
A multi-disciplinary team

# New Mexico Cancer Concerns Work Group Assessment

work group response to a
cancer concern request
submitted by

## Corrales Residents for Clean Air and Water

September 2019

A product of the
**New Mexico Cancer Concerns Work Group**
New Mexico Department of Health
New Mexico Tumor Registry
https://nmtracking.org/health/cancer/CancerConcernsWorkgroup.html

## New Mexico Cancer Concerns Work Group

*A multi-disciplinary team*


Our team responds to concerns about cancers among specified groups with a coordinated response from New Mexico Department of Health and the New Mexico Tumor Registry.

**Assessment for Corrales Residents for Clean Air and Water – September 2019**
**C O N F I D E N T I A L**

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# SECTION 1: INTRODUCTION

This assessment was prepared by the New Mexico Cancer Concerns Work Group (CCW) in response to a request from Corrales Residents for Clean Air and Water (CRCAW). CRCAW members expressed concern that an excess number of cancer cases diagnosed in their community may have resulted from exposure to emissions from the Intel manufacturing plant in Sandoval County, adjacent to the Village of Corrales. Together, CRCAW and CCW members identified 12 specific types of cancer that are the focus of this assessment.

The primary purpose of this assessment is to document the number of cancer cases that were diagnosed among residents of the geographic area of interest (hereafter referred to as the investigation area) during the time period 2006-2015. The investigation area (see Section 3.1) included 14 census tracts that were selected based on their proximity to the Intel manufacturing plant. The time period of study (2006-2015) was chosen because it represents the most recent 10-year period for which the New Mexico Tumor Registry has complete surveillance data.

The secondary purpose of this assessment is to determine whether the number of cancer cases observed among residents in the investigation area differed from what would have been expected based on prevailing statewide cancer rates during the study period.

# SECTION 2: GENERAL BACKGROUND

Cancer is a leading cause of illness and death in New Mexico and in the United States. In 2019, an estimated 9,460 new cases of cancer will be diagnosed and approximately 3,720 deaths from cancer will occur among New Mexican residents [1]. According to the New Mexico Department of Health, cancer is the leading cause of death for American Indians and Hispanics in New Mexico, and the second leading cause of death for Whites [2].

The term cancer is used to refer to many different diseases that share common characteristics or hallmarks, such as uncontrolled cell growth and the ability to spread throughout the body [3]. Although different types of cancer may share some characteristics, research has shown that the causes of cancer often vary from one type of cancer to another [4]. For example, tobacco use is highly associated with several types of cancer, including that of the lung. However, many types of cancers are unrelated to tobacco use. In preparing and interpreting an assessment such as this, it is a common and best practice to examine individual types of cancer in addition to assessing the burden of all types of cancer combined.

Results from previous studies have shown that cancer incidence rates differ by race/ethnicity in New Mexico [5, 6]. Whites have the highest incidence rates for most types of cancer and their rates are similar to Whites nationwide. With some exceptions, Hispanics and American Indians have lower rates of cancer than Whites in New Mexico. Nonetheless, cancer is a leading cause of illness and death for all racial/ethnic groups in New Mexico.

Because cancer incidence and mortality rates vary by race/ethnicity, it is important to consider the racial/ethnic composition of a specified geographic area within the state when assessing the cancer burden in that area.

# SECTION 3: METHODS

## 3.1 Geographic Area and Population

The Intel Corporation operates a large manufacturing plant in Rio Rancho, New Mexico. This investigation was undertaken to address concerns that emissions from this facility may have influenced the rates of cancer among individuals who reside in close proximity to that plant. In collaboration with representatives of CRCAW, the CCW identified 14 census tracts that served as the investigation area for this analysis. The investigation census tracts are adjacent to or in close proximity to the Intel manufacturing plant. Two of the investigation census tracts in Sandoval County, 0106.01 and 0106.02, encompass the Village of Corrales. The 14 investigation census tracts are listed in Table 1, along with estimates of the respective resident population for each tract in calendar year 2015. Maps of the investigation area are shown in Appendix 1.

**Table 1**
**Fourteen Census Tracts in the Investigation Area of Concern**

| New Mexico County | Census Tract (2010 US Decennial Census*) | 2015 Estimated Population |
|---|---|---|
| **Sandoval** | **0106.01** | **4,483** |
| | **0106.02** | **4,158** |
| | **0107.05** | **6,254** |
| | **0107.14** | **4,936** |
| | **0107.15** | **3,736** |
| | **0107.16** | **6,099** |
| | **0107.19** | **4,085** |
| | **0107.20** | **8,105** |
| **Bernalillo** | **0036.00** | **6,225** |
| | **0047.16** | **2,063** |
| | **0047.17** | **7,798** |
| | **0047.23** | **7,410** |
| | **0047.52** | **3,852** |
| | **0047.53** | **3,656** |
| **TOTAL** | **N/A** | **72,860** |

** Census tract boundary definitions are from the 2010 US Decennial Census*
*** Population estimates were obtained from the* New Mexico Indicator-Based Information System (available on-line from the following URL: https://ibis.health.state.nm.us/) and are derived from US Census Bureau figures.

In this assessment, results are reported for a combined area that includes each of the fourteen census tracts listed in Table 1.

### 3.2 Cancer Cases

The number and type of cancer cases diagnosed among residents of the investigation area were obtained from existing records of the New Mexico Tumor Registry (NMTR). The NMTR is a population-based cancer registry that was established in 1966 and is a founding member of the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program. Cancer is a reportable disease in New Mexico and the New Mexico Department of Health (NMDOH) has identified the NMTR as its designee for collecting, maintaining and utilizing cancer surveillance data on behalf of the NMDOH. Cancer registrars at the NMTR and at local health care facilities throughout the state identify and collect information on all incident cancer cases that are diagnosed among New Mexico residents through systematic review of medical records, pathology reports, death certificates, and other relevant sources of information. The NMTR conducts these activities in accordance with standards set by the National Cancer Institute and the North American Association of Central Cancer Registries.

This assessment focused on cancer cases that were diagnosed during the time period from January 1, 2006 through December 31, 2015, which represents the most recent ten-year period of complete surveillance data. Analyses were conducted for each of the following twelve types of cancer that were jointly identified by representatives of CRCAW and CCW: 1) colorectal; 2) liver; 3) lung and bronchus; 4) female breast; 5) prostate; 6) testicular; 7) kidney and renal pelvis; 8) brain; 9) non-Hodgkin lymphoma; 10) myeloma; 11) lymphocytic leukemia; and 12) myeloid and monocytic leukemia. We also evaluated a category that contained all types of cancers combined (which includes all types of cancer, not just the 12 individual types of cancer that are the focus of this assessment). The definition of each cancer category was based on combinations of cancer primary anatomic site and histology codes from the International Classification of Diseases or Oncology-Third Edition [7] that are consistent with categories commonly used by the National Cancer Institute's SEER Program (Appendix 2) [8]. A primary cancer is defined as the original anatomic site where the cancer began; primary cancers are not cancers that have spread (metastasized) from other sites.

### 3.3 Observed-to-Expected Ratios

The **Observed-to-Expected (O/E) ratio** compares the number of cases that were observed among residents of the investigation area to the number of cases that were expected to occur in that area during the study period. The components of the O/E ratio, as well as methods for calculating and interpreting the O/E ratio, are described in the following paragraphs.

**Observed Number of Cases**: For the purposes of this assessment, the observed number of cases was the actual number of cancer cases that were diagnosed among residents of the investigation area during the ten-year study period, 2006-2015. The observed number of cases for the assessment were obtained from the New Mexico Tumor Registry (see Section 3.2).

**Expected Number of Cases:** We calculated the number of cases for each type of cancer that would be expected to occur in a population of the same size and with the same demographic characteristics of the investigation area. The expected number of cases was calculated by applying statewide race/ethnic and age-specific cancer incidence rates to the corresponding population estimates for the investigation area over the ten-year study period.

**O/E Ratio:** The O/E ratio was calculated by dividing the observed number of cases for each type of cancer by the expected number of cases for that same cancer. The O/E ratios may be broadly interpreted as follows. If the investigation area experienced the same rate of cancer as the comparison statewide rate, then the observed number of cases in that community would be the same as the expected number of cases. In this situation, the O/E ratio will have a value of one (1.00). If the investigation area has a rate of cancer that exceeds the comparison statewide rate, then the observed number of cases in that area will exceed the expected number of cases and the O/E ratio will be greater than one (>1.00). Conversely, the O/E ratio will have a value less than one (<1.00) when fewer cancer cases are observed in the investigation area than are expected.

### 3.4 Confidence Intervals for Observed-to-Expected Ratios

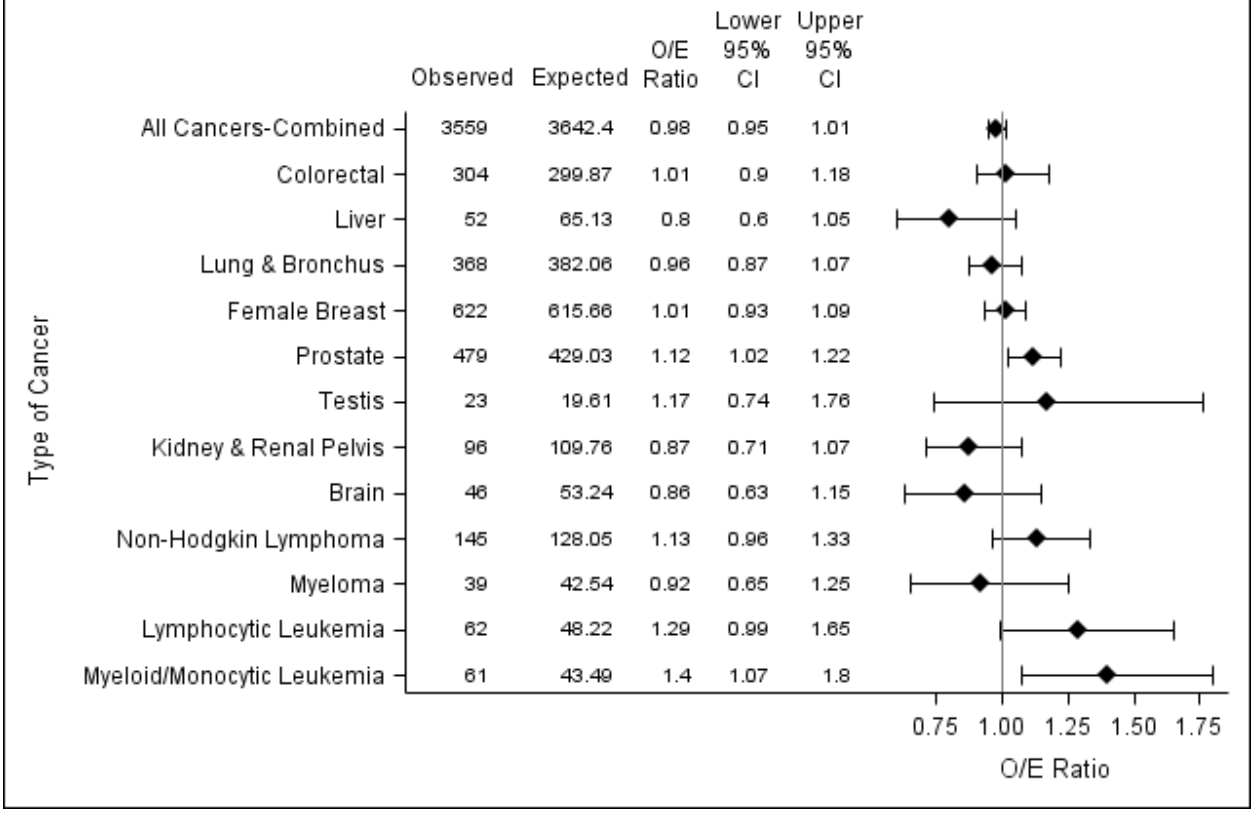
We calculated 95 percent confidence intervals for each O/E ratio. Methods for calculating the 95 percent confidence intervals were based on the Poisson distribution, as described in a technical report from the Washington State Department of Health [9] that was derived from methods previously published by Daly [10]. By standard convention, an O/E ratio with a corresponding 95 percent confidence interval that excluded the value of 1.00 was considered to be statistically significant for the purposes of this assessment. A detailed, non-technical explanation of the O/E ratio, confidence intervals, and guidelines for interpreting these measures is presented in Appendix 3.The summary statements and recommendations presented in Section 6 of this assessment are based, in part, on the guidelines summarized in Appendix 3.

## SECTION 4: RESULTS

### 4.1 All Cancer Types-Combined

During the study period 2006-2015, a total of 3,559 new cancer cases (i.e., all cancer types combined) were diagnosed among residents of the 14-tract investigation area (Figure 1), an average of 356 new cases each year. Based on statewide incidence rates for New Mexico, we would expect to see 3,642.40 cases of cancer in a population of the size, race/ethnic and age-distribution of the 14-tract area during the 10-year period, 2006-2015. The observed-to-expected ratio for all cancers is 0.98 (i.e., 3,559 divided by 3,642.40). The 95 percent confidence interval for the observed-to-expected ratio was 0.95 to 1.01. Since the corresponding confidence interval includes the value of 1.00, the overall occurrence of all types of cancer-combined in the 14-tract area is judged to be similar to the statewide experience. Based on these observations, there was no evidence of a systematic excess of cancer cases (i.e., for all cancer types combined) in the investigation area during the study period.

**Figure 1**
**Observed-to-Expected (O/E) Ratios and Corresponding 95% Confidence Intervals (CI)**
**By Type of Cancer for Residents of the Fourteen-Tract Investigation Area**




## 4.2 Colorectal Cancer

A total of 304 colorectal cancer cases were newly diagnosed among residents of the 14-tract investigation area during the study period (Figure 1). We expected 299.87 colorectal cancer cases to be diagnosed in this population during the study period based on statewide rates. The O/E ratio for colorectal cancer in the 14-tract area was 1.01 with a 95% confidence interval of 0.90 to 1.18. Based on these observations, there was no evidence of a systematic excess of colorectal cancer cases in the investigation area during the study period.

## 4.3 Liver Cancer

Fewer cases of liver cancer were diagnosed in the 14-tract investigation area during the study period than would have been expected (52 observed cases; 65.13 expected cases; O/E ratio=0.80; 95% confidence interval=0.60-1.05) (Figure 1). Based on these observations, there was no evidence that an excess number of liver cancer cases were diagnosed in the area during the study period.

### 4.4 Cancer of the Lung and Bronchus

The number of lung and bronchus cancer cases diagnosed among residents of the 14-tract investigation area in the study period (368 observed cases) was slightly lower than expected (382.06 expected cases; O/E ratio=0.96; 95% confidence interval=0.87-1.07) (Figure 1). Based on these observations, there was no evidence that an excess number of lung cancer cases were diagnosed in the area during the study period.

### 4.5 Female Breast Cancer

Breast cancer is the most common type of cancer among women in New Mexico and was the most commonly-diagnosed cancer among women in the investigation area during the study period. A total of 622 cases of female breast cancer were diagnosed among women in the 14-tract investigation area during the study period (Figure 1), an average of 62 cases per year. Based on statewide rates, we expected 615.66 cases in this area during this period. The O/E ratio was 1.01 and the corresponding 95% confidence interval was 0.93 to 1.09. A slightly higher-than-expected number of breast cancer cases were observed in the investigation area, but this observation did not achieve statistical significance.

### 4.6 Prostate Cancer

Prostate cancer is the most common type of cancer diagnosed among men in New Mexico and was the most common cancer diagnosed among male residents of the investigation area during the study period. A total of 479 cases were observed in the 14-tract investigation area during the study period, which exceeded the expected number (429.03) by approximately 12 percent (O/E ratio=1.12; 95% confidence interval=1.02-1.22), which was statistically significant (Figure 1).

### 4.7 Testicular Cancer

Twenty-three (23) cases of testicular cancer were diagnosed among male residents of the 14-tract investigation area during the study period (19.61 cases expected; O/E ratio=1.17; 95% confidence interval=0.74-1.76) (Figure 1). No consistent pattern of excess or deficit of testicular cancer was documented in the investigation area during the study period.

### 4.8 Cancer of the Kidney and Renal Pelvis

Ninety-six (96) cases of kidney and renal pelvis cancer were diagnosed in the 14-tract investigation area during the study period, which is fewer than the 109.76 cases expected (O/E ratio=0.87; 95% confidence interval=0.71-1.07) (Figure 1).

### 4.9 Brain Cancer

A total of 46 cases of malignant brain cancer were diagnosed among residents of the 14-tract investigation area during the study period, slightly fewer than the expected number of cases (53.24 expected cases; O/E ratio=0.86; 95% confidence interval=0.63-1.15) (Figure 1).

### 4.10 Non-Hodgkin Lymphoma

The number of non-Hodgkin lymphoma cases diagnosed in the 14-tract investigation area was higher than expected during the study period, though this difference was not statistically significant (145 observed cases; 128.05 expected cases; O/E ratio=1.13; 95% confidence interval=0.96-1.33) (Figure 1).

### 4.11 Myeloma

Thirty-nine (39) cases of myeloma were diagnosed among residents of the 14-tract investigation area during the study period, slightly fewer than the expected number of 42.54 (O/E ratio=0.92; 95% confidence interval=0.65-1.25) (Figure 1).

### 4.12 Lymphocytic Leukemia

Sixty-two (62) cases of lymphocytic leukemia were diagnosed among residents of the 14-tract investigation area during the study period, while 48.22 cases were expected (O/E ratio=1.29; 95% confidence interval=0.99-1.65) (Figure 1). This observation did not achieve statistical significance.

### 4.13 Myeloid and Monocytic Leukemia

A statistically significant excess of myeloid and monocytic leukemia cases was documented among residents of the 14-tract investigation area during the study period (61 observed cases; 43.49 expected cases; O/E ratio=1.40; 95% confidence interval=1.07-1.80) (Figure 1).
We examined records of the 61 cases of myeloid and monocytic leukemia cases to further characterize the occurrence of this disease in the 14-census tract investigation area. Five of the fourteen census tracts in the investigation area were directly adjacent to the Intel plant (i.e., Bernalillo County census tracts 0047.16 and 0046.17, and Sandoval County census tracts 0106.02, 0107.16 and 0107.19) (Appendix 1). Of these, three census tracts had O/E ratios that exceeded 1.0 and two had O/E ratios that were less than one. None of the O/E ratios in tracts directly adjacent to the Intel plan were statistically significant. The remaining nine census tracts in the investigation area were not directly adjacent to the Intel plant. Of these, five had O/E ratios that exceeded 1.0 and four had O/E ratios that were less than 1.0. Incident cases were not clustered in a single year of the study period (Table 2). Rather, cases were diagnosed each year from 2006-2015, ranging from two cases in calendar year 2012 to 13 in 2006. The number of cases observed early in the study period was slightly higher than in the latter years, with the exception of calendar year 2014 (10 cases).

The median age at diagnosis was 67 years for both those cases diagnosed among residents of the 14-tract investigation area and all such cases, statewide.

**Table 2.**
**Enumeration of Incident Myeloid and Monocytic Leukemia Cases in the 14-Tract Investigation Area by Year of Diagnosis, 2006-2015**

| Diagnosis Year | Number of Cases |
|---|---|
| 2006 | 13 |
| 2007 | 8 |
| 2008 | 7 |
| 2009 | 6 |
| 2010 | 3 |
| 2011 | 5 |
| 2012 | 2 |
| 2013 | 3 |
| 2014 | 10 |
| 2015 | 4 |

## SECTION 5: LIMITATIONS

We utilized the best available data sources and standard methods to prepare this assessment. Nonetheless, it is important to consider possible limitations when critically reviewing and interpreting the results.

Information regarding the number of incident cases in the investigation area was obtained from the New Mexico Tumor Registry. As summarized in Section 3.2, the New Mexico Tumor Registry has historically conducted its operations in accordance with standard and well-established policies and procedures. If the Registry consistently underreported cases in the investigation area but not in other areas of the state, then the observed number of cases would have been consistently lower than the expected number of cases for each cancer. If this had happened, then the resulting O/E ratios would have been systematically underestimated and a disproportionate number of the O/E ratios would have had a value less than 1.0. We believe that the latter scenario is unlikely since the figure presented in this assessment includes a robust mixture of O/E ratios that are above, below, or near the value of 1.0.

Population estimates for the investigation area were obtained from the New Mexico Department of Health and were derived from figures generated by the United States Census Bureau. Inaccurate estimates of the resident population within the investigation area could result in underestimates or overestimates of the expected number of cases. The investigation area experienced robust population growth over the last two decades. If the population figures underestimated the true size of the population in this area, then the expected number of cancer cases in this assessment would also have been underestimated. In that case, the O/E ratios in this assessment would have been systematically underestimated and the true O/E ratios would be systematically higher than reported herein. Again, we believe that the latter scenario is unlikely since the figure presented in this assessment includes a mixture of O/E ratios that are above, below, or near the value of 1.0.

Finally, we want to be clear that results presented in this assessment do not tell us what caused specific cancers in this community. Rather, results from this assessment provide insight into whether or not the number of cancer cases observed in the investigation population exceeded the number of cases that would be expected to occur in a population of this size and demographic composition.

## SECTION 6: SUMMARY AND RECOMMENDATIONS

Results from this assessment indicate that the overall burden of cancer in the investigation area is generally similar to that observed elsewhere in New Mexico. The overall number of cancer cases diagnosed in the investigation area during the period 2006-2015 is consistent with what would be expected - based on statewide rates - for a community of this size and corresponding racial, ethnic and age composition. Similar findings were obtained for the majority of cancer types that were examined in this analysis.

Over the last three decades, screening with the Prostate Specific Antigen (PSA) test has heavily influenced the number of prostate cancer cases diagnosed in all areas of the United States, including New Mexico. Such screening is most common in communities of upper socioeconomic status where residents have ready access to health care. We speculate that the modest elevation in prostate cancer cases in the 14-tract investigation area could be attributed to such screening.

We documented an excess of myeloid and monocytic leukemia cases among residents of the 14-tract investigation area during the study period. Upon close examination, however, no consistent geographic nor temporal patterns emerged. The risk for myeloid and monocytic leukemias increases with age, but the role of specific causes is not well characterized. Results from previous studies have identified several possible risk factors, including cigarette smoking and exposure to benzene.

The distribution of possible risk factors for myeloid and monocytic leukemia has not been systematically documented among residents of the 14-tract investigation area, which constrains further examination with existing records. The relatively rare nature of this disease would also make it difficult to mount an epidemiological investigation that would have sufficient statistical power to support a robust study of cause-and-effect in this population.

In recognition of the heightened concern of cancer in this community, the NMDOH recommends that this entire analysis be repeated in November of 2020. At that time, three additional calendar years of data should be available for analysis in the New Mexico Tumor Registry (i.e., data for calendar years 2016, 2017 and 2018). Based on results from that future assessment, the NMDOH should evaluate the need for additional assessments.

## SECTION 7: REFERENCES

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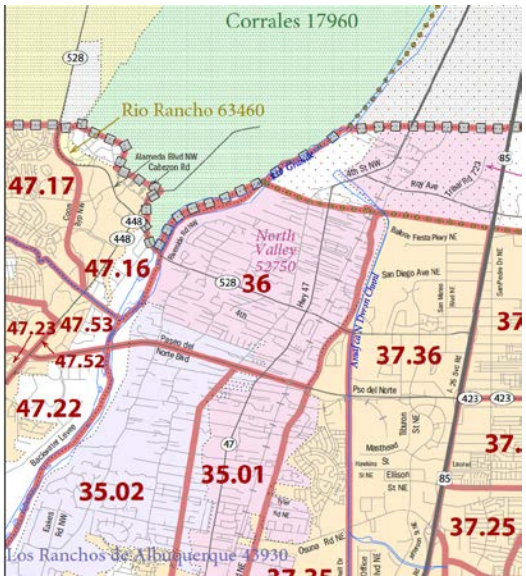
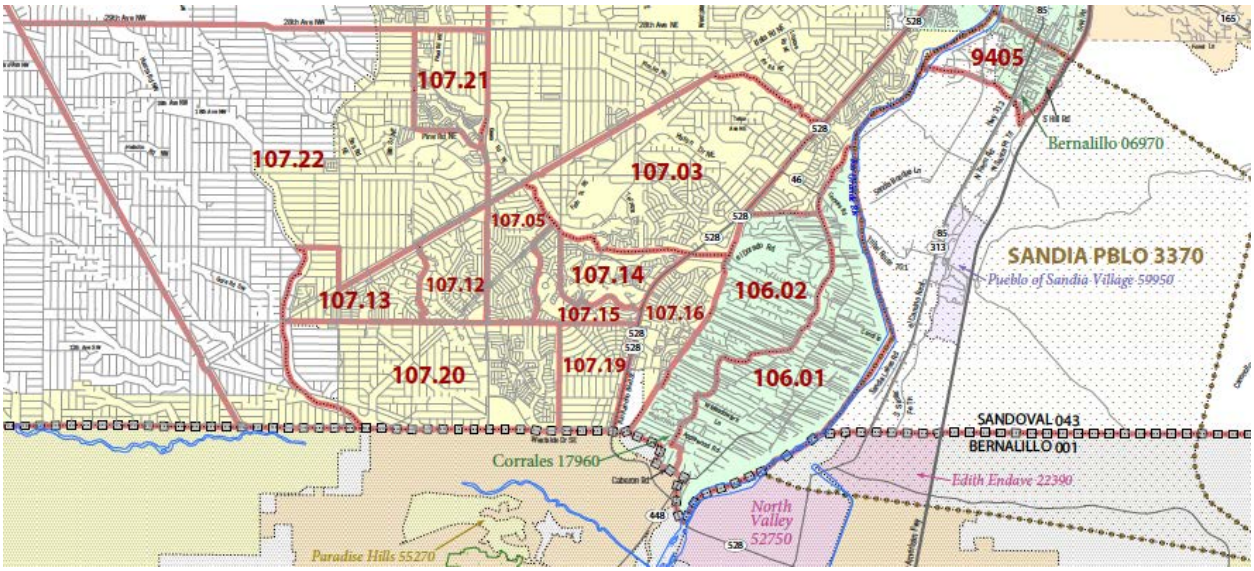
# APPENDIX 1

## Maps of Focus Area by County

### Bernalillo County




### Sandoval County



# APPENDIX 2

**Cancer Categories Utilized in the Assessment**

| Type of Cancer | ICD-O-3 Anatomic Site Codes[1] | ICD-O-3 Histology (Type) Codes[2] |
|---|---|---|
| Oral Cavity and Pharynx | C000-C009, C019-C029, C079-C089, C040-C049, C030-C039, C050-C059, C060-C069, C110-C119, C090-C099, C100-C109, C129, C130-C139, C140, C142, C148 | Excluding 9050-9055, 9140, 9590-9992 |
| Esophagus | C150-C159 | |
| Stomach | C160-C169 | |
| Small Intestine | C170-C179 | |
| Colorectal | C180-C189, C199, C209, C260 | |
| Anus | C210-C212, C218 | |
| Liver | C220 | |
| Intrahepatic Bile Duct | C221 | |
| Gallbladder | C239 | |
| Other Biliary | C240-C249 | |
| Pancreas | C250-C259 | |
| Retroperitoneum | C480 | |
| Peritoneum | C481-C482 | |
| Other Digestive | C268-C269, C488 | |
| Larynx | C320-C329 | |
| Lung and Bronchus | C340-C349 | |
| Other Respiratory | C384, C339, C381-C383, C388, C390, C398, C399 | |
| Bones and Joints | C400-C419 | |
| Soft Tissue | C380, C470-C479, C490-C499 | |
| Cutaneous Melanoma | C440-C449 | 8720-8790 |
| Other Skin | C440-C449 | Excluding 8000-8005, 8010-8046, 8050-8084, 8090-8110, 8720-8790, 9050-9055, 9140, 9590-9992 |
| Female Breast | C500-C509 (Females Only) | Excluding 9050-9055, 9140, 9590-9992 |
| Cervix (Invasive) | C530-C539 | |
| Uterus | C540-C549, C559 | |
| Ovary | C569 | |
| Other Female Genital | C529, C510-C519, C570-C579, C589 | |
| Prostate | C619 | |
| Testis | C620-C629 | |
| Other Male Genital | C600-C609, C630-C639 | |
| Bladder | C670-C679 | |
| Kidney & Renal Pelvis | C649, C659 | |
| Other Urinary | C680-C689 | |
| Eye and Orbit | C690-C699 | |
| Brain | C710-C719 | Excluding 9050-9055, 9140, 9530-9539, 9590-9992 |
| Other Nervous System | C710-C719 | 9530-9539 |
| | C700-C709, C720-C729 | Excluding 9050-9055, 9140, 9590-9992 |

**APPENDIX 2 (continued)**

| Type of Cancer | ICD-O-3 Anatomic Site Codes[1] | ICD-O-3 Histology (Type) Codes[2] |
|---|---|---|
| Thyroid | C739 | Excluding 9050-9055, 9140, 9590-9992 |
| Other Endocrine | C379, C740-C749, C750-C759 | |
| Hodgkin Lymphoma | | 9650-9667 |
| Non-Hodgkin Lymphoma | C024, C098, C099, C111, C142, C379, C422, C770-C779 | 9590-9597, 9670-9671, 9673, 9675, 9678-9680, 9684, 9687-9691, 9695, 9698-9702, 9705, 9708-9709, 9712, 9714-9719, 9724-9729, 9735, 9737-9738, 9811-9818, 9823, 9827, 9837 |
| | All sites except C024, C098-C099, C111, C142, C379, C422, C770-C779 | 9590-9597, 9670-9671, 9673, 9675, 9678-9680, 9684, 9687, 9688, 9689-9691, 9695, 9698-9702, 9705, 9708-9709, 9712, 9714-9719, 9724-9729, 9735, 9737, 9738 |
| | All sites except C024, C098-C099, C111, C142, C379, C420-C422, C424, C770-C779 | 9811-9818, 9823, 9827, 9837 |
| Myeloma | | 9731-9732, 9734 |
| Lymphocytic Leukemia | | 9826, 9835-9836, 9820, 9832-9834, 9940 |
| | C420, C421, C424 | 9811-9818, 9837, 9823 |
| Myeloid/Monocytic Leukemia | | 9840, 9860, 9861, 9863, 9865-9867, 9869, 9871-9874, 9875-9876, 9891, 9895-9897, 9898, 9910-9911, 9920, 9930, 9945-9946 |
| Other leukemia | | 9733, 9742, 9800, 9801, 9831, 9870, 9948, 9963-99649805-9809, 9931 |
| | C420, C421, C424 | 9827 |
| Mesothelioma | | 9050-9055 |
| Kaposi Sarcoma | | 9140 |
| Miscellaneous | | 9740-9741, 9750-9769, 9950, 9960-9962, 9965-9967, 9970-9971, 9975, 9980, 9982-9987, 9989, 9991-9992 |
| | C420-C424 , C760-C768, C770-C779, C809 | excluding 9050-9055, 9140, 9590-9992 |
| All Types of Cancer-Combined | *All anatomic site and histology codes as listed above* | |

[1] This column displays the anatomic site codes that were used to define the cancer category that is shown in the respective row of this table. The anatomic site codes are from the International Classification for Diseases for Oncology-Third Edition (ICDO-3) [7].

[2] This column displays the histology codes that were used to define the cancer category that is shown in the respective row of this table. The histology codes are from the International Classification for Diseases for Oncology-Third Edition (ICDO-3) [7].

# APPENDIX 3

## An Overview of the Observed-to-Expected Ratio and Associated Measures

The Observed-to-Expected (O/E) ratio is a measure that is commonly used to assess the burden of cancer, especially in relatively small geographic areas. As the name implies, the O/E ratio compares the number of cases that were observed in an investigation area in a specified time period with the number of cases that were expected to have occurred in that population during that same period. The components of the O/E ratio, as well as methods for calculating and interpreting the O/E ratio, are described in the following sections.

In this assessment, the observed number of cases represents the actual number of cancer cases that were diagnosed among residents of the investigation area during the ten-year study period, 2006-2015. As previously mentioned, the observed number of cases for the assessment was ascertained from the New Mexico Tumor Registry. For each cancer category that was examined, we calculated the number of cases that would have been expected to occur in the investigation area if the statewide rates had been applied to the resident population of that area. The O/E ratio was calculated by simply dividing the observed number of cases for each type of cancer by the expected number of cases for that same cancer.

There is random variation in every measurement, including the O/E ratio. For this reason, we rarely encounter an O/E ratio with the exact value of 1.0 (i.e., indicating no difference in cancer burden between the investigation community and its comparison). Rather, some O/E ratios fall above the value of 1.0 and others fall below that value. But how far above or below the value of 1.0 does the O/E ratio have to be before we say that the cancer burden in the investigation community is truly different from what is expected? To assist in making this judgement, we calculated 95 percent confidence intervals for each O/E ratio provided in this assessment. According to statistical theory, the true value of the O/E ratio will lie between the lower and upper bounds of the 95 percent confidence interval most of the time (i.e., in 95 percent of all assessments, the true value of the O/E ratio will fall within these bounds). By convention, we state that the O/E ratio is "statistically significant" when its corresponding 95 percent confidence interval excludes the value of 1.0. When the O/E ratio is not "statistically significant," we assume that the magnitude of the O/E ratio could well be attributed to chance (i.e., random variation). In contrast, when the O/E ratio is labeled "statistically significant," we consider that it is unlikely for such an observation to be attributable to chance alone. In the latter situation, we consider the possibility that factors other than chance may have contributed to the observed excess or deficit of cancer.

Guidelines for interpreting the O/E ratio are summarized in the following table.

## Guidelines for Interpreting the Observed-To-Expected Ratio and Corresponding 95 Percent Confidence Interval

| Value of the Observed-To-Expected Ratio | 95% Confidence Interval for the Observed-To-Expected Ratio | Interpretation |
|---|---|---|
| One (1), and → | The value of one (1) lies between the lower and upper bounds of the 95% confidence interval, therefore → | Cancer experience in the community is similar to other communities, statewide |
| Less than one (<1) , and → | The value of one (1) lies between the lower and upper bounds of the 95% confidence interval, therefore → | The community may have a lower risk of cancer than other communities, statewide, but this difference is not statistically significant |
| Less than one (<1) , and → | The value of one (1) lies above the upper bound of the 95% confidence interval, therefore → | Statistically significant deficit of cancer in the community |
| Greater than one (>1) , and → | The value of one (1) lies between the lower and upper bounds of the 95% confidence interval, therefore → | The community may have a higher risk of cancer than other communities, statewide, but not a statistically significant increase |
| Greater than one (>1) , and → | The value of one (1) lies below the lower bound of the 95% confidence interval, therefore → | Statistically significant excess of cancer in the focus community |