ASSESSING CHANGES IN ENVIRONMENTAL RADIOACTIVITY AND HEALTH NEAR THE SAVANNAH RIVER SITE

A PROTOYPE TO BE USED AT DOE FACILITIES

A Report to the Community Involvement Fund
Radiation and Public Health Project
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December 5, 2011

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SUMMARY.

The Savannah River Site (SRS) a nuclear weapons facility operated by the federal government since 1950, is situated on the South Carolina-Georgia border, just 13 miles south of Aiken SC. Operations over six decades have left large amounts of radioactive (and non-radioactive) contaminants at the Site. With the end of the Cold War in the early 1990s, nuclear weapons manufacturing at SRS ceased, and soon the long and arduous process of Environmental Management (EM), or clean up, began. The U.S. Department of Energy (DOE), which oversees EM activities, has maintained consistently that its EM work is successfully decontaminating the area, a contention with which a number of citizen advocacy groups have taken issue.

This report will review existing data on contamination levels at or near SRS, along with trends on local health status; such data is plentiful, but virtually no attempt has been made to analyze it in a format understandable to the public. The findings are as follows:

1. Radioactivity Generally Increasing. From the late 1990s to the 2000s (when EM activities reached full capacity), emissions and environmental concentrations of radioactivity in or near SRS increased for 71% (45 of 63 types) of measures with complete data. With nuclear weapons manufacturing at an end and environmental remediation attempting to reduce radioactivity, this finding differs from the expectation that levels would steadily decrease over time.

2. Radiosensitive Health Indicators Worsening. In the five counties within 25 miles of SRS, with a current population of 417,000, rate increases in 96% (46 of 48) of radiosensitive diseases or causes of death exceeded that of the U.S. In 20, the increase was statistically significant. The categories included were those affecting the fetus (infant deaths, fetal deaths, low weight births); cancer among children and the very elderly; radiosensitive cancers (thyroid, female breast, and leukemia); and those conditions in which previous articles had detected a risk among SRS workers (leukemia, lymphoma, lung cancer, myeloma, and non-cancerous lung diseases).

3. Nearly 2,000 Excess Cases of Disease and Death in Nine Years. Approximately 2,000 "excess" deaths and cases of disease occurred in the five counties during the latest nine year period.

This report is important for several reasons. It provides substantial amounts of information that reflects DOE clean up operations not previously made understandable to "stakeholders" with an interest in SRS. It questions the DOE assertion that its EM operations are reducing contamination at SRS. It establishes a basis for evaluating EM operations at SRS and other DOE nuclear facilities. Finally, it empowers "stakeholders" by providing them evidence they can use in future communications with the DOE, leading to a more transparent and more successful EM process. All of these benefits occur *before* the building of numerous new nuclear facilities at SRS, and hopefully will ensure that future DOE plans and activities maximize the safety and health of local residents and workers.

PREFACE.

The end of the Cold War over two decades ago halted nuclear weapons production in the U.S. But many years of furious efforts to generate as many of these weapons of mass destruction as possible left a sad legacy of extensive pollution at the sites managed by the Atomic Energy Commission (AEC), which passed authority to the Department of Energy (DOE) in 1975.

Since the early 1990s, DOE has embarked on a program of environmental management (EM) to remediate the environmental problems at each of the locations. Certain sites have been completed, while others will take years (and many billions of dollars) to complete. Some skeptics doubt whether complete remediation is even possible, while others question the DOE position that remediation is being accomplished in an efficient, effective manner. Even over 20 years later, enormous pollution problems remain at the nuclear weapons sites.

The Community Involvement Fund (CIF) presents an opportunity for independent experts to examine the degree to which DOE-EM efforts have reduced contamination to the environment and risks to health. The Radiation and Public Health Project (RPHP) has maintained a decades-long interest in radioactive contamination at U.S. nuclear plants, and the potential health threats they pose to humans. The following report will present RPHP research that evaluates DOE-EM efforts to reduce contamination and improve health near the Savannah River Site (SRS). Savannah River was one of the principal components of the U.S. nuclear weapons program for many years, and is still a site where federal officials are attempting to build new nuclear-related facilities.

SAVANNAH RIVER – ONE OF THE MOST RADIOACTIVE SITES.

SRS, which was known for years as the Savannah River Plant, is a 310 square mile plot of land in the southwest portion of South Carolina. The site is close to two large cities, Aiken SC (13 miles to the north) and Augusta GA (20 miles to the northwest). Just along the northern edge of the SRS perimeter are the South Carolina towns of Jackson, New Ellenton, Snelling, and Williston, poor and rural communities with a population of just over 7,000. Along its southwestern edge runs the Savannah River, which flows towards and empties into the Atlantic Ocean at Savannah GA, about 100 miles from the plant.

About 750,000 persons live within 50 miles of SRS. At the plant alone, there are hundreds of species, including birds (260), reptiles (60), amphibians (40), freshwater fish (85), mammals (50), and plants (950). (Jannik and Manatey)

In the late 1940s, federal officials selected Savannah River as a site for its weapons production program, largely because of the access to a large body of water needed to operate nuclear reactors. The land was previously a series of small towns and farms, which was cleared to make way for the new complex. In an act of patriotism during the Cold War, local residents loyally stepped aside for the new plant that was to play a major part in America's nuclear arms program.

About 1000 facilities were eventually built at SRS, all bunched in an area that made up only about 10% of the land (Appendix 1). The key facilities were five large nuclear reactors, which produced virtually all of the tritium and half of the plutonium in the U.S. used as fuel for nuclear weapons. These reactors were built rapidly, and were all operating by 1955 (below):

REACTOR	START	CLOSE
Tritium-producing reactor – R	1953	1964
Tritium-producing reactor – P	1954	1988
Tritium-producing reactor – K	1954	1992
Tritium-producing reactor – L	1954	1988
Plutonium-producing reactor – C	1955	1985

Operations at SRS, which were critical to the U.S. effort to build an arsenal for what many believed to be an inevitable nuclear war with the Soviet Union, generated a huge amount of pollution. Some of this radioactivity was emitted into the environment, while the remainder had to be stored as high level waste. The history of slipshod management practices to reduce environmental health risks at the plant has been well documented. The priority given to safety and health was far behind the primary purpose of SRS – to produce as much fuel for nuclear weapons as quickly as possible.

Many dangerous practices at SRS were kept secret from the American public and its leaders. Not until the end of the Cold War did clandestine secretive practices and the extent of contamination at the site become publicly known. Senator John Glenn held hearings in late 1988 first publicizing these problems.

A corollary to the radiation-related environmental problems at SRS is the operations at nearby facilities. The Barnwell Radioactive Waste Facility just 10 miles east of SRS has been accepting low-level radioactive waste from various sources since its opening in 1971. The Alvin Vogtle nuclear power plant, just across the Savannah River from SRS, has operated two large reactors since the late 1980s. Recently, Vogtle was recently named the recipient of $8.3 billion in federal loan guarantees, and early construction of two new reactors has begun.

SRS ADDING NEW OPERATIONS AS WELL AS CLEANUP.

One of the five reactors (reactor R) closed in 1964, but the others continued operating until the end of the Cold War. At that point, the original contractor that operated the plant (E.I. du Pont de Nemours) had been replaced by Westinghouse (in 1989). Facilities aside from the five main reactors, such as those used for converting isotopes, storing waste, and storing fuels, have been closed as well.

The site has many facilities still operating. These are used for nuclear research and development, production of new radioactive isotopes, nuclear waste processing, plutonium processing, and storage of spent (used) fuels.

But what makes SRS stand out from virtually all other DOE nuclear weapons sites is the new facilities that are being planned. In 2007, construction began on a MOX (mixed oxide) facility in Aiken SC (near SRS), which converts plutonium from decommissioned nuclear weapons into fuel for nuclear power plants. The DOE is planning new research reactors and facilities to store plutonium at SRS. DOE has also chosen the site for a new plant that will reprocess used high-level nuclear fuel, a dirty method that was attempted briefly at the West Valley facility near Buffalo NY, but scrapped in the 1970s by Presidents Ford and Carter leaving behind a highly toxic mess at the site. Finally, the two new power reactors at Vogtle, just a few miles from SRS, complete the list of new nuclear facilities in the area. Reprocessing was also conducted at SRS, also leaving considerable contamination.

Thus, the effort to understand the extent of cleanup and health improvements is not just necessary, but timely – before the startup of these other facilities, in what still is one of the most radioactive places on earth. While all DOE sites should be scrutinized by parties independent of the DOE, RPHP selected Savannah River to provide stakeholders with valuable information BEFORE the opening of these new nuclear facilities, to affect public policies so that they best protect local residents and workers.

CLEANUP A TALL ORDER – WILL TAKE MUCH MORE TIME.

The DOE remediation program at SRS is a massive undertaking that began in 1993 and the Department expects it to continue until 2031 (some believe it will take considerably longer than that). The lengthy time needed to complete remediation may partly be attributed to substandard planning and execution. But some contend a substantial factor is that the site is highly contaminated with liquid radioactive sludge, radioactive soil in waste dumps, radioactive groundwater, and high levels of airborne radioactivity still being released from both operations and cleanup. (BREDL)

The radioactive contamination at SRS features tritium, a gamma-releasing chemical with a half life of 13 years. In addition, slow-decaying radioactive by-products (known as fission products) such as Plutonium-239, Cesium-137, and Strontium-90, remain on the site, and without proper remediation, will do so for hundreds and thousands of years. SRS also produced a large amount of non-radioactive metals such as mercury and lead, along with toxic chemicals including sulfur dioxide, carbon monoxide, nitrogen dioxide, and Volatile Organic Compounds, that now contaminates the site. Much of the waste is buried at seepage basins, reactor disassembly basins, landfills, original reactors, and ponds at SRS. Many of these are leaking, worsening the problem. (ANA)

This project, as an outgrowth of the CIF mission, occurs at an important time. Because the cleanup at SRS will take at least 20 more years, and quite possibly many more than that, it is critical that the work be performed with maximum competence and efficiency.

The DOE (and its predecessor agency Atomic Energy Commission) has performed work in a substandard manner with respect to public safety and health, both while manufacturing nuclear weapons and during remediation. Accompanying this substandard work is a lack of accountability to the public, who paid for weapons production and is paying the enormous price of remediation. RPHP believes that increasing public accountability of DOE work will improve the effectiveness and efficiency of the work.

RPHP will document patterns and trends of how much contamination is still being released into the environment, how much remains in the environment, and what health risks these toxins may pose. It will rely on knowledge of problems identified thus far by stakeholders, mostly concerned groups of citizens. As the project progresses, it will return findings to these stakeholders, who will be encouraged to use these in efforts to make the DOE improve its work at SRS. Other stakeholders such as media and public officials will be urged to do the same.

CITIZEN OPPOSITION TO DANGEROUS PRACTICES AT SRS.

A culture of secrecy prevailed among government officials and subcontracting industries during the period when nuclear weapons were manufactured. This culture was an outgrowth of the national security incentives that required secrecy in building the original atomic bombs during World War II and in building more bombs in the subsequent nuclear arms race with the Soviet Union. Unfortunately, this secrecy gave government and industry leaders complete control over bomb production with virtually no public accountability, and allowed them to contaminate sites like SRS – and put the lives of workers and local residents in danger - in the name of national security.

Some, including nuclear weapons workers, felt that harmful practices should have been corrected; however, they either felt fearful of speaking out or their contentions were stifled by DOE leaders. As the Cold War waned and the national security imperative of making more nuclear weapons ended, the atmosphere of secrecy surrounding nuclear weapons plants like SRS thawed. Senator John Glenn was probably the first to identify problems at the plant during Senate hearings in October 1988.

Subsequently, concerned citizens began organizing and going public with concerns about SRS. Among the most prominent of these groups are:

- Alliance for Nuclear Accountability
- Blue Ridge Environmental Defense League
- Friends of the Earth
- Institute for Energy and Environmental Research
- Radioactive Waste Management Associates
- South Carolina Sierra Club
- The RadioActivist Campaign
- Nuclear Watch South
- Women’s Action for New Directions

These organizations have produced a number of publications on the environmental contamination at SRS. Some are focused solely on SRS, while others examine a broader range of DOE nuclear weapons facilities, including SRS. Among these publications, listed by the publishing agency, are the following:

1. Alliance for Nuclear Accountability. In 2004, ANA published an extensive 270 page report that had been prepared by Radioactive Waste Management Associates, using a grant from the Citizens Monitoring and Technical Assessment Fund. The report's chapter on SRS described the site, its demographics, the extent of contamination, and the cleanup efforts being made by DOE. Making note of the vast contamination and threat to the area's water supply and the slow progress to date to remediate it, the report concluded that "It is unwise for the facility to accept additional hazardous materials when it is still unknown how to securely store the large inventory of plutonium and other dangerous substances already on site." (Alliance for Nuclear Accountability).

2. Blue Ridge Environmental Defense League. In 2007, BREDL produced an 84 page report entitled "Sow the Wind" describing types of pollutants from ongoing operations at SRS and their potential hazards. Among these were storage of highly radioactive liquid waste, storage of spent fuel elements, dis-assembly and reprocessing of plutonium pits, recovery and recycling of excess plutonium/uranium for MOX reactor fuel, and production of replacement tritium. The conclusion of "Sow the Wind" was that no new facilities should be built at SRS. (Zeller and Utley)

3. Institute for Energy and Environmental Research - 1997. In October 1997, members of the group produced a report on waste disposal at various DOE facilities. It described the contents of SRS waste disposal sites, including the Old and New Burial Grounds (discarded tanks, pipes, other equipment, reactor and fuel hardware, clothes, gloves, plutonium-238 from the Mound and Los Alamos sites, and debris from two accidents involving planes carrying nuclear weapons in Spain and Greenland). It also described the burial trenches that are filling with water, making cardboard boxes in the trenches collapse. (Fioravanti and Makhijani)

4. Institute for Energy and Environmental Research – 2004. In October 2004, IEER produced another report voicing concerns about the DOE plan – agreed to by Congress and the state of South Carolina – to permanently cover an unspecified portion of high level waste in underground tanks at SRS with cement-based grout. The author indicated that this plan could allow huge amounts of contamination to reach the groundwater below SRS in decades, and that gradual leaching was preferable to burial with grout. (Smith)

5. The Radioactivist Campaign. The group known as TRAC issued a report in 2003 that investigated patterns of radioactive cesium and cobalt at the SRS site. It examined levels in dust from pine needles, squirrel tails, and sorrel from Tinker Creek in the northeast portion of SRS. Findings were that local levels were at least 50 times greater than background concentrations. (Buske)

Perhaps due to the efforts of citizen groups, government agencies also weighed in on the situation at SRS. In 1991, the Office of Technology Assessment published a report on threats to water sources at nuclear weapons sites, especially non-arid sites like SRS. (U.S. Congress) Eight years later, the National Academy of Sciences issued a report on remediation of contaminated groundwater and soil at DOE sites, emphasizing the extent of the problem and slow progress to date. (Committee on Technologies for Cleanup)

DOE made some modifications and some practices became somewhat more public, but the culture of secrecy, coupled with safety/health taking a back seat proved difficult to remove entirely. Thus, the need for independent studies of contamination and health in places like SRS remain as important as ever.

LITERATURE REVIEW OF STUDIES OF SRS CONTAMINATION.

Trends in Contamination Over Time Virtually Unaddressed. In addition to the reports by citizen organizations on contamination at SRS, the medical literature was searched for similar studies. There are a number of reports on patterns of contamination at or near the SRS site, almost always indicating elevated levels at the site compared to offsite locations – but only a single study examining trends over time was identified. This article was published in January 2011 by researchers at the Savannah River National Laboratory in Aiken SC. It documented that concentrations of radioactive Iodine-129 in groundwater in a well near leaking basins closed in 1988 have risen from 200 to 400-1000 picocuries per liter from 1993 to the present.

This change represents a rise in I-129 concentrations of 2-5 times in less than two decades – the era of clean up. The authors conclude that these increases "may be exacerbated by the initial remediation efforts." (Kaplan et al). I-129 has a half life of 15.7 million years, and thus remains on earth forever. While this is just one article, it represents a warning that SRS remediation activities may not necessarily results in reduced radiation burdens and improved health.

Patterns of Contamination Show Much Higher Levels at/near SRS. With just a single article assessing trends in contamination – one of the goals of this report – a search of the medical and scientific literature addressing patterns of contamination at or near SRS was also conducted. Many more articles comparing onsite vs. offsite radioactivity patterns were found, including studies of the environment (air, water, soil) and animals/plants.

It is not necessary to cite all of the studies that concluded levels of radioactivity close to SRS were higher than more distant sites, as there is uniform agreement about this pattern. However, some studies are worth mentioning to illustrate the magnitude of SRS contamination, especially when in-body radioactivity levels were the subject because in-body radiation levels are directly correlated with health risks. One showed that the whole body count of radioactive tritium (H-3) in mice at the site was 1750 times higher than mice in more distant sites. (Kelsey-Wall et al.) Another examined I-129 in the thyroid glands of local deer, finding levels near SRS hundreds to thousands of times above sites far from nuclear facilities. In addition 89% of deer samples near SRS exceeded the level of 0.1 becquerels of Iodine-129 per gram^{-1}, far more than the 38% figure recorded at the highly contaminated Oak Ridge site. The author described I-129 as a "marker for fission products," or all radioactive chemicals. (Van Middlesworth)

Other articles examined environmental levels of contamination including Cesium-137 in the Savannnah River, Plutonium-239 in groundwater, Tritium Oxide in the air, and Tritium, Technecium-99, and Iodine-129 in water. Animal studies reviewed levels of various radioactive chemicals in local snakes, raccoons, sea bass, and alligators. All articles consistently found much higher concentrations at the SRS site, but unfortunately none examined changes over time, during the period when atomic bombs were built, and during the subsequent period of remediation. This lack of information makes the need for the current project all the more critical, as communities need to be informed about important topics like contamination and trends in health.

At least one article suggested that the official measurements of environmental radioactivity were strongly underestimated. This report, based on 10,000 samples, found that within 80 kilometers of SRS, there had been 280,000 person-rems of exposure to residents, compared to the government estimate of just 6,000 person-rems within 100 kilometers. The report found that the highest exposures occurred from the early 1950s to the early 1960s. (Franke and Alvarez)

LITERATURE REVIEW OF SRS HEALTH STUDIES – WORKERS.

A search was also conducted for any peer-reviewed journal articles on human health hazards posed by contamination at SRS in the medical literature. Very few such articles exist, even though SRS began operating over 60 years ago.

Most studies of health effects to humans at SRS concerned plant workers. This group is easier for researchers to study, since 1) workers wear badges and a "dose" is measured each day of work, and 2) health records of current and former workers are maintained by the DOE.

A group of researchers from the University of North Carolina School of Public Health led by epidemiology professor Dr. Steven Wing has been most active in studying SRS worker health. Wing and his colleagues became interested in SRS in the 1990s, having studied worker exposure and health at the Oak Ridge facility. The UNC group published its first article on SRS in 2000, analyzing multiple myeloma mortality for 489 workers at Oak Ridge, Hanford, Santa Susana, and SRS facilities; they found elevated risks, especially for blacks, workers hired before 1948, and persons receiving doses at older ages. (Wing et al).

In the last several years, Wing and colleagues have published a number of journal articles specifically focused on SRS workers, using large data bases ranging from 13,000 to 19,000 SRS workers, and found the following:

- Lung cancer risk is linked with occupational radiation exposure when adjustment is made for smoking among deceases workers and living controls (Richardson and Wing, 2011)

- Deaths rates were elevated among SRS male workers for cancer of the pleura and leukemia (workers paid hourly or monthly), and female cancer of the kidney and skin (Richardson, Wing, and Wolf)

- There is a relationship between rising tritium intake and rising mortality from leukemia, especially for myeloid leukemia (Richardson and Wing, 2007)

- There is a link between dose and risk of dying of lymphoma – similar to the link found in survivors of the Hiroshima and Nagasaki bombs (Richardson et al)

Few other published studies, other than the above, examined SRS workers. One recent study by Duke University looked at health records from construction workers at SRS, Oak Ridge, Hanford, and the DOE Amchitka sites in Alaska. The study found below-average death rates for all causes, but significantly elevated rates for all cancers (28% higher), lung cancer (54% higher), mesothelioma (493% higher), and asbestiosis (3289% higher). (Dement et al)

Another study from 1983 found no elevation in death rates from all causes and all cancers among workers at the Rocky Flats, Mound, Los Alamos, and SRS facilities. (Voelz et al) Another pointed out the need to explain why relative mortality rates among SRS workers were lower for blacks than whites. (Wartnenberg et al) Still another found significantly higher rates of pulmonary diseases (other than lung cancer) for SRS male workers. (Makie et al).

Overall, there is growing evidence that SRS workers suffer from elevated rates of cancer and other diseases. However, there are only a small number of studies published in the medical literature, and many of these have been conducted only in recent years, suggesting that additional analyses be conducted, as many SRS workers are aging and are dying in greater numbers.

LITERATURE REVIEW OF SRS HEALTH STUDIES – RESIDENTS.

Although there is a relative paucity of articles on health of SRS workers, there are even fewer on health of persons living proximate to the site. In 1982, Dr. Carl Johnson, a public health official in Colorado near the Rocky Flats plutonium production site, published an article revealing "preliminary report on significant increases of cancer" near Los Alamos, Rocky Flats, and SRS, especially in cancers most sensitive to radiation. (Johnson) In 1985, Franck and Alvarez used a data base of 10,000 environmental radiation readings to translate figures into amounts of radiation that local residents absorbed from SRS, and estimated up to 50 additional cancers. (Franck and Alvarez) But years passed after these reports, with no additional articles assessing impact of health of local residents from SRS.

Other studies that addressed potential health risk from persons living near SRS, all published between 1998 and 2001, include:

- Hypothyroidism – or under-active thyroid gland, which can be caused by exposure to radioactive iodine - in newborns near SRS over two decades were no different than in other groups (Helfrick et al).

- The 1991-1995 incidence of childhood leukemia near SRS was lower than near the Kruemmel nuclear plant in Germany, which released smaller amounts of radioactivity than did SRS (Grosche et al)

- A team from Rutgers University used estimated cancer risks to children along with contamination levels (of radioactive cesium and six metals) in SRS-area mourning doves, the most popular U.S. game bird, to conclude that local wildlife not use contaminated reservoirs (Burger et al, 1998)

- The Rutgers team estimated, based on Cesium-137 levels in bass (fish), that fisherman consuming bass would have a 20 times greater risk of developing cancer from fish caught in Steel Creek at the SRS site, compared to the Savannah River (Burger et al, 2001)

Considering has been operating since 1950, there is a great paucity of information in the professional literature on health risk to local residents. While there are methodological obstacles to assessing any radiation-cancer link, but it is troubling that so few efforts have been made to assess this link, which affects tens of thousands of workers and millions of local residents over the past six decades.

The only study by federal officials on cancer near nuclear plants was mandated by Senator Edward M. Kennedy. Released in July 1990 by the National Cancer Institute, the study included cancer data near 62 U.S. nuclear sites (including SRS). The report concluded that "the survey has produced no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities." (Jablon et al)

Despite this conclusion, a number of analysts found problems with the study. First, the data only covered the years 1950 to 1984, which is now at least 27 years old (no similar study has been attempted since). Second, only mortality data were used (except for facilities in Connecticut and Iowa), since no established cancer registry existed in most states during the period of study. Third, no accounting for upwind/downwind or upstream/downstream communities was made in the study.

There were other critiques, but perhaps the most important one was that study data near a number of U.S. nuclear plants often raised "red flags" suggesting that radiation released from nuclear plants <u>increased</u> the risk of cancer in local residents. For example, incidence data near nuclear plants near Iowa and Connecticut consistently showed a rise in childhood cancer and thyroid – which are generally acknowledged to be most closely linked with radiation exposure - after plant startup:

Nuclear Plant	Before Startup	After Startup	Standard Incidence Ratio+ (Cases) Before Startup	After Startup	Change
Thyroid Cancer					
Haddam Neck CT	1950-67	1968-84	0.94 (36)	1.03 (76)	**+ 9**
Millstone CT	1950-70	1971-84	0.69 (64)	0.79 (90)	**+10**
Duane Arnold IA	1969-74	1975-84	0.92 (23)	1.13 (77)	**+21**
Ft. Calhoun IA	1969-73	1974-84	0.52 (1)	0.92 (6)	**+40**
TOTAL			0.785 (124)	0.950 (249)	**+16.5****
Childhood Cancer, Age 0-19					
Haddam Neck CT	1950-67	1968-84	0.86 (62)	0.96 (95)	**+10**
Millstone CT	1950-70	1971-84	0.88 (173)	1.03 (172)	**+15***
Duane Arnold IA	1969-74	1975-84	1.06 (50)	1.28 (119)	**+22***
Ft. Calhoun IA	1969-73	1974-84	0.82 (2)	1.05 (9)	**+23**
TOTAL			0.903 (287)	1.076 (249)	**+17.3****

* Borderline significant at p<.06; ** Significant at p<.05
\+ County rate vs. state rate; for example, and SIR of 1.02 means the county rate exceeds the state by 2%

The Standard Incidence Ratio (county rate divided by state rate) rose consistently near all four facilities. For thyroid cancer, the SIR rose from 0.785 to 0.950 (-21.5% below the state to -5.0% below the state), while the rise for child cancer was 0.903 to 1.076 (-9.7% below to +7.6% above). Increases were consistent for each of the four facilities.

Unfortunately, the 1990 NCI study only contained mortality data near SRS, as neither Georgia nor South Carolina had an established cancer registry by the late 1980s. However, data in the study suggests that over time, as composite releases from the plant increased, local cancer risk increased as well. The NCI selected Aiken and Barnwell Counties (South Carolina) along with Burke County (Georgia) as most proximate to the SRS facility. Mortality data for all cancers (except leukemia, which accounts for only 4% of cancer deaths) in the three-county area were as follows:

Period	Deaths	SMR	% Local vs. U.S. Rate
1950	74	0.74	**- 26%**
1951-1955	473	0.88	**- 12%**
1956-1960	548	0.91	**- 9%**
1961-1965	621	0.90	**-10%**
1966-1970	724	0.91	**- 9%**
1971-1975	838	0.90	**-10%**
1976-1980	1047	0.94	**- 6%**
1981-1984	1005	0.99	**- 1%**

From the early 1950s to the early 1970s, the three-county cancer death rate was 9 to 12 percent below the U.S. In the periods following, the local rate moved to -6% and then to

-1% --- about equal to the U.S. Thus, since SRS started operating, these three proximate counties no longer have a low cancer death rate.

STUDIES (NOT IN MEDICAL LITERATURE) OF SRS HEALTH

In addition to the articles that appear in medical and scientific journals, other reports address health status of Savannah River Site workers and nearby residents. These are not as critical as those in journals, as they are often just in-house publications that may be subject to the bias of the writer(s) and the organization. Still, it is worth understanding what has been found thus far, prior to the original data and analyses in this report.

The reports are taken from a 2002 compilation by the Westinghouse Savannah River Company and the U.S. Department of Energy (Brown, Crase, and Singh). Working under an Energy Department contract, these reviewers listed 16 such articles, 12 about SRS workers and 4 on local residents, published between 1976 and 2000. Only 2 of the 16 reports were eventually sent to a peer reviewed scientific journal for publication.

Thirteen (13) of 16 reports failed to identify any disease or death rates near SRS that exceeded the expected rate. Of the other three, only a few elevated local rates were identified, and each still concluded there was “no link” between radiation exposure and disease risk. The three reports include:

- The National Cancer Institute and Environmental Protection Agency prepared a report U.S. Cancer Mortality Rates and Trends, 1950-1979. They found that an elevated lung cancer death rate in Aiken County starting in 1960; the study ends in 1979.

- A 1991 draft report by the Westinghouse Savannah River Company found higher leukemia mortality among workers with the highest exposure

- A 1997 DOE study (still in the early stages at the time) found elevated skin cancer in white female workers and breast cancer in males (based on 9 and 3 deaths, respectively).

The fact that most studies found no adverse health effects, that most were not subjected to peer review in journals, and that most were written by federal employees or their contractors, supports the contentions of the various citizen groups already mentioned, i.e. that the DOE cannot be an unbiased, objective party to studying contamination and health near SRS, and that independent experts should instead conduct such research.

CONTAMINATION TRENDS.

This section will explore historical data on **trends** in radiation emissions and radioactivity levels at SRS or close to it, various sources. These sources include:
- The U.S. Department of Energy, Environmental Monitoring Section
- The South Carolina Department of Health and Environmental Control
- The Georgia Department of Natural Resources
- The Georgia Power Company Alvin Vogtle Electric Generating Plant

The DOE must comply with numerous local, state, and federal laws in its environmental monitoring/cleanup operations. (Terry) Among the federal laws that it must address (listed by years enacted) are:

1899 Rivers and Harbors Act of 1899
1947 Federal Insecticide, Fungicide, and Rodenticide Act
1966 National Historic Preservation Act
1969 National Environmental Policy Act
1970 Clean Air Act
1973 Endangered Species Act
1974 Safe Drinking Water Act
1976 Toxic Substances Control Act
1976 Resource Conservation and Recovery Act
1977 Clean Water Act
1980 Comprehensive Environmental Response, Compensation, and Liability Act
1986 Superfund Amendments and Reauthorization Act
1986 Emergency Planning and Community Right-to-Know Act
1992 Federal Facility Compliance Act

The DOE has established a relatively complex system of monitoring environmental radioactive releases and contamination. The next few sections will summarize trends for a number of radiation measures.

A. U.S. Department of Energy – Program to Monitor Radioactivity. The primary responsibility for taking environmental samples of radioactivity levels and monitoring patterns and trends lies with the U.S. Energy Department. To this end, the Environmental Permitting & Monitoring Group at DOE compiles an Annual Environmental Report. By the summer of 2011, reports for each year from 2001 to 2009 were available on line, and some contained results for years prior to 2001, enabling an analysis of trends for the period after cessation of nuclear weapons production to be conducted. (Environmental Permitting & Monitoring Group)

The DOE probably has greater and more sophisticated resources to assess contamination patterns of contamination at the SRS site. However, the long-standing concerns of DOE management of the site and potential concerns about DOE interpretation of data by many in the local community and among regional and national environmental leaders suggests strongly that DOE data should not be the only source to rely on.

The DOE reports indicate that SRS releases are a result of 1) legacy contamination at the site, and 2) ongoing operations processing nuclear materials at the site. Whatever the relative weight of these two factors, successful remediation activities should result in lower releases and lower environmental levels of radioactivity over time.

Radioactive airborne effluent releases are tracked by DOE officials using online monitoring and/or sampling systems. Samples of liquid effluents from discharge points are taken to labs with greater ability to detect concentrations of radioactivity. Non-radioactive chemicals are actually measured by the South Carolina Department of Health and Environmental Control, through sampling broiler exhaust gases, monthly samplings, and pollutant monitoring control devices. Results are presented in annual DOE reports. (Faugl et al)

The DOE operates an extensive system that measures radioactivity levels at or near the SRS site. It maintains 15 air stations, 15 rainwater stations, stations at each of 5 streams leading into the Savannah River, multiple stations in the Savannah River upstream and downstream of SRS, 4 stations at water treatment facilities that use Savannah River water, a sampling program of terrestrial food in each SRS quadrant, 9 surveillance points on the Savannah River for aquatic food, a program for analyzing deer and feral hogs during hunting season, 15 soil sampling locations, 27 sediment sampling locations in the beds of the Savannah River and its streams, a vegetation program of Bermuda grass, and 54 locations in Savannah River swamps. (Padgett et al)

In addition, the DOE estimates potential radiation doses to local humans. Maximum exposures to humans from airborne and liquid emissions are calculated, as are maximum doses to hunters and fishermen. (Jannik et al)

1. Tritium Emissions. Because tritium was produced at SRS for many years, and because it decays slowly (half life of 13 years) this radioactive isotope is probably more plentiful at SRS than any other. The DOE claims that tritium makes up 99% of all airborne radioactive emissions from the site. The latest DOE annual report provides annual airborne releases of tritium from 1992 to 2009 (Table 1):

Table 1
Annual Airborne Releases of Tritium From SRS, 1992-2009

Year	Releases (curies)	Year	Releases (curies)
1992	156,000	2001	47,400
1993	191,000	2002	47,300
1994	160,000	2003	50,000
1995	97,000	2004	61,300
1996	55,300	2005	40,800
1997	58,000	2006	34,600
1998	82,700	2007	30,800
1999	51,600	2008	34,600
2000	44,800	2009	36,900

Period	% Change	Annual % Change
1992 to 1996	-64.6%	**-16.2%**
1996 to 1997-2009	-13.7%	**- 1.1%**

Annual tritium releases plunged 64.6% from 1992 to 1996, after nuclear weapons production ceased, but before the cleanup program began. But while the declines continued after 1996, they were much slower. The annual average of 47,700 curies in the 13 year period 1997-2009 was only 13.7% less than the level of 55,000 reached in 1996. A number of factors could account for the sharply slower decline. Because weapons production ceased by the early 1990s, it is possible that a most of the tritium emissions represent remediation activities.

Another means of recording tritium contamination at SRS is the concentration of this chemical in liquid. The DOE annual reports include this amount in each year from 2001 to 2009, and these figures are displayed in Table 2.

Table 2
Annual Liquid Release of Tritium From SRS, 2001-2009

Year	Releases (curies)
2001	4,320
2002	4,830
2003	7,450
2004	3,630
2005	4,480
2006	3,330
2007	1,940
2008	2,660
2009	2,780

Period	% Ch.	Annual % Ch.
2001 to 2002-2009	-10.0%	**- 1.3%**

Clearly, the amount of tritium released each year at the end of the decade is considerably lower than in 2001. But several "jumps" early in the decade (2002, 2003, and 2005) mean that the 2002-2009 average was little changed from 2001 (10% less). The annual decline of -1.3% is similar to the figure of -1.1% for airborne releases (Table 1).

One type of liquid emissions of tritium from SRS - to streams at the site - is also reported annually by DOE. Table 3 presents each year's total from 2000 to 2009.

Table 3
Annual Liquid Releases of Tritium From SRS Into Site Streams, 2000-2009

Year	Releases (curies)
2000	1,795
2001	1,748
2002	1,140
2003	1,553
2004	756
2005	326
2006	214
2007	684
2008	320
2009	238

Period	% Ch.	Annual % Ch.
2000 to 2005	-81.8%	**-16.4%**
2005 to 2006-2009	+11.7%	**+ 2.9%**

From 2000-2005, there was a sharp plunge in liquid tritium releases at SRS, especially in 2004 and 2005. But since then, average amounts have increased slightly, mostly from a large rise in 2007. Again, the expectation that tritium releases should decline steadily each year as remediation activities progress is true in certain periods, but not in others. The fact that annual airborne and liquid tritium releases have not changed much in the most recent years leaves open the question of whether unneeded exposures are now being experienced by workers and local residents.

In addition to airborne and liquid releases of tritium, the amount of this isotope migrating from site seepage basins at the plant is also recorded by DOE each year. This statistic is a measure of the efficacy of cleanup activities, since one desired outcome is to reduce the amount of radioactivity leaking from the plant. Table 4 provides annual amounts of tritium migration from basins for the years 2001 to 2009.

Table 4
Annual Migration of Tritium From SRS Site Seepage Basin, 2001-2009

Year	Releases (curies)			
2001	2,675			
2002	2,007			
2003	2,783			
2004	1,927	Period	% Ch.	Annual % Ch.
2005	2,180	2001 to 2007	-50.8%	**- 8.5%**
2006	1,644	2007 to 2008-2009	- 3.7%	**- 1.8%**
2007	1,317			
2008	1,215			
2009	1,321			

After little change from 2001-2005, there were substantial drops in annual migration totals of tritium from the site in 2006 and 2007 – only to be followed by virtually no change in 2008 and 2009. This measure of tritium, along with the other two measures, shows an improvement in the long term. But in most recent years, typically the latter half of the first decade of the 21st century, the progress has sharply slowed, presenting a concern for environmental contamination and health risk.

2. Environmental Releases Other than Tritium. The annual liquid releases of tritium from SRS operations, discussed in the prior section, are accompanied by releases of 13 other isotopes in the DOE Annual Environmental Report. Release levels are much smaller than tritium, but should not be discounted. These toxic chemicals all have slow rates of decay, and exist in the environment for hundreds and thousands of years. They include the three isotopes that make up the great majority of high-level radioactive waste (Strontium-90, Cesium-137, and Plutonium-239).

Sr-90 and Cs-137 are often considered among the most toxic of the 100 to 200 radioactive isotope from atomic bombs and nuclear reactors. They emit hazardous beta particles that penetrate into the body, at a relatively rapid rate (their half lives of 29 and

30 years are far shorter than other isotopes in the DOE report). Sr-90 seeks out the bone, and can penetrate the bone marrow (where the red and white blood cells critical to the immune system that fight diseases like cancer are formed), while Cs-137 disperses throughout all the body's soft tissues and muscle.

Of the 13 isotopes, four (4) had incomplete reporting (Zinc-65, Technecium-99, Iodine-129, and Neptunium-237) and were not analyzed in this report. Annual figures and temporal trends for the other nine (9) are given in Table 5.

Table 5
Annual Liquid Releases From SRS, in Curies, 2001-2009

Year	Sr90	Cs137	U234	U235	U238	Pu238	Pu239	Am241	Cm244
2001	2.05^{-2}	6.58^{-2}	9.47^{-5}	1.70^{-6}	1.24^{-4}	4.50^{-5}	7.43^{-6}	7.07^{-6}	7.09^{-6}
2002	3.45^{-2}	7.63^{-2}	2.76^{-4}	1.09^{-5}	2.89^{-4}	1.15^{-5}	2.57^{-6}	1.05^{-5}	1.97^{-6}
2003	9.67^{-2}	2.10^{-1}	6.97^{-4}	2.43^{-5}	7.05^{-4}	1.52^{-4}	8.48^{-5}	1.32^{-4}	1.05^{-4}
2004	9.23^{-2}	6.77^{-2}	2.71^{-4}	8.74^{-6}	3.27^{-4}	2.13^{-4}	6.29^{-5}	4.33^{-5}	1.52^{-5}
2005	3.76^{-2}	1.34^{-1}	5.54^{-4}	2.68^{-5}	3.78^{-4}	9.85^{-4}	4.42^{-5}	9.22^{-5}	4.14^{-5}
2006	3.51^{-2}	8.87^{-2}	6.50^{-4}	2.50^{-5}	7.18^{-4}	3.65^{-4}	4.86^{-5}	7.62^{-5}	3.59^{-5}
2007	2.45^{-2}	4.18^{-2}	3.18^{-4}	1.46^{-5}	2.09^{-4}	2.59^{-4}	7.79^{-6}	3.16^{-5}	1.46^{-5}
2008	3.11^{-2}	3.96^{-2}	9.14^{-4}	3.26^{-5}	8.08^{-4}	1.07^{-2}	8.35^{-4}	4.86^{-4}	4.80^{-5}
2009	4.02^{-2}	9.15^{-2}	1.62^{-4}	2.17^{-6}	1.16^{-4}	2.28^{-3}	1.55^{-4}	1.05^{-4}	2.92^{-5}
Average									
2001-2	2.75^{-2}	7.11^{-2}	1.85^{-4}	6.30^{-6}	2.07^{-4}	2.83^{-5}	5.00^{-6}	8.79^{-6}	4.53^{-6}
2003-9	5.11^{-2}	9.62^{-2}	5.09^{-4}	1.92^{-5}	4.66^{-4}	2.14^{-3}	1.77^{-4}	1.38^{-4}	4.13^{-5}
% Ch.	+**86**	**+35**	**+175**	**+204**	**+115**	**+7448**	**+3438**	**+1560**	**+812**

Note: The isotopes included are Strontium-90 (half life 29 years), Cesium-137 (30 years), Uranium-234 (245,000 years), Uranium-235 (704 million years), Uranium-238 (4,468 million years), Plutonium-238 (87 years), Plutonium-239 (24,000 years), Americium-241 (432 years), and Curium-244 (18 years).

The results in Table 9 are startling. For 9 of 9 isotopes, the 2003-2009 average exceeded the 2001-2002 baseline. All increases were substantial; the lowest were Cesium-137 (+35%) and Strontium-90 (+86%). Some of these increases were staggering. For example, concentrations of Plutonium-238 soared 7448%, meaning 2003-2009 levels were more than 74 times higher than 2001-2002 levels. The rise for Plutonium-239 was 3438%, or 34 times greater. In addition, for many of the isotopes, the most recent years showed the greatest concentrations, meaning the increases are still occurring.

Each of the nine chemicals decays slowly. Four of them have half lives from 18 to 87 years, while half lives for the others are in the thousands and millions of years – meaning they will be part of the biosphere permanently.

These findings carry a strong and consistent message. In a period with no nuclear weapons tests above or beneath the earth, and when nuclear weapons production had ceased for at least two decades at SRS, concentrations of ALL long-lived isotopes released into liquid are rising rapidly. This pattern has several implications:

- plants and animals at the SRS site have been ingesting greater amounts of these highly toxic chemicals, which may eventually result in additional exposure to humans who eat irradiated plants or animals

- the possibility of additional liquid releases at SRS eventually entering water sources outside the plant, including drinking water, is also raised

- higher releases suggest workers and local residents may ingest more radioactivity through breathing

- rising liquid releases suggest similar trends in airborne releases, although the DOE annual reports do not provide these data

Another type of annual radioactivity emission measurement presented in DOE annual reports is levels entering Four Mile Branch from the General Separations Area (GSA) seepage basins. Four Mile Branch is one of five tributaries of the Savannah River that drain the SRS plant. The GSA is located at the F- and H- areas at the plant; from 1955 to 1988, the separation facilities in the area discharged hazardous chemicals into seven seepage basins (all but one unlined), which also contaminated the soil and groundwater between these basins and Four Mile Branch. (Friday) Four Mile Branch is one of the most contaminated areas of SRS, and of all nuclear facilities in the U.S.

The amounts of Strontium 89 and 90 (combined), Technecium-99, Iodine-129, and Cesium-137 entering the basins were recorded each year beginning in 2001. Table 6 provides the results, and the change in concentrations after the initial year.

Table 6
Annual Radioactivity Amounts Entering Four Mile Branch
From GSA Seepage Basins at SRS, in Curies, 2001-2009

Year	Sr89/90	Cs137	I129	Tc99
2001		37.5		45.6
2002	32.8	20.7		29.4
2003	94.1	69.8		
2004	91.5	29.2		4.9
2005	36.1	96.4	8.0	4.4
2006	33.1	41.3	8.3	6.4
2007	22.2		9.2	2.3
2008	25.4	153.0	19.9	9.7
2009	36.3	68.9	35.5	19.3

Average	Sr89/90	Cs137	I129	Tc99
Earliest	32.8	37.5	8.0	45.6
Subsequent	48.4	79.9	18.2	10.9
% Ch.	**+48**	**+113**	**+118**	**- 76**

Note: The isotopes included are Strontium-89 (half life 50 days), Strontium-90 (29 years), Iodine-129 (15.7 million years), and Technetium-99 (212,000 years).

Again, the trends in this table are concerning. The 48% rise in Strontium-89/Strontium-90 represents an up-and-down patters each year, but may be of greatest concern due to the very short half life of Sr-89 (only 50 days), which would indicate larger amounts of this isotope being generated THAT YEAR, not left over from long-ago operations. Another worry is Iodine-129; data are only available from 2005 to 2009, but the concentration in Four Mile Branch increased every year, more than doubling (+118%) during the four-year period. The one exception is Technetium-99, which showed a sharp decline during the decade – however, the latest two years (2008 and 2009) showed steady increases, exceeding all annual levels since 2002.

3. Radioactivity Concentrations in the Environment. Another set of data provided by DOE for which trends can be analyzed is the concentration of radioactivity levels in the Savannah River. Samples are taken at the river's mile marker 118.8, at the intersection of state Highway 301, located close to and downstream from the SRS plant. There are 10 radioactive chemicals for which sampling data are available for each year from 2001 to 2009 – the same listed in Table 5, plus Iodine-131. The findings (12 month average) are listed in Table 7.

Table 7
Annual Concentration of Radioactivity (12 Month Average), Various Chemicals
In Savannah River (mile 118.8 @ Highway 301)
In Picocuries of Radioactivity per Liter, 2001-2009

Year	Sr90	Cs137	U234	U235	U238	Pu238	Pu239	Am241	Cm244	I129
2001	4.84^{-6}	1.55^{-5}	2.24^{-8}	4.01^{-10}	2.93^{-8}	1.06^{-8}	1.75^{-9}	1.67^{-9}	1.67^{-9}	1.85^{-5}
2002	7.24^{-6}	1.60^{-5}	5.77^{-8}	2.28^{-9}	6.04^{-8}	2.40^{-9}	5.39^{-10}	2.20^{-9}	4.12^{-10}	1.64^{-5}
2003	9.72^{-6}	2.11^{-5}	7.01^{-8}	2.44^{-9}	7.09^{-8}	1.53^{-8}	8.52^{-9}	1.33^{-8}	1.06^{-8}	7.86^{-6}
2004	1.68^{-5}	1.23^{-5}	4.93^{-8}	1.59^{-9}	5.95^{-8}	3.88^{-8}	1.15^{-8}	7.88^{-9}	2.77^{-9}	1.42^{-5}
2005	4.58^{-6}	1.63^{-5}	6.75^{-8}	3.27^{-9}	4.61^{-8}	1.20^{-7}	5.39^{-9}	1.12^{-8}	5.05^{-9}	9.75^{-7}
2006	6.80^{-6}	1.72^{-5}	1.26^{-7}	4.84^{-9}	1.39^{-7}	7.07^{-8}	9.42^{-9}	1.48^{-8}	6.96^{-9}	1.61^{-6}
2007	5.09^{-6}	8.69^{-6}	6.61^{-8}	3.04^{-9}	4.35^{-8}	5.39^{-8}	1.62^{-9}	6.57^{-9}	3.04^{-9}	1.93^{-6}
2008	8.02^{-6}	1.02^{-5}	2.36^{-7}	8.41^{-9}	2.08^{-7}	2.76^{-6}	2.15^{-7}	1.25^{-7}	1.24^{-8}	5.13^{-6}
2009	7.12^{-6}	1.62^{-5}	2.87^{-8}	3.84^{-10}	2.05^{-8}	4.04^{-7}	2.74^{-8}	1.86^{-8}	5.17^{-9}	6.29^{-6}
Average										
2001-2	6.04^{-6}	1.58^{-5}	4.01^{-8}	1.34^{-9}	4.49^{-8}	6.50^{-9}	1.14^{-9}	1.94^{-9}	1.04^{-9}	1.75^{-5}
2003-9	8.30^{-6}	1.46^{-5}	9.20^{-8}	3.42^{-9}	8.39^{-8}	4.95^{-7}	3.98^{-8}	2.82^{-8}	6.57^{-9}	5.43^{-6}
% Ch.	**+37**	**- 8**	**+129**	**+155**	**+ 87**	**+7515**	**+3391**	**+1354**	**+532**	**- 69**

Note: The isotopes included are Strontium-90 (half life 29 years), Cesium-137 (30 years), Uranium-234 (245,000 years), Uranium-235 (704 million years), Uranium-238 (4,468 million years), Plutonium-238 (87 years), Plutonium-239 (24,000 years), Americium-241 (432 years), Curium-244 (18 years)., and Iodine-129 (15.7 million years)

Results of Tables 5 and 7 – trends in releases and concentrations of the same chemicals - are remarkably similar. While this pattern provides confidence in the consistency of the data, the results show a consistent trend of increases in radioactivity levels since 2001-2002. In the Savannah River, concentrations of 8 of the 9 isotopes increased, compared with 9 of 9 for emissions. The one exception was Cesium-137 in the Savannah River, which fell by 8% (the 35% increase in Cs-137 emissions was the smallest of all nine isotopes).

There are three isotopes with the largest increases by far – Plutonium-238, Plutonium-239, and Americium-241. The percent increases for releases and concentrations in the river are remarkably similar; Pu-238 (7448 vs. 7515), Pu-239 (3438 vs. 3391), and Am-241 (1560 vs. 1354).

The isotope for which concentrations in the Savannah River (but not emissions data) were available was Iodine-129. There was a substantial decrease in I-129 in the river, which is puzzling given the large and steady increases in the same chemical entering the seepage basin on the SRS grounds (Table 6). However, the concentration of I-129 in the Savannah River had risen steadily in the latest three years (2007, 2008, and 2009), nearly quadrupling during this time.

4. Non-Radioactive Toxic Emissions Into the Air. Another means of examining trends in contamination at SRS during the current era of remediation is to analyze levels of non-radioactive chemicals at the site. Historically, SRS produced substantial amounts of non-radioactive toxic chemical, along with radionuclides. Remediation activities are intended to reduce the amount of non-radioactive chemicals at the site, along with the radionuclides already discussed.

The DOE annual environmental reports include nine of these non-radioactive chemicals. The environmental concentration of each is affected by industrial uses. Each represents a threat to human health, as they are linked with higher risk of conditions such as cancer, respiratory diseases, and other conditions. They nine chemicals listed in the DOE report include

- Sulfur dioxide (SOx)
- Total particulate matter (PM)
- Particulate matter less than 10 micrometers (PM10)
- Particulate matter less than 2.5 micrometers (PM2.5)
- Carbon monoxide (CO)
- Ozone/Volatile Organic Compounds (O3)
- Gaseous Fluorides (GF)
- Nitrogen Dioxide (NOx)
- Lead and Lead Components (Pb)

Table 8 lists annual airborne emissions at SRS for each of these nine chemicals, given in tons, for each year from 2001 to 2008. Reporting is complete, with the exception of particulate matter under 2.5 micrometers for the years 2001-2004. Amounts are substantial, with a number of the nine chemicals typically emitting hundreds or thousands of tons into the air each year.

Table 8
Annual Airborne Emissions of Various Non-Radioactive Chemicals
From SRS Plant, in Tons, 2001-2009

Year	SOx	PM	PM10	PM2.5	CO	O3	GF	NOx	Pb
2001	5.37^{+2}	5.64^{+2}	5.71^{+2}	----	4.58^{+3}	1.54^{+2}	1.67^{-1}	3.87^{+2}	7.95^{-2}
2002	5.58^{+2}	2.15^{+2}	3.82^{+2}	----	1.22^{+3}	7.99^{+2}	1.26^{-1}	3.06^{+2}	3.47^{-1}
2003	5.36^{+2}	3.02^{+2}	2.45^{+2}	----	2.29^{+3}	9.33^{+1}	1.14^{-1}	2.66^{+2}	5.58^{-1}
2004	2.15^{+3}	4.89^{+2}	3.13^{+2}	----	9.28^{+3}	5.44^{+2}	1.39^{-1}	4.24^{+3}	1.58^{-1}
2005	6.97^{+3}	9.28^{+2}	1.96^{+2}	4.77^{+2}	1.03^{+3}	5.48^{+2}	1.43^{-1}	7.18^{+3}	1.74^{-1}
2006	5.10^{+3}	5.04^{+2}	9.86^{+1}	3.19^{+2}	7.83^{+1}	1.69^{+1}	1.42^{+1}	3.15^{+3}	7.60^{-2}
2007	4.25^{+3}	4.17^{+2}	1.18^{+2}	2.20^{+2}	7.62^{+1}	1.61^{+1}	1.27^{+1}	2.63^{+3}	1.91^{-2}
2008	4.07^{+3}	4.59^{+2}	1.89^{+2}	2.65^{+2}	6.73^{+2}	6.53^{+1}	1.22^{+1}	1.89^{+3}	2.67^{-2}
Average									
2001	5.37^{+2}	5.64^{+2}	5.71^{+2}	----	4.58^{+3}	1.54^{+2}	1.67^{-1}	3.87^{+2}	7.95^{-2}
2002-8	3.38^{+3}	4.73^{+2}	2.74^{+2}	3.20^{+2}	8.99^{+2}	1.95^{+2}	5.66^{+0}	2.81^{+3}	1.94^{-1}
% Ch.	+**529**	**- 16**	**- 52**	**----**	**- 80**	**+ 27**	**+3289**	**+ 626**	**+144**

For 5 of 7 types of chemicals with complete data, an increase in emissions was found in the period after 2001. (No change could be detected for PM2.5 because of missing data from 2001-2004). Some of the increases were extreme; for example, levels of gaseous fluorides rose 7161% above the 2001 level, while increases for Nitrogen Dioxide and Sulfur Dioxide were 626% and 529%, respectively.

Knowing that non-radioactive chemical releases are increasing is helpful information. It suggests that human health will be at greater risk over the past decade, as these non-radioactive chemicals also can increase rates of disease when ingested. These non-radioactive chemicals also work "synergistically" with radioactive ones – meaning that together, a combination of the two pose a much greater risk to health than a sum of the two. Rachel Carson's famous 1962 book Silent Spring was the first to discuss synergy in environmental toxins, noting that pesticides were the "sinister partner" of radiation. Strontium-90 in atom bomb explosions is given as an example. (Carson) Later studies showed that, for example, while both smokers and coal miners were at elevated risk for lung cancer, coal miners who smoked were at risk far beyond the combined risk of smokers and coal miners.

5. Radioactivity Concentrations in Humans and Animals. The next type of annual measurement made in DOE environmental reports at SRS is the concentration of Cesium-137 in the muscle of deer and hogs killed within the plant grounds. Large numbers of specimens are tested each year; for example, in 2001, the first year for which data are available, average Cs-137 was calculated based on 79 deer and 102 hogs. In 2003, the numbers had grown to 1128 and 106, respectively. Table 9 provides the annual average

concentration of Cs-137; the 2002 report provided no data, simply stating that Cs-137 was “analyzed in some” of the samples.

Table 9
Annual Average Concentrations of Cs-137 in Deer and Hog Muscle
At SRS, in Picouries of Cs-137 per gram muscle, 2001-2009

Year	Cs-137 in Deer	Cs137 in Hogs			
2001	1.00	1.00			
2002					
2003	1.29	1.18			
2004	1.16	1.21	Animal/Period	Ann. Avg.	% Ch.
2005	2.32	1.68	Deer 2001	1.00	---
2006	2.65	3.19	Deer 2002-9	1.81	**+81**
2007	1.46	1.58			
2008	2.40	2.91	Hogs 2001	1.00	---
2009	1.38	1.06	Hogs 2002-9	1.83	**+83**

Since 2001, the average Cs-137 concentrations in deer and hog muscle have nearly doubled, rising 81% and 83%, respectively. The eating and migratory habits of deer and hogs can be assumed to be relatively unchanged over the decade. Thus, it appears highly likely that greater radioactivity levels exist in the locations from which they feed. These higher levels can only be due to current activities at SRS, which are primarily for the purpose of cleanup and remediation.

A related set of DOE data relating to animal hunting is that of exposures to hunters and fishermen. Each 2001-2009 annual report contains a “maximally exposed” level of exposure to onsite hunters, creek-mouth fisherman, and Savannah River swamp fishermen consuming fish from Steel Creek (Table 10):

Table 10
Annual Maximum Exposures, in Millirems
To SRS Onsite Hunters, Creek-Mouth Fishermen,
And Savannah River Swamp Fishermen (Steel Creek), 2001-2009

	Hunters	Creek-Mouth Fishermen	Savannah River Swamp Fishermen			
2001	14.0	0.26	0.10	Type/Period	Ann. Avg.	% Ch
2002	39.5	0.35	0.08	Hunters 2001	14.0	---
2003	15.6	0.58	0.12	Hunters 2002-9	23.4	**+67**
2004	70.8	0.97	0.17			
2005	8.8	0.24	0.24	CM Fishermen 2001	0.26	---
2006	22.0	0.24	0.24	CM Fishermen 2002-9	0.39	**+50**
2007	9.0	0.24	0.22			
2008	13.0	0.11	0.09	SR Fishermen 2001	0.10	---
2009	8.4	0.35	0.10	SR Fishermen 2002-9	0.16	**+60**

The figures in Table 10 are DOE-estimated exposures to hunters and fishermen. For each of the three categories, the 2002-2009 average exposures are between 50% and 67% greater than that in 2001, the earliest year available. These results are relatively consistent with the 81% and 83% rises found in Cesium-137 in deer and hog muscle (Table 8). While it appears that 2004 was a year with unusually large exposure estimated, the most recent years are not noticeably different than 2001, indicating that the expected decrease in exposures to humans is not occurring over the past decade.

C. State of Georgia Environmental Reports. In addition to the Energy Department, environmental officials in Georgia and South Carolina (which flank the Savannah River Site) also take measurements of radioactive emissions and environmental concentrations. The Georgia Department of Natural Resources has developed such a program. In 2003, it produced a 157 page report that included measurements of tritium (for example) in air, rain, vegetation, crops, game, milk, groundwater, river water, drinking water, and fish. The Department used locations at the SRS sites, and compared them with "control areas" in a 400 square mile area adjacent to SRS. The report provided tables and graphs of trends in radioactivity from January 2000 to January 2003. (Environmental Protection Division)

However, no further reports were produced in the past nine years. The explanation from the Natural Resources Department was that funding cuts made it impossible to continue the program, and that no future activities were planned because of the dire financial straits that Georgia and most other states are in. (Simonton) Thus, the Georgia report is of little value in understanding trends in environmental radioactivity – although health patterns in Georgia closest to SRS will be examined later in this report.

D. State of South Carolina Environmental Reports. The South Carolina Department of Health and Environmental Control also maintains a program of monitoring environmental radioactivity levels in and near SRS. Data are available on the Internet, beginning in the late 1990s until 2007, in the form of annual reports (Department of Health and Environmental Control).

Examining long term trends using South Carolina state data has some limitations. The latest data available at this writing is from the year 2007. In addition, the earlier volumes are relatively short (30-50 pages, before they jumped to over 300 pages per year after the 2003 volume), and contain numerical data for a relatively small number of radioactivity measures. Trends from 2003 to 2007 are relatively short-term, and of limited use; thus, this report will mostly list indicators for which at least eight years of data are available.

1. Environmental Radioactivity Trends – South Carolina vs. DOE. The South Carolina state reports sometimes produce information on its sampling results for the same types of radioactivity that the Energy Department measures, allowing a comparison to be made. Two of these are the concentration of total beta-emitting radioactivity in air and tritium in air at the perimeter of SRS, less than five miles from the plant's external boundary. Tables 11 and 12 provide annual results for the years 1999 to 2007 for these indicators.

Table 11
Annual Average Gross Beta Concentrations in Air
At the SRS Perimeter, in Picocuries per Cubic Meter, 1999-2007

Year	DOE	SCDHEC
1999	.019	.015
2000	.020	.020
2001	.018	.020
2002	.016	.020
2003	.015	.0195
2004	.016	.023
2005	.015	.024
2006	.016	.024
2007	.010	.0238

Source	Annual Avg. 1999	Annual Avg. 2000-7	% Ch.
DOE	.0190	.0158	**- 17%**
SC	.0150	.0218	**+45%**

Table 12
Annual Average Tritium Concentrations in Air
At the SRS Perimeter, in Picocuries per Cubic Meter, 1999-2007

Year	DOE	SCDHEC
1999	14	6
2000	8	5
2001	15	7
2002	14	8
2003	14	4.8
2004	10.5	6
2005	8	5
2006	7	5
2007	6	5

Source	Annual Avg. 1999	Annual Avg. 2000-7	% Ch.
DOE	14.0	10.3	**- 26%**
SC	6.0	5.7	**- 5%**

Some substantial differences between DOE and South Carolina patterns are noted. For gross beta, the DOE samples reveal a generally unchanged level year to year, while South Carolina samples find a generally steady increase, peaking in the last three years of study (2005-2007). The South Carolina samples show an increase since 1999 of +45%, while the DOE figures show a decrease of -17%. This suggests that differences in equipment and technique are not the reason for the two differing results, since equipment and methods are unchanged over time. There is no way of knowing which set of results are correct; but should South Carolina measures prove correct, the DOE is minimizing a substantial and long-term increase.

Tritium concentrations also show differences between DOE and state measures. The DOE detected a steady and sharp decline from 2003 to 2007 (14, 10.5, 8, 7, and 6 picocuries of tritium per cubic meter of air), while for the same period, South Carolina levels were almost exactly the same (4.8, 6, 5, 5, 5). Again, the DOE figures present a more “rosy” situation than do South Carolina samples.

Another type of airborne measurement made by South Carolina state officials is ambient beta/gamma concentrations at the SRS perimeter. Table 13 shows annual averages for each year from 1999 to 2007; DOE figures for 2004, 2005, and 2006 are missing.

Table 13
Annual Average Ambient Beta/Gamma Concentrations in Air
At the SRS Perimeter, in Millirems per Year, 1999-2007

Year	DOE	SCDHEC
1999	80	25
2000	80	40
2001	75	60
2002	65	80
2003	65	25
2004		28
2005		28
2006		27
2007	77	98

Annual Avg.

Source	1999	2000-7	% Ch.
DOE	80.0	72.4	**- 10%**
SC	25.0	48.3	**+93%**

South Carolina officials found an average of 25 millirems in 1999, the first year measurements were provided. The three years immediately after showed a sharp and steady increase (40, 60, 80), before returning to the 1999 levels for several years. But in 2007, an exceptionally high average of 98 was recorded. Ironically, the narrative in the South Carolina report stated that the samples showed "no major changes" in this measure. By contrast, the 1999 DOE measurement of 80 millirems was followed by slight decline. Again, trends using DOE data show more "positive" results (-10% decline since 1999) than do South Carolina's (+93% increase since 1999).

There is one type of radioactivity (Cesium-137 in surface soil) for which Energy Department and South Carolina Department of Health samples are available for a five-year period. Cesium-137 in surface soil was measured at locations within 50 miles of SRS, on a weekly basis from 2003-2007. These data cover only five years, and thus cannot show a long-term trend, but it can be compared with similar Energy Department samples for the same years (Table 14).

Table 14
Annual Average Cesium-137 in Surface Soil
Within 50 Miles of SRS, in Picocuries per Gram, 2003-2007

Year	DOE	SCDHEC
2003	0.24	0.18
2004	0.26	0.15
2005	0.33	0.20
2006	0.36	0.59
2007	0.10	1.10

Source	2003	2004-7	% Ch.
DOE	0.24	0.26	**+ 9%**
SC	0.18	0.51	**+183%**

The DOE found annual Cesium-137 averages from 2004-2007 was only 9% above the 2003 mark. But the rise found by South Carolina, due mostly to sharp rises in 2006 and 2007, was 183%. The source of such as sharp rise in Cesium-137 can only be a current one, because of its long half life of 30 years.

Oddly, the 2007 South Carolina annual report (p. 205) acknowledges that South "data from 2007 shows increased average levels of Cs-137, while DOE-SR reports for 2007 that Cs-137 levels have decreased from previous years," – without providing any further explanation for this highly unusual divergence. Once again, the DOE data represent a better-case scenario than does South Carolina.

2. Measurements of Trends in Environmental Radioactivity. In the most recent five annual reports from the state of South Carolina (2003-2007), airborne levels of gross alpha, gross beta, and tritium are given for seven locations in and near SRS. Five (5) of these seven locations provide actual measurements for all years. Three (3) of these five also give measurements of tritium in rainfall for each year from 2003 to 2007. Table 15 provides the actual measurements for each of these locations, along with area-wide averages.

Table 15
Annual Radioactive Airborne Concentrations in Air, Plus Tritium in Rain
Locations Near SRS Plant, in Picocuries per Cubic Meter, 2003-2007

Year	Gross Alpha	Gross Beta	Tritium-Air	Tritium-Rain
Location – Aiken SC Elementary Water Tower				
2003	.004	.018	3.50	Incomplete
2004	.003	.023	3.73	
2005	.003	.021	3.43	
2006	.003	.024	4.90	
2007	.004	.024	4.28	
Location – New Ellenton SC				
2003	.004	.020	6.73	155
2004	.003	.024	5.80	326
2005	.003	.023	4.40	416
2006	.004	.024	4.40	228
2007	.005	.026	5.57	274
Location – Jackson SC				
2003	.004	.020	5.67	114
2004	.003	.022	7.50	305
2005	.003	.022	3.40	224
2006	.003	.024	4.60	281
2007	.003	.026	5.42	267

Location – Allendale SC Barricade				
2003	.004	.019	2.96	Incomplete
2004	.003	.022	4.90	
2005	.003	.021	3.40	
2006	.003	.020	3.80	
2007	.003	.020	3.44	
Location – Snelling SC				
2003	.004	.019	4.90	95
2004	.003	.023	7.30	282
2005	.003	.023	4.70	239
2006	.003	.025	4.80	296
2007	.003	.024	6.33	335
Average Five Locations (Three For Tritium in Rain)				
2003	.0040	.0192	4.75	121
2004	.0030	.0228	5.85	304
2005	.0030	.0220	3.87	293
2006	.0032	.0234	4.50	268
2007	.0040	.0240	5.01	292

As noted, five years is probably not enough time to discern significant trends. However, it is clear that the gross beta is steadily rising, at each location. Results for airborne gross alpha and tritium showed inconsistent patterns. Tritium in rain is relatively similar for each year, except for a low level in 2003.

3. Radioactivity in Animals/Food. South Carolina officials also measured radioactivity Strontium-90 in 10 non-edible bass caught at several local sites each year from 1999 to 2007. Averages are calculated in Table 16 only for those with detectable levels of Sr-90. Only those fish with detectable levels of Sr-90 are used in calculating averages.

Table 16
Strontium-90 Concentrations (Dry) in Non-Edible Bass
Locations Near SRS Plant, in Picocuries per Gram, 1999-2007

Year	Fish with/without Detectable Sr-90	Avg. 1	Avg. 2
1999	5 / 5	1.560	0.780
2000	5 / 5	0.724	0.362
2001	6 / 4	0.735	0.441
2002	2 / 8	0.895	0.179
2003	8 / 2	0.356	0.285
2004	3 / 7	0.176	0.053
2005	9 / 0	0.333	0.333
2006	10 / 0	0.311	0.311
2007	9 / 1	0.480	0.432

Period	Annual Avg. 1	% Ch.
1999	1.560	---
2000-2007	0.501	**- 68%**

At first look, the trend of Sr-90 concentrations in fish is quite different than those other measures of radioactivity in the South Carolina reports. Easily the highest average occurred in the first year (1999), and the last five years were well below the first four. This pattern is consistent whether only those fish with detectable levels were included ("Average1" in Table 16), or if fish with non-detectable levels are counted as "0" ("Average2" in Table 16). However, the years 2005, 2006, and 2007 (when 28 of 29 fish had detectable Sr-90) showed consistent increases from 2004, regardless of which method was used.

Another type of measurement by made by South Carolina health officials in animals was that of Cesium-137 in white tailed deer outside of the SRS site, including those close (under five miles) and further away (under 50 miles). The number of deer in the sample is substantially more than fish; within five miles of the SRS border, the annual number of deer tested varied from 34 to 68, while the number within 50 miles varied from 5 to 20 (except 2006, when 60 samples were included). Table 17 shows the results for each year from 2000 to 2007.

Table 17
Cesium-137 in White-Tailed Deer, <5 miles and 5-50 miles from SRS Border
In Picocuries per Gram (Wet), 2000-2007
Number of Samples in Parentheses

Year	<5 mi. from SRS	5-50 mi. from SRS
2000	1.00 (34)	0.60 (6)
2001	1.27 (35)	1.14 (5)
2002	2.18 (52)	0.90 (6)
2003	1.46 (50)	1.17 (7)
2004	1.60 (50)	1.16 (15)
2005	1.00 (66)	1.19 (15)
2006	1.29 (68)	3.90 (60)
2007	0.62 (65)	0.75 (20)

Location	2000	2001-7	% Ch.
< 5 miles	1.00	1.35	**+ 35%**
5-50 miles	0.60	1.46	**+143%**

The results for deer samples near SRS are much different than those for fish, found in the previous tables. For those samples closest to the plant, the 2001-2007 annual average was 35% greater than that for the first year (2000). For those further away from the plant, the annual rate after 2000 more than doubled (+143%). The 2006 report noted that the extremely high 3.90 mark offsite was more than triple the usual level, yet was "not significant" because it fell within two standard deviations of the average, even though 60 samples, by far the most ever, were tested that year.

Again, the South Carolina reports attribute any increases in Cs-137 in deer as "due to nuclear weapons testing," even though large-scale atmospheric testing in the U.S. ended in 1962. Because Cs-137 has a half life of 30 years, most of the isotope should have disappeared from the soil and vegetation upon which deer feed. U.S. government samples taken since 1957 reveal that U.S. Cs-137 in milk peaked in 1964 at the height of bomb testing, and is now about 3% of that amount.

The next type of sample taken by state of South Carolina officials with historical data beginning prior to 2000 is the concentration of Strontium-89 and Strontium-90 in milk given by cows near the SRS site. Only a small number of samples per year were used to generate annual averages; for example, in 2007, there were 7 samples from cows within 50 miles of SRS.

Table 18 provides the figures for milk samples in the 10 year period. No comparable DOE samples are given, since most DOE measurements did not detect any Sr-89/90. Again, Strontium is an important type of radioactivity, since one of the two isotopes given (Sr-89) has a half life of just 50 days, and represents current emissions.

Table 18
Annual Average Strontium-89/90 in Cows Milk
Outside the SRS Perimeter, in Picocuries per Liter, 1998-2007

Year	Average
1998	0.9
1999	0.9
2000	1.1
2001	2.2
2002	<LLD (Lowest level detectable) – assumed to be 0
2003	1.2
2004	1.8
2005	0.5
2006	1.9
2007	3.36

Period	Ann. Avg.	% Ch.
1998-1999	0.90	---
2000-2007	1.72	**+91%**

Averages for the first two years in the series were identical (0.9 picocuries of Strontium-89/90 per liter of milk each year). But averages in six of the next eight years were higher, culminating in a 3.36 average in 2007, more than triple the average in the late 1990s. While results for one year such as 2007 may reflect unusual factors, and not yet regarded as a trend, it is clear that concentrations are rising.

The average Strontium-89/90 level in local milk in the period 2000-2007 was 91% higher, or nearly double, than the level in 1998-1999. This is yet another reason for concern about the ramifications of DOE EM efforts at Savannah River.

The statement on page 33 of the 2002 report, after a high level of Cesium-137 in milk was found near SRS in Girard, Georgia was that the sample is "probably a result of radioactive fallout from atmospheric atomic bomb tests conducted by several nations until 1985." The statement is misleading in several ways. The final above-ground bomb test was conducted by China in 1980, not 1985. The last U.S. above-ground test, along with the Soviet Union and the United Kingdom, occurred in 1962 – ending large-scale testing (the French and Chinese tested only a small number of bombs thereafter, in distant locations). Perhaps most importantly, a trend of rising Strontium levels in local milk during the 2000s, covering a period of seven years, does not reflect a pre-1962 phenomenon, but a current source of radioactivity – meaning operations at SRS. The state of South Carolina's explanation for high radioactivity levels in local milk appears to be misleading and false.

E. Southern Company Environmental Reports on Vogtle Nuclear Power Plant. The Alvin W. Vogtle Electric Generating Plant is situated just across the Savannah River on the Georgia side, less than five miles from SRS. Vogtle is a nuclear power plant consisting of two reactors (Vogtle 1 and 2) that began operating in 1987 and 1989. The reactors have recently received 20 year extensions to their original 40 year license, allowing them to operate until 2047 and 2049. Vogtle units 3 and 4 are being planned at the site, which would be the first new U.S. power reactors in decades.

The Southern Company, which owns Vogtle, is required by federal law to conduct measurements of radioactive releases and concentrations in the nearby environment. The U.S. Nuclear Regulatory Commission accepts annual reports from the Southern Company, and make them available to the public on the Internet.

1. Close to vs. Further from SRS Area. The latest annual report includes measurements for various types of radioactivity each year from 1987 to 2010. Some samples are "indicators" (closest to or downwind/downriver from Vogtle), while others are "control" locations – which typically are less than 10 miles from the plant. Samples are taken on a weekly, monthly, or annual basis, and include air, water, fish, and sediment. (Southern Company)

Because of the large number of years available, it is possible to establish a four-year baseline period representing the time when SRS EM activities were just starting (1995-1998). Such a large pre-2000 baseline was generally not possible with measurements of radiation contamination from the U.S. Energy Department or South Carolina Department of Health, which typically had little data before 1999.

The follow up period will be the 12 most recent years, or 1999-2010. The Vogtle plant was consistently operating at full capacity throughout this entire period, while the SRS plant had stopped producing nuclear weapons and was developing its program of environmental remediation.

Table 19 shows the 1995-2010 annual average concentrations of gross beta (all types of beta radioactivity combined) in the air near Vogtle. The location closest to Vogtle ("indicator") is given, along with "control" and "community" samples further away and upwind from the plant. Again, one must be cautious in interpreting data in this section, because there is no way of knowing whether environmental contamination is from Vogtle or SRS.

Beta emitting radiation sources and tritium are also found in nature, in air and water, as well as in nuclear reactors. Levels vary somewhat by geography, but this does not affect studies of trends in radioactivity, as natural levels do not change much over time.

Table 19
Weekly Gross Beta in Air Near Vogtle Plant
Indicator (Closest to Plant) vs. Control and Community
In Picocuries Per Cubic Meter,1995-1998 and 1999-2010

Indicator				Control				Community			
1995	21.1	1999	22.5	1995	20.7	1999	21.9	1995	20.7	1999	22.2
1996	23.3	2000	24.5	1996	21.0	2000	21.5	1996	20.0	2000	21.1
1997	20.6	2001	22.4	1997	20.6	2001	22.0	1997	19.0	2001	22.7
1998	22.7	2002	19.9	1998	22.4	2002	18.9	1998	20.9	2002	18.6
		2003	19.4			2003	20.5			2003	18.3
		2004	21.6			2004	22.8			2004	21.4
		2005	20.5			2005	20.4			2005	19.4
		2006	25.5			2006	24.6			2006	24.3
		2007	27.3			2007	25.1			2007	26.5
		2008	24.0			2008	23.2			2008	23.7
		2009	23.0			2009	22.4			2009	22.5
		2010	25.8			2010	24.4			2010	25.5
Avg. 1995-1998			21.93			21.18				20.15	
Avg. 1999-2010			23.03			22.31				22.18	
% Change			**+ 5.1%**			**+ 5.4%**				**+10.1%**	

Indicator = Discharge Area 0.6 miles NE of Vogtle, Simulator Building 1.7 miles SE, Met Tower 0.9 miles SSW, River Road site 1.2 miles WSW, and Hancock Landing Road 1.4 miles WSW. Control = GPC Waynesboro Operations Headquarters, 13.9 miles WSW; Community = Girard GA, 6.6 miles SSE.

In the most recent 12 years, gross beta at the indicator location is just slightly higher than the control and community sites (23.03 vs. 22.31 and 22.18). Moreover, the increase from the late 1990s at the indicator site is actually less than the control and community site (+5.1% vs. +5.4% and +10.1%). This suggests that sources other than Vogtle – perhaps SRS emissions - contribute to gross beta totals.

The “indicator” category consists of five locations that are between 0.6 and 1.7 miles from Vogtle. The “control” site is 13.9 miles to the west-southwest, while the “community” site is 6.6 miles to the south-southeast. One can question whether a small number of miles represents an adequate distance to compare close and distant locations. Moreover, the fact that control site is west-southwest of Vogtle (and closer to the SRS plant, which is north-northwest) raises the question of whether SRS activities influence these results.

Table 20 provides a similar comparison as in Table 19 – indicator (closest) vs. control and “special” - using tritium concentrations in water as a measure.

Table 20
Monthly Tritium in Water Near Vogtle Plant
Indicator (Closest to Plant) vs. Control and Special
In Picocuries Per Liter, 1995-1998 and 1999-2010

Indicator				Control				Special			
1995	597	1999	2005	1995	236	1999	389	1995	699	1999	859
1996	1187	2000	1564	1996	387	2000	496	1996	719	2000	885
1997	1547	2001	2010	1997	254	2001	743	1997	686	2001	931
1998	1226	2002	2628	1998	196	2002	437	1998	640	2002	1280
		2003	1376			2003	399			2003	800
		2004	1269			2004	351			2004	743
		2005	800			2005	458			2005	713
		2006	2307			2006	384			2006	852
		2007	879			2007	344			2007	489
		2008	1874			2008	832			2008	1105
		2009	1203			2009	221			2009	614
		2010	814			2010	235			2010	607
Avg. 1995-1998			1139			268				686	
Avg. 1999-2010			1568			441				823	
% Change			**+37.7%**			**+64.6%**				**+20.0%**	

Indicator = Station 83, Savannah River 0.6 mi. ENE; Control = Station 82, Savannah River, 0.8 mi. NNE; Special = Station 84, Savannah River 1.6 mi. ESE.

Again, there is an increase in radioactivity (in this case, a +37.7% rise in tritium) for the indicator site closest to Vogtle (and SRS). However, the other sites also rose, at rates above and below the indicator's (+64.6% and +20.0%). Although each of the locations are extremely close to Vogtle (0.6 miles, 0.8 miles, and 1.6 miles, in different directions), the levels for the "indicator" category are much higher than the other two. The question of whether only Vogtle emissions make up this radioactivity arises again, especially with SRS so close.

2. Upriver vs. Downriver from Nuclear Plant. In addition to comparing proximate and non-proximate sites near Vogtle, the Southern Company also provided a number of comparison of radioactivity in water upriver and downriver from the plant. All measurements were taken at stations in the Savannah River (upriver is towards the northwest, and downriver is towards the Atlantic Ocean to the southeast).

Several tables that follow make this upriver-downriver comparison. Table 21 provides gross beta, measured monthly, in raw drinking water. There are three sites, each 112 to 122 miles from Vogtle, which make up the downriver figures in the analysis, while a single upriver site, 56 miles from the plant, is used.

Table 21
Monthly Gross Beta, Raw Drinking Water, Upriver/Downriver of Vogtle Plant
In Picocuries Per Liter, 1995-1998 and 1999-2010

Indicator (Downriver)				Control (Upriver)			
1995	3.06	1999	4.10	1995	4.90	1999	4.37
1996	5.83	2000	4.52	1996	3.02	2000	3.59
1997	2.93	2001	3.21	1997	2.94	2001	2.94
1998	3.31	2002	3.09	1998	2.58	2002	2.61
		2003	3.73			2003	2.59
		2004	4.06			2004	2.39
		2005	3.75			2005	2.48
		2006	3.85			2006	2.93
		2007	4.00			2007	3.13
		2008	3.46			2008	2.37
		2009	3.28			2009	2.26
		2010	2.95			2010	1.71
Avg. 1995-1998			3.783			3.360	
Avg. 1999-2010			3.667			2.781	
% Change			**- 3.1%**			**- 17.2%**	

Indicator = Station 87, Beaufort-Jasper Water Treatment Plant, 112 river miles downriver (SE); Station 88, Cherokee Hill Water Treatment Plant, 122 river miles downriver (SSE); Station 89, Purrysburg Water Treatment Plant, 112 river miles downriver (SSE); Control = Station 80, Augusta Water Treatment Plant, 56 river miles upriver (NNW)

As expected, beta levels in water downriver of Vogtle are somewhat greater than those upriver. Average levels of beta fell both upriver (-17.2%) and downriver (-3.1%) since the late 1990s. However, the long distance from the Vogtle plant (56 to 122 miles) of the sampling stations means that factors other than Vogtle emissions, perhaps SRS, contributed to these trends. The fact that the average monthly beta level downriver fell only 3.1% since the late 1990s suggests that continued radioactive emissions from varied sources prevented substantial declines from occurring.

The Southern Company also measured gross beta in finished (as opposed to raw) drinking water, at the same locations upriver and downriver of Vogtle. Typical beta concentrations in finished drinking water are about 30% below levels in raw water. Obviously, finished drinking water is a much more helpful indicator of trends in human consumption of radioactivity than raw water.

Table 22 provides trend data in gross beta radioactivity levels upriver and downriver from Vogtle. The stations used are the same ones given in Table 21 (three downriver 112 to 122 miles from Vogtle, and one upriver 56 miles from Vogtle). Each of these is a water treatment plant.

Table 22
Monthly Gross Beta, Finished Drinking Water, Upriver/Downriver of Vogtle Plant
In Picocuries Per Liter, 1995-1998 and 1999-2010

Indicator (Downriver)				Control (Upriver)			
1995	2.74	1999	3.23	1995	2.32	1999	3.21
1996	2.19	2000	3.39	1996	2.21	2000	2.68
1997	2.38	2001	2.67	1997	1.77	2001	2.00
1998	3.23	2002	2.80	1998	1.67	2002	2.61
		2003	2.51			2003	2.34
		2004	2.36			2004	1.92
		2005	2.61			2005	2.00
		2006	3.23			2006	3.25
		2007	3.19			2007	3.36
		2008	2.80			2008	2.07
		2009	2.53			2009	2.13
		2010	2.89			2010	2.23
Avg. 1995-1998			2.635			1.993	
Avg. 1999-2010			2.856			2.484	
% Change			**+ 8.4%**			**+24.6%**	

Indicator = Station 87, Beaufort-Jasper Water Treatment Plant, 112 river miles downriver (SE); Station 88, Cherokee Hill Water Treatment Plant, 122 river miles downriver (SSE); Station 89, Purrysburg Water Treatment Plant, 112 river miles downriver (SSE); Control = Station 80, Augusta Water Treatment Plant, 56 river miles upriver (NNW)

Again, downriver concentrations are greater than they are upriver, as expected. But unlike raw water, finished water levels rose since the late 1990s (+8.4% downriver and +24.6% upriver). This unexpected trend raises the question of what source accounted for such an increase; and because the sampling stations are located far from the nuclear sites at Vogtle and Savannah River, either of the plants could contribute to the unusual patterns.

In addition to gross beta in water processing plants upriver and downriver from Vogtle and SRS, tritium in these same plants were also measured and reported. Results for the same two periods (1995-1998 and 1999-2010) are given in Tables 23 (raw drinking water) and 24 (finished drinking water).

Table 23
Monthly Tritium, Raw Drinking Water, Upriver/Downriver of Vogtle Plant
In Picocuries Per Liter, 1995-1998 and 1999-2010

Indicator (Downriver)				Control (Upriver)			
1995	917	1999	908	1995	201	1999	<LLD (Lowest level detect)
1996	1014	2000	1020	1996	207	2000	373
1997	956	2001	889	1997	230	2001	525
1998	791	2002	938	1998	160	2002	304
		2003	563			2003	203
		2005	463			2005	393
		2006	690			2006	451
		2007	462			2007	357
		2008	726			2008	386
		2009	602			2009	587
		2010	343			2010	244
Avg. 1995-1998			920			200	
Avg. 1999-2010			682			368	
% Change			**- 25.9%**			**+84.0%**	

Indicator = Station 87, Beaufort-Jasper Water Treatment Plant, 112 river miles downriver (SE); Station 88, Cherokee Hill Water Treatment Plant, 122 river miles downriver (SSE); Station 89, Purrysburg Water Treatment Plant, 112 river miles downriver (SSE); Control = Station 80, Augusta Water Treatment Plant, 56 river miles upriver (NNW)

Table 24
Monthly Tritium, Finished Drinking Water, Upriver/Downriver of Vogtle Plant
In Picocuries Per Liter, 1995-1998 and 1999-2010

Indicator (Downriver)				Control (Upriver)			
1995	847	1999	920	1995	279	1999	263
1996	884	2000	1043	1996	168	2000	251
1997	887	2001	1037	1997	221	2001	516
1998	713	2002	1060	1998	180	2002	340
		2003	473			2003	196
		2004	531			2004	255
		2005	546			2005	223
		2006	688			2006	710
		2007	494			2007	229
		2008	681			2008	391
		2009	579			2009	667
		2010	374			2010	262
Avg. 1995-1998			833			212	
Avg. 1999-2010			701			359	
% Change			**- 15.8%**			**+69.3%**	

Indicator = Station 87, Beaufort-Jasper Water Treatment Plant, 112 river miles downriver (SE); Station 88, Cherokee Hill Water Treatment Plant, 122 river miles downriver (SSE); Station 89, Purrysburg Water Treatment Plant, 112 river miles downriver (SSE); Control = Station 80, Augusta Water Treatment Plant, 56 river miles upriver (NNW)

Changes in tritium levels since the late 1990s are mixed. Downriver concentrations declined, for both raw (-25.9%) and finished (-15.8%) drinking water. But upriver concentrations rose sharply, nearly doubling for raw (+84.0%) and finished (+69.3%) drinking water. Emissions from a major nuclear source of tritium, which attaches to water molecules, could cause this increase, even 56 river miles upriver from Vogtle (and several fewer from SRS). There is another nuclear power plant at Oconee, with three reactors, northwest of Station 80 (where the upriver samples were taken), which could theoretically contribute to tritium at this water treatment plant. However, Oconee is not directly on the Savannah River, and the path of waterborne radioactivity from this plant may or may not affect the plant like SRS or Vogtle.

A final set of historical measurements of environmental radioactivity near the Vogtle plant, and quite close to SRS, is Cesium-137 in largemouth bass fish in the Savannah River. Measurements have been included in annual reports by Southern Company, and are given in Table 25. Both the upriver and downriver sites are very close to Vogtle (4.3 miles and 2.5 miles).

Table 25
Cesium-137 in Largemouth Bass Fish (Wet), Upriver/Downriver of Vogtle Plant
In Picocuries Per Kilogram, 1995-1998 and 1999-2010

Indicator (Downriver)				Control (Upriver)			
1995	125	1999	848	1995	96	1999	221
1996	194	2000	55	1996	404	2000	96
1997	93	2001	48	1997	139	2001	39
1998	190	2002	59	1998	200	2002	133
		2003	62			2003	21
		2004	56.4			2004	26.0
		2005	39.3			2005	40.2
		2006	257			2006	35.7
		2007	58.7			2007	37.7
		2008	39.4			2008	47.0
		2009	<LLD			2009	30.4
		2010	42.6			2010	74.4
Avg. 1995-1998			150.5			209.8	
Avg. 1999-2010			142.3			66.8	
% Change			**- 5.4%**			**- 68.2%**	

Indicator = Station 85, Savannah River (4.3 miles ESE); Control = Station 81, Savannah River (2.5 miles N).

This set of data provides unusual results. In the late 1990s, the bass tested at the control (upriver) station had considerably greater Cesium-137 levels than did the bass caught at the downriver station. But thereafter, the average for the downriver fish was more than double that of upriver fish. The decline in Cesium-137 since the late 1990s for downriver fish was small (-5.4%), while the decline for the upriver fish was much greater (-68.2%). The data should be studied further, especially in light of what the Energy Department found while sampling bass near SRS.

F. Summary of Findings on Trends in Environmental Radioactivity in/near SRS. As presented in this report, there is a substantial amount of data on environmental radioactivity in and near SRS that has been collected and published each year for a decade or more. Unfortunately, very little trend analysis has been conducted using these data, especially as a tool to measure the success (or lack thereof) of the DOE EM plan to reduce local contamination levels.

The U.S. Energy Department, which is responsible for all environmental management activities, has collected far more data than any other source. In addition, the South Carolina Department of Health and Environmental Conservation, the Georgia Department of Natural Resources, and the Southern Company (which owns and operates the nearby Vogtle nuclear power plant, and reports its results to the U.S. Nuclear Regulatory Commission) have collected data on emissions and radioactivity levels, in compliance with legal mandates.

The DOE annual environmental operating reports, which are posted on the Internet for each year from 2001 to 2009, are probably the most important source of radioactivity data. The DOE is responsible for monitoring contamination at all of its nuclear weapons-related facilities (SRS is one), and receives the needed funds from Congress to operate such a system. It is also mandated to make public its findings, especially to Congress and to concerned citizens.

DOE reports contain considerable data that can be used for tracking contamination and potential harm to the public, through spatial (geographic) and temporal (over time) patterns. Each DOE annual report refers to the ALARA (an acronym for As Low As Reasonably Achievable) philosophy, in terms of its goal for reducing existing radioactive contamination at SRS. Setting a goal of zero radionuclides in the SRS environment from weapons production and other operations is unrealistic, and thus ALARA is substituted.

But the large data base provided in annual DOE reports is disappointing in several ways.

1. DOE does little to explain trends in contamination levels. It only graphs temporal trends of a few types of radioactivity in the most recent five years. In its narrative, DOE typically reports a current and previous year for a type of radioactivity, such as average tritium in air at SRS for 2009 vs. 2008, rather than discuss long term trends for the past ten or more years.

2. DOE often gives exceptionally positive explanations for contamination trends. It typically uses phrases such as “making progress” or “below federal standards” – even when radioactivity increases are reported from one year to the next. Substantial increases, like those found in this report, are largely ignored. The implication that meeting the federal standard means there is no harm posed to the public is irresponsible because many studies have shown a link between relatively low dose radiation and disease risk, a topic addressed later in this report.

3. These rosy DOE data and conclusions contrast with those for the same indicators from South Carolina officials, which are more likely to document rising radioactivity than the DOE. While it is impossible to say if DOE data are accurate or inaccurate, it is important to recognize that DOE EM efforts are more likely to be judged successful by oversight parties if reductions in radioactivity occur. Increases in radioactivity over time would, by contrast, raise concerns about the safety of DOE activities.

4 Large increases are sometimes dismissed by the DOE as statistically insignificant, because the increase is within two standard deviations – usually due to the small number of samples taken. While statistical significance is important, not meeting this test should not be a reason for ignoring unexpectedly high levels.

5. DOE is quick to blame any unusual patterns on fallout from atmospheric atomic bomb tests instead of operations at SRS. Because large-scale atmospheric tests were banned in 1963, there should be no increases over time attributed to testing. The huge amount of radioactivity produced from SRS weapons production operations into the early 1990s, and possibly from EM activities thereafter, means that DOE should consider SRS as the most likely source of any increase.

Trends in measurements of 63 types of radioactivity examined in this report produced a mixture of results. Of the 63, 45 (71.4%) revealed an increase after the late 1990s (or occasionally the years 2000 or 2001), with the others revealing decreases. Some changes were large, while others were much smaller. A summary of the findings are given in Table 26.

Interestingly, of those 12 measures involving tritium, 5 showed increases over time while 7 showed decreases (41.7%). That means that 78.4% (40 of 51) of all other measures recorded increases. There may be reasons why tritium levels are declining more than other types of radioactivity, but they are not obvious.

The South Carolina Department of Health data of airborne radioactivity concentrations from 2003-2007 (Table 15) are not included here, as they represent only five years; all others represent eight or more years, and thus show a relatively long term trend. (Incidentally, the 2003-2007 data, using 2003 as a baseline, would show increases in radioactivity levels in 3 of 4 indicators).

Table 26
Summary of Changes in Types of Radioactivity over the Past Decade
By Source of Information

US Energy Department	SC Dept of Health + EC	Southern Company (NRC)
INCREASES		
1. Liquid releases – Sr-90		
2. Liquid releases – Cs-137		
3. Liquid releases – U-234		
4. Liquid releases – U-235		
5. Liquid releases – U-238		
6. Liquid releases – Pu-238		
7. Liquid releases – Pu-239		
8. Liquid releases – Am-241		
9. Liquid releases – Cm-244		
10. River concentration – Sr-90		
11. River concentration – U-234		
12. River concentration – U-235		
13. River concentration – U-238		
14. River concentration – Pu-238		
15. River concentration – Pu-239		
16. River concentration – Am-241		
17. River concentration – Cm-241		
18. Levels entering 4 Mi. Br. – I-129		
19. Levels entering 4 Mi. Br. – Cs-137		
20. Levels entering 4 Mi. Br. – Sr-89/90		
21. Airborne releases - SOx		
22. Airborne releases – O3		
23. Airborne releases – GF		
24. Airborne releases – No		
25. Airborne releases - Pb		
26. Max. exposure – hunters		
27. Max. exposure – creek mouth fishermen		
28. Max. exposure – swamp river fishermen		
29. Cs-137 in SRS deer		
30. Cs-137 in SRS hogs		
	1. Beta/gamma in air	
	2. Sr-89/90 in cow milk	

3. Cs-137 in deer (< 5 mi.)
4. Cs-137 in deer (5-50 mi.)

5. Beta in air

1. Beta in air–near plant
2. Beta in air–control site
3. Beta in air–community site

4. Tritium in river-near plant
5. Tritium in river-control
6. Tritium in river-special

7. Beta,finished water-upriver
8. Beta,finished water-d'river

9. Tritium, raw water-upriver
10. Tritium fin. water-upriver

DECREASES

1. Tritium emissions in air

2. Tritium liquid emissions

3. Migration of tritium from SRS seepage basins

4. Levels entering 4 mi. Br. – Tc99

5. Tritium into streams (liquid)

6. Beta/gamma in air

7. Airborne releases – PM
8. Airborne releases – PM10
9. Airborne releases – CO

10. River concentration I129

1. Tritium levels in air
2. Sr-90 in bass fish

1. Cs-137 in bass - upriver
2. Cs-137 in bass - d'river

3. Tritium releases into river

		4. Beta, raw water - d’river	
		5. Beta, raw water - upriver	
		6. Tritium, fin. Water–d’river	
TOTAL			
30 increases	5 increases	10 increases	= **45**
10 decreases	2 decreases	6 decreases	= **18**

These results raise concerns, and more studies are needed to understand reasons for these trends. The late 1990s represented a time long after nuclear weapons production had ceased, and a time when DOE EM activities had begun. It also represented a decade after the nearby Vogtle nuclear power plant had started operating at full power – suggesting that Vogtle emissions in the 1990s and 2000s should be roughly equal. Thus, the hypothesis that steady reductions in environmental radioactivity would be expected in the early 21st century has a solid basis. The fact that the hypothesis was not supported by most empirical data raises a “red flag” that interested stakeholders should be informed of, and requires further study of reasons why this occurred. In particular, any potential effects of EM operations at SRS on radioactive emissions and environmental levels should be examined.

LOCAL HEALTH TRENDS

A. Methods. This section will explore historical data on **trends** in health status of the local population, for various health measures considered most sensitive to radiation.

The local population is defined as that most likely to be affected by radioactive emissions from SRS. The 1990 National Cancer Institute study “Cancer in Populations Living Near Nuclear Facilities,” remains the only nationwide study of cancer near U.S. nuclear plants. The NCI selected “study” counties near 62 U.S. nuclear plants (including SRS), which were counties most proximate to each plant.

The NCI selected Aiken (SC), Barnwell (SC), and Burke (GA) as “study” counties for SRS. These counties are located totally or mostly within 25 miles of the plant. However, there are two other counties that also meet this criterion, i.e. Allendale (SC) and Richmond (GA). Thus, this report will compare health trends in the five-county area with those for the U.S., similar to what the NCI study did. The five counties, with their 2010 population, are listed below:

Allendale SC	10,419
Aiken SC	160,099
Barnwell SC	22,621
Burke GA	23,316
Richmond GA	200,549
TOTAL	417,004

Nearly 90% of the area's residents are in Aiken County (site of the city of Aiken and its suburbs) and Richmond County (site of the city of Augusta and its suburbs).

Earlier in this report, trends in SRS radioactive emissions and local levels of radioactivity were examined. The most recent period was typically the years 2000 to later in the decade (according to the most recent year data were available). This analysis of health trends will do the same, i.e. measure a baseline period in the 1990s with the 2000s. Like the 1990 NCI study, the baseline measure will be the ratio of local to national rates.

Before examining health trends, it is important to examine any demographic changes over the past decade in the five-county area that might affect health status. Table 27 lists changes in a number of demographic criteria for the 2000 and 2010 censuses, for the five counties closest to SRS and the U.S.

Table 27
Changes in Selected Demographic Criteria, 2000 vs. 2010
Five Counties Closest to the Savannah River Site vs. the U.S.
Includes Aiken SC, Allendale SC, Barnwell SC, Burke GA, Richmond GA

	United States		5 Cos. Near SRS		% Change	
Criterion	2000	2010	2000	2010	U.S.	5 Cos.
Population	281.4M	308.7M	399250	417004	+ 9.7	+ 4.4
% Under Age 18	25.7	24.0	26.9	24.2	- 1.7	- 2.7
% Over Age 65	12.4	13.0	11.7	13.1	+ 0.6	+ 1.4
% Female	50.9	50.8	51.7	51.5	- 0.1	- 0.2
% Black	12.3	12.6	41.4	42.5	+ 0.3	+ 1.1
% Hispanic	12.5	16.3	2.4	4.2	+ 3.8	+ 1.8
% Asian	3.6	4.8	1.0	1.2	+ 1.2	+ 0.2
% HS grad	80.4	84.6	76.0	80.9	+ 4.2	+ 4.9
% College grad	24.4	27.5	17.9	19.8	+ 3.1	+ 1.9
Median H'hold Inc.	41994	50221	33904	37572	+19.6	+10.6
% Below Poverty	12.4	14.3	18.5	21.9	+ 1.9	+ 3.4

Notes: High school and college graduates are for adults age 25 and older, for the year 2000 and the period 2005-2009; median household income and percent below poverty are for the years 1999 and 2009

Changes over the past decade for the five county area are roughly the same as national changes. The one potential exception is that median household income rose 10.6%, compared to 19.6% nationally. But the changes in local age distribution, racial and ethnic composition, and educational levels, and poverty rates were roughly similar to those in the U.S. Thus, there are no obvious demographic criteria that would affect a comparison of local and national health trends.

The five-county area had a population of 417,004 according to the 2010 census. Nearly half (42.5%) of local residents are black, which is far greater than the U.S. proportion of 12.6%; thus, trend analyses of health outcomes will be presented for whites and blacks whenever the data is available, as race-specific disease and death rates are often quite large. Only 4.2% and 1.2% of local residents are Hispanic and Asian, far less than the U.S. Fewer local residents completed high school or college, and economic criteria show that the area is poorer (household income is below/poverty rate is above the U.S.).

Local-national health trends in the past decade are compared for several health status indicators that are considered relatively sensitive to radiation exposure.

U.S. vital statistics on births and deaths are collected by county and state health departments, and sent to the U.S. Centers for Disease Control and Prevention (CDC). Statistical data on deaths by county have been made public by the CDC since 1937, in hard copy volumes now maintained only by large reference libraries. The hard copy volumes ceased in 1993.

With the increasing use of the Internet, CDC made county-specific (according to the county of residence at time of death) mortality data available; as of late 2011, information on deaths for each year from 1979 to 2007 are included in the data base. Aggregate information on deaths in this 29 year period are available by county, as well as by sex, age, race, and cause of death. (U.S. Centers for Disease Control and Prevention) Deaths occurring in the most recent year are added to the CDC system annually. A total of 64.6 million U.S. deaths are included in the 29 year data base.

The CDC web site also makes available the following:

- Information on U.S. births for each year from 1995 to 2006, including low weight and premature births, by county (only the most populated counties)

- Information on cancer incidence for each year from 1999 to 2006, not by county but by Metropolitan Statistical Area (Augusta-Richmond MSA is a six-county area that includes densely populated Aiken and Richmond counties, so results should approximate that of the five-county area used in many comparisons.

B. Infant Mortality. Infant mortality, defined as deaths before age one as a proportion of live births, has long been regarded as possibly the most indicative measure of overall health of a population. Infant deaths have been collected by county and state health departments for many years, and are available on the CDC web site from 1979 to 2007.

Infant deaths are also a useful indicator when studying radiation's effects on a population, since the fetus and infant are most susceptible to the harmful effects of radiation exposure. The immune system of the young is not fully developed, and is less likely to fight off toxins such as radiation. In addition, the very rapid rate of growth in the fetal and infant periods means that young cells are dividing extremely rapidly (far faster than adults). A fetal or infant cell damaged by radiation is not as likely as a damaged adult cell to repair itself before duplicating into more damaged cells.

To understand a trend in local rates of infant deaths, statistics were divided into relatively equal decades 1989-1998 (10 years), and 1999-2007 (9 years). They are also arranged into rates for whites, blacks, and all races combined. The area around SRS has a very small proportion of residents who are not white or black, and thus analyzing these groups would not be very meaningful.

Table 28 provides infant death rates, using the standard definition of deaths to infants under one year per 1000 live births, for all races, whites, and blacks. They are expressed in terms of the local rate compared to the U.S. rate, the method used by the National Cancer Institute in its large 1990 study of cancer mortality near 62 U.S. nuclear plants.

Table 28
Deaths to Infants <1 Year Per 1000 Live Births, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
All	11.80 (737)	11.33 (601)	8.24	7.00	+43.2	+62.0	**+18.8** p<.03
White	8.42 (273)	7.63 (194)	6.77	5.85	+24.4	+30.4	**+ 6.0**
Black	15.79 (461)	15.12 (404)	16.24	13.16	- 2.8	+14.9	**+16.7** p<.02

The local/national infant death ratio increased for all races, whites, and blacks; increases were statistically significant for all races (p<.03) and blacks (p<.02). The current infant death rate in the five counties is 62.0% above the nation for all races (+30.4% for whites and +14.9% for blacks).

C. Neonatal Deaths. About two thirds of deaths to infants less than one year occur in the first 28 days of life. These deaths are called neonatal deaths, and often represent an outcome of one or more insults that occurred to the fetus – perhaps more than infant deaths. Table 29 compares the race-specific neonatal mortality trends of counties closest to SRS with the U.S.

Table 29
Deaths to Infants <28 Days Per 1000 Live Births, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
All	7.90 (493)	7.52 (399)	5.28	4.66	+49.6	+61.4	**+11.8**
White	5.24 (170)	4.95 (126)	4.34	3.91	+20.7	+26.6	**+ 5.9**
Black	10.96 (320)	10.18 (272)	10.52	8.73	+ 4.2	+16.6	**+12.4**

Local/national ratios of neonatal deaths increased during the past decade for all races (+11.8%), whites (+5.9%), and blacks (+12.4%). None of the increases were statistically significant. This pattern was very similar to the one found for infant deaths under one year. The local neonatal mortality rate was 61.4% above the U.S. in the most recent decade.

D. Low Weight Births . Another indicator of infant health that can reflect environmental contamination is the percent of babies born under weight. Low weight babies often reflect the inability to grow to full size in the womb, which may be caused by factors such as exposure to toxic chemicals like radiation. Low weight babies are much more likely to die as infants than those born at normal weight; those who survive have been found to suffer frequently from physical and developmental problems in childhood and later in life. The standard definition of low weight is less than 5½ pounds (under 2500 grams), and the rate of low births is the percentage of live births born under 2500 grams.

The U.S. Centers for Disease Control and Prevention only provides birth weight data for those counties with over 100,000 residents. Thus, the sources for these data are the respective state health departments in Georgia (Georgia Department of Public Health) and South Carolina. (South Carolina Department of Health and Environmental Control) Georgia began publishing data in the late 1990s, and South Carolina in 1990. Because this report found numerous increases in radioactivity concentrations near SRS from the late 1990s to the 2000s, birth weight data will use the same periods.

Table 30 shows the change in the local/national ratio of low birth weight rates, from 1998-1999 to 2000-2008.

Table 30
Births <5.5 Pounds Per 100 Live Births, by Race
Counties Closest to SRS vs. U.S., 1998-1999 to 2000-2008

	5 Cos. Rate (Cases)		U.S. Rate		% Local vs. US		
Race	1989-99	2000-08	1998-99	2000-08	1998-99	2000-08	% Ch.
All	9.88 (1156)	10.67 (5785)	7.60	7.94	+30.0	+34.4	**+ 4.4**
White	6.59 (382)	7.68 (1959)	6.55	6.92	+ 0.6	+11.0	**+10.4** p<.07
Black	13.42 (765)	13.77 (3732)	13.08	13.32	+ 2.6	+ 3.4	**+ 0.8**

The local/national ratio has increased since the late 1990s for all races, whites and blacks. The 10.4% increase for whites is borderline statistically significant (p<.07, where p<.05 is significant). Like neonatal deaths and infant deaths, the local rate of low weight births exceeds the U.S. rate, for all races, whites, and blacks.

E. Fetal Deaths/Stillbirths. Another measure of fetal health is the rate of spontaneous abortions, also known as stillbirths or fetal deaths, after 20 weeks of pregnancy. The rejection of the fetus often represents the inability to thrive in the womb, which (among other reasons) may be an outcome of exposure to toxic chemicals.

Local and state health departments have collected fetal deaths over 20 weeks gestation for decades, and the U.S. Centers for Disease Control and Prevention has published rates. Presently, there is one reported fetal death in the U.S. for every 160 live births. There are some problems with this measure. Most miscarriages occur within the first trimester of pregnancy, and thus those over 20 weeks represent only a small portion. In addition, some experts believe that fetal deaths are generally underreported; but assuming that underreporting is consistent over time, it is feasible to examine trends near SRS vs. U.S. trends.

Table 31 shows the trends in fetal death rates near SRS, compared to the U.S. The years 1998-1999 are compared with 2000-2008, since the data are taken from the web sites of the Georgia and South Carolina state health departments, and no data are available prior to the late 1990s. These periods correspond with many measures of local environmental radioactivity near SRS analyzed earlier in this report.

Table 31
Fetal Deaths Over 20 Weeks Gestation Per 1000 Live Births, by Race
Counties Closest to SRS vs. U.S., 1998-1999 to 2000-2008

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1998-99	2000-08	1998-99	2000-08	1998-99	2000-08	% Ch.
All	10.85 (127)	11.89 (645)	6.74	6.32	+61.0	+88.1	**+27.1** p<.10
White	6.38 (37)	7.25 (185)	5.71	5.37	+11.7	+35.0	**+23.3**
Black	15.79 (90)	16.75 (454)	12.47	11.70	+26.6	+43.2	**+16.6**

The local/national fetal death ratio in the five counties near SRS rose for all races (+27.1%), whites (+23.3%), and blacks (+16.6%) after the late 1990s. The increase for all races is of borderline statistical significance (p<.l0). The current local fetal death rate is 88.1% greater than, or nearly double, the U.S.

F. Child Cancer Incidence. While fetuses and infants are most susceptible to the toxic effects of radiation exposure, children also are at elevated risk. While an exposure to the fetus or infant can manifest as a condition in the womb, such as a low weight birth or fetal death, or it can take several years for the damage to transform into a diagnosed case of cancer. While childhood cancer is relatively rare (about 1 of 300 U.S. children will be diagnosed with the disease by age 19), cancer diagnosed in infants before age one is extremely rare. Childhood cancer is probably the most commonly studied condition in journal articles assessing risks of nuclear reactor emissions. Thus, it is logical to examine child cancer rates and a potential link with exposure to radioactivity from SRS.

The CDC has recently begun to publish national data on cancer incidence (cases), in addition to mortality, because state cancer registries, which only existed in a few states until the late 20th century, are now operational and comprehensive in all states. The CDC web site lists cancer incidence for the years 1999-2006. It does not give county-specific data, but only for Metropolitan Statistical Areas (MSAs), including Augusta-Richmond, which consists of six counties Georgia and South Carolina. While Aiken (SC), Burke (GA), and Richmond (GA) counties make up 92% of the residents in the five-county area used in this report, they also make up 69% of the MSA population (see below):

AUGUSTA-RICHMOND MSA COUNTIES

Aiken SC	160,099
Edgefield SC	26,985
Burke GA	23,316
Columbia GA	124,053
McDuffie GA	21,875
Richmond GA	200,549
TOTAL	556,907

In Table 32, the initial two-year period 1999-2000 will serve as a baseline period, with 2001-2006 as a follow up period. The change in annual childhood (age 0-19) cancer incidence, in the Augusta-Richmond MSA compared to the U.S., is given.

Table 32
Childhood Cancer Incidence (Cases per 100,000 Persons Age 0-19)
Augusta-Richmond MSA vs. U.S., 1999-2000 and 2001-2006

	Local MSA Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1999-00	2001-06	1999-00	2001-06	1999-00	2001-06	% Ch.
All	12.97 (39)	15.98 (146)	16.04	16.83	- 19.1	- 5.1	**+14.0**
White	17.95 (30)	19.24 (98)	16.91	17.60	+ 6.1	+ 9.3	**+ 3.2**
Black	9.27 (9)	11.16 (43)	11.58	12.29	- 19.9	- 9.2	**+10.7**

There was an increase in local/national child cancer incidence ratio in the Augusta-Richmond MSA for all races, whites, and blacks. These differences are not statistically significant, partially because childhood cancer is a rare event and only eight years are analyzed. But the local increase of 23.2% (12.97 to 15.98) was 7th greatest of 86 MSAs in the United States included on the CDC web site, and well above the U.S. rise of 4.9% (Table 33):

Table 33
Highest % Changes in Childhood Cancer Incidence
Of 86 U.S. MSAs With Available Data, 1999-2000 vs. 2001-2006

	Rate/100,000 (Cases)		
MSA	1999-00	2001-06	% Change
1. Columbia (SC)	11.29 (42)	15.89 (184)	+40.7%
2. Boise City-Nampa (ID)	16.18 (47)	21.99 (209)	+35.9%
3. Columbus (OH)	14.54 (134)	19.02 (548)	+30.8%
4. Honolulu (HI)	12.18 (28)	15.33 (208)	+25.9%
5. Charleston/N. Charleston (SC)	12.71 (41)	15.90 (161)	+25.1%
6. Oklahoma City (OK)	14.52 (93)	18.08 (352)	+24.5%
7. Augusta-Richmond (SC-GA)	**12.97 (39)**	**15.98 (146)**	**+23.2%**
8. Sacramento-Arden-Arcade-Roseville (CA)	13.72 (147)	16.87 (575)	+23.0%
United States (86 MSAs)	16.04	16.83	+ 4.9%

Interestingly, the highest increase for any MSA was Columbia SC, which includes the six South Carolina counties of Calhoun, Fairfield, Kershaw, Lexington, Richland, Saluda. The rate of childhood cancer incidence rose 40.7% for the latest six years. All of these counties are located directly downwind (northeast) of SRS, 20 to 80 miles from the border of the site.

Another source of data for local childhood cancer incidence is the South Carolina Department of Health and Environmental Control. The Department's web site provides statistical information on child cancer incidence for each South Carolina county for each year from 1996 to 2008. Unfortunately, the exact number of cases or incidence rate is not given for any county with fewer than 15 cases for a period. Thus, there are two limitations to examining local trends as no data is given for smaller South Carolina counties and for all Georgia counties.

The only South Carolina county close to SRS with a large enough population for the state data base to provide actual numbers of child cancer cases is Aiken. Studying only this county would be an incomplete analysis of SRS-area trends.

G. Child Cancer Mortality. The CDC mortality data base from 1979-2007, which was previously used in this report to examine infant deaths, can also be used to analyze trends in cancer deaths to children near SRS. Because of advances in technology, many children stricken with cancer now survive the disease into adulthood. Every year among American children age 0-19, about 13,000 are diagnosed with cancer but only 2,000 die from the disease. Thus, caution should be used in examining data on deaths from child cancer, as it may reflect the effectiveness of treatment more than any other factor, including exposure to radioactivity from nuclear plants. Caution should also be used because the number of child cancer deaths in a relatively small geographic area will tend to be low and lack statistical power.

Table 34 provides information on trends in local child cancer mortality age 0-14, for counties closest to SRS, compared to the U.S. The two most recent decades (1989-1998 vs. 1999-2007) are used. Data for whites and blacks are presented separately, even though race-specific rates are nearly identical for persons under age 25; blacks have higher cancer mortality for those over 25.

Table 34
Cancer Mortality, Age 0-14 Years Per 100,000 Persons, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
All	3.72 (33)	3.69 (29)	3.25	2.78	+14.5	+32.7	**+18.2**
White	4.27 (19)	4.81 (18)	3.29	2.82	+29.8	+70.6	**+40.8**
Black	3.23 (14)	2.74 (11)	3.16	2.75	+ 2.2	- 0.4	**- 2.6**

In the past decade, the local rate of childhood cancer mortality did not change (3.72 to 3.69 per 100,000), while the U.S. rate declined substantially. Thus, the five-county rate moved from 14.5% to 32.7% above the U.S. rate. There was a rise for local whites, but a slight decline for blacks. No change was statistically significant, as the number of deaths in the two decades (33 and 29) is relatively small.

H. Cancer Mortality Among the Very Elderly. If the fetus, infant, and young child are most vulnerable to the toxic effects of radiation exposure, the next most vulnerable age group is the very elderly. As the body ages, the strength of the immune system to combat outside invaders (like radiation) is reduced. Moreover, many elderly people are afflicted with one or more chronic conditions that weaken the body's ability to cope with environmental toxins.

One way to address any potential effects of SRS radioactive emissions on local elderly residents is to examine cancer death rates among persons age 85 and older – the same type of analysis as children age 0-14, only for the age group on the other end of the spectrum. One advantage of using the 85 and over group is that there are large numbers of cancer deaths among the very elderly compared to children, making it more likely to detect any statistically significant trends. Table 35 shows the changes in the local/national cancer mortality ratio for residents age 85 and over in counties most proximate to SRS.

Table 35
Cancer Mortality, Age 85 and Older Per 100,000 Persons, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
All	1601 (615)	1803 (882)	1811	1772	- 11.6	+ 1.7	**+13.3** p<.01
White	1615 (408)	1881 (614)	1801	1779	- 10.3	+ 5.7	**+16.0** p<.01
Black	1583 (206)	1667 (265)	2022	1888	- 21.7	- 11.7	**+10.0**

In the past decade, the local/national ratio of cancer mortality among persons over age 85 increased for all races (+13.3%), whites (+16.0%), and blacks (+10.0%). The changes for all races and whites were statistically significant. In the 1990s, local rates were below the U.S. for all races, but in the 2000s the local white and all-race rates now exceed those of the nation.

Another way to measure health trends for the very elderly living near SRS is to use cancer incidence (cases), in addition to mortality. The state of South Carolina provides age-specific incidence data by county on its web site for the years 1996 to 2008. But the state of Georgia generates no such data; only a single age-adjusted rate. This precludes any analysis of age-specific incidence for the five county area closest to SRS.

I. Cancer Incidence, All Ages – Radiosensitive Cancers. The very young and very old are most susceptible to the damaging effects of radiation exposure. However, radiation has been shown in numerous earlier studies, beginning with studies of survivors of the atom bombs used at Hiroshima and Nagasaki, to adversely affect humans of all ages.

Several types of cancer have been shown to be especially radiosensitive, including thyroid cancer, breast cancer, and leukemia. It is likely that exposure to particular isotopes accounts for these findings. Iodine-131 seeks out the thyroid gland. Cesium-137 disperses throughout the soft tissues, including the breast. Strontium-90 enters the bone, and can penetrate into the bone marrow, where it kills or injures white and red cells important to preventing leukemia.

While long-term data on incidence trends of these radiosensitive cancers are not available, such data exist on the CDC web site for the six-county Augusta-Richmond Metropolitan Statistical Area (MSA) for the years 1999-2006. Earlier, this report showed an unexpectedly high increase in childhood cancer incidence for this MSA, when the periods 1999-2000 and 2001-2006 were compared. This can now be done for certain radiosensitive cancers diagnosed in persons of all ages.

Table 36 shows the change in rates for the six local counties and the U.S. for all cancers, thyroid cancer, female breast cancer, and leukemia, from 1999-2000 and 2001-2006. All races are combined, which will not affect trend analysis because the racial distribution is largely unchanged over a relatively short period of time. Rates are adjusted to the 2000 U.S. standard population.

Two types of breast cancer, invasive and in situ, are shown separately. In situ breast cancers are malignant, but refer to those that are relatively small in size and that are found only in one particular area of the breast. Invasive breast cancers include those that are larger in size and that are often found in various portions of the breast. Health departments have been tracking both types of breast cancer in recent years, because of the much greater numbers of in situ cancers, which have grown along with the greater use of mammography technology. Most recently, close to one in five breast cancers reported to state cancer registries are in situ cancers.

Table 36
Age-Adjusted Incidence Per 100,000 Persons, Radiosensitive Cancers
Augusta-Richmond MSA vs. U.S., 1999-2000 and 2001-2006

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Type	1999-00	2001-06	1999-00	2001-06	1999-00	2001-06	% Ch.
All	432.0 (3944)	455.0 (13587)	481.4	473.9	- 10.2	- 4.0	**+ 6.2** p<.0002
Thyroid	5.00 (48)	8.70 (267)	7.11	9.29	- 29.7	- 6.4	**+23.3** p<.05
F Breast[1]	124.0 (638)	124.7 (2089)	132.8	122.8	- 6.6	+ 1.6	**+ 8.2** p<.06
F Breast[2]	20.8 (107)	24.9 (419)	28.4	28.9	- 26.6	- 13.9	**+12.7**
Leukemia	10.2 (93)	11.6 (340)	12.7	12.3	- 19.7	- 5.8	**+13.9**

[1] Invasive [2] In Situ

For each type of radiosensitive cancer (all cancers combined, thyroid, female breast invasive/in situ, and leukemia), the local/national ratio increased from 1999-2000 to 2001-2006. Increases were statistically significant for all cancers combined, thyroid cancer, and invasive female breast cancer. Current local rates are still below the U.S. (except for invasive female breast cancer), but the gap is closing.

Of perhaps greatest interest is cancer of the thyroid, a butterfly-shaped gland located in the throat area. There are virtually no known causes of thyroid cancer, other than exposure to ionizing radiation, especially iodine (which seeks out the gland). A half century ago, certain radiation treatments to infants and children for head and neck conditions like acne were found to increase risk of thyroid cancer and discontinued. Iodine in fallout from Nevada above-ground atomic bomb tests, which were banned in 1963, was estimated to have caused thyroid cancer in up to 212,000 Americans. (Institute of Medicine/National Research Council) But in recent years, the major source of radioactive iodine so harmful to the thyroid gland is nuclear reactors.

Thyroid cancer is the most rapidly growing cancer in the U.S., having tripled from 1980 to 2008. The annual number of Americans diagnosed with the disease soared from 12,000 to 46,000 since 1991. Scientists have discounted better diagnosis methods as a reason for this enormous change, but have yet to find support for any other potential cause. With head and neck irradiation and atom bomb testing ceased, the major source of thyroid-seeking radiation originates from nuclear facilities, including SRS.

The 74.0% local increase (5.00 to 8.70 cases per 100,000) in thyroid cancer incidence, compared to just 30.7% nationally (7.11 to 9.29), is one of the key findings in Table 36. The increase was 8th highest of 86 MSAs in the U.S. (accounting for two-thirds of the country's population) included in the CDC web site (Table 37); in Table 33 of this report, the local increase for childhood cancer ranked 7th highest of 86.

Table 37
Highest % Changes in Thyroid Cancer Incidence
All 86 U.S. MSAs With Available Data, 1999-2000 vs. 2001-2006

	Rate/100,000 (Cases)		
MSA	1999-00	2001-06	% Change
1. Modesto (CA)	3.74 (31)	8.52 (231)	+127.8%
2. Ogden-Clearfield (UT)	5.70 (44)	12.31 (308)	+116.0%
3. Omaha-Council Bluffs (NE-IA)	4.50 (68)	9.18 (428)	+104.0%
4. Portland-S. Port.-Biddeford (ME)	4.71 (48)	9.31 (298)	+ 97.7%
5. Pittsburgh (PA)	6.98 (361)	13.61 (2125)	+ 95.0%
6. Provo-Orem (UT)	6.78 (35)	12.52 (237)	+ 84.7%
7. Boise City-Nampa (ID)	7.53 (65)	13.45 (407)	+ 78.6%
8. Augusta-Richmond (SC-GA)	**5.00 (48)**	**8.70 (267)**	**+74.0%**
9. Boston-Cambridge-Quincy (MA)	8.28 (748)	14.11 (3930)	+ 70.4%
United States (86 MSAs)	7.11	9.29	+ 30.7%

J. Cancer Mortality, All Ages, All Cancers Combined. The recent increase in the local/national incidence ratio near SRS for all cancers combined raises the question of whether the mortality ratio has increased as well. Table 38 provides age-adjusted mortality ratios for local populations, comparing the most recent decades (1989-1998 vs. 1999-2007). Rates are adjusted to the 2000 U.S. standard population.

Table 38
Age-Adjusted Cancer Mortality Per 100,000 Persons, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
All	233.0 (7614)	216.3 (7651)	213.2	194.1	+ 7.9	+11.4	**+ 3.5** p<.05
White	219.0 (5011)	209.9 (5009)	209.4	192.6	+ 4.6	+ 9.0	**+ 4.4** p<.05
Black	256.9 (2570)	231.6 (2590)	272.8	236.9	- 5.8	- 2.2	**+ 3.6**

The percentage increases in local/national ratios for all races, whites, and blacks were relatively small (+3.5%, +4.4%, and +3.6%). However, due to the large number of deaths involved (7651 in the most recent nine years), increases for all races and whites were statistically significant. Current rates for all races and whites exceed the U.S., while the rate for blacks is nearing the U.S. standard.

Mortality rates for perhaps the most radiosensitive cancer (thyroid) are not given. Thyroid cancer is not only relatively rare, but is among the most treatable cancers, and the small number of deaths from this disease in the five-county area near SRS makes any analysis meaningless. In addition, breast cancer, which is split into invasive and in situ when analyzing diagnosed cases, is given as a single entity for deaths.

K. Cancer Mortality, All Ages, Conditions Shown to Harm SRS Workers. Earlier in this report, medical journal articles by a team from the University of North Carolina were summarized; these studies showed that occupational exposures of radiation from SRS increased the risk of certain cancers to workers. These include cancer of the lung, leukemia, lymphoma, and multiple myeloma. In addition, Makie et al. showed an elevated death rate from all pulmonary conditions (excluding lung cancers) among male workers at SRS. UNC researchers also found elevated rates of skin and kidney cancer among female workers; these will not be examined further, because there is no adequate data on skin cancer for blacks (the rates are low and few cases are available), and because kidney cancer has not been shown to be elevated among male workers, who represent the large majority of the SRS work force.

Table 39 presents mortality changes in the past two decades for the five local counties vs. the U.S. for cancer of the lung, leukemia, lymphoma, and multiple myeloma. In addition, it includes changes in pneumonia/influenza and Chronic Obstructive Pulmonary Disease rates, as these make up the large majority of respiratory conditions accounting for death, aside from lung cancer.

Table 39
Age-Adjusted Cancer Mortality Per 100,000 Persons, by Race
Counties Closest to SRS vs. U.S., 1989-1998 to 1999-2007
Conditions Found to be Elevated in SRS Workers

	5 Cos. Rate (Deaths)		U.S. Rate		% Local vs. US		
Race	1989-98	1999-07	1989-98	1999-07	1989-98	1999-07	% Ch.
Lung Cancer							
All	65.13 (2204)	62.63 (2240)	58.43	53.66	+11.5	+16.7	**+ 5.2**
White	68.37 (1619)	65.83 (1599)	58.05	54.01	+17.8	+21.9	**+ 4.1**
Black	57.89 (579)	56.42 (634)	69.66	60.32	- 16.9	- 6.5	**+10.4** p<.04
Leukemia							
All	7.80 (260)	7.60 (264)	7.80	7.41	+ 0.0	+ 2.6	**+ 2.6**
White	8.25 (183)	7.95 (187)	7.94	7.63	+ 3.9	+ 4.2	**+ 0.3**
Black	6.77 (76)	6.41 (76)	7.12	6.49	- 4.9	- 1.2	**+ 3.7**
Non-Hodgkins Lymphoma							
All	5.92 (196)	7.31 (257)	8.47	7.36	- 30.1	- 0.7	**+29.4** p<.0002
White	6.88 (156)	8.62 (204)	8.81	7.68	- 21.9	+12.2	**+34.3** p<.0006
Black	3.60 (40)	4.47 (52)	5.79	5.07	- 37.8	- 11.8	**+26.0** p<.10
Multiple Myeloma							
All	4.47 (146)	4.30 (152)	3.89	3.63	+14.9	+18.5	**+ 3.6**
White	3.23 (72)	3.64 (88)	3.58	3.37	- 10.0	+ 8.0	**+18.0**
Black	7.57 (74)	5.80 (62)	7.57	6.85	+ 0.0	- 15.3	**- 15.3**
Pneumonia and Influenza							
All	38.49 (1157)	26.51 (892)	34.23	20.73	+12.5	+27.9	**+15.4** p<.005
White	38.30 (774)	25.47 (577)	33.86	20.58	+13.1	+23.8	**+10.7**
Black	39.44 (380)	29.23 (308)	36.89	22.58	+ 6.9	+29.5	**+23.6** p<.02
Chronic Obstructive Pulmonary Disease							
All	39.88 (1290)	42.65 (1476)	39.54	35.67	+ 0.9	+19.6	**+18.7** p<.00001
White	47.21 (1057)	52.22 (1246)	40.82	37.62	+15.7	+38.8	**+23.1** p<.00001
Black	23.27 (230)	21.97 (228)	29.46	23.91	- 21.0	- 8.1	**+12.9**

Trends for the three racial groups for the six causes of deaths make a total of 18 categories. Out of the 18 there were 17 in which the local rate increase exceeded the U.S. rate. Of the 17, eight (8) of these increases were statistically significant. The only category in which the local rate increase did not exceed the U.S. was multiple myeloma for blacks.

L. Summary of Trends. While there are numerous other health status indicators that can be analyzed, those examined in Tables 29 to 39 constitute those most likely to reflect the harmful effects of radiation exposure. Most of these have relatively large local numbers of cases or deaths in the past decade, and thus it will be more likely that any difference between local and national rate changes will be statistically significant.

Table 40 summarizes changes in disease/death rates in the five counties closest to SRS (compared to the U.S.) from the 1990s to the 2000s, and notes which changes are statistically significant or of borderline significance.

Table 40
Changes in Incidence and Mortality Rates, 1989-1998 to 1999-2007
Five Closest Counties to SRS vs. the U.S.

Indicator	Race	Local % Ch. is Greater	U.S. % Ch. is Greater
Infant Mortality	All	X*	
Infant Mortality	White	X	
Infant Mortality	Black	X*	
Neonatal Mortality	All	X	
Neonatal Mortality	White	X	
Neonatal Mortality	Black	X	
Low Weight Births	All	X	
Low Weight Births	White	X+	
Low Weight Births	Black	X	
Fetal Mortality	All	X+	
Fetal Mortality	White	X	
Fetal Mortality	Black	X	
Cancer Incidence 0-19	All	X	
Cancer Incidence 0-19	White	X	
Cancer Incidence 0-19	Black	X	
Cancer Mortality 0-14	All	X	
Cancer Mortality 0-14	White	X	
Cancer Mortality 0-14	Black		X
Cancer Mortality >85	All	X*	
Cancer Mortality >85	White	X*	
Cancer Mortality >85	Black	X*	
Cancer Incidence – Total	All	X*	
Cancer Incidence – Thyroid	All	X*	

Cancer Incidence – F Breast	All	X+	
Cancer Incidence – F Breast in situ	All	X	
Cancer Incidence – Leukemia	All	X	
Cancer Mortality All Ages	All	X*	
Cancer Mortality All Ages	White	X*	
Cancer Mortality All Ages	Black	X	
Lung Cancer Mortality	All	X	
Lung Cancer Mortality	White	X	
Lung Cancer Mortality	Black	X*	
Leukemia Mortality	All	X	
Leukemia Mortality	White	X	
Leukemia Mortality	Black	X	
Lymphoma Mortality	All	X*	
Lymphoma Mortality	White	X*	
Lymphoma Mortality	Black	X+	
Multiple Myeloma Mortality	All	X	
Multiple Myeloma Mortality	White	X	
Multiple Myeloma Mortality	Black		X
Pneumonia/Influenza Mortality	All	X*	
Pneumonia/Influenza Mortality	White	X	
Pneumonia/Influenza Mortality	Black	X*	
COPD Mortality	All	X*	
COPD Mortality	White	X*	
COPD Mortality	Black	X	
TOTAL (No. Significant/Borderline Significant)		46 (20)	2 (0)

Notes: Births <2500g compares 1998-1999 vs. 2000-2008; Fetal Deaths compares 1997-1998 vs. 1999-2008; Cancer Incidence 0-19 and various cancer types compares 1999-00 vs. 2001-2006. All other measures compare 1989-98 to 1999-2007. COPD stands for Chronic Obstructive Pulmonary Disease.

The change in rate for the five local counties exceeded the national change during the past decade for an overwhelming 46 of 48 indicators. Of these 46 increases, 20 were statistically significant or of borderline significance. This finding is strong evidence that some factor(s) worsened the health of residents of the five counties. There are many potential reasons that could account for this, but one that must be included is the rising levels of radioactivity emitted into the environment from SRS and detected in the local air, water, and food during the 2000s.

M. Upwind vs. Downwind Increases. Because one can assume the majority of the radioactivity travels downwind, more analyses of health trends near SRS can test this theory. Prevailing winds in the Aiken/Augusta area blow towards the northeast most of the year. (NOAA) Thus, health status changes for the proximate counties in the downwind (northeast) and upwind (southwest) directions will be compared (Table 41). These counties, with 2010 populations, are listed below. They include the same five counties used in Tables 29-38, with the addition of rural Jefferson County GA.

DOWNWIND COUNTIES		UPWIND COUNTIES	
Aiken SC	160,099	Richmond GA	200,549
Barnwell SC	22,621	Jefferson GA	16,930
Allendale SC	10,419	Burke GA	23,316
TOTAL	193,139	TOTAL	240,795

Table 41
Changes in Incidence and Mortality Rates, 1989-1998 to 1999-2007
Closest Counties to SRS, Downwind vs. Upwind

	Downwind Counties Rate (Deaths/Cases)		Upwind Counties Rate (Deaths/Cases)		% Change	
Indicator/Race	1989-98	1999-07	1989-98	1999-07	Down	Up
Inf. Mortality – T	9.68 (241)	11.34 (242)	13.38 (542)	11.39 (388)	**+17.1**	-14.9 p<.0003
Inf. Mortality - W	7.32 (114)	8.53 (111)	9.45 (168)	6.58 (87)	**+16.5**	-30.3 p<.0004
Inf. Mortality – B	13.94 (127)	15.92 (128)	16.78 (371)	14.89 (301)	**+14.2**	-11.3 p<.03
Neo. Mortality – T	6.03 (150)	7.36 (157)	9.36 (379)	7.75 (264)	**+22.1**	-17.2 p<.0004
Neo. Mortality - W	4.36 (68)	5.69 (74)	5.91 (106)	4.01 (53)	**+30.5**	-32.1 p<.0004
Neo. Mortality – B	9.00 (82)	10.20 (82)	12.26 (271)	10.44 (211)	**+13.3**	-14.8 p<.04
Births <2500g – T	10.13 (471)	10.46 (2256)	9.87 (750)	10.88 (3812)	+ 3.3	**+10.2** p<.02
Births <2500g - W	6.96 (198)	7.81 (1032)	6.30 (198)	7.39 (971)	+12.2	**+17.3**
Births <2500g – B	15.54 (270)	14.85 (972)	12.57 (544)	13.41 (2770)	- 4.4	**+ 6.7** p<.003
Fetal Mortality –T	9.36 (44)	10.23 (245)	11.88 (90)	12.87 (500)	**+ 9.3**	+ 8.3
Fetal Mortality -W	5.53 (16)	6.55 (96)	5.23 (17)	7.89 (116)	+18.4	**+50.9** p<.08
Fetal Mortality– B	15.97 (28)	16.86 (149)	17.14 (72)	16.55 (378)	**+ 5.6**	- 3.4
Can. Mort. 0-14-T	4.99 (19)	4.44 (15)	2.73 (15)	3.11 (15)	- 11.0	**+13.9**
Can. Mort. >85- T	16.07 (264)	18.67 (449)	16.19 (409)	17.65 (492)	**+16.2**	+ 9.0
Can. Mort. >85-W	15.95 (185)	19.03 (339)	16.50 (257)	18.64 (306)	**+21.6**	+13.0
Can. Mort. >85-B	16.45 (79)	17.80 (109)	15.69 (152)	16.46 (184)	**+ 8.2**	+ 4.9
Can. Mort. All -T	218.5 (3319)	206.2 (3586)	239.8 (4726)	226.5 (4452)	- 5.6	**- 5.5**
Can. Mort. All -W	209.0 (2399)	202.5 (2680)	228.1 (2829)	220.4 (2542)	- 3.1	**- 3.4**
Can. Mort. All -B	251.0 (914)	218.0 (891)	261.9 (1870)	238.9 (1873)	- 13.2	**- 8.8**

TOTAL INCREASES THAT ARE GREATER (No. Significant) 11 (6) 8 (3)
Notes: Births <2500g compares 1998-99 vs. 2000-08; Fetal Deaths compares 1997-98 vs. 1999-2008

Of the 19 health status indicators, a larger increase occurred in downwind counties for 11 (6 significant), versus 8 in the upwind counties (3 significant). This shows only a slightly more harmful effect of living downwind vs. upwind from SRS. Even results for fetuses and infants have split results. Downwind increases were greater downwind for infant and neonatal death rates; were greater upwind for low weight birth rates; and mixed for fetal death rates.

It is possible that using just two years as a baseline for low weight births and fetal deaths, as opposed to 10 years for all other indicators, may alter results. If these two were eliminated from the analysis, nine (9) indicators would have higher increases downwind (6 significant) while four (4) indicators had higher increases upwind, none significant.

Finally, it may be that within a small radius of SRS such as the 25 mile limit in this analysis, relatively similar amounts of radioactivity are dispersed throughout the area. While each area has a prevailing wind direction, winds blow and swirl in all directions; there may not be huge differences in local airborne radioactivity levels. The amounts ingested also depend on patterns of precipitation (i.e., radiation levels when it rains or snows) and food consumption, for which there are no data.

N. Upriver vs. Downriver Increases. In addition to upwind/downwind comparisons, it is possible to analyze counties upriver and downriver from SRS. Naturally, the Savannah River is the main body of water in the area, flowing in a southeasterly direction towards the Atlantic Ocean. Earlier in the report, a series of measurements by officials from the Energy Department and state of South Carolina showed that higher radioactivity concentrations in the southeastern (downriver) direction from SRS.

Counties in both South Carolina and Georgia border on the Savannah River, and residents of these counties are more likely to consume fish from the river. Thus, it is logical to expect that residents in counties southeast (downriver) from SRS ingest greater amounts of radioactive chemicals from fish than do residents in counties northwest (upriver) from the plant. This analysis will include counties up to about 85 miles upriver and downriver of SRS. These counties are listed below, with their 2010 populations:

DOWNRIVER COUNTIES		UPRIVER COUNTIES	
Hampton SC	21,090	Aiken SC	160,099
Barnwell SC	22,621	Edgefield SC	26,985
Allendale SC	10,419	McCormick SC	10,233
Jasper SC	24,777	Abbeville SC	25,417
Burke GA	23,316	Richmond GA	200,549
Screven GA	14,593	Columbia GA	124,053
Effingham GA	52,250	Lincoln GA	7,996
TOTAL	169,066	TOTAL	555,332

The upriver counties have a much greater number of residents than downriver counties (555,332 to 169,066), because the three most-populated (Aiken SC, Columbia GA, and Richmond GA) are upriver. Table 42 provides health status trends in downriver and upriver counties.

Table 42
Changes in Incidence and Mortality Rates, 1989-1998 to 1999-2007
Closest Counties to SRS, Downriver vs. Upriver

	Downriver Counties Rate (Deaths/Cases)		Upriver Counties Rate (Deaths/Cases)		% Change		
Indicator/Race	1989-98	1999-07	1989-98	1999-07	Down	Up	
Inf. Mortality – T	11.34 (247)	10.78 (224)	10.60 (771)	10.59 (677)	- 4.9	**- 0.1**	
Inf. Mortality - W	7.86 (80)	7.98 (86)	7.78 (333)	7.02 (255)	**+ 1.5**	- 9.8	
Inf. Mortality – B	14.45 (167)	14.00 (137)	15.09 (435)	15.97 (420)	- 3.1	**+ 5.8**	
Neo. Mortality – T	7.39 (161)	7.51 (156)	7.17 (521)	7.28 (465)	**+ 1.6**	+ 1.5	
Neo. Mortality - W	4.72 (48)	5.29 (57)	4.95 (212)	4.68 (170)	**+12.0**	- 5.5	
Neo. Mortality – B	9.78 (113)	10.12 (99)	10.62 (306)	11.18 (294)	+ 3.5	**+ 5.3**	
Births <2500g – T	9.89 (440)	10.49 (2253)	9.26 (1280)	9.73 (6343)	**+ 6.1**	+ 5.1	
Births <2500g - W	6.90 (155)	7.52 (837)	6.47 (513)	7.09 (2569)	+ 9.0	**+ 9.6**	
Births <2500g – B	12.80 (281)	14.09 (1380)	13.36 (752)	13.65 (2770)	**+10.0**	+ 2.2	p<.03
Fetal Mortality –T	9.12 (40)	11.41 (271)	9.06 (125)	10.77 (780)	**+25.1**	+18.9	
Fetal Mortality -W	2.79 (6)	7.47 (92)	5.18 (42)	7.26 (292)	**+167.7**	+40.2	p<.0002
Fetal Mortality– B	15.37 (34)	16.28 (177)	15.23 (83)	16.31 (480)	+ 5.9	**+7.1**	
Can. Mort. 0-14-T	4.66 (16)	3.41 (11)	2.61 (28)	3.35 (33)	- 26.8	**+28.4**	p<.09
Can. Mort. >85- T	14.96 (233)	16.59 (317)	16.50 (726)	18.36 (1097)	+10.9	**+11.3**	
Can. Mort. >85-W	12.16 (101)	15.71 (176)	16.54 (512)	19.00 (815)	**+29.2**	+14.9	
Can. Mort. >85-B	18.19 (132)	17.94 (141)	16.55 (213)	17.02 (278)	- 1.4	**+ 2.8**	
Can. Mort. All -T	220.1 (2651)	214.6 (2828)	226.0 (8874)	212.2 (9391)	**- 2.5**	- 6.1	p<.10
Can. Mort. All -W	203.7 (1517)	201.7 (1681)	215.5 (6167)	206.9 (6586)	**- 1.0**	- 4.0	
Can. Mort. All -B	246.0 (1132)	237.5 (1141)	257.9 (2660)	229.9 (2723)	**- 3.5**	- 10.9	p<.03
TOTAL INCREASES THAT ARE GREATER (No. Significant)					11 (4)	8 (1)	

Notes: Births <2500g compares 1998-99 vs. 2000-08; Fetal Deaths compares 1997-98 vs. 1999-2008

The downriver counties had higher rate increases for 11 conditions (4 significant) while the upriver counties had higher rate increases for 8 conditions (1 significant). This finding was similar to the downwind/upwind comparison.

Downriver/upriver trends show only a slightly more harmful effect of living downriver vs. upriver from SRS. There may be methodological problems that block the ability to understand effects of living downriver. Fish consumption patterns from county to county are not known. Selecting counties up to 85 miles away from SRS may skew results (perhaps only more proximate areas are relevant). There is a "mixing" of some counties, i.e. Aiken County SC is classified as a downriver county but also as an upwind county. Finally, downriver counties are all rural, and may not be comparable to the mostly urban/suburban upriver counties.

DISCUSSION.

The Savannah River Site is a 60 year old facility that produced nuclear weapons for decades, and (since the early 1990s) for other nuclear-related purposes. The massive contamination of the site was ignored for years, but since the end of the Cold War, the U.S. Department of Energy has finally commenced a program of Environmental Management to remediate the toxic mess at the site.

The EM program at SRS is part of a larger program managed by the DOE to reduce and remove radioactive contamination at the various nuclear weapons sites. Work has been completed or is nearing completion at some of these sites. However, work at SRS will continue until at least 2031, according to DOE; some believe that it will take longer to complete, or that it is not possible to achieve full remediation.

Several factors make SRS a key component of the EM program. First, the extent of contamination at the site is one of the worst (if not THE worst) of any DOE nuclear facility. Second, it will take much longer to complete work, if ever, at SRS, compared to other DOE nuclear facilities. Finally, nuclear-related facilities are still operating and new facilities are being planned at SRS, while most other DOE nuclear facilities have no other purpose than remediation.

The DOE EM program has met with mixed reviews. The Department itself contends it is making substantial progress in reducing environmental contamination at the site, and is doing so in an efficient manner. However, other parties (including citizen groups) have other views. They assert that the program is progressing slowly, and may last well beyond 2031. Moreover, they believe that the contamination is not truly being removed as completely as possible, and that the EM process may be shifting contamination, or actually be adding to contamination levels over time.

These differing viewpoints make it important that reviews of DOE EM programs at SRS and other DOE nuclear weapons sites be conducted by parties INDEPENDENT of the federal government and the nuclear industry. The CIF has recognized this need, and has established a 5-year program to address the issues.

The Radiation and Public Health Project (RPHP) has always believed that U.S. citizens must be educated on nuclear-related issues, so that their input into these very public matters is well-informed. The current project proposes to develop information on

TRENDS in contamination levels and health status in and near SRS, since the era of nuclear weapons manufacture ended and the era of environmental clean up began.

The belief that virtually no such data has been made easily available to the public was confirmed early in this report after a review of the medical and scientific literature. While there have been numerous articles comparing environmental contamination levels at SRS vs. levels offsite, there is virtually NO INFORMATION ON TRENDS in contamination over time. Moreover, there are less than a dozen medical journal articles on local health, and none address TRENDS over time in local rates of disease and death.

This report first examined trends in changes in radioactive emissions from SRS and levels of radioactive contamination at or near the site. Examining raw data from the DOE, government agencies in South Carolina and Georgia, and from the Southern Company that operates the Vogtle nuclear power plants close to SRS, allowed a comparison to be made in levels during the 2000s compared to the late 1990s. This comparison is meaningful, as the EM program at SRS took several years to become active after nuclear weapons operations ceased in the early 1990s.

Most measures use a baseline of one or more years in the late 1990s, although some use a later period (2000 and/or 2001) when earlier data are not available. Many of the indicators include data up to 2008, 2009, or 2010, making the analyses current.

There were many types of contamination, expressed as both emissions and levels in air/water/food, to be analyzed. Of 63 total measures, increases over time were detected for 45 (71.4%). If measures of tritium are eliminated, the proportion of increases goes up to 78.4% (40 of 51). These are highly unexpected trends, given the extensive EM activities in the past decade.

While all measures of environmental contamination trends are important, arguably the most meaningful are in-body measurements, as they represent not just what enters the environment but what actually enters bodies. Unfortunately, there have been no studies of radioactivity in human bodies near SRS, but a number of studies in animals were cited in this report. A summary of these studies, and trends that were found, are as follows:

Table 9 – Cesium 137 in deer muscle	+ 81%
Table 9 – Cesium 137 in hog muscle	+ 83%
Table 16 – Strontium 90 in fish	- 68%
Table 17 – Cesium 137 in white tailed deer	+ 35% < 5 mi.
Table 17 – Cesium 137 in white tailed deer	+143% 5-50 mi.
Table 18 – Strontium 89/90 in cow milk	+ 91%
Table 25 – Cesium 137 in bass downriver	- 5% (vs. -68% upriver)

All of the findings show substantial increases in the 2000s, with the exception of fish. Of the two fish studies, one shows a decrease, while the other shows only a small (5%) decrease downriver (in the Savannah River), compared to a large (68%) decline upriver.

A strong pattern of increased radioactivity in bodies of deer, hogs, fish, and cows suggests that there may well have been an increase in human bodies as well.

The data on trends in radioactive emissions from SRS and environmental levels of radioactivity are supplemented by data on local health trends. This report generally compares the trends in local disease and death rates from the 1990s to the 2000s. Most mortality analyses use data from the U.S. Centers for Disease Control and Prevention web site, while those for fetal deaths use official data from South Carolina and Georgia Health Departments. Cancer incidence and birth weight data are also taken from the CDC web site.

Most of the measures used are mortality rates. The time periods used in analyzing these rates are 1989-1998 to 1999-2007, which essentially compares the 1990s and 2000s. Information on fetal deaths, low weight births, and cancer incidence trends use a two-year baseline from the late 1990s, along with data from the 2000s (usually a six- or eight-year period). The 2000s constitute the period in which EM operations at SRS were fully operational.

The "local" area near SRS is defined as those counties completely or mostly within 25 miles of the plant. Five counties meet these criteria, including Aiken, Allendale, and Barnwell in South Carolina, and Burke and Richmond in Georgia. Because the cities of Aiken SC and Augusta GA are within this five-county area, a relatively large population (417,004 according to the 2010 U.S. Census) makes meaningful analyses possible. The five county area rates, compared to the U.S. rate, for the baseline and follow-up periods, are used to measure trends in disease and death rates. Changes for whites, blacks, and all races combined were analyzed to further assess any potential effects of radioactive contamination from SRS.

While many conditions can be examined, only those believed to be most sensitive to radiation exposure were used, including:

- Conditions affecting the fetus and infant (infant deaths, neonatal deaths, low weight births, and fetal deaths)

- Deaths from cancer for the very young (<15) and very old (>85)

- Incidence for those cancers (all ages) known to be most sensitive to radiation exposure (thyroid, female breast, and leukemia)

- Deaths for those cancers and other conditions already found in published articles to be elevated in SRS workers (lung cancer, leukemia, lymphoma, multiple myeloma, pulmonary diseases excluding lung cancer)

Results of these analyses showed in 46 of 48 instances, the local rate rose faster than the U.S. rate from the 1990s to the 2000s. Moreover, 20 of the 46 increases were statistically significant or of borderline significance. This set of findings provides overwhelming evidence that some factor or factors has worsened local health for certain age groups and for certain conditions. Moreover, because prior studies have shown that these indicators can reflect negative outcomes of radiation exposure, SRS emissions – both from recent years and the more distant past – should be considered one of these potential factors.

The unexpectedly high death and cancer rates can be translated into "excess" numbers of humans in the five counties near SRS who died or suffered from diseases studied beyond what would have been if local trends had equaled national ones. For example, the rise in local-national ratio of infant deaths from 1989-1998 to 1999-2007 is 18.8%; multiplying the number of infant deaths (601) by 18.8% yields an "excess" number of 113.

Excess deaths and cases for the most recent nine years (most 1999-2007, some 2000-2008) in the five-county area closest to SRS include:

<u>MORTALITY</u>:		
Infant Deaths < 1 Year	113	(601 deaths x 18.8%)
Fetal Deaths > 20 Weeks Gestation	175	(645 deaths x 27.1%)
Deaths from Cancer	268	(7651 deaths x 4.4%)
Deaths, Pneumonia and Influenza	137	(892 deaths x 15.4%)
Deaths, Chronic Obstructive Pulmonary Disease	276	(1476 deaths x 18.7%)
TOTAL EXCESS DEATHS	969	
<u>ADULT NON-FATAL CASES:</u>		
Cancer incidence, All Ages	842	(13587 cases x 6.3%)
<u>INFANT NON-FATAL CASES</u>		
Births <2500 grams	255	(5875 cases x 4.4%)
TOTAL EXCESS DEATHS/CASES	2066	

The total of 2,066 excess cases and deaths is slightly inflated, because some low weight births are also infant deaths and because some cancers represented in the incidence category are also counted as cancer deaths. However, an approximate number approaching 2,000 excess cases and deaths reflect the results documented in this report.

While there could be many factors contributing to these unexpected rises, none are apparent. An examination of demographic characteristics in the five counties finds that local trends in the past decade are similar to the U.S. These include age, race, and sex distribution, educational status, and financial status. Thus, rising local poverty rates can not account for the worsening local-national health ratios, since poverty rates are increasing at a similar rate nationwide.

This report attempted to further examine trends in health status within the SRS area. Counties that best represented downwind and upwind areas, along with downriver and upriver from the plant, were chosen, and trends from the 1990s to the 2000s were compared for some of the indicators. Greater local increases were documented in downwind counties and downriver counties for 11 of 19 indicators. Ten (10) of the 22 measures in which downwind/downriver counties had higher increases were statistically significant, while just 4 of 16 were significantly higher in upwind or upriver areas.

These findings provide some, but not strong evidence that wind direction and river flow are as strongly linked with increased health risk from SRS as proximity to the site. There were some difficulties with the methodology used in selecting counties. For example, the upriver and downriver counties were located up to 85 miles from SRS, which may be too distant to detect adverse health effects. In addition, some downwind counties were classified as upriver counties – adding an element of conflict to the hypothesis that river direction and wind direction will affect health risk. Finally, downriver counties were all rural, while upriver counties were mostly urban, which may represent an invalid comparison. Identifying portions of the local area whose residents are most likely to absorb more SRS radioactivity is a daunting task that needs more work.

Rising local rates of deaths and cases of conditions known to be sensitive to radiation during the past decade are of concern. These trends become more meaningful because the majority of measures of local radioactivity (emissions and environmental concentrations) in and near SRS were found to also be rising during this time. While such a radiation-health link is not indisputable, concerns should be raised about whether such a link exists.

EVALUATION/CONCLUSIONS.

Evaluating the Radiation and Public Health Project effort for the Community Involvement Fund is a somewhat incomplete process at this writing. There are several important steps that will quickly follow, including:

- Sharing this report with major stakeholders, and prepare public dissemination; *the Blue Ridge Environmental Defense League agreed in December 2011 to coordinate a press conference announcing results*

- Sharing this report with DOE and elected federal officials responsible for DOE oversight; these groups should be stakeholders but aren't always

- Sharing this report with other awardees of CIF grants, to give them thoughts on how to improve current and future work

- Preparing an article for a medical/scientific journal article (on all or part of the report's contents) and submit manuscript for publication; *a journal was selected and the article begun in December 2011*

- Place report on the RPHP web site and face book page, and encourage other stakeholders to do the same

- Encourage stakeholders to use information at public events, and offer RPHP expertise on how best to accomplish this goal

Even though these activities remain in the future, this report has already proved helpful. Probably most important of all ramifications is that it has provided extensive information upholding the principal concept of CIF, i.e. that INDEPENDENT activities must be conducted on DOE EM activities, so that communities and residents most likely to be affected by the DOE cleanup process ("stakeholders") can ensure EM is conducted in a transparent and effective manner. Interested stakeholders have been identified, and await the report; a methodology of understanding results of DOE EM activities has been developed; and useful information for studying EM activities has been compiled.

Even before this report was completed, evidence existed that indicated independent review of DOE EM activities was warranted. It is critical that the remediation work at the heavily-contaminated DOE sites is conducted as effectively as possible; radioactive contamination has threatened many humans for decades, due to the "back seat" assigned to safety and health by government officials, and the lack of public accountability. To allow the DOE self-report on the progress of its activities, given its history speckled with secrecy, deception, and lack of accountability, would be irresponsible public policy. Clearly, independent reporting from outside independent organizations is needed.

There are several ways to track DOE EM activities. One of these is to assess processes – how DOE plans its EM activities, and how well personnel actually carry out tasks. Another way to examine EM is to assess outcomes, i.e. trends in local contamination and health at or near SRS. This report selected an outcomes-based approach, because:

- Outcomes measures are often more empirical and measurable than process measures, the assessment of which can be subjective

- Outcomes measures have generally has been overlooked or glossed over by the DOE without examining and presenting details

- Outcomes measures address the most crucial aspect of DOE activities, i.e. whether public health and safety are harmed

This report was prepared by the Radiation and Public Health Project, which for over two decades has specialized in the analysis of the relationship between exposures to radioactive fission products from nuclear reactors and health hazards to local residents. RPHP has no ties to, nor receives no support from, the federal government or to the nuclear industry; thus, assessing the work of DOE and its subcontractors can be done with no conflicts of interest.

Evaluation of this report can be based on the following items illustrating the importance of the project thus far:

- It collected and summarized a large amount of data that has been previously been made publicly available, but not easily accessible for analysis by stakeholders, and made them more user-friendly, both in summary or in detailed form

- It showed that, despite DOE assurances, local levels of radioactivity (emissions and environmental levels) near SRS are mostly rising, as are virtually all local rates of disease and death for conditions most sensitive to radiation exposure

- It raised the question of whether the DOE EM work was being conducted in an efficacious manner, and whether the plans to add more nuclear-related facilities at SRS constitute an even greater health/safety threat

- It generated a substantial basis for evaluating the outcomes of DOE work, which can be applied to DOE sites other than SRS

- It makes publicly available not just considerable new information, but specifically on one of the DOE sites of greatest concern, because of the history of extensive contamination at SRS and because of the plans to add a number of new nuclear-related facilities at the site

- It indicates the need not just for future studies, but specifically the need to refine analytical techniques and the need to include other types of studies (such as an analysis of in-body levels of radioactivity near SRS and other DOE sites)

Completion of this report is just the beginning of the process outlined by RPHP in its application to CIF. Upcoming activities will shift the focus of the work away from RPHP and towards stakeholders to disseminate the findings and use them to improve DOE work. Those who will benefit most from the information in this report include citizen advocacy groups, elected officials, regulators (DOE and other), media, the population at large, and other CIF grantees. The information will be focused on those involved with the SRS area, but also those concerned with DOE EM activities at all nuclear weapons-related facilities.

In summary, the project's work thus far has made strong headway towards the Community Involvement Fund primary goal of increasing public participation and input on DOE environmental cleanup decisions and activities.

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APPENDIX 1

FACILITIES AT THE SAVANNAH NUCLEAR SITE

	Start	Close
A. Past facilities – now closed		
1. Tritium-producing reactor – R	1953	1964
2. Tritium-producing reactor – P	1954	1988
3. Tritium-producing reactor – K	1954	1992
4. Tritium-producing reactor – L	1954	1988
5. Plutonium-producing reactor – C	1955	1985
6. F Canyon – PUREX separation plant – converted Np to Pu-238, recovered U-238 and Pu-239 Part of F Area Materials Storage Facility	1955	2006
7. FB Line Facilities – converted Pu-239 from nitrate solution To solid form – package for storage	1963	2002
8. Heavy Water Components Test Reactor (HWCTR) – tested heavy water-cooled reactor for civilian power	1962	1971
9. M Area Settling Basin – for cleanup – over 30 years, 2 million lbs. of solvents leaked into a basin	1981	1991
10. Cooling tower for K reactor	1990	1992
11. Mixed Waste Management Facility	?	1991
12. High level radioactive waste tanks – contain liquid waste – 49 tanks total, 12 with known leaks	?	1997
13. H Tank Farm – 29 underground radioactive waste tanks - may be contaminating ground water	?	2012
14. F Tank Farm – 22 tanks of high level radioactive waste 171.3 million curies liquid	?	2012
15. Receiving Basin for Offsite Fuels – 1950 casks from overseas - transferred to L Basin in 2007	1963	2003

B. <u>Current facilities – still operating</u>

1.	Savannah River National Lab (weapons detection, environmental remediation at nuclear plants)	1951
2.	H Canyon – chemical separation facility – recovered U-235, Np-237, and Pu-238	1955
3.	HB Line Facilities – produces Pu-238 for NASA programs	1985
4.	Effluent Treatment Facility - for low-level radioactive waste water from Areas F and H	1988
5.	Saltstone – Production and Disposal Facilities – disposes Low-level radioactive liquid salt waste	1990
6.	Replacement Tritium Facility (recover, purify, separate hydrogen isotopes from gas containers)	1992
7.	Defense Waste Processing Facility – including vitrification, processing transuranic waste, two melters	1993
8.	Consolidated Incineration Facility – mostly PUREX liquid solvent – incinerates liquid and solid waste, including low and mixed level	1997
9.	Tritium Extraction Facility (extracts tritium from TVA-operated commercial nuclear reactors)	2007
10.	Plutonium facilities – major ones include	
	- MOX fuel fabrication (Pu oxide mixed w/ U to make assemblies)	1999
	- Pit disassembly/conversion (dismantle warheads, convert to Pu oxide)	1999
	- Pu immobilization – put Pu in ceramic pucks and seal into cans	1999
11.	Savannah River Technology Center – applied research + development reactor studying production of hydrogen from water	2002
12.	Salt Waste Processing Facility – processes radioactive liquid waste Which has many salt solutions – removes Cs-137, Sr-90, actinides	2012
13.	L Basin – stores most of SRS spent nuclear fuel, in casks	1997

C. Future facilities – now being planned or constructed

1. Mixed oxide (MOX) manufacturing plant (converts weapons grade Pu into reactor fuel	2016
2. Future reactors (research reactors, Energy Park)	???
3. Reprocessing plant (just outside SRS border in Barnwell Co.) Construction halted in early 1980s, some support completion	???
4. K Area Materials Storage Facility – storage of Pu from DOE sites in containers	2000

APPENDIX 2

DIAGNOSIS CODES USED IN CAUSE OF DEATH ANALYSES

Cause of Death	ICD-9 Code Used 1989-1998	ICD-10 Code Used 1999-2007
All Cancers	140.0 - 239.9	C00 – D48.9
Lung Cancer	162.0 – 162.9	C33 – C34
Leukemia	204.0 – 208.9	C90.1 – C95.9
Non Hodgkin's Lymphoma	200.0 – 200.9 202.0 – 202.9	C82 – C85
Multiple Myeloma	203.0 – 203.9	C90.0
Pneumonia and Influenza	480.0 – 487.0	J09 – J18
Chronic Obstructive Pulmonary Disease	490.0 – 496.9	J44