SECONDARY ANALYSIS OF DELAWARE'S CENSUS TRACTS WITH ELEVATED OVERALL CANCER RATES IN 2008-2012

(June 2016)

In June 2016, Delaware Health and Social Services, Division of Public Health (DPH) released its annual *Cancer Incidence and Mortality in Delaware (I&M) Report, 2008-2012.* In accordance with Delaware legislation, DPH calculated 2008-2012 overall cancer incidence rates for each of Delaware's census tracts and these results are included in the 2008-2012 I&M Report. This report summarizes the secondary analyses for the 14 census tracts with a significantly elevated all-site (i.e., overall) cancer incidence rate for the 2008-2012 period (New Castle County: 163.01, 163.02, 166.01; Kent County: 401.00, 417.01, 418.01, 422.02, 428.00, 430.00, 432.02; and Sussex County: 504.05, 504.08, 507.04, 508.03).

In Delaware, all-site cancer incidence rates measure the total cancer burden for an area over a five-year time period. Cancer incidence rates are calculated by dividing the total number of cancer cases in an area by the total number of people living in that area. Rates are age-adjusted to the 2000 U.S. standard population and expressed as the average annual number of new cases diagnosed per year per 100,000 people. Census 2000 and Census 2010 data were used to interpolate census tract population totals for intervening years 2001-2009. Data for 2011 and 2012 was extrapolated using the most recent Census 2010 data. Beginning with the 2010 Census, Delaware was divided into 214 census tracts. (Previously, Census 2000 had divided Delaware into 197 census tracts).

The 2008-2012 all-site cancer incidence rate for each of Delaware's 214 census tracts was compared to the overall cancer incidence rate for the entire state. DPH used standard statistical procedures to determine if the difference between each census tract rate and the state rate reached the threshold of statistical significance. If a census tract rate is significantly higher from the state rate, the difference between the rates is interpreted as "larger than would be expected by chance alone." If a census tract rate is significantly lower from the state rate, the difference is interpreted as "smaller than would be expected by chance alone." If a census tract rate is not significantly different from the state rate, the difference between the rates is interpreted as "not meaningfully different." Please refer to the 2008-2012 I&M Report for additional details pertaining to rate calculation methodology and testing for statistical significance.

There is an inherent instability in calculating cancer incidence rates at the census tract level. In a small group, such as a census tract, the snapshot changes considerably from year to year. If one case of cancer is diagnosed in a census tract one year, and three cases of cancer are diagnosed in the same census tract the next year, the cancer rate for that census tract will change dramatically from one year to the next. These large fluctuations do not typically occur in larger populations. If we compare the cancer rate for a census tract to the cancer rate for the whole state of Delaware for a given time period, it would not be unusual to find the comparison different (perhaps even reversed) in the following time period.

When assessing cancer incidence data by census tract, it should be kept in mind that the occurrence of cancer may differ across census tracts for a variety of reasons. For example, lifestyle behaviors may cluster in a homogeneous community. In addition, the presence or absence of exposure to environmental or occupational carcinogen(s) is often limited to a defined geographic area. In addition, residents in certain geographic areas may be more impoverished than other residents. This may affect their access to health care, including cancer screening services. Finally, chance or random variation can also influence whether a census tract's all-site cancer incidence rate is significantly different from the overall state rate. Statistically-speaking, 5 percent of all numerical comparisons are significantly different due to chance alone.

Results for 2008-2012 show that:

- In 14 of Delaware's 214 census tracts, the 2008-2012 all-site cancer incidence rates were statistically significantly higher than Delaware's 2008-2012 all-site cancer incidence rate (503.9 per 100,000).
- In 14 census tracts, the 2008-2012 all-site cancer incidence rates were significantly lower than Delaware's 2008-2012 incidence rate (503.9 per 100,000).

Secondary Analysis of Elevated Census Tracts for 2008-2012

DPH analyzed cancer data within each of the 14 elevated census tracts to determine unique patterns which could suggest an environmental, occupational, or other unusual cause. DPH conducted the following analyses on census tracts with an elevated overall cancer incidence:

- Sex distribution
- Age at diagnosis
- Types of cancers elevated
- Cancer sites with substantiated environmental risk factors

Sex Distribution of Cases for 2008-2012

To determine if the elevated overall cancer rate in a census tract affected males and females differently, age-adjusted overall cancer incidence rates were calculated separately by sex for each of the 14 elevated census tracts. Male- and female-specific rates for each census tract were compared to those at the state level. The 14 census tracts fell into one of the following four categories compared to the state of Delaware:

- 14 census tracts (100 percent) had significantly elevated all-site cancer incidence rates for both males and females combined.
- Seven census tracts (43 percent) had a significantly elevated all-site cancer incidence rate for males only.
- Three census tracts (21 percent) had a significantly elevated overall cancer incidence rate for females only.
- Seven census tracts (50 percent) did not have a significantly elevated all-site cancer incidence rate for either males or females. Rather, minor (i.e.; not statistically significant) elevations in male and female cancer rates produced a significantly elevated overall cancer rate for both sexes combined.

Age at Diagnosis of Cases for 2008-2012

The median age of diagnosis for all cancer cases diagnosed during 2008-2012 in Delaware was 66. Therefore, half of all Delawareans diagnosed with cancer during this time period were younger than 66 years; the other half were older than 66 years. The median age of cancer cases in each census tract was compared to the median age of cancer cases at the state level for the same time period. A younger median age at diagnosis in the census tract could suggest a unique exposure, such as from the environment or an occupation. Of the 14 census tracts analyzed:

- Six census tracts (43 percent) had a lower median age of diagnosis (range: 62-65 years) compared to the state's median age at diagnosis (66 years).
- Four census tracts (29 percent) had a median age at diagnosis identical to the state's median age at diagnosis (66 years).
- Four census tract (29 percent) had a higher median age at diagnosis (67-71 years) compared to the state's median age at diagnosis (66 years).

Significantly-Elevated Site-Specific Cancer Types for 2008-2012

Cancer is a generic term used to describe more than 100 different diseases. Fourteen of Delaware's 214 census tracts had a significantly elevated all-site cancer incidence rate for 2008-2012. It is important to note that these census tracts were not elevated for every individual cancer type. To investigate specific patterns of cancer diagnoses within the 14 census tracts with elevated all-site cancer incidence rates, DPH calculated incidence rates for the 24 most commonly-diagnosed cancers. These analyses helped to determine which cancers, if any, contributed to the higher-than-expected overall cancer rate. Results for the 14 census tracts are as follows:

- Two census tracts (14 percent) did not have any cancer type that was significantly elevated.
- Four census tracts (29 percent) had one cancer type that was significantly elevated.
- Three census tracts (21 percent) had two cancer types that were significantly elevated.
- Three census tracts (21 percent) had three cancer types that were significantly elevated.
- One census tract (7 percent) had four cancer types that were significantly elevated.
- One census tract (7 percent) had five cancer types that were significantly elevated.

The higher-than-expected cancer incidence rates among the 14 elevated census tracts were confined to 15 cancer types (Table 1, below). Note that the frequencies in Table 1 total 28 because eight of the 14 census tracts under review were significantly elevated for more than one cancer type.

Table 1. Number of Occurrences of Significantly-Elevated Site-Specific Cancer Types within the Nine Delaware Census Tracts with Elevated All-Site Cancer Incidence Rates, 2008-2012

Site-Specific Cancer Type	Number of Occurrences of Significantly Elevated Site-Specific Cancer Type
Lung	5
Colorectal	4
Prostate	3
Bladder	2
Kidney	2
Melanoma	2
Thyroid	2
Brain	1
Esophagus	1
Hodgkin lymphoma	1
Larynx	1
Liver	1
Non-Hodgkin lymphoma	1
Stomach	1
Testis	1
TOTAL	28

SOURCE: Delaware Cancer Registry, Delaware Health and Social Services, Division of Public Health, 2015.

When a census tract has an elevated rate for a cancer type with many risk factors, it is difficult to pinpoint any single causal factor. Rather, the elevated cancer rate is likely due to a mix of non-modifiable, modifiable, and/or unidentified risk factors. For example, the American Cancer Society cites 19 substantiated risk factors for breast cancer alone: 12 of these risk factors are non-modifiable (e.g., age, family history), and the remaining seven are modifiable (e.g., lack of exercise, being overweight/obese). The

impact of other potential breast cancer risk factors is still under scientific review. Adding to the complexity is that the interaction of several risk factors may increase a person's cancer risk more than the sum of the individual risk factors acting separately. For example, research shows that while alcohol use and tobacco use are both individual risk factors for laryngeal cancer, their joint effect is greater than the sum of the two risk factors acting separately (i.e., when they occur together, the two risk factors exert a multiplicative, rather than additive, effect).[1]

Site-Specific Cancer Types with Environmentally-Based Risk Factors

The Delaware Cancer Consortium has identified seven cancer types with substantiated environmental risk factors:

a. Brain/Central Nervous System (CNS) cancer
b. Hodgkin lymphoma
c. Leukemia
d. Liver cancer
e. Non Hodgkin lymphoma
f. Thyroid cancer
g. Urinary bladder cancer

It is important to note that while these seven malignancies have been known to be associated with environmental risk factors, they may also be related to modifiable risk factors. For example, in addition to chemical exposures in the manufacturing of dyes, rubber, and leather, tobacco use is the primary risk factor for bladder cancer.

Among the 14 census tracts, results related to these seven cancer types are as follows:

- Two census tracts (14 percent) had significantly elevated rates for **two** of the seven cancer types with substantiated environmental risk factors.
- Four census tracts (29 percent) had a significantly elevated rate for **one** of the seven cancer types with substantiated environmental risk factors.
- Eight census tracts (57 percent) did not have a significantly elevated rate for any of the seven cancer types with substantiated environmental risk factors.

Of the seven cancers with environmentally-suspected causes:

- Brain cancer was significantly elevated among males in census tract 504.08.
- Hodgkin lymphoma was significantly elevated in males in census tract 430.00.
- Liver cancer was significantly elevated among females in census tract 163.01.
- Non-Hodgkin lymphoma was significantly elevated in females in census tract 430.00.
- Thyroid cancer was significantly elevated in females in census tract 504.05 and significantly-elevated in females and in the overall population in census tract 401.00.
- Urinary bladder cancer was significantly elevated in the overall population in census tracts 401.00 and 507.04

While some of the elevated cancer types in these census tracts were those with environmental risk factors, some other cancer types without these risk factors were also significantly higher compared to the state average. These may simply be statistical aberrations resulting from the very small number of cancer cases in these communities, or, especially when combined with unusual sex and age distributions, there may be

[1] Pelucchi, C., Gallus, S., Garavello, W., Bosettie, C., & La Vecchia, C. (2008). Alcohol and tobacco use, and cancer risk for upper aerodigestive tract and liver. *European Journal of Cancer Prevention, 17*(4), 340-4.

underlying occupational or environmental causes. Further investigation of these concerns cannot be conducted with data routinely collected by DPH.

Table 2 summarizes results of the secondary analyses for the nine census tracts that were significantly elevated for all-site cancer for the 2008-2012 time period. Table 3 summarizes substantiated risk factors for the 14 different site-specific cancers with significantly-elevated incidence rates among the nine census tracts under review. Table 4 displays census tracts that are consistently elevated over two or more of the seven five-year time periods from 2001-2005 through 2008-2012.

TABLE 2. CHARACTERISTICS OF THE 14 DELAWARE CENSUS TRACTS WITH STATISTICALLY SIGNIFICANTLY ELEVATED 2008-2012 ALL-SITE CANCER INCIDENCE RATES

Census Tract (County)	Avg. Cases / year	Overall Age-Adjusted Cancer Incidence Rates per 100,000, 2008–2012**			Significantly Elevated Cancer Site(s) by Sex	Median Age at Diagnosis		Area(s) of Concern
						DE	CT	
		All	Male	Female				
Delaware	5,260	503.9	580.7	447.2				
163.01 (NCC)	34	**629.0**	692.7	**584.1**	• Liver: female only	66	64	• Prevention • Screening • Sex distribution
163.02 (NCC)	36	**604.2**	729.9	487.2	• Lung: male and female combined	66	62	• Prevention • Screening
166.01 (NCC)	64	**581.2**	674.9	517.4	• Melanoma: male only, male and female combined	66	66	• Prevention • Screening
401.00 (Kent)	46	**831.2**	**950.5**	**719.0**	• Bladder: male and female combined • Colorectal: male only, male and female combined • Esophagus: male only, male and female combined • Lung: male only, male and female combined • Thyroid: female only, male and female combined	66	65	• Prevention • Screening • Cancer type • Sex distribution
417.01 (Kent)	44	**831.2**	**950.5**	**719.0**	• None	66	68	• Prevention • Screening
418.01 (Kent)	64	**632.5**	**762.5**	521.5	• Larynx: male only, male and female combined • Lung: male only, male and female combined • Prostate	66	64	• Prevention • Screening • Sex distribution • Cancer type
422.02 (Kent)	54	**599.8**	686.1	528.0	• Kidney: female only, male and female combined • Prostate	66	65	• Prevention • Screening • Cancer type
428.00 (Kent)	53	**691.8**	**779.2**	**613.1**	• Colorectal: male and female combined • Kidney: female only, male and female combined	66	66	• Prevention • Screening • Cancer type • Sex distribution
430.00 (Kent)	36	**617.9**	686.9	547.8	• Hodgkin lymphoma: male only • Lung: male only, male and female combined • Non-Hodgkin lymphoma: female only	66	63	• Prevention • Screening • Cancer type

TABLE 2. CHARACTERISTICS OF THE 14 DELAWARE CENSUS TRACTS WITH STATISTICALLY SIGNIFICANTLY ELEVATED 2008-2012 ALL-SITE CANCER INCIDENCE RATES, cont.

Census Tract (County)	Avg. Cases / year	Overall Age-Adjusted Cancer Incidence Rates per 100,000, 2008–2012**			Significantly Elevated Cancer Site(s) by Sex	Median Age at Diagnosis		Area(s) of Concern
						DE	CT	
		All	Male	Female				
432.02 (Sussex)	30	**642.7**	**729.0**	518.3	• None			• Prevention • Screening • Sex distribution
504.05 (Sussex)	31	**615.7**	**782.9**	510.7	• Lung: male only • Prostate • Testis • Thyroid: female only	66	71	• Prevention • Screening • Sex distribution • Cancer type
504.08 (Sussex)	34	**627.0**	**764.1**	506.9	• Brain: male only • Colorectal: male and female combined • Stomach: male and female combined	66	66	• Prevention • Screening • Sex distribution • Cancer type
507.04 (Sussex)	41	**612.8**	658.3	561.5	• Bladder: male and female combined • Colorectal: female only, male and female combined	66	70	• Prevention • Screening • Cancer type
508.03 (Sussex)	62	**587.5**	639.3	543.7	• Melanoma: female only, male and female combined	66	67	• Prevention • Screening

** Age-adjusted incidence rate in bold indicates that the census tract rate is significantly elevated compared to the state rate.
Note: NCC=New Castle County; CT=Census Tract
Rates are per 100,000 and age-adjusted to 2000 U.S. standard population
SOURCE: Delaware Cancer Registry, Delaware Health and Social Services, Division of Public Health, 2015.

TABLE 3. KNOWN RISK FACTORS OF ELEVATED CANCER TYPES AMONG THE 14 DELAWARE CENSUS TRACTS WITH SIGNIFICANTLY ELEVATED ALL-SITE CANCER INCIDENCE RATES, 2008-2012**

CANCER TYPE	KNOWN RISK FACTORS
BLADDER	Age (risk increases with age), arsenic in drinking water, bladder birth defects, chronic bladder irritation and infections, gender (more common in males), not drinking enough fluids, personal history of bladder or other urothelial cancer, prior chemotherapy, race and ethnicity, smoking
BRAIN	Family history (rare), genetic disorders (neurofibromatosis type 1, neurofibromatosis type 2), immune system disorders, radiation exposure
COLORECTAL	Age (50 and older), alcohol abuse, diabetes (type 2), family history, high-fat diet, history of bowel disease, overweight or obesity, physical inactivity, smoking (cigarettes, cigars, or pipes)
ESOPHAGUS	Age (risk increases with age), alcohol, Barrett's esophagus (reflux of stomach acid into the lower esophagus over a long period of time), gender (males are three times more at risk than females), gastroesophageal reflux disease, history of other cancers, HPV, injury to esophagus, obesity, tobacco, workplace exposures to chemical fumes
HODGKIN LYMPHOMA	Age (early adulthood (15-40 years) and later adulthood (after age 55), family history, gender (male), HIV infection, previous occurrence of infectious mononucleosis (caused by the Epstein-Barr virus)
KIDNEY	Advanced kidney disease with long-term dialysis, cigar or cigarette smoking, family history, gender (male), hypertension, certain medications, overweight or obesity, workplace exposures
LARYNX	Alcohol abuse, diet, gastroesophageal reflux disease, gender (male), genetic syndromes, human papilloma virus, poor nutrition, secondhand smoke, smoking (cigarettes, cigars, or pipes), workplace exposure
LIVER	Alcohol use, anabolic steroid use, diabetes (type 2) gender (male), hepatitis B or C (chronic infection), liver cirrhosis, obesity, previous exposure to certain chemicals (including arsenic and vinyl chloride), race (especially Asian Americans and Pacific Islanders), tobacco use
LUNG	Asbestos, diet low in fruits and vegetables, family history, radiation therapy, radon exposure, secondhand smoke, smoking (cigarettes, cigars, or pipes), tuberculosis, workplace exposures
MELANOMA	Age (risk increases with age), fair skin, freckling and light hair, family history of melanoma, gender (males are more at risk), moles on the skin, personal history of melanoma, UV exposure, weakened immune system, Xeroderma pigmentosa (rare inherited condition that affects skin cells' ability to repair damage to their DNA
NON-HODGKIN LYMPHOMA	Age (60 and older), certain autoimmune disorders (e.g., rheumatoid arthritis, lupus), chronic immune stimulation (e.g., H. pylori, hepatitis C), gender (male), immune system deficiency, overweight or obesity, previous exposure to radiation and certain chemicals (including benzene and certain herbicides and insecticides), race (Caucasian)
PROSTATE	Age (50 and older), diet high in red meat and high-fat dairy, ethnicity (non-Hispanic), family history, gene mutations, inherited DNA changes, obesity, race (African American)

TABLE 3. KNOWN RISK FACTORS OF ELEVATED CANCER TYPES AMONG THE 14 DELAWARE CENSUS TRACTS WITH SIGNIFICANTLY ELEVATED ALL-SITE CANCER INCIDENCE RATES, 2008-2012, cont.**

CANCER TYPE	KNOWN RISK FACTORS
STOMACH	Age (risk increases with age), Common variable immune deficiency, diet (consumption of smoked foods), Epstein-Barr virus infection, ethnicity (Hispanics, African Americans, Asian/Pacific Islanders are at higher risk), family history of stomach cancer, gender (males at higher risk), geography (more common in Japan, China, and Southern and Eastern Europe), *H. pylori* infection, Menetrier disease (excess growth of stomach lining), inherited cancer syndromes, overweight or obese, pernicious anemia, previous stomach surgery, some types of stomach polyps, tobacco, Type A blood, work in the coal, metal and rubber industries
TESTIS	Age (younger males at higher risk), cancer in the other testicle, carcinoma in situ, family history, HIV infection, race/ethnicity (higher in Caucasians), undescended testicle
THYROID	Age (younger females and older males at increased risk), diet low in iodine, family history, hereditary conditions, radiation

**Cancer-specific risk factors are listed in descending alphabetical order and do not necessarily represent descending order of relative risk factor strength.

SOURCES: American Cancer Society (www.cancer.org) and National Cancer Institute (www.cancer.gov).

TABLE 4. CONSISTENTLY-ELEVATED ALL-SITE CANCER INCIDENCE RATES BY DELAWARE CENSUS TRACTS, BY COUNTY AND TIME PERIOD, DELAWARE: 2001-2005 TO 2008-2012**

COUNTY	CENSUS TRACT	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009	2006-2010	2007-2011	2008-2012
KENT	417.01					X	X		X
	421.00				X	X	X		
	428.00		X		X	X	X	X	X
NEW CASTLE	6.02	X	X	X	X				
	139.01	X	X	X	X				
	149.06	X	X						
	156.00			X	X	X			
	159.00					X	X		
	160.00	X	X	X					
	163.01					X	X	X	X
	169.01	X	X	X					
	169.04	X	X	X					
SUSSEX	501.05			X	X	X			
	506.02	X	X						
	513.02	X	X	X	X				
	513.05	X	X						
	517.01			X	X		X		

**Two or more adjacent time periods with a significantly elevated overall cancer incidence rate.
SOURCE: Delaware Cancer Registry, Delaware Health and Social Services, Delaware Division of Public Health, 2015.

For questions or comments related to any information found in this report, please call the Delaware Comprehensive Cancer Control Program at 302-744-1020.

This report as well as the full *2008-2012 Delaware Cancer Incidence and Mortality Report* can be found at the following link: http://www.dhss.delaware.gov/dhss/dph/dpc/cancer.html