Southeast El Paso County Perfluorinated Chemicals Preliminary Assessment of Cancer and Birth Outcomes

This is a summary of a preliminary assessment of cancer and birth outcomes in Southeast El Paso County areas where perfluorinated compounds have been detected in groundwater and public drinking water source wells.

Background

Perfluorinated compounds (PFCs) are a family of human-made substances that do not occur naturally in the environment. They have been used for decades as an ingredient to make products that resist heat, oil, stains, grease and water. They also are used in various products including firefighting foams, coating additives, and surface protection products for carpets and clothing. The main way people come into contact with PFCs is through food and personal care products. In fact, human contact with PFCs is widespread, and nearly all people have measureable levels of PFCs in their blood.

When large amounts of PFCs are released into the environment, they can enter rivers and underground aquifers that may be used as drinking water sources. In 2013 and 2014, the U.S. Environmental Protection Agency collected samples from public water systems across the country as part of their Unregulated Contaminant Monitoring Rule (UMCR). This is a routine program that aims to gather data on the occurrence of unregulated substances in drinking water. Results of this testing indicated that 94 drinking water systems across the U.S. had detectable levels of PFCs in their water.

Through this national monitoring program, perfluorinated compounds (PFCs) were found in water supply sources near Security, Widefield and Fountain. The extent of the area where PFCs were detected is shown in Figure 1. The specific PFCs that were identified included:
- PFBS (Perfluorobutanesulfonic acid)
- PFHpA (Perfluoroheptanoic acid)
- PFHxS (Perfluorohexane sulfonic acid)
- PFOA (Perfluorooctanoic acid)
- PFOS (Perfluorooctansulfonic acid)

PFC Health Effects

If you are exposed to PFCs, whether or not you may experience health effects depends on how much PFC you are exposed to; how long you are exposed; and personal factors including age, lifestyle and how healthy you are.

Overall, we don't know a lot about the health effects of PFCs. We know the most about PFOA and PFOS. Some human studies show that increased exposure to PFOA and PFOS might increase the risk for certain health problems such as increases in blood cholesterol, liver enzymes, and uric acid levels, which may be linked with an increased risk of heart disease, liver disease or high blood pressure. Other studies show a possible link – but not a cause-and-effect relationship – between levels of PFOA and PFOS in the blood and low birth weight, thyroid disease, some immune system effects, kidney cancer and testicular cancer.

There is very limited scientific information on the health effects of other PFCs, such as PFHxS, PFBS and PFHpA. While it is possible that these other PFCs may have health effects

similar to PFOA and PFOS, there is not enough scientific information to be sure at this time. There is also not enough scientific information to evaluate the health effects of mixtures of PFCs at this time.
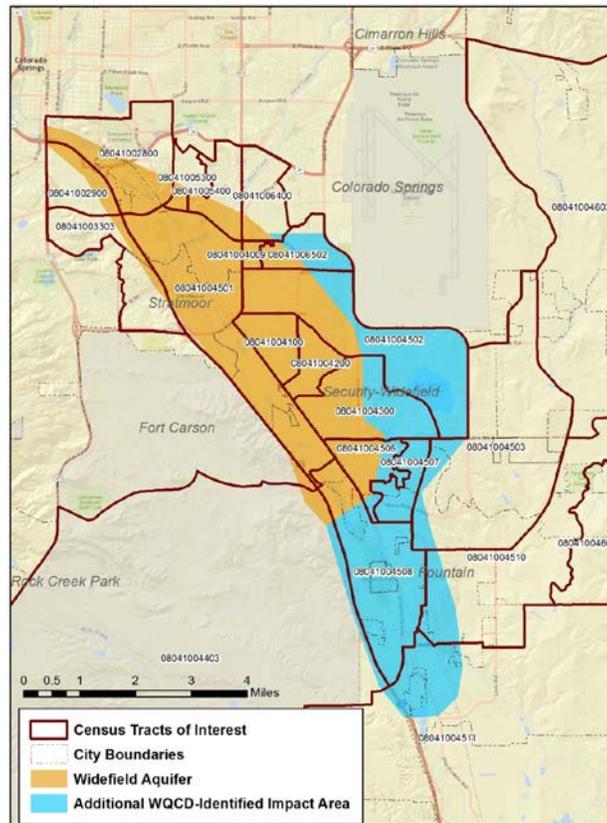

Figure 1 – Potential extent of PFC detection (PFC Area)

Summary of Current Assessment

Based on anticipated public concerns regarding health effects that have been associated with PFCs such as cancer and low birth weight, CDPHE conducted preliminary analyses to determine whether there has been a measureable change in these health outcomes in the areas where PFCs have been detected. Full details of these analyses are presented in Appendices A and B.

Low Birth Weight

For low birth weight analyses, all single births from mothers living the PFC Area were compared to births from mothers living in the Non-PFC Area for 2010-2014 (Table 1). There was no significant difference in the percentage of low weight births in the PFC Area (8.1%) compared to the Non-PFC Area (7.6%).

Table 1 – Low birth weight

	Low Weight Birth	All Births	% All Births – low weight	95% Confidence Interval
El Paso County	3,331	43,072	7.7%	7.4 - 8.0 %
Non-PFC Area	2,521	33,083	7.6%	7.3 - 7.9 %
PFC Area	810	9,989	8.1%	7.6 - 8.6 %

Cancer

For cancer analyses, the number of cancers diagnosed in the study area from 2000-2014 was compared to a "typical" or "expected" number of cancer cases using data routinely collected by the Colorado Cancer Registry. The full report contains analyses for 11 types of cancer (Appendix B). This summary reports on two of the cancer types that have been associated with exposure to PFCs (kidney and testicular).

Table 2 – Number of cancer diagnoses compared to the expected number in PFC Area, 2000-2014 – Males and Females

Type of Cancer	Cancers Diagnosed	Cancers Expected	Diagnosed/ Expected	95% C.I. for Ratio
Kidney (includes renal & pelvis)	195	167.283	1.17[*]	(1.01-1.34)
Testes	53	52.148	1.02	(0.76-1.33)

*Ratio is statistically significant at p=0.05 level

There was a statistically higher than expected number of kidney cancers in the PFC area. However, based on the analysis, we believe the majority of this increase may be explained by higher rates of smoking and obesity in the PFC area compared to the non-PFC area. Smoking is a strong risk factor for kidney cancer. Of the diagnosed cancer cases in the PFC area, 54% of kidney cancer cases had a known history of tobacco use and an additional 12% of kidney cancer cases had an unknown smoking history. Obesity is also a strong risk factor for kidney cancer. All of the census tracts in the PFC area have a higher than average rate of obesity. Our analysis indicated that higher percentages of the risk of kidney cancer in the PFC area could be attributed to smoking (40% vs. 24%) and obesity (32% vs. 20%) as compared to the non-PFC area.

Overall Findings

- There was no significant difference in the percentage of low weight births in areas of El Paso County potentially impacted by PFCs compared to the rest of El Paso County.
- While there was a statistically higher than expected number of kidney cancers in areas of El Paso County potentially impacted by PFCs compared to the rest of El Paso County, there were also higher rates of smoking and obesity in the study area, which are known to be substantial contributors to the risk of kidney cancer.
- CDPHE will continue to monitor birth and cancer outcomes over time in the areas of El Paso County potentially impacted by PFCs.

Appendix A
Perfluorinated Compounds and Low Birth Weight

In a study looking at 5,262 pregnancy outcomes of women exposed prenatally to perfluorooctane sulfonate (PFOS), the authors found a weak association with preeclampsia and low birth weight.(Stein et.al., 2009). Several other studies have also indicated similar exposure outcomes to PFOS and low birth weight. (Verner et.al., 2015).

- Low birth weight is defined as a baby born weighing less than 5 pounds, 8 ounces (2500 grams). Approximately 1 in every 12 babies in the United States is born with low birth weight. In 2014 the number of babies born in the United States weighing less than 2500 grams was 318,847 translating into 8% of all births.(Centers for Disease Control and Prevention-CDC)

- There are two main reasons why a baby may be born with low birth weight: premature birth and fetal growth restriction also known as small for gestational age. Certain infections that the mother may have been exposed to prenatally that may cause fetal growth restriction are cytomegalovirus, rubella, chicken pox and toxoplasmosis.

- Other maternal risk factors are chronic health conditions that may lead to low birth weight include high blood pressure, diabetes and heart, lung and kidney problems. Smoking , drinking and use of illicit and/or prescription drugs may also lead to a newborn's low birth weight.

- Pregnant women who smoke are two times as likely to have a low birth weight baby as women who do not smoke. Smoking, drinking alcohol, using street drugs and abusing prescription drugs during pregnancy can also slow a baby's growth in the womb and increase the risk for premature birth and birth defects.

- Finally, other risk factors for having a low-birth weight baby are age and race/ethnicity. Women who are younger than 17 years of age or older than 35 years of age are more likely than other women to have a low-birth weight baby. In the United States, black women are more likely than others to have a low-birth weight baby. As for other races/ethnicities in this country, 8.4 percent of Asian babies, 7.6 percent of Native American babies, and about 7 percent of Hispanic and white babies are born with low birth weight. It is not known what role race/ethnicity contributes to low birth weight in newborns. (March of Dimes-MOD)

Based on these findings we selected El Paso County as our referent geographic area and compared the number of singleton live births over a 5 –year period (2010-2014) to the study area live births-- with low birth weight as the outcome of interest.

The study area consisted of 21 census tracts in the Security, Widefield and Fountain water systems where PFCs were detected.

Security-Widefield, Colorado Area Census Tracts and WQCD Identified Areas of Interest
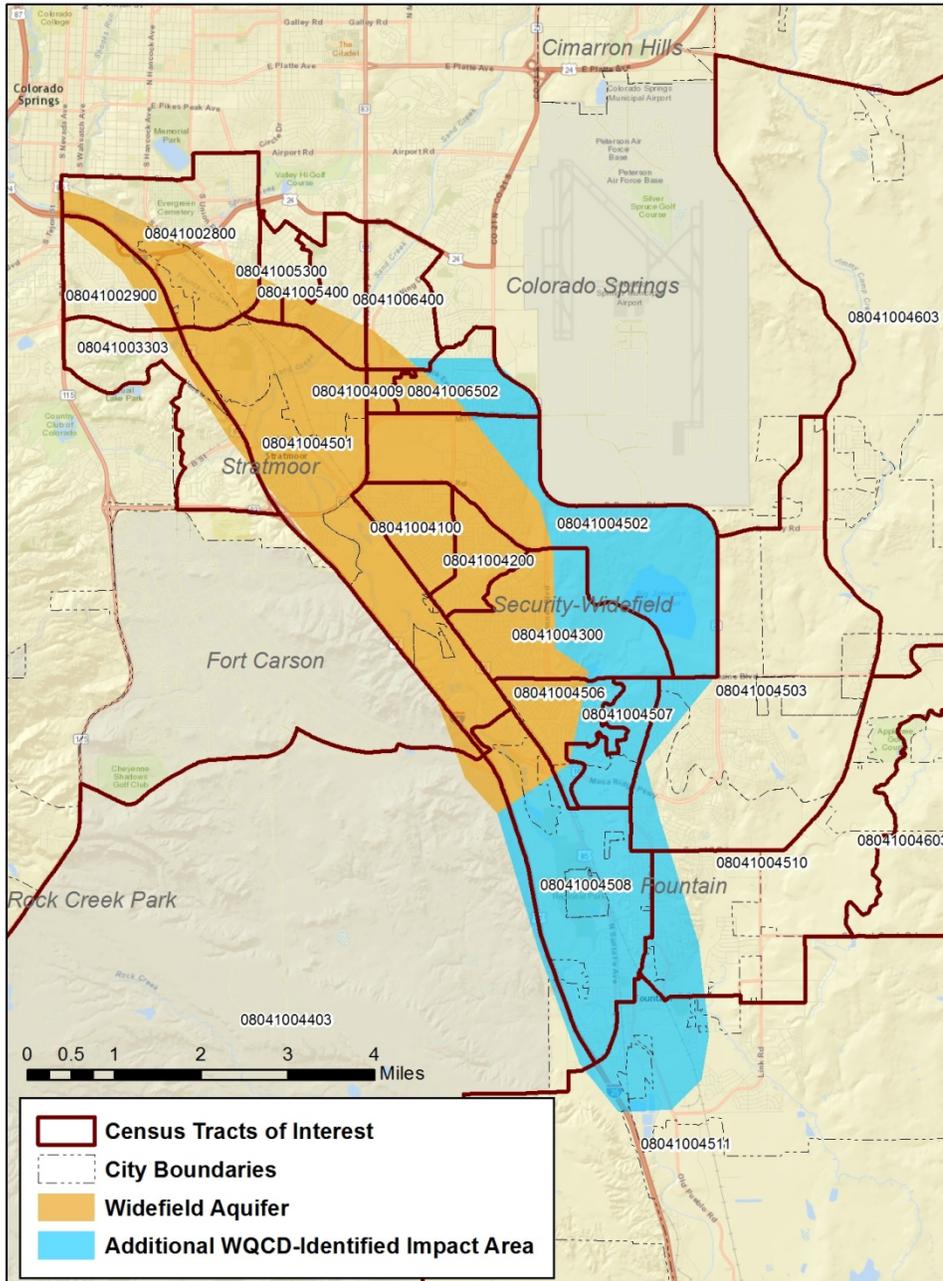
The remainder of El Paso County was included as the referent area.

5-YR Crude Low Birth Weight Rate (Singleton LWB/All Singleton births) by Census Tract (2010-2014)

	Low Weight Birth	All Births	% All Births – low weight	95% Confidence Interval
El Paso County	3331	43,072	7.7%	7.4 - 8.0 %
Referent	2521	33,083	7.6%	7.3 - 7.9 %
Study Area	810	9,989	8.1%	7.6 - 8.6 %

*Results generated from the Colorado Birth Dataset, Center for Health and Environmental Data

The above table compares the 5-Year (2010-2014) rate of singleton low weight births among all singleton births for the study area, referent area, and El Paso County. In the study area which included 21 census tracts there were 810 low weight births out of 9,989 total births (8.1%). In the referent area which included the portion of El Paso County not included in the study area there were 2,521 low weight births out of 33,083 total births (7.6%). In El Paso County overall there were 3,331 low weight births out of 43,072 total births (7.7%). The confidence intervals calculated for each of these   rates overlap, demonstrating that there is not a statistical difference between the rates. Therefore the 5-year low birth weight rate for the study area is not higher than the referent rate or county rate calculated for the same time period.

References
1. Centers for Disease Control and Prevention (CDC). National Center for Health Statistics- FastStats , 2016.
2. March of Dimes (MOD). Low Birth Weight, October 2014.
3. Stein, C.R., Savitz, D.A. , Dougan,M. Serum Levels of Perfluorooctanoic Acid and Perfluorooctane Sulfonate and Pregnancy Outcome, *American Journal of Epidemiology*, June 2009.
4. Verner, Marc-Andre et.al., Associations of Perfluoroalkyl Substances (PFAS) with Lower Birth Weight: An Evaluation of Potential Confounding by Glomerular Filtration Rate Using a Physiologically Based Pharmacokinetic Model (PBPK), *Environmental Health Perspectives. Volume* 123/ *number* 12/, December 2015.

APPENDIX B
ANALYSIS OF DIAGNOSED VS. EXPECTED CANCER CASES
IN SOUTHEAST EL PASO COUNTY , 2000-14

INTRODUCTION

This document reports findings of cancer incidence statistics for 2000-2014 for communities in the vicinity of water wells tested for perfluorinated chemicals located in southeast El Paso County, Colorado.

Cancer is a general term applied to a wide variety of different diseases characterized by uncontrolled growth and spread of abnormal cells. These diseases are common within the population, and therefore remain at the forefront of public health concern. Over 20,000 new cases of cancer are registered annually in Colorado, and Coloradans have, on average, an individual lifetime risk of developing cancer of approximately one chance in three. Whether an individual develops a cancer during his or her lifetime may be greatly influenced by a variety of factors, many of which are not currently understood. We do know that the development of cancer is a complex, multistage, process involving both external (e.g. chemical, radiation, and viruses) and internal factors (e.g., hormonal, immune conditions, and inherited mutations). Unfortunately, this complexity and its associated latencies, that is, the time period between the initiation of the cancer and subsequent diagnosis, have limited scientific efforts to identify causative factors or combinations of factors. We may, however, monitor incidence rates so as to be alert to significant deviation from the expected background rates. This in turn allows investigation of deviations with respect to potential environmental associations.

METHODS

In Colorado, surveillance of cancer incidence is possible using data collected by the Colorado Central Cancer Registry (CCCR) at CDPHE. All cancers diagnosed in Colorado are reported to the Cancer Registry with the exception of non-melanoma skin cancers. The registry is mandated by Colorado law and by Colorado Board of Health regulation. Information is collected from all Colorado hospitals, pathology labs, outpatient clinics, physicians solely responsible for diagnosis and treatment, and state Vital Statistics. Pertinent data is registered on all malignant tumors, except basal and squamous cell carcinomas of the skin. All individual patient, physician, and hospital information is confidential as required by Colorado law. This invaluable data allows the CCCR to effectively answer questions about cancer incidence in communities statewide. In this particular case, the CCCR was used to assess the incidence of cancer in the vicinity of water wells tested for PFOS and PFOA in southeast El Paso County.

The study design used was an analysis of the number of cancers diagnosed in the study area compared to a "typical," or expected, number of cancer cases, using data routinely collected by the cancer registry. The CCCR has maintained an incidence-based registry of all cancer cases reported at medical facilities in most parts of the state since the mid-1980s; complete state reporting has been available since 1988.

Data from incidence-based registries provide several benefits compared to mortality-based data. Because incidence-based registries identify each case at the time a diagnosis of cancer is reported, rather than at the time of death, a more complete count of cancers that have occurred, regardless of survival, is available. Incidence data will not be affected by differences in survival across cancer types and sites, whereas mortality data are susceptible to bias from differences in treatment and access to health care. In addition, medical records used to compile incidence-based registry statistics typically have more detailed information on cancer diagnoses (e.g., pathology reports, etc.) than is collected on death certificates, which are used to compile mortality statistics.

The epidemiological study design used in this analysis of diagnosed and expected numbers of cancer cases is descriptive and ecological. The descriptive element provides a numerical summary of disease frequency, whereas the ecological component examines entire communities or populations, rather than individuals. Ecological studies have been conducted frequently in communities adjacent to potential environmental exposures, since they are efficient and can be completed within a reasonable period of time. Ecological studies are usually viewed as exploratory and may generate hypotheses to be considered in additional studies, if appropriate. A weakness inherent in such studies is that information on potential causes of disease, other than the one under investigation (for example, lifestyle behaviors, occupation, or genetic predisposition) is lacking or limited.

Another weakness of ecological studies is that, because potential exposure is not actually measured over time for each individual, a geographical area of residence is used as a substitute measure of exposure. The use of a geographical area raises the likelihood of exposure misclassification, which reduces the ability of the study to observe a statistically significant difference between groups. Lastly, the design of this cancer incidence analysis does not allow conclusions to be made about causal association between exposure and any single cancer or group of cancers. The study design and results only aid in determining whether the total number of cancers or certain types of cancers are greater or less than expected, and whether that difference is statistically significant, and whether future studies would be useful.

Choice of Study Area and Population Estimates
As part of this present investigation, cancer diagnosis counts were compared to expected counts for an area in the vicinity of water wells tested for perfluorinated chemicals for the time period of 2000-2014 when cancer reporting was complete and the 2000 and 2010 Census years of population could be used. The boundaries of this area were selected for this analysis based on U.S. Census designations combining census tract and block group information. The study area had a population of 91,204 in 2000 and 111,231 in 2010. The study area was defined by census geography; it includes all of census tracts 28.00, 29.00, 33.03, 40.09, 41.00, 42.00, 43.00, 45.01, 45.02, 45.03, 45.06, 45.07, 45.08, 45.09 (45.10 and 45.11 from 2010 Census), 53.00, 54.00, 64.00, and 65.02, plus block group 2 from census tract 46.03 using 2010 Census boundaries.

This analysis examined all diagnosed malignancies combined, as well as cases of 11 individual types of cancer: liver, lung, kidney and renal pelvis, bladder, non-Hodgkin lymphoma, testes, prostate, pancreas, thyroid, female breast, and ovary. All cases of cancer diagnosed between

2000 and 2014 that were residents in the study area at the time of diagnosis were identified. Data for an analysis of this type is obtained from the Colorado Central Cancer Registry. The address at the time of diagnosis for each case was used to assign residence within the census boundaries.

Identification and registration of cancer cases by the Cancer Registry involves standard processes including searching hospital medical charts, pathology laboratory records, and examining death certificate information.

U.S. Census counts of population by age, race/ethnicity, and gender for 2000 and 2010 were obtained from the Colorado Division of Local Government (State Demographers Office) or from the U.S. Census website, www.census.gov.

Calculation of Diagnosed-to-Expected Ratios
Cancer rates from El Paso County (excluding the study area) over this time period were used as standards for calculating expected numbers of cancers for the study area because complete age-specific rates by race/ethnicity and gender were available from the CCCR. The El Paso County area provides a large population base to generate reliable cancer rates and serves as a local standard of comparison, which is preferable to using a statewide or national standard since these areas may be less likely to reflect local background cancer rates.

Cancer rates from the Cancer Registry for men and women of comparable race/ethnic groups and ages were used to calculate the expected number of cancers for the study area. A cancer rate is the number of new cancer cases diagnosed per 100,000 population per year. The population in the study area, stratified by age, gender, and race/ethnicity, was multiplied by the cancer rate for each age, gender, and race/ethnic group in the comparison population to produce the expected number of cancers. This method assures that any differences found are not due to differences in demographic composition. For example, census tracts with a higher proportion of elderly individuals would be expected to have higher cancer rates since incidence of most cancers increases dramatically with increasing age.

A diagnosed-to-expected ratio is then calculated by dividing the number of cancers diagnosed in the area by the number of expected cases. If the ratio is greater than 1, then more cancer cases than expected were reported in the area. When this occurs, the next step is to look more closely at that relationship. It is important to know if that ratio could have been higher by chance alone, so a confidence interval is calculated for the ratio. The confidence interval has a lower number (minimum value) and a higher number (maximum value). It is common to use a 95 percent confidence interval which means that we are 95 percent sure that the true ratio is within the range between the lower and higher values. If the ratio is greater than 1 but the confidence interval includes the number 1, then the ratio is within expected statistical limits. If the confidence interval does not include the number 1, then the ratio is statistically significant. A statistically significant elevated ratio means that there were more diagnosed cases than expected and that there is less than a 5 percent chance that this greater number is due to chance alone.

Because the estimate of expected cancers is based on the larger El Paso County population, this estimate will be a central tendency, or average number, of expected cases for the time

period, 2000-14. Cancer rates for specific populations, such as in smaller cities, towns, or neighborhoods, will likely be either higher or lower than the "average expected." Smaller populations tend to show greater variability. The variability of small populations is statistically reflected in the 95 percent confidence interval for the ratio of diagnosed to expected cases. Confidence intervals for small populations are wider than for large populations. When the expected number of cancer cases is small, slight increases can result in seemingly large diagnosed to expected ratios. For example, if only one case of cancer is expected in a small population in a given year, and two were actually diagnosed, the ratio would of course show a doubling of cases. But, in this situation, twice the number of expected cases would be within expected statistical limits. Statistical testing was not done on ratios with less than three diagnosed cases because of the inherent variability in such small numbers.

When statistically significant elevations of diagnosed-to-expected ratios were observed, other data recorded in the Cancer Registry abstract were also reviewed. These data help to characterize potential exposure commonalities among the cases, including the presence of important known risk factors for certain cancers, and separating selected anatomical categories of cancer into cell types. The case abstract data reviewed included occupation, smoking history, obesity and cell type.

Population Attributable Risk Percent
For lung, bladder and kidney cancers, calculations were performed to estimate the population attributable risk percent (PAR%) due to smoking in both the study and comparison areas for the 2012-14 time period for persons age 18+. For kidney cancers the PAR% due to obesity was also calculated for the same time period for those age 18+. The PAR% is defined as the percent of the incidence of a particular cancer in the population due to a particular risk factor, like smoking or obesity. The PAR% is calculated by subtracting the cancer incidence in the unexposed population from the cancer incidence in the whole population (both exposed and unexposed), then dividing by the cancer incidence in the whole population.

Cancer-case smokers were defined as ever-smoked (current plus former) from Cancer Registry records. Smokers in the population at large were defined as ever-smoked from the Behavioral Risk Factor Surveillance System (BRFSS) during 2012-14 by counting current smokers from census tract-level and county-level survey data and counting former smokers estimated from El Paso County overall. Cancer cases with missing smoking data were excluded from these PAR% calculations.

Cancer cases from the Cancer Registry with obesity were defined as those with a body mass index (BMI) of 30 or greater. Similarly, data from the BRFSS for the population at large during 2012-14 defined obesity as persons with a BMI of 30 or greater. Cancer cases with missing BMI data were excluded from these PAR% calculations.

FINDINGS

Tables 1, 2, and 3 display the number of diagnosed cancers in the study area by cancer type and gender for 2000-2014,compared to the number that would be expected based on the population of male and female residents in the area by race/ethnicity and age. Table 4 displays additional detail for kidney and renal pelvis cancer cases. Table 5 displays additional detail for bladder cancer cases. Cancer rates from the Cancer Registry for men and women of comparable race/ethnic groups and ages were used to calculate the expected number of cancers for the study area. The ratios of diagnosed to expected cases along with the 95 percent confidence intervals for these ratios provide information about the relative rate of cancer in the study area.

All Cancers Combined. – Table 1 shows that the overall number of 6,229 cancers diagnosed among males and females combined in the study area during 2000-2014 was higher than the 6,020 cancers expected (ratio of diagnosed to expected cancers of 1.04, which was statistically higher than expected).   Excluding lung cancer, all other cancers combined were within expected statistical variation, 5,378 cases compared to 5,507 cases expected for an observed to expected ratio of 0.98.   Lung cancer for males and females combined was statistically higher than expected, 851 cases compared to about 512 cases expected for an observed to expected ratio of 1.66. Kidney and renal pelvis cancer for males and females combined was also statistically higher than expected with 195 cases compared to about 167 cases expected for an observed to expected ratio of 1.17. See Table 4 for further detail on the kidney and renal pelvis cancer findings. Bladder cancer for males and females combined was likewise statistically higher than expected with 282 cases compared to about 210 cases expected for an observed to expected ratios of 1.34. See Table 5 for further detail on the bladder cancer findings.

Table 1 – Number of Cancer Diagnoses Compared to the Expected Number in Study Area, 2000-2014 – Males and Females				
	Cancers Diagnosed	Cancers Expected	Diagnosed / Expected	95% C.I. for Ratio
All Cancers	6229	6019.531	1.04[**]	(1.01-1.06)
All Cancers excl. lung cancer	5378	5507.373	0.98	(0.95-1.00)
Pancreas	143	136.910	1.04	(0.88-1.23)
Liver	100	84.194	1.19	(0.97-1.45)
Lung	851	512.158	1.66[**]	(1.55-1.78)
Kidney & Renal Pelvis	195	167.283	1.17[*]	(1.01-1.34)
Bladder	282	210.015	1.34[**]	(1.19-1.51)
Thyroid	243	230.263	1.06	(0.93-1.20)
Non-Hodgkin Lymphoma	210	223.703	0.94	(0.82-1.08)
Female Breast	973	1091.173	0.89[**]	(0.84-0.95)
Ovary	88	85.806	1.03	(0.82-1.26)
Testes	53	52.148	1.02	(0.76-1.33)
Prostate	742	836.944	0.89[**]	(0.82-0.95)

Note: Diagnosed/Expected ratios that have a 95% Confidence Interval that brackets the value 1.00 are not considered statistically high or low.
[*] Ratio is statistically significant at p=0.05 level. ([**] p=0.01 level)
NC = not calculated due to less than 3 diagnoses (see text for explanation).

Male Cancers. Table 2 shows that the overall number of cancers diagnosed among males in the study area during 2000-2014 was statistically higher than the expected number calculated. There were 3,047 cancers diagnosed among males compared to about 2,842 cancers expected, for a ratio of 1.07. Excluding lung cancer, all other cancers combined were within expected statistical variation, 2,575 cases compared to 2,586 cases expected for an observed to expected ratio of 1.00. Lung cancer for males was statistically higher than expected, 472 cases compared to about 256 cases expected for an observed to expected ratio of 1.84. Bladder cancer for males was also statistically higher than expected with 212 cases compared to about 151 cases expected for an observed to expected ratio of 1.41. See Table 5 for further detail on the bladder cancer findings.

Table 2– Number of Cancer Diagnoses Compared to the Expected Number in Study Area, 2000-2014 – Males				
	Cancers Diagnosed	Cancers Expected	Diagnosed / Expected	95% C.I. for Ratio
All Cancers	3047	2842.241	1.07**	(1.04-1.11)
All Cancers excl. lung cancer	2575	2585.884	1.00	(0.96-1.03)
Pancreas	75	63.396	1.18	(0.93-1.48)
Liver	71	57.206	1.24	(0.97-1.57)
Lung	472	256.357	1.84**	(1.68-2.01)
Kidney & Renal Pelvis	119	105.169	1.13	(0.94-1.36)
Bladder	212	150.842	1.41**	(1.22-1.61)
Thyroid	47	54.789	0.86	(0.63-1.14)
Non-Hodgkin Lymphoma	106	117.616	0.90	(0.74-1.09)
Testes	53	52.148	1.02	(0.76-1.33)
Prostate	742	836.944	0.89**	(0.82-0.95)

Note: Diagnosed/Expected ratios that have a 95% Confidence Interval that brackets the value 1.00 are not considered statistically high or low.
*Ratio is statistically significant at p=0.05 level. (** p=0.01 level)
NC = not calculated due to less than 3 diagnoses (see text for explanation).

COLORADO
Department of Public
Health & Environment

Female Cancers. Table 3 shows that the overall number of cancers diagnosed among females in the study area during 2000-2014 was not statistically higher than the expected number calculated. There were 3,182 cancers diagnosed among females compared to about 3,177 cancers expected, for a ratio of 1.00. Lung cancer for females was statistically higher than expected with 379 cases compared to about 256 cases expected for an observed to expected ratio of 1.48.

Table 3 – Number of Cancer Diagnoses Compared to the Expected Number in Study Area, 2000-2014 –Females				
	Cancers Diagnosed	Cancers Expected	Diagnosed / Expected	95% C.I. for Ratio
All Cancers	3182	3177.290	1.00	(0.97-1.04)
All Cancers excl. lung cancer	2803	2921.489	0.96	(0.92-1.00)
Pancreas	68	73.514	0.93	(0.72-1.17)
Liver	29	26.988	1.08	(0.72-1.54)
Lung	379	255.801	1.48[**]	(1.34-1.64)
Kidney & Renal Pelvis	76	62.114	1.22	(0.97-1.53)
Bladder	70	59.173	1.18	(0.92-1.50)
Thyroid	196	175.474	1.12	(0.97-1.28)
Non-Hodgkin Lymphoma	104	106.087	0.98	(0.80-1.19)
Female Breast	973	1091.173	0.89[**]	(0.84-0.95)
Ovary	88	85.806	1.03	(0.82-1.26)

Note: Diagnosed/Expected ratios that have a 95% Confidence Interval that brackets the value 1.00 are not considered statistically high or low.
[*]Ratio is statistically significant at p=0.05 level. ([**] p=0.01 level)
NC = not calculated due to less than 3 diagnoses (see text for explanation).

Kidney and Renal Pelvis Cancers. Table 4 examines the number of kidney and renal pelvis cancers diagnosed by race/ethnicity and age. Ratios of diagnosed to expected cases were not statistically elevated for Hispanics and blacks. The ratios for kidney cancers in non-Hispanic whites of 1.22, and other races of 2.37, were statistically high. Kidney cancers among the 65-74 age group (ratio of 1.45) were also statistically higher than expected.

Race/ Ethnicity	Cancers Diagnosed	Cancers Expected	Ratio of Diagnosed to Expected	95% C.I. for Ratio
White Non-Hispanic	140	115.202	1.22[*]	(1.02-1.43)
Hispanic	25	28.487	0.88	(0.57-1.29)
Black	21	19.790	1.06	(0.65-1.62)
Other	9	3.802	2.37[*]	(1.09-4.49)
Age				
0-4	3	1.847	1.62	(0.33-4.75)
25-34	1	3.087	NC	NC
35-44	9	13.935	0.65	(0.30-1.23)
45-54	42	31.982	1.31	(0.95-1.78)
55-64	44	40.556	1.09	(0.79-1.46)
65-74	57	39.322	1.45[**]	(1.10-1.88)
75+	39	35.216	1.11	(0.79-1.51)
Total	195	167.283	1.17[*]	(1.01-1.34)

Table 4 – Number of Kidney and Renal Pelvis Cancer Diagnoses by Race/Ethnicity and by Age Compared to the Expected Number in Study Area, 2000-2014 – Males and Females

Note: Diagnosed/Expected ratios that have a 95% Confidence Interval that brackets the value 1.00 are not considered statistically high or low.
[*]Ratio is statistically significant at p=0.05 level. ([**] p=0.01 level)
NC = not calculated due to less than 3 diagnoses (see text for explanation).

Additional assessments of male and female kidney cancer cases using Cancer Registry data included: (1) a variety of occupations with no particular pattern; (2) of the 195 kidney cancer cases, 106 cases (54%) had a history of using tobacco, which is a risk factor for kidney cancer, and including only cases with known smoking status, there were 106 cases out of 171 cases (62%) with a history of tobacco use; (3) the distribution of cell types among the 195 kidney

cancers was similar to the remainder of El Paso County kidney cancers over this time period with adenocarcinomas (renal cell carcinomas and other adenocarcinomas) accounting for 85% of cases in the study area and 84% of kidney cancer cases in El Paso County.

Obesity has also been linked with kidney cancers and all of the census tracts in the study area population were found to be either in the 3rd or highest quartile among census tracts in Colorado for obesity according to 2012-14 Behavioral Risk Factor Surveillance Survey (BRFSS) data published by CDPHE. From CCCR data, for the 2011-14 time period, when height and weight data have been collected, 47% of kidney cancer cases were obese in the study area. This percentage compares to about 20% of the general population in Colorado and about one-third of the U.S. population being obese according to the CDPHE (Health Watch No. 98: Disparities in the Prevalence of Adult Overweight and Obesity by Demographic Characteristics—Colorado BRFSS, 2011-2014).

Etiologic Features of Kidney Cancer
Current epidemiological literature indicates that the incidence of kidney cancer represents approximately 2-3% of new cancers each year. Men are affected twice as often as women, and the average age at diagnosis is sixty years (Greenlee, 2000). Risk factors that have been proved or implicated in the causes of kidney cancer include smoking, obesity, analgesic abuse, and certain occupational exposures to agents such as cadmium. Approximately one per cent of kidney cancers cluster in families. Also, there are studies that show that individuals, who smoke, whether they are men or women, have an increased risk of kidney cancer. (La Vecchia, 1990; Talamini, 1990; Yuan, 1998).

Bladder Cancers. Table 5 examines the number of kidney and renal pelvis cancers diagnosed by race/ethnicity and age. Ratios of diagnosed to expected cases were not statistically elevated for Hispanics and blacks. The ratios for kidney cancers in non-Hispanic whites of 1.22, and other races of 2.37, were statistically high. Kidney cancers among the 65-74 age group (ratio of 1.45) were also statistically higher than expected.

Table 5 – Number of Bladder Cancer Diagnoses by Race/Ethnicity and by Age Compared to the Expected Number in Study Area, 2000-2014 – Males and Females				
Race/ Ethnicity	Cancers Diagnosed	Cancers Expected	Ratio of Diagnosed to Expected	95% C.I. for Ratio
White Non-Hispanic	247	163.657	1.51**	(1.33-1.71)
Hispanic	16	21.978	0.73	(0.42-1.18)
Black	13	15.437	0.84	(0.45-1.44)
Other	6	11.884	0.51	(0.18-1.10)
Age				
25-34	1	0.817	NC	NC
35-44	7	6.376	1.10	(0.44-2.26)
45-54	23	18.026	1.28	(0.81-1.92)
55-64	57	40.067	1.42*	(1.08-1.84)
65-74	97	62.092	1.56**	(1.27-1.91)
75+	97	82.636	1.17	(0.95-1.43)
Total	282	210.015	1.34**	(1.19-1.51)

Note: Diagnosed/Expected ratios that have a 95% Confidence Interval that brackets the value 1.00 are not considered statistically high or low.
*Ratio is statistically significant at p=0.05 level. (** p=0.01 level)
NC = not calculated due to less than 3 diagnoses (see text for explanation).

Additional assessments of male and female bladder cancer cases using Cancer Registry data included: (1) a variety of occupations with no particular pattern; (2) of the 282 bladder cancer cases, 169 cases (60%) had a history of using tobacco, which is a risk factor for bladder cancer, and including only cases with known smoking status, there were 169 cases out of 219 cases (77%) with a history of tobacco use; (3) the distribution of cell types among the 282 bladder cancers was similar to the remainder of El Paso County bladder cancers over this time period with transitional cell carcinomas accounting for 92% of bladder cancer cases in the

study area and 92% of bladder cancer cases in El Paso County.

With smoking being such an important risk factor for bladder cancer, nearly 80% of the census tracts in the study area population were found to be either in the 3rd or highest quartile among census tracts in Colorado for smoking according to 2012-14 Behavioral Risk Factor Surveillance Survey (BRFSS) data published by CDPHE.

Etiologic Features of Bladder Cancer
According to the American Cancer Society, smoking is the most important risk factor for bladder cancer. Smokers are at least 3 times as likely to get bladder cancer as nonsmokers. Smoking causes about half of all bladder cancers in both men and women.

Population Attributable Risk Percent Due to Smoking and Obesity
As smoking is a strong risk factor for lung, bladder, and kidney cancers, analyses were performed to determine the population attributable risk percent (PAR%) for these cancers due to smoking. PAR% is the percent of the incidence of a specific type of cancer in the population due to a particular risk factor like smoking. This analysis is limited to 2012-2014 data as census tract estimates of smoking rates are not available for other years. Increases in PAR% in the study area compared to the standard area may indicate a higher incidence of smoking related cancer rather than that attributed to other potential exposures. Conversely, a lower PAR% in the study area compared to the standard area may indicate a larger contribution of other exposures.

Table 6 – Population Attributable Risk Percent Due to Smoking (2012-2014 data only)– Males and Females		
Cancer Type	Study Area	Standard Area
Lung	95%	79%
Bladder	52%	54%
Kidney	40%	24%

As obesity is a strong risk factor for kidney cancers, analyses were performed to determine the PAR% for kidney cancers due to obesity. The PAR% for kidney cancer due to obesity in the study area was 32% and 20% in the standard area

DISCUSSION AND CONCLUSIONS

Statistical Analysis
Overall cancer cases diagnosed in the study area for 2000-2014 for males and females combined, and for males alone, were statistically higher than expected counts based on El Paso County cancer rates with diagnosed to expected ratios of 1.04 and 1.07, respectively. However, when lung cancers were excluded, all other cancers combined were within expected statistical variation for males and females combined and for males alone. Lung, kidney and bladder cancers were statistically elevated in the study area. Lung cancers were

about 66% higher, kidney cancers were about 17% higher, and bladder cancers were about 34% higher than expected based on El Paso County rates. Each of these cancers has been linked to smoking, according to the epidemiological literature, and in the study area over 80% of lung cancer cases (82%), and over half of kidney cancer cases (54%) and bladder cancer cases (60%) had a history of tobacco use. Obesity has also been linked with kidney cancers. All of the census tracts in the study area population were found to be either in the 3rd or highest quartile for obesity and 80% of census tracts in the study area were found to be either in the 3rd or highest quartile for current smoking according to 2012-14 Behavioral Risk Factor Surveillance Survey (BRFSS) data published by CDPHE. CCCR data also show a high percentage of persons diagnosed with kidney cancer in the study area to be obese (47% during 2011-14), which compares to about 20% of Coloradans being obese.

Further analyses, using only 2012-2014 data, suggested a higher population attributable risk percent due to smoking for lung and kidney cancer in the study area as compared to the standard area. The population attributable risk percent due to smoking for bladder cancer was similar in the study and standard areas. The population attributable risk percent due to obesity for kidney cancer was higher in the study area as compared to the standard area.

There is inadequate information available on risk factors for individual cases and drinking water exposures to make definitive causal associations between drinking water exposures and increases in kidney and bladder cancer. However, available data suggest possible causes other than drinking water exposure including:

- Higher smoking rates and higher population attributable risk percentages due to smoking in the study area suggest an increased contribution of smoking to lung and kidney cancer in the study area.
- Higher obesity rates and a higher population attributable risk percent due to obesity in the study area suggest an increased contribution of obesity to kidney cancer in the study area.

REFERENCES

Bailar JC, Ederer F. Significance Factors for the Ratio of a Poisson Variable to its Expectation. Biometrics 20(3): 639-643, 1964.

Health Watch No. 98: Disparities in the Prevalence of Adult Overweight and Obesity by Demographic Characteristics—Colorado BRFSS, 2011-2014.

Kaelin, Mark A. and Bayona, Manuel. Attributable Risk Applications in Epidemiology. College Entrance Examination Board, **www.collegeboard.com/prod_downloads/yes/4297_MODULE_17.pdf** 2004.