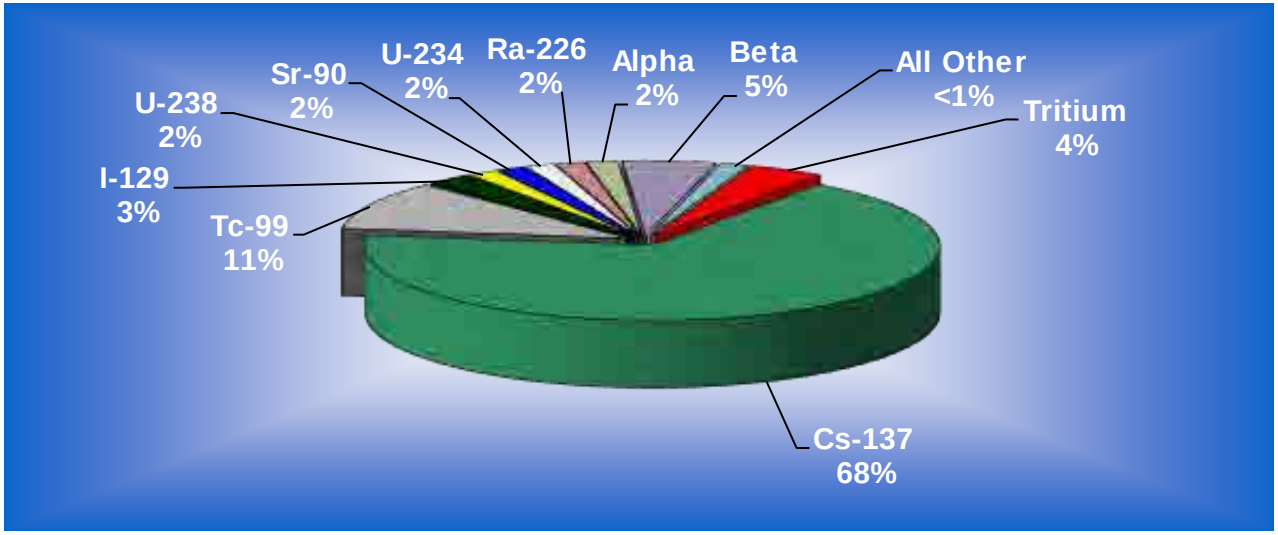
Liquid Effluent Monitoring – 2019 Results

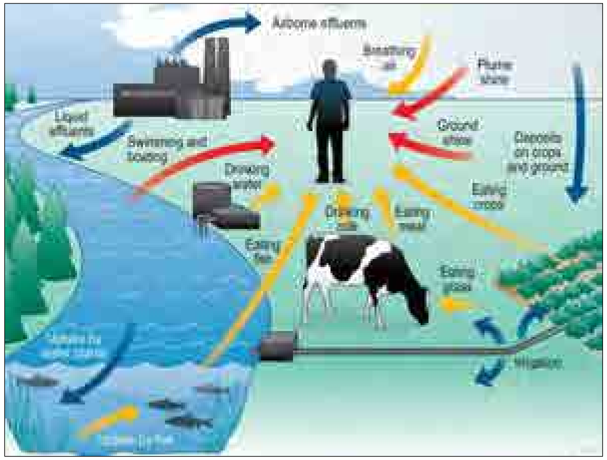
Potential Dose to the Representative Person from SRS Liquid Releases in 2019

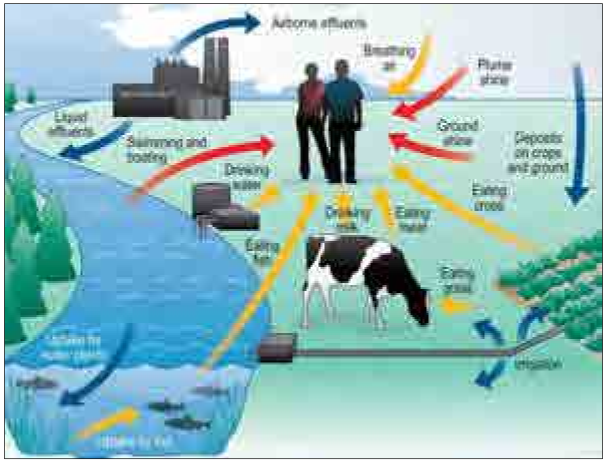
	Committed Dose (mrem)	Applicable Standard (mrem)	Percent of Standard (%)
Near Site Boundary (All Liquid Pathways)			
All Liquid Pathways Except Irrigation	0.11		
Irrigation Pathways	0.050		
Total Liquid Pathways	0.16	100	0.16

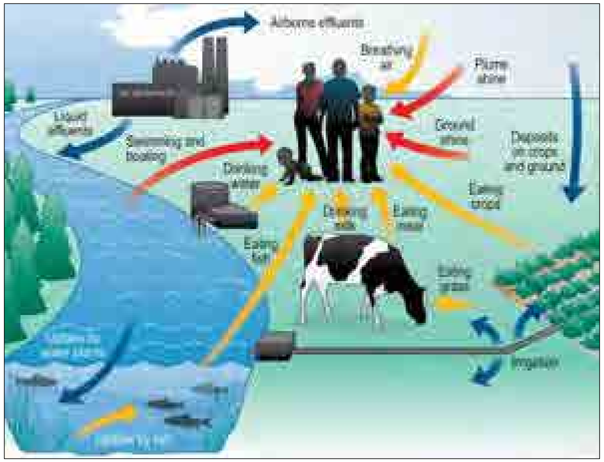
Radionuclide Contribution to the 2019 Representative Person Liquid Pathway Dose



Representative Person Concept







1960 – "Standard Man" Introduced

- International Commission on Radiological Protection Publication #2 (ICRP-2)
- Based on exposures to an average Male Radiation Worker.
  - 20-30 years old

1974 – "Reference Man" Introduced

- ICRP-23
- Much more detailed than ICRP-2
- Extensively used for many years
- Still primarily focused on exposures to an adult male radiation worker
  - 20-30 years old

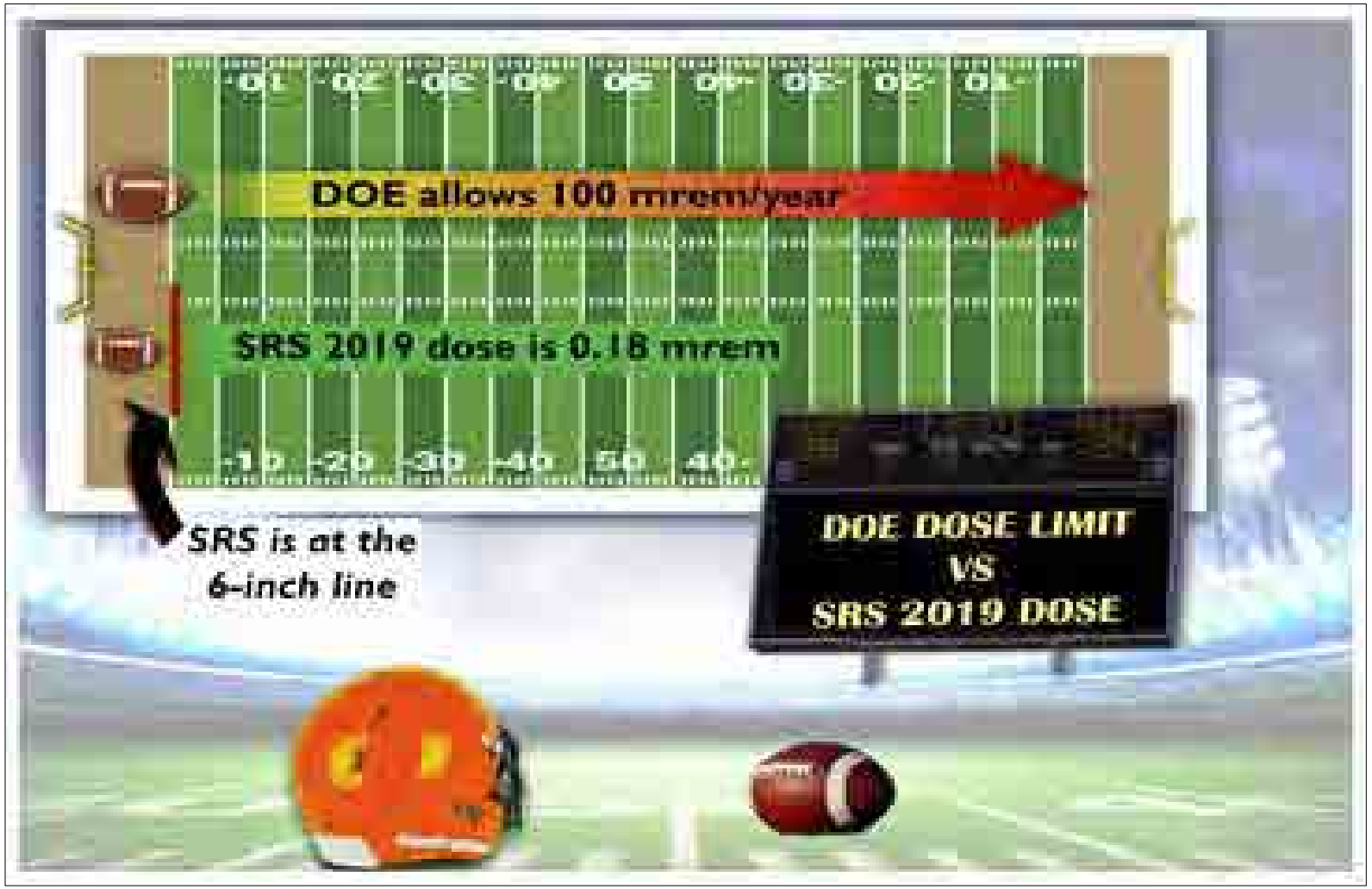
1989 – "Maximally Exposed Individual"

- Department of Energy – DOE Order 5400.5 Public Dose Limit of 100 mrem/year
- Based on ICRP-30 dose factors
  - Exposures to Adult Males but added Female Workers
  - 20-30 years old
  - However, food and water consumption and breathing rates still based on an Adult Male

2012 - "Representative Person"

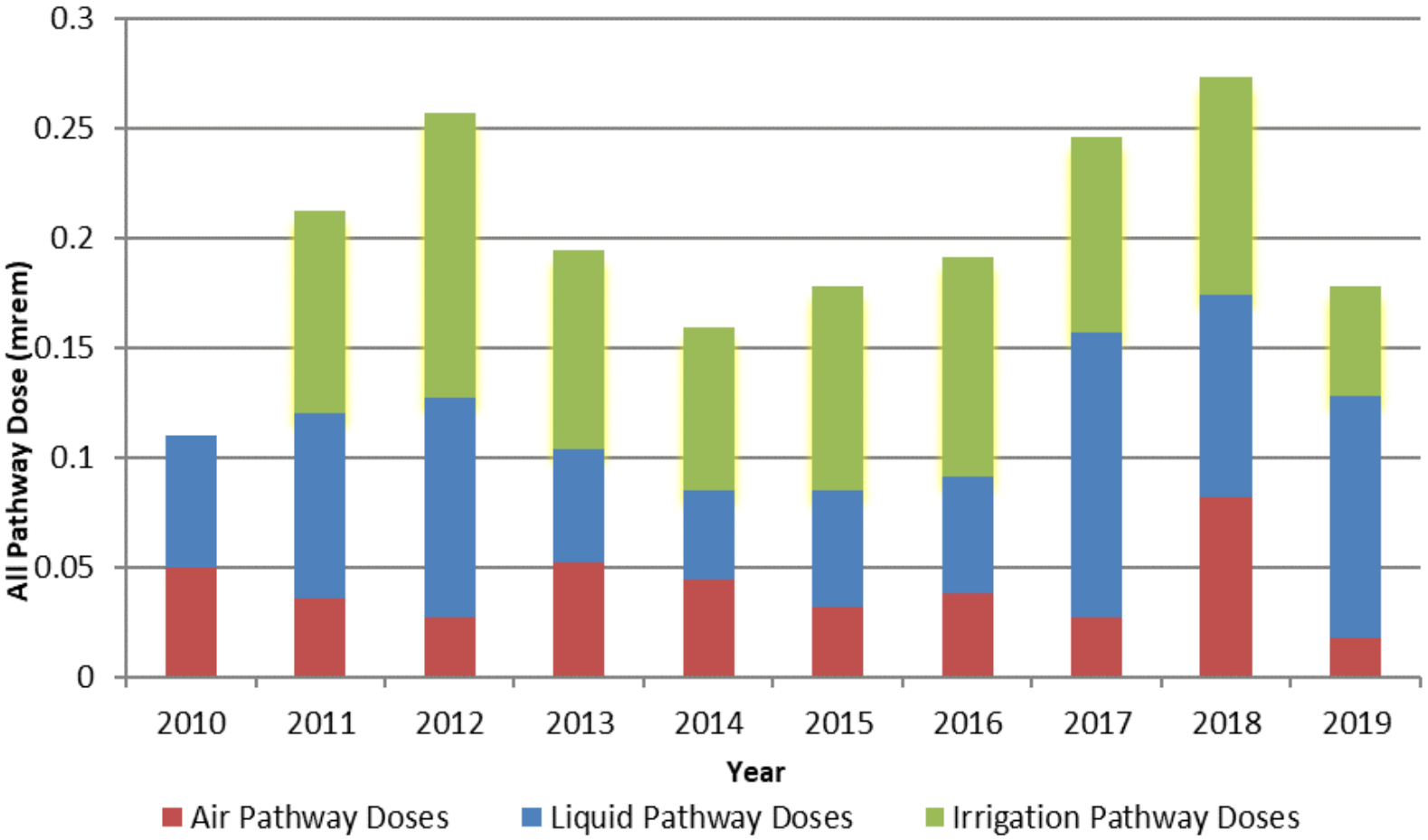
- DOE Order 458.1 allows use of representative person
- Per ICRP 101 and 103 recommendations
- Based on exposures to an age- and gender-averaged Reference Person
  - Exposures to Males and Females
  - Includes 6 age groups
    - New Born
    - 1 year old
    - 5 year old
    - 10 year old
    - 15 year old
    - 17 and older
- Results in more conservative dose estimates

Representative Person All-Pathway Dose – 2019 Results

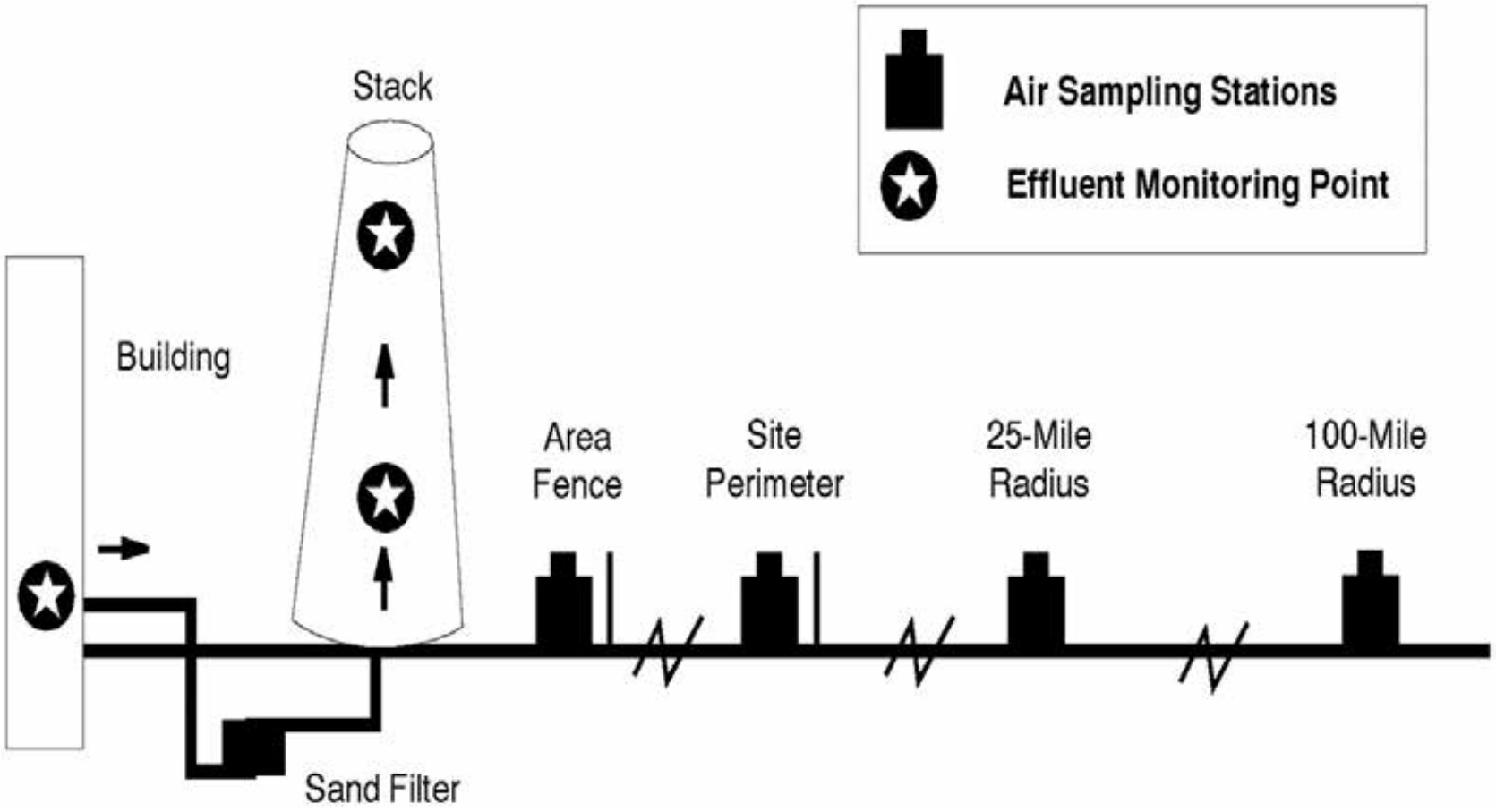


2019 Representative Person All Pathway Dose: (0.16 mrem-liquid + 0.02 mrem-air)

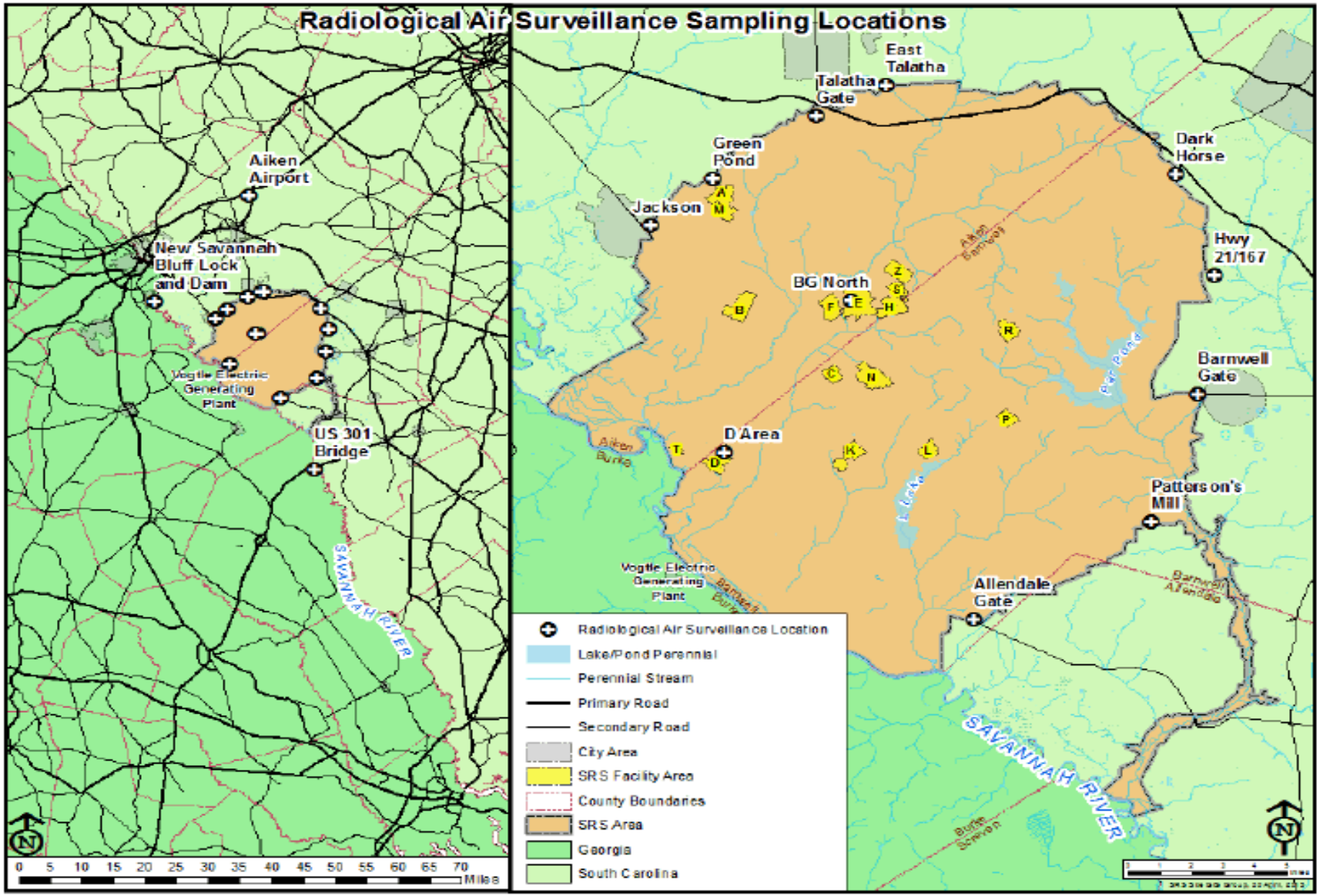
10-year history of SRS All-Pathway Doses



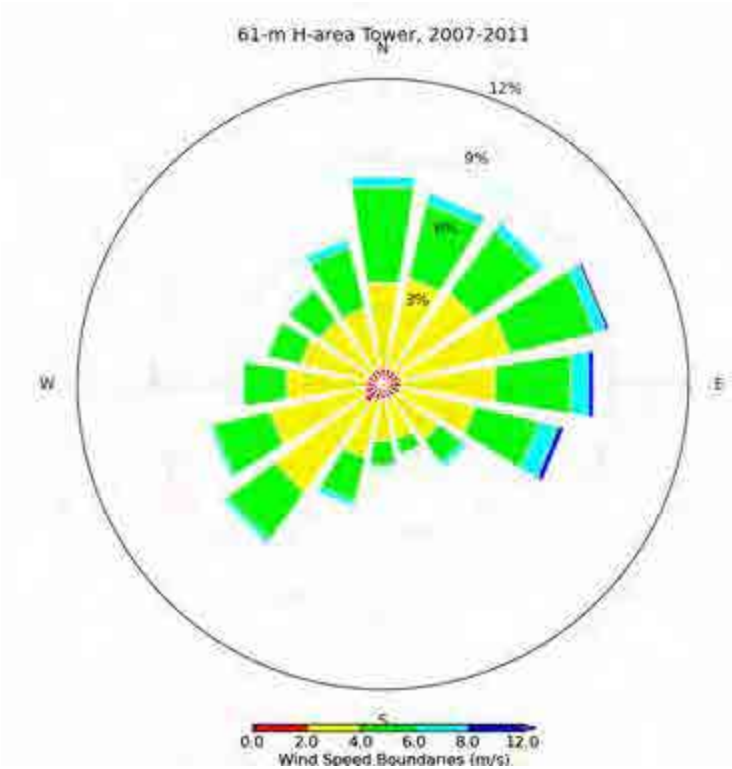
SRS Air Surveillance Program



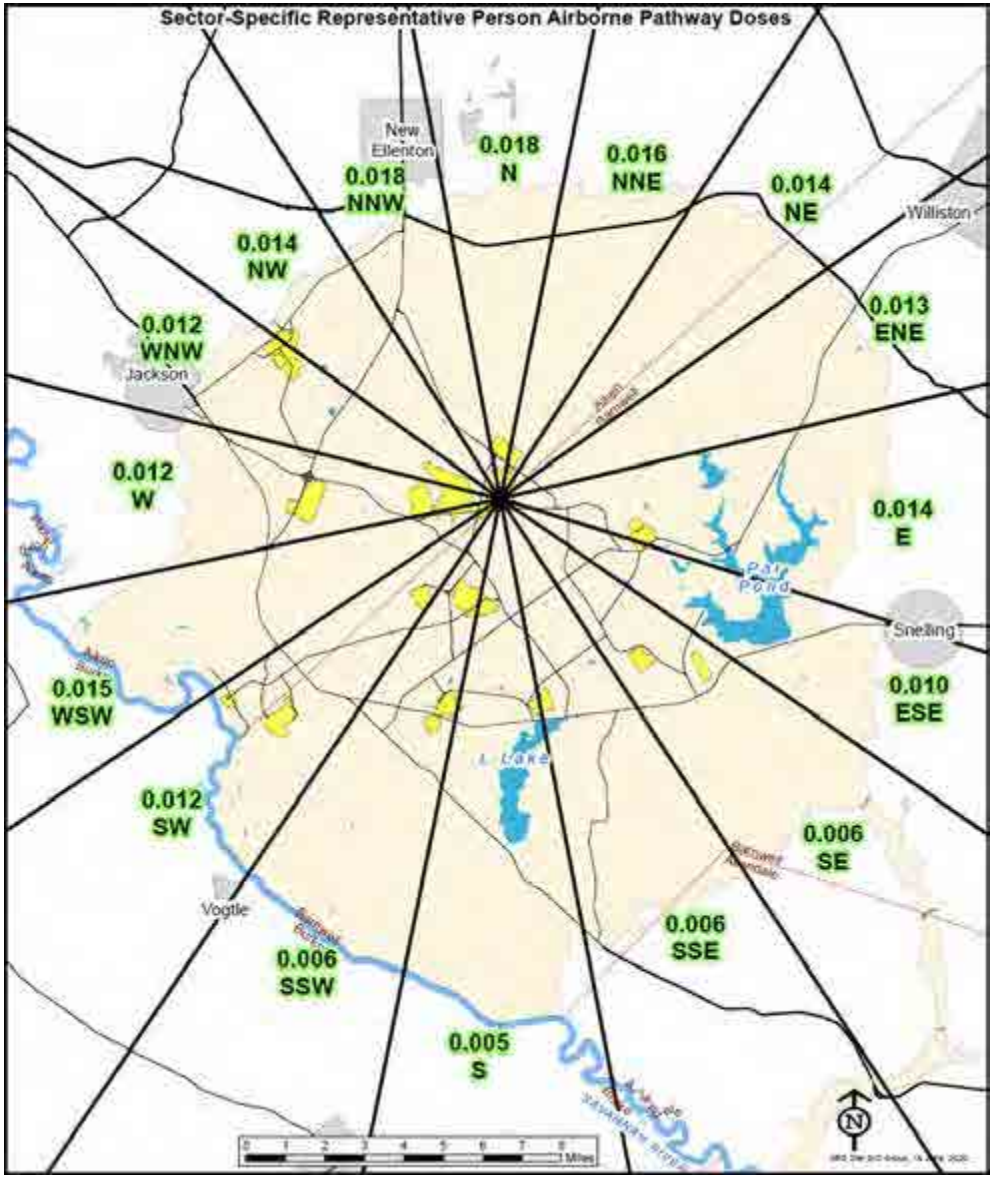
Air Surveillance Locations



SRS Windrose and Sector Dose



Towards which the wind blows

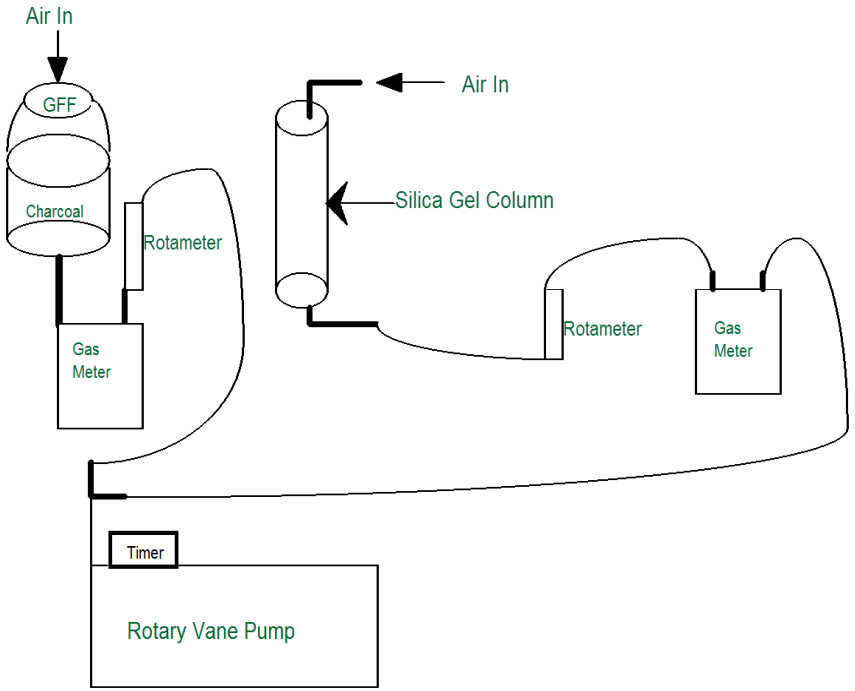


Radiological Airborne Surveillance Program

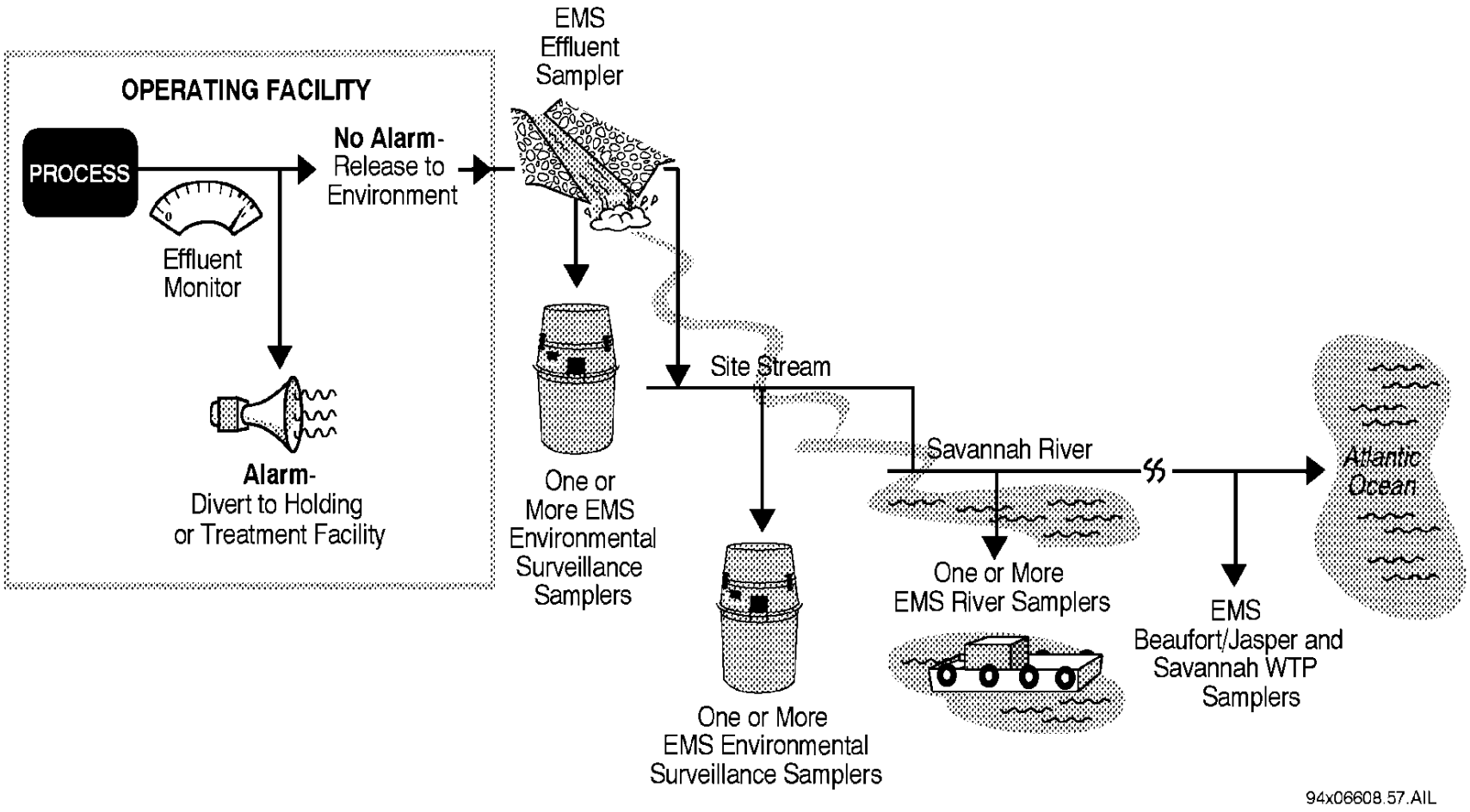
- Program design is from DOE guidance and SRS critical pathway analysis
  - SRS maintains a network of 14 atmospheric surveillance sampling stations in and around SRS to monitor the concentration of tritium and radioactive particulate matter in the air and rainwater
  - Sampling locations are based on meteorological conditions and population centers downwind of stacks
  - System is designed to collect a continuous representative sample of ambient air at inhalation height (1.5-2.0 m)
  - Results are reported in the ASER
  - No nonradiological air surveillance program

Radiological Airborne Surveillance Program

- Typical ambient air sampling system arrangement

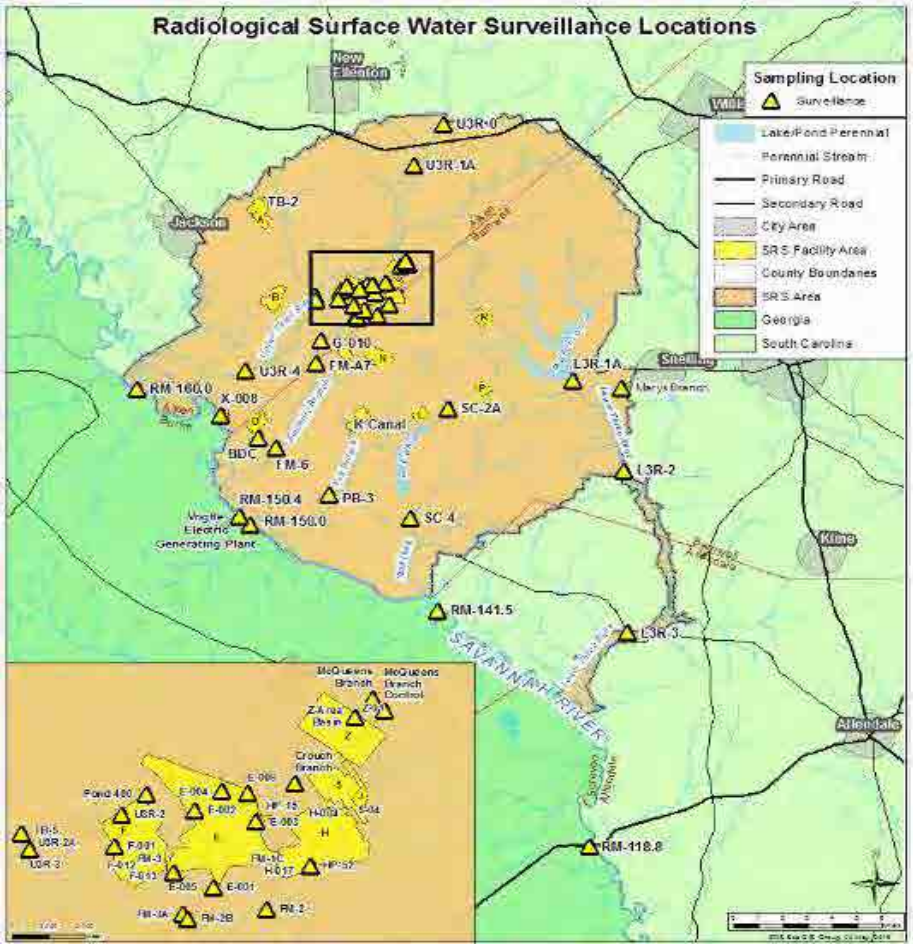


SRS Surface Water Surveillance Program



Environmental Surface Water Surveillance Program

- Historical trending of the potential effects of Site effluents on the environment
  - Nonroutine release monitoring capabilities
  - Verify contaminants are behaving in the environment as expected



Surface Water Measurements

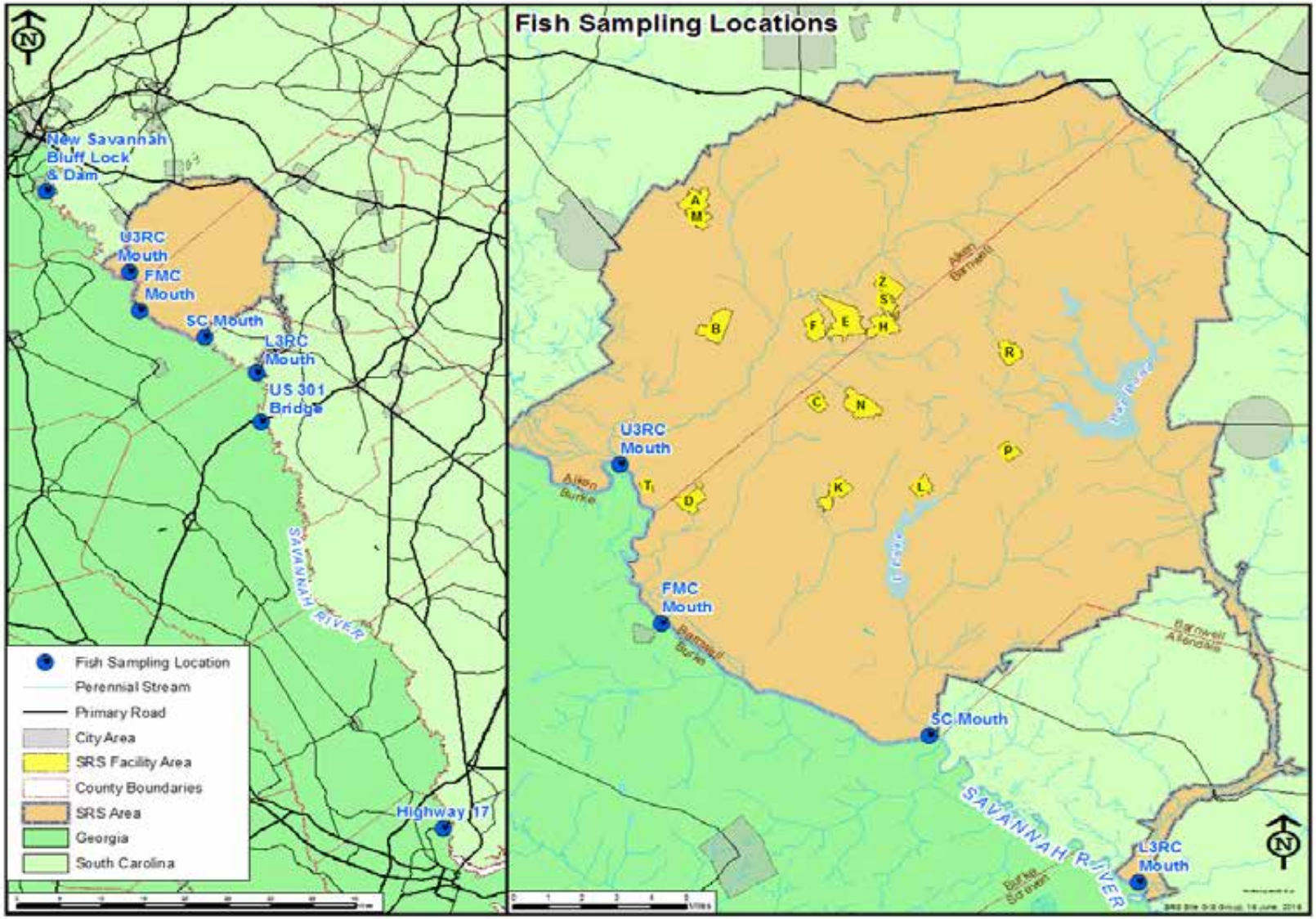
- Two important measurements for surface-water sampling include:
  - Concentration (amounts per volume) of contaminants
  - Flow (movement of volume over time)
- Concentration and Flow are used to determine the total amount of contaminates released from SRS
  - These, in turn, are used to determine potential dose

Surveillance Monitoring of Other Environmental Media

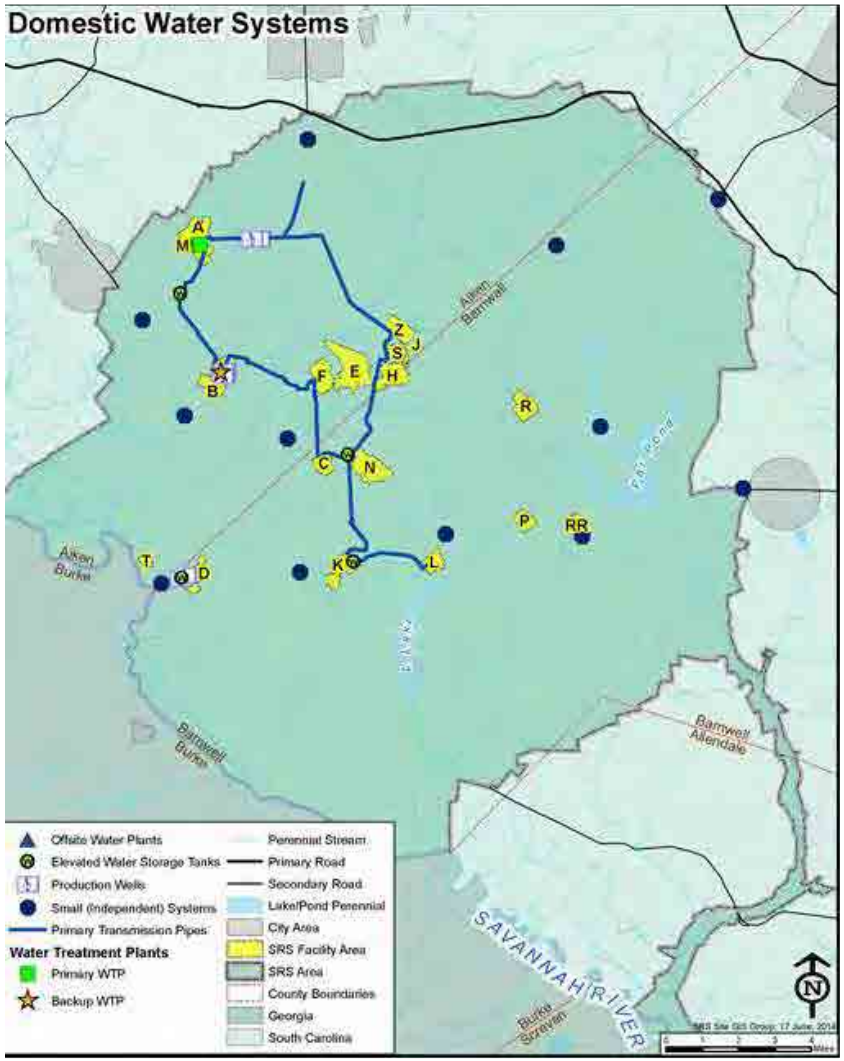
- Program design is from DOE guidance, the SRS critical pathway analysis from liquid and air effluents, and dose/risk assessments
- From this, the surveillance media and frequency of sampling are determined

Environmental Surveillance Media
Airborne Pathway
Ambient Air (air and TLDs)
Rainwater
Vegetation
Soil
Food Products
Liquid Pathway
Surface Water (river, streams)
Sediment and Settleable solids
Fish
Drinking Water
Groundwater
SRS Wildlife Consumption Pathway
Deer and Hogs

SRS Fish Sampling Locations



Drinking Water Sampling Locations



Critical Radionuclide/Critical Pathways for SRS

	Committed Dose (mrem)	Applicable Standard (mrem)[a]	Percent of Standard (%)
Representative Person Dose			
All-Pathways (Liquid Plus Airborne Pathways)	0.18	100	0.18
Sportsman Dose			
Onsite Hunter	17.4	100	17.4
Creek-Mouth Fisherman[b]	0.227	100	0.227
Savannah River Swamp Hunter			
Offsite Hog Consumption	7.74		
Offsite Deer Consumption	2.12		
Soil Exposure[c]	1.86		
Total Offsite Hunter Dose (Hog + Soil Exposure)	9.60	100	9.60
Savannah River Swamp Fisherman			
Steel Creek Fish Consumption	0.118		
Soil Exposure[d]	2.08		
Total Offsite Fisherman Dose (Fish + Soil Exposure)	2.20	100	2.20

All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)

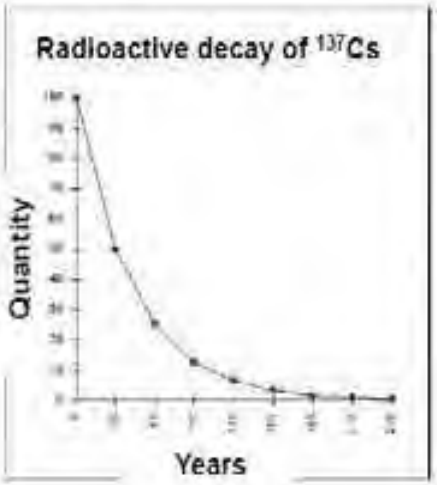
In 2019, the maximum dose to a hypothetical fisherman resulted from the consumption of bass from the mouth of Lower Three Runs Branch

Includes the dose from a combination of external exposure to and incidental ingestion and inhalation of the worst-case Savannah River swamp soil

Includes the dose from a combination of external exposure and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek

Characteristics of Cesium-137

- Relatively long physical half-life (30.2 y)
- High fission yield
- Biologically available due to physiological similarity to potassium
- Can bioaccumulate in consumers
- Concentrates in edible skeletal muscle



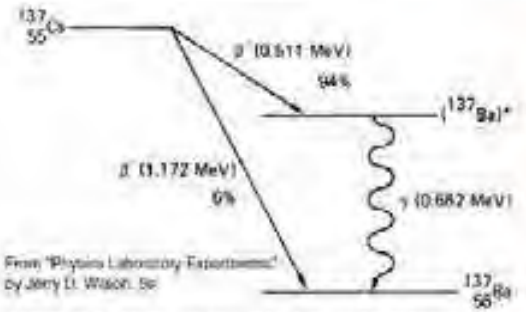
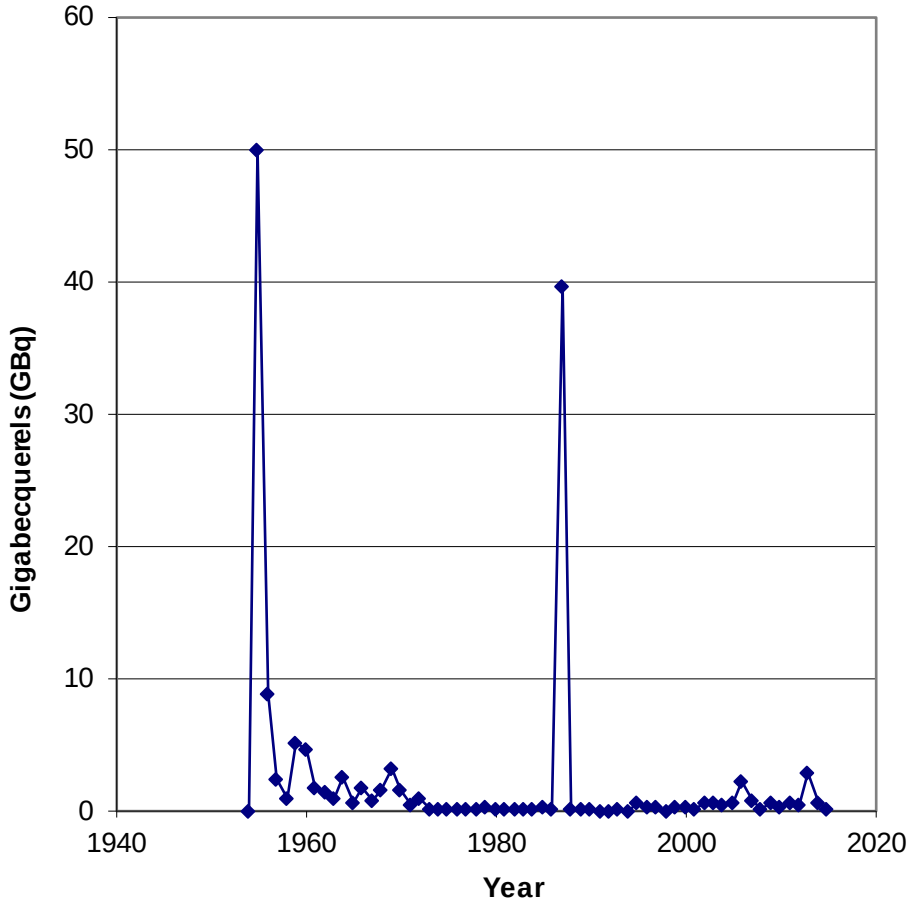


Figure 49.2 Decay scheme of Cs-137. Most of the cesium-137 (Cs-137) nuclei (94%) decay to an excited state of barium-137 ($^{137}Ba^*$), which then gamma decays to a stable state.

Atmospheric Deposition and SRS Releases of Cesium-137

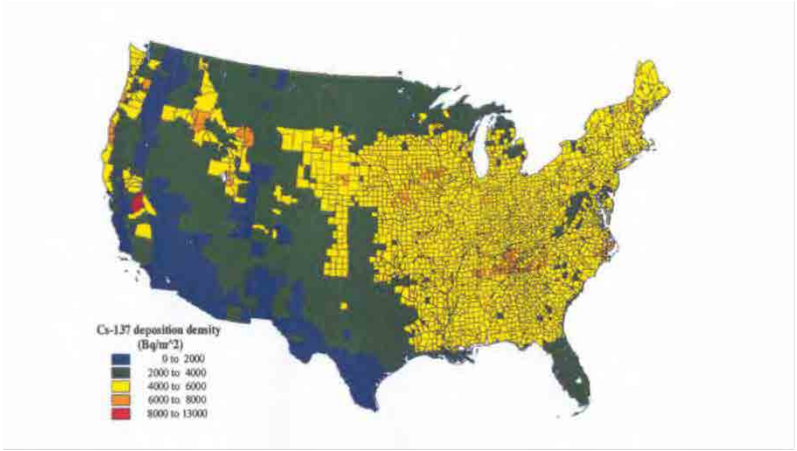
SRS Atmospheric Releases



CS-137 TOTAL ATMOSPHERIC

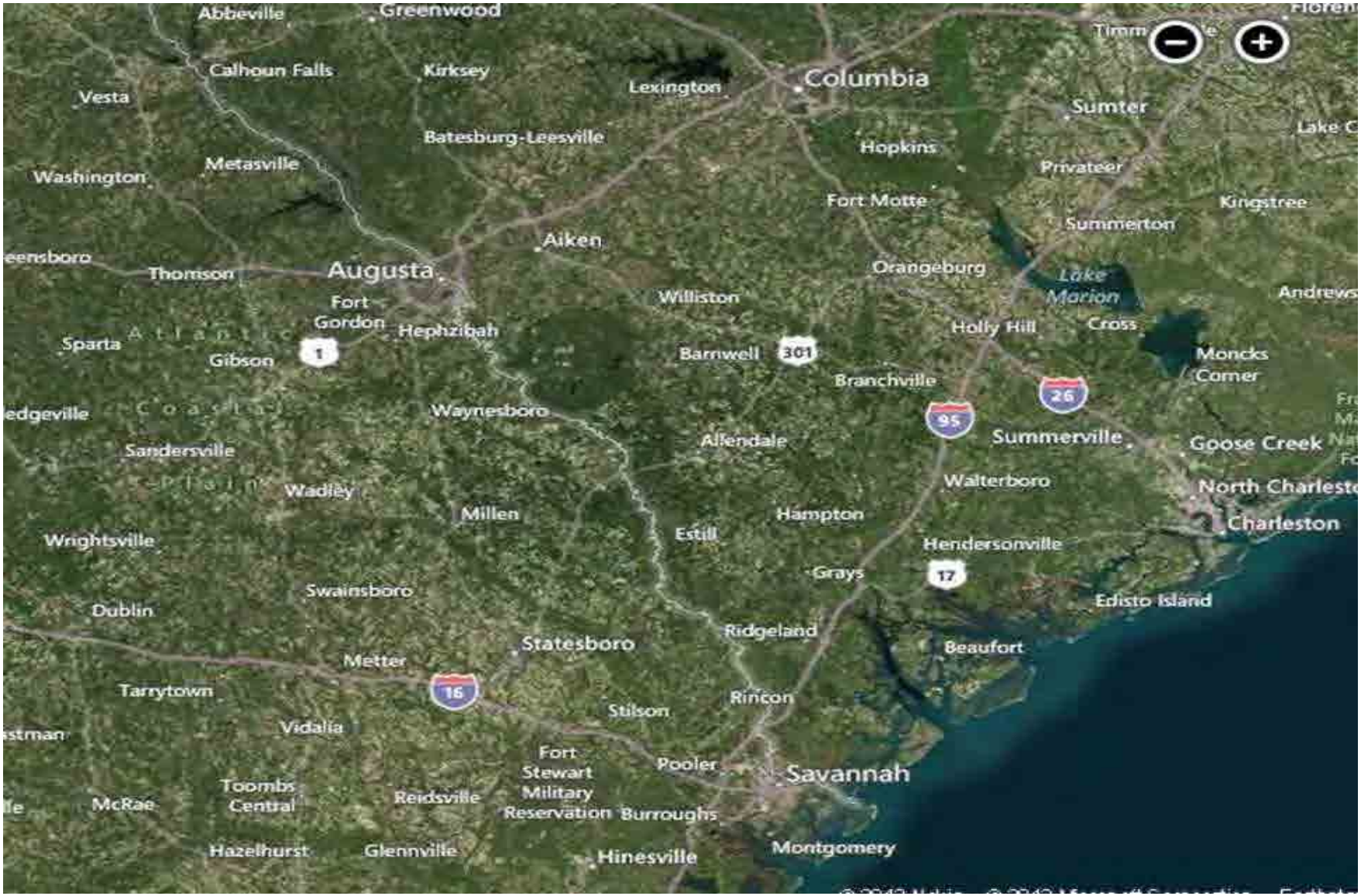
Fallout from Nuclear Testing

Nation	Number of Above Ground Detonations	Years	Total Yield
United States	216	1945-1962	153.8 mt
U.S.S.R.	214	1949-1962	281.6 mt
United Kingdom	21	1952-1958	10.8 mt
France	46	1960-1974	11.4 mt
P.R.China	23	1964-1980	21.5 mt
South Africa	1	1979	0.003 mt



Cs-137 Deposition Density (Bq/m²) from CDC/NCI 2002

Long Term Assessment of Cesium-137 in Soil and Biota at SRS



SRS Deer Hunt History

- Annual hunts began in 1965
  - Control the SRS deer and feral hog populations
    - *4,000 optimum*
  - Reduce animal-vehicle accidents
- Run by U.S. Forest Service
  - Herd management (dog drives)
- Hunter Dose Tracking System – 1992
  - Tracks individual hunter doses
- Keep doses < DOE Limit (100 mrem/y)
  - Administrative limit
    - *22 mrem/y*
- Lifetime limit – added in 2012
  - 450 mrem total
    - *Going back to 2000*

Hunter Dose Tracking System (HDTS)

- Dose calculation assumptions
  - Edible weight = 0.45 * live (now dead) weight
  - Hunter consumes all of the edible weight that he/she harvested
    - *Commonly > 350 lbs (>800 live weight) from multiple animals*

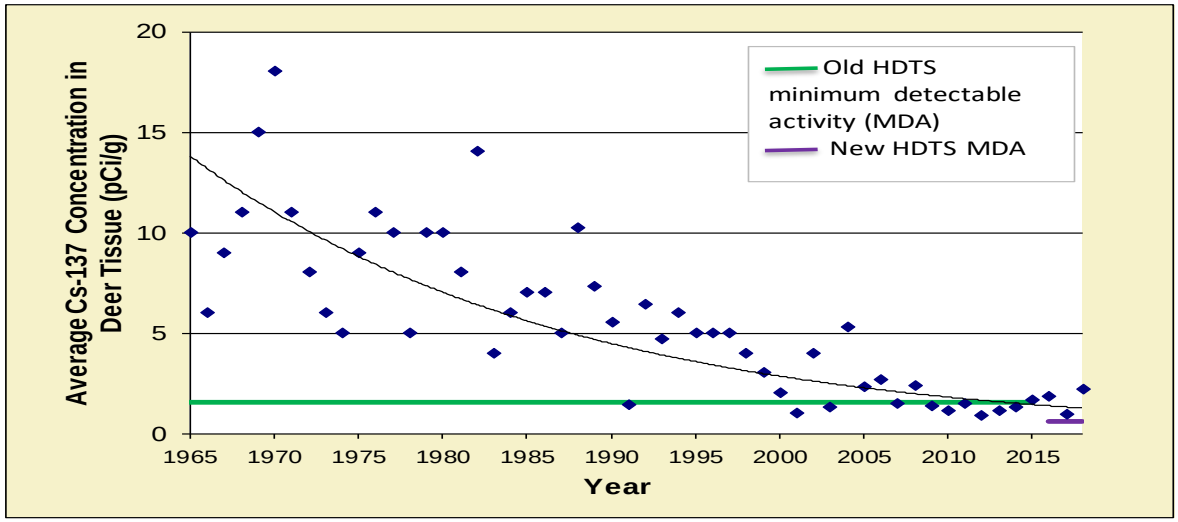
$$\text{Dose} = Conc.\left(\frac{pCi}{g}\right) * \text{Weight (g)} * 0.45 * 0.0000481\ \left(\frac{mrem}{pCi}\right)$$

Concentration Measured in the Field is the Key Parameter

All Deer (and Hogs) are Monitored Prior to Release to the Hunter

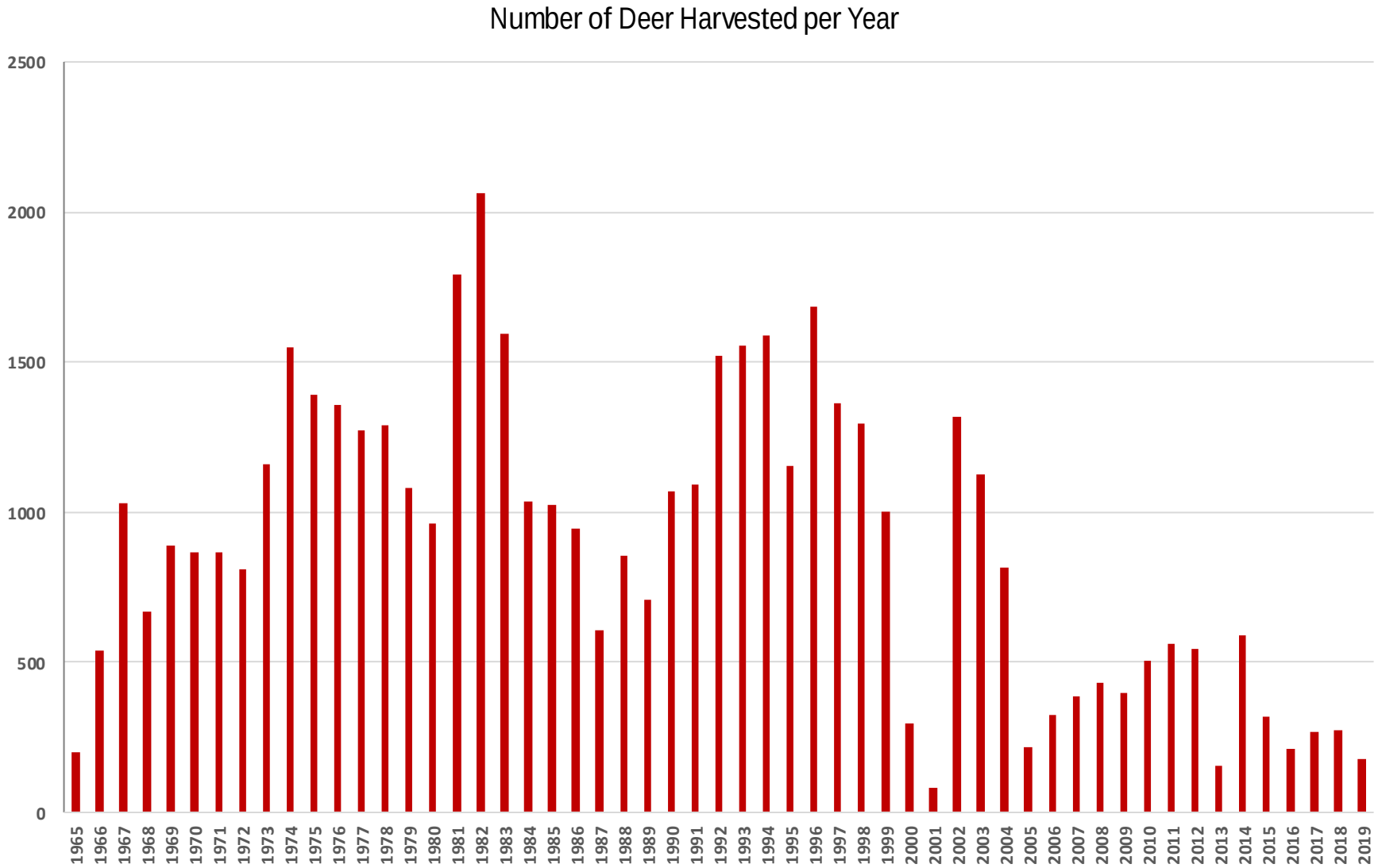
Pre-2016

Post-2016

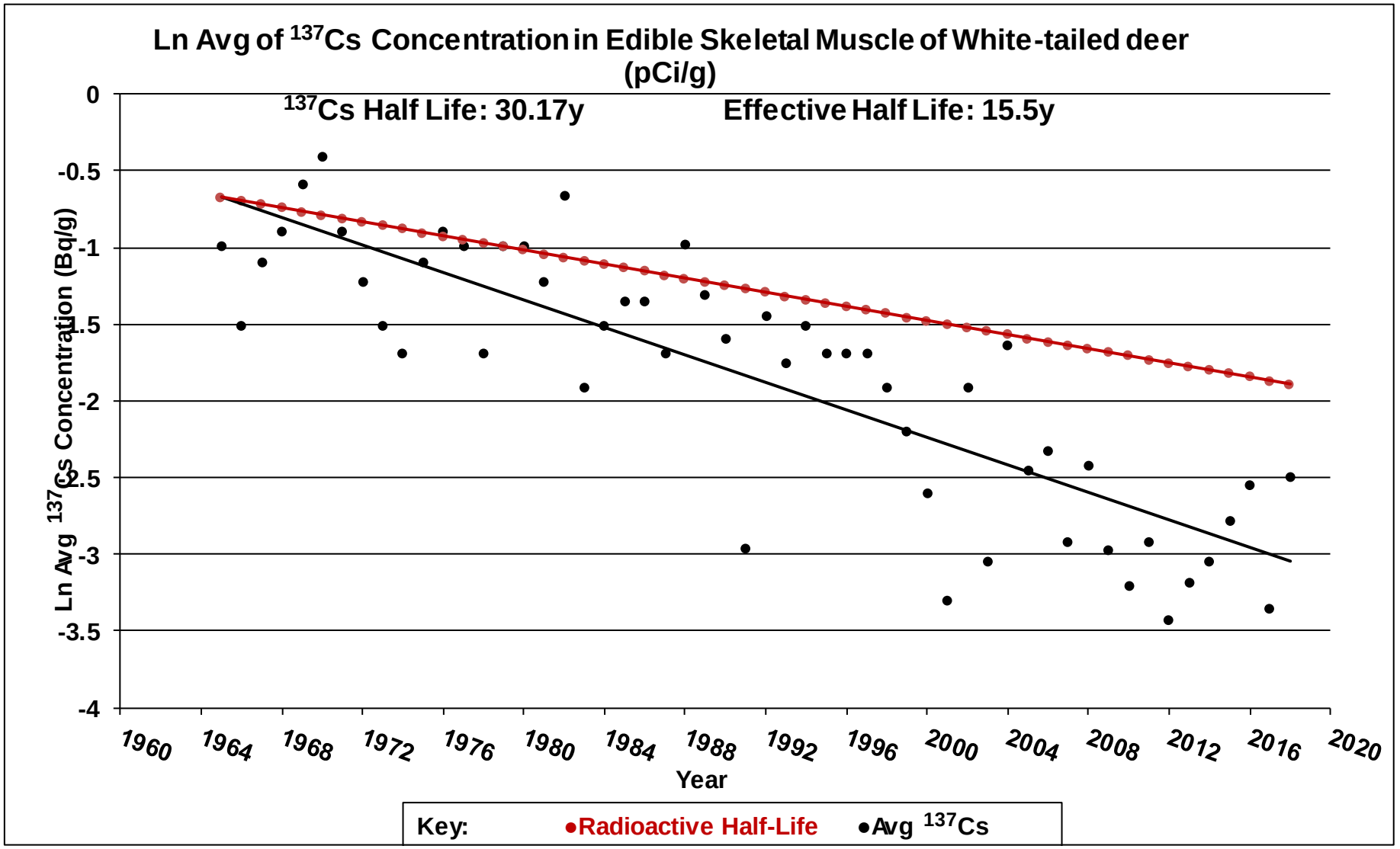


Historical Trend of Average Cesium-137 Concentration in Deer Tissue (1965-2018)

Deer Hunt History at SRS



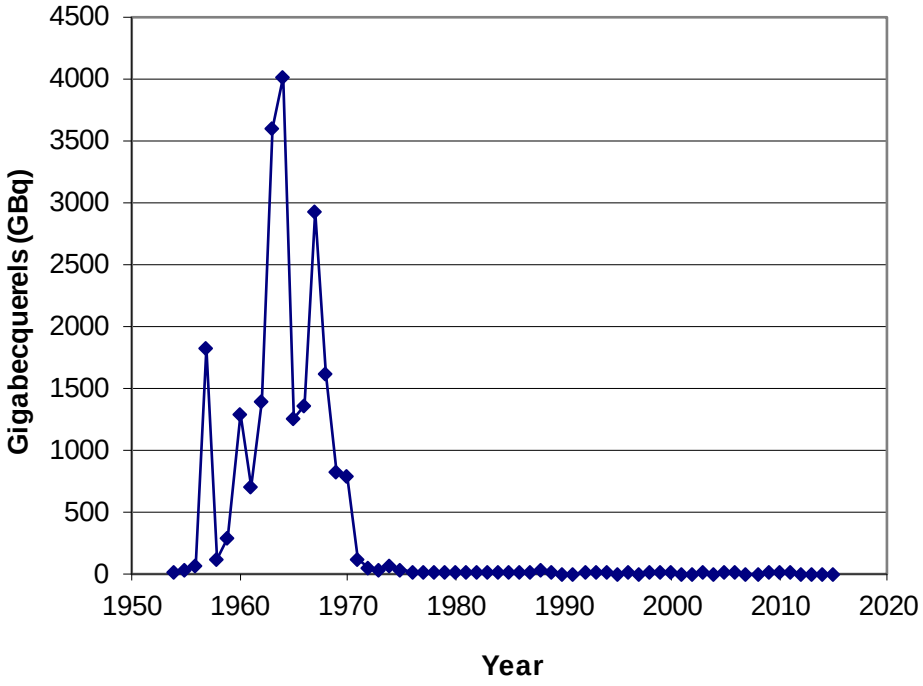
Field data: Ln Avg ^{137}Cs Concentration From 1964 to 2018



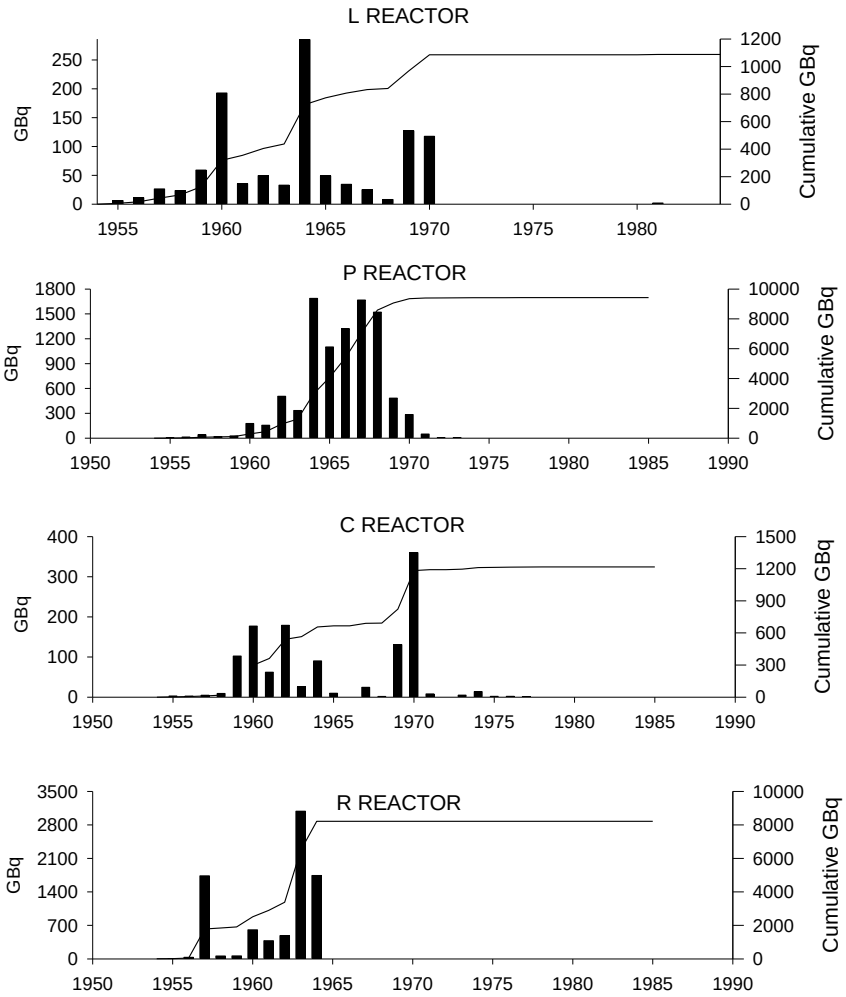
Aqueous Releases of Cesium-137 at SRS

SRS aqueous releases

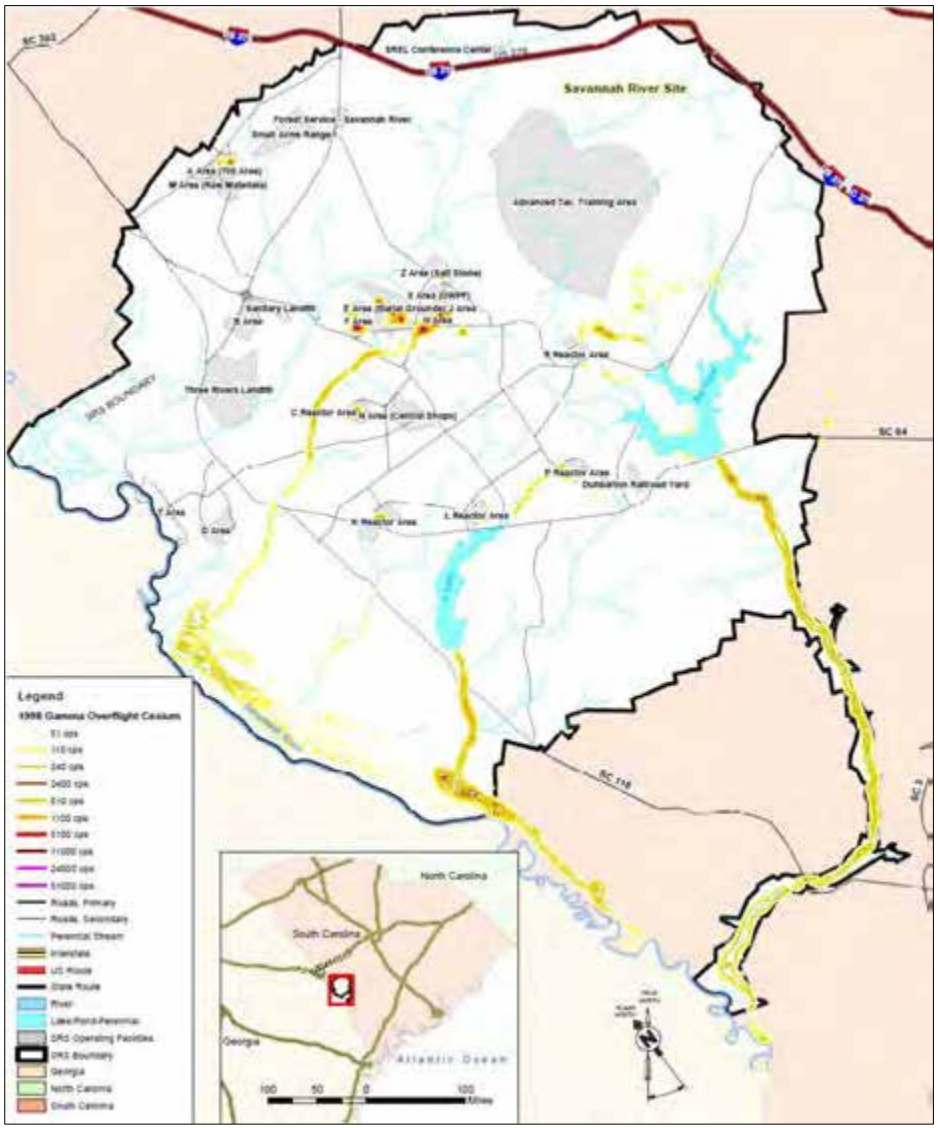
- Five reactors formerly operated at SRS
- Operational problems resulted in the release of ^{137}Cs from four reactors into cooling water and subsequent contamination of aquatic ecosystems



Cumulative releases



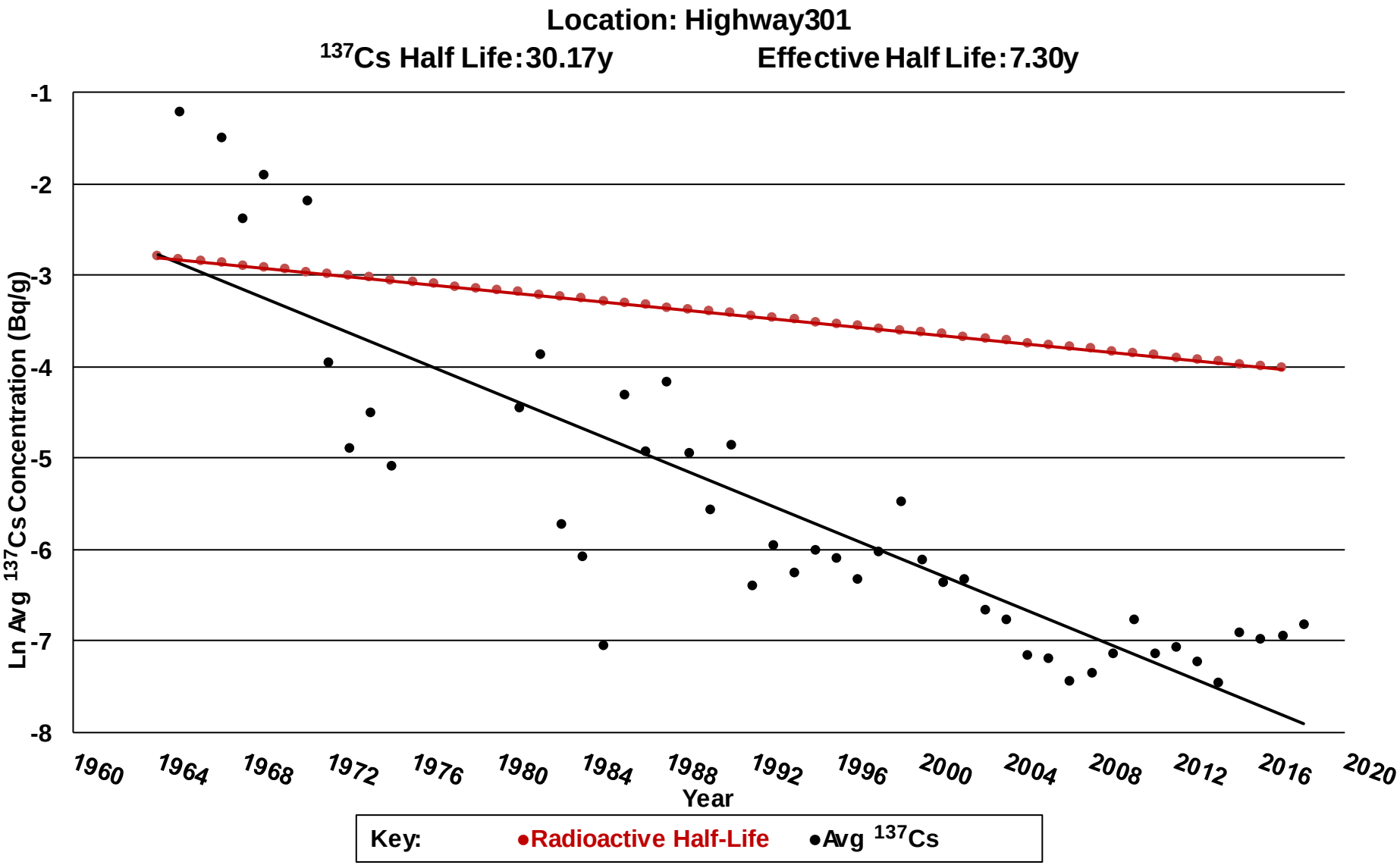
Aqueous Releases of Cesium-137 at SRS



Contaminated aquatic ecosystems

- Fourmile Creek
- Steel Creel
- Lower Three Runs
- Par Pond
- Pond B
- Savannah River
- Savannah River floodplain
- Collections made annually
- Panfish, bottom-feeders, predators
- Individual fish or composite samples

Ln of Concentration of Fish Composites Cont.



Key Points and Conclusions

- SRS has a large and thorough Environmental Monitoring Program
  - Meteorological monitoring
  - Effluent monitoring
  - Environmental surveillance
- Program design
  - DOE Orders and guidance
  - EPA and state laws
  - Industry standards
- All-pathway compliance dose to a Representative Person from typical pathways
  - About 0.2 mrem/y << 100 mrem/y limit
- Nontypical/unique pathways are important at SRS because of legacy cesium-137
  - Onsite and offsite hunters
  - Creek mouth fishermen
- Cesium-137 is still in the SRS environment
  - Reducing faster than its physical half-life of 30 years

Another Reason Not to Go Near Swampy Areas at SRS