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RISING DEATH RATES IN BURKE COUNTY AFTER STARTUP OF THE ALVIN VOGTLE NUCLEAR PLANT: ADDRESSING ENVIRONMENTAL INJUSTICE

Blue Ridge Environmental Defense League, North Myrtle Beach, SC

March 28, 2024 – **The death rate in Burke County GA, 19% above the U.S. before the Vogtle 1/2 reactors operated, was 35% above the U.S. after startup, says a new report.**

The change equals **1,223 "excess" deaths in Burke County from 1988-2020**. The county/national ratio increased for Burke County blacks and whites, and were largest for young and old residents. For example, **infant mortality under age one rose from 34% above to 79% above the U.S**.

The county death rate from all cancers shifted from 7% BELOW to 13% ABOVE the U.S. after Vogtle startup; 303 of the 1,223 excess deaths were due to cancer. The change in cancer death rates from below to above the U.S. occurred for both races and all ages.

The county's most recent (2016-2020) incidence rate of new cancer cases ranks 16th highest of 159 Georgia counties; 150 Burke County residents are diagnosed with cancer each year.

"Since the late 1980s, dramatic increases have occurred in Burke County death rates," says Joseph Mangano MPH MBA. "Many factors can affect mortality, but adding two large nuclear reactors must be regarded as a major cause." Mangano, the report's author, is an epidemiologist and Executive Director of the Radiation and Public Health Project (RPHP).

Vogtle generates over 100 radioactive chemicals to produce electricity. Each can cause cancer and other diseases. They are not found in nature, but are only created when reactors operate or a nuclear weapon explodes. Some of these radioactive particles and gases are released into the environment, and enter the body through breathing and the food chain.

Vogtle is the site of two new reactors, which began operating in July 2023, and February 2024. Vogtle 3 and 4 are the only U.S. reactors ordered since 1973 that were completed. Vogtle will be the only U.S. nuclear plant with four reactors (most have one or two).

Burke County consists mostly of small towns and rural areas. Its population is 24,000; nearly half are African-American. It has long had socioeconomic disadvantages; for example, its poverty rate is nearly double the U.S. rate. These factors, plus the presence of four nuclear reactors, raise issues of environmental injustice and environmental racism.

The Blue Ridge Environmental Defense League (BREDL) commissioned RPHP to conduct the study, which is an update of a 2007 analysis.

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INTRODUCTION

Background – Nuclear Power in a High-Risk Community. The Alvin Vogtle Electric Generating Plant is situated in Waynesboro GA (Burke County), on the Savannah River, 26 miles southeast of Augusta, the third largest city in the state. Vogtle is about 155 miles east of Atlanta, Georgia's largest city. The 2010 population living within 50 miles from the site was 726,640 (Dedman, 2011).

Vogtle consists of four nuclear reactors, each of which generates electrical power. The original two reactors (units 1 and 2) began operating in 1987 and 1989. Units 3 and 4 were introduced more recently; the startup for unit 3 was July 31, 2023, while unit 4 is expected to begin generating power in 2024. The four reactors are large, each with a capacity of generating over 1,100 megawatts of electricity (U.S. Nuclear Regulatory Commission, 2023).

All nuclear plants in the U.S. consist of only one or two reactors, except for Browns Ferry AL, Oconee SC, and Palo Verde AZ (three each). Thus, Vogtle will soon be the only U.S. nuclear plant with four reactors.

Burke County's 827 square miles consists of small towns and rural areas. Its estimated 2022 population is 24,388, which has changed little since the late 1800s. County residents are mostly Caucasians (50.9%) and African-Americans (45.8%) (U.S. Census Bureau, 2024).

The county's socioeconomic status measures consistently fall below national standards (see Table 1). Perhaps most crucial is the fact that 21.8% of the county's residents live below the poverty level, nearly double the U.S. rate of 11.5%. Only 14.7% of residents over age 25 have at least a bachelor's degree (versus 34.3% in the U.S.), while 14.1% of those under age 65 have no health insurance (versus 9.3% in the U.S.).

Table 1
Socioeconomic Status, Burke County vs. U.S.
For Selected Measures, 2018-2022

Measure	Burke	U.S.
% over 25 who are high school graduates	84.7	89.1
% over 25 with a bachelor's degree	14.7	34.3
% under 65 without health insurance	14.1	9.3
% under 65 with a disability	10.8	8.9
% over 16 in labor force	58.3	63.0
% persons in poverty	21.8	11.5

Numerous studies have documented that the economically disadvantaged - those in poverty, with lower educational status, without health insurance, with higher unemployment, etc. - are at greater risk of developing and/or dying from various diseases. Thus, the addition of two new nuclear reactors, bringing the total at Vogtle to four (unprecedented in the U.S.), raises the issue of whether local health has been harmed.

Aging and New Reactors at Vogtle. Reactors were originally granted 40-year licenses by the U.S. Nuclear Regulatory Commission, as reactors were not expected to last beyond 40 years. After 1998, as many reactors approached the 40-year mark, the Commission began granting 20-year license extensions; 83 of the 92 operating U.S. reactors that applied have received extensions.

Vogtle 1 and 2 received their extensions in 2009, and are licensed to operate until 2027 and 2029. No license extension has ever been denied by federal regulators (U.S. Nuclear Regulatory Commission, 2024).

Vogtle 3 and 4 are the only U.S. reactors ordered since 1973 to eventually operate. The project was started in 2006, and thus planning and construction took 17 and 18 years. The original expected cost was $14 billion, but eventual costs soared to $35 billion. Increases in electric bills to Georgia Power customers pay most of these costs (Kann, 2023).

The combination of two aging reactors and two new ones at one site raises questions about risk to local health. Reactors generate a large amount of highly radioactive waste. Splitting uranium atoms to generate high heat, the same process used in detonating nuclear weapons, also creates waste, over 100 chemicals not found in nature, each of which raises cancer risk, in the form of gases and tiny metal particles.

Most of this radioactive waste is stored on the site of each plant. Vogtle currently stores the equivalent of twice the amount of radioactivity released during the 1986 Chernobyl meltdown (Alvarez, 2011). At first, waste is moved from reactor cores to constantly-cooled pools of deep water, and eventually moved to "dry" casks made of concrete and steel.

About 90% of the waste consists of three of the 100-plus chemicals produced in reactor operations; cesium-137, plutonium-241, and strontium-90. Nearly 70 years after the first U.S. reactor began operating, no permanent waste repository has been built, leaving sites like Vogtle to maintain the waste for the foreseeable future, if not forever.

Vogtle Reactor Emissions and Risk to Human Health. All reactors must release some of the waste into air and water. Waste enters human bodies through breathing, food, and water. Each chemical affects human biology differently. For example, radioactive iodine seeks out the thyroid gland, and radioactive strontium seeks out bone and teeth.
All radioactive isotopes damage DNA in cells or kills them outright, leading to an elevated risk of disease and death. Several major findings are clear after decades of study:

1. All humans are affected negatively by radiation exposure, even at the lowest doses (BEIR V, 1990)

2. The most severe effects of a dose are borne by the fetus and infant, whose immune systems are immature; by the frail elderly, whose immune systems are failing; and by those who are immunocompromised

3. The lag time between exposure and onset of disease or death may take several years, or even decades

4. While some cancers are known to be especially sensitive to radioactivity, such as thyroid cancer or bone cancer, the risk of all cancers are increased after radiation exposure

Numerous articles have appeared in the medical literature, documenting the excess in cancers after relatively low-dose exposures. A recent article in the Journal of the National Cancer Institute found 21 of the 26 studies determined an excess of cancer from low-level radiation (Gonzalez, 2020).

A recent review of workers at nuclear plants in France, the United States, and the United Kingdom followed 310,000 workers for an average of 35 years. The study concluded that cancer risk was more elevated than current estimates, at levels of exposure well below those studied among survivors of the atomic bomb at Hiroshima (Richardson, 2023).

Since reactors began operating in the U.S. in 1957, federal officials have conducted just one study of cancer near nuclear plants, performed at the mandate of Senator Edward Kennedy. The study looked at cancer mortality from 1950 to 1984 and found no consistent link between cancer and proximity to nuclear plants (National Cancer Institute, 1990).

The federal study only included nuclear plants that had started operations by 1981. Thus, Vogtle was not part of this analysis, and health patterns in the area most proximate to the reactors remain unstudied by officials, or academic researchers.

In 2007, the Blue Ridge Environmental Defense League (BREDL) commissioned the Radiation and Public Health Project (RPHP) to review health patterns near Vogtle. RPHP is a research and education group that analyzes health risk of exposures to atomic bomb fallout and nuclear reactor releases. The request occurred just after the planning and construction of Vogtle 3 and 4 began (Blue Ridge Environmental Defense League, 2007).

The 2007 study documented rising mortality rates in Burke County and surrounding counties after the first two Vogtle units began operation. At the time, only data up to the year 2003 was publicly available for study. Because Burke is a small county, the ability to analyze cancer trends was limited by small numbers of deaths in a short period after reactor startup.

BREDL has recently commissioned RPHP to conduct an updated study. Mortality data up to the year 2021 is now available online, and cancer incidence data is now available after the year 2000. Because the county has a high proportion of minorities (almost all African-Americans) and is an economically distressed area, concerns about environmental injustice and environmental racism have been raised. This study will provide information on whether these concerns may be justified.

STUDY METHODS

Burke County will be the focus of this report, which follows the approach used in the 1990 National Cancer Institute study. That report selected the home county of each nuclear plant,

sometimes along with an adjoining county, to be the "study" county (close to plants). Virtually all Burke residents reside within 25 miles of Vogtle, with the majority living much closer – closer than any adjoining county. Thus, the largest effects of exposure to radioactive emissions from Vogtle would most likely be expected in Burke County.

The 1990 study selected the U.S. cancer mortality rate as the control for each county and calculated a county vs. national ratio for cancer mortality, before and after startup of each plant. This report will also use the same county-versus-nation ratio.

Mortality trends for all causes, and for all cancers combined, will be the principal measures used in this report. Radioactivity can affect various organ systems in humans. A study of 5,000 papers on local health trends after the Chernobyl meltdown found increases in numerous disorders (Yablokov, 2009).

The principal source for the study will be the Centers for Disease Control and Prevention's "CDC Wonder" data base. Available online, CDC Wonder includes information on every U.S. death, each year from 1968 to 2021, as of late 2023, with preliminary data available for 2022 and 2023 (U.S. Centers for Disease Control and Prevention, 2024). The Georgia Comprehensive Cancer Registry will be the source of cancer incidence data, available from 2001 to 2020.

The periods before and after Vogtle startup will be

- 1968-1987 (before startup – 20 years)
- 1988-2020 (after startup – 32 years)

The measure used in the study will be the death rate, from all causes and all cancers, per 100,000 persons. These rates are age-adjusted to the 2000 U.S. standard, a method commonly used in epidemiology to account for any unusual age distributions in the population, allowing for "apples to apples" comparisons to be made. Age-adjusted rates were used in the 1990 National Cancer Institute study. The report will address changes in the county/national ratio for individual age groups, as did the 1990 study.

The 2007 RPHP report on cancer near Vogtle was performed at a time when the CDC mortality data was only available for 1979 to 2003. The increase in available years for study from 25 to 56 means larger numbers of deaths, making it more likely to assess if a trend is or isn't significant.

The 1968-1987 county/national ratio (before Vogtle startup) will be the baseline or "expected" ratio for the follow-up period of 1988-2020 (after startup). Significance testing for the latter period will assess if the ratio differs from the expected. A p-value of .05 or less is the standard for significance, meaning that there is a 95% or greater chance that changes in county/national ratios after 1987 are not due to random chance, but due to a factor or factors.

RESULTS

Radioactive Emissions from Vogtle. Studies assessing the relationship between radiation exposure and cancer typically consist of a "dose" and a "response." In this report, the "dose" is the exposure of Burke County residents to routine releases from Vogtle, and the "response" is cancer deaths.

While the optimal measure of dose would be total in-body exposures to a population, this measure is not possible for various reasons:

1. Measurement is an involved process, sometimes involving autopsies.
2. There are many radioactive chemicals, making it very difficult to measure each one.
3. Some chemicals decay quickly and are impossible to measure once they enter the body.
4. Each person in a population would have to be measured.
5. No regulatory body requires in-body measurements of persons living near nuclear plants.

The Radiation and Public Health Project (RPHP) has conducted the only study of in-body radioactivity near U.S. nuclear power plants. The "Tooth Fairy Project" measured Strontium-90 levels in 5,000 baby teeth, as did 1960s studies of fallout from above-ground atomic bomb tests.

Results of the RPHP tooth study, which were published in five medical journal articles, showed a 30-50% greater average concentration of Strontium-90 in areas closest to nuclear plants; increases over time through the 1980s and 1990s, and a matching of trends of Strontium-90 and cancer incidence in children under age five (Mangano, 2003; Mangano, 2006).

The 2007 report on Vogtle included changes in radioactivity levels in the local environment between 1987 and 2003. Using data reported by plant operators to the U.S. Nuclear Regulatory Commission, large increases were observed in radioactivity concentrations in drinking water, river water, and sediment before and after Vogtle startup, for various radioactive chemicals. Increases were much greater in areas downriver from Vogtle. These findings are reprinted as Appendix 1.

More recent data on emissions are included in this report, specifically on the annual amount of airborne tritium releases, from the years 2008 to 2022. Table 2 (below) and Appendix 2 provide results. From the earliest three-year period (2008-2010) to the most recent (2020-2022), the amount released steadily increased, and more than doubled from 127.32 to 293.65 curies. Results suggest that environmental radioactivity is increasing over time.

Table 2
Trends in Gaseous Releases of Tritium, in Curies
Vogtle Nuclear Plant, by Three Year Groups 2008-2022

Periods	Total Curies
2008-2010	127.32
2011-2013	170.41
2014-2016	202.00
2017-2019	228.36
2020-2022	293.65

Trends in All-Cause Mortality by Race. One of the broadest measures of a population's health is mortality for all causes combined, which can also measure adverse health effects of environmental hazards such as radioactivity, since multiple organs of the body can be affected (Yablokov, 2009). Table 3 provides the changes in the Burke County age-adjusted all-cause mortality rate (versus the U.S. rate) for the periods before and after startup of Vogtle 1 and 2.

Table 3
Change in Age-Adjusted Death Rate, All Causes Combined.
Burke County vs. U.S., by Race, 1968-1987 to 1988-2020

Race	1968-1987	1988-2020	Change
Total	+19.0%	+35.1%	**+16.1%**
White	+15.4%	+28.3%	**+12.9%**
Black	+ 2.8%	+18.0%	**+15.2%**

County/national ratios have increased for all races combined, for whites, and for blacks. The 19.0% excess from the pre-Vogtle period has been replaced by a 35.1% excess, up 16.1%, based on 7,596 deaths from 1988-2020. If the 19.0% excess had continued in the latter period, 1,223 fewer deaths would have occurred among Burke County residents (7,596 x 16.1%). All increases are statistically significant. See Appendix 3 for more detailed data.

A revealing aspect of the data is the fact that in 1968-1987, before the Vogtle reactors operated, the mortality rate for Burke County blacks was only 2.8% greater than the U.S. rate. This was followed by an 18.0% excess in the years after Vogtle startup. Thus, excess mortality for Burke County blacks is mostly a function of the post-startup period, starting in the late 1980s.

Trends in All-Cause Mortality by Age. Another means of analyzing all-cause mortality is by age groups. Table 4 presents changes in the county/U.S. mortality ratio for the youngest and oldest age groups; because of the underdeveloped immune systems in the young, and the declining immune systems in the elderly, these groups may be most susceptible to damage from radiation exposure.

Table 4
Change in Age-Adjusted Death Rate, All Causes Combined.
Burke County vs. U.S., by Selected Age Groups, 1968-1987 to 1988-2020

Age	1968-1987	1988-2020	Change
0-1	+34.3%	+79.0%	**+46.7%**
1-24	+52.4%	+73.0%	**+20.6%**
75-84	- 6.6%	+27.9%	**+34.5%**
85+	- 24.3%	+ 9.0%	**+33.3%**
All Ages	+19.0%	+35.1%	**+16.1%**

Although county versus national mortality for all ages combined increased (+16.1%), such changes were greater for the very young and very old. These included persons age 0-1 (+46.7%); 1-24 (+20.5%); 75-84 (+34.5%); and over 85 (+33.3%). All changes except for age 1-24 were statistically significant.

Moreover, Burke County mortality among the elderly before Vogtle startup was below the U.S., but has exceeded the U.S. ever since. Appendices 3, 4, and 5 have more detailed data.

Trends in All-Cause Mortality by Cause of Death. Burke County death rates compared to the U.S. was also analyzed for nine categories, which account for 91% of U.S. deaths, for the years 1999-2020. Table 5 shows county/national differences; Appendix 6 has more detailed data).

Table 5
Mortality, Burke County vs. U.S., All Races
By Most Common Causes of Death, 1999-2020

Cause	% Burke rate vs. U.S.
All Causes Combined	**+38.6**
Diseases of the Circulatory System	**+38.4**
Neoplasms (Cancer)	**+18.9**
Diseases of the Respiratory System	**+40.2**
External Causes (Accidents, Suicide, Homicide)	**+62.8**
Diseases of the Nervous System	**+15.1**
Endocrine, Nutritional, and Metabolic Diseases	**+37.8**
Mental and Behavioral Diseases	**+20.4**
Diseases of the Digestive System	**+29.2**
All Other Causes	**+92.1**

For each of the eight most common categories of death, plus deaths from all other causes combined, the Burke County rate was higher than the national rate. All excesses are statistically significant except for diseases of the nervous system and mental/behavioral diseases. Excesses ranged from 15.1% higher (diseases of the nervous system) to 92.3% higher (all other causes).

Trends in Cancer Mortality by Race. While exposure to radiation can raise risk of multiple diseases, cancer risk has been studied most often. Ionizing radiation induces breaks in DNA strands in the cell, which can result in gene mutation and the ability of cells to reproduce properly, which can result in cancer (Borrego-Soto, 2015; Little, 2003). Thus, reviewing trends in cancer mortality in Burke County, compared to the U.S. standard, is appropriate.

Table 7 shows the ratio of county-to-national cancer death rates for the periods before Vogtle startup (1968-1987) and after Vogtle startup (1988-2020). Appendix 7 provides more detailed data.

Table 7
Change in Age-Adjusted Death Rate, Neoplasms (Cancers)
Burke County vs. U.S., by Race, 1968-1987 to 1988-2020

Race	1968-1987	1988-2020	Change
Total	- 7.1%	+13.0%	**+20.1%**
White	- 5.9%	+ 8.0%	**+13.9%**
Black	- 21.6%	+ 3.2%	**+24.8%**

Unlike all causes combined, Burke County cancer death rates before Vogtle startup were below U.S. rates, for both races. After startup, county rates are consistently above the U.S. Thus, the county has shifted from a low-cancer area to a high-cancer area. All changes are statistically significant, as 1506 Burke County residents died of cancer in the period after startup.

Trends in Cancer Mortality by Age. The transition from Burke County from a low-cancer area to a high-cancer area can be analyzed in various ways. One of these is to compare periods before and after Vogtle startup, by age of death. Table 8 provides this comparison for four age groups, as does Appendix 7.

Table 8
Change in Age-Specific Death Rate, Neoplasms (Cancers)
Burke County vs. U.S., 1968-1987 vs. 1988-2020

Age	1968-1987	1988-2020	Change
0-24	**- 28.2**	**+ 3.9**	**+32.1%**
25-44	**+ 9.8**	**+29.8**	**+20.0%**
45-64	**+11.2**	**+25.1**	**+13.9%**
65+	**- 17.6**	**+ 7.8**	**+25.4%**

The county/national ratio increased for each group, with the largest changes occurring for old and young persons. In the period of Vogtle operations (1988-2020), county rates exceed the U.S. for all ages. Only the change for those age 65 and older is statistically significant.

Trends in Cancer Mortality by Gender. Another means of analyzing changes in cancer patterns is by gender. Table 9 provides the county/national ratio for both males and females, for four periods between 1968 and 2020. More detailed data is provided in Appendix 8.

Table 9
Change in Age-Adjusted Death Rate, Neoplasms (Cancers)
Burke County vs. U.S., by Gender, By Periods, 1968 to 2020

	% Burke Rate vs. U.S.		% Excess Rate
Period	Males	Females	Males vs. Females
1968-1978	**- 8.4**	**- 13.7**	**+ 5.3**
1979-1987	**+ 8.6**	**- 16.9**	**+25.5**
1988-1998	**+16.4**	**- 7.6**	**+24.0**
1999-2020	**+38.1**	**+ 1.5**	**+36.6**

In each period, Burke County males fared worse than females. In the earliest period, county rates were below the U.S. for both genders (-8.4% for males, and -13.7% for females), a gap of 5.3%. But the excess for males has expanded, reaching a gap of 36.6% in the most current period of 1999-2020; in those years, the Burke County rate was 38.1% above the U.S. for males, and just 1.5% above the U.S. rate for females.

Cancer Mortality, by Most Common Types of Cancer. Another question raised by high and rising cancer mortality rates in Burke County is which cancers are affected. Table 10 provides data on the gap in Burke County and U.S. rates for the most common types of cancer in the period 1999-2020. Appendix 9 contains more detailed information.

Table 10
Neoplasm (Cancer) Mortality, Burke County GA vs. U.S.
By Most Common Types of Cancer, 1999-2020

Type	% Burke rate vs. U.S.
All	**+18.9**
Lung/bronchus	**+21.6**
(F) Breast	**- 19.6**
(M) Prostate	**+84.1**
Colorectal	**+43.5**
Pancreas	**+15.6**

Cancer of the lung/bronchus, breast, prostate, colon/rectum, and pancreas account for nearly 60% of all cancer deaths in the U.S. For each of these cancers, the current Burke County mortality rate is higher than the U.S. rate, except for female breast cancer. Differences are statistically significant for all categories except for breast and pancreatic cancer.

In this report, cancer deaths are given for the years 1968 to 2020. As of this writing, the Centers for Disease Control and Prevention has posted crude totals of cancer deaths for the years 2021, 2022, and 2023; the latter two years are only provisional, but likely to be close to final figures).

It appears that the rising cancer death rate in Burke County will continue in the most recent three years. Annual totals for 2018-2023 were 51, 40, 44, 47, 53, and 52. Thus, cancer deaths in Burke County rose from 2018-2020 (135) to 2021-2023 (152), a rise of 12.6%. The increase in the U.S. cancer deaths over the same periods was only 1.3%, from 1,848,684 to 1,872,549.

Trends in Cancer Incidence. Unlike cancer mortality data, which has been collected and reported by health departments for nearly a century, data on incidence of newly-diagnosed cases is relatively recent. This information relies on each state's cancer registry, and many states did not have a registry until late in the 20th century. Even after registries were enacted by law, states often did not report comprehensive data on new cases for years.

All 50 states now have registries, and each reports data to the federal Centers for Disease Control and Prevention and National Cancer Institute. The Institute makes public incidence data for each U.S. county, but only for the most current five-year period (2016-2020). Georgia's Comprehensive Cancer Registry has county-specific data for each year from 2001 to 2020; however, none of the data are available on the Internet, and can only be accessed through special requests.

Table 10 provides cancer incidence data for Burke County (using data from the state registry) and the U.S. (using data from the CDC Wonder system from the Centers for Disease Control and Prevention). Five-year periods are used, starting with 2001-2005 and ending 2016-2020. Appendix 10 also has detailed data on this comparison.

Table 10
Cancer Incidence, Burke County GA vs. U.S.
By Five-Year Periods, 2001 to 2020

Period	Burke Co. Cases	% Burke Rate vs. U.S.
2001-2005	516	+ **3.8**
2006-2010	559	+ **1.2**
2011-2015	604	+ **2.9**
2016-2020	713	**+16.3**

For the first three five-year periods, Burke County's incidence rate for all cancers was just slightly above the U.S. (+3.8%, +1.2%, and +2.9%). However, the excess surged to +16.3% for the period 2016-2020, based on 713 newly-diagnosed cases. Excesses exist for non-Hispanic whites (+18.2%) and non-Hispanic blacks (+11.0%).

Incidence data is also available for single years. For 2018, 2019, and 2020, the Burke County rate exceeded the U.S. rate by 17.8%, 25.8%, and 26.0%. Just over 150 cases per

year were diagnosed in Burke County residents in that time. As of this writing, it appears that gap between county and national rates is widening over time.

Data on Burke County cancer incidence from 2016-2020 posted by the National Cancer Institute were also reviewed. Table 11 shows the difference in rates between the county and nation for various indicators (race, ethnicity, gender, age, and type of cancer) and provides Burke County ranking among 159 Georgia counties (1 being the county with the highest rate, 159 being the county with the lowest rate). Appendix 11 provides more detailed data.

Table 11
Cancer Incidence, Burke County GA vs. U.S.
By Selected Demographics, 2016-2020

Demographic	% Burke Rate vs. U.S.	Burke County Rank
White non-Hispanic	**+18.5**	**8**
Black non-Hispanic	**+11.2**	39
Males	**+29.8**	11
Females	**+ 5.7**	54
< Age 65	**+22.0**	19
Age 65+	**+12.6**	23
Lung/bronchus	**+50.9**	23
(F) Breast	**+12.4**	25
(M) Prostate	**+ 1.2**	96
Colorectal	**+77.0**	**4**

For each category, the Burke County rate exceeds the U.S. rate. Excesses are greatest for whites, males, and persons under age 65. Lung cancer and colorectal cancer are also particularly high. Some of these rates are among the 10th highest of all 159 Georgia counties. Excesses are statistically significant for whites, males, all ages, lung cancer, and colorectal cancer.

DISCUSSION

The Vogtle nuclear plant consists of two reactors that have operated since the late 1980s, and two more that are in the process of starting. Like all reactors, they produce large amounts of highly radioactive waste, some of which is stored, first in deep pools of water and eventually in steel and concrete casks. The lack of a permanent repository means that this waste will remain at Vogtle for many years, perhaps forever.

Some of the radioactivity produced by Vogtle is released into the environment, and can enter human bodies through breathing and the food chain. Data from the plant's owner are spotty, but provide evidence that releases and environmental levels of radioactivity are rising over time, posing a health risk to the local population.

No studies on changes in health to the local population near Vogtle have ever been conducted by health departments or academic researchers. This report seeks to update findings from a 2007 report on changes in local health status after the first two reactors began operating. Many of the analyses on changes in death rates used the periods 1968-1987 and 1988-2020, the 20 and 32 years before and after Vogtle startup.

Major findings were as follows (each indicates the percent that the Burke County rate does or doesn't exceed the U.S. rate):

1. All-cause mortality rose from +19.0% to +35.1% above the U.S.; 1,223 deaths were "excess."

2. All-cancer mortality rose from -7.1% to +13.0%; 303 deaths were "excess."

3. Infant mortality rose from +34.3% to +79.0%

4. Cancer incidence, which was roughly equal to the U.S. in the 15 years prior, rose to +16.3% above the nation in 2016-2020

For each of the above results, the pattern was consistent for all age groups, for both whites and blacks, for males and females, and for specific cancers and major causes of death. In many instances, the changes were statistically significant at $P < .05$.

Burke County is, and has always been, a socially and economically distressed area. Its rates of poverty, persons lacking health insurance, and adults lacking a college degree are much greater than U.S. rates. Moreover, it has a high proportion of minorities – nearly all African-Americans.

These factors may explain why county rates of disease and death are high, but it does not explain why these excesses are rising over time. Burke County's socioeconomic problems have not changed markedly since the late 1980s. A factor or factors other than socioeconomic issues is affecting these trends.

One of these potential factors is environmental contamination, which can take many forms. However, the startup of two large nuclear reactors in the late 1980s must be regarded as a major change to the area's environment. Routine releases of radioactive chemicals into the local air and water, which appear to be rising over time, can affect the risk of developing a disease such as cancer, or the risk of dying.

This elevated risk can be especially hazardous when coupled with other risk factors – a dynamic known as synergy. For example, numerous scientific studies show that coal miners and smokers are each at elevated risk for lung disease – and that coal miners who smoke are at far greater risk than those who mine coal or who smoke alone. In Burke County, combining socioeconomic factors with exposure to radioactivity may result in a synergy that raises health risk in the local population.

The data show that both whites and blacks were adversely affected. However, in the 20 years before Vogtle began operating, the death rate for Burke County blacks was just 2.8% above that for all U.S. blacks, but was 15.4% above the U.S. for whites. Thus, high death rates for Burke County blacks essentially only began after Vogtle began operating – unlike that of whites.

The introduction of two large reactors to Vogtle should be regarded as an additional health hazard to the local population. Because of the socioeconomic conditions in Burke County, it can also be seen as environmental injustice; and because of the high proportion of minorities, it can be seen as environmental racism. Future studies should address these critical issues, in the hope of making public policy changes that improve local health.

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Appendix 1
Trends in Environmental Radioactivity Levels Near Vogtle Nuclear Plant, 1987-2003

Type of Radioactivity	Annual Avg. 1987-1990	Annual Avg. 1991-2003	% Ch
Beta in Raw Drinking Water			
- Indicator (downriver)[1]	2.583	3.540	+ 37.1%
- Control (upriver)[2]	3.535	3.202	- 9.4%
Beta in Finished Drinking Water			
- Indicator (downriver)[1]	2.205	2.597	+ 17.8%
- Control (upriver)[2]	2.113	2.230	+ 5.6%
Beryllium-7 in Sediment			
- Indicator (at Vogtle)[3]	930.5	1297.8	+ 39.5%
- Control (off site)[4]	578.3	1229.8	+112.7%
Cobalt-60 in Sediment			
- Indicator (at Vogtle)[3]	51.33	138.3	+169.5%
Cesium-137 in Sediment			
- Indicator (at Vogtle)[3]	192.3	264.2	+ 37.4%
- Control (off site)[4]	137.8	112.5	- 18.3%
Tritium in River Water (average of six sites)	744.9	1077.3	+ 44.6%

1Beaufort/Jasper County Water Treatment Plant, Beaufort SC, 112 mi downriver, plus Cherokee Hill Water Treatment Plant, Port Wentworth SC, 122 mi. downriver.
2Augusta Water Treatment Plant, Augusta GA, 56 mi. upriver.
3 Savannah River, 0.8 mi. ENE of Vogtle plant.
4 Savannah River, 2.5 mi. N of Vogtle plant. Beta and tritium in picocuries per liter, others in picocuries per kilogram dry.
Source: Vogtle Electric Generating Plant Annual Radiological Environmental Operating Report for 2005, www.nrc.gov.

Appendix 2
Trends in Gaseous Releases of Tritium
Vogtle Nuclear Plant, by Year, 2008-2022 (in curies)

	Tritium Releases		
Year	Vogtle 1	Vogtle 2	Total
2008	15.17	6.72	21.89
2009	53.30	16.44	69.74
2010	19.34	16.35	35.69
2011	12.46	28.41	40.87
2012	46.64	23.87	70.51
2013	39.53	19.50	59.03
2014	40.64	32.37	73.03
2015	25.72	31.22	56.94
2016	60.22	11.81	72.03
2017	43.08	14.82	57.90
2018	83.53	35.00	118.53
2019	24.16	27.76	51.93
2020	44.30	42.53	86.83
2021	61.42	38.30	99.72
2022	32.10	75.00	107.10

Three-Year Totals:	
2008-2010	**127.32**
2011-2013	**170.41**
2014-2016	**202.00**
2017-2019	**228.36**
2020-2022	**293.65**

Source: U.S. Nuclear Regulatory Commission. Radioactive Effluent and Environmental Reports.
https://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html.

Appendix 3
ALL-CAUSE MORTALITY BY AGE, U.S. vs. Burke County GA
1968-1987 vs. 1988-2020, All Races Combined

	1968-1987		1988-2020		% Burke Rate vs. U.S.	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
<1	1974.1 (154)	1470.2	1267.3 (148)	708.0	+34.3	+ 79.0*
1-4	95.2 (28)	68.1	71.1 (34)	32.7	+39.8	+117.2
5-14	59.6 (48)	34.2	21.4 (26)	17.2	+74.1	+ 24.3
15-24	180.3 (127)	112.7	153.3 (160)	80.3	+59.9	+ 90.9
25-34	256.0 (124)	136.7	218.8 (204)	119.5	+87.2	+ 83.1
35-44	466.3 (173)	249.2	357.8 (342)	201.6	+87.1	+ 77.5
45-54	1104.5 (387)	621.5	665.2 (612)	426.4	+77.7	+ 56.0*
55-64	2263.1 (761)	1432.7	1501.2 (1153)	954.6	+58.0	+ 57.3
65-74	4248.4 (1152)	3117.9	3067.5 (1598)	2143.6	+36.3	+ 43.1
75-84	6470.2 (889)	6925.3	6648.6 (1837)	5199.0	- 6.6	+ 27.9*
85+	12166.3 (401)	16066.5	15754.2 (1482)	14452.5	- 24.3	+ 9.0*
TOT	1282.5 (4244)	1078.2	1099.3 (7596)	813.8	**+19.0**	**+ 35.1***
1-24	112.5 (203)	73.8	80.4 (220)	46.5	+52.4	+ 73.0*

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 4
ALL-CAUSE MORTALITY BY AGE, U.S. vs. Burke County GA
1968-1987 vs. 1988-2020, Whites

	1968-1987		1988-2020		% Burke Rate vs. U.S.	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
<1	842.3 (22)	1283.5	826.1 (37)	594.6	- 34.4	+ 38.8*
1-4	28.7 (3)	61.4	63.9 (12)	29.5	- 53.2	+116.6*
5-14	45.6 (13)	32.5	18.2 (9)	16.1	+40.1	+ 12.8
15-24	206.7 (55)	106.8	142.7 (62)	74.7	+93.5	+ 91.0
25-34	177.0 (43)	117.5	160.8 (74)	109.8	+50.5	+ 46.6
35-44	282.8 (59)	215.1	267.4 (133)	185.6	+31.5	+ 44.0
45-54	842.4 (163)	568.4	512.7 (258)	400.4	+48.2	+ 28.0
55-64	1923.3 (343)	1361.2	1333.5 (591)	915.0	+41.3	+ 45.7
65-74	3835.0 (476)	3039.2	2747.3 (839)	2107.4	+26.2	+ 30.4
75-84	6853.6 (462)	6941.1	6403.0 (1062)	5212.7	- 1.3	+ 22.8*
85+	16441.1 (243)	16368.3	17597.1 (870)	14708.8	+ 0.4	+ 19.6*
TOT	1215.44 (1882)	1052.79	1029.60 (3947)	802.46	**+15.4**	**+ 28.3***
1-24	93.0 (61)	69.8	74.3 (83)	43.2	+33.2	+ 72.0*

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 5
ALL-CAUSE MORTALITY BY AGE, U.S. vs. Burke County GA
1968-1987 vs. 1988-2020, Blacks

	1968-1987		1988-2020		% Burke Rate vs. U.S.	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
<1	2550.7 (132)	2511.8	1553.5 (111)	1335.5	+ 1.5	+16.3
1-4	132.3 (25)	106.7	76.5 (22)	50.9	+24.0	+50.1
5-14	67.3 (35)	44.7	23.8 (17)	24.2	+50.7	- 1.4
15-24	187.2 (82)	151.9	160.2 (97)	120.2	+23.2	+33.3
25-34	336.6 (81)	286.7	279.0 (130)	202.6	+17.4	+37.7
35-44	704.1 (114)	544.7	462.3 (209)	349.0	+29.3	+32.6
45-54	1436.2 (224)	1143.7	857.0 (352)	697.3	+25.6	+22.9
55-64	2652.5 (418)	2248.9	1759.1 (561)	1463.8	+17.9	+20.2
65-74	4578.9 (672)	4134.1	3652.4 (757)	2915.0	+10.8	+25.3*
75-84	6111.4 (427)	7039.2	7039.2 (771)	5931.1	- 13.2	+18.7*
85+	8690.9 (158)	13066.8	13789.2 (611)	13505.0	- 33.5	+ 2.1*
TOT	1374.7 (2368)	1337.3	1198.1 (3638)	1015.3	**+ 2.8**	**+18.0***
1-24	123.8 (142)	99.1	84.7 (136)	68.3	+24.9	+ 23.9

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 6
Mortality, U.S. vs. Burke County GA, All Races
By Most Common Causes of Death, 1999-2020

Cause	Burke Rate (Deaths)	U.S. Rate	% Burke rate vs. U.S.
All	1076.56 (5216)	775.31	**+38.6***
Circulatory Diseases	352.02 (1693)	254.38	**+38.4***
Neoplasms (Cancer)	208.06 (1058)	175.05	**+18.9***
Respiratory Diseases	104.10 (497)	74.27	**+40.2***
Acc/Sui/Hom	101.54 (493)	62.37	**+62.8***
Neurological Diseases	52.04 (234)	45.23	**+15.1**
End/Metab/Nutri	45.19 (224)	32.80	**+37.8***
Mental Diseases	37.76 (165)	31.35	**+20.4**
Digestive Diseases	36.90 (191)	28.56	**+29.2***
All Other	136.95 (661)	71.29	**+92.1***

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 7
NEOPLASM (CANCER) MORTALITY, U.S. vs. Burke County GA
By Age and Race, 1968-1987 vs. 1988-2020

All Races Combined

	1968-1987		1988-2020		% Burke Rate vs. US	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
0-24	4.25 (8)	5.92	3.50 (10)	3.37	- 28.2	+ 3.9
25-44	33.90 (29)	30.88	29.13 (55)	22.44	+ 9.8	+29.8
45-64	336.41 (231)	302.53	270.11 (456)	215.89	+11.2	+25.1
65+	826.69 (365)	1003.39	1105.11 (985)	1025.43	- 17.6	+ 7.8*
Total*	190.80 (633)	205.30	209.58 (1506)	185.43	**- 7.1**	**+13.0***

Whites

	1968-1987		1988-2020		% Burke Rate vs. US	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
0-24	4.40 (3)	6.04	3.44 (4)	3.42	- 27.1	+ 0.5
25-44	28.79 (13)	29.63	24.02 (23)	21.93	- 2.8	+ 9.6
45-64	311.96 (116)	292.73	257.83 (244)	212.95	+ 6.6	+21.1
65+	877.32 (181)	999.49	1067.81 (556)	1034.06	- 12.2	+ 3.3*
Total*	190.30 (313)	202.30	200.59 (827)	185.73	**- 5.9**	**+ 8.0***

Blacks

	1968-1987		1988-2020		% Burke Rate vs. US	
Age	Burke	U.S.	Burke	U.S.	1968-1987	1988-2020
0-24	4.17 (5)	5.54	3.58 (6)	3.42	- 24.7	+ 4.4
25-44	39.75 (16)	43.27	34.86 (32)	29.68	- 8.1	+17.4
45-64	366.76 (115)	420.49	289.18 (211)	283.44	- 12.8	+ 2.0
65+	783.61 (184)	1098.83	1165.58 (427)	1134.18	- 28.7	+ 2.8*
Total*	193.81 (320)	247.12	223.19 (676)	216.35	**- 21.6**	**+ 3.2***

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 8
NEOPLASM (CANCER) MORTALITY, U.S. vs. Burke County GA
By Gender, by Period, 1968-2020

Period	Burke Rate (Deaths)	U.S. Rate	% Burke Rate vs. U.S.
Males			
1968-1978	237.00 (175)	258.67	**- 8.4**
1979-1987	299.51 (189)	275.69	**+ 8.6**
1988-1998	317.90 (252)	273.05	**+16.4**
1999-2020	292.71 (618)	211.96	**+38.1***
Females			
1968-1978	142.99 (137)	165.76	**- 13.7**
1979-1987	142.55 (133)	171.62	**- 16.9**
1988-1998	162.28 (196)	175.70	**- 7.6**
1999-2020	151.38 (440)	149.12	**+ 1.5**

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 9
NEOPLASM (CANCER) MORTALITY, U.S. vs. Burke County GA
By Most Common Type of Cancer, 1999-2020

Type	Burke Rate (Deaths)	U.S. Rate	% Burke rate vs. U.S.
All	208.06 (1058)	175.05	**+18.9***
Lung/bronchus	55.10 (290)	45.32	**+21.6***
- Male	85.83 (191)	57.63	**+48.9***
- Female	33.31 (99)	36.04	**- 7.6**
(F) Breast	17.93 (52)	22.30	**- 19.6**
(M) Prostate	40.96 (75)	22.25	**+84.1***
Colorectal	22.63 (117)	15.77	**+43.5***
Pancreas	12.58 (65)	10.88	**+15.6**

Rates = deaths per 100,000 persons. Total rates are adjusted to 2000 U.S. standard population.
* = Increase significant at P < .05. Source: U.S. Centers for Disease Control and Prevention, https://wonder.cdc.gov.

Appendix 10
INCIDENCE, ALL CANCERS, U.S. vs. Burke County GA
By Race and Hispanic Origin, 2001-2020 (Five-Year Periods)

Period	Burke Rate (Cases)	U.S. Rate	% Burke Rate vs. U.S.
All Races and Ethnicities			
2001-2005	502.6 (516)	484.3	+ **3.8**
2006-2011	486.9 (559)	481.1	+ **1.2**
2011-2015	472.9 (604)	459.7	+ **2.9**
2016-2020	514.4 (713)	442.2	+**16.3***
2018	529.9 (146)	449.7	+**17.8**
2019	566.9 (160)	450.8	+**25.8**
2020	508.0 (146)	403.3	+**26.0**
White Non-Hispanic			
2001-2005	449.3 (338)	494.8	- **9.2**
2006-2012	501.3 (326)	494.3	+ **1.4**
2011-2015	458.3 (326)	475.9	- **3.7**
2016-2020	544.5 (406)	460.5	+**18.2***
Black Non-Hispanic			
2001-2005	511.0 (217)	507.0	+ **0.8**
2006-2013	472.1 (229)	504.2	- **6.4**
2011-2015	505.2 (272)	475.5	+ **6.2**
2016-2020	494.5 (295)	445.5	+**11.0**

Sources:
https://wonder.cdc.gov, cancer statistics (U.S. data). Georgia Comprehensive Cancer Registry, personal correspondence, January 30, 2024 (Burke County data).

Appendix 11
CANCER INCIDENCE, U.S. vs. Burke County GA
By Various Characteristics, 2016-2020

Characteristic	Burke Rate (Cases)	U.S. Rate	% Burke Rate vs. U.S.	Burke County Rank (of 159)
All	516.5 (715)	442.3	**+16.8***	**16**
Race/Hispanic Origin				
White non-Hispanic	547.2 (410)	461.9	**+18.5***	**8**
Black non-Hispanic	495.7 (295)	445.9	**+11.2**	39
Gender				
Males	623.9 (395)	480.6	**+29.8***	11
Females	440.3 (320)	416.4	+ **5.7**	54
Age at Diagnosis				
< Age 65	274.4 (335)	225.0	**+22.0***	19
Age 65+	2190.1 (380)	1944.4	**+12.6***	23
Most Common Types of Cancer				
Lung/bronchus	81.5 (120)	54.0	**+50.9***	23
(F) Breast	142.7 (105)	127.0	**+12.4**	25
(M) Prostate	111.8 (75)	110.5	+ **1.2**	96
Colorectal	64.6 (85)	36.5	**+77.0***	**4**

* = county rate significantly different than U.S. rate at p <.05

Source: National Cancer Institute, State Cancer Profiles. https://www.statecancerprofiles.cancer.gov/incidencerates/index.php