary can be found in Section 2.5.3, Table 8.

Sodium Iodide (NaI) Detector Results

Data was collected with a NaI detector for two of the three sampling transects established in 2007 in order to ascertain levels of Cs-137 in the floodplains of LTR and Steel Creek. The net count rate in the Cs-137 gamma ray peak was determined at each location. All transects extend across higher Cs-137 activities to background areas bisecting the floodplain. The first LTR transect (LTR 1) is located north of Patterson Mill Road. The Steel Creek transect is located on the flood plain of Creek Plantation, a privately owned land area on the southeastern border of SRS, approximately 100 meters from the Steel Creek boat ramp public access point. Data could not be collected for the second LTR transect (LTR 2), situated approximately one mile from the Savannah River, due to extensive storm damage in 2008 and 2009. Transect construction and data collection details are outlined in the ESOP Data Report for 2007. In 2007, evaluation of NaI field measurements compared to the standard laboratory analyses of Cs-137 indicated that the NaI field method provides a good indicator of areas of Cs-137 contamination (SCDHEC 2008).

Although the results for 2009 are slightly lower than the previous year, future readings will be necessary in order to trend Cs-137 in-situ data. NaI detector results can be found in Section 2.5.3, Table 8, Figure 7 and Figure 8.

SCDHEC and DOE-SR Data Comparison

Radiological data comparison of 2009 sediment samples from SCDHEC and DOE-SR resulted in similar findings. SCDHEC Cs-137 data from the SRS creek mouths were trended for 2005-2009 (Section 2.5.3, Figure 5). Average Cs-137 levels increased from 2007 to 2009. The 2009 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-ESOP split 13 SRS stream sediment and four stormwater basin sediment samples in 2009. All SCDHEC samples were analyzed for gross alpha- and gross beta-emitting particles and gamma-emitting radionuclides. Select samples (the five creek mouths, SMSV-118, SMSV-2069, SMSV-2073, and SM-Z Basin) were also analyzed for Tc-99, Pu-238, Pu-239. Additionally, SMSV-2069, SMSV-2073, and SM-Z Basin were analyzed for I-129. Nonradiological samples results by SCDHEC are discussed in Section 2.5.4 of this report.

Both agencies detected Cs-137 concentrations in SRS streams, SRS creek mouths and SRS stormwater basins. DOE-SR highest Cs-137 concentration (85.4 pCi/g) was detected in sediment from R-Canal in R Area, which is not accessible to the public. When averaging all the SRS on-site stream sediment samples, SCDHEC found 1.806 (± 2.285) pCi/g Cs-137 while DOE-SR found 8.37 pCi/g. When the Cs-137 concentration at R-Area (85.4 pCi/g) is removed from the SRS on site stream average, the mean Cs-137 SRS on site stream concentration decreases to 1.96 pCi/g .The publicly accessible Savannah River and SRS creek mouths averaged 1.110 (± 1.384) pCi/g in the SCDHEC data. DOE-SR detected Cs-137 at seven locations along the Savannah River and creek mouths at an average of 0.479 pCi/g. The average concentration of Cs-137 in the four stormwater basins sampled was found to be 0.755 (± 1.122) pCi/g by SCDHEC. DOE-SR took twelve samples from each of the seven on site stormwater basins (except EAV Basin South which was sampled nine times). Results ranged from less than MDC to a maximum Cs-137 concentration of 13.0 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 9-11 in Section 2.5.3 illustrate the findings.

SCDHEC had one Am-241 detection at SMSV-2073 (0.382 pCi/g). DOE-SR had eight detections at an average of 0.0231 pCi/g in SRS stream sediments. DOE-SR did not detect any Am-241 in the Savannah River and SRS creek mouths above the MDC. The average MDA for the 2009 SCDHEC sediment samples was 0.182 pCi/g, which is much higher than the DOE-SR minimum detectable concentration (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 2009). Only detections are averaged from the SCDHEC data.

SCDHEC did not detect any Pu-238 in the six creek mouths and Savannah River (SMSV-118) sediment samples. DOE-SR had three detections in the Savannah River and SRS creek mouths sediment samples at an average of 0.0577 pCi/g. SCDHEC detected Pu-238 in the two on-site stream sediment samples that were analyzed - SMSV-2073 (0.064 pCi/g) and SMSV-2069 (0.042 pCi/g). DOE-SR had 14 Pu-238 detections in the on-site stream sediment samples which averaged 0.0577 pCi/g. Plutonium-238 was analyzed by SCDHEC in one stormwater basin location (SM-Z Basin) and was detected at 0.010 pCi/g. DOE-SR took twelve samples from each of the seven on site stormwater basins (except EAV Basin North which was sampled nine times). DOE-SR on site stormwater basins detections averaged 0.028 pCi/g for Pu-238. The average MDC for the 2009 SCDHEC sediment samples was 0.0157 pCi/g, which is higher than the DOE-SR representative MDC of 0.0029 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 MDC.

SCDHEC had one Pu-239 detection from the six creek mouth and Savannah River sediment samples at SMSV-2011 (0.017 pCi/g). DOE-SR did not detect any Pu-239 in the Savannah River and SRS creek mouths above the MDC. SCDHEC detected Pu-239 in the two on-site stream sediment samples that were analyzed - SMSV-2073 (0.014 pCi/g) and SMSV-2069 (0.017 pCi/g). DOE-SR had 14 detections in on-site stream sediment samples which averaged 0.0223 pCi/g.. Plutonium-239 was analyzed by SCDHEC in one stormwater basin location (SM-Z Basin) and was detected at 0.009 pCi/g. DOE-SR took twelve samples from each of the seven on site stormwater basins (except EAV Basin South which was sampled nine times). Results ranged from less than MDC to a maximum Pu-239 concentration of 0.0441 pCi/g at Pond 400. The MDC for the 2009 SCDHEC sediment samples was 0.0169 pCi/g, which is higher than the DOE-SR representative MDC of 0.0028 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 MDC

The tables comparing results from SCDHEC and DOE-SR are in Section 2.5.3, Tables 10-11.

CONCLUSIONS AND RECOMMENDATIONS

The creek mouths of SRS are a conduit for the dispersal of radionuclides into publicly 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 radionuclide found in the sediment samples. Cesium-137 levels of 2009 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 2009 sediment samples occurred in the on-site sample collected from LTR. Past releases from SRS into LTR may account for this elevated level due to accumulation in the sediment. Four of the publicly accessible creek mouths of the SRS streams had Cs-137 activity, which was higher than average when compared to background levels. The creek mouths of Upper Three Runs and

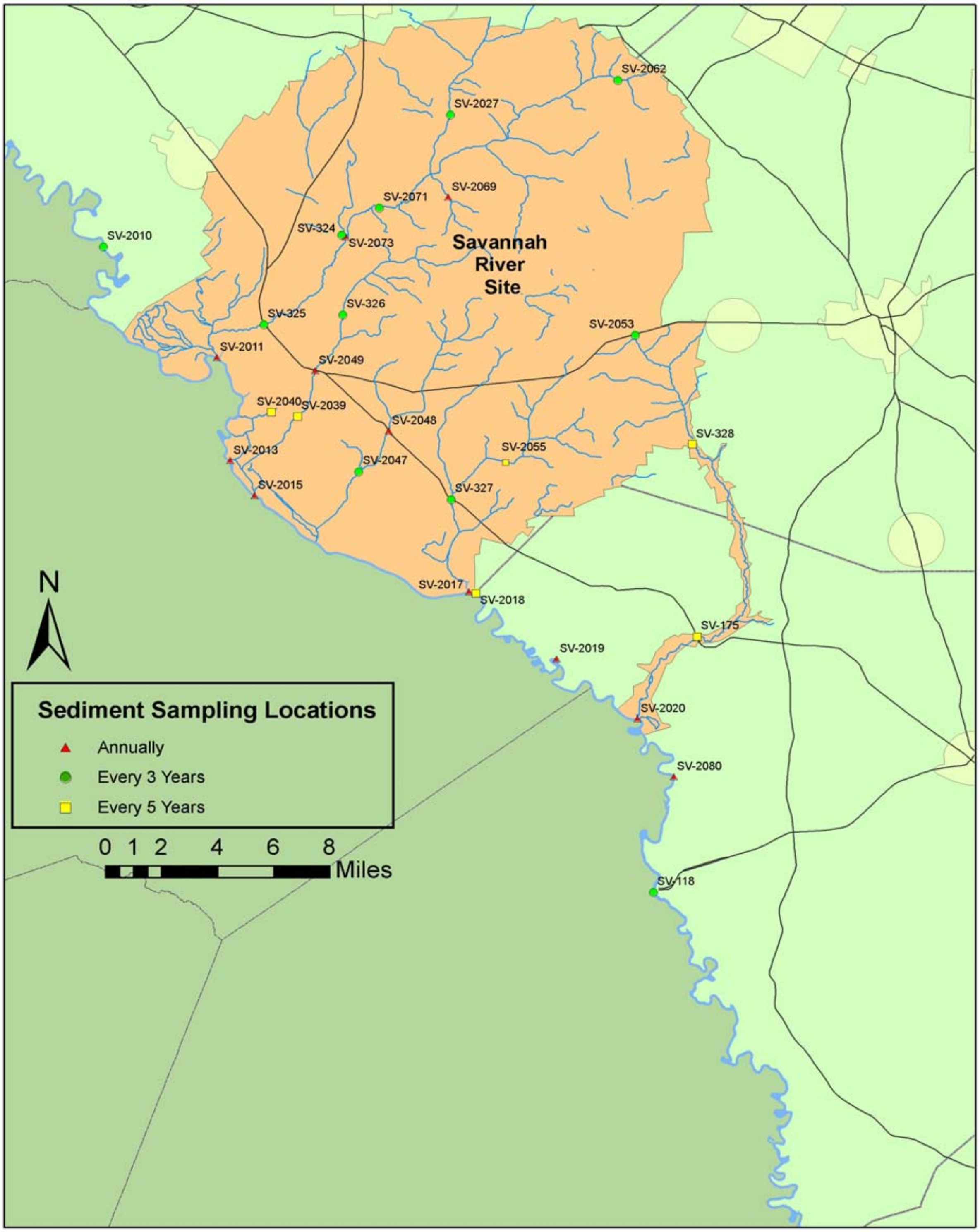
Steel Creek exhibited lower Cs-137 activity than in 2008. The 2009 levels in Upper Three Runs creek mouth were lower than in 2008. Levels in the mouth of Steel Creek were higher in 2008 than in 2009. The mouth of Fourmile Branch had lower Cs-137 in 2008 than in 2009, yet the past two years were higher than when data trending began in 2003. The creek mouth sediment of Upper Three Runs also had detectable levels of Pu-239.

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. Savannah River metals were on average higher upstream of SRS than were downstream of SRS operations. All 2008 samples were below the ESV for chromium, copper and lead. The creek mouth sediment of Upper Three Runs had ESV exceedances for mercury and nickel. Zinc was only exceeded in Z basin. Manganese ESV exceedances were found in the samples from LTR, although these levels were much lower than the sediment collected at Jackson Boat Landing, upstream of SRS on the Savannah River. Cadmium had ESV exceedances on SRS, although the highest level was found in a background sample from Oconee County. The majority of samples found barium greater than the ESV. The highest on-site sample on LTR was equal to what was found at Jackson Boat Landing. DDT was detected at levels less than the ESV in the creek mouth sediment of Upper Three Runs.

SRS sediments should continue to be monitored due to the potential of 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. Other locations will be sampled to evaluate impacts of SRS within the surrounding area. Multiple background locations are sampled for a comparison to ambient levels of radionuclides. ESOP will perform annual in-situ monitoring of the three floodplain transects and will compare data to previous results to see if Cs-137 net results are declining by natural radioactive decay or possibly increasing due to the movement of re-suspended sediment along the floodplains. Monitoring will continue at the SRS as long as there is a potential for contamination. 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 will give a more definitive answer 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 2009 ESOP Data Report. Cooperation between DOE-SR and SCDHEC provides credibility and confidence in the information being provided to the public.

2.5.2

Map 7. SRS Sediment Sampling Locations



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2.5.3 Tables and Figures

Table 1. Locations of SRS Sediment Samples

2009 ESOP Sediment Sample Locations on SRS		
Sample Location	**Location Description**	**Stream Abbr.**
SV-328	Lower Three Runs at Patterson Mill Road.	LTR
SV-2010	Savannah River @ RM 170.5 (Jackson Landing)	118
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-2062	Tinker Creek on Kennedys Pond Road	SC
SV-2069	McQueen Branch off Monroe Owens Road.	McQ
SV-2071	Upper Three Runs off USFS Rd C-4.	UTR
SV-2073	Upper Three Runs off Road C.	UTR
SME-001	E-001 E Area stormwater basin	
SME-002	E-002 E Area stormwater basin	
SME-005	E-005 E Area stormwater basin	
SME-Z BASIN	Stormwater basin in N.E. perimeter of Z Area	

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Table 2. Random Quadrant Locations

2009 Random Sediment Sampling Locations

Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.

Quad	7.5' Quad Name	Latitude by Lat and Longitude by Long	Geological Region
B33	Bradley	3400 by 3407.5 and -8207.5 by -8215	PM
B34	Greenwood	3407.5 by 3415 and -8207.5 by -8215	PM
B35	Limestone	3352.5 by 3400 and -8200 by -8207.5	PM
B38	Laurens North	3430 by 3437.5 and -8200 by -8207.5	PM
B40	Waterloo	3415 by 3422.5 and -8200 by -8207.5	PM
B41	Gilbert (50 mi.)	3352.5 by 3400 and -8122.5 by -8130	PM

Random Quadrants Within SRS Perimeter or "E" Quadrants

Quad	7.5' Quad Name	Latitude by Lat and Longitude by Long	Geological Region
E41	Windsor	3322.5 by 3330 and -8130 by -8137.5	UCP
E43	Olar	3307.5 by 3315 and -8107.5 by -8115	LCP
E48	Orangeburg N.(50 mi.)	3330 by 3337.5 and -8045 by -8052.5	UCP
E53	New Ellenton	3322.5 by 3330 and -8137.5 by -8145	UCP

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" & -81deg. 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.

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Table 3. Sediment Samples Collected from Savannah River Boat Landings in 2009

2009 Publicly Accessable Boat Landing Sediment Sampling Locations		
Sample Name	**Abbr.**	**Location Description**
Upstream of SRS		
SSFF001	FF	Fury's Ferry Boat Landing, McCormick County
SMRVP001	RVP	North Augusta Riverview Park Boat Landing, Aiken County
SSJBL002	JBL	Jackson Boat Landing, Aiken County
Downstream of SRS		
SSSCL002	SCL	Steel Creek Landing, Barnwell County
SSLHL002	LHL	Little Hell Landing, Allendale County
SSJL001	JL	Johnson's Landing, Allendale County
SS301GA002	301	Burton's Ferry Landing near HWY. 301 Bridge, Screven County, GA
SSCB001	CB	Cohen's Bluff Landing, Allendale County
SSSBL001	SBL	Stoke's Bluff Landing, Hampton County
SMMSL001	MS	Millstone Boat Landing, Jasper County

Table 4. Sediment Samples Collected Along from Lower Three Runs Tributaries.

2009 Lower Three Runs Tributary Sediment Sampling Locations		
Sample Name	**Abbr.**	**Location Description**
SMLTRT1	LTRT1	Gant's Mill Creek and SSR 80
SMLTRT2	LTRT2	Big Branch and SSR 855
SMLTRT3	LTRT3	Furse Mill and SC Highway 125

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Table 5. 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 6. 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.

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Table 7. 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

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Table 8. NaI Field Counts

LTRC 1	NaI Gross Counts	NaI Background Counts	NaI Net Counts
Location	Counts/Second	Counts/Second	Counts/Second
1	110	60	50
2	151	105	46
3	1465	564	901
4	1407	1222	185
5	391	294	97
6	1175	508	667
7	1255	532	723
8	470	221	249
9	119	56	63
10	67	35	32

Creek Plantation	NaI Gross Counts	NaI Background Counts	NaI Net Counts
Location	Counts/Second	Counts/Second	Counts/Second
1	550	249	301
2	675	383	292
3	1043	508	535
4	1108	526	582
5	1684	685	999
6	1152	554	598
7	1096	539	557
8	1127	528	599
9	1027	387	640
10	433	226	207
11	59	31	28

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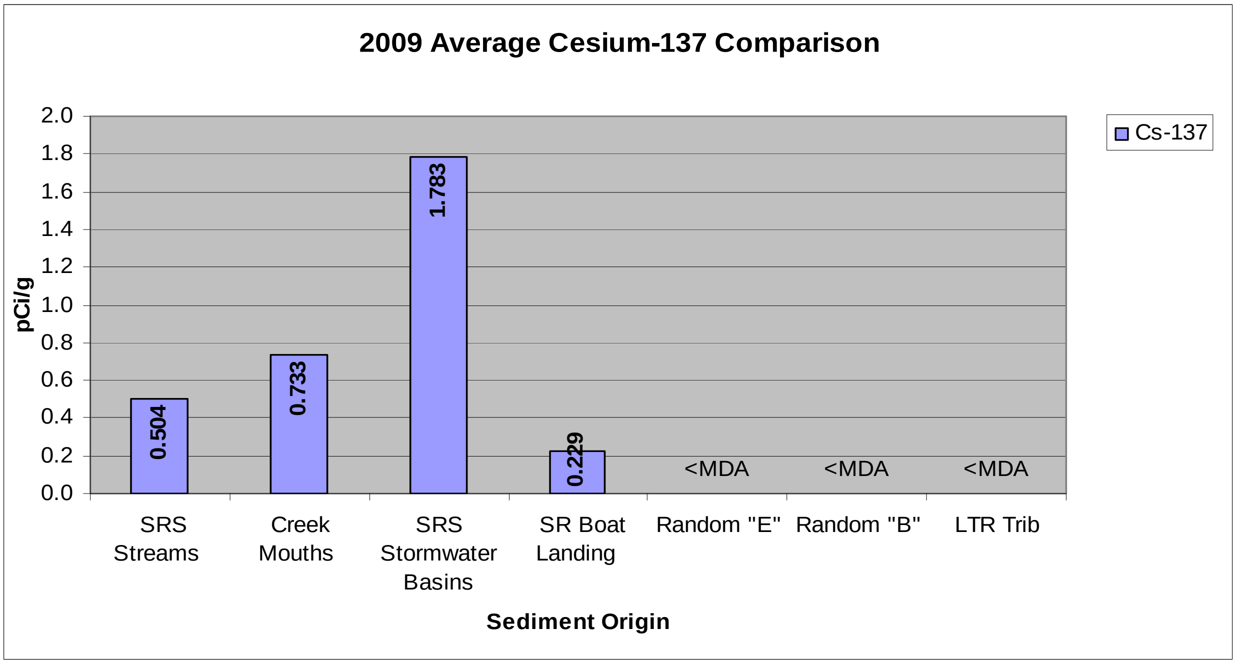
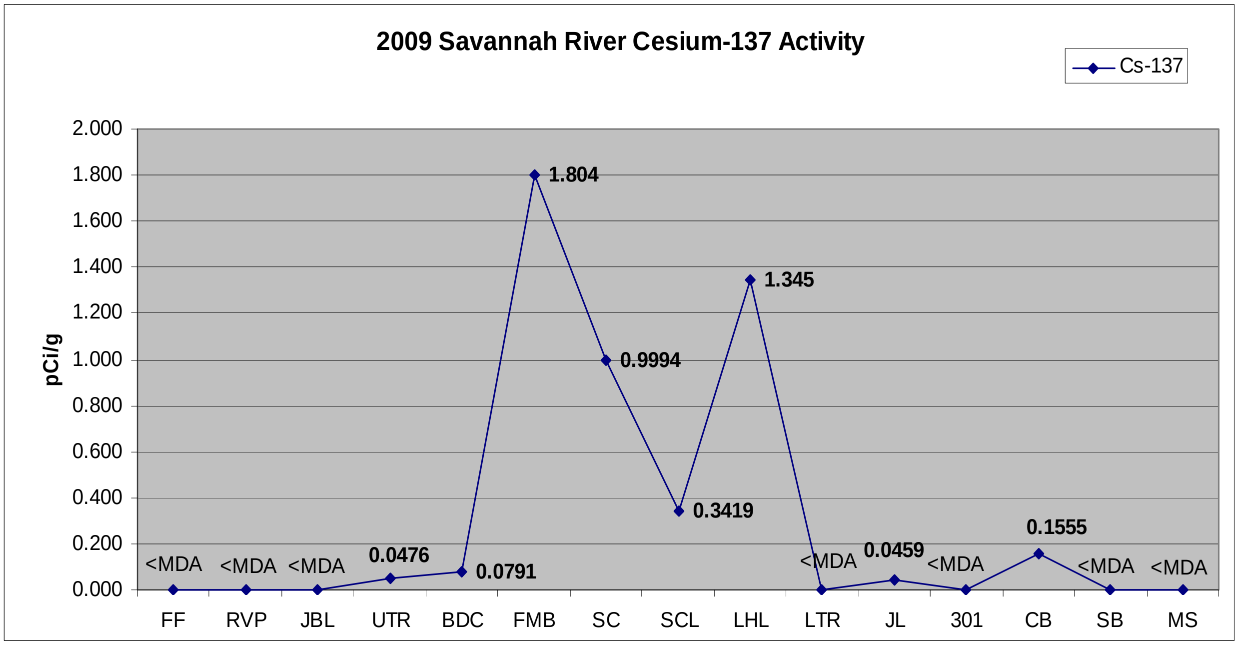
Figure 1. Comparisons of Cs-137 Activity Among Sample Groups



Note: No detections for random samples and LTR samples**.**

Figure 2. Cesium-137 Activity in Savannah River Sediment 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. No detections for FF, RVP, JBL, LTR, 301, SB, and MS.

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

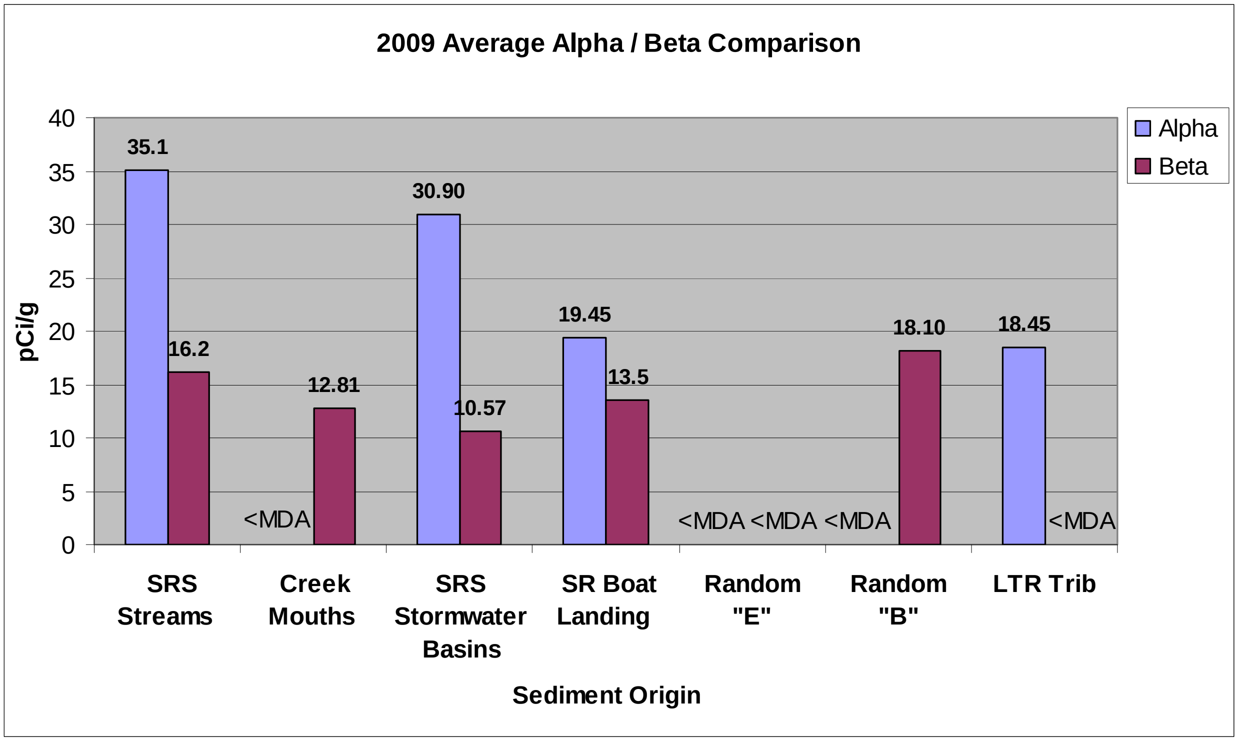

Figure 4. Results of Isotopic Analysis

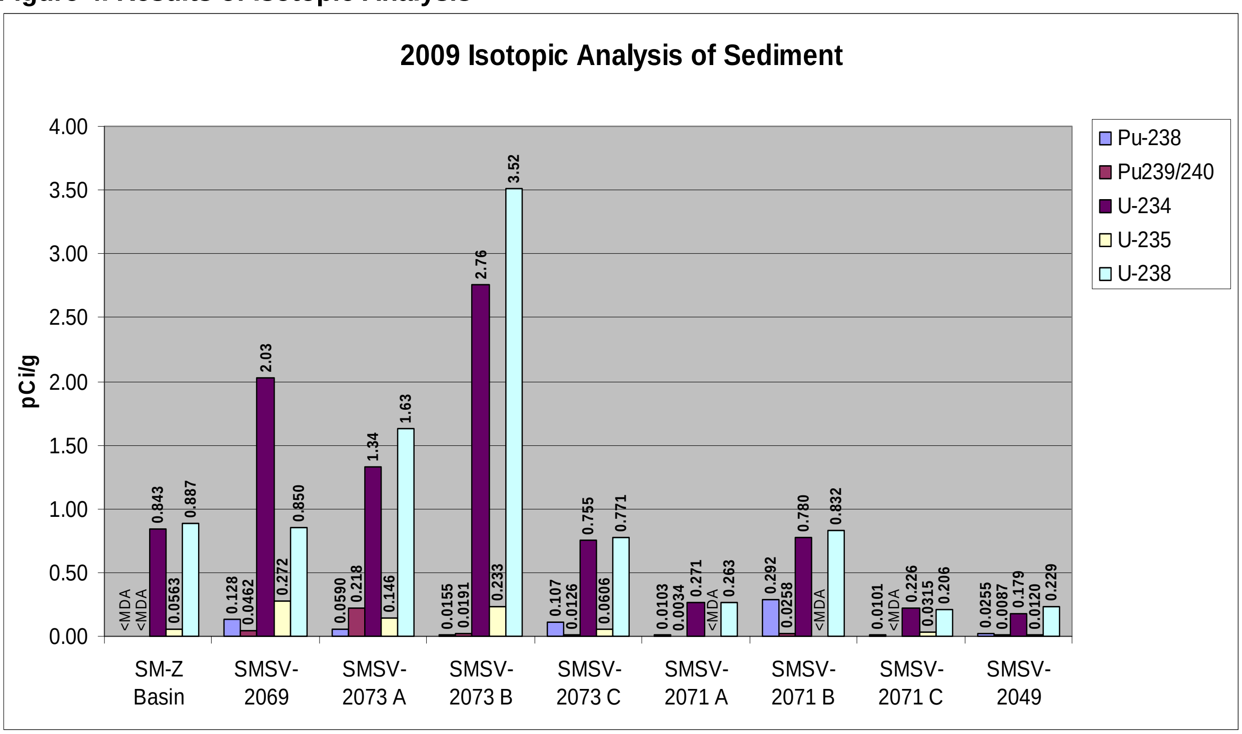

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Figure 5. Trending Data for Cs-137 in SRS Creek Mouth Samples

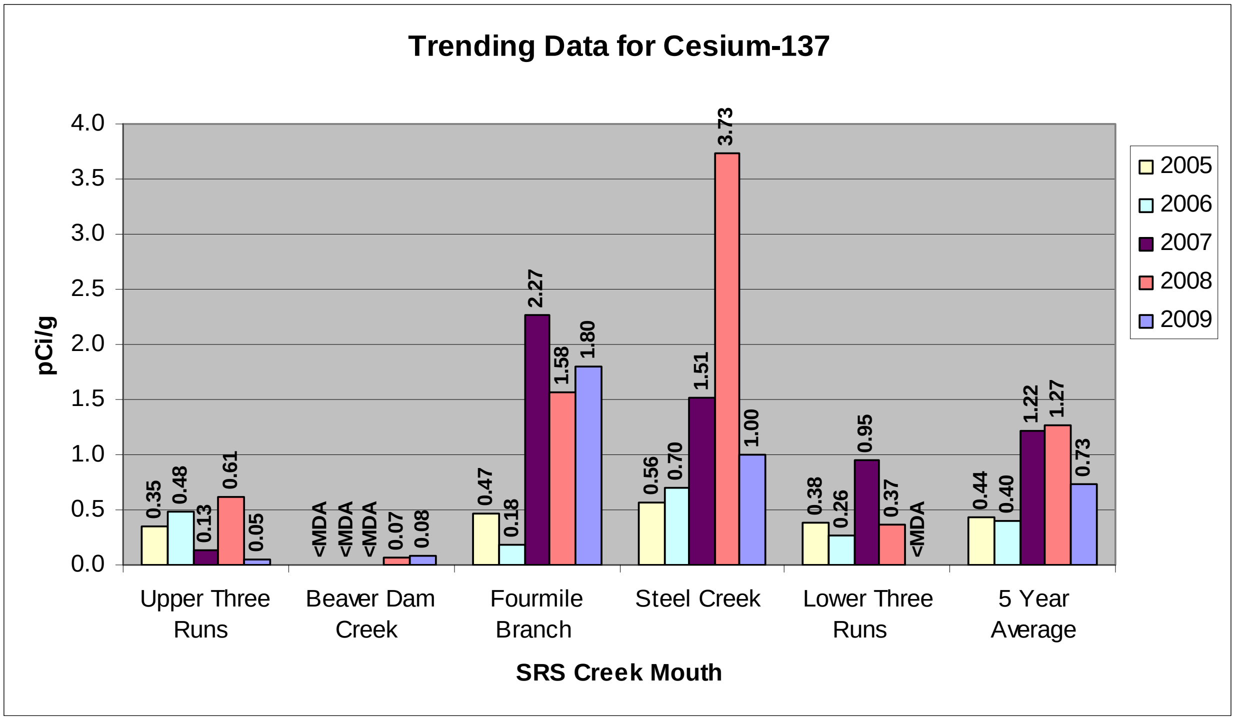

Figure 6. Comparisons of Metal Concentrations Among Sample Groups

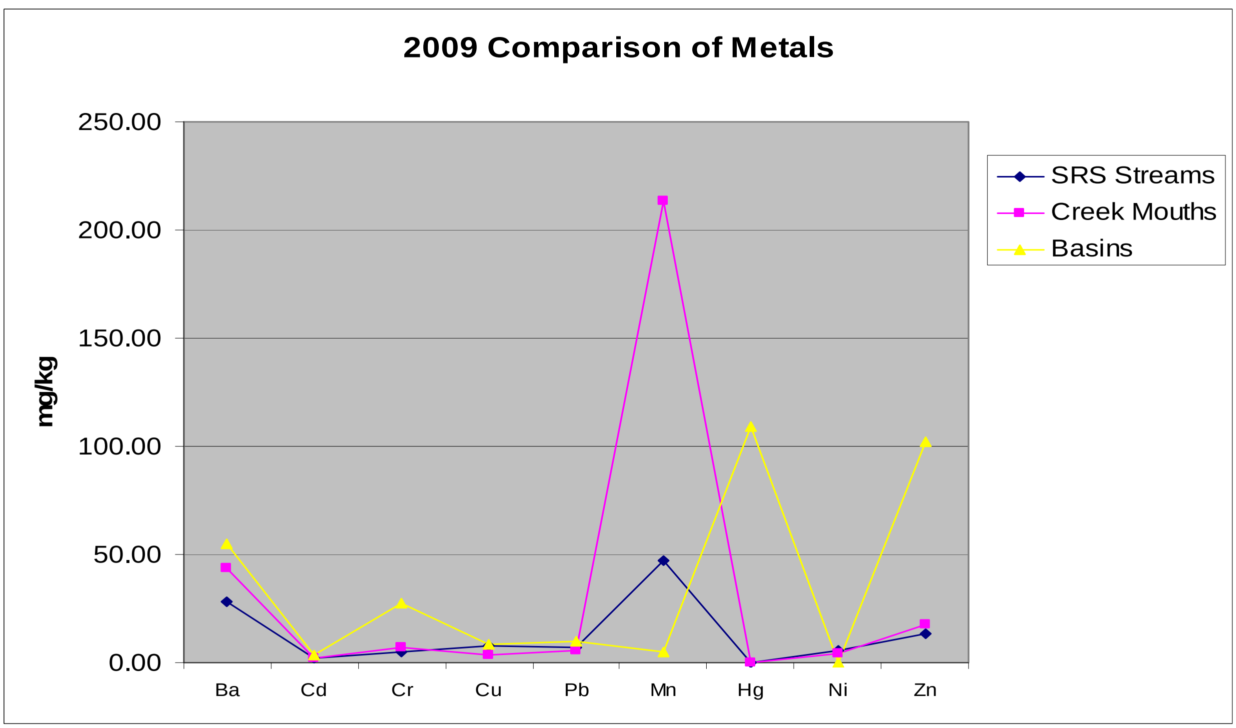

Figure 7. NaI Field Measurements for Lower Three Runs 1

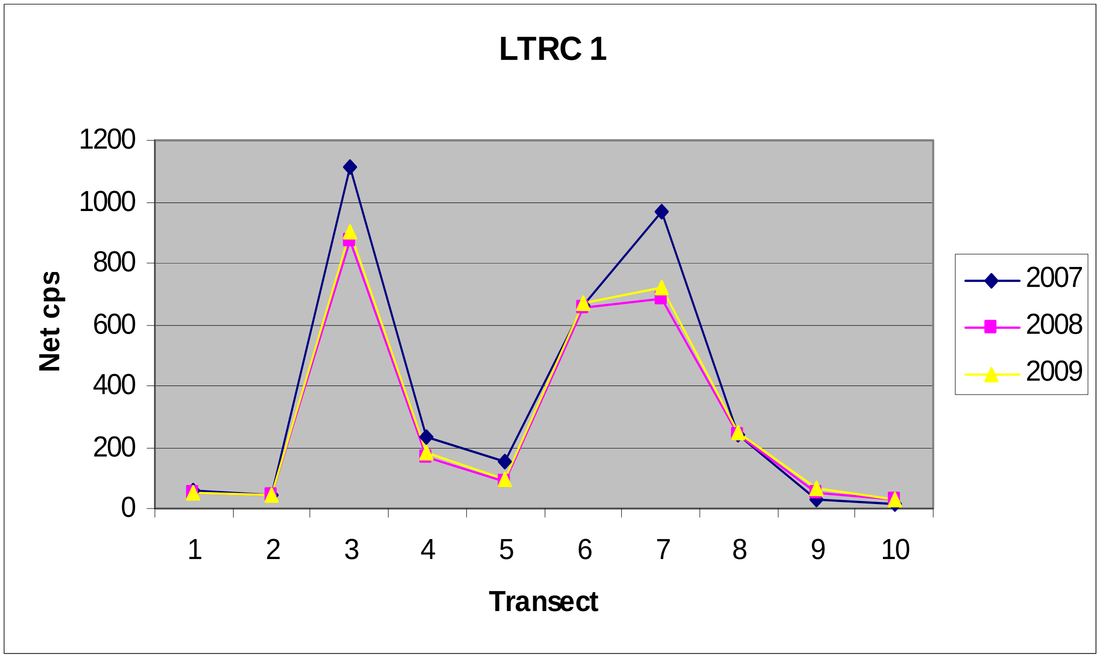

Figure 8. NaI Field Measurements for Creek Plantation

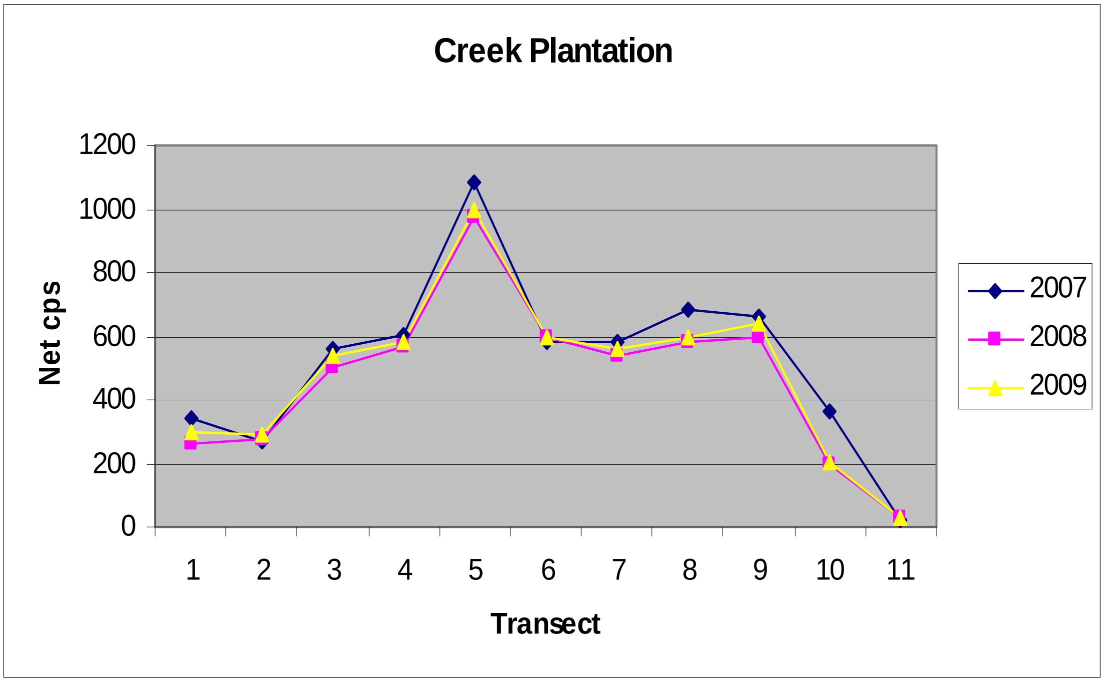

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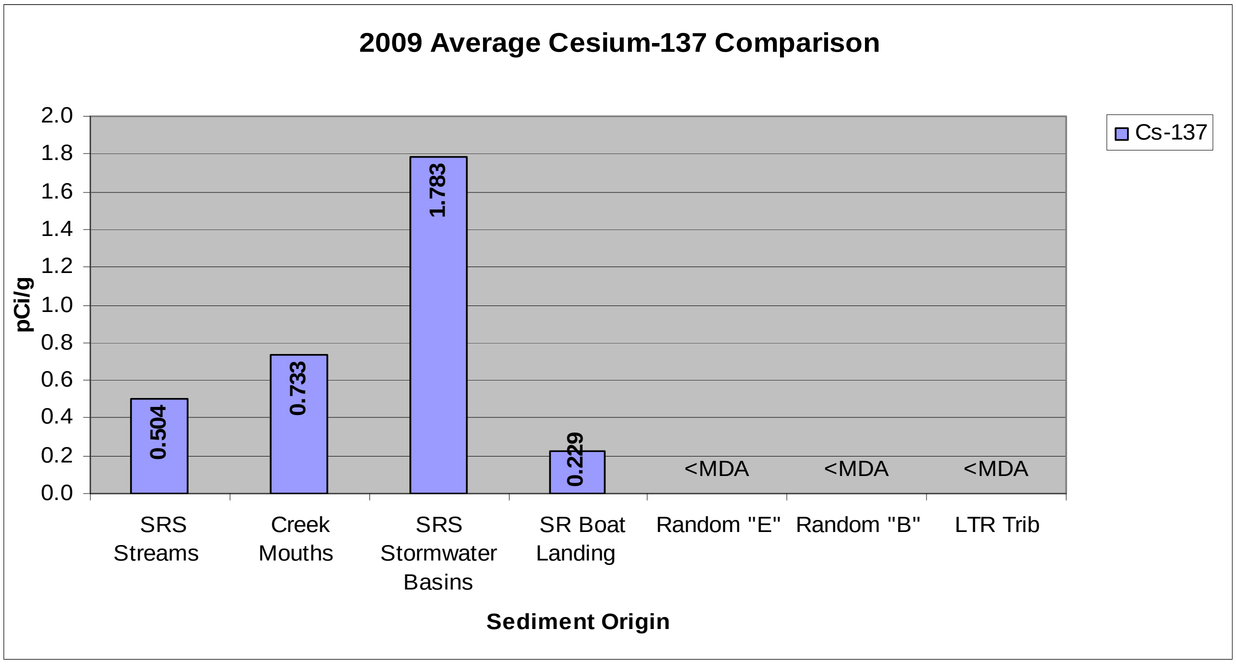
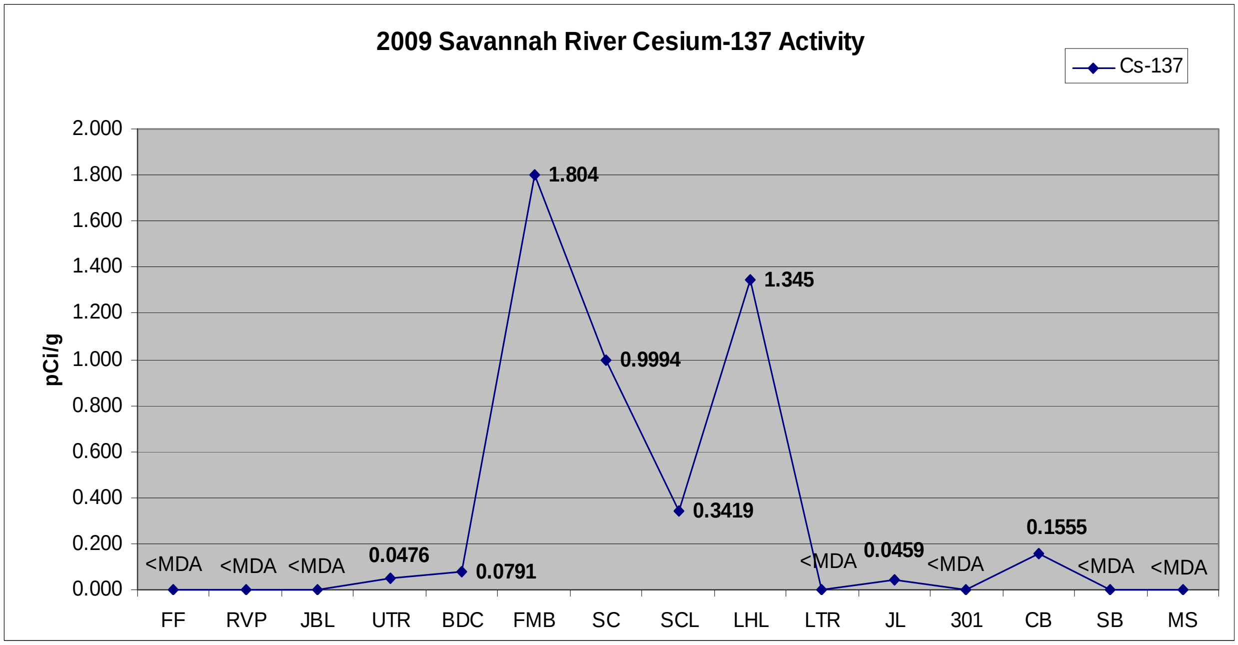
Figure 9. Comparisons of Cs-137 Activity Among Sample Groups



Note: No detections for random samples and LTR samples**.**

Figure 10. Cesium-137 Activity in Savannah River Sediment 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. No detections for FF, RVP, JBL, LTR, 301, SB, and MS.

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Figure 11. Comparisons of Gross-Alpha and Non-volatile Beta Activity Among Sample Groups

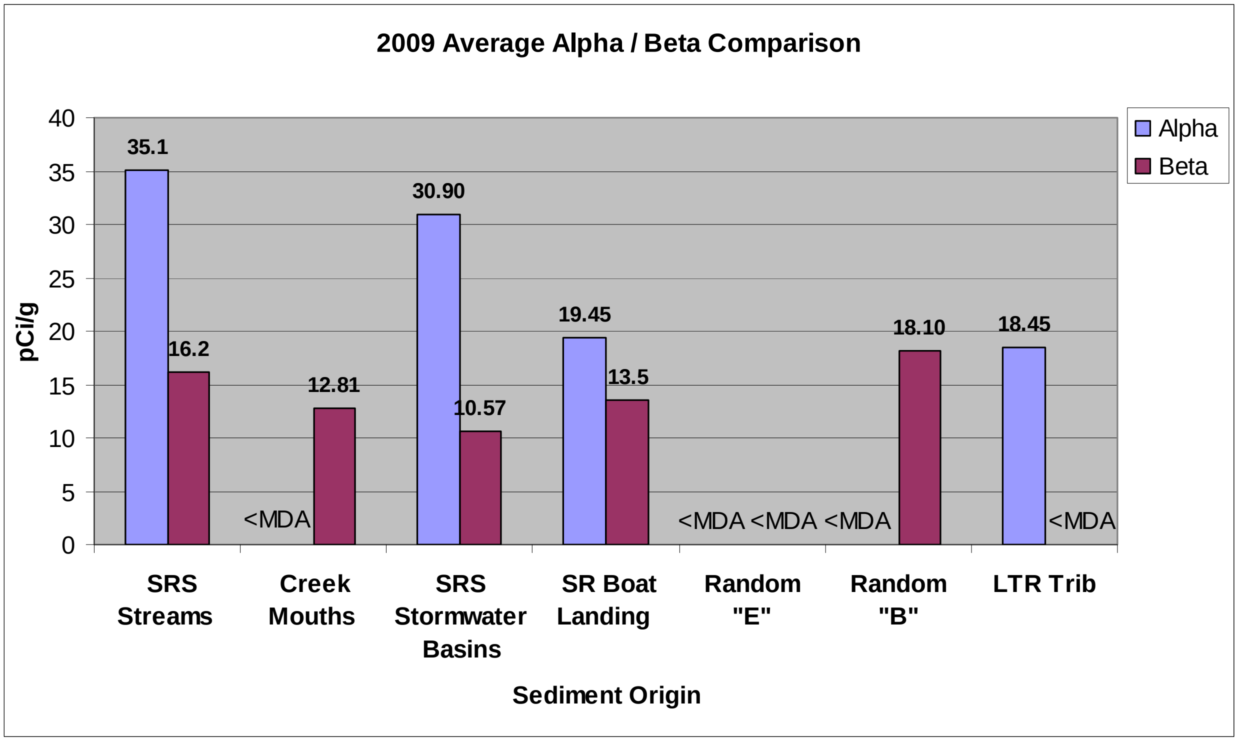

Figure 12. Results of Isotopic Analysis

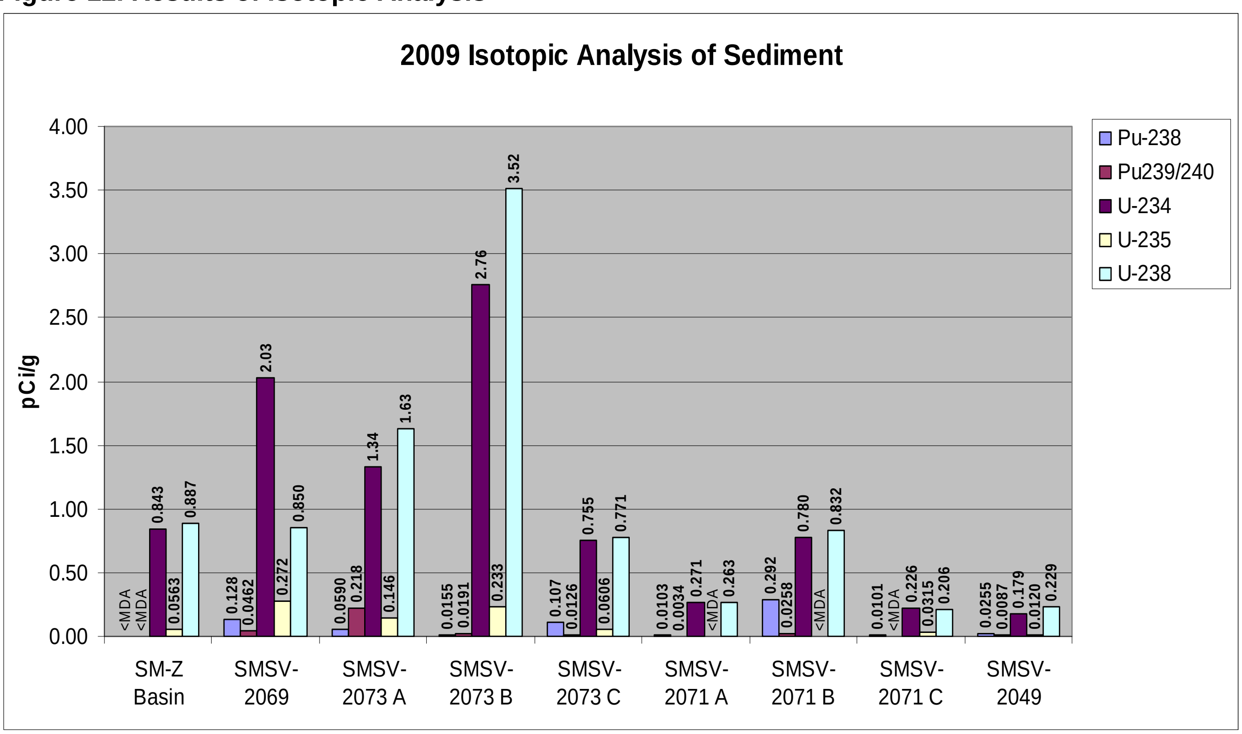

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Figure 13. Trending Data for Cs-137 in SRS Creek Mouth Samples

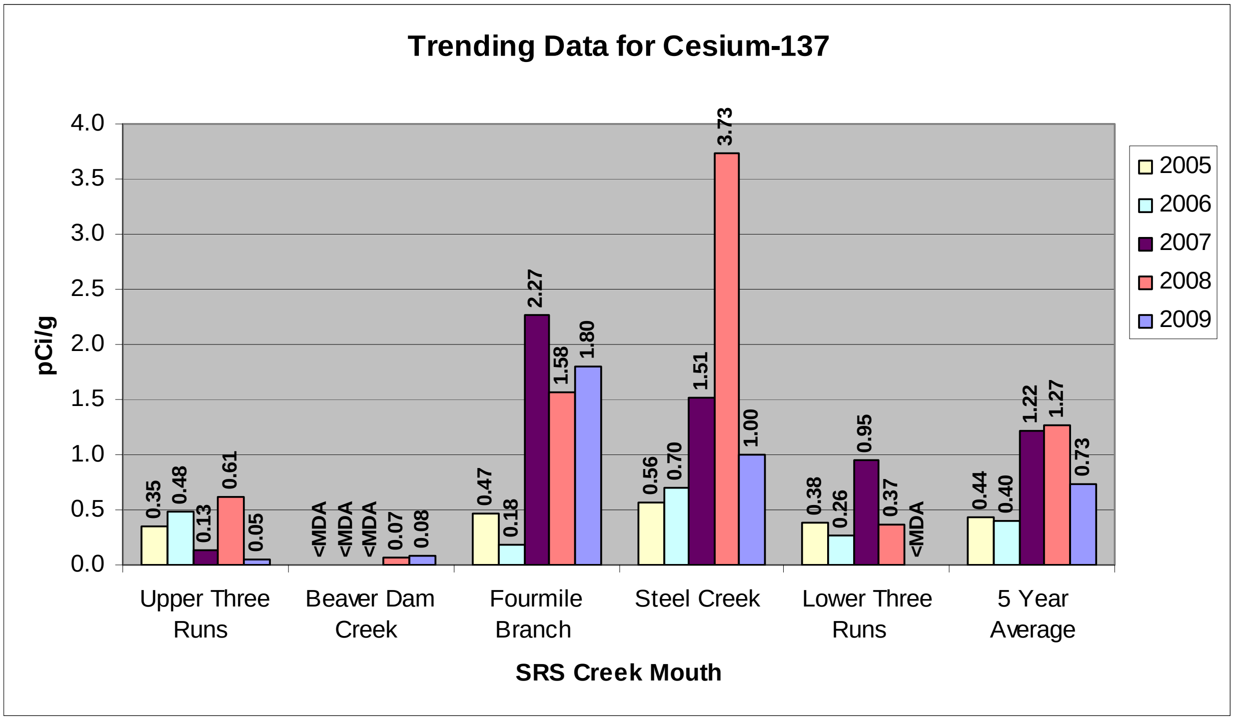

Figure 14. Comparisons of Metal Concentrations Among Sample Groups

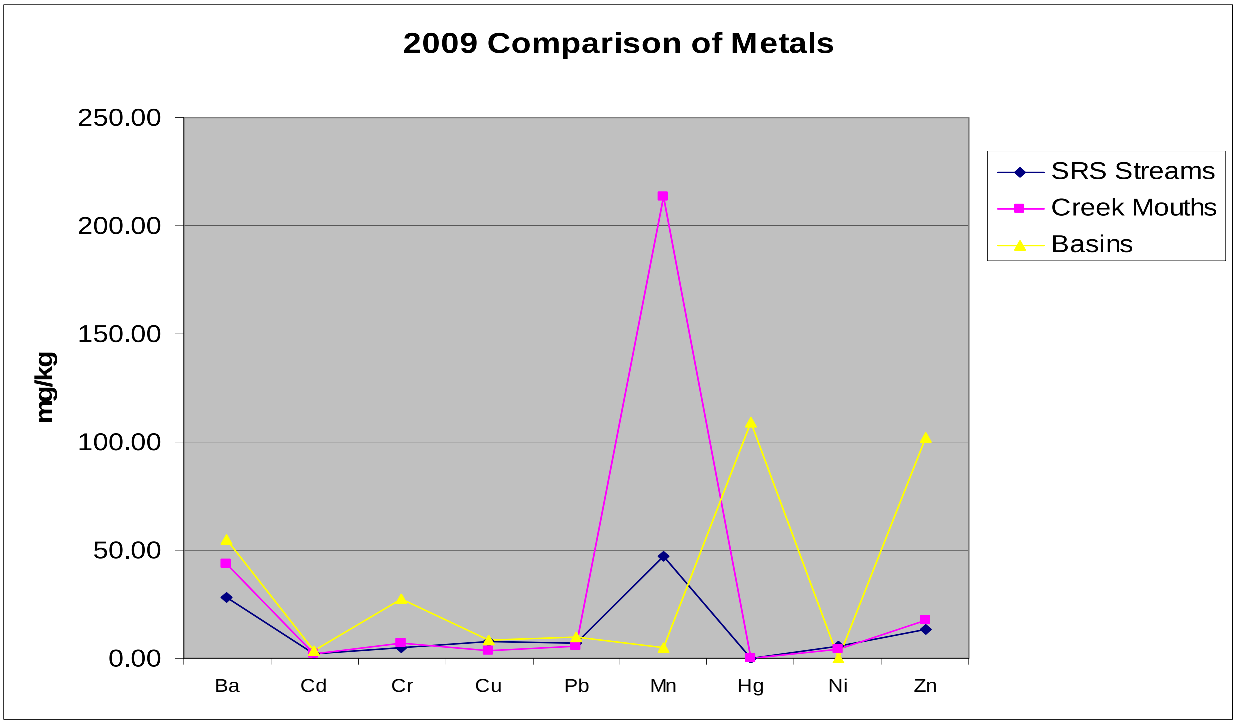

Figure 15. NaI Field Measurements for Lower Three Runs 1

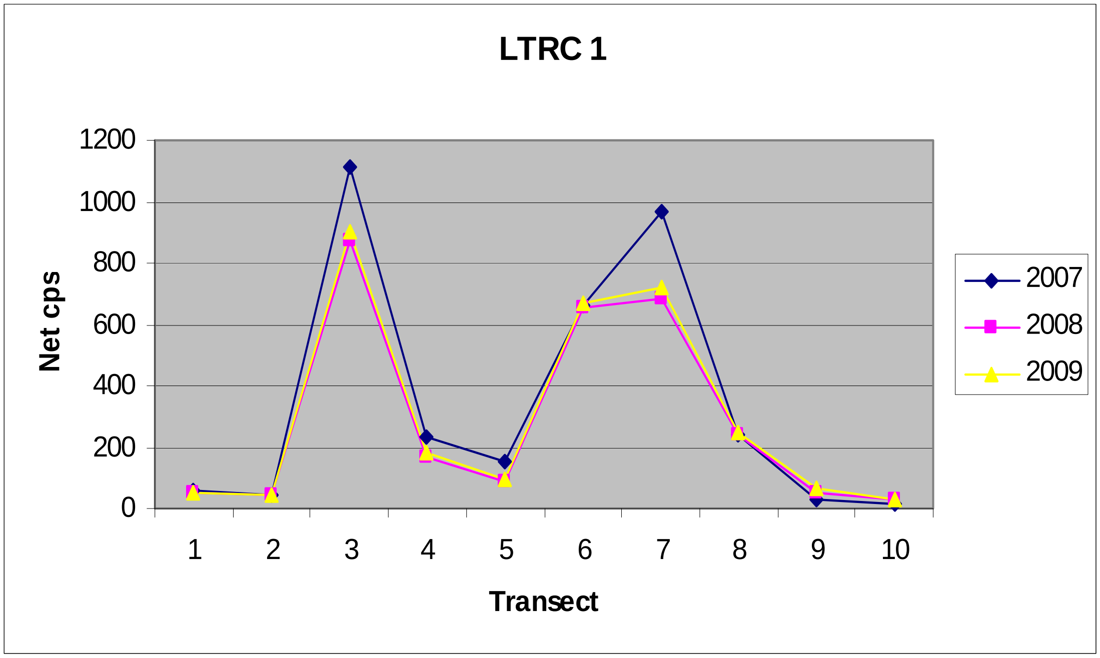

Figure 16. NaI Field Measurements for Creek Plantation

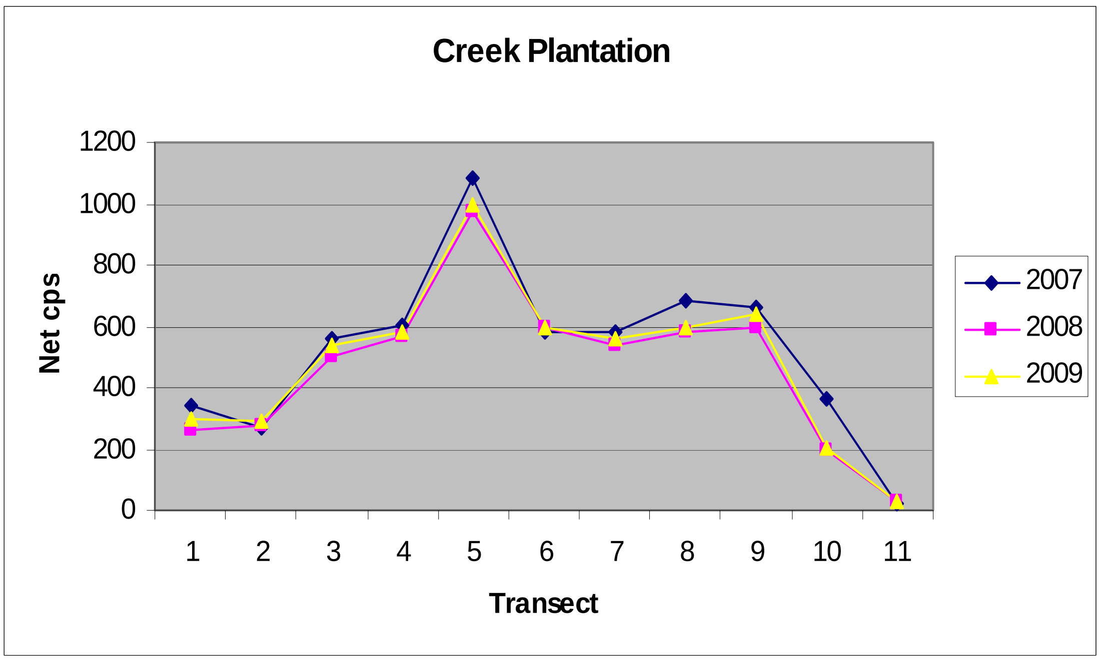

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Figure 17. Cesium-137 in Savannah River Creek Mouths – SCDHEC Comparison to DOE-SR Data

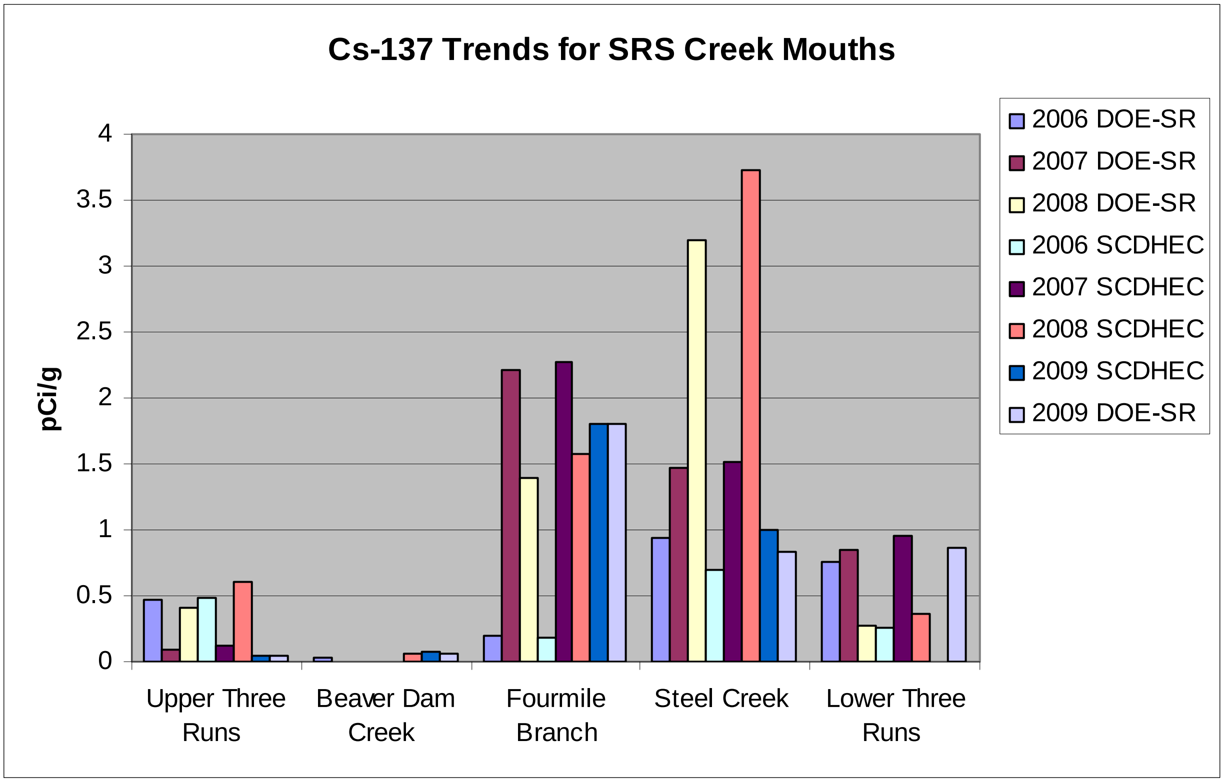

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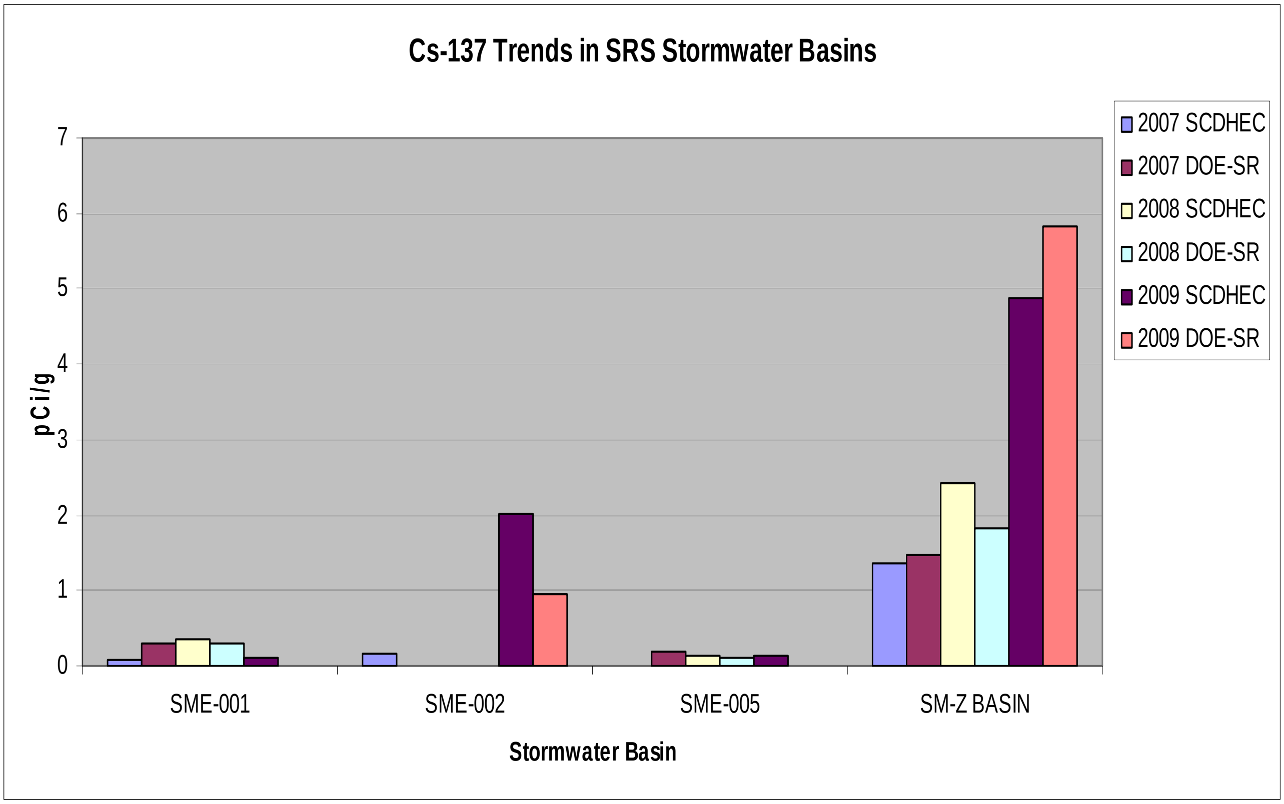
Figure 18. Cesium-137 in SRS Stormwater Basins – SCDHEC Comparison to DOE-SR Data



TOC

2.5.4 Data

2009 Ambient Sediment Monitoring

Notes:

4. Bold numbers denotes a 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

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River and Creek Mouths Accessible to the Public

Location Description	SMSV-2010	SMSV-2011	SMSV-2013
Collection Date	**4/22/2009**	**4/22/2009**	**4/22/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	25.3	22.0	24.7
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	9.01	8.77	8.86
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.3072	0.3094	0.3852
K-40 Activity	**11.92**	**3.080**	**17.75**
K-40 Confidence Interval	**0.8736**	**0.3200**	**1.280**
K-40 MDA	**0.1164**	**0.1372**	**0.1736**
Cs-137 Activity	<MDA	**0.0476**	**0.0791**
Cs-137 Confidence Interval	NA	**0.0154**	**0.0202**
Cs-137 MDA	0.0182	**0.0164**	**0.0248**
Pb-212 Activity	**0.9075**	**0.7372**	**1.276**
Pb-212 Confidence Interval	**0.0821**	**0.0701**	**0.1139**
Pb-212 MDA	**0.0355**	**0.0377**	**0.0487**
Pb-214 Activity	**0.6650**	**1.522**	**1.504**
Pb-214 Confidence Interval	**0.0457**	**0.0746**	**0.0784**
Pb-214 MDA	**0.0351**	**0.0393**	**0.0483**
Ra-226 Activity	**1.571**	**2.430**	**2.864**
Ra-226 Confidence Interval	**0.4659**	**0.4972**	**0.7002**
Ra-226 MDA	**0.4434**	**0.4907**	**0.5896**
Ac-228 Activity	**0.8966**	**0.8899**	**1.251**
Ac-228 Confidence Interval	**0.0741**	**0.0715**	**0.0926**
Ac-228 MDA	**0.0581**	**0.0592**	**0.0780**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	1.030	1.012	1.100
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.1846	0.1922	0.2501

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River and Creek Mouths Accessible to the Public

Location Description	**SMSV-2015**	**SMSV-2017**	**SMSV-2020**
Collection Date	**4/22/2009**	**4/23/2009**	**4/23/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	22.5	25.4	23.3
Beta Activity	**9.82**	**15.8**	<LLD
Beta Confidence Interval	**5.23**	**5.42**	NA
Beta LLD	**9.03**	**8.71**	9.39
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.5341	0.3793	0.3134
K-40 Activity	**17.45**	**8.311**	**11.59**
K-40 Confidence Interval	**1.263**	**0.6444**	**0.8494**
K-40 MDA	**0.1648**	**0.1245**	**0.1135**
Cs-137 Activity	**1.804**	**0.9994**	<MDA
Cs-137 Confidence Interval	**0.1510**	**0.0857**	NA
Cs-137 MDA	**0.0236**	**0.0174**	0.0181
Pb-212 Activity	**1.198**	**0.6751**	**0.8562**
Pb-212 Confidence Interval	**0.1103**	**0.0658**	**0.0771**
Pb-212 MDA	**0.0521**	**0.0374**	**0.0351**
Pb-214 Activity	**1.356**	**0.7150**	**0.6358**
Pb-214 Confidence Interval	**0.0867**	**0.0542**	**0.0455**
Pb-214 MDA	**0.0558**	**0.0376**	**0.0361**
Ra-226 Activity	**2.976**	**1.223**	**1.448**
Ra-226 Confidence Interval	**0.8336**	**0.4192**	**0.4225**
Ra-226 MDA	**0.6533**	**0.4720**	**0.4408**
Ac-228 Activity	**1.252**	**0.7517**	**0.8782**
Ac-228 Confidence Interval	**0.1014**	**0.0672**	**0.0686**
Ac-228 MDA	**0.0782**	**0.0594**	**0.0591**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	1.4210	0.9979	0.8219
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.2669	0.1864	0.1835

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2071A	SMSV-2071B	SMSV-2071C
Collection Date	**4/15/2009**	**4/15/2009**	**4/15/2009**
Alpha Activity	<LLD	**26.1**	<LLD
Alpha Confidence Interval	NA	**17.0**	NA
Alpha LLD	20.4	**22.1**	23.1
Beta Activity	<LLD	**18.7**	<LLD
Beta Confidence Interval	NA	**5.94**	NA
Beta LLD	9.41	**9.31**	9.49
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.6130	1.049	0.5056
K-40 Activity	<MDA	**1.907**	<MDA
K-40 Confidence Interval	NA	**0.5827**	NA
K-40 MDA	0.2677	**0.4912**	0.2048
Cs-137 Activity	<MDA	**0.1517**	<MDA
Cs-137 Confidence Interval	NA	**0.0500**	NA
Cs-137 MDA	0.0368	**0.0553**	0.0300
Pb-212 Activity	**0.9844**	**2.301**	**0.9919**
Pb-212 Confidence Interval	**0.1005**	**0.2165**	**0.0968**
Pb-212 MDA	**0.0590**	**0.0971**	**0.0484**
Pb-214 Activity	**3.160**	**8.223**	**1.934**
Pb-214 Confidence Interval	**0.1498**	**0.3309**	**0.1017**
Pb-214 MDA	**0.0666**	**0.1115**	**0.0526**
Ra-226 Activity	**4.321**	**13.98**	**3.746**
Ra-226 Confidence Interval	**0.8297**	**1.695**	**0.7527**
Ra-226 MDA	**0.7443**	**1.296**	**0.6147**
Ac-228 Activity	**1.327**	**2.352**	**1.061**
Ac-228 Confidence Interval	**0.1202**	**0.2044**	**0.0998**
Ac-228 MDA	**0.1170**	**0.2019**	**0.0909**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	0.7334	1.200	0.6333
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.0845	0.1469	0.0730

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2073A	SMSV-2073B	SMSV-2073C
Collection Date	4/15/2009	4/15/2009	4/15/2009
Alpha Activity	**40.7**	<LLD	**38.4**
Alpha Confidence Interval	**19.8**	NA	**18.6**
Alpha LLD	**22.3**	23.0	**21.0**
Beta Activity	**25.7**	**11.8**	**14.3**
Beta Confidence Interval	**6.05**	**5.46**	**5.70**
Beta LLD	**8.74**	**9.19**	**9.31**
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	1.185	0.6296	0.9610
K-40 Activity	<MDA	**1.149**	**1.313**
K-40 Confidence Interval	NA	**0.4204**	**0.5627**
K-40 MDA	0.5667	**0.2954**	**0.5006**
Cs-137 Activity	**0.1361**	<MDA	**0.1419**
Cs-137 Confidence Interval	**0.0612**	NA	**0.0546**
Cs-137 MDA	**0.0841**	0.0374	**0.0541**
Pb-212 Activity	**2.905**	**1.573**	**2.329**
Pb-212 Confidence Interval	**0.2682**	**0.1510**	**0.2156**
Pb-212 MDA	**0.1184**	**0.0676**	**0.1011**
Pb-214 Activity	**10.98**	**4.165**	**9.533**
Pb-214 Confidence Interval	**0.4303**	**0.1855**	**0.3662**
Pb-214 MDA	**0.1312**	**0.0739**	**0.1126**
Ra-226 Activity	**18.52**	**8.771**	**14.50**
Ra-226 Confidence Interval	**2.013**	**1.225**	**1.614**
Ra-226 MDA	**1.512**	**0.8601**	**1.301**
Ac-228 Activity	**3.691**	**1.624**	**3.237**
Ac-228 Confidence Interval	**0.2638**	**0.1375**	**0.2257**
Ac-228 MDA	**0.2480**	**0.1341**	**0.1997**
U/Th-238 Activity	<MDA	**3.539**	<MDA
U/Th-238 Confidence Interval	NA	**1.5720**	NA
U/Th-238 MDA	1.421	**0.8350**	1.253
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.1795	0.1041	0.1461

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2069	SMSV-2062	SMSV-328
Collection Date	**4/16/2009**	**4/16/2009**	**4/16/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	21.4	20.3	22.6
Beta Activity	**14.5**	**15.7**	<LLD
Beta Confidence Interval	**5.10**	**5.03**	NA
Beta LLD	**7.89**	**7.60**	7.55
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.8965	0.5740	0.4612
K-40 Activity	**3.047**	<MDA	<MDA
K-40 Confidence Interval	**0.5886**	NA	NA
K-40 MDA	**0.3811**	0.2498	0.1152
Cs-137 Activity	**0.2688**	<MDA	**1.362**
Cs-137 Confidence Interval	**0.0505**	NA	**0.1137**
Cs-137 MDA	**0.0454**	0.0344	**0.0199**
Pb-212 Activity	**1.995**	**2.947**	**0.3555**
Pb-212 Confidence Interval	**0.1851**	**0.2406**	**0.0481**
Pb-212 MDA	**0.0758**	**0.0584**	**0.0370**
Pb-214 Activity	**3.635**	**1.426**	**0.6497**
Pb-214 Confidence Interval	**0.1759**	**0.0917**	**0.0543**
Pb-214 MDA	**0.0872**	**0.0609**	**0.0428**
Ra-226 Activity	**6.166**	**2.489**	**1.561**
Ra-226 Confidence Interval	**1.137**	**0.7124**	**0.5258**
Ra-226 MDA	**0.9595**	**0.7261**	**0.4405**
Ac-228 Activity	**2.045**	**2.947**	<MDA
Ac-228 Confidence Interval	**0.1666**	**0.1576**	NA
Ac-228 MDA	**0.1423**	**0.1004**	0.1312
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	0.9208	0.7045	0.4106
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.1148	0.0874	0.0464

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Site Streams That Are Not Publicly Accessible

Location Description	SMSV-2048	SMSV-2049
Collection Date	**4/16/2009**	**4/16/2009**
Alpha Activity	<LLD	<LLD
Alpha Confidence Interval	NA	NA
Alpha LLD	20.2	21.2
Beta Activity	**12.5**	<LLD
Beta Confidence Interval	**4.70**	NA
Beta LLD	**7.29**	7.69
Be-7 Activity	<MDA	<MDA
Be-7 Confidence Interval	NA	NA
Be-7 MDA	0.6598	0.5004
K-40 Activity	<MDA	<MDA
K-40 Confidence Interval	NA	NA
K-40 MDA	0.3524	0.2014
Cs-137 Activity	<MDA	**0.9657**
Cs-137 Confidence Interval	NA	**0.0892**
Cs-137 MDA	0.0365	**0.0242**
Pb-212 Activity	**4.738**	**0.6893**
Pb-212 Confidence Interval	**0.3583**	**0.0722**
Pb-212 MDA	**0.0648**	**0.0413**
Pb-214 Activity	**2.266**	**1.047**
Pb-214 Confidence Interval	**0.1224**	**0.0682**
Pb-214 MDA	**0.0696**	**0.0482**
Ra-226 Activity	**4.651**	**1.567**
Ra-226 Confidence Interval	**0.8995**	**0.5238**
Ra-226 MDA	**0.8277**	**0.5316**
Ac-228 Activity	**4.977**	**0.6794**
Ac-228 Confidence Interval	**0.2142**	**0.0793**
Ac-228 MDA	**0.0983**	**0.0815**
U/Th-238 Activity	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA
U/Th-238 MDA	0.8280	0.4803
Am-241 Activity	<MDA	<MDA
Am-241 Confidence Interval	NA	NA
Am-241 MDA	0.1027	0.0591

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for SRS Stormwater Basins That Are Not Publicly Accessible

Location Description	**SME-001**	**SME-002**	**SME-005**	**SM-Z BASIN**
Collection Date	**4/15/2009**	**4/15/2009**	**4/15/2009**	**4/16/2009**
Alpha Activity	<LLD	**39.5**	<LLD	**22.3**
Alpha Confidence Interval	NA	**19.2**	NA	**15.6**
Alpha LLD	20.8	**21.7**	22.5	**20.8**
Beta Activity	<LLD	**11.9**	<LLD	**9.24**
Beta Confidence Interval	NA	**5.32**	NA	**4.43**
Beta LLD	9.00	**8.96**	9.44	**7.31**
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.4386	0.7662	0.5779	0.8528
K-40 Activity	**2.798**	**19.68**	**2.397**	**1.491**
K-40 Confidence Interval	**0.4060**	**1.420**	**0.4311**	**0.3798**
K-40 MDA	**0.1922**	**0.2658**	**0.2507**	**0.2403**
Cs-137 Activity	**0.1029**	**2.022**	**0.1421**	**4.864**
Cs-137 Confidence Interval	**0.0400**	**0.1722**	**0.0318**	**0.3764**
Cs-137 MDA	**0.0239**	**0.0407**	**0.0335**	**0.0330**
Pb-212 Activity	**1.150**	**1.969**	**2.249**	**1.315**
Pb-212 Confidence Interval	**0.1071**	**0.1766**	**0.1926**	**0.1255**
Pb-212 MDA	**0.0442**	**0.0658**	**0.0574**	**0.0625**
Pb-214 Activity	**0.8495**	**1.300**	**1.589**	**1.059**
Pb-214 Confidence Interval	**0.0636**	**0.0973**	**0.0977**	**0.0902**
Pb-214 MDA	**0.0481**	**0.0760**	**0.0615**	**0.0716**
Ra-226 Activity	**2.368**	**3.532**	**3.054**	**2.468**
Ra-226 Confidence Interval	**0.6484**	**0.8533**	**0.6995**	**0.7261**
Ra-226 MDA	**0.5370**	**0.7944**	**0.7344**	**0.7623**
Ac-228 Activity	**1.147**	**1.881**	**2.169**	**1.277**
Ac-228 Confidence Interval	**0.0989**	**0.1513**	**0.1434**	**0.1201**
Ac-228 MDA	**0.0851**	**0.1335**	**0.1192**	**0.0976**
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.5189	0.7039	0.6938	0.6297
Am-241 Activity	<MDA	**0.2111**	<MDA	<MDA
Am-241 Confidence Interval	NA	**0.0964**	NA	NA
Am-241 MDA	0.0651	**0.0910**	0.0868	0.0790

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Isotopic Data for SRS Streams That Are Not Publicly Accessible

Location Description	SMSV-2071 A	SMSV-2071 B	SMSV-2071 C	SMSV-2049
Collection Date	4/15/2009	4/15/2009	4/15/2009	4/16/2009
Plutonium-238 Activity	0.0103	0.292	0.0101	0.0255
Plutonium-238 Confidence Interval	0.0057	0.0463	0.0055	0.0085
Plutonium-238 MDA	0.0050	0.0060	0.0054	0.0017
Plutonium-239/240 Activity	0.0034	0.0258	<MDA	0.0087
Plutonium-239/240 Confidence Interval	0.0031	0.0100	NA	0.0047
Plutonium-239/240 MDA	0.0018	0.0060	0.0043	0.0017
Uranium-234 Activity	0.271	0.780	0.226	0.179
Uranium-234 Confidence Interval	0.0556	0.152	0.0462	0.0424
Uranium-234 MDA	0.0272	0.0468	0.0115	0.0286
Uranium-235 Activity	<MDA	<MDA	0.0315	0.0120
Uranium-235 Confidence Interval	NA	NA	0.0178	0.0125
Uranium-235 MDA	0.0369	0.0517	0.0179	0.0181
Uranium-238 Activity	0.263	0.832	0.206	0.229
Uranium-238 Confidence Interval	0.0545	0.158	0.0439	0.0477
Uranium-238 MDA	0.0271	0.0418	0.0168	0.0206

Location Description	SMSV-2073 A	SMSV-2073 B	SMSV-2073 C
Collection Date	4/15/2009	4/15/2009	4/15/2009
Plutonium-238 Activity	0.0590	0.0155	0.107
Plutonium-238 Confidence Interval	0.0211	0.0068	0.0261
Plutonium-238 MDA	0.0165	0.0019	0.0031
Plutonium-239/240 Activity	0.218	0.0191	0.0126
Plutonium-239/240 Confidence Interval	0.0457	0.0081	0.0089
Plutonium-239/240 MDA	0.0180	0.0064	0.0104
Uranium-234 Activity	1.34	2.76	0.755
Uranium-234 Confidence Interval	0.207	0.350	0.139
Uranium-234 MDA	0.0306	0.0155	0.0421
Uranium-235 Activity	0.146	0.233	0.0606
Uranium-235 Confidence Interval	0.0490	0.0522	0.0340
Uranium-235 MDA	0.0096	0.0151	0.0293
Uranium-238 Activity	1.63	3.52	0.771
Uranium-238 Confidence Interval	0.243	0.438	0.139
Uranium-238 MDA	0.0263	0.0122	0.0088

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Isotopic Data for Streams and Stormwater Basins That Are Not Publicly Accessible

Location Description	SMSV-2069	SM-Z Basin
Collection Date	**4/16/2009**	**4/16/2009**
Plutonium-238 Activity	**0.128**	<MDA
Plutonium-238 Confidence Interval	**0.0257**	NA
Plutonium-238 MDA	**0.0061**	0.0134
Plutonium-239/240 Activity	**0.0462**	<MDA
Plutonium-239/240 Confidence Interval	**0.0138**	NA
Plutonium-239/240 MDA	**0.0061**	0.0049
Uranium-234 Activity	**2.03**	**0.843**
Uranium-234 Confidence Interval	**0.337**	**0.134**
Uranium-234 MDA	**0.0665**	**0.0208**
Uranium-235 Activity	**0.272**	**0.0563**
Uranium-235 Confidence Interval	**0.0881**	**0.0282**
Uranium-235 MDA	**0.0160**	**0.0257**
Uranium-238 Activity	**0.850**	**0.887**
Uranium-238 Confidence Interval	**0.171**	**0.139**
Uranium-238 MDA	**0.0347**	**0.0164**
Iodine-129 Activity	<MDA	<MDA
Iodine-129 Confidence Interval	NA	NA
Iodine-129 MDA	0.0681	0.0633
Technetium-99 Activity	<MDA	<MDA
Technetium-99 Confidence Interval	NA	NA
Technetium-99 MDA	1.44	1.36

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Boat Landings That Are Publicly Accessible

Location Description	**SMMSL001**	**SMSBL002**	**SMCB002**
Collection Date	**7/7/2009**	**7/7/2009**	**7/10/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	26.9	27.2	26.6
Beta Activity	<LLD	**10.4**	<LLD
Beta Confidence Interval	NA	**5.38**	NA
Beta LLD	9.65	**9.32**	9.69
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.2151	0.2350	0.2496
K-40 Activity	**10.06**	**7.126**	**12.10**
K-40 Confidence Interval	**0.7525**	**0.5517**	**0.8899**
K-40 MDA	**0.1211**	**0.1053**	**0.1165**
Cs-137 Activity	<MDA	<MDA	**0.1555**
Cs-137 Confidence Interval	NA	NA	**0.0232**
Cs-137 MDA	0.0170	0.0175	**0.0171**
Pb-212 Activity	**1.177**	**1.852**	**1.067**
Pb-212 Confidence Interval	**0.1039**	**0.1486**	**0.0969**
Pb-212 MDA	**0.0347**	**0.0352**	**0.0347**
Pb-214 Activity	**1.119**	**1.187**	**0.9514**
Pb-214 Confidence Interval	**0.0645**	**0.0835**	**0.0751**
Pb-214 MDA	**0.0352**	**0.0348**	**0.0358**
Ra-226 Activity	**2.288**	**1.674**	**1.844**
Ra-226 Confidence Interval	**0.4612**	**0.4487**	**0.5596**
Ra-226 MDA	**0.4244**	**0.4535**	**0.4213**
Ac-228 Activity	**1.244**	**1.874**	**1.097**
Ac-228 Confidence Interval	**0.0807**	**0.0989**	**0.0752**
Ac-228 MDA	**0.0555**	**0.0521**	**0.0552**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	1.005	1.012	0.9843
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.1827	0.1839	0.1771

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Savannah River Boat Landings That Are Publicly Accessible

Location Description	**SM301SC001**	**SMJL002**	**SMLHL002**
Collection Date	**7/10/2009**	**7/10/2009**	**7/10/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	27.0	27.5	28.9
Beta Activity	**12.5**	<LLD	**17.0**
Beta Confidence Interval	**5.65**	NA	**5.81**
Beta LLD	**9.63**	9.87	**9.40**
Be-7 Activity	<MDA	**0.4023**	<MDA
Be-7 Confidence Interval	NA	**0.1741**	NA
Be-7 MDA	0.2336	**0.2186**	0.2698
K-40 Activity	**8.967**	**12.48**	**7.071**
K-40 Confidence Interval	**0.6674**	**0.8932**	**0.5727**
K-40 MDA	**0.1202**	**0.1180**	**0.1177**
Cs-137 Activity	<MDA	**0.0459**	**1.345**
Cs-137 Confidence Interval	NA	**0.0138**	**0.1089**
Cs-137 MDA	0.0176	**0.0167**	**0.0177**
Pb-212 Activity	**2.122**	**1.510**	**0.9780**
Pb-212 Confidence Interval	**0.1722**	**0.1269**	**0.0886**
Pb-212 MDA	**0.0356**	**0.0338**	**0.0349**
Pb-214 Activity	**1.188**	**1.140**	**0.9861**
Pb-214 Confidence Interval	**0.0824**	**0.0821**	**0.0722**
Pb-214 MDA	**0.0362**	**0.0361**	**0.0367**
Ra-226 Activity	**2.256**	**2.206**	**1.494**
Ra-226 Confidence Interval	**0.4618**	**0.4785**	**0.3802**
Ra-226 MDA	**0.4547**	**0.4285**	**0.4456**
Ac-228 Activity	**2.112**	**1.500**	**0.9917**
Ac-228 Confidence Interval	**0.1096**	**0.0861**	**0.0726**
Ac-228 MDA	**0.0499**	**0.0551**	**0.0508**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	1.024	0.7698	0.7309
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.1900	0.1756	0.1751

Radiological and Nonradiological Monitoring of Sediments Data

2009 Data for Savannah River Boat Landings That Are Publicly Accessible

Location Description	SMSCL002	SMJBL002	SMRVP001	SMFF002
Collection Date	**7/13/2009**	**7/13/2009**	**7/14/2009**	**7/14/2009**
Alpha Activity	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA
Alpha LLD	27.1	28.1	25.0	26.1
Beta Activity	<LLD	**12.4**	<LLD	**11.4**
Beta Confidence Interval	NA	**5.32**	NA	**5.76**
Beta LLD	9.42	**8.96**	9.02	**9.92**
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.2877	0.2262	0.181	0.237
K-40 Activity	**17.28**	**11.52**	**7.97**	**15.44**
K-40 Confidence Interval	**1.253**	**0.8486**	**0.61**	**1.10**
K-40 MDA	**0.1490**	**0.1201**	**0.10**	**0.11**
Cs-137 Activity	**0.3419**	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	**0.0365**	NA	NA	NA
Cs-137 MDA	**0.0207**	0.0174	0.015	0.016
Pb-212 Activity	**1.268**	**1.412**	**0.872**	**0.885**
Pb-212 Confidence Interval	**0.1124**	**0.1191**	**0.078**	**0.081**
Pb-212 MDA	**0.0419**	**0.0348**	**0.027**	**0.031**
Pb-214 Activity	**1.454**	**1.108**	**0.632**	**0.856**
Pb-214 Confidence Interval	**0.0962**	**0.0758**	**0.054**	**0.064**
Pb-214 MDA	**0.0442**	**0.0365**	**0.029**	**0.032**
Ra-226 Activity	**3.086**	**2.039**	**1.367**	**1.235**
Ra-226 Confidence Interval	**0.5457**	**0.4218**	**0.376**	**0.354**
Ra-226 MDA	**0.5011**	**0.4331**	**0.340**	**0.371**
Ac-228 Activity	**1.252**	**1.319**	**0.895**	**0.942**
Ac-228 Confidence Interval	**0.0913**	**0.0823**	**0.062**	**0.070**
Ac-228 MDA	**0.0689**	**0.0554**	**0.046**	**0.054**
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.9151	0.7578	0.800	0.678
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.2118	0.1818	0.143	0.158

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Lower Three Runs Tributaries That Are Publicly Accessible

Location Description	**SMLTRT1**	**SMLTRT2**	**SMLTRT3**
Collection Date	**8/25/2009**	**8/25/2009**	**8/25/2009**
Alpha Activity	<LLD	**17.5**	**19.4**
Alpha Confidence Interval	NA	**12.5**	**13.8**
Alpha LLD	16.0	**14.4**	**16.0**
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	9.83	9.38	10.0
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.4374	0.5267	0.4290
K-40 Activity	<MDA	**2.056**	<MDA
K-40 Confidence Interval	NA	**0.3610**	NA
K-40 MDA	0.43220	**0.1790**	0.15280
Cs-137 Activity	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA
Cs-137 MDA	0.02292	0.02370	0.01949
Pb-212 Activity	**0.6618**	**0.9223**	**0.7414**
Pb-212 Confidence Interval	**0.0662**	**0.0898**	**0.0710**
Pb-212 MDA	**0.0397**	**0.0469**	**0.0392**
Pb-214 Activity	**0.6008**	**0.7045**	**0.6622**
Pb-214 Confidence Interval	**0.0563**	**0.0632**	**0.0542**
Pb-214 MDA	**0.0449**	**0.0509**	**0.0432**
Ra-226 Activity	**1.217**	**1.437**	**1.723**
Ra-226 Confidence Interval	**0.5263**	**0.4915**	**0.6197**
Ra-226 MDA	**0.5131**	**0.5805**	**0.4814**
Ac-228 Activity	**0.6949**	**0.9756**	**0.7032**
Ac-228 Confidence Interval	**0.0705**	**0.0858**	**0.0693**
Ac-228 MDA	**0.0687**	**0.0781**	**0.0629**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	1.319	1.484	1.261
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.4326	0.4878	0.4092

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Random Perimeter "E" Samples < 50 miles from the SRS Center Point

Lab Sample ID	**XA15828**	**XA15829**	**XA15830**	**XA15835**
Location Description	**SM E41**	**SM E43**	**SM E53**	**SM E48**
Collection Date	**1/23/2009**	**1/23/2009**	**1/23/2009**	**3/6/2009**
Alpha Activity	**24.0**	<LLD	<LLD	<LLD
Alpha Confidence Interval	**15.7**	NA	NA	NA
Alpha LLD	**20.3**	21.4	22.2	22.6
Beta Activity	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA
Beta LLD	7.63	8.18	7.75	8.01
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.428	0.808	0.791	0.361
K-40 Activity	<MDA	<MDA	<MDA	**1.172**
K-40 Confidence Interval	NA	NA	NA	**0.265**
K-40 MDA	0.140	0.279	0.386	**0.206**
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	0.018	0.040	0.036	0.021
Pb-212 Activity	**0.366**	**2.409**	**2.212**	**0.860**
Pb-212 Confidence Interval	**0.046**	**0.210**	**0.192**	**0.086**
Pb-212 MDA	**0.031**	**0.061**	**0.062**	**0.041**
Pb-214 Activity	**0.792**	**1.729**	**2.391**	**0.921**
Pb-214 Confidence Interval	**0.056**	**0.110**	**0.140**	**0.063**
Pb-214 MDA	**0.035**	**0.062**	**0.067**	**0.049**
Ra-226 Activity	**1.317**	**2.951**	**4.568**	**1.779**
Ra-226 Confidence Interval	**0.412**	**0.800**	**0.849**	**0.579**
Ra-226 MDA	**0.405**	**0.742**	**0.774**	**0.520**
Ac-228 Activity	<MDA	**2.450**	**2.231**	**0.875**
Ac-228 Confidence Interval	NA	**0.145**	**0.140**	**0.083**
Ac-228 MDA	0.128	**0.111**	**0.101**	**0.076**
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.396	0.710	0.738	0.485
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.045	0.089	0.093	0.059

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Random Background "B" Samples > 50 miles from the SRS Center Point

Lab Sample ID	XA15831	XA15832	XA15833
Location Description	**SM B41**	**SM B38**	**SM B40**
Collection Date	**2/3/2009**	**2/19/2009**	**2/19/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	23.2	23.5	22.9
Beta Activity	**25.9**	**11.1**	**17.3**
Beta Confidence Interval	**5.63**	**4.96**	**5.43**
Beta LLD	**7.51**	**8.14**	**8.20**
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.758	0.560	0.387
K-40 Activity	**9.73**	**17.94**	**22.52**
K-40 Confidence Interval	**0.79**	**1.29**	**1.50**
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	**0.990**	**0.680**	**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	**0.110**	**0.109**	0.174
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	0.810	0.696	0.433
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.101	0.087	0.057

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for Random Background "B" Samples > 50 miles from the SRS Center Point

Lab Sample ID	**XA16402**	**XA16403**	**XA16404**
Location Description	**SMB35**	**SMB33**	**SMB34**
Collection Date	**4/8/2009**	**4/8/2009**	**4/8/2009**
Alpha Activity	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA
Alpha LLD	20.2	22.8	21.3
Beta Activity	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA
Beta LLD	8.96	9.14	9.42
Be-7 Activity	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA
Be-7 MDA	0.346	0.237	0.341
K-40 Activity	**6.16**	**1.76**	**5.79**
K-40 Confidence Interval	**0.53**	**0.24**	**0.50**
K-40 MDA	**0.16**	**0.12**	**0.13**
Cs-137 Activity	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA
Cs-137 MDA	0.020	0.013	0.019
Pb-212 Activity	**0.410**	**0.157**	**0.518**
Pb-212 Confidence Interval	**0.048**	**0.024**	**0.051**
Pb-212 MDA	**0.032**	**0.022**	**0.030**
Pb-214 Activity	**0.359**	**0.148**	**0.347**
Pb-214 Confidence Interval	**0.043**	**0.026**	**0.036**
Pb-214 MDA	**0.034**	**0.025**	**0.034**
Ra-226 Activity	**0.800**	<MDA	**0.959**
Ra-226 Confidence Interval	**0.339**	NA	**0.418**
Ra-226 MDA	**0.378**	0.258	**0.357**
Ac-228 Activity	**0.507**	<MDA	**0.543**
Ac-228 Confidence Interval	**0.069**	NA	**0.064**
Ac-228 MDA	**0.070**	0.086	**0.065**
U/Th-238 Activity	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA
U/Th-238 MDA	0.408	0.263	0.327
Am-241 Activity	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA
Am-241 MDA	0.043	0.028	0.041

Radiological and Nonradiological Monitoring of Sediments Data

2009 Radiological Data for MFFF Baseline Monitoring

	Random Quad B27	Random Quad B41	Stokes Bluff Landing
Lab Sample ID	**09-09079-04**	**09-09079-05**	**09-09079-06**
Location Description	**SM B27**	**SM B41**	**SM SBL 002**
Collection Date	**7/24/2008**	**2/3/2009**	**7/7/2009**
Plutonium-238 Activity	**0.0045**	**0.0170**	**0.0064**
Plutonium-238 Confidence Interval	**0.0027**	**0.0054**	**0.0033**
Plutonium-238 MDA	**0.0030**	**0.0023**	**0.0040**
Plutonium-239/240 Activity	<MDA	**0.0092**	**0.0019**
Plutonium-239/240 Confidence Interval	NA	**0.0039**	**0.0016**
Plutonium-239/240 MDA	0.0027	**0.0023**	**0.0016**
Uranium-234 Activity	**0.247**	**0.554**	**0.245**
Uranium-234 Confidence Interval	**0.0429**	**0.107**	**0.0425**
Uranium-234 MDA	**0.0066**	**0.0099**	**0.0043**
Uranium-235 Activity	**0.0165**	**0.0272**	**0.0130**
Uranium-235 Confidence Interval	**0.0086**	**0.0163**	**0.0076**
Uranium-235 MDA	**0.0066**	**0.0061**	**0.0064**
Uranium-238 Activity	**0.248**	**0.534**	**0.229**
Uranium-238 Confidence Interval	**0.0431**	**0.103**	**0.0403**
Uranium-238 MDA	**0.0076**	**0.0050**	**0.0021**

Radiological and Nonradiological Monitoring of Sediments Data

2009 Nonradiological Data for Savannah River and Creek Mouths Accessible to the Public

Lab Sample ID	AC49872	AC49873	AC49874
Location Description	SMSV-2010	SMSV-2011	SMSV-2013
Collection Date	4/22/2009	4/22/2009	4/22/2009
Barium in Sediment	57	17	72
Cadmium in Sediment	2	<1.0	2.6
Chromium in Sediment	13	2.7	9.6
Copper in Sediment	5.8	1.1	6.9
Lead in Sediment	5.9	<5.0	5.9
Nickel in Sediment	4.5	2.5	7.1
Zinc in Sediment	16	6.9	26
Mercury in Sediment	<0.10	<0.10	<0.10
Manganese in Sediment	340	110	310

Lab Sample ID	AC49875	AC49876	AC49877
Location Description	SMSV-2015	SMSV-2017	SMSV-2020
Collection Date	4/22/2009	4/23/2009	4/23/2009
Barium in Sediment	60	26	28
Cadmium in Sediment	2.2	1.4	1.2
Chromium in Sediment	8.4	4.5	5.3
Copper in Sediment	4.6	2.5	1.5
Lead in Sediment	<5.0	<5.0	<5.0
Nickel in Sediment	5.7	2.6	2.2
Zinc in Sediment	28	17	9.9
Mercury in Sediment	<0.10	<0.10	<0.10
Manganese in Sediment	130	220	170

Radiological and Nonradiological Monitoring of Sediments Data

2009 Nonradiological Data for Savannah River Site Streams and Stormwater Basins That Are Not Publicly Accessible

Location Description	SMSV-2069	SMSV-2062	SMSV-328	SMSV-2048
Collection Date	4/16/2009	4/16/2009	4/16/2009	4/16/2009
Barium in Sediment	61	7.7	10	6.3
Cadmium in Sediment	2.1	<1.0	<1.0	<1.0
Chromium in Sediment	19	1.1	2.9	2
Copper in Sediment	34	<1.0	<1.0	<1.0
Lead in Sediment	7.1	<5.0	<5.0	<5.0
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	160	7.7	45	44
Nickel in Sediment	7.5	<2.0	<2.0	<2.0
Zinc in Sediment	46	<1.0	2.5	<1.0

Location Description	SMSV-2049	SMSV-2073A	SMSV-2073B	SMSV-2073C
Collection Date	4/16/2009	4/15/2009	4/15/2009	4/15/2009
Barium in Sediment	9.1	48	27	51
Cadmium in Sediment	<1.0	<1.0	<1.0	<1.0
Chromium in Sediment	1.6	7.1	5.6	7.7
Copper in Sediment	<1.0	3.2	1.8	3.2
Lead in Sediment	<5.0	<5.0	<5.0	<5.0
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	48	63	16	61
Nickel in Sediment	<2.0	5.7	7.7	4.2
Zinc in Sediment	14	14	8.9	14

Location Description	SMSV-2071A	SMSV-2071B	SMSV-2071C
Collection Date	4/15/2009	4/15/2009	4/15/2009
Barium in Sediment	22	49	16
Cadmium in Sediment	<1.0	<1.0	<1.0
Chromium in Sediment	2.6	5.6	2.2
Copper in Sediment	1.3	3.2	<1.0
Lead in Sediment	<5.0	<5.0	<5.0
Mercury in Sediment	<0.10	<0.10	<0.10
Manganese in Sediment	36	21	16
Nickel in Sediment	<2.0	2.8	<2.0
Zinc in Sediment	5.7	10	4.8

Lab Sample ID	AC49864	AC49865	AC49862	AC49863
Location Description	SME-002	SM-Z BASIN	SME-005	SME-001
Collection Date	4/15/2009	4/16/2009	4/15/2009	4/15/2009
Barium in Sediment	50	42	90	38
Cadmium in Sediment	2.7	4.7	5.6	2
Chromium in Sediment	17	43	34	17
Copper in Sediment	12	12	6.2	4.1
Lead in Sediment	8.3	9.8	14	6.3
Nickel in Sediment	6.5	5.1	6.6	2.7
Zinc in Sediment	230	160	26	21
Mercury in Sediment	<0.10	<0.10	<0.10	<0.10
Manganese in Sediment	220	40	90	58

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2.5.5 Summary Statistics for Ambient Sediment Monitoring

Notes:

3. St. Deviation = Standard Deviation
4. N/A = Not Applicable
5. Min. – Minimum
4. Max. = Maximum

Publicly Accessable SRS Creek Mouths and Savannah River Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Alpha	N/A	N/A	N/A	N/A	N/A	0	6
Beta	12.81	4.23	12.81	9.82	15.80	2	6
Be-7	N/A	N/A	N/A	N/A	N/A	0	6
K-40	11.68	5.58	11.76	3.08	17.75	6	6
Zr-95	N/A	N/A	N/A	N/A	N/A	0	6
Cs-137	0.733	0.840	0.539	0.048	1.804	4	6
Ce-144	N/A	N/A	N/A	N/A	N/A	0	6
Pb-212	0.942	0.244	0.882	0.675	1.276	6	6
Pb-214	1.07	0.44	1.04	0.64	1.52	6	6
Ra-226	2.09	0.77	2.00	1.22	2.98	6	6
Ac-228	0.987	0.212	0.893	0.752	1.252	6	6
U/Th-238	N/A	N/A	N/A	N/A	N/A	0	6
Am-241	N/A	N/A	N/A	N/A	N/A	0	6

Non-Publicly Accessable SRS Stream Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Alpha	35.1	7.9	38.4	26.1	40.7	3	11
Beta	16.2	4.8	14.5	11.8	25.7	7	11
Be-7	N/A	N/A	N/A	N/A	N/A	0	11
K-40	1.85	0.86	1.61	1.15	3.05	4	11
Zr-95	N/A	N/A	N/A	N/A	N/A	0	11
Cs-137	0.504	0.528	0.210	0.136	1.362	6	11
Ce-144	N/A	N/A	N/A	N/A	N/A	0	11
Pb-212	1.98	1.27	2.00	0.36	4.74	11	11
Pb-214	4.27	3.62	3.16	0.65	10.98	11	11
Ra-226	7.30	5.86	4.65	1.56	18.52	11	11
Ac-228	2.39	1.33	2.20	0.68	4.98	10	11
U/Th-238	NA	NA	NA	NA	NA	1	11
Am-241	N/A	N/A	N/A	N/A	N/A	0	11
Pu-238	0.081	0.097	0.042	0.010	0.292	8	9
Pu-239/240	0.048	0.077	0.019	0.003	0.218	7	9
U-234	1.019	0.880	0.780	0.179	2.760	9	9
U-235	0.116	0.103	0.061	0.012	0.272	7	9
U-238	1.020	1.037	0.832	0.206	3.515	9	9

Non-Publicly Accessable SRS Stormwater Basin Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Alpha	30.90	12.16	30.90	22.30	39.50	2	4
Beta	10.57	1.88	10.57	9.24	11.90	2	4
Be-7	N/A	N/A	N/A	N/A	N/A	0	4
K-40	6.59	8.74	2.60	1.49	19.68	4	4
Zr-95	N/A	N/A	N/A	N/A	N/A	0	4
Cs-137	1.78	2.24	1.08	0.10	4.86	4	4
Ce-144	N/A	N/A	N/A	N/A	N/A	0	4
Pb-212	1.67	0.52	1.64	1.15	2.25	4	4
Pb-214	1.20	0.32	1.18	0.85	1.59	4	4
Ra-226	2.86	0.54	2.76	2.37	3.53	4	4
Ac-228	1.62	0.49	1.58	1.15	2.17	4	21
U/Th-238	N/A	N/A	N/A	N/A	N/A	0	4
Am-241	0.211*	0.0964*	N/A	N/A	N/A	1	4

Publicly Accessable Savannah River Boat Landing Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Alpha	N/A	N/A	N/A	N/A	N/A	0	10
Beta	12.74	2.53	12.40	10.40	17.00	5	10
Be-7	N/A	N/A	N/A	N/A	N/A	1	10
K-40	11.00	3.46	10.79	7.07	17.28	10	10
Zr-95	N/A	N/A	N/A	N/A	N/A	0	10
Cs-137	0.472	0.595	0.249	0.046	1.35	4	10
Ce-144	N/A	N/A	N/A	N/A	N/A	0	10
Pb-212	1.31	0.417	1.22	0.872	2.12	10	10
Pb-214	1.06	0.222	1.11	0.632	1.45	10	10
Ra-226	1.95	0.550	1.94	1.24	3.09	10	10
Ac-228	1.32	0.403	1.25	0.895	2.11	10	10
U/Th-238	N/A	N/A	N/A	N/A	N/A	0	10
Am-241	N/A	N/A	N/A	N/A	N/A	0	10

Lower Three Runs Tributary Monitoring

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Alpha	18.45	1.34	18.45	17.5	19.4	2	3
Beta	N/A	N/A	N/A	N/A	N/A	0	3
Be-7	N/A	N/A	N/A	N/A	N/A	0	3
K-40	N/A	N/A	N/A	N/A	N/A	1	3
Zr-95	N/A	N/A	N/A	N/A	N/A	0	3
Cs-137	N/A	N/A	N/A	N/A	N/A	0	3
Ce-144	N/A	N/A	N/A	N/A	N/A	0	3
Pb-212	0.7752	0.1335	0.7414	0.6618	0.9223	3	3
Pb-214	0.6558	0.0521	0.6622	0.6008	0.7045	3	3
Ra-226	1.459	0.2537	1.437	1.217	1.723	3	3
Ac-228	0.7912	0.1597	0.7032	0.6949	0.9756	3	3
U/Th-238	N/A	N/A	N/A	N/A	N/A	0	3
Am-241	N/A	N/A	N/A	N/A	N/A	0	3

MFFF Baseline Monitoring

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Pu-238	0.009	0.007	0.006	0.005	0.017	3	3
Pu-239/240	0.006	0.005	0.006	0.002	0.009	3	2
U-234	0.349	0.178	0.247	0.245	0.554	3	3
U-235	0.019	0.007	0.017	0.013	0.027	3	3
U-238	0.337	0.171	0.248	0.229	0.534	3	3

Non-Publicly Accessable SRS Stream Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Barium	27.9	20.5	22.0	6.3	61	11	11
Cadmium	NA	NA	NA	NA	NA	1	11
Chromium	5.2	5.1	2.9	1.1	19	11	11
Copper	7.8	12.9	3.2	1.3	34	6	11
Lead	NA	NA	NA	NA	NA	1	11
Manganese	47.1	41.8	44.0	7.7	160	11	11
Mercury	NA	NA	NA	NA	NA	0	11
Nickel	5.6	2.1	5.7	2.8	7.7	5	11
Zinc	13.3	13.0	10.0	2.5	46	9	11

Publicly Accessable SRS Creek Mouths and Savannah River Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Barium	43.3	22.4	42.5	17	72	6	6
Cadmium	1.9	0.6	2.0	1.2	2.6	5	6
Chromium	7.3	3.8	6.9	2.7	13	6	6
Copper	3.7	2.4	3.6	1.1	6.9	6	6
Lead	5.9	0.0	5.9	5.9	5.9	2	6
Manganese	213.3	94.8	195.0	110	340	6	6
Mercury	NA	NA	NA	NA	NA	0	6
Nickel	4.1	2.0	3.6	2.2	7.1	6	6
Zinc	17.3	8.4	16.5	6.9	28	6	6

Non-Publicly Accessable SRS Stormwater Basin Sediments

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	No. of Detections	Total Number Sampled
Barium	55.0	23.9	46.0	38	90	4	4
Cadmium	3.8	1.7	3.7	2	5.6	4	4
Chromium	27.8	12.9	25.5	17	43	4	4
Copper	8.6	4.0	9.1	4.1	12	4	4
Lead	9.6	3.3	9.1	6.3	14	4	4
Manganese	102.0	81.3	74.0	40	220	4	4
Mercury	NA	NA	NA	NA	NA	0	4
Nickel	5.2	1.8	5.8	2.7	6.6	4	4
Zinc	109.3	103.1	93.0	21	230	4	4

Note: Units are in miligrams per kilogram (mg/kg).

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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 exposing 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 other media. 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 Department of Energy – Savannah River (DOE-SR) environmental monitoring programs. ESOP personnel independently evaluated surface soils from ground surface to 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 3.1.3 Map 1 for random sampling locations. ESOP initiated the random sampling system to determine if elevated levels of contaminants are attributed to SRS activities. Perimeter and background averages were used to determine if SCDHEC data were comparable to radiological data from DOE-SR data. Since DOE-SR 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 historically impacted areas. In 2007, in addition to samples collected near the perimeter of SRS, publicly accessible boat landings were included in the sampling regime to exemplify areas where direct contact to surface soil often occurs by the public.

ESOP collected samples in 2009 from three random perimeter sites within the 50-mile radius of the SRS center point and five random background sites outside of the 50-mile SRS center point radius. 17 nonrandom samples were collected from SRS perimeter locations as well as riverbank soils from 10 publicly accessible boat landings. ESOP split surface soil samples with DOE-SR personnel from six SRS locations located at air monitoring stations. A list of all nonrandom sampling locations is in Section 3.1.3, Table 2. Gamma spectroscopy led to detections of the anthropogenic radionuclide cesium-137 (Cs-137). The majority of all the samples had detectable amounts of Cs-137 that were consistent with levels attributed to atmospheric fallout from past nuclear weapons testing. The average of those collected as a background sample was the highest, being slightly higher than the other locations collected around SRS. Cs-137 activity in 2009 was slightly lower but, coincide with levels detected by ESOP in the past. There were no surface soil samples collected in 2009 that were above the USEPA Preliminary Remediation Goals (PRGs) or the USEPA Regional Screening Levels (RSLs) (USEPA 2009). Furthermore, there were no riverbank soil samples in 2009 that exceeded the 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 based on radioactive contamination in soil. USEPA Regional Screening Levels (RSLs) are based on the generic/default values based on the toxicity of chemical contaminants in soil. The PRGs and RSLs of select radionuclides and metals sampled by SCDHEC are listed in Section 3.1.3, Tables 5 and 6.

Gross alpha-emitting radionuclides were detected in one sample from the SRS perimeter and none from the riverbank soils. There was one detection among the random perimeter samples and none from the background samples. Gross non-volatile beta was detected among all sample types. Those from the perimeter, riverbanks and random samples from both a 50-mile radius, had similar averages.

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 2009 surface soil data from SCDHEC and DOE-SR resulted in similar findings. Both data sets report average Cs-137 levels higher within 50 miles of SRS than in background samples. SCDHEC data from 2009 shows a slightly decreased average level of Cs-137 from the 2008 data. DOE-SR reports for 2009 that Cs-137 concentrations are consistent with historical results. Metals could not be compared to SCDHEC results since SRS 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 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 in not only samples collected on SRS, but in background samples as well. The USEPA PRG is used as a screening tool that corresponds to certain levels of human health risk in regards to radioactivity in soil (USEPA 2009). The conservative PRGs, corresponds to a chronic risk for soil ingestion for a residential scenario and a one in a million (1E-06) increased cancer risk. Uranium soil samples may fall under both PRG and RSL values because it is both carcinogenic and toxic (USEPA 2009). In 2009, ESOP analyzed for all of the radioisotopes listed in Section 3.1.3, Table 3.

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 17 SRS nonrandom perimeter samples at an average of 0.494 (±0.757) picocuries per gram (pCi/g) and ranged from 0.03 to 3.14 pCi/g. The highest detection was located at SSBWL0903 in Barnwell County. Eight riverbank soil samples had Cs-137 detections at an average of 0.40 (±0.1) pCi/g. The samples ranged from 0.05 to 1.31 pCi/g. The highest detection of all samples was at Steel Creek Boat Landing (SSBWL0903). This area in the Steel Creek floodplain has a history of elevated Cs-137 due to releases from SRS operations (WSRC 2005a). Analysis of Cs-137 from riverbank soils collected at public boat landings show that all landings sampled in 2009, with the exception of Steel Creek Boat Landing, 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.The Steel Creek Boat Landing is located immediately downstream of SRS and has historically experienced periodic flooding. These past events may have led to the increased levels of Cs-137 in the surface soil (WSRC 2005a).

One random perimeter and four random background samples had Cs-137 detections. The random perimeter sample detection was 0.196 pCi/g. The random background samples had detections averaging 0.571 (±0.3999) pCi/g and ranged from 0.159 to 1.109 pCi/g. Cesium-137, on average, was highest in the random background samples followed by the SRS perimeter soils. The results are depicted in Section 3.1.3, Figure 2.

In addition, potassium-40, lead-212, lead-214, radium-226, actinium-228, Uranium/Thorium-238 and thorium-234 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 each quarter of 2009. Gross alpha-emitting radionuclides were detected in two samples among the nonrandom SRS perimeter at an averaged 32.9 (±16.263) pCi/g and ranged from 21.2 to 44.5 pCi/g. There were no detections from the riverbank soil samples. The random SRS perimeter samples had one detection of 26.9 pCi/g. The highest detection (44.5 pCi/g) was from soil collected at the intersection of Old Barnwell Road and Upper Three Runs Creek in Aiken County. There were two detections of alpha-emitting radionuclides from the random background sample locations. The random background samples averaged 24.35 (±0.495) pCi/g and ranged from 24.0 to 24.7 pCi/g. These samples were collected in Fairfield and Orangeburg counties, respectively.

Gross beta-emitting radionuclides were released from the separations areas on the SRS (CDC 2006). Gross non-volatile beta was detected in three SRS nonrandom perimeter samples at an average of 17.323 (±14.277) pCi/g and ranged from 8.6 to 33.8 pCi/g. The highest detection was in soil collected in Aiken County. Nine riverbank boat landing soil samples had detections for gross beta-emitting radionuclides. The riverbank landing average was 18.23 (±4.7) pCi/g, and the values ranged from 7.76 to 29.7 pCi/g. The SC side of the Highway 301 bridge (SS 301SC 002) yielded the highest riverbank soil detection. One random perimeter samples had one detection of 17.2 pCi/g and was collected in Orangeburg County. No random background samples had detections for gross beta.

When comparing gross alpha and gross non-volatile beta detections among the samples, only one gross alpha detection occurred from the SRS random perimeter. No detections were found from the riverbank boat landing soil samples. The gross alpha average was higher in the random perimeter samples collected within 50 miles of SRS than from the random background samples collected greater than 50 miles from SRS. The gross beta average activity was slightly greater in the riverbank boat landing samples than the SRS nonrandom perimeter samples random perimeter and random background soil. The gross alpha average was slightly higher in the nonrandom perimeter than the SRS random perimeter samples and the random background soil. There were no gross alpha emitters detected in the riverbank boat landing samples. Figures 3 and 4 in Section 3.1.3 depict these findings.

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 2009. A complete list of all nonradiological analytes can be found in Section 3.1.3, Table 4. 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 samples were below the conservative generic/default USEPA RSLs, corresponding to a chronic risk for soil ingestion for a residential scenario. ESOP 2009 samples had detections of barium, chromium, copper, lead, manganese, nickel, and zinc. There were no detections above the MDL for cadmium and 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 15.7 (± 1.3) milligrams per kilogram (mg/kg) and ranged from 6.6 to 29 mg/kg. The highest detection was located at SSAIK-0901 in Aiken County. All samples were well below the RSL of 15,000 mg/kg and also below the state 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 12 SRS nonrandom perimeter samples at an average of 2.9 (± 3.5) milligrams per kilogram (mg/kg) and ranged from 1.7 to 5.0 mg/kg. The highest detections were located in SSAIK-0904 in Aiken County. For comparison, the most conservative RSL screening level (ChromiumVI) is 230 mg/kg. The South Carolina (SC) state average for 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 eight SRS nonrandom perimeter samples at an average of 1.8 (± 0.7) mg/kg and ranged from 1.1 to 3.7 mg/kg. The highest detection was located in SSAIK0901 in Aiken County. All samples were below the RSL of 3,100 mg/kg .The SC state 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 residence 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 6.9 (± 1.1) mg/kg and ranged from 5.2 to 9.7 mg/kg. The highest detection was located at SSALD-0901 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 85.3 (± 67.7) mg/kg and ranged from 6.2 to 200 mg/kg. The highest detection was located at SSAIK-0901 in Aiken County. A number of samples exceeded state average of 100 mg/kg (Canova 1999) 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 four SRS nonrandom perimeter samples at an average of 2.4 (± 0.6) mg/kg and ranged from 2.1 to 3.2 mg/kg. The highest detection was SSAIK-0901 in Aiken County. There were no samples above the state average of 6 mg/kg (Canova 1999), and all samples were below the RSL 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 5.4 (± 4.2) mg/kg and ranged from 2.1 to 9.9 mg/kg. The highest detection was located at SSBWG-09 in Barnwell County. The RSL is 23,000 mg/kg. All samples were also below the state average of 23 mg/kg.

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 2009 yielded detections above the Minimum Detection Limit (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). None of the surface soil samples collected in 2009 yielded detections above the Minimum Detection Limit (MDL) of 1.0 mg/kg for cadmium. The RSL for cadmium in soil is 70 mg/kg.

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 2010, 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. Other locations will be sampled to evaluate impacts of SRS within the surrounding area, as well as sampling background locations for a comparison to ambient levels of radionuclides. Metal analysis will be limited to the perimeter of SRS. 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.

In order to better compare the environmental monitoring programs of SCDHEC and DOE-SR, a portion of the surface soil samples will be collected as split samples in cooperation with DOE-SR personnel. Each program will then independently analyze the samples for radionuclides and results will be compared in the 2010 ESOP Data Report.

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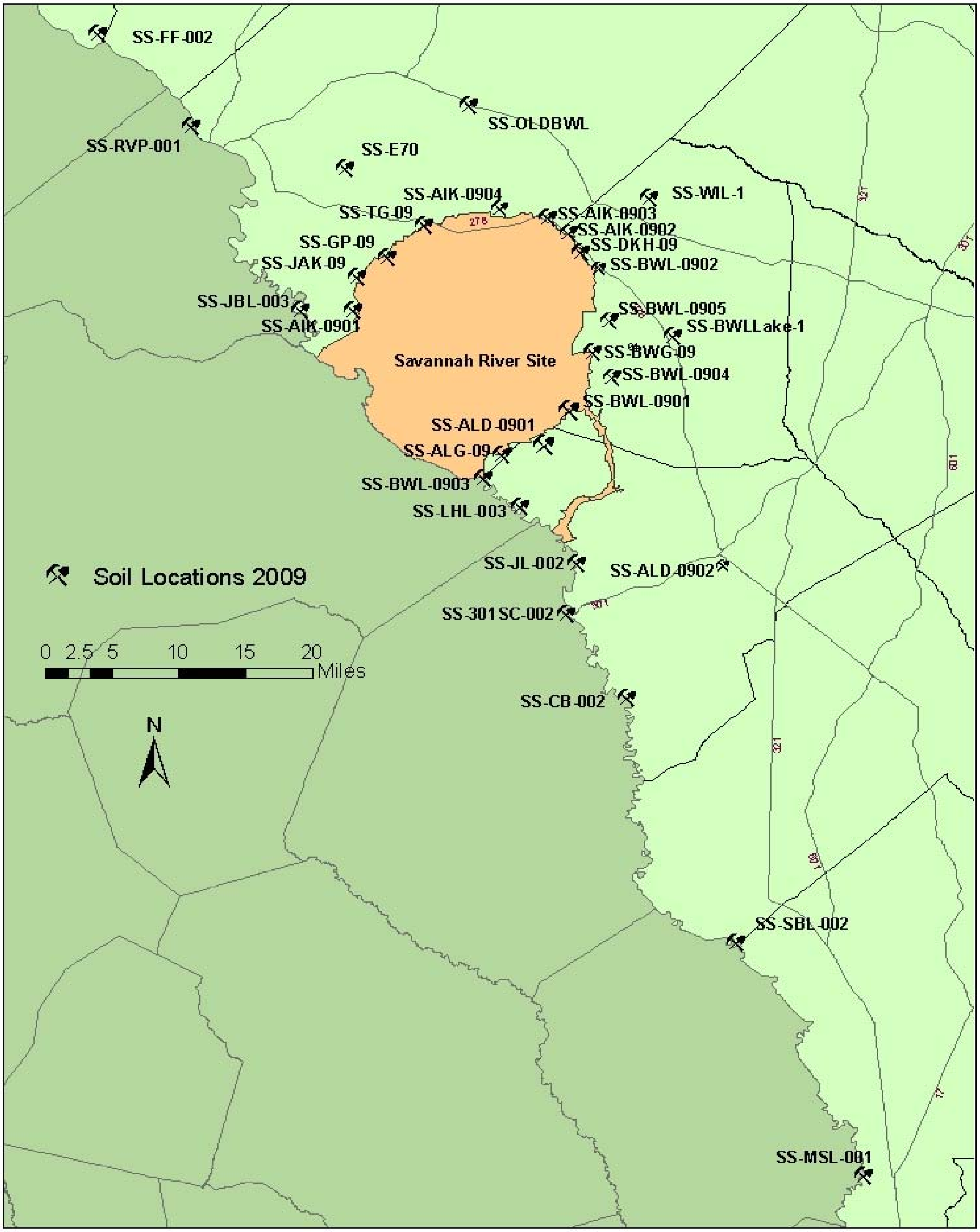
3.1.2

Map 2. SRS Perimeter Surface Soil Monitoring Locations



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3.1.3 TABLES AND FIGURES

Surface Soil Monitoring Adjacent to SRS

Table 1. Random Soil Samples Collected in 2009

Random Quadrants Within SRS Perimeter or "E" Quadrants.

Quad	7.5' Quad Name	Latitude by Lat and Longitude by Long	Region
E65	Ridge Spring	3345 by 3352.5 and -8137.5 by -8145	UCP
E70	Hollow Creek	3322.5 by 3330 and -8145 by -8152.5	UCP
E72	Aiken NW	3337.5 by 3345 and -8137.5 by -8145	UCP

Random Quadrants Outside the 50-mile SRS Perimeter or "B" Quadrants.

Quad	7.5' Quad Name	Latitude by Lat and Longitude by Long	Region
B65	Sardinia	3345 by 3352.5 and -8000 by -8007.5	LCP
B68	Winnsboro	3422.5 by n3430 and -8100 by -8107.5	PM
B69	Lake Murray West	3400 by 3407.5 and -8122.5 by -8130	PM
B72X&E48X	Orangeburg N.(50mi.)	3330 by 3337.5 and -8045 by -8052.5	UCP
B74	Delmar	3400 by 3407.5 and -8130 by -8137.5	PM

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" 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.
8. LCP is lower coastal plain region, UCP is upper coastal plain region, PM is the piedmont region, and BR is the Blue Ridge region of South Carolina.

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 2. Nonrandom Soil Samples Collected in 2009

2009 ESOP Surface Soil Sample Locations		
SAMPLE ID	**LOCATION**	**COUNTY**
SS AIK 0902	Co-located at VEG site AKN-007	Aiken
SS ALD 0901	Co-located at VEG site ALD-001	Allendale
SS AIK 0901	Co-located at VEG site AKN-002	Aiken
SS BWL 0901	Co-located at VEG site BWL-004	Barnwell
SS WIL 1	Co-located at EV site BWL-02	Barnwell
SS BWL Lake 1	Lake Edgar Brown boat landing	Barnwell
SS BWL 0902	Co-located at VEG site BWL-001	Barnwell
SS AIK 0903	Co-located at EV site AIK 0903	Barnwell
SS AIK 0904	Boggy Gut Road	Aiken
SS BWL 0903	Steel Creek Landing area	Barnwell
SS ALD 0902	Co-located at Allendale VEG Site ALD-251	Allendale
SS BWL 0904	Co-located at VEG site BWL-003	Barnwell
SS BWL 0905	Co-located at VEG site BWL-002	Barnwell
SS OLDBWL	UTR/ Old Barnwell Rd.	Aiken
SS ALG 09	Allendale Gate	Allendale
SS BWG 09	Barnwell Gate	Barnwell
SS DKH 09	Darkhorse (Williston Gate)	Barnwell
SS JAK 09	Jackson	Aiken
SS GP 09	Green Pond	Aiken
SS TG 09	Talatha (Aiken) Gate	Aiken
SS MSL 001	Mill Stone Landing	Jasper
SS SBL 002	Stoke's Bluff Landing	Hampton
SS CB 002	Cohen's Bluff	Allendale
SS 301SC 002	301 Bridge SC side	Allendale
SS JL 002	Johnson's Landing	Allendale
SS LHL 003	Little Hell Landing	Allendale
SS SCL 003	Steel Creek Landing	Barnwell
SS JBL 003	Jackson Boat Landing	Aiken
SS RVP 001	North Augusta Riverview Park	Aiken
SS FF 002	Fury's Ferry	McCormick

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 3. 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 4. 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 5. 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 6. 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**

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Table 7. Cs-137 Surface Soil Data Comparison: Nonrandom Perimeter SCDHEC and DOE-SR Perimeter Surface Soil Samples 25 miles of SRS Perimeter

SCDHEC

Sample ID	County	Cs-137
SSAIK0902	Aiken	0.22
SSALD0901	Allendale	0.03
SSAIK0901	Aiken	0.25
SSOLDBWLA	Barnwell	1.18
SSOLDBWLC	Barnwell	0.34
SSOLDBWLD	Barnwell	0.54
SSOLDBWLE	Barnwell	0.48
SSBWL0901	Barnwell	0.16
SSWIL1	Barnwell	0.03
SSBWL LAKE1	Barnwell	<0.02
SSBWL0902	Barnwell	0.17
SSAIK0903	Aiken	0.07
SSAIK0904	Aiken	0.11
SSALD0902	Allendale	0.48
SSBWL0903	Barnwell	3.14
SSBWL0904	Barnwell	0.10
SSBWL0905	Barnwell	0.33
AVG		**0.477**
MEDIAN		**0.240**
STD		**0.764**

DOE-SR

Sample Location	Cs-137
Allendale Gate	0.04
D-Area	0.10
Darkhorse @ Williston Gate	0.16
East Talatha	0.08
Green Pond	<MDC
Highway 21/167	0.09
Jackson	0.11
Patterson Mill Road	0.02
Talatha Gate	0.07
West Jackson	0.07
Windsor Road	0.08
AVG	**0.080**
MEDIAN	**0.080**
STD	**0.037**

DOE-SR 25 mile Perimeter Samples

Sample Location	Cs-137
Aiken Airport	0.10
Augusta Lock and Dam 614	0.15
Highway 301 @ State Line	0.06
AVG	**0.104**
MEDIAN	**0.085**
STD	**0.450**

Surface Soil Monitoring Adjacent to SRS

**Table 8. Cs-137 Surface Soil Data Comparison: SCDHEC and DOE-SR Surface Soil Samples Collected
> 50 miles of the SRS Center Point.**

SCDHEC

Sample ID	County	Cs-137
SSB68	Fairfield	<.0345
SSB74	Saluda	0.580
SSB69	Saluda	1.109
SSB65	Clarendon	0.438
SSB72	Orangeburg	0.159
AVG		**0.5712**
MEDIAN		**0.5085**
STD		**0.3989**

DOE-SR

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

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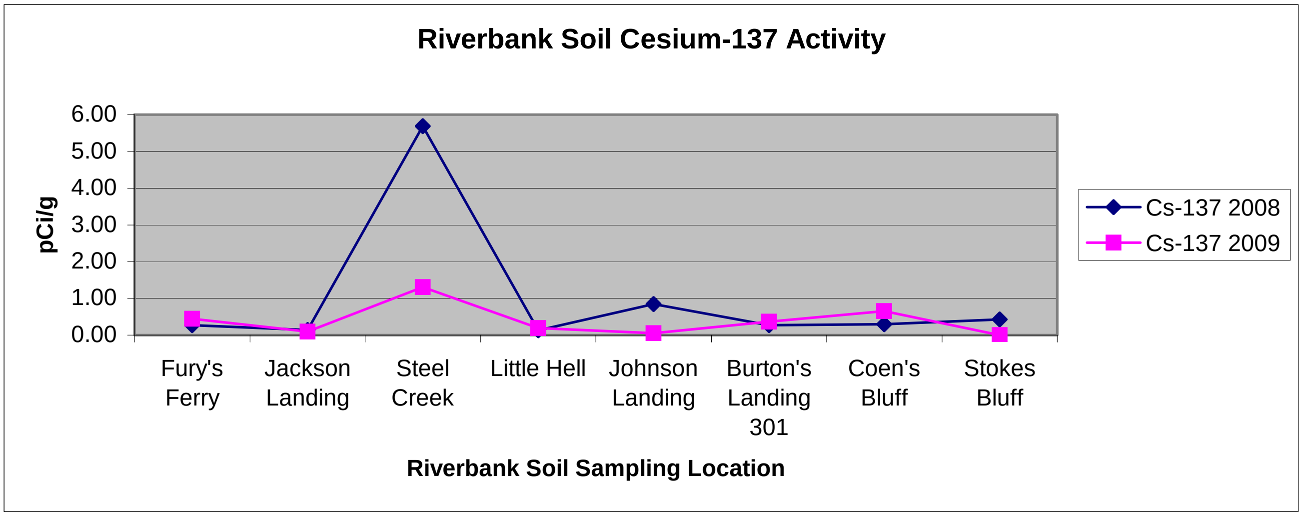
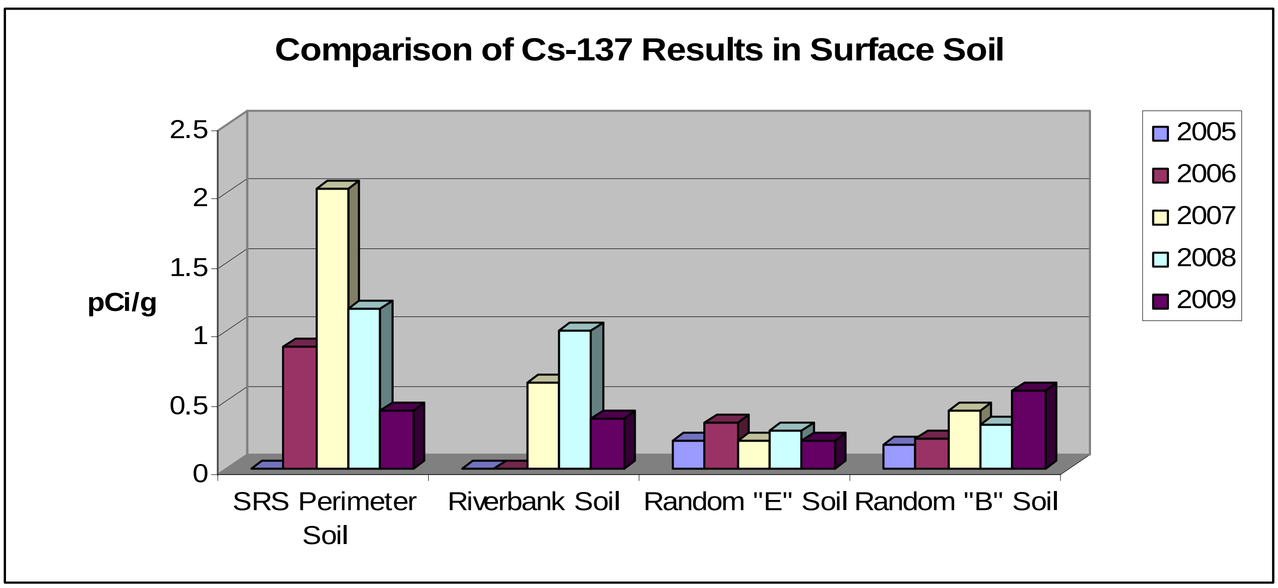
Surface Soil Monitoring Adjacent to SRS

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.

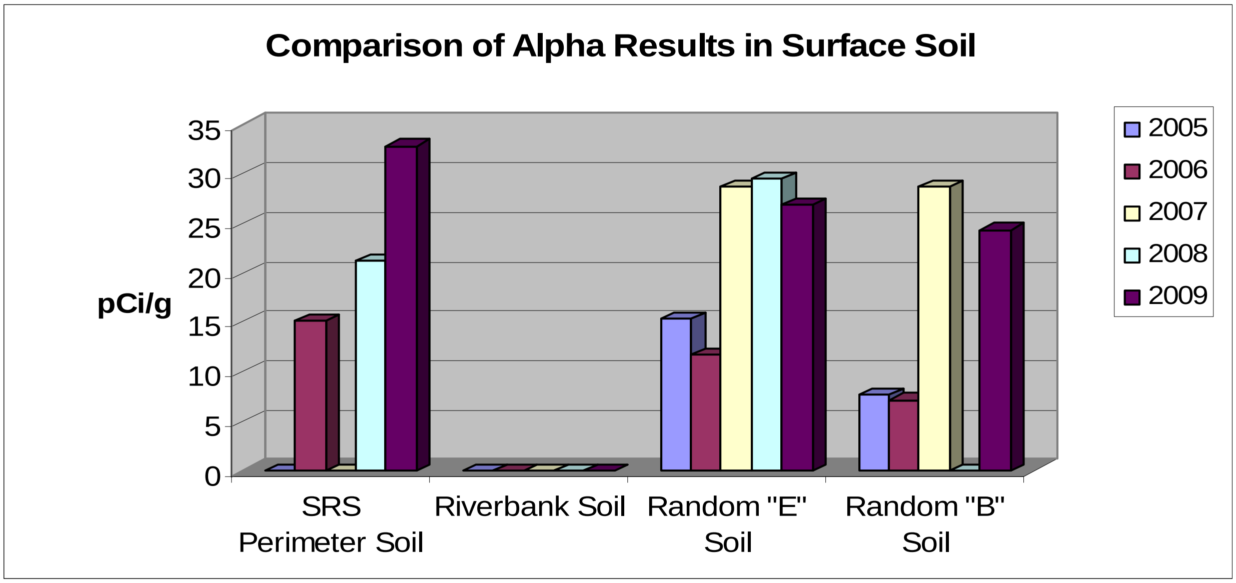
Figure 2. Trending Data for Cesium-137 by Average of 2005-2009 and Individual Years



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

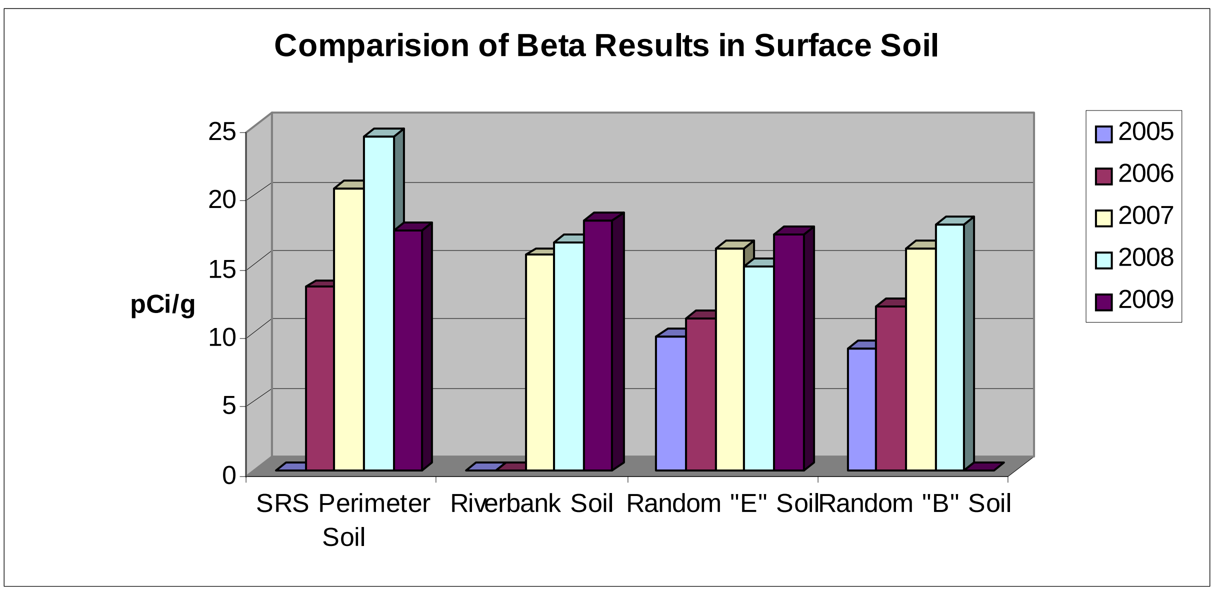
Tables and Figures
Surface Soil Monitoring Adjacent to SRS

Figure 3. Trending Data for Alpha Detections by Average of 2004-2008 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. There were no alpha detections in any of the riverbank soil samples.

Figure 4. Trending Data for Beta Detections by Average of 2004-2008 and Individual Years

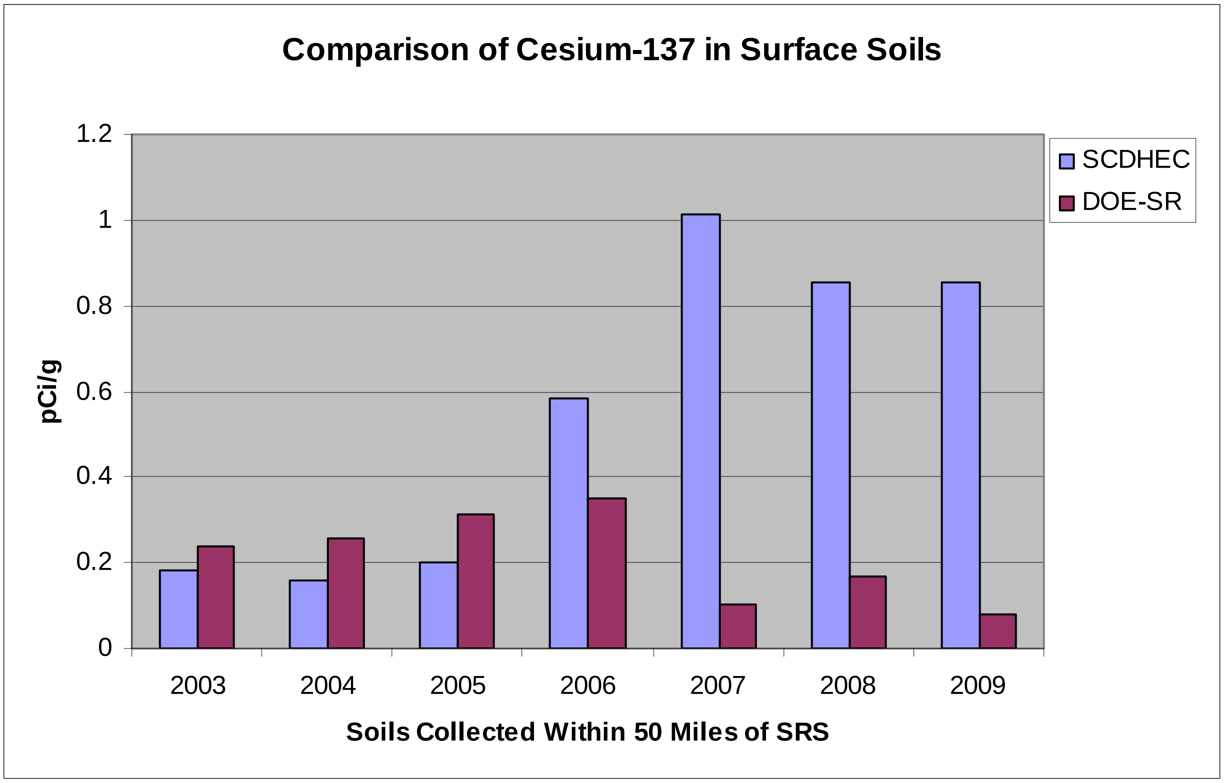


Note: There were no samples collected from the SRS perimeter in 2005. There were no samples collected from riverbank soil from 2005-2006. There were no beta detections in any of the random “B” soil samples in 2009.

Tables and Figures

Surface Soil Monitoring Adjacent to SRS

Figure 5. SCDHEC and DOE-SR Trending Data for Cesium-137 from 2003-2009



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3.1.4 DATA

Surface Soil Monitoring Adjacent to SRS

Notes:
1. LLD= Lower Limit of Detection
2. MDA= Minimum Detectable Activity
3. SS= Surface soil

Surface Soil Monitoring Adjacent to SRS Data

2009 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SSAIK0902	SSALD0901	SSAIK0901	SS OLDBWL A	SS OLDBWL C	SS OLDBWL D
Collection Date	**2/11/2009**	**2/11/2009**	**2/11/2009**	**6/10/2009**	**6/10/2009**	**6/10/2009**
Alpha Activity	<LLD	<LLD	<LLD	**44.50**	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	**18.00**	NA	NA
Alpha LLD	22.00	20.50	22.00	**14.70**	14.90	15.30
Beta Activity	<LLD	<LLD	<LLD	**33.80**	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	**6.56**	NA	NA
Beta LLD	8.51	9.20	8.37	**8.83**	9.35	9.01
K-40 Activity	<MDA	**0.70**	**1.41**	**3.05**	**1.20**	**0.85**
K-40 Confidence Interval	NA	**0.24**	**0.32**	**0.92**	**0.46**	**0.34**
K-40 MDA	0.21	**0.18**	**0.21**	**0.72**	**0.30**	**0.18**
Cs-137 Activity	0.22	0.32	0.25	1.18	0.34	0.54
Cs-137 Confidence Interval	**0.04**	**0.05**	**0.04**	**0.12**	**0.06**	**0.07**
Cs-137 MDA	**0.02**	**0.03**	**0.03**	**0.07**	**0.04**	**0.03**
Pb-212 Activity	**0.71**	**0.68**	**1.07**	**1.95**	**1.26**	**0.81**
Pb-212 Confidence Interval	**0.07**	**0.07**	**0.10**	**0.21**	**0.13**	**0.09**
Pb-212 MDA	**0.04**	**0.04**	**0.04**	**0.13**	**0.06**	**0.05**
Pb-214 Activity	**0.45**	**0.56**	**0.78**	**17.65**	**1.89**	**1.15**
Pb-214 Confidence Interval	**0.04**	**0.06**	**0.06**	**0.83**	**0.17**	**0.14**
Pb-214 MDA	**0.04**	**0.05**	**0.05**	**0.30**	**0.12**	**0.11**
Ra-226 Activity	**1.45**	**1.03**	**1.86**	**51.89**	**5.01**	**2.37**
Ra-226 Confidence Interval	**0.51**	**0.50**	**0.59**	**4.04**	**1.02**	**0.80**
Ra-226 MDA	**0.47**	**0.52**	**0.52**	**1.76**	**0.74**	**0.61**
Ac-228 Activity	<MDA	<MDA	**1.03**	**1.90**	**1.40**	**0.71**
Ac-228 Confidence Interval	NA	NA	**0.09**	**0.24**	**0.13**	**0.11**
Ac-228 MDA	0.19	0.21	**0.09**	**0.30**	**0.11**	**0.11**

Location Description	SS OLDBWL E	SS BWL 0901	SS WIL 1	SS BWL LAKE 1	SSBWL0902	SSAIK0903
Collection Date	**6/10/2009**	**6/10/2009**	**9/11/2009**	**9/11/2009**	**9/11/2009**	**9/11/2009**
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA	NA	NA
Alpha LLD	14.90	14.70	28.20	30.00	29.40	28.50
Beta Activity	<LLD	<LLD	<LLD	**9.57**	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	**4.66**	NA	NA
Beta LLD	8.79	8.50	7.38	**7.60**	7.35	7.46
K-40 Activity	<MDA	<MDA	<MDA	**0.71**	**0.38**	<MDA
K-40 Confidence Interval	NA	NA	NA	**0.20**	**0.15**	NA
K-40 MDA	0.25	0.16	0.09	**0.12**	**0.11**	0.11
Mn-54 MDA	0.03	0.02	NA	0.02	0.02	NA
Cs-137 Activity	**0.48**	**0.16**	**0.03**	<MDA	**0.17**	**0.07**
Cs-137 Confidence Interval	**0.06**	**0.03**	**0.02**	NA	**0.02**	**0.02**
Cs-137 MDA	**0.03**	**0.02**	**0.01**	0.02	**0.02**	**0.02**
Pb-212 Activity	**1.00**	**0.75**	**0.30**	**1.12**	**1.05**	**0.57**
Pb-212 Confidence Interval	**0.11**	**0.08**	**0.03**	**0.10**	**0.09**	**0.06**
Pb-212 MDA	**0.05**	**0.03**	**0.02**	**0.04**	**0.03**	**0.03**
Pb-214 Activity	**1.28**	**0.64**	**0.31**	**0.85**	**0.65**	**0.52**
Pb-214 Confidence Interval	**0.15**	**0.09**	**0.04**	**0.07**	**0.06**	**0.05**
Pb-214 MDA	**0.11**	**0.07**	**0.03**	**0.04**	**0.03**	**0.03**
Ra-226 Activity	**2.09**	**1.52**	**0.73**	**1.41**	**1.07**	<MDA
Ra-226 Confidence Interval	**0.74**	**0.47**	**0.31**	**0.43**	**0.42**	NA
Ra-226 MDA	**0.66**	**0.47**	**0.31**	**0.46**	**0.43**	0.40
Ac-228 Activity	**1.00**	**0.77**	**0.33**	**1.12**	**1.02**	**0.56**
Ac-228 Confidence Interval	**0.12**	**0.08**	**0.04**	**0.08**	**0.07**	**0.05**
Ac-228 MDA	**0.10**	**0.07**	**0.04**	**0.05**	**0.05**	**0.05**

Note: Units are in pCi/g. There were no detections in any 2009 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 Data

2009 Alpha, Beta and Gamma Detections for Nonrandom SRS Perimeter Surface Soil Samples

Location Description	SSAIK0902	SSALD0901	SSAIK0901	SS OLDBWL A	SS OLDBWL C	SS OLDBWL D
Collection Date	2/11/2009	2/11/2009	2/11/2009	6/10/2009	6/10/2009	6/10/2009
Alpha Activity	<LLD	<LLD	<LLD	**44.50**	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	**18.00**	NA	NA
Alpha LLD	22.00	20.50	22.00	**14.70**	14.90	15.30
Beta Activity	<LLD	<LLD	<LLD	**33.80**	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	**6.56**	NA	NA
Beta LLD	8.51	9.20	8.37	**8.83**	9.35	9.01
K-40 Activity	<MDA	**0.70**	**1.41**	**3.05**	**1.20**	**0.85**
K-40 Confidence Interval	NA	**0.24**	**0.32**	**0.92**	**0.46**	**0.34**
K-40 MDA	0.21	**0.18**	**0.21**	**0.72**	**0.30**	**0.18**
Cs-137 Activity	0.22	0.32	0.25	1.18	0.34	0.54
Cs-137 Confidence Interval	**0.04**	**0.05**	**0.04**	**0.12**	**0.06**	**0.07**
Cs-137 MDA	**0.02**	**0.03**	**0.03**	**0.07**	**0.04**	**0.03**
Pb-212 Activity	**0.71**	**0.68**	**1.07**	**1.95**	**1.26**	**0.81**
Pb-212 Confidence Interval	**0.07**	**0.07**	**0.10**	**0.21**	**0.13**	**0.09**
Pb-212 MDA	**0.04**	**0.04**	**0.04**	**0.13**	**0.06**	**0.05**
Pb-214 Activity	**0.45**	**0.56**	**0.78**	**17.65**	**1.89**	**1.15**
Pb-214 Confidence Interval	**0.04**	**0.06**	**0.06**	**0.83**	**0.17**	**0.14**
Pb-214 MDA	**0.04**	**0.05**	**0.05**	**0.30**	**0.12**	**0.11**
Ra-226 Activity	**1.45**	**1.03**	**1.86**	**51.89**	**5.01**	**2.37**
Ra-226 Confidence Interval	**0.51**	**0.50**	**0.59**	**4.04**	**1.02**	**0.80**
Ra-226 MDA	**0.47**	**0.52**	**0.52**	**1.76**	**0.74**	**0.61**
Ac-228 Activity	<MDA	<MDA	**1.03**	**1.90**	**1.40**	**0.71**
Ac-228 Confidence Interval	NA	NA	**0.09**	**0.24**	**0.13**	**0.11**
Ac-228 MDA	0.19	0.21	**0.09**	**0.30**	**0.11**	**0.11**

Note: Units are in pCi/g. There were no detections in any 2009 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 SRS Data

2009 Beta and Gamma Detections for Savannah River Boat Landing Riverbank Soil Samples

Location Description	SS MSL 001	SS SBL 002	SS CB 002	SS 301SC 002	SS JL 002
	Mill Stone Landing	**Stokes Bluff Landing**	**Cohens Bluff**	**SC Side of hwy 301 bridge**	**Johnson's Landing**
Collection Date	7/7/2009	7/7/2009	7/10/2009	7/10/2009	7/10/2009
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA	NA
Alpha LLD	21.6	21.7	21.7	21.7	21.5
Beta Activity	12.5	17.4	25.9	29.7	7.76
Beta Confidence Interval	4.45	4.80	5.39	5.59	4.06
Beta LLD	6.68	6.71	6.71	6.70	6.68
K-40 Activity	7.93	6.04	13.92	15.21	0.53
K-40 Confidence Interval	0.71	0.52	1.13	1.15	0.21
K-40 MDA	0.20	0.13	0.27	0.27	0.17
Cs-137 Activity	<MDA	<MDA	0.65	0.37	0.05
Cs-137 Confidence Interval	NA	NA	0.08	0.06	0.03
Cs-137 MDA	0.03	0.02	0.05	0.03	0.02
Pb-212 Activity	0.83	0.47	1.53	1.30	0.64
Pb-212 Confidence Interval	0.09	0.05	0.15	0.12	0.07
Pb-212 MDA	0.05	0.03	0.07	0.06	0.04
Pb-214 Activity	0.90	0.37	1.80	1.48	0.62
Pb-214 Confidence Interval	0.09	0.06	0.15	0.12	0.06
Pb-214 MDA	0.05	0.04	0.08	0.07	0.05
Ra-226 Activity	2.03	<MDA	3.30	2.82	1.23
Ra-226 Confidence Interval	0.71	NA	0.93	0.83	0.46
Ra-226 MDA	0.55	0.37	0.82	0.69	0.42
Ac-228 Activity	0.77	0.53	1.49	1.43	0.63
Ac-228 Confidence Interval	0.10	0.06	0.14	0.13	0.08
Ac-228 MDA	0.10	0.07	0.13	0.12	0.07

Location Description	SS LHL 003	SS SCL 003	SS JBL 003	SS RVP 001	SS FF 002
	Little Hell Landing	**Steel Creek Landing**	**Jackson Boat Landing**	**Riverview Park**	**Fury's Ferry**
Collection Date	7/10/2009	7/13/2009	7/13/2009	7/14/2009	7/14/2009
Alpha Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	NA	NA
Alpha LLD	21.6	21.7	21.5	21.6	21.6
Beta Activity	17.5	21.4	12.7	<LLD	19.2
Beta Confidence Interval	4.84	5.09	4.49	NA	4.92
Beta LLD	6.71	6.69	6.68	6.65	6.71
K-40 Activity	13.23	20.20	7.74	7.07	16.82
K-40 Confidence Interval	1.10	1.43	0.71	0.66	1.22
K-40 MDA	0.33	0.27	0.21	0.21	0.20
Cs-137 Activity	0.19	1.31	0.10	0.06	0.44
Cs-137 Confidence Interval	0.05	0.12	0.03	0.02	0.06
Cs-137 MDA	0.05	0.04	0.04	0.03	0.03
Pb-212 Activity	2.06	2.04	1.40	0.81	0.99
Pb-212 Confidence Interval	0.19	0.18	0.13	0.09	0.10
Pb-212 MDA	0.07	0.07	0.05	0.04	0.05
Pb-214 Activity	2.49	1.76	1.14	0.82	0.93
Pb-214 Confidence Interval	0.18	0.14	0.10	0.08	0.09
Pb-214 MDA	0.09	0.08	0.06	0.05	0.06
Ra-226 Activity	4.30	3.29	2.82	1.66	1.88
Ra-226 Confidence Interval	0.97	0.80	0.84	0.61	0.64
Ra-226 MDA	0.88	0.82	0.63	0.54	0.61
Ac-228 Activity	2.04	2.14	1.43	0.91	1.05
Ac-228 Confidence Interval	0.17	0.16	0.12	0.09	0.11
Ac-228 MDA	0.16	0.14	0.11	0.09	0.10

Surface Soil Monitoring Adjacent to SRS Data

2009 Alpha, Beta and Gamma Detections for Random Perimeter “E” (<50 miles) Surface Soil Samples

Location Description	SSE65	SSE72	SSE70
Collection Date	2/12/2009	2/12/2009	2/12/2009
Alpha Activity	<LLD	26.9	<LLD
Alpha Confidence Interval	NA	16.5	NA
Alpha LLD	23.0	20.9	21.4
Beta Activity	<LLD	17.2	<LLD
Beta Confidence Interval	NA	5.43	NA
Beta LLD	9.29	8.51	9.05
K-40 Activity	5.7320	3.430	7.133
K-40 Confidence Interval	0.6080	0.6222	0.7106
K-40 MDA	0.2201	0.3217	0.2581
Cs-137 Activity	<MDA	0.1959	<MDA
Cs-137 Confidence Interval	NA	0.0464	NA
Cs-137 MDA	0.0309	0.0444	0.0344
Pb-212 Activity	1.430	2.901	1.347
Pb-212 Confidence Interval	0.1304	0.2538	0.1274
Pb-212 MDA	0.0484	0.0813	0.0543
Pb-214 Activity	1.044	3.401	1.449
Pb-214 Confidence Interval	0.0761	0.1702	0.0927
Pb-214 MDA	0.0511	0.0908	0.0582
Ra-226 Activity	1.844	9.186	3.285
Ra-226 Confidence Interval	0.5819	1.362	0.7381
Ra-226 MDA	0.6189	0.9805	0.6621
Ac-228 Activity	1.360	2.751	1.285
Ac-228 Confidence Interval	0.1082	0.1751	0.1194
Ac-228 MDA	0.0935	0.1530	0.1145
U/Th-238 Activity	<MDA	3.892	<MDA
U/Th-238 Confidence Interval	NA	1.826	NA
U/Th-238 MDA	0.5862	0.9544	0.6193

Note: Units are in pCi/g. There were no detections in any 2009 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 Data

2009 Alpha, Beta and Gamma Detections for Random Perimeter "E" (<50 miles) Surface Soil Samples

Lab Sample ID	XA15904	XA15905	XA15906	XA15914	XA15915
Location Description	SSB68	SSB74	SSB69	SSB65	SSB72
Collection Date	1/8/2009	2/3/2009	2/3/2009	3/6/2009	3/6/2009
Alpha Activity	24.0	<LLD	<LLD	<LLD	24.7
Alpha Confidence Interval	16.8	NA	NA	NA	17.3
Alpha LLD	22.4	20.4	21.5	22.2	23.1
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA	NA
Beta LLD	8.93	8.88	8.93	9.11	9.11
K-40 Activity	9.086	8.502	12.61	1.018	0.8477
K-40 Confidence Interval	0.7913	0.8249	1.138	0.3200	0.3439
K-40 MDA	0.2183	0.2381	0.2640	0.2788	0.2367
Cs-137 Activity	<MDA	0.5795	1.1090	0.4375	0.1587
Cs-137 Confidence Interval	NA	0.0670	0.1171	0.0560	0.0360
Cs-137 MDA	0.0345	0.0367	0.0435	0.0356	0.0295
Pb-212 Activity	0.9350	0.8463	0.5128	1.345	1.299
Pb-212 Confidence Interval	0.0952	0.0950	0.0936	0.1298	0.1240
Pb-212 MDA	0.0474	0.0555	0.0584	0.0546	0.0571
Pb-214 Activity	0.6477	0.7348	0.3276	1.420	1.289
Pb-214 Confidence Interval	0.0671	0.0764	0.0628	0.0980	0.0901
Pb-214 MDA	0.0502	0.0630	0.0740	0.0631	0.0629
Ra-226 Activity	1.608	2.698	<MDA	3.172	2.646
Ra-226 Confidence Interval	0.5957	0.9148	NA	0.7690	0.6364
Ra-226 MDA	0.5622	0.6346	0.6504	0.6984	0.6941
Ac-228 Activity	0.9417	0.8272	<MDA	1.239	1.205
Ac-228 Confidence Interval	0.0992	0.1018	NA	0.1132	0.1142
Ac-228 MDA	0.1057	0.1069	0.2454	0.1115	0.1045

Surface Soil Monitoring Adjacent to SRS Data
2009 Metal Detections for Nonrandom Samples

Location Description	SSAIK0902	SSALD0901	SSAIK0901	SSALG09
Collection Date	2/11/2009	2/11/2009	2/11/2009	4/29/2009
Analyte				
Barium in Soil	19	11	29	25
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	3.5	2.4	4	3.5
Copper in Soil	2.2	<1.0	3.7	1.1
Lead in Soil	<5.0	9.7	6.4	5.8
Manganese in Soil	89	15	200	130
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Nickel in Soil	2.1	<2.0	3.2	2.1
Zinc in Soil	8.6	2.8	9.4	8

Location Description	SSBWG09	SSDKH09	SSJAK09	SSGP09
Collection Date	4/29/2009	4/29/2009	4/29/2009	4/29/2009
Analyte				
Barium in Soil	15	6.6	8.6	22
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	2.2	2.2	1.8	3.3
Copper in Soil	<1.0	<1.0	1.3	1.3
Lead in Soil	5.2	<5.0	6.7	8
Manganese in Soil	79	32	13	170
Mercury in Soil	<0.10	<0.10	<0.10	<0.10
Nickel in Soil	<2.0	<2.0	2.1	<2.0
Zinc in Soil	9.9	3.6	2.3	7.7

Location Description	SSTG09	SSBWL0901	SSAIK0904	SSBWL0905
Collection Date	4/29/2009	6/10/2009	9/11/2009	10/20/2009
Analyte				
Barium in Soil	7.7	13	18	14
Cadmium in Soil	<1.0	<1.0	<1.0	<1.0
Chromium in Soil	2.5	3.1	5	1.7
Copper in Soil	1.7	<1.0	1.9	1.2
Lead in Soil	5.4	5.5	8.2	8.1
Manganese in Soil	6.2	49	70	170
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	2.1	2.6	5	2.6

Surface Soil Monitoring Adjacent to SRS Data

2009 Alpha, Beta and Gamma Detections for SRS Split Samples taken at SRS Air Monitoring Stations

Location Description	SS ALG 09	SS BWG 09	SS DKH 09	SS JAK 09	SS GP 09	SS TG 09
Collection Date	4/23/2009	4/23/2009	4/23/2009	4/23/2009	4/23/2009	4/23/2009
Alpha Activity	<LLD	<LLD	<LLD	11.50	<LLD	<LLD
Alpha Confidence Interval	NA	NA	NA	10.00	NA	NA
Alpha LLD	11.10	10.30	10.50	10.70	11.30	10.50
Beta Activity	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Beta Confidence Interval	NA	NA	NA	NA	NA	NA
Beta LLD	8.14	8.52	8.15	8.56	8.25	8.36
K-40 Activity	0.57	0.57	0.35	0.62	0.78	0.47
K-40 Confidence Interval	0.18	0.17	0.14	0.19	0.19	0.18
K-40 MDA	0.14	0.10	0.11	0.12	0.12	0.12
Cs-137 Activity	0.11	0.23	0.27	0.26	0.25	0.21
Cs-137 Confidence Interval	0.03	0.03	0.03	0.03	0.03	0.03
Cs-137 MDA	0.02	0.01	0.01	0.02	0.02	0.02
Pb-212 Activity	0.91	0.37	0.66	0.99	0.73	0.84
Pb-212 Confidence Interval	0.08	0.04	0.06	0.09	0.07	0.08
Pb-212 MDA	0.04	0.03	0.03	0.04	0.03	0.03
Pb-214 Activity	0.90	0.29	0.62	0.73	0.61	0.65
Pb-214 Confidence Interval	0.06	0.03	0.04	0.05	0.05	0.05
Pb-214 MDA	0.04	0.03	0.03	0.04	0.03	0.03
Ra-226 Activity	1.41	0.97	1.26	1.28	1.41	0.99
Ra-226 Confidence Interval	0.50	0.40	0.45	0.48	0.49	0.43
Ra-226 MDA	0.49	0.35	0.41	0.47	0.42	0.44
Ac-228 Activity	0.94	<MDA	0.68	0.97	0.73	0.81
Ac-228 Confidence Interval	0.07	NA	0.06	0.07	0.06	0.07
Ac-228 MDA	0.06	0.10	0.05	0.05	0.05	0.05

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Summary Statistics

Surface Soil Monitoring Adjacent to SRS

Notes: N/A = Not Applicable

Surface Soil Monitoring Adjacent to SRS Summary Statistics

2009 Summary Statistics – SCDHEC Surface Soil Metals Data
Nonrandom Perimeter Samples

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Barium	15.7	3.5	14.5	6.6	29	12	12
Chromium	2.9	1.3	2.8	1.7	5	12	12
Copper	1.8	0.7	1.5	<1.0	3.7	8	12
Lead	6.9	1.1	6.6	<5.0	9.7	10	12
Manganese	85.3	67.7	74.5	6.2	200	12	12
Nickel	2.4	0.6	2.1	<2.0	3.2	4	12
Zinc	5.4	4.2	4.3	2.3	9.9	12	12

Note: Units are in mg/kg.

2009 Summary Statistics – SCDHEC Surface Soil Radiological Data
Nonrandom Perimeter Samples

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Alpha	32.85	16.263	32.85	21.2	44.5	2	17
Beta	17.323	14.277	9.570	8.60	33.80	3	17
K-40	1.320	1.271	0.793	0.38	4.69	11	17
Cs-137	0.494	0.757	0.288	0.03	3.14	15	17
Pb-212	0.910	0.379	0.800	0.30	1.95	16	17
Pb-214	1.790	4.104	0.780	0.31	17.65	16	17
Ra-226	4.963	12.554	1.691	0.73	51.89	15	17
Ac-228	0.944	0.405	0.841	0.33	1.90	14	17

Note: Units are in pCi/g.

2009 Summary Statistics – SCDHEC Surface Soil Radiological Data Boat Landings
Note: Units are in pCi/g.

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Alpha	NA	NA	NA	NA	NA	0	10
Beta	18.23	4.7	17.50	7.76	29.70	9	10
K-40	10.87	6.3	10.58	0.53	20.20	10	10
Cs-137	0.40	0.1	0.28	0.05	1.31	8	10
Pb-212	1.21	0.1	1.14	0.47	2.06	10	10
Pb-214	1.23	0.0	1.04	0.37	2.49	10	10
Ra-226	2.59	0.1	2.82	1.23	4.30	9	10
Ac-228	1.24	0.2	1.24	0.53	2.14	10	10

Surface Soil Monitoring Adjacent to SRS Summary Statistics
2009 Summary Statistics – SCDHEC Surface Soil Radiological Data

Random Perimeter "E" Samples (<50 miles)

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Alpha	26.90	NA	26.9	26.9	26.9	1	3
Beta	17.20	NA	17.2	17.2	17.2	1	3
K-40	5.432	1.870	5.732	3.430	7.133	3	3
Cs-137	0.196	NA	0.196	0.196	0.196	1	3
Pb-212	1.893	0.874	1.430	1.347	2.901	3	3
Pb-214	1.965	1.260	1.449	1.044	3.401	3	3
Ra-226	4.772	3.890	3.285	1.844	9.186	3	3
Ac-228	1.799	0.826	1.360	1.285	2.751	3	3
U/Th- 238	3.892	NA	3.892	3.892	3.892	1	3

Note: Units are in pCi/g.

2009 Summary Statistics – SCDHEC Surface Soil Radiological Data
Random Background "B" Samples (>50 miles)

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Alpha	24.350	0.495	24.4	24.0	24.7	2	5
Beta	NA	NA	NA	NA	NA	0	5
K-40	6.413	5.244	8.502	0.848	12.610	5	5
Cs-137	0.571	0.399	0.509	0.159	1.109	4	5
Pb-212	0.988	0.344	0.935	0.513	1.345	5	5
Pb-214	0.884	0.458	0.735	0.328	1.420	5	5
Ra-226	2.531	0.659	2.672	1.608	3.172	5	5
Ac-228	1.053	0.201	1.073	0.827	1.239	5	5

Note: Units are in pCi/g.

There were no detections in any 2009 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.

2009 Summary Statistics – SCDHEC Surface Soil Radiological Data
2009 Alpha, and Gamma Detections for SRS Split Samples taken at SRS Air Stations

Analyte	Average	Standard Deviation	Median	Minimum	Maximum	Number of Detections	Total Number Sampled
Alpha	11.5	NA	11.5	11.5	11.5	1	6
Beta	NA	NA	NA	NA	NA	0	6
K-40	0.558	0.144	0.567	0.35	0.78	6	6
Cs-137	0.22	0.058	0.238	0.11	0.27	6	6
Pb-212	0.75	0.222	0.787	0.37	0.99	6	6
Pb-214	0.632	0.198	0.635	0.29	0.90	6	6
Ra-226	1.221	0.196	1.269	0.97	1.41	6	6
Ac-228	0.826	0.129	0.810	0.68	0.97	5	6

Note: Units are in pCi/g.

There were no detections in any 2009 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.

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3.2 2009 Radiological Monitoring of Terrestrial Vegetation Related to the Savannah River Site

3.2.1 SUMMARY

Terrestrial vegetation, fungi, lichens, mosses, etc., 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 2010). 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 2009 ESOP conducted independent vegetation monitoring at 17 locations around the perimeter of SRS, three former SRS monitoring locations 25 miles from the center of SRS, and six locations selected at random (three near SRS and three background sites around South Carolina). Sampling was performed on a quarterly basis with samples obtained in February, May, June, August, September, November, and December. ESOP and DOE-SR perimeter stations sampled in 2009 are shown in Section 3.2.2.

Samples from 17 perimeter stations were analyzed for tritium activity, 13 of which exhibited tritium levels greater than the Lower Limit of Detection (LLD). Average activity levels were fairly uniform around SRS, with the highest activity located on the western side. Vegetation was collected for gamma analysis at eight selected perimeter stations where sampling had consistently shown detectable levels of cesium-137 (Cs-137), and one station added in 2005. Cesium-137 was detected at all but one of these locations, with the highest activities from stations on the northern and northwest sides of SRS. Both tritium and Cs-137 results are consistent with historical findings.

Precedence for the monitoring of fungi was established at the SRS when mushroom samples were found to contain 2 to 540 picocuries per gram (pCi/g) of Cs-137 in 1983, and 19 to 640 pCi/g in 1984 at locations within SRS (DuPont 1984). The abundance of mushrooms may be related to weather factors and could explain some Cs-137 concentration variations in deer and hogs. The Cs-137 contribution to food dose in humans was over one hundred times greater for fungi than the next largest food source (berries) at Chernobyl (Botsch 1999). DOE-SR mushroom samples collected in the 1980s were obtained from eleven DOE-SR locations that were administratively controlled to prevent public access.

ESOP added fungi sampling to the vegetation project in 2004. Evidence from European studies of the Chernobyl meltdown radioactive releases indicated that bolete fungi are among the greatest bio-concentrators of many radionuclides (Botsch 1999). Also, the DOE-SR survey of fungi noted that the Cs-137 activity concentration fluctuation in deer may be related to the availability of fungi (DuPont 1984).

Edible fungi were collected at 22 perimeter locations (within 50 miles of an SRS center-point) and three background locations (outside of the 50-mile 'study area perimeter), and inedible fungi were collected at 14 perimeter locations and 14 background locations in 2009. A special effort to collect bolete fungi and other edibles was continued in 2009 to supply data for a potential dose to the wild mushroom consumer. The edible fungi collected included boletes, jellies, oysters, golden chanterelles, and the chicken or red sulfur fungi.

Fungi are routinely collected within 50 miles of an SRS center-point and designated as "E" area samples in Appendix B, and outside of the 50-mile perimeter, but within the remainder of South Carolina as background samples in "B" area quadrants. Samples were analyzed for a gamma suite of 24 radionuclides found in Appendix A.

The 2009 data statistics were summarized on an average, standard deviation, median, and maximum basis for edible and inedible samples (Section 3.2.4, Data). The radionuclide detection statistics were compared on a South Carolina geological region basis for the period from 2004-2008 (SCDHEC 2009).

RESULTS AND DISCUSSION

Results from vegetation and fungi analyses are included in Section 3.2.4; summary statistics are presented in Section 3.2.5. The following radionuclides were not detected above the minimum detectable activity in 2009 vegetation and fungi: 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), actinium-228 (Ac-228), uranium/thorium-238 (U/Th-238), and americium-241 (Am-241). Fungi had one additional nondetect, radium-226 (Ra-226).

A final statistical analysis of randomly collected samples for ESOP media is summarized in the 2009 Random Study Report using ProUCl (USEPA 2002). Refer to this report for the comparison of the SRS 50-mile study area (excluding the area within the SRS border) to the South Carolina background (SCDHEC 2009).

<u>Tritium in Vegetation</u>

Tritium is a naturally occurring radioisotope, although in very low concentrations (USEPA 2007). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases on SRS include both atmospheric and liquid contributions (SRNS 2010). 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). Tritium was detected in vegetation from 13 of the 17 perimeter sites sampled in 2009. The highest tritium levels detected during 2009 for each quarter were:

- Quarter 1 (February): AKN-003 at 1628 pCi/L (laurel oak)
- Quarter 2 (May): AKN-001 at 1234 pCi/L (laurel oak)
- Quarter 3 (August): AKN-002 at 1044 pCi/L (wax myrtle)

- Quarter 4 (December): BWL-002 at 777 pCi/L (wax myrtle)

Tritium levels at each of the randomly chosen background stations as well as the 25-mile radius and 50-mile radius stations were less than LLD.

Three of the four highest quarterly tritium detections in 2009 were from sites on the western side of SRS. This is similar to results from 2005 through 2008 sampling (Figures 1 and 2; SCDHEC 2010). Tritium releases from the nearby Vogtle Electric Generating Plant in Georgia may account for elevated tritium levels in this area of SRS, or the influence of Fourmile Branch and Pen Branch, both of which have high levels of tritium. However, stations on the north, south, and east sides of SRS also exhibited relatively high tritium activities in 2009. These results underscore the variability of tritium occurrence around SRS.

Sampling was also conducted in three randomly selected quadrants within 50 miles of SRS ("E" sites) and in three random background quadrants ("B") throughout South Carolina (Section 3.2.4; Appendix B). Tritium levels at each of these sites were less than 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:

$$\text{pCi/L} = \text{pCi/ml} \times 1000 = [\text{pCi/g} \times (1/0.3)] / (1 - 0.3).$$

Results from the two colocations were less than the detection limit for both programs, although ESOP had tritium detections at BWL-006 during other times of the year. The DOE-SR program detected tritium from eight perimeter stations in 2009; ESOP detected tritium in samples from four comparable stations at similar times, although there were additional detections during other times of the year. Average tritium levels at the stations in Table 1 were compared, using only detections to calculate averages. The DOE-SR average, 214 (± 238) pCi/L, was within one standard deviation of the ESOP average, 210 (± 23) pCi/L.

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 2009. The lead (Pb) isotopes Pb-212 and Pb-214 were also detected, but not from all locations. Radium-226 (Ra-226) was detected at one location (AKN-002) from a sample obtained in February of 2009. 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 60s (WSRC 1999).

Cesium-137 was detected at eight of nine perimeter stations sampled in 2009, and four of the eight stations produced Cs-137 results greater than the Minimum Detectable Activity (MDA) in all four quarters (Section 3.2.4). AKN-003 exhibited the highest Cs-137 activity in the first and second quarters (February and May), 0.976 and 0.820 pCi/g respectively. AKN-008 exhibited the highest activity in the third quarter (August), at 0.718 pCi/g. AKN-005 showed the highest activity during the fourth quarter (November), at 0.710 pCi/g. All of these high activities were found in laurel oak leaves.

Sampling was also conducted in three randomly selected quadrants within 50 miles of SRS ("E" sites) and in three random background quadrants ("B") throughout South Carolina (Section 3.2.4; Appendix B). No Cs-137 was detected in any of these samples.

Results of analysis for Cs-137 at five of nine perimeter sampling locations followed what appear to be downward trends in 2009 (Figure 3; SCDHEC 2010). BWL-004 has shown a decrease in average activity every year since 2005; AKN-005 and AKN-006 have decreased since 2006; AKN-001 and BWL-006 since 2007. Station AKN-002 was < MDA as it has been since the most recent Cs-137 detection occurred in 2005.

Contrary to recent trends (Figure 3; SCDHEC 2010), sampling locations AKN-003, AKN-008, and ALD-001 each showed an average Cs-137 activity increase relative to 2008. However, each of the observed activity increases is within one standard deviation from last year's figure and is likely due to either simple statistical variation within the data, natural factors such as wind direction and precipitation, or some combination of the two. AKN-003, located on the northwest side of SRS near Jackson, South Carolina, showed the highest average Cs-137 activity during 2009, at 0.574 pCi/g; AKN-008 showed the second highest average activity, at 0.504 pCi/g.

Gamma analysis results for Cs-137 from ESOP and DOE-SR sampling in 2009 are presented in Section 3.2.3, Table 2. The Patterson Mill Road/BWL-004 colocation showed similar results: 0.20 (±0.06) pCi/g and 0.21 (±0.04) pCi/g. The Allendale Gate/BWL-006 colocation exhibited dissimilar results: 0.78 (±0.07) pCi/g and < MDA. 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 0.17 (±0.05) pCi/g. This gamma sampling location does not have a corresponding ESOP gamma sampling location and any attempted comparison would be invalid. Including colocations, DOE-SR detected Cs-137 at 11 of 12 sampling stations whereas ESOP had detections at six of nine comparable locations. There was an additional Cs-137 detection 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 0.19 (±0.22) pCi/g was within one standard deviation of the ESOP average 0.36 (±0.28) pCi/g. Taken in total, the DOE-SR and ESOP data are similar.

Gamma in Fungi

Fungi, whether edible or non-edible, are an excellent survey media for detecting Cs-137 from atmospheric depositions. Bolete fungi are a primary bioconcentrator of Cs-137 (Botsch 1999). Cesium-137 is the primary radionuclide of concern due to the extremely high levels detected in fungi by Botsch and the possible biomagnification in mushroom consumers (human or animal).

Previous years' (2004-2008) fungi collections came primarily from random 7.5-minute United States Geological Survey quadrants and were compared on a quadrant average basis for all fungi collected. The random quadrant study purpose was to compare the study area radionuclides occurring in different media to the rest of South Carolina on a problematical basis (hypothesis testing). The statistical results are compared in the SCHEC 2010 report Section 3.2.5 Summary Statistics. A nonrandom collection of fungi within the study area and the South Carolina background began in 2009 with increased sampling close to the SRS perimeter and background sampling close to the 50-mile study area perimeter. These radiological concentrations will be compared to each other and to the overall random study summary statistics to monitor yearly trends in fungi for the 24 radionuclides surveyed.

Many of the radionuclides surveyed are naturally occurring radioactive materials (NORM) that have also been stored or produced as byproducts at SRS. Detections above background are not necessarily due to DOE-SR production activities, since many radionuclides could have other sources such as NORM in soil, past nuclear test fallout, or commercial nuclear facility releases. Also, radionuclide detections in fungi represent bioaccumulations over many years, and do not represent yearly deposits in South Carolina.

Since DOE-SR stopped reactor operations, the primary radionuclides of concern in this gamma survey were generally long-lived radionuclide contaminants released in the past that may have significant risk potential in airborne critical pathways (WSRC 1997). These included Am-241, Cs-137, Cs-134, Co-60, Eu-154, Eu-155, and thorium-234 (Th-234). Only those radionuclide concentrations found outside of the SRS boundary and within the 50-mile perimeter of an SRS center-point that were greater than the South Carolina background warranted discussion.

Section 3.2.5 Table 1 summarizes the statistics for mixed-fungi, both edible and inedible species, and specifically for bolete fungi radionuclide detections in 2009. Mixed-fungi samples from 36 locations within the study area and 17 South Carolina background locations were summarized for average, standard deviation, and median. The two areas were also summarized in Table 1 for different groupings of fungi types: bolete fungi only, other edible fungi (not boletes), and inedible fungi species.

Five of 24 radioisotopes surveyed were detected in mixed-fungi samples collected throughout South Carolina in 2009: beryllium-7 (Be-7), potassium-40 (K-40), Cs-137, lead-212, (Pb-212), and lead-214 (Pb-214)(Section 3.2.4 Table 1). All five of these radionuclides were found in the typically inedible fungi species, but the edible fungi did not have any detections for Be-7. Edible fungal species were tentatively identified as boletes, chanterelles, oysters, jellies, Bear's Head fungi, American Caesar, and Chicken (Red Sulfur Shelf) species.

The highest Cs-137 activity found in 2009 (24.21 pCi/g) occurred in an unidentified leather-type polypore fungus growing on a downed oak log found in a ditch near Steel Creek Landing. This area was flooded many times in the past with runoff from SRS and was documented in a previous SCDHEC Data Report (2009) as having Cs-137 contamination. It was not determined if the concentration of Cs-137 contamination was due to the relative abundance of cesium compared to potassium in the swamp soil or was a result of bioaccumulation.

The background edible fungi species did not contain bolete mushrooms, but compared to inedible species (mostly leather, gill, and polypore types) had no Be-7 detections and lower concentrations of Cs-137, Pb-212, and Pb-214 on an average and median basis (Section 3.2.5 Table 1). The higher K-40 may be a result of the occurrence of the respective samples in differing geological regions and soil types (SCDHEC 2009). The same pattern was noted in the study area radionuclide concentrations for inedible versus edible species except for Cs-137, which had a higher median concentration for the edible species. However, except for the single high Cs-137 detection in the leather-type fungus at Steel Creek Landing, bolete fungi had higher Cs-137 concentrations than other edible and inedible fungi species (Section 3.2.4 Data). The overall edible fungi had lower Cs-137 concentrations than inedibles and bolete mushrooms on average. The median (eliminates the extremes) clearly indicated that bolete mushrooms were usually higher in Cs-137 than other mushroom species whether edible or inedible (Section 3.2.5 Summary Statistics). Thus, the single high Cs-137 concentration in a single shelf fungus found in a previously known contaminated area was probably an outlier that distorted the inedible fungi average. Cesium-137 activity was higher in the study area than in the South Carolina background. Also, the average Cs-137 detection in fungi collected in the study area compared to the South Carolina background was approximately ten times higher in boletes than other edible fungi, and nearly four times higher than in inedible fungi. The median Cs-137 detection in the study area were nearly 18 times higher in bolete fungi and six times greater in inedible fungi compared to the South Carolina other edible fungi background. This suggests a possible correlation with SRS releases, but other sources are possible such as past nuclear test fallout tracks.

2004-2009 Mixed Fungi Statistics

Fungi results in previous years were presented primarily as random quadrant results with a few additional nonrandom results. The 2004-2008 summary statistics were included in the 2008 vegetation report (SCDHEC 2009). A problematical analysis of that random study is included in the SCDHEC 2009 Data Report. The 2004-2008 summary statistics will be used in future reports as a basis for yearly comparisons to the nonrandom results to monitor the trend of radionuclide concentrations in fungi, especially bolete fungi and other edible fungi.

Section 3.2.3 Figure 4 compares the 2009 study area nonrandom fungi collections on a sample basis to the 2004-2009 sample basis summary statistics and to the 2004-2008 quadrant basis results. Summary statistics of bolete fungi and other 2009 edible fungi species indicate that Cs-137 adds exposure to the wild mushroom consumer, whether deer or human. A total of seven radionuclides were detected within the period 2004-2009, but not all in the same year: Ac-228, Be-7, K-40, Cs-137, Pb-212, Pb-214, and radium-228 (Ra-228). The Ac-228 detection, 2.34 pCi/g, occurred only once in 2004 in the E6 Foxtown quadrant. Actinium-228 is part of the natural thorium series and its' half-life is too short (6.13 hrs) to have come from SRS operations at that time. Also, Be-7 (half-life 53.44 days), Pb-212 (half-life 10.64 hrs), and Pb-214 (half-life 26.80 minutes) detections were probably not of SRS origin, but rather are due to their respective decay series, which occur in decaying base rock. Seven Ra-226 detections occurred within the 2004-2009 period out of 135 samples. Radium-226 is also a decay product in the natural radium series. Only Cs-137 is of potential SRS origin since it occurs above the South Carolina background and is a fission reactor product of sufficiently long life to still be detectable in the environment after cessation of SRS reactor operations. However, there are many other potential contributors to Cs-137 occurrence in the environment including fallout from past nuclear explosions and accidents.

Section 3.2.3 Figure 4 also indicates a slight increase of K-40 in the study area fungi samples in 2009, especially boletes and other edible fungi. However, K-40 abundance is highly variable in different soil types especially if contaminated with fertilizers. Note from Section 3.2.3 Figure 4, and Section 3.2.5 Table 2 that Be-7, K-40, Cs-137, Pb-212, Pb-214, and Ra-226 all tend to be lower in the background comparisons for the respective time periods in sample and quadrant averages except for Ra-226 in background quadrants.

The summary statistics data indicate a clear difference between the study area and background locations whether on an individual sample or quadrant study basis. Compare Section 3.2.5 Tables 1 and 2 and note that Cs-137 occurrence was greater in the study area than in the background. The median may be a more reliable indicator of the central tendency since it reduces the effect of any extreme data. The average Cs-137 concentration within the study area on a sample basis is 2.6 times higher than the background versus 2.1 times higher for the median (Section 3.2.5 Table 2). The study area quadrant basis comparison for the average Cs-137 activity is similar with 1.5 times higher than the average background and 1.8 times higher for the study area median than the median background. A comparison of the maximum values also indicates the same pattern with 5.8 times higher for the individual sample basis in the study area versus background and 1.9 for the quadrant basis. This difference was apparent in earlier vegetation reports based on summary statistics and resulted in the 2004-2008 Random Study (SCDHEC 2010), which answers the question on a problematical basis in this 2009 SCDHEC Data Report.

A comparison of the 2004-2008 Cs-137 averages above background for random fungi (1.50 pCi/g for all South Carolina) and surface soil (0.00 pCi/g) indicated a consistently higher Cs-137 activity concentration in fungi (compare Section 3.2.5 Table 2 to ESOP Soil Reports). Also, a comparison of the 2004-2008 Cs-137 medians above background for random fungi (0.91 pCi/g for all South Carolina) and surface soil (0.00 pCi/g) indicated a consistently higher Cs-137 activity concentration in fungi. The 2009 Cs-137 concentration in soil within the study area was 0.494 pCi/g versus 0.571 pCi/g in the background for a net concentration above background of zero pCi/L. The net concentration of Cs-137 in fungi was higher than background for all categories of fungi. Thus, both average and median basis statistics confirm that Cs-137 activity was bioconcentrated in fungi relative to soil concentrations.

These results indicate that Cs-137 may become bioconcentrated in fungi, and represent increased exposure for the wild mushroom consumer, whether deer or human. Research of the literature suggests the occurrence of a higher Cs-137 concentration may be dependent on the depth and content of the organic layer, and on K-40 availability at the sampled locations (Linkov and Schell 1999). The uptake of particular elements or compounds is heavily influenced by the lack or abundance of other elements within the local soil type. Cesium-137, for example, tends to be bound in the organic layer of soil. Thus, soils that are very sandy and overlain only by a thin organic layer may tend to have increased leaching of Cs-137 to deeper soil layers not accessible by many plant roots or fungal mycelia.

The upper coastal plain is the geological regional location of SRS and lies generally northeast of the SRS in South Carolina. The upper coastal plain Cs-137 higher activities noted in the SCDHEC 2008 Data Report may reflect past depositions from nuclear tests in the 1950's and 1960's that tracked across South Carolina (Plumbbob, Priscilla shot, Whitney shot, Galileo shot, Doppler shot) from the southwest to the northeast (Aracnet 1957). The higher activities of the other radioisotopes may reflect radioactive decay products from NORM since DOE-SR reactors have been inactive after a test run of K reactor in 1992 (WSRC 1999). All maximums, whether mixed-sample or bolete-only samples, occurred in the upper coastal plain. However, this is not solely assignable to SRS due to other Cs-137 sources in the environment. Current concentrations of Cs-137 in fungi samples were detectable, but well below concentrations that would pose a public health threat on a radiological basis (USDHHS 1998).

CONCLUSIONS AND RECOMMENDATIONS

ESOP conducted independent vegetation monitoring in 2009 at 17 locations around the perimeter of SRS, three locations 25 miles from the center of SRS, three locations selected at random from within a 50-mile radius of SRS and three background locations greater than 50 miles from SRS. Tritium was detected in vegetation from 13 of the perimeter stations, but none of the 25-mile, 50-mile, or background stations. As in previous years, activity levels were generally higher in vegetation collected from the western side 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. Both ESOP and DOE-SR samples did not exhibit tritium activity at either colocation. DOE-SR detected tritium from eight perimeter stations, while ESOP detected tritium at 13 perimeter locations. 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.

Samples from all of the nine SRS perimeter stations exhibited Cs-137 activity at levels similar to 2005-2008. Five of these locations showed decreasing activity, three showed increasing activity, and one did not change (<MDA). All of the increases/decreases were within one standard deviation of the 2008 results.

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. ESOP and DOE-SR detected Cs-137 at the Patterson Mill Road sampling location while only DOE-SR had a detection at the Allendale gate.

A quarterly sampling schedule will be continued in 2010. Additional sampling will also be conducted at selected sites around South Carolina to determine background and near-SRS levels for plutonium and uranium.

Radionuclide detections in fungi occurred only for Be-7, K-40, Cs-137, Pb-212, and Pb-214 in 2009. The 2004 to 2008 Random Quadrant Study and the 2004 to 2009 Sample Analysis gave the same results for radionuclide trends in fungi. All maximum detections occurred in the upper coastal plain of South Carolina within the 50-mile perimeter study area around SRS. Both approaches to summarizing the data indicated that Cs-137 concentration activities in fungi are generally greater than two times higher within a 50-mile perimeter of an SRS center-point compared to the rest of South Carolina. The comparison of Cs-137 activity in fungi and soil found in the random quadrants from 2004 through 2008 indicated a consistently higher average Cs-137 activity concentration in mixed-fungi and especially in bolete fungi compared to soil. These results indicate that Cs-137 may become bioconcentrated in some fungi, and represent increased exposure for the wild mushroom consumer, whether deer or human.

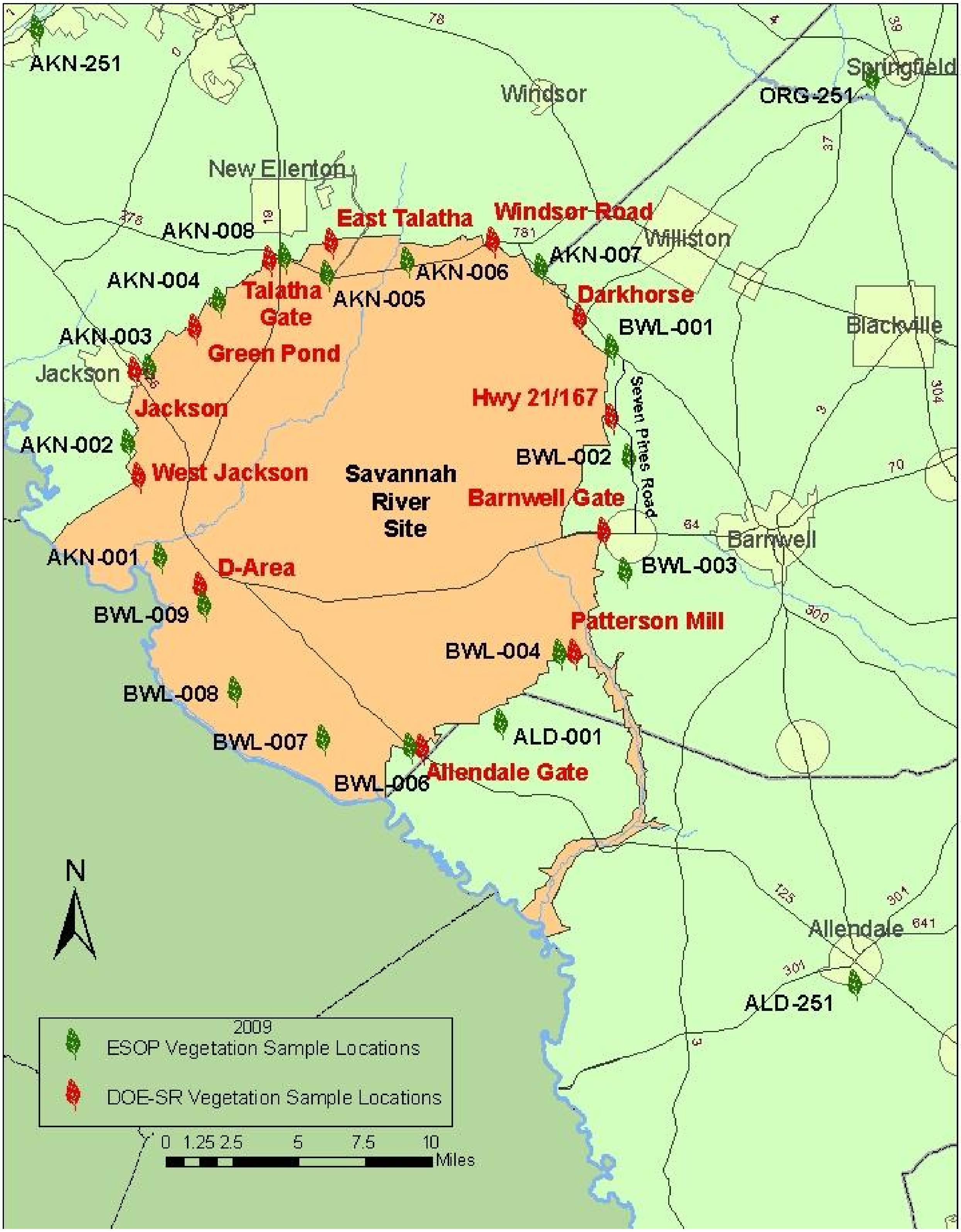
The radioisotope background contributions found in fungi from 2004 to 2009, which were outside of a 10-mile radius from reactors, may have originated from past atomic tests or other nuclear power sources. This historical contamination cannot be distinguished from the DOE-SR site contributions within a 50-mile perimeter of a center-point within the SRS. Elevated levels of Cs-137 in mushroom consumers after Chernobyl indicated that bioconcentration was found in many bolete fungi (Botsch 1999). Increased summer rainfall and other factors such as controlled burns may determine bolete fruit abundance and the subsequent increase of Cs-137 in wild mushroom consumers. Research of the literature suggests the occurrence of a higher Cs-137 activity at the surface may be dependent on the depth and content of the organic layer at the sampled locations (Linkov and Schell 1999). SCDHEC will continue to collect fungi, preferably boletes when available, to monitor the bioaccumulation of Cs-137 in fungi and contributions to human exposure.

Cesium-137 is a primary contributor to human exposure within the study area and a study during August, September, and no later than October, of bolete abundance related to weather, K-40, and Cs-137 concentrations in deer and boletes could prove fruitful. This would quantify the relative importance of Cs-137 activity in bolete fungi and deer for the mushroom and deer consumers.

TOC

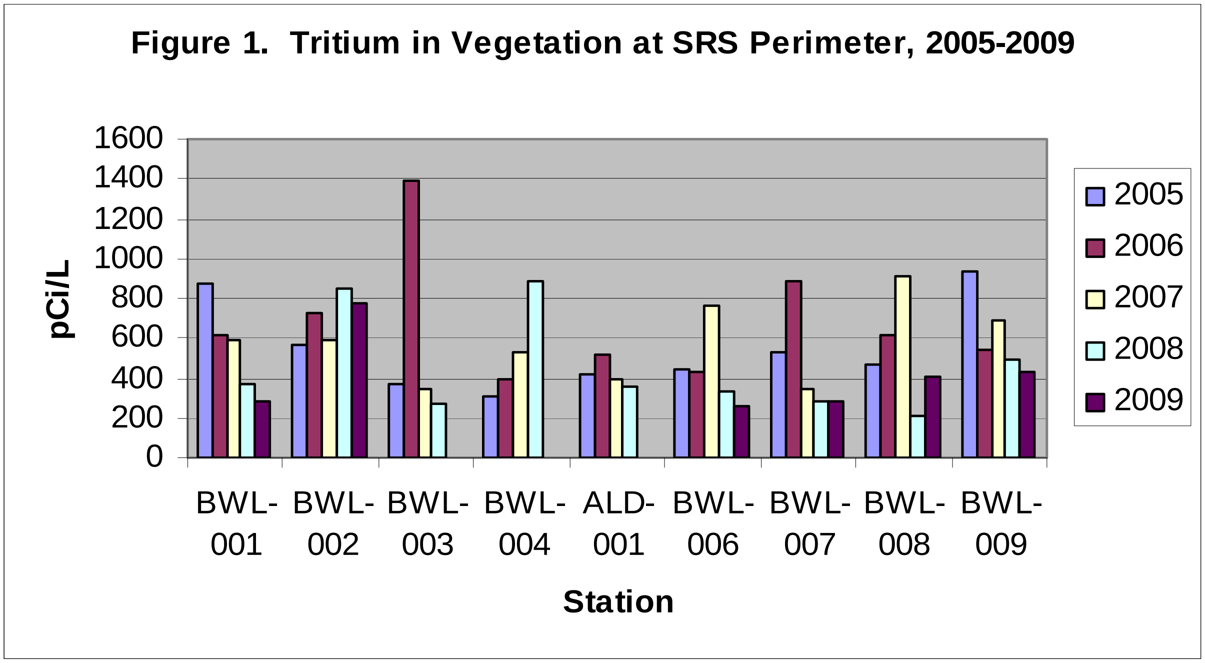
3.2.2 Radiological Monitoring of Terrestrial Vegetation TOC

Map 1. ESOP and DOE-SR Radiological Vegetation Sampling Locations, 2009

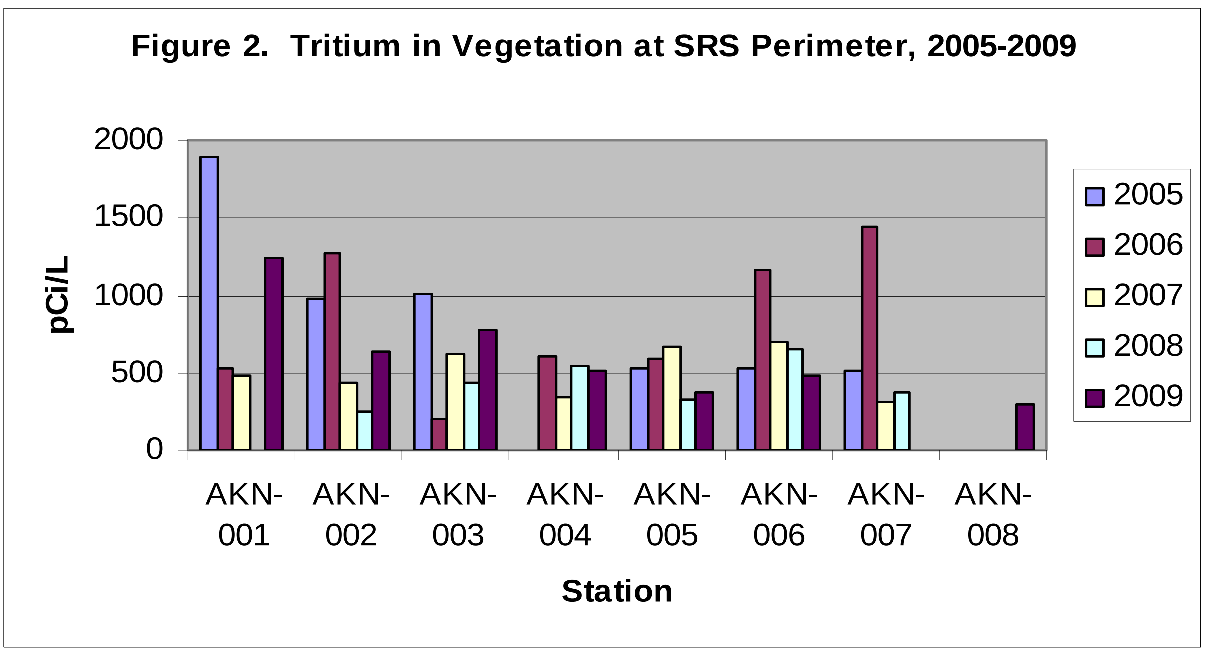


3.2.3 Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

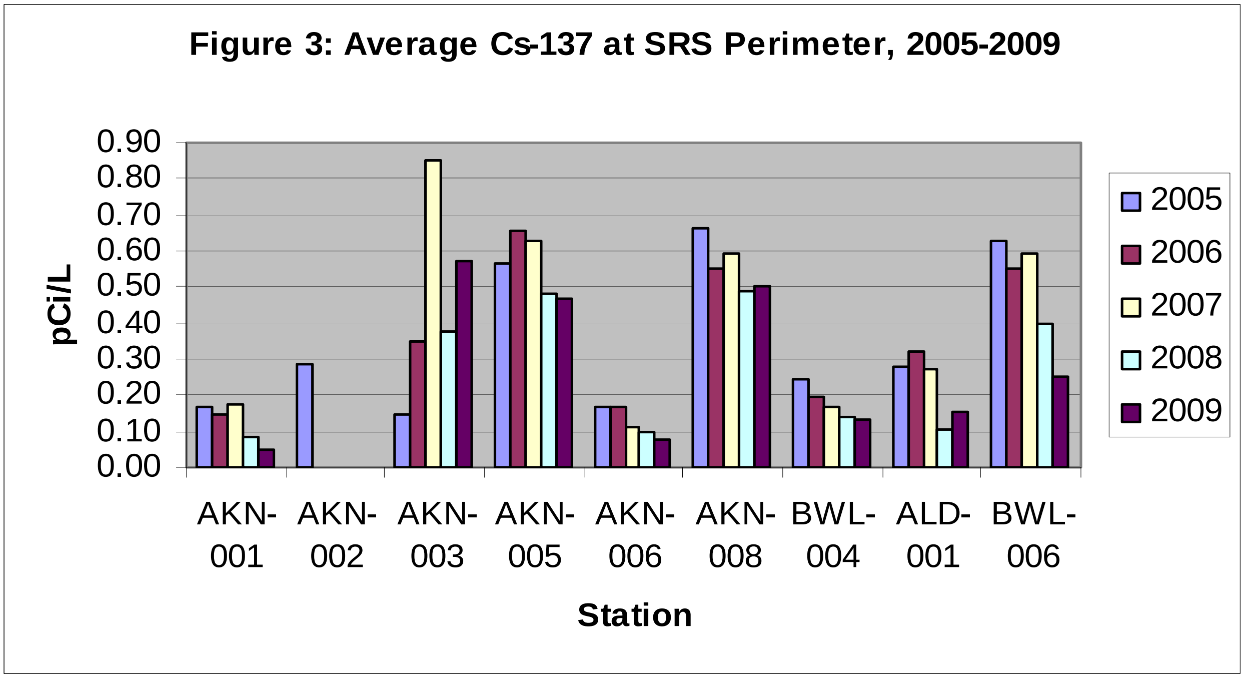


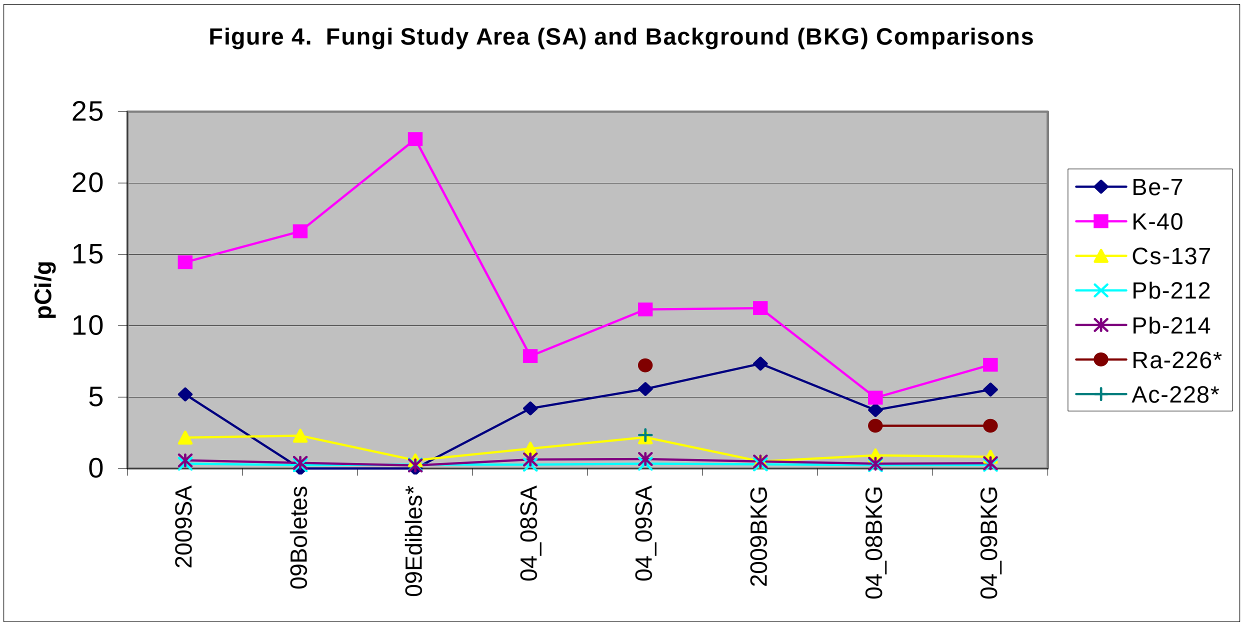
Note: This graph depicts the average of all detections for calendar years 2005-2009 by sampling station.



Notes:
(1) This graph depicts the average of all detections for calendar years 2005-2009 by sampling station.
(2) 2009 was the first year AKN-008 was sampled for tritium.
Tables and Figures

Radiological Monitoring of Terrestrial Vegetation





Notes:
1 - SA is the study area, a 50-mile perimeter outside of the SRS boundary.
2 - BKG is the South Carolin background outside of the SA.
3 - Edibles are all other edible fungi excluding bolete fungi.
4 - 04_08 refers 2004-2009 averages on a Random Quadrant basis.
5 - 04_09 refers to 2004-2009 average on a Sample basis.
6 - Asterisk denotes single detections for Ra-226 and Ac-228.

Tables and Figures

Radiological Monitoring of Terrestrial Vegetation

Table 1. Comparison of Tritium Analyses, DOE-SR and ESOP Data, 2009

DOE-SR DATA		Tritium			ESOP DATA		Tritium	
Station	**Date**	**pCi/g**	**Confidence Interval**	**pCi /L[a]**	**Station**	**Date**	**pCi/L**	**Confidence Interval**
D-Area	5/19/2009	0.166	0.0160	790	BWL-009 [a]	5/20/2009	183	83
West Jackson	5/19/2009	0.0112	0.0143	53.3	BWL-002 a	5/20/2009	<LLD	
Jackson	5/13/2009	0.0225	0.0142	107	AKN-003 [a]	5/20/2009	<LLD	
Green Pond	5/13/2009	0.0289	0.0167	137	AKN-004 [a]	5/20/2009	235	86
Talatha Gate	6/10/2009	0.0492	0.0175	234	AKN-005 [a]	6/19/2009	200	84
East Talatha	6/10/2009	0.027	0.0122	128	AKN-006 [a]	5/19/2009	222	85
Windsor Road	5/13/2009	0.0341	0.015	162	AKN-007	5/19/2009	<LLD	
Darkhorse	5/13/2009	0.0217	0.0258	103	BWL-001 [a]	5/19/2009	<LLD	
Highway 21/167	6/10/2009	<MDC			BWL-002 [a]	5/19/2009	<LLD	
Barnwell Gate	6/10/2009	<MDC			BWL-004 [a]	5/19/2009	<LLD	
					BWL-003	5/19/2009	<LLD	
Patterson Mill Road	5/13/2009	<MDC			BWL-004 [b]	5/19/2009	<LLD	
					ALD-001	5/19/2009	<LLD	
Allendale Gate	5/19/2009	<MDC			BWL-006 [b]	5/20/2009	<LLD	

Average	214	**Average**	210
Std Dev	238	**Std Dev**	23
Median	133	**Median**	211

<MDC denotes less than the WSRC Minimum Detectable Concentration

< LLD denotes less than reported Lower Limit of Detection

[a] Comparable ESOP location **[b] Colocation**

Tables and Figures
Radiological Monitoring of Terrestrial Vegetation
Table 2. Comparison of Cs-137 Analyses, DOE-SR and ESOP Data, 2009 TOC

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	5/19/2009	0.07	0.04	AKN-001 [a]	5/20/2009	<MDA	
West Jackson	5/19/2009	0.01	0.04	AKN-002 [a]	5/20/2009	<MDA	
Jackson	5/13/2009	0.02	0.04	AKN-003 [a]	5/20/2009	0.82	0.07
Green Pond	5/13/2009	<MDC		AKN-003 [a]	5/20/2009	0.82	0.07
Talatha Gate	6/10/2009	0.06	0.03	AKN-008 [a]	6/19/2009	0.45	0.04
East Talatha	6/10/2009	0.39	0.04	AKN-005 [a]	6/19/2009	0.44	0.04
Windsor Road	5/13/2009	0.05	0.03	AKN-006 [a]	5/19/2009	0.09	0.02
Darkhorse	5/13/2009	0.19	0.05	AKN-006 [a]	5/19/2009	0.09	0.02
Highway 21/167	6/10/2009	0.17	0.05				
Barnwell Gate	6/10/2009	0.20	0.04	BWL-004 [a]	5/19/2009	0.21	0.04
Patterson Mill Road [b]	5/13/2009	0.20	0.06	BWL-004 [b]	5/19/2009	0.21	0.04
				ALD-001 [a]	5/19/2009	0.12	0.04
Allendale Gate [b]	5/19/2009	0.78	0.07	BWL-006 [b]	5/20/2009	<MDA	

Average	0.19	**Average**	0.36
Std Dev	0.22	**Std Dev**	0.28
Median	0.17	**Median**	0.33

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

3.2.4 Data

Radiological Monitoring of Terrestrial Vegetation

Notes:

1. pCi/L - picocuries per liter
2. pCi/g - picocuries per gram
3. NA denotes not applicable
4. LLD - Lower Limit of Detection
5. MDA - Minimum Detectable Activity
6. C.I. – Confidence Interval
7. See Appendix A for radionuclide definitions

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2009 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	09/23/09	12/15/09
VG AKN-001	Tritium Activity	<LLD	1234	<LLD	<LLD
VG AKN-001	Tritium Confidence Interval	NA	123	NA	NA
VG AKN-001	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	08/27/09	12/03/09
VG AKN-002	Tritium Activity	646	<LLD	1044	221
VG AKN-002	Tritium Confidence Interval	108	NA	121	88
VG AKN-002	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	08/27/09	12/03/09
VG AKN-003	Tritium Activity	1628	<LLD	502	189
VG AKN-003	Tritium Confidence Interval	135	NA	102	87
VG AKN-003	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	08/27/09	12/03/09
VG AKN-004	Tritium Activity	<LLD	235	803	<LLD
VG AKN-004	Tritium Confidence Interval	NA	86	113	NA
VG AKN-004	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/06/09	06/19/09	08/27/09	11/17/09
VG AKN-005	Tritium Activity	725	200	<LLD	189
VG AKN-005	Tritium Confidence Interval	115	84	NA	86
VG AKN-005	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/06/09	05/19/09	08/27/09	11/17/09
VG AKN-006	Tritium Activity	709	222	<LLD	531
VG AKN-006	Tritium Confidence Interval	110	85	NA	100
VG AKN-006	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/19/09	08/27/09	12/08/09
VG AKN-007	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG AKN-007	Tritium Confidence Interval	NA	NA	NA	NA
VG AKN-007	Tritium LLD	195	178	195	186

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2009 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)		06/19/09	08/14/09	11/17/09
VG AKN-008	Tritium Activity	Not	223	<LLD	379
VG AKN-008	Tritium Confidence Interval	Collected	82	NA	94
VG AKN-008	Tritium LLD		170	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/19/09	09/04/09	12/10/09
VG BWL-001	Tritium Activity	278	<LLD	<LLD	<LLD
VG BWL-001	Tritium Confidence Interval	94	NA	NA	NA
VG BWL-001	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/19/09	09/04/09	12/10/09
VG BWL-002	Tritium Activity	<LLD	<LLD	<LLD	777
VG BWL-002	Tritium Confidence Interval	NA	NA	NA	110
VG BWL-002	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/19/09	08/19/09	12/10/09
VG BWL-003	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG BWL-003	Tritium Confidence Interval	NA	NA	NA	NA
VG BWL-003	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/06/09	05/19/09	09/17/09	12/08/09
VG BWL-004	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG BWL-004	Tritium Confidence Interval	NA	NA	NA	NA
VG BWL-004	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/06/09	05/19/09	08/19/09	12/10/09
VG ALD-001	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG ALD-001	Tritium Confidence Interval	NA	NA	NA	NA
VG ALD-001	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/06/09	05/20/09	08/19/09	12/17/09
VG BWL-006	Tritium Activity	301	<LLD	<LLD	213
VG BWL-006	Tritium Confidence Interval	95	NA	NA	88
VG BWL-006	Tritium LLD	195	178	195	186

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter and 25-Mile Stations
2009 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/12/09	05/20/09	09/17/09	12/17/09
VG BWL-007	Tritium Activity	<LLD	<LLD	<LLD	282
VG BWL-007	Tritium Confidence Interval	NA	NA	NA	91
VG BWL-007	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	09/04/09	12/15/09
VG BWL-008	Tritium Activity	<LLD	<LLD	402	<LLD
VG BWL-008	Tritium Confidence Interval	NA	NA	99	NA
VG BWL-008	Tritium LLD	195	178	195	186

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	09/04/09	12/15/09
VG BWL-009	Tritium Activity	269	183	962	307
VG BWL-009	Tritium Confidence Interval	93	83	114	91
VG BWL-009	Tritium LLD	195	178	179	185

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/09/09	05/20/09	08/14/09	11/13/09
VG AKN-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG AKN-251	Tritium Confidence Interval	NA	NA	NA	NA
VG AKN-251	Tritium LLD	191	170	179	185

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/12/09	05/19/09	08/19/09	11/13/09
VG ORG-251	Tritium Activity	<LLD	<LLD	<LLD	<LLD
VG ORG-251	Tritium Confidence Interval	NA	NA	NA	NA
VG ORG-251	Tritium LLD	191	170	179	185

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/L)	02/12/09	05/19/09	08/19/09	11/13/09
VG ALD-251	Tritium Activity	<LLD	230	<LLD	<LLD
VG ALD-251	Tritium Confidence Interval	NA	83	NA	NA
VG ALD-251	Tritium LLD	191	170	179	185

Radiological Monitoring of Terrestrial Vegetation Data; Background and <50-Mile Stations
2009 Tritium in Vegetation

Location Description	Analyte	Collection Date/Result
	Results pCi/L	02/19/09
VG B63	Tritium Activity	<LLD
VG B63	Tritium Confidence Interval	N/A
VG B63	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results pCi/L	02/19/09
VG B65	Tritium Activity	<LLD
VG B65	Tritium Confidence Interval	N/A
VG B65	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results pCi/L	02/19/09
VG B72	Tritium Activity	<LLD
VG B72	Tritium Confidence Interval	N/A
VG B72	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results (pCi/L)	02/12/09
VG E71	Tritium Activity	<LLD
VG E71	Tritium Confidence Interval	NA
VG E71	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results pCi/L	02/13/09
VG E74	Tritium Activity	<LLD
VG E74	Tritium Confidence Interval	N/A
VG E74	Tritium LLD	191

Location Description	Analyte	Collection Date/Result
	Results pCi/L	02/13/09
VG E76	Tritium Activity	<LLD
VG E76	Tritium Confidence Interval	N/A
VG E76	Tritium LLD	191

“B” denotes randomly chosen background locations greater than 50 miles from SRS center.
“E” denotes randomly chosen locations less than 50 miles from SRS center.

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	02/09/09	05/20/09	09/23/09	12/15/09
VGAKN-001	Be-7 Activity	1.839	1.216	1.529	<MDA
VGAKN-001	Be-7 Confidence Interval	0.366	0.324	0.413	NA
VGAKN-001	Be-7 MDA	0.274	0.290	0.313	0.845
VGAKN-001	K-40 Activity	1.910	2.660	1.247	<MDA
VGAKN-001	K-40 Confidence Interval	0.266	0.467	0.440	NA
VGAKN-001	K-40 MDA	0.121	0.188	0.196	0.187
VGAKN-001	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Co-60 MDA	0.012	0.024	0.026	0.022
VGAKN-001	Cs-137 Activity	<MDA	<MDA	0.047	<MDA
VGAKN-001	Cs-137 Confidence Interval	NA	NA	0.021	NA
VGAKN-001	Cs-137 MDA	0.014	0.025	0.028	0.024
VGAKN-001	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Pb-212 MDA	0.031	0.047	0.058	0.052
VGAKN-001	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Pb-214 MDA	0.033	0.054	0.073	0.061
VGAKN-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-001	Am-241 MDA	0.108	0.382	0.443	0.380

	Results (pCi/g) fresh weight	02/09/09	05/20/09	08/27/09	12/03/09
VGAKN-002	Be-7 Activity	2.251	0.990	<MDA	2.979
VGAKN-002	Be-7 Confidence Interval	0.406	0.320	NA	0.899
VGAKN-002	Be-7 MDA	0.301	0.310	0.455	0.929
VGAKN-002	K-40 Activity	2.461	3.760	1.609	<MDA
VGAKN-002	K-40 Confidence Interval	0.320	0.510	0.484	NA
VGAKN-002	K-40 MDA	0.125	0.190	0.247	0.196
VGAKN-002	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Co-60 MDA	0.015	0.020	0.021	0.022
VGAKN-002	Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Cs-137 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Cs-137 MDA	0.016	0.020	0.026	0.024
VGAKN-002	Pb-212 Activity	0.077	<MDA	<MDA	<MDA
VGAKN-002	Pb-212 Confidence Interval	0.028	NA	NA	NA
VGAKN-002	Pb-212 MDA	0.030	0.050	0.057	0.052
VGAKN-002	Pb-214 Activity	0.552	0.180	<MDA	0.092
VGAKN-002	Pb-214 Confidence Interval	0.044	0.040	NA	0.044
VGAKN-002	Pb-214 MDA	0.034	0.050	0.073	0.049
VGAKN-002	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-002	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-002	Am-241 MDA	0.128	0.390	0.403	0.383
VGAKN-002	Ra-226 Activity	0.768	<MDA	<MDA	<MDA
VGAKN-002	Ra-226 Confidence Interval	0.357	NA	NA	NA
VGAKN-002	Ra-226 MDA	0.393	0.602	0.663	0.565

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	02/09/09	05/20/09	08/27/09	12/03/09
VGAKN-003	Be-7 Activity	3.992	0.970	1.633	7.156
VGAKN-003	Be-7 Confidence Interval	0.511	0.370	0.523	1.355
VGAKN-003	Be-7 MDA	0.365	0.320	0.507	1.054
VGAKN-003	K-40 Activity	1.802	2.690	1.946	1.037
VGAKN-003	K-40 Confidence Interval	0.308	0.450	0.497	0.452
VGAKN-003	K-40 MDA	0.133	0.160	0.263	0.177
VGAKN-003	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Co-60 MDA	0.014	0.020	0.024	0.024
VGAKN-003	Cs-137 Activity	0.976	0.820	0.264	0.234
VGAKN-003	Cs-137 Confidence Interval	0.090	0.070	0.039	0.040
VGAKN-003	Cs-137 MDA	0.014	0.020	0.030	0.025
VGAKN-003	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Pb-212 MDA	0.036	0.050	0.061	0.053
VGAKN-003	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Pb-214 MDA	0.039	0.060	0.075	0.068
VGAKN-003	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-003	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-003	Am-241 MDA	0.121	0.370	0.447	0.420

	Results (pCi/g) fresh weight	02/06/09	06/19/09	08/27/09	11/17/09
VGAKN-005	Be-7 Activity	2.568	1.613	1.143	<MDA
VGAKN-005	Be-7 Confidence Interval	0.428	0.273	0.519	NA
VGAKN-005	Be-7 MDA	0.304	0.180	0.530	1.326
VGAKN-005	K-40 Activity	1.960	1.730	2.226	0.988
VGAKN-005	K-40 Confidence Interval	0.281	0.271	0.492	0.406
VGAKN-005	K-40 MDA	0.129	0.122	0.204	0.216
VGAKN-005	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Co-60 MDA	0.014	0.012	0.026	0.024
VGAKN-005	Cs-137 Activity	0.246	0.436	0.489	0.710
VGAKN-005	Cs-137 Confidence Interval	0.035	0.041	0.052	0.063
VGAKN-005	Cs-137 MDA	0.015	0.015	0.027	0.028
VGAKN-005	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Pb-212 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Pb-212 MDA	0.037	0.032	0.059	0.052
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	0.060	0.069	0.067
VGAKN-005	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-005	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-005	Am-241 MDA	0.115	0.115	0.443	0.377

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations
2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	02/06/09	05/19/09	08/27/09	11/17/09
VGAKN-006	Be-7 Activity	1.614	1.410	1.638	2.867
VGAKN-006	Be-7 Confidence Interval	0.314	0.330	0.565	1.409
VGAKN-006	Be-7 MDA	0.272	0.230	0.454	1.091
VGAKN-006	K-40 Activity	1.426	2.110	0.895	0.897
VGAKN-006	K-40 Confidence Interval	0.242	0.380	0.411	0.419
VGAKN-006	K-40 MDA	0.116	0.150	0.218	0.212
VGAKN-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Co-60 MDA	0.013	0.020	0.022	0.022
VGAKN-006	Cs-137 Activity	0.064	0.090	0.078	<MDA
VGAKN-006	Cs-137 Confidence Interval	0.017	0.020	0.033	NA
VGAKN-006	Cs-137 MDA	0.015	0.020	0.026	0.025
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	0.040	0.059	0.045
VGAKN-006	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Pb-214 MDA	0.038	0.040	0.066	0.058
VGAKN-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-006	Am-241 MDA	0.112	0.310	0.408	0.380

	Results (pCi/g) fresh weight	02/06/09	06/19/09	08/14/09	11/17/09
VGAKN-008	Be-7 Activity	2.349	1.069	2.574	4.508
VGAKN-008	Be-7 Confidence Interval	0.493	0.284	0.699	1.286
VGAKN-008	Be-7 MDA	0.317	0.189	0.640	1.302
VGAKN-008	K-40 Activity	2.067	2.203	1.315	0.917
VGAKN-008	K-40 Confidence Interval	0.315	0.295	0.473	0.415
VGAKN-008	K-40 MDA	0.121	0.125	0.222	0.187
VGAKN-008	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Co-60 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Co-60 MDA	0.014	0.013	0.025	0.025
VGAKN-008	Cs-137 Activity	0.415	0.452	0.718	0.432
VGAKN-008	Cs-137 Confidence Interval	0.044	0.043	0.069	0.049
VGAKN-008	Cs-137 MDA	0.015	0.016	0.028	0.025
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	0.060	0.052
VGAKN-008	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Pb-214 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Pb-214 MDA	0.035	0.063	0.072	0.066
VGAKN-008	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGAKN-008	Am-241 Confidence Interval	NA	NA	NA	NA
VGAKN-008	Am-241 MDA	0.111	0.116	0.442	0.400

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations

2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	02/06/09	05/19/09	09/17/09	12/08/09
VGBWL-004	Be-7 Activity	1.639	<MDA	<MDA	<MDA
VGBWL-004	Be-7 Confidence Interval	0.357	NA	NA	NA
VGBWL-004	Be-7 MDA	0.308	0.320	0.381	0.965
VGBWL-004	K-40 Activity	2.088	2.680	1.531	1.142
VGBWL-004	K-40 Confidence Interval	0.310	0.450	0.529	0.414
VGBWL-004	K-40 MDA	0.132	0.190	0.180	0.202
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	0.020	0.022	0.022
VGBWL-004	Cs-137 Activity	0.036	0.210	<MDA	<MDA
VGBWL-004	Cs-137 Confidence Interval	0.018	0.040	NA	NA
VGBWL-004	Cs-137 MDA	0.016	0.020	0.028	0.025
VGBWL-004	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Pb-212 MDA	0.034	0.040	0.052	0.050
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	0.050	0.064	0.064
VGBWL-004	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-004	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-004	Am-241 MDA	0.115	0.370	0.383	0.391

	Results (pCi/g) fresh weight	02/06/09	05/19/09	08/19/09	12/10/09
VGALD-001	Be-7 Activity	1.565	0.780	2.124	2.330
VGALD-001	Be-7 Confidence Interval	0.381	0.340	0.649	0.889
VGALD-001	Be-7 MDA	0.326	0.330	0.545	0.996
VGALD-001	K-40 Activity	2.451	2.520	1.157	0.961
VGALD-001	K-40 Confidence Interval	0.326	0.490	0.460	0.432
VGALD-001	K-40 MDA	0.128	0.200	0.243	0.184
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	0.020	0.025	0.025
VGALD-001	Cs-137 Activity	<MDA	0.120	0.241	0.094
VGALD-001	Cs-137 Confidence Interval	NA	0.040	0.040	0.038
VGALD-001	Cs-137 MDA	0.017	0.030	0.028	0.026
VGALD-001	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Pb-212 Confidence Interval	NA	NA	NA	NA
VGALD-001	Pb-212 MDA	0.035	0.050	0.057	0.055
VGALD-001	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Pb-214 Confidence Interval	NA	NA	NA	NA
VGALD-001	Pb-214 MDA	0.036	0.060	0.068	0.064
VGALD-001	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGALD-001	Am-241 Confidence Interval	NA	NA	NA	NA
VGALD-001	Am-241 MDA	0.116	0.360	0.410	0.365

Radiological Monitoring of Terrestrial Vegetation Data; Perimeter Stations

2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result	Collection Date/Result	Collection Date/Result	Collection Date/Result
	Results (pCi/g) fresh weight	02/06/09	05/20/09	08/19/09	12/17/09
VGBWL-006	Be-7 Activity	3.051	0.750	<MDA	<MDA
VGBWL-006	Be-7 Confidence Interval	0.457	0.260	NA	NA
VGBWL-006	Be-7 MDA	0.326	0.300	0.628	0.892
VGBWL-006	K-40 Activity	1.707	2.050	1.685	1.004
VGBWL-006	K-40 Confidence Interval	0.288	0.460	0.512	0.430
VGBWL-006	K-40 MDA	0.120	0.200	0.185	0.183
VGBWL-006	Co-60 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Co-60 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Co-60 MDA	0.012	0.020	0.025	0.022
VGBWL-006	Cs-137 Activity	0.245	0.180	0.307	0.262
VGBWL-006	Cs-137 Confidence Interval	0.032	0.030	0.046	0.039
VGBWL-006	Cs-137 MDA	0.017	0.020	0.032	0.025
VGBWL-006	Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-212 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-212 MDA	0.035	0.050	0.062	0.052
VGBWL-006	Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Pb-214 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Pb-214 MDA	0.037	0.050	0.075	0.064
VGBWL-006	Am-241 Activity	<MDA	<MDA	<MDA	<MDA
VGBWL-006	Am-241 Confidence Interval	NA	NA	NA	NA
VGBWL-006	Am-241 MDA	0.122	0.370	0.438	0.393

Radiological Monitoring of Terrestrial Vegetation Data; Background and <50-Mile Stations
2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	2/12/2009
VG E71	Be-7 Activity	1.330
VG E71	Be-7 Confidence Interval	0.307
VG E71	Be-7 MDA	0.268
VG E71	K-40 Activity	2.730
VG E71	K-40 Confidence Interval	0.348
VG E71	K-40 MDA	0.125
VG E71	Co-60 Activity	<MDA
VG E71	Co-60 Confidence Interval	NA
VG E71	Co-60 MDA	0.013
VG E71	Cs-137 Activity	<MDA
VG E71	Cs-137 Confidence Interval	NA
VG E71	Cs-137 MDA	0.015
VG E71	Pb-212 Activity	<MDA
VG E71	Pb-212 Confidence Interval	NA
VG E71	Pb-212 MDA	0.030
VG E71	Pb-214 Activity	<MDA
VG E71	Pb-214 Confidence Interval	NA
VG E71	Pb-214 MDA	0.040
VG E71	Am-241 Activity	<MDA
VG E71	Am-241 Confidence Interval	NA
VG E71	Am-241 MDA	0.117

	Results (pCi/g) fresh weight	2/12/2009
VG E74	Be-7 Activity	1.130
VG E74	Be-7 Confidence Interval	0.342
VG E74	Be-7 MDA	0.269
VG E74	K-40 Activity	2.660
VG E74	K-40 Confidence Interval	0.313
VG E74	K-40 MDA	0.122
VG E74	Co-60 Activity	<MDA
VG E74	Co-60 Confidence Interval	NA
VG E74	Co-60 MDA	0.015
VG E74	Cs-137 Activity	<MDA
VG E74	Cs-137 Confidence Interval	NA
VG E74	Cs-137 MDA	0.018
VG E74	Pb-212 Activity	<MDA
VG E74	Pb-212 Confidence Interval	NA
VG E74	Pb-212 MDA	0.033
VG E74	Pb-214 Activity	0.171
VG E74	Pb-214 Confidence Interval	0.030
VG E74	Pb-214 MDA	0.031
VG E74	Am-241 Activity	<MDA
VG E74	Am-241 Confidence Interval	NA
VG E74	Am-241 MDA	0.113

Radiological Monitoring of Terrestrial Vegetation Data; Background and <50-Mile Stations

2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	2/12/2009
VG E76	Be-7 Activity	2.710
VG E76	Be-7 Confidence Interval	0.400
VG E76	Be-7 MDA	0.267
VG E76	K-40 Activity	1.700
VG E76	K-40 Confidence Interval	0.276
VG E76	K-40 MDA	0.128
VG E76	Co-60 Activity	<MDA
VG E76	Co-60 Confidence Interval	NA
VG E76	Co-60 MDA	0.013
VG E76	Cs-137 Activity	<MDA
VG E76	Cs-137 Confidence Interval	NA
VG E76	Cs-137 MDA	0.016
VG E76	Pb-212 Activity	<MDA
VG E76	Pb-212 Confidence Interval	NA
VG E76	Pb-212 MDA	0.030
VG E76	Pb-214 Activity	0.084
VG E76	Pb-214 Confidence Interval	0.023
VG E76	Pb-214 MDA	0.031
VG E76	Am-241 Activity	<MDA
VG E76	Am-241 Confidence Interval	NA
VG E76	Am-241 MDA	0.112

	Results (pCi/g) fresh weight	2/19/2009
VG B63	Be-7 Activity	4.060
VG B63	Be-7 Confidence Interval	0.507
VG B63	Be-7 MDA	0.269
VG B63	K-40 Activity	1.630
VG B63	K-40 Confidence Interval	0.247
VG B63	K-40 MDA	0.125
VG B63	Co-60 Activity	<MDA
VG B63	Co-60 Confidence Interval	NA
VG B63	Co-60 MDA	0.015
VG B63	Cs-137 Activity	<MDA
VG B63	Cs-137 Confidence Interval	NA
VG B63	Cs-137 MDA	0.014
VG B63	Pb-212 Activity	<MDA
VG B63	Pb-212 Confidence Interval	NA
VG B63	Pb-212 MDA	0.028
VG B63	Pb-214 Activity	0.075
VG B63	Pb-214 Confidence Interval	0.025
VG B63	Pb-214 MDA	0.030
VG B63	Am-241 Activity	<MDA
VG B63	Am-241 Confidence Interval	NA
VG B63	Am-241 MDA	0.109

Radiological Monitoring of Terrestrial Vegetation Data; Background and <50-Mile Stations
2009 Gamma in Vegetation

Location Description	Analyte	Collection Date/Result
	Results (pCi/g) fresh weight	2/19/2009
VG B65	Be-7 Activity	3.100
VG B65	Be-7 Confidence Interval	0.418
VG B65	Be-7 MDA	0.268
VG B65	K-40 Activity	1.150
VG B65	K-40 Confidence Interval	0.229
VG B65	K-40 MDA	0.111
VG B65	Co-60 Activity	<MDA
VG B65	Co-60 Confidence Interval	NA
VG B65	Co-60 MDA	0.012
VG B65	Cs-137 Activity	<MDA
VG B65	Cs-137 Confidence Interval	NA
VG B65	Cs-137 MDA	0.013
VG B65	Pb-212 Activity	<MDA
VG B65	Pb-212 Confidence Interval	NA
VG B65	Pb-212 MDA	0.028
VG B65	Pb-214 Activity	0.059
VG B65	Pb-214 Confidence Interval	0.025
VG B65	Pb-214 MDA	0.031
VG B65	Am-241 Activity	<MDA
VG B65	Am-241 Confidence Interval	NA
VG B65	Am-241 MDA	0.112

	Results (pCi/g) fresh weight	2/19/2009
VG B72	Be-7 Activity	7.210
VG B72	Be-7 Confidence Interval	0.698
VG B72	Be-7 MDA	0.297
VG B72	K-40 Activity	1.950
VG B72	K-40 Confidence Interval	0.295
VG B72	K-40 MDA	0.120
VG B72	Co-60 Activity	<MDA
VG B72	Co-60 Confidence Interval	NA
VG B72	Co-60 MDA	0.015
VG B72	Cs-137 Activity	<MDA
VG B72	Cs-137 Confidence Interval	NA
VG B72	Cs-137 MDA	0.015
VG B72	Pb-212 Activity	<MDA
VG B72	Pb-212 Confidence Interval	NA
VG B72	Pb-212 MDA	0.036
VG B72	Pb-214 Activity	0.463
VG B72	Pb-214 Confidence Interval	0.042
VG B72	Pb-214 MDA	0.031
VG B72	U/Th-238 Activity	<MDA
VG B72	U/Th-238 Confidence Interval	NA
VG B72	U/Th-238 MDA	0.759
VG B72	Am-241 Activity	<MDA
VG B72	Am-241 Confidence Interval	NA
VG B72	Am-241 MDA	0.121

Radiological Monitoring of Terrestrial Vegetation Data

2009 Gamma in Fungi (pCi/g)

Table 1. 2009 Study Area[1] Radionuclide Detection Activities (pCi/g) in Inedible Mixed-Fungi

Field ID[3]	NR39	NR40B	NR41	NR42	NR44	E61	NR62B	NR63B	NR66	NR67	E67A	E67B	NR68	E72
Quad Loc[4]	E4	E80	E52	E49	E49	E61	E37	E74	E20	E59	E67	E67	E41	E72
Fungi Type	shelf	gill	shelf	leather	leather	gill	leather	leather	leather	leather	lichen	lichen	leather	lichen
Be-7	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**1.86**	**3.15**	**<MDA**	**8.63**	**6.44**	**5.90**	**<MDA**
C.I.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.57	1.35	N/A	2.18	1.58	1.44	N/A
MDA	1.10	1.37	0.43	5.51	17.88	1.24	1.01	0.53	1.10	1.27	1.83	1.44	1.06	1.61
K-40	**7.33**	**30.65**	**3.04**	**<MDA**	**<MDA**	**1.87**	**10.33**	**2.54**	**4.85**	**2.38**	**1.37**	**<MDA**	**2.52**	**7.44**
C.I.	0.92	3.16	0.64	N/A	N/A	0.89	1.07	0.62	0.81	0.72	0.67	N/A	0.67	1.02
MDA	0.26	0.79	0.39	0.28	2.55	0.53	0.41	0.28	0.37	0.41	0.51	0.49	0.41	0.44
Cs-137	**<MDA**	**1.93**	**0.08**	**0.13**	**24.21**	**<MDA**	**1.27**	**0.50**	**1.72**	**0.96**	**0.34**	**1.26**	**0.55**	**0.18**
C.I.	N/A	0.22	0.04	0.04	1.60	N/A	0.13	0.06	0.16	0.11	0.07	0.14	0.08	0.05
MDA	0.04	0.10	0.04	0.04	0.10	0.05	0.04	0.02	0.03	0.04	0.06	0.06	0.04	0.04
Pb-212	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.27**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.47**	**0.42**	**<MDA**	**0.35**
C.I.	N/A	N/A	N/A	N/A	N/A	0.08	N/A	N/A	N/A	N/A	0.11	0.09	N/A	0.08
MDA	0.06	0.20	0.07	0.07	0.22	0.08	0.10	0.06	0.09	0.11	0.10	0.09	0.10	0.07
Pb-214	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.18**	**<MDA**	**<MDA**	**<MDA**	**1.69**	**1.02**	**0.33**	**0.52**
C.I.	N/A	N/A	N/A	N/A	N/A	N/A	0.07	N/A	N/A	N/A	0.15	0.12	0.08	0.09
MDA	0.08	0.23	0.14	0.09	0.30	0.24	0.09	0.07	0.08	0.08	0.12	0.11	0.08	0.08

Table 2. 2009 South Carolina Background[2] Radionuclide Detection Activities (pCi/g) in Inedible Mixed-Fungi

Field ID[3]	B54	B55	B57	B60	B63	B64	NR64A	B65	NR65B	B68	B69	B71	B72	B87
Quad Loc[4]	B54	B55	B57	B60	B63	B64	B83	B65	Bkg	B68	B69	B71	B72	B87
Fungi Type	lichen	lichen	lichen	lichen	lichen	shelf	parasols	lichen	gill	lichen	lichen	lichen	lichen	lichen
Be-7	**4.27**	**4.66**	**6.98**	**7.23**	**7.31**	**5.31**	**<MDA**	**14.97**	**<MDA**	**6.30**	**9.08**	**8.89**	**<MDA**	**5.83**
C.I.	1.71	1.32	0.91	2.30	1.56	2.14	N/A	5.79	N/A	1.59	1.84	1.58	N/A	1.53
MDA	1.55	0.96	0.60	1.74	1.29	1.87	1.30	4.50	3.33	1.28	1.49	1.14	6.53	1.40
K-40	**5.68**	**<MDA**	**1.10**	**4.29**	**<MDA**	**15.37**	**36.85**	**<MDA**	**27.79**	**1.27**	**2.09**	**<MDA**	**<MDA**	**<MDA**
C.I.	1.26	N/A	0.55	1.19	N/A	1.90	2.71	N/A	2.70	0.57	0.62	N/A	N/A	N/A
MDA	0.60	0.71	0.38	0.69	0.99	0.66	0.40	1.19	0.71	0.42	0.43	0.37	1.86	0.36
Cs-137	**<MDA**	**<MDA**	**<MDA**	**0.18**	**0.48**	**2.12**	**0.18**	**<MDA**	**0.80**	**<MDA**	**0.26**	**0.13**	**<MDA**	**0.90**
C.I.	N/A	N/A	N/A	0.08	0.08	0.21	0.06	N/A	0.12	N/A	0.06	0.05	N/A	0.10
MDA	0.06	0.07	0.04	0.07	0.05	0.08	0.04	0.12	0.09	0.04	0.06	0.04	0.14	0.05
Pb-212	**0.38**	**<MDA**	**<MDA**	**0.29**	**0.35**	**0.46**	**0.30**	**<MDA**	**<MDA**	**0.25**	**0.20**	**0.22**	**<MDA**	**0.35**
C.I.	0.10	N/A	N/A	0.12	0.09	0.15	0.07	N/A	N/A	0.09	0.07	0.07	N/A	0.08
MDA	0.11	0.11	0.09	0.12	0.09	0.12	0.07	0.23	0.14	0.07	0.08	0.07	0.29	0.07
Pb-214	**0.27**	**0.65**	**0.29**	**<MDA**	**1.12**	**<MDA**	**0.90**	**<MDA**	**<MDA**	**<MDA**	**0.56**	**0.25**	**<MDA**	**0.46**
C.I.	0.12	0.13	0.08	N/A	0.12	N/A	0.11	N/A	N/A	N/A	0.11	0.08	N/A	0.09
MDA	0.12	0.13	0.07	0.23	0.10	0.35	0.08	0.44	0.22	0.11	0.10	0.08	0.62	0.09

Notes:

1 - Study Area (SA) is the area external to the SRS boundary and within 50-miles of an SRS center-point.

2 - South Carolina background is the area outside of the study area with the exception of 10-mile exclusion zones around commercial reactors.

3 - Field ID (identification) was given a nonrandom designation if the quadrant location was uncertain at the time of collection.

4 - Quad (quadrant) Loc (location) was given after establishing the location was within a quadrant.

Radiological Monitoring of Terrestrial Vegetation Data

2009 Gamma in Fungi (pCi/g)

Table 3. 2009 Study Area[1] Radionuclide Detection Activities (pCi/g) in Edible Mixed-Fungi

Field ID[2]	NR45	NR45B	NR48A	NR48B	NR48C	NR48D	NR52	NR47A	NR47B	NR47C	NR47D
Quad Loc[3]	E14	E14	E14	E14	E14	E14	E14	E24	E24	E24	E24
Fungi Type	boletes	oysters	boletes	boletes	boletes	boletes	boletes	boletes	boletes	boletes	boletes
K-40	**17.22**	**30.47**	**16.67**	**17.31**	**15.29**	**19.61**	**27.93**	**15.94**	**14.44**	**19.05**	**17.13**
C.I.	1.71	2.24	1.71	1.77	1.74	1.86	2.40	2.03	2.21	2.69	2.46
MDA	0.45	0.39	0.42	0.48	0.54	0.49	0.51	0.72	0.91	0.99	0.88
Cs-137	**0.22**	**0.13**	**0.64**	**1.91**	**2.30**	**1.10**	**0.32**	**2.60**	**3.55**	**4.70**	**7.25**
C.I.	0.06	0.05	0.08	0.17	0.19	0.11	0.07	0.25	0.30	0.37	0.54
MDA	0.05	0.05	0.06	0.06	0.08	0.06	0.06	0.09	0.12	0.13	0.11
Pb-212	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.23**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
C.I.	NA	NA	NA	NA	0.11	NA	NA	NA	NA	NA	NA
MDA	0.11	0.09	0.12	0.11	0.13	0.12	0.12	0.19	0.20	0.24	0.23
Pb-214	**<MDA**	**<MDA**	**0.36**	**<MDA**	**<MDA**	**<MDA**	**0.29**	**<MDA**	**0.56**	**<MDA**	**<MDA**
C.I.	NA	NA	0.13	NA	NA	NA	0.14	NA	0.25	NA	NA
MDA	0.15	0.13	0.12	0.13	0.19	0.15	0.13	0.25	0.22	0.31	0.31

Table 3 (continued). 2009 Study Area[1] Radionuclide Detection Activities (pCi/g) in Edible Mixed-Fungi

Field ID[2]	NR47E	NR47F	NR47G	NR53	NR64B	NR46	NR50	NR51	NR43	NR43B	NR57
Quad Loc[3]	E24	E24	E24	E38	E39	E49	E49	E49	E59	E59	E64
Fungi Type	boletes	boletes	boletes	boletes	amanita	oysters	boletes	boletes	boletes	hericium	chicken
K-40	**18.29**	**20.23**	**21.52**	**2.07**	**16.25**	**<MDA**	**4.75**	**8.23**	**26.79**	**28.19**	**17.35**
C.I.	2.39	2.36	2.53	0.89	1.69	NA	1.25	1.67	2.43	2.54	1.37
MDA	0.75	0.76	0.93	0.41	0.51	0.77	0.53	0.58	0.54	0.46	0.21
Cs-137	**2.87**	**1.95**	**2.71**	**<MDA**	**0.72**	**0.63**	**3.12**	**1.18**	**0.41**	**0.19**	**1.16**
C.I.	0.27	0.19	0.25	NA	0.09	0.13	0.25	0.15	0.08	0.08	0.11
MDA	0.10	0.09	0.11	0.05	0.06	0.09	0.08	0.08	0.06	0.07	0.02
Pb-212	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.28**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
C.I.	NA	NA	NA	NA	0.10	NA	NA	NA	NA	NA	NA
MDA	0.20	0.19	0.22	0.10	0.11	0.20	0.15	0.15	0.13	0.13	0.06
Pb-214	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**0.21**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
C.I.	NA	NA	NA	NA	0.10	NA	NA	NA	NA	NA	NA
MDA	0.25	0.23	0.22	0.13	0.12	0.20	0.19	0.17	0.14	0.17	0.07

Table 4. 2009 South Carolina Background Radionuclide Detection Activities (pCi/g) in Edible Mixed-Fungi

Field ID[2]	NR54	NR55	NR65
Quad Loc[3]	B90	B20	B83
Fungi Type	chanterell	chanterell	chicken
K-40	**9.73**	**10.02**	**26.14**
C.I.	0.88	0.86	1.99
MDA	0.22	0.19	0.32
Cs-137	**0.40**	**0.12**	**0.11**
C.I.	0.05	0.03	0.04
MDA	0.02	0.02	0.03
Pb-212	**<MDA**	**<MDA**	**0.11**
C.I.	NA	NA	0.05
MDA	0.04	0.05	0.05
Pb-214	**<MDA**	**0.07**	**0.36**
C.I.	NA	0.03	0.08
MDA	0.06	0.04	0.06

Notes:

1 - Study Area (SA) is the area external to the SRS boundary and within 50-miles of an SRS center-point.

2 - South Carolina background is the area outside of the 50-mile perimeter study area.

3 - Field ID (identification) was given a nonrandom designation if the quadrant location was uncertain at the time of collection.

4 - Quad (quadrant) Loc (location) was given for future 7.5 minute quadrant comparisons.

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. ND denotes non-detect
5. NA denotes not applicable
6. Std Dev / SD – standard deviation
7. LLD - Lower Limit of Detection
8. MDA - Minimum Detectable Activity
9. >8hle – Indicates no determination due to greater than 8 half-lifes elapsed
10. See Appendix A for radionuclide definitions

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2009 Vegetation Statistics

Tritium Levels (pCi/L) in Vegetation from SRS Perimeter Stations, 2009						
Station	**N (ND)**	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
AKN-001	1 (3)	1234	N/A	1234	1234	1234
AKN-002	3 (1)	637	412	646	1044	221
AKN-003	3 (1)	773	757	502	1628	189
AKN-004	2 (2)	519	402	519	803	235
AKN-005	3 (1)	371	306	200	725	189
AKN-006	3 (1)	487	246	531	709	222
AKN-007	0 (4)	N/A	N/A	N/A	<LLD	<LLD
AKN-008	2 (2)	301	110	301	379	223
BWL-001	1 (3)	278	N/A	278	278	278
BWL-002	1 (3)	777	N/A	777	777	777
BWL-003	0 (4)	N/A	N/A	N/A	<LLD	<LLD
BWL-004	0 (4)	N/A	N/A	N/A	<LLD	<LLD
ALD-001	0 (4)	N/A	N/A	N/A	<LLD	<LLD
BWL-006	2 (2)	257	62	257	301	213
BWL-007	1 (3)	282	N/A	282	282	282
BWL-008	1 (3)	402	N/A	402	402	402
BWL-009	4 (0)	430	358	288	962	307
AKN-251	0 (4)	N/A	N/A	N/A	<LLD	<LLD
ALD-251	1 (3)	230	N/A	230	230	230
ORG-251	0 (4)	N/A	N/A	N/A	<LLD	<LLD

Tritium Levels (pCi/L) in SRS Perimeter Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
27 (41)	506	373	307	1628	189

Tritium Levels (pCi/L) in 25-mile Radius Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
1 (11)	230	N/A	230	230	230

Tritium Levels (pCi/L) in 50-mile Radius Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
0 (3)	N/A	N/A	N/A	<LLD	<LLD

Tritium Levels (pCi/L) in S.C. Background Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
0 (3)	N/A	N/A	N/A	<LLD	<LLD

Note: All averages exclude non-detections.

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2009 Vegetation Statistics

Cesium-137 Levels (pCi/g-fresh) in SRS Perimeter Vegetation Samples, 2009						
Station	**N (ND)**	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
AKN-001	1 (3)	0.05	N/A	0.05	0.05	0.05
AKN-002	0 (4)	N/A	N/A	N/A	<LLD	<LLD
AKN-003	4 (0)	0.57	0.38	0.54	0.98	0.23
AKN-005	4 (0)	0.47	0.19	0.47	0.71	0.25
AKN-006	3 (1)	0.08	0.02	0.08	0.09	0.06
AKN-008	4 (0)	0.50	0.15	0.44	0.72	0.41
BWL-004	2 (2)	0.13	0.12	0.13	0.21	0.04
ALD-001	3 (1)	0.15	0.08	0.12	0.24	0.09
BWL-006	4 (0)	0.25	0.05	0.25	0.03	0.02

Cs-137 Levels (pCi/g) in SRS Perimeter Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
25 (11)	0.33	0.26	0.25	0.98	0.04

Cs-137 Levels (pCi/g) in 50-mile Radius Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
0 (3)	N/A	N/A	N/A	<MDA	<MDA

Cs-137 Levels (pCi/g) in S.C. Background Vegetation Samples, 2009					
N (ND)	**Average**	**Std Dev**	**Median**	**Maximum**	**Minimum**
0 (3)	N/A	N/A	N/A	<MDA	<MDA

Note: All averages exclude non-detections.

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2009 Fungi Statistics (pCi/g)

Table 1. Survey of Fungi 2009

SA[1] - All Fungi			N = 36	pCi/g	SC Bkg[2] - All Fungi			N = 17
Avg	**SD**	**Median**	**Max**	**Radionuclide**	**Avg**	**SD**	**Median**	**Max**
5.19	2.70	5.90	8.63	**Be-7**	7.35	2.96	6.98	14.97
14.45	9.34	16.25	30.65	**K-40**	11.25	11.85	7.70	36.85
2.16	4.18	1.13	24.21	**Cs-137**	0.49	0.62	0.22	2.12
0.34	0.09	0.31	0.47	**Pb-212**	0.29	0.10	0.29	0.46
0.57	0.49	0.36	1.69	**Pb-214**	0.49	0.32	0.41	1.12
SA - All Inedible Fungi			**N = 14**	**pCi/g**	**SC Bkg - Inedible Fungi**			**N = 14**
Avg	**SD**	**Median**	**Max**	**Radionuclide**	**Avg**	**SD**	**Median**	**Max**
5.19	2.70	5.90	8.63	**Be-7**	7.35	2.96	6.98	14.97
6.76	8.42	3.04	30.65	**K-40**	11.81	13.68	4.98	36.85
2.76	6.78	0.75	24.21	**Cs-137**	0.63	0.67	0.37	2.12
0.38	0.09	0.39	0.47	**Pb-212**	0.31	0.08	0.30	0.46
0.75	0.61	0.52	1.69	**Pb-214**	0.56	0.32	0.51	1.12
SA - All Edible Fungi			**N = 22**	**pCi/g**	**SC Bkg - Other Edibles[3]**			**N = 3**
Avg	**SD**	**Median**	**Max**	**Radionuclide**	**Avg**	**SD**	**Median**	**Max**
17.84	7.11	17.31	30.47	**K-40**	15.30	9.39	10.02	26.14
1.89	1.77	1.18	7.25	**Cs-137**	0.21	0.16	0.12	0.40
0.25	0.03	0.25	0.28	**Pb-212**	0.11	NA	0.11	0.11
0.35	0.15	0.33	0.56	**Pb-214**	0.21	0.20	0.21	0.36
SA - Bolete Fungi Only			**N = 17**	**pCi/g**	**SA - Other Edible Fungi**			**N = 5**
Avg	**SD**	**Median**	**Max**	**Radionuclide**	**Avg**	**SD**	**Median**	**Max**
16.62	6.69	17.22	27.93	**K-40**	23.07	7.31	22.77	30.47
2.30	1.84	2.12	7.25	**Cs-137**	0.57	0.42	0.63	1.16
0.23	NA	0.23	0.23	**Pb-212**	0.28	NA	0.28	0.28
0.40	0.14	0.36	0.56	**Pb-214**	0.21	NA	0.21	0.21

Notes:
1 - SA is the study area outside of the SRS border and within 50-miles of an SRS center-point.
2 - SC Bkg is the South Carolina background outside of the 50-mile perimeter study area.
3 - Other edibles refers to edibles that were not boletes. No boletes were collected in the SC Bkg.
4 - Beryllium-7 (Be-7) was not found in the edible fungi surveyed.
5 - See Acronyms and Radionuclide lists for definitions of abbreviations/acronyms.
6 – All data in table are in pCi/g.

Radiological Monitoring of Terrestrial Vegetation Summary Statistics
2009 Fungi Statistics (pCi/g)

Table 2. Fungi Summary Statistics Random Quadrant Versus Nonrandom Sample Basis

Background - Nonrandom Sample Basis 2004-09, N=80				Background - Random Quad Basis 2004-2008, N=50				
AVG	SD	Median	MAX	Radionuclide	MAX	AVG	SD	Median
5.54	3.32	4.98	14.97	Be-7	12.51	4.09	2.97	3.18
7.27	8.28	3.99	36.85	K-40	17.66	4.96	3.75	3.81
0.83	0.91	0.47	4.16	Cs-137	4.16	0.92	0.99	0.51
0.26	0.12	0.27	0.46	Pb-212	0.45	0.23	0.14	0.18
0.38	0.24	0.29	1.12	Pb-214	0.66	0.34	0.14	0.30
2.99	NA	2.99	2.99	Ra-226	2.99	2.99	NA	2.99
Study Area - Nonrandom Sample Basis 2004-09, N=135				**Study Area - Random Quad Basis 2004-08, N=54**				
AVG	**SD**	**Median**	**MAX**	**Radionuclide**	**MAX**	**AVG**	**SD**	**Median**
5.57	4.60	4.58	20.00	Be-7	11.58	4.21	2.70	3.26
11.14	11.31	6.90	63.40	K-40	26.59	7.88	6.61	5.81
2.19	3.93	0.98	24.21	Cs-137	7.84	1.40	1.68	0.90
0.33	0.24	0.32	0.83	Pb-212	0.62	0.28	0.20	0.22
0.66	0.75	0.37	3.50	Pb-214	3.30	0.63	0.68	0.37
7.22	3.16	7.49	10.91	Ra-226	<MDA	<MDA	<MDA	<MDA
2.34	0.00	2.34	2.34	Ac-228	<MDA	<MDA	<MDA	<MDA
Study Area Minus Background - Sample Basis				**Study Area Minus Background - Random Quad Basis**				
AVG	**SD**	**Median**	**MAX**	**Radionuclide**	**MAX**	**AVG**	**SD**	**Median**
0.02	1.28	-0.40	5.03	Be-7	-0.93	0.12	-0.27	0.08
3.87	3.03	2.91	26.55	K-40	8.92	2.92	2.86	2.00
1.36	3.02	0.51	20.05	Cs-137	3.68	0.48	0.69	0.38
0.07	0.12	0.05	0.37	Pb-212	0.18	0.05	0.06	0.03
0.28	0.51	0.07	2.38	Pb-214	2.63	0.29	0.54	0.07
4.23	NA	4.50	7.92	Ra-226	NA	NA	NA	NA
-2.34	0.00	-2.34	-2.34	Ac-228	NA	NA	NA	NA

Notes:
1- "N" is the number of samples or quadrants.
2 - See acronyms for all other abbreviations.
3 - SA is the study area outside of the SRS border and within 50-miles of an SRS center-point.
4 - The South Carolina background is outside of the 50-mile perimeter study area.
5 - Other edibles refers to edibles that were not boletes. No boletes were collected in the SC Bkg.
6 - Beryllium-7 (Be-7) was not found in the edible fungi surveyed.
7 - See Acronyms and Radionuclide lists for definitions of abbreviations/acronyms.
8 – All data in table are in pCi/g.

TOC

3.3 Radiological Monitoring of Edible Vegetation

3.3.1 Summary

Radionuclide deposition on crops and other plants may result in entry into the food chain in several ways. One pathway is by direct absorption into the plant through the foliage; another is by ingestion of the contaminated plant by animals or man. Radionuclides deposited on plants may also be washed off and enter the ground where they can be taken up by plants or may enter aquatic systems (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 IAFS 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 products from perimeter and background locations around the Savannah River Site (SRS). SCDHEC ESOP addresses public concerns pertaining to SRS operations through independent monitoring of radionuclide activities in edible vegetation grown around the perimeter of SRS. Edible vegetation was collected based solely on availability, and was directly dependent upon the growing season. To gain access to samples, relationships are established on an ongoing basis with farmers, gardeners, and/or businesses surrounding the perimeter of SRS. Vegetation samples, such as wild plums and pears, were collected as available.

Annual sampling began in February 2009 with ESOP collecting samples on a routine basis through the end of November. Thirty-five samples were collected. Twelve of these samples were split samples with DOE-SR (Department of Energy – Savannah River) for data comparison purposes. Three of the 35 were new plum sampling locations established around the SRS for better coverage of the perimeter. Section 3.3.2, Map 9 depicts only sampling collection sites that have become annual sampling locations for the project.

The DOE-SR annually collects and analyzes terrestrial food products to determine the presence of gamma-emitting radionuclides, tritium, total strontium (Sr-89/90), uranium-234 (U-234), uranium-235 (U-235), uranium-238 (U-238), plutonium-238 (Pu-238), plutonium-239 (Pu-239), americium-241 (Am-241), cobalt-60 (Co-60), curium-244 (Cm-244), cesium-137 (Cs-137), neptunium-237, gross alpha, and gross beta activity. In comparison, the ESOP analyzes food products collected to determine the presence of gamma-emitting radionuclides (Cs-137, Co-60, iodine-131 (I-131), radium-226 (Ra-226), uranium/thorium-238 (U/Th238, Am-241), tritium, Sr-89-90. Alphas (or betas) are not directly comparable due to the unknown nature (species) of the contributing alphas (or betas) in any two compared samples. A complete list of the gamma-emitting radionuclides suite can be found in Table 1a. As resources become available and situations warrant, samples are shipped to a contract laboratory for Sr-89/90, U-234, U-235, U-238, Pu-238, Pu-239 testing. The DOE-SR collects collards and watermelons annually from one location within each of four quadrants. Secondary crops are also included on an annual rotating schedule (pecans, peanuts, soybeans, corn, cabbage, and wheat).

According to the 2009DOE-SR reported data, edible vegetation samples (collards, soybeans and fruit, and wheat) collected in 2009were found to have activities above the minimum detectable concentrations (MDC) for cesium-137 (Cs-137), total strontium (Sr-89/90), uranium-234 (U-234, uranium-235, and uranium-238, americium-241, gross beta and gross alpha. ESOP reported activities above the minimum detectable activities for tritium and Sr-89/90 in plum samples. No direct comparisons could made between ESOP and DOE-SR program.

RESULTS AND DISCUSSION

The International Atomic Energy Agency (IAEA) has established guideline levels for radionuclides in foods for general consumption for gamma-, beta-, and alpha-emitters. Table 1b in Section 5 shows the radionuclides of concern, the guideline level and their conversion to pCi/g for data comparison. IAEA emphasizes that the limits refer to the cumulative radioactivity in the food for a particular category (beta-emitters, alpha-emitters, and gamma-emitters) and should not be considered as individual limits for each nuclide (IAEA 2009).

The US Food and Drug Administration (USFDA) also has guidance levels for radionuclide activity concentration (Sr-90, I-131, Cs-134+Cs-137, Pu-238 +Pu-239+Am-241, Ruthenium-103+Ruthenium-106), called derived intervention levels, 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 as shown in Table 1c. A derived intervention level for tritium is not addressed by the USFDA. The USFDA's guidance documents do not establish legally enforceable responsibilities. Instead, guidance's should be viewed only as recommendations, unless specific regulatory or statutory requirements are cited (USFDA 2005).

2004-2009 Detections by Counties surrounding SRS

Between the years of 2004-2009, ESOP collected 168 total edible vegetation samples consisting of various fruits and vegetables for analysis across South Carolina. Radionuclide detections among these samples were 43 detects of tritium with an average of 0.291 (±0.120) pCi/g and a median of 0.266 pCi/g; 15 strontium 89/90 (Sr-89/90) detects with an average of 0.251 (±0.386) pCi/g and a median of 0.076 pCi/g, and all other gamma-emitting radionuclides were below the minimum detectable activity (MDA). Data for 2004-2009 are found in Tables 2 – 4d in Section 3.3.2. These tables only reflect data detected, not all data points collected.

The three counties that immediately surround the SRS are Aiken, Allendale, and Barnwell, South Carolina. In Tables 2a – 2e, all edible vegetation samples from 2004-2009 are given by county. During this time period, there were a total of 33 samples collected across Aiken County. Of these, there were 10 detections of tritium with an average of 0.260 (±0.050) pCi/g with a median of 0.259 pCi/g. There were six detections of Sr-89/90 with an average of 0.260 (±0.201) pCi/g with a median of 0.224 pCi/g. The Sr-89/90 detections are well below the IAEA and the USFDA guidelines. For Allendale County, ESOP collected a total of 20 samples during this time period. Of these 20 samples, 6 samples had tritium detects with an average of 0.256 (±0.049) pCi/g and a median of 0.273 pCi/g. There were no strontium detects. ESOP collected a total of 17 samples across Barnwell County. Of these, there were five tritium detects with an average of 0.421 (±0.294) pCi/g and median of 0.257 pCi/g. The strontium results for the Barnwell area were 0.056 pCi/g. For each county, all other radionuclides were below the MDA. Results from all three counties were within one standard deviation of each other, and meet the IAEA and the USFDA guidance recommendations. Tritium detections for edible vegetation outside of the counties mentioned was 0.281 pCi/g (±0.081) with a median of 0.260 pCi/g. Strontium detects were 0.054 pCi/g(±0.020) with a median of 0.051 pCi/g.

In addition, K-40, Pb-212, Pb-214, and Be-7 were the only other gamma-emitting radionuclides detected among edible vegetation samples. These are Naturally Occurring Radioactive Material (NORM) decay products, which includes all radioactive elements found in the environment (World-Nuclear Organization 2009).

Tritium

Tritium is naturally present as a very small percentage of ordinary hydrogen in water, both liquid and vapor (ANL 2005). 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 (WSRC[2] 2006). Because it moves through living cells in the same manner as water, tritiated water is more biologically hazardous than tritium gas (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. This facility's mission is to transfer new tritium gas to the nation's tritium inventory (WSRC[2] 2006). Adjacent to the SRS, the Southern Nuclear Operating Company operates the Vogtle Electric Generating Plant (VEGP) located in Burke County, Georgia. 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 1998).

Tritium was detected in six of the total 35 ESOP samples collected in 2009. Of these, two corn samples and four plum samples within the 50-mile perimeter of the SRS had tritium detections. The 2009 tritium average was 0.254 (± 0.059) pCi/g with a median of 0.259 pCi/g. The highest detection from these perimeter samples, found in plums from a New Ellenton (Aiken County) location, was 0.353 pCi/g. The lowest perimeter tritium detection (0.182 pCi/g) was also found in a plum sample from a Barnwell County location. During 2009, ESOP collected plums from 11 perimeter sampling locations (Aiken, Barnwell, Snelling, Jackson, and New Ellenton). Of the 11 sampling locations, four were new plum sampling locations added in 2009 to provide better perimeter coverage around the SRS. The tritium average was 0.263 (± 0.070) pCi/g with a median 0.259 pCi/g. For 2009, the DOE-SR reported that the only tritium detected was in collard samples at two locations in 2009 (0.089 and 0.088). One was located within the 0-10 mile NE quadrant and the other was located with the 0-10 mile NW quadrant. Section 4, Map 2 depicts the permanent sampling locations established for collecting plums around the perimeter of SRS. All of the detects described are well below the IAEA guideline for tritium (beta emitters).

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 2000).

Pathways through plant foods are relatively unimportant as cesium is poorly absorbed by the plants from the soil. Cesium is relatively uniformly distributed throughout all portions of the plant and does not tend to concentrate in the edible portions. Grains, however, do tend to have relatively high concentrations although fruits and root vegetables, which have a high water content, tend to have low concentrations of cesium (Kathren 1984).

Cs-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 pCi/g, averaging less than 0.4 pCi/g. Cesium is generally one of the less mobile radioactive metals in the environment. It preferentially adheres quite well to soil, 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 2005).

None of the 35 ESOP samples collected in 2009 had Cs-137 detections.

Strontium 89-90

The food crop pathway for strontium is important largely because the downward movement of strontium in soils is relatively slow; even in soils with low clay and humus content, through which movement is fastest, most of the strontium will remain in the upper few centimeters several years after deposition. Strontium preferentially adheres to soil particles, and the amount in sandy soil is typically about 15 times higher than in interstitial water; concentrations ratios are typically higher (110) in clay soil (ANL 2007). Low calcium content of the soil furthers strontium uptake by plants, as does low pH. Treatment of soil with lime to increase pH has been suggested as a means of reducing plant uptake of radiostrontium from soil (Kathren 1984).

Although ESOP and DOE-SR analyze for total strontium (Sr89-90), Argonne National Laboratory (ANL) states that Sr-90 is present in surface soil around the world as a result of fallout from past atmospheric nuclear weapons tests. According to ANL, in 2005 Sr-90 levels in surface soil typically ranged from 0.01 to 1 pCi/g reflecting various rainfall and wind patterns, elevation, and terrain. Most levels fall between 0.05 and 0.5 pCi/g, with 0.1 pCi/g as a general average.

In 2009, ESOP analyzed one watermelon and four plum samples for Sr-89/90. One plum sample from Snelling had a Sr-89/90 detect of 0.056 pCi/g which is well below the guidelines of both the IAEA and the USFDA. ESOP could not make plum data comparisons with DOE-SR since plums are not collected by DOE-SR.

ESOP reported one plum sample detection (0.056 pCi/g) within the 50-mile perimeter (Snelling) of SRS.

Uranium

Uranium is present naturally in virtually all soil, rock and water. Uranium in soil and rocks is distributed throughout the environment by wind, rain and geologic processes. Rocks weather and break down to form soil, and soil can be washed by water and blown by wind, moving uranium into streams and lakes, and ultimately settling out and reforming as rock. All uranium isotopes are radioactive. The three natural uranium isotopes found in the environment, U-234, U-235, and U-238, undergo radioactive decay by emission of an alpha particle accompanied by weak gamma radiation. The dominant isotope, U-238, forms a long series of decay products that includes the key radionuclides radium-226, and radon-222. Because uranium has such a long radioactive half-life (4.47x109 years for U-238), the total amount of it on earth stays almost the same (USEPA 2010).

Releases of uranium occurred at the SRS since the start of the facility in the early fifties. These releases have generally been associated with the fabrication of reactor fuel and target elements (M area), or the chemical processing of spent target and fuel material (F and H areas). Smaller releases have occurred from waste storage and research areas. Releases have primarily been in the form of particulates into the atmosphere (F,H and M and A areas). Additionally, there have been some unplanned releases to streams, air, soil, and seepage basins. Uranium recovered from the SRS processes may contain as little as 0.2% ^{235}U and enriched material may be as high as 97% ^{235}U. For comparison, commercial power reactors normally use uranium that is 1.5% to 3.0% ^{235}U. In all cases the uranium used at SRS has been chemically purified. Because of the relatively long half-lives of the uranium isotopes, SRS uranium has undetectable amounts of the lower atomic-number decay products such as actinium, polonium, and radium that are present in natural uranium. All of these have been removed chemically and have not had time to grow back to a measurable degree (WSRC[1] 1992).

In 2009, ESOP sent four samples of plums and one watermelon sample to the contract laboratory for uranium analysis. All samples analyses returned from the laboratory with detections of U-234, U-235, and U-238 of less than 1 pCi/g.

Plutonium

Plutonium in its pure form is a very heavy, silver-colored, radioactive metal about twice as dense as lead. Essentially all the plutonium on earth as been created within the past six decades by human activities involving fissionable materials. Several plutonium isotopes exist, all of which are radioactive (ANL 2005).

Plutonium at the SRS predominantly originated in the fuel and targets that were irradiated in the nuclear materials production reactors. Other site operations and offsite sources contributed to the inventory of plutonium at the SRS. Small quantities of plutonium were produced at SRS by test reactors and neutron activation analysis. The activity levels of plutonium from these sources were insignificant when compared to activity levels in irradiated nuclear fuel and targets.

Routine operations at SRS facilities have released plutonium to the regional environment surrounding the SRS. The most significant releases occurred during the early years of site operations when plutonium was released to the atmosphere, seepage basins and site streams. The greatest releases of plutonium originated in the F- and H- Area chemical separation facilities. The only significant release of plutonium from the reactor areas occurred in 1957 as a result of the failure of an experimental fuel element in 100-R. The R-Area release was to seepage basins, not plant streams (WSRC[1] 1992).

All 2009 ESOP samples were below the MDA for Pu-238.

Naturally Occurring Isotopes

Lead (Pb-212, Pb-214), Beryllium-7 (Be-7), and Potassium-40 (K-40) are all naturally occurring radioactive isotopes in the environment. Pb-212, Pb-214 and Be-7 were detected in several samples (soybeans, corn, and greens) ESOP collected in 2009. Discussion on these isotopes is brief as they do not occur on a routine basis. K-40 is discussed briefly as it is detected in all edible vegetation samples. These naturally occurring isotopes are not included in the data tables provided in Section 6.

Lead occurs 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). Concentrations in sandy soil particles are estimated to be 270 times higher than in the water in pore spaces. Lead binds even more tightly to clay and loam soils, with concentration ratios of about 500 to more than 16,000. 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 (ANL 2007). In 2009, Pb-212 was below MDA for all samples, while Pb-214 was detected in seven samples: one sample each of peaches, corn, plums along with four soybean samples.

Beryllium (Be-7), like potassium, occurs naturally in the earth's crust. The concentration generally ranges from 1 to 15 milligrams per kilogram, 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 zero to 40 ppm. Concentrations in sandy soil are estimated to be up to 250 times higher than in the water in the pore space between the soil particles, with much higher concentration ratios in loam and clay soils. Being naturally present in various food types, beryllium has a median concentration of 22.5 micrograms/kilograms reported across 38 different food types, ranging from less than 0.1 microgram/kilogram to 2,200 micrograms/kilogram in kidney beans for example. The major source of environmental releases from human activities is combustion of coal and fuel oil (ANL 2007). Beryllium-7 was less than the MDA for all samples collected in 2009.

Potassium occurs in the earth's crust, oceans and all 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, so levels of K-40 in soils are strongly influenced by fertilizer use; it is estimated that about 3,000 Curies of K-40 are added annually to U.S. soils. Potassium behaves in the environment the same as other potassium isotopes, being assimilated into the tissues of plants and animals through normal biological processes. For example, milk contains about 2000 pCi/L of natural K-40 (ANL 2007).
Potassium-40 was detected in all food samples collected around the perimeter of the SRS with concentrations ranging from a minimum detection of 1.282 pCi/g (plums) to a maximum detection of 13.94 pCi/g (soybeans).

ESOP and DOE-SR Data Comparison

In comparing averages between ESOP and the DOE-SR programs, the only nuclides common to both were tritium, Cs-137, and Sr-89/90 and U-234,-238, -235, Pu-238. DOE-SR also reported detections of americium-241, and technicium-99, whereas ESOP did not analyze for those radionuclides in 2009.

The ESOP tritium average was 0.263 pCi/g (±0.070) with a median of 0.259 pCi/g. For 2009, the DOE-SR reported that the only tritium detected was in collard samples at two locations in 2009 (0.089 and 0.088). One was located within the 0-10 mile NE quadrant and the other was located with the 0-10 mile NW quadrant.

The DOE-SR, for 2009, reported Cs-137 in collards at four locations and soybeans at one. The highest detection in collards was 0.074 from the south eastern 25-mile quadrant, while the highest detection in soybeans was 0.0089 at the NE Quadrant 0-10 miles. However, none of the 35 ESOP samples collected in 2009 had Cs-137 detects. The difference in detectable concentrations between the two programs can be contributed to the respective detection limits. The average minimum detectable concentration for the ESOP program is 0.0289 pCi/g whereas the minimum detectable concentration for DOE-SR is 0.0059 pCi/g.

For Sr-89/90, DOE-SR reported detections in collards at all five locations and a soybean sample at one location. The samples ranging from 0.056 pCi/g to 0.289 pCi/g. ESOP reported one plum sample detection (0.056 pCi/g) within the 50-mile perimeter (Snelling) of SRS.

In 2009, ESOP sent four samples of plums and one watermelon sample to the contract laboratory for uranium analysis. All samples analyses returned from the laboratory with detections of U-234, U-235, and U-238 of less than 1 pCi/g. DOE-SR reported that in 2009 U-234 was detected in collards at all locations and in fruit and soybeans at one location; U-235 was detected in collards at one location; and U-238 was detected in collards at four locations. As with the ESOP results, the DOE-SR results were also less than 1 pCi/g.

All 2009 ESOP samples were below the MDA for Pu-238. The DOE-SR reported that Pu-238 was detected in collards at three locations. However, all results were below 1 pCi/g.

With the exception of plums, all ESOP samples were below the MDA for Cs-137, Sr-89/90, Tritium, U-234,-235,-238. No comparisons between the ESOP and DOE-SR programs can be made at this time.

In 2009, DOE-SR split samples of corn, wheat, and watermelon with ESOP for comparison. The ESOP sample results on the split samples were all below the MDA for all radionuclides.

CONCLUSIONS AND RECOMMENDATIONS

ESOP and DOE-SR have similar sampling schemes. The DOE-SR has annual participants from 0-10 miles from the perimeter of the SRS and has a 25 mile control station. The ESOP will continue to establish relationships with annual contributors around the perimeter of the SRS for similar food products for DOE-SR data comparisons.

Tritium continues to be the prevailing analyte across all edible vegetation. Of the counties immediately surrounding SRS, Aiken County shows the only results for Sr-89/90. Averages for both tritium and strontium for all edible vegetation sampled around SRS are well below (approximately three orders of magnitude) the IAEA standards for these emitters. Traces of the naturally occurring radionuclides Pb-212,Pb-214, Be-7, and K-40 continue to be sporadically detected in edible vegetation.

ESOP compared results with DOE-SR and found that the data could not be compared by media. The only detections in ESOP edible vegetation was in plums. Historically, both programs have had tritium detects; however, this year DOE-SR had two detects of tritium in collards samples while ESOP detected tritium only in plum samples. Differences in sampling methodology, location of samples or a difference in minimum detection levels of analysis equipment could explain the detection difference between the two programs. All ESOP plum sample detections were well below the IAEA guidelines for tritium, Cs-137 and Sr-89/90.

In 2010, ESOP plans to continue to collect vegetation similar to that of the DOE-SR program for better comparisons of data between the two programs. DOE-SR, establish more annual perimeter sampling locations, and annual background locations. As ESOP collects more data from the perimeter of SRS, concentrations versus distance comparisons will be made by type of vegetation.

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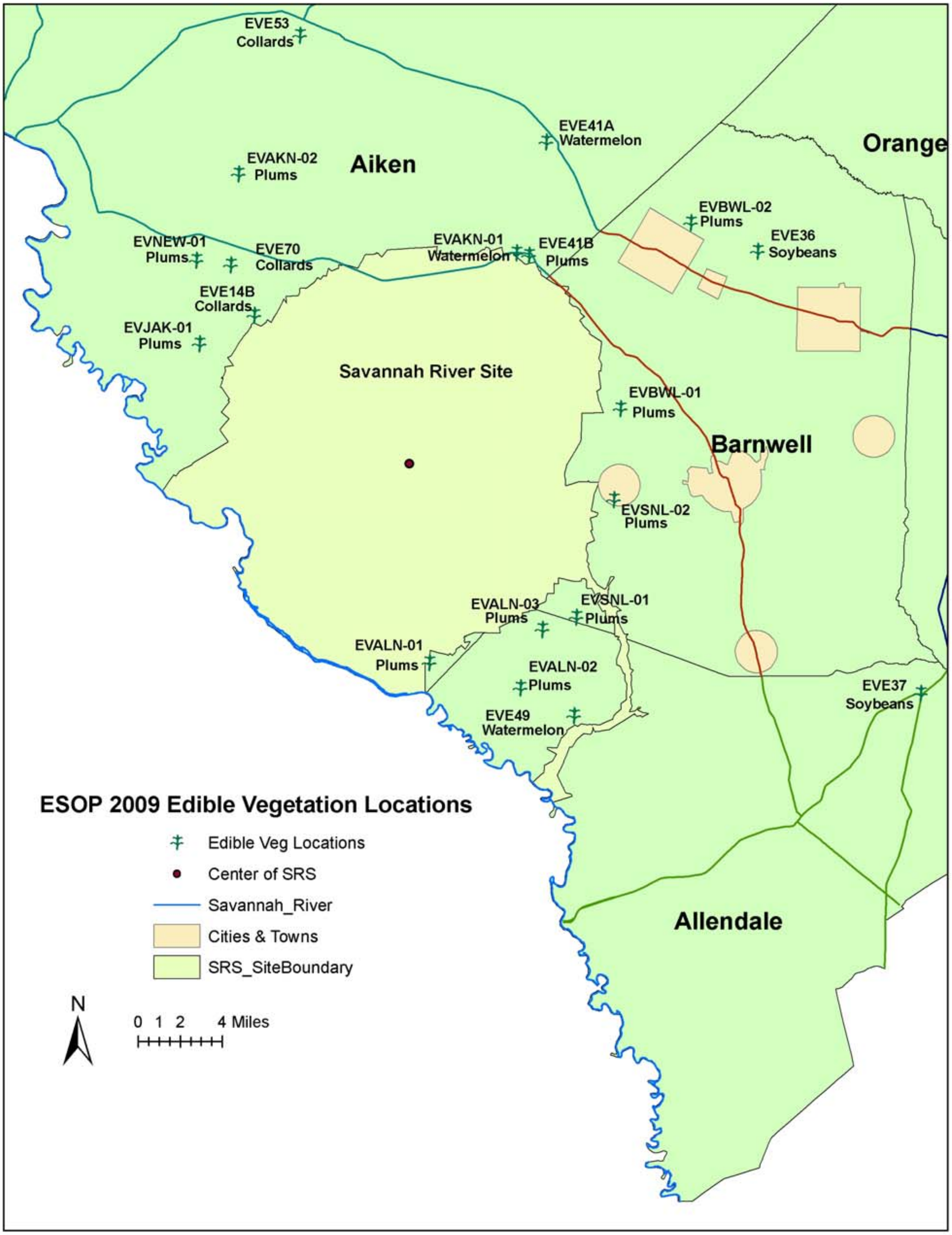
3.3.2 2009 Radiological Monitoring of Edible Vegetation TOC

Map 9. Edible Vegetation Locations



3.3.3 Tables and Figures

2009 Radiological Monitoring of Edible Vegetation ***Note: All reported values are in pCi/g.***

Table 1 a. Gamma-emitting Radionuclide Suite

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

Table 1 b. International Atomic Energy Agency Radionuclides Guidelines for Food (To convert Bq/kg to pCi/g, multiply by 0.027) (SCI Journals 2009, IAEA 2009)

Radionuclides in foods	Guideline Levels	
	(Bq/kg)	pCi/g
Pu-238, Pu-239, Pu-240, Am-241	1	0.027
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

Table 1 c.
USFDA Derived Intervention Levels (DILS) for Each Radionuclide Group for Food in Domestic Commerce and Food Offered for Import

Radionuclide Group	Guideline Levels	
	(Bq/kg)	pCi/g
Strontium-90	160	4.32
Iodine-131	170	4.59
Cesium134 + Cesium 137	1200	32.4
Plutonium-238 + Plutonium 239 + Am-241	2	0.054

Tables and Figures
2009 Radiological Monitoring of Edible Vegetation

Table 2a. 2009 Edible Vegetation Annual Stations

Location	Station	Date	Type
Aiken	EVE7209	02/08/09	Collards
Hollow Creek	EVE70A	02/19/09	Mustards
Jackson	EVE14B	03/04/09	Collards
New Ellenton	EVE5309	03/11/09	Collards
New Ellenton	EVNEW-01	04/29/08	Plums
Jackson	EVJAK-01	04/29/09	Plums
Aiken	EVAKN-01	04/30/09	Plums
Barnwell	EVBWL-01	04/30/09	Plums
Snelling	EVSNL-01	05/07/09	Plums
Allendale	EVALN-01	05/13/09	Plums
Allendale	EVALN-02	05/13/09	Plums
Allendale	EVALN-03	05/13/09	Plums
Snelling	EVSNL-02	05/13/09	Plums
Barnwell	EVBWL-02	05/20/09	Plums
Aiken	EVAKN-02	05/22/09	Plums
Williston	EVE59-02	06/29/09	Corn
Jackson	EVE62	07/02/09	Corn
Windsor	EVE41B	07/14/09	Watermelon
Elko	EVE36	11/12/09	Soybeans
Ulmer	EVE3708	11/12/09	Soybeans

Table 2b. 2009 Edible Vegetation Annual Stations

Analyte:	Average	Median	SD
Be-7 Activity	N/A	N/A	N/A
K-40 Activity	4.640	2.740	4.344
Co-60 Activity	N/A	N/A	N/A
I-131 Activity	N/A	N/A	N/A
Cs-134 Activity	N/A	N/A	N/A
Cs-137 Activity	N/A	N/A	N/A
Pb-212 Activity	N/A	N/A	N/A
Pb-214 Activity	0.150	0.170	0.061
Ra-226 Activity	N/A	N/A	N/A
Ac-228 Activity	N/A	N/A	N/A
U/Th-238 Activity	N/A	N/A	N/A
Am-241 Activity	N/A	N/A	N/A
Tritium Activity	0.254	0.256	0.059
Sr-89/90 Activity	0.056	0.056	N/A

SD = Standard Deviation N/A = not applicable

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3.3.4 Data

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Notes:

8. Bold numbers denote a detection.
9. A blank field following ±2 SIGMA occurs when the sample is NA (Not applicable).
10. LLD= Lower Limit of Detection
11. MDA= Minimum Detectable Activity
12. Denotes not analyzed.
13. All units are in pCi/g.

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Collards	Collards	Collards	Collards
Location Description	EVE7209	EVE7009	EVE14B09	EVE5309
Collection Date	2/7/09	2/19/09	3/4/09	3/10/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.6486	0.5591	0.5120	0.4581
Na-22 Activity	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA
Na-22 MDA	0.0181	0.0169	0.0188	0.0200
K-40 Activity	4.6900	4.2910	6.9280	3.6090
K-40 Confidence Interval	0.5178	0.4427	0.6600	0.4176
K-40 MDA	0.1558	0.1261	0.1621	0.1264
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA
Mn-54 MDA	0.0229	0.0196	0.0245	0.0213
Co-58 Activity	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA
Co-58 MDA	0.0533	0.0388	0.0368	0.0368
Co-60 Activity	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA
Co-60 MDA	0.0195	0.0162	0.0214	0.0195
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA
Zn-65 MDA	0.0526	0.0483	0.0587	0.0474
Y-88 Activity	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA
Y-88 MDA	0.0321	0.0257	0.0290	0.0261
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA
Zr-95 MDA	0.1031	0.0849	0.0904	0.0763
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA
Ru-103 MDA	0.1400	0.0977	0.0887	0.0780
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA
Sb-125 MDA	0.0546	0.0472	0.0578	0.0558
I-131 Activity				
I-131 Confidence Interval	NA	NA	NA	NA
I-131 MDA	NA	NA	NA	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA
Cs-134 MDA	0.0199	0.0180	0.0193	0.0194
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	0.0206	0.0162	0.0211	0.0189

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Collards	Collards	Collards	Collards
Location Description	EVE7209	EVE7009	EVE14B09	EVE5309
Collection Date	2/7/09	2/19/09	3/4/09	3/10/09
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA
Ce-144 MDA	0.1815	0.1607	0.1867	0.1740
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA
Eu-152 MDA	0.0554	0.0478	0.0569	0.0554
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA
Eu-154 MDA	0.0390	0.0328	0.0382	0.0401
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA
Eu-155 MDA	0.0719	0.0644	0.0749	0.0703
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA
Pb-212 MDA	0.0376	0.0321	0.0466	0.0433
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA
Pb-214 MDA	0.0447	0.0438	0.0479	0.0457
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA
Ra-226 MDA	0.5182	0.4176	0.5343	0.4999
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA
Ac-228 MDA	0.0749	0.0820	0.0970	0.0821
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.8670	0.7491	0.9302	0.8383
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.1260	0.1037	0.1335	0.1133
Tritium	<LLD	<LLD	<LLD	<LLD
Confidence Interval	NA	NA	NA	NA
Tritium LLD	0.180	0.180	0.180	0.180
Pu-238 Activity				
Pu-238 Confidence Interval				
PU-238 MDA				
Total Strontium				
Total Sr Confidence Interval				
Total Sr MDA				
U-234				
U-234 Confidence Interval				
U-234 MDA				
U-235				
U-235 Confidence Interval				
U-235 MDA				
U-238				
U-238Confidence Interval				
U-238 MDA				

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Plums	Plums	Plums	Plums	Plums
Location Description	EVNEW-01	EVJAK-01	EVAKN-01	EVBWL-01	EVSNL-01
Collection Date	4/29/09	4/29/09	4/30/09	4/30/09	5/7/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	0.2507	0.2616	0.2600	0.3026	0.2233
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	0.0166	0.0175	0.0167	0.0179	0.0151
K-40 Activity	**2.2240**	**2.8160**	**2.6740**	**2.3910**	**2.5380**
K-40 Confidence Interval	0.3218	0.3641	0.3631	0.3686	0.3303
K-40 MDA	0.1376	0.1460	0.1194	0.1514	0.1316
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	0.0162	0.0170	0.0173	0.0193	0.0145
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	0.0243	0.0230	0.0240	0.0278	0.0228
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	0.0142	0.0173	0.0148	0.0173	0.0127
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	0.0337	0.0425	0.0402	0.0442	0.0337
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	0.0147	0.0198	0.0171	0.0204	0.0146
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA	NA
Zr-95 MDA	0.0402	0.0454	0.0494	0.0505	0.0377
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	0.0332	0.0356	0.0369	0.0416	0.0296
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	0.0449	0.0512	0.0472	0.0531	0.0430
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	0.9738	1.1330	0.9819	1.1780	0.5399
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	0.0154	0.0169	0.0168	0.0186	0.0143
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	0.0156	0.0183	0.0175	0.0190	0.0158

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Plums	Plums	Plums	Plums	Plums
Location Description	**EVNEW-01**	**EVJAK-01**	**EVAKN-01**	**EVBWL-01**	**EVSNL-01**
Collection Date	**4/29/09**	**4/29/09**	**4/30/09**	**4/30/09**	**5/7/09**
Ce-144 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	0.1360	0.1523	0.1438	0.1612	0.1295
Eu-152 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	0.0480	0.0531	0.0498	0.0565	0.0434
Eu-154 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	0.0341	0.0367	0.0357	0.0376	0.0302
Eu-155 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	0.0614	0.0614	0.0639	0.0722	0.0558
Pb-212 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	0.0346	0.0411	0.0379	0.0409	0.0346
Pb-214 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	0.0371	0.0416	0.0442	0.0461	0.0396
Ra-226 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	0.4420	0.4817	0.4505	0.4853	0.3792
Ac-228 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	0.0737	0.0786	0.0772	0.0816	0.0686
U/Th-238 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	0.7498	0.7849	0.7498	0.8921	0.7205
Am-241 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	0.1103	0.1196	0.1073	0.1251	0.1040
Tritium	**0.353**	**0.259**	**0.258**	**0.182**	**<LLD**
Confidence Interval	**0.897**	**0.858**	**0.858**	**0.823**	**NA**
Tritium LLD	**0.177**	**0.177**	**0.177**	**0.177**	**0.177**
Pu-238 Activity		**<MDA**		**<MDA**	**<MDA**
Pu-238 Confidence Interval		0.002		0.003	0.002
PU-238 MDA		0.007		0.005	0.004
Total Strontium		**<MDA**		**<MDA**	**0.056**
Total Sr Confidence Interval		0.023		0.022	0.019
Total Sr MDA		0.064		0.061	0.045
U-234		**<MDA**		**<MDA**	**0.004**
U-234 Confidence Interval		0.002		0.001	0.003
U-234 MDA		0.001		0.002	0.002
U-235		**<MDA**		**<MDA**	**0.003**
U-235 Confidence Interval		0.001		0.000	0.002
U-235 MDA		0.002		0.001	0.002
U-238		**0.001**		**0.002**	**0.002**
U-238Confidence Interval		0.001		0.002	0.002
U-238 MDA		0.001		0.002	0.002

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Plums	Plums	Plums	Plums	Plums
Location Description	EVALN-01	EVALN-02	EVALN-03	EVSNL-02	EVBWL-02
Collection Date	5/13/09	5/13/09	5/13/09	5/13/09	5/20/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	0.2112	0.2107	0.2068	0.2204	0.1766
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	0.0178	0.0152	0.0167	0.0170	0.0151
K-40 Activity	**2.8020**	**1.6910**	**2.0190**	**1.8690**	**1.6170**
K-40 Confidence Interval	0.3781	0.3034	0.3283	0.3101	0.2835
K-40 MDA	0.1587	0.1365	0.1219	0.1450	0.1380
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	0.0179	0.0156	0.0152	0.0191	0.0142
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	0.0217	0.0197	0.0200	0.0230	0.0177
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	0.0164	0.0163	0.0150	0.0166	0.0137
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	0.0398	0.0359	0.0383	0.0379	0.0381
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	0.0163	0.0163	0.0156	0.0176	0.0171
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NS	NA	NA
Zr-95 MDA	0.0445	0.0356	0.0390	0.0474	0.0390
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	0.0308	0.0278	0.0298	0.0345	0.0249
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	0.0501	0.0429	0.0470	0.0527	0.0420
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	0.3581	0.3598	0.3711	0.4191	0.1832
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	0.0176	0.0158	0.0161	0.0195	0.0158
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	0.0173	0.0164	0.0172	0.0186	0.0161

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Plums	Plums	Plums	Plums	Plums
Location Description	EVALN-01	EVALN-02	EVALN-03	EVSNL-02	EVBWL-02
Collection Date	5/13/09	5/13/09	5/13/09	5/13/09	5/20/09
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	0.1410	0.1327	0.1355	0.1476	0.1310
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	0.0484	0.0473	0.0483	0.0538	0.0447
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	0.0330	0.0331	0.0342	0.0384	0.0308
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	0.0649	0.0634	0.0585	0.0678	0.0564
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	0.0403	0.0350	0.0319	0.0375	0.0359
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	**0.0616**
Pb-214 Confidence Interval	NA	NA	NA	NA	0.0273
Pb-214 MDA	0.0410	0.0447	0.0417	0.0477	0.0342
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	0.4822	0.3764	0.4241	0.4987	0.4355
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	0.0732	0.0683	0.0657	0.0755	0.0668
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	0.7913	0.7592	0.7846	0.8815	0.7307
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	0.1112	0.1080	0.1097	0.1245	0.1081
Tritium	<LLD	<LLD	<LLD	<LLD	<LLD
Confidence Interval	NA	NA	NA	NA	NA
Tritium LLD	0.177	0.177	0.177	0.177	0.177
Pu-238 Activity	<MDA				
Pu-238 Confidence Interval	0.004				
PU-238 MDA	0.007				
Total Strontium	<MDA				
Total Sr Confidence Interval	0.022				
Total Sr MDA	0.056				
U-234	<MDA				
U-234 Confidence Interval	0.001				
U-234 MDA	0.002				
U-235	**0.002**				
U-235 Confidence Interval	0.002				
U-235 MDA	0.001				
U-238	**0.002**				
U-238Confidence Interval	0.001				
U-238 MDA	0.001				

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Peaches	Corn	Corn	Watermelon
Location Description	EVE209	EVE59	EVE62	EVE41B
Collection Date	5/21/09	6/29/09	7/2/09	7/14/2009
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.3747	0.2198	0.2063	0.485
Na-22 Activity	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA
Na-22 MDA	0.0173	0.0199	0.0173	0.025
K-40 Activity	**1.8510**	**2.9800**	**2.7420**	**1.672**
K-40 Confidence Interval	0.2977	0.3741	0.3720	0.465
K-40 MDA	0.1582	0.1501	0.1707	0.197
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA
Mn-54 MDA	0.0180	0.0169	0.0199	0.027
Co-58 Activity	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA
Co-58 MDA	0.0362	0.0222	0.0238	0.041
Co-60 Activity	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA
Co-60 MDA	0.0164	0.0171	0.0191	0.024
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA
Zn-65 MDA	0.0461	0.0397	0.0414	0.062
Y-88 Activity	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA
Y-88 MDA	0.0263	0.0166	0.0182	0.029
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA
Zr-95 MDA	0.0637	0.0388	0.0420	0.089
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA
Ru-103 MDA	0.0654	0.0268	0.0299	0.077
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA
Sb-125 MDA	0.0600	0.0513	0.0494	0.082
I-131 Activity	E COMMEN	<MDA	<MDA	SEE
I-131 Confidence Interval	NA	NA	NA	NA
I-131 MDA	NA	0.2402	0.2205	NA
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA
Cs-134 MDA	0.0201	0.0161	0.0203	0.026
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	0.0195	0.0199	0.0204	0.028

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Peaches	Corn	Corn	Watermelon
Location Description	EVE209	EVE59	EVE62	EVE41B
Collection Date	5/21/09	6/29/09	7/2/09	7/14/2009
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA
Ce-144 MDA	0.1687	0.1395	0.1616	0.268
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA
Eu-152 MDA	0.0537	0.0506	0.0567	0.084
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA
Eu-154 MDA	0.0380	0.0358	0.0401	0.061
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA
Eu-155 MDA	0.0717	0.0643	0.0739	0.122
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA
Pb-212 MDA	0.0448	0.0416	0.0458	0.061
Pb-214 Activity	**0.0692**	<MDA	**0.2273**	<MDA
Pb-214 Confidence Interval	0.0329	NA	0.0420	NA
Pb-214 MDA	0.0414	0.0815	0.0403	0.059
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA
Ra-226 MDA	0.5117	0.4936	0.5277	0.721
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA
Ac-228 MDA	0.0855	0.0743	0.0821	0.134
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.8949	0.8440	0.9063	1.379
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.1212	0.1214	0.1335	0.410
Tritium	<MDA	**0.267**	**0.206**	<LLD
Confidence Interval	**NA**	**0.92**	0.89	N/A
Tritium LLD	**0.191**	**0.191**	0.191	0.181
Pu-238 Activity				<MDA
Pu-238 Confidence Interval				0.002
PU-238 MDA				0.006
Total Strontium				<MDA
Total Sr Confidence Interval				0.021
Total Sr MDA				0.062
U-234				<MDA
U-234 Confidence Interval				0.002
U-234 MDA				0.001
U-235				<MDA
U-235 Confidence Interval				0.001
U-235 MDA				0.001
U-238				<MDA
U-238Confidence Interval				0.001
U-238 MDA				0.001

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

Type	Soybeans	Soybeans	Soybeans	Soybeans
Location Description	**EVE3709**	**EVE3609**	**EVE2109**	**EVE4009**
Collection Date	**11/12/09**	**11/12/09**	**11/19/09**	**11/26/09**
Be-7 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.477	0.545	0.561	0.467
Na-22 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Na-22 Confidence Interval	NA	NA	NA	NA
Na-22 MDA	0.032	0.036	0.038	0.035
K-40 Activity	**13.94**	**12.86**	**13.39**	**13.90**
K-40 Confidence Interval	1.370	1.378	1.445	1.410
K-40 MDA	0.231	0.230	0.296	0.256
Mn-54 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Mn-54 Confidence Interval	NA	NA	NA	NA
Mn-54 MDA	0.029	0.036	0.035	0.032
Co-58 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Co-58 Confidence Interval	NA	NA	NA	NA
Co-58 MDA	0.044	0.048	0.047	0.039
Co-60 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Co-60 Confidence Interval	NA	NA	NA	NA
Co-60 MDA	0.029	0.033	0.031	0.031
Zn-65 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Zn-65 Confidence Interval	NA	NA	NA	NA
Zn-65 MDA	0.068	0.083	0.091	0.081
Y-88 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Y-88 Confidence Interval	NA	NA	NA	NA
Y-88 MDA	0.028	0.038	0.033	0.027
Zr-95 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Zr-95 Confidence Interval	NA	NA	NA	NA
Zr-95 MDA	0.087	0.102	0.092	0.081
Ru-103 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Ru-103 Confidence Interval	NA	NA	NA	NA
Ru-103 MDA	0.074	0.087	0.082	0.065
Sb-125 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Sb-125 Confidence Interval	NA	NA	NA	NA
Sb-125 MDA	0.082	0.094	0.099	0.089
I-131 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
I-131 Confidence Interval	NA	NA	NA	NA
I-131 MDA	4.627	5.758	3.439	1.786
Cs-134 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Cs-134 Confidence Interval	NA	NA	NA	NA
Cs-134 MDA	0.024	0.028	0.034	0.029
Cs-137 Activity	**<MDA**	**<MDA**	**<MDA**	**<MDA**
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	0.028	0.032	0.034	0.032

2009 EDIBLE VEGETATION RADIOLOGICAL MONITORING DATA

TOC

Type	Soybeans	Soybeans	Soybeans	Soybeans
Location Description	EVE3709	EVE3609	EVE2109	EVE4009
Collection Date	11/12/09	11/12/09	11/19/09	11/26/09
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA
Ce-144 MDA	0.250	0.286	0.301	0.280
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA
Eu-152 MDA	0.085	0.099	0.104	0.094
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA
Eu-154 MDA	0.060	0.071	0.071	0.069
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA
Eu-155 MDA	0.123	0.144	0.155	0.135
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA
Pb-212 MDA	0.057	0.065	0.068	0.060
Pb-214 Activity	0.179	0.166	0.176	0.171
Pb-214 Confidence Interval	0.052	0.052	0.057	0.062
Pb-214 MDA	0.060	0.073	0.075	0.065
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA
Ra-226 MDA	0.635	0.730	0.770	0.771
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA
Ac-228 MDA	0.141	0.158	0.185	0.151
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	1.405	1.609	1.701	1.526
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.396	0.500	0.521	0.471
Tritium	<LLD	<LLD	<LLD	<LLD
Confidence Interval	NA	NA	NA	NA
Tritium LLD	0.186	0.186	0.186	0.186
Pu-238 Activity				
Pu-238 Confidence Interval				
PU-238 MDA				
Total Strontium				
Total Sr Confidence Interval				
Total Sr MDA				
U-234				
U-234 Confidence Interval				
U-234 MDA				
U-235				
U-235 Confidence Interval				
U-235 MDA				
U-238				
U-238Confidence Interval				
U-238 MDA				

3.3.5 Summary Statistics

2009 Radiological Monitoring of Edible Vegetation

Notes:

1. Units of measure used in tables are pico curies per gram (pCi/g).
2. LLD = Lower Limit of Detection
3. MDA = Minimum Detectable Activity

2004-2009 All Edible Vegetation

Note: Comparisons are made on an Average and Standard Deviation basis.

Sample Location	Quad Location	Sample Date	Type	H-3(pCi/g)	Cs-137	Sr-89/90
AKN202	Aiken	10/22/04	Pears	0.266	<MDA	
AKN-203	Aiken	10/22/04	Pears	<LLD	<MDA	
EVE4	Aiken	10/12/05	Pears	<LLD	<MDA	
EVAKN-01	Aiken	05/16/07	Plums	<LLD	<MDA	
EVAKN-01	Aiken	05/02/08	Plums	0.329	<MDA	
EVAKN-01	Aiken	04/30/09	Plums	0.258	<MDA	
EVAKN-02	Aiken	05/22/09	Plums	<LLD	<MDA	
EVE7209	Aiken NW	02/07/09	Collards	<LLD	<MDA	
EVALN-01	Allendale	05/16/07	Peaches	0.315	<MDA	
ALN-201	Allendale	06/03/04	Plums	0.273	<MDA	
ALN-203	Allendale	06/03/04	Plums	0.284	<MDA	
EVALN-01	Allendale	05/16/07	Plums	<LLD	<MDA	
EVALN-01	Allendale	05/13/09	Plums	<LLD	<MDA	<MDA
EVALN-02	Allendale	05/13/09	Plums	<LLD	<MDA	
EVALN-03	Allendale	05/13/09	Plums	<LLD	<MDA	
EVE29	Allendale	10/27/06	Soybeans	<LLD	<MDA	
EVE29	Allendale	11/03/06	Soybeans	<LLD	<MDA	
ALVB9-001	Alvin	07/11/05	Green Beans	<LLD	<MDA	
EVB608	Antreville (Laurens Co)	09/03/08	Pears	0.353	<MDA	
EVB6B	Antreville (Laurens Co)	02/08/06	Collards	<LLD	<MDA	0.383
EVB6A	Antreville (Laurens Co)	02/08/06	Broccoli	<LLD	<MDA	0.076
EVE209	Barnwell	05/21/09	Peaches	<MDA	<MDA	
EVE208	Barnwell	08/19/08	Pears	<LLD	<MDA	
EVBWL-01	Barnwell	05/16/07	Plums	<LLD	<MDA	
EVBWL-01	Barnwell	05/02/08	Plums	<LLD	<MDA	<MDA
EVBWL-01	Barnwell	04/30/09	Plums	0.182	<MDA	<MDA
EVBWL-02	Barnwell	05/20/09	Plums	<LLD	<MDA	
EVE2-001	Barnwell	10/07/05	Soybean	0.257	<MDA	
EVE208	Barnwell	10/29/08	Soybeans	<LLD	<MDA	
EVE47	Barr Lake	03/26/07	Pokeberry	<LLD	<MDA	
EVB808	Bingham	10/01/08	Pears	<LLD	<MDA	
EVB8	Bingham	12/13/07	Collards	<LLD	<MDA	
EVE4008	Blackville	10/29/08	Soybeans	0.673	<MDA	
EVE4009	Blackville	11/26/09	Soybeans	<186	<MDA	
EVE40-02	Blackville	02/06/07	Collards	<LLD	<MDA	
EVE40A	Blackville	06/27/07	Collards	<LLD	<MDA	
EVE40-01	Blackville	02/06/07	Turnips	<LLD	<MDA	
EVE56	Branchville North	05/23/08	Plums	<LLD	<MDA	
EVE39	Bull Pond	08/17/07	Watermelon	<LLD	<MDA	
EVB5	Carlisle	10/24/05	Persimmons	<LLD	<MDA	
EVB2202	Carlisle SE	07/18/08	Peaches	<LLD	<MDA	
EVB2201	Carlisle SE	07/18/08	Corn	<LLD	<MDA	
EVE21-001	Clear Pond	06/23/06	Blackberries	0.371	<MDA	
EVE21-002	Clear Pond	06/23/06	Watermelon	0.423	<MDA	
EVE2109	Clear Pond	11/19/09	Soybeans	<LLD	<MDA	
EVE12	Colliers	05/11/06	PokeBerry	<LLD	<MDA	
EVE46	Cordova	07/17/07	Corn	<LLD	<MDA	
EVE51	Crocketville	10/12/07	Soybeans	0.191	<MDA	
EVE51-01	Crocketville	05/23/08	Wheat	<LLD	<MDA	
EVE51-02	Crocketville	05/23/08	Cabbage	<LLD	<MDA	
EVE16-001	Denmark	07/12/06	Canteloupe	<LLD	<MDA	
EVE16-002	Denmark	07/12/06	Watermelon	<LLD	<MDA	
EVB27-001	Edgefield	09/21/06	Grapes	<LLD	<MDA	
EVB27-003	Edgefield	09/21/06	Pears	<LLD	<MDA	
EVB27-002	Edgefield	09/21/06	Tomatoes	<LLD	<MDA	
EVE5-002	Ehrhardt	10/07/05	Pears	<LLD	<MDA	
EVE5-001	Ehrhardt	10/07/05	Soybean	<LLD	<MDA	
EVE5-003	Ehrhardt	10/07/05	Turnip	<LLD	<MDA	

2004-2009 All Edible Vegetation (cont.)
Note: Comparisons are made on an Average and Standard Deviation basis.

EVE7	Emory	10/17/05	Grapes	<LLD	<MDA	
PINEB2-001	Estill	06/17/05	Corn	0.253	<MDA	
EVE15	Evans	05/11/06	PokeBerry	<LLD	<MDA	
EVB308	Felderville (Oburg Co)	08/22/08	Pears	<LLD	<MDA	
FELB3-001	Felderville (Oburg Co)	06/27/05	Corn	<LLD	<MDA	
EVE6	Foxtown	10/12/05	Pears	<LLD	<MDA	
EVE108	Furman	08/19/08	Pears	<LLD	<MDA	
EVB208	Furman	08/20/08	Pears	<LLD	<MDA	
ESTE1-001	Furman	06/17/05	Turnips	0.201	<MDA	
ESTE1-002	Furman	06/17/05	Turnips	0.212	<MDA	
ESTE1-003	Furman	06/17/05	Squash	0.201	<MDA	
FURE1-001	Furman	06/17/05	Squash	<LLD	<MDA	
EVE45	Gifford	10/12/07	Soybeans	0.329	<MDA	0.051
EVE34	Gilbert	07/19/07	Watermelon	<LLD	<MDA	
EVB41-01	Gilbert	07/19/07	Watermelon	0.204	<MDA	
EVB41-02	Gilbert	07/19/07	Corn	0.403	<MDA	
EVE44	Girard	07/12/07	Corn	<LLD	<MDA	
EVE30-001	Graniteville	11/17/06	Collards	0.271	<MDA	
EVE30-002	Graniteville	11/17/06	Collards	<LLD	<MDA	
EVE22	Grays	08/04/06	Okra	0.332	<MDA	
EVB26	Grays (Hampton Co)	08/04/06	Corn	<LLD	<MDA	
EVE8-002	HarleysMillPond	10/17/05	Pears	<LLD	<MDA	
EVE8-001	HarleysMillPond	10/17/05	Persimmons	<LLD	<MDA	
EVB18	Hartsville South	05/08/08	Wheat	<LLD	<MDA	
EVB17	Hartwell Dam	02/15/07	Turnips	<LLD	<MDA	
EVE7009	HollowCreek	02/19/09	Collards	<LLD	<MDA	
EVE70A	HollowCreek	01/31/08	Mustards	<LLD	<MDA	0.623
EVE70B	HollowCreek	01/31/08	Turnips	<LLD	<MDA	0.253
EVJAK-01	Jackson	05/16/07	Plums	<LLD	<MDA	
EVJAK-01	Jackson	05/01/08	Plums	<LLD	<MDA	
EVJAK-01	Jackson	04/29/09	Plums	0.259	<MDA	<MDA
EVE14B	Jackson	02/14/08	Collards	<LLD	<MDA	0.195
EVE14B09	Jackson	03/04/09	Collards	<LLD	<MDA	
EVE14	Jackson	02/02/06	Mustards	<LLD	<MDA	0.321
EVE14A	Jackson	02/08/08	Mustards	N/A	<MDA	0.091
EVE20-001	Kitchens Mill	07/12/06	Cucumbers	<LLD	<MDA	
EVE20-002	Kitchens Mill	07/12/06	Squash	<LLD	<MDA	
EVB14	Lake Murray E	08/31/07	Pears	0.280	<MDA	
LAU-201	Laurens	08/28/04	Scuppernongs	<LLD	<MDA	
EVB24	Lexington	07/05/06	Grapes	<LLD	<MDA	
EVB24	Lexington	10/17/05	Persimmons	<LLD	<MDA	
EVE24-002	Long Branch	08/16/06	Apples	0.192	<MDA	
EVE24-001	Long Branch	08/04/06	Grapes	<LLD	<MDA	
EVE2408	LongBranch	07/08/08	Corn	<LLD	<MDA	
EVE62	Martin	05/15/08	Wheat	<LLD	<MDA	
EVE32	Martinez	10/26/06	Mustards	0.199	<MDA	0.035
EVB21	Mayesville	05/08/08	Wheat	<LLD	<MDA	
EVE19	Mechanics Hill	05/11/06	Plums	<LLD	<MDA	
EVE18-001	Midway	06/23/06	Corn	0.252	<MDA	
EVE18-004	Midway	06/23/06	Potatoes	<LLD	<MDA	
EVE18-002	Midway	06/23/06	Squash	0.246	<MDA	
EVE18-003	Midway	06/23/06	Tomatoes	0.371	<MDA	
EVE49A-02	Millett	07/12/07	Watermelon	<LLD	<MDA	
EVE4908	Millett	08/06/08	Watermelon	0.273	<MDA	
EVE49A-01	Millett	07/12/07	Corn	<LLD	<MDA	
EVE9	Monetta	10/17/05	Persimmons	<LLD	<MDA	

2004-2009 All Edible Vegetation (cont.)
Note: Comparisons are made on an Average and Standard Deviation basis.

EVNEW-01	New Ellenton	04/29/09	Plums	0.353	<MDA	
EVE53	New Ellenton	02/08/08	Cabbage	<LLD	<MDA	
EVE64	New Ellenton	03/14/08	Collards	<LLD	<MDA	
EVE5309	New Ellenton	03/10/09	Collards	<LLD	<MDA	
EVE62	New Ellenton NW	07/02/09	Corn	0.206	<MDA	
EVE3X	New Ellenton, SE	10/12/05	Grapes	0.195	<MDA	
EVNEW-01	New Ellenton, SE	05/23/07	Plums	<LLD	<MDA	
EVNEW-01	New Ellenton, SE	04/29/08	Plums	<LLD	<MDA	
EVE11-02	North	05/25/06	Plums	<LLD	<MDA	
EVE11-01	North	05/25/06	Pokeberry	<LLD	<MDA	
EVE13	Norway East	05/25/06	Blackberries	<LLD	<MDA	
EVE10	Norway West	10/21/05	Persimmons	<LLD	<MDA	
EVB30	Oakgrove (Dillon Co)	12/04/06	Soybeans	<LLD	<MDA	
EVE31	Oakwood	11/17/06	Persimmons	<LLD	<MDA	
EVE43	Olar	05/24/07	Plums	<LLD	<MDA	
EVE43A	Olar	06/27/07	Corn	<LLD	<MDA	
EVB25	Orangeburg	11/20/06	Soybeans	<LLD	<MDA	
EVE17	Orangeburg S	05/25/06	Pokeberry	<LLD	<MDA	
EVE28	Salley	01/30/07	Collards	0.240	<MDA	0.076
EVB19	Salters	10/01/07	Soybeans	<LLD	<MDA	0.009
EVB708	Saluda	08/28/08	Pears	<LLD	<MDA	
EVB32-02	Saluda South	03/30/07	Collards	<LLD	<MDA	1.50
EVB32-01	Saluda South	03/30/07	Kale	<LLD	<MDA	
EVB13	Sharon	07/18/08	Corn	<LLD	<MDA	
EVSNL-01	Snelling	05/16/07	Plums	<LLD	<MDA	
EVSNL-01	Snelling	05/02/08	Plums	<LLD	<MDA	
EVSNL-01	Snelling	05/07/09	Plums	<LLD	<MDA	0.056
EVSNL-02	Snelling	05/13/09	Plums	<LLD	<MDA	
SNL-201	Snellings	06/03/04	Plums	<LLD	<MDA	
SNL-203	Snellings	06/03/04	Plums	0.803	<MDA	
EVE33-02	Snellings	07/12/07	Watermelon	<LLD	<MDA	
EVE33-01	Snellings	07/12/07	Corn	<LLD	<MDA	
EVE3609	Springfield	11/12/09	Soybeans	<LLD	<MDA	
EVE36	Springfield	02/06/07	Mustard	0.216	<MDA	0.076
EVE35-02	Steedman	08/10/07	Peaches	0.410	<MDA	
EVE35-01	Steedman	08/10/07	Watermelon	0.271	<MDA	
EVB12	Summerton	10/12/07	Soybeans	0.302	<MDA	0.013
EVE3708	Sycamore	10/29/08	Soybeans	0.202	<MDA	
EVE3709	Sycamore	11/12/09	Soybeans	<LLD	<MDA	
EVE37	Sycamore	07/17/07	Corn	<LLD	<MDA	
EVE58	Tony Hill Bay	05/23/08	Cabbage	<LLD	<MDA	
WAG-201B	Wagener	10/22/04	Collards	<LLD	<MDA	
WAG-201A	Wagener	10/22/04	Mustards	<LLD	<MDA	
EVB16	Westminster	02/15/07	Mustard	<LLD	<MDA	
WIL-204	Williston	08/29/04	Passion Fruit	0.189	<MDA	
EVE59-01	Williston	06/02/08	Plums	<LLD	<MDA	
EVE59A	Williston	06/18/07	Corn	<LLD	<MDA	
EVE59-02	Williston	06/23/08	Corn	<LLD	<MDA	
EVE59	Williston	06/29/09	Corn	0.267	<MDA	
WIN-201	Windsor	10/22/04	Persimmons	0.224	<MDA	
EVE41-02	Windsor	07/17/07	Watermelon	<LLD	<MDA	
EVE4108	Windsor	07/21/08	Watermelon	<LLD	<MDA	
EVE41B	Windsor	07/14/09	Watermelon	<LLD	<MDA	<MDA
EVE41-01	Windsor	07/17/07	Corn	<LLD	<MDA	
		168.00	Average	0.291		0.251
			Median	0.266		0.0764
			Std Dev	0.120		0.386
			N =	43		15

2004-2009 Aiken County Edible

Sample Location	Quad Location	Sample Date	Matrix	Type	H-3(pCi/g)	Cs-137	Sr-89/90
AKN202	Aiken (AKN)	10/22/04	Fruit	Pears	0.266	<MDA	
EVAKN-01	Aiken (AKN)	05/02/08	Fruit	Plums	0.329	<MDA	
EVAKN-01	Aiken (AKN)	04/30/09	Fruit	Plums	0.258	<MDA	
EVE30-001	Graniteville (AKN)	11/17/06	Greens	Collards	0.271	<MDA	
EVE70A	HollowCreek (AKN)	01/31/08	Greens	Mustards	<LLD	<MDA	0.623
EVE70B	HollowCreek (AKN)	01/31/08	Greens	Turnips	<LLD	<MDA	0.253
EVJAK-01	Jackson (AKN)	04/29/09	Fruit	Plums	0.259	<MDA	<MDA
EVE14B	Jackson (AKN)	02/14/08	Greens	Collards	<LLD	<MDA	0.195
EVE14	Jackson (AKN)	02/02/06	Greens	Mustards	<188	<MDA	0.321
EVE14A	Jackson (AKN)	02/08/08	Greens	Mustards	N/A	<MDA	0.091
EVNEW-01	New Ellenton NW (AKN)	04/29/09	Fruit	Plums	0.353	<MDA	
EVE62	New Ellenton NW (AKN)	07/02/09	Vegetable	Corn	0.206	<MDA	
EVE3X	New Ellenton, SE (AKN)	10/12/05	Fruit	Grapes	0.195	<MDA	
EVE28	Salley (AKN)	01/30/07	Greens	Collards	0.240	<MDA	0.076
WIN-201	Windsor (AKN)	10/22/04	Fruit	Persimmons	0.224	<MDA	
				Average	0.260		0.260
				Median	0.259		0.224
				Std Dev	0.050		0.201
			Detects	N =	10		6

2004-2009 Allendale County Edible Vegetation Locations Around SRS Vegetation Locations around SRS

Sample Location	Quad Location	Sample Date	Matrix	Type	H-3(pCi/g)	Cs-137	Sr-89/90
EVE4908	Millett (ALN)	08/06/08	Fruit	Watermelon	0.273	<MDA	
EVALN-01	Allendale (ALN)	05/16/07	Fruit	Peaches	0.315	<MDA	
ALN-201	Allendale (ALN)	06/03/04	Fruit	Plums	0.273	<MDA	
ALN-203	Allendale (ALN)	06/03/04	Fruit	Plums	0.284	<MDA	
EVE51	Crocketville (ALN)	10/12/07	Grain	Soybeans	0.191	<MDA	
EVE3708	Sycamore (ALN)	10/29/08	Grain	Soybeans	0.202	<MDA	
				Average	0.256		
				Median	0.273		
				Std Dev	0.049		
				N =	6		

2004-2009 Barnwell County Edible Vegetation Locations – Detections Only

Sample Location	Quad Location	Sample Date	Matrix	Type	H-3(pCi/g)	Cs-137	Sr-89/90
EVBWL-01	Barnwell (BRN)	04/30/09	Fruit	Plums	0.182	<MDA	<MDA
EVE2-001	Barnwell (BRN)	10/07/05	Grain	Soybean	0.257	<MDA	
EVE4008	Blackville (BRN)	10/29/08	Grain	Soybeans	0.673	<MDA	
EVE24-002	Long Branch (BRN)	08/16/06	Fruit	Apples	0.192	<MDA	
EVSNL-01	Snelling (BRN)	05/07/09	Fruit	Plums	<LLD	<MDA	0.056
SNL-203	Snelling (BRN)	06/03/04	Fruit	Plums	0.803	<MDA	
				Average	0.421		0.056
				Median	0.257		0.056
				Std Dev	0.294		N/A
				N =	5		1

2004 – 2009 All Other Edible Vegetation Locations

Sample Location	Quad Location	Sample Date	Matrix	Type	H-3(pCi/g)	Cs-137	Sr-89/90
EVE21-001	Clear Pond (BMBG)	06/23/06	Fruit	Blackberries	0.371	<MDA	
EVE21-002	Clear Pond (BMBG)	06/23/06	Fruit	Watermelon	0.423	<MDA	
EVE18-001	Midway (CAL)	06/23/06	Vegetable	Corn	0.252	<MDA	
EVE18-002	Midway (CAL)	06/23/06	Vegetable	Squash	0.246	<MDA	
EVE18-003	Midway (CAL)	06/23/06	Vegetable	Tomatoes	0.371	<MDA	
EVE32	Martinez (EDG)	10/26/06	Greens	Mustards	0.199	<MDA	0.035
EVE45	Gifford (HMP)	10/12/07	Grain	Soybeans	0.329	<MDA	0.051
EVE22	Grays (HMP)	08/04/06	Vegetable	Okra	0.332	<MDA	
ESTE1-001	Furman (HMP)	06/17/05	Greens	Turnips	0.201	<MDA	
ESTE1-002	Furman (HMP)	06/17/05	Greens	Turnips	0.212	<MDA	
ESTE1-003	Furman (HMP)	06/17/05	Vegetable	Squash	0.201	<MDA	
EVE36	Springfield (OBURG)	02/06/07	Greens	Mustard	0.216	<MDA	0.076
EVE35-02	Steedman (LEX)	08/10/07	Fruit	Peaches	0.410	<MDA	
EVE35-01	Steedman (LEX)	08/10/07	Fruit	Watermelon	0.271	<MDA	
WIL-204	Williston (BRN)	08/29/04	Fruit	Passion Fruit	0.189	<MDA	
EVE59	Williston (BRN)	06/29/09	Vegetable	Corn	0.267	<MDA	
				Average	0.281		0.054
				Median	0.260		0.051
				Std Dev	0.081		0.020
				N =	16		3

2009 Radiological Monitoring of Edible Vegetation – Split Samples - Corn

	ESOP Data		SRS Data			
Location Description	EVE59	EVE62	EV25SE	EV10NW	EV10SE	EV10NE
Collection Date	6/29/09	7/2/09	6/30/09	7/1/09	7/1/09	6/30/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	0.2198	0.2063	0.2313	0.2211	0.2152	0.2133
K-40 Activity	2.9800	2.7420	2.8960	2.8530	2.7050	2.6200
K-40 Confidence Interval	0.3741	0.3720	0.3761	0.3843	0.3503	0.3762
K-40 MDA	0.1501	0.1707	0.1498	0.1356	0.1370	0.1355
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	0.0171	0.0191	0.0182	0.0182	0.0184	0.0163
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA	NA
Ru-103 MDA	0.0268	0.0299	0.0288	0.0291	0.0291	0.0306
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	0.2402	0.2205	0.2327	0.2493	0.3073	0.3857
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	0.0199	0.0204	0.0192	0.0191	0.0178	0.0183
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	0.0416	0.0458	0.0447	0.0432	0.0369	0.0396
Pb-214 Activity	<MDA	0.2273	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	0.0420	NA	NA	NA	NA
Pb-214 MDA	0.0815	0.0403	0.0862	0.0501	0.0463	0.0440
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	0.4936	0.5277	0.4924	0.4676	0.4684	0.4949
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	0.8440	0.9063	0.8366	0.8693	0.7967	0.8410
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	0.1214	0.1335	0.1272	0.1237	0.1126	0.1214
Tritium	0.267	0.206	<0.191	<0.191	<0.191	<0.191
Confidence Interval	0.92	0.89				
Tritium LLD	0.191	0.191				
	EVE59	EVE62	EV25SE	EV10NW	EV10SE	EV10NE

Tritium	
EVE59	0.267
EVE62	0.206
Average	0.2365
Std Dev	0.043
Median	0.2365
N =	2

2009 Radiological Monitoring of Edible Vegetation - Plums

Location Description	EVNEW-01	EVJAK-01	EVAKN-01	EVBWL-01	EVSNL-01	EVALN-01
Collection Date	4/29/09	4/29/09	4/30/09	4/30/09	5/7/09	5/13/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA	NA
Be-7 MDA	0.2507	0.2616	0.2600	0.3026	0.2233	0.2112
K-40 Activity	2.2240	2.8160	2.6740	2.3910	2.5380	2.8020
K-40 Confidence Interval	0.3218	0.3641	0.3631	0.3686	0.3303	0.3781
K-40 MDA	0.1376	0.1460	0.1194	0.1514	0.1316	0.1587
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA	NA
Co-60 MDA	0.0142	0.0173	0.0148	0.0173	0.0127	0.0164
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA	NA
I-131 MDA	0.9738	1.1330	0.9819	1.1780	0.5399	0.3581
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-134 MDA	0.0154	0.0169	0.0168	0.0186	0.0143	0.0176
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA	NA
Cs-137 MDA	0.0156	0.0183	0.0175	0.0190	0.0158	0.0173
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-212 MDA	0.0346	0.0411	0.0379	0.0409	0.0346	0.0403
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA	NA
Pb-214 MDA	0.0371	0.0416	0.0442	0.0461	0.0396	0.0410
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA	NA
Ra-226 MDA	0.4420	0.4817	0.4505	0.4853	0.3792	0.4822
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA	NA
Ac-228 MDA	0.0737	0.0786	0.0772	0.0816	0.0686	0.0732
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	0.7498	0.7849	0.7498	0.8921	0.7205	0.7913
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA	NA
Am-241 MDA	0.1103	0.1196	0.1073	0.1251	0.1040	0.1112
Tritium Activity	0.353	0.259	0.258	0.182	<LLD	<LLD
Tritium Confidence Interval	90	86	86	82	NA	NA
Tritium LLD	0.177	0.177	0.177	0.177	0.177	0.177
Pu-238 Activity		<0.007		<0.005	<0.004	<.007
Pu-238 Confidence Interval		0.002		0.003	0.002	0.004
PU-238 MDA		0.007		0.005	0.004	0.007
Total Strontium		<0.064		<0.061	0.056	<0.056
Total Sr Confidence Interval		0.023		0.022	0.019	0.022
Total Sr MDA		0.064		0.061	0.045	0.056
U-234		<0.001		<0.002	0.004	<0.002
Confidence Interval		0.002		0.001	0.003	0.001
MDA		0.001		0.002	0.002	0.002
U-235		0.001		<0.001	0.003	0.002
Confidence Interval		0.001		0.000	0.002	0.002
MDA		0.002		0.001	0.002	0.001
U-238		0.001		0.002	0.002	0.002
Confidence Interval		0.001		0.002	0.002	0.001
MDA		0.001		0.002	0.002	0.001

2009 Radiological Monitoring of Edible Vegetation - Plums

Tritium Activity	
EVNEW-01	0.353
EVJAK-01	0.259
EVAKN-01	0.258
EVBWL-01	0.182

Average	0.263
Median	0.259
Std Dev	0.070
N - detects	4

2009 Radiological Monitoring of Edible Vegetation - Plums

Location Description	EVNEW-01	EVJAK-01	EVAKN-01	EVBWL-01
Collection Date	4/29/09	4/29/09	4/30/09	4/30/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA
Be-7 MDA	0.2507	0.2616	0.2600	0.3026
Na-22 Activity	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA
Na-22 MDA	0.0166	0.0175	0.0167	0.0179
K-40 Activity	2.2240	2.8160	2.6740	2.3910
K-40 Confidence Interval	0.3218	0.3641	0.3631	0.3686
K-40 MDA	0.1376	0.1460	0.1194	0.1514
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA
Mn-54 MDA	0.0162	0.0170	0.0173	0.0193
Co-58 Activity	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA
Co-58 MDA	0.0243	0.0230	0.0240	0.0278
Co-60 Activity	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA
Co-60 MDA	0.0142	0.0173	0.0148	0.0173
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA
Zn-65 MDA	0.0337	0.0425	0.0402	0.0442
Y-88 Activity	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA
Y-88 MDA	0.0147	0.0198	0.0171	0.0204
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NA
Zr-95 MDA	0.0402	0.0454	0.0494	0.0505
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA
Ru-103 MDA	0.0332	0.0356	0.0369	0.0416
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA
Sb-125 MDA	0.0449	0.0512	0.0472	0.0531
I-131 Activity	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA
I-131 MDA	0.9738	1.1330	0.9819	1.1780
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA
Cs-134 MDA	0.0154	0.0169	0.0168	0.0186
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA

2009 Radiological Monitoring of Edible Vegetation - Plums

Location Description	EVNEW-01	EVJAK-01	EVAKN-01	EVBWL-01
Collection Date	4/29/09	4/29/09	4/30/09	4/30/09
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA
Cs-137 MDA	0.0156	0.0183	0.0175	0.0190
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA
Ce-144 MDA	0.1360	0.1523	0.1438	0.1612
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA
Eu-152 MDA	0.0480	0.0531	0.0498	0.0565
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA
Eu-154 MDA	0.0341	0.0367	0.0357	0.0376
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA
Eu-155 MDA	0.0614	0.0614	0.0639	0.0722
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA
Pb-212 MDA	0.0346	0.0411	0.0379	0.0409
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA
Pb-214 MDA	0.0371	0.0416	0.0442	0.0461
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA
Ra-226 MDA	0.4420	0.4817	0.4505	0.4853
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA
Ac-228 MDA	0.0737	0.0786	0.0772	0.0816
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA
U/Th-238 MDA	0.7498	0.7849	0.7498	0.8921
Am-241 Activity	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA
Am-241 MDA	0.1103	0.1196	0.1073	0.1251
Tritium Activity	**0.353**	**0.259**	**0.258**	**0.182**
Tritium Confidence Interval	**90**	**86**	**86**	**82**
Tritium LLD	**0.177**	**0.177**	**0.177**	**0.177**
Pu-238 Activity		<MDA		<MDA
Pu-238 Confidence Interval		0.002		0.003
PU-238 MDA		0.007		0.005
Total Strontium		<MDA		<MDA
Total Sr Confidence Interval		0.023		0.022
Total Sr MDA		0.064		0.061
U-234		<MDA		<MDA
Confidence Interval		0.002		0.001
MDA		0.001		0.002
U-235		<MDA		<MDA
Confidence Interval		0.001		0.000
MDA		0.002		0.001
U-238		**0.001**		**0.002**
Confidence Interval		0.001		0.002
MDA		0.001		0.002

2009 Radiological Monitoring of Edible Vegetation – Plums

Location Description	EVSNL-01	EVALN-01	EVALN-02	EVALN-03	EVSNL-02
Collection Date	5/7/09	5/13/09	5/13/09	5/13/09	5/13/09
Be-7 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Be-7 Confidence Interval	NA	NA	NA	NA	NA
Be-7 MDA	0.2233	0.2112	0.2107	0.2068	0.2204
Na-22 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Na-22 Confidence Interval	NA	NA	NA	NA	NA
Na-22 MDA	0.0151	0.0178	0.0152	0.0167	0.0170
K-40 Activity	2.5380	2.8020	1.6910	2.0190	1.8690
K-40 Confidence Interval	0.3303	0.3781	0.3034	0.3283	0.3101
K-40 MDA	0.1316	0.1587	0.1365	0.1219	0.1450
Mn-54 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA	NA	NA	NA
Mn-54 MDA	0.0145	0.0179	0.0156	0.0152	0.0191
Co-58 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-58 Confidence Interval	NA	NA	NA	NA	NA
Co-58 MDA	0.0228	0.0217	0.0197	0.0200	0.0230
Co-60 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60 Confidence Interval	NA	NA	NA	NA	NA
Co-60 MDA	0.0127	0.0164	0.0163	0.0150	0.0166
Zn-65 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA	NA	NA	NA
Zn-65 MDA	0.0337	0.0398	0.0359	0.0383	0.0379
Y-88 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Y-88 Confidence Interval	NA	NA	NA	NA	NA
Y-88 MDA	0.0146	0.0163	0.0163	0.0156	0.0176
Zr-95 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA	NA	NS	NA
Zr-95 MDA	0.0377	0.0445	0.0356	0.0390	0.0474
Ru-103 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA	NA	NA	NA
Ru-103 MDA	0.0296	0.0308	0.0278	0.0298	0.0345
Sb-125 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA	NA	NA	NA
Sb-125 MDA	0.0430	0.0501	0.0429	0.0470	0.0527
I-131 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
I-131 Confidence Interval	NA	NA	NA	NA	NA
I-131 MDA	0.5399	0.3581	0.3598	0.3711	0.4191
Cs-134 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA	NA	NA	NA
Cs-134 MDA	0.0143	0.0176	0.0158	0.0161	0.0195

2009 Radiological Monitoring of Edible Vegetation – Plums

Location Description	EVSNL-01	EVALN-01	EVALN-02	EVALN-03	EVSNL-02
Collection Date	5/7/09	5/13/09	5/13/09	5/13/09	5/13/09
Cs-137 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA	NA	NA	NA
Cs-137 MDA	0.0158	0.0173	0.0164	0.0172	0.0186
Ce-144 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA	NA	NA	NA
Ce-144 MDA	0.1295	0.1410	0.1327	0.1355	0.1476
Eu-152 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA	NA	NA	NA
Eu-152 MDA	0.0434	0.0484	0.0473	0.0483	0.0538
Eu-154 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA	NA	NA	NA
Eu-154 MDA	0.0302	0.0330	0.0331	0.0342	0.0384
Eu-155 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA	NA	NA	NA
Eu-155 MDA	0.0558	0.0649	0.0634	0.0585	0.0678
Pb-212 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA	NA	NA	NA
Pb-212 MDA	0.0346	0.0403	0.0350	0.0319	0.0375
Pb-214 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214 Confidence Interval	NA	NA	NA	NA	NA
Pb-214 MDA	0.0396	0.0410	0.0447	0.0417	0.0477
Ra-226 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA	NA	NA	NA
Ra-226 MDA	0.3792	0.4822	0.3764	0.4241	0.4987
Ac-228 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA	NA	NA	NA
Ac-228 MDA	0.0686	0.0732	0.0683	0.0657	0.0755
U/Th-238 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA	NA	NA	NA
U/Th-238 MDA	0.7205	0.7913	0.7592	0.7846	0.8815
Am-241 Activity	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241 Confidence Interval	NA	NA	NA	NA	NA
Am-241 MDA	0.1040	0.1112	0.1080	0.1097	0.1245
Tritium Activity	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium Confidence Interval	NA	NA	NA	NA	NA
Tritium LLD	0.177	0.177	0.177	0.177	0.177
Pu-238 Activity	<MDA	<MDA			
Pu-238 Confidence Interval	0.002	0.004			
PU-238 MDA	0.004	0.007			
Total Strontium	0.056	<MDA			
Total Sr Confidence Interval	0.019	0.022			
Total Sr MDA	0.045	0.056			
U-234	0.004	<MDA			
Confidence Interval	0.003	0.001			
MDA	0.002	0.002			
U-235	0.003	0.002			
Confidence Interval	0.002	0.002			
MDA	0.002	0.001			
U-238	0.002	0.002			
Confidence Interval	0.002	0.001			
MDA	0.002	0.001			

2009 Radiological Monitoring of Edible Vegetation – Plums

Location Description	EVBWL-02	EVAKN-02
Collection Date	5/20/09	5/22/09
Be-7 Activity	<MDA	<MDA
Be-7 Confidence Interval	NA	NA
Be-7 MDA	0.1766	0.1889
Na-22 Activity	<MDA	<MDA
Na-22 Confidence Interval	NA	NA
Na-22 MDA	0.0151	0.0153
K-40 Activity	1.6170	1.2820
K-40 Confidence Interval	0.2835	0.2548
K-40 MDA	0.1380	0.1225
Mn-54 Activity	<MDA	<MDA
Mn-54 Confidence Interval	NA	NA
Mn-54 MDA	0.0142	0.0159
Co-58 Activity	<MDA	<MDA
Co-58 Confidence Interval	NA	NA
Co-58 MDA	0.0177	0.0195
Co-60 Activity	<MDA	<MDA
Co-60 Confidence Interval	NA	NA
Co-60 MDA	0.0137	0.0162
Zn-65 Activity	<MDA	<MDA
Zn-65 Confidence Interval	NA	NA
Zn-65 MDA	0.0381	0.0358
Y-88 Activity	<MDA	<MDA
Y-88 Confidence Interval	NA	NA
Y-88 MDA	0.0171	0.0147
Zr-95 Activity	<MDA	<MDA
Zr-95 Confidence Interval	NA	NA
Zr-95 MDA	0.0390	0.0394
Ru-103 Activity	<MDA	<MDA
Ru-103 Confidence Interval	NA	NA
Ru-103 MDA	0.0249	0.0248
Sb-125 Activity	<MDA	<MDA
Sb-125 Confidence Interval	NA	NA
Sb-125 MDA	0.0420	0.0456
I-131 Activity	<MDA	<MDA
I-131 Confidence Interval	NA	NA
I-131 MDA	0.1832	0.1793
Cs-134 Activity	<MDA	<MDA
Cs-134 Confidence Interval	NA	NA
Cs-134 MDA	0.0158	0.0165

2009 Radiological Monitoring of Edible Vegetation – Plums

Location Description	EVBWL-02	EVAKN-02
Collection Date	5/20/09	5/22/09
Cs-137 Activity	<MDA	<MDA
Cs-137 Confidence Interval	NA	NA
Cs-137 MDA	0.0161	0.0181
Ce-144 Activity	<MDA	<MDA
Ce-144 Confidence Interval	NA	NA
Ce-144 MDA	0.1310	0.1314
Eu-152 Activity	<MDA	<MDA
Eu-152 Confidence Interval	NA	NA
Eu-152 MDA	0.0447	0.0440
Eu-154 Activity	<MDA	<MDA
Eu-154 Confidence Interval	NA	NA
Eu-154 MDA	0.0308	0.0315
Eu-155 Activity	<MDA	<MDA
Eu-155 Confidence Interval	NA	NA
Eu-155 MDA	0.0564	0.0589
Pb-212 Activity	<MDA	<MDA
Pb-212 Confidence Interval	NA	NA
Pb-212 MDA	0.0359	0.0356
Pb-214 Activity	**0.0616**	<MDA
Pb-214 Confidence Interval	0.0273	NA
Pb-214 MDA	0.0342	0.0407
Ra-226 Activity	<MDA	<MDA
Ra-226 Confidence Interval	NA	NA
Ra-226 MDA	0.4355	0.4395
Ac-228 Activity	<MDA	<MDA
Ac-228 Confidence Interval	NA	NA
Ac-228 MDA	0.0668	0.0702
U/Th-238 Activity	<MDA	<MDA
U/Th-238 Confidence Interval	NA	NA
U/Th-238 MDA	0.7307	0.7635
Am-241 Activity	<MDA	<MDA
Am-241 Confidence Interval	NA	NA
Am-241 MDA	0.1081	0.1091
Tritium Activity	<LLD	<LLD
Tritium Confidence Interval	NA	NA
Tritium LLD	0.177	0.177
Pu-238 Activity		
Pu-238 Confidence Interval		
PU-238 MDA		
Total Strontium		
Total Sr Confidence Interval		
Total Sr MDA		
U-234		
Confidence Interval		
MDA		
U-235		
Confidence Interval		
MDA		
U-238		
Confidence Interval		
MDA		

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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). The milk pathway is especially important in the case of infants and children. They are more likely to drink large quantities of milk, and are actively developing bones and teeth. Radioactive strontium is a calcium analogue and may show a tendency to accumulate in these structures (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 muscle 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. Most of the Cobalt-60 (Co-60) contamination came 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, and therefore targets the whole body**.**

During 2009, DOE-SR collected samples from eight dairy locations, four of which are located in South Carolina (SRNS 2010). DOE-SR milk samples are collected quarterly within a 25-mile radius of the SRS. Only four of the dairies that DOE-SR sample are located in South Carolina and the remaining four are located in Georgia. The South Carolina Department of Health and Environmental Control (SCDHEC) Environmental Surveillance and Oversight Program (ESOP) collected milk at seven cow dairy locations within the state (four perimeter and two background) to provide an independent source of data on radionuclide concentrations of concern in milk (Map 11, Section 3.4.2).

SCDHEC personnel collected unpasteurized milk samples on a quarterly basis in 2009. Cow milk samples from each quarter were analyzed for tritium, strontium-89/90 (Sr-89/90), and select gamma-emitting radionuclides, specifically iodine-131 (I-131), cesium-137 (Cs-137), and cobalt-60 (Co-60).

SCDHEC did not detect any man-made gamma-emitting or tritium radionuclides in any of the 24 milk samples collected during 2009. Sr-89/90 was detected in four samples collected from perimeter locations in 2009. 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 2009 exceeded the United States Environmental Protection Agency (USEPA) drinking water Maximum Contaminant Level (MCL) of 8 picocuries per liter (pCi/L) for strontium-90 (Sr-90) (USEPA 2002).

DOE-SR had one detection of Co-60 from a sample, collected during Febuary in Girard, Georgia (GA), with an activity of 4.57 pCi/l in 2009. DOE-SR detected Sr-90 in April (1.59),August (1.44pCi/l), and October 1.52) in Barnwell, SC in 2009. Tritium was not detected in 2009 by DOE-SR (SRNS 2010).

During 2009, 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 2003) have tritium contributions (atomic legacy source likely) that are higher than the range found in milk. Tritium averages 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 2009 exhibited tritium activity above the Lower Limit of Detection (LLD) of 207 pCi/l. In 2008 one perimeter milk sample, collected from Norway, South Carolina, (SC) exhibited tritium activity of 218 (±128) pCi/L (SCDHEC 2009). Figure 1 of Section 5.0 illustrates average tritium detections for the ten years SCDHEC has sampled milk. All tritium detections have been below the USEPA drinking water MCL of 20,000 pCi/L for tritium. No summary statistics were calculated for tritium as all results were below the MDA. DOE-SR did not report any tritium detections in 2009. (SRNS 2010). 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.

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. 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 2009. All analytical results for these radionuclides were below the sample Minimum Detectable Activity (MDA). These results are consistent with 2008 results (SCDHEC 2009). 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 gamma-emitting radionuclides from ONE samples in 2009. One DOE-SR sample from Girard, GA exhibited a Co-60 activity of 4.57 pCi/L. (SRNS 2010).

Strontium-89/90 Results and Statistics

Strontium is present around the world due to nuclear weapons 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 2002; 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 and H separation areas (WSRC 1998).

Samples were collected quarterly in 2009 for Sr-89/90 analysis (Section 3.4.4). Four SCDHEC milk samples collected in 2009 exhibited strontium activities above the MDA. The range for these detections was 0.44 pCi/L to 1.15 pCi/L, with the minimum detection in a sample from Leesville, SC, and the maximum detection in a sample from Govan, SC. These perimeter detections averaged 0.73 (± 0.37) pCi/L (Section 7.0). This perimeter average is below the USEPA established MCL of 8 pCi/L for Sr-90 in drinking water (USEPA 2002). This average is a decrease from 2008, when the strontium average was 0.94 (± 0.20) pCi/L (SCDHEC 2009). 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 began in 1998. DOE-SR detected Sr-90 in three samples from Barnwell, SC. The range for these detections was 1.44 pCi/L to 1.59 pCi/L. (SRNS 2010).

Statistical analysis was limited to a comparison of averages of all perimeter samples collected within 50 miles of the SRS perimeter and all background samples, as shown in Section 3.4.5. Locations closer to SRS have higher strontium levels than background locations for averaged values. All background samples for 2009 were below detection.

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. Perimeter data show higher strontium than background locations for averaged values.

A large portion of the radiological activity observed in collected 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 doing well and have gives 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.

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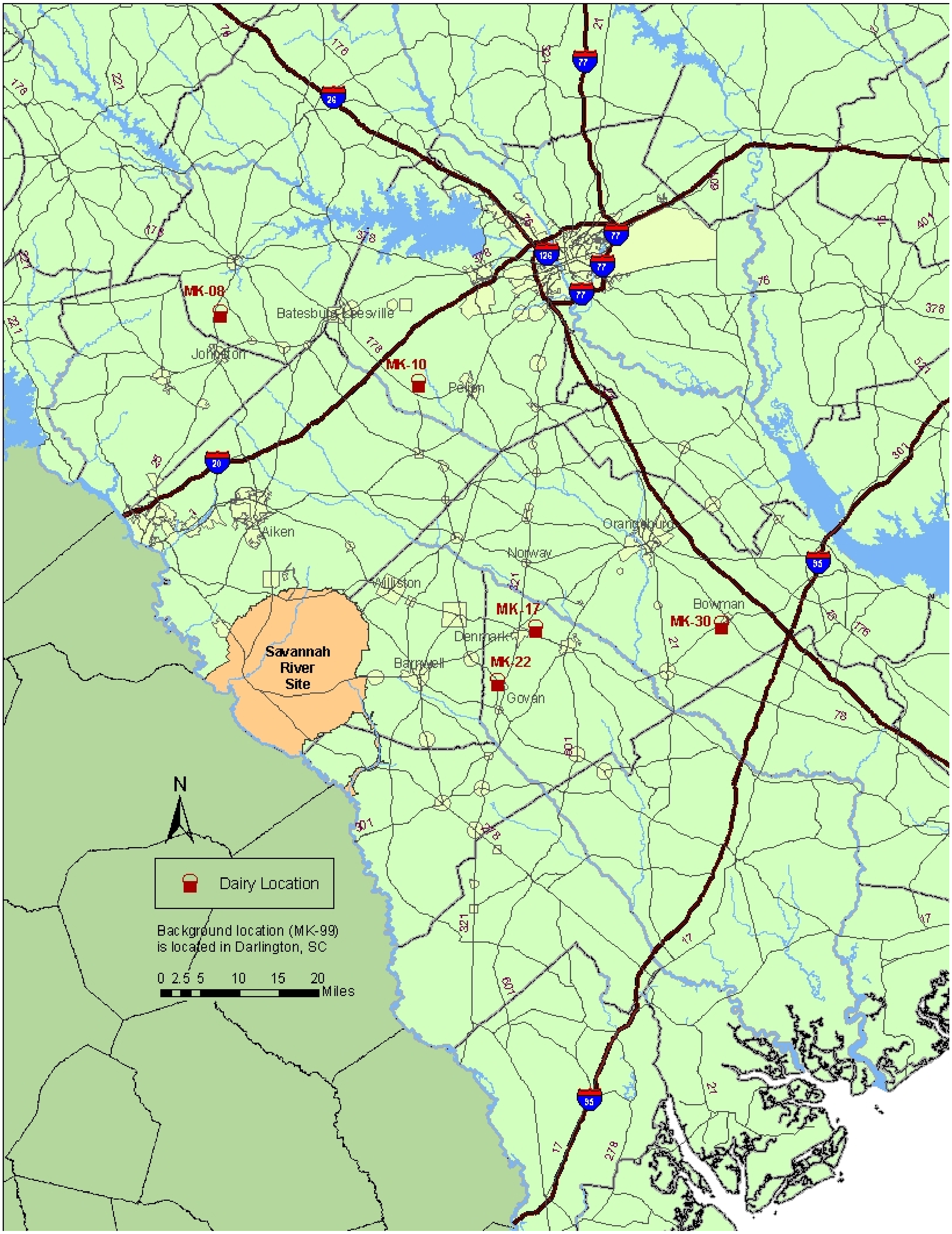
3.4.2 Radiological Monitoring of Dairy Milk

Map 11. 2009 SCDHEC Radiological Monitoring Locations for Dairy Milk



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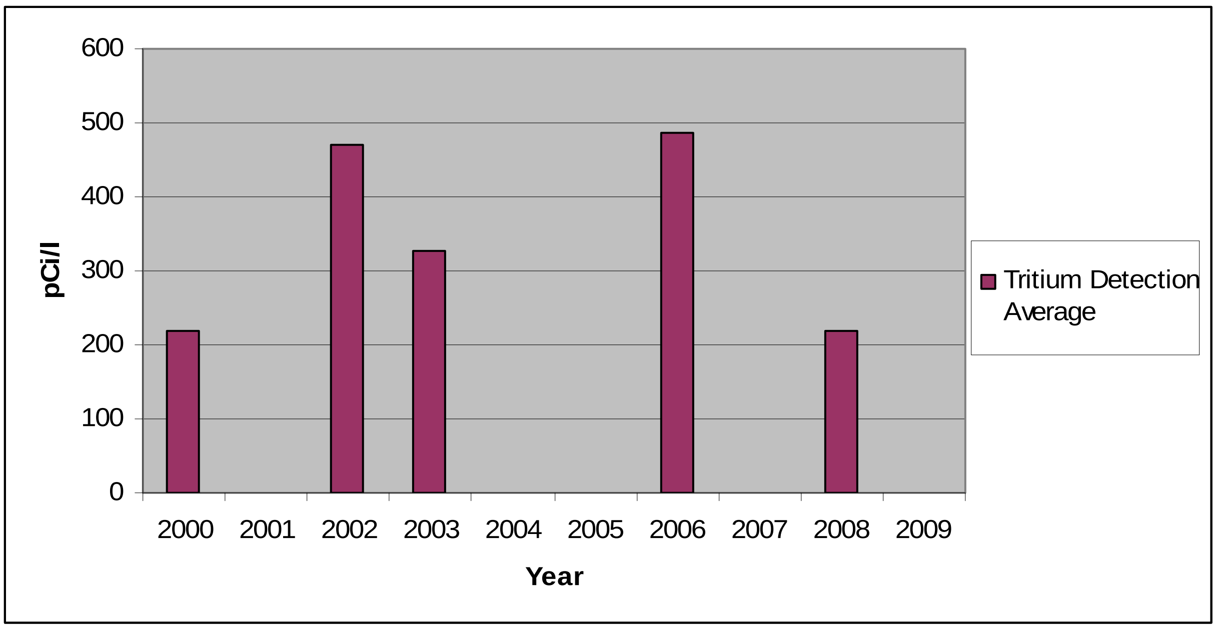
3.4.3 Tables and Figures
Radiological Monitoring of Dairy Milk

Table 1. 2009 SCDHEC and DOE-SR Dairy Milk Sampling Locations

2009 SCDHEC and DOE-SR Dairy Milk Sampling Locations	
SCDHEC Cow Dairy Locations	**DOE-SR Cow Dairy Locations**
Denmark, SC, MK-17	Barnwell, SC
Norway, SC, MK-14	Denmark, SC
Leesville, SC, MK-10	Ehrhardt Road, Govan, SC
Johnston, SC, MK-8	Partridge Rd, Govan, SC
Govan, SC, MK-22	Girard, GA
Bowman, SC*, MK-30	Hwy 23 Girard, GA
Darlington, SC*, MK-99	Hwy 23 McBean, GA
	Waynesboro, GA

*Background Locations

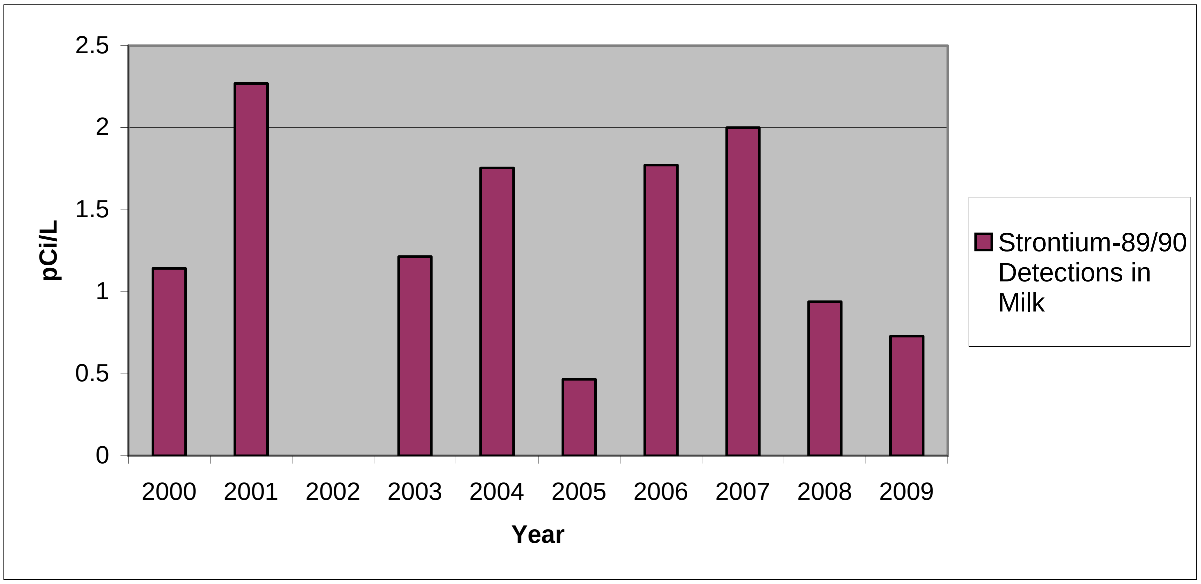
Figure 1. Average Tritium Detections in SCDHEC Milk, 2000-2009



Average detections are below the USEPA MCL of 20,000 pCi/L for drinking water.
No dectections above the MDA were observed in 2001, 2004, 2005, 2007 and 2009.

Tables and Figures
Radiological Monitoring of Dairy Milk

Figure 2. Strontium-89/90 Detection Averages, 2000-2009



Average detections are below the USEPA MCL of 8.0 pCi/L for drinking water.
No detections above the MDA were observed in 2002.

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3.4.4 Data

Radiological Monitoring of Dairy Milk

Notes:

14. LLD - Lower Limit of Detection
15. MDA - Minimum Detectable Activity
16. MDC - Minimum Detectable Concentration
17. SC - South Carolina
18. * Indicates a background sampling location

RADIOLOGICAL MONITORING OF DAIRY MILK DATA

2009 Tritium and Gamma-emitting Milk Data

Sample Location			MK-8 Johnston, SC		
Collection Date		2/12/2009	5/18/2009	8/12/2009	12/9/2009
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	204	210	208	207
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.47	2.33	2.79	2.44
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	152.00	19.70	8.37	403.00
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.13	2.70	2.69	2.69

Sample Location			MK-10 Leesville, SC		
Collection Date		2/11/2009	5/18/2009	8/12/2009	12/7/2009
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	205	207	209	207
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	1.96	2.38	2.50	2.61
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	154.00	20.20	8.81	589.00
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.38	2.70	2.52	2.63

Sample Location			MK-17 Denmark, SC		
Collection Date		2/11/2009	5/18/2009	8/13/2009	12/7/2009
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	204	207	207	208
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.27	2.48	2.47	2.80
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	149.00	21.30	7.01	614.00
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.33	2.70	2.70	2.69

Radiological Monitoring of Dairy Milk Data

2009 Tritium and Gamma-emitting Milk Data

Sample Location			MK-22 Govan, SC		
Collection Date		2/11/2009	5/18/2009	8/14/2009	12/8/2009
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	204	208	208	209
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.19	2.42	2.61	2.79
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	139.00	21.20	5.39	633.00
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.33	2.70	1.94	2.67

Sample Location			MK-30 Bowman, SC*		
Collection Date		No Sample	5/19/2009	8/13/2009	12/9/2009
Radionuclides:	Tritium (pCi/L)		<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD		207	207	211
	Co-60 (pCi/L)		<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA		2.60	2.77	2.45
	I-131 (pCi/L)		<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA		31.90	7.97	577.00
	Cs-137 (pCi/L)		<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA		2.70	2.66	2.64

Sample Location			MK-99 Darlington, SC*		
Collection Date		2/13/2009	5/20/2009	2/11/2009	12/9/2009
Radionuclides:	Tritium (pCi/L)	<LLD	<LLD	<LLD	<LLD
	+/- 2 sigma				
	LLD	204	210	209	207
	Co-60 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.06	2.34	2.82	2.76
	I-131 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	192.00	29.30	10.30	628.00
	Cs-137 (pCi/L)	<MDA	<MDA	<MDA	<MDA
	+/- 2 sigma				
	MDA	2.34	2.70	2.67	2.48

Radiological Monitoring of Dairy Milk Data

2009 Strontium Milk Data TOC

Units are in picocuries per Liter (pCi/L)

Sample Location	MK-8 Johnston, SC			
Collection Date	2/12/2009	5/18/2009	8/12/2009	12/9/2009
Sr - 89/90	0.70	<MDA	<MDA	0.51
± 2 sigma	0.19			0.15
MDA	0.62	0.53	0.47	0.50

Sample Location	MK-10 Leesville, SC			
Collection Date	2/11/2009	5/18/2009	8/12/2009	12/7/2009
Sr - 89/90	<MDA	<MDA	0.44	<MDA
± 2 sigma			0.11	
MDA	0.57	0.54	0.43	0.59

Sample Location	MK-17 Denmark, SC			
Collection Date	2/11/2009	5/18/2009	8/13/2009	12/7/2009
Sr - 89/90	<MDA	<MDA	<MDA	<MDA
± 2 sigma				
MDA	0.64	0.58	0.51	0.60

Sample Location	MK-22 Govan, SC			
Collection Date	2/11/2009	5/18/2009	8/14/2009	12/8/2009
Sr - 89/90	1.15	<MDA	<MDA	<MDA
± 2 sigma	0.17			
MDA	0.49	0.55	0.45	0.50

Sample Location	MK-30 Bowman, SC*			
Collection Date	No Sample	5/19/2009	8/13/2009	12/9/2009
Sr - 89/90		<MDA	<MDA	<MDA
± 2 sigma				
MDA		0.59	0.48	0.53

Sample Location	MK-99 Darlington, SC*			
Collection Date	2/13/2009	5/20/2009	8/11/2009	12/9/2009
Sr - 89/90	<MDA	<MDA	<MDA	<MDA
± 2 sigma				
MDA	0.69	0.55	0.42	0.51

3.4.5 Summary Statistics

Radiological Monitoring of Dairy Milk Data

Notes:

6. Avg. - Average
7. St. Dev. - Standard Deviation
8. Min. - Minimum
9. Max. - Maximum
10. Statistics calculated for detections only
11. Non-detect denotes <MDA
12. N/A - Not Applicable

Radiological Monitoring of Dairy Milk Data

2009 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**	2 (2)	0.61	0.13	0.61	0.51	0.70
	MK-10	1 (3)	0.44	N/A	0.44	0.44	0.44
	MK-17	0 (4)	<MDA	N/A	N/A	N/A	N/A
	MK-22	1 (3)	1.15	N/A	1.15	1.15	1.15
	MK-30	0 (4)	<MDA	N/A	N/A	N/A	N/A
	MK-99	0 (4)	<MDA	N/A	N/A	N/A	N/A
Yearly Average			0.73				
Standard Deviation			0.37				
Median			0.61				

Non-detects ( ) excluded from computations

Radiological Monitoring of Dairy Milk Data

2009 Strontium Summary Statistics Comparison of Perimeter and Background Locations
Units are in picocuries per liter (pCi/L)

	Perimeter Locations (E) (< 50 miles)			Background locations (B) (> 50 Miles)			E minus B	
	Average	**Std Dev.**	**Median**	**Average**	**Std Dev.**	**Median**	**Average**	**Median**
Sr-89/90	(N=4) 0.73	0.37	0.61	N/A	N/A	N/A	0.7	0.61

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 new 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 2000). One chain pickerel (*Esox niger*) was also collected as part of an ongoing effort to sample an additional species each study year. Red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), and striped mullet (*Mugil cephalus*) were collected near Savannah, Georgia. Stations sampled in 2009 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 (SV-2011, SV-2013, SV-2015, SV-2017, SV-2020). Samples were also collected from an upstream tributary of the river as a background location (SV-2059), one Savannah River station upstream of the SRS (SV-2028), and four stations downstream of the SRS (SV-118, SV-355, SV-2090, SV-2091). All these locations are accessible to the public. Typically, five fish of each species were collected at each sample location. Each species was separated into edible and non-edible portions, and the portions were combined into homogeneous composites. 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).

Three locations did not produce samples with detectable tritium activity in 2009: the background location on the Edisto River, the location upstream of SRS near Augusta, Georgia, and Beaver Dam 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, Fourmile

Branch, 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 radionuclide levels 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 2009: 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 27 through October 15, 2009. Five largemouth bass were collected from all Savannah River locations and the Edisto River background site. Five channel catfish were collected at eight Savannah River locations; five white catfish were collected at one river. Although several attempts were made, only three catfish were collected from the Edisto River, one channel catfish and two white catfish. One chain pickerel was collected at one Savannah River station. Four red drum, four spotted seatrout, and five mullet were collected from the saltwater location.

A total of 112 fish was collected. Forty-six composites and one individual fish sample were processed in 2009. 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 2009 and 2005-2009 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 2005 – 2009 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 2007). Sources of man-made tritium include nuclear reactors and government weapons production plants. Tritium releases at SRS include both atmospheric and liquid contributions (SRNS 2009). 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 2008).

Activity levels of tritium were analyzed in 23 edible composites and one individual sample. Seven of the ten freshwater stations exhibited detectable tritium activity in 2009 (Section 4.1.3, Figure 1a); the saltwater sampling location (SV-2091) produced detections in all three 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 Beaver Dam Creek (SV-2013) also had no tritium activity. The only chain pickerel analyzed for tritium, a single large individual from the NSBLD location did not exhibit tritium activity. All stations downstream of Beaver Dam Creek exhibited tritium activity.

Six of nine bass samples from the Savannah River exhibited detectable tritium activity, with an average of 729 (± 603) pCi/L. The composite from the US Highway 17 location (Hwy. 17, SV-2090) had the highest reported tritium activity, 1870 pCi/L; Fourmile Branch (SV-2015) had the second-highest activity, 893 pCi/L. Five of nine Savannah River catfish samples exhibited tritium activity, with an average of 591 (± 698) pCi/L. The highest tritium level observed in the catfish composites, 1832 pCi/L, was also from the Hwy. 17 location.

With the exception of the Hwy. 17 location, samples from downstream of SRS exhibited little tritium activity in 2009. The 2009 data were generally similar to SCDHEC historically reported data (Section 4.1.3, Figures 1b and 1c; SCDHEC 2009). 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 2009. 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 1999).

Activity levels of Cs-137 were analyzed in 46 edible and non-edible portions of bass, catfish, red drum, seatrout, and mullet composites, and one individual pickerel sample. The NSBLD, Fourmile Branch, 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).

Six of nine edible bass composites from Savannah River locations exhibited detectable levels of Cs-137, ranging from 0.041 to 0.910 picocuries per gram (pCi/g), with an average of 0.398 (± 0.376) pCi/g (Section 4.1.3, Figure 2a). The sample from the Steel Creek location had the highest reported activity level. Cesium-137 levels reported above the MDA were observed in edible bass composites from three of five creek mouth locations adjacent to SRS and two 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 two edible catfish composites exhibited detectable levels of Cs-137, 0.048 and 0.036 pCi/g, with an average of 0.042 (± 0.008) pCi/g (Section 4.1.3, Figure 3a). No non-edible catfish composites produced detectable Cs-137 activity. The Lower Three Runs location (SV-2020) exhibited the highest activity for the non-edible samples.

The edible chain pickerel composite did not exhibit detectable Cs-137 activity.

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 2009). 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 2009. Strontium-89 and -90 are present around the world as a result of fallout from past atmospheric nuclear weapons tests (MII 2008). Strontium-90 is the more important isotope in the environment, although Sr-89 can be found around reactors. 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 2007).

Portions of 23 non-edible composites were selected for Sr-89,90 analysis in 2009. 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 US Highway 301 location (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 2008).

Section 4.1.3, Figures 4b and 4c show historically reported SCDHEC data for Sr-89,90 (SCDHEC 2009). The data from 2005-2007 represents calculated wet results using a dry/wet conversion ratio from the actual dry analyses. The 2008 and 2009 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 2009. The results from the single chain pickerel collected from SV-2028 are discussed in the appropriate analysis sections.

Mercury and Metals Analyses

In 2009 ESOP initiated analysis of edible fish samples for mercury and selected metals. A total of 103 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 (USEPA 2010). 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.

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 2010).

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 five bass samples. Mercury was detected in one of three catfish samples from the Edisto River, at a slightly higher concentration than any of the Savannah River samples.

Mercury was detected in 22 of 44 bass samples from eight of nine Savannah River locations, ranging from 0.1 to 1.4 milligrams per kilogram (mg/kg), with an average of 0.38 (± 0.32) 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 43 Savannah River catfish samples, from three locations, exhibited detectable mercury concentrations, ranging from 0.20 to 0.12 mg/kg, with an average of 0.17 (± 0.03) mg/kg (Section 4.1.3, Figure 5). The Stokes Bluff location had the highest average mercury concentration.

The following metals were not detected in any samples in 2009: antimony, arsenic, cadmium, lead, and nickel. Chromium was detected in only one sample, manganese in eight. Copper was detected in 43 samples from all locations except Fourmile Branch and Hwy. 301. Zinc was detected in all 103 samples analyzed.

SCDHEC and DOE-SR Data Comparison

SCDHEC bass and catfish data collected for this project in 2009 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 detected tritium in fish from seven of nine Savannah River freshwater locations, while DOE-SR detected tritium at three locations. ESOP largemouth bass samples from six locations and DOE-SR bass samples from two locations exhibited tritium activity. ESOP detected tritium in catfish samples from five sites, DOE-SR from two. Cesium-137 was detected in fish from most locations by both programs in 2009. Cesium-137 results for 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 two to five standard deviations apart for Sr-89,90, but the detections were at very low levels, averaging 0.08 pCi/g for DOE-SR and 0.04 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 2007).

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.

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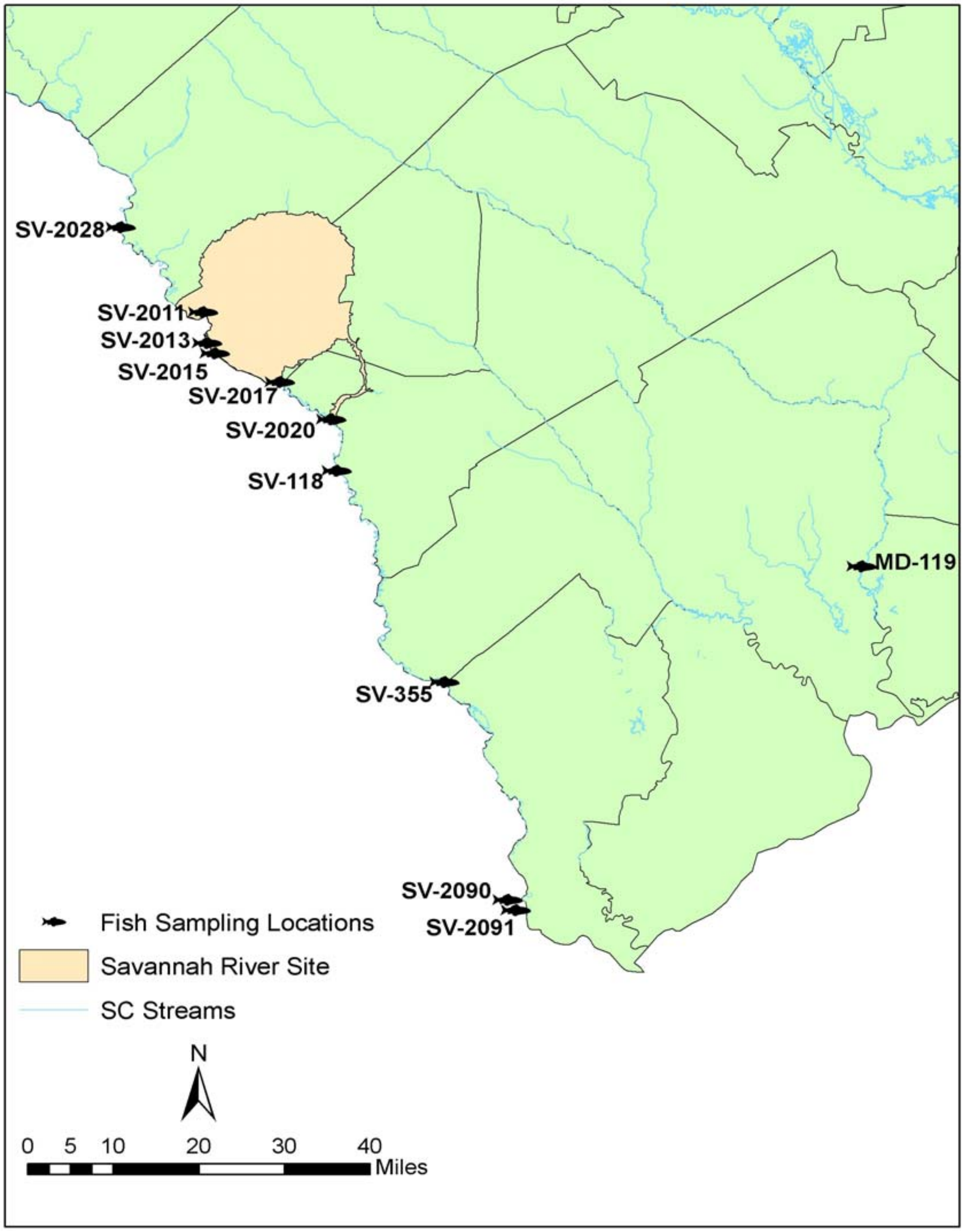
4.1.2

Map 14. Radiological Fish Monitoring, Sampling Locations, 2009



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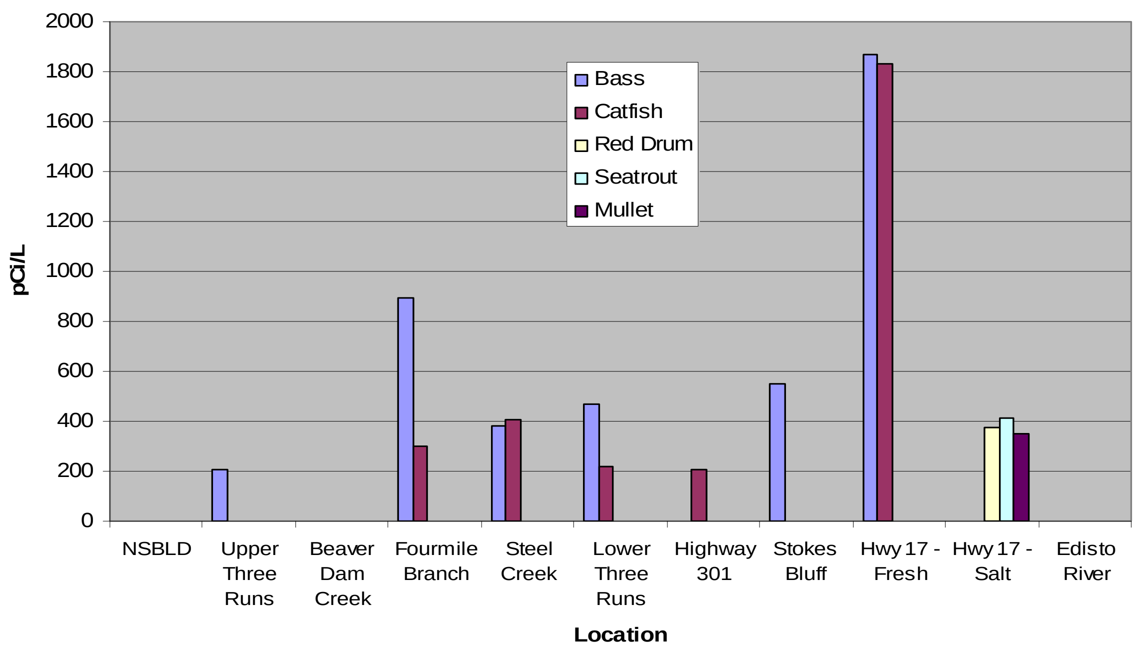
4.1.3 Tables and Figures

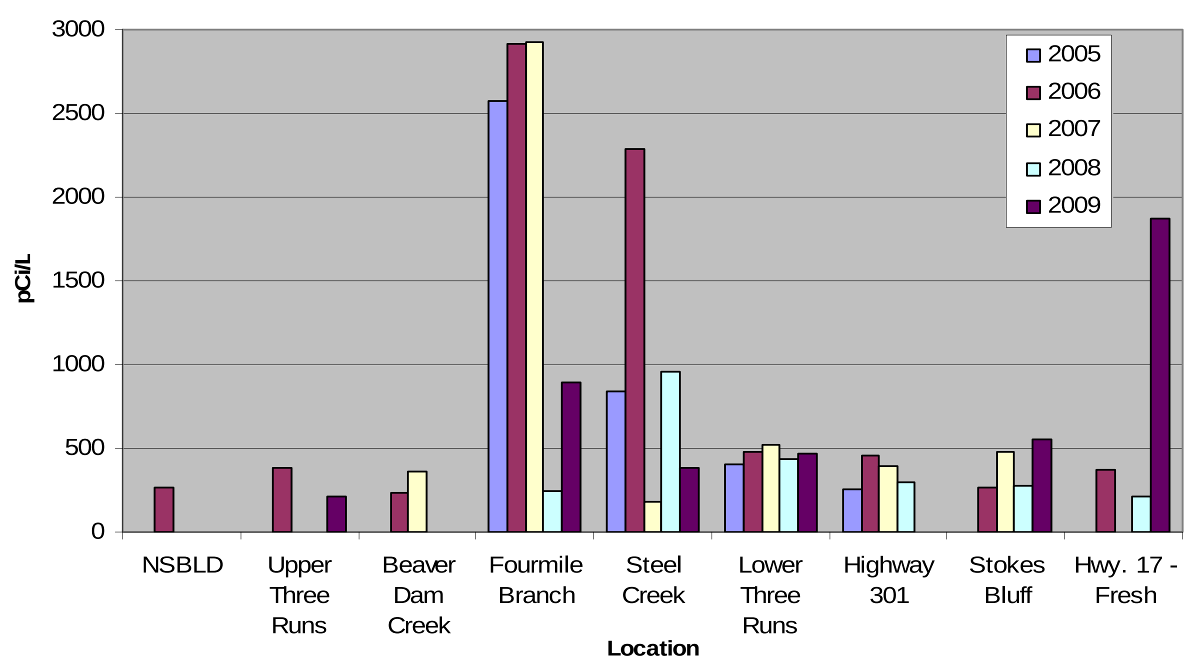
Radiological Fish Monitoring

Figure 1a. Tritium in Fish Composites, 2009



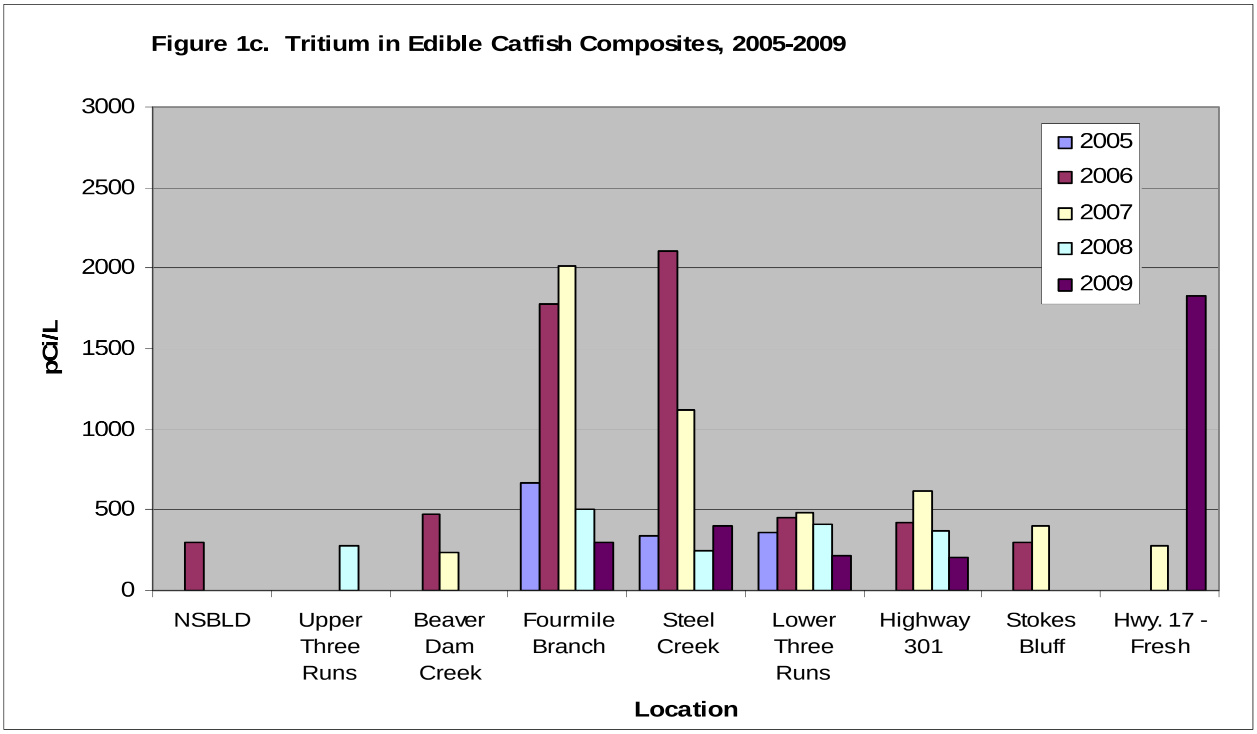
Note: No tritium activity in pickerel sample

Figure 1b. Tritium in Edible Bass Composites, 2005-2009

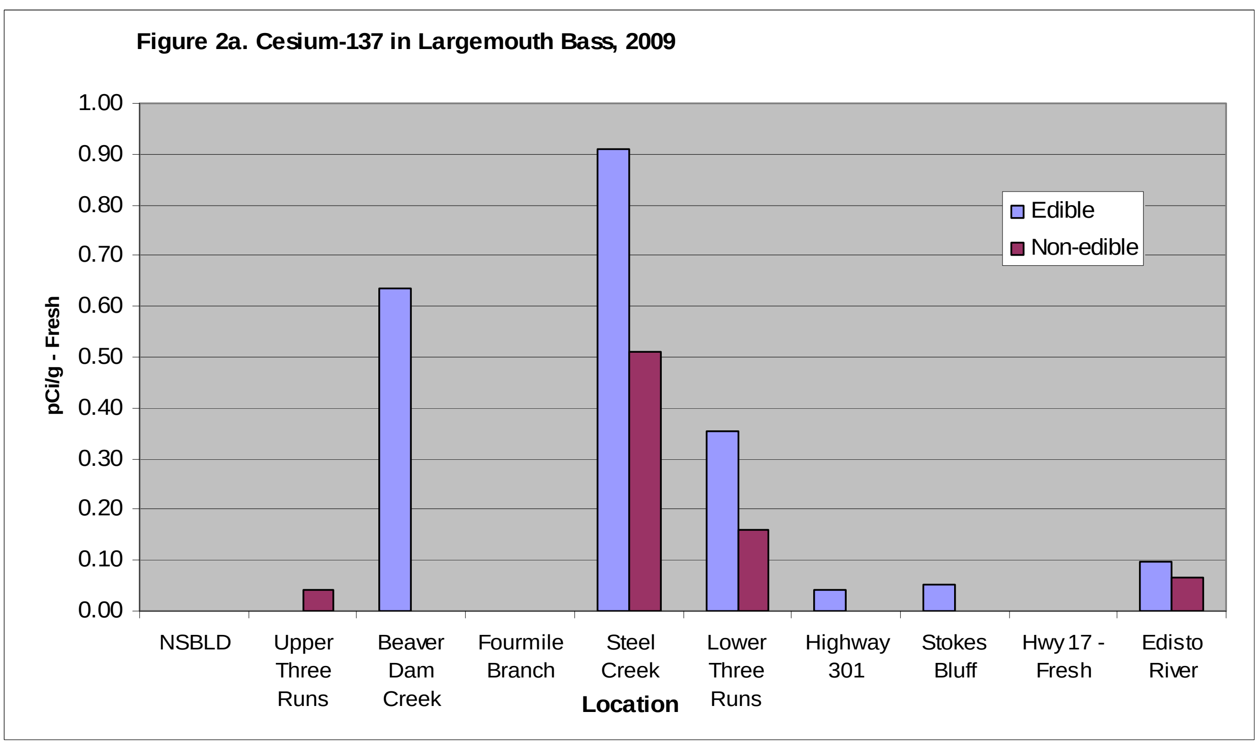


Note: Sampling at the Hwy. 17 location started in 2006

Tables and Figures
Radiological Fish Monitoring

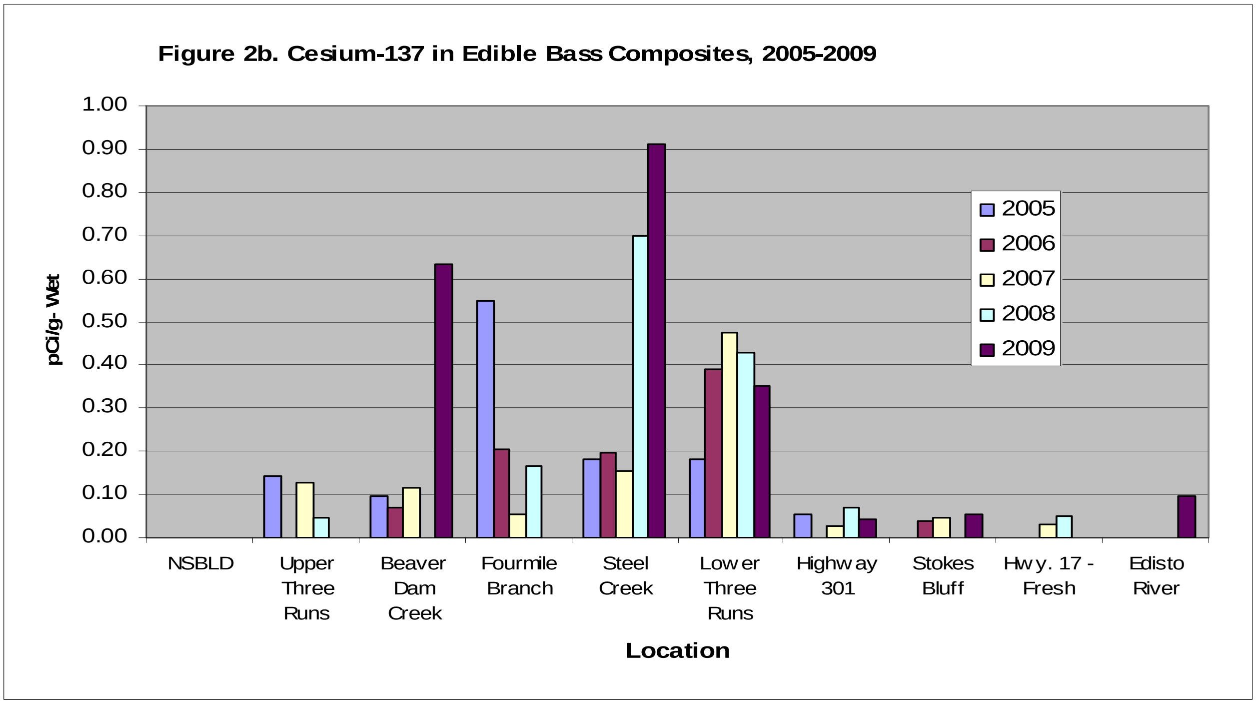


Note: Sampling at the Hwy. 17 location started in 2006

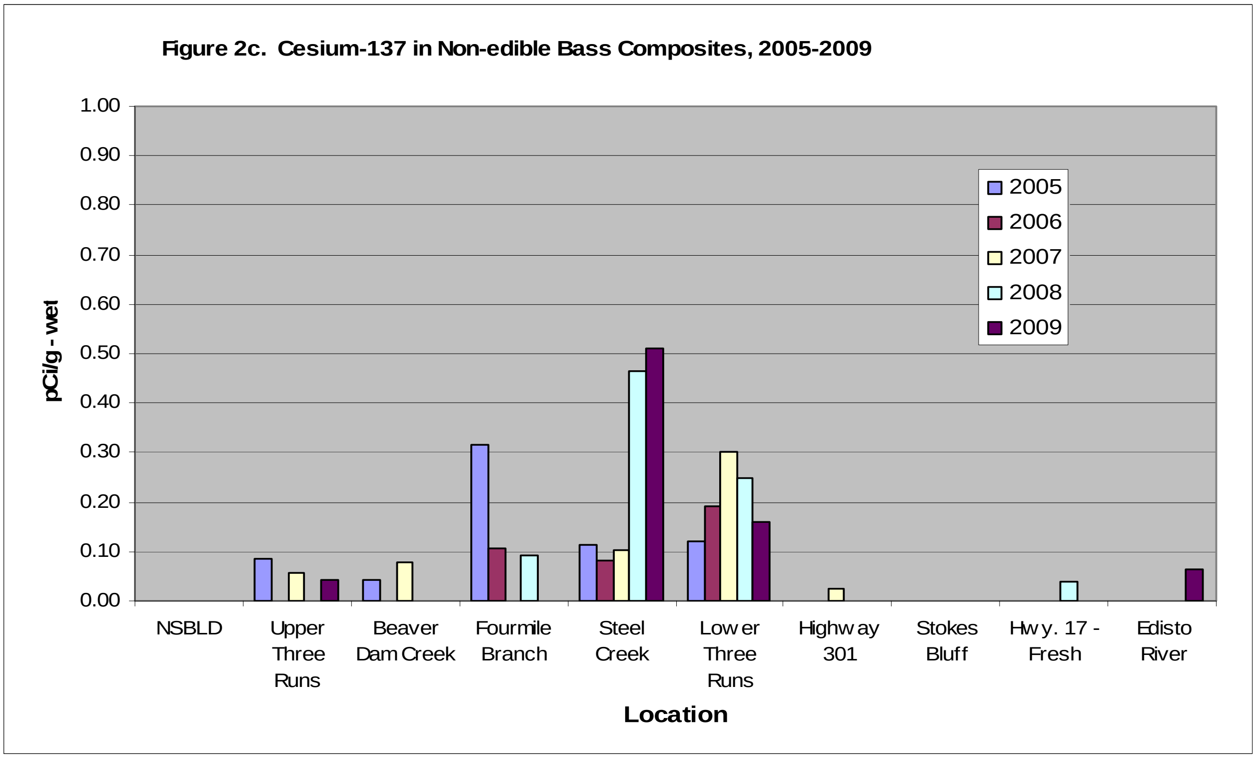


Note Cs-137 activity not detected in non-edible pickerel

Tables and Figures
Radiological Fish Monitoring

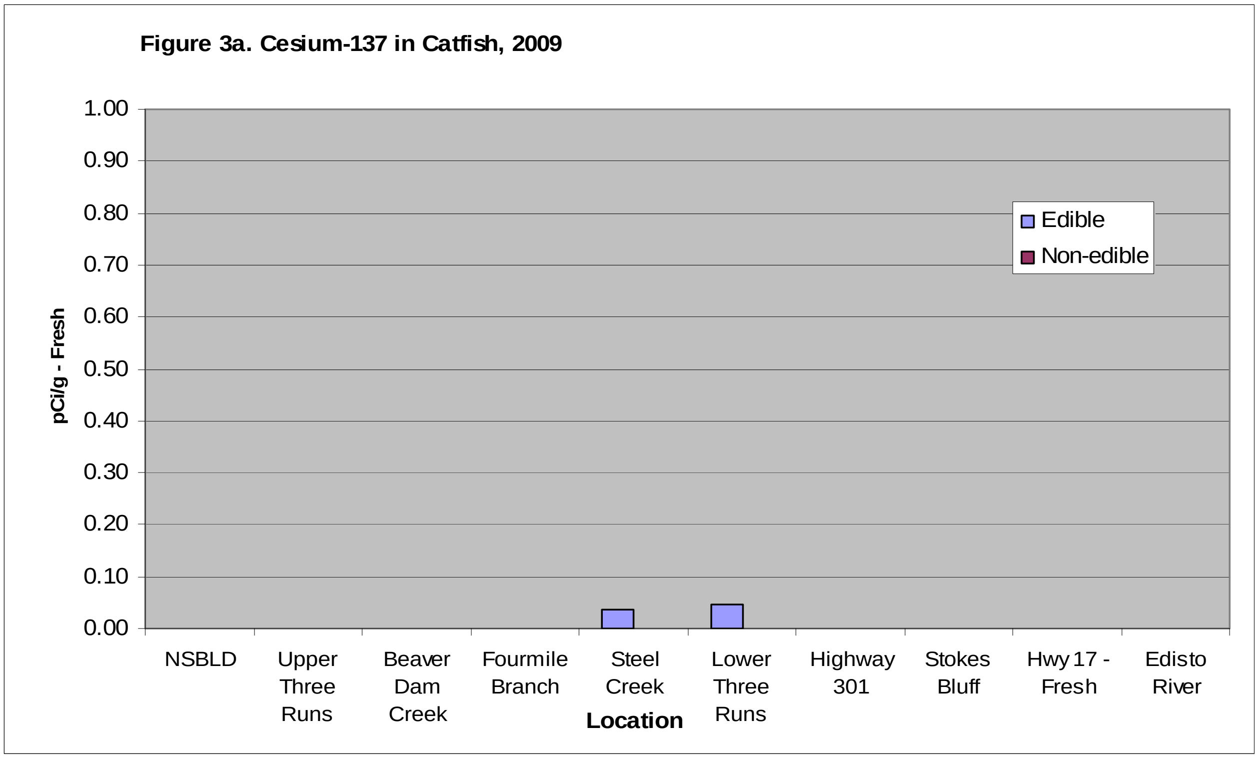


Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

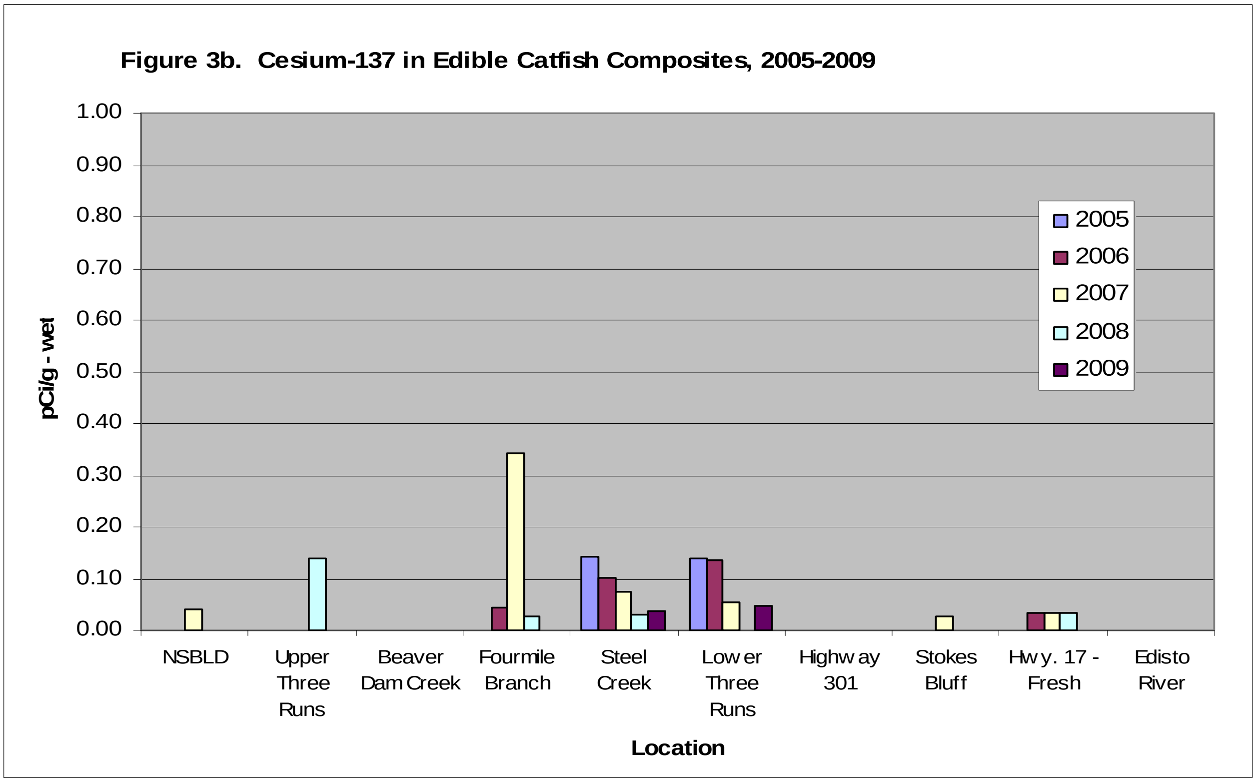


Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

Tables and Figures
Radiological Fish Monitoring

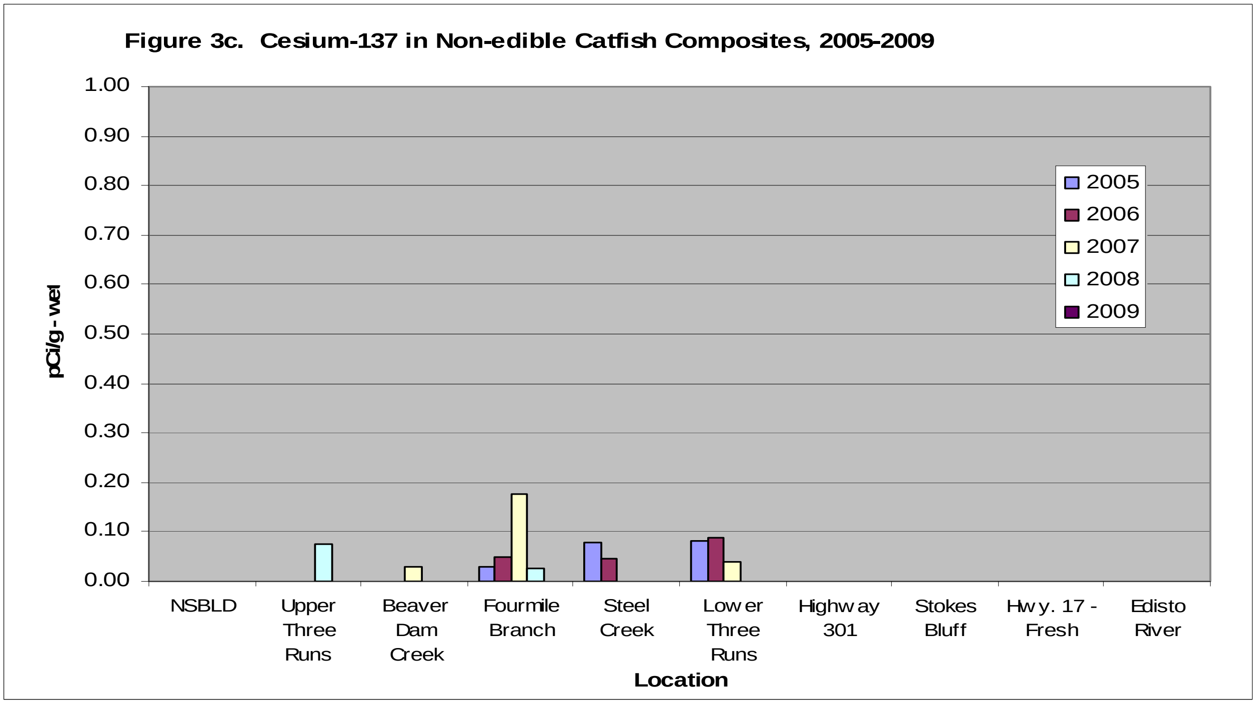


Note: No catfish collected from Stevens Creek

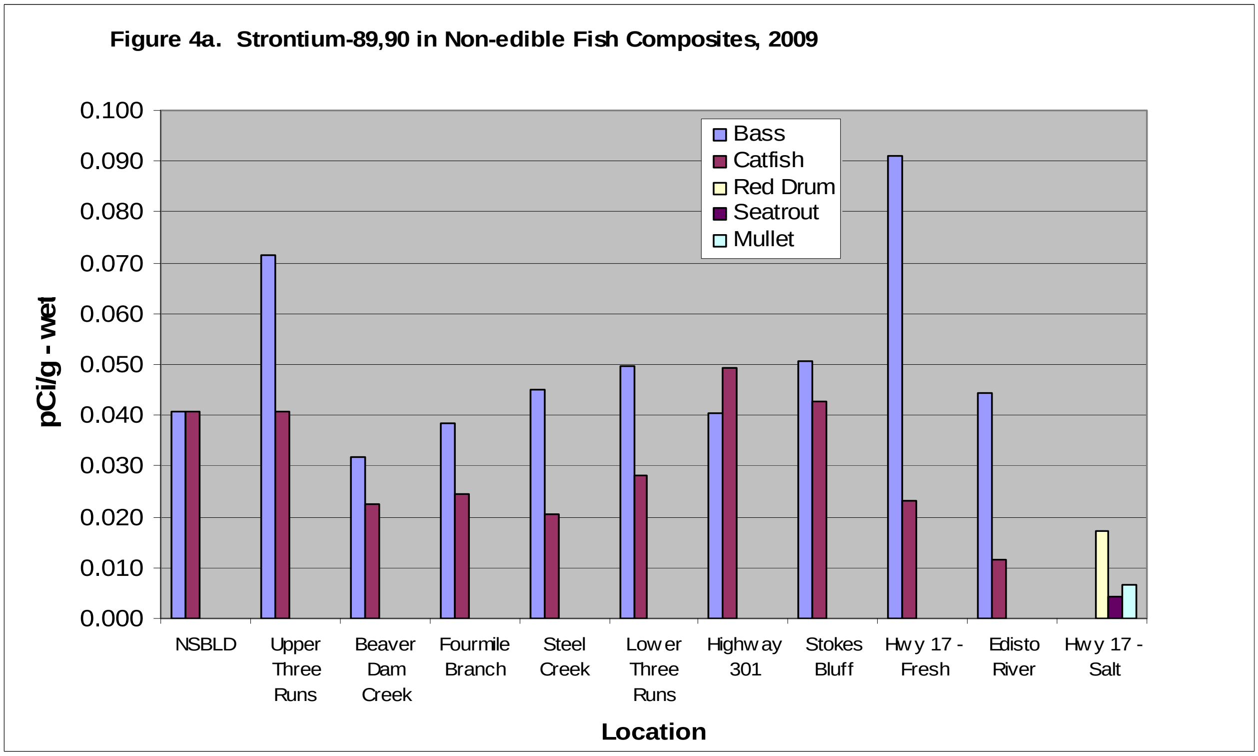


Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

Tables and Figures
Radiological Fish Monitoring

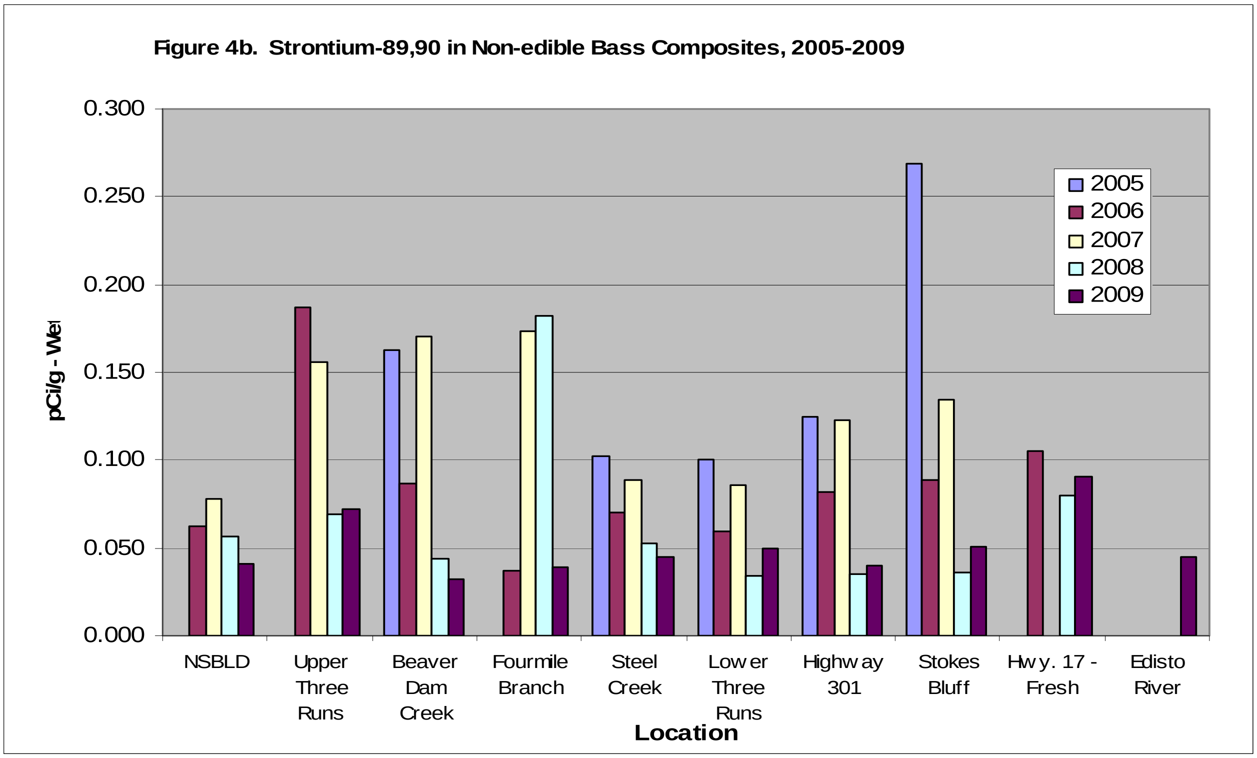


Note: Sampling at the Hwy. 17 location started in 2006
Sampling at the Edisto River location started in 2009

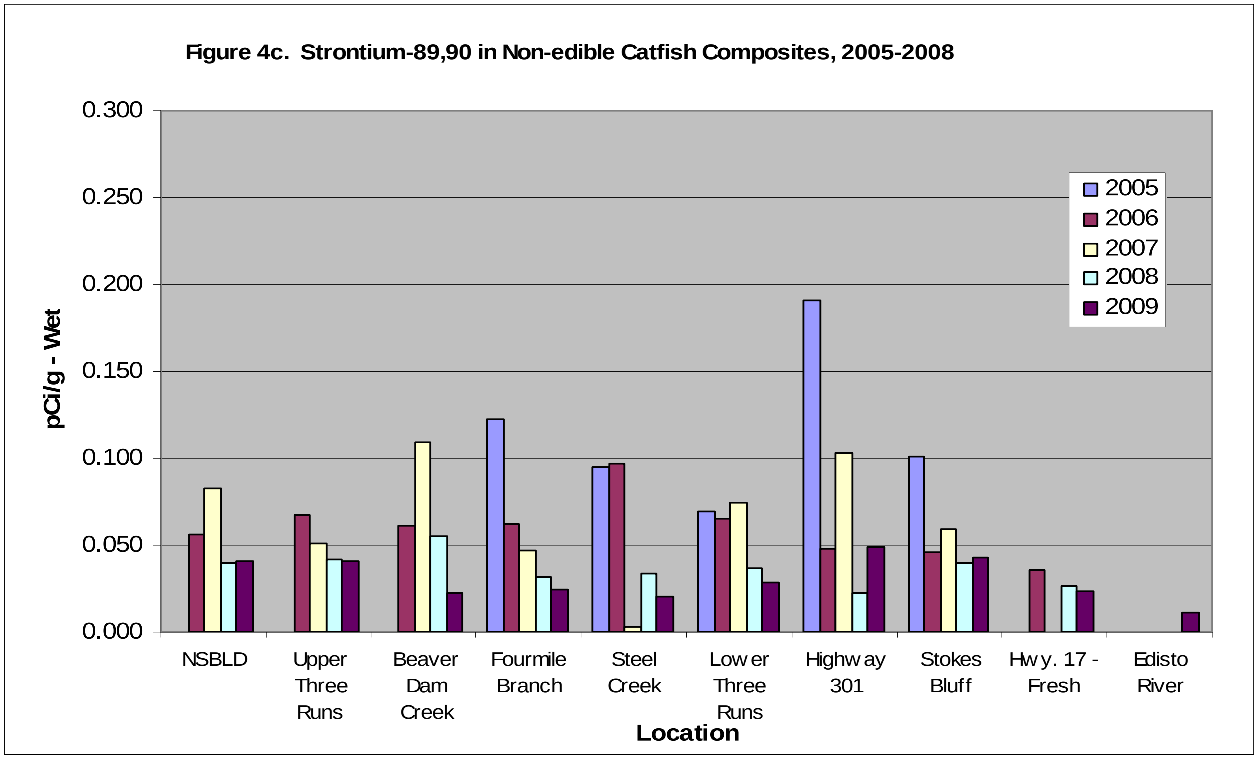


Note: Pickerel and Lake Brown catfish not analyzed for strontium; strontium not detected in seatrout

Tables and Figures
Radiological Fish Monitoring

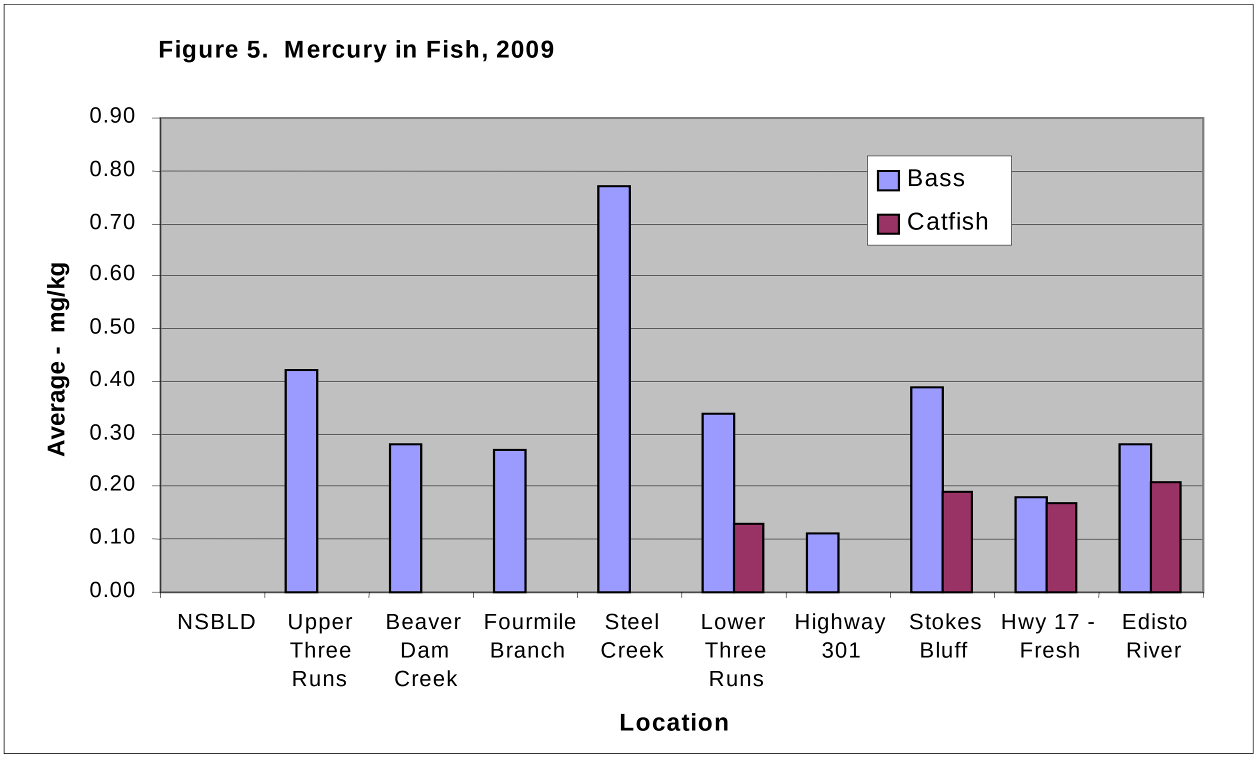


Note: Wet results not reported for Stevens Creek, NSBLD, Upper Three Runs, and Fourmile Branch in 2005; Hwy. 17 not sampled in 2005, not analyzed in 2007



Note: Wet results not reported for Upper Three Runs and Beaver Dam Creek in 2005
Hwy. 17 not sampled in 2005, not analyzed in 2007

Tables and Figures
Fish Monitoring Associated with the Savannah River Site



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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

2009 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
New Sav. Bluff	FMSV-2028A	Tritium Activity	4/27/2009	<LLD
Lock & Dam	FMSV-2028A	Tritium Confidence Interval	4/27/2009	NA
Bass	FMSV-2028A	Tritium LLD	4/27/2009	185
New Sav. Bluff	FMSV-2028C	Tritium Activity	4/27/2009	<LLD
Lock & Dam	FMSV-2028C	Tritium Confidence Interval	4/27/2009	NA
Catfish	FMSV-2028C	Tritium LLD	4/27/2009	185
New Sav. Bluff	FMSV-2028E	Tritium Activity	4/27/2009	<LLD
Lock & Dam	FMSV-2028E	Tritium Confidence Interval	4/27/2009	NA
Pickerel	FMSV-2028E	Tritium LLD	4/27/2009	185
Upper	FMSV-2011A	Tritium Activity	5/28/2009	209
Three Runs	FMSV-2011A	Tritium Confidence Interval	5/28/2009	87
Bass	FMSV-2011A	Tritium LLD	5/28/2009	185
Upper	FMSV-2011C	Tritium Activity	5/28/2009	<LLD
Three Runs	FMSV-2011C	Tritium Confidence Interval	5/28/2009	NA
Catfish	FMSV-2011C	Tritium LLD	5/28/2009	185
Beaver	FMSV-2013A	Tritium Activity	5/29/2009	<LLD
Dam Creek	FMSV-2013A	Tritium Confidence Interval	5/29/2009	NA
Bass	FMSV-2013A	Tritium LLD	5/29/2009	185
Beaver	FMSV-2013C	Tritium Activity	5/29/2009	<LLD
Dam Creek	FMSV-2013C	Tritium Confidence Interval	5/29/2009	NA
Catfish	FMSV-2013C	Tritium LLD	5/29/2009	185
Fourmile	FMSV-2015A	Tritium Activity	6/2/2009	893
Branch	FMSV-2015A	Tritium Confidence Interval	6/2/2009	112
Bass	FMSV-2015A	Tritium LLD	6/2/2009	185
Fourmile	FMSV-2015C	Tritium Activity	6/2/2009	298
Branch	FMSV-2015C	Tritium Confidence Interval	6/2/2009	90
Catfish	FMSV-2015C	Tritium LLD	6/2/2009	185

Radiological Monitoring of Fish

2009 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Steel	FMSV-2017A	Tritium Activity	5/14/2009	383
Creek	FMSV-2017A	Tritium Confidence Interval	5/14/2009	94
Bass	FMSV-2017A	Tritium LLD	5/14/2009	185
Steel	FMSV-2017C	Tritium Activity	5/14/2009	405
Creek	FMSV-2017C	Tritium Confidence Interval	5/14/2009	95
Catfish	FMSV-2017C	Tritium LLD	5/14/2009	185
Lower	FMSV-2020A	Tritium Activity	6/11/2009	468
Three Runs	FMSV-2020A	Tritium Confidence Interval	6/11/2009	97
Bass	FMSV-2020A	Tritium LLD	6/11/2009	185
Lower	FMSV-2020C	Tritium Activity	6/11/2009	216
Three Runs	FMSV-2020C	Tritium Confidence Interval	6/11/2009	87
Catfish	FMSV-2020C	Tritium LLD	6/11/2009	185
Hwy. 301	FMSV-118A	Tritium Activity	6/30/2009	<LLD
Bass	FMSV-118A	Tritium Confidence Interval	6/30/2009	NA
	FMSV-118A	Tritium LLD	6/30/2009	187
Hwy. 301	FMSV-118C	Tritium Activity	6/30/2009	205
Catfish	FMSV-118C	Tritium Confidence Interval	6/30/2009	87
	FMSV-118C	Tritium LLD	6/30/2009	187
Stokes	FMSV-355A	Tritium Activity	7/8/2009	550
Bluff	FMSV-355A	Tritium Confidence Interval	7/8/2009	101
Bass	FMSV-355A	Tritium LLD	7/8/2009	187
Stokes	FMSV-355C	Tritium Activity	7/8/2009	<LLD
Bluff	FMSV-355C	Tritium Confidence Interval	7/8/2009	NA
Catfish	FMSV-355C	Tritium LLD	7/8/2009	187

Radiological Monitoring of Fish

2009 Tritium Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/L) in Extracted Water
Hwy. 17	FMSV-2090A	Tritium Activity	7/7/2009	1870
Freshwater	FMSV-2090A	Tritium Confidence Interval	7/7/2009	141
Bass	FMSV-2090A	Tritium LLD	7/7/2009	187
Hwy. 17	FMSV-2090C	Tritium Activity	7/7/2009	1832
Freshwater	FMSV-2090C	Tritium Confidence Interval	7/7/2009	141
Catfish	FMSV-2090C	Tritium LLD	7/7/2009	187
Hwy. 17	FMSV-2091A	Tritium Activity	10/15/2009	378
Saltwater	FMSV-2091A	Tritium Confidence Interval	10/15/2009	95
Red drum	FMSV-2091A	Tritium LLD	10/15/2009	187
Hwy. 17	FMSV-2091C	Tritium Activity	10/15/2009	414
Saltwater	FMSV-2091C	Tritium Confidence Interval	10/15/2009	96
S. Seatrout	FMSV-2091C	Tritium LLD	10/15/2009	187
Hwy. 17	FMSV-2091E	Tritium Activity	10/15/2009	352
Saltwater	FMSV-2091E	Tritium Confidence Interval	10/15/2009	94
Mullet	FMSV-2091E	Tritium LLD	10/15/2009	187
Edisto	FMSV-119A	Tritium Activity	6/17/2009	<LLD
River	FMSV-119A	Tritium Confidence Interval	6/17/2009	NA
Bass	FMSV-119A	Tritium LLD	6/17/2009	187
Edisto	FMSV-119C	Tritium Activity	6/17/2009	<LLD
River	FMSV-119C	Tritium Confidence Interval	6/17/2009	NA
Catfish	FMSV-119C	Tritium LLD	6/17/2009	187

Radiological Monitoring of Fish

2009 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff	FMSV-2028A	Cs-137 Activity	4/27/2009	<MDA
Lock & Dam	FMSV-2028A	Cs-137 Confidence Interval	4/27/2009	NA
Bass	FMSV-2028A	Cs-137 MDA	4/27/2009	0.018
New Sav. Bluff	FMSV-2028C	Cs-137 Activity	4/27/2009	<MDA
Lock & Dam	FMSV-2028C	Cs-137 Confidence Interval	4/27/2009	NA
Catfish	FMSV-2028C	Cs-137 MDA	4/27/2009	0.018
New Sav. Bluff	FMSV-2028E	Cs-137 Activity	4/27/2009	<MDA
Lock & Dam	FMSV-2028E	Cs-137 Confidence Interval	4/27/2009	NA
Pickerel	FMSV-2028E	Cs-137 MDA	4/27/2009	0.021
Upper	FMSV-2011A	Cs-137 Activity	5/28/2009	<MDA
Three Runs	FMSV-2011A	Cs-137 Confidence Interval	5/28/2009	NA
Bass	FMSV-2011A	Cs-137 MDA	5/28/2009	0.016
Upper	FMSV-2011C	Cs-137 Activity	5/28/2009	<MDA
Three Runs	FMSV-2011C	Cs-137 Confidence Interval	5/28/2009	NA
Catfish	FMSV-2011C	Cs-137 MDA	5/28/2009	0.017
Beaver	FMSV-2013A	Cs-137 Activity	5/29/2009	0.634
Dam Creek	FMSV-2013A	Cs-137 Confidence Interval	5/29/2009	0.073
Bass	FMSV-2013A	Cs-137 MDA	5/29/2009	0.035
Beaver	FMSV-2013C	Cs-137 Activity	5/29/2009	<MDA
Dam Creek	FMSV-2013C	Cs-137 Confidence Interval	5/29/2009	NA
Catfish	FMSV-2013C	Cs-137 MDA	5/29/2009	0.016
Fourmile	FMSV-2015A	Cs-137 Activity	6/2/2009	<MDA
Branch	FMSV-2015A	Cs-137 Confidence Interval	6/2/2009	NA
Bass	FMSV-2015A	Cs-137 MDA	6/2/2009	0.031
Fourmile	FMSV-2015C	Cs-137 Activity	6/2/2009	<MDA
Branch	FMSV-2015C	Cs-137 Confidence Interval	6/2/2009	NA
Catfish	FMSV-2015C	Cs-137 MDA	6/2/2009	0.014

Radiological Monitoring of Fish

2009 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel	FMSV-2017A	Cs-137 Activity	5/14/2009	0.910
Creek	FMSV-2017A	Cs-137 Confidence Interval	5/14/2009	0.086
Bass	FMSV-2017A	Cs-137 MDA	5/14/2009	0.015
Steel	FMSV-2017C	Cs-137 Activity	5/14/2009	0.036
Creek	FMSV-2017C	Cs-137 Confidence Interval	5/14/2009	0.016
Catfish	FMSV-2017C	Cs-137 MDA	5/14/2009	0.016
Lower	FMSV-2020A	Cs-137 Activity	6/11/2009	0.353
Three Runs	FMSV-2020A	Cs-137 Confidence Interval	6/11/2009	0.044
Bass	FMSV-2020A	Cs-137 MDA	6/11/2009	0.030
Lower	FMSV-2020C	Cs-137 Activity	6/11/2009	0.048
Three Runs	FMSV-2020C	Cs-137 Confidence Interval	6/11/2009	0.017
Catfish	FMSV-2020C	Cs-137 MDA	6/11/2009	0.015
Hwy. 301	FMSV-118A	Cs-137 Activity	6/30/2009	0.041
Bass	FMSV-118A	Cs-137 Confidence Interval	6/30/2009	0.015
	FMSV-118A	Cs-137 MDA	6/30/2009	0.014
Hwy. 301	FMSV-118C	Cs-137 Activity	6/30/2009	<MDA
Catfish	FMSV-118C	Cs-137 Confidence Interval	6/30/2009	NA
	FMSV-118C	Cs-137 MDA	6/30/2009	0.015
Stokes	FMSV-355A	Cs-137 Activity	7/8/2009	0.053
Bluff	FMSV-355A	Cs-137 Confidence Interval	7/8/2009	0.019
Bass	FMSV-355A	Cs-137 MDA	7/8/2009	0.015
Stokes	FMSV-355C	Cs-137 Activity	7/8/2009	<MDA
Bluff	FMSV-355C	Cs-137 Confidence Interval	7/8/2009	NA
Catfish	FMSV-355C	Cs-137 MDA	7/8/2009	0.018

Radiological Monitoring of Fish

2009 Cs-137 Data

Edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17 Freshwater Bass	FMSV-2090A	Cs-137 Activity	7/7/2009	<MDA
	FMSV-2090A	Cs-137 Confidence Interval	7/7/2009	NA
	FMSV-2090A	Cs-137 MDA	7/7/2009	0.032
Hwy. 17 Freshwater Catfish	FMSV-2090C	Cs-137 Activity	7/7/2009	<MDA
	FMSV-2090C	Cs-137 Confidence Interval	7/7/2009	NA
	FMSV-2090C	Cs-137 MDA	7/7/2009	0.026
Edisto River Bass	FMMD-119A	Cs-137 Activity	6/17/2009	0.097
	FMMD-119A	Cs-137 Confidence Interval	6/17/2009	0.029
	FMMD-119A	Cs-137 MDA	6/17/2009	0.032
Edisto River Catfish	FMMD-119C	Cs-137 Activity	6/17/2009	<MDA
	FMMD-119C	Cs-137 Confidence Interval	6/17/2009	NA
	FMMD-119C	Cs-137 MDA	6/17/2009	0.038
Hwy. 17 Saltwater Red drum	FMSV-2091A	Cs-137 Activity	10/15/2009	<MDA
	FMSV-2091A	Cs-137 Confidence Interval	10/15/2009	NA
	FMSV-2091A	Cs-137 MDA	10/15/2009	0.022
Hwy. 17 Saltwater S. Seatrout	FMSV-2091C	Cs-137 Activity	10/15/2009	<MDA
	FMSV-2091C	Cs-137 Confidence Interval	10/15/2009	NA
	FMSV-2091C	Cs-137 MDA	10/15/2009	0.023
Hwy. 17 Saltwater Mullet	FMSV-2091E	Cs-137 Activity	10/15/2009	<MDA
	FMSV-2091E	Cs-137 Confidence Interval	10/15/2009	NA
	FMSV-2091E	Cs-137 MDA	10/15/2009	0.021

Radiological Monitoring of Fish

2009 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff	FMSV-2028B	Cs-137 Activity	4/27/2009	<MDA
Lock & Dam	FMSV-2028B	Cs-137 Confidence Interval	4/27/2009	NA
Bass	FMSV-2028B	Cs-137 MDA	4/27/2009	0.025
New Sav. Bluff	FMSV-2028D	Cs-137 Activity	4/27/2009	<MDA
Lock & Dam	FMSV-2028D	Cs-137 Confidence Interval	4/27/2009	NA
Catfish	FMSV-2028D	Cs-137 MDA	4/27/2009	0.020
Upper	FMSV-2011B	Cs-137 Activity	5/28/2009	0.042
Three Runs	FMSV-2011B	Cs-137 Confidence Interval	5/28/2009	0.017
Bass	FMSV-2011B	Cs-137 MDA	5/28/2009	0.017
Upper	FMSV-2011D	Cs-137 Activity	5/28/2009	<MDA
Three Runs	FMSV-2011D	Cs-137 Confidence Interval	5/28/2009	NA
Catfish	FMSV-2011D	Cs-137 MDA	5/28/2009	0.022
Beaver	FMSV-2013B	Cs-137 Activity	5/29/2009	<MDA
Dam Creek	FMSV-2013B	Cs-137 Confidence Interval	5/29/2009	NA
Bass	FMSV-2013B	Cs-137 MDA	5/29/2009	0.022
Beaver	FMSV-2013D	Cs-137 Activity	5/29/2009	<MDA
Dam Creek	FMSV-2013D	Cs-137 Confidence Interval	5/29/2009	NA
Catfish	FMSV-2013D	Cs-137 MDA	5/29/2009	0.024
Fourmile	FMSV-2015B	Cs-137 Activity	6/2/2009	<MDA
Branch	FMSV-2015B	Cs-137 Confidence Interval	6/2/2009	NA
Bass	FMSV-2015B	Cs-137 MDA	6/2/2009	0.017
Fourmile	FMSV-2015D	Cs-137 Activity	6/2/2009	<MDA
Branch	FMSV-2015D	Cs-137 Confidence Interval	6/2/2009	NA
Catfish	FMSV-2015D	Cs-137 MDA	6/2/2009	0.019

Radiological Monitoring of Fish
2009 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel Creek Bass	FMSV-2017B	Cs-137 Activity	5/14/2009	0.512
	FMSV-2017B	Cs-137 Confidence Interval	5/14/2009	0.050
	FMSV-2017B	Cs-137 MDA	5/14/2009	0.017
Steel Creek Catfish	FMSV-2017D	Cs-137 Activity	5/14/2009	<MDA
	FMSV-2017D	Cs-137 Confidence Interval	5/14/2009	NA
	FMSV-2017D	Cs-137 MDA	5/14/2009	0.022
Lower Three Runs Bass	FMSV-2020B	Cs-137 Activity	6/11/2009	0.160
	FMSV-2020B	Cs-137 Confidence Interval	6/11/2009	0.035
	FMSV-2020B	Cs-137 MDA	6/11/2009	0.017
Lower Three Runs Catfish	FMSV-2020D	Cs-137 Activity	6/11/2009	<MDA
	FMSV-2020D	Cs-137 Confidence Interval	6/11/2009	NA
	FMSV-2020D	Cs-137 MDA	6/11/2009	0.026
Hwy. 301 Bass	FMSV-118B	Cs-137 Activity	6/30/2009	<MDA
	FMSV-118B	Cs-137 Confidence Interval	6/30/2009	NA
	FMSV-118B	Cs-137 MDA	6/30/2009	0.021
Hwy. 301 Catfish	FMSV-118D	Cs-137 Activity	6/30/2009	<MDA
	FMSV-118D	Cs-137 Confidence Interval	6/30/2009	NA
	FMSV-118D	Cs-137 MDA	6/30/2009	0.021
Stokes Bluff Bass	FMSV-355B	Cs-137 Activity	7/8/2009	<MDA
	FMSV-355B	Cs-137 Confidence Interval	7/8/2009	NA
	FMSV-355B	Cs-137 MDA	7/8/2009	0.020
Stokes Bluff Catfish	FMSV-355D	Cs-137 Activity	7/8/2009	<MDA
	FMSV-355D	Cs-137 Confidence Interval	7/8/2009	NA
	FMSV-355D	Cs-137 MDA	7/8/2009	0.023

Radiological Monitoring of Fish
2009 Cs-137 Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17	FMSV-2090B	Cs-137 Activity	7/7/2009	<MDA
Freshwater	FMSV-2090B	Cs-137 Confidence Interval	7/7/2009	NA
Bass	FMSV-2090B	Cs-137 MDA	7/7/2009	0.018
Hwy. 17	FMSV-2090D	Cs-137 Activity	7/7/2009	<MDA
Freshwater	FMSV-2090D	Cs-137 Confidence Interval	7/7/2009	NA
Catfish	FMSV-2090D	Cs-137 MDA	7/7/2009	0.019
Edisto	FMMD-119B	Cs-137 Activity	6/17/2009	0.066
River	FMMD-119B	Cs-137 Confidence Interval	6/17/2009	0.024
Bass	FMMD-119B	Cs-137 MDA	6/17/2009	0.019
Edisto	FMMD-119D	Cs-137 Activity	6/17/2009	<MDA
River	FMMD-119D	Cs-137 Confidence Interval	6/17/2009	NA
Catfish	FMMD-119D	Cs-137 MDA	6/17/2009	0.025
Hwy. 17	FMSV-2091B	Cs-137 Activity	10/15/2009	<MDA
Saltwater	FMSV-2091B	Cs-137 Confidence Interval	10/15/2009	NA
Red drum	FMSV-2091B	Cs-137 MDA	10/15/2009	0.024
Hwy. 17	FMSV-2091D	Cs-137 Activity	10/15/2009	<MDA
Saltwater	FMSV-2091D	Cs-137 Confidence Interval	10/15/2009	NA
S. Seatrout	FMSV-2091D	Cs-137 MDA	10/15/2009	0.024
Hwy. 17	FMSV-2091F	Cs-137 Activity	10/15/2009	<MDA
Saltwater	FMSV-2091F	Cs-137 Confidence Interval	10/15/2009	NA
Mullet	FMSV-2091F	Cs-137 MDA	10/15/2009	0.024

Radiological Monitoring of Fish
2009 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
New Sav. Bluff	FMSV-2028B	Strontium-89,90	4/27/2009	0.041
Lock & Dam	FMSV-2028B	Strontium Uncertainty	4/27/2009	0.007
Bass	FMSV-2028B	Strontium MDA	4/27/2009	0.011
New Sav. Bluff	FMSV-2028D	Strontium-89,90	4/27/2009	0.041
Lock & Dam	FMSV-2028D	Strontium Uncertainty	4/27/2009	0.007
Catfish	FMSV-2028D	Strontium MDA	4/27/2009	0.011
Upper	FMSV-2011B	Strontium-89,90	5/28/2009	0.072
Three Runs	FMSV-2011B	Strontium Uncertainty	5/28/2009	0.010
Bass	FMSV-2011B	Strontium MDA	5/28/2009	0.015
Upper	FMSV-2011D	Strontium-89,90	5/28/2009	0.041
Three Runs	FMSV-2011D	Strontium Uncertainty	5/28/2009	0.008
Catfish	FMSV-2011D	Strontium MDA	5/28/2009	0.014
Beaver	FMSV-2013B	Strontium-89,90	5/29/2009	0.032
Dam Creek	FMSV-2013B	Strontium Uncertainty	5/29/2009	0.002
Bass	FMSV-2013B	Strontium MDA	5/29/2009	0.004
Beaver	FMSV-2013D	Strontium-89,90	5/29/2009	0.023
Dam Creek	FMSV-2013D	Strontium Uncertainty	5/29/2009	0.001
Catfish	FMSV-2013D	Strontium MDA	5/29/2009	0.003
Fourmile	FMSV-2015B	Strontium-89,90	6/2/2009	0.038
Branch	FMSV-2015B	Strontium Uncertainty	6/2/2009	0.002
Bass	FMSV-2015B	Strontium MDA	6/2/2009	0.006
Fourmile	FMSV-2015D	Strontium-89,90	6/2/2009	0.025
Branch	FMSV-2015D	Strontium Uncertainty	6/2/2009	0.002
Catfish	FMSV-2015D	Strontium MDA	6/2/2009	0.004

Radiological Monitoring of Fish
2009 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Steel	FMSV-2017B	Strontium-89,90	5/14/2009	0.045
Creek	FMSV-2017B	Strontium Uncertainty	5/14/2009	0.003
Bass	FMSV-2017B	Strontium MDA	5/14/2009	0.006
Steel	FMSV-2017D	Strontium-89,90	5/14/2009	0.020
Creek	FMSV-2017D	Strontium Uncertainty	5/14/2009	0.001
Catfish	FMSV-2017D	Strontium MDA	5/14/2009	0.003
Lower	FMSV-2020B	Strontium-89,90	6/11/2009	0.050
Three Runs	FMSV-2020B	Strontium Uncertainty	6/11/2009	0.008
Bass	FMSV-2020B	Strontium MDA	6/11/2009	0.013
Lower	FMSV-2020D	Strontium-89,90	6/11/2009	0.028
Three Runs	FMSV-2020D	Strontium Uncertainty	6/11/2009	0.007
Catfish	FMSV-2020D	Strontium MDA	6/11/2009	0.013
Hwy. 301	FMSV-118B	Strontium-89,90	6/30/2009	0.040
Bass	FMSV-118B	Strontium Uncertainty	6/30/2009	0.008
	FMSV-118B	Strontium MDA	6/30/2009	0.014
Hwy. 301	FMSV-118D	Strontium-89,90	6/30/2009	0.049
Catfish	FMSV-118D	Strontium Uncertainty	6/30/2009	0.008
	FMSV-118D	Strontium MDA	6/30/2009	0.012
Stokes	FMSV-355B	Strontium-89,90	7/8/2009	0.051
Bluff	FMSV-355B	Strontium Uncertainty	7/8/2009	0.007
Bass	FMSV-355B	Strontium MDA	7/8/2009	0.010
Stokes	FMSV-355D	Strontium-89,90	7/8/2009	0.043
Bluff	FMSV-355D	Strontium Uncertainty	7/8/2009	0.007
Catfish	FMSV-355D	Strontium MDA	7/8/2009	0.011

Radiological Monitoring of Fish
2009 Strontium Data

Non-edible Samples	Location Description	Analyte	Collection Date	Result (pCi/g) Fresh Weight
Hwy. 17	FMSV-2090B	Strontium-89,90	7/7/2009	0.091
Freshwater	FMSV-2090B	Strontium Uncertainty	7/7/2009	0.010
Bass	FMSV-2090B	Strontium MDA	7/7/2009	0.013
Hwy. 17	FMSV-2090D	Strontium-89,90	7/7/2009	0.023
Freshwater	FMSV-2090D	Strontium Uncertainty	7/7/2009	0.007
Catfish	FMSV-2090D	Strontium MDA	7/7/2009	0.012
Edisto	FMMD-119B	Strontium-89,90	6/17/2009	0.044
River	FMMD-119B	Strontium Uncertainty	6/17/2009	0.008
Bass	FMMD-119B	Strontium MDA	6/17/2009	0.013
Edisto	FMMD-119D	Strontium-89,90	6/17/2009	0.012
River	FMMD-119D	Strontium Uncertainty	6/17/2009	0.002
Catfish	FMMD-119D	Strontium MDA	6/17/2009	0.004
Hwy. 17	FMSV-2091B	Strontium-89,90	10/15/2009	0.017
Saltwater	FMSV-2091B	Strontium Uncertainty	10/15/2009	0.003
Red drum	FMSV-2091B	Strontium MDA	10/15/2009	0.006
Hwy. 17	FMSV-2091D	Strontium-89,90	10/15/2009	0.004
Saltwater	FMSV-2091D	Strontium Uncertainty	10/15/2009	0.001
S. Seatrout	FMSV-2091D	Strontium MDA	10/15/2009	0.002
Hwy. 17	FMSV-2091F	Strontium-89,90	10/15/2009	0.007
Saltwater	FMSV-2091F	Strontium Uncertainty	10/15/2009	0.001
Mullet	FMSV-2091F	Strontium MDA	10/15/2009	0.003

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2005-2009

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
2009	Radionuclide	Tritium (pCi/L)	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
2005			ND	ND	ND	2,572	836

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
2009	Radionuclide	Tritium (pCi/L)	468	ND	550	1,870	ND
2008			436	301	279	215	NS
2007			518	396	477	ND	NS
2006			474	454	265	368	NS
2005			403	257	ND	NS	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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			ND	0.144	0.096	0.547	0.182

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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			0.182	0.053	ND	NS	NS

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Edisto R. - Edisto river

Fish Monitoring Data
SCDHEC Historical Radiological Data, 2005-2009

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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			ND	0.084	0.042	0.314	0.113

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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			0.122	ND	ND	NS	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
2009	Radionuclide	Sr-89,90 (pCi/g Wet)	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
2005			NR	NR	0.163	NR	0.102

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
2009	Radionuclide	Sr-89,90 (pCi/g Wet)	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
2005			0.100	0.125	0.269	NS	NS

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Fish Monitoring Data
SCDHEC Historical Radiological Data, 2005-2009

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
2009	Radionuclide	Tritium (pCi/L)	ND	ND	ND	298	405
2008			ND	278	ND	507	247
2007			ND	ND	233	2,010	1,120
2006			302	ND	469	1,779	2,104
2005			ND	ND	ND	669	340

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
2009	Radionuclide	Tritium (pCi/L)	216	205	ND	1832	ND
2008			406	373	ND	ND	NS
2007			484	621	396	273	NS
2006			451	423	296	ND	NS
2005			362	ND	ND	NS	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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			ND	ND	ND	ND	0.143

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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			0.140	ND	ND	NS	NS

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Fish Monitoring Data

SCDHEC Historical Radiological Data, 2005-2009

	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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			ND	ND	ND	0.028	0.078

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
2009	Radionuclide	Cs-137 (pCi/g wet)	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
2005			0.082	ND	ND	NS	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
2009	Radionuclide	Sr-89,90 (pCi/g Wet)	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
2005			ND	NR	NR	0.122	0.095

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
2009	Radionuclide	Sr-89,90 (pCi/g Wet)	0.028	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
2005			0.070	0.191	0.101	NS	NS

Notes:
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LTR - Lower Three Runs
Stokes - Stokes Bluff
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Fish Monitoring Data
SCDHEC Historical Radiological Data, 2005-2009

Year	**Sample Location**		Hwy. 17	Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091	SV-2091
	Sample Cut		Edible	Edible	Edible
	Species		Red drum	Seatrout	Mullet
2009	Radionuclide	Tritium (pCi/L)	378	414	352
2008			ND	ND	300
2007			ND	ND	ND
2006			223	296	303
2005			NS	NS	NS

Year	**Sample Location**		Hwy. 17	Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091	SV-2091
	Sample Cut		Edible	Edible	Edible
	Species		Red drum	Seatrout	Mullet
2009	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND
2008			ND	ND	ND
2007			ND	ND	ND
2006			ND	ND	ND
2005			NS	NS	NS

Year	**Sample Location**		Hwy. 17	Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible	Non-edible
	Species		Red drum	Seatrout	Mullet
2009	Radionuclide	Cs-137 (pCi/g wet)	ND	ND	ND
2008			ND	ND	ND
2007			NA	NA	NA
2006			ND	ND	NA
2005			NS	NS	NS

Year	**Sample Location**		Hwy. 17	Hwy. 17	Hwy. 17
	Sample Station		SV-2091	SV-2091	SV-2091
	Sample Cut		Non-edible	Non-edible	Non-edible
	Species		Red drum	Seatrout	Mullet
2009	Radionuclide	Sr-89,90 (pCi/g Wet)	0.017	0.004	0.007
2008			0.010	ND	0.006
2007			NA	NA	NA
2006			0.015	ND	NA
2005			NS	NS	NS

Notes: ND - Non-Detect
NA - Not Analyzed
NS - Not Sampled

Fish Monitoring Data
2009 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
New Sav. Bluff Lock & Dam Bass	FMSV-2028A-1	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028A-2	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028A-3	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028A-4	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028A-5	Mercury in Fish	4/27/2009	<0.10
New Sav. Bluff Lock & Dam Catfish	FMSV-2028C-1	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028C-2	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028C-3	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028C-4	Mercury in Fish	4/27/2009	<0.10
	FMSV-2028C-5	Mercury in Fish	4/27/2009	<0.10
Upper Three Runs Bass	FMSV-2011A-1	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011A-2	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011A-3	Mercury in Fish	5/28/2009	0.42
	FMSV-2011A-4	Mercury in Fish	5/28/2009	0.41
	FMSV-2011A-5	Mercury in Fish	5/28/2009	<0.10
Upper Three Runs Catfish	FMSV-2011C-1	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011C-2	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011C-3	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011C-4	Mercury in Fish	5/28/2009	<0.10
	FMSV-2011C-5	Mercury in Fish	5/28/2009	<0.10
Beaver Dam Creek Bass	FMSV-2013A-1	Mercury in Fish	5/29/2009	<0.10
	FMSV-2013A-2	Mercury in Fish	6/18/2009	<0.10
	FMSV-2013A-3	Mercury in Fish	6/18/2009	0.28
	FMSV-2013A-4	Mercury in Fish	7/14/2009	<0.10
	FMSV-2013A-5	Mercury in Fish	7/14/2009	<0.10
Beaver Dam Creek Catfish	FMSV-2013C-1	Mercury in Fish	5/29/2009	<0.10
	FMSV-2013C-2	Mercury in Fish	5/29/2009	<0.10
	FMSV-2013C-3	Mercury in Fish	5/29/2009	<0.10
	FMSV-2013C-4	Mercury in Fish	5/29/2009	<0.10
	FMSV-2013C-5	Mercury in Fish	5/29/2009	<0.10

Fish Monitoring Data
2009 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Fourmile Branch Bass	FMSV-2015A-1	Mercury in Fish	6/2/2009	<0.10
	FMSV-2015A-2	Mercury in Fish	7/14/2009	0.52
	FMSV-2015A-3	Mercury in Fish	7/14/2009	<0.10
	FMSV-2015A-4	Mercury in Fish	7/14/2009	0.19
	FMSV-2015A-5	Mercury in Fish	7/14/2009	0.1
Fourmile Branch Catfish	FMSV-2015C-1	Mercury in Fish	6/2/2009	<0.10
	FMSV-2015C-2	Mercury in Fish	6/18/2009	<0.10
	FMSV-2015C-3	Mercury in Fish	7/14/2009	<0.10
	FMSV-2015C-4	Mercury in Fish	7/14/2009	<0.10
Steel Creek Bass	FMSV-2017A-1	Mercury in Fish	5/14/2009	0.5
	FMSV-2017A-2	Mercury in Fish	5/14/2009	0.24
	FMSV-2017A-3	Mercury in Fish	5/14/2009	1.4
	FMSV-2017A-4	Mercury in Fish	5/14/2009	0.95
	FMSV-2017A-5	Mercury in Fish	5/14/2009	<0.10
Steel Creek Catfish	FMSV-2017C-1	Mercury in Fish	5/14/2009	<0.10
	FMSV-2017C-2	Mercury in Fish	5/14/2009	<0.10
	FMSV-2017C-3	Mercury in Fish	5/14/2009	<0.10
	FMSV-2017C-4	Mercury in Fish	5/14/2009	<0.10
	FMSV-2017C-5	Mercury in Fish	5/14/2009	<0.10
Lower Three Runs Bass	FMSV-2020A-1	Mercury in Fish	6/11/2009	<0.10
	FMSV-2020A-2	Mercury in Fish	6/11/2009	0.12
	FMSV-2020A-3	Mercury in Fish	6/11/2009	<0.10
	FMSV-2020A-4	Mercury in Fish	6/30/2009	0.22
	FMSV-2020A-5	Mercury in Fish	9/14/2009	0.68
Lower Three Runs Catfish	FMSV-2020C-1	Mercury in Fish	6/11/2009	<0.10
	FMSV-2020C-2	Mercury in Fish	6/11/2009	<0.10
	FMSV-2020C-3	Mercury in Fish	6/11/2009	0.13
	FMSV-2020C-4	Mercury in Fish	6/11/2009	<0.10
	FMSV-2020C-5	Mercury in Fish	6/11/2009	<0.10

Fish Monitoring Data
2009 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Hwy. 301 Bass	FMSV-118A-1	Mercury in Fish	6/30/2009	0.11
	FMSV-118A-2	Mercury in Fish	6/30/2009	<0.10
	FMSV-118A-3	Mercury in Fish	6/30/2009	<0.10
	FMSV-118A-4	Mercury in Fish	6/30/2009	<0.10
	FMSV-118A-5	Mercury in Fish	6/30/2009	<0.10
Hwy. 301 Catfish	FMSV-118C-1	Mercury in Fish	6/30/2009	<0.10
	FMSV-118C-2	Mercury in Fish	6/30/2009	<0.10
	FMSV-118C-3	Mercury in Fish	6/30/2009	<0.10
	FMSV-118C-4	Mercury in Fish	6/30/2009	<0.10
	FMSV-118C-5	Mercury in Fish	6/30/2009	<0.10
Stokes Bluff Bass	FMSV-355A-1	Mercury in Fish	7/8/2009	0.32
	FMSV-355A-2	Mercury in Fish	7/8/2009	0.14
	FMSV-355A-3	Mercury in Fish	7/8/2009	0.76
	FMSV-355A-4	Mercury in Fish	7/8/2009	0.32
Stokes Bluff Catfish	FMSV-355C-1	Mercury in Fish	7/8/2009	0.2
	FMSV-355C-2	Mercury in Fish	7/8/2009	<0.10
	FMSV-355C-3	Mercury in Fish	7/8/2009	0.17
	FMSV-355C-4	Mercury in Fish	7/8/2009	<0.10
Hwy. 17 Bass	FMSV-2090A-1	Mercury in Fish	7/7/2009	0.19
	FMSV-2090A-2	Mercury in Fish	7/7/2009	0.24
	FMSV-2090A-3	Mercury in Fish	7/7/2009	0.17
	FMSV-2090A-4	Mercury in Fish	7/7/2009	<0.10
	FMSV-2090A-5	Mercury in Fish	7/7/2009	0.11
Hwy. 17 Catfish	FMSV-2090C-1	Mercury in Fish	7/7/2009	<0.10
	FMSV-2090C-2	Mercury in Fish	7/7/2009	0.19
	FMSV-2090C-3	Mercury in Fish	7/7/2009	0.12
	FMSV-2090C-4	Mercury in Fish	7/7/2009	0.18
	FMSV-2090C-5	Mercury in Fish	7/7/2009	0.2

Fish Monitoring Data
2009 Mercury Data

Edible Samples	Location Description	Analyte	Collection Date	Result (mg/kg)
Hwy. 17 Red Drum	FMSV-2091A-1	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091A-2	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091A-3	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091A-4	Mercury in Fish	10/15/2009	<0.10
Hwy. 17 Seatrout	FMSV-2091C-1	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091C-2	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091C-3	Mercury in Fish	10/15/2009	<0.10
	FMSV-2091C-4	Mercury in Fish	10/15/2009	<0.10
Edisto River Bass	FMMD-119A-1	Mercury in Fish	6/17/2009	0.14
	FMMD-119A-2	Mercury in Fish	6/17/2009	0.27
	FMMD-119A-3	Mercury in Fish	6/17/2009	0.59
	FMMD-119A-4	Mercury in Fish	7/16/2009	0.17
	FMMD-119A-5	Mercury in Fish	6/17/2009	0.21
Edisto River Catfish	FMMD-119C-1	Mercury in Fish	7/16/2009	0.21
	FMMD-119C-2	Mercury in Fish	6/17/2009	<0.10
	FMMD-119C-3	Mercury in Fish	6/17/2009	<0.10

Fish Monitoring Data
2009 SCDHEC and DOE-SR Data Comparison

Table 1
Tritium Activity Levels in Edible Bass
pCi/g[1]

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<LLD
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	0.209
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	<LLD
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	0.893
	DOE-SR	3	.092*
Steel Creek	ESOP	1	0.383
	DOE-SR	3	0.156
Lower Three Runs	ESOP	1	0.468
	DOE-SR	3	<MDC
Hwy. 301	ESOP	1	<LLD
	DOE-SR	3	<MDC
Stokes Bluff	ESOP	1	0.550
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	1.870
	DOE-SR	3	<MDC
Average[2]	ESOP	6	0.729
	DOE-SR	2	0.124
Standard Deviation[2]	ESOP	6	0.603
	DOE-SR	2	0.045

Table 2
Tritium Activity Levels in Edible Catfish
pCi/g[1]

Location	Agency	# of samples	Result
NSBLD	ESOP	1	<LLD
	DOE-SR	3	<MDC
Upper Three Runs	ESOP	1	<LLD
	DOE-SR	3	<MDC
Beaver Dam Creek	ESOP	1	<LLD
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	0.298
	DOE-SR	3	0.103
Steel Creek	ESOP	1	0.405
	DOE-SR	3	<MDC
Lower Three Runs	ESOP	1	216
	DOE-SR	3	<MDC
Hwy. 301	ESOP	1	205
	DOE-SR	3	<MDC
Stokes Bluff	ESOP	1	<LLD
	DOE-SR	3	.067**
Hwy. 17	ESOP	1	1.832
	DOE-SR	3	<MDC
Average[2]	ESOP	5	0.591
	DOE-SR	2	0.085
Standard Deviation[2]	ESOP	5	0.698
	DOE-SR	2	0.025

Notes:
[1]ESOP - per gram of water in fish tissue
DOE-SR data from SRNS 2010
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only
N/A - Not Applicable

Fish Monitoring Data
2009 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	<MDA
	DOE-SR	3	0.07
Beaver Dam Creek	ESOP	1	0.63
	DOE-SR	3	0.06
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	.06**
Steel Creek	ESOP	1	0.91
	DOE-SR	3	.067*
Lower Three Runs	ESOP	1	0.35
	DOE-SR	3	0.34
Hwy. 301	ESOP	1	0.041
	DOE-SR	3	0.041
Stokes Bluff	ESOP	1	0.05
	DOE-SR	3	<MDC
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	5	0.40
	DOE-SR	6	0.11
Standard Deviation[2]	ESOP	5	0.38
	DOE-SR	6	0.12

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	.01*
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	<MDC
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	<MDC
Steel Creek	ESOP	1	0.04
	DOE-SR	3	.04*
Lower Three Runs	ESOP	1	0.05
	DOE-SR	3	.26*
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	2	0.04
	DOE-SR	3	0.10
Standard Deviation[2]	ESOP	2	0.01
	DOE-SR	3	0.13

Notes: DOE-SR data from SRNS 2010
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring
2009 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	0.04
	DOE-SR	3	0.04
Beaver Dam Creek	ESOP	1	<MDA
	DOE-SR	3	.02*
Fourmile Branch	ESOP	1	<MDA
	DOE-SR	3	0.05
Steel Creek	ESOP	1	0.51
	DOE-SR	3	.04**
Lower Three Runs	ESOP	1	0.16
	DOE-SR	3	0.18
Hwy. 301	ESOP	1	<MDA
	DOE-SR	3	0.03
Stokes Bluff	ESOP	1	<MDA
	DOE-SR	3	.03**
Hwy. 17	ESOP	1	<MDA
	DOE-SR	3	<MDC
Average[2]	ESOP	3	0.24
	DOE-SR	7	0.06
Standard Deviation[2]	ESOP	3	0.24
	DOE-SR	7	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	<MDC
Lower Three Runs	ESOP	1	<MDA
	DOE-SR	3	0.11
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	0	N/A
	DOE-SR	1	0.11
Standard Deviation[2]	ESOP	0	N/A
	DOE-SR	1	N/A

Notes: DOE-SR data from SRNS 2010
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

Fish Monitoring Data
2009 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	0.04
	DOE-SR	3	0.09
Upper Three Runs	ESOP	1	0.07
	DOE-SR	3	0.09
Beaver Dam Creek	ESOP	1	0.03
	DOE-SR	3	0.08
Fourmile Branch	ESOP	1	0.04
	DOE-SR	3	0.10
Steel Creek	ESOP	1	0.05
	DOE-SR	3	0.08
Lower Three Runs	ESOP	1	0.05
	DOE-SR	3	0.08
Hwy. 301	ESOP	1	0.04
	DOE-SR	3	0.04
Stokes Bluff	ESOP	1	0.05
	DOE-SR	3	0.09
Hwy. 17	ESOP	1	0.09
	DOE-SR	3	0.09
Average[2]	ESOP	9	0.05
	DOE-SR	9	0.08
Standard Deviation[2]	ESOP	9	0.02
	DOE-SR	9	0.01

Table 8
Strontium-89,90 Activity Levels in Non-edible Catfish
pCi/g

Location	Agency	# of samples	Result
NSBLD	ESOP	1	0.04
	DOE-SR	3	0.06
Upper Three Runs	ESOP	1	0.04
	DOE-SR	3	0.14
Beaver Dam Creek	ESOP	1	0.02
	DOE-SR	3	0.08
Fourmile Branch	ESOP	1	0.03
	DOE-SR	3	0.08
Steel Creek	ESOP	1	0.02
	DOE-SR	3	0.07
Lower Three Runs	ESOP	1	0.03
	DOE-SR	3	0.08
Hwy. 301	ESOP	1	0.05
	DOE-SR	3	0.06
Stokes Bluff	ESOP	1	0.04
	DOE-SR	3	0.05
Hwy. 17	ESOP	1	0.02
	DOE-SR	3	0.08
Average[2]	ESOP	9	0.03
	DOE-SR	9	0.08
Standard Deviation[2]	ESOP	9	0.01
	DOE-SR	9	0.03

Notes:
DOE-SR data from SRNS 2010
DOE-SR results are averages
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only
NA - Not Analyzed

Fish Monitoring Data
2009 SCDHEC and DOE-SR Data Comparison

Mercury Levels in Edible Bass mg/kg			
Location	Agency	# of samples	Result
NSBLD	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.24
Upper Three Runs	ESOP	5 (2)	0.42
	DOE-SR	15(15)	0.61
Beaver Dam Creek	ESOP	5 (1)	0.28
	DOE-SR	15(15)	0.30
Fourmile Branch	ESOP	5 (3)	0.27
	DOE-SR	15(15)	0.23
Steel Creek	ESOP	5 (4)	0.77
	DOE-SR	15(15)	0.21
Lower Three Runs	ESOP	5 (3)	0.34
	DOE-SR	15(15)	0.27
Hwy. 301	ESOP	5 (1)	0.11
	DOE-SR	15(15)	0.43
Stokes Bluff	ESOP	4 (4)	0.39
	DOE-SR	15(15)	0.59
Hwy. 17	ESOP	5 (4)	0.18
	DOE-SR	15(15)	0.24
Average[2]	ESOP	44 (22)	0.38
	DOE-SR	140(140)	0.35
Standard Deviation[2]	ESOP	44 (22)	0.32
	DOE-SR	140(140)	0.27

Mercury Levels in Edible Catfish mg/kg			
Location	Agency	# of samples	Result
NSBLD	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.09
Upper Three Runs	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.30
Beaver Dam Creek	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.07
Fourmile Branch	ESOP	4 (0)	<PQL
	DOE-SR	15(15)	0.12
Steel Creek	ESOP	5 (0)	<PQL
	DOE-SR	11(11)	0.10
Lower Three Runs	ESOP	5 (1)	0.13
	DOE-SR	19(19)	0.15
Hwy. 301	ESOP	5 (0)	<PQL
	DOE-SR	15(15)	0.21
Stokes Bluff	ESOP	4 (2)	0.19
	DOE-SR	15(15)	0.20
Hwy. 17	ESOP	5 (4)	0.17
	DOE-SR	15(15)	0.40
Average[2]	ESOP	43 (7)	0.17
	DOE-SR	135(135)	0.18
Standard Deviation[2]	ESOP	43 (7)	0.03
	DOE-SR	135(135)	0.18

Notes:
DOE-SR data from SRNS 2010
( ) denotes number of detections
Results are averages, unless ( ) = 1
* includes one result below MDC
** includes two results below MDC
[2]Calculated using detections only

PQL - Practical Quantitation Limit
mg/kg - milligrams per kilogram
DOE-SR results converted from ug/g (microgram per gram)

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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.

2009 Fish Monitoring Summary Statistics

Tritium Levels (pCi/L) in Savannah River Fish, 2009

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	6 (3)	729	603	509	1870	209
Catfish	5 (4)	591	698	298	1832	205
Pickerel	0 (1)	N/A	N/A	N/A	N/A	N/A

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, 2009

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	5 (4)	0.398	0.376	0.353	0.910	0.041
Catfish	2 (7)	0.042	0.008	0.042	0.048	0.036
Pickerel	0 (1)	N/A	N/A	N/A	N/A	N/A
Non-edible	**N (ND)**	**Average**	**Standard Deviation**	**Median**	**Maximum**	**Minimum**
Bass	3 (6)	0.355	0.271	0.512	0.512	0.042
Catfish	0 (9)	N/A	N/A	N/A	N/A	N/A

Non-detections (ND) excluded from computations
Non-edible pickerel not analyzed

Strontium-89,90 Levels (pCi/g - Wet) in Savannah River Fish, 2009

Non-edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	9 (0)	0.051	0.019	0.045	0.091	0.032
Catfish	9 (0)	0.033	0.011	0.011	0.049	0.020

Mercury Levels (mg/kg) in Savannah River Fish, 2009

Edible	N (ND)	Average	Standard Deviation	Median	Maximum	Minimum
Bass	44 (22)	0.38	0.32	0.24	1.4	0.1
Catfish	43 (7)	0.17	0.03	0.18	0.2	0.12

Non-detections (ND) excluded from computations

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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 of 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. 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. Of all of the mammalian species investigated, white-tailed deer and feral hogs have shown the highest potential for a human exposure pathway for 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, consequently, 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. Cs-137 is of concern because of its relatively long physical half-life of 30 years, and its availability to game animals and associated health risk to humans.

Cs-137 is readily incorporated into the human body because of its similarity to potassium-40 (K-40) in physiological processes (Davis 1963). Cs-137 concentrates in animal skeletal muscles, which are selectively consumed by hunters (Brisbin 1975). Cs-137 is an important radionuclide because of its relatively long physical half-life of 30 years and its associated health risks (Haselow 1991). Cs-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 South Carolina Department of Health and Environmental Control (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 2009 for Cs-137 from 47 deer and seven hogs collected from area hunters via hunting clubs, plantations, and Crackerneck Wildlife Management Area within a five-mile study area adjacent to the SRS.

Additionally, 12 tissue samples were collected and analyzed from a background location 120 miles northeast of the SRS in the McBee, South Carolina area. Cesium-137 data ranged from less than the minimum detectable activity (MDA) to 3.13 picocuries per gram (pCi/g) for deer within the five-mile study area adjacent to the SRS. Cesium-137 data ranged from 0.77 to 3.60 pCi/g for deer at the 120-mile background location. Sample size, location, and collection dates were dependent on the participating hunters. ESOP was not able to obtain any hog samples from hunters in 2009.

RESULTS AND DISCUSSION

Cs-137

Cesium-137 and the naturally occurring isotopes K-40, lead-212, lead-214, and radium-226 were the only isotopes detected in game samples collected in 2009. 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 (Map 15, Section 4.2.2). Analytical results are listed under each zone in Section 4.2.4.

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 Laboratory. A number of other facilities handled material containing Cs-137, but releases, if any are not documented.

A total of 47 deer and seven hog samples were collected within five miles of the SRS perimeter. Twelve deer background samples were collected 120 miles northeast of the SRS. ESOP compared Cs-137 activities to DOE-SR results.

ESOP and DOE-SR Data Comparison

Cesium-137 activities from the 47 SCDHEC perimeter deer samples ranged from less than the MDA (<MDA) to 3.13 pCi/g, with an average of 0.89 (± 0.81) pCi/g (Section 4.2.5). Cesium-137 activities from the seven SCDHEC perimeter hog samples ranged from <MDA to 0.05 pCi/g with an average of 0.05 (± 0.01) pCi/g (Section 4.2.5). All SCDHEC hunt zone averages were within one standard deviation of the overall perimeter average. Results from the 12 background samples (Section 6.0) ranged from 0.77 pCi/g to 3.60 pCi/g, with an average of 1.81 (± 0.88) pCi/g. DOE-SR reported an approximate field measurement range of 1 pCi/g to 9.17 pCi/g with an average of 1.38 pCi/g from 396 deer and 1.06 pCi/g from 78 feral hogs harvested on the SRS in 2009 (SRNS 2010). The DOE-SR field average was within three standard deviations 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 2009 perimeter Cs-137 average result, 0.89 pCi/g, is within two standard deviations of the background average 1.81 (± 0.88) pCi/g. The 2005 to 2009 SCDHEC yearly off-site Cs-137 average activity, 0.90 (± 0.26) pCi/g, is within two standard deviations of the DOE-SR on-site average of 2.04 (± 0.58) pCi/g (Section 7.0). 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/RECOMMENDATIONS

A portion of the elevated Cs-137 activity found in deer harvested in hunt zones five and six Figure 2, (Section 4.2.3) may be attributed to historic SRS operations. These 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 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 USEPA, 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.

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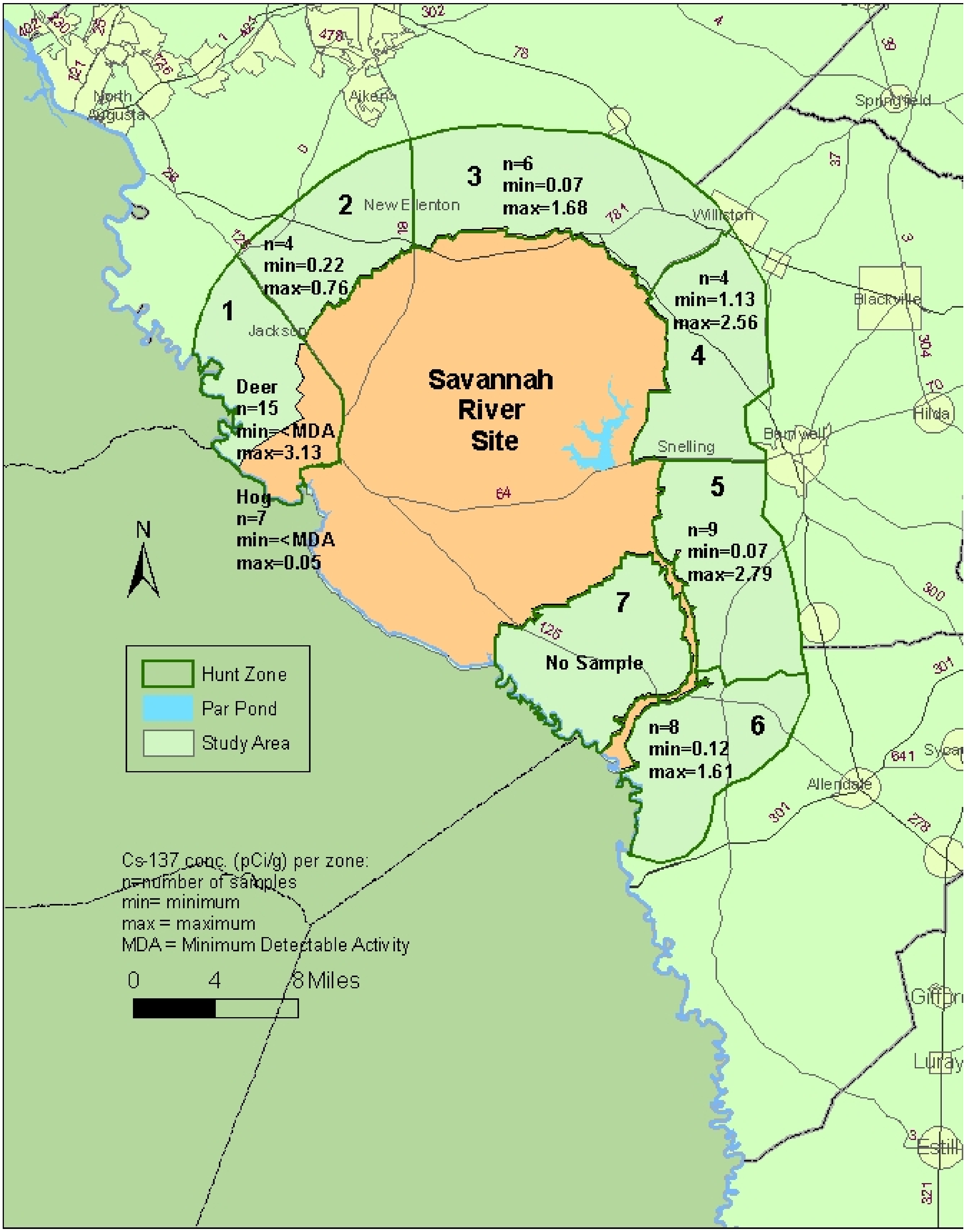
4.2.2

Map. 15 Cesium-137 Ranges In Game Animals Adjacent to SRS, 2009



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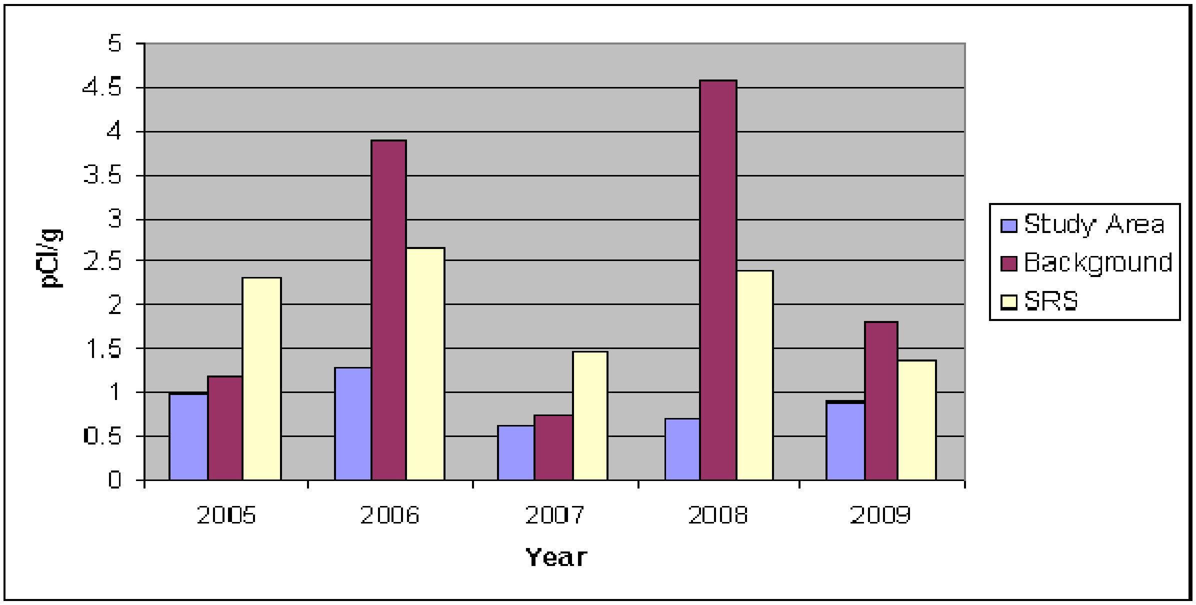
4.2.3 Tables and Figures

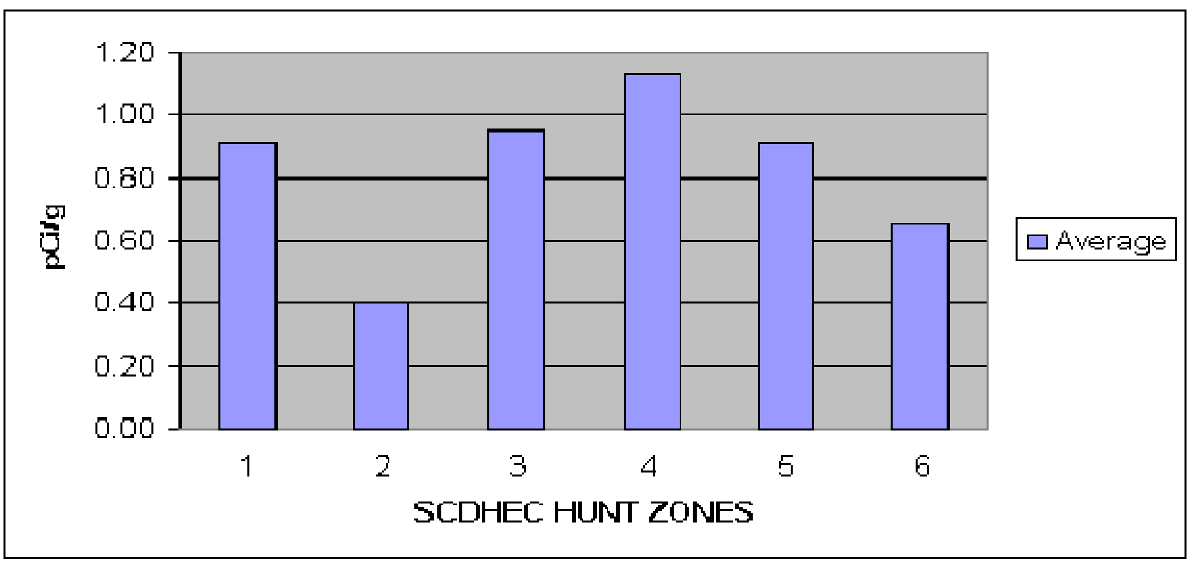
Radiological Game Animal Monitoring Adjacent to SRS

Figure 1. Average Cs-137 Concentration In Deer, 2005-2009



Background Locations
2004 - 2005 = Francis Marion National Forest. Hellhole Wildlife Management Area
2006 - 2008 = Carolina Sandhills National Wildlife Refuge

Figure 2. SCDHEC Hunt Zone Average Cs-137 Concentration In Deer, 2009



4.2.4 Data

Radiological Game Animal Monitoring Adjacent to SRS

Notes:
19. MDA - Minimum Detectable Activity
20. Sig - Sigma

Radiological Game Animal Monitoring Adjacent to SRS Project Data

2009 Perimeter Cs-137 Data

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/19/2009	10/19/2009	10/19/2009	10/19/2009	10/19/2009	10/19/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Buck	Buck
Weight	Pounds	120	110	120	175	125	90
Cesium-137	(pCi/g) wet	0.34	0.92	0.22	0.13	1.1	0.92
Uncertainty	(+/- 2sig)	0.05	0.08	0.04	0.04	0.10	0.08
MDA	(pCi/g) wet	0.03	0.03	0.03	0.03	0.04	0.03

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/19/2009	10/19/2009	10/19/2009	10/19/2009	10/19/2009	10/17/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Buck	Buck	Buck	Buck
Weight	Pounds	125	85	105	100	85	80
Cesium-137	(pCi/g) wet	0.11	0.83	<MDA	2.02	0.38	<MDA
Uncertainty	(+/- 2sig)	0.03	0.07	NA	0.16	0.05	NA
MDA	(pCi/g) wet	0.03	0.03	0.04	0.04	0.03	0.04

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		10/17/2009	10/17/2009	10/17/2009	10/22/2009	8/20/2009	8/20/2009
Species		Deer	Deer	Deer	Deer	Hog	Hog
Sex		Buck	Doe	Buck	Doe	Boar	Sow
Weight	Pounds	195	85	145	110	200	80
Cesium-137	(pCi/g) wet	0.68	0.98	3.13	1.07	<MDA	<MDA
Uncertainty	(+/- 2sig)	0.07	0.09	0.23	0.10	NA	NA
MDA	(pCi/g) wet	0.03	0.04	0.04	0.02	0.02	0.02

Sample Location		Zone-1	Zone-1	Zone-1	Zone-1	Zone-1
Sample Date		8/20/2009	8/24/2009	9/19/2009	9/20/2009	9/20/2009
Species		Hog	Hog	Hog	Hog	Hog
Sex		Sow	Boar	Boar	Sow	Sow
Weight	Pounds	25	400	85	150	125
Cesium-137	(pCi/g) wet	<MDA	0.04	0.05	<MDA	<MDA
Uncertainty	(+/- 2sig)	NA	0.02	0.02	NA	NA
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02

Sample Location		Zone-2	Zone-2	Zone-2	Zone-2
Sample Date		12/2/2009	12/2/2009	12/2/2009	12/2/2009
Species		Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck
Weight	Pounds	185	175	180	140
Cesium-137	(pCi/g) wet	0.78	0.22	0.25	0.37
Uncertainty	(+/- 2sig)	0.07	0.03	0.03	0.04
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02

Sample Location		Zone-3	Zone-3	Zone-3	Zone-3	Zone-3	Zone-3
Sample Date		10/17/2009	10/17/2009	10/17/2009	10/17/2009	10/22/2009	10/22/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Buck	Doe	Buck	Buck	Doe	Doe
Weight	Pounds	105	70	110	95	85	115
Cesium-137	(pCi/g) wet	0.87	1.89	0.44	0.07	1.44	1.19
Uncertainty	(+/- 2sig)	0.08	0.14	0.05	0.02	0.13	0.11
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02	0.02

Radiological Game Animal Monitoring Adjacent to SRS Project Data

2009 Perimeter Data

Sample Location		Zone-4	Zone-4	Zone-4	Zone-4
Sample Date		11/1/2009	11/1/2009	12/2/2009	12/2/2009
Species		Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck
Weight	Pounds	190	140	130	125
Cesium-137	(pCi/g) wet	2.99	1.13	1.79	1.62
Uncertainty	(+/- 2sig)	0.21	0.10	0.15	0.16
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02

Sample Location		Zone-4	Zone-6	Zone-4	Zone-4	Zone-4	Zone-4
Sample Date		11/17/2009	11/17/2009	11/17/2009	11/17/2009	11/17/2009	11/17/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Buck	Buck	Buck	Buck
Weight	Pounds	165	145	110	175	140	130
Cesium-137	(pCi/g) wet	2.79	2.84	0.07	0.10	0.13	0.20
Uncertainty	(+/- 2sig)	0.23	0.22	0.02	0.03	0.03	0.04
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02	0.02

Sample Location		Zone-4	Zone-6	Zone-4
Sample Date		12/2/2009	12/2/2009	12/2/2009
Species		Deer	Deer	Deer
Sex		Doe	Buck	Doe
Weight	Pounds	110	130	90
Cesium-137	(pCi/g) wet	0.16	0.79	1.37
Uncertainty	(+/- 2sig)	0.03	0.07	0.12
MDA	(pCi/g) wet	0.02	0.02	0.02

Sample Location		Zone-9	Zone-9	Zone-9	Zone-9	Zone-9	Zone-9
Sample Date		11/27/2009	11/27/2009	11/27/2009	11/27/2009	11/27/2009	11/27/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Doe	Doe	Buck	Doe	Doe	Buck
Weight	Pounds	110	90	135	95	105	130
Cesium-137	(pCi/g) wet	0.72	0.12	0.39	0.47	0.18	0.47
Uncertainty	(+/- 2sig)	0.07	0.03	0.04	0.05	0.03	0.05
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02	0.02

Sample Location		Zone-9	Zone-9
Sample Date		11/27/2009	11/27/2009
Species		Deer	Deer
Sex		Doe	Buck
Weight	Pounds	95	125
Cesium-137	(pCi/g) wet	1.61	1.32
Uncertainty	(+/- 2sig)	0.14	0.12
MDA	(pCi/g) wet	0.02	0.02

Radiological Game Animal Monitoring Adjacent to SRS Project Data

2009 Background Data

Sample Location		Background	Background	Background	Background	Background	Background
Sample Date		11/5/2009	11/5/2009	11/5/2009	11/5/2009	11/5/2009	11/5/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Buck	Buck	Doe	Buck	Buck	Doe
Weight	Pounds	87	164	100	105	132	119
Cesium-137	(pCi/g) wet	2.77	1.12	1.40	0.77	2.21	1.53
Uncertainty	(+/- 2sig)	0.22	0.10	0.12	0.07	0.18	0.13
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02	0.02

Sample Location		Background	Background	Background	Background	Background	Background
Sample Date		11/5/2009	11/5/2009	11/5/2009	11/5/2009	11/5/2009	11/5/2009
Species		Deer	Deer	Deer	Deer	Deer	Deer
Sex		Doe	Buck	Buck	Buck	Buck	Buck
Weight	Pounds	78	142	125	139	117	107
Cesium-137	(pCi/g) wet	1.04	2.63	2.15	0.83	3.60	1.62
Uncertainty	(+/- 2sig)	0.09	0.21	0.17	0.07	0.29	0.14
MDA	(pCi/g) wet	0.02	0.02	0.02	0.02	0.02	0.02

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4.2.5 Summary Statistics

Radiological Game Animal Monitoring Adjacent to SRS

Notes:

13. N - Number of Samples
14. Std.Dev. - Standard Deviation
15. Min - Minimum
16. Max - Maximum
17. MDA - Minimum Detectable Activity
18. 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 2009

	N	Average	Std. Dev.	Median	Min.	Max
Study Area Deer	47	0.69	0.61	0.63	<MDA	3.13
Study Area Hogs	7	0.05	0.01	0.05	<MDA	0.05
Background Deer	12	1.81	0.89	1.69	0.77	3.80

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected in 2009 SCDHEC Hunt Zones

Hunt Zone	N	Average	Std. Dev.	Median	Min.	Max
Zone 1 Deer	16	0.91	0.83	0.61	<MDA	3.13
Zone 1 Hogs	7	0.05	0.01	0.05	<MDA	0.05
Zone 2	4	0.40	0.25	0.31	0.22	0.78
Zone 3	6	0.95	0.61	1.03	0.07	1.69
Zone 4	4	1.83	0.68	1.81	1.13	2.68
Zone 5	9	0.91	1.11	0.20	0.07	2.79
Zone 6	8	0.85	0.64	0.47	0.12	1.81

Cs-137 concentration (pCi/g wet weight) in deer and hogs collected from 2005 - 2009

	Year	N	Average	Std.Dev	Median	Min.	Max.
Study Area	2005	68	0.98	0.87	0.70	< MDA	4.32
Background	2005	16	1.19	0.38	1.25	0.49	1.80
SRS	2005	216	2.32	NA	NA	1.00	8.10
Study Area	2006	68	1.29	1.05	0.85	< MDA	3.90
Background	2006	60	3.90	1.38	3.68	1.17	7.02
SRS	2006	324	2.85	NA	NA	1.00	9.05
Study Area	2007	65	0.62	0.61	0.38	< MDA	3.30
Background	2007	20	0.76	0.68	0.67	0.16	2.09
SRS	2007	398	1.48	NA	NA	1.00	8.70
Study Area	2008	61	0.72	0.63	0.38	<MDA	4.80
Background	2008	10	4.69	2.45	4.11	1.91	10.69
SRS	2008	432	2.40	NA	NA	1.00	12.85
Study Area	2009	47	0.69	0.61	0.63	<MDA	3.13
Background	2009	12	1.81	0.89	1.69	0.77	3.80
SRS Deer	2009	398	1.39	NA	NA	1.00	9.17
SRS Hogs	2009	78	1.08	NA	NA	1.00	2.78
Study Area Deer	2005 -2009	297	0.90	0.28	0.69	< MDA	4.80
Background Deer	2005 -2009	117	2.46	1.70	0.68	0.16	10.69
SRS Deer	2005 -2009	1765	2.04	0.68	2.32	1.00	12.85

Background Locations
2004 - 2005 - Francis Marion National Forest. Hellhole Wildlife Management Area
2006 - 2008 - Carolina Sandhills National Wildlife Refuge

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5.1 2009 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 and SCDHEC 1999-2009). 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 (1999-2008) 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 (Section 5.1.1). 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 (Section 5.1.2 Table 1), scenario (Section 5.1.2 Table 2), and individual optional scenario (Section 5.1.2 Table 1) 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 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, e.g., a one time filling of a water cistern from the Savannah River water. Even where one time storage of an exposure does not seem possible, the MAX calculation also represents an upper limit estimate of potential accumulated exposure that may not have been detected. 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 data were assigned to the maximally exposed individual (MEI). The health of the public and environment are protected when all of these estimates are below established protective dose standards for the various pathways of exposure.

The 2009 non-scenario media calculations were represented on an average exposed individual (AEI) basis and as a single highest detection exposure (MAX) per media basis above the average background (Section 5.1.2 Table 1). The MAX (12.920 mrem) 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 totals (1.378 mrem). Individual exposures may be 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 added DOE-SR releases that were not detected (Section 5.1.2 Tables 1 and 3).

The SCDHEC plus DOE total (24.570 mrem) for applicable MAX (assigned to the maximum exposed individual or MEI) is based on the total of the highest possible exposure from environmental media (MAX column) 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 SCDHEC data alone, which calculate a dose relative to public exposure activities (Section 5.1.2 Table 2) in 2009 and averaged over the period 1999-2009: 1) Public scenario - 0.202 mrem in 2009 and averaged 0.094 (± 0.056) mrem with a median of 0.093 mrem; 2) Farmer scenario – 0.203 mrem in 2009 and averaged 0.122 (± 0.113) mrem with a median of 0.074 mrem; 3) Average Sportsman scenario – 1.072 mrem in 2009 and averaged 1.419 (± 1.445) mrem with a median of 1.072 mrem; 4) Average Survivalist scenario – 1.378 mrem in 2009 and averaged 1.514 (± 1.443) mrem with a median of 1.183 mrem; 5) MAX Sportsman scenario – 11.306 mrem in 2009 and averaged 11.407 (± 10.454) mrem with a median of 9.168 mrem; and 6) MAX Survivalist scenario – 12.920 mrem in 2009 and averaged 7.753 (± 4.503) mrem with a median of 5.677 mrem. The MAX Survivalist scenario annual dose was the highest in all years and the average was lower only because it was a new scenario that started in 2008. The 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, e.g., edible wild fungi consumption.

The main non-NORM radionuclide dose contributions from 1999 through 2009 were 18.008 mrem from Cs-137, 1.069 mrem from all SR-89/90, and 0.829 mrem from tritium (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 (Section 5.1.1 Dose Critique).

The SCDHEC 2009 AEI exposures from APW total airborne (0.612 mrem) and LPW (0.793 mrem, mostly tritium) pathway accumulations were within the respective 10 mrem and 4 mrem annual DOE release limits (Section 5.1.2 Table 1). An upper bound MEI dose potential using combined data from DOE-SR and SCDHEC, but excluding NORM (24.570 mrem) was within the 100-mrem annual DOE dose limit. Most SCDHEC detected dose represented accumulated dose over many years (not just 2009 releases), and yet was within the yearly air, liquid, and facility public dose total release limit of 100 mrem (SRNS 2010).

RESULTS AND DISCUSSION

The SCDHEC MEI was a subsistence and survivalist type of individual who resided in the downriver swamp area below all SRS contributions to the Savannah River, and received the MEI dose based on the single highest detection per radionuclide per media collected in the environment (highest potential dose). Section 5.0 contains the dose data tables from which all other tables and figures are derived. The 2009 data and dose results are discussed under the following headings in section 5.1.1: the 2009 non-scenario basis, scenario basis, the individual optional personal scenario, the 2009 added dose basis, the DOE-SR and SCDHEC comparisons, critical pathways summary, 1999-2009 statistical summary, and dose critique. The statistical summary covers the 1999-2009 period, whereas the other headings except critical pathways discuss only 2009 data. The critical pathways were analyzed both on a 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 the DOE-SR and SCDHEC estimates may or may not be similar.

The 2009 Non-Scenario Basis

The 2009 non-scenario media calculations were represented on an AEI and MAX basis per media above the average background (Section 5.1.2 Table 1). Radiation exposures to a single highest detection greater than background from each radionuclide exposure per media were assigned to the SCDHEC MEI. This MEI (12.920 mrem) basis provides a radiation exposure limit based on the single highest potential dose detections (upper bound estimate). 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 the maximum exposure rate (protective). This MEI dose was due mostly to single maximum food detections (from MAX column, Section 5.1.2 Table 1) 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 closer to the AEI media totals in Section 5.1.2 Table 1, 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, e.g., a one time storage of river or rainwater in a cistern for use within the year.

Each media radionuclide dose above background excluding NORM was considered as part of a different critical pathway lifestyle with contributions through the inhalation, ingestion, and direct exposure routes. The typical perimeter dose exposure greater than background (if the individual were exsposed to all media collected) would most likely occur on an AEI (1.378 mrem) basis (Section 5.1.2 Table 1). 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 (1.378 mrem) or MAX detection (12.920 mrem) basis that excludes probable NORM. The SCDHEC plus DOE dose total for applicable MAX (assigned to the MEI) was based on the total of the highest possible exposure from SCDHEC environmental media (MAX column) detections plus all other dose detected or modeled by DOE-SR greater than the respective SCDHEC detections that had the potential to impact the public (Section 5.1.2 Table 3).

Only specific radionuclide (speciated) doses were included in the estimated dose for 2009. The use of detections only in determining averages above background per radionuclide per media (AEI), the calculation of dose based on the single highest detection (MAX) for each radionuclide/media, and conservative consumption references provided a protective dose estimate. The SCDHEC MEI grand total was based on the total of all SCDHEC MAX detections plus any release estimates by DOE-SR not detected by SCDHEC. 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 alpha as plutonium-239 (Pu-239) and beta as strontium-90 (Sr-90) more than doubles 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

An All-Sources Dose Upper Bound and a Perimeter Dose total are given in Section 5.1.2 Table 1 for the AEI and MAX column totals. The All-Sources Dose Upper Bound totals for AEI (1.405 mrem) and MAX (12.988 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. The All-Sources Upper Bound dose total is not an achievable dose based on temporal and location conflicts, the same consumption factor for all water sources (not proportioned out), and the fact that single MAX detections are treated as if they occurred at unvarying concentration activities (were stored and used) throughout the entire year. The Perimeter Dose total is an applicable dose potential estimate 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 was used (underlined in Section 5.1.2 Table 1) instead of proportioning each water source. The AEI air inhalation (0.000 mrem), food ingestion (1.341 mrem), and direct exposure (0.001 mrem) totals were added to the highest drinking water dose (0.030 mrem) and the swimming ingestion dose (0.006 mrem) to obtain the 2009 Perimeter Dose AEI results. The 2009 MAX perimeter dose potential used the same logic and resulted in 0.001 mrem for air inhalation, 12.557 mrem for food ingestion, 0.358 mrem for water ingestion, and 0.004 mrem direct exposure for a total MAX perimeter dose of 12.920 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 (protective). The AEI and MAX applicable Perimeter Dose totals used only the single highest drinking water source (underlined in Section 5.1.2 Table 1) on an AEI and MAX basis, respectively.

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 (12.920 mrem). The perimeter AEI dose total (more realistic) was 1.378 mrem in 2009 (AEI) and no individual dose should exceed the MAX dose total (12.920 mrem) on a non-scenario basis. The exception was the addition of DOE-SR additional dose potential not measured by SCDHEC that was included in a combined SCDHEC and DOE-SR MEI estimate that should capture the upper bound for any nondetected dose. A personal scenario different from those described above can be calculated per the following: add any applicable MAX column media dose detections to the perimeter AEI column dose total, then subtract the corresponding AEI column dose to determine a personal scenario dose potential. Leave out or subtract any media dose for which there was no media exposure. Note the 1.378 mrem AEI perimeter dose was approximately the same dose attributed to watching TV for 1.5 years, while the 12.920 mrem perimeter MAX dose was similar to the dose typically received from NORM by living in a brick house (7 mrem) for two years (SCDHEC 2006b). Also, compare this dose to the AEI NORM dose exposure for people living in the United States (300 mrem) (Section 5.1.2 Figure 2). 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 1998 food protective action guideline of 500 mrem to the whole body indicates that dose level health concerns were higher than the NORM plus non-NORM dose in 2009 (USDHHS 1998).

The 2009 Scenario Basis

Four basic AEI and two MAX scenarios were developed based on SCDHEC data alone, which calculate a potential dose relative to public exposure activities (Section 5.1.2 Table 2). See the results section 2.0 for the six scenario details for 2009. Even the AEI totals were conservative estimates of potential dose and should be greater than any actual typical dose per individual.

The basic scenario results for 1999-2009 are given in the summary statistics section 5.1.4 and 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.

Four critical pathway basic scenarios (Public, Farmer, Sportsman, and Survivalist) were calculated in 2009 as estimates for the general public dose potential based on averages for lifestyle activities that result in media exposure (Section 5.1.2 Table 2). The following calculations come from the AEI column in Section 5.1.2 Table 1. The Public scenario dose total for 2009 (0.202 mrem) was based on the non-scenario AEI dose potential from air (0.000 mrem), the highest public water supply (0.009 mrem), the milk (0.002 mrem), and the edible vegetation (0.191 mrem) (Section 5.1.2 Table 1). Most of this dose estimate (0.186 mrem) was due to Sr-90 in wild plums found at one location near Snellings. The dose estimate for the public who does not eat wild plums was typically less than 0.016 mrem. The Farmer scenario dose (0.203 mrem) was based on substituting the highest AEI dose from groundwater (0.009 mrem) (also the highest public water supply dose), and adding the air, edible vegetation, milk dose, and soil shine (0.001 mrem) plus resuspended soil inhalation (0.000 mrem). The Average Sportsman scenario dose total (1.072 mrem) was based on adding the fish (0.740 mrem), sediment and soil (0.001 mrem) ingestion, game animal dose (0.101 mrem), and the highest water dose (0.030 mrem) in place of the wellwater dose to the Farmer dose. The sportsman may boil surface water for consumption in the field especially at fish fries near the Savannah River. Then add recreational AEI swimming ingestion dose (0.006 mrem) at creek mouths, and sediment dose from wading barefoot (0.000 mrem) to give a total of 1.072 mrem for the average sportsman. The Average Survivalist scenario dose (1.378 mrem) was based on adding the remaining dose (resident swamp dweller was 0.000 mrem, and edible fungi dose was 0.306 mrem) to the sportsman dose (1.072 mrem). The Average Survivalist scenario dose was equal to the AEI perimeter dose (1.378 mrem), since the Survivalist received all dose detections greater than background. Note that only one drinking water dose (the highest per scenario source) was used in each scenario.

Two additional scenario basis averages (MAX column calculations) were developed to represent the highest potential exposures for the MAX Sportsman and the MAX Survivalist, which received the highest dose. The MAX Sportsman Scenario dose (11.306 mrem) substitutes a hunter MEI dose (based on a single hunter consuming all the edible portion of four deer) for the respective AEI game dose in the sportsman scenario. The sportsman also consumed the hog dose. The MAX Survivalist Scenario (12.920 mrem) dose was based on all dose detection maximums in column two except for the use of only one drinking water maximum. The MAX Survivalist dose was greater than the Sportsman dose due primarily to the addition of the highest edible fungi dose (1.285 mrem) to the Sportsman dose. The MAX Survivalist dose was equal to the MAX Perimeter dose and was the MEI based on SCDHEC data alone. The 11-year summary (1999-2009) can be found in Section 4, Table 2 and the Summary Statistics section (Section 5.1.4 Tables 1 and 2). The reader should not assume that the AEI or MEI dose applied to them except on an optional individual personal scenario basis that follows in the next section.

The 2009 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. These results are given under the critical pathway and statistical sections.

The public can estimate their potential dose based on activities that involve exposure to one or more media not covered by these scenarios provided their personal scenario dose calculation does not exceed 12.920 mrem. 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 1) 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 (8.923 mrem) to the Perimeter AEI Dose total (1.378 mrem) to obtain a dose of 10.301 mrem and then subtract the corresponding media AEI dose average for deer (0.00). Thus, by adding deer meat from the local area to the general diet, the non-scenario dose potential would increase from 1.378 mrem (AEI) to a maximum of 10.301 mrem for the worst-case deer consumption personal scenario. However, the probability that this person would receive all four deer from the one 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 12.920 mrem (MEI) based on SCDHEC data alone.

Likewise, if someone consumed wild edible mushrooms in 2009, then a maximum of 1.285 mrems could be added and subtract the corresponding AEI dose (0.306 mrem) to obtain the potential maximum dose exposure of 2.357 mrem (see the 2009 Added Dose Basis section 5.1.1) (Botsch 1999). Any dose observed by DOE-SR 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). For example, an onsite deer hunter could add 8.40 mrem of potential dose (SRNS 2010 Table 6-4). The grand total for any personal scenario dose calculated from this data cannot exceed the SCDHEC plus DOE-SR upper bound (24.570 mrem) given in Section 5.1.2 Table 3 (refer to the following 2009 Added Dose Basis section).

2009 Added Dose Basis

Section 5.1.2 Table 3 includes data from Table 6-4 data of the SRS Environmental Report (SRNS 2010) that can be added to give a SCDHEC MEI total offsite potential dose of 12.920 mrem to give a combined onsite and offsite dose potential of 24.570 mrem for the SCDHEC 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 2009 (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 2009 edible fungi dose was well below the 1998 food protective action guideline of 500 mrem to the whole body (USDHHS 1998).

DOE-SR and SCDHEC 2009 Comparisons

The 2009 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 (or sportsman) and wild mushroom consumer pathways. The SCDHEC MEI and AEI estimates were inflated (see Dose Critique section) and represented a potential dose accumulated over several years found 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 protective (conservative). The addition of and comparison to DOE-SR dose estimates may be directly relevant (onsite deer also represented accumulated dose), while other detections may be from yearly release estimates or measurements that do not necessarily result in depositions within the 50-mile study area. Also, most 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 (0.202 mrem in 2009) was the most relevant dose estimate for the general public upper limit, but certain data (wild food, e.g.) must be subtracted for the general public when comparing DOE-SR Atmospheric and Liquid Pathways to SCDHEC data (Section 5.1.2 Table 1 and Section 5.1.3 Data).

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 2009 (SRNS 2010). This comparison assisted in evaluating the 2009 DOE-SR environmental monitoring program and the SCDHEC ESOP environmental monitoring program. The study area SCDHEC detections of dose 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 on the MEI estimates (SCDHEC 12.92 mrem, DOE-SR 13.93 mrem) between the two monitoring programs that included nontypical exposure pathways was due primarily to Cs-137 occurrence in bioconcentrators of dose in the sportsman food pathway and not to correspondence between releases and detected dose in media (Section 5.1.2 Table 1, and SRNS 2010 Table 6-4). Both programs MEI dose estimates were less than twice the dose expected from living in a block house for two years (Section 5.1.2 Figure 2).

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 2009 (SRNS 2010). The National Emission Standards for Hazardous Air Pollutants (NESHAP) for all radionuclide air pollutants (diffuse and fugitive) in 2010 was

0.0149 mrem for the MEI effective dose equivalent and the total estimated atmospheric release dose was 0.04 mrem (SRNS 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 (cow milk, vegetation, rainwater, and meat), and direct exposure routes.

Not all SRS dose releases resulted in depositions within the sample area, as evidenced by the inhalation pathway detections noted in the following paragraph, which were far less than SRS releases. 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. The SCDHEC AEI dose determination was the best estimate for a typical exposure versus atypical MAX dose basis, if the individual was exposed to all media listed in Section 5.1.2 Table 1. The scenario basis and the individual optional scenario provided the best individual estimate based on scenarios or actual media exposure. The individual seeking to calculate their most accurate personal dose estimate should use the Section 5.0 Data and add up only the radionuclide dose in specific media they encountered within the year.

Four comparable SCDHEC and DOE-SR media pathway dose results (air, liquid, soil, food) were totaled and compared for 2009 in Section 5.1.2 Table 5. SCDHEC detected less air inhalation dose (0.001 mrem MAX) than estimated by DOE-SR releases (0.040 mrem), because all releases were not detected and were not necessarily deposited within the study area. The air pathway difference between SCDHEC and DOE-SR was due to dose based primarily on field measurements versus 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 atmospheric releases in 2009 were the terrestrial sportsman food pathway (10.18 mrem)(hunter, hog, deer) and the hunter soil exposure pathway (2.90 mrem) compared to the airborne contributions to the cow milk pathway alone (0.0419 mrem)(SRNS 2010 Table 6-4 and the MAXDOSE-SR MEI Dose Using Cow Milk Pathway data).

SCDHEC MAX atmospheric pathway maximum dose detections in 2009 came mostly from the sportsman food and soil media. Inhalation (0.001 mrem) had the smallest dose detections, terrestrial food (8.923+0.160+0.192+0.003+1.285 or 10.563 mrem) was highest, and dose from sediments and riverbank soil shine was minor (0.002+0.004 or 0.006 mrem)(Section 5.1.2 Table 1). SCDHEC only monitors offsite dose, and terrestrial food did not include an onsite hunter dose (8.40 mrem for DOE-SR)(SRNS 2010 Table 6-4)(Section 5.1.2 Table 3). SCDHEC hog samples maximum dose was 0.160 mrem in 2009. SCDHEC monitored the edible bolete fungi (1.285 mrem) and DOE-SR did not (Section 5.1.2 Table 1).

A comparison of atmospheric dose maximums (air, soil, and food pathways) that were monitored by both DOE-SR and SCDHEC programs gave totals of 5.457 mrem and 11.635 mrem, respectively (Section 5.1.2 Table 5). The prime difference between the two estimates was due to one hunter theoretically consuming all of the edible portion of four deer (8.923 mrem above background) that were sampled by SCDHEC. However, the sportsman maximum doses were trending toward lower dose levels whether from onsite or offsite deer (Section 5.1.2 Figure 8). Also, the SCDHEC MAX deer dose from 2000 to 2009 averaged 7.724 (± 6.212 mrem) with a median of 6.910 mrem, whereas the AEI deer dose averaged 0.275 (± 0.459 mrem) with a median of 0.040 mrem (Section 5.1.4 Table 2). Previous years SCDHEC background study areas averaged 1.06 mrem in the Bowman area and 1.08 mrem in the Francis Marion area (both in the lower coastal plain region) for Cs-137 in deer. The McBee area (upper coastal plain) was 0.79 mrem in 2007, but spiked in 2006 at 4.39 mrem and at 4.85 mrem in 2008, and dropped back to 2.13 mrem in 2009 for an average of 3.17 mrem. This higher background in the McBee area compared to the previous background areas may be due to natural factors such as the abundance of bolete 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 in the 1950's and 1960's, or a variation in weather patterns that affect atmospheric depositions at a distance from potential sources. This may indicate that maximums in the deer Cs-137 activity concentration were a result of the historical or 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 of 0.275 mrem or less due to further decay.

Most of the dose estimate from either DOE-SR or SCDHEC was due to atmospheric deposits and bioaccumulation. Approximately 73.08 % (10.18/13.93 mremx100%) of the DOE-SR 2009 dose in Table 6-4 came primarily from the sportsman food subpathway within the atmospheric pathway (SRNS 2010). The SCDHEC sportsman food pathway accumulated dose was 70.30 % (9.083/12.920x100%) of the detected dose in the atmospheric pathway (Section 5.1.2 Table 1). Thus, atmospheric dose accumulations in sportsman field samples (SCDHEC) were less than the DOE-SR annual atmospheric dose estimate for sportsman media. The DOE-SR total for committed dose (release modeling and field measurements) in 2009 was 13.93 mrem (SRNS 2010 Table 6-4) compared to the SCDHEC maximum perimeter dose detection estimate of 12.920 mrem (Section 5.1.2 Table 1). Again, the SCDHEC MEI estimate was less than the DOE-SR annual estimate. The SCDHEC maximum perimeter estimate (12.920 mrem) plus DOE-SR added potential dose (11.650 mrem) from releases (in specific media estimates and additions) gave an overall upper bound limit for a combined MEI potential of 24.570 mrem (Section 5.1.2 Tables 1 and 3). Both MEI estimates (SCDHEC and DOE-SR) contained low probability sportsman food maximum estimates, and the SCDHEC estimate included bolete fungi (1.285 mrem maximum) as a survivalist food (Section 5.1.2 Table 1). A more relevant comparison, if the fungi dose is subtracted, left 11.635 mrem (SCDHEC measured media dose accumulations) compared to 13.93 mrem (DOE-SR 2009 release estimate). This relatively close agreement 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 correspondence between releases and detected dose in media. Both total MEI estimates were very similar despite the differences in dose factors and monitoring method considerations. Both environmental program MEI estimates indicated that the upper bound of the combined MEIs (24.570 mrem) in 2009 was far less than the 100-mrem DOE-SR Order 5400.5 all-pathway yearly dose standard despite the contributions from bioaccumulation.

The MAX limit of available dose or upper bound for the 2009 MEI air dose excluding nontypical exposure pathways (the sportsman and survivalist dose) was based on exposure to the total of the single highest maximums (SCDHEC data) for air inhalation (0.001 mrem), local vegetables (0.192 mrem, excluded wild plums) and milk production (0.003 mrem) for a total of 0.196 mrem of accumulated dose, which was well under the DOE-SR yearly air limit for dose to the public (10 mrem/yr.) (Section 5.1.2 Table 1 and Section 5.1.3 Data). Atypical exposures were included by DOE order 5400.5 under the 100 mrem or total annual limit. The addition of an upper bound (ALL-Sources) dose calculation illustrated the MEI atmospheric exposure could not be greater than 10.564 mrem from all atmospheric deposits plus 2.356 mrem for the liquid pathway total detections or 12.920 mrem total based on SCDHEC sampled media MAX detections, which is also less than the 100 mrem/yr limit for all dose. Note that atmospheric pathway samples contained depositions accumulated over many years mostly in sportsman media (which did not apply to the 10-mrem air limit). The accumulated value was not directly comparable to the DOE-SR 10-mrem yearly air dose release limit for the atmospheric pathway that excluded nontypical exposure for the general public. The All-Sources upper bound (12.988 mrem) included extra water dose not assigned to the Perimeter Dose (only one maximum consumption rate can be applied), and was therefore greater than the 12.920 mrem perimeter dose maximum.

SCDHEC detected soil exposure dose (0.006 mrem) for the sportsman was far less than the estimated DOE-SR (3.180 mrem) combined soil dose due to the sampling of riverbank soil and forest soils versus DOE-SR locations of maximum radionuclide contamination in Savannah River Swamp soil, respectively (Section 5.1.2 Table 5). Again, DOE-SR calculations were based on an annual dose potential, whereas SCDHEC data results measure accumulated dose (sometimes at higher consumption rates and protective scenarios, e.g., the survivalist) in sampled media and were not therefore directly comparable. However, note the SCDHEC accumulated dose was often 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 and dispersed. The combined SCDHEC and DOE MEI dose estimates (24.570 mrem) allowed for undetected dose to the public. This combined MEI dose potential (included accumulations) was less than that expected from cosmic radiation (26 mrem) and the DOE-SR 100 mrem/yr annual limit for all dose (Section 5.1.2 Figure 2).

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 who 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 (0.323 mrem) in 2009 (Section 5.1.2 Table 1). Calculation of this maximum yearly dose based on the single highest sample, however improbable, served to illustrate that the survivalist (an atypical scenario) could not receive a higher dose than 0.323 mrem from untreated Savannah River water. The comparable drinking water maximum detection for the typical public exposure for SCDHEC was 0.029 mrem. Both atypical and typical liquid exposures were well below the 4 mrem/yr DOE 5400.5 drinking water pathway standard. Compare this accumulated potential survivalist maximum to the annual calculation of 0.09 mrem in 2009 for the DOE-SR MEI maximum committed dose (which included plant Vogtle contributions) for all liquid pathways from source term data. This landing location was unique in that it was not far downstream from the Steel Creek mouth. Would the swamp dwelling survivalist save that dose to a cistern on that date and drink only that water for the rest of the year?

The SCDHEC fish dose MAX value was 1.992 mrem and the DOE-SR Creekmouth Fisherman dose was 0.35 mrem (SRNS 2010 Table 6-4). This difference may be partially explained by the fact that SCDHEC determined the fish MAX dose based on the sum of the highest dose per radionuclide in fish and not per fish, since the survivalist was assumed to eat all fish. The rest 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. Most of this liquid pathway difference (1.959 mrem MAX) was due to Cs-137 in fish (highest in bass at Fourmile Creek)(Section 5.1.3 Data Tables). The SCDHEC AEI dose (0.740 mrem) applied to the average potential exposure rather than the highly improbable MAX based on single highest detections (Section 5.1.2 Table 1). Ingestion of 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 liquid medium contributed to the food, surface water, groundwater, and sediment exposure pathways (Section 5.1.2 Figure 1). Cesium-137 (61%), tritium (17%), unknown alpha (14%), Sr-90, I-129, Pu-238, and nonvolatile beta (all 2% each) account for the majority of the total potential dose to the MEI from DOE-SR liquid releases in 2009 (SRNS 2010 MEI Dose Liquid Pathways). The DOE-SR liquid releases percent of dose potential in 2009 was 64 % for fish consumption, 36 % for water consumption, and <1 % each for the shoreline, swimming, and boating.

The SCDHEC nonsportsman single highest dose (a maximum calculated as a constant for the year) in Savannah River public water supplies was tritium (0.029 mrem), which averaged 0.006 mrem in 2009 and averaged 0.028 (± 0.020 mrem) with a median of 0.020 mrem from 1999-2009 (Section 5.1.2 Table 1)(Section 5.1.4 Table 2). The DOE-SR 2009 measured tritium levels at the downstream water supply locations were 0.02 mrem at Chelsea and 0.02 mrem at Purrysburg and Savannah for an average of 0.02 mrem (SRNS 2010). This was within the SCDHEC expected first standard deviation and the differences were attributable primarily to the inclusion of alpha and beta as assignable Pu-239 and Sr-90 dose by DOE-SR and other radionuclide releases that were calculated and not measured. SCDHEC tritium detections averaged 0.006 mrem tritium in drinking water at the downstream locations (0.029 mrem MAX) compared to the DOE-SR liquid release MEI of 0.02 mrem. The time of sampling may be the critical factor in the differences since the tritium concentration varied continually. For example, the tritium concentration upstream at Savannah River boat landings were closer to 0.030 mrem on average with a maximum of 0.323 mrem (a one time detection calculated as if it were stored in a cistern and used throughout the year) compared to 0.08 mrem (0.09 mrem including VEGP releases). Weather also played a role in that tributary streams floodwater can greatly dilute radionuclide concentrations in the Savannah River at any given time.

The SCDHEC order of MAX detected radionuclide dose in the 2009 liquid pathway excluding assigned NORM was Cs-137 in bass fish (1.959 mrem), tritium in Savannah River water (0.323 mrem), tritium incidental ingestion from swimming in Fourmile creekmouth water (0.035 mrem), tritium in PWS Savannah River water (0.029 mrem), tritium in rainwater (0.028 mrem), Sr-89/90 (0.027 mrem) in bass, and <0.01mrem for all others (Section 5.1.3 Data). The bioconcentrated radionuclides, primarily Cs-137 and Sr-89/90 in the food pathway, were the major contributors to the liquid pathway dose besides tritium. The dose from drinking water was far less than that from watching TV (1 mrem) in 2009 (Section 5.1.2 Figure 2).

<u>All-Pathway SCDHEC and DOE-SR Comparison</u>

The All-Pathway yearly dose basically represented typical exposure from the airborne and liquid pathways (excluded atypical exposures) for the general public who were not subject to increased exposure from other activity (e.g., not farmer, sportsman, survivalist, mushroom or wild vegetation consumer). The liquid and airborne pathways dose maximum detections excluding the nontypical sportsman and survivalist media (such as wild plums and deer) near the site boundary were 0.12 mrem (DOE-SR) and 0.039 mrem (0.010+0.029 mrem) (SCDHEC). Differences can be attributed to factors already discussed under the atmospheric and liquid pathways. The single highest detections for SCDHEC that excluded sportsman and survivalist media were tritium in surface water (0.006 mrem). The single occurrence of a Sr-89/90 detection in wild plums was not assignable except to atypical scenarios. The general public liquid plus air maximum potential dose in 2009 (0.205 mrem MAX), which excluded the sportsman dose (included air+vegetable+milk+highest PWS or GW) was typically less than that received from watching TV (1 mrem), (Section 5.1.2 Figure 2). Note that the AEI total was nearly the same (0.202 mrem). The DOE-SR 2009 All Pathway dose of 0.12 mrem was comparable to the SCDHEC Public scenario that included wild vegetables, which averaged 0.122 (± 0.113 mrem) with a median of 0.074 mrem (Section 5.1.2 Table 2). The median was more applicable if the Public scenario excluded wild vegetables for the median reduced the influence of outliers (generally in wild vegetation) in this large environmental data set (1999-2009).

The DOE-SR All-Pathway potential has not exceeded 0.28 mrem in the last eleven years and had an overall downward trend since 1999 (did not include the atypical exposure pathways for hunter and fisherman, SCDHEC Section 5.1.2 Table 8).

The Food Pathway SCDHEC and DOE-SR Comparison

DOE-SR 2009 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 food sources). The 2009 DOE-SR media contributing dose to the food pathway from atmospheric annual releases were: vegetation (38.70 %), cow milk (12.16 %), and meat (4.73 %) pathways for a total of 55.59 % of the atmospheric releases in 2009 (SRNS 2010 Cow Milk Pathway). The SCDHEC order of radionuclide detected maximum potential dose in the 2009 atmospheric pathway excluding assigned NORM was mostly Cs-137 in deer (8.923/12.920x100%=69.06 % of MEI dose), Cs-137 in hogs (0.160/12.920x100=1.24 % of MEI dose), Sr-89/90 (0.186/12.920x100%=1.44 %) in wild plums and 0.003/12.920x100=0.023 % in milk were the comparable media for a total of 71.76 % of the dose. DOE-SR did not sample fungi so this comparison excluded the SCDHEC fungi. The atmospheric pathway appeared to accumulate or retain some of the annual released dose in wild game.

The 2009 DOE-SR media contributing annual dose to the food pathway from liquid releases were: fish (64.00 %), water (36.00 %), and others at <1% for a total of nearly 100 % of the liquid releases in 2009 (SRNS 2010 Cow Milk Pathway). The SCDHEC media maximums in the 2009 liquid pathway excluding assigned NORM occurred mostly in fish (1.992/12.920x100%=15.42 % of MEI dose) as Cs-137 and in Savannah River water (0.323/12.920x100=2.50 % of MEI dose) as H-3. These comparable media totaled 17.92 % of the dose (Section 5.1.2 Table 1). Thus, all of the liquid pathway dose did not result in exposure or appear to accumulate dose from annual releases. However, Cs-137 in fish was a known bioaccumulator, but apparently fish did not ingest or accumulate all of the released annual dose. Some radionuclides may have formed metal complexes in SRS sediments and were not transported offsite to the Savannah River fish population.

The DOE-SR comparable totals for all maximum food doses in 2009 were offsite MEI deer consumption (1.54 mrem), creek mouth fisherman (0.35 mrem), offsite hog (0.240 mrem), irrigation pathway (0.016 mrem), and goat milk (0.011 mrem) for a total of 2.157 mrem of potential food dose versus 11.270 mrem total for the SCDHEC comparable food maximum dose (SRNS 2010 Table 6-4, and SCDHEC Section 5.1.2 Table 5). DOE-SR offsite deer and hog hunter dose was based on measured average concentration of Cs-137, 1.38 pCi/g and 1.06 pCi/g, respectively. Both DOE-SR and SCDHEC maximum deer dose were based on the single highest dosed hunter eating all of his harvested deer/hog edible portions harvested by the MEI hunter. DOE-SR also had a 0.24 mrem food dose for offsite hog consumption in 2009 compared to SCDHEC 0.16 mrem. The SCDHEC deer hunter maximum potential accumulated dose (8.923 mrem) was close to the DOE-SR maximum onsite deer or hog hunter dose (8.4 mrem) for 2009. However, the 2009 MEI offsite deer dose for DOE-SR was 1.54 mrem and lower than the SCDHEC single highest maximum deer dose (not hunter MEI dose) of 2.737 mrem (Section 5.1.3 Data). Also, the DOE-SR maximum fish dose was 0.35 mrem compared to the SCDHEC fish dose of 1.992 mrem. Differences were attributable to 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. Note that both DOE-SR offsite food dose estimates (deer, hog, fish = 2.13 mrem) and the SCDHEC 2009 AEI sportsman food estimate (0.841 mrem) were within one standard deviation of the 11-year SCDHEC sportsman food dose average of 1.242 (± 1.495) mrem with a median of 0.841 mrem (Section 5.1.2 Table 4).

The food difference between the two agency averages was primarily dependent upon the highest deer or hog dose in previous years, but the hog ranking was displaced by fish and mushrooms in 2009 for SCDHEC. A highly variable background for SCDHEC sampled deer (2.127 mrem at McBee in 2009 and 4.85 mrem in 2008) points out the importance of background locations and the potential influence of historical Cs-137 depositions in any given area and media. The 2009 MAX dose for milk (0.003 mrem for cow milk) and edible vegetation (0.192 mrem) was 0.005 mrem and 0.016 mrem, respectively for the DOE-SR (SRNS 2010) MEI dose. This single highest maximum detection dose would depend on storing and consuming the single highest milk sample (at a consumption rate of 230 kg/yr), which could not be delivered in one milking at one site. The milk difference was primarily due to Sr-89/90 detections and location and temporal factors. The edible vegetation difference was due mostly to the single high detection of Sr-90 in one wild plum sample. Compare this to the SCDHEC 11-year AEI for nonsportsman food 0.056 (± 0.063 mrem) with a median of 0.043 mrem (Section 5.1.2 Table 4). Thus, the reader should keep in mind that the MAX calculation potential applied only if that MAX dose were somehow stored and delivered to the MEI (e.g., the MEI received that single highest dose from all cow milk stored on that day). 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 the SCDHEC AEI represents the most probable dose for any scenario. DOE-SR tritium atmospheric releases were 0.033 mrem in the 2009 MEI Cow Milk pathway (SRNS 2009 MAXDOSE-SR MEI Cow Milk Pathway) versus SCDHEC MAX detection of 0.000 mrem in milk. Thus, tritium bioaccumulation potentially had far less impact on the AEI or MEI than Cs-137 and Sr-89/90.

Unknown variables caused fluctuation in the 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). Inclusion of the single worst-case or MEI dose (8.923 mrem) instead of the AEI deer dose (0.00 mrem) in 2009 resulted in a very different dose (12.920 mrem for MAX deer dose versus 0.000 mrem with AEI dose) that could occur only for one individual (not necessarily a hunter if the deer meat was a gift) who ate the most contaminated deer sampled (Section 5.1.2 Table 1). However, SCDHEC adds the single worst-case deer consumption by a single hunter to all other 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, and mushrooms, which is most of the MEI dose or 12.360/12.920x100%=95.665 %. (Section 5.1.2 Table 1). All food maximums (sportsman and public) together were 12.555 mrem (97.175 % of MEI) (Section 5.1.2 Table 1) (Section 5.1.2 Table 4). Compare these MEI percentages to the AEI percentages for the food pathway ((0.841+0.193+0.306)x100)/1.378=97.242 %). The food pathway was clearly the dominate dose pathway whether on a MAX or AEI basis.

The DOE-SR total potential dose from irrigation pathways (0.06 mrem) was 0.051 mrem for vegetables, 0.0065 mrem for milk, and 0.0021 mrem for meat. This represents a potential increase in dose compared to the Cow Milk MEI atmospheric pathway (0.0162 mrem for vegetables, 0.00509 mrem for milk, and 0.00198 mrem for meat) (SRNS 2010). The greatest theoretical influence from large-scale irrigation was an increase in vegetable dose of approximately 0.0338 mrem. Cobalt-60 was detected in milk, Cs-137 in collards and soybeans, U-234 in collards, fruit, beef, and soybeans, U-235 in collards, U-238 in collards and beef, Pu-238 in collards and beef, Americium-241 in collards and wheat, Technetium-99 in collards, and tritium in collards (SRNS 2010).

SCDHEC detected potassium-40 (K-40), lead-214 (Pb-214), and tritium in various fruits; K-40, tritium, total strontium, U-234, U-235, and U-238 in plums; and only K-40 in leafy vegetables (collards) (SCDHEC 2010). However, only the tritium and total strontium were potentially not of natural origin and contributed dose to the MEI. Only tritium (0.006 mrem) in corn and wild plums, and Sr-90 in one wild plum source (0.186 mrem total) contributed to the SCDHEC MEI. This total strontium detection was calculated as Sr-90 with a background of zero, and was potentially biased high. Cesium-137 detections in edible bolete fungi contributed the highest potential dose (1.285 mrem) to the minority wild mushroom consumer, whether deer or human. The combined SCDHEC and DOE-SR MEI dose potential (24.570 mrem) confirmed that any scenario or individual was not exposed to a dose greater than the DOE-SR dose limit of 100 mrem/yr. DOE-SR monitored individual hunters on the SRS to ensure that they did not exceed the DOE 100 mrem standard (SRNS 2010). Both SCDHEC and DOE-SR programs sampled predominantly the same dose contributors despite differences in locations, methods, and analyses. Section 4.0, Table 8 statistics derived from DOE-SR release dose estimates revealed that the overall dose to the onsite hunter (8.40 mrem) was similar to the SCDHEC offsite MAX deer (8.923 mrem) in 2009 (SRNS 2010 Table 6-4 and SCDHEC 2010 Section 5.1.2 Table 1).

Most of the dose in the environment may come from legacy dose instead of current releases from DOE-SR. The DOE-SR calculations totaled 0.0419 mrem for the Cow Milk Pathway (air particulates) in 2009 and 0.077 mrem via the liquid pathway (SRNS 2010) or 0.1189 mrem. Thus, the dose detected in comparable media that was greater than either pathway potentially came from previous years dose accumulations or bioconcentrations of legacy dose, which may or may not have come from DOE-SR. The SCDHEC MAX comparable media dose total was approximately 0.039 mrem in 2009 for the typical public dose maximum or up to 0.519 mrem for the atypical public (0.196 mrem, included wild vegetation, plus 0.323 mrem for filling a drinking water cistern with the single highest dose, Section 5.1.3 Data).

Critical Pathways 2009 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 2009 to denote their relative importance to overall dose exposure (Section 5.1.2 Table 1, and Section 5.1.3 Data). The 1999-2009 Statistics Summary section covers the overall trend. 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 Atmospheric Pathway 2009 Summary

The SCDHEC 2009 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 atmospheric pathway (APW) were 81.765 % of the MEI total and was dominant compared to the liquid pathway (LPW) (18.235 %) on a single highest exposure basis (Section 5.1.2 Table 1). The SCDHEC AEI column contributions to the total AEI (more typical of actual exposure potential) was 43.541 % APW and 56.459 % LPW. Food ingestion was 97.315 % of the SCDHEC detected non-NORM dose, drinking water ingestion 2.612 %, direct exposure 0.073 %, and inhalation less than 0.000 %.

Exposure from all AEI food detections subject to the atmospheric pathways was only 43.541 % of the AEI perimeter dose (Section 5.1.2 Table 1). Most of the 2009 total (atmospheric and liquid) food pathway dose was clearly due to food sources on an AEI (97.242 %) or MAX (97.175 %) basis. Compare this to the Table 6 or 1999-2009 Statistics Section where the APW was only slightly dominant. However, the food subpathway dominated public exposure within the atmospheric pathway on an AEI and MAX basis, and over the 11-year period (Section 5.1.2 Tables 1 and 6).

Note that most MAX detections occurred in the APW, and the APW was always dominant in any year on a MAX basis, which represented the extremes (81.765 % in 2009). Most exposure occurred as a result of the ingestion of wild food sources containing Cs-137 (10.368/12.920x100%=80.248 %) (MAX deer, hog, and mushrooms) in the atmospheric pathway (Section 5.1.3 Data).

The APW ALL-sources limit or upper bound (MAX row) for the atmospheric dose potential in Section 4.0 Table 1 based on exposure to the single highest media maximums was not directly comparable to the DOE-SR ALL-pathway atmospheric dose limit (did not include atypical sportsman and survivalist media).

The Liquid Pathway 2009 Summary

The 2009 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) pathway, but was only dominant over the farmer, sportsman, and survivalist scenarios on an AEI basis for the public scenario. 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 2009 AEI detected dose potential from the LPW was 56.459 % (Section 5.1.2 Table 1). This AEI liquid dose was due mostly to fish consumption or food dose from the Savannah River (0.740/1.378x100%=53.701% of the AEI dose), but did not dominate under the MAX dose basis (1.992/12.920x100%=15.418% of MAX dose). Cesium-137 in fish (1.959/12.920x100%=15.163%) was the highest detected dose for the liquid pathway in 2009 on a MAX basis (Section 5.1.3 Data). Thus, fish dose was less dominant on a MAX basis compared to terrestrial food sources (deer, hog, and wild mushrooms). 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 maximums in 2009 occurred in largemouth bass due to Cs-137 (15.163 % of MEI), Sr-89/90 (0.027/12.920x100%=0.209 %), and tritium (0.006/12.920x100%=0.046 %).

The tritium dose from untreated water supplies (0.030 mrem or 2.18 % of AEI/ and 0.323 mrem or 2.50 % of MAX), such as the consumption of untreated boiled river water at boat landings, was typically the second highest potential exposure from the liquid pathway (Section 5.1.3 Data). Tritium in rainwater (0.87% AEI/0.22% MAX) was third or fourth with the order dependent on consideration as AEI or MAX basis, respectively. Tritium incidental ingestion by swimming in the Fourmile Creek Mouth was also third or fourth dependent on the dose basis (0.44 % AEI/0.27% MAX, respectively), and PWS riverwater (0.44 % AEI/0.22% MAX) was a close third or fourth. Tritum in untreated well water (DNR wells) was typically the smallest tritium dose (<0.000%) in the 2009 liquid pathway. Riverbank sediment shine due to Cs-137 gave the smallest observed dose (0.07% AEI/0.03% MAX, respectively).

The LPW ALL-sources limit or upper bound (MAX row) for the liquid dose potential in Section 5.1.2 Table 1 based on exposure to the single highest media maximums was not directly comparable to the DOE-SR ALL-pathway liquid dose limit for the upper bound total also included all water dose (not proportioned by consumption rates).

The Food Pathway

The 2009 SCDHEC MAX food pathway dose order calculated from Section 4.0, Table 1 data was deer (69.06%), fish (15.42%), wild edible mushrooms (9.95%), edible vegetation (0.05%), and milk (0.02%). The order changes on an AEI basis (typical exposure) to fish (53.70%), wild edible mushrooms (22.21%), vegetables (13.86%), hogs (7.33%), milk (0.15%), and deer (<0.00%). 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, Sr-89/90 second, and tritium third (Section 5.1.3 Data). The radionclide order responsible for dose remainded the same whether on an AEI or MAX basis. The food MAX dose in 2009 was 97.175 % of the perimeter potential dose (Section 5.1.2 Table 4). This calculation did not include incidental soil or sediment ingestion with food. The survivalist and sportsman food categories compared to the general public food sources were the dominate contributors to dose whether on an AEI or MAX basis. The dominant radionuclide dose in 2009 for the food pathway was Cs-137 on both an AEI and MAX basis (Section 5.1.3 Data).

1999-2009 Statistics

Section 5.1.2 Table 7 summarizes the 1999-2009 DOE-SR atmospheric and liquid release data, but was not directly comparable to field detections. Percent of dose changes with scenario or optional dose considerations. Therefore, only the AEI exposure calculations (typical dose levels) were given in this section as a basis for the 1999-2009 comparisons (Section 5.1.2 Table 2 and Figures 3-7, Section 5.1.3 Data, and Section 5.1.4 Tables 1 and 2) with the median preferred as the environmental central tendency for large data sets. The median may be a more accurate central tendency indicator than the average for large amounts of data due to the influence of extremes (one time variables) in averages. Also, the average data were inflated to begin with (protective) due to the averaging of detections only (less than minimum detectable activity data were not included). Additionally, most media detections were few in number and a comparison of radionuclide averages or medians may not be statistically relevant compared to total dose and percentages (Section 5.1.4 Tables 1 and 2). Therefore, only the top three averages were discussed in detail (see N# and N#yrs in Section 5.1.4 Tables 1 and 2). Percentages based on fractions of total dose detections indicated the dominant exposure routes for pathways and radionuclides.

Most exposure (Cs-137 85.76%), irregardless of the basis of comparison, occurred as a result of exposure to wild food sources (Section 5.1.4 Tables 1 and 2). Total strontium (5.10%) was second and tritum ingestion (3.95%) third. All other potential non-NORM radionuclides were less than 1% of the dose exposure for the period 1999-2009.

The average, standard deviation, and medians of radionuclide dose were summarized for 11 years of SCDHEC samples (1999-2009) on an AEI basis by media, exposure scenarios, and dominant critical pathway categories (Section 5.1.2 Tables 2 and 6 and Figures 3-8, and Section 5.1.4 Table 2). Section 5.1.2 Table 6 and Figure 3 show the total 11-year millirem dose and percent of dose on a pathway and subpathway basis. 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 (55.341%) over the liquid pathway (44.659%) on an AEI dose basis (Section 5.1.2 Table 6). The food subpathway (88.208% of dose) was the dominant route of exposure, the nonpotable drinking water supply was second (5.516%), the direct exposure pathway third (3.089%), the public water supply pathway fourth (2.813%), and the inhalation pathway least (0.374%).

Section 5.1.4 Table 2 summarized all dose detections on an AEI basis relevant to pathways and eliminated some potential NORM. The SCDHEC 1999-2009 AEI fish dose was the primary contributor to dose (35.807% of dose and averaged 0.566 (±0.295) mrem with a median of 0.440

mrem over 11 years) for the period 1999-2009. Fish was followed by hog (26.983% of dose and averaged 1.173 (±1.689) mrem with a median of 0.536 mrem over four years), deer (15.818% and averaged 0.275 (±0.459) mrem with a median of 0.0.040 mrem over 10 years), edible fungi (5.959% and averaged 0.518 (±0.300) mrem with a median of 0.518 mrem over two yeas), surface water at boat landings (3.503% and averaged 0.055 (±0.028) mrem with a median of 0.050 mrem over 11 years), edible vegetation (2.307% and averaged 0.050 (±0.072) mrem with a median of 0.010 mrem over eight years), soil (2.036% and averaged 0.032 (±0.076) mrem with a median of 0.010 mrem over 11 years), PWS from Savannah River Water (1.743% and averaged 0.028 (±0.020) mrem with a median of 0.020 mrem over 11 years), DNR groundwater wells outside SRS (1.375% and averaged 0.034 (±0.053) mrem with a median of 0.014 mrem over 11 years), milk (1.225% and averaged 0.019 (±0.031) mrem with a median of 0.003 mrem over 11 years) (would be comparable to untreated private wells), PWS from groundwater (1.070% and averaged 0.017 (±0.019) mrem with a median of 0.010 mrem over 11 years), sediments (1.053% and averaged 0.017 (±0.052) mrem with a median of 0.000 mrem over 11 years), and rainwater least (0.638% and averaged 0.010 (±0.006) mrem with a median of 0.010 mrem over 11 years) (private cistern dose). Note that all statistics were not on the same basis for the number of years collected and number of samples varied for some media such as hogs versus fish or deer. Dose was always more relevant to the individual exposure rather than percentages, which only established the order of dominance in the critical pathway.

The median may be a more applicable reference for deciding the central tendency when all media samples number in the thousands. Also, the radionuclide environmental exposure trend is a dynamic and not a static function. The DOE-SR study area shows a gradual downward exposure trend due to inactive 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.

Note from Section 5.1.4 Table 2 a 1999-2009 MAX basis for the prime contributors to dose were calculated for deer (7.724 (±6.212) mrem, median 6.910 mrem), hog (5.350 (±7.984) mrem, median 2.225 mrem), fish (2.262 (±1.524) mrem, median 1.768 mrem), and edible fungi (1.526 Section 5.1.2 Table 4 1999-2009 food statistics indicated that sportsman media (1.242 (±1.495) mrem, median 0.841 mrem) contained more dose even on an AEI basis than the local area nonsportsman public food dose (0.056 (±0.063) mrem, median 0.043 mrem), and the wild mushroom consumer (Fungi 0.518 (±0.300) mrem, median 0.518 mrem). Section 5.1.2 Table 8 and Figure 8 show the 1999-2009 trends for offsite hunter and fisherman, but only the fisherman field collections were directly comparable. Compare the DOE-SR offsite fisherman average dose of 0.71 (±0.41) mrem with a median of 0.61 mrem to the SCDHEC fisherman average dose of 0.566 (±0.295) mrem with a median of 0.440 mrem that did not include a soil exposure contribution (Section 5.1.2 Table 8, and Section 5.1.4 Table 2). The fisherman soil average contribution calculated by DOE-SR was typically 0.28 mrem/yr, which was near the difference between the two averages (SRNS 2010 Table 6-4). The DOE-SR hunter dose included hogs and was 8.27 (±5.15) mrem with a median of 9.10 mrem compared to the SCDHEC MAX hunter dose average of 8.968 (±10.524) mrem with a median of 7.640 mrem. The differences were attritutable to the individual hunter who was the MEI. Also, compare both to the SCDHEC AEI hunter dose average of 0.676 (±1.482) mrem with a median of 0.080 mrem, which was based on an overall average dose instead of a single hunter maximum. Thus, the typical hunter who was not the MEI would receive far less dose on average. The scenario statistics given below were different due to the inclusion of other media.

The 1999-2009 AEI dose per radionuclide that had a sufficient number of detections for relevancy gave the following central tendency statistics over all media collected: Cs-137 (0.487 (±0.854) mrem, median 0.113 mrem for N#37), Sr-89/90 (0.071 (±0.089) mrem, median 0.021 mrem for N#12), and H-3 (tritium) (0.013 (±0.014) mrem, median 0.008 mrem for N#65). Most sampling resulted in no detections or 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.

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 1999-2009 were:

- the general public 0.094 mrem average, ± one standard deviation of (0.056), with a median of 0.093 mrem;
- the farmer, 0.122 (± 0.113) mrem with a median of 0.074 mrem;
- the average sportsman, 1.419 (± 1.445) mrem with a median of 1.072 mrem.
- The average survivalist (as a minority group) was added in 2008 and included edible fungi consumption; the average survivalist, 1.514 (± 1.443) mrem with a median of 1.183 mrem (2008 & 2009 statistics).

Two MAX scenarios based on single highest detections were the maximally exposed sportsman, 11.407 (± 10.454) mrem with a median of 9.168 mrem, and the maximally exposed survivalist, 7.753 (± 4.503) mrem with a median of 5.677 mrem (Section 5.1.2 Table 2). The MAX Survivalist was lower than the MAX Sportsman only because of the averaging of two years of data versus 10 years, respectively. The MAX Survivalist by definition adds more media/dose will always be higher than the MAX Sportsman in any single year unless no dose results occur in the added media that year.

Dose Critique

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 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 minimum detectable activity (MDA). 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 Pu-239 and unknown beta as Sr-90.

The 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. However, the 2009 SCDHEC dose calculations 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 1, and Section 5 Data). For example, the potential dose in 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 detections/radionuclide/media and defined a limit of possible dose. 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.

Only specific radionuclide (speciated) doses were included in the estimated dose for 2009. 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 some data published in the SRS Environmental Reports. The USEPA and SCDHEC both 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.

3.0 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 was 12.920 mrem in 2009. The SCDHEC MEI total potential dose was based on the single highest maximum detections/radionuclide/media in 2009 that included edible fungi, and was less than the dose typically received by living in a brick home for two years (7 mrem/yr) (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 24.570 mrem for the combined MEI. This improbable combined MEI potential confirmed that the DOE-SR 100 mrem dose standard to the public was not exceeded in 2009 despite contributions from other years dose and bioaccumulations (Section 5.1.2 Table 3). The relatively close agreement of the 2009 SCDHEC MEI (12.920 mrem) and 2009 DOE-SR MEI (13.93 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 correspondence between releases and detected dose in media. However, a conservative estimate by SCDHEC of the average DOE-SR perimeter dose potential above background was only 1.378 mrem in 2009 (Section 5.1.2 Table 1).

The SCDHEC 2009 All-Sources MAX atmospheric (0.196 mrem), liquid (0.029 mrem), and total MEI (12.920 mrem) dose estimates that contain accumulated dose over several years were protective and well within the respective 10 mrem, 4 mrem, and 100 mrem DOE Order 5400.5 limits (Section 5.1.2 Table 1 and SRNS 2010). The atmospheric and liquid estimates exclude atypical dose, which was captured under the total MEI estimate for comparison to DOE defined dose limit categories. Inhalation was 0.000% of the dose to the critical pathway, ingestion was 99.927 %, and direct exposure was 0.073% in 2009 (Section 5.1.2 Table 1).

Four dose scenario estimates were calculated based on SCDHEC data from 1999 through 2009 as an average exposed individual (AEI) dose above background (Section 5.1.2 Table 2). The average sportsman who was not the MEI was exposed to 1.072 mrem of dose in 2009 and averaged 1.419 (±1.445) mrem with a median of 1.072 mrem for 1999-2009. The farmer, who was not a hunter, but inhaled, ingested, or received direct exposure from soil, received a dose of 0.203 mrem in 2009 and averaged 0.122 (±0.113) mrem with a median of 0.074 mrem from 1999-2009. A minority category, the survivalist, who was a wild mushroom consumer (new in 2008), received an average dose of 1.378 mrem in 2009 and averaged 1.514 (±1.443) mrem with a median of 1.183 mrem from 2008-2009. The general public who ate wild vegetation (e.g., wild plums), but was not a sportsman or wild mushroom consumer, and was not exposed to swamp soils received less than 0.202 mrem of dose in 2009 and averaged 0.094 (±0.056) mrem with a median of 0.093 mrem from 1999-2009 (Section 5.1.2 Table 2). The increase in public dose in 2009 was due mostly to one Sr-90 detection in a wild plum sample. The general public dose was the dose that applied to most people within the study area and was a conservative and protective estimate (Dose Critique Section 5.1.1).

Most of the 1999-2009 AEI dose was the result of atmospheric pathway deposits (55.34 % or 9.621 mrem total) and the balance was from the liquid pathway route (44.66 % or 7.764 mrem total) (Section 5.1.2 Table 6). The food ingestion subpathway contained mostly Cs-137 and contributed 88.21 % or 15.335 mrem of dose from 1999 through 2009 primarily through the hog, deer, fish, and wild mushroom ingested dose. The second highest dose subpathway was due to the nonpotable drinking water subpathway consumption (5.52 % or 0.959 mrem), primarily from tritium ingestion by sportsmen at boat landings near SRS. The direct exposure subpathway was the third major pathway (3.09 % 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 (2.81 % or 0.489 mrem) due to tritium, and inhalation was fifth (0.37 % or 0.065 mrem), primarily from tritium. Cesium-137 and Sr-89/90 were the main contributors of dose through the wild food pathway, and tritium was the primary contributor to dose through the ground and surface water subpathways.

The SCDHEC Critical Pathway Dose Project will continue to monitor the MEI dose trends. SCDHEC expanded the ESOP in 2004 by adding random SRS perimeter and South Carolina background samples to improve statistical comparisons (see Random Sampling Statistics Report section). 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. Bolete fungi sampling was started in 2008 to address the concern for Cs-137 bioconcentration in edible fungi. Other edible fungi species were also sampled in 2009.

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 Am-241, plutonium and uranium radionuclides from the Mixed Oxide Fuel Fabrication Facility (MFFF) through the air and surface water environmental mediums (Duke, COGEMA, 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 mushroom consumer 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.

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Section 5.1.2 Tables and Figures
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Table 1. 2009 SCDHEC Non-Scenario Dose (mrem) Estimates for Pathways, Exposure Routes, and Media (in mrem)

Pathways	Routes	Media	AEI[1]	MAX[2]	MAX minus AEI[3]
APW[4]	Inhalation	Air (filters)	*0.000*	*0.001*	0.001
APW	Inhalation	Resuspended Soil	*0.000*	*0.000*	0.000
LPW[4]	Inhalation	Resuspended Riverbank Sediment	*0.000*	*0.000*	0.000
AEI **%**	0.000	**Air Inhalation Totals**	**0.000**	**0.001**	0.001
LPW	Ingestion	Fish[5]	*0.740*	*1.992*	1.252
APW	Ingestion	**Deer[10]**	*0.000*	*8.923*	8.923
APW	Ingestion	Hog	*0.101*	*0.160*	0.059
APW	Ingestion	Vegetable	*0.191*	*0.192*	0.001
APW	Ingestion	Milk	*0.002*	*0.003*	0.001
APW	Ingestion	Soil	*0.000*	*0.000*	0.000
LPW	Ingestion	Riverbank Sediments	*0.001*	*0.002*	0.001
APW	Ingestion	Bolete Fungi	*0.306*	*1.285*	0.979
AEI **%**	97.315	**Food Ingestion Dose Totals**	**1.341**	**12.557**	11.216
LPW	Ingestion	PWS River Water	*0.006*	*0.029*	0.023
LPW	Ingestion	PWS Wells	*0.009*	*0.009*	0.000
LPW	Ingestion	DNR GW Wells	*0.000*	*0.002*	0.002
LPW	Ingestion	SR Water at Boat Landings	*0.030*	*0.323*	0.293
APW	Ingestion	Rainwater	*0.012*	*0.028*	0.016
LPW	Ingestion	Swimming Ingestion	*0.006*	*0.035*	0.029
AEI **%**	underlined (2.612)%	**All DW Ingestion Dose Totals**	**0.063**	**0.426**	0.363
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 (Shine)	*0.000*	*0.000*	0.000
LPW	Direct	Boating	*0.000*	*0.000*	0.000
LPW	Direct	Riverbank (Shine)	*0.001*	*0.004*	0.003
LPW	Direct	Swamp Dweller Surface Water	*0.000*	*0.000*	0.000
AEI **%**	0.073	**All Direct Exposure Dose Totals**	**0.001**	**0.004**	0.003
All-Sources[6] Dose (Upper Bound of Detections) Totals			1.405	12.988	11.583
Perimeter[7] Dose (Applicable Media Only Underlined[8]) Totals			***1.378***	***12.920***	11.542
Examples of maximum dose substitutions for an AEI media average result.					
Examples of adding		Replace Avg Deer with Max Deer	**10.301**	1.459 plus 8.923	
maximums to avg dose		Replace Avg Fish with Max Fish	**2.630**	1.459 plus 1.252	
Perimeter Dose Detections Applicable to MEI					
Critical Pathway Summary of MEI Perimeter Dose (mrem)			**AEI[1]**	**MAX[2]**	**MAX minus AEI[3]**
The Atmospheric Pathway Totals (**APW**)			0.600	10.564	9.964
The Liquid Pathway Totals (**LPW**)			0.778	2.356	1.578
Perimeter Critical Pathways Percent Contributions (%)			**AEI**	**MAX**	**MAX minus AEI[3]**
Atmospheric (**APW**) Pathway			**APW%**	**APW%**	
Percentage Totals for Perimeter Dose			43.541	81.765	38.223
Liquid (**LPW**) Pathway			**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose			56.459	18.235	-38.223
All-Sources 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			0.612	10.592	9.980
The Liquid Pathway Totals (**LPW**) From All-Sources			0.793	2.396	1.603
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			43.559	81.552	37.993
Liquid (**LPW**) Pathway			**LPW%**	**LPW%**	
Percentage Totals for Perimeter Dose From All-Sources			56.441	18.448	-37.993

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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 potential estimate.
10 - Deer is highlighted since the maximum in this case is based on the consumption of four deer by one hunter.

Table 2. Dose Scenario Estimates

Scenarios in Millirem of Exposure	2009	1999-2009		
	Avg.	Avg.	SD	Median
Public[1]	0.202	0.094	0.056	0.093
Farmer[2]	0.203	0.122	0.113	0.074
Average Sportsman[3]	1.072	1.419	1.445	1.072
Average Survivalist[4]	1.378	1.514	1.443	1.183
MAX Sportsman[5]	11.306	11.407	10.454	9.168
MAX Survivalist[6]	12.920	7.753	4.503	5.677

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 and/or hog) dose to the farmer dose and uses the highest public, private, or river water source dose (underlined in Table 1).
4 – The 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.
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.

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Table 3. 2009 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 plus Airborne[4]	0.130	0.324	NA
Sportsman	Onsite Hunter	8.400	**NS**	8.400
	Creek Mouth Fish	0.350	1.992	NA
	Offsite Hog	0.240	0.160	0.080
	Offsite Deer	1.540	8.923	NA
	Hunter Soil Exposure[5]	2.900	0.004	2.896
	Fisherman Soil Exposure[6]	0.280	0.006	0.274
	Other Pathway[7]	0.060	0.230	NA
Mushroom Consumer	Edible Fungi[8]	0.000	1.285	NA
Totals	**SCDHEC MEI**	NA	**12.920**	NA
	Total Difference to be added for MEI	NA	**11.650**	**11.650**
	SCDHEC plus DOE-SR MEI Additions[9]	NA	**24.570**	NA

Notes:
1 - Data from DOE-SR data Table 6-4 (WSRC 2010).
2 - Maximums or single highest detection basis for all media per route of exposure (Table 1).
3 - MEI all-source 2009 dose additions. DOE-SR offsite dose is based mostly 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 - Irrigation/milk and vegetable, and recreational swimming ingestion sources
8 - Bolete fungi dose from Cs-137 bioconcentration averaged 0.73 mrem > background and maximum was 1.760 mrem.
9 - Biased high primarily due to single maximums (SCDHEC), assigned dose (DOE-SR), and released dose basis.
Not all released dose results in exposure, and explains why field measurements do not detect all dose released.

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Table 4. Sportsman versus Nonsportsman Food Comparison

2009		**1999-09 mrem**			
2009 AEI Food Categories	**Total mrem**	**Media**	**Avg.**	**SD**	**Median**
Sportsman	0.841	Fish,Deer,Hog	1.242	1.495	0.841
Nonsportsman Public Food	0.193	Veg and Milk	0.056	0.063	0.043
Fungi	0.306	Fungi	0.518	0.300	0.518
AEI All-Food Ttl[1]	**1.340**				
MAX Wild Food Ttl	**12.360**	**Fish,Deer,Hog,Fungi**	**11.507**	**10.387**	**9.076**
Substitute MAX Deer for AEI Deer[2]	10.195	**2009 Food**		**MAX**	**% of MEI[3]**
Substitute MAX Fish for AEI Fish	2.524	Fungi Only		1.285	9.946
Substitute MAX Fungi for AEI Fungi	2.251	Sportsman (fish, deer, hog)		11.075	85.720
		Public (vegetables and milk)		0.195	1.509
All Food MAX Totals[1]				**12.555**	**97.175**

Notes:
1 - The AEI All-Food totals and statistics is 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 (12.920 mrem).

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Table 5. Variability in SCDHEC and DOE-SR Media Dose Pathway Maximums

Environmental Monitors - 2009	SCDHEC				DOE-SR (1)			
Pathways - - - - - - - Media and mrem Dose[2]	Air	Liquid	Soil	Food	Air	Liquid	Soil	Food
Water		0.323				0.080		
Inhalation	0.001				0.040			
Combined Soil[3]			0.006				3.180	
Swimming		0.035				0.000		
Boating		0.000				0.000		
Milk				0.003				0.011
Edible Vegetation				0.192				0.016
Creek Mouth Fish				1.992				0.350
Offsite Deer				8.923				1.540
Offsite Hog				0.160				0.240
Totals	0.001	0.358	0.006	11.270	0.040	0.080	3.180	2.157
Avg	0.001	0.119	0.006	2.254	0.040	0.027	3.180	0.431
SD	NA	0.177	NA	3.816	NA	0.046	NA	0.637
Median	0.001	0.035	0.006	1.092	0.040	0.000	3.180	0.183
2009 MEI Comparison	Media				Summary Statistics			
Program Totals	Air	Liquid	Soil	Food	Totals	Avg[4]	SD[5]	Median
SCDHEC	0.001	*0.358*	0.006	*11.270*	11.635	**2.909**	*5.577*	0.182
DOE-SR	*0.040*	0.080	*3.180*	2.157	5.457	**1.364**	*1.563*	1.119
Combined average	0.021	0.219	1.593	6.714	8.546	2.137	NA	0.650
with standard deviation	0.028	0.197	2.244	6.444	NA	1.092	NA	0.662
% of standard[6]	**0.400**	**8.950**	Highest media totals across programs in italics.				*14.848*	

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 2009, SRNS-STI-2010-00175.
2. These media are not directly comparable due to media dose factors and release data, and annual releases versus fielc accumulations over several years, but do *illustrate potential variance levels* including modeling versus detections.
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 air (10 mrem) and liquid (4 mrem) standards using highest result (underlined), SCDHEC or DOE-SR.

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Table 6. 1999-2009 AEI Critical Pathways, Subpathways, and Potential Exposure Summary

Critical Pathways Dose Totals 1999-2009		Millirems	% of Total
	Atmospheric Pathway (AP)[1]	9.621	55.341
	Liquid Pathway (LP)[2]	7.764	44.659
Subpathways	Food or Ingestion Pathway (FP)[3]	15.335	88.208
	Inhalation Pathway(IhP)[4]	0.065	0.374
	Direct Exposure Pathway (DXP)[5]	0.537	3.089
	Public Water Supply Pathway (PWS)[6]	0.489	2.813
	Nonpotable Drinking Water Pathway (NPDW)[7]	0.959	5.516

Notes:

1 – AP is the atmospheric pathway or air plus deposition dose.

2 – LP is the liquid pathway or water dose.

3 – FP is the food subpathway.

4 – IhP is the inhalation subpathway.

5 – DXP is the direct exposure subpathway

6 – PWS is the public water systems drinking water subpathway.

7 – NPDW is the nonpotable drinking water pathway.

8 - Does not include alpha, beta, or beta-gamma since they are nonspecific screening values.

Table 7. 1999-2009 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
Plume	0.1	0.4	0.5	0.2	0.4	0.0	0.0	0.0	0.0	0.00	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
Inhalation	48.3	45.7	42.6	41.0	33.5	43.4	42.7	41.6	41.1	43.20	41.1
Vegetation	44.4	41.9	44.1	44.5	51.9	39.4	40.7	46.3	39.6	39.32	38.7
Cow Milk	4.6	7.3	9.0	9.1	9.6	11.3	10.3	1.5	10.9	12.34	12.2
Meat	1.7	2.9	3.2	3.2	2.9	4.4	4.0	4.3	4.6	4.84	4.7

Cow Milk Pathway			
1999-2009	Avg	SD	Median
Plume	0.1	0.2	0.0
Ground	2.2	1.7	1.7
Inhalation	42.2	3.6	42.6
Vegetation	42.8	4.0	41.9
Cow Milk	8.9	3.3	9.6
Meat	3.7	1.0	4.0

MEI from Liquid Releases Percent of Total Dose											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fish	61.0	45.8	40.2	42.5	55.4	47.0	59.0	59.0	51.0	43.0	64.0
Water	38.5	53.9	59.5	57.2	44.2	53.0	41.0	41.0	49.0	57.0	36.0
Shoreline	0.4	0.3	0.3	0.3	0.4	<1	<1	<1	<1	<1	<1
Swimming	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1
Boating	0.0	0.0	0.0	0.0	0.0	<1	<1	<1	<1	<1	<1

Potential MEI Dose from the Liquid Releases			
1999-2009	Avg	SD	Median
Fish	51.6	8.4	51.0
Water	48.2	8.4	49.0
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.

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Table 8. 1999-2009 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
All Pathway	0.28	0.18	0.18	0.18	0.19	0.15	0.13	0.20	0.10	0.12	0.12
Onsite Hunter	77.00	63.00	14.00	39.50	15.60	70.80	8.80	22.00	9.00	13.00	8.4
Offsite Hunter	9.10	10.10	0.53	12.15	1.20	17.30	8.30	9.60	4.80	13.40	4.44
Offsite Fisherman	0.61	1.18	1.74	0.62	0.66	0.71	0.52	0.52	0.50	0.37	0.38

1. Empty cells (NA) indicate no data reported or not applicable.
2. Data from tables in all WSRC referenced reports.
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.

	Statistics		
1999-2009	Avg	SD	Median
All Pathway	0.17	0.05	0.18
Onsite Hunter	31.01	26.86	15.60
Offsite Hunter	8.27	5.15	9.10
Offsite Fisherman	0.71	0.41	0.61

Notes:
1 - See the list of acronyms for abbreviation definitions.
2 - Data accumulated from the DOE-SR SRS Environmental Reports for the listed years.

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Figure 1. DOE-SR Critical Pathways and Dose Media

SRS Exposure Pathway

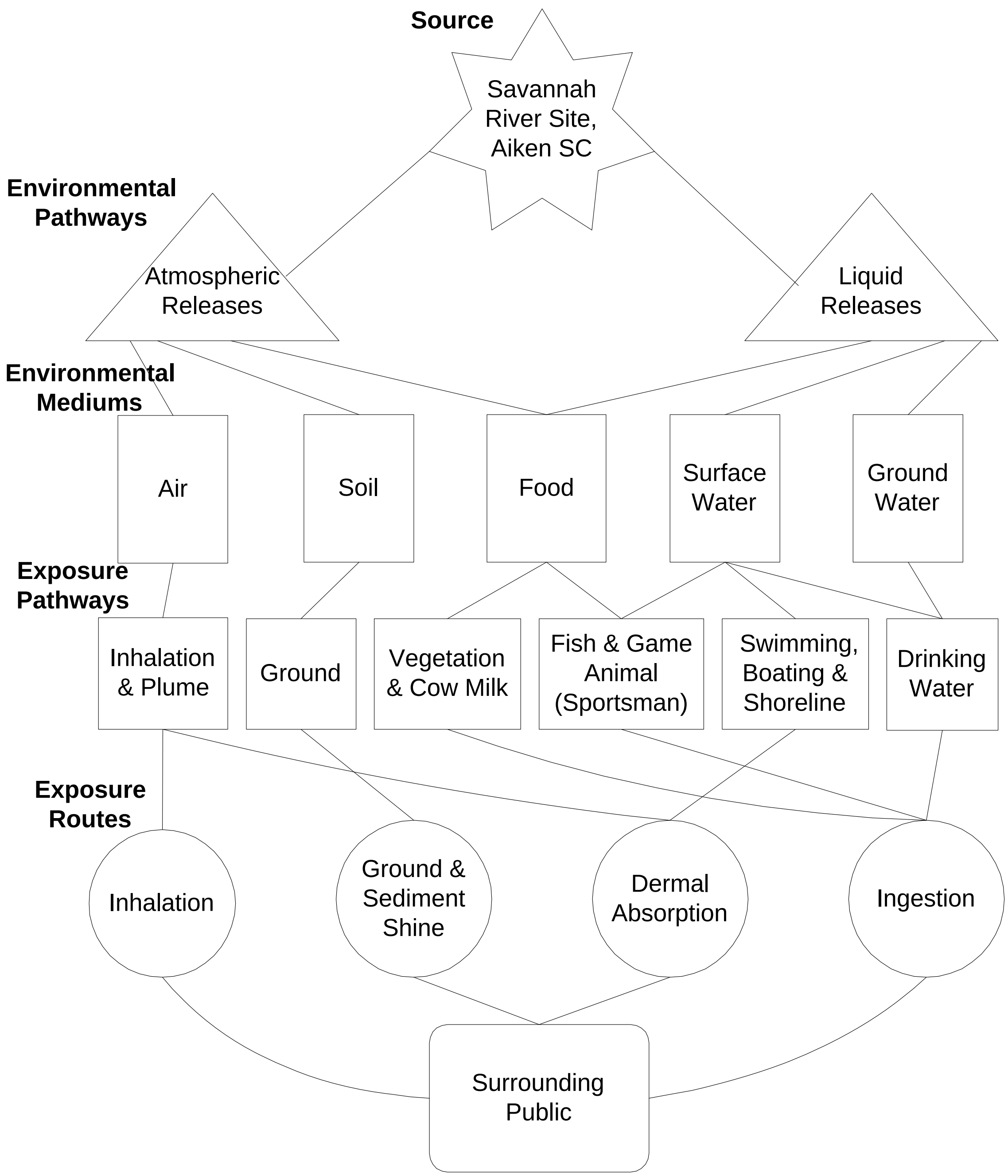

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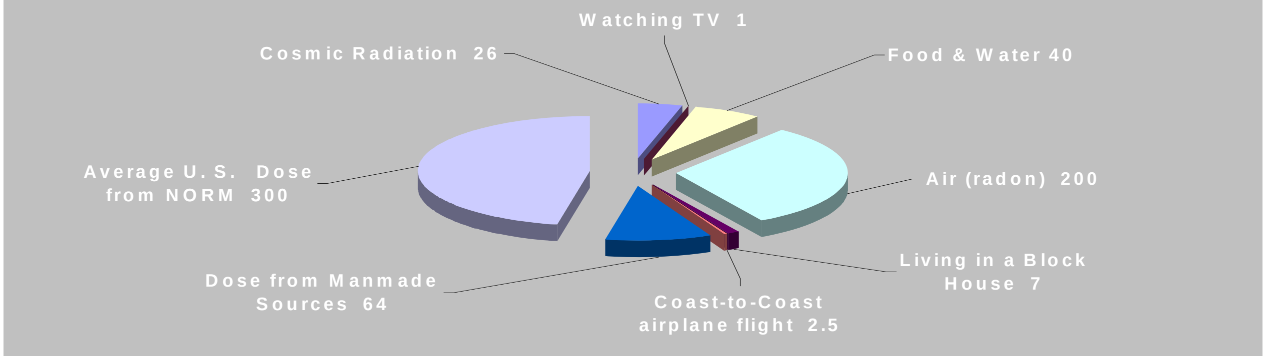
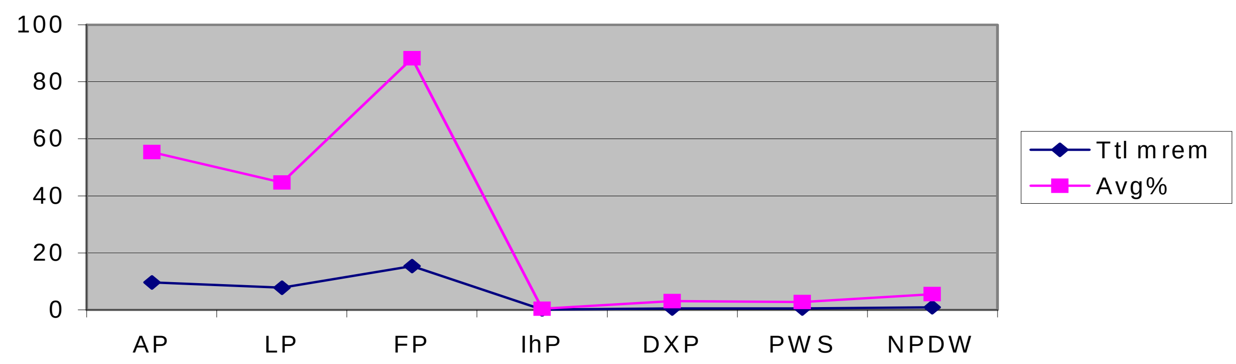
Figure 2. Comparison of Dose Levels (mrem/yr)



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. 1999-2009 Critical Pathway Basis Comparison



Notes:
1 – AP is the atmospheric pathway or air plus deposition dose.
2 – LP is the liquid pathway or water dose.
3 – FP is the food subpathway.
4 – IhP is the inhalation subpathway.
5 – DXP is the direct exposure subpathway.
6 – PWS is the public water systems drinking water subpathway.
7 – NPDW is the nonpotable or untreated drinking water pathway.
8 - Does not include alpha, beta, or beta-gamma since they are nonspecific screening values.
9 – Figure 6 is based on Table 6.

Tables and Figures
2009 Critical Pathway Dose Report

Figure 4. 1999-2009 AEI Food Media Trends (mrem)

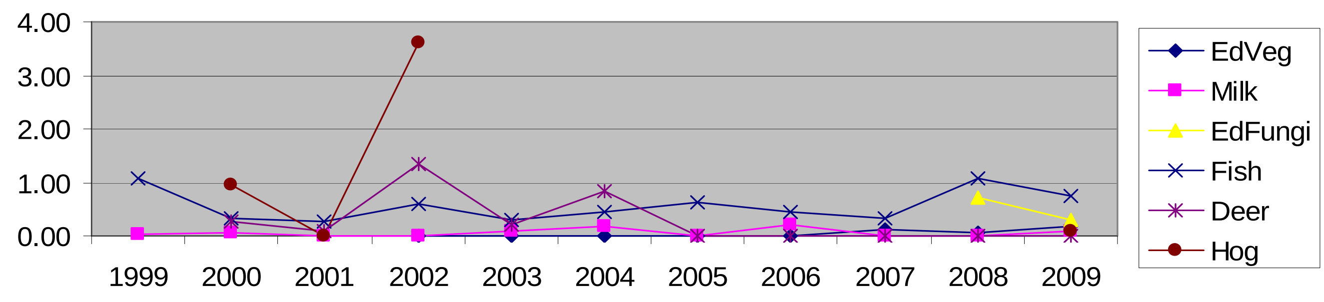


Figure 5. 1999-2009 AEI Versus MAX Dose Trends in Food Media (mrem)

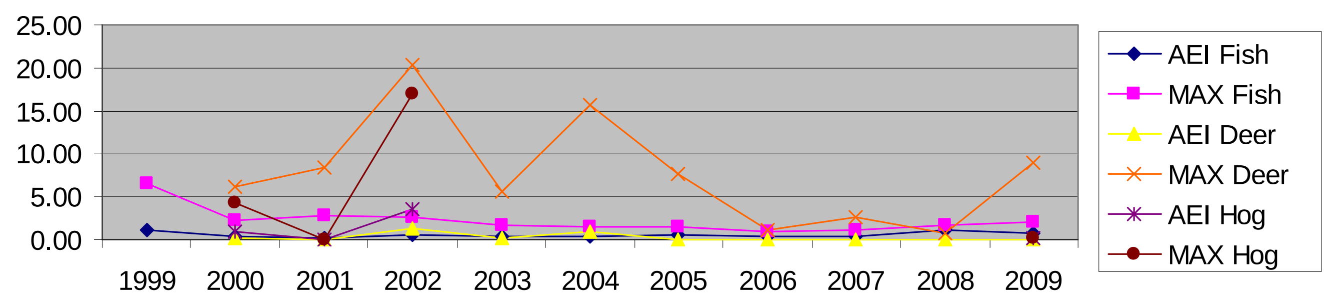


Figure 6. SCDHEC Detected Dose Trends in Water Sources 1999-2009 Excluding NORM

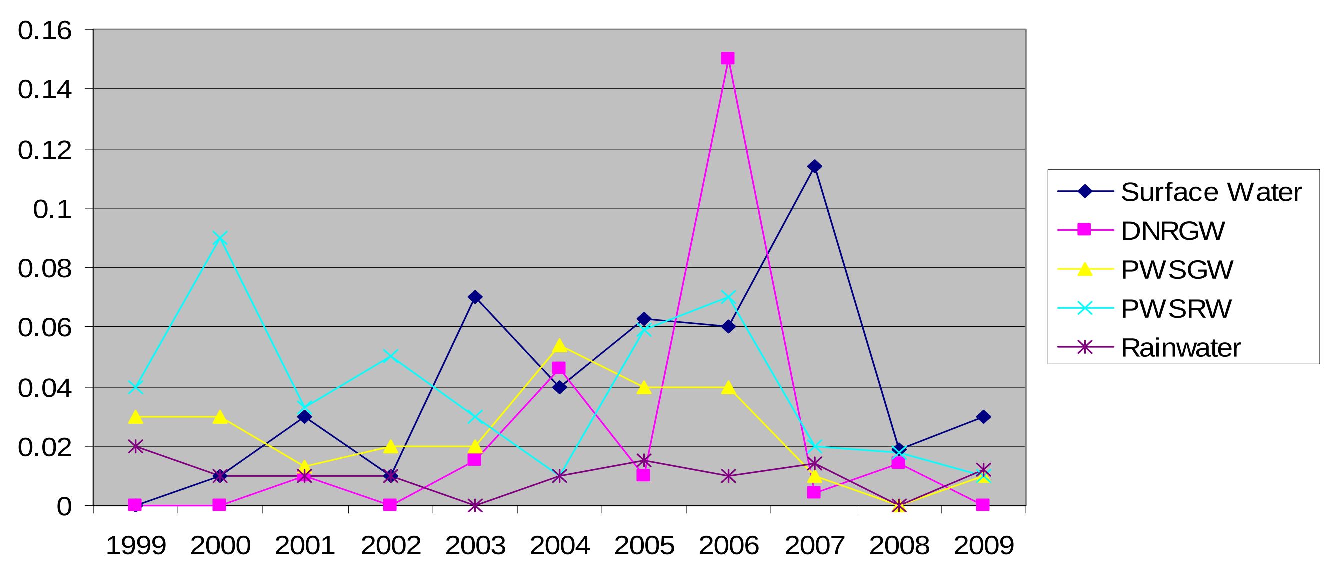


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Figure 7. SRS 50-Mile Perimeter Dose by Media Averages (mrem)

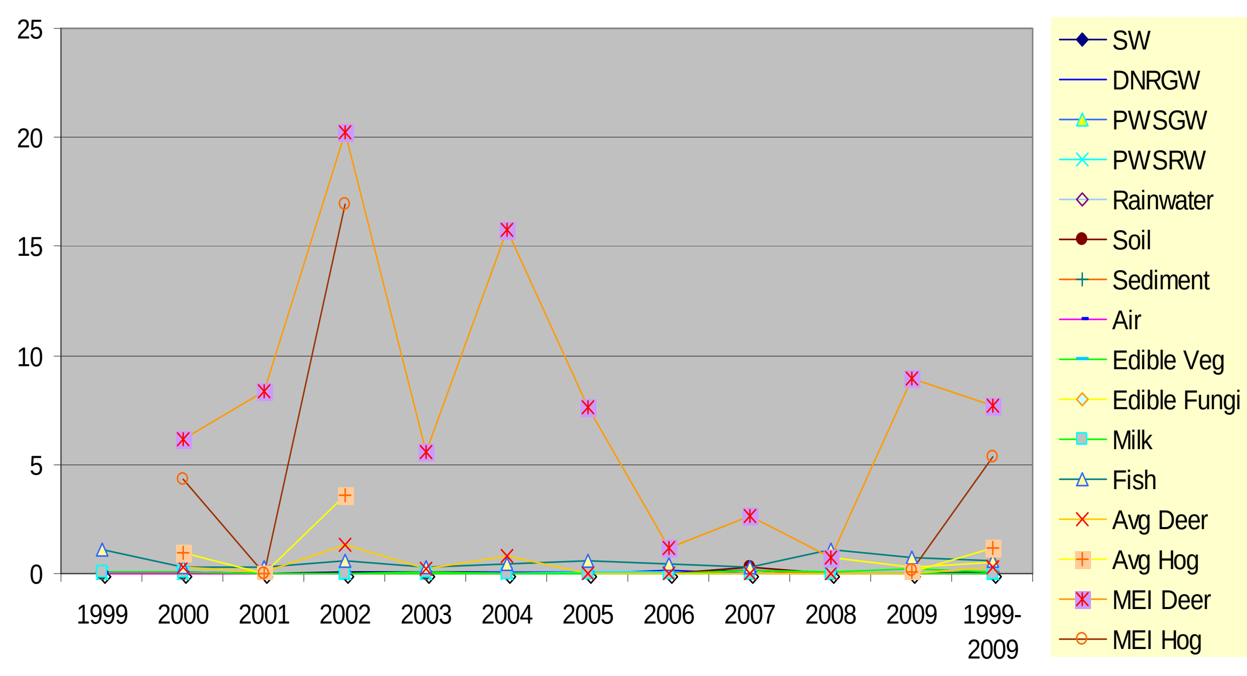
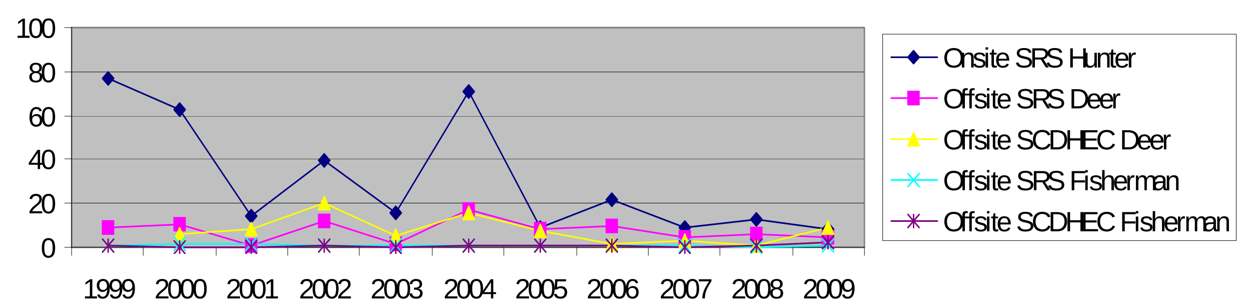


Figure 8. SCDHEC and DOE-SR Sportsman Dose Trend (mrem)



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Section 5.1.3 Data

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 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 gives the resultant dose that was assigned to the maximum exposed individual.
5 – The subtotal column exposure per radionuclide columns show other dose of interest; for example, NORM dose totals not assigned to the MEI. 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 a actual detected radionuclide factor instead of an assigned substitute factor.
6 – See the list of acronyms, radionuclides, and units for abbreviation definitions.
7 – Note that some tables are continued on a second page where the dose assigned to the MEI and NORM are totaled to represent typical dose from water (liquid pathway), soil and air (atmospheric pathway), and food (ingestion pathway) media.
8 - Section 4.0, 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 non-NORM.
9 – Examples of factors affecting dose assignment are discussed as needed.
10 – Calculations by SCDHEC are to three decimal places in millirem determinations and rounded as needed for appropriate comparisons to DOE-SR data.

2009 Average Dose Detections in Food Media

Project	Isotope	AVG	Bkg	Net	MCR	Dose	Summaries		MEI
Media		**Activity**	**Activity**	**Activity**		**mrem**	**Species**		**Dose**
Potential Dose from Fish Ingestion							**Average**	**Totals**	**NonNORM**
Fish		**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**per Isotope**	**per Isotope**	**Basis**
Bass	**H-3**	**0.833**	**0.000**	**0.833**	48.2	**0.003**	**H-3**	**H-3**	**0.003**
	Cs-137	**0.398**	**0.097**	**0.301**	48.2	**0.725**	0.001	0.007	
	Sr-89/90	**0.051**	**0.044**	**0.007**	48.2	**0.004**			
	Bass nonNORM dose average					0.244	**Cs-137**	**Cs-137**	**0.725**
Catfish	**H-3**	**0.281**	**0.000**	**0.281**	48.2	**0.001**	0.413	0.826	
	Cs-137	**0.042**	**0.000**	**0.042**	48.2	**0.100**			
	Sr-89/90	**0.033**	**0.012**	**0.021**	48.2	**0.012**	**Sr-89/90**	**Sr-89/90**	**0.012**
	Catfish nonNORM dose average					0.038	0.006	0.032	
Mullet	**H-3**	**0.352**	**0.000**	**0.352**	48.2	**0.001**	**Totals per Fish**		
	Sr-89/90	**0.007**	**0.000**	**0.007**	48.2	**0.004**	**Catfish**	**Red Drum**	
	Mullet nonNORM dose average					0.003	0.113	0.011	
Red Drum	**H-3**	**0.378**	**0.000**	**0.378**	48.2	**0.001**	**Mullet**	**Sea Trout**	
	Sr-89/90	**0.017**	**0.000**	**0.017**	48.2	**0.010**	0.005	0.004	
	Red Drum nonNORM dose average					0.005	**Bass**		
Sea Trout	**H-3**	**0.414**	**0.000**	**0.414**	48.2	**0.001**	0.732		
	Sr-89/90	**0.004**	**0.000**	**0.004**	48.2	**0.002**	**Fish Avg**	**Fish Total**	
	Sea Trout nonNORM dose average					0.002	0.173	0.865	
Potential Dose from Milk Ingestion									**0.002**
Cow		**pCi/L**	**pCi/L**	**pCi/L**	**kg/yr**	**mrem**	**H-3**		
	H-3	**0.000**	**0.000**	**0.000**	230.0	**0.000**	**0.000**		
	Sr-89/90	**0.730**	**0.000**	**0.730**	230.0	**0.002**	**Sr-89/90**	**Cow Ttl**	
	Cow milk nonNORM dose avg					**0.001**	**0.002**	**0.002**	
Potential Dose From Game									**0.101**
Game Animal		**Study Area Average**		**Bkg Average**				**Game Ttl**	
Ingestion		**mrem**		**mrem**		**mrem**		0.101	
Avg Deer	**Cs-137**	**1.118**		2.127		**0.000**			
Avg Hog	**Cs-137**	**0.101**		0.000		**0.101**			
	Game Animal nonNORM dose average					**0.051**			
Potential Dose from NonNorm in Edible Vegetation									**0.191**
Edible Vegetation	**Isotope**	**pCi/g**	**pCi/g**	**pCi/g**	**kg/yr**	**mrem**	**H-3**	**H-3**	
Leafy	K-40	4.197	6.928	0.000	73.0	0.000	0.004	0.004	
Leafy Vegetables NORM Average						0.000	**Sr-89/90**	**Sr-89/90**	
Fruit	**H-3**	**0.254**	**0.000**	0.254	276.0	**0.004**	0.186	0.186	
	Sr-90	**0.056**	**0.000**	0.056	276.0	**0.186**	**NORM Basis**		
	K-40	4.755	1.672	3.083	276.0	15.820	**Avg**	**Totals**	
	Pb-214	0.150	0.000	0.150	276.0	0.026	Leafy		
	U-234	0.004	0.000	0.004	276.0	0.029	0.000	0.000	
	U-235	0.003	0.000	0.003	276.0	0.020	Fruit		
	U-238	0.002	0.000	0.002	276.0	0.011	3.181	15.905	
Vegetable fruits NORM plus nonNORM Average						4.009	Edible Mushroom		
Edible	**Cs-137**	**1.888**	**0.210**	1.678	3.65	**0.306**	0.163	0.490	
Mushrooms	K-40	17.844	15.296	2.548	3.65	0.173			
	Pb-212	0.253	0.112	0.141	3.65	0.316			
	Pb-214	0.355	0.214	0.141	3.65	0.000	**nonNORM in Fungi**		**0.306**
Edible Mushrooms[5] NORM plus nonNORM Average						0.199	Total NORM		16.394
							Total nonNORM		**1.340**
							All Detected Dose		17.735

Table notes:
1 - Bold denotes NonNORM isotope or radionuclide activity detections.
2 - Nonbold denotes NORM activity detections.
3 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.
4 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.
5 - These edible fungi were not identified to species level. Most boletes are edible and therefore their potential dose was added only as a special case representing a minority consumer of wild mushrooms.

2009 Single Highest Dose Detections in Food Media

Project	Isotope	AVG	Bkg	Net	MCR	Dose	Summaries		MEI
Media		Activity	Activity	Activity		mrem	Species		Dose
Potential Dose from Fish Ingestion							Average	Totals	NonNORM
Fish		pCi/g	pCi/g	pCi/g	kg/yr	mrem	per Isotope	per Isotope	Basis
Bass	H-3	1.870	0.000	1.870	48.2	0.006	H-3	H-3	0.006
	Cs-137	0.910	0.097	0.813	48.2	1.959	0.003	0.015	
	Sr-89/90	0.091	0.044	0.047	48.2	0.027			
	Bass non-NORM dose average					0.664	Cs-137	Cs-137	1.959
Catfish	H-3	1.832	0.000	1.832	48.2	0.006	1.037	2.074	
	Cs-137	0.048	0.000	0.048	48.2	0.115			
	Sr-89/90	0.049	0.012	0.037	48.2	0.021	Sr-89/90	Sr-89/90	0.027
	Catfish non-NORM dose average					0.047	0.013	0.065	
Mullet	H-3	0.352	0.000	0.352	48.2	0.001	Totals per Fish		
	Sr-89/90	0.007	0.000	0.007	48.2	0.004	Catfish	Red Drum	
	Mullet non-NORM dose average					0.003	0.142	0.011	
Red Drum	H-3	0.378	0.000	0.378	48.2	0.001	Mullet	Sea Trout	
	Sr-89/90	0.017	0.000	0.017	48.2	0.010	0.005	0.004	
	Red Drum non-NORM dose average					0.005	Bass		
Sea Trout	H-3	0.414	0.000	0.414	48.2	0.001	1.992		
	Sr-89/90	0.004	0.000	0.004	48.2	0.002	Fish Avg	Fish Total	
	Sea Trout non-NORM dose average					0.002	0.431	2.154	
Potential Dose from Milk Ingestion									0.003
Cow		pCi/L	pCi/L	pCi/L	kg/yr	mrem	H-3		
	H-3	0.000	0.000	0.000	230.0	0.000	0.000		
	Sr-89/90	1.150	0.000	1.150	230.0	0.003	Sr-89/90	Cow Ttl	
	Cow milk nonNORM dose avg					0.002	0.003	0.003	
Potential Dose From Game									9.083
Game Animal		Study Area Average		Bkg Average				Game Ttl	
Ingestion		mrem		mrem		mrem		2.897	
MAX Deer	Cs-137	4.864		2.127		2.737			
MAX Hog	Cs-137	0.160		0.000		0.160			
Hunter MEI	Cs-137	11.050		2.127		8.923	Based on 4 deer-1 hunter		
Deer & Hog	Game Animal nonNORM dose average					1.449			
Potential Dose from NonNorm in Edible Vegetation									0.192
Edible Vegetation	Isotope	pCi/g	pCi/g	pCi/g	kg/yr	mrem	H-3	H-3	
Leafy	K-40	4.690	6.928	0.000	73.0	0.000	0.006	0.006	
Leafy Vegetables NORM Average						0.000	Sr-89/90	Sr-89/90	
Fruit	H-3	0.353	0.000	0.353	276.0	0.006	0.186	0.186	
	Sr-90	0.056	0.000	0.056	276.0	0.186	NORM Basis		
	K-40	13.940	1.672	12.268	276.0	62.954	Avg	Totals	
	Pb-214	0.227	0.000	0.227	276.0	0.039	Leafy		
	U-234	0.004	0.000	0.004	276.0	0.029	0.000	0.000	
	U-235	0.003	0.000	0.003	276.0	0.022	Fruit		
	U-238	0.002	0.000	0.002	276.0	0.012	12.611	63.057	
Vegetable fruits NORM plus nonNORM Average						15.796	Edible Mushroom		
Edible	Cs-137	7.250	0.210	7.040	3.65	1.285	0.466	1.399	
Mushrooms	K-40	30.470	15.296	15.174	3.7	1.030			
	Pb-212	0.276	0.112	0.164	3.7	0.368			
	Pb-214	0.557	0.214	0.343	3.7	0.001	nonNORM in Fungi		1.285
Edible Mushrooms[5] NORM plus nonNORM Average						0.671	Total NORM		64.455
							Total nonNORM		12.556
							All Detected Dose		77.011

Table notes:
1 - Bold denotes NonNORM isotope or radionuclide activity.
2 - Nonbold denotes NORM activity.
3 - Underlined data is the highest detection per isotope by media contributing to the stated MEI value.
4 - Fish total MEI dose is based on adding the highest values per each radionuclide regardless of fish species.
5 - These edible fungi were not identified to species level. Most boletes are edible and therefore their potential dose was added only as a special case representing a minority consumer of wild mushrooms.

2009 Average Dose Detections in Water Media

Project	**Isotope**	**Avg**	**Bkg**	**Net**	**MCR**	**Dose**	**Exposure Group**		**MEI**
Water		**Activity**	**Activity**	**Activity**		**mrem**			**Dose**
Sources	**Radionuclide Ingestion From Surface Water (SW) and Wells**							Totals	**(mrem)**
PWSRW(DW)		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.006**
SW	**H-3**	**424.700**	**288.500**	136.200	730	**0.006**	NORM/Unk		
Savannah River Public Water Supplies (PWS) Drinking Water (DW)							Avg	Totals	
PWS Savannah River Water (SRW) Average Dose All Rads						0.006	0.000	0.000	
Includes SRW from Chelsea, Beaufort Jasper, and City of Savannah minus North Augusta background.									
PWSGW(DW)		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.009**
GW	**H-3**	**202.000**	**0.000**	202.000	730	**0.009**	NORM/Unk		
Public Water Supplies with Groundwater (GW) Sources							Avg	Totals	
PWS Average Dose from Random plus nonRandom Wells.						0.009	0.000	0.000	
DNRGW		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.000**
GW	**H-3**	**274.250**	**303.000**	0.000	730	**0.000**	NORM/Unk		
DNR Monitoring Wells (comparable to local untreated private wells)							Avg	Totals	
Department of Natural Resources (DNR) Ground Water Avg Dose						0.000	0.000	0.000	
Nonpotable		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.030**
SW	**H-3**	**871.700**	**237.000**	**634.700**	730	**0.030**	NORM/Unk		
Survivalist Ingestion at Savannah River Boat Landings							Avg	Totals	
Average Dose from Random plus nonRandom Samples.						0.030	0.000	0.000	
Rainwater	**H-3**	**251.233**	0.000	**251.233**	730	**0.012**	**NonNORM……**		**0.012**
Nonpotable Average Dose Potential from Rainwater and Boat Landings.						0.021			
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)									
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.006**
Ingestion	**H-3**	**10720.625**	**214.500**	**10506.125**	91	**0.006**	NORM/Unk		
Ingestion while swimming at Savannah River Site Creek Mouths							Avg	Totals	
Swimming Ingestion Average Dose from Swallowing Creek Water						0.005	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Immersion	**H-3**	**10720.625**	**214.500**	**10506.125**	91	0.000	NORM/Unk		
Direct exposure to the skin while swimming at SRS Creek Mouths.							Avg	Totals	
Average Dose from Skin Exposure to Creek Water						0.000	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Boating	**H-3**	**10720.625**	**214.500**	**10506.125**	192	0.000	NORM/Unk		
Direct exposure from SRS Creek Mouth Water while Boating							Avg	Totals	
Boating Average Dose from Skin Exposure to Creek Water						0.000	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Resident	**H-3**	**10720.625**	**214.500**	**10506.125**	4380	0.000	NORM/Unk		
Swamp House or Houseboat Dose Exposure to Water							Avg	Totals	
Swamp Resident Average Dose from Skin Exposure to Creek Water						0.000	0.000	0.000	
Sediment Random plus Nonrandom at Creek Mouths									
Sediment Dose		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Skin	**Cs-137**	**0.566**	0.000	**0.566**	91	**0.000**			
Wading	Ac-228	1.254	1.827	0.000	91	0.000			
Barefoot	Be-7	0.402	0.000	0.402	91	0.000			
to 1 cm	K-40	12.078	10.981	1.096	91	0.003			
(centimeter)	Pb-212	1.219	1.449	0.000	91	0.000	NORM/Unk		
sediment	Pb-214	1.328	0.928	0.399	91	0.000	Avg	Totals	
depth	Ra-226	2.343	1.967	0.377	91	0.001	0.001	0.004	
Table notes:							Total NORM		0.004
1 - Bold denotes NonNORM isotope or radionuclide activity.							**Total nonNORM**		**0.063**
2 - Nonbold denotes NORM activity.							All Detected Dose		0.068

2009 Single Highest Dose Detections in Water Media

Project	Isotope	MAX	Bkg	Net	MCR	Dose	Exposure Group		MEI
Water		Activity	Activity	Activity		mrem			Dose
Sources	Ingestion							Totals	(mrem)
PWSRW(DW)		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.029**
SW	**H-3**	**9.060E+02**	**2.885E+02**	6.175E+02	730	**0.029**	NORM/Unk		
Savannah River Public Water Supplies (PWS) Drinking Water (DW)							Avg	Totals	
PWS Savannah River Water Average Dose						0.029	0.000	0.000	
Includes SRW from Chelsea, Beaufort Jasper, and City of Savannah minus North Augusta background.									
PWSGW(DW) Ingest		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.009**
GW	**H-3**	**2.020E+02**	0.000E+00	2.020E+02	730	**0.009**	NORM/Unk		
Public Water Supplies with Groundwater (GW) Sources							Avg	Totals	
PWS Average Dose from Random and nonRandom Wells.						0.009	0.009	0.009	
DNRGW		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.002**
GW	**H-3**	**3.460E+02**	**3.030E+02**	4.300E+01	730	**0.002**	NORM/Unk		
DNR Monitoring Wells (comparable to local untreated private wells)							Avg	Totals	
Department of Natural Resources (DNR) Ground Water Avg Dose						0.002	0.000	0.000	
Nonpotable		**pCi/L**	**pCi/L**	**pCi/L**	**L/yr**	**mrem**	**NonNORM……**		**0.323**
SW	**H-3**	**7.153E+03**	**2.37E+02**	6.916E+03	730	**0.323**	NORM/Unk		
Survivalist Ingestion at Savannah River Boat Landings							Avg	Totals	
Average Dose from Random plus nonRandom Samples						0.323	0.000	0.000	
Rainwater	**H-3**	**5.881E+02**	0.000E+00	5.881E+02	730	**0.028**	**NonNORM……**		**0.028**
Nonpotable Average Dose Potential from Rainwater and Boat Landings						0.175	NA	NA	
Streams and Savannah River Surface Water Samples Excluding PWSRW(DW)									
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.035**
Ingestion	**H-3**	**6.026E+04**	**2.15E+02**	**6.004E+04**	91	**0.035**	NORM/Unk		
Ingestion while swimming at Savannah River Creek Mouths							Avg	Totals	
Swimming ingestion Average Dose from Swallowing Creek Water						0.021	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Immersion	**H-3**	**6.026E+04**	**2.15E+02**	**6.004E+04**	91	0.000	NORM/Unk		
Direct exposure to the skin while swimming at SRS Creek Mouths							Avg	Totals	
Average Dose from Skin Exposure to Creek Water						0.000	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Boating	**H-3**	**6.026E+04**	**2.15E+02**	**6.916E+03**	192	0.000	NORM/Unk		
Direct exposure from SRS Creek Mouth Water while Boating							Avg	Totals	
Boating Average Dose from Skin Exposure to Creek Water						0.000	0.000	0.000	
Surface Water		**pCi/L**	**pCi/L**	**pCi/L**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
Resident	**H-3**	**6.026E+04**	**2.15E+02**	**6.004E+04**	4380	0.000	NORM/Unk		
Swamp House or Houseboat Dose Exposure to Water							Avg	Totals	
Swamp Resident Average Dose from Skin Exposure to Creek Water						0.000	0.000	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**
Skin	**Cs-137**	**1.804E+00**	**0.000E+00**	**1.804E+00**	91	**0.000**			
Wading	Ac-228	2.112E+00	1.827E+00	2.852E-01	91	0.002			
Barefoot	Be-7	4.023E-01	0.000E+00	4.023E-01	91	0.000			
to 1 cm	K-40	1.775E+01	1.098E+01	6.769E+00	91	0.019			
(centimete	Pb-212	2.122E+00	1.449E+00	6.731E-01	91	0.000			
sediment	Pb-214	4.439E+00	9.284E-01	3.511E+00	91	0.000			
depth	Ra-226	5.883E+00	1.967E+00	3.916E+00	91	0.013			
							NORM/Unk		
							Avg	Totals	
							0.006	0.034	
Table notes:							Highest Isotopes Total		
1 - Bold denotes NonNORM isotope or radionuclide activity.							0.000		
2 - Nonbold denotes NORM activity.							Total NORM		0.043
							Total nonNORM		**0.426**
							All Detected Dose		0.470

2009 Average Dose Detections in Soil and Air Media

Project	Isotope	Avg	Bkg	Net	MCR	Dose	Exposure Group		MEI
Surface		**Activity**	**Activity**	**Activity**		**mrem**			**Dose**
Soil								Totals	**Total**
Surface Soil & Riverbank Soil Random plus Nonrandom Sample Detections									
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	**mrem**	**NonNORM……**		**0.000**
	Cs-137	**0.216**	**0.571**	**0.000**	100	**0.000**			
	Pb-212	1.131	0.988	0.143	100	0.000			
Ingestion	Pb-214	1.076	0.884	0.192	100	0.000	NORM/Unk		
	Ra-226	2.405	2.531	0.000	100	0.000	Avg	Totals	
	Ac-228	1.190	1.053	0.137	100	0.000	0.001	0.004	
	K-40	2.183	6.413	0.000	100	0.000			
	U/Th-238	3.892	0.000	3.892	100	0.003			
Surface Soil Ingestion Average Dose All Isotopes						0.001			
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	mrem	**NonNORM……**		**0.001**
Boat	**Cs-137**	**0.514**	**0.081**	**0.433**	100	**0.001**			
Landings	K-40	11.001	7.404	3.597	100	0.002			
	Pb-212	1.266	1.102	0.164	100	0.000	NORM/Unk		
Survivalist	Pb-214	1.344	0.984	0.360	100	0.000	Avg	Totals	
Potential	Ra-226	2.827	2.240	0.587	100	0.028	0.006	0.031	
	Ac-228	1.290	1.168	0.122	100	0.000			
Riverbank Soil Ingestion Avg Dose All Isotopes at Boat Landings						0.006			
All Soil Ingestion Dose (NORM plus nonNORM)					Avg	0.003	Total	0.036	
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
	Cs-137	**0.216**	**0.571**	**0.000**	4380	**0.000**			
	Pb-212	1.131	0.988	0.143	4380	0.019			
Direct	Pb-214	1.076	0.884	0.192	4380	0.049	NORM/Unk		
Exposure	Ra-226	2.405	2.531	0.000	4380	0.000	Avg	Totals	
	Ac-228	1.190	1.053	0.137	4380	0.150	0.036	0.219	
	K-40	2.183	6.413	0.000	4380	0.000			
	U/Th-238	3.892	0.000	3.892	4380	0.000			
Surface Soil Direct Exposure Average Dose All Isotopes						0.036			
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM……**		**0.001**
	Cs-137	**0.514**	**0.081**	**0.433**	4380	**0.001**			
	K-40	11.001	7.404	3.597	4380	0.488			
Direct	Pb-212	1.266	1.102	0.164	4380	0.042	NORM/Unk		
Exposure	Pb-214	1.344	0.984	0.360	4380	0.002	Avg	Totals	
	Ra-226	2.827	2.240	0.587	4380	0.157	0.144	0.722	
	Ac-228	1.290	1.168	0.122	4380	0.033	Page 1 Atmospheric		
Riverbank Soil Average Direct Exposure All Isotopes						0.144	NORM total		0.975
							nonNORM total		**0.0021**

Table notes: Sheet 1 of 2.

1 - Bold denotes NonNORM isotope or radionuclide activity.

2 - Nonbold denotes NORM activity.

2009 Average Dose Detections in Soil and Air Media - continued

Project	Isotope	Avg	Bkg	Net	MCR	Dose	Exposure Group		MEI
Surface		Activity	Activity	Activity		mrem			Dose
Soil								Totals	Total
Soil Resuspension and Air Inhalation Dose									
Surface Soil Resuspension		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM……**		**0.000**
	Cs-137	**0.216**	**0.571**	**0.000**	8000	**0.000**			
	Pb-212	1.131	0.988	0.143	8000	0.000			
	Pb-214	1.076	0.884	0.192	8000	0.000			
	Ra-226	2.405	2.531	0.000	8000	0.000	NORM/Unk		
	Ac-228	1.190	1.053	0.137	8000	0.000	Avg	Totals	
	K-40	2.183	6.413	0.000	8000	0.000	0.062	0.369	
	U/Th-238	3.892	0.000	3.892	8000	0.369			
Surface Soil Resuspension All Inhalation Avg Dose						0.062			
Riverbank Soil Resuspension		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM……**		**0.000**
	Cs-137	**0.514**	**0.081**	**0.433**	8000	**0.000**			
	K-40	11.009	7.404	3.605	8000	0.000			
	Pb-212	1.266	1.102	0.164	8000	0.000	NORM/Unk		
	Pb-214	1.344	0.984	0.360	8000	0.000	Avg	Totals	
	Ra-226	2.827	2.240	0.587	8000	0.004	0.001	0.004	
	Ac-228	1.290	1.168	0.122	8000	0.000			
Riverbank Soil Resuspension All Inhalation Avg Dose						0.001	**NonNORM……**		**0.000**
Air Inhalation		**pCi/m3**	**pCi/m3**	**pCi/m3**	**m3/yr**	**mrem**			
Inhalation	**H-3**	**4.238**	3.580	**0.659**	8000	**0.000**	NORM/Unk		
							Avg	Totals	
							0.000	0.000	
Air Inhalation Avg Dose						**0.000**	Page 1 Atmospheric		
							NORM total		0.975
							nonNORM total		**0.002**
							Page 2 Atmospheric		
							NORM total		0.373
							nonNORM total		**0.000**
							Total NORM		1.348
							Total nonNORM		**0.002**
							All Detected Dose		1.351

Sheet 2 of 2.

2009 Single Highest Dose Detections in Soil and Air Media

Project	Isotope	MAX	Bkg	Net	MCR	Dose	Exposure Group		MEI
Surface		**Activity**	**Activity**	**Activity**		**mrem**			**Dose**
Soil								Totals	**Total**
Surface Soil & Riverbank Soil Random and Nonrandom Sample Detections									
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	**mrem**	**NonNORM……**		**0.000**
	Pb-212	2.901	0.988	1.913	100	0.003			
Maximum	Pb-214	3.401	0.884	2.517	100	0.000			
Potential	Ra-226	9.186	2.531	6.655	100	0.322	NORM/Unk		
Ingestion	Ac-228	2.751	1.053	1.698	100	0.000	Avg	Totals	
Dose	K-40	7.133	6.413	0.000	100	0.000	0.055	0.328	
	U/Th-238	3.892	0.000	3.892	100	0.002			
	Cs-137	**0.268**	**0.571**	**0.000**	100	**0.000**			
Upturned Soil NORM plus nonNORM Ingestion Average Dose						0.047			
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**mg/day**	mrem	**NonNORM……**		**0.002**
	K-40	20.200	7.404	12.796	100	0.009			
Maximum	Pb-212	2.058	1.102	0.956	100	0.002	NORM/Unk		
Potential	Pb-214	2.486	0.984	1.502	100	0.000	Avg	Totals	
Ingestion	Ra-226	4.302	2.240	2.062	100	0.100	0.022	0.110	
Dose	Ac-228	2.142	1.168	0.974	100	0.000			
	Cs-137	**1.309**	**0.081**	**1.228**	100	**0.002**			
Riverbank - All maximums NORM plus NonNORM dose average						0.019			
Sportsman/Recreational potential riverbank soil dose at public boat landings.									
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM……**		**0.000**
	Pb-212	2.901	0.988	1.913	4380	0.260			
Direct	Pb-214	3.401	0.884	2.517	4380	0.644	NORM/Unk		
Exposure	Ra-226	9.186	2.531	6.655	4380	0.041	Avg	Totals	
	Ac-228	2.751	1.053	1.698	4380	1.855	0.522	3.134	
	K-40	7.133	6.413	0.720	4380	0.192			
	U/Th-238	3.892	0.000	3.892	4380	0.143			
	Cs-137	**0.268**	**0.571**	**0.000**	4380	**0.000**			
Upturned Soil NORM plus nonNORM Direct Exposure Avg Dose						0.448			
Farming Potential Dose From Surface Soils							TLD Building Control		
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**hrs/yr**	**mrem**	**NonNORM……**		**0.004**
	K-40	20.200	7.404	12.796	4380	3.415			
Direct	Pb-212	2.058	1.102	0.956	4380	0.130	NORM/Unk		
Exposure	Pb-214	2.486	0.984	1.502	4380	0.384	Avg	Totals	
	Ra-226	4.302	2.240	2.062	4380	0.013	1.001	5.005	
	Ac-228	2.142	1.168	0.974	4380	1.064	See continued sheet.		
	Cs-137	**1.309**	**0.081**	**1.228**	4380	**0.004**	**Page 1 Atmospheric**		
Potential Riverbank Soil Direct Dose Average at Boat Landings.						0.835	**Sheet 1 of 2.**		
Notes: These tables are based on detections versus non-detects, and all <MDA non-detect results are assigned as zeros.							NORM total		8.577
							nonNORM total		**0.006**

Sheet 1 of 2

2009 Single Highest Dose Detections in Soil and Air Media - continued

Project	Isotope	MAX	Bkg	Net	MCR	Dose	Exposure Group		MEI
Surface		Activity	Activity	Activity		mrem			Dose
Soil	Inhalation from Atmospheric Pathway							Totals	Total
Soil Resuspension and Inhalation Dose									
Surface Soil		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM……**		**0.000**
	Pb-212	2.901	0.988	1.913	8000	0.000			
	Pb-214	3.401	0.884	2.517	8000	0.000	NORM/Unk		
Inhalation	Ra-226	9.186	2.531	6.655	8000	0.046	Avg	Totals	
	Ac-228	2.751	1.053	1.698	8000	0.000	0.008	0.046	
	K-40	7.133	6.413	0.720	8000	0.000			
	U/Th-238	3.892	0.000	3.892	8000	0.000			
	Cs-137	**0.268**	**0.571**	**0.000**	8000	**0.000**			
All Surface Soil Resuspension/Inhalation Average Dose						0.007			
Riverbank Soil		**pCi/g**	**pCi/g**	**pCi/g**	**m3/yr**	**mrem**	**NonNORM……**		**0.000**
	K-40	20.200	7.404	12.796	8000	0.000			
	Pb-212	2.058	1.102	0.956	8000	0.000	NORM/Unk		
	Pb-214	2.486	0.984	1.502	8000	0.000	Avg	Totals	
	Ra-226	4.302	2.240	2.062	8000	0.014	0.003	0.015	
	Ac-228	2.142	1.168	0.974	8000	0.000			
	Cs-137	**1.309**	**0.081**	**1.228**	8000	**0.000**			
All Riverbank Soil Resuspension/Inhalation Average Dose						0.015			
Air Inhalation		**pCi/m3**	**pCi/m3**	**pCi/m3**	**Avg**	**0.003**	**NonNORM……**		**0.001**
Inhalation	**H-3**	**5.701**	**3.580**	**2.121**	8000	**0.001**	NORM/Unk		
							Avg	Totals	
							0.001	0.001	
							Page 1 Atmospheric		
							NORM total		8.577
							nonNORM total		**0.006**
							Page 2 Atmospheric		
							NORM total		0.062
							nonNORM total		**0.001**
							Total NORM		8.639
							Total nonNORM		**0.007**
							All Detected Dose		8.646

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Section 5.1.4 Summary Statistics
2009 Critical Pathway Dose Report

Summary Statistics
2009 Critical Pathway Dose Report

Table 1. Average Dose Rank by Radionuclide (Millirems and Percentage)

1999-2009	sum	%	avg	sd	median	N#	2009	sum	%	avg	sd	median	N#
Totals	**20.998**	**100.00**	**NA**	**NA**	**NA**	**146**	**Totals**	**1.984**	**100.00**	**NA**	**NA**	**NA**	**18**
Cs-137	18.008	85.76	0.487	0.854	0.113	37	**Cs-137**	1.237	62.35	0.247	0.346	0.101	5
Sr-89/90	0.848	4.04	0.071	0.089	0.021	12	**U-238**	0.383	19.304	0.192	0.255	0.192	2
H-3	0.829	3.95	0.013	0.014	0.008	65	**Sr-89/90**	0.220	11.089	0.073	0.099	0.032	3
U-238	0.443	2.11	0.055	0.128	0.008	8	**H-3**	0.095	4.788	0.016	0.017	0.011	6
Sr-89	0.209	1.00	0.052	0.078	0.019	4	**U-234**	0.029	1.462	0.029	NA	0.029	1
Ra-228	0.185	0.88	0.093	0.018	0.093	2	**U-235**	0.020	1.008	0.020	NA	0.020	1
U-234	0.177	0.84	0.089	0.084	0.089	2	**Sr-89**	0.000	0.000	NA	NA	NA	0
Eu-155	0.119	0.57	0.060	0.074	0.060	2	**Sr-90**	0.000	0.000	NA	NA	NA	0
Zn-65	0.073	0.35	0.073	NA	0.073	1	**Ra-228**	0.000	0.000	NA	NA	NA	0
U-235	0.047	0.22	0.016	0.005	0.017	3	**Pu-239/240**	0.000	0.000	NA	NA	NA	0
Am-241	0.040	0.19	0.040	NA	0.040	1	**Am-243**	0.000	0.000	NA	NA	NA	0
Sr-90	0.012	0.06	0.006	0.004	0.006	2	**Pu-238**	0.000	0.000	NA	NA	NA	0
Am-243	0.003	0.01	0.003	NA	0.003	1	**Pu-239**	0.000	0.000	NA	NA	NA	0
Pu-239/240	0.002	0.01	0.001	0.000	0.001	2	**Tc-99**	0.000	0.000	NA	NA	NA	0
Zr-95	0.002	0.01	0.002	NA	0.002	1	**Eu-155**	0.000	0.000	NA	NA	NA	0
Pu-238	0.001	0.00	0.001	NA	0.001	1	**Zn-65**	0.000	0.000	NA	NA	NA	0
Tc-99	0.001	0.00	0.001	NA	0.001	1	**Am-241**	0.000	0.000	NA	NA	NA	0
Pu-239	0.000	0.00	NA	NA	NA	0	**Th-234**	0.000	0.000	NA	NA	NA	0
Ce-144	0.000	0.00	0.000	NA	0.000	1	**Zr-95**	0.000	0.000	NA	NA	NA	0

Notes: These charts are limited to comparable radionuclides that may appear in the DOE-SR atmospheric, liquid, and diffuse and fugitive releases related to potential dose. This chart includes some detects considered potential NORM and is not comparable to Section 4.0 Table 1.

Table 2. The 1999-2009 AEI Media Statistics and MAX Game Dose

Media	Totals	EI % Basi	Avg.	SD	Median	N#yrs
SWBL	0.609	3.503	0.055	0.028	0.050	11
DNRGW (2003-2009)	0.239	1.375	0.034	0.053	0.014	7
PWSGW	0.186	1.070	0.017	0.019	0.010	11
PWSRW	0.303	1.743	0.028	0.020	0.020	11
Rainwater	0.111	0.638	0.010	0.006	0.010	11
Swimming	0.019	0.109	0.002	0.003	0.000	11
Soil	0.354	2.036	0.032	0.076	0.010	11
Sediment	0.183	1.053	0.017	0.052	0.000	11
Air	0.065	0.374	0.006	0.007	0.002	11
Edible Vegetation (2002-2009)	0.401	2.307	0.050	0.072	0.010	8
Milk	0.213	1.225	0.019	0.031	0.003	11
Avg Edible Fungi[1] (2008-2009)	1.036	5.959	0.518	0.300	0.518	2
Avg Fish[1] (1999-2009)	6.225	35.807	0.566	0.295	0.440	11
Avg Deer[1] (2000-2009)	2.750	15.818	0.275	0.459	0.040	10
Avg Hog[1] (2000-2002, 2009)	4.691	26.983	1.173	1.689	0.536	4
Offsite AEI Hunter (deer + hog)	7.441	42.801	0.676	1.482	0.080	11
Totals	**24.826**	**142.800**	**2.802**	**3.109**	**1.663**	NA
MAX Deer[2] (2000-2009)	77.243	NA	7.724	6.212	6.910	10
MAX Hog[2] (2000-2002, 2009)	21.400	NA	5.350	7.984	2.225	4
MAX Fish[2] (1999-2009)	24.881	NA	2.262	1.524	1.768	11
MAX Fungi[2] (2008-2009)	3.052	NA	1.526	0.341	1.526	2
Offsite MAX Hunter (deer + hog)	98.643	NA	8.968	10.524	7.640	11

Notes:
1 - Average dose above background.
2 - MEI deer and hog dose and single highest maximum dose for fish and fungi.

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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

ATSDR. 2002. Public Health Statement DDT, DDE, and DDD. Agency for Toxic Substances and Disease Registry Division of Toxicology, Atlanta, GA http://www.atsdr.cdc.gov/toxprofiles/phs35.html#bookmark01

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.

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.

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. 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 For1984, DPSPU 85-30-1. Health Protection Department of E. I. du Pont de Nemours and Company, Savannah River Plant, Aiken, South Carolina.

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. n.d. Isotopic Tracers in Groundwater Hydrology. Retrieved from http://www.swhydro.arizona.edu/archive/V2_N1/featurette2.pdf#search=%22preatomic%20tritium%20levels%22.

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.

Linkov and W. R. Schell (eds.). 1999. Contaminated Forests: Recent Developments in Risk Identification and Future Perspectives, Kluewer, Amsterdam.

References

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

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.

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 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.

Radiological Assessments Corporation (RAC). 1999. 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.

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.

Savannah River Site (SRS). 2008a. 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.

Smith, S.K. 2008. Letter to Sisario, Kelly. August 12, 2008. Self-Disclosure for Potential Non-Compliance with Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA) Section 313 Regarding Under-reporting of Nitrate Releases in the Toxic Chemical Release Forms.

References

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. 2003. South Carolina Department of Health and Environmental Control 2002 Environmental Data Report, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

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.

References

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. 2006c. South Carolina Department of Health and Environmental Control Internet site. http://www.scdhec.net/eqc/water/html/radium.html.

SCDHEC. 2006d. 2006 Nonradiological Ambient Sediment and Surface Water Quality Monitoring Report, Bureau of Environmental Services-Environmental Surveillance and Oversight Program. Aiken, South Carolina.

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. 2007c. State of South Carolina Monitoring Strategy, Technical Report No. 001-07, Bureau of Water, Water Quality Monitoring Section, Columbia, 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. 2008f. 2007 Critical Pathway Dose Project Plan, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2009b. 2008 Environmental Data Report, Bureau or Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2009c. 2008 Monitoring of Fish Associated with the Savannah River Site, Bureau of Environmental Services, Environmental Surveillance and Oversight Program, Aiken, South Carolina.

SCDHEC. 2009d. 2008 Radiological Monitoring of Milk from Dairies Surrounding 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.

References

SCDHEC. 2010b. 2010 South Carolina Fish Consumption Advisories. Division of Health Hazard Evaluation, Columbia, 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).

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. 2000b. 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. 2002. ProUCL Version 4.00.02, A Statistical Software Package for Environmental Applications for Data Sets With and Without Nondetect Observations, Technical Support Center.

USEPA. 2003. National Primary Drinking Water Standards, EPA-816-F-03-016. Office of Water, Washington DC

References

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. 2008e. National Primary Drinking Water Regulations; Radionuclides; Final Rule. Updated October 2008.

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. 2009f. http://www.epa.gov/radiation/radionuclides/tritium.html#where

USEPA. 2009g. http://www.epa.gov/safewater/contaminants/index.html

USEPA. 2009h. Preliminary Remediation Goals for Radionuclides. http://epa-prgs.ornl.gov/radionuclides/download.res_soil_rad_prg_august_2010.xls

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. 2010c. USEPA Website. http://www.epa.gov/wastes/hazard/testmethods/sw846/pdfs/9310.pdf

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.

References

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

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. 2001a. Savannah River Site Environmental Data for 2000, WSRC-TR-2000-00329, Environmental Monitoring Section, Environmental Protection Department, Aiken, South Carolina.

WSRC. 2001b. Savannah River Site Environmental Report for 2000. Savannah River Site. Westinghouse Savannah River Company, Aiken, South Carolina. WSRC-TR-2000 00328.

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

References

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. 2007a. Savannah River Site Environmental Report for 2006. Washington Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-TR-2007-00008.

WSRC. 2007b. Environmental Data for 2006. Environmental Protection Department, Environmental Monitoring Section, Aiken, South Carolina. WSRC-TR-2008-00329

WSRC. 2008a. Savannah River Site Environmental Report for 2007. Washington Savannah River Company, Savannah River Site, Aiken, South Carolina. WSRC-STI-2008-00057.

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

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