

STUDY OF CANCER MORTALITY IN
CHRYSTOLE ASBESTOS MINING COUNTIES
Final Report

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ABSTRACT

The purpose of this study was to implement key data gathering tasks of an epidemiological study protocol formulated as part of the initial program phase. These activities included the asbestos analysis of air and water samples and the identification and development of a study subject data base.

Initially, the ultimate objective of this program was formulated as the evaluation of the hypothesis:

Deaths due to respiratory tract cancer, mesothelioma, and cardiovascular disease are associated with the length of residence proximal to asbestos mining activities after controlling for the effects of cigarette smoking, occupation, and genetic susceptibility.

California death record tapes were secured for the period 1969 through 1978 for the two counties with the most extensive deposits of asbestos bearing serpentine mineral formations. County residents were subdivided according to cause of death as given by the three and four digit ICDA codes. Case and control groups were defined in order to investigate whether the geographical distribution of residence associated with particular categories (case group) differed from that of the control causes. Three case groups were developed for males and females with two controls for each case. Causes of death known to be associated with occupational asbestos exposure were generally taken as case categories whereas controls were selected with precisely the opposing criterion. Case groups were digestive tract cancer, respiratory tract cancer and heart disease with hypertension. Control groups were reproductive cancers, heart disease without hypertension and general categories.

In order to associate an inhalation and ingestion exposure index with each individual's residential history, ambient concentrations of asbestos were determined for airborne and waterborne pathways. The California Air Resources Board made available their archive of cellulose high volume air sampler filters from the early 1970 time period. Twenty two filters were selected for electron microscopic analysis. These encompassed the

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geographical area of importance including the adjacent counties with areas outside the serpentine mineral formations. All samples were analyzed for chrysotile content by scanning electron microscope and several by transmission electron microscope as a quality assurance measure. In the serpentine area fiber counts all exceeded $1.0 \times 10^5/\text{m}^3$ and ranged to $3.7 \times 10^6/\text{m}^3$ (12 samples 6.7×10^5 average). In the non-serpentine areas all fiber counts were less than $1.0 \times 10^5/\text{m}^3$ and averaged $4.9 \times 10^4/\text{m}^3$.

Water samples were gathered throughout the area and analyzed for chrysotile concentration. Eight samples contained chrysotile concentrations above the detectable limit of approximately 0.4×10^6 fibers/liter. The highest concentration measured was approximately 20×10^6 fibers/liter.

Examination of air and water asbestos concentration findings permitted the assignment of an air exposure index-high, medium, low- to each residence community. Water asbestos were insufficiently elevated and geographically coherent to support the definition of an exposure index.

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1.0 INTRODUCTION-HISTORY-SUMMARY

This report documents the second phase of a research effort concerning the association between ambient asbestos and cancer mortality. This segment was primarily a data gathering activity and consisted of air and water sampling for asbestos in the Calaveras and Tuolumne counties of California; collection and coding of certain categories of mortality data for the period 1969-1978; and assignment of asbestos exposure indices to the study subjects. In addition standardized mortality ratios (SMR's) were calculated for somewhat broader mortality categories in the two counties for three years 1969-1971. These SMR values were compared with the expected number of deaths for each cause based upon three-year California rates.

In 1978 the U.S. Environmental Protection Agency performed an in-house study of age adjusted mortality rates in asbestos mining counties across the United States. The results showed increased mortality ratios for buccal and pharyngeal cancer, respiratory cancer, urinary tract cancer and deaths from hypertensive heart disease. Relative risks for these causes of death ranged from 1.2 and 5.6.

One of the limitations of this study was that the exposure to asbestos was defined not on the basis of environmental measurements in the communities, but by census information on mining. The investigators concluded that further investigation was needed and EPA decided to contract (competitively) to fund a case/control study that would include measurements of ambient asbestos exposures. SAI was awarded the procurement in September 1979. The first steps of the program included selecting the most suitable counties for study (resulting in Calaveras and Tuolumne), designing the epidemiological protocol, and developing an air and water sampling and analysis plan. Calaveras and Tuolumne counties were selected for several reasons: A rich and extensive asbestos bearing serpentine formation traverses the western portion of both counties. These counties are rural and individuals tend to be exposed to fewer confounding hazardous emissions. The exposure of this population to asbestos was hypothesized to be significantly elevated in localized portions of the counties while at low background levels in other parts of the counties.

Computer tapes of mortality data were obtained from the office of the State Registrar of Vital Statistics for the two counties for the time period 1969-1978. The data were sorted into computer files according to cause of death (ICDA code), sex, age, and county of residence.* The epidemiologic protocol design was to identify three case groups each of males and females. Each case group consisted of a selected set of causes of death known or suspected of being associated with occupationally related exposure to asbestos. Two control groups were identified for each case group with their selected causes of death categories known to be unrelated to asbestos exposure.

The overall approach thus for each case subject is to identify by age and sex matching, two control group members and associate with each an asbestos exposure index based upon their residence location.

In order to investigate whether air and water ambient levels of asbestos were elevated and to determine their gradients across the county a sampling and analysis approach was designed based upon knowledge of the water distribution systems, populations, and air quality monitoring stations. It was predicted that roughly half the population in these two counties might have been exposed to elevated concentrations of asbestos in the air and/or water.

In September 1980 EPA approved the study protocol and SAI was issued a new contract to collect the mortality and exposure data. This report documents that contract.

The California Air Resources Board provided assistance to SAI in this study phase by making available their archives of high volume air sampler filters for the earliest time period still retained i.e. 1972 through 1974.* Twenty-two cellulose filters were selected for electron microscopic analysis. These encompassed all geographical areas of importance. Results were clear-cut. In the serpentine area fiber counts all exceeded 100,000 fibers/m³, ranged to 3,700,000 and averaged 675,000 for 12 samples. In the non-serpentine areas all samples (10) had fiber counts less than 100,000

* As opposed to county of death.

* It is most desirable to obtain past asbestos concentration information since this more closely reflects the exposure the subject population received

fibers/m³ and averaged 49,000. Blanks and duplicates were run as quality assurance measures.

Since no archived water samples were available, twenty four were gathered from throughout the two counties in order to comprehensively characterize the asbestos content in each distinct water distribution system. Eight samples contained chrysotile concentrations above the detectable limit of approximately 400,000 fibers/liter. The highest concentration value measured was approximately 20×10^6 fibers/liter which may have been a local phenomenon associated with cement asbestos pipe transport. Unlike the airborne case, waterborne levels were neither significantly elevated nor geographically coherent to support the development of an exposure index.

In summary the airborne levels of asbestos found in communities in the serpentine formation areas are significantly elevated over non-serpentine areas and are more illustrative of occupational environments although the fiber sizes distribution is biased toward the fines. Importantly, of course, those exposed is a non-occupational population which is typically less hardy.

The following case and control groups with identifying cause of death codes (ICD, 8th revision) are being utilized for males and females:

<u>Case</u> <u>Groups</u>	<u>Control</u>	<u>Corresponding</u> <u>Groups</u>
1. Trachea, Bronchus and Lung Cancer (ICD 162.0-162.9)	General Causes (various ICD numbers)	Reproductive Cancers (ICD 174, 185-187.9)
2. Digestive Tract Cancer (ICD 150.0-159.9)	General Causes	Reproductive Cancers
3. Hypertensive Heart Disease (ICD 400.0- 404.9, 410.0, 411.0, 412.1-412.2)	General Causes	Non-Hypertensive Heart Disease (ICD 410.9, 411.9, 412.3-412.4)

The total study population is 1382 individuals.

The study group was developed from the State computer tapes discussed above. In order to obtain the information necessary to support the mortality analysis, the death certificate hard copy was located, information abstracted, coded and placed on tape. The death certificate abstract form is shown as Figure 2.1-2. All necessary information has been coded to initiate the tracing of the surviving spouse or informant if that is ever needed.

Subsequent effort for this research would begin at this point. It would be appropriate to perform the analysis of this data base and test for associations between cause of death and the area of residence within the counties. Specifically the correlation between a case group, e.g. the 85 males deceased from the categories of hypertensive heart disease, and their airborne asbestos exposure based on residence history would be statistically contrasted with the 85 age matched males deceased from general causes and finally the 85 who died of non-hypertensive heart disease.

This approach was formulated as the most cost-effective procedure to determine if any categories of mortality correlated with asbestos exposure and to prioritize them.

The master plan for completion of the study, as envisioned by EPA, would be to perform a next of kin survey to improve upon the information base coded from the death certificate. A questionnaire was developed in the initial EPA sponsored contract which primarily obtains or verifies information on smoking, drinking and residence and occupational history. Next of kin interviews would only be considered later for specific case group categories where a convincing association with exposure was found.

2.0 BACKGROUND REVIEW

2.0.1 Health Risks

Health effects due to the occupational exposure to asbestos has been studied particularly in the mining, milling, textile, and construction industries. In their review of findings, EPA researchers (Acquavella, et al. 1979) cited studies* of human cohorts implicating asbestos as a factor in increased mortality from several types of malignancy: mesothelioma, lung and laryngeal cancer (especially for smokers), and possibly GI cancer. Mortality from non-cancerous conditions of the respiratory and possibly cardiovascular system has also been related to chronic occupational exposure (Mancuso, 1967; McDonald, 1971).

Studies have examined the risk of increased mortality among residents in neighborhoods proximal to asbestos processing facilities, in areas with natural asbestos deposits, and in communities having identifiable asbestos fibers in public drinking water. Historically such studies have been equivocal. However, recently with the emergence of two key factors (electron microscopy and cancer incidence registries) several studies undertaken have identified and quantified a risk factor among communities with elevated asbestos exposure to airborne and/or waterborne concentrations.

Specifically Graham (1977) demonstrated, through use of tumor registry data, residents in several Quebec communities had risks from 1.5 to 8.1 times higher than control communities for 10 different cancer sites among males and for seven sites among females. The most prominent excesses were found for cancer of pleura, small intestine, salivary gland, peritoneum, lip and tongue for males; and lip and pleura, salivary gland, kidney and melanoma for females.

* Kleinfield, 1967; Mancuso, 1967; McDonald, 1971; McDonald, 1974; Miller, 1978.

Kanarek et al. 1980, analyzed the asbestos content in the water distribution systems supplying the San Francisco-Oakland Standard Metropolitan Statistical Area (SMSA). The dependent variable of interest was cancer incidence adjusted for age, sex and race. The major independent variable was chrysotile asbestos fiber content. Kanarek showed elevated mortality from cancers of the esophagus, stomach, gall bladder, and pancreas.

Acquavella et al., 1979 investigated the hypothesis that cancer as well as respiratory and cardiovascular disease mortality would be in excess in chrysotile asbestos mining counties across the country. Although national in scope, California figured large in this study since it accounts for over 70% of total U.S. asbestos production. Mortality data from the years 1969-1971 were obtained from the POPATRISK data base. Unfortunately this data base coarsely groups respiratory and digestive tract cancers and does not allow their subdivision into sub-groupings of more specific occupationally asbestos-related sites. Two critical features of the study protocol were that the county level was the smallest population breakdown and in a related limitation a localized source of emissions such as a plant or region of natural asbestos deposits could not be expected to affect the ambient air of an entire county. Thus the study would overestimate the population at risk and therefore dilute potential associations. The study protocol had no mechanism for considering occupational exposure. Control counties were matched according to population density. The results showed increased mortality ratios for buccal and pharyngeal cancer, respiratory cancer, urinary tract cancer, and deaths from hypertensive heart disease. Relative risk for these causes of death ranged from 1.2 to 5.5.

2.0.2 Determination of Air and Water Ambient Asbestos Levels

SAI undertook research to follow-up on the EPA effort discussed above. The purpose of the work was to design and execute an epidemiologic study protocol to further evaluate the hypothesis that asbestos related health effects have been observed among populations without occupational exposure. Two distinct California areas with extensive asbestos bearing serpentine formations were researched. One is associated with a deposit running through the junction of Fresno and San Benito counties (New Idria Deposit). The second is located throughout the western sections of Calaveras and Tuolumne

counties (herein referred to as the Calaveras Deposit). The preferable study area was determined to be that associated with the Calaveras Deposit. Selection criteria were three-fold: greater population base, evidence of elevated airborne and waterborne concentrations of asbestos, and the existence of archives (CARB) of useful ambient air sampler filters dating back over seven years.

Figure 2.0-1 illustrates the asbestos deposits in California. The New Idria and Calaveras Deposits are among the richest and most extensive in the state and contain the only active commercial sites. Figure 2.0-1 depicts the general area of Calaveras and Tuolumne counties.

The oldest measured ambient levels of airborne asbestos taken in the western county area was reported by the California Department of Health in 1965-1967 (California Department of Public Health, 1967). Ambient (upwind) asbestos concentration was measured by dust sample collection through impingers. Quantification was by optical microscopy. Ambient levels on two separate occasions were made and ranged between 0.1 and 2 million particles per cubic foot of air (mppcf). A federal study at about the same time of the area "Environmental Survey of Asbestos Mining and Milling in California " (December 1966, Public Health Service Division of Occupational Health) suggests the equivalence $10 \text{ total fibers/cc} = 1 \text{ mppcf}$ by impinger. In the cited ambient concentrations (from the NIOSH Recommended Asbestos Standards) the levels across the country are summarized as generally $<10 \text{ ng/m}^3$ with occasional peaks as high as 100 ng/m^3 (by electron microscopy). Using optical microscopy, ambient levels are generally less than $0.01 \text{ fibers} > 5 \mu\text{m/cc}$ with peak values as high as $0.03 \text{ fibers} > 5 \mu\text{m/cc}$. Using the Public Health Service equivalence $6 \text{ fibers} > 5 \mu\text{m/cc}$, 1 mppcf by impinger yields the mine area ambient (upwind) concentration range $0.6 - 12 \text{ fibers/cc}$.* Further using the NIOSH suggested equivalent $20 \text{ fibers} > 5 \mu\text{m}$ in length (as determined by optical microscopy) per nanogram of asbestos yields the mine ambient range $12 - 140 \text{ ng/m}^3$. Thus the ambient levels detected at upwind locations in the vicinity of a Calaveras mine/mill are at the extreme high end of surveyed range. A number of subsequent studies of the general area have confirmed that quite elevated concentrations of airborne asbestos exist. The most recent, of course, being the comprehensive analysis done of the area performed by SAI for EPA in 1980.

* Note the current NIOSH recommended standard is 0.1 fiber/cc for an 8 hour time-weighted average (as detected by optical microscopy).

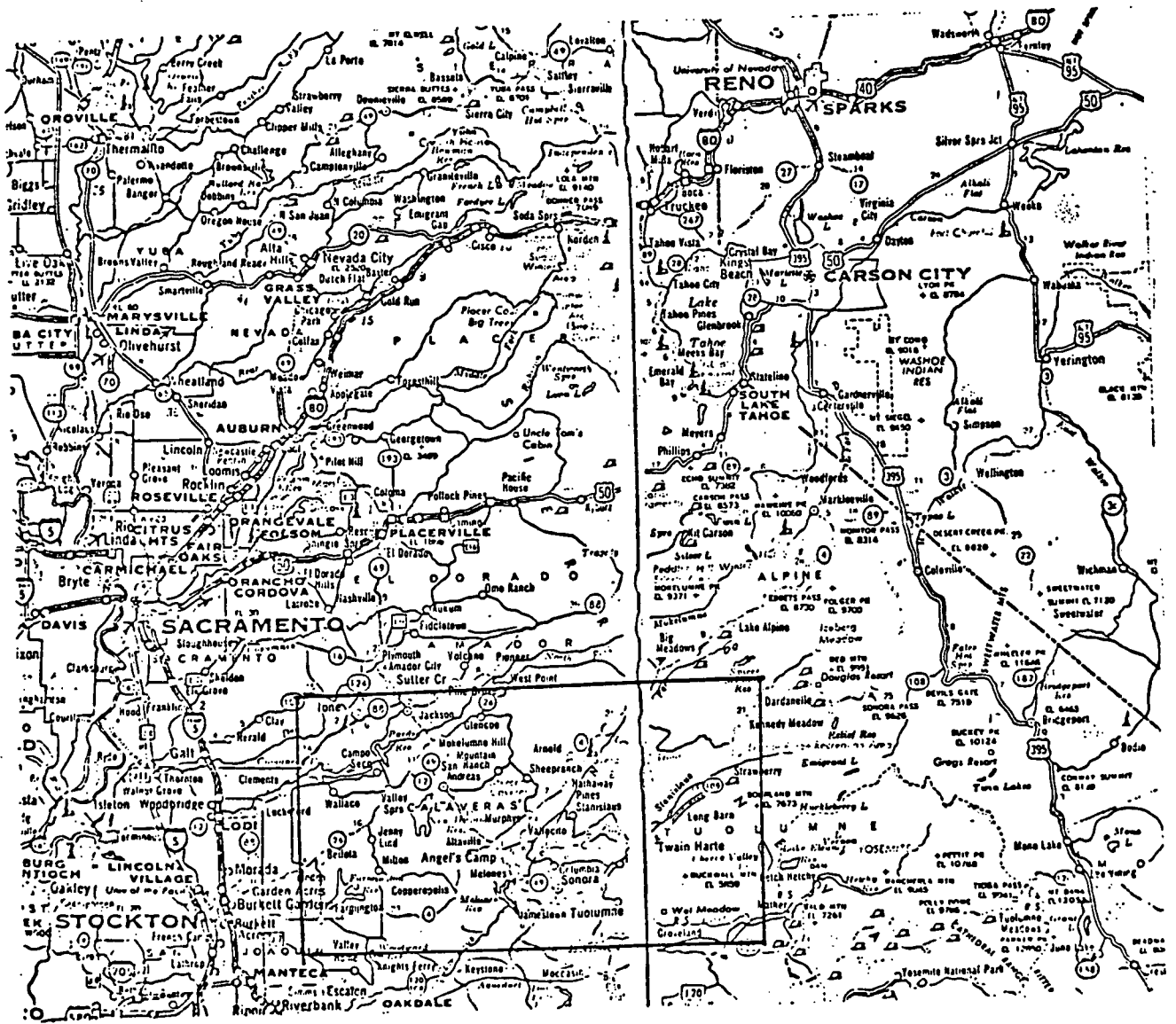


Figure 2.0-2 Serpentine Areas of Calaveras and Tuolumne Counties.

The California Air Resources board provided hi-vol sampler filters from geographical areas of interest. Available samples went back to 1972. Analysis of these filters provided an important basis for the determination of airborne asbestos exposure to the study population.

Filter selection procedure was to obtain 22 filters accounting for seasonal variation at significant single locations, coverage of the entire geographical region, and representation of suspected high and low suspended particulate values. In addition, all hi-vol filter flow traces were inspected to confirm that regular flow rates occurred throughout the collection period and that no data tampering was evidenced.

Table 2.0-1 summarizes the results of the scanning electron microscope analyses. Fiber counts and other data should be read as follows for SAI number 81-1101 there were 3,251,00 fibers/m³ in the fiber size range of less than 5 microns length. Figure 2.0-3 and Table 2.0-2 can be used to explicitly interpret all sample locations. As can be readily seen from Table 2.0-1 the first twelve readings (sites 55922, 55921 and 22741) are significantly elevated over the remainder. i.e. serpentine deposit sites compared to non-serpentine. Furthermore the serpentine area concentrations must be assessed as extremely high by any measure and would be of note even in an occupational environment.

In addition to analysis by scanning electron microscopy several analyses were performed by TEM (transmission electron microscope) as a quality assurance procedure. TEM Analysis was conducted using a Hitachi Model H-500 Scanning Transmission Electron Microscope equipped with both SAED and Dispersive X-ray capabilities. Two grids for each sample were counted at a magnification of 10,000X and the diameter measurements were made at magnifications of 100,000X or 200,000X. The magnifications were calibrated using a carbon grating replica. Chrysotile fibers were identified according to morphology and/or selected area electron diffraction. Comparison of TEM and SEM analysis for 81-1116-2 (Sonora 55922 9/20/74) and 81-1235 (Van401ELD 09001 8/14/73) are summarized in Table 2.0-3.

The fiber counts for the TEM analysis are slightly higher due to the higher resolving power of the TEM.

Table 2.1-1
SUMMARY ASBESTOS ANALYSIS BY ELECTRON MICROSCOPY OF STUDY AREA HI-VOL FILTERS

SAI Number	Location	Site	Collection Date	fibers/m ³ ≤5μm (10 ⁻³)	fibers/m ³ >5μm (10 ⁻³)	mass/m ³ ≤5μm (10 ⁻³)	mass/m ³ >5μm (10 ⁻³)	Surface area/m ³ ≤5μm (10 ⁻³)	Surface area/m ³ >5μm (10 ⁻³)
81-1101	Sonora	55922	08-08-73	3251	448	221	147	2513	1578
81-1097	Sonora	55922	10-25-73	232	24	118	15	379	127
81-1116	Sonora	55922	09-20-74	704	12	46	18	456	105
Δ81-1094	Sonora	55922	12-30-73	247±145	44±23	37±21	24237±33748	234±130	5205±6243
81-1120	Sonora	55922	06-28-74	106	8.4	13	380	89	333
81-1099	Sonora	55922	09-25-73	388	38	43	16	332	185
81-1121	Sonora	55922	04-05-74	231	26	31	27	201	122
81-1118	Sonora	55922	07-22-74	153	9.5	86	1461	204	752
81-1102	Sonora	55921	07-15-73	378	73	73	202	401	526
*81-1106	Sonora	55921	05-24-73	1031±253	79±60	268±130	435±214	1305±106	2100±183
81-1110	Sonora	55921	03-23-73	86	14	3.8	103	45	216
81-1092	Mariposa	22741	07-11-72	417	31	44	7.2	360	104
81-1231	Camino	09663	04-10-73	7.5	0.0	0.4	0.0	4.5	0.0
81-1232	Placerville	09664	04-10-73	29	13	1.6	7.5	15	61
81-1235	Van 401 ELD	09001	08-14-73	14	0.0	0.5	0.0	6.3	0.0
81-1199	Modesto	50557	07-26-72	66	16	10	160	59	232
81-1204	Stockton	39252	07-25-72	29	0.0	5.1	0.0	40	0.0
81-1213	Leevining	26772	09-20-72						
81-1217#2	Madera	20001	11-20-72	46	1.9	1.3	11	21	37
81-1218	Madera	20002	03-13-73	79	8.3	3.1	2.8	38	23
81-1197	Bridgeport	26773	04-07-73	10	3.4	0.1	39	2.0	74
81-1196	Van 201 ELD	09301	06-15-73	18	0.0	11	0.0	33	0.0
Sample blank #29 (same ashed blank dilution as sample filters)				0.0	0.0	0.0	0.0	0.0	0.0
Sample blank #2 (10 fold ashed blank dilution as sample filters)				7.0	0.8	0.3	3.4	4.4	9.6
Sample blank #2 (10 fold aerosol O.T. and filtered water blank)				0.0	0.0	0.0	0.0	0.0	0.0

*denotes filter variation within one sample filtration

Δdenotes sample variation between two separately filtered samples

Figure 2.0-3 Site Locations of Samples Analyzed for Asbestos

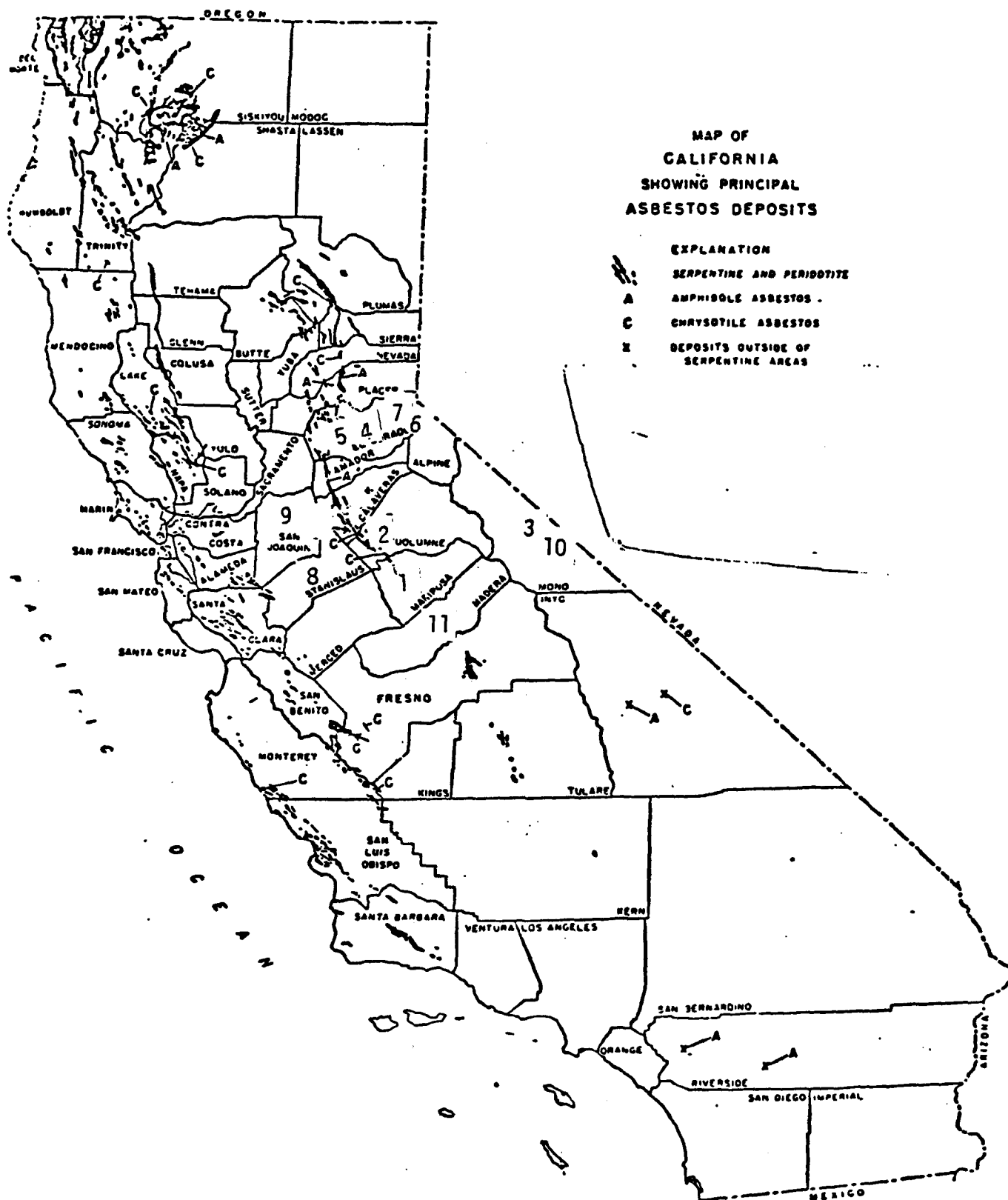


Table 2.0-2 Ambient Asbestos Samples-Site Designations

<u>Site Designation</u>	<u>Site Location</u>	<u>Sample Date</u>
1	Mariposa	7/11/72
2A	Sonora Location #1	3/23/73, 5/24/73, 7/15/73
2B	Sonora Location #2	8/8/73, 9/25/73, 10/25/73, 12/30/73, 4/15/74, 6/28/74. 9/20/74
3	Bridgeport	4/7/73
4	Camino	4/10/73
5	Placerville	4/10/73
6	Van 201	6/15/73
7	Van 401	8/14/73
8	Modesto	7/26/72
9	Stockton	7/25/72
10	Lee Vining	9/20/72
11A	Madera #1	11/20/72
11B	Madera #2	3/13/73

The surface area and mass values are slightly higher in the SEM analysis which is probably due to the apparently larger fiber diameters which result either from gold coating the filters or problems with resolution above magnifications of 50,000X.

Appendix A contains information on the procedures used for the preparation and analysis of the electron microscopy effort. The microscope facilities are described and additional remarks are made pertaining to the results and conclusions.

Analysis of the turbidity and asbestos content of water samples was conducted by the Exposure Evaluation Branch of the Epidemiology Division, Health Effects Research Laboratory, EPA Cincinnati: Twenty three water samples were gathered by SAI staff encompassing the population centers and water distribution systems. Table 2.0-4 delineates the sampling sites and Table 2.0-5 summarizes the analysis results. The water distribution system location and types - both historic and current were discussed in the final report from the initial contract (Ziskind, 1980). Ten samples contained statistically significant amounts of chrysotile asbestos with three samples over 1 million fibers per liter. The highest concentration measured was at Groveland (20×10^6 fibers/liter) and appears to be due to aggressive water transport through asbestos cement pipe (Personal Communication B. Beaudreau, General Manager, Groveland Commercial Services District). The pH in the Groveland system decreases to approximately 6.0 after gas chlorination. Lime treatment is planned to raise pH to greater than 9 which should reduce the asbestos content in the water. In any event the system is localized and fairly recent (16 years).

It was concluded that asbestos concentration in water was neither particularly elevated nor distributed with a sufficient gradient to warrant creating an exposure index for use in the epidemiologic protocol. It was decided, on the other hand, that airborne concentration of asbestos fulfilled both criteria (sufficiently elevated levels and geographic gradient) and exposure indices were formulated. Categories of asbestos concentration areas in the two counties were defined as either high, medium and low according to whether they were less than 5 miles from deposits, between 6 and 10 miles, or greater than 10 miles. Deposits were readily located on the area geological maps and each community was labeled and coded for incorporation into the

Table 2.0-4 ASBESTOS WATER SAMPLING SITES

57303	-	Residency 270 High School Street San Andreas (Utility Sink)
57304	-	Residency 151 Chestnut Street Valley Springs (Garden)
57305	-	Residency 8288 West Main Mukelumne Hill (Garages)
57306	-	Residency Main Street West Point (Garden)
57307	-	Haags Store (Also Residency) R.R. Flats Rd. (Well Water) R.R. Flats (Bathroom Sink) (No Filter)
57308	-	Residency 429 Church Murphys (Kitchen Sink - No Filter)
57309	-	Murphy's Hotel Murphy's (Bathroom Sink - No Filter)
57310	-	Jackpot Gas Main Street Angels Camp (Bathroom Sink - No Filter)
57311	-	Residency 1280 Bush Angels Camp (Garden)
57312	-	Gold Rush Mobile Homes Parrott's Ferry Road Columbia (Bathroom)
57313	-	Old Tuolumne County Court House Yaney Street Sonora (Bathroom)
57314	-	Residency 33 Bradford W. Sonora (Garden)
57315	-	Residency 514 Stewart Sonora (Garden)

57316		Residency 18415 Gardner Ave. Tuolumne (Garden) (A little murky brown)
57317	-	Residency (Apt. Bldg.) 22771 Twain Harte Drive Twain Harte (Garden)
57318	-	Strawberry Store (Gen. Store and residency) Hwy 108 Strawberry (Garden)
57319	-	The Square Nail Restaurant 18376 Bay Ave. Tuolumne (Bathroom)
57320	-	Yosemite Bank Hwy 120 Groveland (Bathroom)
57321	-	Residency 121 (The Main Street) Copperopolis (Garden)
57322	-	Same as 57321
57323	-	Same location as 57320
57324	-	Same location as 57306
57325	-	Black Bart Inn - Garden Faucet 55 St. Charles Street (Hwy 49) San Andreas
Samples		57303 - 57322 were taken in October 1980
Samples		57323 - 57325 were taken in March 1981

Table 2.0-5 Turbidity and Asbestos Results for California Samples

		Chrysotile Concentration Millions of Fibers/liter			
Sample No.	Description	Turbidity (JTU)	Conc.	95% Confidence Limits Upper	Lower
57303	San Andreas	0.6	NSS (0.3)*	0.5	0.05
57304	Valley Springs	2.1	BDL (0.1)**	-	-
57305	McKellumne Hill	3.3	0.4	0.8	0.05
57306	West point	1.6	5.5	6.9	4.0
57307	Railroad Flats	2.5	NSS (0.1)	0.4	0.09
57308	Murphys	1.4	0.6	1.1	0.1
57309	Murphys	2.5	0.6	0.9	0.3
57310	Angels Camp	0.3	NSS (0.1)	0.3	0.02
57311	Angels Camp	0.7	0.7	1.0	0.4
57312	Columbia	0.6	BDL (0.05)	-	-
57313	Sonora	0.3	0.5	0.8	0.2
57314	Sonora	0.2	NSS (0.2)	0.4	0.01
57315	Sonora	0.5	BDL (0.06)	-	-
57316	Tuolumne	10.0	NSS (0.4)	1.0	0.3
57317	Twain Harre	0.3	NSS (0.3)	0.5	0.05
57318	Strawberry	0.9	NSS (0.06)	0.2	0.05
57319	Tuotumne	0.7	BDL (0.07)	-	-
57320	Groveland	0.5	3.2	4.2	2.3
57321	Copperopolis	1.3	BDL (0.3)	-	-
57322	Copperopolis	5.5	BDL (0.3)	-	-
57323	Groveland	-	20.1	-	-
57324	West Point	-	0.4	-	-
57325	San Andreas	-	0.5	-	-
2551A	Blank	0.2	NSS (0.05)	0.2	0.05
2551E	Blank	0.2	BDL (0.05)	-	-
2552E	Blank	0.2	NSS (0.15)	0.4	0.09
2562E	Blank	0.2	BDL (0.05)	-	-
2561E	Blank	0.2	BDL (0.05)	-	-
2581A	Blank	0.2	NSS (0.05)	0.2	0.05
2601A	Blank	-	BDL (0.05)	-	-

* NSS - Non-significant. While concentrations based on less than five fibers may show the presence of asbestos in the water, the actual value is not considered very reliable.

** BDL - Below the detectable limit shown. No fibers were seen in the analysis.

coding of the mortality data base. The flexibility was retained to assign numerical values of fiber concentration to each area. In the serpentine areas fiber counts exceeded 100,000 fibers/m³, ranged to 3,700,000 and averaged 675,000. In the non-serpentine area (all greater than 10 miles distance) all samples had fiber counts less than 100,000 fibers/m³ and averaged 49,000. In addition to the residence of the deceased individual being recorded on the death certificate their length of stay in the county and in the state are recorded as denoted in Figure 2.0-3. Although without further investigation it would not be possible to verify their residence history in the county during that period, it does facilitate the elimination from the study of individuals with less than a minimal period of residence in the county. Furthermore it is thus possible to define an exposure index equal to the product of length of stay in the county and average fiber concentration in the area of residence.

2.0.3 Case and Control Selection

The study group was defined as those individuals who died in Calaveras and Tuolumne Counties during the ten year period 1969 and 1978. Approximately 4300 individuals, nearly all white, were found to be in that population. It was predicted that approximately one half of the population would have resided in the serpentine formation areas and therefore the counties would provide a useful distribution of residence (exposure index) for contrast among ICDA categories.

Both cases and controls were identified from the California state death tapes. The tapes are compiled monthly alphabetically by county of death. Thus it was necessary to obtain the complete tapes from Calaveras and Tuolumne counties and those entries from throughout the state of residents of Calaveras and Tuolumne counties who died elsewhere. These tapes have coded the basic information from the death certificate including the full name, date of death, sex, race, birthplace, date of birth, age, county of death and residence cause of death (4 digit) and local (county) file number.

The listings were sorted into groups according to the International Classification of Diseases (ICD) code for the underlying cause of death. A ten year time interval (1969-1978) was selected in order to gain a sufficient statistical base while not proceeding into the more distant past thereby complicating the study by introducing earlier revisions of the ICD codes.

Causes of death hypothesized as linked to asbestos exposure (primarily based upon the occupational literature) were delineated and case groups formed as follows:

CERTIFICATE OF DEATH

STATE FILE NUMBER

STATE OF CALIFORNIA—DEPARTMENT OF PUBLIC HEALTH

LOCAL REGISTRATION DISTRICT AND CERTIFICATE NUMBER

DECEDENT PERSONAL DATA	1a. NAME OF DECEASED—FIRST NAME		1b. MIDDLE NAME		1c. LAST NAME		2a. DATE OF DEATH—MONTH, DAY, YEAR		2b. HOUR		
	3. SEX		4. COLOR OR RACE		5. BIRTHPLACE (STATE OR FOREIGN COUNTRY)		6. DATE OF BIRTH		7. AGE (LAST BIRTHDAY)		
									IF UNDER 1 YEAR IF UNDER 24 HOURS YEARS		
	8. NAME AND BIRTHPLACE OF FATHER					9. MAIDEN NAME AND BIRTHPLACE OF MOTHER					
	10. CITIZEN OF WHAT COUNTRY			11. SOCIAL SECURITY NUMBER			12. MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (SPECIFY)		13. NAME OF SURVIVING SPOUSE (IF WIFE, ENTER MAIDEN NAME)		
PLACE OF DEATH	18a. PLACE OF DEATH—NAME OF HOSPITAL OR OTHER IN-PATIENT FACILITY				18b. STREET ADDRESS—(STREET AND NUMBER, OR LOCATION)				18c. INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)		
	18d. CITY OR TOWN				18e. COUNTY		18f. LENGTH OF STAY IN COUNTY OF DEATH		18g. LENGTH OF STAY IN CALIFORNIA		
USUAL RESIDENCE (IF DEATH OCCURRED IN INSTITUTION, ENTER RESIDENCE BEFORE ADMISSION)	19a. USUAL RESIDENCE—STREET ADDRESS (STREET AND NUMBER OR LOCATION)				19b. INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)		20. NAME AND MAILING ADDRESS OF INFORMANT				
	19c. CITY OR TOWN		19d. COUNTY		19e. STATE						
PHYSICIAN'S OR CORONER'S CERTIFICATION	21a. CORONER: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I HAVE HELD ON THE REMAINS OF DECEASED AS REQUIRED BY LAW.		21b. PHYSICIAN: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I ATTENDED THE DECEASED		21c. PHYSICIAN OR CORONER—SIGNATURE AND DEGREE OR TITLE		21d. DATE SIGNED				
	21e. ADDRESS		21f. PHYSICIAN'S CALIFORNIA LICENSE NUMBER								
FUNERAL DIRECTOR AND LOCAL REGISTRAR	22a. SPECIFY BURIAL, ENTOMBMENT OR CREMATION		22b. DATE		23. NAME OF CEMETERY OR CREMATORY		24. EMBALMER—SIGNATURE (IF BODY EMBALMED) LICENSE NUMBER				
	25. NAME OF FUNERAL DIRECTOR (OR PERSON ACTING AS SUCH)		26. IF NOT CERTIFIED BY CORONER, WAS THIS DEATH REPORTED TO CORONER? (SPECIFY YES OR NO)		27. LOCAL REGISTRAR—SIGNATURE		28. DATE ACCEPTED FOR REGISTRATION BY LOCAL REGISTRAR				
MEDICAL AND HEALTH DATA	CAUSE OF DEATH		29. PART I. DEATH WAS CAUSED BY: ENTER ONLY ONE CAUSE PER LINE FOR A, B, AND C								APPROXIMATE INTERVAL BETWEEN ONSET AND DEATH
			IMMEDIATE CAUSE (A) CONDITIONS, IF ANY, WHICH GAVE RISE TO THE IMMEDIATE CAUSE (A), STATING THE UNDERLYING CAUSE LAST DUE TO, OR AS A CONSEQUENCE OF (B) DUE TO, OR AS A CONSEQUENCE OF (C)								
			30. PART II: OTHER SIGNIFICANT CONDITIONS—CONTRIBUTING TO DEATH BUT NOT RELATED TO THE IMMEDIATE CAUSE GIVEN IN PART I.								
	INJURY INFORMATION		33. SPECIFY ACCIDENT, SUICIDE OR HOMICIDE		34. PLACE OF INJURY (SPECIFY HOME, FARM, FACTORY, FREIGHT, HIGHWAY, STREET, OFFICE BUILDING, ETC.)		35. INJURY AT WORK (SPECIFY YES OR NO)		36a. DATE OF INJURY—MONTH, DAY, YEAR		36b. HOUR
37a. PLACE OF INJURY (STREET AND NUMBER OR LOCATION AND CITY OR TOWN)				37b. DISTANCE FROM PLACE OF INJURY TO USUAL RESIDENCE (SEE 35)		38. WERE LABORATORY TESTS DONE FOR POISONS OR TOXIC CHEMICALS (SPECIFY YES OR NO)		39. WERE LABORATORY TESTS DONE FOR ALCOHOL (SPECIFY YES OR NO)			
40. DESCRIBE HOW INJURY OCCURRED (ENTER SEQUENCE OF EVENTS WHICH RESULTED IN INJURY. NATURE OF INJURY SHOULD BE ENTERED IN ITEM 29)											
STATE REGISTRAR		A		B		C		D		E	

Figure 2.0-3
CERTIFICATE OF DEATH—California

- A. Case Groups (hypothesized associations with asbestos exposure)
 1. Malignant Neoplasms of Digestive Organs and Peritoneum
ICD 150.0 to 159.9
 2. Malignant Neoplasm of Trachea, Bronchus and Lung ICD 162.0 to 162.9
 3. Hypertensive Heart Disease ICD 400.0 to 404.9, 410.0, 411.0, 412.1 to 2.2
- B. Control Groups (no hypothesized association with asbestos exposure)
 1. Reproductive Neoplasms (matched to digestive and respiratory cancer case groups)
 - Males: ICD 185.0 to 187.9 (Prostate, Testes, Other and Unspecified)
 - Females: ICD 174.0 to 174.9 (Breast)
 2. Non-Hypertensive Heart Disease (matched to hypertensive heart disease case group) ICD 410.9, 411.9, 412.3 to 412.4
 3. General Causes of Death (Matched to digestive, respiratory and hypertensive heart disease case groups). Includes all causes of Death, except:
 - a) Tuberculosis ICD 10.0 to 19.9
 - b) Malignant Neoplasms of Digestive Organs and Peritoneum
ICD 150.0 to 159.9
 - c) Malignant Neoplasms of Trachea, Bronchus and Lung
ICD 162.0 to 162.9
 - d) Malignant Neoplasms of Breast ICD 174.0 to 174.9
 - e) Malignant Neoplasms of Prostate, Testes, Other and Unspecified
Male Genital Organs ICD 185.0 to 187.9
 - f) Malignant Neoplasms Without Specification of Site ICD 199.0 to 199.9
 - g) Mental Disorders ICD 290.0 to 315.9
 - h) Hypertensive Disease ICD 400.0 to 404.9
 - i) Ischaemic Heart Disease ICD 410.0 to 412.9
 - j) Cerebrovascular Disease ICD 430.0 to 438.9
 - k) Diseases of the Respiratory System ICD 460.0 to 519.9
 - l) Diseases of the Digestive System ICD 520.0 to 577.9
 - m) Complications of Pregnancy, Childbirth and the Puerperium
ICD 630.0 to 678.9
 - n) Congenital Anomalies ICD 740.0 to 759.9
 - o) Causes of Perinatal Morbidity and Mortality ICD 760.0 to 779.9
 - p) Water Transport Accidents ICD 830.0 to 833.9
 - q) Other and Unspecified Accidental Falls ICD 887.0 to 887.9
 - r) Accidental Drowning and Submersion ICD 910.0 to 910.9
 - s) Accident Caused by Firearm Missiles ICD 922.0 to 922.9
 - t) Suicide and Self-Inflicted Injury ICD 950.0 to 959.9
 - u) Homicide ICD 960.0 to 969.0
 - v) Legal Intervention ICD 970.0 to 978.9
 - w) Injury Undetermined Whether Accidentally or Purposely Inflicted
ICD 980.0 to 989.9
 - x) Injury Resulting from Operations of War ICD 990.0 to 999.9

These categories were eliminated from the general control causes of death because they included:

1. Other case or control categories (b, c, d, e, h, i)
2. Categories which could be associated with asbestos exposure and/or the three case categories (a, f, j, k, l)
3. Categories unlikely to contain records that would be age-matchable to case records (m, n, o)
4. Categories containing deaths due to recreational activities, which could be related to length of stay in the county, or place of residence within the county (p, q, r, s)
5. Categories containing deaths likely to present difficulties in obtaining information from survivors due to their sensitive nature (g, t, u, v, w, x)

All case and control subjects chosen were white, recorded as residents of either Calaveras or Tuolumne Counties, and died in years 1969 through 1978.

In summary, three case groups were selected which have been cited in the occupational or general epidemiologic literature as suspected of being asbestos related. We have selected specific concomitant cancer or heart disease control groups and a general control group. Table 2.0-6 provides the breakdown on the case and control group sizes.

The general control group included all categories except 1) those which could possibly be associated with asbestos exposure, e.g. digestive and respiratory diseases, 2) those likely to present difficulties in obtaining information from survivors, e.g., suicides, 3) those likely to be poorly age matched with case groups, and 4) those heavily locale specific, e.g., drowning.

Table 2.0-7 illustrates the age and year of death breakdown of male case group II*. Each case subject was then age and year of death matched with two controls- one from control group VI and one from the appropriate designated analog control group which in this case is group IV.

After all case and control subjects were identified, each Certificate of Death was located, reviewed, abstracted, coded and placed on tape. Figure 2.0-3 shows the California Certificate of Death. Additional information abstracted from the Certificate includes material vital to assigning asbestos exposure, e.g. residence and length of stay in the county; assisting in identifying confounding exposures, e.g. last occupation; useful in locating surviving kin; and verifying critical data such as the ICD number.

Residence information was recorded and also coded according to the distance from high asbestos deposit areas. Coding of occupation was performed and occupations classified into asbestos exposure potential as: definite, probable, possible and probably no exposure. Subsequent analysis of these data will focus on residence in the area so the primary measure of exposure and will treat occupational category as a covariate which will be stratified or adjusted for. It is readily acknowledged that death certificate listing of occupation is a poor measure. These other such confounding factors such as

* Numbers disagree with those above since a slightly different analysis was being performed which utilized somewhat different ICD categories.

Table 2.0-7

Male Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163),
by Year and Age at Death,
Calaveras and Tuolumne Counties

		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	1	0	0	0	0	0	0	0	0	0
	10-14	1	0	0	0	0	0	0	0	0	0
	15-19	1	0	0	0	0	0	0	0	0	0
	20-24	1	0	0	1	0	0	0	0	0	0
	25-29	1	0	0	0	0	0	0	0	0	0
	30-34	1	0	0	0	0	0	0	0	0	0
	35-39	1	1	0	0	0	0	0	1	0	0
	40-44	1	0	1	0	0	0	0	0	0	0
	45-49	1	0	0	1	0	1	1	0	0	1
	50-54	1	0	3	1	0	2	5	1	2	1
	55-59	1	3	2	1	0	2	2	3	3	1
	60-64	1	1	1	2	5	5	4	4	2	1
	65-69	1	2	2	3	5	3	4	3	6	2
	70-74	1	2	1	1	3	0	4	5	1	3
	75-79	1	4	2	0	1	4	0	1	2	2
	80-84	1	2	1	1	0	2	4	2	0	1
	GE 85	1	1	0	1	0	2	1	2	3	0
TOTAL		1	16	13	13	14	21	25	22	19	12

smoking and drinking could be accounted for at some future time by means of next-of-kin interviews if the proposed analyses identified specific case groups with a significant elevated risk and there was sufficient interest to minimize additional possible confounding factors.

Figure 2.0-4 shows (in photo-reduced size) the computer generated form developed to record the abstracted information. For each subject decedent, data from the death tapes are filled in when the form is generated. These data are:

- o Social security number
- o Name
- o Data of death
- o Birthplace and birthdate
- o Age at death
- o Marital status
- o Counties of death and of residence
- o Cause of Death
- o Whether or not an autopsy was performed
- o The qualifications of the certifier.

The data recorded by our abstractors from the hard copy death certificate were entered in the appropriate blanks. These are:

- o Identification Number
- o Father's name and birthplace
- o Mother's name and birthplace
- o Name of surviving spouse
- o Last occupation and years worked
- o Name and address of hospital

The format for the death certificate abstract corresponding to Figure 2.0-4 is described in Appendix B. Coding for birthplace, occupational classification, occupational asbestos exposure, city codes (for exposure indices), and county codes are all provided in Appendix B.

DEATH CERTIFICATE ABSTRACT

CARD NO 0 1 ID NO		STATE FILE NO		LOCAL REG NO		SOCIAL SECURITY NO	
01 02 03 04 05 06						07 08 09 10 11 12 13 14 15	
NAME		DATE OF DEATH					
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45		46 47 48 49 50 51					
SEX	RACE	BIRTHPLACE		BIRTHDATE		AGE	
52		53 54		55 56 57 58 59 60 61		62 63 64	
CARD NO 0 2 ID NO		FATHERS NAME				BIRTHPLACE	
01 02 03 04 05 06		07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26				27 28	
MOTHERS MAIDEN NAME				BIRTHPLACE			
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48				49 50			
MARITAL STATUS		NAME OF SURVIVING SPOUSE					
51		52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80					
CARD NO 0 3 ID NO		LAST OCC		YRS		COMPANY	
01 02 03 04 05 06		07 08 09		10 11		12	
NAME AND ADDRESS OF HOSPITAL							
CO OF DEATH		LENGTH OF STAY IN CO		IN CA		USUAL RES	
13 14		15 16		17 18		19 20 21 22	
NAME OF INF				ADDRESS			
23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40				41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59			
CITY		STATE		CAUSE OF DEATH CODE		AUTOPSY	
60 61 62 63 64 65 66 67 68		69 70		71 72 73 74		75 76	
PHYSICIAN/CORONER NAME, ADDRESS				PHYSICIAN LICENSE NUMBER			
IMMEDIATE CAUSE(A)		DUE TO(B)		DUE TO(C)			
OTHER SIGNIFICANT CONDITIONS							
AIR ASBESTOS		X 10		WATER ASBESTOS			
77 78		79		80			

Figure 2.0-4 Death Certificate Abstract

2.0.4 Case and Control Matching System

The system for matching control records to case records was established as follows:

- o Controls were matched to cases of the same sex.
- o Cases were categorized into 5 year age groups (<5, 5-9, 10-14, 15-19..., 80-84, <85), and listed by year of death (1969 through 1978)
- o For each case of given sex, 5 year age group, and year of death a control was chosen randomly from among all controls of the same sex, age group, and year of death. If there were no controls with the same year of death (or if the number of cases out-numbered the controls for a given year of death), a control was sought from the year of death nearest the case. All controls were chosen from the same age group as the case.
- o An effort was made to choose unused controls for each successive case group. But if all controls in a given age range and year (e.g. digestive cancer), controls were used again for another case group (e.g. lung cancer).

For the Reproductive Neoplasms control group, the pool of subjects was so small (only 115 decedents), nearly all had to be used twice to provide matches for the Digestive and Respiratory cancer case groups.

Among controls taken from the General Causes pool, approximately 12% of the male controls and 9% of the female controls had to be used for matches twice.

The Non-Hypertensive Heart Disease pool was large enough that no controls had to be used twice.

2.0.5 Quality Assurance of Death Certificate Abstraction and Coding

As each death certificate was abstracted, the certificate was quickly check for (1) internal consistency, and (2) consistency with the information as coded by the California Office of Vital Statistics on the computerized records. Because of time limitations, this check could not be exhaustive, but nevertheless several errors were detected.

1. Errors in the State Vital Statistics Coding of Residence.

We discovered several instances where the county of residence coded on the state death tape was incorrect. One type of error was to assign either the Calaveras code or the Tuolumne code to the county of residence when the

city of residence actually lies in a different county. This error occurred fifteen times in our series.

<u>Number</u>	<u>City of Residence</u>	<u>Actual County</u>
3	Stockton	San Joaquin
2	Coulterville	Mariposa
1	Knight's Ferry	Stanislaus
1	Oakdale	Stanislaus
1	Berkeley	Alameda
1	Oakland	Alameda
1	Acampo	San Joaquin
1	Linden	San Joaquin
1	Sutter Creek	Amador
1	Santa Clara	Santa Clara
1	San Francisco	San Francisco

Since only decedents who were residents of Calaveras or Tuolumne Counties were to be used in this study, all of the above out of county residents were deleted.

Another error we discovered was the assignment of the Calaveras County code to five decedents who were actually residents of Tuolumne County.

<u>Number</u>	<u>City Residence</u>
3	Sonora
1	Columbia
1	Tuolumne City

We corrected the county of residence codes for these decedents, and kept them in the study.

We should not note one feature of this miscoding in the state records. The decedents in our series were selected from the state tapes on the basis of their residence being coded as Calaveras or Tuolumne. However, any actual residents of Calaveras or Tuolumne who were miscoded as residents of other counties would not have been included. In view of the coding errors displayed above, this last type of misclassification probably did occur, although there were probably few of these since only 20 total errors were detected in roughly 1000 records.

We also found one instance where a coded age at death differed from the death certified age at death by one year, and so this correction was made.

2. Errors in Death Certificate Entries

There were only two errors detected on the death certificates themselves. One was an incorrect year of birth (inconsistent with the year of death), and the other was an inconsistency of the length of stay in the county with the length of stay in California. These errors could not be corrected, since we do not know what the actual entries should be.

3. Errors in Vital Statistics Coding of the Cause of Death

The information abstracted from the death certificate included the complete causes of death as well as the "other significant conditions". We checked the causes of death on the certificate against the Office of Vital Statistics 4 digit ICD code on a 10% sample. In a few instances, the death certificates themselves were vague, and so the given ICD codes were necessarily somewhat arbitrary. But no incorrect ICD codes were found, so we feel confident accepting the codes as given.

4. Errors in Coding the Abstracted Data

For quality control of our own effort--namely the coding of the death certificate data we abstracted--we recoded a 10% systematic sample of the certificates.

One hundred and two records were checked, and 14 coding errors were found. Since each certificate contains 6 variables to be coded*, this translates into a rate of 2 coding errors per 100 variables. This was judged to be acceptable, and the records were sent to be keypunched.

* The birthplace of the decedent, the birthplaces of the parents, the occupation, the likelihood of occupational exposure, and the city of residence.

2.1 Determination of Standardized Mortality Ratios (SMR's)

Standardized mortality ratios were calculated as part of this study utilizing the California State mortality tapes. The purpose of this effort was to examine if the total observed number of deaths in the counties for particular categories of ICD codes were at variance with the expected numbers based on State of California rates. It should be noted that the exact residence of each individual within the counties was not factored into the analysis. Therefore the analysis does not bear directly upon the key study question of whether individuals living in the vicinity of serpentine deposits, i.e. experiencing elevated ambient airborne asbestos concentrations, have different mortality patterns. Rather it examines the gross incidence across the counties in comparison to the State of California. Since the counties are relatively rural in comparison to the significant state population centers many factors differ and remain uncontrolled in this analysis.

In order to compare the mortality of Calaveras and Tuolumne Counties to the experience of the State of California as a whole it is necessary to take into account the potentially confounding effects of age, race, and sex differences. We have calculated standardized mortality ratios (SMR's), adjusting for age, for whites only, separately for males and females.

The causes of death to be examined were grouped into six categories as follows:

- A. Three categories of death from causes possibly associated with asbestos exposure:

- Malignant neoplasms of digestive organs and peritoneum (ICD 150-159*)

- Malignant neoplasms of the respiratory system (ICD 160-163)

- Hypertensive heart disease and hypertensive heart and renal disease (ICD 402-404)

- B. In addition, two comparison groups of deaths were looked at,

composed of deaths from causes that have no reported association with asbestos exposure:

-Malignant neoplasms of the breast (used for females only)
(ICD 174)

-Malignant neoplasms of the genital organs
(ICD 180-187)

C. Finally, we examined the total number of deaths from all causes.

The ICD codes included in these categories are broader than the ICD codes used to delineate the case and control groups. These categories had to be used because the only published source of age, sex, and race specific numbers of deaths for California is the United States Vital Statistics,** and the causes of death were tabulated in these broader categories. Ischaemic heart disease deaths (ICD 410 to 412) were not included in the SMR calculations because the published deaths were not separated into hypertensive and nonhypertensive.

The SMR is a ratio of an observed number of deaths to an expected number. The observed number of deaths for each cause is the sum of the deaths for that cause in Calaveras and Tuolumne Counties for three years, 1969, 1970, and 1971. The expected numbers of deaths for each cause were calculated by multiplying cause-specific three-year California rates (for whites, for each sex, and for each 5 year age group) by the corresponding 1970 subpopulation of Calaveras and Tuolumne Counties. The three year California rates used in the calculations were derived by summing the State deaths in 1969, 1970, 1971, and dividing by the 1970 population given by the U.S. Census.

The expected number of deaths in each 5 year age group were then summed over all ages to give the total number of expected deaths in Calaveras and Tuolumne counties for the three years in question.

* International Classification of Disease, 8th Revision

* Table 7-6 "Deaths from 69 Selected Causes, By Age, Color, and Sex, Each State"

The 95% confidence limits of the SMR's were calculated as outlined in Rothman and Boice (1979), assuming the occurrence of events to be Poisson distributed. For observed numbers less than 30, the upper and lower limits were found from the table in Remington and Schork (1970) (p. 394). For SMR's with observed values greater than 30, Byar's approximation given in Rothman and Boice (1979) was used.

For males, all SMR's were less than 1.00, i.e., there were fewer observed deaths than expected, based upon the experience of white males in California. Even the mortality from all causes was depressed (686 deaths observed vs. 728 expected), indicating that (adjusting for age) white males in Calaveras and Tuolumne had a lower overall mortality than males in California for the years 1969 through 1971. The category of death that most nearly approached the expected figure was malignant neoplasms of the respiratory system.

None of the male SMR's was statistically significant at the $\alpha=0.05$ level, since all confidence limits span the null value, 1.00.

For females, the picture is somewhat different. The all causes mortality was increased to 1.05 times the expected. Among the conditions suggested to be related to asbestos exposure, the SMR's were elevated above unity for cancers of the digestive system (SMR=1.07) and hypertensive heart disease (SMR=1.75). However, the number of observed deaths for respiratory cancer was less than expected (6 to 10.18).

Among the "dummy" conditions not known to be related to asbestos exposure, the malignant neoplasms of the genital organs among women showed an elevated SMR of 1.34. This result was unexpected. However, the recent study by Kanarek et al (1980) of asbestos in drinking water and cancer incidence in the San Francisco-Oakland area found an elevated number of deaths from uterine cancer.

Although none of the female death ratios reached statistical significance at the $\alpha=0.05$ level, the hypertensive heart disease SMR (1.75) had the largest excess of observed over expected.

One difficulty with a community study of an environmental exposure such as this one is that an observed excess mortality might not be caused by ambient environmental exposures, but by occupational exposures. Examining

deaths among males and females separately is one way to check for this possibility. If asbestos related mortality were higher among men than among women, exposure in the workplace might be the cause. In our data, however, males have lower mortality ratios than females for most causes, including total mortality.

The lower than expected overall mortality for males deserves some comment. In studies of males in an occupational setting, this observation has been called the "healthy worker effect." Occupational groups tend to be selected for the healthier, more vigorous individuals in the population. Consequently, even when adjusting for age, the overall mortality of a specific industrial group may be less than expected, if the expected mortality is based on the experience of all males in the general population.

It may be that the occupational and recreational activities prevalent in these two rural counties (where timber and mining are dominant industries) exert a small selective pressure on males, which accounts for a male population with a lower than expected mortality. The fact that the observed mortality was not lowered for females indicates that an occupational selection might be involved. On the other hand, it may indicate the presence of a factor which puts females at a higher risk.

One method to "adjust" for a possible healthy worker effect in occupational studies has been suggested by Tabershaw and Gaffey (1974) , Kupper et al(1978), and others. This involves the calculation of a "relative" standardized mortality ratio (RSMR) by dividing the cause-specific SMR by the all causes SMR. This results in a measure of risk that takes into account the lower underlying mortality of the study population.

Since for males the all causes SMR was 0.94, the calculation of an RSMR increases all of the observed to expected ratios. All cause specific RSMR's tend to be closer to 1 than the SMR's, except respiratory system cancers, where the RSMR=1.04. However, this adjusted SMR is not statistically significant.

One reason for the general lack of statistical significance in this analysis is that many of these SMR's are based upon small numbers. These two counties combined had a 1970 white population of only 17,000 males and 16,000 females. Consequently, the number of deaths accruing in just three years is

not large. Our data set contains all deaths from 1969 through 1978. However, we have elected to use only deaths from 1969 to 1971, spanning the censal year, in order to use the 1970 census population as a denominator. The lack of age, sex, and race specific population figures during the middle and late part of the decade prevents us from making full use of our mortality data.

In order to use all of the observed county deaths during the 1970's, it would be necessary to get population estimates for these years. This would be possible by using the forthcoming 1980 census data. Intercensal populations can be estimated using the 1970 and 1980 figures and estimation procedures, such as those given by Shryock, Siegel, et al (1976).

Finally, we must discuss the choice of a comparison population. The indirect standardization technique measures the experience of the two counties against the experience of the entire state of California. We have restricted the analysis to whites, compared males and females separately, and adjusted for differences in age distribution between the counties and the state by standardization. But there may be other factors that confound the mortality comparisons. The expected values were derived from the death rates of the state of California as a whole. The state death rates include deaths from urban areas such as Los Angeles and San Francisco. These urban areas may have increased cancer mortality over rural areas by virtue of greater air pollution, pollution of drinking water, occupational exposures, and smoking levels in the population. In short, asbestos related mortality in Calaveras and Tuolumne Counties may have been masked by comparing these counties to the state population, which is composed of subpopulations exposed to several other environmental insults that can produce the same effects.

A better comparison would be to use rural California counties near Calaveras and Tuolumne, with similar population densities and industries, but without serpentine deposits. This is not possible at this point in our study, however. Such a comparison would require mortality data from the comparison counties that are age, sex, race and cause specific. Data this detailed are not available from the published California vital statistics. We would have to identify selected comparison counties and access California death tapes the same way the Calaveras and Tuolumne data were acquired.

Table 2.1-1 and 2.1-2 present the SMR results for males and females respectively. Appendix C provides the age specific mortality data for Calaveras and Tuolumne counties from which the three year study interval, 1969-1971 was taken.

Table 2.1-1
STANDARDIZED MORTALITY RATIOS - MALES

Observed deaths reflect Calaveras and Tuolumne County experience (1969-71)
Expected deaths are based upon rates for California (1969-71)

	<u>Males</u>			
	<u>Observed Deaths</u>	<u>Expected Deaths</u>	<u>SMR (O/E)</u>	<u>SMR 95% Conf. Limits</u>
Malignant Neoplasms of Digestive Organs and Peritoneum (ICD 150-159)	33	36.53	0.90	(0.62, 1.27)
Malignant Neoplasms of Respiratory System (ICD 160-163)	42	42.98	0.98	(0.70, 1.32)
Hypertensive Heart and Renal Disease (ICD 402,404)	1	3.06	0.33	(0.01, 1.82)
Malignant Neoplasms of the Genital Organs (ICD 180-187)	11	13.12	0.84	(0.42, 1.50)
Mortality from All Causes	685	723.03	0.94	(0.87, 1.02)

Table 2.1-2

STANDARDIZED MORTALITY RATIOS - FEMALES

	<u>Observed Deaths</u>	<u>Expected Deaths</u>	<u>SMR (O/E)</u>	<u>SMR 95% Conf. Limits</u>
Malignant Neoplasms of Digestive Organs and Peritoneum (ICD 150-159)	27	25.32	1.07	(0.70, 1.55)
Malignant Neoplasms of Respiratory System (ICD 160-163)	6	10.18	0.59	(0.22, 1.28)
Hypertensive Heart and Renal Disease (ICD 402, 404)	6	3.42	1.75	(0.64, 3.82)
Malignant Neoplasms of the Breast (ICD 174)	13	18.18	0.72	(0.38, 1.22)
Malignant Neoplasms of the Genital Organs (ICD 180-187)	18	13.43	1.34	(0.79, 2.12)
Mortality from All Causes	488	464.04	1.05	(0.96, 1.15)

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Appendix A
Description of Electron Microscopy

A-1 Description of Whatman #41 Cellulose Filters

The filters shipped to Science Applications, for analysis by Scanning Electron Microscope were contained individually in glassine negative storage envelopes and appeared to be in good condition. Some filters appeared to have lost some material or were unevenly dispersed. These filters were excluded from the analysis.

The filter dimensions were 8" x 10" with an effective filter surface of 7" x 9" or 63in^2 (406.5 cm^2).

A-2 Laboratory Procedures for Asbestos Measurement of Air Samples Collected
Collected on High Volume Whatman 41 Cellulose Filters

Cleaning of glassware and utensils

All utensils and glassware are cleaned in a sonic bath (Bransonic model 220) using 2 rinses of Milli-Q water ($.2\ \mu\text{m}$ filtered) and a final sonicated rinse of reagent grade acetone. After cleaning, the glassware and utensils are stored in sealed plastic bags. All water is prescreened using the Scanning Electron Microscope to avoid any asbestos contamination.

Procedure for ashing the filter samples:

Sections of filters no greater than 2" x 2" (1" x 2" is optimum) are excised from the original 8" x 10" Whatman 41 high volume filter using precleaned scissors and transferred into engraved precleaned glass vials (70 mm x 30 mm). For almost all samples a 1" x 2" sample is excised. Each filter is placed in the vial with the top surface of the filter against the inner surface of the glass vial.

No more than 2 sample vials are ashed at the same time. The vials are placed into the Low Temperature Asher (International Plasma Corp. Model PM 104C) side by side and lying down with the top of the vial facing the door of the ashing chamber. This will minimize any effect of sample cross-contamination. After the samples are placed in the Low Temperature Asher, the power is turned on and the chamber is placed in the slow evacuation mode. In approximately 5 minutes the vacuum will reach 1 torr; at this time the chamber is switched into the fast vacuum mode and will pump down to less than .1 torr in a matter of minutes. At this point, the RF generator and oxygen flow are turned on and the ashing of the filter begins.

The filters are ashed for 4 hours at a vacuum of 1 torr, oxygen meter flow of 200, and an RF forward power of 20 watts. The reflecting power is kept below 1 watt by the fine tuning on the instrument console. Once ashing

is complete the RF power and oxygen are turned off and the vacuum valve on the instrument is turned to the off position. The purge for the sample chamber is opened to allow the chamber to return to atmospheric pressure over a period of 30 minutes (any shorter time could result in sample loss or contamination). Before the samples are removed from the chamber, the power to the entire instrument must be turned off to avoid turbulence caused by the instrument cooling fans. The samples are removed carefully and capped.

Sample dilution procedures:

All filter handling and filtration were performed in a laminar flow bench with a particle concentration at $\geq .5\mu\text{m}$ of less than 100 particles/cu. ft. A Climet Model 208 particle counter was used to monitor particle levels.

The capped samples containing the ashed filter are transferred to the laminar flow bench and the initial dilution is performed with the air fan turned off so that the dry ashed sample is not blown out of the vial during the first addition of aerosol O.T. dispersant. Exactly 20 ml. of $.2\mu\text{m}$ millipore filtered .1% Aerosol O.T. is carefully pipetted into the sample vial. The vial is capped, shaken gently and then placed in a ultrasonic bath (Bransonic Model 220) for 5 minutes. The sample is removed from the sonic bath and exactly 2.00 ml of the solution is withdrawn 1 cm from the bottom of the vial and transferred to a clean plastic 15 ml. test tube with a screw top cap. Approximately 5 ml. of $.2\mu\text{m}$ filtered deionized water is added to the test tube and gently shaken for approximately 1 minute before pouring into the filter assembly.

The 25 mm filter assembly (Nuclepore stock #410200) is made of borosilicate glass with a sintered glass support and has a funnel volume of 20 ml. and an effective filtered area of 2.14 cm^2 .

The asbestos samples are collected on a $.2\mu\text{m}$ pore size nuclepore filter which is backed by a $.45\mu\text{m}$ pore size millipore filter which aids in a more even dispersal of particles.

The sample contained in the plastic test tube is poured into the filter assembly after 1 ml. of deionized water has been filtered through the funnel to saturate the filter media. The test tube and cap are rinsed twice with 5 ml of deionized water into the filter funnel and a light vacuum is applied to the filter to allow complete filtration within 30 seconds. When the sample solution approaches approx. 1 cm in depth, the walls of the filter funnel are carefully rinsed with 2-3 ml of filtered deionized water and allowed to totally filter. 15 seconds after the sample solution has finished filtering the pump is turned off and the filter is allowed to air dry for 30 minutes before removal from the funnel assembly. The sample filter and the backing filter are removed together with clean polyethylene forceps and transferred to a clean plastic petri dish with a depth no less than 1 cm and taped in place. The filter is ready for sectioning for the Scanning Electron Microscope or the Transmission Electron Microscope analysis.

FILTER PREPARATION FOR THE SCANNING ELECTRON MICROSCOPE

Using a clean razor blade, excise a portion of the taped filter section from the filter by pressing evenly downward on the filter and backing filter (it is not advisable to pull the blade across the filter as this may result in particle loss and filter distortion). Carefully remove the cut section and transfer to a clean sheet of 2" x 2" leucite or plexiglass (keeping the backing filter in place aids in transferring the filter section without warping). The backing filter is removed by carefully sliding the nuclepore sample filter laterally off the backing filter using a sharp needle. 4 mm x 4 mm sections are cut using a new razor and pressing with a downward motion only. The softness of leucite or plexiglass provides for a very even undisturbed cut. The razor blade and the 2" x 2" plastic are discarded after each filter is cut. The filter sections are transferred to aluminum specimen mounts backed with #465 scotch transfer tape and only the edges of the filter are gently pressed down and evened out using a sharp needle.

The samples are coated with gold using an ISI P-SI Sputter Coater Set at 40 ma, 2.5 kV, a vacuum of .1 torr, and coated for 2.5 minutes.

FILTER PREPARATION FOR THE SCANNING TRANSMISSION ELECTRON MICROSCOPE

The filters sections remaining in the petri dishes after SEM sample preparation are transferred to a vacuum evaporator and coated with 40 to 50 nm of carbon in bursts on the order of 5 seconds to avoid polymerization of the nuclepore filter.

3 mm x 3 mm sections are excised from the filter pad as described in the SEM filter preparation procedure and placed carbon side down over a carbon stabilized formvar coated copper grid (200-300 mesh).

The copper grids to be extracted by the Jaffe wick method (EPA 600/2-77-178) are placed on top of a section of Whatman #42 ashless filter paper that is over a square of polyethylene foam that has been triple washed and ultrasonicated in acetone. The entire extraction arrangement is contained in a precleaned 100 mm x 15 mm precleaned glass petri dish. Four grids for each sample are prepared in the following manner. Approximately 10 μ l of reagent grade chloroform is pipetted onto each 3 mm x 3 mm filter section using a syringe and the petri dish is carefully filled with chloroform to a level approaching the top of the foam support. The petri dishes are covered and placed inside a bell jar to maintain a high chloroform atmosphere and reduce evaporation. Each filter grid is allowed 48 hours for dissolution of the nuclepore filter. The grids are then transferred to a clean covered petri dish to dry before analysis by the Transmission Electron Microscope.

FILTER ANALYSIS BY SCANNING ELECTRON MICROSCOPY

The total counts of two separate filter areas of each sample are analyzed at a magnification of 10,000X in the slow scan rate mode with a beam current of 15 kV. The resolution of the ISI Super III-A Scanning Electron Microscope is checked prior to each sample analysis using an asbestos standard sample containing many fibrils with diameters of .02 to .03 μ m. Actual sample analysis proceed only when fibrils of .03 μ m in diameter can be clearly resolved using the slow scan rate at a magnification of 20,000X.

Each sample filter section (two for each sample) is analyzed for a minimum total of 50 fields or 50 fibers (100 total) and the results are combined and totaled in the computer analysis. Chrysotile asbestos fibers are confirmed by morphology and the presence of magnesium and silicon using a Kevex 5100c dispersive X-ray system.

Fiber analysis for the purpose of this survey were placed into four categories; chrysotile, amphibole, ambiguous, and non-asbestos. Confirmation for chrysotile required both morphology and X-ray identification. Very small fibers ($<.1\text{ }\mu\text{m}$ diameter) which do not readily yield strong X-ray peaks were confirmed when their fiber diameters and length were very well defined or when they were found in the same field as another larger fiber confirmed to be Chrysotile by both morphology and X-ray spectra.

Amphiboles when present were confirmed by morphology and X-ray spectra. X-ray spectra typical of an amphibole must be well defined otherwise the particle will be listed as ambiguous.

The ambiguous classification contains all the fibers which have a questionable morphology or an ambiguous X-ray spectrum. The most common example in this category is a fiber which exhibits a silicon peak but no magnesium peak.

The non asbestos fiber category includes all fibers defined as having an aspect ratio of 3:1 but not having an asbestiform morphology. The second criterion includes all fibers greater than $.1\mu\text{m}$ in diameter that exhibit no X-ray spectrum or no silicon peak.

The final reporting of data includes fibers/meter³, mass/meter³ (nanograms) and surface area/meter³ (μm^2) expressed as total fibers, fibers $\leq 5\mu\text{m}$, and fibers $>5\mu\text{m}$.

It is very important to emphasize the instrument parameters used in the analysis.

The accelerating voltage on the SEM was set at 15 kV for a number of reasons. Beam penetration at a higher kV range is much greater and decrease the ability to resolve individual fibers with diameters below .1 μ m. 15 kV is also the optimum energy range for X-ray analysis. The peak to background ratio for Magnesium Aluminum and Silicon is much higher at 15 kV than 20 kV or 25 kV also due to beam penetration (less area below the fiber is being excited). The working distance of the SEM was calibrated and maintained at a working distance of 8 mm and a stage tilt of 15°. This provided for maximum resolution without compromising X-ray yield. The samples were prepared on .2 μ m pore size Nuclepore filters (particles on the shiny side) primarily because of their smooth background as compared to .1 μ m pore size or even the .45 μ m pore size filters.

Microscopy Facilities

SAI's electron microscopy lab contains a scanning electron microscope equipped with a dispersive X-ray spectrometer and a dedicated micro-computer for rapid and tailored data reduction of particle field counts, particle density and size distributions, and elemental abundances. The microscope is equipped with both a high angle back-scatter detector for atomic number contrast and a low angle back scatter detector for high resolution surface detail.

Adjacent to the SEM laboratory is a trace particle clean room which has been tailored for the handling and preparation of ambient air samples for asbestos and trace metals (see Figure A-1). The room is equipped with a HEPA filtered air system producing a variable laminar flow inside the room as well as a positive pressure throughout both the main lab and the anteroom. This eliminates any possible outside contamination for trace metal or asbestos samples. In addition to the ceiling HEPA filter system, the room is equipped with a laminar flow bench.

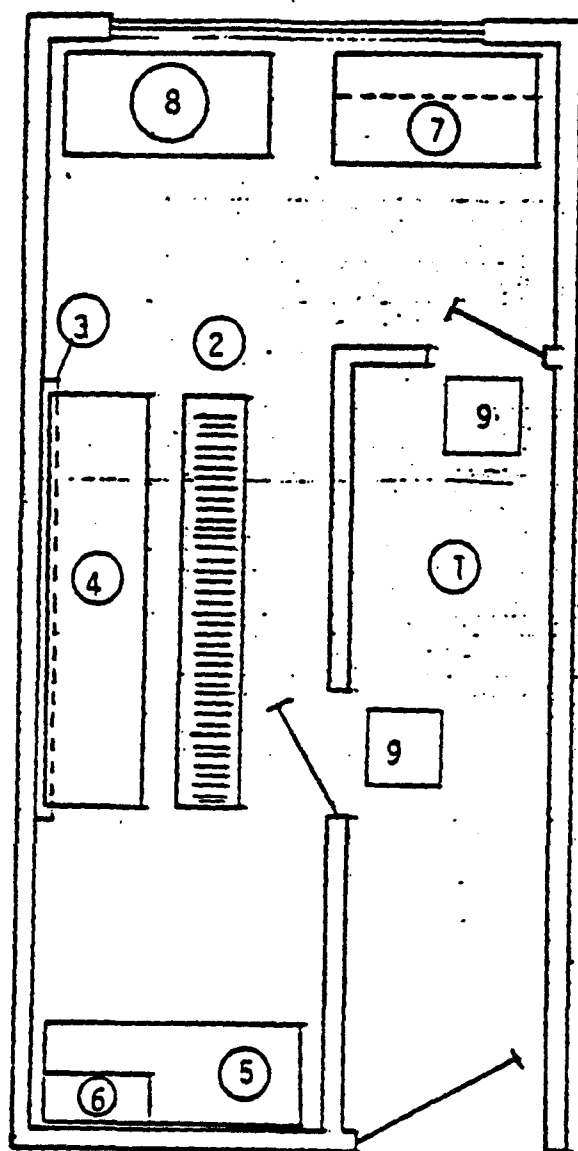
Through a formal agreement with Scripps Institution of Oceanography, SAI utilizes the scanning transmission electron microscope facility located less than 2 miles away. This instrument is an Hitachi Model H-500 with a magnification range of 500,000x and a resolution of $1.4 \text{ \AA}$, and is equipped with both Selected Area Electron Diffraction and computerized dispersive X-ray capabilities.

Instrumentation

SAI:

Model ISI Super IIIA Scanning Electron Microscope $70 \text{ \AA}$ resolution

magnification range 12-200,000x



scale 1" = 4'

1. Semi-clean transfer room (positive pressure to the outside exit).
2. Ceiling Hepa filter.
3. Floor exhaust with dampered control for variation in laminar flow over bench #4 and the positive pressure of the room.
4. Clean work table.
5. Bench for Jaffe-Wick preparation of filters.
6. Vented clean box for chloroform extraction of filters.
7. Laminar flow bench for filter sectioning and filtration.
8. Polyethylene sink.
9. Particle tac mat.

FIGURE A-1 TRACE PARTICULATE CLEAN ROOM.

- Standard secondary electron detector
- High backscatter detector for atomic number contrast
- Low angle backscatter detector (low loss) for high resolution surface imaging and elevation measurement with a resolution of $500\text{\AA}^0$. (Detector is used for measuring particle volume and photographing biological and low atomic number surfaces.)

PS-I Sputter Coater

AuPd and Au target

KeveX 5100 c Dispersive X-ray System

30mm^2 detector area

1.49 eV/channel resolution

Motorola 6800 Computer System with dual floppy disc

Scripps Institute of Oceanography:

Model Hitachi H-500 Scanning Transmission Electron Microscope

Transmission Mode - resolution $1.4\text{\AA}^0$, magnification range to 500,000x equipped for Selected Area Electron Diffraction

Scanning Mode - resolution of $30\text{\AA}^0$; magnification range of 1000-300,000 equipped with a Model 6230 Ortec dispersive X-ray system which includes the computer and dual floppy disc.

Denton Carbon Evaporator

A-4 Results & Conclusions

Viewing the concentration summaries for Sonora and Mariposa sites (Table 2.0 - 1) reveals a minimum of at least one order of magnitude differential in concentration for fibers/m³, mass/m³, and surface area/m³ in contrast to other sites assumed to be very low in concentration (Van 201 ELD, Van 401 ELD, Camino).

Depending upon which parameter is viewed, large differentials can occur in concentration when comparing two samples. For example, comparison of Sonora sample 12-30-73 (SAI #81-1094) with Camino sample 04-10-73 (SAI #81-1231) yields the following concentration effects:

	Total fibers/m ³	Chrysotile Total mass/m ³	Total surface area/m ³
81-1094 Sonora	291	24200	5450
81-1231 Camino	7.5	0.4	4.5
Ratio: <u>Sonora</u> <u>Camino</u>	39	60500	1200

The fiber concentration in Sonora (81-1094) is 39 times higher, the mass concentration is 60500 times higher and the surface area is 5450 times higher. This wide variation in concentration data should be considered carefully when relating to any epidemiological data.

The usual reporting of data includes fiber and mass concentration without reporting surface area. Theoretically mass and surface area do not differ in ratio only when the size distribution of the asbestos population does not change.

In the real world situation the size distribution changes greatly in chrysotile source rock areas with changes in meteorologic conditions. The percent of chrysotile fibers $>5\mu\text{m}$ in the Sonora County samples varied from 1 to 19 percent (Table A-1). This variation in the size distribution is responsible for poor correlation between fibers/ m^3 and mass/ m^3 .

In actuality, the correlation between fibers/ m^3 and surface area/ m^3 is a much better correlation (Table A-2). The correlation of all parameters $\leq 5\mu\text{m}$ is fairly consistent with the correlation between fibers/ m^3 and surface area/ m^3 (.98) being extremely good. Above $5\mu\text{m}$ none of the parameters correlate and it is important to note how poor the correlation is between fibers/ m^3 and mass/ m^3 . It is recommended that some further investigation of surface area/ m^3 as an included parameter in the reporting of asbestos data be considered.

TABLE A-1

Sample Variation in the Percentage
of "Occupational" Chrysotile Fibers
($<5\mu\text{m}$) in Eleven Sonora County Samples

<u>SAI Sample #</u>	<u>Collection Date</u>	<u>%Chrysotile fibers $\leq 5\mu\text{m}$</u>	<u>%Chrysotile fibers $>5\mu\text{m}$</u>	<u>%Ratio of Chrysotile fibers $>5\mu\text{m}$</u>
81-1101	08-08-73	86	12	14%
81-1097	10-25-73	71	7	10%
81-1116	09-20-74	74	1	1%
81-1094	12-30-72	49	9	18%
81-1120	06-28-74	39	3	8%
81-1099	09-25-73	56	5	9%
81-1121	04-05-74	79	9	11%
81-1118	07-22-74	61	4	6%
81-1102	07-15-73	57	11	19%
81-1106	05-24-73	82	6	7%
81-1110	03-23-73	54	9	17%

TABLE A-2
Correlation of Fibers/m³, mass/m³
and Surface Area/m³ for Sonora sites

Compared parameters	<u>Coefficient of Correlation</u>		
	<u><5μm</u>	<u>>5μm</u>	<u>total distribution</u>
Fibers/m ³ (excluding 81-1094) mass(ng)/m ³	.70	-.13	-.002
mass(ng)/m ³ (excluding 81-1094) surface area (μm ²)/m ³	.83	.30	.22
Fibers/m ³ (excluding 81-1094) surface area μm ² /m ³	.98	.59	.96

Appendix B

DEATH CERTIFICATE ABSTRACT FORMAT

<u>Variable Number</u>	<u>Column Location</u>	<u>Field Type</u>	<u>Description</u>
1	01-02	F2.0	Card Number, 01
2	03-06	F4.0	Identification Number
3	07-15	F9.0	Social Security Number:999-99-9999-blank
4	16-45	7A4,A2	Decedent (Last, First, Middle)
5	46-47	F2.0	Date of Death, Year (last two digits)
6	48-49	F2.0	Date of Death, Month
7	50-51	F2.0	Date of Death, Day
8	52	F1.0	Sex: 1-Male , 2-Female
9	53-54	F2.0	Birthplace (see State and Country Codes)
10	55-57	F3.0	Date of Birth, Year (last three digits)
11	58-59	F2.0	Date of Birth, Month
12	60-61	F2.0	Date of Birth, Day
13	62	F1.0	Age Code: 0-100 years or over,1-years
14	63-64	F2.0	Age, years

DEATH CERTIFICATE ABSTRACT

<u>Variable Number</u>	<u>Column Location</u>	<u>Field Type</u>	<u>Description</u>
15	01-02	F2.0	Card Number, 02
16	03-06	F4.0	Identification Number
17	07-26	5A4	Father's Name (First, Middle, Last if different from decedent)
18	27-28	F2.0	Father's Birthplace (see State and Country Codes)
19	29-48	5A4	Mother's Maiden Name (First, Middle, Last)
20	49-50	F2.0	Mother's Birthplace (see State and Country Codes)
21	51	F1.0	Marital Status: 1-Married; 2-Single, Never Married; 4-Divorced; 5-Widowed; 9-Unknown/Not Stated
22	52-80	7A4,A1	Name of Surviving Spouse(First, Middle, Last)

DEATH CERTIFICATE ABSTRACT

<u>Variable Number</u>	<u>Column Location</u>	<u>Field Type</u>	<u>Description</u>
23	01-02	F2.0	Card Number, 03
24	03-04	F4.0	Identification Number
25	07-09	F3.0	Last Occupation (see Occupational Codes): 999-blank
26	10-11	F2.0	Number of Years in Last Occupation: 99-blank
27	12	F1.0	Kind of Occupation: 1-Definite Asbestos Exposure; 2-Probable Exposure; 3-Possible Exposure; 4-Probably No Exposure; 9-No Occupation (see exposure codes)
28	13-14	F2.0	County of Death (see County Codes)
29	15-16	F2.0	Length of Stay in County, years: 99-blank
30	17-18	F2.0	Length of Stay in California, years: 99-blank
31	19-20	F2.0	Usual Residence, City (see City Codes)
32	21-22	F2.0	Usual Residence, County (see County Codes)
33	23-40	4A4,A2	Name of Informant (First, Last, Middle)
34	41-59	4A4,A3	Address of Informant
35	60-68	2A4,A1	City of Informant
36	69-70	A2	State of Informant
37	71-74	F4.1	Cause of Death, ICD 8th Revision Code
38	75	F1.0	Autopsy: 1-No Autopsy; 2-Autopsy, results used; 3-Autopsy, results not used; 4-Autopsy, unknown if results used; 5-Unknown if an autopsy
39	76	F1.0	Certifier: 1-Coroner; 2-M.D. or D.O.; 3-D.C.; 4-Unknown before 1975, Military after 1975; 5-Unknown

BIRTHPLACE
STATE CODES

01 - Alabama	35 - North Dakota
02 - Alaska	36 - Ohio
03 - Arizona	37 - Oklahoma
04 - Arkansas	38 - Oregon
05 - California	39 - Pennsylvania
06 - Colorado	40 - Rhode Island
07 - Connecticut	41 - South Carolina
08 - Delaware	42 - South Dakota
09 - District of Columbia	43 - Tennessee
10 - Florida	44 - Texas
11 - Georgia	45 - Utah
12 - Hawaii	46 - Vermont
13 - Idaho	47 - Virginia
14 - Illinois	48 - Washington
15 - Indiana	49 - West Virginia
16 - Iowa	50 - Wisconsin
17 - Kansas	51 - Wyoming
18 - Kentucky	52 - Virgin Island
19 - Louisiana	54 - Outlying Possessions
20 - Maine	55 - United States, Place Unknown
21 - Maryland	
22 - Massachusetts	
23 - Michigan	
24 - Minnesota	
25 - Mississippi	
26 - Missouri	
27 - Montana	
28 - Nebraska	
29 - Nevada	
30 - New Hampshire	
31 - New Jersey	
32 - New Mexico	
33 - New York	
34 - North Carolina	

BIRTHPLACE
FOREIGN COUNTRY CODES

- 56 - Asia (inc. India, Israel, Korea, Lebanon, Pakistan
other Asia)
- 57 - Austria
- 58 - Belgium
- 59 - Central America (inc. British Honduras, Costa Rica, El Salvador,
Guatemala, Honduras, Nicaragua, Panama)
- 60 - Canada
- 61 - China
- 62 - Czechoslovakia
- 63 - Denmark
- 64 - Eire (inc. Ireland, Northern Ireland)
- 65 - England
- 66 - Finland
- 67 - France
- 68 - Germany
- 69 - Greece
- 70 - Hungary
- 71 - Italy
- 72 - Japan
- 73 - Mexico
- 74 - Netherlands
- 75 - Phillippine Islands
- 76 - Poland
- 77 - Portugal
- 78 - Rumania
- 79 - South America (inc. Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador,
Paraguay, Peru, Uruguay, Venequela, other South American)
- 80 - Scotland
- 81 - Spain
- 82 - Norway, Sweden
- 83 - Switzerland
- 84 - USSR (inc. Russia, Ukrania)
- 85 - Wales
- 86 - West Indies (inc. Cuba, Dominican Republic, Haiti, Jamaica, West Indies
Federated, other West Indies)

FOREIGN COUNTRY CODES

87 - Yugoslavia

88 - All others (inc. Africa, Australia, Azores Islands, New Zealand,
other Pacific Islands)

89 - Unknown Nativity

OCCUPATIONAL CLASSIFICATION SYSTEM

Occupation Code:

Professional, Technical, and
Kindred Workers

001	Accountants	
002	Architects	
	Computer specialists	
003	Computer programmers	
004	Computer systems analysts	
005	Computer specialists, n.e.c.	
	Engineer	
006	Aeronautical & astronautical eng.	074
007	Eng. not specified (4 yrs.college)	075
010	Chemical engineers	076
011	Civil Engineers	
012	Electrical & electronic engineers	080
013	Industrial engineers(incl: gas plant engineers)	081
014	Mechanical engineers	082
015	Metallurgical & materials eng.	
020	Mining engineers	083
021	Petroleum engineers	
022	Sales engineers	084
023	Engineers, n.e.c	085
024	Farm management advisors	
025	Foresters and conservationists	
026	Home management advisors	086
	Lawyers and judges	090
030	Judges	
031	Lawyers	091
	Librarians, archivists, and curators	092
032	Librarians	093
033	Archivists and curators	094
	Mathematical specialists	095
034	Actuaries	096
035	Mathematicians	
036	Statisticians	100
	Life and physical scientists	
042	Agricultural scientists	101
043	Atmospheric and space scientists	
044	Biological scientists	102
045	Chemists	103
051	Geologists	
052	Marine scientists	104
053	Physicists and astronomers	105
054	Life and physical scientists, nec	110
055	Operations & systems researchers and analysts	111
		112
056	Personnel & labor relations workers	113
	Physicians, dentists, & related Practitioners	114
		115
061	Chiropractors	116
062	Dentists	120

Occupations Code:

Professional, Technical, and
Kindred Workers - continued

063	Optometrists
064	Pharmacists
065	Physicians, medical and osteopathic
071	Podiatrists
072	Veterinarians
073	Health Practitioners, n.e.c.
	Nurses, dieticians, & therapists
	Dieticians
	Registered nurses
	Therapists
	Health technologists & technicians
	Clinical laboratory technologists technicians
	Dental hygienists
	Health record technologists & technicians
	Radiological technologists & technicians, n.e.c.
	Therapy assistants
	Health technologists & technicians n.e.c.
	Religious workers
	Clergymen
	Religious workers, n.e.c.
	Social Scientists
	Economists
	Political scientists
	Psychologists
	Sociologists
	Urban & regional planners
	Social Scientists, n.e.c.
	Social & recreation workers
	Social workers (incl. juvenile counseling)
	Recreation workers
	Teachers, college & university
	Agriculture teachers
	Atmospheric, earth, marine & spac teachers
	Biology teachers
	Chemistry teachers
	Physics teachers
	Engineering teachers
	Mathematics teachers
	Health specialties teachers
	Psychology teachers
	Business & commerce teachers
	Economics teachers
	History teachers

Occupation Code:

Professional, Technical, and

Kindred Workers - continued

121	Sociology teachers	191
122	Social science teachers, n.e.c.	192
123	Art, drama, & music teachers	
124	Coaches & physical ed. teachers	193
125	Education teachers	194
126	English teachers	
130	Foreign language teachers	195
131	Home economics teachers	
132	Law teachers	
133	Theology teachers	
134	Trade, industrial & technical	
135	Miscellaneous teachers, college & university	201
140	Teachers, college & university, subject not specified (incl. grad. assistant)	202
	Teachers, except college & university	203
141	Adult education teachers	205
142	Elementary school teachers	210
143	Prekindergarten teachers	211
144	Secondary school teachers	212
145	Teachers, except college & university, n.e.c.	213
146	Teachers, not specified	215
	Engineering and science technicians	220
150	Agriculture & biological technicians, except health	221
151	Chemical technicians	222
152	Draftsmen	223
153	Electrical & electronic engineering technicians	224
154	Industrial engineering technicians	225
155	Mechanical engineering technicians	226
156	Mathematical technicians	230
161	Surveyors	231
162	Engineering & science technicians, n.e.c. (includes trainee)	233
	Technicians, except health & engineering & science	235
163	Airplane pilots	240
164	Air traffic controllers	245
165	Embalmers	
170	Flight engineers	246
171	Radio operators	
172	Tool programmers, numerical control	
173	Technicians, n.e.c.	
174	Vocational & educational counselors	
	Writers, artists, & entertainers	
175	Actors	
180	Athletes & kindred workers	
181	Authors	
182	Dancers	
183	Designers	
184	Editors & reporters	
185	Musicians & composers	
190	Painters & sculptors	

Photographers

Public relations men & publicity writers

Radio & television announcers

Writers, artists, & entertainers, n.e.c.

Research workers, not specified (incl. research director)

Management and Administrators, Except Farm

Assessors, controllers & treasurers; local public administration

Bank officers & financial managers

Buyers & shippers, farm products

Buyers, wholesale & retail trade

Credit men

Funeral directors

Health administrators

Construction inspectors, public administration

Inspectors, except construction, public administration

Office managers, n.e.c.

Officers, pilots & pursers; ship

Officials & administrators; public administration, n.e.c.

Officials of lodges, societies

Postmasters & mail superintendents

Purchasing agents & buyers, n.e.c.

Railroad conductors

Restaurant, cafeteria & bar manager

Sales managers & department heads, retail trade

Sales managers, except retail trade

School administrators, college

School administrators, elementary & secondary

Managers & administrators, n.e.c. (film producer, self employed)

Management trainee

Sales Workers

Advertising agents & salesmen

Auctioneers

Demonstrators

Hucksters & peddlers

Insurance agents, brokers & underwriters (incl. insurance coordinators)

Real Estate agents & brokers

Stock & bond salesmen

Salesmen & sales clerks, n.e.c. (medical distributor, drugstore)

Sales associate

Clerical and Kindred Workers

301	Bank tellers (incl. banking, proofer)	384	Telegraph operators
302	Budgetary control	385	Telephone operators
303	Billing clerks	390	Ticket, station & express agents (incl. railroad station clerk)
305	Bookkeepers (incl. accounting, auditing clerk)	391	Typists
310	Cashiers	392	Weighers
311	Clerical assistants, social welfare	394	Miscellaneous clerical workers (incl. service rep; general office worker)
312	Clerical supervisors, n.e.c. (incl. det. head - office work, office manager)	395	Not specified clerical workers (incl. Volt, Kelly)
313	Collectors, bill & account	396	Other clerical
314	Counter clerks, except food		
315	Dispatcher & starters, vehicle		
320	Enumerators & interviewers		
321	Estimators & investigators, n.e.c. (incl. costumer's representative)	401	Craftsmen and Kindred Workers
323	Expeditors & production controllers	402	Automobile accessories installers
325	File clerks (incl. filers, book store sorting)	403	Bakers
330	Library attendants & assistants (incl. library clerk)	404	Blacksmiths
331	Mail carriers, post office	405	Boilermakers
332	Mail handlers, except post office (incl. mail clerk)	410	Bookbinders
333	Messengers & office boys	411	Brickmasons & stonemasons
334	Meter readers, utilities	412	Brickmasons & stonemasons, apprentice
	Office machine operators	413	Bulldozer operators (incl. tractor driver)
341	Bookkeeping & billing machine operators	415	Cabinetmakers
342	Calculating machine operators	416	Carpenters
343	Computer & peripheral equipment operators	420	Carpenter apprentices
344	Duplicating machine operators	421	Carpet installers
345	Key punch operators	422	Cement & concrete finishers
350	Tabulating machine operators	423	Compositors & typesetters
355	Office machine operators, n.e.c.	424	Printing trades apprentices, exc. pressmen (incl. print shop helper)
360	Payroll & timekeeping clerks	425	Cranemen, derrickmen, hoistmen
361	Postal clerks (incl. postal service)	426	Decorators & window dressers
362	Proofreaders	430	Dental laboratory technicians
363	Real estate appraisers	431	Electricians
364	Receptionists	433	Electricians apprentices
	Secretaries	434	Electric power linemen & cablemen
370	Secretaries, legal	435	Electrotypers & stereotypers
371	Secretaries, medical	436	Engravers, exc. photoengravers
372	Secretaries, n.e.c.	440	Excavating, grading & road machine operators, exc. bulldozer
374	Shipping & receiving clerks	441	Floor layers, exc. tile setters
375	Statistical clerks	442	Foremen & hammermen
376	Stenographers	443	Forgemen and hammermen
379	Administrative assistant	444	Furniture & wood finishers
381	Stock clerks & storekeepers (incl. inventory)	445	Furriers
382	Teacher aides, exc. school monitors (incl. school aide)	446	Glaziers
383	Telegraph messengers	450	Heat treaters, annealers, & temperers
		452	Inspectors, scalers, & graders; log and lumber
		453	Inspectors, n.e.c. (incl. telephone investigation)
			Jewelers & watchmakers (incl. jewelry work)

Operatives, Except Transport - cont'd

656	Punch & stamping press operatives
660	Riveters & fasteners
661	Sailors & deckhands
662	Sawyers
663	Sewers & stitchers
664	Shoemaking machine operatives
665	Stationary firemen
	Textile operatives
670	Carding, lapping & combing operatives
671	Knitters, loopers & toppers
672	Spinners, twistors & winders
673	Weavers
674	Textile operatives, n.e.c. (incl. miller)
680	Welders & flame-cutters
681	Winding operatives, n.e.c.
690	Machine operatives, miscellaneous specified (incl. pottery worker)
692	Machine operatives, not specified
694	Miscellaneous operatives (incl. miscellaneous handywork)
695	Not specified operatives (incl. baker's assistant, paper miller, pie factory, auto factory, jewelry factory, box assembler, aluminum window plant, factory worker, made barricades)
701	Boatmen & canalmen
703	Busdrivers
704	Conductors & motormen, urban rail transit
705	Deliverymen & routemen
706	Fork lift & tow motor operatives
710	Motormen; mine, factory, logging camp, etc.
711	Parking attendants
712	Railroad brakemen
713	Railroad switchmen
714	Taxicab drivers & chauffeurs
715	Truck drivers

Laborers, Except Farm

740	Animal caretakers, exc. farm
750	Carpenters' helpers
751	Construction laborers, exc. carpenters' helpers
752	Fishermen & oystermen
753	Freight & material handlers (incl. furniturs mover)
754	Garbage collectors
755	Gardeners & groundskeepers, exc. farm
760	Longshoremen & stevedores
761	Lumbermen, raftsmen & woodchoppers (incl. lumber)

Laborers, Except Farm - continued

762	Stock handlers (incl. box boy, g ^{en} clerk, stock girl)
763	Teamsters
764	Vehicle washers & equipment cleaners
770	Warehousemen, n.e.c.
780	Miscellaneous laborers
785	Not specified laborers (incl. facto
786	Sanitation man, sanitizer
787	Maintenance man, n.s.

Farmers and Farm Managers

801	Farmers (owners and tenants)
802	Farm managers

Farm Laborers and Farm Foremen

821	Farm foremen
822	Farm laborers, wage workers (incl. farm hand, farm work)
823	Farm laborers, unpaid family workers
824	Farm service laborers, self-employed
825	Civilian Conservation Corp

Service Workers, Exc. Private Household

	Cleaning service workers
901	Chambermaids & maids, except private household
902	Cleaners & charwomen
903	Janitors & sextons (incl. custodi
	Food service workers
910	Bartenders
911	Busboys
912	Cooks, except private household (cook, director, chef)
913	Dishwashers
914	Food counter & fountain workers
915	Waiters (incl. barmaid)
916	Food service workers. n.e.c., exc private household
917	Restaurants, n.s.
918	Hostess
	Health service workers
921	Dental assistants
922	Health aides, exc. nursing (incl asst., nuclear research lab work
923	Health trainees
924	Lay midwives
925	Nursing aides, orderlies & attend
926	Practical nurses
927	Health spa worker

Craftsmen and Kindred Workers - cont'd.

454 Job & die setters, metal
 455 Locomotive engineers
 456 Locomotive firement
 461 Machinists
 462 Machinist apprentices
 Mechanics & repairmen
 470 Air conditioning, heating & refrig.
 471 Aircraft
 472 Automobile body repairmen
 473 Automobile mechanics
 474 Automobile mechanic apprentices
 475 Data processing machine repairmen
 480 Farm implement
 481 Heavy equipment mechanics (incl.
 diesel, factory mech, meter)
 482 Household appliance & accessory
 installers & mechanics (incl. re-
 pairmen)
 483 Loom fixers
 484 Office machine
 485 Radio and television
 486 Railroad & car shop
 491 Mechanic, exc. auto, apprentices
 492 Miscellaneous mechanics & repairmen
 495 Not specified mechanics & repairmen
 501 Millers; grain, flour & feed
 502 Millwrights
 503 Molders, metal
 504 Molder apprentices
 505 Motion picture projectionists
 506 Opticians, & lens grinders & polishers
 510 Painters, construction & maintenance
 (incl. contract)
 511 Painter apprentices
 512 Paperhangers
 514 Pattern & model makers, exc. paper
 515 Photoengravers & lithographers
 516 Piano & organ tuners & repairmen
 520 Plasterers
 521 Plasterer apprentices
 522 Plumbers & pipe fitters
 523 Plumber & pipe fitter apprentices
 525 Power station operators
 530 Pressmen & plate printers, printing
 531 Pressmen apprentices
 533 Rollers & finishers, metal
 534 Roofers & slaters
 535 Sheetmetal workers & tinsmiths
 536 Sheetmetal apprentices
 540 Shipfitters
 542 Shoe repairmen
 543 Sign painters & letterers
 545 Stationary engineers
 546 Stone cutters & stone carvers

Craftsmen and Kindred Workers - cont'd

550 Structural metal craftsmen (incl. iron
 worker)
 551 Tailors
 552 Telephone installers & repairmen
 554 Telephone linemen & splicers
 560 Tile setters
 561 Tool & die makers
 562 Upholsterers
 571 Specified craft apprentices, n.e.c.
 572 Not specified apprentices
 575 Craftsmen & kindred workers, n.e.c.
 580 Former members of the Armed Forces

Operatives, Except Transport

601 Asbestos & insulation workers
 602 Assemblers
 603 Blasters & powdermen
 604 Bottling & canning operatives
 605 Chainmen, rodmen, & axmen; surveying
 610 Checkers, examiners & inspectors;
 manufacturers
 611 Clothing ironers & pressers
 612 Cutting operatives, n.e.c.
 613 Dressmakers & seamstresses, except
 factory
 614 Drillers, earth
 615 Dry wall installers & lathers
 620 Dyers
 621 Filers, polishers, sanders & bugger
 622 Furnacemen, smeltermen & pourers
 623 Garageworkers & gas station attenda
 624 Graders & sorters, manufacturing
 625 Produce graders & packers, except
 factory & farm
 626 Heaters, metal
 630 Laundry & dry cleaning operatives, n.
 631 Meat cutters & butchers, exc. manuf
 turing
 633 Meat cutters & butchers, manufactur
 634 Meat wrappers, retail trade
 635 Metal platers
 636 Milliners
 640 Mine operatives, n.e.c.
 641 Mixing operatives
 642 Oilers & greasers, exc. auto
 643 Packers & wrappers, except meat &
 produce
 644 Painters, manufactured articles
 645 Photographic process workers
 Precision machine operators
 Drill press operatives
 Grinding maching operatives
 Lathe & milling machine operative
 Precision machine operatives, n.e.

Service Workers, Exc. Private Household, cont'd

Personal service workers

931 Airline stewardesses
932 Attendants, recreation & amusement
933 Attendants, personal service, n.e.c.
934 Baggage porters & bellhops
935 Barbers
940 Boarding & lodging house keepers
941 Bootblacks
942 Child care workers, exc. private household (incl. n.s., juvenile detention)
943 Elevator operators
944 Hairdressers & cosmetologists
945 Personal service apprentices
950 Housekeepers, exc. private household
952 School monitors
953 Ushers, recreation & amusement
954 Welfare service aides
Protective service workers
960 Crossing guards & bridge tenders
961 Firemen, fire protection
962 Guards & watchmen
963 Marshals & constables
964 Policemen & detectives (incl. railroad traffic officer)
965 Sheriffs & bailiffs
966 Military
980 Child care workers, private household (incl. baby sitter)
981 Cooks, private household
982 Housekeepers, private household
983 Laundresses, private household
984 Maids & servants, private household

996 Occupation not specific enough to code
998 DK

840 - DISABLED

850 - RETIRED

860 - UNEMPLOYED

890 - HOMEWOMAN, HOUSEWIFE

999 - BLANK, MISSING, NOT REPORTED

Occupational Asbestos Exposure Codes

<u>Code</u>	<u>Category</u>
1	Definite asbestos exposure - decedent employed by asbestos company
2	Probable exposure - including building, house construction, plasterer, automobile mechanic, cement worker
3	Possible exposure - including steel or metal worker railroad workers, house painter, longshoreman, PG & E laborer
4	Probably No exposure - including Farmer, Rancher, lumber worker, office or clerical, food service, health services.

Calaveras and Tuolumne Counties
City Codes

I High Asbestos Areas: less than 5 miles from deposits

Calaveras County

Tuolumne County

11 - San Andreas	20 - Sonora
12 - Altaville	21 - Chinese Camp
13 - Angels Camp, Carson Hill	22 - Jamestown
14 - Melones	23 - Groveland
15 - Valley Springs, Double Springs	24 - Jacksonville
16 - Copperopolis, Salt Spring Valley	25 - Tuttletown
17 - Burson	26 - Big Oak Flat, Moccasin
18 - Calaveritas	
19 - Campo Seco	

II Medium Asbestos Areas: 6 to 10 miles from deposits

Calaveras County

Tuolumne County

31 - Milton	40 - Columbia
32 - Jenny Lind	
33 - Telegraph City	
35 - Mokelumne Hill	
36 - Mountain Ranch	
37 - Murphys	
38 - Douglas Flat	
39 - Vallecito	

III Low Asbestos Area: More than 10 miles from deposits

Calaveras County

51 - West Point
52 - Railroad Flat
53 - Arnold, White Pines
54 - Camp Connell
55 - Avery, Hathaway Pines
56 - Sheep Ranch
57 - Glencoe
58 - Wilseyville

Tuolumne County

60 - Twain Harte
61 - Tuolumne, Bodenhamer
62 - Strawberry
63 - Long Barn, Sierra Village
64 - Soulsbyville
65 - Standard
66 - Mi-Wuk Village, Sugar Pine

CALIFORNIA COUNTY CODES

01 - Alameda	37 - San Diego
02 - Alpine	38 - San Francisco
03 - Amador	39 - San Joaquin
04 - Butte	40 - San Luis Obispo
05 - Calaveras	41 - San Mateo
06 - Colusa	42 - Santa Barbara
07 - Contra Costa	43 - Santa Clara
08 - Del Norte	44 - Santa Cruz
09 - El Dorado	45 - Shasta
10 - Fresno	46 - Sierra
11 - Glenn	47 - Siskiyou
12 - Humboldt	48 - Solano
13 - Imperial	49 - Sonoma
14 - Inyo	50 - Stanislaus
15 - Kern	51 - Sutter
16 - Kings	52 - Tehama
17 - Lake	53 - Trinity
18 - Lassen	54 - Tulare
19 - Los Angeles	55 - Tuolumne
20 - Madera	56 - Ventura
21 - Marin	57 - Yolo
22 - Mariposa	58 - Yuba
23 - Mendocino	98 - Out of State, Out of Country
24 - Merced	
25 - Modoc	
26 - Mono	
27 - Monterey	
28 - Napa	
29 - Nevada	
30 - Orange	
31 - Placer	
32 - Plumas	
33 - Riverside	
34 - Sacramento	
35 - San Benito	
36 - San Bernardino	

Appendix C

SMR Data Base for Calaveras and Tuolumne Counties

Male Deaths from Malignant Neoplasms of the Digestive Organs
and Peritoneum (ICD 150-159), by Year and Age at Death,
Calaveras and Tuolumne Counties

YEAR		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	0	0	0	0	0	0	0	0	0
	10-14	I	0	0	0	0	0	0	0	0	0
	15-19	I	0	0	0	0	0	0	0	0	0
	20-24	I	0	0	0	0	0	0	0	0	0
	25-29	I	0	0	0	0	0	0	0	0	0
	30-34	I	0	0	0	0	0	1	0	0	0
	35-39	I	0	0	0	0	1	0	0	0	0
	40-44	I	0	0	1	0	0	0	0	0	0
	45-49	I	0	0	0	0	3	0	1	1	1
	50-54	I	0	0	1	0	2	1	3	0	0
	55-59	I	1	1	0	0	1	1	0	0	2
	60-64	I	1	0	0	4	2	2	4	0	3
	65-69	I	1	2	1	5	2	0	3	3	6
	70-74	I	3	2	4	1	2	1	2	3	4
	75-79	I	3	2	2	1	0	0	0	1	2
	80-84	I	1	1	3	1	0	2	4	1	2
	GE 85	I	1	1	1	0	0	1	0	2	0
TOTAL		I	11	9	13	12	13	11	8	17	20

Male Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163),
by Year and Age at Death,
Calaveras and Tuolumne Counties

		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	1	0	0	0	0	0	0	0	0	0
	10-14	1	0	0	0	0	0	0	0	0	0
	15-19	1	0	0	0	0	0	0	0	0	0
	20-24	1	0	0	1	0	0	0	0	0	0
	25-29	1	0	0	0	0	0	0	0	0	0
	30-34	1	0	0	0	0	0	0	0	0	0
	35-39	1	1	0	0	0	0	0	1	0	0
	40-44	1	0	1	0	0	0	0	0	0	0
	45-49	1	0	0	1	0	1	1	0	0	1
	50-54	1	0	3	1	0	2	5	1	2	1
	55-59	1	3	2	1	0	2	2	3	3	1
	60-64	1	1	1	2	5	5	4	4	2	1
	65-69	1	2	2	2	5	3	4	3	6	2
	70-74	1	2	1	1	3	0	4	5	1	3
	75-79	1	4	2	0	1	4	0	1	2	2
	80-84	1	2	1	1	0	2	4	2	0	1
	GE 85	1	1	0	1	0	2	1	2	3	0
TOTAL		1	16	13	13	7	14	21	22	19	12

Male Deaths from Hypertensive Heart and Renal
Disease (ICD 402, 404), by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	0	0	0	0	0	0	0	0	0
	10-14	I	0	0	0	0	0	0	0	0	0
	15-19	I	0	0	0	0	0	0	0	0	0
	20-24	I	0	0	0	0	0	0	0	0	0
	25-29	I	0	0	0	0	0	0	0	0	0
	30-34	I	0	0	0	0	0	0	0	0	0
	35-39	I	0	0	0	0	0	0	0	0	0
	40-44	I	0	0	0	0	0	0	0	0	0
	45-49	I	0	0	0	0	0	0	0	0	0
	50-54	I	0	0	0	0	0	0	0	0	0
	55-59	I	0	0	0	0	0	0	0	0	0
	60-64	I	0	0	0	0	0	0	0	0	0
	65-69	I	0	1	0	0	0	0	0	0	0
	70-74	I	0	0	0	0	1	0	0	0	0
	75-79	I	0	0	0	0	0	0	0	0	0
	80-84	I	0	0	0	0	0	0	0	0	0
	GE 85	I	0	0	0	0	2	1	0	0	0
	TOTAL	I	0	1	0	1	2	1	0	0	0

AGE

C-4

Male Deaths from Malignant Neoplasms
of the Genital Organs (ICD 180-187), by Year and Age
at Death, Calaveras and Tuolumne Counties

AGE	YEAR									
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	1	0	0	0	0	0	0	0	0	0
10-14	1	0	0	0	0	0	0	0	0	0
15-19	1	0	0	0	0	0	0	0	0	0
20-24	1	0	0	0	0	0	0	0	0	0
25-29	1	0	0	0	0	0	0	0	0	0
30-34	1	0	1	0	0	0	0	0	0	0
35-39	1	0	0	0	0	0	0	0	0	0
40-44	1	0	0	0	0	0	0	0	0	0
45-49	1	0	0	0	0	0	0	0	0	0
50-54	1	0	0	1	0	0	0	0	0	0
55-59	1	0	0	0	0	0	0	0	0	0
60-64	1	0	0	0	0	0	0	0	2	2
65-69	1	0	0	0	4	0	1	1	1	4
70-74	1	0	1	1	0	2	0	1	2	1
75-79	1	1	0	0	3	1	3	0	1	0
80-84	1	0	0	2	1	3	1	0	2	2
GE 85	1	1	1	0	1	0	2	0	0	2
TOTAL	1	2	3	6	9	6	7	2	8	11

Male Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR											
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978		
AGE		LT 10	1	6	3	8	3	6	1	7	2	4	5
C-6		10-14	1	0	0	0	1	1	1	0	1	2	2
		15-19	1	4	3	3	5	1	1	4	2	7	4
		20-24	1	3	5	5	7	5	5	8	6	4	2
		25-29	1	0	4	1	1	3	2	4	7	4	7
		30-34	1	1	3	2	3	3	0	4	4	2	1
		35-39	1	2	0	5	3	2	2	4	3	7	3
		40-44	1	6	1	5	4	3	7	2	1	6	6
		45-49	1	4	4	12	8	16	7	8	8	5	13
		50-54	1	9	11	9	10	10	10	12	16	7	12
		55-59	1	22	16	13	22	12	16	15	16	17	34
		60-64	1	23	16	25	27	29	27	24	37	26	45
		65-69	1	28	34	38	33	42	28	45	42	33	40
		70-74	1	43	29	31	42	39	25	40	46	36	30
		75-79	1	42	29	26	32	21	30	23	31	30	34
		80-84	1	22	22	32	26	24	37	22	25	28	29
		GE 85	1	22	28	26	22	26	24	20	16	38	24
	TOTAL		1	237	208	241	247	245	224	236	267	253	274

Female Deaths from Malignant Neoplasms of the Digestive Organs
and Peritoneum (ICD 150-159), by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	0	0	0	0	0	0	0	0	0
	10-14	I	0	0	0	0	0	0	0	0	0
	15-19	I	0	0	0	0	0	0	0	0	0
	20-24	I	0	0	0	0	0	0	0	0	0
	25-29	I	0	0	0	0	0	0	0	0	0
	30-34	I	0	0	0	0	0	0	0	0	0
	35-39	I	0	0	0	0	0	0	0	0	0
	40-44	I	0	0	0	0	0	0	0	0	0
	45-49	I	1	2	0	0	0	0	0	0	0
	50-54	I	0	0	0	0	1	0	1	2	1
	55-59	I	1	0	1	1	0	2	2	0	0
	60-64	I	2	1	0	1	0	2	3	1	1
	65-69	I	0	0	0	0	1	4	1	0	1
	70-74	I	3	2	1	0	2	5	1	1	0
	75-79	I	2	2	1	1	1	4	1	0	1
	80-84	I	1	0	3	0	1	0	1	2	3
	GE 85	I	3	1	0	2	1	0	2	1	1
TOTAL		I	13	8	6	5	11	7	17	12	7

Female Deaths from Malignant Neoplasms of Respiratory System (ICD 160-163),
by Year and Age at Death,
Calaveras and Tuolumne Counties

AGE

C-8

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
LT 10	I	0	0	0	0	0	0	0	0	0	0
10-14	I	0	0	1	0	0	0	0	0	0	0
15-19	I	0	0	0	0	0	0	0	0	0	0
20-24	I	0	0	0	0	0	0	0	0	0	0
25-29	I	0	0	0	0	0	0	0	0	0	0
30-34	I	0	0	0	0	0	0	0	0	0	0
35-39	I	0	0	0	0	0	0	0	0	0	0
40-44	I	0	0	0	0	0	0	1	0	1	0
45-49	I	0	0	0	0	0	1	1	0	1	0
50-54	I	0	0	0	1	0	0	0	0	0	1
55-59	I	0	2	1	1	0	0	2	0	2	2
60-64	I	0	0	0	0	2	0	0	0	1	5
65-69	I	0	0	1	0	3	0	0	0	1	1
70-74	I	1	0	0	0	1	0	2	2	1	1
75-79	I	0	0	0	1	0	1	2	0	0	2
80-84	I	0	0	0	0	0	0	1	1	0	1
GE 85	I	0	0	0	0	0	0	0	1	0	0
TOTAL		1	1	2	3	6	2	9	4	7	13

Female Deaths from Malignant Neoplasms
of the Breast (ICD 174), by Year and Age
at Death, Calaveras and Tuolumne
Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE											
LT 10	I	0	0	0	0	0	0	0	0	0	0
10-14	I	0	0	0	0	0	0	0	0	0	0
15-19	I	0	0	0	0	0	0	0	0	0	0
20-24	I	0	0	0	0	0	0	0	0	0	0
25-29	I	0	0	0	0	0	0	0	0	0	0
30-34	I	0	0	0	0	0	0	0	0	0	0
35-39	I	0	0	0	1	1	0	0	0	0	0
40-44	I	0	0	1	0	0	0	0	0	0	0
45-49	I	0	1	0	0	1	1	1	0	1	1
50-54	I	1	0	0	0	1	1	1	0	1	3
55-59	I	0	1	0	1	0	1	1	1	2	1
60-64	I	0	0	3	0	1	1	1	1	0	0
65-69	I	0	1	0	0	0	1	1	1	1	1
70-74	I	0	0	1	1	0	0	2	0	3	2
75-79	I	1	0	0	0	1	0	0	0	0	0
80-84	I	0	0	0	1	0	1	0	0	0	0
GE 85	I	1	1	1	0	1	0	1	0	1	1
TOTAL	I	3	4	6	4	6	6	8	3	9	9

Female Deaths from Malignant Neoplasms
of the Genital Organs (ICD 180-187),
by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	0	0	0	0	0	0	0	0	0
	10-14	I	0	0	0	0	0	0	0	0	0
	15-19	I	0	0	0	0	0	0	0	0	0
	20-24	I	0	0	0	0	0	0	0	0	0
	25-29	I	0	0	0	0	0	0	0	0	0
	30-34	I	0	0	0	0	0	0	0	0	0
	35-39	I	0	0	0	0	0	0	0	0	0
	40-44	I	0	0	0	1	0	0	0	1	0
	45-49	I	0	0	1	0	0	0	0	0	1
	50-54	I	1	0	0	0	1	1	0	0	1
	55-59	I	1	1	0	0	1	0	2	0	0
	60-64	I	0	2	2	2	0	1	0	0	0
	65-69	I	1	1	0	1	0	0	2	1	2
	70-74	I	0	1	1	0	0	0	0	1	0
	75-79	I	1	0	2	2	0	0	0	0	0
	80-84	I	1	1	1	0	0	0	1	1	0
	GE 85	I	0	0	0	0	1	0	0	0	0
	TOTAL	I	5	6	7	6	1	6	3	5	4

C-10

Female Deaths from Hypertensive Heart and Renal
Disease (ICD 402, 404), by Year and Age at Death,
Calaveras and Tuolumne Counties

		YEAR									
		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	0	0	0	0	0	0	0	0	0
	10-14	I	0	0	0	0	0	0	0	0	0
	15-19	I	0	0	0	0	0	0	0	0	0
	20-24	I	0	0	0	0	0	0	0	0	0
	25-29	I	0	0	0	0	0	0	0	0	0
	30-34	I	0	0	0	0	0	0	0	0	0
	35-39	I	0	0	0	0	0	0	0	0	0
	40-44	I	0	0	0	0	0	0	1	0	0
	45-49	I	0	0	0	0	0	0	0	0	0
	50-54	I	0	0	1	0	0	0	0	0	0
	55-59	I	0	0	1	0	0	0	0	0	0
	60-64	I	0	0	0	0	0	0	0	0	0
	65-69	I	2	0	0	0	0	0	0	0	0
	70-74	I	0	0	0	0	1	0	0	0	0
	75-79	I	0	0	0	0	0	0	0	0	0
	80-84	I	0	0	1	0	0	0	0	0	0
	GE 85	I	1	0	0	1	1	0	0	0	0
	TOTAL	I	3	0	3	0	2	0	1	0	0

Female Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

			YEAR									
			1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
AGE	LT 10	I	4	7	5	0	6	5	2	3	2	6
	10-14	I	3	0	1	0	0	1	0	0	0	0
	15-19	I	1	2	0	2	0	1	2	1	4	3
	20-24	I	1	1	1	5	1	0	2	1	2	3
	25-29	I	0	0	3	2	3	0	0	0	1	1
	30-34	I	0	0	0	0	0	1	0	2	0	1
	35-39	I	0	2	1	2	2	1	1	1	4	1
	40-44	I	0	1	6	4	1	3	4	6	5	2
	45-49	I	3	6	5	4	6	4	5	5	6	3
	50-54	I	5	5	10	6	8	8	9	9	5	11
	55-59	I	11	11	12	8	7	12	11	10	10	6
	60-64	I	10	13	15	14	17	15	18	16	9	14
	65-69	I	18	18	10	9	18	19	23	20	14	16
	70-74	I	18	19	20	10	23	21	25	15	21	21
	75-79	I	22	19	22	20	21	24	23	20	20	23
	80-84	I	24	28	21	11	25	27	26	22	29	23
	GE 85	I	35	34	35	36	38	33	41	31	37	52
TOTAL	I		155	166	167	133	176	175	192	162	169	186

Female Deaths from All Causes,
by Year and Age at Death,
Calaveras and Tuolumne Counties

			YEAR										
			1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	
C-12	AGE	LT 10	I	4	7	5	0	6	5	2	3	2	6
		10-14	I	3	0	1	0	0	1	0	0	0	0
		15-19	I	1	2	0	2	0	1	2	1	4	3
		20-24	I	1	1	1	5	1	0	2	1	2	3
		25-29	I	0	0	3	2	3	0	0	0	1	1
		30-34	I	0	0	0	0	0	1	0	2	0	1
		35-39	I	0	2	1	2	2	1	1	1	4	1
		40-44	I	0	1	6	4	1	3	4	6	5	2
		45-49	I	3	6	5	4	6	4	5	5	6	3
		50-54	I	5	5	10	6	8	8	9	9	5	11
		55-59	I	11	11	12	8	7	12	11	10	10	6
		60-64	I	10	13	15	14	17	15	18	16	9	14
		65-69	I	18	18	10	9	18	19	23	20	14	16
		70-74	I	18	19	20	10	23	21	25	15	21	21
		75-79	I	22	19	22	20	21	24	23	20	20	23
		80-84	I	24	28	21	11	25	27	26	22	29	23
		GE 85	I	35	34	35	36	38	33	41	31	37	52
TOTAL			I	155	166	167	133	176	175	192	162	169	186