Appendix E. Health Statistics Review

Health Statistics Review for Populations in Close Proximity to the W.R. Grace & Company Facility in Newark, California

Background

In 1999 a series of articles in the *Seattle Post-Intelligencer* about high rates of asbestos-related disease brought national attention to the W.R. Grace & Company vermiculite mine in Libby, Montana. The Agency for Toxic Substances and Disease Registry (ATSDR), in cooperation with the Montana Department of Public Health and Human Services, analyzed mortality statistics (information on causes of death obtained from death certificates) for the Libby community for a 20-year period (1979–1998). This review found that death due to asbestosis was 40 times more common in the Libby population than in the rest of the state of Montana, and 80 times more common than in the rest of the U.S. population. Death due to lung cancer was 20% to 30% (1.2 to 1.3 times) higher than expected. Although rates of mesothelioma were elevated, it was not possible to quantify by how much. Still, these elevations were high enough that they were considered unlikely to have been due to natural fluctuations in the occurrence of these diseases [1]. Findings from the review of mortality statistics led to several follow-up activities to address the health impacts to those who lived and worked in Libby [2, 3].

Libby vermiculite was distributed to and processed by facilities located throughout the United States. Because human exposure to asbestos has possibly occurred in communities near these facilities, ATSDR's Division of Health Studies initiated a nationwide follow-up effort. This project is designed to screen for similar impacts on the health of populations living near facilities that received shipments of Libby vermiculite. As part of that effort, the Environmental Health Investigation Branch of the California Department of Health Services (CDHS) received funding to conduct health statistics reviews on communities located near facilities that processed or packaged Libby vermiculite.

Health statistics reviews are statistical analyses of information from **cancer registry** and **death certificate** records that investigate whether people in a particular community have developed cancer or have died from a particular disease more often than another comparison population. The health statistics reviews are being conducted in communities located near facilities that received Libby vermiculite, regardless of whether that community was in fact exposed to hazardous levels of asbestos from the vermiculite. (Usually, reviews of health information are conducted only when exposure to a harmful chemical is known to have occurred.) Communities are being investigated because, given the experience in the Libby community, it is not

A **cancer registry** collects, organizes, and analyzes information on cancer cases that have been diagnosed or treated in a specific geographic area (for example, the state of California).

A **death certificate** is an official, legal record of an individual's death. Death certificates provide information on the cause of death (as determined by a physician) and demographic information related to the person who died.

unrealistic to think that exposure to levels of asbestos high enough to have caused disease might have occurred in these communities.

Finding an excess of asbestos-related cancers or disease in a community would alert ATSDR and CDHS to the possibility that workers or community members might have been exposed to hazardous levels of asbestos as a result of the facility's handling or processing of Libby vermiculite. If, however, the health statistics review does not find an excess of asbestos-related disease, this does not prove that the community was not exposed to Libby asbestos.

This appendix presents the results of the health statistics review for the population living near the W.R. Grace & Company plant in Newark, California.

Methods

CDHS followed a health statistics review protocol developed by ATSDR's Division of Health Studies [4]. The objectives of this protocol are

1. to identify the residential area at highest risk of exposure to hazardous levels of asbestos from the exfoliation and processing of Libby vermiculite at the Newark plant
2. to determine whether the population living in this area had higher incidence rates of asbestos-related cancers than the U.S. population as a whole, and
3. to determine whether the population residing in this area had higher mortality rates from asbestos-related disease than the U.S. population as a whole.

The analysis of incidence rates of asbestos-related cancers will be referred to as the "cancer statistics review" and the analysis of mortality rates of asbestos-related disease will be referred to as the "mortality statistics review."

Incidence rate is a measure of the occurrence of disease in a population. It is the number of people in a population who get a disease in a specific time period, divided by the number of people in that population during the time period. For example, the incidence rate of lung cancer in California for the year 1997 was 60.1 new cases per 100,000 people living in California during that year [5].

Mortality rate is a measure of the occurrence of death from a disease in a population. It is the number of people in a population who die from a disease in a specific time period, divided by the number of people in that population during the time period. For example, the mortality rate for lung cancer in California for the year 1997 was 41.8 per 100,000 people residing in California during that year [6].

Diseases Evaluated in the Health Statistics Review

The ATSDR Division of Health Studies selected a variety of diseases for evaluation (1) to assess the full burden of disease and death that exposure to asbestos could have had on a population and (2) to confirm that the information obtained from cancer registries and vital statistics records for this review was consistent and therefore comparable.

Exposure to asbestos is known to cause lung cancer, mesothelioma, and asbestosis. Some studies suggest that exposure to asbestos might also increase the risk of certain digestive organ cancers. It is also possible that exposure to asbestos might worsen and cause premature death from certain diseases of the pulmonary and circulatory system.

One factor complicating the study of asbestos-related diseases is that physicians often misdiagnose these diseases, particularly when establishing a cause of death. This review also evaluated the number of people getting or dying from a certain disease because these people might have actually had an asbestos-related disease that was misdiagnosed.

Incidence rates of eight types of cancer or cancer groups were evaluated in the cancer statistics review (see list, at right). Lung and bronchus cancer, mesothelioma, and digestive organ cancers were studied because of their known or suspected association with asbestos exposure. Cancer of the peritoneum, retroperitoneum and pleura, and cancer of the respiratory system and intrathoracic organs were evaluated because people with these diagnoses might actually have had an asbestos-related cancer instead. Lastly, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether cancer was underreported to the cancer registries that provided information for this review.

Mortality rates from 13 types of diseases or disease groups were evaluated as part of the mortality statistics review (see list, at right). Lung and bronchus cancer, cancer of the peritoneum, retroperitoneum, and pleura—including mesothelioma, asbestosis, and digestive organ cancers were evaluated because of their known or suspected association with asbestos exposure. Respiratory system and intrathoracic organ cancers, cancer with no specification of site, pneumoconioses, and chronic obstructive pulmonary disease were evaluated because these deaths might actually have resulted from misdiagnosed asbestos-related diseases. Chronic obstructive pulmonary disease, disease of the pulmonary circulation, and other diseases of the respiratory system were evaluated because asbestos-exposure might have worsened these conditions and led to premature death. Finally, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether causes of death were underreported to the registries that provided information for the mortality statistics review.

The cancer statistics review evaluated the following types of cancer:

Lung and bronchus
Mesothelioma
Digestive organs
Peritoneum, retroperitoneum, and pleura
Respiratory system and intrathoracic organs
All types of cancer
Female breast
Prostate

The mortality statistics review evaluated death from the following diseases:

Lung and bronchus cancer
Cancer of the peritoneum, retroperitoneum and pleura – including mesothelioma
Asbestosis
Digestive organ cancers
Respiratory system and intrathoracic organ cancers
Cancer – no specification of site
Pneumoconioses
Chronic obstructive pulmonary disease
Diseases of pulmonary circulation
Other diseases of respiratory system
All types of cancer
Female breast cancer
Prostate cancer

Studying mesothelioma

During the years that were evaluated in this review, cancer and causes of death were coded in cancer registries and on death certificates according to two classification systems: the International Classification of Diseases—Oncology Codes, Revision 2 (ICD-O-2) (used by cancer registries), and the International Classification of Diseases, Injury, and Causes of Death Codes, Revision 9 (ICD-9) (used for death certificates).

The ICD-O-2 system has a specific code for mesothelioma, which makes it possible to evaluate the incidence rate of this cancer in the Newark community. In contrast, the ICD-9 system does not have a specific code for mesothelioma. Therefore, it is not possible to analyze mortality rates for mesothelioma alone; only a larger group of diseases (cancer of the peritoneum, retroperitoneum, and pleura—including mesothelioma) can be studied. Nearly all of the deaths in this cancer group are, in fact, deaths from mesothelioma (W. Kaye, ATSDR, personal communication, 2004). So, evaluating mortality from this group of cancers reflects, with relative accuracy, the occurrence of death from mesothelioma.

Study Populations

As discussed earlier in this health consultation, whether people who lived near the Newark plant between 1967 and 1992 were exposed to hazardous levels of asbestos from Libby vermiculite, and if so, which areas of Newark experienced such exposure, is currently unknown.

Therefore, the first step of the health statistics review was to determine which area near the Newark plant was most likely to have experienced an increased burden of asbestos-related disease (assuming that the Newark plant did pollute the surrounding air with hazardous levels of asbestos). CDHS concluded that the population living within ½-mile of the Newark plant site was the most likely population to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease. This distance was selected on the basis of information presented in this health consultation and information from health studies of lung cancer and mesothelioma rates in communities near asbestos industries [7-10].

Figure E–1 shows the location of the Newark plant and the area of Newark that is located within ½-mile of the facility. The health statistics review would ideally evaluate the incidence and mortality rates of asbestos-related disease in the population residing in this area. But the smallest geographic area on which cancer statistics are publicly available is the **census tract** (providing information on a smaller geographic area could make it possible to identify a cancer patient, and thus would violate their right to privacy). For similar reasons pertaining to privacy, the smallest geographic area on which mortality statistics are publicly available is the ZIP Code.

Census tracts are small geographic areas defined by the U.S. Census Bureau. Census tracts usually have 2,500 to 8,000 residents with similar population characteristics, economic status, and living conditions.

Therefore, for the cancer statistics review, CDHS studied the population living in census tract 4446. For the mortality statistics review, CDHS studied the population residing in ZIP Code 94560. Figure E–2 shows the location of the Newark plant, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and census tract 4446. Figure E–3 shows the location of the Newark plant, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and ZIP Code 94560.

Figure E–1. Area of Newark that is most likely to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease, assuming that the Newark plant polluted the outside air with hazardous levels of asbestos.

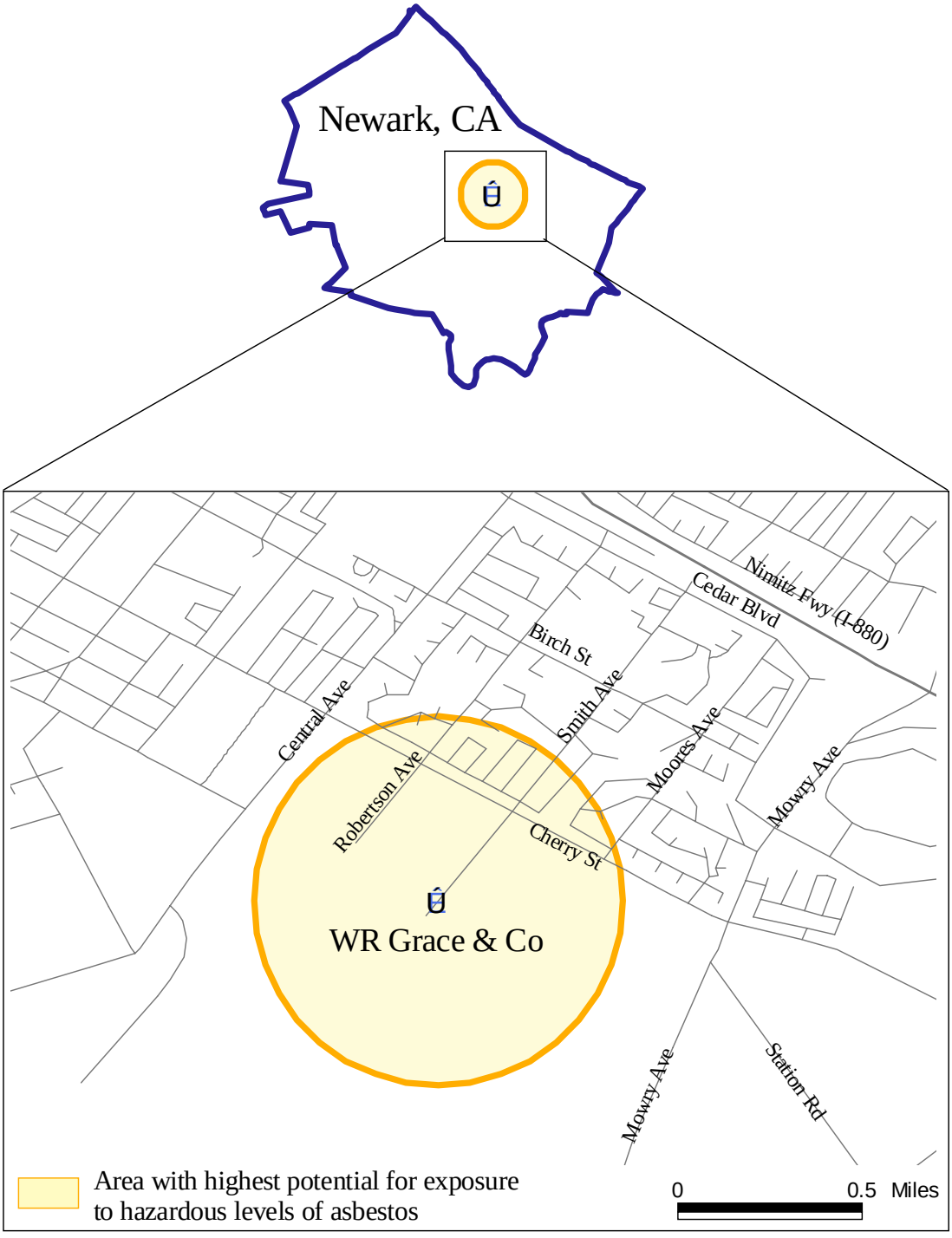


Figure E–2. Map of Census Tract 4446 in Relationship to the Area Located Within ½ Mile of the Newark Plant, Newark, California.

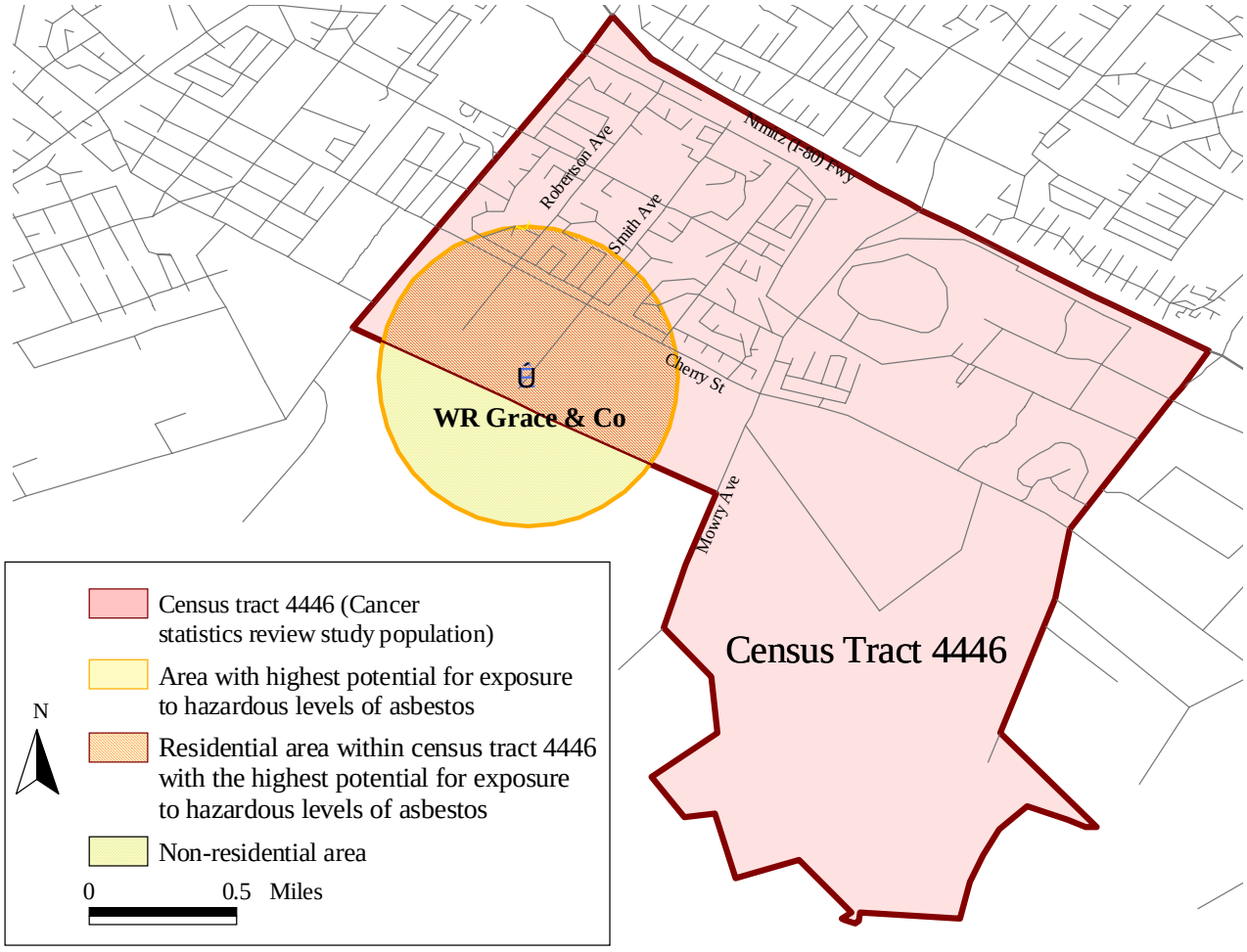
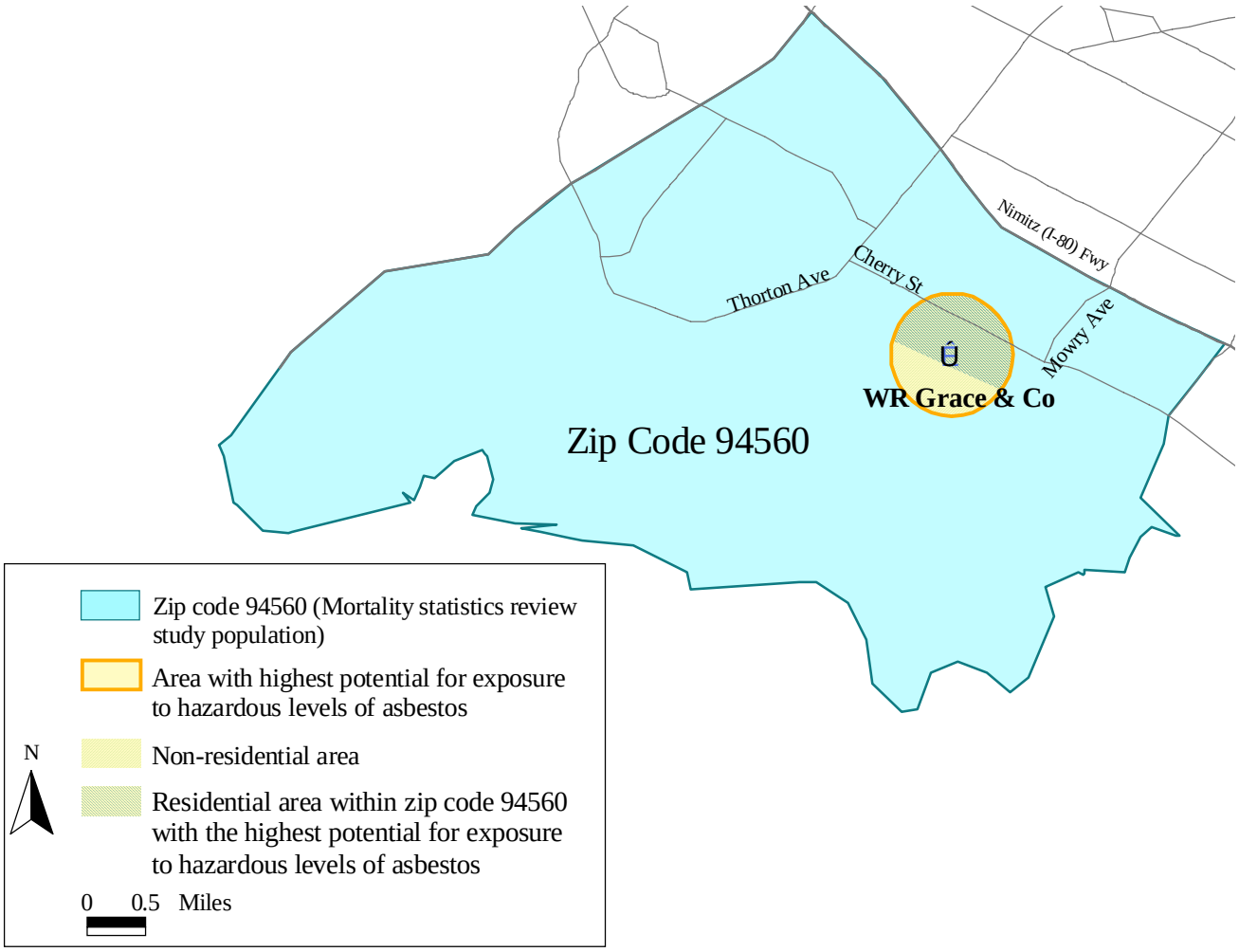


Figure E–3. Map of ZIP Code 94560 in Relationship to the Area Located Within ½ Mile of the Newark Plant, Newark, California.



Study Periods

The cancer statistics review studied the period from January 1, 1986, through December 31, 1995, and the mortality statistics review studied the period January 1, 1989, through December 31, 1998. ATSDR selected these periods for two reasons: (1) they come closest to corresponding to the time of exposure and the latency period of asbestos-related disease, and (2) a 10-year period provides the minimum amount of data required for informative statistical analysis [4].

Demographic Information on the Study Populations

In 1990, there were 7,785 people residing in census tract 4446 and 37,861 people residing in ZIP Code 94560 (see Table E–1). Both study populations had equal number of males and females and were primarily white, with sizeable Asian/Pacific Islander and Hispanic-white populations. Compared with the U.S. population as a whole, the study populations had fewer people age 65 and older and had a higher socioeconomic status, as measured by educational attainment, the percentage of people in the labor force, employment status, and poverty status.

Statistical Analysis

The statistical analysis was designed to screen for an excess of asbestos-related disease in communities with facilities that received Libby vermiculite [4]. Specifically, the analysis explored the following questions.

1. Is the number of people who were diagnosed with an asbestos-related cancer while residing in census tract 4446 from 1986–1995 higher than what we would expect if the incidence rates of these cancers in census tract 4446 population were the same as the rates in the U.S. population as a whole?
2. Are the incidence rates of asbestos-related cancers in census tract 4446 population from 1986–1995 higher than the rates in the U.S. population as a whole?

Table E–1. Demographic Characteristics of the Populations Living in Census Tract 4446, ZIP Code 94560, and in the United States [11]

	Census Tract 4446	ZIP Code 94560	United States
Total population	7,785	37,861	
Sex			
males	50%	50%	49%
females	50%	50%	51%
Race/Ethnicity			
non-Hispanic			
White	63%	58%	76%
Black	4%	4%	12%
Asian/Pacific Islander	18%	15%	3%
Hispanic			
White	8%	11%	5%
Asian/Pacific Islander	1%	1%	0%
Other race	5%	10%	4%
Age			
under 18	26%	28%	27%
18–64	71%	66%	60%
65 and over	4%	5%	13%
Education			
up to 9th grade	3%	7%	7%
some high school	8%	15%	11%
high school graduate	24%	26%	22%
some college or higher	64%	52%	34%
Employment			
in labor force	83%	77%	65%
not in labor force	17%	23%	35%
employed	95%	95%	94%
unemployed	5%	5%	6%
Poverty			
income below poverty level	2%	5%	13%

3. Is the number of people who died from asbestos-related disease while residing in ZIP Code 94560 from 1989–1998 higher than what we would expect if the mortality rates in the ZIP Code 94560 population were the same as the mortality rates in the U.S. population?

4. Are the mortality rates for asbestos-related disease in the ZIP Code 94560 population from 1989–1998 higher than the mortality rates for the U.S. population as a whole from 1989–1998?

These four questions are similar in that they all compare the incidence and mortality rates in the Newark community with the incidence and mortality rates in the U.S. population as a whole. They differ, however, in how the comparison is made.

Statistical Measures of Comparison

The first question is explored by calculating a statistical measure called the **standardized incidence ratio (SIR)**. The SIR is a numerical expression. In this review the SIR compares how many people in the census tract 4446 population were diagnosed with cancer and how many diagnoses would be expected (hypothetically) if the incidence rate of cancer in the census tract 4446 population was the same as the incidence rate of cancer in the U.S. population. Details on how the SIR is calculated are provided in Addendum 1. If the number of people who were diagnosed with an asbestos-related cancer while residing in census tract 4446 is the same as the expected number, the SIR will equal 1. If the number of people in the census tract 4446 population who were diagnosed with an asbestos-related cancer is less than the expected number, the SIR will be less than 1. If the number of people in the census tract 4446 population who were diagnosed with an asbestos-related cancer is more than one would expect, the SIR will be greater than 1.

The second question is explored by calculating a statistical measure called the **standardized rate ratio (SRR)**. The SRR is a numerical expression, and in this review the SRR compares how many people in the United States were diagnosed with cancer and how many would be expected (hypothetically) if the U.S. population had the same incidence rates of cancer as the census tract 4446 population. Details on how the SRR is calculated are provided in Addendum 2. If the incidence rate of cancer in the U.S. population is the same as that in the census tract 4446 population, the SRR will equal 1. If the incidence rate of cancer in the U.S. population is lower than the incidence rate in the census tract 4446 population, the SRR will be less than 1. If the incidence rate of cancer in the U.S. population is higher than that in the census tract 4446 population, the SRR will be greater than 1.

The third question is explored by calculating a statistical measure called the **standardized mortality ratio (SMR)**. The SMR is essentially the same measure as the SIR except that it evaluates the number of people who died from a disease rather than the number of people who were diagnosed with a disease. Thus the SMR is a numerical expression that compares how many people in ZIP Code 94560 died of an asbestos-related disease and how many would be expected to die (hypothetically) if the mortality rates of asbestos-related disease in the ZIP Code 94560 population were the same as the mortality rates in the U.S. population. Details on how the SMR is calculated are provided in Addendum 3. If the number of people who died from an asbestos-related disease while residing in ZIP Code 94560 is the same as the expected number, the SMR will equal 1. If the number of ZIP Code 94560 residents who died from an asbestos-related disease is less than the expected number, the SMR will be less than 1. If the number of

persons in ZIP Code 94560 who died from an asbestos-related disease is more than would be expected, the SMR will be greater than 1.

Finally, the fourth question is also answered by calculating a standardized rate ratio (SRR), but for mortality rates instead of cancer incidence rates. In this review the SRR is a numerical expression that compares the number of people in the United States who died from an asbestos-related disease and the number of people in the United States who would be expected (hypothetically) to die if the U.S. population had the same mortality rates as the ZIP Code 94560 population.

Interpreting the expected number of people to get a disease or die from a disease

The SIR, SMR, and SRR all compare the actual number of persons who get a disease or die from a disease with an expected number. This expected number of persons is a calculated and theoretical number that is often not a whole number. For example, the expected number might be 2.6 persons. Because it is not possible for a fraction of a person to get or die from a disease, the expected number can be thought of as an approximation. In this example, the expected number (2.6 persons) can be interpreted to mean that either 2 or 3 persons are expected to get a disease or die from a disease.

Accounting for differences between the study populations and the comparison population

In this review, the incidence and mortality rates of disease in the Newark and U.S. populations are compared because it is thought that the Newark population might have higher rates of disease due to past exposure to harmful levels of asbestos. But other characteristics can also increase the risk for developing many of the diseases linked to asbestos. If the study populations differ from the U.S. population in terms of how common these characteristics are, then these differences can bias (that is, create a faulty appearance in) the results of the comparison unless they are accounted for in the analysis. For example, smoking can increase the risk of developing lung cancer. If smoking rates in the Newark populations are lower than the smoking rates in the U.S. population, but the analysis does not adjust for this difference, then the study populations might appear to have lower rates of lung cancer in comparison with the U.S. population than they in fact do. This bias can hide a true excess of disease or create the appearance of an excess when none really exists.

This analysis did account for differences in age and sex, but did not account for other risk factors for asbestos-related disease (for example, smoking, race/ethnicity, or socioeconomic status).

Statistical Tests

The number of people who get or die from cancer or other diseases in a given geographic area changes from year to year; this fluctuating pattern is characteristic of the occurrence of disease and is expected. Because of this, the values of the SIR, the SMR, and the SRR will also change, depending on which time period is under study. If the number of cases occurring in one time period under study is higher than average, then the SIR, SMR, or SRR will be higher than 1 (for example, 1.2). If a different time period were under study and the number of cases were lower than average, the SIR, SMR, and SRR would be less than 1 (for example, 0.9). Some degree of fluctuation in the SIR, SMR, and SRR values from one time period to another is normal and expected.

An important question is when is an SIR, an SMR, or an SRR higher or lower than what would be expected, given that the number of people getting disease in a given geographic area normally varies over time? In other words, is the incidence rate or mortality rate in the Newark population the same as that in the U.S. population, or is disease or death occurring less or more frequently in the Newark population than in the U.S. population as a whole?

To answer this question, a statistical test measure called a **confidence interval (CI)** was calculated for the SIR, the SMR, and the SRR using Byar's approximation method [12]. A confidence interval is a range of possible values for the SIR, SMR, or SRR that are consistent with the normal variation in disease over time in a geographic area. If the CI range includes the value one, then there is no "statistically significant" difference between the incidence or mortality rates in the Newark and U.S. populations, as represented by the SIR, SMR, or SRR. In other words, the incidence or mortality rate in the Newark population is the same as the incidence or mortality rate in the U.S. population. If the CI range is less than one or greater than one, then there is a "statistically significant" difference between the incidence or mortality rates in the two populations, and the incidence rate or mortality rate in the Newark population is not the same as the incidence rate or mortality rate in the U.S. population.

Part of the process of calculating a confidence interval includes selecting a level of certainty for this statistical test. CDHS used a 95% level of certainty, which is the standard value selected for these types of analyses.

Sources of Information on Incidence and Mortality Rates

Information on the number of people who developed cancer while residing in census tract 4446 was obtained from the California Cancer Registry (CCR). Information on cancer rates in the U.S. population was obtained from the Surveillance, Epidemiology, and End Results program of the National Cancer Institute (SEER) [13].

Information on the number of people who died while residing in ZIP Code 94560 was obtained from CDHS, Center for Health Statistics, Office of Vital Records (CDHS-OVR). Information on mortality rates in the U.S. population was obtained from the National Center for Health Statistics (NCHS) [14].

Results of the Cancer Statistics Review

The standardized incidence ratios and standardized rate ratios for the census tract 4446 population are presented in Table E–2.

For each cancer group studied, Table E–2 shows the reason for studying that type of cancer.

For the SIR analysis, Table E–2 shows

- the number of persons who were diagnosed with the type of cancer while residing in census tract 4446
- the number of persons expected to be diagnosed (if the census tract 4446 population had the same incidence rate as the U.S. population), and
- the SIR and 95% CI for the SIR.

For the SRR analysis, Table E–2 shows

- the number of persons who were diagnosed with the type of cancer while residing in the United States
- the number of persons expected to be diagnosed (if the U.S. population had the same incidence rate as the census tract 4446 population), and
- the SRR and the 95% CI for the SRR.

Table E–2. Standardized Incidence Ratio (SIR), Standardized Rate Ratio (SRR), and 95% Confidence Interval (CI) of Selected Cancers in the Census Tract 4446 Population, 1986–1995

		Census Tract 4446			United States.		
Cancer Group (ICD-O-2 Code)	**Reason†**	**# of diagnoses**	**expected #**	**SIR (95% CI)**	**# of diagnoses**	**expected #**	**SRR (95% CI)**
Lung and bronchus (C340:C349*)	1	29	27.2	1.07 (0.71–1.53)	148,246	177,777.3	1.20 (0.79, 1.82)
Mesothelioma (M-9050:9053)	1	1	0.4	2.49 (0.03–13.87)	2,360	2,573.7	1.09 (0.15, 7.72)
Digestive organs (C150: C218, C260:C269*)	2	25	27.0	0.92 (0.60–1.36)	163,384	156,787.4	0.96 (0.62, 1.48)
Respiratory system and intrathoracic organs (C320:C399*)	3	32	30.1	1.06 (0.73–1.50)	162,067	192,230.4	1.19 (0.79, 1.77)
Peritoneum, retroperitoneum, and pleura (C480:C488, C384*)	3	3	0.7	4.06 (0.82–11.85)	3,814	14,463.5	3.79 (0.87, 16.61)
All cancers (C000:C809*)	4	197	205.2	0.96 (0.83–1.10)	1,045,968	1,057,077.3	1.01 (0.85–1.20)
Female breast (C500:C509*)	4	43	34.3	1.25 (0.91–1.69)	154,568	196,966.3	1.27 (0.91–1.78)
Prostate (C619*)	4	24	22.4	1.07 (0.69–1.59)	153,845	169,339.6	1.10 (0.70–1.73)

* excluding M-9590:9989

† Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. This cancer or cancer group was studied to confirm that information on cancer diagnoses is reported to CCR and SEER in a consistent manner.

Between 1986 and 1995, the incidence rates of asbestos-related cancers in the census tract 4446 population were not statistically significantly different from the incidence rates in the U.S. population. Twenty-nine persons were diagnosed with lung or bronchial cancer, when 27.2 diagnoses would be expected if the incidence rate in the census tract 4446 population was the same as the incidence rate in the U.S. population (SIR=1.07). The 95% CI (0.71–1.53) indicates that there is no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 4446 population and the U.S. population, as measured by the SIR. Similarly, the SRR for lung and bronchus cancer was 1.20, with a 95% CI of (0.79–1.82). There is also no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 4446 population and U.S. populations, as measured by the SRR. One person was diagnosed with mesothelioma, when 0.4 diagnoses would be expected if the census tract 4446 population had the same incidence rate as the U.S. population (SIR=2.49). However, the 95% CIs for the SIR (0.03–13.87) and the SRR (0.15–7.72) indicate that there is no statistically significant difference between the incidence rate of mesothelioma in the census tract 4446 population and that in the U.S. population during the years 1986–1995.

Between 1986 and 1995 the incidence rate of digestive organ cancers in the census tract 4446 population was not statistically significantly different from the incidence rate in the U.S. population, as measured by the SIR analysis (SIR=0.92; 95% CI, 0.60–1.36) and the SRR analysis (SRR=0.96; 95% CI, 0.62–1.48).

The incidence rate of cancer of the respiratory system and intrathoracic organs in the census tract 4446 population was not statistically significantly different from the incidence rate in the U.S. population, as evaluated by the SIR analysis (SIR=1.06; 95% CI, 0.73–1.50) and the SRR analysis (SRR=1.19; 95% CI, 0.79–1.77). Neither was the incidence rate of cancer of the peritoneum, retroperitoneum, and pleura in the census tract 4446 population statistically significantly different from that in the U.S. population (SIR=4.06; 95% CI 0.82–11.85) and (SRR=3.79; 95% CI, 0.87–16.61).

Finally, according to both the SIR and SRR analyses, the incidence rates of all types of cancer, female breast cancer and prostate cancer in the census tract 4446 population were not statistically significantly different from the incidence rates in the U.S. population. For all types of cancer, the SIR=0.96 and 95% CI, 0.83–1.10; and the SRR=1.01 and 95% CI, 0.85–1.20. For female breast cancer, the SIR=1.25 and 95% CI, 0.91–1.69; and the SRR=1.27 and 95% CI, 0.91–1.78. For prostate cancer, the SIR=1.25 and 95% CI, 0.91–1.69; and the SRR=1.27 and 95% CI, 0.91–1.78.

Results of the Mortality Statistics Review

Standardized mortality ratios and standardized rate ratios for the ZIP Code 94560 population are presented in Table E–3.

For each disease group studied, Table E–3 shows the reason for studying the disease.

For the SMR analysis, Table E–3 shows

- the number of persons who died from the disease while residing in ZIP Code 94560
- the number of persons expected to die (if this population had the same disease mortality rate as the U.S. population), and
- the SMR and 95% CI for the SMR.

For the SRR analysis, Table E–3 shows

- the number of persons who died from the disease while residing in the United States
- the number of persons expected to die (if the U.S. population had the same disease mortality rate as the ZIP Code 94560 population), and
- the SRR and 95% CI for the SRR.

Table E-3. Standardized Mortality Ratio (SMR), Standardized Rate Ratio (SRR), and 95% Confidence Interval (CI) of Selected Causes of Death Occurring in ZIP Code 94560, 1989–1998

Cause of Death (ICD-9 Code)	Reason *	ZIP Code 94560 # deaths	ZIP Code 94560 expected #	SMR (95% CI)	United States # deaths	United States expected #	SRR (95% CI)
Cancer of the lung and bronchus (162.2–162.9)	1	125	124.3	1.01 (0.84–1.2)	**1,476,326**	**1,720,846.9**	**1.17 (1.06–1.28)**
Cancer of the peritoneum, retroperitoneum, and pleura (including mesothelioma) (158, 163)	1	0	0.9	0 (0–4.10)†	10,615	0.0	0‡
Asbestosis (501)	1	1	0.2	4.59 (0.06–25.55)	**3,367**	**11,762.6**	**3.49 (1.29–9.45)**
Cancer of the digestive organs (150–154, 159)	2	74	63.4	1.17 (0.92–1.47)	**832,523**	**1,220,903.3**	**1.47 (1.31–1.64)**
Cancer of the respiratory system and intrathoracic organs (161–165)	3	126	128.7	0.98 (0.82–1.17)	1,524,872	1,727,613.3	1.13 (1.03–1.24)
Cancer - no site specified (199)	3	34	25.9	1.31 (0.91–1.84)	327,646	479,557.6	1.46 (1.24–1.73)
Pneumoconioses (500–505)	3	1	0.7	1.37 (0.02–7.64)	11,617	11,762.6	1.01 (0.37–2.74)
Chronic obstructive pulmonary disease (490–496)	3, 4	79	65.2	1.21 (0.96–1.51)	**986,772**	**1,295,895.0**	**1.31 (1.17–1.47)**
Other diseases of the respiratory system (510–519)	4	8	12.5	0.64 (0.28–1.26)	172,155	119,782.5	0.70 (0.46–1.05)
Diseases of pulmonary circulation (415–417)	4	3	9.9	0.30 (0.06–0.88)	119,554	32,643.9	0.27 (0.11–0.66)
All cancers (140–208)	5	381	429.9	0.89 (0.8–0.98)	5,259,810	5,444,169.4	1.04 (0.98–1.09)
Female breast cancer (174)	5	46	38.8	1.18 (0.87–1.58)	430,680	629,663.4	1.46 (1.21–1.77)
Prostate cancer (185)	5	17	20.4	0.83 (0.49–1.34)	334,151	303,150.5	0.91 (0.69–1.19)

*Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group or this disease.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. Exposure to asbestos might have exacerbated the condition of people with these diseases and thereby led to premature or increased chance of death.
5. This cancer or cancer group was studied to confirm that information is reported to the CDHS-OVR and the NCHS in a consistent manner.

† Exact confidence interval based on Poisson distribution.

‡ Confidence interval not calculated since expected number of deaths was 0 (W. Kaye, ATSDR, personal communication, 2004). **Bold** typeface indicates a statistically significant result.

The mortality statistics review found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from some asbestos-related disease than the U.S. population between the years 1989–1998. First, according to the SMR analysis, the mortality rate of cancer of the lung and bronchus in the ZIP Code 94560 population was not statistically significantly different from the rate in the U.S. population (SMR=1.01; 95% CI, 0.84–1.20). In contrast, the SRR analysis indicates that the mortality rate of cancer of the lung and bronchus in the ZIP Code 94560 population was statistically significantly different from the rate in the U.S. population (SRR=1.17; 95% CI, 1.06–1.28). Second, neither the SMR nor the SRR analysis indicated that the rate of death from cancer of the peritoneum, retroperitoneum, and pleura (including mesothelioma) in the ZIP Code 94560 population was different from the rate in the U.S. population (SMR=0, because no deaths from these cancers occurred; 95% CI, 0–4.10;and SRR=0). Finally, the ZIP Code 94560 population did not experience statistically significantly different rates of death from asbestosis than the U.S. population, as evaluated by the SMR analysis (SMR=4.59; 95% CI, 0.06–25.55). In contrast, the SRR analysis indicates that the ZIP Code 94560 population did have statistically significantly higher rates of death from asbestosis than the U.S. population (SRR=3.49; 95% CI, 1.29–9.45).

The mortality statistics review also found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from digestive organ cancers, which have been inconclusively linked to asbestos exposure in previous epidemiologic studies. Between 1989 and 1999, the rate of death from digestive organ cancers in the ZIP Code 94560 population was not statistically significantly different from the rate in the U.S. population, as measured by the SMR analysis (SMR=1.17; 95% CI, 0.92–1.47). In contrast, the SRR analysis did indicate that the mortality rate for digestive organ cancers in the ZIP Code 94560 population was statistically significantly higher than the rate in the U.S. population (SRR=1.47; 95% CI, 1.31–1.64).

The mortality statistics review also found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from cancer of the respiratory system and intrathoracic organs, cancer with no site specified, and chronic obstructive pulmonary disease than the U.S. population. According to the SMR analysis, the rates of death from these diseases in the ZIP Code 94560 population were not statistically significantly different from the mortality rates in the U.S. population: SMR=0.98, 95% CI 0.82–1.17 for cancer of the respiratory system and intrathoracic organs; SMR=1.31, 95% CI 0.91–1.84 for cancer with no site specified; and SMR=1.21, 95% CI 0.96–1.51 for chronic obstructive pulmonary disease. In contrast, the SRR analysis indicates that the mortality rates for these diseases in the ZIP Code 94560 population were statistically significantly higher than the rates in the U.S. population: SRR=1.13, 95% CI 1.03–1.24 for cancer of the respiratory system and intrathoracic organs; SRR=1.46, 95% CI 1.24–1.73 for cancer with no site specified; and SRR=1.31, 95% CI 1.17–1.47 for chronic obstructive pulmonary disease. Neither the SMR nor the SRR analysis indicated that the ZIP Code 94560 population experienced statistically significantly different rates of death from pneumoconioses (SMR=1.37, 95% CI 0.02–7.64; and SRR=1.01, 95% CI 0.37, 2.74).

The SMR analysis indicates that the rate of death from all types of cancer in the ZIP Code 94560 population was statistically significantly lower than the mortality rate in the U.S. population

(SMR=0.89; 95% CI, 0.80–0.98), but the SRR analysis does not (SRR=1.04; 95% CI 0.98–1.09). The SMR analysis does not indicate that the ZIP Code 94560 female population experienced statistically significantly higher rates of death from breast cancer than the U.S. female population (SMR=1.18; 95% CI, 0.87–1.58), but the SRR analysis does (SRR=1.46; 95% CI, 1.21–1.77). And neither the SMR nor the SRR analysis demonstrates that the ZIP Code 94560 male population had statistically significantly different rates of death from prostate cancer than the U.S. male population (SMR=0.83; 95% CI, 0.49–1.34 and SRR=0.91; 95% CI, 0.69–1.19).

Discussion

Five limitations of this analysis are worth discussion and exploration because they might (1) affect the accuracy of the results, (2) limit the ability of the analyses to observe an excess of asbestos-related disease attributable to vermiculite processing at the Newark plant, if one exists, or (3) limit the degree to which this analysis can serve as an indicator of community exposure to Libby asbestos.

1. **The SIR, SMR, and SRR results might be biased if the analyses do not account for the ways that the Newark and U.S. population differ with respect to other risk factors for asbestos-related diseases (such as race/ethnicity, socioeconomic status, and smoking).**

As discussed previously, this analysis does not account for all the ways that the Newark population differs from the U.S. population with respect to risk factors for diseases that can be caused by exposure to asbestos. As a result, this analysis might not accurately identify an excess or lack of excess of disease attributable to asbestos exposure.

To assess whether the Newark and U.S. populations differ with respect to other risk factors for asbestos-related disease, CDHS gathered information from the U.S. Census. **Table E–1** shows that the population in census tract 4446 differs substantially from the U.S. population in terms of race/ethnicity and socioeconomic status (measured by education level and poverty status). So, too, does the ZIP Code 94560 population differ substantially from the U.S. population in terms of these characteristics. No information on smoking rates in the study populations is available. That said, however, smoking has historically been less common in California [15], and, since the late 1980s, smoking rates in California have been declining more rapidly than the rest of the country [16]. Smoking rates also tend to be higher among people of low socioeconomic status [17] and tend to differ by race and ethnicity [18-20]. Using these statewide trends, it is likely that the smoking rates in the Newark study populations are different from those in the U.S. population.

It is not possible to predict whether or how the combined racial, ethnic, and socioeconomic differences between the study and U.S. populations could bias the analysis (in other words, whether they could be masking a true elevation in rates of asbestos-related disease.) However, any conclusions drawn from this health statistics review could be made more definitively if these differences were accounted for in the SIR, SMR, and SRR analyses.

2. The results of the analyses might be inaccurate if the study populations are larger or smaller than they are assumed to be.

Information on the size of the study populations during the study periods (1986–1995 for the cancer statistics review and 1989–1998 for the mortality statistics review) is needed to calculate the SIR, SMR, and SRRs as well as the 95% CIs. Information on the size of the populations in census tracts and ZIP codes is collected by the U.S. Census once every decade, but not during the intervening years. Therefore, to calculate the statistical measures of comparison, ATSDR made the customary assumption that the size of the study populations in 1990 (as determined by the U.S. Census) represents the average size of the populations during the study periods.

If this assumption does not hold true, then the results of the SIR, SMR, and SRR analyses will be biased (inaccurate). Specifically, if the size of the study populations in 1990 is smaller than the average size of the study populations during the study periods, then the SIR, SMR, and SRR will be inaccurately high numbers, and the statistical tests might falsely indicate a statistically significant excess of disease. And, conversely, if the size of the study populations in 1990 is larger than the average size of the study populations during the study periods, then the SIR, SMR, and SRR will be inaccurately low numbers, and the statistical tests might falsely indicate a lack of disease excess.

Without knowing the true size of the study populations during the study periods, it is not possible to predict whether these statistical measures might be biased or how they might be biased. Still, it is possible to obtain some sense of whether any bias is occurring by referring to information on the size of these populations during U.S. Census years (e.g. 1980, 1990). According to U.S. Census data, the census tract 4446 population grew by 60% between 1980 and 1990 and by 13% between 1990 and 2000 [21]. If these trends represent the growth of the census tract population between 1986 and 1995, then the assumed size of the cancer statistics review study population is smaller than the actual size. This difference will bias the values of the SIR, SRR, and 95% CIs in a way that makes them higher than they actually are.

The ZIP Code 94560 population grew 12% between the years 1990 and 2000 [21]. If this trend represents the growth of this population during the years 1989 and 1998, then the assumed size of the mortality statistics review study population is smaller than the true size. This difference will bias the values of the SMR, SRR, and 95% CIs in a way that makes them higher than they actually are.

In summary, if more accurate information on population size was used in the analysis, then the values of the SIRs, SMRs, and SRRs would be lower than they were in these results: the incidence and mortality rates in the Newark study populations might be even lower, in comparison to the rates in the U.S. population, than this analysis indicates.

3. The analysis might fail to observe a true excess of asbestos-related cancer and disease if the study populations include people who could not have been exposed to asbestos from the processing of vermiculite at the Newark plant.

This health statistics review would ideally evaluate the health status of only those people who were exposed to asbestos from the processing of Libby vermiculite at the Newark plant,

assuming that off-site contamination and exposure did occur. The effect of including people who were not exposed to asbestos in the study population is to lessen the ability to see an excess of asbestos-related disease in the population. This happens because the people who were never exposed to asbestos can make the population appear healthier than it would otherwise appear if they were not included in the analysis.

Due to several reasons (such as lack of information on whether asbestos pollution from the Newark plant occurred, lack of information on how far the asbestos pollution would have traveled in the air, and restrictions on the geographic area for which cancer and mortality statistics are available), it is likely that this health statistics review evaluated the occurrence of asbestos-related cancers and death in a population that included people who were never exposed to asbestos. Therefore, the SIRs, SMRs, SRRs and 95% CIs are likely to be smaller numbers than they would be if unexposed people were not included in the study population. The incidence and mortality rates in the Newark population might be higher, in comparison to the rates in the U.S. population, if the study populations only included people who were exposed to Libby asbestos from the processing of Libby vermiculite at the Newark plant.

4. The analysis might fail to observe a true excess of asbestos-related cancers and disease, attributable to vermiculite processing at the Newark plant if the study periods do not correspond to the years that this excess of disease would be expected to occur.

The diseases caused by exposure to asbestos take many years to develop. Current knowledge is that lung cancer will develop 20 to 30 years after exposure to asbestos, mesothelioma will develop 30 to 40 years after exposure, and asbestosis will develop 10 to 20 years after exposure. The Newark plant received shipments of Libby vermiculite between the years 1967 and 1992. Therefore, we would expect that any lung cancer caused by exposure to Libby asbestos would occur between 1987–2022, any mesothelioma caused by exposure to Libby asbestos would occur between 1997–2032, and any asbestosis caused by exposure to Libby asbestos would occur between 1977–2012.

This health statistics review evaluated the incidence rates and mortality rates from asbestos-related diseases between the years 1985–1996 and 1989–1998, respectively. These study periods do not correspond entirely to the years that disease caused by exposure to Libby asbestos is most likely to occur (see **Table E–4**). Therefore, it is possible that this analysis did not find an excess of asbestos-related disease in the Newark community because this excess of disease has not yet occurred.

Table E–4. Years That Disease Due to Exposure to Libby Asbestos From Vermiculite Processing at the Newark Plant Would Be Expected To Occur (Assuming That Hazardous Exposure Occurred), and Number of Study Period Years During Which Exposure-Related Disease Is Expected To Occur

Disease	Years during which asbestos-related disease is most likely to occur (based on latency period)	Number of years of overlap between the study period and the years that asbestos-related disease is most likely to occur	
		Cancer Statistics Review (1986–1995)	*Mortality Statistics Review (1989–1998)*
Cancer of the lung and bronchus	1987–2022	9	10
Mesothelioma	1997–2032	0	2
Asbestosis	1977–2012	—	10

5. The results of the health statistics review can serve as an indicator of community exposure to Libby asbestos only if the study populations include the people who were living near the Newark plant at the time that Libby vermiculite was processed.

According to the protocol for this health statistics review, finding a statistically significant elevation in asbestos-related disease in a community would alert CDHS and ATSDR to the possibility that community members might have been exposed to asbestos as a result of the facility's handling or processing of vermiculite from Libby. This interpretation is based on an assumption that the study population consists of people who were exposed to Libby asbestos. Therefore, this interpretation is appropriate only if the study populations include the people who were living near the Newark plant during the time that Libby vermiculite was processed.

Cancer registry and vital statistics records do not collect information on residential history. Therefore it is not possible to determine whether the people in the study populations lived near the Newark plant during the years that Libby vermiculite was processed. However, information on population mobility from the U.S. Census can provide some insight into the likelihood that the study populations included the people who were living near the Newark plant during the years that Libby vermiculite was processed (1967–1992).

According to the 2000 U.S. Census, at least 36% and as many as 58% of the people residing in census tract 4446 in 2000 moved into their homes prior to 1992, and at least 38% and as many as 56% of the people residing in ZIP Code 94560 in 2000 moved into their homes prior to 1992 [22]. Therefore, the study populations are likely to include people who were living near the Newark plant during the years of potential exposure. Interpreting the results of this health statistics review as an indicator of past community exposure is therefore appropriate.

Summary

The cancer statistics review did not find any evidence that the census tract 4446 population experienced statistically significantly higher incidence rates of asbestos-caused cancers (lung cancer and mesothelioma) than the U.S. population during the years 1986–1995. The SIR and SRR results for the remaining cancers evaluated in this review indicate that an excess of asbestos-related cancers in this Newark population is not being obscured by physician

misdiagnosis or discrepancies between the way that cancer diagnoses are reported to the CCR and SEER.

The mortality statistics review did find inconsistent evidence that the ZIP Code 94560 population experienced higher mortality rates from asbestos-related diseases than the U.S. population during the years 1989–1998. The SRR analysis indicated that the ZIP Code 94560 population had a 17% higher rate of death from lung and bronchus cancer and a 349% higher rate of death from asbestosis than the U.S. population, and that these differences were statistically significant. The SMR analysis also showed that the ZIP Code 94560 population had higher rates of death from these diseases than the U.S. population, but the statistical tests for this analysis indicated that these differences were consistent with normal variation in disease occurrence and therefore not unusual (not statistically significant). Although there were no recorded deaths from mesothelioma in the ZIP Code 94560 population, it is conceivable that deaths from mesothelioma were misdiagnosed and recorded as cancer – no site specified. If this were the case, then the ZIP Code 94560 population also had higher rates of death from mesothelioma, as measured by the SMR and the SRR. However, statistically speaking, only the SRR analysis found this elevation to be beyond what is considered normal.

Digestive organ cancers have been inconclusively linked to asbestos exposure in previous studies. This analysis found that the ZIP Code 94560 population had higher rates of death from digestive organ cancers than the U.S. population, as measured by the SMR and the SRR. However, statistically speaking, only the SRR analysis found the difference between the rates in the ZIP Code and U.S. populations to be unusual, given normal variation in the occurrence of these cancers.

The results of the mortality statistics review do not suggest that asbestos exposure led to premature or increased rates of death from respiratory and pulmonary diseases (chronic obstructive pulmonary disease, other diseases of the respiratory system, and diseases of the pulmonary circulation). There is also no evidence that the results are biased due to differences in the way that information on mortality is reported to the California Department of Health Services' Office of Vital Records and the National Center for Health Statistics.

A very similar protocol to the one used in this health statistics review identified a statistically significant excess of asbestos-related disease in the Libby, Montana, community. If the Newark study populations were similar to the Libby community in terms of level of exposure to Libby asbestos, population mobility, and other characteristics, then this type of analysis would be expected to also be able to detect a statistically significant excess of asbestos-related disease in the Newark community.

The Newark study populations differ from the Libby community in ways that increase the limitations of this type of analysis. Therefore, although the results of this health statistics review could be correctly reflecting that the health of the Newark community was not impacted by exposure to Libby asbestos, the lack of consistent evidence of disease excess could be due to any or all of the following reasons.

This analysis did not account for the ways in which the Newark and U.S. populations differ with respect to other risk factors for asbestos-related disease.

The assumptions about the size of the Newark study populations made the incidence and mortality rates in the Newark study populations appear more similar to the rates in the U.S. population than they truly are.

The study populations included people who were never exposed to Libby asbestos from the Newark plant, which also made the incidence and mortality rates in the Newark study populations appear more similar to the rates in the U.S. population than they truly are.

Given the years that exposure to Libby asbestos would have occurred, combined with the amount of time that asbestos-related disease takes to develop, this analysis might be failing to observe an excess of disease or death because the time period it evaluates precedes the time period that most of the disease attributable to Libby asbestos would occur.

These limitations do not negate the statistically significant excess of death from asbestos-related disease observed in this analysis, and the findings do not rule out the possibility that community members might have been exposed to hazardous levels of asbestos as a result of the facility's handling or processing of Libby vermiculite.

Conclusions

The number of people who were diagnosed with potentially asbestos-related cancers among the population living in the census tract of the W.R. Grace vermiculite-processing facility in Newark between 1986-1995 was not statistically significantly greater than would be expected, given the normal variation in the occurrence of cancer. The review used two different methods for comparison, which yielded similar results.

The mortality review analyzed the number of persons who died from potentially asbestos-related diseases living in the zip code of the facility between the years 1989-1998. These results were inconsistent. One method of comparison, the standardized rate ratio, found that mortality rates for cancer of the lung and bronchus, asbestosis, digestive organs, and chronic obstructive pulmonary disease, were statistically higher than that of the US population, although the other method of comparison, the standardized mortality ratio, did not.

The review did not find consistent evidence of elevated asbestos-related illness in the population near the W.R. Grace facility. However, the lack of consistent evidence of disease excess could be due to limitations of the analysis, rather than a lack of effect. These limitations include differences in risk factors for asbestos-related disease between the Newark population and the comparison population, changes in the persons living near the facility over time, and the long time period it may take for disease to develop following asbestos exposure.

Public Health Action Plan

The public health action plan is a collection of activities intended to ensure that this health statistics review also provides a plan of action to mitigate and to prevent adverse effects on human health resulting from exposure to asbestos from Libby vermiculite. Some activities have already been taken by CDHS or ATSDR. Others activities are either ongoing or planned for the future.

Actions Completed

CDHS conducted a needs assessment with the Alameda County Health Officer and Environmental Health Department, the goals of which were to educate the departments about the vermiculite health statistics review project, to obtain information about the extent and level of stakeholder concerns, to develop an information dissemination plan, and to identify ways that CDHS can support local efforts or activities pertaining to the Newark PlantNewark plant.

CDHS disseminated information materials on consumer products made with Libby vermiculite to increase public awareness of the potential for adverse health effects and ways to reduce or avoid current or future exposure to asbestos from this source.

CDHS briefed the Occupational Health Branch (of CDHS) about the asbestos contamination of Libby vermiculite, the facilities in California that processed this vermiculite, and the potential for workers at these facilities to have been exposed to asbestos.

Information on the potential for exposure and ways to reduce exposure to asbestos in vermiculite consumer products was included in this health consultation and provided to the Alameda County Health Officer and Environmental Health Director.

Ongoing Actions

CDHS will continue to provide technical assistance related to the vermiculite health statistics review to the Alameda County Health Officer and Environmental Health Director on the vermiculite health statistics review.

Planned Actions

ATSDR has funded health statistics reviews in 25 states with facilities that received Libby vermiculite. Once all of the results from participating states have been received, ATSDR will compare the SRRs for all the sites examined in order to identify trends that might not be apparent when each facility is evaluated individually. The results of the health statistics reviews will also be evaluated in combination with all information on environmental exposures to asbestos produced by research by the National Asbestos Exposure Review project of ATSDR. ATSDR will distribute the results of these analyses to contributing state health departments and other interested parties.

Using the results of ATSDR's review of health statistics for all vermiculite facilities nationwide, CDHS will conduct follow-up activities with the Alameda County Health Officer and

Environmental Health Departments. The specifics of these activities will depend on what is learned from the nationwide review.

References

1. Agency for Toxic Substances and Disease Registry. Health consultation on mortality in Libby, Montana. Atlanta: US Department of Health and Human Services; 2002.

2. Lybarger JA, Miller A, Kess S. Preliminary findings of medical testing of individuals potentially exposed to asbestosform minerals associated with vermiculite in Libby, Montana: an interim report for community health planning. Agency for Toxic Substances and Disease Registry. Atlanta: US Department of Health and Human Services; 2001.

3. Lybarger JA, Miller A, Kess S. Report to the community: medical testing of individuals potentially exposed to asbestosform minerals associated with vermiculite in Libby, Montana from July through November, 2000. Atlanta: US Department of Health and Human Services; 2001.

4. Horton D, Kaye W. Health statistics review protocol for US communities that received asbestos-contaminated vermiculite from Libby, Montana. Atlanta: Agency for Toxic Substances and Disease Registry; 2001.

5. Declines in lung cancer rates – California, 1988–1997. Mor Mortal Wkly Rep 49(47);1066–9. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4947a4.htm. Last accessed: April 20, 2004.

6. California Department of Health Services, Center for Health Statistics, Vital Statistics Query System. Vital statistic rate, lung cancer, California, 1997. Sacramento. Available at: http://www.applications.dhs.ca.gov/vsq/screen_age_dth.asp?cnty_cd=AA&YEAR_DATA=1997&Criteria=1&Res_occ=Residence&Birth_Death=Death&stats=2&cod_cd=11. Last accessed: April 20, 2004.

7. Chang HY, Chen CR, Wang JD. Risk assessment of lung cancer and mesothelioma in people living near asbestos-related factories in Taiwan. Arch Environ Health 54(3):194–201.

8. Magnani C, Dalmasso P, Biggeri A, Ivaldi C, Mirabelli D, Terracini B. Increased risk of malignant mesothelioma of the pleura after residential or domestic exposure to asbestos: a case-control study in Casale Monferrato, Italy. Environ Health Perspect 109(9):915–9.

9. Magnani C, Agudo A, Gonzalez CA, Andrion A, Calleja A, Chellini E, et al. Multicentric study on malignant pleural mesothelioma and non-occupational exposure to asbestos. Br J Cancer 83(1):104–11.

10. Bourdes V, Boffetta P, Pisani P. Environmental exposure to asbestos and risk of pleural mesothelioma: review and meta-analysis. Eur J Epidemiol 16(5):411–7.

11. Bureau of the Census. 1990 census population: American Factfinder, Summary tape file 3, tables: P001, P007, P012, P013, P060, P070, and P117. Washington: US Department of Commerce. Available at:

http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_lang=en&_ts=. Last accessed: April 27, 2004.

12. Breslow N, Day N. Statistical methods in cancer research, vol. 2 – the design and analysis of cohort studies. International Agency for Research on Cancer. New York: Oxford University Press; 1989.

13. Surveillance, Epidemiology, and End Results. SEER Cancer Incidence Public-Use Database, 1973–1997, SEER*Stat 3.0, April 2000.

14. Centers for Disease Control and Prevention. Unpublished data on US population mortality rates, 1989–1998. Hyattsville, MD: National Center for Health Statistics, Division of Vital Statistics; 2000.

15. Siegel M, Mowery PD, Pechacek TP, Strauss WJ, Schooley MW, Merritt RK, et al. Trends in adult cigarette smoking in California compared with the rest of the United States, 1978–1994. Am J Public Health 2000;90(3):372–9.

16. California Department of Health Services. Adult smoking trends in California. Sacramento: Tobacco Control Section; 1999. Available at: http://www.tturc.uci.edu/control/FSAdulttrends.pdf. Last accessed: July 13, 2004.

17. California Department of Health Services. May 26, 2004 news release: California's adult smoking declines to historic lows. Sacramento. Accessed at: http://www.dhs.ca.gov/tobacco/documents/PressRelease5-26-04.pdf. Last accessed: June 15, 2004.

18. Prevalence of cigarette use among 14 racial/ethnic populations—United States, 1999–2001. MMWR Morb Mortal Wkly Rep 53(3):49–52.

19. Cigarette smoking among adults—United States, 1988. MMWR Morb Mortal Wkly Rep 40(44):757–9, 65.

20. Cigarette smoking among adults—United States, 1991. MMWR Morb Mortal Wkly Rep 42(12):230–3.

21. Geolytics, Inc. CensusCD—40 Years. (cd-rom); 2001.

22. Bureau of the Census. 2000 census population: American Factfinder, Summary File 3 (SF 3) – Sample Data, Tables: HCT9, Total population in occupied housing units by tenure by year householder moved into unit. Washington: US Department of Commerce. Available at: http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_lang=en&_ts=. Last accessed: April 27, 2004.

Addendum 1. Standardized Incidence Ratio

The standardized incidence ratio (SIR) is a measure that compares the incidence rate of disease in two populations. In this health statistics review the SIR compares, for the time period 1986 through 1995, the number of people who were diagnosed with a type of cancer while residing in census tract 4446 and the number of people expected to be diagnosed with cancer if the incidence rate of cancer in the census tract 4446 population was the same as the incidence rate in the U.S. population. The SIR was calculated to account for ways in which census tract 4446 and U.S. populations differ in terms of age and sex.

The SIR is calculated in two steps.

Step 1. The expected number is calculated by (1) multiplying the incidence rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the census tract 4446 population, and then (2) summing the products to obtain the total number of expected cases in the census tract 4446 population.

Step 2: The SIR is calculated by dividing the actual number of people who were diagnosed with cancer by the expected number.

These steps are demonstrated in the accompanying table for all types of cancer.

	U.S. incidence rate for all types of cancer 1986–1995		Number of persons in census tract 4446 1986-–1995		Number expected to have any type of cancer in census tract 4446 1986–1995
STEP 1					
Females					
0 to 4	0.000188	×	14,260	=	2.7
5 to 9	0.000097	×	11,620	=	1.1
10 to 14	0.000116	×	11,010	=	1.3
15 to 19	0.000205	×	11,820	=	2.4
20 to 24	0.000351	×	13,990	=	4.9
25 to 29	0.000605	×	14,260	=	8.6
30 to 34	0.000948	×	13,290	=	12.6
35 to 39	0.001601	×	10,750	=	17.2
40 to 44	0.002631	×	7,730	=	20.3
45 to 49	0.004182	×	5,790	=	24.2
50 to 54	0.005868	×	4,370	=	25.6
55 to 59	0.008014	×	3,700	=	29.7
60 to 64	0.010734	×	3,990	=	42.8
65 to 69	0.013577	×	3,380	=	45.9
70 to 74	0.016334	×	2,170	=	35.4
75 to 79	0.018378	×	1,540	=	28.3
80 to 84	0.019683	×	1,060	=	20.9
85 & up	0.019640	×	1,590	=	31.2
Males					
0 to 4	0.000216	×	2,610	=	3.2
5 to 9	0.000123	×	1,950	=	1.6
10 to 14	0.000124	×	1,540	=	1.4
15 to 19	0.000210	×	1,600	=	3.0
20 to 24	0.000333	×	2,440	=	6.1
25 to 29	0.000573	×	5,330	=	10.3
30 to 34	0.000871	×	4,430	=	13.1
35 to 39	0.001191	×	3,340	=	14.7
40 to 44	0.001630	×	2,610	=	14.5
45 to 49	0.002697	×	1,890	=	16.7
50 to 54	0.004991	×	1,140	=	23.7
55 to 59	0.008856	×	640	=	32.2
60 to 64	0.014763	×	560	=	45.3
65 to 69	0.022620	×	550	=	57.9
70 to 74	0.030244	×	310	=	48.7
75 to 79	0.035267	×	180	=	36.3
80 to 84	0.038441	×	230	=	21.1
85 & up	0.037822	×	40	=	16.3
Total number of expected cases:					***721.2***
STEP 2					

SIR = $\frac{\textbf{552}}{\textbf{721.2}}$ **= 0.77**

Addendum 2. Standardized Rate Ratio

The standardized rate ratio (SRR) compares the incidence or the mortality rate for a disease in two populations. For the cancer statistics review, the SRR compares the number of people in the United States who were diagnosed with a type of cancer and the number of people expected to be diagnosed if the U.S. population had the same incidence rate as the census tract 4446 population. For the mortality statistics review, the SRR compares the number of people in the United States who died from a disease and the number of people expected to die if the U.S. population had the same mortality rate as the ZIP Code 94560 population.

The SRR is calculated in a way that accounts for ways in which the study populations and the U.S. population differ in terms of age and sex. The SRR is calculated in two steps.

Step 1. the expected number of cases or deaths in the U.S. population is calculated by (1) multiplying the incidence or mortality rate in each age and sex group in the study population by the number of people in those age and sex groups in the U.S. population and then (2) adding the products.

Step 2. The SRR is calculated by dividing the expected number of cases or deaths (calculated in step 1) by the actual number of cases or deaths that occurred.

These steps are shown in the accompanying table for the mortality rate of all types of cancer.

	ZIP Code 94560 mortality rate, cancer - all types, 1989–1998		Number of people in the United States 1989–1998		Expected number of deaths in the United States 1989–1998
STEP 1					
Females					
0 to 4	0.000059	×	93,966,244	=	5,583.3
5 to 9	0.000000	×	91,867,322	=	0.0
10 to 14	0.000000	×	89,304,231	=	0.0
15 to 19	0.000000	×	87,811,833	=	0.0
20 to 24	0.000000	×	90,427,466	=	0.0
25 to 29	0.000049	×	98,755,306	=	4,876.8
30 to 34	0.000200	×	108,681,120	=	21,725.4
35 to 39	0.000200	×	107,902,167	=	21,623.7
40 to 44	0.000641	×	98,780,341	=	63,275.7
45 to 49	0.000460	×	82,737,629	=	38,040.3
50 to 54	0.001649	×	67,120,643	=	110,714.5
55 to 59	0.002740	×	57,368,622	=	157,174.3
60 to 64	0.003748	×	54,716,238	=	205,069.4
65 to 69	0.005111	×	54,396,949	=	278,028.9
70 to 74	0.007764	×	48,337,651	=	375,292.3
75 to 79	0.007836	×	39,220,867	=	307,327.7
80 to 84	0.037288	×	27,563,804	=	1,027,802.9
85 & up	0.011628	×	24,880,271	=	289,305.5
Males					
0 to 4	0.000000	×	98,444,382	=	0.0
5 to 9	0.000064	×	96,375,416	=	6,162.1
10 to 14	0.000000	×	93,779,769	=	0.0
15 to 19	0.000079	×	92,727,275	=	7,289.9
20 to 24	0.000066	×	93,916,511	=	6,178.7
25 to 29	0.000099	×	99,300,884	=	9,788.2
30 to 34	0.000047	×	107,836,073	=	5,072.3
35 to 39	0.000127	×	106,638,555	=	13,532.8
40 to 44	0.000530	×	96,528,396	=	51,189.3
45 to 49	0.000948	×	79,706,353	=	75,551.0
50 to 54	0.001628	×	63,474,519	=	103,358.9
55 to 59	0.002395	×	52,786,640	=	126,435.1
60 to 64	0.004874	×	48,333,937	=	235,562.5
65 to 69	0.008924	×	44,815,676	=	399,929.9
70 to 74	0.019672	×	36,773,021	=	723,403.7
75 to 79	0.010833	×	26,482,551	=	286,894.3
80 to 84	0.009836	×	15,345,068	=	150,935.1
85 & up	0.034483	×	9,774,311	=	337,045.2
Total number deaths expected in United States					***5,444,169.4***
STEP 2					

SRR = $\frac{\textbf{5,444,169.4}}{\textbf{5,259,810}}$ = 1.04

Addendum 3. Standardized Mortality Ratio

The standardized mortality ratio (SMR) is a measure that compares the mortality rate for a disease in two populations. In this health statistics review, the SMR compares, for the time period 1989 through 1998, the number of people who died from a disease while residing in ZIP Code 94560 to the number of people who would be expected to die if the mortality rate for the disease in the ZIP Code 94560 population were the same as the mortality rate for the disease in the U.S. population. The SMR was calculated in a manner that accounts for ways in which the ZIP Code 94560 and U.S. populations differ in age and sex.

The SMR is calculated in two steps.

Step 1. The expected number of deaths is calculated by (1) multiplying the mortality rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the ZIP Code 94560 population, and then (2) summing the products to obtain the total number of expected deaths in the ZIP Code 94560 population.

Step 2: The SMR is calculated by dividing the actual number of deaths that occurred by the expected number (calculated in step 1).

These steps are demonstrated in the accompanying table for death from all types of cancer.

	U.S. mortality rate for all types of cancer 1989–1998		Number of people in ZIP Code 94560 1989–1998		Expected number of deaths in ZIP Code 94560
STEP 1					
Females					
0 to 4	0.000027	×	16,830	=	0.5
5 to 9	0.000026	×	15,820	=	0.4
10 to 14	0.000024	×	13,680	=	0.3
15 to 19	0.000033	×	12,510	=	0.4
20 to 24	0.000045	×	12,330	=	0.6
25 to 29	0.000082	×	20,250	=	1.7
30 to 34	0.000162	×	20,010	=	3.2
35 to 39	0.000319	×	14,970	=	4.8
40 to 44	0.000591	×	14,050	=	8.3
45 to 49	0.001075	×	13,050	=	14.0
50 to 54	0.001851	×	9,700	=	17.9
55 to 59	0.002916	×	8,030	=	23.4
60 to 64	0.004336	×	5,870	=	25.5
65 to 69	0.005933	×	4,500	=	26.7
70 to 74	0.007832	×	3,220	=	25.2
75 to 79	0.009567	×	2,680	=	25.6
80 to 84	0.011546	×	590	=	6.8
85 & up	0.014049	×	860	=	12.1
Males					
0 to 4	0.000031	×	16,870	=	0.5
5 to 9	0.000032	×	15,640	=	0.5
10 to 14	0.000032	×	13,380	=	0.4
15 to 19	0.000047	×	12,720	=	0.6
20 to 24	0.000064	×	15,200	=	1.0
25 to 29	0.000090	×	20,290	=	1.8
30 to 34	0.000145	×	21,260	=	3.1
35 to 39	0.000252	×	15,760	=	4.0
40 to 44	0.000498	×	13,200	=	6.6
45 to 49	0.001033	×	12,660	=	13.1
50 to 54	0.002057	×	10,440	=	21.5
55 to 59	0.003744	×	8,350	=	31.3
60 to 64	0.006262	×	5,540	=	34.7
65 to 69	0.009319	×	3,810	=	35.5
70 to 74	0.012953	×	1,830	=	23.7
75 to 79	0.016628	×	1,200	=	20.0
80 to 84	0.021582	×	1,220	=	26.3
85 & up	0.027371	×	290	=	7.9
Total number of expected deaths:					***429.9***
STEP 2					

$$\text{SMR} = \frac{381}{429.9} = 0.89$$