

**HEALTH TRENDS AND PATTERNS  
IN SALEM COUNTY, NEW JERSEY  
BEFORE AND AFTER STARTUP  
OF THE SALEM/HOPE CREEK NUCLEAR PLANT**

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The Radiation and Public Health Project (RPHP) was founded as a health research and education group in 1989. It is the only U.S. organization with a focus on disease and death rates near nuclear plants, and has conducted the only study of in-body radiation near U.S. plants, measuring Strontium-90 in 5,000 baby teeth. Group members have published 34 articles and letters in peer-reviewed medical journals; published 8 books; published 56 newspaper op-eds; held 27 press conferences; and been covered by national media including the New York Times, USA Today, NPR, CNN, and Fox News. Its work can be found on its web site, [www.radiation.org](http://www.radiation.org).

TABLE OF CONTENTS

Executive Summary ..... 3

Purpose of Report ..... 4

Brief History of Nuclear Power in New Jersey ..... 4

Radioactive Waste Stored at Nuclear Plants ..... 5

Health Hazards Posed by Reactor Meltdowns ..... 6

Routine Radioactive Releases ..... 6

Radioactivity Levels in the Environment ..... 9

Radioactivity Levels in the Body ..... 9

Radiation Health Effects ..... 10

Government Health Studies of Cancer Near U.S. Nuclear Plants ..... 10

Methodology of Current Study ..... 11

Change in Cancer Incidence Near Salem-Hope Creek Since 1990 ..... 11

Change in Cancer Mortality Near Salem-Hope Creek Since 1990 ..... 12

Change in Non-Cancer Mortality Near Salem-Hope Creek Since 1990 ..... 14

Discussion ..... 16

Appendices ..... 17

## EXECUTIVE SUMMARY

The Salem/Hope Creek nuclear plant consists of three reactors in Salem County, NJ that began operating in 1976, 1980, and 1986, making it one of the largest plants in the nation. Radioactive waste stored at the plant is greater than 216 million curies, exceeding the amount released during the Chernobyl meltdown. In addition, routine releases of radiation from the plant are high; Salem/Hope Creek emitted the 2<sup>nd</sup> greatest amount of tritium (one of hundreds of radioactive elements) into the air during the 2000s, compared to all other U.S. plants.

The sole government study of cancer rates in Salem County included cancer deaths from 1950-1984, and thus covered only the early years of the plant's operation. This study presents trends in Salem County cancer rates up to 2014, using U.S. Centers for Disease Control and Prevention data. All of the county's 65,000 residents live within 18 miles of the plant, in the northeast and southeast direction (downwind of the reactors).

The study found a steady increase in Salem County age-adjusted rates, compared to the state, for:

1. Cancer death rates (5.3% below in 1983-86, to 20.2% above in 2011-14)
2. Non-cancer death rates (2.4% above in 1983-86, to 23.3% above in 2011-14)
3. Cancer incidence rates (1.0% below in 1998-2001 to 9.3% above in 2011-14)

Salem County had the highest cancer rates of any county in the state for the most recent year available (in 2014 for deaths, in 2013 for cases).

Current death rates in Salem County exceed the state rates for both genders, all age groups, all races and ethnic groups, and all major types of cancer.

While there are many potential causes of cancer, these substantial changes since the introduction of over 100 man-made radioactive chemicals into the environment suggest that radiation exposures be considered as one cause. Officials should follow these results with additional studies to be shared with the public, as identifying causes and taking appropriate actions can reduce future risk.

## **Health trends and patterns in Salem County, New Jersey before and after startup of the Salem/Hope Creek Nuclear Plant**

1. Purpose of Report. The following report will analyze local health trends and patterns in the area closest to the Salem-Hope Creek nuclear power plant. The plant, which is located in western Salem County NJ, about 20 miles south of Wilmington Delaware, consists of three reactors – Salem 1, Salem 2, and Hope Creek. It has operated for over 40 years, but very little study of health trends in the area has occurred. With reactors aging, their parts corroding, and leakages of toxic chemicals becoming more common, it is critical that any changes in health of residents living near the plant be assessed.

2. Brief History of Nuclear Power in New Jersey. The discovery of nuclear fission, or creation of high energy by splitting uranium atoms, was first used for military purposes, i.e. the atomic bombs in Japan during World War II. Soon after, other uses of the fission process were introduced. One of these was the creation of electric power from the heat generated by fission. The “Atoms for Peace” speech given at the United Nations by President Dwight Eisenhower in 1953 opened the door for the development of reactors that would produce electricity, and the first reactor (Shippingport, near Pittsburgh) began operating in 1957.

Hundreds of reactors were proposed by electric utilities, who were interested based on the potential to produce clean and cheap energy. In 1974, the U.S. Atomic Energy Commission predicted that the nation would have 1,200 reactors by the turn of the century. New Jersey was no different. As the state’s population grew, utilities envisioned many reactors; Oyster Creek, in Forked River, was one of the first in the nation, opening May 3, 1969 (the reactor will close in 2019).

Following Oyster Creek was the Salem-Hope Creek plant, located in western New Jersey. The Salem 1, Salem 2, and Hope Creek reactors began operating December 11, 1976, August 8, 1980, and June 28, 1986, respectively. Hope Creek lies just five miles from the two Salem reactors. A second Hope Creek reactor was proposed to federal officials, but never built due to concerns over cost overruns. Other reactors in the area cancelled during the 1970s included two in Burlington NJ, two in Summit DE, and two in the Atlantic Ocean just off Atlantic City (Source: U.S. Nuclear Regulatory Commission).

The plan for 1,200 U.S. reactors never materialized. The peak number reached 112 in the early 1990s, and had fallen to 104 in the period 1998-2013. Since 2013, five aging reactors have shut permanently, and another seven will close by 2019. With only two new plants under construction, and lengthy delays and cost overruns holding up their opening, the number of aging and corroding reactors seems certain to plunge over the next two decades.

The Salem-Hope Creek plant is one of only four in the U.S. with three reactors; all others have just one or two. The total number of megawatts electrical capacity at Salem-Hope Creek (3572)

is second only to Palo Verde in Arizona (3900), and ahead of the other three-reactor plants of Browns Ferry Alabama (3291) and Oconee South Carolina (2591).

3. Radioactive Waste Stored at Nuclear Plants. To produce electricity, nuclear power reactors split uranium-235 atoms, generating high energy that is transformed into electrical power. This splitting process, known as fission, also produces over 100 chemicals not found in nature. These chemicals are the same as those found in the large clouds of fallout after above-ground atomic bomb tests.

Fission products, which take the form of gases and particles, include Cesium-137, Iodine-131, and Strontium-90. They are highly unstable atoms which emit alpha particles, beta particles, or gamma rays. When they enter the body, they affect various organs. Cesium seeks out the muscles (including the heart and reproductive organs), iodine attacks the thyroid gland, and strontium attaches to bone. Each causes cancer after breaking cell membranes and damaging cell DNA create mutations, and is especially harmful to the fetus, infant, and child. Some decay quickly (Iodine-131 has a half-life of 8.05 days), while others remain for long periods (Strontium-90 has a half-life of 28.7 years).

Most of the radioactivity produced in reactors is contained within the reactor building and stored as high-level waste in deep pools of water that must be constantly cooled. At Salem-Hope Creek and at other aging plants, the pools are becoming full. About 20% of the waste nationally has been transferred to above-ground outdoor casks. In December 2010, the plant maintained 1,659 tons of waste on site, one of the largest in the U.S. The amount of radioactivity at the plant is equivalent to several times more than that released by the 1986 Chernobyl meltdown, and hundreds of times more than releases from atomic bombs at Hiroshima and Nagasaki in 1945. The list of U.S. nuclear plants with the largest amounts of high-level waste is given in Table 1:

Table 1  
U.S. Nuclear Power Plants (Total = 71)  
With Largest Amounts of High-Level Nuclear Waste, As of December 2010

<u>Plant</u>	<u>State</u>	<u>Metric Tons</u>	<u>Curies</u>
1. Dresden	IL	2,146	350,380,400
2. Browns Ferry	AL	1,932	314,140,400
3. Nine Mile Point	NY	1,865	355,269,600
4. Millstone	CT	1,709	445,230,400
5. Palo Verde	AZ	1,674	360,032,400
<b>6. Salem/Hope Creek</b>	<b>NJ</b>	<b>1,659</b>	<b>216,050,800</b>
7. Peach Bottom	PA	1,554	254,072,600
8. Edwin I. Hatch	GA	1,446	237,432,400
9. D.C. Cook	IL	1,433	286,914,600
10. San Onofre	CA	1,423	315,932,400

Source: Alvarez R. Spent Nuclear Fuel Pools in the U.S.: Reducing the Deadly Risks of Storage. Institute for Policy Studies, May 2011.

In 2002, after decades of investigation and debate, the federal government designated Yucca Mountain in Nevada as a permanent waste site, despite the great opposition Yucca had encountered. In 2010, the Obama administration stopped all expenditures for building the site, and assembled a panel to further consider options for long term waste storage. Some experts believe a permanent repository will never open, leaving existing nuclear plants like Salem-Hope Creek to maintain the waste indefinitely.

4. Health Hazards Posed by Reactor Meltdowns. Much of the health concern posed by nuclear reactors focuses on major meltdowns. The radioactivity in a reactor core and waste pools must be constantly cooled by water, or the fuel will heat uncontrollably, causing a huge release of radioactivity. This release can be caused by mechanical failure (like at Chernobyl in 1986, when safeguard redundancy was deliberately shut off during testing), by act of nature (like the earthquake/tsunami at Fukushima in 2011), or by an act of sabotage.

The experience at Hiroshima and Nagasaki demonstrated how exposure to high levels of radioactivity can harm humans. Those closest to the bombs were vaporized, literally melting from the intense heat. But many other victims who survived the initial blast developed acute radiation poisoning, marked by symptoms such as nausea, vomiting, diarrhea, skin burns, weakness, dehydration, bleeding, hair loss, ulcerations, bloody stool, and skin sloughing (falling off), according to the Medical Encyclopedia of the National Library of Medicine. In addition, a large number of bomb survivors in the two cities developed cancers over the next several decades; thyroid and breast cancer had the greatest excesses. (Source: Thompson DE et al. Cancer Incidence in Atomic Bomb Survivors. Part II: Solid Tumors, 1958-1987. Radiation Effects Research Foundation, Hiroshima Japan, 1994).

If a meltdown resulting in large scale releases of radioactivity from the reactor core or the waste pools occurred at Salem-Hope Creek, there would be no vaporizing of humans. However, many would suffer from acute radiation poisoning (in the short term) and cancer (in the long term). In 1982, the Sandia National Laboratories submitted estimates to Congress for each U.S. nuclear plant in the case of core meltdown. Source: Sandia National Laboratories, Calculation of Reactor Accident Consequences (CRAC-2) for U.S. Nuclear Power Plants. Prepared for U.S. Congress, Subcommittee on Oversight and Investigations, Committee on Interior and Insular Affairs. November 1, 1982. Published in New York Times and Washington Post the following day.

The potential for a meltdown, while not highly likely, is a reality. A recent report by Greenpeace entitled “An American Chernobyl” identified 200 near-miss accidents at American reactors in the past two decades. Source: An American Chernobyl: Nuclear “Near Misses” at U.S. Reactors Since 1986. Washington DC: Greenpeace, 2006. [www.greenpeace.org](http://www.greenpeace.org). The March 2011

meltdown at four reactors in Fukushima, Japan is a reminder that these disasters continue to be a great concern.

5. Routine Radioactive Releases. Utilities operating nuclear power plants are required to submit annual reports on radioactive releases to the federal government. From 1970-1993, the Brookhaven National Laboratories collected and disseminated data for each nuclear plant on emissions of “Iodine-131 and effluents,” or those radioactive chemicals with a half-life of at least eight days, and most likely to enter the food chain and the body. Comparisons of all U.S. plants were halted after 1993 by the U.S. government, and thus are not current. (Source: Brookhaven National Laboratory. Radioactive Materials Released from Nuclear Power Plants. NUREG/CR-2907, annual reports).

However, the U.S. Environmental Protection Agency has made historical data on certain types of emissions from U.S. reactors available online, mostly 2001 to 2009. One of these measures is tritium, a radioactive element found in trace amounts in nature but also produced in atomic bomb explosions and nuclear plant operations. Table 2 lists the amounts of tritium released into the air, for 62 of the 65 operating U.S. nuclear plants.

Table 2  
Gaseous Releases of Tritium, 2009  
By U.S. Nuclear Plant, in Curies

<u>Plant</u>	<u>State</u>	<u>Reactors</u>	<u>Curies</u>
1. Palo Verde	AZ	3	1522.1
2. Salem/Hope Creek	NJ	3	<b>360.8</b>
3. Braidwood	IL	2	324.8
4. Catwaba	SC	2	324.0
5. Brunswick	NC	2	237.1
6. Harris	NC	1	212.0
7. Diablo Canyon	CA	2	196.7
8. Cook	MI	2	181.2
9. McGuire	NC	2	166.4
10. Nine Mile Point	NY	2	142.2
11. Seabrook	NH	1	136.5
12. South Texas Project	TX	2	129.3
13. Clinton	IL	1	108.8
14. Byron	IL	2	104.7
15. Browns Ferry	AL	3	95.5
16. San Onofre	CA	2	85.5
17. Point Beach	WI	2	81.6
18. Millstone	CT	2	78.0
19. Fermi	MI	1	73.6
20. Three Mile Island	PA	1	71.3
21. Vogtle	GA	2	69.7

22. Pilgrim	MA	1	67.7
23. Waterford	LA	1	67.4
24. Ginna	NY	1	61.3
25. LaSalle	IL	2	59.0
26. Oconee	SC	3	56.7
27. Comanche Peak	TX	2	56.3
28. Arkansas	AR	2	54.8
29. Watts Bar	TN	2	53.6
30. Hatch	GA	2	49.0
31. Kewaunee	WI	1	45.9
32. Sequoyah	TN	2	45.3
33. Wolf Creek	KS	1	44.0
34. Palisades	MI	2	41.1
35. Susquehanna	PA	2	37.5
36. Callaway	MO	1	34.9
37. Peach Bottom	PA	2	33.5
38. Limerick	PA	2	33.4
39. Indian Point	NY	2	31.3
40. Farley	GA	2	20.4
41. Washington Nuclear	WA	1	20.1
42. Fitzpatrick	NY	1	17.9
43. River Bend	LA	2	17.4
44. North Anna	VA	2	17.1
45. Monticello	MN	1	15.1
46. Dresden	IL	2	14.3
47. Beaver Valley	PA	2	12.2
48. Quad Cities	IL	2	12.1
49. Grand Gulf	MS	1	11.6
50. Cooper	NE	1	11.4
51. Crystal River	FL	1	11.0
52. Turkey Point	FL	2	10.7
53. Prairie Island	MN	1	10.4
54. Fort Calhoun	NE	1	6.5
55. Robinson	SC	1	6.3
56. Oyster Creek	NJ	1	5.5
57. St. Lucie	FL	2	5.0
58. Davis Besse	OH	1	4.9
59. Calvert Cliffs	MD	2	4.7
60. Vermont Yankee	VT	1	1.8
61. Summer	SC	1	1.4
62. Perry	OH	1	Not detectable

Data missing for Hope Creek (2 quarters); St. Lucie 1 (3 quarters)



Source: U.S. Environmental Protection Agency. [www.reirs.com/effluent](http://www.reirs.com/effluent).

Salem/Hope Creek emitted 360.8 curies into the air in 2009, the highest of any U.S. nuclear plant, except for Palo Verde, in Arizona. The high ranking probably is consistent throughout the 2000s, as prior years have relatively similar emission levels (from 2003-2009, curies were 353.7, 274.5, 335.0, 286.8, 371.9, 278.9, and 360.8).

6. Radioactivity Levels in the Environment. The EPA makes levels of environmental radioactivity at various sites in the U.S. publicly available. Measurements of radioactivity in air, water, and milk are included. The web site, called “Envirofacts,” can be accessed at [http://oaspub.epa.gov/enviro/erams\\_query.simple\\_query](http://oaspub.epa.gov/enviro/erams_query.simple_query), and covers measurements taken since 1978. No site near Salem is included in the EPA data.

7. Radioactivity Levels in the Body. In the 1950s and 1960s, Washington University and the St. Louis Committee for Nuclear Information collected 320,000 baby teeth, and tested them for levels of radioactive Strontium-90 at birth. Sr-90 is one of dozens of radioactive chemicals found only in atomic bomb tests and nuclear reactor emissions. It is chemically similar to calcium, seeking out bone and teeth, and resides in the body for many years (half-life of 28.7 years), making it possible to test in-body levels. Sr-90 impairs and kills cells in the bone and bone marrow (in which the immune system defenses are built) making it a risk factor for all cancers. The St. Louis study found that for children born in 1964, just after above-ground bomb testing ended, the average Sr-90 level was **50 times greater** than for those born in 1950, just before testing began. After above-ground atom bomb tests were banned, Sr-90 averages declined sharply (about 50% from 1964-1969) until the federal government discontinued the study in 1970.

From 1961-1982, the U.S. Atomic Energy Commission (later the U.S. Department of Energy) operated a program measuring Sr-90 concentrations in the vertebrae of healthy adults in San Francisco who had died in accidents. About 50 such measurements were made each year, and a similar program was conducted in New York City. From 1965-74, after the Partial Test Ban Treaty reduced levels of fallout in diet, the average concentration of Sr-90 declined by 50%; but did not change from 1974-1982. (Source: Klusek CS, Strontium-90 in Human Bone in the U.S., 1982. New York: Department of Energy Environmental Measurements Laboratory, 1982). Again, this pattern suggests that a current source of radioactivity was preventing expected declines from decay of old bomb test fallout. The Energy Department terminated its program in 1982. Since then, the U.S. has been without a systematic government program of testing humans for radioactivity levels in their bodies.

From 1996 to 2006, the Radiation and Public Health Project (RPHP) research group conducted a baby tooth study measuring Sr-90 levels, known as the Tooth Fairy Project. The study is patterned on the St. Louis effort, which provides historical data on Sr-90 levels in the U.S. **The**

**RPHP tooth project represents the only study in the U.S. of in-body radioactivity for persons living near nuclear reactors.**RPHP collected and tested nearly 5000 teeth, mostly from California, Connecticut, Florida, New Jersey, and New York. In five medical journal articles, the study showed a rising Sr-90 level of about 50% in teeth of children born in the early 1980s to the late 1990s; an elevated level of about 40% in children living near nuclear plants vs. those more distant; and a link between trends in Sr-90 and cancer incidence in children under age 10 near nuclear plants in New York and New Jersey. Few teeth were tested from the Salem-Hope Creek area, and thus no conclusions could be made. (Source: Mangano JJ et al. An unexpected rise in strontium-90 in US deciduous teeth in the 1990s. *The Science of the Total Environment* 2003;317:37-51).

8. Radiation Health Effects. Since the atomic era began in the 1940s, scientists have studied effects of exposures to man-made radioactivity. Elevated levels of illness and death are attributed to the Hiroshima and Nagasaki bombs; bomb tests in Nevada, the South Pacific, and the former Soviet Union; and the 1986 accident at the Chernobyl nuclear power plant. Each of these involved relatively high levels of exposure to radioactivity.

In addition, researchers have addressed effects of relatively low doses of radioactivity. The first to document hazards of low-dose exposures was British physician Alice Stewart. In the 1950s, Stewart showed that a pelvic X-ray to a pregnant woman nearly doubled the chance the baby would die of cancer before age 10. (Source: Stewart AM, Webb J, and Hewitt D. A Survey of Childhood Malignancies. *British Medical Journal*, 1958;i:1495-1508).

Studies of low-dose exposures have addressed many diseases, but often focus on cancer in children. Radioactive chemicals are known to be more harmful to the young, particularly the developing fetus and infant. Body growth and cell division is most rapid early in life, and thus a damaged cell is most likely to cause harm. **There are at least 19 medical journal articles that identify elevated child cancer rates near different nuclear plants**, mostly power plants (see Appendix 1).

9. Government Studies of Cancer Near U.S. Nuclear Plants. The federal government conducts no systematic tracking of disease and death rates among persons living near nuclear plants. The only comprehensive federal study on cancer near nuclear reactors was a 1990 effort prepared by the National Cancer Institute (NCI), after Senator Edward M. Kennedy wrote to the National Institutes of Health director James Wyngaarden about an article on elevated leukemia rates near the Pilgrim plant in Massachusetts. NCI concluded there was no link between cancer risk and proximity to reactors, even though study methods have received criticism.

Salem-Hope Creek was one of the 62 nuclear plants included in the NCI's 1990 study. The project analyzed cancer mortality in five-year periods before and after reactor startup in the period 1950 to 1984. It used the Standard Mortality Ratio (SMR), or the county rate divided by the U.S. rate, as a measure of mortality. The only cancer incidence in the report was near

reactors in Connecticut and Iowa, the only states that had operating and reliable cancer registries before 1984.

The NCI selected Salem NJ and New Castle DE counties as the “study” counties, or those most proximate to Salem-Hope Creek. But the years after startup (1977-1984) were considered very early for any radiation-induced changes to occur; the inclusion of only mortality, not incidence data is a weakness; and Salem County was not identified separately. (Source: Jablon S. et al. *Cancer in Populations Living Near Nuclear Facilities*. Washington DC: U.S. Government Printing Office, 1990).

In May 2009, the U.S. Nuclear Regulatory Commission published a notice in the Federal Register, announcing it was pursuing another study of cancer near nuclear plants. After dropping its initial choice of subcontractor (Oak Ridge Associated Universities), the NRC picked the National Academy of Science. The NAS has convened a panel to judge the feasibility of such a study, and to conduct and present it. In 2015, the NRC decided to end the study, without any results being produced.

The state of New Jersey has never conducted a study of cancer near nuclear plants.

10. Methodology of Current Study. The target population of this study will be Salem County. Routinely-released radiation moves through the air in all directions for many miles. However, the greatest exposures are to people living closest to the reactor, and all 65,000 Salem County residents reside less than 20 miles from the plant. Moreover, all county residents live east of the plant, or directly downwind, as the prevailing winds are from the northwest (in colder months) and southwest (in warmer months).

The analysis will look at trends in Salem County disease and death rates over time, compared to the New Jersey state rate. The state cancer registry makes annual cancer rates available on the internet for each year from 1990 to 2013 (as of this writing). Rates that are adjusted to the 2000 U.S. population, which allows an “apples to apples” comparison between county and state and is a standard method in epidemiology, will be used. Four-year groups, from 1990-1993 to 2010-2013, will also be used, as larger numbers of cases make comparisons more significant.

The report will also examine county vs. state trends in age-adjusted cancer mortality. Annual rates are provided by the U.S. Centers for Disease Control and Prevention web site for 1968 to 2014. Again, four year combined rates will be used to improve significance (with the exception of the first statistics, in which the three year period 1968-1970 is used). The third and final analysis will be to review age-adjusted mortality for all causes aside from cancer, as radiation exposure will affect all immune-related diseases.

11. Change in Cancer Incidence Near Salem-Hope Creek Since 1990. Table 3 (and Appendix 2) show the percent that Salem County’s cancer incidence rate is higher or lower than the state rate. For the earlier periods (1990-1993, 1994-1997, and 1998-2001), the county and state rate were

essentially equal (county was 0.7% higher, 0.3% lower, and 1.0% lower than the state). Of the 21 New Jersey counties, Salem ranked the 12<sup>th</sup>, 11<sup>th</sup>, and 14<sup>th</sup> highest.

However, in the four-year periods since 2001, the Salem County rate has exceeded the New Jersey rate by progressively greater percentages (+2.9%, +3.8%, and +9.3%). In the most recent period (2010-2013), 1760 county residents were diagnosed with cancer. Moreover, in the most recent year available (2013), the county rate was the highest in New Jersey (+22.5%), based on 504 diagnosed cases. The large number of incident cases make the trends statistically significant. In 2013, Salem County rates exceeded the state for males and females (+28.3% and +14.9%), and blacks and whites (+11.1% and +79.9%). Salem had the highest rate of any county in the state for various types of cancer (Prostate, Colorectal, Oral Cavity/Pharynx, Skin, and Brain/Central Nervous System).

Table 3  
 Cancer Incidence, Salem County vs. New Jersey  
 By Four-Year Periods, 1990 to 2013  
 Cases/100,000 Persons, Adjusted to 2000 U.S. Standard  
 Salem Rank of 21 NJ Counties (1=highest rate, 21=lowest rate)

<u>Years</u>	<u>Salem Co. Cases</u>	<u>Cases/100,000 Salem Co.N.J.</u>		<u>Rank</u>	<u>Salem Rate % +/- NJ</u>
<b>By Year of Diagnosis</b>					
1990-1993	1508	534.2	530.5	12	+ <b>0.7%</b>
1994-1997	1476	519.9	521.6	11	- <b>0.3%</b>
1998-2001	1506	530.1	535.5	14	- <b>1.0%</b>
2002-2005	1577	533.1	518.1	8	+ <b>2.9%</b>
2006-2009	1669	535.5	516.1	9	+ <b>3.8%</b>
2010-2013	1760	535.0	489.5	4	+ <b>9.3%</b>
2013	504	591.9	483.3	1	+ <b>22.5%</b>
<b>Diagnosed 2013</b>					
All	504	591.9	483.3	1	+ <b>22.5%</b>
Male	265	674.2	525.3	1	+ <b>28.3%</b>
Female	239	527.1	458.9	2	+ <b>14.9%</b>
White	400	543.0	488.6	2	+ <b>11.1%</b>
Black	82	781.8	434.6	1	+ <b>79.9%</b>

Salem County has the highest 2013 rates of any New Jersey county for the following cancers:  
 Prostate, Colorectal, Oral Cavity/Pharynx, Skin, Brain/Central Nervous System

Source: New Jersey State Cancer Registry, <http://www.cancer-rates.info/nj/>.

12. Change in Cancer Mortality Near Salem-Hope Creek Since 1968. From the late 1960s to the mid-1980s, Salem County cancer mortality was slightly below the New Jersey rate for each four-year period; in 1983-1986, the county rate was 5.3% below the state. However, the subsequent four-year periods showed an abrupt change, as Salem County rates became progressively higher than the state (+9.0%, +7.8%, +16.9%, +10.5%, +20.2%, and +20.2%). The county ranked 1<sup>st</sup>, 6<sup>th</sup>, 1<sup>st</sup>, and 2<sup>nd</sup> highest in the most recent periods. About 650 to 700 county residents died of cancer in each of these four-year periods. See Table 4 and Appendix 3.

Similar to cancer incidence, in the most recent year available (2014), the county rate was the highest of any in New Jersey (+39.5%), based on 187 cancer deaths. Salem County rates exceeded the state (1999-2014) for both genders, all age groups, and all racial/ethnic groups (white non-Hispanic, black non-Hispanic, and white Hispanic). Local rates for lung, prostate, female breast, and colorectal cancer all exceeded the state (these four cancers account for about 55% of all cancer cases and deaths).

Table 4  
Cancer Mortality, Salem County vs. New Jersey  
By Four-Year Periods, 1968 to 2014  
Cases/100,000 Persons, Adjusted to 2000 U.S. Standard  
Salem Rank of 21 NJ Counties (1=highest rate, 21=lowest rate)

<u>Years</u>	<u>Salem Co. Deaths</u>	<u>Deaths/100,000</u>		<u>Salem</u>	<u>Salem Rate</u>
		<u>Salem Co.</u>	<u>N.J.</u>	<u>Rank</u>	<u>% +/- NJ</u>
By Year of Death					
1968-1970	316	214.49	221.41	15	- <b>3.1%</b>
1971-1974	461	220.94	221.07	10	- <b>0.1%</b>
1975-1978	494	224.07	224.06	10	<b>0.0%</b>
1979-1982	528	218.14	225.27	16	- <b>3.2%</b>
1983-1986	567	217.22	229.44	17	- <b>5.3%</b>
1987-1990	629	229.17	230.19	10	- <b>0.4%</b>
1991-1994	698	248.16	227.69	1	+ <b>9.0%</b>
1995-1998	677	233.65	216.77	2	+ <b>7.8%</b>
1999-2002	701	238.87	204.41	1	+ <b>16.9%</b>
2003-2006	636	207.85	188.06	6	+ <b>10.5%</b>
2007-2010	670	208.40	173.35	1	+ <b>20.2%</b>
2011-2014	656	191.88	159.57	2	+ <b>20.2%</b>
2014	187	217.81	156.09	1	+ <b>39.5%</b>

Died 1999-2014					
All	2663	210.54	180.38	1	<b>+16.7%</b>
Male	1397	260.54	215.00	1	<b>+21.2%</b>
Female	1266	176.14	158.43	3	<b>+11.2%</b>
W N-Hisp	2231	207.74	188.35	5	<b>+10.3%</b>
B N-Hisp	380	245.08	217.17	2	<b>+12.9%</b>
W-Hispanic	29	159.52	116.18	2	<b>+37.3%</b>
0-14	6	*	*	*	*
15-44	80	20.46	15.29	1	<b>+33.8%</b>
45-64	718	237.50	183.26	2	<b>+29.6%</b>
65+	1859	1172.87	1048.78	2	<b>+11.8%</b>
Lung	759	59.81	45.80	2	<b>+30.6%</b>
Prostate	155	31.17	23.19	1	<b>+34.4%</b>
(F) Breast	208	29.96	25.97	1	<b>+15.4%</b>
Colorectal	281	21.87	18.40	1	<b>+18.9%</b>

Lung, Prostate, Breast, and Colorectal are the most common cancers, Accounting for 55% of cancer deaths in the U.S.

\*Insufficient number of Salem County deaths for comparisons with NJ

Source: U.S. Centers for Disease Control and Prevention, <http://wonder.cdc.gov>.

13. Change in Non-Cancer Mortality Near Salem-Hope Creek Since 1968. For causes other than cancer, the Salem County rate has always exceeded the New Jersey rate. From 1968-1970 to 1987-1990, the excess steadily decreased (from +11.8% to +1.7%), a significant trend as about 2000 non-cancer deaths occurred in Salem County in each four-year period.

However, beginning in the early 1990s, this decline abruptly reversed. After the +1.7% excess in 1987-1990, the elevated county rate for the following four-year periods rose steadily, to +7.8%, +14.4%, +15.3, +26.3, +24.4, and +23.3%. In the most recent three four-year periods, the Salem County rate ranked 2<sup>nd</sup> highest of all New Jersey counties (behind Cumberland County). Similar to cancer mortality, in the most recent time span (2003-2014), the county rate exceeded the state for each gender, all racial/ethnic groups, and age groups. Those with the highest excess were white Hispanics and young people (age 0-24 and 25-44).

County and state mortality rates for all causes (cancer and non-cancer combined) for each four-year period since 1968 is given in Table 5 and Appendix 4.

Table 5

All-Cause Mortality Excluding Cancer, Salem County vs. New Jersey  
Cases/100,000 Persons, Adjusted to 2000 U.S. Standard  
Salem Rank of 21 NJ Counties (1=highest rate, 21=lowest rate)

<u>Years</u>	<u>Salem Co. Deaths</u>	<u>Deaths/100,000</u>		<u>Salem</u>	<u>Salem Rate</u>
		<u>Salem Co.</u>	<u>N.J. Rank</u>	<u>% +/-</u>	<u>NJ</u>
<b>By Year of Death</b>					
1968-1970	1569	1191.72	1066.09	3	<b>+11.8%</b>
1971-1974	2033	1083.19	984.94	3	<b>+10.0%</b>
1975-1978	1827	892.18	855.14	9	<b>+ 4.3%</b>
1979-1982	1924	846.66	806.73	7	<b>+ 4.9%</b>
1983-1986	1972	797.37	778.63	8	<b>+ 2.4%</b>
1987-1990	1986	760.57	747.81	9	<b>+ 1.7%</b>
1991-1994	2013	741.44	687.48	5	<b>+ 7.8%</b>
1995-1998	2127	747.52	653.71	3	<b>+14.4%</b>
1999-2002	2114	728.41	631.72	3	<b>+15.3%</b>
2003-2006	2250	734.63	581.60	2	<b>+26.3%</b>
2007-2010	2133	657.02	528.06	2	<b>+24.4%</b>
2011-2014	2165	632.46	513.05	2	<b>+23.3%</b>
2014	515	600.97	504.44	3	<b>+19.1%</b>
<b>Died 2003-2014</b>					
All	6548	672.25	539.92	2	<b>+24.5%</b>
Male	3141	799.05	645.33	2	<b>+23.8%</b>
Female	3407	570.44	456.76	2	<b>+24.9%</b>
W N-Hisp	5371	645.34	543.03	4	<b>+18.8%</b>
B N-Hisp	983	864.44	724.24	1	<b>+19.4%</b>
W-Hispanic	137	779.63	407.29	1	<b>+91.4%</b>
0-24	191	78.21	52.19	2	<b>+59.6%</b>
25-44	314	162.92	104.98	3	<b>+55.2%</b>
45-64	1099	475.23	331.30	3	<b>+43.4%</b>
65+	4943	3880.91	3305.20	3	<b>+17.4%</b>

Source: U.S. Centers for Disease Control and Prevention, <http://wonder.cdc.gov>.

Table 6

All-Cause Mortality, Salem County vs. New Jersey

Cases/100,000 Persons, Adjusted to 2000 U.S. Standard

Salem Rank of 21 NJ Counties (1=highest rate, 21=lowest rate)

<u>Years</u>	<u>Salem Co. Deaths</u>	<u>Deaths/100,000</u>		<u>Salem Rank</u>	<u>Salem Rate % +/- NJ</u>
		<u>Salem Co.</u>	<u>N.J.</u>		
<b>By Year of Death</b>					
1968-1970	1890	1409.24	1290.27	3	+ <b>9.2%</b>
1971-1974	2500	1304.13	1208.62	4	+ <b>7.9%</b>
1975-1978	2331	1120.79	1081.80	8	+ <b>3.6%</b>
1979-1982	2460	1067.66	1034.96	7	+ <b>3.2%</b>
1983-1986	2548	1018.07	1011.55	11	+ <b>0.3%</b>
1987-1990	2625	993.39	982.07	9	+ <b>1.2%</b>
1991-1994	2721	993.20	919.25	5	+ <b>8.0%</b>
1995-1998	2813	984.26	874.40	2	+ <b>12.6%</b>
1999-2002	2827	971.42	841.97	2	+ <b>15.4%</b>
2003-2006	2896	945.67	774.96	3	+ <b>22.0%</b>
2007-2010	2815	869.07	706.27	1	+ <b>23.1%</b>
2011-2014	2831	826.69	677.60	2	+ <b>22.0%</b>
2014	704	821.25	665.68	2	+ <b>23.4%</b>
<b>Died 2003-2014</b>					
All	8542	877.65	718.09	2	+ <b>22.2%</b>
Male	4187	1052.76	856.96	2	+ <b>22.8%</b>
Female	4355	742.12	613.53	2	+ <b>21.0%</b>
W N-Hisp	7054	850.06	730.16	3	+ <b>16.4%</b>
B N-Hisp	1253	1093.55	936.25	1	+ <b>16.8%</b>
W-Hispanic	160	922.77	525.16	1	+ <b>75.7%</b>
0-24	201	82.19	52.19	2	+ <b>57.5%</b>
25-44	369	191.48	124.78	2	+ <b>29.4%</b>
45-64	1644	704.58	507.98	2	+ <b>38.7%</b>
65+	6327	5024.67	4348.81	2	+ <b>15.5%</b>

Source: U.S. Centers for Disease Control and Prevention, <http://wonder.cdc.gov>.



14. Discussion. In the late 1960s, 1970s, and early 1980s, Salem County mortality rates were steadily below New Jersey rates (for all cancers) and were above but steadily declining (for all other causes). Since then, the county rate has risen rapidly (compared to the state), so that it is now 20-25% greater than the state. The gap shows no signs of slowing; because about 700 Salem County residents die each year, the “excess” of 20-25% over the past decade is in excess of 1000.

Even though the earliest date for cancer incidence is 1990 diagnosed cases, and the county and state rates were roughly equal during the 1990s, the county excess has sharply risen since the turn of the century. With 500 cancer cases diagnosed each year in county residents, the number of “excess” cases is likely to be several hundred.

Many factors can account for changes in morbidity and mortality rates. In Salem County, none are apparent. There has been no unusual change in racial or ethnic composition, no major reduction in access to medical care, and no unusual rise in poverty. A low population mobility is likely, as the county population has remained virtually unchanged for decades (between 60,000 and 66,000 since 1970). Any age distribution differences between state and county are accounted for by using age-adjusted incidence and mortality rates.

Other local environmental pollutants, such as chemical plants in Delaware and Superfund sites in southern New Jersey, may account for a portion of the rising cancer rates. However, these plants predate the 1970s, when Salem County mortality rates were below the state; the growing excess of county rates compared to the state only began after the 1970s, when the three Salem-Hope Creek nuclear reactors began operating.

Because Salem-Hope Creek reactors began operating in 1976, 1980, and 1986, and because there is typically a time lag between exposure and cancer diagnosis or death, the introduction of over 100 man-made radioactive chemicals since then suggest that radiation exposures must be considered as one potential factor in the decline of health status in Salem County in recent decades.

It is unfortunate that these trends, which have been occurring for decades, have been ignored by regulatory and elected officials to date. From this time forward, it is important that officials

1. Acknowledge these adverse health trends
2. Conduct more detailed statistical studies to examine changes in health status
3. Conduct studies that specifically examine how much radiation is entering the environment and human bodies
4. Educate local residents on these findings
5. Make efforts to change public policy to reverse these negative trends

## APPENDIX 1

### JOURNAL ARTICLES (19)-HIGH LEVELS OF CHILD CANCER NEAR NUCLEAR PLANTS

Sharp L, McKinney PA, Black RJ. Incidence of childhood brain and other non-haematopoietic neoplasms near nuclear sites in Scotland, 1975-94. *Occupational and Environmental Medicine* 1999; 56(5): 308-314.

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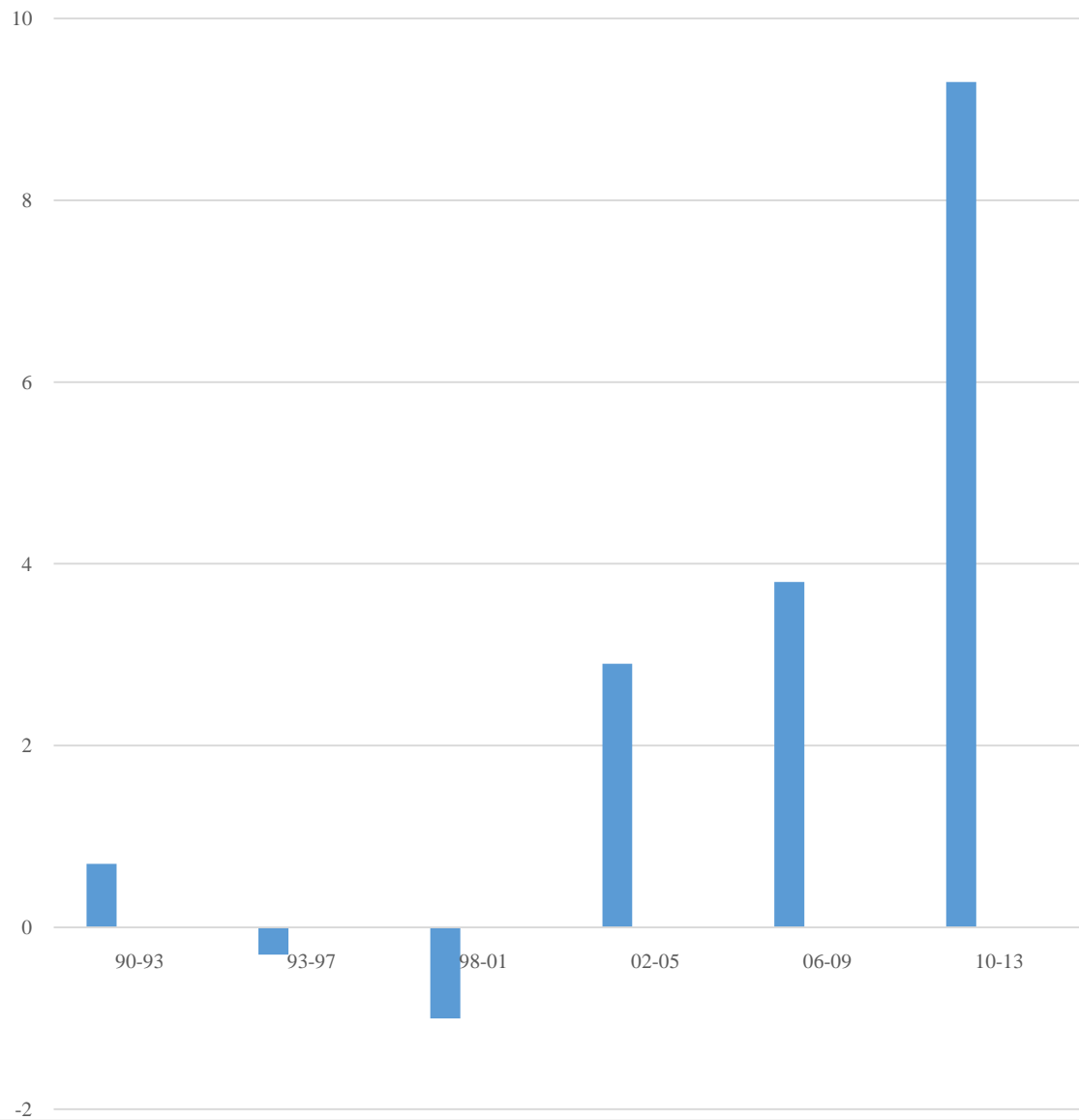
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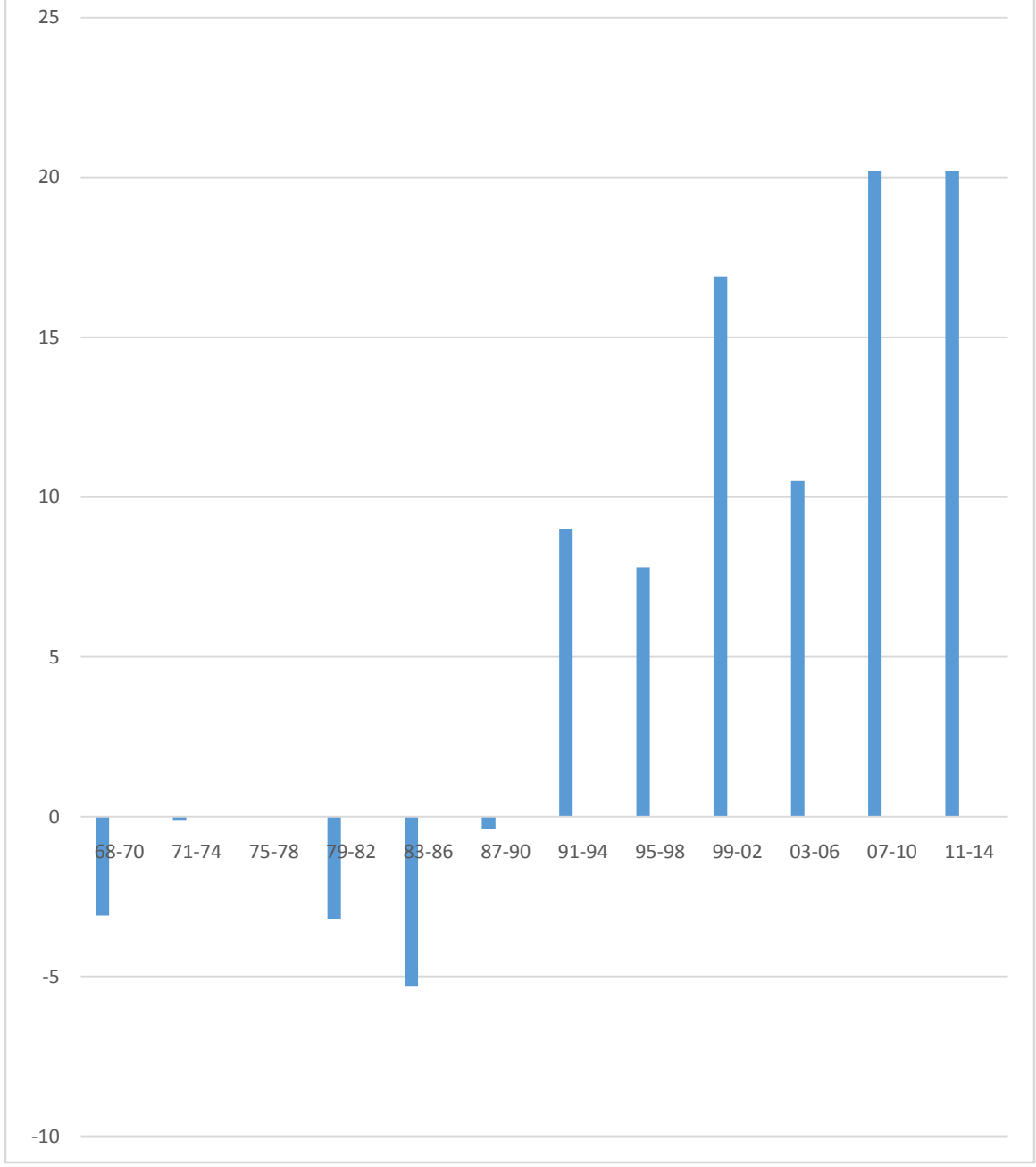
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Appendix 2  
**% SALEM COUNTY RATE IS +/- NJ RATE**  
All Cancer Incidence, by 4 Year Period, 1990-2013



Appendix 3  
**% SALEM COUNTY RATE IS +/- NJ RATE**  
 All Cancer Mortality, by 4 Year Period, 1968-2014



Appendix 4  
**% SALEM COUNTY RATE IS +/- NJ RATE**  
Non-Cancer Mortality, by 4 Year Period, 1968-2014

