Compendium of Issues Surrounding the Levels of Contaminants Contained in Fish Collected in Tributaries Leaving the Savannah River Site (SRS) and Associated Risks from Exposure to Those Levels of Contaminants

June 1, 1997

John R. Stockwell, MD, MPH
Human Health Effects Officer
Federal Facilities Branch

U.S. EPA Region 4

DRAFT

ENVIRONMENTAL PROTECTION AGENCY
Savannah River Fish Fact Sheet

INFORMATION ABOUT RADIATION (May 1997)

WHO should be aware of the information contained in this fact sheet?

- If you are a member of a community along the Savannah River and eat fish from the Savannah River you should carefully read and understand the information contained in this fact sheet.

WHAT should you know?

- **Contaminants of concern:** Radioactive contaminants have been identified in fish taken from the Savannah River.
- **Areas of most concern: Four Mile Creek, Steel Creek, and Lower Three Runs Creek**
  The mouth of these creeks are of the most concern at this time. The areas 35 miles downstream from SRS and 2 miles from the banks of this stretch of the Savannah River are also areas of concern.
- **Fish of greatest concern:** Bottom feeders, ie **Spotted Suckers,** and **Catfish**

- Additional studies are being conducted to determine if other areas and types of fish should be avoided.

IS your drinking water safe?

- Your **drinking water is safe** and recreational activities on Savannah River pose no health risk. Fish eat plants and contaminated sediments then store radioactive contaminants in their body fat, making them harmful to consume.

What are the overall POTENTIAL HEALTH RISKS you should know about?

- Health risks associated with eating fish contaminated with these radioactive contaminants are greatest for pregnant women, infants, children, and adults consuming more than 3 ounces (the size of an average adult palm without the thumb or fingers) of fish a day.

- The risk from eating contaminated fish depends on the amount eaten. The risk from eating less than 3 ounces is 1 excess case of cancer for every 100,000 individuals and the risk from eating more than 3 ounces is 1 excess case of cancer for every 10,000 individuals.

- The levels of radioactive contamination in the fish are low and will not pose significant risk if moderate amounts are eaten . Exposure to these contaminants at increased levels over a long period of time may cause serious health problems.

What are the CONTAMINANTS OF CONCERN and their possible effects on health?

- **Cesium -137 (Cs -137):**
  This radionuclide releases half of its radiation in about 30 years in the environment. Within the human body cesium-137 behaves like potassium and releases half of its radiation in only 73 days.
- **Strontium -90 (Sr-90):**
  This radionuclide releases half of its radiation in about 28 years in the environment. Within the body strontium-90 behaves like calcium and stores in the bones for approximately 10 years.
- **Tritium (H-3):**
  This radionuclide releases half of its radiation in approximately 12 years.

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To Connie Jones | From deLisa Bratcher
Dept./Agency PH# 770 [redacted] | Phone # 803 725-5351
Fax # 770-953-4048 | Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

MOR: 11 DEC 96
SRS CAB
FISH ANALYSIS

Carolina

Warnings don't slow fish consu

By **Karin Schill**
Staff Writer

Their catch might be contaminated, but that isn't killing the appetite of some area fishermen.

Researchers conducting a survey of 315 households along the Savannah River found that a small amount of people on both sides of the waterway eat more river fish than health officials say they should.

And surveyors were surprised to learn that those who consume at least 2 pounds of fish each week do so because they want to – not because they're poor.

"Our hypothesis, if you will, was that they'd fish because they had to," said Milton Morris, a professor at Benedict College in Columbia, who helped oversee the Fish Subsistence or Consumption Survey. "That doesn't seem to be the case."

The survey was paid for by a $73,221 grant from the Department of Energy. It came in response to a fish advisory the South Carolina Department of Health and Environmental Control issued last spring, warning people not to eat more than 1.5 to 1.75 pounds of river fish a month.

SRS

The fish contains small amounts of radioactive Strontium-90 and Cesium-137 that leaked from Savannah River Site when the plant's reactors were running. Such metals can cause cancer.

The fish also contains mercury, although nobody is sure where it came from. Mercury, also a metal, affects the nervous system and is especially harmful to babies.

Some scoffed when DHEC issued its notice last spring, arguing that nobody eats the amount of fish stipulated in the advisory. But preliminary survey data show that at least 3 percent of respondents do.

Keith Collinsworth of DHEC said Tuesday that his agency will evaluate the final report when it is released early next year to determine if the fish advisory is doing its job.

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Keith Collinsworth of DHEC said Tuesday that his agency will evaluate the final report when it is released early next year to determine if the fish advisory is doing its job.

"We will look at it in terms of, are we reaching the right population with our advisory and does that population even exist?" he said. "We were pushing them to do this study to make sure our assumptions were valid."

For seven weeks earlier this fall, students from Benedict College walked door-to-door in river communities near SRS to ask families about their fishing habits.

Preliminary results show that 57 percent of the households surveyed have members who fish in the Savannah River or in its tributaries. More than half of those who do say they eat their catch. Bream and bass were clear favorites among area fisherman, the draft survey shows.

Camilla
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET N E
ATLANTA GEORGIA 30365

DEC 16 1994

4WD-FFB

Dr. Mildred McClain
Citizens for Environmental Justice
P.O. Box 1841
Savannah, GA 31402

SUBJ: Public Availability Session
Savannah, GA

Dear Dr. McClain:

This letter is in regard to our previous discussions and concerns that you have expressed regarding the Department of Energy (DOE) environmental restoration program and information needs of the citizens of Savannah, GA. These discussions and concerns have been shared with other DOE-Savannah River Site (SRS) Citizens Advisory Board members and with the Federal Facilities Environmental Restoration Dialogue Committee at various meetings during this year. These concerns focus on the need for government agencies, namely the Environmental Protection Agency (EPA), DOE, and others to increase their outreach efforts with communities traditionally uninvolved with environmental decision making. EPA has recognized that non-traditional methods should be utilized to improve its own outreach programs. Hence, this office is interested in piloting its first DOE-SRS related public involvement activity in your community.

The DOE-SRS has a public involvement plan. EPA is charged with oversight responsibility of public involvement activities that impact DOE environmental restoration programs. In an effort to better gauge the type and extent of information that has been disseminated in the Savannah area, I am offering our assistance to you and the citizens of Savannah by having an availability session and/or sessions to hear the public's concerns regarding SRS. The goal of this session is to ensure that the public has a forum to express their concerns without enormous focus on technical jargon and regulatory processes. It is anticipated that this will enable the community to participate more fully in future decisions regarding the environmental clean up at SRS.

I am tentatively scheduling this session for March 1995, in coordination with the DOE-SRS Citizens' Advisory Board meeting also planned for that month in Savannah. The availability session will focus on the citizens talking to the EPA and other government agencies: e.g., Agencies for Toxic Substances and

Disease Registry (ATSDR), DOE, Georgia Department of Natural Resources (GA DNR) and others. EPA would appreciate your assistance by identifying those topics where there is strong public interest and assisting us in coordinating this endeavor from a logistical perspective. I believe this will aid EPA in executing its oversight mission as well as hear from the citizens directly regarding their concerns.

I am looking forward to hearing from you. If you have questions or need additional information, you may call me or Camilla Warren, Chief, DOE Remedial Section, at (404) 347-3016.

Sincerely,

Jon D. Johnston

Jon D. Johnston, Chief
Federal Facilities Branch

cc: Timothy Fields, Jr., EPA
Jim Woolford, EPA
Barry Breen, EPA
Mike Stahl, EPA
Col. James Owendoff, DOD
Patricia A. Rivers, DOD
Tad McCall, USAF
Lt. Col Mark Hamilton, USAF
Richard E. Newsome, USA
David Olson, USN
Paul Yaroschak, USN
Cindy Kelly, DOE
James D. Werner, DOE
Suzanne Rudzinski, DOE
Mark M. Bashor, Ph.D., ATSDR
John Craynon, DOI
George Sundstrom, USDA
Drew Caputo, Natural Resources Defense Council
Tim Connor, Energy Research Foundation
Ralph Hutchison, OR Environmental Peace Alliance
Lenny Siegel, Pacific Studies Center
J. Ross Vincent, Sierra Club
Dr. Jay Sorenson, Sierra Club
Pat Bryant, Gulf Coast Tenants Organization
Donald Elisburg, Laborers' Health & Safety Fund of N.A.
Richard Miller, Oil Chemical Atomic Workers Union
Stanley Paytiamo, State of New Mexico
Merv Tano, State of Colorado
Chris Carini, International City/County Mgmt. Assoc.
Phillip A. Niedzielski-Eichner, Energy Communities Alliance
Amy McCabe Fitzgerald, ORR Local Oversight
Ann Ragan, SCDHEC

Pat Haight, KDEP
Earl Lemming, TDEC
Sam Goodhope, State of Texas
Thomas Kennedy, Assoc. of State & Territorial Solid Waste Mgmt. Officials
Dan Miller, State of Colorado
Howard Roitman, State of Colorado
Brian J. Zwit, National Assoc. of Attorneys General

United States
Environmental Protection Agency
Region 4

Waste Management Division
345 Courtland Street, NE
Atlanta, GA 30365

Supplemental Guidance to RAGS: Region 4 Bulletins

Office of Health Assessment

(404) 347-1586

EXPOSURE ASSESSMENT

Human Health Risk Assessment
Bulletin No. 3
November, 1995

INTERIM

The objective of the exposure assessment is to estimate the type and magnitude of exposures to chemicals of potential concern present at or migrating from a site. The exposure assessment should include the following sections.

- Characterization of Exposure Setting
- Identification of Exposure Pathways
- Quantification of Exposure

This bulletin includes a bibliography with acronyms for each entry. The acronyms are used in the bulletin along with page numbers for reference purposes.

Characterization of Exposure Setting

The general physical characteristics of the site and of the populations on and near the site should be presented in this section. Populations should be addressed relative to those characteristics that influence exposure, such as location and activity patterns. In addition, the presence of sensitive subpopulations should be discussed. Current receptors as wells as potential future receptors should be considered.

Identification of Exposure Pathways

This section should identify the pathways by which the previously identified populations may be exposed. A conceptual site model should be developed for each site. The conceptual site model should include known and suspected sources of contamination, types of contaminants and affected media, known and potential routes of migration, and known or potential human and environmental receptors. In addition to the narrative discussion of pathways, a figure following the format of the example presented in the RI/FS guidance should be presented (RI/FS, p. 2-8).

Institutional controls (e.g., fences or guards) should not be used as the justification for elimination of a pathway in the baseline risk assessment for current or future scenarios. However, institutional controls may be used in the determination of exposure frequency for current exposure.

Generally, the baseline risk assessment should consider the reasonably anticipated future land use. However, it may be valuable to evaluate risks associated with a variety of future land uses especially where there is some uncertainty regarding the anticipated future land use (LUG, p. 6).

Residential Scenario

A future residential scenario should be included in the baseline risk assessment unless there is a strong reason to do otherwise, e.g., an industrial area expected to remain industrial or a wetland. If the future residential scenario is not included, a justification for not considering the residential scenario should be presented and many parameters in an effort to establish consistency. However, default values are undesirable when the determination of realistic current risks are sought. Data based on observation of receptor populations are most desirable in deriving site specific current exposure assumptions. Future exposure assumptions may be represented by default values that reflect behavior resulting in reasonable maximum exposure (RME) risk estimates. This Bulletin presents intake assumptions which reflect RME scenarios. The accompanying Risk Characterization Bulletin indicates that quantitative risk values should be developed for central tendency exposure (CTE) assumptions. The Agency will be preparing formal guidance on CTE default assumptions.

Concentration Term

The concentration term in the intake equation is an estimate of the arithmetic average concentration for a chemical within an exposure unit. Ideally the exposure point concentration should be the true average concentration within the exposure unit. However, because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used as the concentration term (CCT, p. 1). However, if the calculated UCL exceeds the maximum detected value the maximum detected value should be used as the concentration term (RAGS, p. 6-22). It is generally reasonable to assume that Superfund soil sampling data are lognormally distributed (CCT, p. 4).

Region 4 makes an exception to the use of the UCL as the exposure point concentration for groundwater. Groundwater exposure point concentrations should be the arithmetic average of the wells in the highly concentrated area of the plume (ERGC, p. 3). Also, it is **unacceptable** to use data from **filtered ground water** samples in a baseline risk assessment (RAGS, p. 6-27).

Chemical degradation or attenuation should not be considered in the baseline risk assessment unless site-specific chemical-specific data are available and prior approval from the RPM and OHA is obtained.

Air concentration can be represented by modeled values or long-term monitoring. PM_{10} values should be used for particulates.

Ingestion

Soil ingestion rates should be as follows: Resident Child 200 mg/day; Resident Adult 100 mg/day; Worker 50 - 480 mg/day, depending on type of worker assumed (SDEF, pp. 6, 10).

Sediments in an intermittent stream should be considered as surface soil for the portion of the year the stream is without water. In most cases it is unnecessary to evaluate human exposures to sediments covered by surface water.

Potable water ingestion rates should be as follows: Resident Child 1 ℓ/day; Resident Adult 2 ℓ/day; Worker 1 ℓ/day (EFH, p. 2-3).

Ingestion of 50 ml/hour of surface water should be used for exposures to water during swimming (RAGS, p. 6-36). Intake rates for exposure to surface water during wading should be 50 ml/hour for children 1-6 and 10 ml/hour for adolescents and adults.

Fish ingestion is highly variable and site specific intake assumptions are most desirable since data vary greatly. Default fish ingestion should be considered at 54 g/day (in combination with a exposure frequency of 350 days/year) unless a site specific fish ingestion study has been performed (SDEF, p. 12). If a site specific fish study is used to determine the number of meals of fish consumed during a given time period, Region 4 suggests a default value of 145 grams per meal. If site-specific information indicates the presence of subsistence fisherman, an evaluation of their greater intake should be considered.

Dermal Contact

The areas of the body receiving exposure to the specific media should be considered and summed to obtain the skin surface area. The Exposure Factors Handbook (EFH), Dermal Exposure Assessment: Principles and Applications (DERMAL), or RAGS can be used to determine the surface area of each portion of the body which is exposed.

Where chemical-specific information is not available, dermal absorption factors of 1.0% for organics and 0.1% for inorganics should be used as defaults in determining the uptake associated with dermal exposure to contaminated soils (this includes the soil matrix effect).

The soil to skin adherence factors given in RAGS (1.45 mg/cm^2 to 2.77 mg/cm^2) are outdated. New data in this area indicates that this range should be changed to 0.2 mg/cm^2 to 1.0 mg/cm^2 (DERMAL, p. 8-17). The value of 1.0 mg/cm^2 is considered appropriate for evaluation of RME intake assumptions.

Dermal-aqueous permeability coefficients should be obtained from tables or calculated from equations presented in EPA's Dermal Guidance. Table 5-3 should be used for inorganics and Table 5-7 should be used for organics (DERMAL, pp. 5-9, 5-39). Additionally, ATSDR Toxicological Profiles are an acceptable alternative source.

Inhalation

The default inhalation rate for adults is 20 m^3/day (SDEF, p. 6). Children should be considered at 15 m^3/day (EFH, p. 3-41). Site specific inhalation rate should be considered based on the worker activity at the site; 20 m^3/work day is an acceptable default (SDEF, p. 10).

Exposure to VOCs During Showering

It should be assumed that showering exposure is equivalent to exposure from ingestion of two liters of contaminated water per day based on the recommendation of The Risk Assessment Forum (RAF, p. 1-2). This method includes exposures via inhalation and dermal routes and is applied to adolescents and adults.

Exposure Frequency

Default exposure frequency should be considered at 350 days/year for residents and 250 days/year for workers (SDEF, pp. 5, 9). Current exposure assumptions should represent conservative actual occurrences as accurately as possible.

As a default, Region 4 believes swimming frequency in the southeast should be 45 days/year. However, for backyard swimming pools, in the southern portion of the region, a substantial increase in exposure frequency over the 45 days/year should be considered based on site specific information. Region 4 recommends that a backyard swimming pool exposure frequency of 90 days/year should be considered.

Exposure Duration

A 30 year exposure duration (6 years as a child and 24 years as an adult) is the default assumption for residents. Default worker exposure duration should be 25 years (SDEF, pp. 5, 9).

Use of the Fraction Ingested (FI) Term

Office of Health Assessment should be consulted regarding the use of the FI term. A FI of 100% is used except in hot spot exposure assessments and in the evaluation of exposures to intermittent streams.

Bibliography

Dermal Exposure Assessment: Principles and Applications, **(DERMAL)**, Interim Report, EPA/600/8-91/011B, January 1992.

Exposure Factors Handbook, **(EFH)**, Internal Draft, NCEA-W-005, May 1995 (Update to Exposure Factors Handbook, EPA/600/8-89/043, May 1989).

Exposure to VOCs During Showering, **(RAF)**, Memorandum from Dorothy E. Patton, Chair, Risk Assessment Forum, to F. Henry Habicht, II, July 10, 1991.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, **(RI/FS)**, EPA/540/G-89/004, October 1988.

Land Use in CERCLA Remedy Selection Process, **(LUG)**, OSWER Directive No. 9355.7-04, May 25, 1995.

Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, **(RAGS)**, Interim Final, EPA/540/1-89/002, December 1989.

Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors, **(SDEF)**, Interim Final, OSWER Directive No. 9285.6-03, March 25, 1991.

Supplemental Guidance to RAGS: Calculating the Concentration Term, **(CCT)**, OSWER Publication 9285.7-081, May 1992.

Supplemental Guidance to RAGS: Estimating Risk from Groundwater Contamination, **(ERGC)**, Internal Draft, December 1993.

Enclosure, Letter From to Shaw/Harris dated JAN 18 1996

RECORD OF SCDHEC/EPA-IV/SR EXECUTIVE FORUM MEETING

NOVEMBER 29, 1995

ISSUES DISCUSSED

Technology Development

- SR briefly updated the progress on deploying new ER technology. Good cooperation between the site and regulatory staffs was highlighted, and a recent letter in which EPA commended SR for involving EPA in the technology development process was noted as further confirmation of a collaborative process.
- EPA will track the $10 million for technology development and a desired FY97 FFA milestone based on technology development.
- Deployment of new ER technology has been an ongoing process for several years, and will be accelerated in FY96 as a result of the post-Rock Hill momentum.

Enforcement Actions

- The possibility of terminating the enforcement action process for the tritium release and the IROD for the F- and H-Areas groundwater remediation was discussed. EPA will continue to leave the enforcement action open for the IROD and track the SRS commitment to meet the RCRA remediation schedule. EPA will determine the status of the tritium NOV.
- Elevating issues to the management of the three parties for resolution prior to initiating enforcement actions was discussed.

Fish Contamination

- SR provided a chronology of the fish contamination events.
- The initiation of the potential EPA enforcement action regarding this action was discussed.
- The technical staffs of the three parties plan to meet to determine if any action is necessary.

Status RCRA Applicability to Nuclear Materials

- SR provided a chronology of actions regarding the applicability of RCRA to nuclear materials.
- A SCDHEC response to the SRS position letter can be expected in December.

MEETING RECORD

MEETING DATE AND TIME: February 6, 1996, 10:00 A.M.

MEETING LOCATION: Lower Savannah District Office of the South Carolina Department of Health and Environmental Control, 218 Beaufort Street, NE, Aiken, SC

PURPOSE OF MEETING: Follow-up on issues related to radioactivity in Savannah River fish

ATTENDEES: See Attachment 1

The attendees were welcomed by Myra Reece of the South Carolina Department of Health and Environmental Control (SCDHEC), Aiken Office.

The meeting was turned over to Gail Whitney of the Environmental Compliance Division of the Department of Energy, Savannah River Operations Office (DOE-SR). Ms. Whitney reviewed the status of issues and actions that the group would discuss (see Attachment 2, Items 1-4, 9, 12, 14, 18, and possibly 16).

SUBJECTS DISCUSSED:

- What methodology and data were or should be used to calculate risk value?
  - A SCDHEC representative showed overheads and led discussions on the following:

    Risk variables for edible and non-edible fish sections (see Attachment 3)
    - What SCDHEC considered edible and non-edible fish.
    - What methodology was used.
    - Multiple sampling locations.

    Risk from ingestion of edible and non-edible sections of fish contaminated with cesium-137 and strontium-90 caught in the Savannah River (see Attachment 4).

    The similarities in the Georgia Department of Natural Resources (GDNR) and the DOE data.

    Subsistence fishermen - a discussion took place on who fishes, where they fish, and why they fish.

- It was stated that the GDNR and SRS are using the WSRC/EMS Fish Monitoring Plan (see Attachment 5).

- It was asked if either agency had data on other rivers. SCDHEC indicated they had not looked at other rivers; GDNR reported they had sampled three other rivers.

- A Westinghouse Savannah River Company representative showed overheads and led discussions on the:

  - Review of data from SCDHEC, GDNR, and SRS regarding radionuclides in Savannah River fish (see Attachment 6).

  - Agency assumptions utilized to calculate risk (see Attachment 7).

- A question was asked about the site's revisions to the environmental monitoring program and if the revisions would impact the fish monitoring program. Ben Gould, DOE-ECD, indicated there are no plans to reduce the current level of sampling nor will any revisions reduce the quality of the monitoring program.

- A GDNR representative presented an overview and led discussions on the actions performed by the State of Georgia:

  - Reviewed 1991 strategies;

  - Looked at lakes and rivers;

  - Targeted fish most likely to be caught;

  - Analyzed for 44 contaminants;

  - Developed and issued guidelines in the form of a pamphlet that provides information to people in a user friendly way.

  - Georgia will base their fish advisories on an approach that informs people how much fish they can eat and how often in order to remain in the safe category.

- Ms. Whitney suggested each agency identify two or three representatives to serve as members of a committee to review of the 1992 adopted Fish Monitoring Plan. This committee should meet in the very near future to assess and identify needed revisions to the plan before the group present today reconvenes.

DECISIONS REACHED:

- SCDHEC will evaluate the data to determine if a concern still exists; review the data from the source sites, and meet to discuss communications strategy.
- All parties should use the same sampling and analyzing procedures.
- DOE will consider conducting a survey regarding subsistence fishermen; SCDHEC indicated they could provide a point of contact for such a survey.
- A few representatives from each agency will meet in the near future (before the larger group meets again) to review the 1992 Fish Monitoring Plan.
- The next meeting will be scheduled within a month. SCDHEC representatives will inform Ms. Whitney of a suitable date.

ATTACHMENTS:

Attachment 1:	Meeting Attendees
Attachment 2:	Issues
Attachment 3:	Risk Variables for Edible + Non-Edible Fish Sections
Attachment 4:	Risk From Ingestion of Edible + Non-Edible Sections of Fish Contaminated With CS-137 + SR-90 Caught in the Savannah River
Attachment 5:	The WSRC/EMS Fish Monitoring Plan
Attachment 6:	Review of Data from SCDHEC, GDNR, and SRS Regarding Radionuclides in Savannah River Fish
Attachment 7:	Agency Assumptions Utilized to Calculate Risk

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

345 COURTLAND STREET N E
ATLANTA GEORGIA 30365

APR 01 1996

MEMORANDUM

SUBJECT: Public Information Exchange Sessions at the Savannah River Site

FROM: Camilla Bond Warren, Chief
Department of Energy Section CBWarren

TO: David Levenstein
Office of Enforcement and Compliance Assurance
(Mail Code 2261)

Marianne Lynch, Regional Liaison
Office of Federal Facilities Reuse and Redevelopment (Mail Code 5101)

The Environmental Protection Agency (EPA), the Department of Energy (DOE), Savannah River Site (SRS) and EPA, Region IV embarked on an innovative approach to access stakeholders - public information exchange sessions. This approach was designed to enhance the dialogue between the stakeholders, the regulating agencies and the DOE Site. On June 26-27, 1995, three information exchange sessions were held in Savannah, Georgia, a downstream community. Although not near the site concerns had been expressed regarding the impact of the drinking water form the Savannah River. This allowed greater opportunity for these stakeholders to express their concerns and hear directly form the agencies.

To capture the concerns of the community and assist in evaluating the information needs of this area, a total of 2000 questionnaires were mailed and distributed at the meetings. These completed questionnaires were returned to EPA via "postage paid" envelopes. Approximately 22 responses were received. In addition, the meetings which were transcribed solicited 59 questions. The questions were categorized; of which 25 were selected and formed the basis for the "Responsiveness Summary."

A second public exchange session was held on December 6, 1995 in Barnwell, South Carolina. The South Carolina Department of Health and Environmental Control (SCDHEC) participated in this session. The Responsiveness Summaries were distributed at the meeting and will also be mailed to those in attendance at the June pilot.

The regulating agencies and DOE have determined that these information exchange sessions are very beneficial and allows greater dialogue and accessibility to the stakeholders. This aspect of DOE-EPA-State coordination was discussed and agreed upon in the July 1995, SRS Workout Session. Since the SRS Workout, DOE,EPA and SCDHEC managers are working to coordinate these meetings on a quarterly basis in order to streamline and improve public involvement activities.

Attachment: Responsiveness Summary

Summary of Questions Asked
at
EPA/DOE PUBLIC INFORMATION EXCHANGES
(June 26 & 27, 1995)

Groundwater

1. Where do the contaminants go when you take them out of the water? (Source: June 26, 1995, Page 9, Line 18)

   Basically, solvents are being removed from the groundwater. When the water goes through the air stripper, the solvents are removed and they are emitted to the air. Ultimately, the ultraviolet rays from the sun destroy the solvents.

2. When you talk about remediating contaminated water, what do you do to it? (Source: June 27, 1995, Evening Meeting, Page 10, Line 14)

   It depends on the contaminant in the water. Water comes into the top of the taller stripper unit and blows air up from the bottom. The solvents go into the air and come out of the water easily. The water that comes out is clean and it goes back into the stream. Although it is clean, it is monitored regularly. The volatiles go into the air and the UV rays from the sun destroy them. We also demonstrated and we intend to put in service bioremediation. Methane is injected into the ground where there are microbes that live in the earth, but they're not very active. When you feed them methane, they become more active and these microbes, eat the solvents and they process them in their own small bodies. The discharge is, again, not hazardous any longer.

3. Do you have monitoring devices to determine if there is contamination in the lower aquifers? (Source: June 27, 1995, Evening Meeting, Page 17, Line 13)

   Yes.

4. Is SRS on the recharge line for the Florida aquifer? (Source: June 27, 1995, Evening Meeting, Page 52, Line 3)

No, SRS is not on the recharge line for the Florida aquifer.

Health

1. Since you have become involved with this, has a study been conducted on the personnel at SRS who work around that material to find out how they are impacted? (Source: June 26, 1995, Page 46, Line 1)

   All the workers at Savannah River are monitored each year. All workers are required to take appropriate training.

   The Agency for Toxic Substances and Disease Registry is looking into any public health impacts of releases from the process and, they're forming a Citizens Advisory Board to address these issues.

   In addition, the National Institute of Occupational Safety and Health (NIOSH) is a part of the National Institute of Health, and they just released a preliminary study that indicated that among a small population of site workers, there has been small incidence and a statistically noticeable blip of leukemia among a very small segment of the site population. The National Institute of Health and the Centers for Disease Control did a cancer study on all nuclear sites, both commercial power plants and DOE facilities, the surrounding communities and then control communities a distance away. No significant differences were found in the cancer rates among those communities. We have had worker studies from day one at the site. Our own studies indicate that there's been no significant difference in the number of cancers seen in the site worker population of those outside.

2. Is strontium also present in drinking water? (Source: June 27, 1995, Page 43, Line 8)

   Yes. Strontium, chemically, is everywhere in nature. Chemically, it's very similar to calcium. You find it in concrete, you find it in your homes, you find it in paint, trees, rivers and minerals. Strontium is a radionuclide. It's produced as a by-product when reactors operate. When atoms split apart, sometimes the fragments have an atomic rate of 90, and it's the element strontium. Strontium-90 has about a 30-year half life. If there was any natural strontium-90, it died billions of years ago, so essentially all strontium-90 in the world today is the result of nuclear industry or weapons production or atmospheric testing of weather.

3. What kind of data/information are available on fish? (Source: June 27, 1995, Morning Meeting, Page 47, Line 7)

   Fish from certain locations near the Department of Energy Savannah River Site are contaminated from off-site releases of radioactive contaminants from the facility. Some of these contaminants are cesium-137 and strontium-90.

4. Were the present EPA standards based on the 1980 conference by the National Academy of Science called the Biological Effects of Ionizing Radiation (BEIR 3)? Source: June 27, 1995, Morning Meeting, Page 54, Line 10)

   EPA radiation protection standards are based largely on the results of the BEIR V Report, which was produced by the National Academy of Sciences (NAS). However, EPA also uses health effects data and dose and risk models from a number of other national and international scientific advisory commissions and organizations. Besides NAS, these organizations include the National Council on Radiation Protection and Measurements (NCRP), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and the International Commission on Radiological Protection (ICRP).

5. What is the greatest risk from SRS to the citizens of Savannah at the present time? (Source: June 27, 1995, Morning Meeting, Page 64, Line 6)

   There are two types of risk - human health and ecological. The greatest current risks we have identified result from contaminated groundwater plumes that are seeping into the Savannah River. We do not see imminent human health exposures to be problematic at this point, but we do see some potential, and probably imminent, ecological issues that need to be addressed from some of those areas. They are identified as the F and H-Areas.

Our worst "potential" human and environmental risks are posed by the presence of the high level waste tanks. There are two reasons why these tanks present our greatest potential risks: 1) their quantity, about 35 million gallons, and 2) the fact that their contents are essentially a liquid. The contents are a sludge, a very concentrated sludge, but it truly is liquid and could be dispersed into the environment, contaminating fairly large areas with very high radioactivity and be very dangerous to fish, human health, and products. The risks presented by the contents of the high level waste tanks are minimized by performing safety integrity checks of the tanks.

6. We know that x-rays build up in your body over a long period of time. If you drink a lot of the water are you going to have a problem with tritium? Is it just going to keep accumulating like strontium-90? (Source: June 27, 1995, Evening Meeting, Page 49, Line 23)

Tritium resembles water so closely that the body can not recognize that it's different from water. Most of the body is water so, it's distributed throughout the body. Tritium does not stay very long, but if you drink it all the time, you may have a certain level in your system at all times. It depends on the concentration and the dose. The drinking water in Savannah comes from the ground right now and not from the river. We know that the level is still safe with regard to the national drinking water standard.

Savannah River

1. Is the Savannah River tested constantly in this Savannah area? (Source: June 26, 1995, Page 26, Line 5)

   Yes. It's tested in several places. It's tested downstream before it reaches the city of Savannah and Beaufort, South Carolina, and at various points in between.

2. Can the Savannah River be used for drinking water? (Source: June 26, 1995, Page 26, Line 20)

   Yes.

3. How safe is the water in Savannah River? (Source: June 27, 1995, Evening Meeting, Page 39, Line 13)

   The Savannah River as it leaves the site and comes on downstream meets all the drinking water standards that there are.

4. Why are there not many fish in the Savannah River in this area? (Source: June 27, 1995, Evening Meeting, Page 40, Line 3)

   The Savannah River corridor has been a heavily industrial area for a long time; so nationally the trends are and the facts are that fishing is not what it used to be, not just in the Savannah, Georgia area, but in other areas. EPA is basically trying to pick off these industrial areas one at a time and try to ratchet back clean water at each stream that enters the Savannah River and make water more fishable and swimmable.

Appendices C, G, and H

1. How long does it take to evaluate the sites listed in each appendix and to move them from one classification to another? Is it possible that you have something on these lists that could endanger citizens? (June 26, 1995, Page 32, Line 4)

   The Appendix G process usually takes between three to six months to evaluate whether or not the site needs to either go to Appendix C or whether or not the contamination, if any is present, does not exceed any of the established requirements. Once it moves from Appendix G to Appendix C, the typical time frame for evaluating what needs to happen, if anything, is approximately eighteen months. Once we determine whether of not there's further remediation needed, then we go through the process of bringing it to the public and identifying the alternatives of the types of cleanup activities we are going to use to clean up that particular area of concern.

Tritium

1. There was a grant given to Georgia last year to study tritium leaking into the river. What were the results of that study? (Source: June 27, Evening Meeting, Page 28, Line 9)

   The conclusion that was drawn by those studies was this was a small amount of airborne tritium coming down with the rainfall rather than the groundwater migrating laterally in to Georgia.

2. What is the level of tritium on the Savannah River? (Source: June 27, 1995, Evening Meeting, Page 41, Line 20)

   The SRS information averages approximately 1,000 picocuries, January through March. The Safe Drinking Water Act has establiblished a Maximum Contaminant Level (MCL) of 4 millirems per year for gross beta emitters, such as tritium. This MCL is equal to 60,900 picocuries per liter of water.

3. Is tritium naturally-occurring in water? (Source: June 27, 1995, Evening Meeting, Page 51, Line 13)

   Tritium is found in rain water and is produced by the interaction of sunlight in the upper atmosphere and, up to World War II, tritium was used to date groundwater.

Budget

1. Is the budget for SRS $60 Million a year? What is the estimated cost to clean it up completely? (Source: June 27, 1995, Evening Meeting, Page 27, Line 2)

   The cost to clean up the site can not be determined.

2. Why is the SRS budget so much lower than other DOE sites? (Source: June 27, 1995, Page 46, Line 5)

   The Department of Energy is responsible for formulating that budget and getting it up to Congress. That question was raised by the EPA one year ago and when the Department of Energy people looked at it they agreed to increase clean up dollars at SRS.

FFA

1. Explain the relationship between EPA, DOE, and the Federal Facilities Agreement as it relates to SRS (Source: June 27, 1995, Evening Meeting, Page 25, Line 25)

   The agencies agree up front to a schedule of compliance for the facility that's suitable to the regulators both at the state and federal levels. It's required by CERCLA of Superfund, Section 120, to get a compliance schedule from the Department of Energy.

CERCLA/RCRA

1. Are CERCLA and RCRA the major tools under the Federal Facilities Agreement? (Source: June 27, 1995, Evening Meeting, Page 38, Line 9)

   The state of South Carolina got out there first with DOE and had some RCRA permits issued and RCRA permits required cleanup of some old waste sites as early as 1987. The site was listed a couple of years later on the NPL as a Superfund site. One of the areas that the state wanted to ensure that the agreement delineated was the CERCLA responsibilities, the old disposal practices that were not part of the RCRA permit and it could be separated out and that things were not duplicated across the board from a state and federal authority standpoint. CERCLA and RCRA are the tools and those are the tools nationwide for the defense and energy sites. Savannah River is no different from the others. Hanford, Oakridge, Fernold, all the big DOE sites have either Federal Facilities Agreements or RCRA permits that are driving the cleanup schedule.

Miscellaneous

1. I would like to know how many underground storage units you have and how many gallons of radioactive waste you have in them and whether they are still leaking. (Source: June 26, 1995, Page 11, Line 18)

   Fifty-one high level radioactive tanks.

2. What interaction does the Environmental Restoration Division have with the co-trustees for the Natural Resources at SRS? (Source: June 27, Morning Meeting, Page 77, Line 24)

   Ms. Duncan - I attended the last Trustee Council meeting, representing the Department of Interior, and I've heard here more today on what is being done at SRS than I've heard in the past three and a half years. The last Trustee Council , made an effort to put together a strategy to get more involved, to get more to the administration of DOE. In response to some of the comments about your budget, I specifically requested that the trustee interest and activities be represented in the SR budget.

Briefing on the Fish Subsistence Survey

Thursday, March 6, 1997
11:00 AM

	Name	Organization	Phone #
1.	MARY S. DODGEN	SRS/WSRC	(803) 725-1058
2.	Thomas M Steeger	Fishery Information Mgmt Sys.	(334) 887-8860
3.	DAN DURETT	UNCF	703-205-3462
4.	Earl Meredith	Fishery Information Mgmt. Syst.	334 887-8860
5.	PETE RAACK	EPA REGION 4 - LEGAL	404-562-9517
6.	CHERYL D. WALKER-SMITH	U.S. EPA R4 / WASTMD-FFB	(404) 562-8507
7.	Camilla Warren	USEPA	404/562-8519
8.	KEN FEELY	USEPA	404/562-8512
9.	KAREN HOOKER	DOE-SR	803-725-9615
10.	deLisa Bratcher	DOE-SR	803-725-5351
11.	Lloyd Gendrette	APTM-EPA	404-562-9138
12.	JOHN R. STOCKWELL, MD, MPH	USEPA / WMD/FFB DOERS	404/562-8511
13.			
15.			

DOE - SRS / EPA GRANT MEETING / FISH

THE COLLEGE FUND / UNCF = FISH

A STUDY OF FISH SUBSISTENCE
de'LISA BRATCHER / DOE GRANT MANAGER (ALONG WITH GRANT FOR RISK COMMUNICATION)

DATA ANALYSIS EARL MEREDITH, Ph.D.

"PORGIE?" = ? SPECIES

DAN DURETT (UNCF) PRESENTED CAPACITY BUILDING IN ENVIRONMENTAL SCIENCES AT HBCU
(BUILDING ENVIRONMENTAL JUSTICE COLLABORATIONS)
7 INSTITUTIONS AROUND SRS
- THIS WAS

USDOE
UNCF
SRS
CLAFLIN COLLEGE
FISK UNIVERSITY
BENEDICT COLLEGE ← (MILTON'S PUBLIC RESEARCH.

CLAFLIN COLLEGE - Hx OF HAZMAT EVALUATIONS

ESTIMATED FISH CONSUMPTION RATES IN SEVEN LOCATIONS AROUND SRS.

SUBSISTENCE - A MEANS OF SUBSISTING, ESPECIALLY MEANS BARELY SUFFICIENT TO MAINTAIN LIFE.

DURETT HAS GOOD DISCUSSION OF WHAT "SUBSISTENCE" IS AROUND SRS.

Dr. EARL MEREDITH

A STUDY OF FACTORS RELATING TO FISH SUBSISTENCE / CONSUMPTION WITHIN COMMUNITIES NEAR THE SAVANNAH RIVER SITE

INTERVIEWEES WERE WITHIN 2 MILES OF SAVANNAH RIVER

NON RESPONSE ISSUES:

- VALID + ACCURATE INFORMATION
- NON - RESPONSE / FILTERING QUESTIONS
- IMPROPER TRAINING OF STUDENTS ~~TO~~ DUE TO TIME CONSTRAINTS

EARL MEREDITH — AUBURN ALABAMA

FISH SUBSISTENCE SURVEYS SINCE 1992.

(CONSULTANTS)

6.5 → 30 gm FOR ALABAMA ~~FISH~~ SUBSISTENCE

LAKE QUEBUGEN (WISCONSIN)

LAKE HARTWELL

McCLELLANVILLE, SC

IN THIS STUDY, NOT PARTICULARLY TARGETING ANGLERS, BUT TO

SUBSISTENCE DEFINITION:

107 LBS FISH / YR = DEFINITION (FROM DHEC ~2 LB/WK)

(54 kg WAS EPA NUMBER) = 2.9 LB/WK

HISTORICALLY, IF ANGLERS ARE PROTECTED, THE PRESUMPTION IS THAT

"WHAT % OF YOUR PROTEIN DIET INTAKE CONSISTS OF FISH FROM FRESHWATER" (WOULD BE A BETTER APPROACH FOR

SAS

OF 269 INTERVIEWS:

30 HOUSEHOLDS THAT FISHED IN SR & AE

204 COULDN'T ANSWER THEIR

37% BLACK

19% WHITE

< 1% HISPANIC

NO NATIVE AMERICAN

MIXED RACIAL

9% < $10,000

QUESTION 37 = EDUCATION

9% < HS

20% $\bar{c}$ HS

12% c HS + SOME COL

6% $\bar{c}$ COLLEGE DEGREE

2% $\bar{c}$ GRAD,

35% UNWILLING/UNABLE TO RESPOND

$$C = \frac{(H)(P)}{S}$$

C = WEEKLY INDIV. CONSUM RATE/lbs.

H = HARVESTED

S = HOUSEHOLD SIZE

"DUNCAN'S MULTIPLE RANGE BY AREA"

"RELATIVE ERROR" IS STANDARD ~~AREA OF~~ ERROR OF MEAN

"AREA 6 HAD NO CONSUMERS"

OF 39 RESPONSES, 4 FELL INTO SUBSISTENCE (HOUSEHOLD) ⇒ ~10% ≅ < 1% OF HOUSEHOLD

OUT OF 269

QUESTION #16 OF PART II

~~#~~ 19.1 % IS IMPORTANT QUESTION

= 13.1%

= 5.5%

19.1%

• "PUFFER STUDY" WAS GROUNDBREAKING STUDY
et al, 1982
(SANFRANCISCO)

49% OF ANGLERS ACTUALLY CONSUMED THEIR CATCHES

• CONNELLY, et AL
(~~NEW ORLEANS~~
LAKE ONTARIO

20gm/d ≡ 5OZ FISH/WK ≈ 1/2 LB fish/wk

3.7 gm FISH CONSUMPTION RATE ⇒ SIG

160 LB

SUMMARY:

- HOUSE HOLD
-
- 2 MO SURVE

FUTURE RESEARCH

- GIS FORMAT AVAILABLE (ARC/INFO - FRIENDLY)
  DEMOGRAPHIC: ETHNICITY, EDUCATION, & INCOME
- BOAT RAMPS & BAIT HOUSES & FISH MARKETS
- OTHER "FISH": EELS, SNAPPING + SOFT BACK, ALLIGATOR TAILS
- LIVING IN CARS / NO HOUSE HOLD
- EATING BONES & ALL — STRONTIUM-90
- ✱ SC FISH ADVISORY KNOWN ABOUT IN GA? HOUSEHOLDS KNOW ABOUT IT?

24 MAR 97 = CAB RESPONSE

QUESTION #27 HAS PICTURE OF STUDY

✱ IMPORTANCE OF COLLABORATION BETWEEN UNIVERSITY

POLLUTED AIR, IT DOESN'T MATTER IF YOU'RE BLACK, WHITE, YOUNG, OLD.

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

FAX MESSAGE

Date: 5-22-97

Number of pages Including Cover Sheet: 39

Please Deliver This Fax Message

TO: John Stockwell
Name

EPA
Organization/Department

(404) 562 8518
Fax Number

( )
Office Phone

ROM: Keith Collinsworth
Name

FFA
Bureau/Division/Section

(803) 896-4001
Fax Number

(803) 896-4055
Office Phone

SUBJECT/COMMENTS:

News Release

FOR IMMEDIATE RELEASE:
May 14, 1996

COLUMBIA - A fish consumption advisory for the Savannah River issued in January 1995 based on mercury in fish is being expanded to include all species of fish based on measured levels of two radioactive isotopes, the S.C. Department of Health and Environmental Control reported today.

The expanded advisory applies only to a portion of the river from Beech Island in Aiken County downstream to the Webb Wildlife Center in Hampton County.

"Results of fish testing in the Savannah River showed elevated levels of Cesium-137 and Strontium-90," according to Harry Mathis, assistant chief of DHEC's Bureau of Solid and Hazardous Waste Management. "While radioisotopes are commonly present in the environment and the presence of Cesium-137 and Strontium-90 have been routinely reported since 1959, this is the first time we have evaluated the data using a more comprehensive quantitative risk analysis. These radioisotope releases occurred due to historical methods for the disposal of radioactive material at the site These methods are no longer used at SRS to dispose of radioactive material, and discharge to streams have been reduced. We believe the results of the risk analysis need to be communicated. The analysis of this data is part of the state's continuing effort to measure levels of radioisotopes in fish near nuclear facilities in the state. The advisory was expanded to communicate these risks, especially to people who routinely eat fish caught in the river."

Mathis said the radioisotope contamination concern is for fish only. As with mercury, fish also concentrate the radioisotopes to levels of concern. Water samples from the Savannah River analyzed for radioactivity indicated that the safety of drinking water is not affected.

"The types of fish sampled include sucker, bowfin, shad, largemouth bass, striped bass, bream, carp, catfish, and mullet," Mathis said. "There are plans to sample additional fish and other aquatic species in the Savannah River that may be exposed to the isotopes."

"We believe expanding the advisory will provide people the information they need to make informed decisions about which fish to eat and how much," he said.

The Savannah River's fish consumption advisory extending from Lake Thurmond downstream to Interstate 95, issued 17 months ago based on the presence of mercury, is still in effect and includes the recommendation that pregnant women, women planning to become pregnant, infants and children may face the highest risk of health problems and should not eat any fish from these waters.

"The U.S. Environmental Protection Agency is working with us to try to identify groups potentially at risk," he said.

"While humans can eliminate some of the radioisotopes through body wastes," said Cheryl Nybro, risk assessor for DHEC's federal facilities section, "the concentrations and types of radioisotopes in these samples are high enough to warrant notification. The risk of an effect

-more-

South Carolina
DHEC
Division of
Media Relations
2600 Bull Street
Columbia, S.C. 29201
(803) 734-5074

from radiation can be reduced if people are aware of and follow guidelines."

Mathis said water from the Savannah River is safe for drinking water purposes and recreational river uses. Finally, consumption of fish obtained from the Savannah River is safe if consumed in a manner consistent with the advisory's guidelines.

People with questions about the advisory or fish consumption guidelines may call DHEC's Environmental Quality Control district offices in Greenwood at (864)223-0333, in Aiken at (803)641-7670 or in Beaufort at (803)522-9097.

###

For Further Information:
Thom Berry - (803)734-5043
Harry Mathis - (803)896-4000
Cheryl Nybro - (803)896-4067

FISH CONSUMPTION ADVISORY

FOR THE SAVANNAH RIVER*

(Pounds per Month)

Lake Thurmond to Beech Island	**LMB** - 4.75** **All other fish - no limit**
Beech Island to Allendale/Barnwell County Line	**LMB** - 1.75** **All other fish -1.5**
Allendale/Barnwell County Line to Webb Wildlife	**LMB** -2.5** **All other fish - 4.0**
Webb Wildlife to I-95	**LMB** -1.0** **All other fish - no limit**

* Pregnant women, women planning to get pregnant, infants and children should not eat fish from the Savannah River.

** LMB - largemouth bass

RISK ASSESSMENT AND FISH CONSUMPTION ADVISORY FOR THE SAVANNAH RIVER BASED ON RADIONUCLIDES PRESENT IN FISH UPSTREAM, ADJACENT TO, AND DOWNSTREAM OF THE SAVANNAH RIVER SITE

Donald L. Siron
Risk Assessor

Introduction

The Savannah River Site (SRS) is a United States Department of Energy facility occupying approximately 310 square miles within Aiken, Barnwell and Allendale counties of South Carolina. The SRS operated from 1952 to 1988 to produce nuclear materials primarily for national defense. As a result of these operations over 50 different radioisotopes were released to the environment (Cummins et al., 1991). The SRS presently serves as a storage facility for radioactive and other contaminated waste.

A risk assessment was performed to assess the potential for adverse human health effects due to ingestion of Savannah River fish contaminated with radioactive material. Human health effects were considered only in this risk assessment; no analyses were performed to quantify risk to ecological receptors. This risk assessment follows the EPA Risk Assessment Guidance for Superfund or RAGS (EPA, 1989) and Region IV Supplemental Guidance to RAGS (EPA, 1995).

The Savannah River Site (SRS) is bounded to the west by a 35 mile stretch of the Savannah River. Five major streams from SRS flow into the Savannah River: Upper Three Runs Creek, Four Mile Creek, Pen Branch, Steel Creek and Lower Three Runs Creek. These streams directly receive effluents from SRS operations as well as runoff from past activities and disposal practices and transport contaminants to the Savannah River. The Savannah River contains Cesium-137 (Cs-137) and Strontium-90 (Sr-90) which are man-made radioactive isotopes that are directly related to SRS operations. These two radionuclides are known to be bioaccumulated in fish and were specifically chosen for risk assessment.

Methods

The Westinghouse Savannah River Company Environmental Protection Department (WSRC-EPD) Savannah River fish sampling database for 1993 and 1994 was used for the basis of the risk calculations (Appendix A). This database contains radionuclide concentrations from 257 fish samples. Fish samples were collected from sites on the Savannah River upstream, adjacent to, and downstream of the Savannah River Site. Concentrations of Cs-137 and Sr-90 were reported in both edible and non-edible fish portions.

Risk calculations were performed using the risk assessment methodology in accordance with United States Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS)(EPA, 1989). The risk was calculated using the following formula:

Risk = (concentration)(exposure duration)(ingestion rate)(slope factor)

Where:
concentration = pCi/kg
exposure duration = years
ingestion rate = kg/year
slope factor = unitless constant

The exposure duration of 30 years was used to represent a lifetime residential exposure based on USEPA guidance (EPA, 1989). Two fish ingestion rates were used: 1) 19 kilograms per year (EPA Region IV Guidance) to address the sport fishing scenario, and 2) 50 kilograms per year (90th percentile as reported in the USEPA Exposure Factors handbook, Draft 1995) to represent the subsistence fishing scenario. Oral slope factors used in the risk calculations were obtained from the EPA's online Health Effects Assessment Summary Tables (HEAST). Radioisotope slope factors are calculated by EPA's Office of Radiation and Indoor Air (ORIA) to assist HEAST users with risk-related evaluations and decision-making at various stages of the site remediation process. The EPA classifies all radioisotopes as Group A (known human) carcinogens. The slope factors used were 3.16×10^{-11} (Risk/pCi) for Cs-137 and 4.09×10^{-11} (Risk/pCi) for Sr-90.

The measured radionuclide concentrations in fish were organized into three groups or "river segments" according to location: 1) Upstream of SRS, 2)Adjacent to SRS, and 3)Downstream of SRS (Appendix B). These "segments" contain data from individual sampling points. The "Upstream of SRS" segment contained data from the area below the Augusta Lock and Dam. The "Adjacent to SRS" segment contained data from Upper Three Runs Creek mouth, Beaver Dam Creek mouth, Four Mile Creek mouth, Steel Creek mouth and Lower Three Runs Creek mouth. The "Downstream of SRS" segment contained data from the Highway 301 Bridge area, Stokes Bluff Landing and Highway 17A Bridge area. Microsoft Excel was used to calculate average and maximum radionuclide concentrations for each sampling point as well as an average of the maximum concentrations of individual sampling points for each segment (Appendix B). The average of the maximum value (concentration) for each segment was used in the risk calculations (Appendix C).

Discussion

The purpose of this risk characterization is to asses the potential for adverse human health effects associated with the ingestion of Savannah River fish containing radionuclides. The CERCLA risk calculation provides numbers reflecting the excess lifetime risk of excess cancer. These calculated incremental lifetime cancer risks are a result of specific exposure (ingestion) to radionuclides in Savannah River fish. Risk numbers generated as a result of this risk assessment are presented in Table 1 below. A graphical presentation of this risk data with respect to river location is presented in Figure 1.

The EPA considers risk numbers less than 1.0×10^{-6} (i.e., one additional case of cancer over what would be normally expected in a group of 1,000,000 people) as negligible. Calculated risk between the 1.0×10^{-4} and 1.0×10^{-6} range requires risk management decisions to either remove the contamination or minimize exposure to the public, workers and the environment. Risk greater than 1.0×10^{-4} (one additional case of cancer in a population of 10,000) could require some form of corrective action or remediation.

FIGURE 1

Average Risk From Cs-137 and Sr-90 Combined

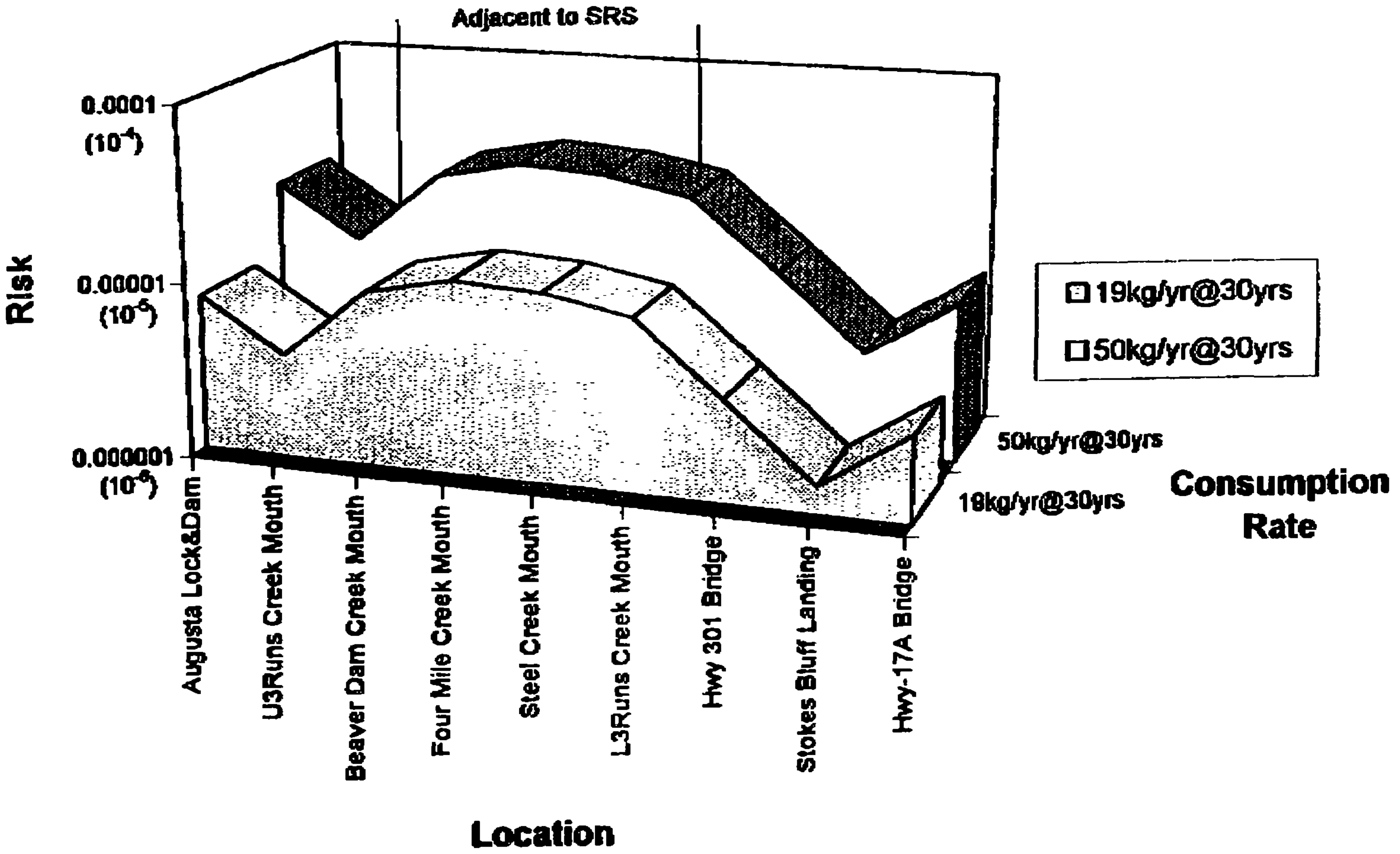

TABLE 1
Calculated risks for ingestion of Savannah River fish containing Cs-137 and Sr-90 (using 1993-94 data).

River Segment	Sportfishing Scenario	Subsistence Fishing Scenario
Upstream of SRS	2.4×10^{-5}	6.3×10^{-5}
Adjacent to SRS	3.8×10^{-5}	1.0×10^{-4}
Downstream of SRS	1.5×10^{-5}	4.0×10^{-5}

Consumption limits of Savannah River fish that are protective of the 1.0×10^{-5} risk range were calculated using the following formula:

Consumption Limit = risk ÷ (concentration)(exposure duration)(slope factor)

Where:
consumption limit = kg/yr
concentration = pCi/kg
exposure duration = years
slope factor = unitless constant

Consumption limits were calculated independently for both Cs-137 and Sr-90 in Savannah River fish since the slope factors are constituent-specific (Appendix C). The resulting consumption limits are presented in Table 2 and Table 3 below. The most conservative of the two consumption limits drives the overall maximum consumption limit in the Fish Advisory.

TABLE 2
Fish Consumption Limit Protective to 1.0×10^{-5} Risk for Cs-137 (Edible and Non-Edible Portions)

River Segment	Kilograms per Year	Pounds per Month
Upstream of SRS	25.1	4.6
Adjacent to SRS	10.9	2.0
Downstream of SRS	38.1	7.0

TABLE 3
Fish Consumption Limit Protective to $1.0x10^{-5}$ Risk for Sr-90 (Edible and Non-Edible Portions)

River Segment	Kilograms per Year	Pounds per Month
Upstream of SRS	15.1	2.8
Adjacent to SRS	11.8	2.2
Downstream of SRS	24.4	4.5

The January 1995 DHEC fish consumption advisory from Lake Thurmond downstream to Interstate 95 based on mercury levels in Savannah River fish was expanded in May 1996 to include all species of fish based on measured concentrations of Cs-137 and Sr-90 (Table 4). The January 1995 fish consumption advisory based on mercury levels only considered Largemouth Bass and Bowfin. The May 1996 advisory only increased the number of fish species from Largemouth Bass and Bowfin to all species of fish. The fish consumption rates were not altered from the original advisory based on mercury.

TABLE 4
Fish Consumption Advisory for the Savannah River Based on Mercury Levels (SCDHEC, 1996).

River Segment	Largemouth Bass Pounds per Month	All Other Fish Pounds per Month
Lake Thurmond to Beech Island	4.75	no limit
Beech Island to Allendale/Barnwell County Line	1.75	1.5
Allendale/Barnwell County line to Webb Wildlife	2.5	4.0
Webb Wildlife to I-95	1.0	no limit

The river segments from Beech Island to the Allendale/Barnwell County line and Allendale/Barnwell County line to Webb Wildlife include the three river segments considered in this radionuclide advisory. The most conservative fish consumption limit (within the three segments considered for radionuclides) based on mercury levels in fish is 1.5 pounds per month. The most conservative fish consumption limit (for the same three segments) based on radionuclides is 2.0 pounds per month, therefore the consumption limits based on mercury are also protective for radionuclides.

Uncertainty

There are several sources of uncertainty associated with risk assessment methodology. These uncertainties may serve to over or under estimate risk.

Quality and Quantity of Data

The fish data used in this risk assessment was from one source (WSRC-EPD) for a two year period only (1993-1994). There were no acceptable quality control samples taken during this period from other organizations for comparison. DHEC is currently developing a fish sampling protocol for the Savannah River which will increase the quantity and quality of data used for risk assessment calculations.

Analysis results from the WSRC-EPD data were reported by fish species as edible or non-edible portions. No information was available regarding fish consumption patterns of local residents (i.e., fish species eaten, preparation, cooking methods). All fish portions were therefore considered to be "edibie" for this risk assessment due to the inability to determine what portion of a fish was considered to be "edible" or "non-edible".

Fish Size

The fish sampling plan used by WSRC-EPD only requires a minimum weight of 200 grams (7 ounces) and no maximum weight was specified. Individual fish weights were not available therefore it is unclear whether larger more mature fish were sampled. Due to the high bioaccumulation potential for Cs-137 and Sr-90 large fish would be expected to contain higher concentrations of these radionuclides. If the majority of fish sampled were relatively small, then the exclusion of large fish would serve to under estimate risk.

Conclusions

The principal risk to the public from the release of the radionuclides Cs-137 and Sr-90 to the environment is from the consumption of Savannah River fish. This risk is due to the high degree of bioaccumulation for radionuclides and other contaminants observed in fish. The element cesium has a bioaccumulation factor of 3,000 in Savannah River fish, therefore the concentration of cesium in fish tissue should be 3,000 times greater than the concentration of cesium in Savannah River water (WSRC, 1996).

Risk numbers calculated for the sportfishing scenario (19kg per year consumption rate) and subsistence fishing scenario (50 kg per year consumption rate) using the 1993-1994 data are in the $1.0x10^{-4}$ to $1.0x10^{-6}$ range. The risk management decision based on these excess lifetime cancer risk numbers was to formally notify the public by expanding the DHEC 1995 Savannah River fish advisory for mercury to include all species of fish

References

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APPENDIX A

WSRC-EPD measured Cs-137 and Sr-90 concentrations in Savannah River fish

(1993 and 1994 data)

SRS DATA BY RIVER SEGMENT

	E= Edible	Nuclide	Result	Uncertainty	Date	Fish	Location
	NE=Nonedible		wet pci/g				
Sample #			*composite				
(UPSTREAM SRS)							
9390793800	E	,Cs-137	6.39E-02	,2.09e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390793800	E	,Sr-90	1.09E-02	,8.34e-03	,10/26/93,	Bass	,Augusta Lock and Dam
9390793900	NE	Sr-90	2.75E-01	,6.23e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390794000	E	,Sr-90	9.00E-03	9.17E-03	10/26/93,	Bass	,Augusta Lock and Dam
9390794200	NE	,Sr-90	3.21E-01	,6.79e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036500	E	,Cs-137	4.21E-01	,3.17e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036500	E	,Sr-90	2.85E-02	,7.31e-03	,10/26/93,	Bass	,Augusta Lock and Dam
9490036600	NE	,Cs-137	3.31E-01	,2.55e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036600	NE	,Sr-90	1.09E-01	,2.77e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390797400	E	,Sr-90	3.32E-03	2.09E-02	10/26/93,	Bream	,Augusta Lock and Dam
9390797500	NE	,Sr-90	6.99E-01	,7.50e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9390797600	E	,Cs-137	1.88E-01	,3.98e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9390797600	E	,Sr-90	6.49E-03	,1.78e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9390797700	NE	,Sr-90	2.36E-01	,6.09e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9490035600	E	,Sr-90	1.96E-02	,1.08e-02	,10/10/93,	Bream	,Augusta Lock and Dam
9490035900	NE	,Sr-90	8.60E-02	,2.76e-02	,10/10/93,	Bream	,Augusta Lock and Dam
9590098700	E	,Sr-90	5.86E-03	,3.94e-03	,09/22/94,	Bass	,Augusta Lock and Dam
9590098800	NE	,Sr-90	1.09E-01	,3.08e-02	,09/22/94,	Bass	,Augusta Lock and Dam
(ADJACENT TO SRS)							
9390448400	E	,Cs-137	5.98E-02	,1.67e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390448500	NE	,Sr-90	3.18E-01	,6.62e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390448900	NE	,Sr-90	2.77E-01	,6.18e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390563100	E	,Cs-137	7.93E-02	,2.39e-02	,05/14/93,	Catfish	,U3R Creek River Mouth
9390563100	E	,Sr-90	3.55E-03	,3.74e-03	,05/14/93,	Catfish	,U3R Creek River Mouth
9390563200	NE	,Sr-90	1.80E-02	,1.99e-02	,05/14/93,	Catfish	,U3R Creek River Mouth
9490299500	E	,Cs-137	6.97E-02	,2.15e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299500	E	,Sr-90	1.10E-02	,3.54e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299600	NE	,Sr-90	1.31E-01	,4.81e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299700	E	,Sr-90	1.86E-02	,7.84e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299800	NE	,Sr-90	1.89E-01	,4.44e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490300100	E	,Sr-90	3.86E-03	,2.88e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490300200	NE	,Sr-90	1.63E-01	,4.33e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490044900	E	,Cs-137	7.07E-01	,4.26e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9490044900	E	,Sr-90	3.89E-02	,8.72e-03	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9490045000	NE	,Cs-137	1.43E-01	,4.01e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9490045000	NE	,Sr-90	9.77E-01	,9.84e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9390503800	E	,Sr-90	2.09E-04	5.04E-03	06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390503900	NE	,Sr-90	6.95E-01	,2.29e-01	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390504000	E	,Sr-90	4.48E-03	,3.65e-03	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390504100	NE	,Cs-137	5.27E-02	,1.61e-02	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390504100	NE	,Sr-90	6.12E-01	,2.33e-01	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9490041500	E	,Cs-137	7.39E-02	,2.21e-02	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9490041500	E	,Sr-90	1.48E-03	6.45E-03	05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9490041700	NE	,Cs-137	2.74E-02	,5.99e-03	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth

SRS DATA BY RIVER SEGMENT

90041700	NE	,Sr-90	1.31E-01	,4.94e-02	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth
90099100	E	,Cs-137	9.37E-01	,2.40e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
90099100	E	,Sr-90	7.21E-03	,4.65e-03	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9590099200	NE	,Cs-137	4.72E-01	,3.02e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9590099200	NE	,Sr-90	1.63E-01	,4.15e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9490213400	E	,Cs-137	5.79E-02	,1.62e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490213400	E	,Sr-90	1.26E-02	,3.55e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490213500	NE	,Sr-90	1.56E-01	,3.16e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214000	E	,Sr-90	3.94E-02	,9.43e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214100	NE	,Cs-137	5.89E-02	,2.11e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214100	NE	,Sr-90	3.07E-01	,4.17e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214200	E	,Sr-90	9.53E-03	,3.49e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214300	NE	,Sr-90	1.07E-01	,2.94e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9390541100	E	,Sr-90	1.42E-02	,7.45e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541300	NE	,Sr-90	1.45E+00	,3.28e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541400	E	,Sr-90	6.98E-03	,7.20e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541600	NE	,Sr-90	1.82E+00	,3.35e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541700	E	,Cs-137	1.52E-01	,4.27e-02	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541700	E	,Sr-90	1.31E-02	,7.33e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541800	NE	,Cs-137	1.17E-01	,3.13e-02	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541800	NE	,Sr-90	1.05E+00	,3.85e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390548100	E	,Cs-137	6.39E-02	,1.88e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548100	E	,Sr-90	2.97E-03	,5.47e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548200	NE	,Sr-90	2.67E-01	,7.06e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548400	E	,Cs-137	8.05E-02	,1.95e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548400	E	,Sr-90	7.05E-03	,4.09e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
390548500	NE	,Cs-137	8.63E-02	,2.33e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548500	NE	,Sr-90	4.88E-02	,5.81e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548700	E	,Sr-90	3.87E-03	,3.85e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548800	NE	,Sr-90	3.02E-01	,6.51e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9490308200	E	,Sr-90	4.11E-02	,8.06e-03	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490308300	NE	,Cs-137	1.08E-01	,3.05e-02	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490308300	NE	,Sr-90	1.08E+00	,1.28e-01	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490309300	E	,Sr-90	8.82E-03	,5.38e-03	,03/28/94,	Bream	,Four Mile Creek River Mouth
9490309500	NE	,Sr-90	2.27E-01	,7.46e-02	,03/28/94,	Bream	,Four Mile Creek River Mouth
9490309800	E	,Cs-137	2.09E-01	,3.00e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490309800	E	,Sr-90	7.53E-02	,1.09e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490309900	NE	,Cs-137	1.46E-01	,2.87e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490309900	NE	,Sr-90	5.22E-01	,7.35e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490203300	E	,Cs-137	9.40E-02	,2.41e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203300	E	,Sr-90	6.25E-02	,7.11e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203400	NE	,Cs-137	7.71E-02	,1.60e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203400	NE	,Sr-90	4.31E-01	,5.05e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203500	E	,Cs-137	2.59E-01	,2.74e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203500	E	,Sr-90	1.87E-02	,4.39e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203600	NE	,Cs-137	1.13E-01	,1.65e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203600	NE	,Sr-90	1.39E+00	,1.29e-01	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203700	E	,Cs-137	3.54E-01	,2.69e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203700	E	,Sr-90	1.23E-02	,4.09e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203800	NE	,Cs-137	9.63E-02	,2.06e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203800	NE	,Sr-90	1.29E+00	,9.23e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth

SRS DATA BY RIVER SEGMENT

9390603800	E	Cs-137	1.42E+00	,4.66e-02	,09/09/93,	Bass	,Steel Creek River Mouth
390603800	E	Sr-90	2.10E-02	,5.50e-03	,09/09/93,	Bass	,Steel Creek River Mouth
390603900	NE	Cs-137	8.14E-01	,2.70e-02	,09/09/93	Bass	,Steel Creek River Mouth
9390603900	NE	,Sr-90	1.98E-01	,4.22e-02	,09/09/93	Bass	,Steel Creek River Mouth
9390604300	E	,Cs-137	1.10E+00	,4.25e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390604300	E	,Sr-90	2.72E-02	,9.86e-03	,09/09/93,	Bass	,Steel Creek River Mouth
9390604400	NE	,Cs-137	6.02E-01	,3.56e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390604400	NE	,Sr-90	7.01E-02	,2.85e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390381000	E	,Sr-90	1.08E-02	,1.06e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390381100	E	,Cs-137	1.36E-01	,3.12e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390382000	NE	,Cs-137	7.64E-02	,2.36e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390382000	NE	,Sr-90	1.91E-01	,3.44e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390385200	NE	,Cs-137	8.52E-02	,2.46e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390385200	NE	,Sr-90	1.06E-01	,2.93e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9490034700	E	,Sr-90	5.15E-03	,1.67e-02	,05/10/93,	Bream	,Steel Creek River Mouth
9490034800	NE	,Sr-90	8.94E-02	,2.70e-02	,05/10/93,	Bream	,Steel Creek River Mouth
9390389700	E	,Cs-137	1.80E-01	,2.76e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389700	E	,Sr-90	7.04E-03	,5.15e-03	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389800	NE	,Cs-137	1.18E-01	,2.45e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389800	NE	,Sr-90	7.49E-02	,2.45e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389900	E	,Cs-137	1.94E-01	,2.85e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389900	E	,Sr-90	2.34E-03	,5.28e-03	,05/10/93,	Catfish	,Steel Creek River Mouth
9390390100	NE	,Cs-137	1.02E-01	,1.95e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390390100	NE	,Sr-90	7.52E-02	,2.02e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390439500	E	,Cs-137	6.46E-02	,1.44e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390439600	NE	,Sr-90	9.92E-01	,3.06e-01	,05/10/93,	Catfish	,Steel Creek River Mouth
590098300	E	,Cs-137	2.12E+00	,6.16e-02	,09/20/94,	Bass	,Steel Creek River Mouth
590098300	E	,Sr-90	1.20E-03	,4.25e-03	,09/20/94,	Bass	,Steel Creek River Mouth
9590098400	NE	,Cs-137	1.14E+00	,4.51e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098400	NE	,Sr-90	2.14E-01	,4.20e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098500	E	,Cs-137	5.68E-01	,3.29e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098600	NE	,Cs-137	3.72E-01	,2.01e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098600	NE	,Sr-90	1.92E-01	,4.06e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9490306600	E	,Sr-90	1.66E-02	,6.50e-03	,03/28/94,	Bream	,Steel Creek River Mouth
9490306700	NE	,Sr-90	1.99E-01	,7.25e-02	,03/28/94,	Bream	,Steel Creek River Mouth
9490201400	E	,Cs-137	2.27E-01	,3.06e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201400	E	,Sr-90	2.04E-02	,4.38e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201500	NE	,Cs-137	1.73E-01	,2.45e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201500	NE	,Sr-90	1.50E-01	,3.46e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201600	E	,Cs-137	2.12E-01	,3.15e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201600	E	,Sr-90	5.83E-03	,3.29e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201700	NE	,Cs-137	1.16E-01	,2.24e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201700	NE	,Sr-90	9.28E-02	,3.95e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490202700	E	,Cs-137	2.72E-01	,2.88e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490202700	E	,Sr-90	2.53E-02	,6.33e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490202800	NE	,Sr-90	3.12E-01	,8.17e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9390761000	E	,Cs-137	7.41E-01	,3.81e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390761000	E	,Sr-90	4.99E-03	,4.20e-03	,09/16/93,	Bass	,L3R Creek River Mouth
9390761100	NE	,Cs-137	3.50E-01	,3.72e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390761100	NE	,Sr-90	2.13E-01	,5.94e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390380900	E	,Cs-137	1.17E-01	,2.26e-02	,05/18/93,	Bream	,L3R Creek River Mouth

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9390380900	E	,Sr-90	3.34E-03	,5.25e-03	,05/18/93,	Bream	,L3R Creek River Mouth
[illegible]0381500	NE	,Cs-137	9.40E-02	,1.75e-02	,05/18/93,	Bream	,L3R Creek River Mouth
[illegible]0381500	NE	,Sr-90	9.87E-02	,2.76e-02	,05/18/93,	Bream	,L3R Creek River Mouth
9390624600	E	,Cs-137	7.86E-01	,5.32e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390624600	E	,Sr-90	7.71E-03	,4.75e-03	,05/14/93,	Bream	,L3R Creek River Mouth
9390624700	NE	,Cs-137	5.46E-01	,4.19e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390624700	NE	,Sr-90	1.98E-01	,5.43e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390625200	E	,Cs-137	3.91E-01	,3.59e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390625200	E	,Sr-90	4.45E-02	,2.24e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390625300	NE	,Cs-137	3.29E-01	,3.73e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390625300	NE	,Sr-90	3.19E-01	,5.78e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390409500	E	,Cs-137	2.61E-01	,2.68e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409500	E	,Sr-90	8.16E-03	,6.02e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409600	E	,Cs-137	1.43E-01	,2.34e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409600	E	,Sr-90	4.43E-03	,5.32e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409700	NE	,Cs-137	1.73E-01	,2.42e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409700	NE	,Sr-90	3.48E-01	,6.19e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435800	E	,Cs-137	2.01E-01	,2.61e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435800	E	,Sr-90	4.64E-03	,5.77e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435900	NE	,Cs-137	1.61E-01	,1.90e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435900	NE	,Sr-90	4.18E-02	,5.34e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9590098900	E	,Cs-137	4.45E-01	,1.80e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9590098900	E	,Sr-90	1.31E-03	,2.83e-03	,09/20/94,	Bass	,L3R Creek River Mouth
9590099000	NE	,Cs-137	2.39E-01	,2.90e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9590099000	NE	,Sr-90	1.02E-01	,3.49e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9490201100	E	,Cs-137	7.58E-01	,5.08e-02	,03/28/94,	Bream	,L3R Creek River Mouth
[illegible]90201100	E	,Sr-90	2.25E-01	,1.73e-02	,03/28/94,	Bream	,L3R Creek River Mouth
[illegible]90201300	NE	,Cs-137	4.33E-01	,3.92e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490201300	NE	,Sr-90	1.50E-01	,3.42e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490213200	E	,Cs-137	1.48E-01	,2.97e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490213200	E	,Sr-90	3.84E-02	,8.61e-03	,03/30/94,	Bream	,L3R Creek River Mouth
9490213300	NE	,Cs-137	1.08E-01	,3.31e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490213300	NE	,Sr-90	1.13E-01	,3.23e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490307200	E	,Cs-137	7.98E-01	,4.58e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307200	E	,Sr-90	3.47E-02	,8.49e-03	,04/18/94,	Bream	,L3R Creek River Mouth
9490307300	NE	.Cs-137	4.41E-01	,3.52e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307300	NE	.Sr-90	2.63E-01	,7.85e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307700	E	.Cs-137	2.73E-01	,3.40e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490307700	E	,Sr-90	1.60E-02	,5.77e-03	,03/30/94,	Bream	,L3R Creek River Mouth
9490343900	NE	Cs-137	1.44E-01	,2.44e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490343900	NE	,Sr-90	1.14E-01	,5.98e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490198600	E	,Cs-137	1.33E+00	,4.83e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198600	E	,Sr-90	4.52E-03	,3.62e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198700	NE	,Cs-137	6.67E-01	,3.91e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198700	NE	,Sr-90	2.26E-01	,4.97e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198800	E	,Cs-137	2.44E-01	,2.29e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198800	E	,Sr-90	2.40E-02	,4.40e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199200	E	,Cs-137	5.91E-01	,3.78e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199200	E	,Sr-90	5.15E-03	,3.50e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199300	NE	,Cs-137	3.16E-01	,3.37e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199300	NE	,Sr-90	2.19E-01	,7.22e-02	,03/28/94,	Catfish	,L3R Creek River Mouth

SRS DATA BY RIVER SEGMENT

...0200900	NE	,Cs-137	9.35E-02	,1.87e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
0200900	NE	,Sr-90	1.03E-01	,4.28e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
(DOWNSTREAM OF SRS)							
9390620400	E	,Sr-90	8.50E-03	,4.41e-03	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390620500	NE	,Sr-90	7.94E-02	,2.61e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390624800	E	,Sr-90	1.22E-03	3.21E-03	9/16/93	Bass	,Hwy-301 Bridge Area
9390624900	NE	,Cs-137	5.67E-02	,1.88e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390624900	NE	,Sr-90	9.50E-02	,2.87e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390613000	E	,Sr-90	1.48E-03	,3.37e-03	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390613100	NE	,Sr-90	1.25E-01	,3.09e-02	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390613200	E	,Sr-90	5.12E-03	,4.63e-03	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390613300	NE	,Sr-90	1.56E-01	,3.55e-02	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390621600	E	,Cs-137	8.60E-02	,2.43e-02	,05/25/93,	Bream	,Hwy-301 Bridge Area
9390621600	E	,Sr-90	9.29E-03	,3.75e-03	,05/25/93,	Bream	,Hwy-301 Bridge Area
9390621700	NE	,Sr-90	1.50E-01	,3.35e-02	,05/25/93,	Bream	,Hwy-301 Bridge Area
9390392300	E	,Sr-90	4.30E-03	5.19E-03	06/21/93,	Catfish	,Hwy-301 Bridge Area
9390392400	NE	,Sr-90	9.84E-02	,2.70e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9390429800	E	,Cs-137	7.18E-02	,1.48e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390429800	E	,Sr-90	6.63E-03	,5.28e-03	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390429900	NE	,Cs-137	9.08E-02	,2.42e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390429900	NE	,Sr-90	2.96E-01	,6.66e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390435600	E	,Cs-137	1.49E-01	,2.01e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9390435700	NE	,Cs-137	4.27E-02	,1.40e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9390435700	NE	,Sr-90	2.55E-01	,1.40e-01	,06/21/93,	Catfish	,Hwy-301 Bridge Area
...590087700	NE	,Cs-137	3.73E-02	,1.24e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
...590087700	NE	,Sr-90	1.52E-01	,3.45e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
...590087800	E	,Cs-137	7.01E-02	,1.72e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590087800	E	,Sr-90	4.13E-03	,3.97e-03	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590088000	NE	,Cs-137	4.41E-02	,9.41e-03	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590088000	NE	,Sr-90	1.37E-01	,3.38e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9490300500	E	,Cs-137	1.11E-01	,2.87e-02	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490300500	E	,Sr-90	3.31E-03	,3.55e-03	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490300600	NE	,Sr-90	2.62E-01	,4.57e-02	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490302400	E	,Sr-90	1.44E-02	,6.37e-03	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302500	NE	,Sr-90	2.38E-01	,4.70e-02	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302600	E	,Sr-90	1.14E-02	,9.75e-03	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302700	NE	,Sr-90	2.07E-01	,4.15e-02	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490306800	E	,Cs-137	4.44E-02	,1.36e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490306800	E	,Sr-90	1.72E-02	,5.75e-03	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490307100	NE	,Cs-137	6.20E-02	,2.10e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490307100	NE	,Sr-90	4.33E-01	,8.28e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490300300	E	,Cs-137	5.52E-02	,2.05e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490330300	E	,Sr-90	6.51E-05	,3.89e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490330400	NE	,Sr-90	2.02E-01	,4.40e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300700	E	,Cs-137	7.07E-02	,2.42e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300700	E	,Sr-90	1.31E-02	,4.51e-03	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300800	NE	,Sr-90	1.78E-01	,4.42e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9390737900	E	,Cs-137	8.63E-02	,1.93e-02	,11/10/93,	Bass	,Stokes Bluff Landing
9390738200	E	,Cs-137	6.58E-02	,2.29e-02	,11/10/93,	Bass	,Stokes Bluff Landing
9390738300	E	,Cs-137	7.97E-02	,2.23e-02	,11/10/93,	Bass	,Stokes Bluff Landing

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[illegible]00034500	E	,Cs-137	4.08E-02	,1.22e-02	,07/15/93,	Bream	,Stokes Bluff Landing
[illegible]0476600	E	,Cs-137	5.75E+00	,1.59e-02	,07/08/93,	Catfish	,Stokes Bluff Landing
[illegible]0476700	E	,Cs-137	7.30E-02	,1.93e-02	,07/08/93,	Catfish	,Stokes Bluff Landing
9490306600	E	,Cs-137	7.98E-02	,1.99e-02	,05/09/94,	Catfish	,Stokes Bluff Landing
9490409200	E	,Cs-137	1.22E-01	,2.58e-02	,05/12/94,	Catfish	,Stokes Bluff Landing
9490409300	E	,Cs-137	6.24E-02	,1.78e-02	,05/16/94,	Catfish	,Stokes Bluff Landing
9390794300	E	,Cs-137	1.33E-01	,2.31e-02	,10/19/93,	Bass	,Hwy-17A Bridge Area
9390794400	E	,Cs-137	7.59E-02	,2.07e-02	,10/19/93,	Bass	,Hwy-17A Bridge Area
9390761300	E	,Cs-137	5.61E-01	,3.12e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Area
9390761400	E	,Cs-137	1.22E-01	,2.16e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Area
9390761500	E	,Cs-137	7.73E-02	,2.07e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Area
9490302200	E	,Cs-137	8.93E-02	,1.47e-02	,05/11/94,	Bass	,Hwy-17A Bridge Area
9490302300	E	,Cs-137	1.07E-01	,2.10e-02	,05/11/94,	Bass	,Hwy-17A Bridge Area

APPENDIX B

Cs-137 and Sr-90 average, maximum, and average of maximum concentrations in Savannah River fish upstream, adjacent to, and downstream of the Savannah River Site

(1993 and 1994 data)

Cs-137 & Sr-90 UPSTREAM

	E= Edible	Nuclide	Result	Uncertainty	Date	Fish	
	NE=Nonedible		wet pci/g				
Sample #			*composite				
(UPSTREAM SRS)							
9390793800	E	,Cs-137	6.39E-02	,2.09e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036500	E	,Cs-137	4.21E-01	,3.17e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036600	NE	,Cs-137	3.31E-01	,2.55e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390797600	E	,Cs-137	1.88E-01	,3.98e-02	,10/26/93,	Bream	,Augusta Lock and Dam
			AVG	MAX	AVG of MAX		
AUG.LOCK&DAM Cs-137			2.51E-01	4.21E-01		pCi/g	
TOTAL UPSTREAM Cs-137			2.51E-01	4.21E-01	4.21E-01	pCi/g	
9390793800	E	,Sr-90	1.09E-02	,8.34e-03	,10/26/93,	Bass	,Augusta Lock and Dam
9390793900	NE	Sr-90	2.75E-01	,6.23e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390794000	E	,Sr-90	9.00E-03	9.17E-03	10/26/93,	Bass	,Augusta Lock and Dam
9390794200	NE	,Sr-90	3.21E-01	,6.79e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9490036500	E	,Sr-90	2.85E-02	,7.31e-03	,10/26/93,	Bass	,Augusta Lock and Dam
9490036600	NE	,Sr-90	1.09E-01	,2.77e-02	,10/26/93,	Bass	,Augusta Lock and Dam
9390797400	E	,Sr-90	3.32E-03	2.09E-02	10/26/93,	Bream	,Augusta Lock and Dam
9390797500	NE	,Sr-90	6.99E-01	,7.50e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9390797600	E	,Sr-90	6.49E-03	,1.78e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9390797700	NE	,Sr-90	2.36E-01	,6.09e-02	,10/26/93,	Bream	,Augusta Lock and Dam
9490035800	E	,Sr-90	1.96E-02	,1.06e-02	,10/10/93,	Bream	,Augusta Lock and Dam
9490035900	NE	,Sr-90	8.60E-02	,2.76e-02	,10/10/93,	Bream	,Augusta Lock and Dam
9590098700	E	,Sr-90	5.86E-03	,3.84e-03	,09/22/94,	Bass	,Augusta Lock and Dam
9590098800	NE	,Sr-90	1.09E-01	,3.08e-02	,09/22/94,	Bass	,Augusta Lock and Dam
			AVG	MAX	AVG of MAX		
AUG.LOCK&DAM Sr-90			1.37E-01	6.99E-01		pCi/g	
TOTAL UPSTREAM Sr-90			1.37E-01	6.99E-01	6.99E-01	pCi/g	

Cs-137 & Sr-90 ADJACENT

	E= Edible	Nuclide	Result	Uncertainty	Date	Fish	
	NE=Nonedible		wet pci/g				
Sample #			*composite				
(ADJACENT TO SRS)							
9390448400	E	,Cs-137	5.98E-02	,1.67e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390563100	E	,Cs-137	7.93E-02	,2.39e-02	,05/14/93,	Catfish	,U3R Creek River Mouth
9490299500	E	,Cs-137	6.97E-02	,2.15e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490044900	E	,Cs-137	7.07E-01	,4.28e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9490045000	NE	,Cs-137	1.43E-01	,4.01e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
9390504100	NE	,Cs-137	5.27E-02	,1.61e-02	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9490041500	E	,Cs-137	7.39E-02	,2.21e-02	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9490041700	NE	,Cs-137	2.74E-02	,5.99e-03	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9590099100	E	,Cs-137	9.37E-01	,2.40e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9590099200	NE	,Cs-137	4.72E-01	,3.02e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9490213400	E	,Cs-137	5.79E-02	,1.62e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214100	NE	,Cs-137	5.89E-02	,2.11e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9390541700	E	,Cs-137	1.52E-01	,4.27e-02	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541800	NE	,Cs-137	1.17E-01	,3.13e-02	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390546100	E	,Cs-137	6.39E-02	,1.86e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548400	E	,Cs-137	8.05E-02	,1.95e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548500	NE	,Cs-137	8.63E-02	,2.33e-02	,06/06/93,	Catfish	,Four Mile Creek River Mouth
9490308300	NE	,Cs-137	1.08E-01	,3.05e-02	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490309800	E	,Cs-137	2.09E-01	,3.00e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
190309900	NE	,Cs-137	1.46E-01	,2.87e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
190203300	E	,Cs-137	9.40E-02	,2.41e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
490203400	NE	,Cs-137	7.71E-02	,1.60e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203500	E	,Cs-137	2.59E-01	,2.74e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203600	NE	,Cs-137	1.13E-01	,1.65e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203700	E	,Cs-137	3.54E-01	,2.69e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203800	NE	,Cs-137	9.63E-02	,2.06e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9390603800	E	Cs-137	1.42E+00	,4.66e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390603900	NE	Cs-137	8.14E-01	,2.70e-02	,09/09/93	Bass	,Steel Creek River Mouth
9390604300	E	,Cs-137	1.10E+00	,4.25e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390604400	NE	,Cs-137	6.02E-01	,3.56e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390381100	E	,Cs-137	1.36E-01	,3.12e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390382000	NE	,Cs-137	7.64E-02	,2.36e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390385200	NE	,Cs-137	8.52E-02	,2.46e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390389700	E	,Cs-137	1.80E-01	,2.76e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389800	NE	,Cs-137	1.18E-01	,2.45e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389900	E	,Cs-137	1.94E-01	,2.85e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390390100	NE	,Cs-137	1.02E-01	,1.95e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9390439500	E	,Cs-137	6.46E-02	,1.44e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
9590098300	E	,Cs-137	2.12E+00	,6.16e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098400	NE	,Cs-137	1.14E+00	,4.51e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098500	E	,Cs-137	5.68E-01	,3.29e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098600	NE	,Cs-137	3.72E-01	,2.01e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9490201400	E	,Cs-137	2.27E-01	,3.06e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201500	NE	,Cs-137	1.73E-01	,2.45e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201600	E	,Cs-137	2.12E-01	,3.15e-02	,03/28/94,	Catfish	,Steel Creek River Mouth

Cs-137 & Sr-90 ADJACENT

90201700	NE	,Cs-137	1.16E-01	,2.24e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
90202700	E	,Cs-137	2.72E-01	,2.86e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
90761000	E	,Cs-137	7.41E-01	,3.81e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390761100	NE	,Cs-137	3.50E-01	,3.72e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390380900	E	,Cs-137	1.17E-01	,2.26e-02	,05/18/93,	Bream	,L3R Creek River Mouth
9390381500	NE	,Cs-137	9.40E-02	,1.75e-02	,05/18/93,	Bream	,L3R Creek River Mouth
9390624600	E	,Cs-137	7.86E-01	,5.32e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390624700	NE	,Cs-137	5.46E-01	,4.19e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390625200	E	,Cs-137	3.91E-01	,3.59e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390625300	NE	,Cs-137	3.29E-01	,3.73e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390409500	E	,Cs-137	2.61E-01	,2.68e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409600	E	,Cs-137	1.43E-01	,2.34e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409700	NE	,Cs-137	1.73E-01	,2.42e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435800	E	,Cs-137	2.01E-01	,2.61e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9390435900	NE	,Cs-137	1.61E-01	,1.90e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
9590098900	E	,Cs-137	4.45E-01	,1.80e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9590099000	NE	,Cs-137	2.39E-01	,2.90e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9490201100	E	,Cs-137	7.56E-01	,5.08e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490201300	NE	,Cs-137	4.33E-01	,3.92e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490213200	E	,Cs-137	1.48E-01	,2.97e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490213300	NE	,Cs-137	1.08E-01	,3.31e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490307200	E	,Cs-137	7.98E-01	,4.58e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307300	NE	,Cs-137	4.41E-01	,3.52e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307700	E	,Cs-137	2.73E-01	,3.40e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490343900	NE	,Cs-137	1.44E-01	,2.44e-02	,03/30/94,	Bream	,L3R Creek River Mouth
490198600	E	,Cs-137	1.33E+00	,4.83e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
490198700	NE	,Cs-137	6.67E-01	,3.91e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198800	E	,Cs-137	2.44E-01	,2.29e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199200	E	,Cs-137	5.91E-01	,3.76e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199300	NE	,Cs-137	3.16E-01	,3.37e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490200900	NE	,Cs-137	9.35E-02	,1.87e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
			AVG	MAX	AVG of MAX		
U3R Creek Mouth Cs-137			5.96E-02	7.93E-02		pCi/g	
Beaver Dam Creek Mouth Cs-137			2.81E-01	9.37E-01		pCi/g	
Four Mile Creek Mouth Cs-137			1.40E-01	3.54E-01		pCi/g	
Steel Creek River Mouth Cs-137			4.81E-01	2.12E+00		pCi/g	
L3R Creek River Mouth Cs-137			3.90E-01	1.33E+00		pCi/g	
TOTAL ADJACENT Cs-137			3.44E-01	2.12E+00	9.64E-01	pCi/g	
9390448500	NE	,Sr-90	3.18E-01	,6.62e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390448900	NE	,Sr-90	2.77E-01	,6.18e-02	,06/14/93,	Catfish	,U3R Creek River Mouth
9390563100	E	,Sr-90	3.55E-03	,3.74e-03	,05/14/93,	Catfish	,U3R Creek River Mouth
9390563200	NE	,Sr-90	1.80E-02	,1.99e-02	,05/14/93,	Catfish	,U3R Creek River Mouth
9490299500	E	,Sr-90	1.10E-02	,3.54e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299600	NE	,Sr-90	1.31E-01	,4.81e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299700	E	,Sr-90	1.86E-02	,7.84e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490299800	NE	,Sr-90	1.89E-01	,4.44e-02	,04/20/94,	Catfish	,U3R Creek River Mouth
9490300100	E	,Sr-90	3.86E-03	,2.86e-03	,04/20/94,	Catfish	,U3R Creek River Mouth
9490300200	NE	,Sr-90	1.63E-01	,4.33e-02	,04/20/94,	Catfish	,U3R Creek River Mouth

Cs-137 & Sr-90 ADJACENT

90044900	E	,Sr-90	3.89E-02	,8.72e-03	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
90045000	NE	,Sr-90	9.77E-01	,9.84e-02	,05/18/93,	Bream	,Beaver Dam Creek River Mouth
90503800	E	,Sr-90	2.09E-04	5.04E-03	06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390503900	NE	,Sr-90	6.95E-01	,2.29e-01	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390504000	E	,Sr-90	4.48E-03	,3.65e-03	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9390504100	NE	,Sr-90	6.12E-01	,2.33e-01	,06/17/93,	Catfish	,Beaver Dam Creek River Mouth
9490041500	E	,Sr-90	1.48E-03	6.45E-03	05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9490041700	NE	,Sr-90	1.31E-01	,4.94e-02	,05/25/93,	Catfish	,Beaver Dam Creek River Mouth
9590099100	E	,Sr-90	7.21E-03	,4.65e-03	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9590099200	NE	,Sr-90	1.63E-01	,4.15e-02	,09/20/94,	Bass	,Beaver Dam Creek River Mouth
9490213400	E	,Sr-90	1.26E-02	,3.55e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490213500	NE	,Sr-90	1.58E-01	,3.16e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214000	E	,Sr-90	3.94E-02	,9.43e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214100	NE	,Sr-90	3.07E-01	,4.17e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214200	E	,Sr-90	9.53E-03	,3.49e-03	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9490214300	NE	,Sr-90	1.07E-01	,2.94e-02	,03/30/94,	Catfish	,Beaver Dam Creek River Mouth
9390541100	E	,Sr-90	1.42E-02	,7.45e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541300	NE	,Sr-90	1.45E+00	,3.26e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541400	E	,Sr-90	6.98E-03	,7.20e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541600	NE	,Sr-90	1.82E+00	,3.35e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541700	E	,Sr-90	1.31E-02	,7.33e-03	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390541800	NE	,Sr-90	1.05E+00	,3.85e-01	,05/06/93,	Bream	,Four Mile Creek River Mouth
9390548100	E	,Sr-90	2.97E-03	,5.47e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548200	NE	,Sr-90	2.67E-01	,7.05e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548400	E	,Sr-90	7.05E-03	,4.09e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9390548500	NE	,Sr-90	4.88E-02	,5.81e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
390548700	E	,Sr-90	3.87E-03	,3.85e-03	,05/06/93,	Catfish	,Four Mile Creek River Mouth
390548800	NE	,Sr-90	3.02E-01	,6.51e-02	,05/06/93,	Catfish	,Four Mile Creek River Mouth
9490308200	E	,Sr-90	4.11E-02	,8.06e-03	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490308300	NE	,Sr-90	1.08E+00	,1.28e-01	,05/02/94,	Bream	,Four Mile Creek River Mouth
9490309300	E	,Sr-90	8.62E-03	,5.38e-03	,03/28/94,	Bream	,Four Mile Creek River Mouth
9490309500	NE	,Sr-90	2.27E-01	,7.46e-02	,03/28/94,	Bream	,Four Mile Creek River Mouth
9490309800	E	,Sr-90	7.53E-02	,1.09e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490309900	NE	,Sr-90	5.22E-01	,7.35e-02	,04/13/94,	Bream	,Four Mile Creek River Mouth
9490203300	E	,Sr-90	6.25E-02	,7.11e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203400	NE	,Sr-90	4.31E-01	,5.05e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203500	E	,Sr-90	1.87E-02	,4.39e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203600	NE	,Sr-90	1.39E+00	,1.29e-01	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203700	E	,Sr-90	1.23E-02	,4.09e-03	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9490203800	NE	,Sr-90	1.29E+00	,9.23e-02	,03/28/94,	Catfish	,Four Mile Creek River Mouth
9390603800	E	Sr-90	2.10E-02	,5.50e-03	,09/09/93,	Bass	,Steel Creek River Mouth
9390603900	NE	,Sr-90	1.98E-01	,4.22e-02	,09/09/93	Bass	,Steel Creek River Mouth
9390604300	E	,Sr-90	2.72E-02	,9.86e-03	,09/09/93,	Bass	,Steel Creek River Mouth
9390604400	NE	,Sr-90	7.01E-02	,2.65e-02	,09/09/93,	Bass	,Steel Creek River Mouth
9390381000	E	,Sr-90	1.08E-02	,1.06e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390382000	NE	,Sr-90	1.91E-01	,3.44e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9390385200	NE	,Sr-90	1.06E-01	,2.93e-02	,05/12/93,	Bream	,Steel Creek River Mouth
9490034700	E	,Sr-90	5.15E-03	,1.67e-02	,05/10/93,	Bream	,Steel Creek River Mouth
9490034800	NE	,Sr-90	8.94E-02	,2.70e-02	,05/10/93,	Bream	,Steel Creek River Mouth
9390389700	E	,Sr-90	7.04E-03	,5.15e-03	,05/10/93,	Catfish	,Steel Creek River Mouth
9390389800	NE	,Sr-90	7.49E-02	,2.45e-02	,05/10/93,	Catfish	,Steel Creek River Mouth

Cs-137 & Sr-90 ADJACENT

90389900	E	,Sr-90	2.34E-03	,5.28e-03	,05/10/93,	Catfish	,Steel Creek River Mouth
90390100	NE	,Sr-90	7.52E-02	,2.62e-02	,05/10/93,	Catfish	,Steel Creek River Mouth
904398800	NE	,Sr-90	9.92E-01	,3.06e-01	,05/10/93,	Catfish	,Steel Creek River Mouth
9590098300	E	,Sr-90	1.20E-03	,4.25e-03	,09/20/94,	Bass	,Steel Creek River Mouth
9590098400	NE	,Sr-90	2.14E-01	,4.20e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9590098600	NE	,Sr-90	1.92E-01	,4.06e-02	,09/20/94,	Bass	,Steel Creek River Mouth
9490306600	E	,Sr-90	1.66E-02	,6.50e-03	,03/28/94,	Bream	,Steel Creek River Mouth
9490306700	NE	,Sr-90	1.99E-01	,7.25e-02	,03/28/94,	Bream	,Steel Creek River Mouth
9490201400	E	,Sr-90	2.04E-02	,4.38e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201500	NE	,Sr-90	1.50E-01	,3.46e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201600	E	,Sr-90	5.83E-03	,3.29e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490201700	NE	,Sr-90	9.28E-02	,3.95e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9490202700	E	,Sr-90	2.53E-02	,6.33e-03	,03/28/94,	Catfish	,Steel Creek River Mouth
9490202800	NE	,Sr-90	3.12E-01	,8.17e-02	,03/28/94,	Catfish	,Steel Creek River Mouth
9390761000	E	,Sr-90	4.99E-03	,4.20e-03	,09/16/93,	Bass	,L3R Creek River Mouth
9390761100	NE	,Sr-90	2.13E-01	,5.94e-02	,09/16/93,	Bass	,L3R Creek River Mouth
9390380900	E	,Sr-90	3.34E-03	,5.25e-03	,05/18/93,	Bream	,L3R Creek River Mouth
9390381500	NE	,Sr-90	9.87E-02	,2.76e-02	,05/18/93,	Bream	,L3R Creek River Mouth
9390624600	E	,Sr-90	7.71E-03	,4.75e-03	,05/14/93,	Bream	,L3R Creek River Mouth
9390624700	NE	,Sr-90	1.99E-01	,5.43e-02	,05/14/93,	Bream	,L3R Creek River Mouth
9390625200	E	,Sr-90	4.45E-02	,2.24e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390625300	NE	,Sr-90	3.19E-01	,5.78e-02	,09/16/93,	Bream	,L3R Creek River Mouth
9390409500	E	,Sr-90	8.16E-03	,5.02e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409600	E	,Sr-90	4.43E-03	,5.32e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
9390409700	NE	,Sr-90	3.48E-01	,6.19e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
190435800	E	,Sr-90	4.64E-03	,5.77e-03	,05/14/93,	Catfish	,L3R Creek River Mouth
90435900	NE	,Sr-90	4.18E-02	,5.34e-02	,05/14/93,	Catfish	,L3R Creek River Mouth
590098900	E	,Sr-90	1.31E-03	,2.83e-03	,09/20/94,	Bass	,L3R Creek River Mouth
9590099000	NE	,Sr-90	1.02E-01	,3.49e-02	,09/20/94,	Bass	,L3R Creek River Mouth
9490201100	E	,Sr-90	2.25E-01	,1.73e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490201300	NE	,Sr-90	1.50E-01	,3.42e-02	,03/28/94,	Bream	,L3R Creek River Mouth
9490213200	E	,Sr-90	3.84E-02	,8.61e-03	,03/30/94,	Bream	,L3R Creek River Mouth
9490213300	NE	,Sr-90	1.13E-01	,3.23e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490307200	E	,Sr-90	3.47E-02	,8.49e-03	,04/18/94,	Bream	,L3R Creek River Mouth
9490307300	NE	,Sr-90	2.63E-01	,7.85e-02	,04/18/94,	Bream	,L3R Creek River Mouth
9490307700	E	,Sr-90	1.60E-02	,5.77e-03	,03/30/94,	Bream	,L3R Creek River Mouth
9490343900	NE	,Sr-90	1.14E-01	,5.98e-02	,03/30/94,	Bream	,L3R Creek River Mouth
9490198600	E	,Sr-90	4.52E-03	,3.52e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198700	NE	,Sr-90	2.26E-01	,4.97e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490198800	E	,Sr-90	2.40E-02	,4.40e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199200	E	,Sr-90	5.15E-03	,3.50e-03	,03/28/94,	Catfish	,L3R Creek River Mouth
9490199300	NE	,Sr-90	2.19E-01	,7.22e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
9490200900	NE	,Sr-90	1.03E-01	,4.28e-02	,03/28/94,	Catfish	,L3R Creek River Mouth
			AVG	MAX	AVG of MAX		
U3R Creek Mouth Sr-90			1.13E-01	3.18E-01		pCi/g	
Beaver Dam Creek Mouth Sr-90			2.04E-01	9.77E-01		pCi/g	
Four Mile Creek Mouth Sr-90			4.23E-01	1.82E+00		pCi/g	
Stee Creek River Mouth Sr-90			1.24E-01	9.92E-01		pCi/g	
L3R Creek River Mouth Sr-90			1.0[illegible]E-01	3.48E-01		pCi/g	

Appendix B

Cs-137 & Sr-90 ADJACENT

TOTAL ADJACENT Sr-90	1.98E-01	1.82E+00	8.91E-01	pCi/g			

Cs-137 &Sr-90 DOWNSTREAM

	E= Edible	Nuclide	Result	Uncertainty	Date	Fish	
	NE=Nonedible		wet pci/g				
Sample #			*composite				
(DOWNSTREAM OF SRS)							
9390624900	NE	,Cs-137	5.67E-02	,1.88e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390621600	E	,Cs-137	8.60E-02	,2.43e-02	,05/25/93,	Bream	,Hwy-301 Bridge Area
9390429800	E	,Cs-137	7.18E-02	,1.48e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390429900	NE	,Cs-137	9.08E-02	,2.42e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390435600	E	,Cs-137	1.49E-01	,2.01e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9390435700	NE	,Cs-137	4.27E-02	,1.40e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9590087700	NE	,Cs-137	3.73E-02	,1.24e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590087800	E	,Cs-137	7.01E-02	,1.72e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590088000	NE	,Cs-137	4.41E-02	,9.41e-03	,09/22/94,	Bass	,Hwy-301 Bridge Area
9490300500	E	,Cs-137	1.11E-01	,2.67e-02	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490306800	E	,Cs-137	4.44E-02	,1.36e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490307100	NE	,Cs-137	6.20E-02	,2.10e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490300300	E	,Cs-137	5.52E-02	,2.05e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300700	E	,Cs-137	7.07E-02	,2.42e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9390737900	E	,Cs-137	8.63E-02	,1.93e-02	,11/10/93,	Bass	,Stokes Bluff Landing
9390738200	E	,Cs-137	8.58E-02	,2.29e-02	,11/10/93,	Bass	,Stokes Bluff Landing
9390738300	E	,Cs-137	7.97E-02	,2.23e-02	,11/10/93,	Bass	,Stokes Bluff Landing
9490034500	E	,Cs-137	4.08E-02	,1.22e-02	,07/15/93,	Bream	,Stokes Bluff Landing
9390476600	E	,Cs-137	omit	,1.59e-02	,07/08/93,	Catfish	,Stokes Bluff Landing
9390476700	E	,Cs-137	7.30E-02	,1.93e-02	,07/08/93,	Catfish	,Stokes Bluff Landing
9490306500	E	,Cs-137	7.98E-02	,1.99e-02	,05/09/94,	Catfish	,Stokes Bluff Landing
9490409200	E	,Cs-137	1.22E-01	,2.58e-02	,05/12/94,	Catfish	,Stokes Bluff Landing
9490409300	E	,Cs-137	6.24E-02	,1.78e-02	,05/16/94,	Catfish	,Stokes Bluff Landing
9390794300	E	,Cs-137	1.33E-01	,2.31e-02	,10/19/93,	Bass	,Hwy-17A Bridge Are
9390794400	E	,Cs-137	7.59E-02	,2.07e-02	,10/19/93,	Bass	,Hwy-17A Bridge Are
9390761300	E	,Cs-137	5.61E-01	,3.12e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Are
9390761400	E	,Cs-137	1.22E-01	,2.16e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Are
9390761500	E	,Cs-137	7.73E-02	,2.07e-02	,10/19/93,	Mullet	,Hwy-17A Bridge Are
9490302200	E	,Cs-137	8.93E-02	,1.47e-02	,05/11/94,	Bass	,Hwy-17A Bridge Are
9490302300	E	,Cs-137	1.07E-01	,2.10e-02	,05/11/94,	Bass	,Hwy-17A Bridge Are
			AVG	MAX	AVG of MAX		
HWY 301 BRIDGE Cs-137			7.08E-02	1.49E-01		pCi/g	
STOKES BLUFF LDG. Cs-137			7.87E-02	1.22E-01		pCi/g	
HWY-17A BRIDGE Cs-137			1.67E-01	5.61E-01		pCi/g	
TOTAL DOWNSTREAM Cs-137			9.81E-02	5.61E-01	2.77E-01	pCi/g	
9390620400	E	,Sr-90	8.50E-03	,4.41e-03	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390620500	NE	,Sr-90	7.94E-02	,2.61e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390624800	E	,Sr-90	1.22E-03	3.21E-03	9/16/93	Bass	,Hwy-301 Bridge Area
9390624900	NE	,Sr-90	9.50E-02	,2.87e-02	,09/16/93,	Bass	,Hwy-301 Bridge Area
9390613000	E	,Sr-90	1.48E-03	,3.37e-03	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390613100	NE	,Sr-90	1.25E-01	,3.09e-02	,09/16/93,	Bream	,Hwy-301 Bridge Area
9390613200	E	,Sr-90	5.12E-03	,4.63e-03	,09/16/93,	Bream	,Hwy-301 Bridge Area

Cs-137 &Sr-90 DOWNSTREAM

90613300	NE	,Sr-90	1.56E-01	,3.55e-02	,09/16/93,	Bream	,Hwy-301 Bridge Area
90621600	E	,Sr-90	9.29E-03	,3.75e-03	,05/25/93,	Bream	,Hwy-301 Bridge Area
90621700	NE	,Sr-90	1.50E-01	,3.35e-02	,05/25/93,	Bream	,Hwy-301 Bridge Area
9390392300	E	,Sr-90	4.30E-03	5.19E-03	06/21/93,	Catfish	,Hwy-301 Bridge Area
9390392400	NE	,Sr-90	9.84E-02	,2.70e-02	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9390429800	E	,Sr-90	6.63E-03	,5.28e-03	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390429900	NE	,Sr-90	2.96E-01	,6.66e-02	,06/24/93,	Catfish	,Hwy-301 Bridge Area
9390435700	NE	,Sr-90	2.55E-01	,1.40e-01	,06/21/93,	Catfish	,Hwy-301 Bridge Area
9590087700	NE	,Sr-90	1.52E-01	,3.45e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590087800	E	,Sr-90	4.13E-03	,3.97e-03	,09/22/94,	Bass	,Hwy-301 Bridge Area
9590088000	NE	,Sr-90	1.37E-01	,3.38e-02	,09/22/94,	Bass	,Hwy-301 Bridge Area
9490300500	E	,Sr-90	3.31E-03	,3.55e-03	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490300600	NE	,Sr-90	2.62E-01	,4.57e-02	,04/25/94,	Bream	,Hwy-301 Bridge Area
9490302400	E	,Sr-90	1.44E-02	,6.37e-03	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302500	NE	,Sr-90	2.38E-01	,4.70e-02	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302600	E	,Sr-90	1.14E-02	,9.75e-03	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490302700	NE	,Sr-90	2.07E-01	,4.15e-02	,05/02/94,	Bream	,Hwy-301 Bridge Area
9490306800	E	,Sr-90	1.72E-02	,5.75e-03	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490307100	NE	,Sr-90	4.33E-01	,8.28e-02	,04/15/94,	Bream	,Hwy-301 Bridge Area
9490300300	E	,Sr-90	6.51E-05	,3.89e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9460300400	NE	,Sr-90	2.02E-01	,4.40e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300700	E	,Sr-90	1.31E-02	,4.51e-03	,04/25/94,	Catfish	,Hwy-301 Bridge Area
9490300800	NE	,Sr-90	1.78E-01	,4.42e-02	,04/25/94,	Catfish	,Hwy-301 Bridge Area
			AVG	MAX	AVG of MAX		
HWY 301 BRIDGE Sr-90			1.05E-01	4.33E-01		pCi/g	
TOTAL DOWNSTREAM Sr-90			1.05E-01	4.33E-01	4.33E-01	pCi/g	

APPENDIX C

Risk calculations based on the average of the maximum concentrations of Cs-137 and Sr-90 in Savannah River fish upstream, adjacent to, and downstream of the Savannah River Site
and
Consumption limits of Savannah River fish protective of the 1.0×10^{-5} risk level

(1993 and 1994 data)

AVERAGE OF MAX RISK (93-94data)

137 CONCENTRATION (pCi/g)				LOCATION
G	MAX	AVG of MAX		
.51E-01	4.21E-01			Augusta Lock&Dam
2.51E-01	4.21E-01	4.21E-01		TOTAL UPSTREAM
6.96E-02	7.93E-02			U3Runs Creek Mouth
2.81E-01	8.37E-01			Beaver Dam Creek Mouth
1.40E-01	3.54E-01			Four Mile Creek Mouth
4.81E-01	2.12E+00			Steel Creek Mouth
3.90E-01	1.33E+00			L3Runs Creek Mouth
3.44E-01	2.12E+00	9.64E-01		TOTAL ADJACENT
7.08E-02	1.49E-01			Hwy 301 Bridge
7.87E-02	1.22E-01			Stokes Bluff Landing
1.67E-01	5.61E-01			Hwy-17A Bridge
9.61E-02	5.61E-01	2.77E-01		TOTAL DOWNSTREAM
Cs-137 RISK =(concentration in pCi/kg)(exposure duration in yrs)(ingestion rate in kg/yr)(slope factor				
19kg/yr@30yrs		50kg/yr@30yrs		LOCATION
7.58E-06		2E-05		TOTAL UPSTREAM
1.74E-05		4.57E-05		TOTAL ADJACENT
4.99E-06		1.31E-05		TOTAL DOWNSTREAM
Sr-90 CONCENTRATION (pCi/g)				LOCATION
AVG	MAX	AVG of MAX		
1.37E-01	6.99E-01			Augusta Lock&Dam
1.37E-01	6.99E-01	6.99E-01		TOTAL UPSTREAM
1.13E-01	3.18E-01			U3Runs Creek Mouth
2.04E-01	9.77E-01			Beaver Dam Creek Mouth
4.23E-01	1.82E+00			Four Mile Creek Mouth
1.24E-01	8.92E-01			Steel Creek Mouth
1.01E-01	3.48E-01			L3Runs Creek Mouth
1.98E-01	1.82E+00	8.91E-01		TOTAL ADJACENT
1.05E-01	4.33E-01			Hwy 301 Bridge
1.05E-01	4.33E-01	4.33E-01		TOTAL DOWNSTREAM
Sr-90 RISK =(concentration in pCi/kg)(exposure duration in yrs)(ingestion rate in kg/yr)(slope factor)				
19kg/yr@30yrs		50kg/yr@30yrs		LOCATION
1.63E-05		4.29E-05		TOTAL UPSTREAM
2.08E-05		5.47E-05		TOTAL ADJACENT

Appendix C

AVERAGE OF MAX RISK (93-94data)

1.01E-05		2.66E-05		TOTAL DOWNSTREAM				
Cs-137 + Sr-90 COMBINED AVG OF MAX RISK								
19kg/yr@30yrs		50kg/yr@30yrs		LOCATION				
2.39E-05		6.28E-05		TOTAL UPSTREAM				
3.81E-05		1.00E-04		TOTAL ADJACENT				
1.51E-05		3.97E-05		TOTAL DOWNSTREAM				
Consumption limit (kg/yr) to be protective (Cs-137)								
		1E-6 risk	1E-5 risk	1E-4 risk				
UPSTREAM		2.51E+00	2.51E+01	2.51E+02				
ADJACENT		1.09E+00	1.09E+01	1.09E+02				
DOWNSTREAM		3.81E+00	3.81E+01	3.81E+02				
Consumption limit (kg/yr) to be protective (Sr-90)								
		1E-6 risk	1E-5 risk	1E-4 risk				
UPSTREAM		1.51E+00	1.51E+01	1.51E+02				
ADJACENT		1.18E+00	1.18E+01	1.18E+02				
DOWNSTREAM		2.44E+00	2.44E+01	2.44E+02				
Consumption limit (pounds per month) to be protective (Cs-137)								
		1E-6 risk	1E-5 risk	1E-4 risk				
UPSTREAM		0.459358	4.593577	45.93577				
ADJACENT		0.200612	2.006116	20.06116				
DOWNSTREAM		0.698157	6.981574	69.81574				
Consumption limit (pounds per month) to be protective (Sr-90)								
		1E-6 risk	1E-5 risk	1E-4 risk				
UPSTREAM		0.276666	2.766661	27.66661				
ADJACENT		0.217048	2.170478	21.70478				
DOWNSTREAM		0.446627	4.466272	44.66272				

GENERAL Q & A FISH ADVISORY INFORMATION

What is a radioactive element?

A radioactive element is an element whose nucleus is unstable and tries to become stable by way of nuclear decay. The term nuclide, is applied to all atomic forms of the element while the term "radioisotope" is the most common term used to describe various unstable forms of a single element. For example, cesium has several different isotopes including Cesium 134 and Cesium 137. Each isotope has the same chemical properties as stable cesium, except they have a different number of neutrons in their atomic structure.

Are there different forms of radiation?

There are three different forms of radiation: alpha and beta particle and gamma rays: Alpha and beta particles can cause damage only when they enter the body. Due to their size, both particles have little potential to cause external radiation damage. A gamma ray is similar to an x-ray and has the ability to penetrate the skin and enter the body from the outside. A gamma ray can also cause damage if the radionuclide is ingested or inhaled into the body.

How do radioactive isotopes become contaminants in fish? Can they build up in humans?

Some radioactive isotopes occur naturally in the environment. However, there are also a number of other isotopes that are released by the activities of man. Some radioisotopes are released by nuclear fallout, some are released through accidental releases or runoff from various processes associated with nuclear facilities. Some radioisotopes are used in medicine and can be released at low levels from the body. Low levels of radioactive isotopes in water can build up in fish over time. Older fish have higher levels of radioactive isotopes in their bodies.

Humans can eliminate some of the radioactive isotopes through body wastes, but some of the radioactive isotopes will remain in the body for long time. For example, Strontium-90, which is a radioactive isotope, acts the same as calcium in the body and since bones need calcium to remain strong, Strontium-90 will go to the bones just like calcium.

Can radiation affect my health?

Radioactive material can build up in the body, but your body can slowly get rid of some of it through body wastes. But if you are eating more than your body can get rid of, it will build up in your system and can cause long-term effects. As stated earlier, alpha and beta particles have the potential to harm the body after they have entered the body. Since gamma rays are more penetrating, they have the potential to produce harmful effects regardless if they are inside or outside of the body.

At unsafe doses, some of the long-term effects of radiation exposure include genetic abnormalities in the chromosome or genetic mutations in cells of your body. Long term exposure to excess levels of radiation can also cause cancer to most organs and systems of the body such as the bones or thyroid.

Can I get tested for radiation exposure?

Currently there are not any methods which allow us to detect long term exposure to radiation.

One of the major problems in detecting the effects of radiation exposure is due to the large amount of uncertainty associated with the chronic effects of low doses of radiation. This uncertainty is in large part due to the time lag (years) present between exposure to low dose radiation and its potential effect.

How do radioactive materials enter the environment?

Radioactive material can be released through the natural weathering of the earth's crust by wind and water. Radioactive materials can be found throughout the environment.

Radioactive material can get into air through natural means from deposits of ore, volcanic dust, or through activities carried out by man such as nuclear weapons testing and the use of nuclear power. Air, water, and soil all contain radioactive material from both natural sources and human activities.

Radioactive material can get into lakes, rivers or soil from rocks containing radioactive material, from accidental releases of radioactive material, or nuclear weapons, or nuclear power plants.

Is the Savannah River Site a potential source for the radioactive material found in the fish from the Savannah River?

Yes. The information that has been collected so far on fish from the Savannah River suggests that one of the sources of the radioisotopes is past releases from the Savannah River Site (SRS). These radioisotope releases occurred due to historical methods for the disposal of radioactive material at the site. These methods are no longer used at SRS to dispose of radioactive material and discharge to streams have been reduced.

In addition, some of the radioisotopes found in the river may be due to nuclear weapons testing fallout and/or natural sources.

Why is the risk from eating fish apparent now but was not evident earlier:

There are different groups of scientists who have been studying and working with things in the environment that may be threats to human health. One group of scientists has focused on radiation and they have tried to answer the question "What dose (exposure) to radiation can humans safely tolerate without affecting their health?" The standards they agreed upon were based on the dosage (exposure) that would cause death, usually from cancer. These standards have been used over the years to monitor work with radioactive materials, not only at SRS and similar facilities, but also with persons who operate x-ray machines and other people who may come in contact with radiation.

A different group of scientists have focused their work on the effects of toxis materials in the environment and their potential effect on human health. These scientists have worked with toxic materials that may be released from operating industries or found at waste sites of disposal or accidental spills. The standards they set for human safety are based on the risk of persons getting sick (for example, cancer) if they come in contact with these materials over time. They have been responsible for establishing the rules for cleaning up contaminated sites to keep them safe from endangering the public.

The methods employed by these scientists can result in different estimates of the risks associated with exposure to radioisotopes in the fish. Based on the method being used here, we believe the risk needs to be communicated so that people who routinely eat fish from the Savannah River can make informed decisions about which fish to eat and how much.

Is the fish contamination from radioactive material due to current or recent releases from SRS?

No. If a current or recent release of radioactive material had occurred at SRS, SCDHEC and DOE would have made sure that the public would have been notified.

What is being done to correct the problem?

There are on-going investigations and remedial actions occurring at SRS which are being coordinated through a Federal Facilities Agreement (FFA). DOE, EPA, and SCDHEC are the three parties involved in the FFA and this Agreement allows for federal and state oversight of projects to investigate and clean up contaminated sites at SRS.

Have all fish in South Carolina been tested for radioactive isotopes contamination?

No. Fish have not been tested in all the state's waterbodies and not all species of fish have been tested. Fish in waterbodies near other nuclear facilities located in South Carolina have been tested for radioactive isotopes. The concentrations of radioactive isotopes found in fish from these waterbodies are lower than the amount of radioactive isotopes present in fish from the Savannah River.

What fish in the Savannah River have been found to be contaminated with radioactive isotopes?

The Savannah River fish that have been sampled and found to contain radioactive isotopes are sucker, bowfin, shad, largemouth bass, striped bass, bream, carp, catfish, and mullet.

Are there studies currently being done to determine if there are higher amounts of cancer in the Savannah River area around the Savannah River Plant?

The Medical University of South Carolina and SCDHEC are working on a joint project called the "Savannah River Regional Health Information System". The purpose of this system is to collect data concerning cancer in this area to determine any trends in the occurrence of cancer among local residents near the site. Additional information about this information about this system can be obtained by calling the Cancer Cluster Hotline at 800-224-1674. They can also respond to concerns about cancer occurrences in your area.

Why is DHEC basing its review on portions of fish some people consider to be non-edible?

DHEC looked at radioisotope contamination in edible and non-edible portions of fish because there may be some individuals who eat sections of the fish which other individuals would consider to be non-edible. For example, after a fish has been fried, some individuals will eat the fried fins.

Is the water from the Savannah River safe to drink?

The water that is drawn from the Savannah River for drinking water purposes is safe to drink. The water is monitored for different contaminants, such as radioactive materials, at the Beaufort/Jasper Water Plant. All water that has been tested from the Savannah River has been found to be safe to drink and daily use.

What about using the water for recreation?

The Savannah River still can be enjoyed for camping, swimming, boating, and skiing. The water itself is not showing high levels of radioactive material and it is safe to handle fish caught in this river. You can continue fishing the Savannah River as long as you pay attention to consumption guidelines which have been published.

Will DHEC test fish from waterbodies near other nuclear facilities in the state?

DHEC has analyzed the concentration of radioactive material in fish from the waterbodies near nuclear facilities and the radioisotope concentrations in these fish are lower than the radioisotope concentration found in fish caught in the Savannah River. The sampling and testing of fish near all nuclear facilities will continue.

Does the presence of radioactive material in the Savannah River affect dredge spoils from the river which are being used for land fill material in the Beaufort area?

No. The levels of radioactive material in the dredge sediments are very low and does not affect the use of this material for land fill.

Will DHEC do more testing?

Yes, DHEC will continue to monitor radioactive material in the Savannah River. The advisory will remain in effect until our fish testing shows that the concentration of radioactive material in the fish has declined to an acceptable level. We will inform the public of new information as it becomes available.

If more testing is to be done, will the potential effects on saltwater species (e.g. oysters, shrimp) be examined?

As part of the continued monitoring of radioactive material in fish, DHEC will be expanding their testing to sample species of fish, oysters, and shrimp from saltwater areas of the Savannah River. In addition, more samples of sediments from the Savannah

River will be collected and analyzed adjacent to and downstream of SRS.

Were there any trends in the data which showed if the levels of the radioisotopes are decreasing or that the concentrations of the radioisotopes were elevated at certain locations along the Savannah River?

Currently, only two years of fish caught in the Savannah River have been analyzed using the current methods employed by DOE, SCDHEC, and GDNR and there is not enough information available to determine any trends. Concentrations of cesium-137 and strontium-90 are higher adjacent to and downstream of SRS than in locations upstream of SRS. These concentrations are probably due to past radioactive material releases at SRS.

How far do fish migrate? Do they swim upstream?

All fish species can and do swim upstream but all species do not migrate. Individuals of some species like bream and largemouth bass remain in relatively small areas their entire lives and don't move around a lot. The Savannah River does contain some species (stripped bass, sturgeon, white bass, some catfish, etc.) that are known to move or migrate great distances in relatively short time-frames. In fact, striped bass may migrate from off-shore waters to Thurmond Dam in less than a couple of days then return to coastal waters.

Cesium 137

Cesium is an alkali metal which occurs naturally in the earth's crust. Cesium-133 is a naturally-occurring isotope while other isotopes of cesium are man made. The most abundant man-made isotope of cesium is Cesium-137, produced as a byproduct of fission reactions. Cesium-137 has been released to the atmosphere through weapons testing and to terrestrial and aquatic systems through accidental releases. Cesium is one of the most important radioisotopes to consider at SRS because it is a primary radioisotope released at SRS, from past operating processes. The half life of Cesium-137 is 30 years.

Fate and Transport

Cesium-137 is removed from the atmosphere because of its tendency to attach to to surface soils, surface waters, and vegetation and plants. In surface soils and in surface waters and groundwaters, Cesium-137 is not carried in the water column of surface waters since it in tends to attach to particles of soil/sediments or plants, settling at bottom of these water bodies.

Human Health Effects

Chemically, Cesium-137 can act as an analog of potassium. This means that it will concentrate in the body the same way that potassium would concentrate. Cesium-137 is retained in higher concentrations when the supply of potassium supply is low. The primary danger from Cesium-137 is through the release of beta particles and gamma rays. Beta particles can only partially penetrate the skin; they are of concern due to their ability to once they are ingested or inhaled. Gamma rays have the ability to fully penetrate the skin and cause damage to internal organs whether they are taken into the body through ingestion or inhalation or not. Cesium-137 can be physically cleared from the body through fecal or urinary excretion, and perspiration. Thus, its elimination occurs both through radioactive decay and biological elimination. The effective half-life of Cesium-137 in the body is approximately 73 days.

Ecological Effects

Cesium-137 has a high bioaccumulation factor in fish and does have the potential to bioaccumulate through the food chain. The uptake of a radioisotope by fish or any organism can be quantified by calculating bioconcentration factors. Bioconcentration factors tend to increase with decreasing concentrations of potassium in Savannah River water (Whicker et al., 1990). The aquatic food chain accumulates Cesium-137 not only from water but also from suspended and bottom sediments and from absorption from food. For the Savannah River, Cummins (1994) reported that Cesium-137 had bioconcentration factors that were orders of magnitude higher than those reported in the literature. The relatively high bioconcentration factors of Cesium-137 in fish flesh can be largely explained by the low concentration of potassium in the water.

Strontium 90

Strontium is an alkaline metal that is found naturally in the earth's crust in small quantities, usually associated with calcium or barium minerals. Due to its atomic structure and chemical properties, strontium is similar in nature to magnesium, calcium, barium, and radium. Strontium-90 is the primary isotope of strontium that is of concern at SRS. Strontium-90 has a 28-year half life and is a beta emitter. Strontium-90 has been released to the atmosphere due to weapons testing and has been released at SRS into onsite seepage basins and site streams (Carlton et al., 1992b).

Fate and Transport

Strontium-90 is found in natural systems. It does not strongly attach to suspended particulate matter in water. Thus, it is soluble in soils, in surface water, and groundwaters.

Human Health Effects

Strontium-90 emits beta particles and is only a significant human health risk when it enters the human body through ingestion or inhalation. Because it behaves like calcium, Strontium-90 can be a potential contributor to the skeletal dose of an individual. Strontium-90's effective half-life is approximately 10 years due to its tendency to be incorporated into the bone.

Ecological Effects

Strontium-90 can also be incorporated into the skeletal structure of terrestrial and aquatic organisms in the same manner as it is incorporated into humans. Strontium-90 uptake in most aquatic organisms occurs directly from the water and only about one-tenth of the Strontium-90 is taken up by fish through the food chain. Therefore, trophic or feeding level appears to have little effect on the bioconcentration factor of Strontium-90. Strontium-90 tends to accumulate in the backbone of fish. As with Cesium-137, the Strontium-90 bioconcentration factors calculated for SRS aquatic systems are higher than those reported in the literature (Cummins, 1994).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 25 1991

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

OSWER Directive 9285.6-03

MEMORANDUM

SUBJECT: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"

FROM: Timothy Fields, Jr., Acting Director
Office of Emergency and Remedial Response

Bruce Diamond, Director
Office of Waste Programs Enforcement

TO: Director, Waste Management Division,
Regions I, IV, V, & VII
Director, Emergency & Remedial Response Division,
Region II
Director, Hazardous Waste Management Division,
Regions III, VI, VIII, & IX
Director, Hazardous Waste Division,
Region X

Purpose

The purpose of this directive is to transmit the Interim Final Standard Exposure Factors guidance to be used in the remedial investigation and feasibility study process. This guidance supplements the Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A that was issued October 13, 1989.

Background

An intra-agency workgroup was formed in March 1990 to address concerns regarding inconsistencies among the exposure assumptions used in Superfund risk assessments. Its efforts resulted in a June 29, 1990, draft document entitled "Standard Exposure Assumptions". The draft was circulated to both technical and management staff across EPA Regional Offices and within Headquarters. It was also discussed at two EPA-sponsored meetings in the Washington, D.C., area. The attached interim final document reflects the comments received as well as the results of recent literature reviews addressing inhalation rates, soil ingestion rates and exposure frequency estimates.

Objective

This guidance has been developed to reduce unwarranted variability in the exposure assumptions used by Regional Superfund staff to characterize exposures to human populations in the baseline risk assessment.

Implementation

This guidance supplements the Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual, Part A. Where numerical values differ from those presented in Part A, the factors presented in this guidance supersede those presented in Part A.

This guidance is being distributed as an additional interim final guidance in the RAGS series. As new data become available and the results of EPA-sponsored research projects are finalized, this guidance will be modified accordingly. We strongly urge Regional risk assessors to contact the Toxics Integration Branch of the Office of Emergency and Remedial Response (FTS 475-9486) with any suggestions for further improvement; as we will begin updating and consolidating the series of RAGS documents in 1992.

Attachment

cc: Regional Branch Chiefs
Regional Section Chiefs
Regional Toxics Integration Coordinators
Workgroup Members

OSWER DIRECTIVE: 9285.6-03

March 25, 1991

RISK ASSESSMENT GUIDANCE FOR SUPERFUND

VOLUME I: HUMAN HEALTH EVALUATION MANUAL

SUPPLEMENTAL GUIDANCE

"STANDARD DEFAULT EXPOSURE FACTORS"

INTERIM FINAL

Office of Emergency and Remedial Response
Toxics Integration Branch
U.S. Environmental Protection Agency
Washington, D.C. 20460
(202)475-9486

* * * * NOTICE * * * *

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Glen Adams, Region IV
Lisa Askari, Office of Solid Waste
Alison Barry, OERR/HSCD
Steve Caldwell, OERR/HSED
David Cooper, OERR/HSCD
Linda Cullen, New Jersey Department of Environmental Protection
Steve Ells, OWPE/CED
Kevin Garrahan, OHEA/EAG
Susan Griffin, OERR/TIB
Gerry Hiatt, Region IX
Russ Kinerson, OHEA/EAG
Jim LaVelle, Region VIII
Mark Mercer, OERR/HSCD
Sue Norton, OHEA/EAG
Andrew Podowski, Region V
John Schaum, OHEA/EAG
Leigh Woodruff, Region X

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1.0 INTRODUCTION

The Risk Assessment Guidance for Superfund (RAGS) has been divided into several parts. Part A, of the Human Health Evaluation Manual (HHEM; U.S. EPA, 1989a), is the guidance for preparing baseline human health risk assessments at Superfund sites. Part B, now in draft form, will provide guidance on calculating risk-based clean-up goals. Part C, still in the early stages of development, will address the risks associated with various remedial actions.

The processes outlined in these guidance manuals are a positive step toward achieving national consistency in evaluating site risks and setting goals for site clean-up. However, the potential for inconsistency across Regions and among sites still remains; both in estimating contaminant concentrations in environmental media and in describing characteristics and behaviors of the exposed populations.

Separate guidance on calculating contaminant concentrations is currently being developed in response to a number of inquiries from both inside and outside the Agency. The best method for calculating the reasonable maximum exposure (RME) concentration for different media has been subject to a variety of interpretations and is considered an important area where further guidance is needed.

This supplemental guidance attempts to reduce unwarranted variability in the exposure assumptions used to characterize potentially exposed populations in the baseline risk assessment. This guidance builds on the technical concepts discussed in HHEM Part A and should be used in conjunction with Part A. However, where exposure factors differ, values presented in this guidance supersede those presented in HHEM Part A.

Inconsistencies among exposure assumptions can arise from different sources: 1) where risk assessors use factors derived from site-specific data; 2) where assessors must use their best professional judgement to choose from a range of factors published in the open literature; and 3) where assessors must make assumptions (and choose values) based on extremely limited data. Part A encourages the use of site-specific data so that risks can be evaluated on a case-by-case basis. This supplemental guidance has been developed to encourage a consistent approach to assessing exposures when there is a lack of site-specific data or consensus on which parameter value to choose, given a range of possibilities. Accordingly, the exposure factors presented in this document are generally considered most appropriate and should be used in baseline risk assessments unless alternate or site-specific values can be clearly justified by supporting data.

Supporting data for many of the parameters presented in this guidance can be found in the Exposure Factors Handbook (EFH; U.S. EPA, 1990). In cases where parameter values are not available in EFH, this guidance adopts well-quantified or widely-accepted data from the open literature. Finally, for factors where there is a great deal of uncertainty, a rationally-derived, conservative estimate is developed and explained. As new data become available, this guidance will be modified to reflect them.

These standard factors are intended to be used for calculating reasonable maximum exposure (RME) estimates for each applicable scenario at a site. Readers are reminded that the goal of RME is to combine upper-bound and mid-range exposure factors in the following equation so that the result represents an exposure scenario that is both protective and reasonable; not the worst possible case:

$$\text{Intake} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

C = Concentration of the chemical in each medium (conservative estimate of the media average contacted over the exposure period)

IR = Intake/Contact Rate (upper-bound value)

EF = Exposure Frequency (upper-bound value)

ED = Exposure Duration (upper-bound value)

BW = Body Weight (average value)

AT = Averaging Time (equal to exposure duration for non-carcinogens and 70 years for carcinogens)

Please note that the Agency is presently evaluating methods for calculating conservative exposure estimates, such as RME, in terms of which parameters should be upper-bound or mid-range values. If warranted, this guidance will be modified accordingly.

1.1 BACKGROUND

An intra-agency workgroup was formed at the Superfund Health Risk Assessment meeting in Albuquerque, New Mexico (February 26 - March 1, 1990)[1]. Its efforts resulted in a June 29, 1990, draft document entitled "Standard Exposure Assumptions". The draft was distributed to Superfund Regional Branch Chiefs, and members of other programs within the Agency, for their review and comment. It was also presented and discussed at two EPA/OERR sponsored meetings. The meetings, facilitated by Clean Sites, Inc., brought members of the "Superfund community" and the Agency together to focus on technical issues in risk assessment.

A final review draft was distributed on December 5, 1990, which reflected earlier comments received as well as the results of more recent literature reviews addressing inhalation rates, soil ingestion rates and exposure frequency estimates (these being areas commented on most frequently).

1.2 PRESENT AND FUTURE LAND USE CONSIDERATIONS

The exposure scenarios, presented in this document, and their corresponding assumptions have been developed within the context of the following land use classifications: residential, commercial/industrial, agricultural or recreational. Unfortunately, it is not always easy to determine actual land use or predict future use: local zoning may not adequately describe land use; and unanticipated or even planned rezoning actions can be difficult to assess. Also, the definition of these zones can differ substantially from region to region. Thus, for the purposes of this document, the following definitions are used:

Residential

Residential exposure scenarios and assumptions should be used whenever there are or may be occupied residences on or adjacent to the site. Under this land use, residents are expected to be in frequent, repeated contact with contaminated media. The contamination may be on the site itself or may have migrated from it. The assumptions in this case account for daily exposure over the long term and generally result in the highest potential exposures and risk.

Commercial/Industrial

Under this type of land use, workers are exposed to contaminants within a commercial area or industrial site. These scenarios apply to those individuals who work on or near the site. Under this land use, workers are expected to be routinely exposed to contaminated media. Exposure may be lower than that under the residential scenarios, because it is generally assumed that exposure is limited to 8 hours a day for 250 days per year.

Agricultural

These scenarios address exposure to people who live on the property (i.e., the farm family) and agricultural workers. Assumptions made for worker exposures under the commercial/industrial land use may not be applicable to agricultural workers due to differences in workday length, seasonal changes in work habits, and whether migrant workers are employed in the affected area. Finally, the farm family scenario should be evaluated only if it is known that such families reside in the area.

Recreational

This land use addresses exposure to people who spend a limited amount of time at or near a site while playing, fishing, hunting, hiking, or engaging in other outdoor activities. This includes what is often described as the "trespasser" or "site visitor" scenario. **Because not all sites provide the same opportunities, recreational scenarios must be developed on a site-specific basis.** Frequently, the community surrounding the site can be an excellent source of information regarding the current and potential recreational use of a site. The RPM/risk assessor is encouraged to consult with local groups to collect this type of information.

In the case of trespassers, current exposures are likely to be higher at inactive sites than at active sites because there is generally little supervision of abandoned facilities. At most active sites, security patrols and normal maintenance of barriers such as fences tend to limit (if not entirely prevent) trespassing. When modeling potential future exposures in the baseline risk assessment, however, existing fences should not be considered a deterrent to future site access.

Recreational exposure should account for hunting and fishing seasons where appropriate, but should not disregard local reports of species taken illegally. Other activities should also be scaled according to the amount of time they could actually occur; for children and teenagers, the length of the school year can provide a helpful limit when evaluating the frequency and duration of certain outdoor exposures.

2.0 RESIDENTIAL

Scenarios for this land use should be evaluated whenever there are homes on or near the site, or when residential development is reasonably expected in the future. In determining the potential for future residential land use, the RPM should consider: historical land use; suitability for residential development; local zoning; and land use trends. Exposure pathways evaluated under this scenario routinely include, but may not be limited to: ingestion of potable water; incidental ingestion of soil and dust; inhalation of contaminated air; and, where appropriate, consumption of home grown produce.

2.1 Ingestion of Potable Water

This pathway assumes that adult residents consume 2 liters of water per day, 350 days per year, for 30 years.

The value of 2 liters per day for drinking water is currently used by the Office of Water in setting drinking water standards. It was originally used by the military to calculate tank truck requirements. In addition, 2 liters happens to be quite close to the 90th percentile for drinking water ingestion (U.S. EPA, 1990), and is comparable to the 8 glasses of water per day historically recommended by health authorities.

The exposure frequency (EF) of 365 days/year for the residential setting used in RAGS Part A has been argued both inside and outside of the Agency as being too conservative for RME estimates. National travel data were reviewed to determine if an accurate number of "days spent at home" could be calculated. Unfortunately, conclusions could not be drawn from the available literature; as it presents data on the duration of trips taken for pleasure, but not the frequency of such trips (OECD, 1989; Goeldner and Duea, 1984; National Travel Survey, 1982-89). However, the Superfund program is committed to moving away from values that represent the "worst possible case." Thus, until better data become available, the common assumption that workers take two weeks of vacation per year can be used to support a value of 15 days per year spent away from home (i.e., 350 days/year spent at home).

In terms of exposure duration (ED), the resident is assumed to live in the same home for 30 years. In the EFH, this value is presented as the 90th-percentile for time spent at one residence. (Please note that in the intake equation, averaging time (AT) for exposure to non-carcinogenic compounds is always equal to ED; whereas, for carcinogens a

70 year AT is still used in order to compare to Agency slope factors typically based on that value).

2.2 Incidental Ingestion of Soil and Dust

The combined soil and dust ingestion rates used in this document were presented in OSWER Directive 9850.4 (U.S. EPA, 1989b), which specifies 200 mg per day for children aged 1 thru 6 (6 years of exposure) and 100 mg per day for others. These factors account for ingestion of both outdoor soil and indoor dust and are believed to represent upper-bound values for soil and dust ingestion (Calabrese, et al., 1989; Calabrese, et al., 1990a,b; Davis, et al., 1990; Van Wijnen, et al., 1990). Presently, there is no widely accepted method for determining the relative contribution of each medium (i.e., soil vs. dust) to these daily totals, and the effect of climatic variations (e.g., snow cover) on these values has yet to be determined. Thus, a constant, year round exposure is assumed (i.e., 350 days/year).

Please note that the equation for calculating a 30-year residential exposure to soil/dust is divided into two parts. First, a six-year exposure duration is evaluated for young children which accounts for the period of highest soil ingestion (200 mg/day) and lowest body weight (15 kg). Second, a 24-year exposure duration is assessed for older children and adults by using a lower soil ingestion rate (100 mg/day) and an adult body weight (70 kg).

2.3 Inhalation of Contaminated Air

In response to a number of comments, the RME inhalation rate for adults of 30 m^3/day (presented in HHEM Part A) was re-evaluated. Activity-specific inhalation rates were combined with time-use/activity level data to derive daily inhalation rate values (see Attachment A). Our evaluation focused on the following population subgroups who would be expected to spend the majority of their time at home: housewives; service and household workers; retired people; and unemployed workers (U.S. EPA, 1985). An inhalation rate of 20 m^3/day was found to represent a reasonable upper-bound value for adults in these groups. This value was derived by combining inhalation rates for indoor and outdoor activities in the residential setting. This rate would be used in conjunction with ambient air levels measured at or downwind of the site. Although sampling data are preferred, procedures described in Hwang and Falco (1986) and Cowherd, et al. (1985) can be used to estimate volatile and dust-bound contaminant concentrations, respectively.

In cases where the residential water supply is contaminated with volatiles, the assessor needs to consider the potential for exposure during household water use (e.g., cooking, laundry, bathing and showering). Using the same time-use/activity level data described above, a total of 15 m^3/day was found to represent a reasonable upper-bound inhalation rate for daily, indoor, residential activities. Methods for modeling volatilization of contaminants in the household (including the shower) are currently being developed by J.B. Andelman and U.S. EPA's Exposure Assessment Group. Assessors should contact the Superfund Health Risk Assessment Technical Support Center for help with site-specific evaluations (FTS-684-7300).

2.4 Consumption of Home Grown Produce

This pathway need not be evaluated for all sites. It may only be relevant for a small number of compounds (e.g., some inorganics and pesticides) and should be evaluated when the assessor has site-specific information to support this as a pathway of concern for the residential setting.

The EFH presents figures for "typical" consumption of fruit (140 g/day) and vegetables (200 g/day) with the "reasonable worst case" proportion of produce that is homegrown as 30 and 40 percent, respectively. This corresponds to values of 42 g/day for consumption of homegrown fruit and 80 g/day for homegrown vegetables. They are derived from data in Pao, et al. (1982) and USDA (1980). EFH also provides data on consumption of specific homegrown fruits and vegetables that may be more appropriate for site-specific evaluations. Although sampling data are much preferred, in their absence plant uptake of certain organic compounds can be estimated using the procedure described in Briggs, et al. (1982). No particular procedure is recommended for quantitatively assessing inorganic uptake at this time; however, the following table developed by Sauerbeck (1988) provides a qualitative guide for assessing heavy metal uptake into a number of plants:

Plant Uptake of Heavy Metals

High	Moderate	Low	Very Low
lettuce	onion	corn	beans
spinach	mustard	cauliflower	peas
carrot	potato	asparagus	melon
endive	radish	celery	tomatoes
cress		berries	fruit
beet and beet leaves			

2.5 Subsistence Fishing

This pathway is not expected to be relevant for most sites. In order to add subsistence fishing as a pathway of concern among the residential scenarios, onsite contamination must have impacted a water body large enough to produce a consistent supply of edible fish, and there must be evidence that area residents regularly fish in this water body (e.g., interviews with local anglers). If these criteria are met, the 95th-percentile for daily fish consumption (132 g/day) from Pao, et al. (1982) should be used to represent the ingestion rate for subsistence fishermen. This value was derived from a 3-day study of people who ate fish, other than canned, dried, or raw. An example of this consumption rate is about four 8-ounce servings per week.
This consumption rate can also be used to evaluate exposures to non-residents who may also use the water body for subsistence fishing. In this case, the exposure estimate would not be added to estimates calculated for other residential pathways, but may be included in the risk assessment as an exposure pathway for a sensitive sub-population.

For further information regarding food chain contamination the assessor is directed to the following documents:

- Methodology for Assessing Health Risks Associated with Indirect Exposures to Combustor Emissions (PB-90-187055). Available through NTIS.

- Development of Risk Assessment Methodology for Land Application and Distribution and Marketing of Municipal Sludge (EPA/600/6-89/001). Available from OHEA/Technical Information at FTS 382-7326.

- Estimating Exposure to 2,3,7,8-TCDD (EPA/600/6-88/005A). Available from OHEA/Technical Information at FTS 382-7326.

3.0 COMMERCIAL/INDUSTRIAL

Occupational scenarios should be evaluated when land use is (or is expected to be) commercial/industrial. In general, these scenarios address a 70-kg adult who is at work 5 days a week for 50 weeks per year (250 days total). The individual is assumed to work 25 years at the same location (95th-percentile; Bureau of Labor Statistics, 1990). This scenario also considers ingestion of potable water, incidental ingestion of soil and dust, and inhalation of contaminated air.

Please note that under mixed-use zoning (e.g., apartments above storefronts), certain pathways described for the residential setting should also be evaluated.

3.1 Ingestion of Potable Water

Until data become available for this pathway, it will be assumed that half of an individual's daily water intake (1 liter out of 2) occurs at work. All water ingested is assumed to come from the contaminated drinking water source (i.e., bottled water is not considered). For site-specific cases where workers are known to consume considerably more water (e.g., those who work outdoors in hot weather or in other high-activity/stress environments), it may be necessary to adjust this figure.

A lower ingestion rate is used in this pathway so that a more reasonable exposure estimate may be made for workers ingesting contaminated water. However, it is important to remember that remedial actions are often based on returning the contaminated aquifer to maximum beneficial use; which generally means achieving levels suitable for residential use.

3.2 Incidental Ingestion of Soil and Dust

In the occupational setting, incidental ingestion of soil and dust is highly dependent on the type of work being performed. Office workers would be expected to contact much less soil and dust than someone engaged in outdoor work such as construction or landscaping. Although no studies were found that specifically measured the amount of soil ingested by workers in the occupational setting, the one study that measured adult soil ingestion included subjects that worked outside of the home (Calabrese, et al., 1990a). Although the study had a limited number of subjects (n=6) and did not associate the findings with any particular activity pattern, it is the only study that did not rely on modeling to estimate adult soil ingestion. Thus, the Calabrese, et al. (1990a) estimate of 50 mg/day is selected as an interim default for adult ingestion of soil and dust in the "typical" workplace. Please be aware that this value may change when the results of ongoing soil ingestion studies sponsored by EPA's Exposure Assessment Group are finalized in 1991.

Attachment B presents modeled rates for adult soil ingestion that should be used to estimate exposures for certain workplace activities where much greater soil contact is anticipated, but with limited exposure frequency and/or duration.

3.3 Inhalation of Contaminated Air

As in the previous discussion regarding inhalation rates for the residential setting, specific time-use/activity level data were used to estimate inhalation rates for various occupational activities. The results indicate that 20 m^3 per 8-hour workday represents a reasonable upper-bound inhalation rate for the occupational setting (see Attachment A). Although analytical data are much preferred, procedures described in Hwang and Falco (1986) and Cowherd, et al. (1985) can be used to estimate volatile and dust-bound contaminant concentrations, respectively.

4.0 AGRICULTURAL

These land use scenarios include potential exposures for farm families living and working on the site, as well as, individuals who may only be employed as farm workers.

4.1 Farm Family Scenario

This scenario should be evaluated only if it is known or suspected that there are farm families in the area. The animal products pathway should not be used for areas zoned residential, because such regulations generally prohibit the keeping of livestock. Farm family members are assumed to have most of the same characteristics as people in the residential setting; the only difference is that consumption of homegrown produce will always be evaluated. Thus, default values for the soil ingestion, drinking water, and inhalation pathways would be the same as those in the residential setting.

4.1.1 Consumption of Homegrown Produce

The values used in evaluating this pathway are the same as those presented in Section 2.4. While it is more likely for farm families to cultivate fruits and vegetables, it is not necessarily true that they would be able to grow a sufficient variety to meet all their dietary needs and tastes. Thus, the consumption rate default values will be 42 g/day and 80 g/day for fruits and vegetables, respectively. Again, EFH presents consumption rates for specific homegrown fruits and vegetables. The assessor is reminded that the plant uptake pathway is not relevant for all contaminants and sampling of fruits and vegetables is highly recommended. However, in the absence of analytical data, plant uptake of organic chemicals can be estimated using the procedure described in Briggs, et al. (1982). No particular procedure is recommended for quantitatively assessing inorganic uptake at this time; however, the table (presented in Section 2.4) developed by Sauerbeck (1988) provides a qualitative guide for assessing heavy metal uptake into a number of plants.

4.1.2 Consumption of Animal Products

Animal products should only be addressed if it is known that local residents produce them for home consumption or are expected to do so in the future. The best way to determine which items are produced is by interviews or consultation with the local County Extension Service which usually has data on the type and quantity of local farm products.

EFH provides average ingestion rates for beef and dairy products and assumes that the farm family produces 75 percent of what it consumes from these categories. This corresponds to a "reasonable worst case" consumption rate of 75 g/day for beef and 300 g/day for dairy products. Although sampling data are much preferred, in their absence the procedure described in Travis and Arms (1988) may be used to estimate organic contaminant concentrations in beef and milk. This procedure does not provide transfer coefficients for poultry and eggs. Thus, the latter two pathways can be evaluated only if site-specific concentrations for poultry and eggs are available, or if transfer coefficients can be obtained from the literature.

Additional references addressing potential exposures from contaminated foods are listed in Section 2.0.

4.2 Farm Worker

Many farm activities, such as plowing and harrowing, can generate a great deal of dust. The risk assessor should consider the effects of observed (or expected) agricultural practices when using the fugitive dust model suggested under the residential scenario. Note that soil ingestion rate may be similar to the outdoor yardwork scenario discussed in Attachment B, although it will be necessary to modify the exposure frequency and duration to account for climate and length of employment. The local County Extension Service should be able to provide information on agricultural practices around a site. In addition, the Biological and Economic Analysis Division in the Office of Pesticide Programs maintains a database of the usual planting and harvesting dates for a number of crops in most U.S. states. This information may be very helpful for estimating times of peak exposure for farm workers, and, if needed, can be obtained through the Superfund Health Risk Assessment Technical Support Center (FTS 684-7300).

5.0 RECREATIONAL

As stated previously, sites present different opportunities for recreational activities. The RPM or risk assessor is encouraged to consult with the local community to determine whether there is or could be recreational use of the property along with the likely frequency and duration of any activities.

5.1 Consumption of Locally Caught Fish

This pathway should be evaluated when there is access to a contaminated water body large enough to produce a consistent supply of edible-sized fish over the anticipated exposure period. Although the local authorities should know if the water body is used for fishing, illegal access (trespassing) and deliberate disregard of fishing bans should not necessarily be ruled out; the risk assessor should check for evidence of these activities. If required, the scenario can be modified to account for fishing season, type of edible fish available, consumption habits, etc.

For recreational fishing, the average consumption rate of 54 g/day from Pao, et al. (1982) is used. This value is derived from a 3-day study of people who ate finfish, other than canned, dried or raw. An example of this consumption rate is about two 8-ounce servings per week. Other values presented in EFH, for consumption of recreationally caught fish, are from limited studies of fishermen on the west coast and may not be applicable to catches in other areas.

When evaluating this pathway please consider the possibility of subsistence fishing. Unlike the residential scenario, exposure estimates from this pathway would not necessarily be added to any other exposure estimates (see Section 2.5). Instead, it would be included as an estimate of exposure for a sensitive sub-population.

5.2 Additional Recreational Scenarios

A number of commentors requested standard default values for the following recreational scenarios: hunting, dirtbiking, swimming and wading. One approach to address exposure during swimming and wading is presented in HHEM Part A. The Agency is currently involved in research projects designed to estimate dermal uptake of contaminants from soil, water and sediment. Results of these studies will be used to update the swimming and wading scenarios as well as other scenarios that rely on estimates of dermal absorption. Unfortunately, lack of data and problems in estimating exposure frequencies and durations based on regional variations in climate have precluded the standardization of other recreational scenarios at this time. Additional guidance will be developed as data become available.

6.0 SUMMARY

This supplemental guidance has been developed to provide a standard set of default values for use in exposure assessments when site-specific data are lacking. These standard factors are intended to be used for calculating reasonable maximum exposure (RME) levels for each applicable land use scenario at a site.

Supporting data for many of the assumptions can be found in the Exposure Factors Handbook (EFH; U.S. EPA, 1990). When supporting information was not available in EFH, well-quantified or widely-accepted data from the open literature were adopted. Finally, for factors where there is a great deal of uncertainty, a rationally conservative estimate was developed and explained.

As new data become available, either for the factors themselves or for calculating RME, this guidance will be modified accordingly.

The following table summarizes the exposure pathways that will be evaluated on a routine basis for each land use, and the current default values for each exposure parameter in the standard intake equation presented below (refer to HHEM: Part A, U.S. EPA, 1989a, for a more detailed discussion of each exposure parameter):

$$\text{Intake} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

C = Concentration of the chemical in each medium

IR = Intake/Contact Rate

EF = Exposure Frequency

ED = Exposure Duration

BW = Body Weight

AT = Averaging Time

SUMMARY OF STANDARD DEFAULT EXPOSURE FACTORS (1)

Land Use	Exposure Pathway (2)	Daily Intake Rate	Exposure Frequency	Exposure Duration	Body Weight
Residential					
	Ingestion of Potable Water	2 liters	350 days/year	30 years	70 kg
	Ingestion of Soil and Dust	200 mg (child) 100 mg (adult)	350 days/year	6 years 24 years	15 kg (child) 70 kg (adult)
	Inhalation of Contaminants	20 cu.m (total) 15 cu.m (indoor)	350 days/year	30 years	70 kg
Commercial/ Industrial					
	Ingestion of Potable Water	1 liter	250 days/year	25 years	70 kg
	Ingestion of Soil and Dust	50 mg	250 days/year	25 years	70 kg
	Inhalation of Contaminants	20 cu.m/workday	250 days/year	25 years	70 kg
Agricultural					
	Ingestion of Potable Water	2 liters	350 days/year	30 years	70 kg
	Ingestion of Soil and Dust	200 mg (child) 100 mg (adult)	350 days/year	6 years 24 years	15 kg (child) 70 kg (adult)
	Inhalation of Contaminants	20 cu.m (total) 15 cu.m (indoor)	350 days/year	30 years	70 kg
	Consumption of Homegrown Produce	42 g (fruit) 80 g (veg.)	350 days/year	30 years	70 kg
Recreational					
	Consumption of Locally Caught Fish	54 g	350 days/year	30 years	70 kg

(1) - Factors presented are those that should generally be used to assess exposures associated with a designated land use. Site-specific data may warrant deviation from these values; however, use of alternate values should be justified and documented in the risk assessment report.

(2) - Listed pathways may not be relevant for all sites and, other exposure pathways may need to be evaluated due to site conditions. Additional pathways and applicable default values are provided in the text of this guidance.

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ATTACHMENT A

ACTIVITY SPECIFIC INHALATION RATES

Background

The standard default value of 20 m^3/day has been used by EPA to represent an average daily inhalation rate for adults. According to EFH, this value was developed by the International Commission on Radiologic Protection (ICRP) to represent a daily inhalation rate for "reference man" engaged in 16 hours of "light activity" and 8 hours of "rest". EPA (1985) reported on a similar study that indicated the average inhalation rate for a man engaged in the same activities would be closer to 13 m^3/day. EFH, in turn, reiterated the findings of ICRP and EPA (1985) then calculated a "reasonable worst case" inhalation rate of 30 m^3/day. This reasonable worst case value was used in Part A of the Human Health Evaluation Manual as the RME inhalation rate for residential exposures.

Commentors from both inside and outside the Agency expressed concerns that this value may be too conservative. Many also added their concern that exposure values calculated using this inhalation rate would not be comparable to reference doses (RfD) and cancer potency factors (q1*) values based on an inhalation rate of 20 m^3/day. Thus, the Toxics Integration Branch of Superfund (TIB) conducted a review of the literature to determine the validity of using 30 m^3/day as the RME inhalation rate for adults. Members of EPA's Environmental Criteria Assessment Office-Research Triangle Park (A. Jarabek, 9/20/90) and the Science Advisory Board (10/26/90) have suggested that inhalation rates could be calculated using time-use/activity level data reported in the "Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments" (OHEA; U.S. EPA, 1985). Thus, TIB used this data to calculate an RME inhalation rate for both the residential and occupational settings, as follows.

Methodology

- The time-use/activity level data reported by OHEA (1985) were analyzed for each occupation subgroup;
- The data were divided into hours spent at home vs. hours spent at the workplace (lunch hours spent outside of work and hours spent in transit were excluded);
- The hourly data were subdivided into hours spent indoors vs. outdoors (to allow for estimating exposures to volatile contaminants during indoor use of potable water);

ATTACHMENT B

ESTIMATING ADULT SOIL INGESTION IN THE COMMERCIAL/INDUSTRIAL SETTING

Most of the available soil ingestion studies focus on children in the residential setting; however, two studies were found that address adult soil ingestion that also have application to the commercial/industrial setting (Hawley, 1985; Calabrese, et al., 1990).

Hawley (1985) used a number of assumptions for contact rates and body surface area to estimate the amount of soil and dust adults may ingest during a variety of residential activities. For indoor exposures, Hawley estimated levels based on contact with soil/dust in two different household areas, as follows: 0.5 mg/day for daily exposure in the "living space"; and 110 mg/day for cleaning dusty areas such as attics or basements. For outdoor exposures, Hawley estimated a soil ingestion rate during yardwork of 480 mg/day. The assumptions used to model exposures in the residential setting may also be applied to similar situations in the workplace. The amount of soil and dust adults contact in their houses may be similar to the amount an office or indoor maintenance worker would be expected to contact. Likewise, the amount of soil contacted by someone engaged in construction or landscaping may be more analogous to a resident doing outdoor yardwork.

Calabrese, et al. (1990) conducted a pilot study that measured adult soil ingestion at 50 mg/day. Although the study has several drawbacks (e.g., a limited number of participants and no information on the participants daily work activities), it included subjects that worked outside the home. It is also interesting to note that this measured value falls within the range Hawley (1985) estimated for adult soil ingestion during indoor activities.

From these studies, 50 mg/day was chosen as the standard default value for adult soil ingestion in the workplace. It was chosen primarily because it is a measured value but also because it falls within the range of modeled values representing two widely different indoor exposure scenarios. The 50 mg/day value is to be used in conjunction with an exposure frequency of 250 days/year and an exposure duration of 25 years. For certain outdoor activities in the commercial/industrial setting (e.g., construction or landscaping), a soil ingestion rate of 480 mg/day may be used; however, this type of work is usually short-term and is often dictated by the weather. Thus, exposure frequency would generally be less than one year and exposure duration would vary according to site-specific construction/maintenance plans.

- The corresponding activity level was assigned to each hour and the total number of hours spent at each activity level was calculated;
- For time spent inside the home, 8 hours per day were assumed to be spent at rest; and
- The total number of hours spent at each activity level was multiplied by average inhalation rates reported in the EFH. Note: average values were used since only minimum, maximum and average values were reported. The use of maximum values would have to be considered "worst case". Values for average adults were applied to all but the housewife data (where average rates for women were applied).

The results showed that the highest weekly inhalation rate was 18.3 m^3/day for the residential setting and 18 m^3/day for the workplace. These values represent the highest among the weekly averages and were derived from coupling "worst case" activity patterns with "average" adult inhalation rates. It was concluded from these data that 30 m^3/day may in fact be too conservative and that 20 m^3/day would be more representative of a reasonably conservative inhalation rate for total (i.e., indoor plus outdoor) exposures at home and in the workplace.

RAGS Part B will specifically model exposure to volatile organics via indoor use of potable water. Using the method described previously, it was determined that 15 m^3/day would represent a reasonably conservative inhalation rate for indoor residential exposures.

EPA 904/R-96/006

POTENTIAL HUMAN HEALTH EFFECTS OF INGESTING FISH WHICH ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

May 1996

Atlanta, Georgia

U.S. EPA Region 4

Waste Management Division

Department of Energy Remedial Section / Federal Facilities Branch

INTRODUCTION

This screening-level risk assessment is for a hazardous waste site. This analysis characterizes risks due to ingesting fish which have radioactive and nonradioactive contaminants and are taken from locations along the Savannah River near the Savannah River Site (SRS), which is located near Aiken, South Carolina. The potential human health effects of the radioactive contaminants in these fish are analyzed in Part I; the nonradioactive contaminants in Part II; and their combined effects in Part III. Part IV presents the overall risk characterization for this risk screening.

The risk characterization, Part IV, clearly highlights both the confidence and the uncertainty associated with this screening-level risk assessment. This risk characterization conveys the assessor's judgment as to the nature and existence of both human and ecological risks. However, even though there is a limited discussion of the ecological considerations of chemical releases from this site in Part IV, the primary site-specific focus of this analysis is potential human health risks.

RESULTS IN BRIEF

This section provides an executive summary of overall risks derived in this analysis. Individual risk (including both central tendency and high end) are presented, along with population risk. Important subgroups, such as highly exposed or highly susceptible, are identified. Refer to Part IV, the risk characterization section, for more detailed information from several types of exposure scenarios and the use of multiple risk descriptors (e.g., central tendency, high end of individual risk, population risk, important subgroups, if known) consistent with terminology in the Agency's Guidance on Risk Characterization, Agency Risk Assessment Guidelines (RAGs) and program-specific guidance.

*Hazard Indexes (HIs) for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with selected **nonradioactive** contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)*

Four nonradioactive contaminants were analyzed. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. Of the four nonradioactive contaminants studied, mercury had the highest hazard index (0.62). However, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

Summary of Part I Results

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected radioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Estimated risks for rural resident with RME to Strontium-90 (SR-90), Cesium-137 (CS-137), *Tritium* (H-3), and Gross Alpha (α)

- The estimated lifetime excess total **cancer risk for a Reasonably Maximally Exposed (RME)** rural resident ingesting Savannah River fish taken from the Vogtle Electric Generating Plant Discharge (VEGPD) (which is close to Four Mile Creek), the mouth of Four Mile Creek, the mouth of Steel Creek, and the mouth of Lower Three Runs Creek (radioactive combined) is 5.46E-5

  - **In short, with arithmetic rounding, this risk from SR-90, CS-137, H-3, and α combined for a RME rural resident should be considered to be a "1.00E-4" risk**

  - **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 10,000 individuals with maximum exposure to SR-90, CS-137, H-3, and α**

Estimated risks for rural residents with *average* exposure to SR-90 and CS-137, H-3, and α

- The upper bound estimate of lifetime excess total cancer risk due to SR-90, CS-137, H-3, and α combined for an ***average*** rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) (radioactive combined) is 8.40E-6.

  - **In short, with arithmetic rounding, the upper bound estimate of this risk from SR-90, CS-137, H-3, and α combined for an *average* rural resident should be considered to be a "1.00E-5" risk**

  - **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with *average* exposure to SR-90, CS-137, H-3, and α**

- The lower bound estimate of lifetime excess total cancer risk due to SR-90, CS-137, H-3, and α combined for an ***average*** rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) (radioactive combined) is 3.98E-6.

  - **In short, with arithmetic rounding, the lower bound estimate of this risk from SR-90, CS-137, H-3, and α combined for an *average* rural resident should be considered to be a "1.00E-6" risk**

- ●● **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 1,000,000 individuals with *average* exposure to SR-90, CS-137, H-3, and α**

Summary of Part II results

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

<u>Estimated risks for rural resident with RME to As, b-BHC, and DDE</u>

- The estimated lifetime excess total **cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for a Reasonably Maximally Exposed (RME) <u>rural</u> resident** ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.06E-5**

  - ●● **In short, with arithmetic rounding, this risk from As, b-BHC, and DDE combined for a RME <u>rural</u> resident should be considered to have a "1.00E-5" risk**

  - ●● **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with <u>maximum</u> exposure to As, b-BHC, and DDE**

<u>Estimated risks for rural resident with *average* exposure to As, b-BHC, and DDE</u>

- The upper bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* <u>rural</u> resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **6.19E-6**

  - ●● **In short, with arithmetic rounding, the upper bound estimate of this risk from As, b-BHC, and DDE combined for an *average* <u>rural</u> resident should be considered to have a "1.00E-5" risk**

  - ●● **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with *average* exposure to As, b-BHC, and DDE**

  The lower bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* <u>rural</u> resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **2.78E-6**

- - **In short, with arithmetic rounding, the lower bound estimate of this risk from As, b-BHC, and DDE combined for an *average* <u>rural</u> resident should be considered to have a "1.00E-6" risk**

  - **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 1,000,000 individuals with *average* exposure to As, b-BHC, and DDE**

Summary of Part III Results

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected radioactive and nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

<u>Estimated risks for rural resident with RME to radioactive and nonradioactive contaminants</u>

- The estimated lifetime excess total cancer risk due to <u>radioactive and nonradioactive contaminants combined</u> for a Reasonably Maximally Exposed (RME) <u>rural</u> resident ingesting Savannah River fish taken from these locations is **6.52E-5**

  - **In short, with arithmetic rounding, this risk from both radioactive and nonradioactive contaminants for a RME <u>rural</u> resident should be considered to be a "1.00E-4" risk**

  - **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 10,000 individuals with <u>maximum</u> exposure to both radioactive and nonradioactive contaminants**

<u>Estimated risks for rural resident with *average* exposure to radioactive and nonradioactive contaminants</u>

- The upper bound estimate of lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for an *average* <u>rural</u> resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.46E-5**

  - **In short, with arithmetic rounding, this risk from radioactive and nonradioactive contaminants combined for an *average* <u>rural</u> resident should be considered to be a "1.00E-5" risk**

  - **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with *average* exposure to radioactive and nonradioactive contaminants**

- The lower bound estimate of lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for an *average* <u>rural</u>

resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **6.76E-6**

- ●● **In short, with arithmetic rounding, this risk from radioactive and nonradioactive contaminants combined for an average rural resident should be considered to be a "1.00E-5" risk**

- ●● **Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with average exposure to radioactive and nonradioactive contaminants**

An executive summary of overall risks derived in this analysis is shown in Tables 1. and 2. which follow:

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	**Reasonably Maximally Exposed (RME)**	**0.62**
	Maximum Estimate of Average Exposure	**0.30**
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Radioactive and Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Radioactive	Nonradioactive	Radioactive and Nonradioactive Combined
Reasonably Maximally Exposed (RME)	5.46E-5	1.06E-5	1.30E-4
Maximum Estimate of Average Exposure	8.40E-6	6.19E-6	1.46E-5
Minimum Estimate of Average Exposure	3.98E-6	2.78E-6	6.76E-6

POTENTIAL HUMAN HEALTH EFFECTS OF INGESTING FISH WHICH ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART I. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE **RADIOACTIVE** CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART II. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE **NONRADIOACTIVE** CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART III. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE **COMBINED RADIOACTIVE AND NONRADIOACTIVE** CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART IV. **OVERALL RISK CHARACTERIZATION** OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE **COMBINED RADIOACTIVE AND NONRADIOACTIVE** CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART I.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE RADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Key to Radioactive Risk Screening Tables	
Table Number	**Title**
1	Summary Table Of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Mean Levels of Selected Radioactive Contaminants in Edible Portions of Fish From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
3	Mean Annual Dose Of Radioactivity From Selected Radioactive Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
4	Summary Table Of Unit Risk Factors (q_1*s) for Oral Exposure To Selected Radioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
5	Estimated Lifetime Excess Total Cancer Risk From Selected Radioactive Contaminants to a Resident Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
6-1	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)
6-2	Mean Annual Dose Of Radioactivity Per kg of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth Of Four Mile Creek Near the Savannah River Site (SRS)
6-3	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)
6-4	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)
7-1	Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)
7-2	Estimated Lifetime Excess Total Cancer Risk for a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth Of Four Mile Creek Near the Savannah River Site (SRS)

7-3	Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)
7-4	Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	α Hot Zone (STN 360) Resident Consumes Fish From Vogtle Electric Generating Plant Discharge (VEGPD) Here SR-90, CS-137, H-3, and α all are present, but [α] is highest	SR-90 Hot Zone (STN 365) Resident Consumes Fish From Mouth Of Four Mile Creek Here SR-90, CS-137, H-3, and α all are present, but [SR-90] is highest	H-3 Hot Zone (STN 410) Resident Consumes Fish From Mouth Of Steel Creek Here SR-90, CS-137, H-3, and α all are present, but [H-3] is highest	CS-137 Hot Zone (STN 440) Resident Consumes Fish From Mouth Of Lower Three Runs Creek Here SR-90, CS-137, H-3, and α all are present, but [CS-137] is highest	Radioactive Hot Zones Combined Resident Consumes Fish From VEGPD, Four Mile Creek, Steel Creek, and Lower Three Runs Creek Here Resident consumes Fish With the Highest Concentrations of SR-90, CS-137, H-3, and α together
Reasonably Maximally Exposed (RME) Resident Consumes Fish From Specific Hot Zones at the Mouths of Streams Leaving SRS	4.53E-5	1.18E-4	4.64E-5	1.05E-5	5.46E-5

Maximum Estimate of Average Exposure Resident Consumes Fish From Various Locations Along the Savannah River Near SRS (Assumes Higher Annual Consumption Rate)	7.39E-6	1.09E-5	9.84E-8	1.52E-5	8.40E-6
Minimum Estimate of Average Exposure Resident Consumes Fish From Various Locations Along the Savannah River Near SRS (Assumes Lower Annual Consumption Rate)	3.50E-6	5.18E-6	4.66E-8	7.20E-6	3.98E-6

Table 2.

Mean Levels Of Selected Radioactive Contaminants In Edible Portions of Fish From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: Lab results (i.e. dry) were converted to fresh (i.e. wet) concentrations in this risk screening; the dry concentration results were multiplied by 0.3, which approximates the typical dry/wet (D/W) ratios observed in these samples (which were 0.3+/-0.1)

Sampling Station Number (STN)	CS-137		SR-90		H-3		α	
	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)
330	667.14	200.14	543.33	163.00	1,128.57	338.57	305.00	91.50
335	394.33	118.30	---	---	166.67	50.00	---	---
350	2,078.75	623.63	5,295.00	1588.5	5,612.50	1,683.75	185.00	55.50
355	116.67	35.00	---	---	---	---	---	---
360 (VEGPD, *which is close to the Mouth of Four Mile Creek*)	386.67	116.00	475.00	142.50	916.67	275.00	504.29	151.29
365 (Mouth of Four Mile Creek)	2,154.55	646.37	8,642.86	2,592.86	28,411.11	8,523.33	296.67	89.00
375	620.00	186.00	---	---	2,000.00	600.00	425.00	127.50
410 (Mouth of Steel Creek)	2,560.00	768.00	273.33	82.00	31,138.46	9,341.54	345.00	103.50
420	970.00	291.00	---	---	1,733.33	520.00	---	---

440 (Mouth of Lower Three Runs Creek)	2,851.42	855.43	---	---	1,771.43	531.43	300.00	90.00
460	213.33	64.00	---	---	1,575.00	472.50	165.00	49.50
530	186.67	56.00	---	---	1,800.00	540.00	215.00	64.50
540	138.29	41.49	30.00	9.00	2,216.67	665.00	---	---
Overall Arithmetic Means	1,025.99	307.80	1,173.81	352.14	6036.19	1810.86	210.84	63.25

Table 3.

Mean Annual Dose of Radioactivity From Selected Radioactive Contaminants Per kg of Fish Obtained by Ingesting Fish Taken from Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Consumption Scenario	CS-137	SR-90	H-3	*α*
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	307.80 pCi/kg X 9 kg/yr = 2,770.20 pCi/yr	352.14 pCi/kg X 9 kg/yr = 3,169.26 pCi/yr	1,810.86 pCi/kg X 9 kg/yr = 16,297.74 pCi/yr	63.25 pCi/kg X 9 kg/yr = 569.25 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	307.80 pCi/kg X 19 kg/yr = 5,848.20 pCi/yr	352.14 pCi/kg X 19 kg/yr = 6,690.66 pCi/yr	1,810.86 X 19 kg/yr = 34,406.34 pCi/yr	63.25 pCi/yr X 19 pCi/yr = 1,201.75 pCi/yr

Table 4.

Summary Table Of Unit Risk Factors (q_1*s) for Oral Exposure To Selected Radioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	CS-137	SR-90	H-3	α
q_1^* $(mg/kg\text{-}d)^{-1}$	3.16E-11 (Risk/pCi)	4.09E-11 (Risk/pCi)	7.15E-14 (Risk/pCi)	3.16E-10 (Risk/pCi)

Table 5.

Estimated Lifetime Excess Total Cancer Risk From Selected Radioactive Contaminants to a Resident Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	2,770.20 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 3.50E-6	3,169.26 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 5.18E-6	16,297.74 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 4.66E-8	569.25 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 7.20E-6	3.98E-6
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	5,848.20 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 7.39E-6	6,690.66 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 1.09E-5	34,406.34 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 9.84E-8	1,201.75 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.52E-5	8.40E-6

Table 6-1.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)

(STN 360)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	116.00 pCi/kg X 9 kg/yr = 1,044.00 pCi/yr	142.50 pCi/kg X 9 kg/yr = 1,282.50 pCi/yr	275.00 pCi/kg X 9kg/yr = 2,475.00 pCi/yr	151.29 pCi/kg X 9kg/yr = 1,361.61 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	116.00 pCi/kg X 19 kg/yr = 2204.00 pCi/yr	142.50 pCi/kg X 19 kg/yr = 2,707.50 pCi/yr	275.00 pCi/kg X 19 kg/yr = 5,225.00 pCi/yr	151.29 pCi/kg X 19 kg/yr = 2,874.51 pCi/yr

Table 6-2.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Four Mile Creek Near the Savannah River Site (SRS) (STN 365)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	646.37 pCi/kg X 9 kg/yr = 5,817.33 pCi/yr	2,592.86 pCi/kg X 9 kg/yr = 23,335.74 pCi/yr	8,523.33 pCi/kg X 9 kg/yr = 76,709.97 pCi/yr	89.00 pCi/kg X 9 kg/yr = 801.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	646.37 pCi/kg X 19 kg/yr = 12,281.03 pCi/yr	2,592.86 pCi/kg X 19 kg/yr = 49,264.34 pCi/yr	8,523.33 pCi/kg X 19 kg/yr = 161,943.27 pCi/yr	89.00 pCi/kg X 19 kg/yr = 1,691.00 pCi/yr

Table 6-3.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS) (STN 410)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	768.00 pCi/kg X 9 kg/yr = 6,912.00 pCi/yr	82.00 pCi/kg X 9 kg/yr = 738.00 pCi/yr	9,341.54 pCi/kg X 9 kg/yr = 84,073.86 pCi/yr	103.50 pCi/kg X 9 kg/yr = 9,315.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	768.00 pCi/kg X 19 kg/yr = 14,592.00 pCi/yr	82.00 pCi/kg X 19 kg/yr = 1,558.00 pCi/yr	9,341.54 pCi/kg X 19 kg/yr = 177,489.26 pCi/yr	103.50 pCi/kg X 19 kg/yr = 1,966.50 pCi/yr

Table 6-4.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)

(STN 440)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	855.43 pCi/kg X 9 kg/yr = 7,698.87 pCi/yr	---	531.43 pCi/kg X 9 kg/yr = 4,782.87 pCi/yr	90.00 pCi/kg X 9 kg/yr = 810.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	855.43 pCi/kg X 19 kg/yr = 16,253.17 pCi/yr	---	531.43 pCi/kg X 19 kg/yr = 10,097.17 pCi/yr	90.00 pCi/kg X 19 kg/yr = 1,710.00 pCi/yr

Table 7-1.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)

(STN 360)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	1,044.00 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.32E-6	1,282.50 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 2.10E-6	2,475.00 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 7.08E-9	1,361.61 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.72E-5	= 2.06E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	2,204.00 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 2.79E-6	2,707.50 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 4.43E-6	5,225.00 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 1.49E-8	2,874.51 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 3.63E-5	= 4.35E-5

Table 7-2.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Four Mile Creek Near the Savannah River Site (SRS)

(STN 365)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	5,817.33 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 7.35E-6	23,335.74 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 3.82E-5	76,709.97 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.19E-7	801.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.01E-5	= 5.59E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	12,281.03 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.55E-5	49,264.34 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 8.06E-5	161,943.27 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 4.634E-7	1,691.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.14E-5	= 1.18E-4

Table 7-3.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)

(STN 410)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	6,912.00 pCi/yr X 40 yrs X 8.74E-6 (Risk/pCi) = 8.74E-6	738.00 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 1.21E-6	84,073.86 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.40E-7	931.50 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.18E-5	= 2.20E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	14,592 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.84E-5	1,558.00 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 2.55E-6	177,489.26 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 5.08E-7	1,966.50 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.49E-5	= 4.64E-5

Table 7-4.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)

(STN 440)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr).

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	7,698.87 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 9.73E-6	---	4,782.87 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 1.37E-8	810.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.02E-5	= 4.99E-6
Maximum Estimate (Assumes Higher Annual Consumption Rate)	16,253.17 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 2.05E-5	---	10,097.17 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.89E-8	1,710.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.16E-5	= 1.05E-5

PART II.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Key to Nonradioactive Risk Screening Tables	
Table Number	**Title**
1	Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
3	Mean Levels Of Selected **Nonradioactive** Contaminants In Edible Portions of Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
4	Mean Daily Doses of Selected **Nonradioactive** Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
5	Summary Table Of Reference Doses (RfDs) For Oral Exposure To Selected **Nonradioactive** Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
6	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Contaminated With **Arsenic** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
7	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Mercury** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
8	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Selenium** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
9	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Zinc** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

10	Summary Table Of Unit Risk Factors (q_1*s) For Oral Exposure To Selected Nonradioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
11	Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With Arsenic And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
12	Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With b-BHC And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
13	Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With DDE And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	Reasonably Maximally Exposed (RME)	0.62
	Maximum Estimate of Average Exposure	0.30
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	As	b-BHC	DDE	Nonradioactive Combined
Reasonably Maximally Exposed (RME)	1.86E-9	2.68E-5	5.06E-6	**1.06E-5**
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	7.45E-10	1.73E-5	1.26E-6	**6.19E-6**
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	3.53E-10	8.24E-6	5.94E-7	**2.78E-6**

Table 3.

Mean Levels of Selected Nonradioactive Contaminants In Edible Portions Of Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

County	Locus	Species Sampled	Average Length in Inches	Contaminant of Concern (mg/kg)											
				As		Hg		Se		Zn		b-BHC		DDE	
				run	avg	run	avg	run	avg	run	avg	run	avg	run	avg
Richmond	Downstream Lock & Dam	Largemouth Bass	14.8	—	—	0.18 to 0.21	0.20	0.32 to 0 38	0.36	8.80 to 10.00	9.40	—	0.02	< 0.01	< 0.1
		Sucker	14.9	—	—	0.10 to 0 26	0.18	0.26 to 0.36	0.31	8.30 to 12.00	9.70	< 0.01	< 0.01	< 0.01 to 0.02	0.005
Chatham	US 17	Channel Catfish	16.1	0 02 to 0.05	0.03	0 04 to 0.08	0.06	0.06 to 0.14	0.10	5.10 to 6.30	5.35	—	—	—	—
		Largemouth Bass	13.3	< 0.02 to 0.03	0 01	0.02 to 0 06	0.04	0.11 to 0.19	0.14	4.20 to 5.70	5.17	—	—	—	—
Combined Counties		Composite	14.8	0.02 to 0.05	0.02	0.02 to 0 25	0.12	0.06 to 0.38	0.23	4.20 to 12.00	7.40	< 0.01 to 0.02	0.013	< 0.01 to 0.02	0.005

Table 4.

Mean Daily Doses Of Selected Nonradioactive Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Consumption Scenario	As	Hg	Se	Zn	b-BHC	DDE
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	0.02 mg/kg X 9 kg/yr = 0.18 mg/yr = 4 93E-4 mg/d = 7.05E-8 mg/kg-d	0.12 mg/kg X 9 kg/yr = 1.08 mg/yr = 2.96E-3 mg/d = 4.23E-5 mg/kg-d	0.23 mg/kg X 9 kg/yr = 2.07 mg/yr = 5.67E-3 mg/d = 8.10E-5 mg/kg-d	7.40 mg/kg X 9 kg/yr = 66 6 mg/yr = 0.18 mg/d = 2.61E-3 mg/kg-d	0.013 mg/kg X 9 kg/yr = 0.117 mg/yr = 3.21E-4 mg/d = 4.58E-6 mg/kg-d	0.005 mg/kg X 9 kg/yr = 0.045 mg/yr = 1.23E-4 mg/d = 1.76E-6 mg/kg-d
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	0.02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	0.12 mg/kg X 19 kg/yr = 2.28 mg/yr = 6.25E-3 mg/d = 8.93E-5 mg/kg-d	0.23 mg/kg X 19 kg/yr = 4.37 mg/yr = 1.20E-2 mg/d = 1.71E-4 mg/kg-d	7.40 mg/kg X 19 kg/yr = 140.60 mg/yr = 3.85E-1 mg/d = 5.50E-3 mg/kg-d	0.013 mg/kg X 19 kg/yr = 0.247 mg/yr = 6.77E-4 mg/d = 9.67E-6 mg/kg-d	0.005 mg/kg X 19 kg/yr = 0.950 mg/yr = 2.60E-4 mg/d = 3.72E-6 mg/kg-d

Table 5.

Summary Table Of Reference Doses (RfDs) For Oral Exposure To Selected Nonradioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	As	Hg	Se	Zn	b-BHC	DDE
RfD (mg/kg-day)	3.00E-4	3.00E-4	5.00E-3	3.00E-1	Not Available at this time	Not Available at this time

Table 6.

Hazard Index (HI) for Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Arsenic And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Channel Catfish Taken Solely at US 17, Chatham County]	0.05 mg/kg X 19 kg/yr = 0.95 kg/yr = 2.60E-3 mg/d = 3.72E-5 mg/kg-d	3.72E-5 mg/kg-d ______________ = 3.00E-4 mg/kg-d 0.12
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.49E-5 mg/kg-d	1.49E-5 mg/kg-d ______________ = 3.00E-4 mg/kg-d 0.05

Table 7.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Mercury and Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Sucker Taken Solely at Downstream Lock & Dam, Richmond County]	0.25 mg/kg 19 kg/yr = 4.75 mg/yr = 1.30E-2 mg/d = 1.86E-4 mg/kg-d	$\frac{1.86E\text{-}4 \text{ mg/kg-d}}{3.00E\text{-}4 \text{ mg/kg-d}} = 0.62$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	8.93E-5 mg/kg-d	$\frac{8.93E\text{-}5 \text{ mg/kg-d}}{3.00E\text{-}4 \text{ mg/kg-d}} = 0.30$

Table 8.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Selenium And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.38 mg/kg X 19 kg/yr = 7.22 mg/yr = 1.98E-2 mg/d = 2.83E-4 mg/kg-d	2.83E-4 mg/kg-d ______________ = 0.06 5.00E-3 mg/kg-d
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.71E-4 mg/kg-d	1.71E-4 mg/kg-d ______________ = 0.03 5.00E-3 mg/kg-d

Table 9.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Zinc And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Sucker Taken Solely at Downstream Lock & Dam, Richmond County]	12.00 mg/kg X 19 kg/yr = 228 mg/yr = 0.62 mg/d = 8.92E-3 mg/kg-d	$\frac{8.92E\text{-}3 \text{ mg/kg-d}}{3.00E\text{-}1 \text{ mg/kg-d}} = 0.03$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	5.50E-3 mg/kg-d	$\frac{5.50E\text{-}3 \text{ mg/kg-d}}{3.00E\text{-}1 \text{ mg/kg-d}} = 0.02$

Table 10.

Summary Table of Unit Risk Factors (q_1*s) For Oral Exposure To Selected Nonradioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	As	b-BHC	DDE
q_1^* $(mg/kg\text{-}d)^{-1}$	5.00E-5	1.80E+0	3.40E-1

Table 11.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With Arsenic And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Channel Catfish Taken Solely at US 17, Chatham County]	0.05 mg/kg X 19 kg/yr = 0.95 kg/yr = 2.60E-3 mg/d = 3.72E-5 mg/kg-d	3.72E-5 mg/kg-d X = 1.86E-9 5.00E-5 $(mg/kg\text{-}d)^{-1}$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X = 7.45E-10 5.00E-5 $(mg/kg\text{-}d)^{-1}$
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	7.05E-6 mg/kg-d	7.05E-6 mg/kg-d X = 3.53E-10 5.00E-5 $(mg/kg\text{-}d)^{-1}$

Table 12.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With b-BHC And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Maximum Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X 1.80E+0 $(mg/kg\text{-}d)^{-1}$ = 2.68E-5
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	9.67E-6 mg/kg-d	9.67E-6 mg/kg-d X 1.80E+0 $(mg/kg\text{-}d)^{-1}$ = 1.73E-5
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	4.58E-6 mg/kg-d	4.58E-6 mg/kg-d X 1.80E+0 $(mg/kg\text{-}d)^{-1}$ = 8.24E-6

Table 13.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With DDE And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X = 5.06E-6 3.40E-1 $(mg/kg\text{-}d)^{-1}$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	3.72E-6 mg/kg-d	3.72E-6 mg/kg-d X = 1.26E-6 3.40E-1 $(mg/kg\text{-}d)^{-1}$
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.76E-6 mg/kg-d	1.76E-6 mg/kg-d X = 5.94E-7 3.40E-1 $(mg/kg\text{-}d)^{-1}$

PART III.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Key to Combined Radioactive and Nonradioactive Risk Screening Tables	
Table Number	**Title**
1	Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Radioactive and Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	**Reasonably Maximally Exposed (RME)**	**0.62**
	Maximum Estimate of Average Exposure	**0.30**
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Radioactive and Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Radioactive	Nonradioactive	Radioactive and Nonradioactive Combined
Reasonably Maximally Exposed (RME)	5.46E-5	1.06E-5	6.52E-5
Maximum Estimate of Average Exposure	8.40E-6	6.19E-6	1.46E-5
Minimum Estimate of Average Exposure	3.98E-6	2.78E-6	6.76E-6

PART IV.

OVERALL RISK CHARACTERIZATION OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Risk Characterization

The purpose of this section is to clearly communicate results of the risk assessment to the risk manager. Key scientific concepts, data, and methods are discussed here. This section provides an evaluation of the overall quality of the assessment and the degree of confidence the authors have in the estimates of risk and conclusions drawn. Section also describes risks to individuals and populations in terms of extent and severity of probable harm. This section integrates individual characterizations from:

A. Hazard Identification

1. *What is known about the capacity of the contaminants of concern for causing cancer or other adverse health effects in humans, laboratory animals, or wildlife species?*

EPA classifies all radionuclides as Group A (known human) carcinogens. Radionuclide slope factors are calculated by EPA's Office of Radiation and Indoor Air (ORIA) to assist HEAST (Health Effects Assessment Summary Tables) users with risk-related evaluations and decision-making at various stages of the remediation process. Therefore, the radioactive contaminants of concern in this risk screening, Strontium-90 (SR-90), Cesium-137 (CS-137), Tritium (H-3), and Gross Alpha (α) are analyzed as Group A (known human) carcinogens.

The unit risk factors (q_1^*s) for these four radioactive contaminants appear in Part I, Table 4.These q_1^*'s have been obtained from the most currently available version of HEAST (November, 1994).

There are six nonradioactive contaminants of concern in this risk screening: Arsenic (As); Mercury (Hg); Selenium (Se); Zinc (Zn); Hexachlorocyclohexane, Beta (b-BHC); and 2,2-BIS(p-CHLOROPHENYL)-1,1-DICHLOROETHYLENE (DDE).

Three of these nonradioactive contaminants of concern are also carcinogens:

- As is a Group A (known human) carcinogen
- b-BHC is a Group B2 (probable human) carcinogen
- DDE is a Group B2 (probable human) carcinogen

The q_1^*s for these three nonradioactive contaminants appear in Part II, Table 10. These q_1^*s have been obtained from an on line search of EPA's IRIS (Integrated Risk Information System) on July 25, 1995.

All six of these nonradioactive contaminants of concern can cause deleterious non-cancer systemic effects. However, Reference Doses (RfDs) for b-BHC and DDE are not available at this time in IRIS. Consequently, these two nonradioactive contaminants of concern were not analyzed further.

The RfDs for four of the nonradioactive contaminants appear in Part II, Table 5. These RfDs have been obtained from an on line search of EPA's IRIS (Integrated Risk Information System) on July 25, 1995.

2. *What are the related uncertainties and science policy choices?*

Since b-BHC and DDE were not analyzed, due to RfDs for these two contaminants not being available, it is not known if consumption of fish with existing levels of these two pollutants can produce deleterious non-cancer systemic effects.

B. Dose-Response Assessment

1. *What is known about the biological mechanisms and dose-response relationships underlying any effects observed in the laboratory or epidemiology studies providing data for this assessment?*

See entries for these contaminants of concern in EPA's Integrated Risk Information System (IRIS).

2. *What are the related uncertainties and science policy choices?*

See entries for these contaminants of concern in EPA's Integrated Risk Information System (IRIS).

C. Exposure Assessment

In this subsection several types of risk information are presented on the range of exposures derived from exposure scenarios and on the use of multiple risk descriptors consistent with terminology in the EPA Guidance on Risk Characterization, Agency risk assessment guidelines, and program-specific guidance.

1. *What is known about the principle paths, patterns, and magnitudes of human and wildlife exposure and numbers of persons or wildlife species likely to be exposed?*

All aquatic species are likely to be affected. No attempt has been made to evaluate the bioaccumulation of these aquatic species through selected food chains from smaller species of fish to other wetland species such as the raptors (e.g., kingfishers, hawks, owls, cormorants, osprey, and eagles), as well as several varieties of turtles and alligators. Since bones and carcass are usually taken whole as prey, the bone seeking characteristic of SR-90 should be considered, because one could reasonably hypothesize that levels of SR-90 might be successively magnified through the food chains of these predacious species.

The principle human pathway is fish ingestion. All individuals in the general population who ingest these fish should sustain some small, but measurable, additional risk. Recreational and subsistence fishermen, because of higher consumption rates, should be expected to sustain relatively higher levels of these risks than the general population.

2. *What are the related uncertainties and science policy choices?*

Subsistence fishermen frequently do not release undersized fish. This is especially true for small panfish like bluegills, sunfish, and suckers. These small fish frequently are simply gutted, fried whole and consumed "bones and all". This local consumption practice would necessarily increase SR-90 levels, because there would be relatively more SR-90 in the bones of the fish vis-à-vis the filet.

Additionally, subsistence fishermen frequently don't simply consume pan fish. Local subsistence fishermen in this area are known to include other aquatic species such as eels, turtles, and alligators in their catch. One would expect that these particular aquatic species, because they are further along the food chain than pan fish, might successively magnify levels of SR-90 in the bones of fish that they prey on. Subsistence fishermen may thereby obtain higher levels of SR-90 in their diet than either recreational fishermen or fish consumers in the general population. Therefore, the risks for subsistence fishermen, who in this analysis are consuming only fish filets, would probably be underestimated.

Locally grown vegetable crops around SRS are monitored for radionuclide content. Vegetable crops which normally have high calcium content, e.g., collard greens, can also have relatively increased levels of SR-90. As a local favorite, particularly among people of color, this staple of the local diet may serve as an additional avenue of exposure, in addition to that which is obtained by Savannah River fish consumption. However, the potential pathway for SR-90 in locally grown collard greens is not analyzed here. The amount of SR-90 consumed by fish consumers thereby may be higher than the amounts calculated here, and this would tend to underestimate the risk due to SR-90.

II. Discussion of Uncertainty in the Overall Assessment

The purpose of this section is to discuss fully the uncertainty in the overall assessment. The quality and quantity of available data, gaps in the database for specific chemicals, and the quality of the measured data are discussed. Use of default assumptions is reviewed. Any incomplete understanding of general biological phenomena is discussed here. Importantly, scientific judgments or science policy positions that were employed to bridge information gaps are presented here.

A. Quality and Quantity of Available Data

1. Variability

There are two separate sets of data which have been analyzed in this screening-level risk assessment. the nonradioactive contaminants and the radioactive contaminants were measured in separate groups of fish samples at two different periods. Further, there is incomplete overlap of the portions of the Savannah River selected for sampling the fish. Ideally, simultaneous analyses of both radioactive and nonradioactive contaminants should be obtained in the same fish, from the same locations. However, to the Agency's knowledge these are the only sets of fish sampling data available for analysis at this time.

2. Uncertainty

There are many more aquatic species, and many more samples for each of these species, in the radioactive data set than in the nonradioactive data set. Therefore, one should be much more confident about the risks identified in this analysis for the radioactive contaminants vis-à-vis the nonradioactive contaminants.

B. Data Gaps

The special circumstance of a lack of data for nonradioactive contaminants in the Savannah River basin limit a detailed analysis of the impacts of these pollutants on human health and the environment of this community. There is relatively much more data on radioactive contaminants for this geographic area, and the analysis of the potential effects of this class of pollutants is consequently more robust. The authors are therefore much more confident about the risk characterization of the radioactive contaminants vis-à-vis the nonradioactive contaminants.

C. Process of Alternatives Selection

1. Rationale for the Choice

Maximum estimate of *average* exposure is based on fish samples taken at random along a 132.8 mile stretch of the Savannah River, this length being determined by the availability of sampling data near the Savannah River Site.

Georgia Department of Natural resources provided the data used in this risk screening.

a. Radioactive Contaminant Data Source

In December, 1994, the Georgia Department of Natural Resources (DNR) Environmental Protection Division (Environmental Radiation Section) had provided EPA Region IV the document titled: "Environmental Radioactivity Data: SRS (Savannah River Site) area ...1/1/90 - 4/20/94" (compiled 4/20/94).

Radioactivity levels in fish samples, reported in picoCuries per dry kilogram, appear on pp 72-75 of this document, which was the primary source of radioactive contaminant data used in this risk screening.

b. Nonradioactive Contaminant Data Source

Data sheets for the Augusta and Savannah site sampling of fish on the Savannah River was collected September 22 - 23, 1993 as part of the Georgia Department of Natural Resources River Assessment Project.

c. Scope and Methodology

Levels for CS-137, K-40, H-3, ALPHA, BETA, BETAS, and SR-90 are reported for several aquatic species. On advice of the Region IV Office of Radiation, the alpha levels are considered to be contributed predominantly by

α. This risk screening focuses on only CS-137, SR-90, H-3, and α levels in fish taken from a 132.8 mile stretch of the Savannah River close to the Savannah River Site.

Even though levels of radioactivity in both edible and inedible portions of fish are reported, only portions designated as "edible" or "filet" have been used in this risk screening. Lab results (i.e. **dry**) were converted to fresh (i.e. **wet**) concentrations by multiplying by 0.3, which approximates the typical Dry/Wet (D/W) ratios observed in these samples (which were 0.3 +/- 0.1).

Both minimum (9 kg/yr) and maximum (19 kg/yr) consumption rates, for both urban and rural residents were used in this risk screening. Risks for urban residents (consumption period 30 years) and rural residents (consumption period 40 years) were estimated.

Arithmetic means of radioactivity levels in fish for various locations along this 132.8 mile stretch of the Savannah River adjacent to the Savannah River Site (SRS) were calculated. Next, a mean dose of radioactivity per kg of fish for various locations along this stretch of the Savannah River was obtained. This mean dose of radioactivity was then used to estimate *average* cancer risk for both urban residents and rural residents taking fish from various locations along this 132.8 mile stretch of the Savannah River.

In like fashion, a mean dose of radioactivity per kg of fish was obtained for fish taken at the Vogtle Electric Generating Plant Discharge (VEGPD) [which is close to the mouth of Four Mile Creek], and the confluences of Four Mile Creek, Steel Creek, and Lower Three Runs Creek. Similarly, this mean dose of radioactivity was then used to estimate *Reasonable Maximum Exposure (RME)* cancer risk for rural residents taking fish from each respective confluence.

Sport fish data were derived from a creel survey conducted by the Georgia Department of Natural Resources from the Savannah River Lock and Dam to the Atlantic Ocean 1/10/88 - 12/24/88. See report by Dennis Schmidt (DNR-Fisheries @912-727-2112), "Savannah River Creel Survey", Report F-30-16.

Two consumption rates were used in this risk screening: a minimum estimate of 9 kg/yr and a maximum estimate of 19 kg/yr. These consumption rates are taken from WSRC-RP-91-17, "Land and Water Use Characteristics of the Savannah River Site (U)", published in March, 1991. Nuclear Regulatory commission (NRC) default values for average and maximum consumption are 6.3 and 21 kg respectively.

2. Effects of Alternatives Selected on the Assessment

These Savannah River sampling sites are spread along 132.8 miles of stream near the vicinity of the Savanah River Site (SRS). The Vogtle Electric Generating Plant discharge is 3.5 miles downstream from the first sampling site and 0.9 miles upstream of the mouth of Four Mile Creek. Although the Vogtle Plant is believed to discharge a small quantity of CS-137, DNR considers SRS to be the major contributor of CS-137 and the sole contributor of SR-90.

Samples taken at the mouth Four Mile Creek contained the highest concentrations of SR-90. The highest concentrations of H-3 were found at the mouth of Steel Creek, and the highest levels of α were found 50 yards downstream of VEGPD. The highest concentrations of CS-137 were found in samples taken near the confluence of Lower Three Runs Creek.

3. Comparison with Other Plausible Alternatives

Actual risk estimates that might be obtained from a formal risk assessment could vary substantially from this initial risk screening; most probably they would be greater than the estimates presented here. For instance, some risk assessors may chose to include all portions of the available fish samples and not restrict the analysis to the edible flesh portions. It is likely that the SR-90 risk estimates could be substantially greater if the whole fish were to be consumed, because SR-90 is a known "bone seeker"; this would increase risk estimates. Additionally, some risk assessors may choose to use 70 years of fish consumption, instead of the 40 year period used in this risk screening; this would further increase risk estimates shown above.

III. Conclusions

This risk characterization is separate from any risk management considerations. In decision-making, risk managers should use risk information appropriate to their program legislation.

This risk characterization presents several types of information. Information is presented on the range of exposures derived from exposure scenarios and the use of multiple risk descriptors (e.g., central tendency, high end of individual risk, population risk, important subgroups, if known) consistent with terminology in the Agency's Guidance on Risk Characterization, Agency Risk Assessment Guidelines (RAGs) and program-specific guidance.

A. Noncancer Systemic Effects

Hazard Indexes (HIs) for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with selected **nonradioactive** contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Four nonradioactive contaminants were analyzed. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. however, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

B. Cancer Effects

1. Risk due to selected **radioactive** contaminants

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected **radioactive** contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

a. <u>Estimated risks for rural resident with RME to SR-90, CS-137, H-3, and α:</u>

An analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to SR-90, CS-137,H-3, and α was performed for sampling data from VEGPD, and the mouths of Four Mile Creek, Steel Creek, and Lower Three Runs Creek, those locations of this stretch of the Savannah River which have the highest levels these radionuclides. The estimated lifetime excess total **cancer risk due to SR-90, CS-137, H-3, and α for a *Reasonably Maximally Exposed (RME)* rural resident** ingesting Savannah River fish taken solely from these locations is **5.46E-5. In short, with arithmetic rounding, the risk from these radionuclides combined for a RME rural resident should be considered to be a "1.00E-4" risk.**

b. Estimated risks for rural residents with *average* exposure to SR-90, CS-137, H-3, α:

An analysis was performed of an individual rural resident consuming fish from various locations along the Savannah River near the Savannah River Site (SRS). In this consumption scenario this rural resident consumes fish from the VEGPD as well as from the mouths of Four Mile Creek, Steel Creek, and Lower Three Runs Creek. Thereby this rural resident obtains fish with the highest concentrations of SR-90, CS-137, H-3, and α.

The upper bound estimate of lifetime excess total **cancer risk due to SR-90, CS-137, H-3, and α for a rural resident** ingesting the upper limit of an *average* amount of Savannah River fish taken solely from these locations is **8.40E-6. In short, with arithmetic rounding, the upper bound estimate of this risk from these radionuclides for an *average* rural resident should be considered to be a "1.00E-5" risk.**

The lower bound estimate of lifetime excess total **cancer risk due to SR-90, CS-137, H-3, and α for a rural resident** ingesting the lower limit of an *average* amount of Savannah River fish taken solely from these locations is **3.98E-6. In short,**

with arithmetic rounding, the upper bound estimate of this risk from these radionuclides for an *average* rural resident should be considered to be a "1.00E-6" risk.

2. Risk Due to Selected Nonradioactive Contaminants

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

a. Estimated risks for rural resident with RME to As, b-BHC, and DDE

i. *Arsenic (As)*

An analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to **As** was performed for sampling data from various locations along the Savannah River near the Savannah River Site (SRS).

The estimated lifetime excess total cancer **risk due to As for a Reasonably Maximally Exposed (RME) rural resident** ingesting Savannah River fish taken from these locations is 1.86E-9. **In short, with arithmetic rounding, this risk from As for a RME rural resident should be considered to be a "1.00E-9" risk.**

ii. *b-BHC*

Likewise, an analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to **b-BHC** was performed for sampling data from the from various locations along the Savannah River near the Savannah River Site (SRS).

The estimated lifetime excess total cancer **risk due to b-BHC for a *Reasonably Maximally Exposed (RME)* rural resident** ingesting Savannah River fish taken from these locations is **2.68E-5. In short, with arithmetic rounding, the upper bound estimate of this risk from b-BHC for a**

RME rural resident should be considered to be "1.00E-5".

iii. *DDE*

Again, an analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to DDE was performed for sampling data from the from various locations along the Savannah River near the Savannah River Site (SRS).

The estimated lifetime excess total **cancer risk due to DDE for a Reasonably Maximally Exposed (RME) rural** resident ingesting Savannah River fish taken solely from these locations is **5.06E-6. In short, with arithmetic rounding, this risk from DDE for a RME rural resident should be considered to be "1.00E-5".**

iv. *As, b-BHC, and DDE (nonradioactive combined)*

Therefore, the estimated lifetime excess total **cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for a *Reasonably Maximally Exposed (RME)* rural resident** ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.06E-5. In short, with arithmetic rounding, this risk from As, b-BHC, and DDE combined for a RME rural resident should be considered to be "1.00E-5".**

b. Estimated risks for rural resident with *average* exposure to As, b-BHC, and DDE

An analysis of an individual rural resident with a maximum estimate of *average* exposure to **As** was performed for sampling data from various locations along the Savannah River near the Savannah River Site.

i. *Arsenic (As)*

The upper bound estimate of lifetime excess total **cancer due to As risk for a rural resident** ingesting an *average* amount of Savannah River fish taken from these locations is **7.45E-10. In short, with arithmetic rounding, the upper bound estimate of this risk from As for an** ***average*** **rural resident should be considered to be "1.00E-9".**

The lower bound estimate of lifetime excess total **cancer due to As risk for a rural resident** ingesting an *average* amount of Savannah River fish taken from these locations is **3.53E-10. In short, with arithmetic rounding, the lower bound estimate of this risk from As for an** ***average*** **rural resident should be considered to be "1.00E-10".**

ii. *b-BHC*

Likewise, an analysis of an individual rural resident with an *average* exposure to **b-BHC** was performed for sampling data from these locations.

The upper bound estimate of lifetime excess total **cancer risk due to b-BHC for an** ***average*** **rural resident** ingesting Savannah River fish taken solely from these locations is **1.73E-5. In short, with arithmetic rounding, the upper bound estimate of this risk from b-BHC for an** ***average*** **rural resident should be considered to be "1.00E-5".**

The lower bound estimate of lifetime excess total **cancer risk due to b-BHC for an** ***average*** **rural resident** ingesting Savannah River fish *taken solely from these locations is* **8.24E-6. In short, with arithmetic rounding, the lower bound estimate of this risk from b-BHC for an** ***average*** **rural resident should be considered to be "1.00E-5".**

iii. *DDE*

Again, an analysis of an individual rural resident with an *average* exposure to **DDE** was performed for sampling data from the from various locations along the Savannah River near the Savannah River Site (SRS).

The upper bound estimate of lifetime excess total cancer risk due to DDE for an *average* rural resident ingesting Savannah River fish taken solely from these locations is 1.26E-6. In short, with arithmetic rounding, the upper bound estimate of this risk from DDE for an *average* rural resident should be considered to be "1.00E-6".

The lower bound estimate of lifetime excess total cancer risk due to DDE for an *average* rural resident ingesting Savannah River fish taken solely from these locations is 5.94E-7. In short, with arithmetic rounding, the upper bound estimate of this risk from DDE for an *average* rural resident should be considered to be "1.00E-6".

iv. *As, b-BHC, and DDE (nonradioactive combined)*

Therefore, the combined upper bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is 1.86E-5. In short, with arithmetic rounding, the upper bound estimate of this risk from As, b-BHC, and DDE combined for an *average* rural resident should be considered to be "1.00E-5".

Similarly, the lower bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is 2.78E-6. In short, with arithmetic rounding, the lower bound estimate of this risk from As, b-BHC, and DDE combined for an *average* rural resident should be considered to be "1.00E-6".

3. Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected radioactive and nonradioactive contaminants and are taken

from various locations along the Savannah River near the Savannah River Site (SRS)

a. <u>Estimated risks for rural resident with RME to radioactive and nonradioactive contaminants</u>

   i. The estimated lifetime excess total cancer risk for an individual <u>rural</u> resident with a *Reasonable Maximum Exposure (RME)* to <u>radioactive</u> contaminants (see above) is **1.19E-4**.

   ii. The analysis of an individual <u>rural</u> resident with a *Reasonable Maximum Exposure (RME)* to <u>nonradioactive</u> contaminants (see above) is **1.06E-5**.

   iii. Therefore, the estimated lifetime excess total cancer risk due to <u>radioactive and nonradioactive contaminants combined</u> for a ***Reasonably Maximally Exposed*** *(RME)* <u>rural</u> resident ingesting Savannah River fish taken from these locations is **1.30E-4. In short, with arithmetic rounding, this risk from both radioactive and nonradioactive contaminants for a RME <u>rural</u> resident should be considered to be a "1.00E-4" risk.**

   iv. ***Stated in other terms, this is roughly equivalent to one extra case of cancer in every 10,000 individuals with <u>maximum</u> exposure.***

b. <u>Estimated risks for rural resident with *average* exposure to radioactive and nonradioactive contaminants</u>:

   i. The upper bound estimate of **lifetime excess total cancer due to all <u>radioactive</u> contaminants studied for a <u>rural</u> resident** ingesting an *average* amount of Savannah River fish taken from these locations is **8.40E-6, roughly a 1.00E-5 risk.**

The lower bound estimate of lifetime excess total **cancer due to all radioactive contaminants studied for a rural resident** ingesting an *average* amount of Savannah River fish taken from these locations is **3.98E-6, roughly a 1.00E-6 risk.**

ii. The upper bound estimate of lifetime excess total **cancer risk due to all nonradioactive contaminants for an *average* rural resident** ingesting Savannah River fish taken solely from these locations is **6.19E-6, roughly a 1.00E-5 risk.**

The lower bound estimate of lifetime excess total **cancer risk due to all nonradioactive contaminants for an *average* rural resident** ingesting Savannah River fish taken solely from these locations is **2.78E-6, roughly a 1.00E-6 risk.**

iii. The upper bound estimate of lifetime excess total **cancer risk due to radioactive and nonradioactive contaminants combined for an average rural resident** ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.46E-5. In short, with arithmetic rounding, this risk for a RME rural resident from nonradioactive and radioactive contaminants combined should be considered to be a "1.00E-5" risk.**

The lower bound estimate of lifetime excess total **cancer risk** due to all radioactive and nonradioactive contaminants combined for an ***average*** rural resident ingesting Savannah River fish taken solely from these locations is **6.76E-6. In short, with arithmetic rounding, this risk for a RME rural resident from nonradioactive and radioactive contaminants combined should be considered to be a "1.00E-5" risk.**

iv. *Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with* ***average*** *exposure.*

IV. Information Regarding Strengths and Limitations of this Risk Assessment For:

A. Other Risk Assessments

The Office of Radiation of APTMD uses a different method which compares levels of environmental radioactivity to radiation protection standards, not the estimation of excess cancer. This may be problematic, in that a level of radioactivity which may be deemed "safe" under these radiation protection standards may nevertheless account for an excess total number of cancers that can be estimated using standard risk screening methods.

Importantly, of many potential human health risks, only lifetime excess total cancer risks from two radionuclides, strontium-90 (SR-90) and cesium (CS-137), are estimated in this analysis. Even though data may exist for a variety of radionuclides in these waters, only cancer risks from ingestion of fish containing concentrations of these two radionuclides have been evaluated. Consideration of other radionuclides which are known to exist in this stream would increase the risk estimates derived in this risk screening. One should realize that the individual levels of contaminants used in the *Reasonably Maximally Exposed (RME)* estimates were, in fact, high-end, not maximum, values. The radioactive contaminant levels of all fish samples for each sampling station (STN) were averaged for that respective location. Next, those locations with the highest levels of specific radionuclides were selected as loci for further *RME* analysis. This *RME* approach is consistent with the Administrator's policy guidance on risk characterization.

This risk screening is based on preliminary data provided by the Georgia Department of Natural resources. The Georgia Department of Natural Resources is cooperating with EPA on further analysis of non-radiological contaminants in this waterway. We have learned that the Georgia Department of Natural Resources has new fish sampling data, but these data are not available to the Agency at this time. We hope to obtain these new data for further analysis of the risks in this community.

B. Relevance of this Risk Assessment for EPA Decision-Makers

The SRS F & H Area groundwater plume drains into Four Mile Creek. EPA Records of Decision (RODs) require groundwater remediation to prevent additional contamination of Four Mile Creek.

There is one perspective of this analysis which deserves special mention. Fish consumers in the Savannah River community may be highly exposed. In this community some of these fish consumers have been identified as poor people of color. EPA has evidence that some of these same people are, in fact, subsistence fishermen. Selection of this population segment was a matter of discovery of a highly exposed subgroup during the assessment process, and not a matter of a priori interest in the subgroup because of environmental justice considerations. These findings must be given careful consideration.

C. Caveats for the Risk Manager

For the most part, this risk screening addresses human health considerations, not ecological risks. There are other potential adverse human health effects, besides cancer, that could be produced by other non-radiological contaminants. The contributions of non-radioactive toxic compounds to the production of adverse human health effects, including cancer, are not analyzed here.

D. Public Involvement Issues

1. Ecological Considerations

a. Alligators and aquatic turtles (especially soft back and snapping turtles) have not been included in this risk screening. Even though these species are know to be harvested by local fishermen, creel survey-type data on these edible game species have not been located to date.

b. Another species of special interest are catadromous eels of the genus *anguilla*. These eels are apparently a favorite delicacy of local residents, some adult eels reaching about three feet in length. These eels migrate from the Savannah River to the Sargossa Sea (part of the North Atlantic between the West Indies and the Azores) to spawn. Some of these eels have been found on the Savannah River Site, specifically in Par Pond. However, to date, neither the Georgia DNR or Region IV's Environmental Services Division (ESD) have sampled these eels for heavy metals or radionuclides.

c. In consideration of these potential ecological impacts the reader should note that this risk screening focuses primarily on potential human health risks, not ecological risks. Nevertheless, in so far as several of these aquatic species are part of the human diet in this community, there are probably shared adverse impacts.

2. Human Health Considerations

1. Who are the people at greatest risk?

The people at greatest risk are subsistence fishermen, who in this area have been identified as primarily poor people of color.

2. What risk levels are they subjected to?

The estimated lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for a ***Reasonably Maximally Exposed (RME)*** rural resident ingesting Savannah River fish taken from these locations is **5.08E-4. In short, with arithmetic rounding, this risk from both radioactive and nonradioactive contaminants for a RME rural resident should be considered to be a "1.00E-3" risk.**

In other terms, one would expect one extra case of cancer in 1,000 such individuals with similar exposure.

3. *What are they doing, where do they live, etc., that might place them at this higher risk?*

These individuals are placed at greater risk by fishing at the Savannah River confluences of Four Mile Creek and Steel Creek, because these are the locations along the Savannah River with the highest concentration of radioactive pollutants.

4. *What is the average risk for individuals in the population of interest?*

The upper bound estimate of lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for an ***average*** <u>rural</u> resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is 6.25E-5. In short, with arithmetic rounding, this risk from radioactive and nonradioactive contaminants combined for a RME <u>rural</u> resident should be considered to have a "1.00E-4" risk.

In other terms, one would expect one extra case of cancer in 10,000 such individuals with similar exposure.

Hazard Indexes (HIs) obtained by ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS).

Four nonradioactive contaminants were analyzed for deleterious non-cancer systemic effects during a lifetime. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. The highest Hazard Index obtained was that for mercury (0.61). However, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

E. EPA Region IV Comments

The Office of Risk Assessment of WMD reviewed a draft of this risk screening. They considered it a balanced presentation of the potential risks associated with ingesting fish contaminated with CS-137, SR-90, H-3, and α along this 132.8 stretch of the Savannah River. Also, their technical comments were incorporated as appropriate.

READING FILE COPY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

APR 10 1996

4WD-FFB

Mr. Harry Mathis, Director
Division of Hydrogeology
South Carolina Department of
Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Ms. Cynthia Anderson
Savannah River Operations
U.S. Department of Energy
P.O. Box A
Aiken, South Carolina 29802

Mr. James C. Hardeman
Program Manager
Environmental Radiation Program
4244 International Pkwy, Suite 114
Atlanta, Georgia 30354

Subject: Joint DOE/EPA/DHEC Community Involvement Plan for the Savannah River Site

Dear Mr. Mathis and Ms. Anderson:

The purpose of this letter is to transmit a proposed communication plan regarding the issues discussed in our meetings held October 17, 1995, and February 6, 1996. Those issues included levels of contaminants contained in fish collected in tributaries leaving the Savannah River Site (SRS), and associated risks from exposure to those levels of contaminants.

Based on discussions during these meetings, the Environmental Protection Agency (EPA) expects the Department of Energy Savannah River Site (DOE-SRS) to work with the federal and state regulators to ensure that the public is informed of any risks associated with these contaminants. The EPA has prepared a plan for involving and notifying impacted stakeholders. As you will see in the enclosed plan, EPA would expect DOE to notify the list of impacted stakeholders of any related Department decisions and/or actions, e.g. public meetings and notices, etc. The EPA particularly encourages special consideration be made for those who may not be aware of the usual public notification processes.

Please find enclosed EPA's proposed plan for your review and further consideration. This plan is offered only for purposes of assistance and coordination. We hope that these draft documents will be helpful as information becomes available that should be passed on to interested parties and the general public. We would certainly recommend that the benefit of State experiences be included in DOE's efforts to involve the public.

Please contact Constance Jones of my staff, or me, for further information and action on this community involvement plan. Thank you again for your support and valuable contributions in better serving the public in this important matter.

Sincerely yours,

CBWarren

Camilla Bond Warren
Chief
DOE Remedial Section
Federal Facilities Branch

Enclosure

cc: Myra Reece, Aiken
Ann Ragan, Ex officio CAB
Keith Collinsworth, SCDHEC
Lil Mood, SCDHEC
Edward Younginer, SCDHEC
Russell Berry, Beaufort Office
Sandra Threatt, SCDHEC
Randy Manning, GA-DNR
de'Lisa Bratcher, DOE
Mary Flora, WSRC
Rick Ford, DOE
Wade Whittaker, DOE
Ben Gould, DOE
Tom Heenan, Ex officio, CAB

bc: Elmer Akin
Carl Terry
Pete Raack
MaryAnn Lynch, OSWER-HQ
David Levenstein, OFFE
Jon Richards
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J.R.STOCKWELL/js: 4WD-FFB: 347-3016/November-2-95/a:FISHYBIZ4.WP

Stockwell JRS **Warren**_____
29MAR96

Joint DOE/EPA/DHEC Community Involvement Plan for the Savannah River Site

Purpose

- To fully communicate these findings to all potentially affected communities

- To coordinate with State and federal counterparts on a risk communication strategy

- To identify important groups to notify regarding risk

How to Prepare for Community Interest in the Joint DOE/EPA/DHEC COMMUNITY INVOLVEMENT PLAN FOR THE SAVANNAH RIVER SITE

- *Step 1*

  Identify the contaminants, both radioactive and nonradioactive, in this watershed which are most likely to be of concern

  Note: This critical first step has just been accomplished.

- *Step 2*

  Obtain additional toxicity and exposure information on these contaminants, including information on any associated risks

  Of particular importance is interpreting the significance of this technical information to personal health

- Step 3

  Identify the perceptions and concerns of individuals in these potentially affected communities

  - If possible, assess the "chemical risk" awareness in these potentially affected communities with some type of baseline study
  - Influencing factors may include proximity to downstream releases of SRS
  - It is absolutely critical that we know the public with whom we are dealing

- Step 4

  Determine the types of questions, specific to potentially affected communities, that we might be asked, such as *"Is it safe to drink my water?"* and *"Is it safe to eat fish taken from the Savannah River?"*

Strategy

1) Communicate findings

   a) What findings?

      - Contaminants
      - Type fish
      - Size fish
      - Found where?

   b) Recommendations

      - Don't eat
      - Eat limited amount (how much)
      - Anyone at risk?

2) Coordination (State & Federal)

      - Joint advisory
      - State advisory
      - Shared press advisory statements with organizations listed herein

3) Groups

      - Subsistence Fishermen
      - Sport Fishermen
      - South Carolina and Georgia Residents
      - Town of Martin
      - Town of Barnwell
      - City of Aiken
      - City of Beaufort
      - City of Hilton Head
      - City of Savannah

Answering Questions

- How we handle the calls as they come in?

- If we intend to designate people to answer questions, do we know who within Region IV, State, or locality are the contact points for answering specific questions?

- How will we document calls as they come in?

- If a serious problem is apparent what do we plan to do?

Assembling Information

- Have we assembled the appropriate materials that may be needed to answer the questions?

  - Do we have information related to the health and/or environmental effects of these radioactive contaminants?

    Note: As of this date the Agency does NOT have any available information of this type for any of these radioactive contaminants!

    * EPA Hazardous Substance Fact Sheets; (presently, none exist)
    * Agency for Toxic Substances Disease Registry (ATSDR) Toxicological Profiles; (presently, none exist)
    * Printouts from EPA's Integrated Risk Information System (IRIS); (presently these radioactive chemicals do not appear on IRIS)
    * And Chemical Emergency Preparedness Program (CEPP); (presently, none exist)

  - Do we have a listing of environmental medicine physicians and certified toxicologists in the potentially affected areas who are willing to assist in responding to citizens' health questions?

    Note: To date, no such listing has been compiled by any Headquarters or EPA Region IV staff member

  - Do we know the status of federal regulations on these radioactive contaminants?

- Do we know how Georgia and South Carolina regulate these radioactive contaminants?

Disseminating Information

- Have we made plans to distribute the risk analysis of these radioactive chemicals that this community involvement initiative is based on?
    - Will we distribute an executive summary of this risk analysis
- Do we have summary information that we can give to the public concerning:
    - The Community Right-To-Know Program?
    - Health and Environmental Effects?
    - Access to the original risk analysis?
    - Access to the fish data upon which the original risk analysis is based?
- Do other programs in Georgia, South Carolina, and the Savannah River Watershed as a whole know (or actually have) what we have in terms of materials we have assembled?
- Will we be developing communication channels for sharing call information between federal agencies, States, and localities?
    - If so, how will we publicize this information?

Important Groups to Notify/Involve

- *Key Interagency Liaisons*
    - Savannah National Wildlife Refuge
    - Georgia State Health Officer
    - South Carolina State Health Officer
    - Agency for Toxic Substances and Disease Registry (ATSDR)
    - National Oceanographic and Atmospheric Administration (NOAA)
    - U.S. Fish and Wildlife Service
    - Corps of Engineers (COE)

- U.S. Geologic Survey
- Natural Resource Conservation Service
  [Note: previously named Soil Conservation Service (SCS)]
- Georgia Department of Natural Resources
- South Carolina Department of Natural resources (SCDNR)

- *Environmental Interest Groups*

  - Coastal Conservation League
  - Costal Office of the Georgia Conservancy
  - South Carolina Wildlife Federation
  - Georgia Wildlife Federation
  - The Nature Conservancy, Georgia Field Office, Atlanta, GA
    [which services the Savannah area]
  - Greenpeace USA, Atlanta, GA
  - Sierra Club, Georgia Chapter, Atlanta, GA
  - Sierra Club, South Carolina Chapter, Columbia, SC
  - Georgia and South Carolina Bassmasters Chapters

  Note: These Environmental Interest Groups are the U.S. EPA Region IV field offices of the "Top Ten" national environmental groups which are located in either Georgia or South Carolina

- *Governmental Contacts*

  - All applicable congressional delegations
  - All applicable Offices of Mayor and Boards of County Commissioners
  - All applicable City and County Health Officers
  - Water Authorities for City of Savannah, City of Hilton Head, and City of Beaufort

- *Corporate Interests*

  - Savannah Seafood Restaurant Association(s)
  - Savannah Seafood Distributors
  - All applicable Fish Markets for Savannah River Fish
  - Georgia Power
  - All applicable Chambers of Commerce
  - All applicable Boards of Realtors
  - All applicable County Medical Societies

Intended Audiences

- Subsistence Fishermen who take fish from within two miles of the confluences of either Four Mile Creek, Steel Creek, or Lower Three Runs Creek
- Sport fishermen who take fish from within two miles of the confluences of Four Mile Creek, Steel Creek, and Lower Three Runs Creek or within 15 miles downstream of any of these streams
- South Carolina and Georgia Residents who live within two miles of the banks of the Savannah River from two miles above the mouth of Four Mile Creek to the Atlantic ocean
- Residents of Town of Barnwell; City of Aiken; City of Beaufort; City of Hilton Head; City of Savannah
- All applicable operators of bait shops and custodians of nearby boat ramps and bridges