Upper Cape Cancer Incidence Study
Final Report

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TABLE OF CONTENTS

List of Figures and Tables

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

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LIST OF TABLES (continued)

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EXECUTIVE SUMMARY

UPPER CAPE CANCER INCIDENCE STUDY

On December 23, 1987 the Massachusetts Department of Public Health issued a Request for Proposals to respond to the following three important public health issues affecting the Upper Cape (here defined as Barnstable, Bourne, Falmouth, Mashpee, and Sandwich).

First, apparent elevations in cancer incidence and mortality were observed for certain kinds of cancer as compared to state-wide averages and the nearby Lower Cape region. In particular, consistently elevated mortality rates were seen for lung cancer and leukemia for the towns of Falmouth and Bourne. In addition, since the inception of the Massachusetts Cancer Registry in 1982, statistically significant excesses were seen in the incidence of cancers of the breast, colon/rectum, lung and blood forming organs and statistically unstable increases were seen for cancers of the pancreas, kidney, and bladder in at least one of the Upper Cape towns.

Second, there were many known or suspected environmental hazards affecting the Upper Cape. These included both groundwater and air contaminants from a variety of sources including the Massachusetts Military Reservation.

Third, there was substantial concern among organized elements of the general public who pressed forcefully and persistently for an in-depth evaluation of the relationship between the environmental hazards and cancer rates noted above.

On December 9, 1988 the Commonwealth of Massachusetts contracted with the Boston University School of Public Health to conduct an epidemiologic study in the Upper Cape region on the relationship between environmental factors and cancer occurrence. This report describes the results of a set of population-based case-control studies that evaluated the relationship between exposures to known or suspected environmental hazards and nine types of cancer. Cases consisted of newly diagnosed cancers in the years 1983-1986 among permanent Upper Cape residents. The main environmental exposures considered were air and water pollution associated with the Massachusetts Military Reservation (MMR), Canal Electric Plant, Barnstable Airport, and other sources, perchloroethylene in water distribution system pipes, radiofrequency radiation from PAVEPAWS, electric and magnetic fields from 115 Kv transmission lines and substations, and possible exposure to pesticides among residents who lived near cranberry bogs.

The study cases consisted of incident cancer of the lung (N=251), breast (N=265), colon/rectum (N=315), bladder (N=62), kidney (N=35), pancreas (N=37), leukemia (N=36), brain (N=37), and liver (N=4) as reported to the Massachusetts Cancer Registry in the years 1983 to 1986. Since many cases were deceased by the start of the study, both living and deceased Upper Cape residents were selected as controls (N=1,285). Living controls aged 64 and under were selected using random digit dialing to sample all telephone subscribers in these towns. Living controls aged 65 and over were selected randomly from lists of the elderly population provided by the Health Care Financing Administration (HCFA). Deceased controls were selected randomly from all death certificates of Upper Cape residents who had died since 1983.

Trained interviewers queried all subjects or their next-of-kin either by telephone or in person to obtain a demographic, occupational and residential history and information on potential confounding variables such as smoking. Overall, approximately 81% of cases and 79% of controls were interviewed. The majority of the environmental exposure data was collected independently of the interview and linked to the study subjects using the residential histories.

Each exposure was examined separately in relation to all cancers combined and to the individual cancer sites. Most exposures were categorized as dichotomous variables (i.e. ever vs. never exposed) with further subdivisions according to distance, cumulative duration, and direction. An exposure metric was also developed that took account of distance, direction and duration in a single number. Some exposures were examined as continuous variables (e.g. estimated ground level concentrations from the Canal Electric Plant).

The strength of the relationship between a particular exposure and cancer site was measured by the odds ratio (an estimate of relative risk). P-values and 95% confidence intervals were used to assess the statistical "significance", or stability, of the odds ratios. Most analyses were conducted with and without latency to account for the possibility that the exposures under study could be either cancer initiators or a combination of both initiators and promoters. Multiple logistic regression models were used to control for potential confounding variables. Sex, age, vital status at interview, and, depending on the cancer site, other potential confounders were controlled. The other confounders consisted of well-known relatively strong risk factors for the particular cancer including a history of work in jobs associated with cancer risk.

The overall findings are as follows. Few study subjects had potential exposure to drinking water contaminants from groundwater plumes emanating from various sites on or off the MMR. These plumes, including the Ashumet Valley plume, do not appear to account for much, if any, of the cancer burden to the population to this time. We cannot say what the health effects might be to the small number of people currently exposed or to others if and when the plumes extend to cause additional exposures.

The results suggested approximate two-fold elevations in the risk of brain cancer among those who ever had a residence supplied with public water on the Upper Cape, particularly from the Barnstable Water Co., but these findings cannot be considered conclusive because of several limitations of the data. The limitations include the lack of details regarding the historical pattern of water contamination in the area and the pattern of water use among the subjects, the large number of subjects dropped from these analyses because of missing data, and the almost complete overlap between exposure to the Barnstable Water Co. and Barnstable Airport for which an elevation in brain cancer risk was also seen. The overlap makes it impossible to separate the association with the Barnstable Water Co. from that of the airport. In fact, these exposures may merely be markers for still other exposures in the Hyannis area or characteristics of Hyannis residents that are associated with brain cancer. Taking all of these things into account, we believe that it would be prudent to study all current public drinking water supplies on the Upper Cape, particularly the Barnstable Water Co., and identify and eliminate any currently contaminated sources.

We examined another public drinking water exposure, perchlorethylene (PCE) from the water distribution pipes, in relation to leukemia and bladder and kidney cancer. There was nearly a two-fold increase in the risk of leukemia (whether or not the latent period was considered) and bladder cancer (when the latent period was ignored) among those supplied with water from pipes that leached PCE. These risk estimates were not statistically stable, a reflection of small numbers, but the increases are biologically plausible and, in the case of leukemia, appear to exhibit a dose-response relationship. For these reasons, we believe that our results are consistent with a hazard of PCE contamination in some of the distribution systems of the Upper Cape. We recommend continued vigilance to minimize population exposure to this contaminant.

Among residents located near the gun and mortar positions on the MMR we found associations between possible airborne exposures and the risk of lung and breast cancer. Subjects who lived closer to the gun and mortar positions had a modest increase in the risk of lung cancer (relative risks were 1.75 for those within 2 km of the sites while it dropped to 1.05 for those 2 km to 3 km). Likewise, there was an increased risk of breast cancer among subjects who lived closer to the sites (relative risks were 1.92 for those within 2 km and 1.25 for those 2 km to 3 km). Among residents exposed for more than 20 years, we also found increases in the risk of lung and breast cancer (relative risks were 2.48 for lung cancer and 2.15 for breast cancer when the latent period was taken into account). These results were not statistically stable, probably because few subjects were exposed for long periods of time or lived close to the sites. No meaningful elevations were seen for the other cancer sites.

These results are of concern since 2,4-dinitrotoluene, a constituent of the propellants used on the MMR, has been rated a probable human carcinogen by the U.S. Environmental Protection Agency. Given the strength of the association, the presence of dose-response relationships, and information from the scientific literature, we believe that the association between proximity to the gun and mortar positions and lung cancer may be real. The association with breast cancer is less plausible and so we give this finding considerably less weight; however, we do not think that it should be entirely dismissed. The results suggest that the practice of propellant bag burning should not take place so close to populated areas.

Results from analyses that examined potential exposure to air contaminants from the MMR and Barnstable Airport runways also suggested an association with brain cancer. When considering exposures without latency, there appeared to be an increase in the risk of brain cancer associated with residence within 3 km of the MMR runways. The association was evident only when subjects who ever lived within 3 km were compared to those who never lived within that distance, but not when the exposure metric was used. The relative risk was fairly strong (adjusted relative risk was 3.98) and statistically stable (p=.02).

While an association was also seen between brain cancer and the Barnstable Airport runways (adjusted relative risks were 1.62 with latency and 1.50 without latency), it was completely confounded with exposure to water of the Barnstable Water Co. As with the MMR runways, the elevated risk occurred with use of the ever/never comparison but not with use of the exposure metric.

While brain cancer was associated with both facilities, the confounding between the airport and the water company make the latter association difficult to interpret. Since a potential hazard has not been ruled out, we believe that further study is warranted. A first step might be an examination of brain cancer rates in other Massachusetts cities and town with similar facilities. In the meantime, the air quality around the MMR and Barnstable Airport should be studied, both with regard to current state and federal regulations, and non-regulated contaminants.

To gauge the global effect of the MMR considered as one large site, we examined residence near the MMR base border in several different ways. We found an increased risk of lung and breast cancer among subjects exposed for more than 20 years, with exposure defined as living within 3 km of the border and with latency taken into account. However, it appears that these increased risks merely reflected the increased risks associated with the gun and mortar positions and that there was no independent association with the border itself.

Few subjects ever resided on the MMR itself. For such residents, we could not assess most cancer risks because of small numbers. There appeared to be some increase in the risk of colorectal cancer in the adjusted analyses whether or not the latent period was considered. Since a potential confounding factor, physical activity level, remained uncontrolled, it is not clear what the meaning of the association might be.

The results of analyses examining the MMR and Barnstable Fire Training Areas, the MMR AVGAS dump site, and the MMR UTES/BOMARC site were inconsistent and do not support associations with these sites. For the remaining MMR sites including the Railroad Fuel Pumping Station (FS2), Johns Pond Road Dump Site (FS3), Storm Drains, and Non-Destructive Inspection Laboratory, there were too few exposed subjects within an appropriate distance to provide meaningful results. While it is unlikely that these sites contributed to the elevated cancer rates on the Upper Cape, we cannot say what the health effects would be if more people had been exposed.

While no association was seen for PAVEPAWS, the available exposure data were inadequate. We strongly recommend that systematic power density measurements be taken throughout the area scanned by PAVEPAWS so that useful exposure data will be available for future analyses of its potential health impact.

There was also no apparent relation between emissions from the Canal Electric Power Plant and any cancer site, whether or not the latent period was considered. This was not unexpected since the EPA dispersion model for the plant indicated that ground level concentrations were low and uniformly spread throughout the study area.

Possible pesticide exposure associated with living near cranberry bogs was also examined. When the latent period was considered, a statistically stable 2.4-fold increase in the unadjusted risk of brain cancer was seen among individuals who ever lived within a half mile of a bog. The risk remained elevated when subjects with other relevant exposures were excluded. However, an inverse dose-response relationship was seen with duration and distance. There were also no apparent trends with cumulative bog acreage or calendar time, nor was there an increased risk when latency was ignored and the exposure metric was used. The findings were similar when confounders were controlled. No meaningful associations were seen for the other cancer sites.

While the results lack internal consistency, the strength and stability of the overall association and its consistency with numerous studies in the scientific literature lead us to put additional weight on the observation. Since our study leaves many questions unanswered, we recommend that a larger, more detailed investigation be performed on the relationship between cranberry bog cultivation and brain cancer in Massachusetts. In the meantime, the various methods used to apply pesticides should be reexamined with an eye towards keeping population exposure to a minimum. In particular, the adequacy of the current buffer zones should be evaluated.

Electric and magnetic fields from transmission lines and substations were also studied. Exposure was defined as living within 500 feet of these structures. There was a modest unstable increase in the risk of lung cancer associated with the transmission lines and substations (adjusted relative risks were 1.57 and 2.78, respectively). There were also unstable increases in the risk of bladder cancer associated with transmission lines (adjusted relative risk was 2.57) and breast cancer associated with substations (adjusted relative risk 1.69) but not transmission lines (adjusted relative risk 1.23). These results suggest that extremely low frequency electromagnetic fields might be biologically active and confirm the necessity for continued investigation and attention.

Associations were also seen between brain cancer and ever swimming in Johns Pond; and leukemia and ever swimming in local ponds (other than Johns and Ashumet Ponds), and ever eating fish from local ponds. A more detailed inquiry revealed that many different ponds were involved in the leukemia associations with no apparent pattern and so we give these findings very little weight. In addition, while more brain cancer cases than controls stated that they ever swam in Johns Pond, when we asked about the frequency of swimming we found that the exposed controls actually swam there more often. Since these results lack internal consistency, in the absence of external confirmatory data it is difficult to determine if these results implicate the pond itself as a source of brain cancer. However, we are aware that a plume from the MMR is in close proximity to Johns Pond and so we recommend that the pond water be thoroughly tested and the precise relationship between the plume and pond be determined.

Finally, examination of the length and calendar years of residence revealed that, with the exception of leukemia, cases and controls had similar lengths of residence and moved to the Upper Cape at similar rates. A larger proportion of leukemia cases than controls moved to the study area in the 1940s (35.3% vs. 23.2%) and their length of residence was, on average, two years longer than controls. These differences were not statistically stable. Thus, cancer risk, with the possible exception of leukemia, was not generally related to how long or when a person resided on the Upper Cape, and cases and controls appear to have contributed similarly to the population growth in the area. These results do not contradict the risk increases seen among subjects exposed for more than 20 years previously described, since the latter focused on a small subset of long term residents who lived near particular exposure sites.

In interpreting these results one should keep in mind the limitations of the epidemiologic method in general and this study in particular. The main problems in this study stem from exposure misclassification and low statistical power, both of which tend to make it more difficult to see any real associations. While confounding, selection and observation bias are problems inherent in epidemiologic research, we think that they are less likely explanations for the findings.

In summary, this inquiry was begun because of concern about the generally increased cancer rates in the Upper Cape region along with the presence of known or suspected environmental hazards. After an extensive review of the environmental factors it is clear that there was ample cause for concern. While it was understood that an epidemiologic study would be unlikely to identify all the causes of the cancer in the region, it was hoped that a thorough investigation would narrow the large area of uncertainty surrounding possible environmental associations. Our results suggest that there is some association with environmental factors, although our study was unable to estimate its magnitude. On the basis of the results obtained, however, and bearing in mind the limitations of the study, it does not appear that we have explained more than a small part of the cancer increase in the region. Thus, either some factors other than those we investigated may be responsible, or some methodological limitation of the study, most likely the unavoidable exposure misclassification, made it undetectable (or perhaps a combination of both). It is possible that further analyses and the addition of more cases from subsequent years of the Cancer Registry would clarify and resolve some of these remaining issues.

I. INTRODUCTION

On December 23, 1987 the Massachusetts Department of Public Health issued a Request for Proposals in response to three important public health issues affecting the Upper Cape.

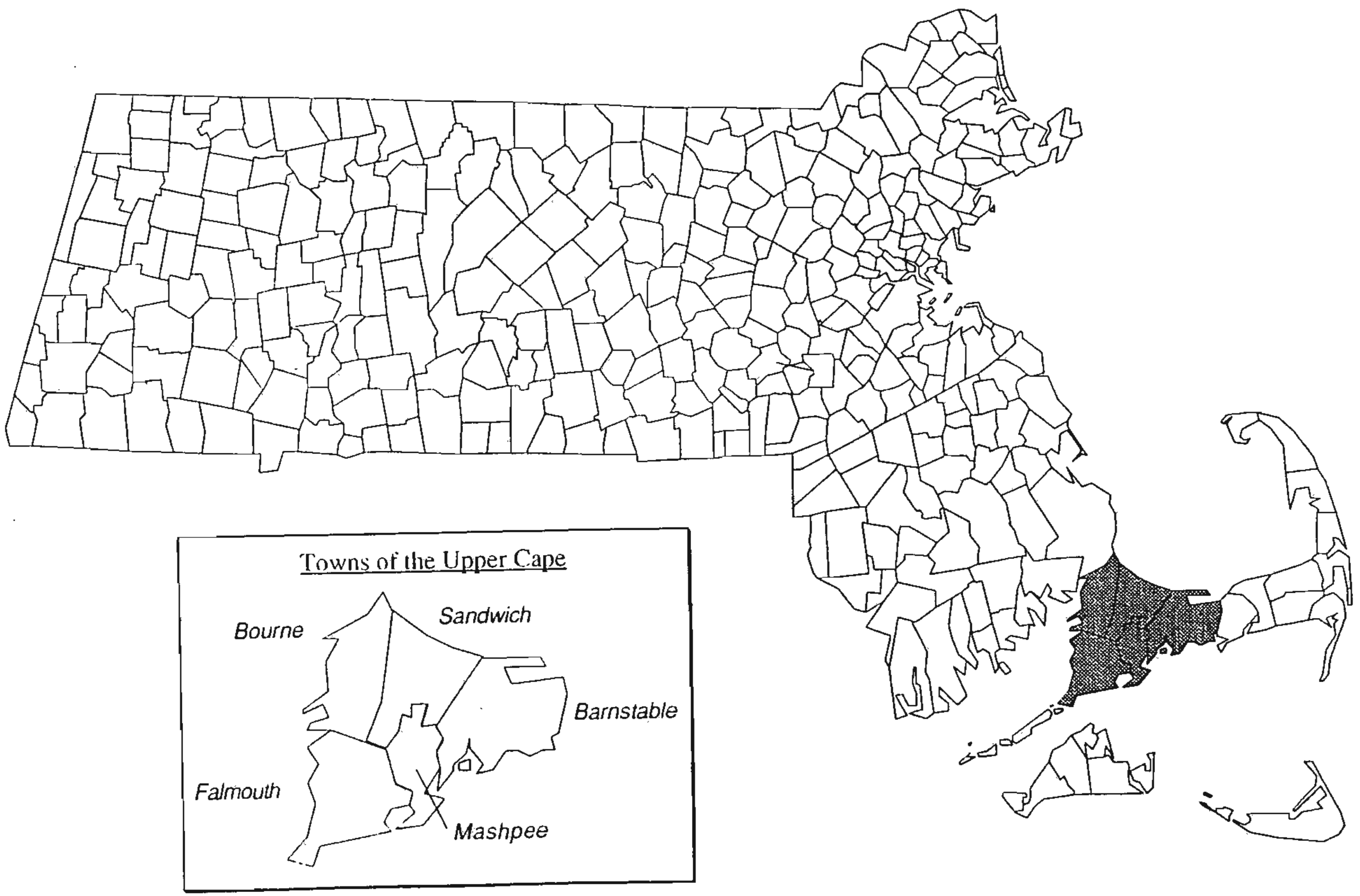
First, apparent elevations in cancer incidence and mortality were observed in certain kinds of cancer as compared to state-wide averages and the nearby Lower Cape region. In particular, consistently elevated mortality rates were seen for lung cancer and leukemia for the towns of Falmouth and Bourne. In addition, statistically significant excesses were seen in the incidence of cancers of the breast, colon/rectum, lung and blood forming organs and statistically unstable increases were seen for cancers of the pancreas, kidney, and bladder in at least one of the Upper Cape towns. For example, 1982-84 standardized incidence ratios were 141 for breast cancer among women in Barnstable ($p < .001$), 149 for colon and rectum cancer among both men and women in Bourne ($p < .01$), and 179 for lung cancer among women in Falmouth ($p < .01$).

Second, there were many known or suspected environmental hazards uniquely affecting the Upper Cape. These included both groundwater and air contaminants from a variey of sources including the Massachusetts Military Reservation.

Third, there was substantial concern among organized elements of the general public who pressed forcefully and persistently for an in-depth evaluation of the relationship between the environmental hazards and cancer rates noted above.

The Upper Cape is here defined as the five towns of Barnstable, Bourne, Falmouth, Mashpee and Sandwich (Figure I.1).

Figure I.1 Upper Cape Area of Massachusetts



On December 9, 1988 the Commonwealth of Massachusetts entered into a contract with the Boston University School of Public Health for the purpose of studying the relationship between cancer in the Upper Cape region and environmental factors there. This report describes the results of a set of population-based case-control studies on the relationship between cancer of nine sites newly diagnosed in the years 1983-1986 among permanent Upper Cape residents and exposures to a variety of known or suspected environmental hazards.

Overview of the Report

Environmental problems on the Upper Cape have received a considerable amount of attention in the media, from local, state and federal agencies, and by citizens' groups. Some of the hazards are acknowledged concerns of all groups, some are the concerns of only the citizens' group, while still others have received little or no attention to date but seemed to us worthy of attention. Section A of the "Methods" section describes the chemical and physical hazards considered in this study and gives the reasons why certain environmental factors were chosen for detailed investigation. More than forty separate exposure sources were studied in relation to nine different kinds of cancers.

Section B of the "Methods" section gives complete details of the study population and the methods used to select and obtain information from them. Study subjects included all Upper Cape permanent residents diagnosed with cancers of the breast, colon-rectum, lung, pancreas, blood system (leukemia), kidney, bladder, brain and liver from January 1983 to December 1986. These cancer sites were selected because their rates were elevated in at least one of the Upper Cape towns and/or because of community concern. Control subjects were randomly selected from the Upper Cape population.

In Section C we describe the means we used to determine whether a study subject was exposed to any of the environmental hazards.

The final part of the "Methods" section, Section D, provides information on the data analysis procedures that we followed.

The "Methods" section is followed by the "Results" section. Here the results of all the analyses are described in relation to each cancer type and each exposure. This is followed by a "Discussion" section which examines and interprets the results in the light of existing knowledge and within the context of the strengths and limitations of the epidemiologic method.

The Report concludes with references and appendices to allow the interested reader to fill in details left out of the main report.

The Epidemiologic Method

Epidemiologic studies of this size and complexity seem to consist of many bewildering technical details and to use many sophisticated tools. In their essence, however, they are quite simple. Because it is not ethically possible to perform experiments on human populations that would allow a determination of whether an environmental hazard causes a serious disease like cancer, we must instead look to see if there is some unintended circumstance that is similar to such an experiment that would allow us to learn important information nonetheless. For example, we might examine whether workers exposed to a particular hazard in the work place, such as asbestos, have health histories that are different from the general population. Epidemiology is simply the art and science of obtaining as much information as possible from observing real individuals in the real world.

As such it has important strengths and just as important weaknesses. Its strengths are that it studies human beings (as opposed to some laboratory animal, for example) under the usual conditions of their lives (as opposed to some artificial laboratory environment). On the other hand, because we must take the circumstances as they are given, epidemiology may give answers that can be interpreted in more than one way. Even more important, as a method it tends to be rather insensitive to all but the most powerful influences on health. Views through the epidemiologic lens are inherently blurred and health effects must be large in order to be seen. Hence failure to see a relationship with this method is no guarantee that it is not there. On the contrary, we know that epidemiology may easily miss important and significant relationships.

In the Report that follows we have attempted to make clear what can be said and what cannot. At the outset it was agreed by all concerned that inherent limitations in the method of epidemiology would make it unlikely that this study could settle all of the important questions about the higher than usual rate of cancer in the Upper Cape region. However it was also hoped that the application of the best methods available could succeed in shrinking the large area of uncertainty regarding the influence of various environmental factors and provide a basis to ask further questions. We leave it to the Reader to judge how well this has been accomplished.

II. METHODS

A. Identification of Environmental Hazards on the Upper Cape

No independent environmental measurements were performed by study personnel. Sources of air and groundwater contamination in the study area (Barnstable, Bourne, Falmouth, Mashpee, and Sandwich) were identified by reviewing existing environmental data and consulting with staff at the Massachusetts Department of Environmental Protection (DEP) and the Barnstable County Department of Health.

We used the DEP's "List of Confirmed Disposal Sites and Locations to be Investigated" (January 15, 1989) to identify known hazardous waste sites that are not associated with the Massachusetts Military Reservation (MMR) in the study area. We assessed each site's potential as a source of exposure to the population during the study period (1943-1986) based on the available data and discussions with DEP staff.

Three of the sixteen sites on the list (the J.Braden Thompson Rd. site in Sandwich, the Briarwood area of Mashpee, and the Mashpee Landfill) were judged to be of sufficient potential impact to include in the study, and are described in detail later in the report. The other sites on the list were, for the most part, leaking underground storage tanks with very small areas of impact, or sites where contamination occurred after the study period. Table II.1 lists these sites and the reasons they were not considered in the study.

Table II.1 Hazardous Waste Sites in the Study Area Not Considered Sources of Exposure

BARNSTABLE

British Petroleum Station at 230 Iyanough Rd. and Old Colony Station at 258 Iyanough Rd. - Leaking underground storage tanks and old spills. No evidence that they impact on water supply wells.

Hyannis Mobile Service station on Rte. 132 - Leaking underground storage tank, discovered 1986; installed 1983. No wells down gradient of site. Exposure potential low; too late for relevance in this study.

Property at 57 Lake St. - Leaking underground home heating oil tank discovered Oct. 1987. In residential area where houses are on public water supply.

Residence at 355 Bel River Rd. - Leaking underground storage tank on private residence. No private or public wells in area. Discovered 1988.

Warren Buick at 100 Barnstable Rd. - Leaking underground storage tank discovered 1986. Contamination began before April 1986. No records of any impact on water supplies.

BOURNE

Bourne Exxon at Rte. 6 Rotary - Leaking underground storage tank. Leak discovered 1984, tanks were installed 1977-78. Site in a commercial area; no public or private wells in vicinity.

Buzzards Bay Cinema at 105 Main St. - Leaking underground storage tank. No private or public wells in area.

Kingman Marina on Shipyard Lane - Diesel oil spill occurred about 1977, probably source of contamination. Contamination confined to the marina site, slowly flushing out to the harbor; no public or private wells in area.

Southeast Wildlife District - Leaking underground storage tank discovered June 1987. Tanks installed in 1959, not known when leak began. Site is within zone of contribution of Buzzards Bay Water District wellfield #1 but there is no evidence supply has been affected.

Table 1 (cont.) Hazardous Waste Sites in the Study Area Not Considered Sources of Exposure

Bourne, (cont'd):

Mass. Gas & Electric at 156 Herring Pond Rd. - Oil spill, cleaned up promptly. Listed on previous DEQE list but not on current one.

SANDWICH

KWE Enterprises (Earl's Sunoco Station) at 182 Rte. 10A -Leaking underground storage tanks discovered June 1987. Tanks installed 1964, date leak began not known. One private well contaminated.

FALMOUTH

Souza's Texaco at 121 Main St. - Leaking underground storage tank and spill occurred probably in 1985-1986. Too late for relevance to this study.

Fuller Field Building on Main St. - Small leaking underground storage tank; on previous DEQE list but not on current one.

[Source: List of Confirmed Disposal Sites and Locations to be Investigated, Mass. DEQE, January 15, 1989]

To identify current sources of air emissions, we used the Stationary Source Enforcement and Inventory System (SSEIS) for the study area obtained from the DEP Division of Air Quality. This inventory identified all facilities which are registered with DEP as emitters of volatile organic compounds. With the exception of the Canal Electric Power Plant, these officially registered air emissions sources in the study area were all of minor significance. Automobile emissions were not considered in this study. Table II.2 lists the sources of air emissions registered with DEP and their emissions for 1989.

Table II.2: Registered Sources of Air Emissions in the Study Area

Greater than 5 Tons, 1989 (in tons)

Facility	TSP*	SO_2	NO_2	CO	VOC+
Canal Electric Plant	294	71,899	13,693	1,022	--
MA Air National Guard	14	96	54	19	27
MA Maritime Academy	--	25	--	--	--
Falmouth High School	--	6	--	--	--
Cape Cod Air Force Station	--	--	32	7	--

[Source: 1989 SSEIS, Mass. D.E.P.]

To identify industrial activities that might have resulted in population exposures to hazards in the past we considered the past records of the Directory of New England Manufacturers (later the Directory of Massachusetts Manufacturers). In addition we interviewed a number of local town and environmental officials about industries that were present during their lifetimes.

Other than the industrial activities at the MMR, this review confirmed that the Upper Cape has not been a major industrial area. While a few small industries have had their brief day on the Cape over the past 40 years, those with some potential for releasing significant amounts of hazardous materials into the environment include only the Canal Electric Plant, activities associated with the Massachusetts Military Reservation, and the cultivation of cranberries.

Table II.3 summarizes the environmental exposures determined as described above and considered by the study. Each is described in detail below.

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* Total suspended particulates
+ Volatile organic compounds

Table II.3 Environmental Exposures Considered in the Study

Air Pollution Sources	Location	Years of Operation Within the Study Period
MMR Runways	MMR	1943 - 1986
Fire Training Area 1	MMR	1958 - 1985
Fire Training Area 2	MMR	1948 - 1956
Fire Training Area 3	MMR	1956 - 1958
Storm Drain 1	MMR	1955 - 1986
Storm Drain 2/Petrol Fuel Spill Area (PFSA)	MMR	1955 - 1986
Storm Drain 4	MMR	1955 - 1986
Storm Drain 5	MMR	1943 - 1986
Propellant Bag Burning Sites	MMR	1943 - 1985
BOMARC Site (CS10)	MMR	1962 - 1973
UTES Site (CS10)	MMR	1978 - 1986
AVGAS Dumpsite (FS1)	MMR	1955 - 1969
Railway Fuel Station (FS2)	MMR	1955 - 1965
Johns Pond Rd. Fuel Dump (FS3)	MMR	1955 - 1962
Non Destructive Inspection Laboratory (NDIL)	MMR	1955 - 1986
Canal Electric Plant	Sandwich	1969 - 1986
Barnstable Airport	Barnstable	1943 - 1986
Barnstable Fire Training Area	Barnstable	1956 - 1986

Table II.3 Environmental Exposures Considered in the Study

Water Pollution Sources	Location	Years of Operation Within the Study Period
Ashumet Valley Plume	Falmouth	1964(?) - 1986
MW 603 Plume	MMR	1941(?) - 1986
MMR Landfill	MMR	1970(?) - 1986
UTES Site (CS10)	MMR	1978 - 1986
BOMARC SITE (CS10)	MMR	1962 - 1973
AVGAS Dump Site (FS1)	MMR	1955 - 1969
Railroad Fuel Station (FS2)	MMR	1955 - 1965
Fuel Spill 12/Forestdale Neighborhood	MMR/ Sandwich	1972(?) - 1986
Falmouth Landfill	Falmouth	1955 - 1986
Mashpee Landfill	Mashpee	1961 - 1986
Briarwood Neighborhood	Mashpee	1964 - 1986
J. Braden Thompson Rd. Site	Sandwich/ Mashpee	1960's (?) - 1986

Table II.3 Environmental Exposures Considered in the Study

Other Exposures	Location	Years of Operation Within the Study Period
PCE in Water Distribution Systems	All Towns	1968 - 1986
PAVEPAWS Radar Facility	MMR	1978 - 1986
Cranberry Bogs	All Towns	1943 - 1986
Transmission Lines	All Towns	1943 - 1986
Substations	All Towns	?. - 1986
Proximity to MMR Border	All Towns except Barnstable	1943 - 1986
Residence on MMR	MMR	1943 - 1986
Length of Residence on Upper Cape	All Towns	1943 - 1986
Questionnaire Data	-----	--.--

1. Contamination Associated with the Massachusetts Military Reservation

The Massachusetts Military Reservation (MMR) consists of several separate subunits situated on a 20,000 acre site in the middle of the Upper Cape. Much of the environmental concern about MMR stems from the fact that it sits upon a sole source aquifer that supplies Cape residents with their drinking water. MMR is situated upon the highest elevation in the area and represents a major groundwater recharge area, with water flowing radially but with generally greater flow to the south. A number of past and current environmental practices on the MMR involving fuels management and aircraft and vehicle maintenance have resulted in contamination of the sandy, porous soil above the water table and the groundwater below it.

From the environmental standpoint, MMR is not a single site, but a collection of sites, each with its own potential for causing population exposures to chemical agents. An extensive environmental investigation and remediation effort, the Installation Restoration Program (IRP), has been underway at the MMR since at least 1983. The IRP is managed by the Department of Defense (DOD) and has as its objective the evaluation of hazardous contamination on DOD property. The E.C. Jordan Company (Jordan), now known as A.B.B. Environmental Services Inc., is the contractor in charge of the environmental assessment program at MMR. Technical reports produced by Jordan are the main source of data used in the current study to assess the off-base impact of improper fuels and hazardous waste management at MMR.

The IRP comprises a four step process whereby hazardous waste sites at MMR are identified, investigated and quantified by means of field exploration programs, and then subjected to remedial activity (1).

In the original records search and field inspection phase of the IRP, over sixty sites "where there is a potential for environmental contamination resulting from past waste disposal practices" were identified (2). Of these original sites, forty-six were determined to have "the potential for contamination and contamination migration" (2). These forty six sites received a hazard ranking which weighted such factors as site and waste characteristics, potential for migration, and proximity to receptors. The purpose of the hazard ranking was to indicate the relative need for follow-up investigation.

Forty-one sites were recommended for so-called Phase II exploration based on their hazard ranking (1). The other sites were removed from the list, and there is no additional information beyond the records search, and therefore no data on which to base exposure assessment. Thus these sites were not included in the study, with the exception of the propellant bag burning sites. These sites, collectively designated CS18 in the IRP, received a low hazard ranking score, and so were removed from the list of sites to receive further investigation. Despite the low hazard ranking assigned in the IRP, we considered sites of propellant bag burning as a source of air contamination.

The forty-one sites remaining on the list for further Phase II investigation were rank ordered by the contractor based on hazard and proximity to receptors. Seven sites were judged of top priority: CS10 (UTES/BOMARC), FTA1 (Current Fire Training Area), LF1 (Base Landfill), FS2 (Railroad Fuel Pumping Site), FS1 (AVGAS Dump Site), CS16 (Sewage Treatment Plant), and CS1 (USCG Transmitter Station) (1). We consider five of these sites as separate sources of air and/or water contamination (CS10, FTA1, LF1, FS2, and FS1). The two sites we do not consider are CS16, the sewage treatment plant, and CS1, the USCG Transmitter Station. The impact of the sewage treatment plant is accounted for by its contribution to the Ashumet Valley Plume. CS1 is a large site in the northeastern portion of the base. Here waste solvents, transformer oil, and fuels were spilled and/or disposed. At the time of this study, there was no information on groundwater flow in the area, making it difficult to determine off-base exposure to any plume that might (or might not) be there.

An additional thirteen sites were also listed as Priority I sites, but they were of less importance than the seven listed above (1). Of these thirteen sites, we considered six as separate sources of air and/or water exposure: FTA2 (Former Fire Training Area 1948-1956), SD2 (Aircraft Maintenance Drainage Ditch), SD5 (Aquafarm Drainage Swale), FTA3 (Former Fire Training Area 1956-1958), SD1 (Aircraft Maintenance Drainage Ditch), and FS3 (Johns Pond Fuel Dump). The off-base impact of six of the other sites is unclear (CS8, FS21 (Current Product Tank 90), CS17 (Former Sludge Bed), FS20 (Current Product Tank 88), CS3 (South Truck Road Motor Pool), CS13 (Contractor's Yard)). Finally, SD3 (Coal/ash runoff ditch) is so close to FTA3 that our consideration of FTA3 effectively takes into account exposure to SD3. In addition, SD3 may contribute to the Briarwood plume which we also consider.

The remaining sites of the original forty one on the IRP Phase II list were assigned IRP Priority II or III status (1). Priority II sites have not yet affected receptors, but are located either upgradient of areas where there is the potential for development, or upgradient of a potential base water supply (Well B). Priority III sites have "a lower potential to be hazardous to the environment and are not located upgradient of receptors" (1). Of these sites, we actually considered three as potential contamination sites in our study: SD4 (Hangar 128 Maintenance Drain) is a potential source of air contamination, CS4 (West Truck Motor Pool) is the probable source of the MW603 groundwater plume, and FS12 (Range Fuel Line Leak) is a potential source of groundwater contamination. There was insufficient data on the remaining Priority II and III sites on which to base exposure assessment. Therefore, they were not included in the study.

New sites have come to light since the original records search, several known sites have been found to be worse than previously thought and there are potentially many unknown or undiscovered additional sites on the base. In order to account for the impact of unknown and uncharacterized sites, we also considered the entire base as a site, and have constructed and exposure variable using distance and direction to the base border.

The detailed reports of contaminant characterization and quantification at the Priority I and II sites, published in a number of separate documents, have been our principal source for assessing potential exposure to contaminants from MMR (1-12, 30). We have been assisted in our interpretation of these findings by staff at the Massachusetts Department of Environmental Protection, the United States Geological Survey, the Barnstable County Department of Health, and the civil engineering office of the Massachusetts Military Reservation.

The contamination at MMR is, in general, the result of the maintenance and fueling of aircraft and ground vehicles, along with certain other ancillary activities. These operations result in the leakage and spillage of fuels, oils, lubricants, and halogenated and nonhalogenated solvents, with fuels and solvents comprising the bulk of the environmental contaminants at MMR. In addition, there are quantities of miscellaneous contaminants, including pesticides, PCBs, paints, lead-acid batteries, and other contaminants from specific activities such as film developing, corrosion control, engine repair, and similar activities.

The fuels used and spilled at MMR include jet fuel 4 (JP4), MOGAS, and AVGAS. When fuel is spilled, organic and inorganic compounds remain in the soil and volatilize into the air. These compounds include benzene, toluene, and xylenes (BTX), naphthalene, C6 to C24 alkane hydrocarbons, and lead (28). In addition to these fuels, diesel fuel, fuel oil, propane, kerosene, hydraulic fluid, and various grades of lubricating oil were among the fuels and oils spilled at the MMR. These materials are referred to collectively as POLs (petroleum oil lubricants).

Solvents are used in many of the activities in the MMR shops. Halogenated solvents include 1,1,1,-trichloroethane (TCA), trichloroethylene (TCE), methylene chloride, and tetrachloroethylene (PCE). Non-halogenated solvents include 2-

butanone, methylisobutyl ketone (MIBK), and toluene. (These solvents are also used in many non-military commercial and industrial establishments, and have been found at other sites in the study area not related to the base.)

Other contaminants used at the MMR and found in soil and groundwater include de-icing compounds (ethylene glycol), film developer, emulsifiers, penetrants, and other industrial contaminants. Pesticides including DDT, dieldrin, lindane, and Sevin (2) have been used on the base, and they are sometimes found in soil and groundwater. PCBs (Arachlor 1260) were used as a dedusting agent and fire retardant at the base, and PCBs from transformer oils are also present (9). The missile propellant hydrazine was used and stored at the BOMARC missile site (CS10). However, no hydrazine or its decomposition products have yet been reported in environmental analysis.

Thus most of the contamination on and by the MMR is from a mixture of chemicals, and usually contain some amount of fuel related contaminants, solvents, and others in varying proportions. At some sites contamination from fuel-related components may be more significant than solvents, or vice-versa, but in general there is some quantity of both.

Table II.4 summarizes what is currently known about the carcinogenic and mutagenic properties of the major contaminants found at MMR. This is not a comprehensive list of all the compounds ever used or ever found.

Table II.4 Carcinogenic and Mutagenic Properties of Major Contaminants Found at MMR

(cf. Notes after Table for abbreviations)

Substance	*Carcinogenicity*	*Mutagenicity*
ethyl benzene	no data	limited evidence
1,2-dichloroethene	no data	limited evidence is negative
xylenes	no data	negative data
tricholoroethylene	NTP test = P IARC = 3 EPA rating = B2	conflicting data
toluene	no ratings assigned	conflicting data
chlorobenzene	NTP-some evidence	limited evidence is negative
2-butanone	no data	conflicting data
tetrachloroethylene	NTP test = P IARC rating = 2B EPA rating = B2	negative
benzene	IARC rating = 1 NTP test = P NTP class = CK EPA rating = A	mixed results
methylene chloride	NTP test = P IARC rating = 2B EPA rating = B2	suggestive evidence
acetone	no ratings assigned	limited evidence
1, 1-dichloroethane	no ratings assigned	negative
naphthalene	no ratings assigned	negative data

Substance	*Carcinogenicity*	*Mutagenicity*
Aluminum (processing industry)	IARC rating = 1	data not available
Arsenic	NTP class = CK IARC rating = 1 EPA rating = A	data not available
Lead	IARC rating = 2B	data not available
Manganese	data not available	data not available
Chromium	NTP class = CK IARC rating = 1 EPA rating = A	data not available
PCBs	IARC rating = 2A NTP class = CS EPA rating = B2	inadequate data
endrin	IARC rating = 3	data not available
DDT	IARC rating = 2B	conflicting data
Dieldrin	IARC rating = 3	data not available
JP-4	no data on mixture*	negative data
automotive gasoline	no rating assigned	negative data
fuel oils	no rating assigned	limited evidence
hydraulic fluid	no data	no data

[Sources: EPA SARA Section 313 Roadmap Database. Arthur D. Little, Inc. The Installation Restoration Program Toxicology Guide, June 1987]

* Constituents of JP-4 include benzene, toluene, and lead. See carcinogenic and mutagenic properties of these substances.

Notes on Table II.4:

NTP Test: P indicates National Toxicology Program (NTP) bioassay results showing positive result in at least one animal species.

NTP Class.: National Toxicology Program (NTP) carcinogenicity rating.

CK -- indicates an NTP-known carcinogen.
CS -- indicates a chemical anticipated to be a carcinogen.

IARC Rating: Carcinogenicity rating assigned by the International Agency for Research on Cancer (IARC). Codes are listed below:

AP -- animal positive
AS -- animal suspected
HP -- human positive
HS -- human suspected
1 -- the agent is carcinogenic to humans
2A -- the agent is probably carcinogenic to humans
2B -- the agent is possibly carcinogenic to humans
3 -- the agent is not classifiable as to its carcinogenicity to humans

EPA Rating: EPA Carcinogenicity classification. Codes as follows:

A -- human carcinogen, sufficient evidence from epidemiology
B1 -- Probable Human Carcinogen (limited evidence in humans)
B2 -- Probable Human Carcinogen (sufficient evidence in animals)
C -- Potential Human Carcinogen (limited evidence in animals)

The purpose of our exposure assessment of MMR activities was to estimate the off-base impact of these hazardous sites. Thus our main interest was to identify sites which were (1) the source of groundwater plumes which extended off-base, or (2) the source of air emissions which would potentially expose populations off-base.

Although there are many distinct sites at the MMR, some of them have a common off-base impact. For example, a number of sites in the southern portion of the base appear to contribute to a plume of contaminated groundwater in the Ashumet Valley. In this case, assessment of exposure to the plume is what concerned us, not the individual contribution of each separate site to the plume. On the other hand, a number of major MMR sites might have distinct impacts on air or groundwater quality and are assessed separately.

Sources of chemical contamination on the MMR generally fall into one of three categories: 1) fire training areas, 2) storm drains, and 3) fuel and/or chemical spills. Specific sites are described below. We also describe other sources of potential hazards on the MMR including the firing ranges, the runways, and the PAVEPAWS radar facility.

a. Fire Training Areas: Three Sites (FTA1, FTA2, FTA3)

Fire training areas were sites where fire-fighting exercises were held for the MMR fire department. The three sites operated over consecutive time periods: FTA2 from 1950 to 1956, FTA3 from 1956 to 1958, and FTA1 from 1958 to 1985. Activities at the three sites were similar. Flammable waste, including various fuels, oils and solvents, was set afire and the blaze extinguished by the fire department. In the past MMR fire training occurred on a quarterly basis, with 12 to 16 training fires per year. More recently a schedule of six to eight fire training sessions per year was implemented (9).

Large volume training exercises involved 300 to 500 gallons of flammable material per training session, while small volume training sessions involved between 50 to 100 gallons. Standard operating procedure, as described for FTA1, was to leave flammable material in pits overnight to volatilize and seep into the soil after a fire training exercise, and then burn off what remained the following day. It is estimated that approximately 70 percent of the ignited material burned, while the remaining 30 percent either volatilized or percolated down through the soil (9). The fire training areas therefore have contaminated groundwater at the sites themselves, and have most likely contributed to the off base plumes. These sites were also sources of air contamination, both when fires were burning with contaminants carried by smoke and convection currents, and when they were not, from volatilization of materials from contaminated soil.

b. Storm Drains: Five Sites (SD1, SD2, SD3, SD4, SD5)

There are five major storm drains on the base which drain various portions of the runways, industrial areas, and hangar/maintenance areas. Storm drains 1, 2, and 4 have been in use since 1955. The period when contamination potential was highest was 1955 through 1970 (2). SD5 has been in use since 1940 (2). With the exception of SD3, the storm drains are similar in receiving drainage from areas where large quantities of fuel and solvents were used. Storm drain 3 abuts one of the fire training areas and a coal pile. It does not drain large areas where fuel or solvents are handled, and the major drainage contaminants are coal pile and ash landfill runoff. This drain has been used since 1956 (2).

We considered storm drains 1, 2, 4, and 5 as possible sources of air emissions from the volatilization of contaminants in the surface water discharging through the drain. Each of these storm drains received surface runoff contaminated with fuels, solvents, and other industrial materials. Sampling of the soil and sediment in the drains in general found organic and inorganic fuel components, and lesser amounts of solvents.

SD1 and SD2 are similar in receiving large amounts of AVGAS and JP4 (4,5). SD2 is located directly next to the Petrol Fuel Storage Area (PFSA), the main delivery and distribution point for JP-4, AVGAS, and MOGAS. Small and large quantity fuel spills occurred during operation of the PFSA (9).

SD4 may have received more solvents than fuels, as solvents were disposed into the storm sewers in this area, and it receives unknown quantities of solvents flushed into storm drains at Hangar 128 (2). SD5 most likely received wastes from the Non Destructive Inspection Laboratory (see below) and Corrosion Control Shop, since it is in such close proximity to them.

c. Fuel Spills (FS) and Chemical Spills (CS): Six Sites (CS10, FS1, FS2, FS3, LF1, MW603 Plume)

i. UTES/BOMARC Site (CS10)

From 1962 to 1973 this area was used as a BOMARC ground-to-air missile site, and maintenance of fifty six missile units was conducted there. In 1978, UTES (Unit Training and Equipment Support) was established. UTES is responsible for the storage and maintenance of large vehicles.

During operation of the site as a BOMARC facility, hazardous wastes generated from maintenance activities included TCE, PCE, TCA, and JP-4. Fuel for the missiles was stored in several underground storage tanks on the site. Here, also, old or spilled propellant oxidizer, Red Fuming Nitric Acid (RFNA), was neutralized with limestone in a leaching pit. The highly reactive propellant Aerozine-50 (unsymmetrical dimethyl hydrazine (UDMH) and hydrazine) was also stored in underground fuel tanks. Aerozine-50 was disposed of in a septic system, which was meant to allow the fuel to auto-oxidize (5).

Hydrazine (N_2H_4) decomposes to water and nitrogen gas; UDMH ($N_2C_2H_8$) spontaneously decomposes by auto-oxidation to water, carbon dioxide, and nitrogen gas. However, when oxygen is limited UDMH can react to form N-nitrosodimethylamine (2), a potent carcinogen. Such a reaction might result from spilled UDMH, although no UDMH spills have been reported at MMR (2). No analysis for N-nitrosodimethylamine in MMR groundwater has been reported. The former UDMH septic system has been filled with earth. No record of materials buried in this system exists (2). During the site's latter use as a UTES facility (1978 to the present), wastes have included waste oil, halogenated and non-halogenated solvents, and battery electrolyte. The wastes are stored in drums or in an underground storage tank until pick up for off-site disposal. Transfer operations have reportedly resulted in 10 to 20 percent of the wastes being spilled on the ground (5). These spills also present the opportunity for air contamination through volatilization.

In addition, a plume of VOCs and fuel components has been detected emanating generally to the southwest. The plume appears to be confined to base property but is thought to be very wide. CS10 is close to the recharge area for the western Cape and the groundwater elevation contour lines bend sharply in this area. Because groundwater flow is perpendicular to these contour lines, the contamination could spread out over a wide area (31).

ii. AVGAS Dump Site (FS1)

Aircraft fuel dump valves were tested at this site from 1955 to 1969. The test required opening four valves on the aircraft, resulting in the dumping of 200 to 1000 gallons of AVGAS each time (2). The fuel on the pavement was then pushed into the surrounding soil to diminish the vapors. It is estimated that over the life of the site, 1 to 5 million gallons of AVGAS were dumped, of which a significant amount would have volatilized.

This site is the source of a plume of contaminated groundwater moving roughly southeast. Groundwater flow in this area is predominantly southeast along Ashumet Rd. towards Mashpee pond (4).

iii. Railroad Fuel Pumping Site (FS2)

This site near the southern border of the base was the distribution point for JP-4, MOGAS and AVGAS from 1955 to 1965. Here fuel was transferred from railroad tank cars or fuel trucks to pipes that transported the fuel to the current fuel storage area. Small spills occurred at each fuel transfer. Large-volume spills of up to 10,000 gallons were also reported to have occurred (4).

Volatilization of fuels would have occurred during spills. In addition, a plume of groundwater contamination may have migrated from 8,400 to 19,600 feet downgradient from this site (4).

iv. Base Landfill (LF1)

The base landfill opened in 1944. The portion of the landfill which began receiving waste after 1970 (the "post-1970" cell) is the probable source of a groundwater plume which flows to the southwest through the base residential area. Data shows that groundwater has been affected by organic compounds leaching from wastes in the post-1970 cell (4). It is likely that a plume of organic contamination extends from this cell 8,000 feet downgradient towards the MMR boundary (4). Groundwater sampling indicates that this plume probably has not yet reached the southern boundary of the base.

v. Johns Pond Road Fuel Dump Site (FS3)

Between 1955 and 1962, fuel or fuel contaminated water was drained onto the ground at this site by refueler trucks prior to their maintenance. Approximately three trucks per week drained forty gallons each of fluid onto the road (4). The site is not physically on the base property, but is located just to the south of the base border near the Briarwood neighborhood of Mashpee.

It is likely that volatilization of fuel occurred during dumping, with consequent potential for population exposure. No fuel related organic or inorganic compounds were found in groundwater at the site (4).

vi. Non Destructive Inspection Laboratory (NDIL)

The Non Destructive Inspection Lab (NDIL) has been operating in Building 156, located at the upper end of SD5, since 1978. The lab tests the structural integrity of aircraft parts. As part of the testing procedure several wastes are generated, notably penetrant, emulsifier, developer, TCA degreaser and "inspection oil." Building 156 also contains other shops which generate hazardous waste, including halogenated and non halogenated solvents, paints, methyl ethyl ketone (MEK), metals and spent electrolyte (2). This site was included as a specific source of exposure at the request of the community advisory board.

vii. MW 603 Plume

A long thin plume emanates from a source on MMR past the southern boundary. It is referred to as the MW603 plume after the off-base monitoring well that detected it. The source is probably site CS4, a motor pool area in operation from 1941 to 1983. The plume is approximately 12,000 feet long. The downgradient edge is about 500 feet north of Route 151 in the Crane Wildlife Refuge Area (12).

d. Other Plumes Associated with MMR

i. Briarwood Plume

The Briarwood neighborhood of Mashpee is an area south of the MMR lying between Johns and Ashumet Ponds. The Briarwood Homes Development was begun in 1964. Private wells in the area were sampled between 1986 and 1988 and VOC contamination was discovered in approximately forty of one hundred homes sampled.

Contaminants include acetone, benzene, chloroform, methyl ethyl ketone, methylene chloride, perchloroethylene, toluene, TCE, trichloropropane, and xylene. The exact source of the contamination is unknown, but is probably a number of sites on MMR which have been operating since the 1950s.

Based on past practices at MMR, there are likely several discrete areas of groundwater contamination in the area. Recent groundwater sampling data indicate that groundwater in Briarwood is affected by two types of contaminants in three plumes. Chlorinated solvents (including PCE and TCE) are thought to flow under the areas of East and West Briarwood, and fuel-related hydrocarbons may extend from MMR site storm drain 2 (SD2) and flow under West and Central Briarwood (30, 86).

ii. Ashumet Valley Plume

The Ashumet Valley area of Falmouth is the site of a groundwater plume approximately 11,000 feet long and 3,500 feet wide. A number of sources on MMR contribute to the plume, including the Sewage Treatment Plant and sludge drying beds, as well as other fuel and chemical spill sites such as FTA1 in the southern portion of the base. The plume includes contaminants characteristic of sewage, such as boron, detergents, and nitrates, as well as a slug of VOCs from other sources. Private wells were sampled in the area in the 1980s and a number were found to be contaminated.

The Ashumet Valley plume has received the most study of any plume in the study area. In 1984, the United States Geological Survey (USGS) reported on the location of different constituents of the plume (14). This plume delineation puts the leading edge (as defined by boron and detergents) 11,000 feet downgradient of the southern border of MMR. However, the VOC portion is shown extending only 3,000 feet south of the base boundary, well upgradient of the toe of the plume as delineated by boron and detergents. The USGS speculates that while non-biodegradable detergents began infiltrating the groundwater in 1946, the VOCs only entered the groundwater in the early 1970s (14). However E.C.Jordan also estimated the location of ethenes within the plume, and places the leading edge of the plume about 12,000 feet south of the base order.

iii. Forestdale Neighborhood of Sandwich

The discovery of high benzene contamination (1,100 ppb) in a monitoring well in the Forestdale neighborhood of Sandwich led to sampling in that neighborhood west of Weeks Pond. (This area is very close to the area impacted by the J.Braden Thompson Rd. plume described below.) The probable source is MMR site FS12, where a leak of several thousand gallons of JP-4 occurred in 1972 from a 4" diameter fuel line (36).

Sampling of private wells in the area did not find any additional benzene contamination (38). There are no data to indicate if a plume of benzene contamination exists, or if it does, what its extent might be.

e. Gun and Mortar Positions

A large area of the northern portion of the base is given over to use as a firing range. Activities at permanent gun and mortar positions are a probable source of hazardous emissions into the air. At these positions, propellant is first burned when shells are fired and later when bags of unused nitrocellulose propellant are disposed of by burning*. The burning of unused propellant occurs on bare ground, approximately 200 meters from the point of firing. Nitrocellulose is the principal ingredient in smokeless powder propellant, and 2,4-dinitrotoluene (2,4-DNT) is added at approximately 10% concentration to control propellant burn rate (2). Ash from burning

* Burning the unused portion of propellants is a form of disposal for this hazardous waste. This practice normally requires special permits (MGL Ch.21c). Since this is a federal military facility, the legality of this practice is not clear.

propellant has been found to contain substantial quantities of 2,4-DNT, a suspected carcinogen (26). Other residues include lead and traces of nitrocellulose (2).

Artillery practice takes place on every non-holiday weekend and during two week annual training periods which occur three or four times per year. Firing occurs between the hours of 8:00 AM and 4:30 PM. It is difficult to determine the exact amount of propellants which may be burned during the course of one day. Burning of the unused propellants may occur at any time after firing has been concluded. It has been estimated that Camp Edwards generates 500-700 pounds of unused artillery propellants over the course of a year (27). However, in 1989 it was estimated that 5,500 pounds of artillery propellants were generated (86). The major combustion species produced are CO, CO_2, water, N_2 and H_2 . However many other compounds are produced in smaller amounts, including benzene, ethyl acetate, naphthalene and cyanobenzene (25).

Due to the potential for exposure to hazardous emissions from burning of propellant bags, we considered these gun positions a source of air contaminants.

f. **Base Runways**

Fuel and exhaust related emissions occur during take-off and landing of aircraft, makes the runways areas a potential source of exposure to neighborhoods near them. Thus, we considered the base runways a source of air contaminants.

g. **PAVEPAWS Radar Facility**

The Cape Cod Air Station on Flat Rock Hill on MMR is the site of a powerful radar transmitter known as the Precision Acquisition of Vehicle Entry, Phased Array Warning System (PAVEPAWS). The primary mission of the facility is to detect and track incoming sea-launched ballistic missiles, and secondarily, to provide support to another system that tracks objects in space orbit. To accomplish these ends PAVEPAWS produces a flat blanket of electromagnetic radiation which can be set at elevation angles between 3° to 10° above horizontal. It is a stationary, computer controlled radar transmitter, over 70 feet in diameter, that sends electromagnetic pulses in different directions from various arrays in the dish in a predetermined manner. This results in coverage similar to a moving radar dish. The frequency of emissions is automatically sequenced through twenty four values, approximately equally spaced between 420 MHz and 450 MHz (microwave frequencies) (29).

The beam from PAVEPAWS scans a 240^{o} sector from 347^{o} to 227^{o} (where 360^{o} is due north of the facility). Sandwich, Sagamore, and North Pocasset lie within this area. Field measurements have been made with the beam set at 3^{o} above horizontal and the radar operating in its normal space-tracking mode. Time averaged power density measurements were taken in nearby community locations in order to estimate exposures to dense populations. The results at all locations were well below current state and federal standards for radiofrequency exposures (23).

However, certain factors temper the interpretation of the levels. The measurements themselves are technically difficult and have a margin of error of plus or minus 60%. More importantly, the measure of biological absorbed dose (Specific Absorption Rate, or SAR, in units of watts/kg) is a complex function of the source configuration, resonant frequency of a person (86 MHz), an individual's size and shape, radar power output, and other factors. The biological significance of the fact that the beam is pulsed rather than continuous is unclear. Moreover, although the measured values were low, and many were below detection, some locations receive as much radiation in the narrow frequency range of 420 MHz to 450 MHz as the median US population exposure of 0.014 mW/cm^2 for the entire spectrum from 54 Hz-900 MHz (29).

2. Non MMR-Associated Groundwater Contamination in the Study Area

In addition to plumes associated with specific MMR sites, several other sites in the study area are the source of plumes of groundwater contaminants.

a. Falmouth Landfill Plume

The Thomas Landers Road landfill in Falmouth is a municipal landfill which began operation in the mid-1950s (33). Contaminants from the landfill are leaching into groundwater, and include arsenic, barium, strontium, iron, manganese, ammonia, sodium, potassium, chloride, and VOCs. The path of the plume has been delineated by Camp, Dresser, McKee Inc. (CDM). CDM's work indicates that the leading edge of the plume is just east of Route 28.

b. Mashpee Landfill Plume

The Mashpee sanitary landfill located on Asher's Path began operation in 1961. The landfill site is about 21 acres in size, and the active portion occupies the western two-thirds of the site (16). The landfill is the source of a groundwater plume flowing to the southwest toward the Mashpee River. Private wells in the area were sampled and a number of VOCs detected. The most commonly detected were 1,1,1-trichloroethane (TCA), Freon 113, and 1,1-dichloroethene. The highest concentrations of these VOCs were found in wells serving the Summerwood Condominiums, south of the landfill.

The plume outline was delineated by Weston & Sampson engineers in 1987. At that time they estimated that the contamination had not yet reached the Mashpee River, but that it would reach the river in 2 years (1989) (16).

c. J. Braden Thompson Road Plume

A 12-acre property on J. Braden Thompson Road in Mashpee was used for the disposal of cars, household goods, and other trash from the 1960s, or earlier. About thirty to forty drums of waste liquids and some tanks were found on the site. Many of the drums were corroded and empty. The full nature and extent of the waste materials are unknown. Contamination was discovered in 1987 when the well of the home closest to the site was found to be contaminated with VOCs (35). Nineteen private wells near the site were sampled. Nine have been found to be contaminated with VOCs, including tetrachloroethylene, trichloroethylene, methylene chloride, and chloroform (37). When monitoring wells were subsequently drilled the contamination was found to be more extensive than originally seen from testing of the private wells (86).

3. Non MMR- Associated Sites in the Study Area with Air Impact

We identified three sites in the study towns, in addition to the MMR sites described above, which are potential sources of population exposure to air emissions. These sites are the Barnstable Airport, the Barnstable Fire Training Area, and the Canal Electric Generating Plant.

a. Barnstable Fire Training Area

The Barnstable Fire Training Area is located in the town of Barnstable within an undeveloped industrial-technology park off Mary Dunn Road. It has operated for thirty years as a site where firefighter trainees can practice extinguishing high temperature fires. Number Two fuel oil is ignited in concrete-lined pits and extinguished with water. It is estimated that the School operated 130 to 140 days of the year. Training was discontinued in 1986 when a leak was found in an underground fuel pipe (32).

Although groundwater was contaminated beneath the site from fuel leaks, a report prepared for the Barnstable County Commissioners concluded that no water supply wells had been affected by the site (32). Thus, from sources available to us at the time the study was initiated, there was no evidence that this site was a source of exposure through contaminated groundwater. However, like the fire training areas on the MMR, we consider it a potential source of exposure to air contaminants. We have recently learned that the site has effected the Mary Dunn well which was shut down in early 1990 (86).

b. Barnstable Airport

Takeoff and landing of aircraft at the runways at Barnstable Airport are a source of fuel- and exhaust-related air emissions similar to the runways at MMR (see above). The airport has been in operation throughout the study period.

c. Canal Electric Plant

Until 1969 the Upper Cape region drew all its electricity from the New England power grid. In that year Commonwealth Electric began operating Unit 1 of the Canal Electric power plant in Sandwich. Unit 1 had an electrostatic precipitator installed in 1972. In 1976 a second unit, including an electrostatic precipitator, was added to meet increasing demand. Although the plant has not had a history of operating problems, it is still a major source of emissions in the area. The National Emissions Data System, an EPA inventory of air emissions, lists the plant as emitting the following amounts of criteria pollutants in 1985: 66,335 tons of SO_2, 12,633 tons of NO_x, 78 tons of particulates, 943 tons of CO, and 143 tons of VOCs.

4. Pesticide Application from Agricultural Activities

An agricultural inventory of the five towns prepared by the University of Massachusetts indicates that cranberry cultivation is the only major crop grown in the study area (39). Table II.5 shows acreage devoted to various crops in the study area for the year 1986. Data in Table II.6 from the Massachusetts Department of Agriculture indicate that the five study towns have had substantial acreage in cranberry production over the years (10,39, 40).

Table II.5 Acres Under Cultivation or in Golf Courses, 1986

Town	Cranberry	Fruit, Orchards, Vegetables	Pasture, Nursery	Unplanted Agricultural Land	Golf Courses
Barnstable	418	20	258	159	612
Bourne	234	0	52	62	96
Falmouth	211	24	243	245	396
Mashpee	270	0	31	6	194
Sandwich	156	5	144	192	307
Total	1,289	49	728	664	1,555

[Source: Barker and Dery, Assessment of Agricultural Activities on Cropland in Massachusetts, Dept. Plant and Soil Sciences, University of Massachusetts, Amherst, June, 1986.]

Table II.6 Acres in Cranberry Cultivation

TOWN	1980	1966	1956	1946
Barnstable	418	367	397	506
Mashpee	270	243	248	330
Falmouth	211	199	211	223
Bourne	234	140	162	268
Sandwich	192	133	177	167

Various pesticides and herbicides have been used on cranberry bogs since the 1940s. Tables II.7 and II.8 list pesticides and herbicides recommended for use by the University of Massachusetts Cranberry Experiment Station in Wareham, Massachusetts.

Kerosene was the most frequently used herbicide (in terms of acres treated) until the mid-1960s, when Casoran (dichlorobenil or 2,6-dibenzonitrile) was introduced (52). Casoran proved to be a very effective herbicide, and its use surpassed that of all other chemicals. Casoran continued to be widely used through 1984.

A large number of pesticides have been used on bogs over the study period. Many of them are no longer approved for use, including DDT, dieldrin, aldrin, 2,4,5-T, heptachlor, and chlordane.

From the 1940s through the late 1960s, the most frequently used insecticides were pyrethrum, malathion, DDT, parathion and dieldrin. Between 1946 and 1955, use of pyrethrum, cryolite and lead arsenate dropped substantially while use of malathion, dieldrin and parathion increased. DDT was used on bogs for about twenty years. It was removed from the charts of approved chemicals about 1969 (52).

Parathion has probably been used longer than any other chemical on cranberry bogs (52). It was approved for almost thirty years beginning in 1956 and was used throughout the study period. Compounds other than parathion that were used during the 1960s and 1970s are dieldrin, carbaryl, Diazinon, and gluthion. Diazinon and parathion were used more frequently than the others (52).

Aminotriazole, a suspected carcinogen, was approved for a brief period (about 2 years) before it was removed from the list of approved pesticides in 1960. It had been approved for about one year when traces of the herbicide were found in berries from bogs treated with the chemical. On November 9, 1958, the government stopped sale of berries. In spite of a program of indemnification, there was a severe effect on growers and the cranberry market. In subsequent testing it was found that less than one percent of berries were tainted (52).

Table II.7 Herbicides approved for Cranberry Bogs, 1944-1986 [Source: 52]

*Ferrous Sulfate or Iron Sulfate
Ferric Sulfate
*Salt
Sodium Arsenate
*Copper Sulfate
Sodium Arsenite
*White Water Kerosene
Nitrate of Soda
Paradichlorobenzene (1947)
2,4-D (1952)
Ammate or Ammonium sulphanate (1952)
*Stoddard Solvent (1955)
2,4,5-T (1956)
No. 2 Fuel Oil (1957)
Aminotriazole and Dalapon (1959)
*Simazine (1962)
*Chloro-IPC (1963)
*Dalapon (1963)
*Casoran or Dichlorobenil (1965)
Alanap (1965)
*Evital (1976)
*Diquat (1976)
*Ethrl or Ethrphon (1976)
*Devrinol (1979)
*Weedar 64 (1980)
*Roundup (1983)
Fusilade (1983)
*Gorlon (1984)

(Year) indicates year of first approval
* indicates those still approved for use in 1984

Table II.8 Pesticides Approved for Use, 1944-1986 [Source: 52]

Sodium Cyanide
Paradichlorobenzene
Cryolite
Lead Arsenate
Fuel Oil
Kerosene
Pyrethrum
Nicotine Sulfate with Fish Oil Soap
Sabadilla Dust (1945)
Rotenone (1945)
DDT (1946)
Ryania (1951)
Dieldrin (1955)
Aldrin (1955)
Heptachlor (1955)
*Malathion (1955)
Chlordane (1956)
*Parathion (1956)
*Diazinon (1960)
*Carbaryl (1963)
*Gluthion (1967)
*Pyrenone (1975)
Methoxychlor (1975)
*Omite (1976)

(Year) indicates year of first approval
* indicates those still approved for use in 1984

Pesticides may be applied from ground level or by aerial methods. Ground-based methods include truck and power nozzle spraying, power dusting and hand spraying. In the early part of the study period, from about 1944 to the early 1950s, most pesticides were applied by ground-based methods (52).

Aerial application of pesticides was introduced in the early 1950s. By 1955, aircraft, both fixed-wing and helicopter, were used about twice as often as ground-based methods of application. By the late 1970s most aerial application was by helicopter (43). When pesticide is applied aerially a portion of the material "drifts" from the target area (the bog itself) to other areas nearby. Aerial application of pesticides is a potential source of air exposure to populations within areas affected by drift.

A currently popular ground-based method is "chemigation," application of pesticide through the sprinkler system in a bog. Introduced in the early 1960s, most pesticides were applied by chemigation by the end of the study period. Chemigation results in less drift than aerial application. All methods of application have the potential to impact groundwater (44).

5. Overall Quality of Public Water Supplies

There are eleven public water suppliers in the study area. They are: the Barnstable Water Co., Centerville/Osterville Fire District, Barnstable Fire District, and Cotuit Fire District in Barnstable; the Bourne Water District, Buzzards Bay Water District, North Sagamore Water District, and South Sagamore Water District in Bourne; the Falmouth Department of Public Works in Falmouth; the High Wood Water Co. in Mashpee; and the Sandwich Water District in Sandwich. All draw from groundwater sources with the exception of Falmouth, which draws from Long Pond. We base the following descriptions of water quality on sampling performed by the state DEP in 1980 and 1985-86 as part of the Division of Water Supply's State Purgeable Organic Testing

(SPOT) Program, and on sampling by the Barnstable County Health Department in 1984, 1987 and 1989.

Table II.9 lists VOCs found in Cape waters and the percentage of wells in which they were found in the study towns. Comparable percentages for the entire Cape are also given in the last column. All wells of the eleven study area water suppliers were tested, as were virtually all public wells on the Cape. Table II.10 shows the highest value found in a well or distribution point in each town, based on data from Barnstable County Department of Health in 1984, 1987, and 1989.

Chloroform is by far the most common contaminant in Cape public supply drinking waters. It was measured in all but one well in the study area. Chloroform is often a byproduct of water chlorination but on the Cape it is found even in untreated water. The reason for the widespread occurrence of chloroform in Cape waters is unknown.

Most levels in public supplies in the study towns are less than 3 ppb for 1984 and 1987, with two exceptions. Chloroform in supply well #2 of the Barnstable Fire District was measured at 42 ppb in 1989. (In 1980, 2.2 ppb were found in this same well).

In 1987, samples at several distribution points in the Falmouth supply showed chloroform levels greater than 10 ppb. Falmouth draws from a surface supply, Long Pond, and this water is treated by chlorination. Trihalomethanes (THMs), including chloroform, are formed by the reaction of chlorine with organic matter in the raw water. Therefore we might expect higher levels of THMs in the Falmouth supply. In fact, in 1987, THMs in distribution samples from Falmouth averaged 13 ppb, which is relatively low for a treated surface water supply.

TABLE II.9

Number of Wells in Which VOCs Detected in 1984/1987

Compound	*Barnstable*	*Bourne*	*Falmouth*	*Mashpee*	*Sandwich*	*All Cape Cod*
CHCl3	31 (100%)	10 (100%)	2 (100%)	3 (100%)	7 (87%)	98%
1,1,1-TCA	17 (55%)	2 (20%)	0	0	2 (25%)	26%
TCE	7 (22%)	2 (20%)	0	1 (33%)	3 (37%)	11%
CCl4	0	2 (20%)	0	0	0	2.5%
1,1,-DCE	3 (13%)	0	0	0	0	5%
BENZENE	3 (10%)	0	0	0	0	2.5%
1,1-DCA	10 (32%)	1 (10%)	0	0	2 (25%)	11%
TCFM	1 (3%)	0	0	0	0	1%
DCMA	4 (13%)	0	0	0	0	0.4%
TOLUENE	0	0	0	0	2+	N A
1,2-DCE	1 (3%)	0	0	0	0	1%
PCE	13 (42%)	1 (10%)	0	1 (33%)	2 (25%)	N A
TOTAL WELLS	31	10	2^	3	8	

\+ found in monitoring wells, not supply wells
^ one well, one reservoir

CHCl3	--	chloroform
1,1,1-TCA	--	trichloroethane
TCE	--	trichloroethylene
CCl4	--	carbon tetrachloride
1,1-DCE	--	dichloroethylene
1,1-DCA	--	dichloroethane
TCFM	--	trichlorofluoromethane
DCMA	--	methylene chloride (dichloromethane)
1,2-DCE	--	dichloroethylene
PCE	--	tetrachloroethylene
N A	--	Not available

TABLE II.10
Highest Level Found in Well or Distribution Point
(in ppb)

Compound*	Barnstable	Bourne	Falmouth	Mashpee	Sandwich	MCL^
CHCl3	5.8	1.8	13	2.0	2.3	#
1,1,1-TCA	35.**	1.7	-	-	1.8	200
TCE	1.3	0.38	-	TR	0.1	5
CCl4	-	0.4	-	-	-	5
1,1-DCE	3.3	-	-	-	-	7
BENZENE	0.5	-	-	-	-	5
1,1-DCA	15.**	4.5	-	-	0.1	-
TCFM	0.6	-	-	-	-	-
DCMA	1.3	-	-	-	-	-
TOLUENE	-	-	-	-	0.7	1,000
1,2-DCE	0.4	-	-	-	-	70 (cis)
PCE	2.3**	1.0	9.7	4.0	35.	5

* See Table II.9 for chemical compound names

^ Massachusetts maximum contaminant level

Chloroform is a type of trihalomethane. The Massachusetts MCL for total trihalomethanes is 100 ppb in chlorinated water supplies.

** These levels were found in the Maher Wells in 1987.
Other Barnstable levels for these compounds were <2 ppb.

TR = Trace

- = Not found

The second most common VOC in Upper Cape public drinking water supplies is 1,1,1-trichloroethane (TCA), which was found in 26% of all wells on the Cape. The Barnstable Water Company stands out as having had 1,1,1-TCA detected in more of its wells - 55% - than any other study town. Levels are usually less than 1 or 2 ppb, with the exception of the Maher wells which supply the Barnstable Water Company. In 1987, the levels were 27, 12, and 11 ppb in Maher Wells #1, #2, and #3, respectively. 1984 values for the wells are not high.

Tetrachloroethylene (PCE) is a contaminant found in 31% of study area public wells. A more important source of PCE in public water supplies is the distribution system itself. Exposure to PCE from vinyl lined/asbestos cement (VL/AC) water distribution pipes is discussed in the following section.

After PCE, 1,1-dichloroethane (1,1-DCA) and trichloroethylene (TCE) are the most common contaminants. TCE was found in 24% of study area wells compared to 11% cape-wide. The highest level (1.3 ppb) was found in the Barnstable Water Company's Maher Well #2.

1,1-DCA occurred in Barnstable in nine of the thirty one wells. Again, the highest values (15 ppb) occurred in the Maher wells. In the other wells, levels were less than 1 ppb. The other VOCs occurred sporadically in the study area, and once again the Maher wells in Barnstable had unusually high levels of 1,1-dichloroethane (1,1-DCA) and 1,1,1-trichloroethane (1,1,1-TCA).

The following wells have been forced to close due to contamination: the Mary Dunn #3 well (early 1990), and the Maher Wells #1, 2, 3 (June 1990) of Barnstable Water Company; the Barnstable Fire District Well #2 (after 1986); the Ashumet Well #1 in Falmouth (1979). The Ashumet Well is located in the Ashumet Valley and was affected by the plume of sewage and solvent contaminated groundwater emanating from MMR. Ashumet Well #1 was closed in July 1979 due to the presence of boron and detergents. Subsequent investigation (in 1984) confirmed the presence of VOCs in the water. The well operated from June 1977 till June of 1979 (41). In 1979, VOCs were below detectable limits, so it is unclear whether the VOC slug in the plume affected water quality while it was operating or only reached the well after it was closed. Recently, the Department of Environmental Protection Bureau of Waste Site Clean Up instituted a multi-site investigation of groundwater contamination in the Hyannis area (86).

In summary, public water supplies in the study area in general have been shown to have low levels of common industrial contaminants. In this study we consider the Falmouth DPW water supply and the Barnstable Water Company supply as potential sources of exposure to THMs and solvents, respectively. In Falmouth the treatment of Long Pond water generates higher levels of THMs than other supplies in the study area, although these levels are still modest. In the latter part of the 1980s the Maher wells, which supply the Barnstable Water Company, have shown higher levels of solvent contamination than other supply wells, suggesting that perhaps these wells have been subjected to influence by some intermittent contaminant source operating in the past.

6. Tetrachloroethylene in Public Water Distribution Systems

In 1980 the six new England states discovered that tetrachloroethylene (PCE) was leaching into drinking water from the inner vinyl lining of asbestos cement (AC) water distribution pipes. The vinyl liner was introduced in the late 1960s to solve taste and color problems associated with the action of aggressive New England water on the conventional black-asphaltic coatings used in AC pipe since the 1930s. The vinyl lining was applied to the inner surface of the pipe as a slurry of vinyl resin in the solvent PCE, which, because of its volatility, was assumed to disappear in the curing process. In January of 1980, however, it was found that PCE had instead been slowly leaching into water from the 0.025 inch lining.

Initial investigation by DEP disclosed approximately 700 miles of vinyl-lined/asbestos (VL/AC) cement pipes throughout Massachusetts. About two-thirds of this pipe had been installed in the southeastern part of the state, much of it on the Cape.

Several studies on the leaching rate of PCE under various water flow conditions were conducted in 1980. These studies showed that the highest concentrations of PCE were in dead-end pipes and in pipes where low water flow persisted. The concentration of PCE declined over time in an exponential manner (first order kinetics) with a half-life of one to two years. After approximately seven years, the PCE concentrations reached the then existing EPA Suggested Action Guideline of 40 ppb (42).

When the problem was discovered bleeder valves were installed to keep water flowing through the pipes and thereby reduce exposure. These management efforts were immediately successful in reducing exposure to PCE below the 40 ppb level after 1980. Exposures before 1980 were higher, and since then EPA has revised downward their PCE action level to 5 ppb.

We assessed exposure to this source of PCE using a model developed by Dr. Halina Brown and Mr. Thomas Webler of the Environment, Technology, and Society Program of Clark University, Worcester Massachusetts. A full description of the model is included in an appendix. Model input parameters include size and length of pipe, installation date, and duration and calendar years a subject lived at the address on that section of pipe, and yields a dimensionless parameter called "relative delivered dose" of PCE. A detailed description of our methodology and final exposure categories can be found in the section on exposure measurement.

7. Electric and Magnetic Fields

Extremely low frequency (ELF) electromagnetic fields (60Hz) have recently come under suspicion as etiologic agents for various cancers. Concerns about possible carcinogenic effects of electrical power distribution systems were raised by a 1979 study of Wertheimer and Leeper of the relationship between electric distribution system wiring configurations and childhood cancer in the Denver area (45). A study by Fulton et al. in Rhode Island that attempted to replicate these findings found no association

(46), but yet another study by Savitz in Denver again revealed a positive association (47). At the same time a variety of occupational studies and experimental work lent support to the proposition of an association between cancer and electic and magnetic fields, although the matter remains controversial.

Power is delivered to the customer through a network of transmission and distribution lines. The electricity is generated at power plant facilities where it is stepped up by transformers to typical transmission voltages (115 kV and 345 kV). Transmission lines carry the electricity to various substations, where the voltage is reduced to distribution levels. Electricity is then delivered to the customer through a system of primary and secondary wires, the primary wires being of a higher voltage (typically 5 kV) than the secondaries. The voltage from the primary wires is stepped down through the use of distribution transformers to the secondary voltage used by the customer.

The electric field around the transmission and primary distribution lines is relatively constant and is related to voltage, but the current varies, depending on load, producing a concomitant variation in the magnetic field. At the user's end, unbalanced (fault) currents result in charge movement through ground conductors (such as plumbing) that produce magnetic fields in residences. These magnetic fields are greatest where currents are greatest. Current strength, in turn, depends on the location of the residence within the electric transmission and distribution system components.

We originally proposed to examine the relationship of electric and magnetic fields and cancer in our study population by considering: 1) proximity to transmission lines, 2) proximity to substations and 3) magnetic field at the subject residence based on distribution wiring characteristics near the house. Only the first two were completed for reasons discussed in the section on exposure assessment.

B. Study Population and Data Collection

The relationship between nine types of cancer and the environmental exposures described above were examined using a set of population-based case-control studies. This type of study design includes cases that occur during a specified time period and geographic area and controls that are a representative sample of the underlying population that gave rise to the cases. Specifically, the current study included cancer cases among permanent residents of the Upper Cape diagnosed during 1983-1986 and controls that were a sample of 1983-1986 residents of the same towns with similar demographic characteristics.

At the start of the study, cases diagnosed over the five year period 1982 through 1986 were available for inclusion. However, budgetary constraints permitted inclusion of only four years of cases. The most recently diagnosed cases (1983-1986) were selected to maximize the follow-up rates and minimize the number of proxy interviews that would be needed for deceased subjects.

There were several reasons why a case-control study was the most appropriate design for the current investigation. This design provided the most efficient means of evaluating the etiology of a rare disease such as cancer while permitting inclusion of almost all of the cancer cases that constituted the elevated rates among Upper Cape residents. This design could also provide information on the large number of exposures that needed to be evaluated in this setting.

In addition, there were important reasons for using a population-based control series. First, this control group would be comparable to the population-based case series. Second, because the control series was selected without restriction to non-diseased individuals, the estimates from this study would be unbiased and consistent estimators of the incidence rate ratios (53).

1. Selection of Cases

The source of the cases were cancer patients reported to the Massachusetts Cancer Registry. Comparison with cancer rates from the Connecticut Cancer Registry and American Cancer Society indicates that the Massachusetts Registry has nearly complete reporting for the cancer sites and geographic area under study (54).

Once we obtained approval of the Registry's Research Sub-Committee and gave assurances that the information would be kept confidential, the Cancer Registry provided us with the name, address, diagnosing hospital, and demographic characteristics of 1,336 incident cases of cancer of the breast, colon/rectum, lung, bladder, kidney, pancreas, leukemia, brain, and liver diagnosed from 1983 through 1986 among permanent residents of Barnstable, Bourne, Falmouth, Mashpee and Sandwich.

The first seven cancer sites were selected because their rates were elevated among men or women or both sexes in at least one of the Upper Cape towns. Brain and liver cancers were not included in the initial study population but were added during the first year of the project at the request of our community advisory board. The rationale for adding these sites stemmed from their more likely environmental etiology (55).

According to the Cancer Registry guidelines, we first obtained permission from current physicians before interviewing the living cancer cases. Physicians' names and addresses were obtained from the hospital tumor registrars. Permission was granted by 96% of the doctors (188/195). When the physician named by the tumor registrar was retired and no other current physician could be identified, permission was given by default. The seven physicians that refused permission denied us access to only 10 patients.

2. Selection of Controls

Three sources were used to identify controls. Living controls were chosen from one of two population-based sources, depending upon age. Living controls under 65 were selected using random digit dialing as a strategy for drawing a random sample of Upper Cape residents. Living controls aged 65 and over were selected randomly from lists of Medicare beneficiaries provided by the Health Care Financing Administration (HCFA). Deceased controls were selected randomly from death certificates of appropriately aged Upper Cape residents who have died since 1983.

First, the age and vital status distribution of all cases combined were examined to determine the number of controls needed from each of the above sources. Individuals from each of these sources were combined to form a common control group from which controls for the site-specific analyses were selected. Most controls were used for more than one site-specific analysis.

It was determined that selection of approximately 1,800 controls would achieve site specific allocation ratios of approximately 3-5 controls for each case of breast, lung, and colo-rectal cancer and allocation ratios of approximately 10-25 controls for each case of pancreatic, bladder, kidney, brain and liver cancer and leukemia. Considerations of cost, statistical power, and information gain led to the decision to aim for these allocation ratios.

a. Living Controls Aged 64 and Under

<u>Sampling Procedure</u>: After examining the age and gender frequency distributions of the living cases, we determined that approximately 190 living controls aged 64 and under should be selected from among individuals who lived in Upper Cape towns during the case ascertainment period. Random digit dialing was the sampling strategy used to select subjects in this category. Its goal was to select a

random sample of housing units with telephone service to represent individuals who resided in the Upper Cape area during the case ascertainment period.

Random digit dialing is a technique which circumvents certain limitations of telephone directories, such as the omission of unpublished numbers and numbers that have been assigned since the directory was compiled. Each housing unit with telephone service has a known chance of selection. According to the 1980 Census, more than 95 percent of the housing units in Massachusetts had telephone service.

A variation suggested by Waksberg (56) on the random digit dialing sampling method was used to increase the efficiency of the sampling. As the first stage of sampling, a recent AT&T tape which included all working exchanges serving the Upper Cape towns was sampled systematically. A random four-digit number was added to selected exchanges. Interviewers called those numbers and ascertained whether or not they were associated with a residential address. If so, they were retained for the second stage of the sampling. If not, they were deleted from the sample. Extensive efforts through repeated call backs during the day and evening and phone company contacts were made to ascertain the status of all selected numbers. Approximately 25 percent of the numbers screened at this stage yielded working residential numbers which formed the clusters for the second stage of sampling.

In the second stage of sampling, clusters resulting from the first stage of screening, consisting of the area code, the exchange, and the first two digits of the four digit number dialed, defined a second stage cluster (i.e. 508-888-11_). Then a specified number of random pairs of digits from 00 to 99 was added to these roots to define telephone numbers within each cluster. Numbers so created that led to residential units were maintained in the sample. Those that led to businesses, that were not working, or that were nonresidential for other reasons were removed from the sample and replaced with another number from the same cluster by adding two additional random digits. No number was deleted from the sample for any reason other than a determination that it was not an occupied residential address. At the end of this stage of the sampling, 2,236 residential households in the Upper Cape area were identified.

Eligibility for interview: After examining the age and gender distribution of the living cases aged 64 and under, we defined the eligibility categories for RDD controls. When a sample household was contacted, the interviewer screened it for eligibility by determining whether or not there were any current residents in any of the age and gender categories who resided in the Upper Cape before January 1, 1987. This was a rolling process and meant that early in the screening process, a larger fraction of households had eligible respondents while later in the study when most cells had been filled, only a small percentage of contacted households had eligible respondents. If there was no eligible person, the household was considered ineligible and dropped.

Respondent selection: If there was more than one eligible person, one person was randomly selected using an objective selection procedure which allowed no interviewer or respondent selection. We used a variation on the procedures developed by Kish (57). Once the number of eligible individuals in the household was determined, the interviewer used a selection table stamped on the questionnaire coversheet which designated a specific person to be the respondent. The set of 12 selection tables developed by Kish were stamped in systematic serial fashion throughout all questionnaire coversheets. Eligible adults within each household were numbered by age, from oldest to youngest.

The table on each coversheet then designated a specific person to be the respondent. For example, when there were four eligible individuals in a household, one fourth of the time the oldest was designated, one fourth of the time the second oldest was be designated, and one fourth of the time the third oldest was designated, etc. Once this designation was made, there was no substitution for any reason. This procedure gave every eligible person a known probability of selection.

While some sampling schemes allow for substitution of selected numbers when no one answers, when a respondent refuses, or when a respondent is not available, this was not the case in the sampling scheme that we used. The only basis on which a number was dropped and substituted was if it was specifically ascertained that a selected number did not lead to a residential unit. If a selected number produced a ring and no answer after repeated calls, the phone company was contacted to find out whether or not the phone was a residential unit.

If a number was definitely determined to be residential and a working number, it was maintained in the sample and every effort was made to complete an interview with a designated person in the household linked to that number. Interviewers called back a minimum of ten times at different times of the day and days of the week in order to contact a difficult-to-reach household or respondent.

The selection and enrollment process for the RDD controls is described in Table II.11. Selection of the RDD controls required screening 2,236 households. 62.5% did not have any members that met our eligibility criteria. Another 20.4% never answered the phone after numerous calls and 5.8% refused to answer the screening questions that determined eligibility. Thus, an eligible respondent was identified in only 254 of the households called of which 189 were interviewed for the study.

Table II.11 Selection and Enrollment of Random Digit Dial (RDD) Controls for the Upper Cape Study

Households Called	2,236
Exclusions:	
Never reached any household member	456
Reached household but no eligible respondent	1,397
Reached household but respondent refused screening questions	129
Eligible respondent identified	254
Exclusions:	
Eligible respondent refused interview	27
Eligible respondent never able to contact	27
Eligible respondent too ill or language barrier	11
Interviewed	189

b. Living Controls Aged 65 and Over

At diagnosis, 79 percent of the cases were aged 65 and over and 39 percent were aged 75 and over. Since random digit dialing is not an efficient technique for identifying elderly individuals, especially the very old, we decided to identify living controls aged 65 and over using lists of the elderly provided by the Health Care Financing Administration (HCFA). It is estimated that HCFA has a 95 percent enumeration of individuals 65 years of age and older in the United States (58).

HCFA agreed to provide the names of beneficiaries if we followed their protocol for epidemiologic studies. This protocol, which is similar to that required by a hospital institutional review board, included use of a HCFA form letter to make initial contact with the study subject and written assurances that the subject's identity will be kept confidential (see appendix for letter).

Postal zip codes covering the Upper Cape area were used to select potential HCFA controls. HCFA generated a random sample of almost 1,700 current Upper Cape residents using the terminal digit of the individual's social security number, and provided us with a computerized listing that included the individual's name, social security number, most recent mailing address, date of birth, gender and race. We randomly selected 611 individuals after stratifying the HCFA population on the basis of age and gender. Before interviewing these subjects, the Center for Survey Research verified that the potential HCFA control was still alive and a resident of the Upper Cape during the case ascertainment period and all deceased individuals and non-residents were excluded.

c. Deceased Controls

We randomly selected deceased controls from death certificates of appropriately aged Upper Cape residents who died since January 1, 1983. We selected controls who died from January 1, 1983 through December 31, 1988 from a computerized listing of all Upper Cape resident deaths provided to us by the Massachusetts Department of Vital Statistics and Research. We selected manually controls who died in 1989 from death files maintained at the state Department of Vital Statistics. All individuals, regardless of cause of death, were eligible for inclusion.

918 deceased controls were selected using a random number sampling scheme that was stratified on age, gender and year of death. Before the interview, the Center for Survey Research verified that the potential deceased control that was selected was a resident of the Upper Cape during the case ascertainment period and all non-residents were excluded.

The rationale for including deceased controls was to ensure comparable information quality between cases and controls (59). Since 55% of cases had died by the start of the study and so required proxy interviews, we believed that a similar proportion of deceased controls should be included in the study so that controls would also have proxy interviews.

3. Follow-Up and Enrollment of Subjects

This section, described in Table II.12, applies to all subjects except controls obtained through random digit dialing.

In order to conduct the interviews, subjects or next-of-kin had to be identified and their current addresses and telephone numbers obtained. Cases and controls were identified by the methods described above. Next-of-kin were identified from cases' and controls' death certificates. The next-of-kin was usually the spouse or offspring of the study subject. If the first identified next-of-kin was also deceased, we obtained their death certificate to identify another next-of-kin. If this person was not likely to know our study subject well, we attempted to identify other next-of-kin from obituary notices in local newspapers. Also, if the identified next-of-kin was deemed to be uninformed (i.e. did not know enough of the information we were requesting at interview), the Center for Survey Research attempted to obtain the name of a better informed person to interview.

Depending on the group, current addresses were initially obtained from the Cancer Registry, HCFA records, or death certificates. Massachusetts Resident's Lists were used to verify that the address was current and, if not, to obtain the present address. Massachusetts Registry of Motor Vehicle drivers' license records, Department of Vital Statistics' death, birth, and marriage records, diagnosing and current physicians, and tumor registrars were also used to trace subjects and their next-of-kin. Current telephone numbers were obtained from telephone books or directory assistance. When we learned that a case had died out of state, we requested a copy of the death certificate and so were still able to obtain informant information.

Lastly, field interviewers occasionally visited a subject's last known address to see if there was a neighbor or apartment house superintendent who had the current address of the individual.

Subjects who were located but for whom a current telephone number could not be obtained (e.g. the number was unpublished or published under another individual's name) were contacted by mail. In addition, field interviewers visited these homes to conduct either in person interviews or obtain telephone numbers for subsequent telephone interviews.

Ninety-four and nine tenths percent of the cases and HCFA and dead controls combined were successfully traced. Slightly more cases than these controls were not found (7.4% vs. 3.0%). Another 2.3% of these subjects were not eligible to be in the study either because they had never lived on the Upper Cape (2 cases and 20 dead controls) or were HCFA controls who recently died (N=45). (HCFA controls were required to be alive at interview.)

When a current address was obtained for subjects or their next-of-kin, introductory letters, and information sheets were sent describing the general purpose of the study and informing subjects that we would be contacting them in a few days for an interview (see appendix for letter). Because telephone interviewing was considerably less costly than in person interviews, efforts were made to do as much interviewing by telephone as possible. However, in person interviews were conducted under the following circumstances:

(1) We were unable to obtain a working telephone number.

(2) We were unable to contact the household by telephone. If we failed to contact the household after five well spaced telephone calls, varying the time of day and including both weekdays and weekends, we verified the phone number with the telephone company. If the number was not working or incorrect, the address was assigned to a field interviewer. If

the phone number was working, five additional well spaced phone calls were made before an in person interview was considered.

(3) The individual was unable to be interviewed on the telephone because of ill health or hearing problems or simply preferred to be interviewed in person.

(4) An initial refusal was received over the telephone. The success rate in converting refusals to interviews tended to be higher in person than over the phone.

We also conducted proxy interviews for living subjects who were physically too ill to be interviewed either on the phone or in person. These surrogates were other household members or next-of-kin. In addition, if the designated surrogate was also unable to be interviewed, we requested that another surrogate be identified. Ultimately, 86% of the interviews were conducted by telephone and the remainder were conducted in person.

4. Interviews

Telephone interviewing was carried out by the professional interviewing staff of the University of Massachusetts Center for Survey Research (CSR) in a centralized interviewing facility at its Boston Downtown Center. Interviewing began on April 10, 1989 and ended on January 8, 1990. Random digit dialing interviews were conducted between May 13 and May 31 and between July 9 and July 17, 1989.

An interviewing shift, which lasted six hours, consisted of a maximum of thirteen interviewers plus one supervisor. A total of 29 interviewers worked on the project, four of whom did in person interviews. Interviewing was conducted between 9:00 a.m. and 9:15 p.m. A large portion of interviewing was done on nights and weekends. A systematic sample of each interviewer's work was monitored by the supervisor every shift to ensure the quality of data collection.

Once a subject was telephoned, the interviewer's job was to find a convenient time to conduct the interview with the subject. Before administering the questionnaire, the interviewer explained the general purpose and sponsorship of the study, assured the subject of confidentiality and the right to skip questions (see appendix).

The interview which lasted, on average, 31 minutes obtained the following information:

(1) Demographic characteristics;

(2) Data on confounders such as smoking and alcohol use;

(3) Occupational history since age 18, including occupations held on the MMR and specific occupational exposures such as exposure to asbestos or radiation;

(4) Relevant medical and obstetrical history;

(5) Pertinent environmental data including water source and consumption;

(6) Residential history since 1943.

Separate questionnaires were developed for proxy and non-proxy interviews (see appendix) in conjunction with the Center for Survey Research and with input from the Department of Public Health, and our community and scientific advisory boards. The questionnaires were pre-tested on a handful of cancer cases (diagnosed at the end of December 1986) and extra HCFA controls. These subjects were not included in the formal study.

Overall, 80.6% of cases, 78.1% of HCFA controls, 81.7% of dead controls and 74.4% of eligible RDD controls were interviewed (Tables II.11 and II.12). Reasons for not being interviewed included physician refusal (0.7% of cases), subject refusal (7.2% of cases and 9.5% of all controls), and never able to contact (3.9% of cases and

4.2% of all controls). Subjects who fell into the not contacted category either lived out of state and had an unpublished number and never answered our letters, or were never reached after at least ten well spaced phone calls and at least one home visit. Except for the liver cancer case group in which the starting population was very small, interview rates were similar among the different cancer sites (Table II.13).

Table II.12 Selection and Enrollment of Living and Dead Cases, Health Care Financing Administration (HCFA) and Dead Controls for the Upper Cape Study

	Cases		Controls	
	Living	Dead	HCFA	Dead
Selected	601	735	611	918
Exclusions:				
Not Found	30	69	12	34
Not Eligible	1	1	45	20
M.D. Refusal	10	----	----	----
Subject Refusal	54	42	72	70
No Contact	18	34	4	43
Too Ill	0	0	1	1
Total Excluded	113	146	134	168
Interviewed	488	589	477	750

Table II.13 Interview Rates According to Cancer Site	
Cancer Site	Percent Interviewed (%)
Breast	81.4
Lung	79.8
Colo-Rectal	78.3
Bladder	81.0
Kidney	83.3
Leukemia	84.1
Pancreas	88.4
Brain	90.5
Liver	66.7

Given the nature of the questionnaire and the interview setting, we were not able to blind the interviewers to the disease status of the subject. Furthermore, there were very practical reasons why the interviewers had to know whether they were speaking with a subject or a surrogate. Since the interview format was highly structured and the questions were well written the possibility of systematic differences in soliciting, recording or interpreting information (interviewer bias) was quite small.

However, the possibility of recall bias did exist. This type of bias occurs when subjects with particular health outcomes such as cancer remember or report exposures differently than individuals not affected. Since most of the environmental data was collected independently of the interview, it was not subject to this type of bias. However, given the knowledge and concern of Upper Cape residents regarding a possible association between environmental pollution and cancer, cancer cases and their surrogates may have recalled exposures differently than controls and their surrogates. To address this bias, subjects and surrogates were asked their opinions about the quality of the water and air and about the possible effects of environmental pollution on health (60).

5. Quality Control for Interviews

All CSR interviewers were fully trained by the Center in basic non-directive, standardized interviewing skills. They received a minimum of four days general training plus training for our specific study. In addition, after 120 hours of production work, each interviewer attended a supplemental seminar in interviewing techniques and was required to pass tests in interviewing procedures that consisted of both a written examination and a review of a tape recorded interview.

Samples of all interviewers' work were systematically monitored. On each of their shifts, a supervisor gave them a score on standardized interviewing skills. Working on the telephone at the CSR involved continuous evaluation and learning. The CSR telephone facility had the capacity to monitor any interviewer at any time without the interviewer (or the respondent) being aware of the monitoring.

a. Quality Control System

Once the roster of study subjects was generated, labels including the phone number and other information were printed. They were put on coversheets which had an identifying number that allowed them to be matched to completed interviews. The entire call record for each study subject was on the coversheet.

At the beginning of each shift, coversheets were distributed by the shift supervisor according to directions from the CSR field director. For all shifts (after the initial one, which included only new numbers not called before) the distribution included phone-backs for previously made appointments, calls to previous "no answer" numbers, calls to households where the designated respondent was not available and, finally, calls to new numbers. Each morning the previous day's work was entered into the computer and so the computer files were updated daily. The computer control system tracked coversheets so there was daily update on completed interviews, first refusals, and final outcomes for all study subjects. The interviewer's identification number was included in the record, so there was also be a daily update on the performance of individual interviewers.

Detailed information about each phone call was recorded on the coversheet for each study subject. The call record included the date, time, interviewer identification number, and information about with whom the interviewer spoke, whether an interview was obtained, and, if not, what transpired (e.g. information about when to call to reach the designated respondent, the tone of the interaction, the source and nature of a refusal). This information was used in reassigning the coversheet and in making decisions about how best to convert any refusals. Coversheets remained active until the final disposition was a completed interview, a final refusal, or the determination that it was an unreachable number.

In person (field) interviewers worked at least one six hour shift on the telephone so their interviewing could be monitored. Every one of their completed interviews was reviewed as they were returned to the office. During the first weeks of the study, field interviewers were required to tape one interview each week for review. Each field interviewer reported at least twice a week to their supervisor to review the quality of their performance.

b. Quality Assurance for the Interview

Quality control is a special focus at CSR and was reflected in their standard interviewer supervision arrangements. Each shift (maximum 13 interviewers) had a supervisor present for the entire shift. The supervisor did no interviewing but remained in the room to answer questions, review completed interviews, and to provide ongoing feedback and retraining to interviewers. The supervisor, using a monitoring phone, monitored a minimum of one interview by each interviewer during every shift.

Immediate "retraining" was provided whenever problems were noted. On the spot retraining included practice interviewing and role playing with the supervisor, taping and playing back the interviewer's side of an interview, and having the interviewer listen to other interviewers. Any interviewer who had difficulty was more closely monitored for subsequent shifts. When there was a problem with an interviewer's response rate, emphasis was placed on the introduction and on techniques to gain respondent cooperation. A minimum of 10 calls were made to each number in the sample in the attempt to contact the household.

Attempts were made to convert all first refusals. These assignments were made by the supervisor in consultation with the interviewers. Only the most experienced interviewers worked on refusal conversions, which were usually made 4 to 5 days after the initial refusal. An interviewer did not attempt to convert his/her own refusals. Lastly, ten percent of subjects and proxies interviewed in person were contacted to verify the interviews.

c. Quality Assurance for Coding and Computerizing the Interview Data

At CSR coding and computerizing the questionnaire data were separated into three parts: the residential histories, occupational histories, and all other non-occupational data. These sections of the questionnaire were set up for direct data entry, and code books and coding instructions were developed (see appendix). Trained coders reviewed the completed interview schedules for completeness, filling in missing data codes, and coding open ended answers as needed.

The interview data were entered directly using a program that checked for wild codes and contingencies. All data was one-hundred percent verified, that is, either a second person independently re-entered the data (occupational and non-occupational data) or the entered data was visually checked against the actual questionnaire (residential history data).

6. Confidentiality

The Center for Survey Research and Boston University maintained strict confidentiality of the study roster and data. All employees including research assistants, students, interviewers, and coders were required to sign confidentiality agreements upon entering employment and confidentiality was stressed in training as well as in standard procedures for tracing and data collection.

At CSR information about the study subjects (name, address, etc.) was kept on computer file during the course of the study. This subject control file did not contain any information from the interview. Once an interview was completed, an identification number was assigned to the interview and entered into the control file. Upon completion of the study, the identifying information in the control file was removed and only the interview number was used subsequently.

Interview booklets themselves had no identifying information about the subject. Identifying and locating information was kept on a separate "coversheet." Coversheets and interviews were kept in locked files in locked rooms. Only a small number of study staff had access to the questionnaires or cover sheets.

At Boston University, paper and computer diskette files with identifying and tracing information were also kept in locked cabinets in locked rooms and only the study staff had access to this information. Access to computerized data could only be accomplished using a password that was known only to a few study staff members. When data collection was completed at CSR, all the interview forms and cover sheets were moved to Boston University where they are kept in a locked closet.

C. Exposure Assessment Methods

Three general methods were employed to assess a study subject's potential exposure to various contaminant sources. Each used geographic location, as given by residence during a specific time period, as an indicator of exposure.

In the first method, residential location was connected to exposure by mapping impact zones around contaminant sources, and overlaying the resulting contaminant map on the subject residence map to identify subjects whose residences were within the impact zones during the appropriate time period. This method was used to estimate exposure from plumes of groundwater contamination.

The second method converted the distance of a subject's residence from an exposure source to an exposure estimate, using specific distance and direction dependent exposure functions described below. This method was used for all sources of contamination through the air, for assessment of exposure to cranberry bog pesticides, and, using distance only, for assessment of exposure to electric and magnetic fields from substations and electrical transmission lines.

A third method of exposure assessment applied specific physical models to quantify exposure at each subject location. Such models were used to estimate exposure to PCE in water pipes and exposure to emissions from the Cape Electric Plant.

It should be noted that exposures were assigned to a study subject's residence, not to a study subject, so that time spent away from the residence and other factors would affect an individual's actual exposure. Methods used to aggregate like exposures at multiple residences and from multiple sources at a single residence are given below.

Before giving the details of the exposure assessments we describe how subject residences were located geographically.

1. Subject Mapping

Base Maps

All subjects' residences in Barnstable, Bourne, Falmouth, Mashpee, and Sandwich during the period 1943 to 1986 were located on United States Geological Survey (USGS) 7-1/2 minute quadrangles. USGS maps were chosen because they are topographically accurate and of a workable scale. The Sagamore, Sandwich, Hyannis, Cotuit, Pocasset, Onset, Woods Hole, and Falmouth quadrangles comprised the study area. We enlarged these corresponding eight maps from the original scale of 1:25,000 (one mile equals approximately 2-1/2 inches) to 1:12,500 (one mile equals 5 inches).

Subject Identification

Each subject's residence was represented on the base map by a 1/4 inch diameter yellow dot. At the map scale, one dot is approximately 250 feet in diameter. A blue "cluster" dot represented multiple residences at the same location (e.g., an apartment complex or nursing home). A unique subject identification number was indicated on the dot followed by an alphabetical "sub-id" linking it to a computerized data file on the calendar years of residence. The number of different residences each subject had in the study area ranged from one to twelve. Altogether there were 3,917 Upper Cape residences mapped for the 2,493 interviewed subjects, or an average of 1.6 residences per subject.

Mapping Protocol

The location of each subject address in the study area going back to 1943, as reported at interview, was located using tax assessment maps published by the Realty Publishing Center of Providence, R.I. When the exact subject address location was found on the assessors map, a dot was placed on the USGS map as closely as possible. The address location was approximate on the USGS map because of the change in scale between the assessors and USGS maps. In the case of a short street (750 feet long or less), the dot was placed in the center, halfway along the street. For a longer street the location of the house was found in the assessors book and then, transferred to the USGS map with the center of the dot corresponding to the estimated house location.

All mapping was done without knowledge of who was a case or control. Location of each mapped residence within 1 km x 1 km coordinate squares was entered in a computer file. This procedure was used both to keep track of subjects on the maps and for certain exposure assessments.

Sources of Inaccuracy

There are several possible sources of inaccuracy in the mapping process. Study subjects were asked to recall their entire residential history on the Upper Cape for the last 45 years, but exact recall of addresses, particularly street numbers from many years ago was likely to be difficult for this mainly elderly population. While we attempted to obtain information on cross streets and/or other locators, such as landmarks, in order to mitigate this problem, often this information was not obtainable or useful (e.g. when the landmark no longer existed).

As regards the actual mapping procedure, the dots were 250 feet across on the scale of the USGS maps, so residence locations could be no more accurate than this. Moreover the USGS maps date from the late 1970s and newer developments and streets do not appear on them. When an address was on an unmapped street, its location was approximated. For addresses without street numbers, or with street numbers that could not be located in the assessors book the dot was placed in the location of the house with the street number closest to the reported number. When no street number was reported and could not be traced, the dot was placed halfway down the length of the street. An effort was made to find valid street numbers for incomplete addresses using town Residents Lists.

Subjects with no reported addresses were not included in the exposure assessments or analyses. Of the 3,897 Upper Cape addresses, 93.7% had sufficient information to be mapped. Information on another 3.8% was vague or incomplete (e.g., no street number) and so were mapped using the less exact protocol just described. The remaining 2.5% did not have sufficient information to be mapped.

In addition to some degree of geographical uncertainty in subject location, there was temporal uncertainty for subjects with incomplete reporting of years at each residence. When a beginning and end year were reported for residential history, the intervening years were divided evenly among the intervening addresses. Subjects with no years reported with their residential history were excluded from analysis.

Mapping Verification

The mapping process was verified to insure that subjects were being mapped in a consistent and replicable manner. A random sample of approximately 100 mapped addresses was remapped on USGS maps printed on transparent acetate. These were placed over the original mapped locations to identify discrepancies in location. 87% of the remapped dots were within 1 centimeter (approximately 400 feet, at map scale) of each other. Of the 13% (12 dots) that were further than 1 cm of each other, 9 were within 5 centimeters (approximately 2,000 feet) of each other.

Implications of Mapping Inaccuracies

Since mappers were unaware if subjects were cases or controls it is likely that the sources of inaccuracy described above led only to non-differential errors in residence locations and subsequent environmental exposure assessments. Furthermore, we believe that the actual number of subjects whose exposure was incorrectly assigned was relatively small since many exposure assignments were made on the basis of residence in the relatively large 1 km^2 grid. Moreover only a small subset of residences were on the border between unexposed and exposed zones (e.g.. inside or outside a plume delineation).

Residential History Database

A final database comprising a record for each subject's residence was compiled from the residential histories obtained at interview and the mapping information. Each record includes a unique subject identifier, sub-id, address, calendar years of residence, cross-streets and locator information, a map identifier, and location in specific 1 km^2 map regions. The database was used to link subjects to environmental exposure data.

2. Exposure to Groundwater Contaminants

Several plumes of contaminated groundwater in the study area emanated from landfills and various spill sites on the MMR. The most obvious route of human exposure from contaminated groundwater is via contaminated drinking water. It is not clear, however, that this is the only route of exposure. Volatilization of contaminants from the soil and groundwater, contact with contaminated soil, and infiltration of contaminated soil gas into basements are other potential routes of exposure. For the first round of exposure assessments we attempted to identify all subject residences that were located *over* a plume. We planned next to identify all subject residences with private water supplies located over a plume, but as discussed later, there were too few subjects located over a plume to make this second step informative.

a. Method of Plume Delineation

We assembled all available data for each source of groundwater contamination. These data varied from very sparse to extensive groundwater sampling data and maps of the plume path. To assess the exposure of study subjects to contaminated groundwater, the following procedure was followed:

1) The plume was outlined on a transparent sheet showing the location of the plume at the end of the study period.

2) Using estimates of groundwater velocity and direction, we calculated the plume's past location by one year intervals.

3) The sheet was overlaid on the relevant study subject map.

4) Subjects whose residence fell within a plume outline at a relevant time period were considered exposed; all others were considered not exposed.

Because there was insufficient resolution to distinguish different levels of contamination within a plume, subjects were not classified as high, medium, or low exposure. Thus exposure to groundwater contamination is a dichotomous variable.

A path has been delineated for the Ashumet Valley and the MW603 plume by E.C. Jordan. We used these two outlines to indicate plume locations at these sites as of approximately 1983 for the Ashumet Valley plume and the late 1980's for the MW603 plume. We then estimated historical location based on groundwater velocity and direction.

For the remaining plumes, plume delineation is based on: 1) year the contaminant source began operation, 2) groundwater velocity, and 3) groundwater direction. Data from available groundwater sampling were used to confirm the basic location of the plume.

Groundwater velocity indicates how far contaminated water will move in a given period of time. Estimates of groundwater velocity for the sand and gravel aquifer which underlies most of the study area range from 0.8 to 2.3 feet per day, or 292 to 803 feet per year (13). For some sites a specific groundwater velocity was given. In these cases, this figure was used in estimating the historical plume location. When no specific velocity was cited, we used a general groundwater velocity of 1.7 feet per day, or 620 feet per year. This figure was derived from Darcy's Law (3, 37):

$$V = kI/n$$

where V = velocity in feet/day
K = hydraulic conductivity = 380 feet/day
I = hydraulic gradient = 0.0014
n = porosity = .3

[Values are for the Mashpee Pitted Plain glacial outwash deposits; "I" was measured in the southern part of MMR (37)]

Direction of groundwater flow was derived from a map of groundwater contours developed by E.C. Jordan (3). Groundwater flow is orthogonal to these contours. While the contours indicate, in general, what direction the groundwater will flow, they do not account for irregularities and directional changes in flow due to the presence of ponds, streams, or changes in subsurface conditions.

Because of the many unknowns in contaminant flow the plume path estimated by this method should be considered as a "best estimate" path. Hence, the potential exposure classification is in actuality "probable exposure" based on the stated assumptions of flow, direction, and time.

For certain sites there was a known area of definite contamination and additional areas that might be contaminated if certain assumptions were true. For example, the plume emanating from the UTES/BOMARC site on MMR is generally flowing to the southwest. However, since this site is close to the top of the "hill" of groundwater which underlies MMR, the plume is probably wide, although the width is uncertain. If the plume is very wide, a number of study subjects who lived south of Weeks Pond might have been exposed. In such a situation we were conservative in our plume delineation and included those areas of potential but unverified contamination in the exposure zone. Overall, however, our goal was to minimize exposure misclassification by delineating as accurately as possible groundwater plumes while acknowledging that precise plume boundaries are not known. Details for each plume are as follows:

b. Falmouth Landfill Plume

The Thomas Landers Road landfill in Falmouth is a municipal landfill which began operation in the mid-1950s. The path of the plume has been demarcated in a report prepared for the town by Camp, Dresser, McKee Inc. (33). Their delineation puts the leading edge of the plume just east of Route 28.

If we assume that contamination began when the landfill began operation in 1955 and that groundwater velocity is 1.7 feet/day, then the plume would have reached the sea before the end of the study period (about 1975). Our outline of the exposure zone comprises the plume as delineated by Camp Dresser McKee and includes additional area west of Route 28 to the sea.

c. Mashpee Landfill Plume

The Mashpee sanitary landfill located on Asher's Path began operation in 1961. The landfill is the source of a plume flowing to the southwest toward the Mashpee River.

The plume path was delineated by Weston & Sampson engineers in 1987. At that time they concluded that the contamination had not yet reached the Mashpee River, and estimated it would reach the river in 2 years (1989). However, if we assume that the contaminants began to migrate in 1961, the year the landfill opened, and migrated at a rate of 1.7 feet per day, the plume would have reached the river within one to three years. We therefore include the area west to the Mashpee River as exposed.

d. J. Braden Thompson Road Plume

A plume of groundwater contamination was discovered near this site in 1987. A first round of groundwater sampling indicated a general area of contamination to the south and west. Sampling done in late 1989 and 1990, however, suggested that the contamination was further to the southeast than previously thought. A DEP monitoring well located southeast of Route 130 and Pimlico Pond Road was contaminated with greater than 600 ppb each of TCE and 1,1,2-trichloroethane (37). Thus it is thought that the plume path may extend southeast all the way to Pickerel Cove in Wakeby Pond.

The potential exposure zone therefore includes an area immediately to the south and west of the site, as indicated by the original sampling effort, and an area running southeast to Pickerel Cove.

e. Briarwood Plume

The Briarwood neighborhood of Mashpee is an area south of the MMR, between Johns and Ashumet Ponds. Briarwood Homes Development began in 1964. Although contamination was not discovered until 1986, the area could have been contaminated at the time that the first homes were built.

Based on past practices at MMR there are probably several discrete areas of groundwater contamination in the area. Recent groundwater sampling data indicates that groundwater in Briarwood is affected by two kinds of contamination in three plumes: 1) chlorinated solvents (including PCE and TCE) are thought to underflow the area of East and West Briarwood, and 2) fuel-related hydrocarbons from the MMR site storm drain 2, underflowing West and Central Briarwood (30, 86).

The area considered exposed to this plume comprises the Briarwood neighborhood south to the intersection of Highland Street and Hooppole Road, and also the area to the east, including the Otis Trailer Village.

f. Ashumet Valley Plume

The Ashumet Valley plume has received the most study of any plume on Cape Cod. The United States Geological Survey (USGS) published a report in 1984 which gave the location of different constituents of the plume (14). This delineation puts the leading edge of the plume, as defined by boron and detergents, 11,000 feet downgradient of the southern border of MMR. However, the VOC portion of the plume is shown extending only 3000 feet south of the base boundary, well upgradient of the toe of the plume as delineated by boron and detergents. The USGS speculates that while non-biodegradable detergents began infiltrating the groundwater in 1946, the VOCs only entered the groundwater in the early 1970s (14).

E.C. Jordan also estimated the location of ethenes within the plume, which places the leading edge of the plume about 12,000 feet south of the base border. Individuals interviewed from the USGS (49) and the Massachusetts DEP (37) believed that the E.C. Jordan delineation is the most representative. Consequently we have used it to indicate the area of potential exposure.

Estimates of groundwater velocity in the Ashumet Valley vary from .8 to 2.3 feet per year (13). We have used a velocity of 1.7 feet per day, derived from Darcy's Law, to estimate historical location of the plume. Assuming the E.C. Jordan plume shows its location as of 1986, and estimating past plume location by year at a rate of 620 feet per year, the plume crossed the southern edge of the base in about 1964.

g. Forestdale Neighborhood of Sandwich

The discovery of high benzene contamination (1,100 ppb) in a monitoring well in the Forestdale neighborhood of Sandwich led to sampling in that neighborhood west of Weeks Pond. Sampling of private wells in the area by the Barnstable County Health Department found no further benzene contamination (38). However, groundwater flow is not well characterized in this area. Although there were insufficient data with which to estimate a plume, we considered an area to the northwest of Snake Pond as potentially exposed to contaminants.

h. Additional Sites on MMR

There are many sites on MMR which have contaminated the groundwater, and where subsequent migration of the contaminant has occurred. Of these sites, we were most interested in those where contamination has migrated off the base and affected residential areas. We have identified five sites which have discrete plumes which may have affected off-base sites.

MW 603 Plume

A long thin plume emanates from a source on MMR past the southern base border. The source is probably site CS4, a motor pool in operation from 1941 to 1983. This plume has been demarcated by E.C. Jordan and is approximately 12,000 feet long. The downgradient edge is about 500 feet north of Route 151 in the Crane Wildlife Refuge Area (12).

AVGAS Dump Site (FS1)

Aircraft fuel dump valves were tested at this site from 1955 to 1969. Groundwater flow in the vicinity is predominantly southeast along Ashumet Road towards Mashpee Pond. Groundwater velocity there is 2.03 ft/day, or 741 ft/yr (4). The plume has not been well defined as yet. If we assume contaminants began migrating in 1955 when the site began operation, then contaminants would have moved far to the east into Mashpee Pond. We estimate a potential area of exposure to be to the east, as far as Mashpee Pond, in a path delineated by E.C. Jordan's proposed test wells. (These wells were sited to intercept the plume; however sample results were not yet available for inclusion in this report).

Base Landfill (LF1)

Results of groundwater samples indicate that this plume most likely has not moved past the southern boundary of the base. At no time did any study subjects reside in the area south of the base where the plume is expected to cross the base boundary. We assumed that the location of the plume as of 1989 is 8,000 feet downgradient of the landfill, and used a groundwater velocity of 1.7 feet per day to estimate its historical location. The plume underlies almost the entire base residential area.

UTES/BOMARC Site (CS10)

The UTES/BOMARC site was used as a missile maintenance area from 1962 to 1973. From 1978 to the present, it has been used as a vehicle maintenance and hazardous waste storage area. A plume of VOCs and fuel components has been detected flowing generally to the southwest. The plume appears to be confined to base property but could be very wide. Since CS10 is close to the recharge area for the western Cape and the groundwater elevation contour lines bend sharply in this area, the contamination could spread out over a wide area (31).

If the plume is in fact very wide, it could affect the area to the west and south of Weeks Pond. We consider an area to the west and south of the pond as potentially exposed.

Railroad Fuel Pumping Site (FS2)

This site is the source of a plume that flows to the southwest. Assuming the most potentially significant fuel spillage occurred between 1959 and 1961 (4), potential groundwater contamination may have migrated from 8,400 to 19,600 feet downgradient of FS2 (4). We projected a southern path to the point where it would intercept Coonamesset Pond (approximately 9,500 feet downgradient of the site).

3. Air Contaminants

The principal determinants of exposure to airborne contaminants are the extent of the emissions, the configuration of the source, and meteorological conditions. Since concentrations of pollutants at the receptor end (individuals) is directly proportional to the extent of emissions, the relative exposures of subjects remains the same for different emission rates. For our purposes it is only this relative measure (e.g., that subject A's exposure is 3.7 times that of subject B's) that is needed, and we could ignore the difficulty of estimated emission rates.

The source configurations in our study area were one large point source (the Canal Electric Plant) and numerous smaller area sources. The estimate from the Canal Electric Plant is described in more detail below. We give here the general methods used to estimate exposure to the area sources.

Three kinds of exposure variables were used. The first designated an impact zone around the source and then determined whether a subject residence was within this zone, and if so, a distance and direction to the source was also measured. For some smaller sources this impact zone was 2 km, for larger sources 3 km. These distances were chosen because exposures fall off fairly rapidly from small area sources and rough calculations indicated that by these distances exposures would not be meaningful. Because the process of measuring subject distances to sources was tedious and time consuming we were concerned not to extend these distances unnecessarily. After consultation with the Community Advisory Board and at their request, the measured distances for three of these sites were extended to 9 km (AVGAS Dumpsite, the MMR Fire Training Areas, and the UTES/BOMARC site).

In the case of the base border the original 3 km distance was extended to 11 km by using the 1 km^2 map coordinates, as described below.

A second exposure metric was devised that took account of distance, direction and years of exposure in a single number. This used a more physically accurate measure obtained by reducing a complex Gaussian-plume model for dispersion from area sources. Using this model we examined the dependency of ground level concentrations on distance in this model for 16 compass directions and area sources with areas ranging over an order of magnitude. For the meteorological conditions of our study area we found that modelled concentrations were proportional to $1/d^{3/2}$ (where d stands for distance) and scaled according to the frequency with which the wind blew in each of the compass directions. Figure II.1 shows this linear dependency in a log-log plot of concentration versus distance for four compass directions. The slope of the line is -3/2.

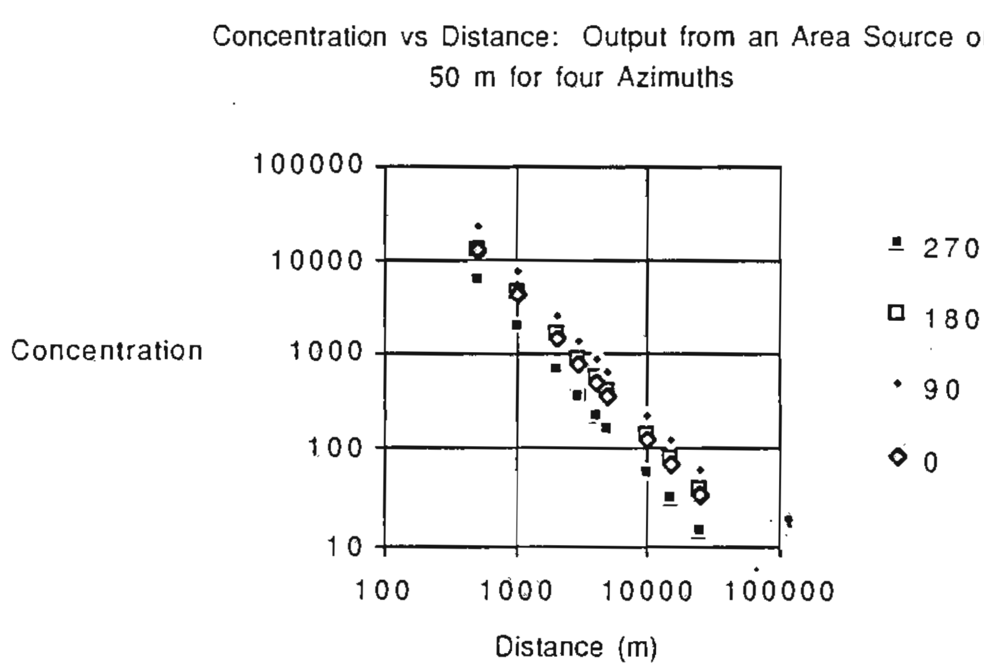

Figure II.1: Log-log plot showing relationship between concentration and distance.

Thus the exposure metric is given by:

$$E = \sum_{\text{all addresses}} \frac{1}{d^{3/2}} \bullet \text{(no. years).} \bullet \text{(wind freq.)}$$

Almost the same metric was used for the cranberry bogs, except that here a 1/d dependency was used because the subjects were closer to the source. This causes the exposure to fall off more slowly within distances that are comparable to the size of the source.

For the same reason a different metric was used for estimating the effect of the base border. In collaboration with one of the Advisory Board members, Dr. Joel Feigenbaum, the following formula was used in recognition of the fact that the MMR itself, considered as one large area source, would have exposures drop off more slowly than $\frac{1}{d^{3/2}}$ because most of the study area would be within a distance that was comparable to the size of the source:

$$\sum_{\text{all addresses.}} \left(\frac{L}{\sqrt{\text{dist.} + L} + \sqrt{\text{dist.}}}\right) \bullet \text{(wind freq.)} \bullet \text{(no. years)}$$

where L is the distance across the base on a line between the receptor and the base center.

A variation of this formula that included the inverse of the square root of the wind velocity was also used in certain analyses.

$$\sum_{\text{all addresses.}} \left(\frac{L}{\sqrt{\text{dist.} + L} + \sqrt{\text{dist.}}}\right) \bullet \frac{\text{wind freq.}}{\sqrt{\text{wind speed}}} \bullet \text{(no. years)}$$

a. Canal Electric Generating Plant

The EPA's standard regulatory air model, the Industrial Source Complex Long Term model (ISCLT) was used to assign exposure to SO_2 emissions from the Canal Electric Plant in Sandwich. We used ISCLT as available on the EPA's PC-based Graphical Exposure Modelling System (GEMS). Although SO_2 is not a carcinogen, it could indicate the dispersion pattern of uncharacterized and possibly carcinogenic contaminants from the plant.

ISCLT is a steady-state Gaussian plume model which uses statistical wind summaries to calculate ground-level concentrations for stack (point) pollutant sources. The area surrounding a continuous source of pollutants is divided into sectors of equal angular width corresponding to wind sectors of the annual frequency distribution of wind direction, wind speed, and stability. Annual emissions from the source are partitioned among the sectors according to the frequencies of wind blowing toward the sectors (48).

Input variables for the model include meteorological data and plant stack and emissions parameters for each year of operation. Meteorological data were available in GEMS for Otis Air Force Base. Stack and emissions parameters were provided by Commonwealth Electric Company. When the plant began operation in 1969, the plant had one 298 foot stack and one boiler. In 1975 a second boiler was added, and the stack was increased to 498 feet, with two flues for the two boilers. The plant burns oil with relatively constant sulfur content. The sulfur content determines the emission rate, which is one of the input variables for the model. Other variables include emissions exit velocity, temperature, stack height, and stack exit diameter.

The model was run for each year of operation during the study period (1969 - 1986). Although emission rates varied, the concentration and dispersion pattern was similar for all years. We used 1981 data, the year of highest emissions, to assign yearly exposures for the relevant portion of the study period. Model output was in the form of a concentration value for each one square kilometer cell in the map grid. Each subject residence was assigned the concentration value of that cell in which it was located, cumulated by years of residence during years of operation.

b. Barnstable Airport and MMR Runways

The distance of each study subject residence within 3 kilometers (1.9 miles) of the airport and base runways was measured. Distance was measured to the nearest fifty meters from the center of the subject dot to the nearest point on the runway. Duration of residence within this distance was calculated using the calendar years of residence obtained at interview and the years of operation of the site. Both the airport and the base runways have been in operation for the entire study period. Direction of each residence from the nearest point on the runway was also noted (N, NE, E, SE, S, SW, W, NW).

c. Fire Training Areas

The distances of all study subject residences within 3 kilometers were measured to the center of each fire training area (MMR FTA1, FTA2, FTA3, and the Barnstable County Fire Training Academy). Distances were measured to the nearest 50 meters. Subsequently, at the request of the community advisory board, distances of all subjects within 9 km of the MMR fire training areas were measured. Direction and duration of residence were noted as for the runways and airport.

d. MMR Gun and Mortar Positions

The distance of all study subject residences within 3 kilometers of the nearest of the approximately 20 gun and mortar positions was measured. Distance was measured to the nearest 50 meters. While propellant bags have been burned throughout the entire study period, we were unable to obtain specific information on the operating history of each gun and mortar position from MMR representatives. Thus we assumed that each position operated for the entire study period. The direction of the gun and mortar positions and duration of residence were also noted.

e. Chemical and Fuel Spills

Distance was measured for each subject residence within 2 kilometers of a chemical and fuel spill (UTES/BOMARC site, AVGAS dump site, Railroad Fuel Pumping Station, and Johns Pond Road Fuel Dump site). At the request of the community advisory board, the distance was increased to include all subject residences within 9 kilometers for the AVGAS dump site and the UTES/BOMARC site. Direction and duration of residence were noted as described above.

f. Storm Drains

Distance was measured for each subject residence within 2 kilometers of the outfall of each storm drain (SD1, SD2/PFSA, SD4, SD5, and the Non-Destructive Inspection Laboratory located adjacent to SD5). In the same fashion as for other air sites, direction and duration of residence were noted.

g. MMR Base Border

As this study was underway, site investigation was also underway at MMR. We made use of sampling data as they became available, but new information was being produced as our work on the study proceeded and continues to come out of the MMR remediation program. Because the known sites may be incompletely characterized, and unknown sites may not yet have been discovered, we constructed another exposure category, "proximity to MMR base border." The purpose of this exposure category is to take into account the uncertainties in exposure assessments for this large and complex site.

Initially we measured the distance of all study subject residences within 3 kilometers of the base border. Measurements were from the center of the dot to the nearest point on the border. We demarcated a "northern" and "southern" portion of the base, with a line drawn just north of CS10, and noted whether each subject was near the northern or southern portion. This distinction was to identify proximity to the more industrialized southern portion of the base as opposed to the more open northern section. As with the other air sites, direction and duration of residence was noted.

At the request of the community advisory board, we subsequently assessed distance of all subjects to the base border. This was calculated using the computerized 1 km^2 cell coordinates of each subject residence. A distance and direction was assigned to each subject residence according to its cell location in the 1 km^2 map grid. Two sets of additional analyses were conducted. One considered all study subjects within 11 kilometers as exposed and the second made use of the exposure metric developed in collaboration with Dr. Feigenbaum.

4. Proximity to Cranberry Cultivation

Location of Cranberry Bogs

The cultivation of cranberries has been the major agricultural activity in the area throughout the study period; however the number of acres in cultivation has been declining over the study period. The first task in assessment of potential exposure to cranberry bog pesticides was to locate the bogs in the study area and identify their years of production.

Information about bog location was obtained from aerial land use photographs and maps prepared by the Department of Forestry and Wildlife Management at the University of Massachusetts in Amherst. Maps were available for three points in time: 1951, 1971, and 1984. Outlines of cranberry bogs during each of these time periods were transferred to a set of acetate overlays at a scale of 1:12,500. The acetate overlays also noted the acreage of each bog at each point in time.

To determine the years when the cranberry bog was active, some assumptions were necessary. Bog locations were available for three points in time, but no information on when a bog went into or out of production between these reference points. Table II.14 describes the calendar years that the bogs were presumed to operate during the study period. Thus if a bog appeared on the 1951 map, but not on the 1971 map we assumed that the bog went out of operation in 1961, half way between 1951 and 1971.

Table II.14 Presumed Calendar Years of Cranberry Bog Operation

Calendar Years Bog Seen in Aerial Photographs	*Presumed Calendar Years of Operation During the Study Period*
1951 alone	1943-1961
1971 alone	1961-1977
1984 alone	1977-1986
1971, 1984	1966-1986
1951, 1971	1943-1977
1951, 1984	1943-1961, 1977-1986
1951, 1971, 1984	1943-1986

Exposure Assessment

Both ground and aerial methods were used to spray pesticides in the cultivation of cranberries. While we did not have specific information on the particular method that was used for each bog, aerial spraying occurred for the longest portion of the study period (1950s to 1970s). Thus, we were principally concerned with possible exposure through the air as a result of aerial spraying.

Distance, direction, and bog acreage were used to describe potential exposure. We measured the distance of all subject residences within 2,600 feet (one half a mile) of a cranberry bog to the nearest 100 feet. Distance was measured to the bog's nearest edge. The 2,600 foot distance was based on a study which examined pesticide drift which concluded that the most "driftable" portion of a pesticide formulation (droplets less than 100 microns in diameter) could be carried to a distance of one half a mile from the flight line (51). We also noted the direction of a subject residence to the bog using sixteen 22.5^{0} sectors, and the acreage of all bogs within one half mile, since acreage was hypothesized to be related to the amount of pesticides sprayed.

5. Public Water Supplies

The public water supply in Falmouth (provided by the Falmouth Department of Public Works Water and Sewer Division) and the Barnstable Water Company were considered potential sources of exposure to THMs and low-level solvents, respectively.

Since the Falmouth water system is the only public water system in Falmouth, we used interview data to identify subjects who ever lived in Falmouth and used the public water supply. The Barnstable Water Company serves the village of Hyannis. Again, we used interview data to identify all subjects who ever lived in Hyannis and used a public water supply. Both water systems operated during the entire study period. Because of incomplete data from proxy respondents being unable to supply information on water supply, we were not able to examine duration of residence in these areas.

6. PCE in Public Water Distribution System

To assess exposure to PCE in public water supplies, a model was developed by Dr. Halina Brown and Mr. Thomas Webler of Clark University. The model assumes that the concentration of PCE in a distribution pipe liner drops exponentially over time The rate of decline varies with the volume of water flowing through the pipe; greater volumes reduce the amount of PCE more quickly. Thus, input variables to the model are: 1) those that determine volume of water moving through a pipe: pipe length and diameter; 2) those that determine what volume of water is reaching the subject residence: the distribution of loads on the pipe (i.e., location of residences along the pipe) and the location of subject residence; 3) those that indicate timing of subject exposure: pipe installation date and beginning and ending years of residency.

A detailed description of the model is included in the appendix. As noted there:

> The choice of variables was based on the following assumptions. First, there is a finite amount of PCE in the lining (Piccotex) of each pipe and it is distributed uniformly on the inside surface of the of the pipes. Second, all pipes have identical amounts of PCE per unit length at their installation date. Third, PCE leaches from the Piccotex into the water without reaching a steady state condition since the water is always flowing. Fourth, the PCE leaching rate decreases with time, because of assumptions one and three.

Model output is a "relative delivered dose" for each subject residence. This output is defined as the mass of PCE in milligrams which entered a given house as a solute in drinking water over a specific time period. Because of the complexity of the water distribution system and the uncertainty about the initial amount of PCE in the pipes, output should not be interpreted as an absolute dose of PCE, but rather a relative dose.

Implementation of the Model

The first task in implementing the model was to identify the location of vinyl lined/asbestos cement (VL/AC) pipes in all public water supply systems. Five of the eleven water suppliers reported no VL/AC pipes in their districts. The remaining six suppliers provided maps or street lists indicating the location of VL/AC pipes. A master list was then compiled of all streets in the study area containing sections of VL/AC pipes.

This list was then compared to our address database. All residences after 1967 (the first year VL/AC pipes were installed) on any street supplied entirely or in part by VL/AC pipe were flagged as potentially exposed.

To obtain a relative delivered dose for each subject residence it was necessary to locate the subject on the distribution network to determine the model input variables of water flow direction, number of nodes, length of pipe sections, etc. The values for some variables often required judgement. A strict protocol was devised so that decisions were made in a consistent way. Modelers were unaware of whether subjects were cases or controls.

7. Electric and Magnetic Fields

We planned to assess exposure to three sources of electric and magnetic fields: 1) transmission lines, 2) substations, and 3) distribution lines near the subject residence. Only the first two were completed for reasons discussed below.

Transmission Lines

Information on location, size, and operating years of high voltage transmission lines was obtained from Commonwealth Electric Company. Locations of all 115 kV and higher transmission lines were marked on subject residence maps. All subject residences within 500 feet of a transmission line were identified and further classified as to whether they were within approximately 300 feet or from approximately 300 to 500 feet. Five hundred feet was chosen as a cut-off after considering: (1) the rapid fall off of electrical field intensities and magnetic flux density (rapid fall off begins at about 10 meters) (87), and (2) the accuracy of our mapping process (dot size, etc.). The same cautions should be applied to these measures as to others in light of the limitations on determining exact location in the mapping process.

Substations

Location of all 25 kV (low voltage) and 115 kV ("bulk") substations were marked on subject residence maps. Information on location, size, and operating years of substations was obtained from Commonwealth Electric. All subjects within 500 feet of a substation were identified, and subclassified as within approximately 250 feet, or within approximately 251 to 500 feet.

Distribution Wiring Configuration

We had planned to estimate magnetic flux densities (MFD) at subject residences using a regression model developed by W. Kaune (61). This model used easily obtainable data on wiring systems to estimate magnetic field exposure. A special study was conducted under our direction that attempted to validate Kaune's model (62). Instantaneous MFD measurements were taken in the morning and evening outside the front door of 171 Upper Cape study subject residences. Since the study failed to validate the model, exposure estimates are not available at the time of this writing.

8. PAVEPAWS

The PAVEPAWS radar facility is located on Flatrock Hill in the northern portion of MMR, approximately 4000 feet from the Mid-Cape Highway. The facility began operating in 1978.

The beam from PAVEPAWS scans a 240^{o} sector, from 347^{o} to 227^{o} (where 360^{o} is due north of the facility). Sandwich, Sagamore, and North Pocasset lie within this area. Power density measurements in nearby community locations were taken by the Department of Defense at the request of the State to estimate exposures to residents. Testing results are not a random sample which describe the distribution of power density from PAVEPAWS in the whole study area but a spatially biased sample designed to describe power density levels at nearby population centers.

Two sets of power density measurements were available to us and are shown in Table II.15. In October of 1978, an Air Force survey team measured levels at twenty-one locations in Bourne, Sandwich, Mashpee, and Falmouth. These tests were witnessed by independent observers from the local communities. Results are reported as peak power densities in mW/cm^2 and average power densities in mW/cm^2. In this round, the highest levels were measured at the public rest area on Route 6 about 3500 feet from PAVEPAWS (average density = .061 mW/cm and peak density = 19.5 mW/cm^2) (23). At twelve sites, average power densities were below recordable levels (less than .001 mW/cm^2).

In September 1986 additional testing at fifteen sites was jointly performed by the Massachusetts Radiation Control Office of the Department of Public Health and the Air Force (53). Only average power densities were reported for this round. Ten of the values were below the recordable level.

We mapped the locations of the testing sites and the average power densities reported at each site. Since testing locations were not precisely specified, our map locations are approximate. Most measurements were made to the north of PAVEPAWS, in Sandwich from Sagamore Beach to Scorton Neck. Nine measurements were made south of the Mid-Cape Highway, of which six were below the reportable level. Eleven values north of the highway were above the reportable level.

Here, a special procedure, implemented by Dr. Daniel Wartenberg of the University of Medicine and Dentistry of New Jersey, was used to assess exposure. It is in some sense the reverse of the usual one. This was necessary because the geographic distribution of the environmental monitoring data did not allow for reliable interpolation because the data were cluster sampled. Cluster sampling is a methodology used in situations in which investigators are trying to identify and characterize a hot spot or localized region of exposure (63). Fairly wide-spaced samples are taken in the field and, when an above background reading is observed, the immediate surrounding area is sampled more intensively. While useful in characterizing the regions of highest contamination, the procedure biases the samples towards high values and is problematic for assessing the general pattern of contamination and low level of contaminants. Hot spots (if large enough) may be identified but contour maps of the region will be subject to large interpolation errors. Similarly, epidemiologic assessment of cluster sampled environmental data using standard interpolation methods will be compromised particularly when the study subjects are widely dispersed geographically without regard to the cluster sampling.

In Wartenberg's method, the study subject data are interpolated to estimate the probability of being a case at each testing point. Since the geographic distribution of the study subjects is less clustered than the contaminant data, the interpolated values of case-control status, or a contour map of these data will be more reliable than the corresponding environmental contamination data if it were interpolated. The details of this method are given in the "Data Analysis" Section (Section D.).

Table II.15: Power Density Measurements at Locations Near PAVEPAWS (October 20-21, 1978)

Test Point	Measurement Location	Approx. Distance in Miles from PAVEPAWS	Average Power Density mW/cm^2
1	Rest Area, Route 6	0.6	0.061
2	Shawme & Shaker House Roads	2.1	0.027
3	Henry T. Wing School	2.1	**
4	Dillingham & Knott Roads	2.4	0.02
5	Sandwich High School	4.4	0.001
6	Entrance, Lakewood Hills Dev.	4.6	**
7	Knolltop & Greenhouse Roads	5.4	**
8	Mashpee Police Department	7.3	**
9	Mashpee Middle School	9.2	**
10	Seabury Golf Club	13.8	**
11	Sagamore Bridge	1.6	0.051
12	Canalside Apartments	2.0	0.016
13	Hoxie Elementary School	1.7	0.001
14	Old Plymouth Road	2.8	0.002
15	Hilltop Drive (Maiolini Residence)	1.0	0.003
16	Keith Field	1.4	**
17	Stone School, Otis Air Force Base	7.1	**
18	Ashumet Development, Hatchville	8.8	**
19	Benthos Corp.	8.9	**
20	North Falmouth Elementary School	9.0	**
21	Falmouth High School	11.8	**

** Below recordable level (less than 0.001 μwatts/cm^2)

Table II.15 (Continued): Power Density Measurements at Locations Near PAVEPAWS (September 18-30, 1986)

Test Point	Measurement Location	Approx. Distance in Miles from PAVEPAWS	Average Power Density mW/cm^2
1	Cardinal Rd. (Christophers Hollow)	2.8	0.026*
2	Sandwich Fire Tower	3.2	0.139*
3	Sandwich Public Library	2.3	**
4	Crowley State Park (Les Perry's House)	1.2	0.012
4A	Crowley State Park (Near Camp Site A-10)	1.2	0.020*
5	Rt. 130 and Greenway and Gibbs (Across From Base Gate)	3.5	**
6	Corner of Friendly and Freedom Rd. (Near Snake Pond Area)	5.0	**
7	Beach Area (Snake Pond)	4.8	**
8	Intersection of Rt. 130 before Central Rd.	7.4	**
9	Near Mashpee Middle School on Lowell Rd.	8.4	**
10	Lowell Rd. near Quessot Golf Course	8.8	**
11	Nickelodeon Theatre on Rt. 151	7.8	**
12	Otis Central Tower	5.9	0.003
13	VA Cemetery near entrance on Rt. 151	5.6	**
14	Scussett Beach Pier	1.9	0.004
15	Henry Wing School, Sandwich	2.1	**

* Power density measurements where the PAVEPAWS facility was in direct view. (Only reported for 1986 testing).

** Below recordable level (less than 0.001 μwatts/cm^2)

9. Environmental and Occupational Exposure Data Obtained At Interview

In addition to ascertaining exposures indirectly based on subject residence location and the methods described above, study subjects and proxy respondents were asked directly about a number of environmental exposures during the interview. Detailed information on personal risk factors was obtained including: use of electrical devices such as heating pads, electric blankets, water bed heaters, and ham radios, use of bottled water, use of hobby-related chemicals such as paint and pesticides, use of hair dyes, and usual bathing habits. Information was also obtained on specific study area exposures including use of public or private drinking water sources, swimming and fishing habits at study area ponds and beaches, and residence on the MMR.

In order to compare the migration rates of cases and controls to the Upper Cape, the residential history data obtained at interview were also used to examine the total number of years and calendar years each subject resided in the Upper Cape towns.

In addition, information was obtained on all full-time jobs held since age 18 including the job title, industry, location of employer (Upper Cape or not), and calendar years of employment. Data were also collected on military and civilian jobs held on the MMR and employment in cranberry bog cultivation. Lastly, direct questions were asked about occupational exposure to hazardous substances such as asbestos, ionizing radiation, microwaves, pesticides, heavy metals (lead, mercury, cadmium and arsenic), and solvents (see appendix for questionnaires).

Job titles and industries were coded using a modification of the 1987 Standard Industrial Classification (64) and 1980 Standard Occupational Classification (65) manuals. Occupational exposures to particular substances were assessed using either the industry and job title information or direct questions from the interview or a combination of the two.

A variable was also developed that grouped together all subjects who ever worked in jobs for which there is evidence of a cancer association in the published literature (66, 67). Table II.16 lists the occupations and occupational exposures considered for inclusion in this variable according to cancer site. An asterisk indicates the occupations in which none of our study subjects appear to have ever been employed.

Table II.16 Occupations and Occupational Exposures Associated with the Cancers Under Study

Cancer Site	*Occupations/Occupational Exposures*
Lung	Arsenic (e.g. alloy makers, painters, weed sprayers) Asbestos (e.g. shipyard workers, plumbers) Benzoyl chloride manufacturing workers* Chromium (e.g. metal workers, photographers) Coke oven workers* Coal tar pitch workers (e.g. roofers) Iron ore, uranium workers/miners* Nickel refinery workers Rubber manufacturing workers
Colo-Rectal	Asbestos Coke oven workers* Solvents (e.g. painters, mechanics)
Bladder	Rubber and cable manufacturing workers Dye manufacturing Leather workers
Kidney	Arsenic Coke ovens workers* Solvents

* No study subjects appear to have ever been employed in these jobs.

Table II.16 Occupations and Occupational Exposures Associated with the Cancers Under Study (continued)

Cancer Site	*Occupations/Occupational Exposures*
Pancreas	Coke oven workers*
	Oil refinery workers*
	Nursery men
	Dentists
	Radiologists*
	Rubber workers
	Dry cleaners
	Service station workers and garagemen
Leukemia	Shoe leather workers
	Pliofilm workers*
	Chemical manufacturing workers
	Petrochemical manufacturing workers*
	Oil refinery workers*
	Rubber manufacturing workers
	Chemists
	Farmers
	Machinists
	Asbestos
	Hydrocarbon workers (e.g. service station workers)
	X-rays (e.g. dental hygienists, x-ray technicians)
Brain	Petrochemical manufacturing workers*
	Chemists
	Farmers
	Vinyl chloride workers*
	Rubber manufacturing workers
	Oil refinery workers*
Liver	Vinyl chloride workers*

* No study subjects appear to have ever been employed in these jobs.

D. Data Analysis

1. Selection of the Final Study Population

For the analysis, ten study populations were created corresponding to cases and controls for all cancers combined and each of the nine specific cancer sites. Controls were selected for each cancer group (except for all cases combined) first by stratifying each case group on the basis of age (in decades), gender, vital status at interview, and if dead, year of death, and then by selecting all controls who fell into a stratum with at least one case. This scheme increased efficiency by using controls for more than one analysis and improved statistical power since the control:case allocation ratios were high. All controls were used for the comparison with the all cancers combined group.

Next, an index year was selected for each control group that would be comparable to the diagnosis date for the cases. We chose the <u>median</u> diagnosis year of each case group to serve as the index year for its control group since that year (1984 or 1985) was, on average, closest to the diagnosis year.

Lastly, we excluded controls who first moved to the Upper Cape after the index year and cases and controls with incomplete residential histories. A residential history could be incomplete if the dates of residence were missing and could not be inferred from notes in the questionnaire, or if any address in the history was insufficient for mapping. These exclusions are given in Tables II.17.1 - 17.10 and the final sizes of the case and control groups are given in Table II.18. Note that the units of observation in Tables II.17 and II.18 are cases and controls not individuals.

Tables II.17.1 - II.17.10 Summary of Exclusions for Final Analyses

Table II.17.1 Cancer Site: All Cancers

	Cases	Controls
Interviewed	1,077	1,416
Excluded:		
Incomplete Residential History*	35	61
Moved to Upper Cape after index date	0	70
Included in Final Analysis	1,042	1,285

Table II.17.2 Cancer Site: Lung

	Cases	Controls
Interviewed	260	1,311
Excluded:		
Incomplete Residential History*	9	57
Moved to Upper Cape after index date	0	26
Included in Final Analysis	251	1,228

* Years of residence were incomplete or residential address had insufficient information for mapping

Table II.17.3 Cancer Site: Breast

	Cases	Controls
Interviewed	273	778
Excluded:		
Incomplete Residential History*	8	31
Moved to Upper Cape after index date	0	46
Included in Final Analysis	265	701

Table II.17.4 Cancer Site: Colo-Rectal

	Cases	Controls
Interviewed	328	1,304
Excluded:		
Incomplete Residential History*	13	57
Moved to Upper Cape after index date	0	68
Included in Final Analysis	315	1,179

* Years of residence were incomplete or residential address had insufficient information for mapping

Table II.17.5 Cancer Site: Bladder

	Cases	Controls
Interviewed	64	925
Excluded:		
Incomplete Residential History*	2	41
Moved to Upper Cape after index date	0	17
Included in Final Analysis	62	867

Table II.17.6 Cancer Site: Kidney

	Cases	Controls
Interviewed	35	870
Excluded:		
Incomplete Residential History*	0	31
Moved to Upper Cape after index date	0	47
Included in Final Analysis	35	792

* Years of residence were incomplete or residential address had insufficient information for mapping

Table II.17.7 Cancer Site: Pancreas		
	Cases	Controls
Interviewed	38	673
Excluded:		
Incomplete Residential History*	1	31
Moved to Upper Cape after index date	0	9
Included in Final Analysis	37	633

Table II.17.8 Cancer Site: Leukemia		
	Cases	Controls
Interviewed	37	833
Excluded:		
Incomplete Residential History*	1	41
Moved to Upper Cape after index date	0	41
Included in Final Analysis	36	751

* Years of residence were incomplete or residential address had insufficient information for mapping

Table II.17.9 Cancer Site: Brain

	Cases	Controls
Interviewed	38	773
Excluded:		
Incomplete Residential History*	1	43
Moved to Upper Cape after index date	0	15
Included in Final Analysis	37	715

Table II.17.10 Cancer Site: Liver

	Cases	Controls
Interviewed	4	58
Excluded:		
Incomplete Residential History*	0	4
Moved to Upper Cape after index date	0	4
Included in Final Analysis	4	50

* Years of residence were incomplete or residential address had insufficient information for mapping

Table II.18 Size of Final Case and Control Groups

Site	*Number of Cases*	*Number of Controls*
All Cancers Combined	1,042	1,285
Lung	251	1,228
Breast	265	701
Colo-Rectal	315	1,179
Bladder	62	867
Kidney	35	792
Pancreas	37	633
Leukemia	36	751
Brain	37	715
Liver	4	50

2. Development and Merging of Data Sets

In the course of data collection, the following data sets were created: A "key" or "base" data set was produced for each of the ten case groups and their controls that contained a unique subject identification number, an identification letter for each residence (sub-id), variables for case/control status, cancer type, and diagnosis or index year. Questionnaire information was divided into three data sets: (1) residential histories and map locations, (2) non-occupational data, and (3) occupational data (i.e. industry and job title codes). In addition, thirty six separate data sets were created for each environmental exposure or set of exposures.

All data sets contained subject and residence identifiers. The residential history and environmental data sets also contained an identifier that indicated on which map each residence was located. Data sets were merged, as needed, using the subject, residence, and map identifiers. In this way, the exposure data were correctly matched to the appropriate subject or residence.

3. Crude Analysis

The crude analysis examined each exposure separately in relation to all cancers combined and the individual cancer sites. Exposures were examined as dichotomous variables (i.e. ever vs. never exposed) and also were subdivided according to distance, cumulative duration, direction, and sometimes calendar year categories. Individuals were considered exposed if they had at least one exposed residence during the relevant time period. If an individual had more than one exposed residence, distance and direction were assessed to the nearest exposed residence and cumulative duration was summed over all exposed residences.

Many exposures were also examined as continuous variables. The exposure metric for the MMR-associated air exposures and MMR base border took into account distance, wind frequency in a given direction, and duration of residence. The relative delivered dose of PCE in the water distribution system was modeled to give an exposure metric as were SO_2 emissions from the Canal Electric Plant.

The exposure time window was first defined by the years of operation of a particular exposure site. Most sites operated for the entire study period (1943 through 1986). However some operated for only a portion of this period (e.g. activities at FS1 occurred only from 1955 through 1969). Since there was potential for exposure even after an operation ended, at the request of the community advisory board, we also conducted crude categorical analyses that extended the exposure windows through the end of the study period. These additional analyses were conducted only for sites at the MMR whose operation had ended before 1986 (e.g., FTAs) or whose operation was temporarily suspended (e.g.. CS 10). These analyses assumed that the potential for exposure was the same during and post operation.

Most crude analyses were conducted with and without taking the latent period for cancer into account since we hypothesized that the exposures under study could be either cancer initiators or a combination of both initiators and promoters. When latency was taken into account, only exposures that occurred prior to the latent period were counted whereas when latency was not taken into account exposures that occurred up until the time of the diagnosis or index year were counted. The latent period used was fifteen years for all solid tumors and five years for leukemia (68, 69). Exposures that were hypothesized to be only promoters were electric and magnetic fields from transmission lines and microwave radiation associated with PAVEPAWS and so latency was ignored for these analyses (108).

The odds ratio (an estimate of the relative risk) was used to measure the strength of the relationship between a particular exposure or exposure category and the cancer site. In the categorical analysis, the referent category always consisted of unexposed subjects. Crude odds ratios were calculated only if there were at least three exposed cases. To assess the statistical significance of the crude associations, 95% confidence intervals were first calculated using a test-based method (70). To account for potential small sample problems, exact confidence intervals were calculated and reported when the test-based interval indicated that the association was statistically significant (the null odds ratio was not included in the confidence interval) (71).

When the continuous exposure variables were analyzed, odds ratios were estimated from logistic regression models using the antilog of the beta coefficient from the model (72). Here, the odds ratios compared exposed subjects at the 75th percentile to either unexposed subjects or exposed subjects at the 25th percentile, depending on the exposure frequency. The frequency distribution of the continuous exposure variable among all cases and controls combined was used to determine the 75th and 25th percentiles. 95% confidence intervals and p values were calculated using the maximum likelihood estimates of the standard errors from the logistic model (73).

4. PAVEPAWS Crude Analysis

For the PAVEPAWS data, two methods were used by Dr. Daniel Wartenberg to interpolate the case-control data. First a simple weighted average was used in which the weights were the inverse of the squared distance of the study subject from the site. Thus, the distance of each subject from the measurement site was calculated and a weighted average of the subject values (case=1, control=0) was taken; the weights were the inverse of the squared distance from the site to the study subject. These values were then compared to the observed exposure value by calculating a product-moment correlation coefficient and by testing whether the slope of the regression of the exposure value on the probability of being a case (the interpolated value) is statistically significantly greater than zero. A related but more statistically rigorous approach has been proposed by Diggle et. al. (74).

For the second method, a kriging algorithm was used to interpolate the case-control data (75). To do so, a variogram for the case-control data was estimated and used as a weighting function to derive weighted average estimates of the probability of being a case, as above. These data were compared with the measured exposure values as above.

The approach was limited by the relatively small number of measurements (twenty-three) given by the clustered sample distribution and by the variation of measurement. Another obstacle is the lack of accommodation of the distribution of the exposure measurements and their associated errors. Because the data are skewed, disproportionate weight is given to the larger values. It is also assumed that the exposure measurement errors are identically and independently distributed and follow a normal distribution. Given the distribution of the sample values, this is unlikely. Thus we view the analytic approach as exploratory, meant to overcome serious obstacles to more conventional analyses.

5. Confounding Variables and Adjusted Analysis

We examined the frequency distribution of demographic characteristics, occupational exposures, smoking habits, alcohol use, and other potential confounders among the cases and controls and reviewed published data on the well-established risk factors for each cancer site in order to determine which variables to control in the adjusted analysis. Study design characteristics (e.g. the inclusion of living and dead subjects), the frequency of the confounder among the study subjects, the size of the case group, and the strength of the association between the potential confounder and the cancer, as well as how firmly established a risk factor it was in the published literature were all considered in deciding which variables to control. Our goal was to control for well-known, relatively strong risk factors (associated with two-fold increases or decreases in risk) that occurred with reasonable frequency in our study population. Our rule of thumb was that at least three cases had to have a positive history of the potential confounder for the variable to be included in the adjusted analysis.

We ultimately decided to control for sex, age at diagnosis or index year, and vital status at interview in all analyses. Sex was controlled by restriction in the breast cancer population since all cases were female, and by multivariate modelling in all other cancer sites. Sex and age were controlled because they are known to be important determinants of cancer risk. Vital status at interview was controlled because it was a design variable and often varied between cases and controls and may have resulted in differences in information quality.

Other confounders that were controlled varied according to the cancer site and included a history of work in jobs associated with cancer risk (see Table II.16) and other well-known cancer risk factors (e.g. age at first birth for breast cancer). Table II.19 lists the variables that were controlled in the all cancers combined and site specific analyses.

In addition, when we conducted the adjusted analysis on pesticide exposure from cranberry bog cultivation, we also controlled for occupational and gardening exposure to herbicides and pesticides, including a history of work in cranberry bogs. Likewise when we conducted the adjusted analyses on transmission lines and substations we controlled for occupational exposure to power lines and electric and magnetic fields. These additional confounders were included only if at least three cases reported this history.

Multiple logistic regression models were used to control simultaneously for all included confounders (72). The adjusted analyses paralleled the crude analyses examining exposures as categorical and continuous variables. The antilog of the beta coefficient for the exposure variable served as an estimate of the odds ratio (72). For the continuous variables, exposed subjects at the 75th percentile were compared to unexposed subjects or exposed subjects at the 25th percentile, depending on the exposure frequency. The frequency distribution of the continuous exposure variables among all cases and controls combined was used to determine the 75th and 25th percentiles. 95% confidence intervals and p values for the adjusted odds ratios were calculated using the maximum likelihood estimates of the standard errors (73). Since there were a total of only four cases, no adjusted analyses were performed for liver cancer. For the remaining cancer sites, adjusted analyses were performed if there were at least three exposed cases.

Table II.19 Confounders Included in Adjusted Analysis

Cancer Site *	*Confounder*	*Categories*
All Cancers	Sex	Male/Female
	Age at diagnosis or index year	1-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual number of cigarettes smoked	0, 1-10, 11-20, 21-40, >40, amount unknown
	Cigar smoker	Ever/Never
	Pipe Smoker	Ever/Never
	Lived with a smoker	Ever/Never
	Usual Alcohol Consumption	Almost every day, less, none
	History of cancer associated job**	Ever/Never
Lung Cancer	Sex	Male/Female
	Age at diagnosis or index year	30-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual number of cigarettes smoked	0, 1-10, 11-20, 21-40, >40, amount unknown
	Cigar smoker	Ever/Never

* No adjusted analyses were performed for liver cancer since there were only a total of four cases.
** See text and Table II.16 for description of cancer associated jobs.

Table II.19 Confounders Included in Adjusted Analysis (continued)

Cancer Site	*Confounder*	*Categories*
Lung Cancer (continued)	Pipe Smoker	Ever/Never
	Lived with a smoker	Ever/Never
	Usual Alcohol Consumption	Almost every day, less, none
	History of cancer associated job**	Ever/Never
Breast Cancer	Age at diagnosis or index year	20-49, 50-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Mother or sister with breast cancer	Yes/No
	Age at first live- or stillbirth	Nulliparous, < 30, >=30
	Prior benign breast disease	Yes/No
	Prior breast cancer	Yes/No
Colo-Rectal Cancer	Sex	Male/Female
	Age at diagnosis or index year	20-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual alcohol consumption	Almost every day, less, none
	Family history of polyposis	Yes/No

** See text and Table II.16 for description of cancer associated jobs.

Table II.19 Confounders Included in Adjusted Analysis (continued)

Cancer Site	*Confounder*	*Categories*
Colo-Rectal Cancer (continued)	History of inflammatory bowel disease or ulcerative colitis	Yes/No
	History of cancer associated job**	Ever/Never
Bladder Cancer	Sex	Male/Female
	Age at diagnosis or index year	40-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual number of cigarettes smoked	0, 1-10, 11-20, 21-40, >40, amount unknown
	History of bladder infection or stones	Yes/No
	History of cancer associated job**	Ever/Never
Kidney Cancer	Sex	Male/Female
	Age at diagnosis or index year	30-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual number of cigarettes smoked	0, 1-10, 11-20, 21-40, >40, amount unknown
	History of kidney infection or stones	Yes/No

** See text and Table II.16 for description of cancer associated jobs.

Table II.19 Confounders Included in Adjusted Analysis (continued)

Cancer Site	*Confounder*	*Categories*
Pancreas Cancer	Sex	Male/Female
	Age at diagnosis or index year	40-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Usual number of cigarettes smoked	0, 1-10, 11-20, 21-40, >40, amount unknown
	Usual Alcohol Consumption	Almost every day, less, none
Leukemia	Sex	Male/Female
	Age at diagnosis or index year	1-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead
	Prior medical treatment with ionizing radiation	Yes/No
Brain Cancer	Sex	Male/Female
	Age at diagnosis or index year	1-59, 60-69, 70-79, 80+
	Vital status at interview	Alive/Dead

III. RESULTS

A. Population Characteristics

1. Demographic and Personal Characteristics of Cases and Controls

Tables III.1.1 - III.1.10 describe the demographic and personal characteristics among the case and control groups. The distributions of sex, race, age, vital status at interview, marital status, religion, educational level, and occupational and military service history were similar among all cancer cases and all controls combined (Table III.1.1). Both cases and controls had a larger proportion of females than males (57.8% and 58.4% female, respectively), were predominantly White (97.0% and 96.5%, respectively) and married (60.4 and 58.9, respectively).

As a result of the control selection scheme, the distributions of age and vital status among all cases and controls were also similar. 82.8% of cases and 83.1% of controls were 60 years and older at the diagnosis or index year, and, at the time the study was conducted, 45.4% of all cases and 47.3% of all controls were still alive. Proxy interviews were conducted if participants were deceased or very ill.

Cases and controls had also similar and high levels of education, were mainly Catholic or Protestant, born in Massachusetts or another part of the United States, and almost all had held a full-time job at some point in their lives. Among subjects who held full-time jobs, a similar proportion of cases and controls (19.9% and 18.7%, respectively) ever held a job located in one of the Upper Cape towns.

Only about a quarter of the cases and controls had ever served in the military reflecting the large proportion of women in the study population. As regards behavioral characteristics, 70.1% of all cases compared to 64.2% of all controls reported that they ever regularly smoked cigarettes, and 87.3% and 85.9% of all cases and controls reported ever drinking alcoholic beverages.

Many of these demographic characteristics including race, marital status, religion, educational level were also similar among the site-specific case and control groups. However, depending on the cancer site, cases were different from controls on sex (lung, colo-rectal, bladder, kidney and brain cancer), age (kidney, pancreas, brain cancer and leukemia), birthplace (pancreas and brain cancer), vital status at interview (lung, kidney, pancreas, brain cancer and leukemia), history of cigarette smoking (lung, bladder, kidney, and pancreas cancer), and consumption of alcoholic beverages (lung, bladder and pancreas cancer), and employment on the Upper Cape (lung and pancreas cancer, leukemia). Among the cases, the percent still alive at interview ranged from a high of 67.2% for breast cancer to a low of 0% for liver cancer. The frequency distributions for the liver cancer cases were highly unstable since this group included only four cases.

About 20% of the selected population did not participate in the study. The available demographic characteristics of non-participants were similar to those of all cases and controls combined. Overall, 96.1% of non-participants were white, 60.1% were female, 83.7% were sixty years and over, and 48.7% were still alive when we attempted contact. These percentages were similar among both non-participating cases and controls.

2. Occupational Exposures

Tables III.2.1 - III.2.10 describe the occupational exposures among the cases and controls. Most of the information in these tables was based on direct questions from the interview but potential exposures based on the industry and job title data were also gathered for occupational exposures that were directly related to the environmental exposures under study -- pesticides and herbicides, microwaves, and electric and magnetic fields. Unfortunately, the industry and job title data always captured fewer exposed individuals than did the direct questions.

Most job-related exposures were reported infrequently by the study subjects (less than 10% of subjects) with the notable exceptions of asbestos (16.1% of all cases and 14.8% of all controls), hydrocarbons (23.9% of cases and 24.7% of controls), gasoline or kerosene (13.6% of cases and 13.1% of controls), and other solvents (18.3% of cases and 18.0% of controls). Benzene, gasoline, kerosene, and other solvents were included in the hydrocarbon category.

Generally similar proportions of all cases and controls reported ever holding a job with exposure to asbestos, ionizing radiation, beryllium, hydrocarbons, benzene, gasoline or kerosene, other solvents, lead, pesticides and herbicides, cranberry bogs, microwaves, power lines, electric and magnetic fields, and welding materials. About 50% fewer cases than controls reported occupational exposure to mercury and cadmium, and about 50% more cases reported arsenic exposure. 15.9% of all cases vs. 14.1% of all controls reported holding jobs for which there is evidence of a cancer association in the published literature (66-68).

Most site-specific case and control groups also gave similar histories of occupational exposures; however, several case groups reported occupational exposures more often than their control groups. Most notably, lung cancer cases more often reported job-related exposures to almost all the substances queried. Furthermore, 23.9% of lung cancer cases compared to only 12.1% of their controls reported ever holding a job associated with lung cancer risk.

About twice as many bladder cancer cases as controls reported occupational exposure to asbestos, gasoline or kerosene, and lead and almost five times as many bladder cancer cases as controls reported holding a job associated with bladder cancer risk. Lastly, about twice as many kidney and pancreas cancer cases as controls reported occupational exposure to ionizing radiation and herbicides and pesticides, respectively. Again, the liver cancer data were highly unstable due to the small number of cases.

3. Other Potential Confounders

Tables III.3.1 - III.3.9 give the distributions of cases and controls according to important potential confounders either not included or not described in detail in the prior tables on demographic characteristics and occupational exposures.

Among the lung cancer population (Table III.3.1), 93.6% of cases vs. 66.1% of controls reported a history of regular cigarette smoking and a greater proportion of cases than controls smoked more than 20 pack-years (84.8% vs. 68.8%). There were no important differences between cases and controls with respect to pipe and cigar smoking or ever living with someone who regularly smoked.

Among the breast cancer population (Table III.3.2), twice as many cases as controls reported that their mother or sister had breast cancer (8.6% vs. 4.2%). Cases were also about four times as likely to report a history of benign breast cysts, nodules, and fibrocystic disease. 3.4% of the breast cancer cases reported that this was their second episode of breast cancer as compared to 6.0% of controls who reported a history of breast cancer before the index year.

In addition, more breast cancer cases than controls were nulliparous (13.1% vs. 11.7%), delivered their first live- or stillbirth over the age of 30 (20.3% vs. 17.9%), experienced menarche at less than 13 years of age (37.0% vs. 29.0%), used hormones for menopausal symptoms (26.4% vs. 24.2%), diethylstilbestrol (DES) during a pregnancy (5.0% vs. 3.8%), oral contraceptives (18.4% vs. 11.6%), and had medical treatment with ionizing radiation prior to their diagnosis date or index year (11.3% vs. 8.4%). Slightly fewer breast cancer cases than controls had experienced either surgical or natural menopause (overall 90.0% of cases vs. 92.6% of controls). While among menopausal subjects, cases and controls tended to experience menopause at a similar age. Slightly more breast cancer cases than controls reported ever drinking alcoholic beverages (85.2% vs. 80.4%, Table III.1.3). Lastly, fewer cases than controls were considered obese on the basis of a Quetlet Index (weight/height2) greater than 25.

Among the colo-rectal cancer population (Table III.3.3), slightly fewer cases than controls reported ever drinking alcoholic beverages such as wine, beer and liquor (83.8% vs. 85.9%). However, a greater proportion of cases than controls drank alcoholic beverages for more than 40 years (49.8% vs. 43.7%) and were more likely to be almost daily drinkers during their drinking years (32.8% vs. 23.9%). Cases were also more likely than controls to consume only liquor or only beer.

As regards relevant medical conditions, a greater proportion of colo-rectal cancer cases than controls had a history of familial polyposis (40.9% vs. 8.4%), inflammatory bowel disease (10.6% vs. 3.6%), and ulcerative colitis (5.2% vs. 3.9%). Cases were also more likely than controls to have a family history of colo-rectal cancer (8.8% vs. 6.1%).

Among the bladder cancer population (Table III.3.4), 88.7% of cases vs. 66.7% of controls reported that they had been regular cigarette smokers and a greater portion of cases than controls smoked more than 20 pack-years (78.0% vs. 71.8%). More cases than controls were also regular pipe smokers (16.1% vs. 10.1%) but about the same percent were regular cigar smokers (8.2% vs. 8.0%). Fewer cases than controls reported ever having lived with a smoker (63.8% vs. 75.7%).

95.0% of bladder cancer cases and 91.8% of controls were ever regular coffee drinkers and cases tended to drink more cups of coffee per day during their adult lives. As regards related medical conditions, about two to three times as many cases as controls reported a history of bladder infections (58.6% vs. 20.5%) and kidney or urinary bladder stones (15.3% vs. 8.3%).

Among the kidney cancer population (Table III.3.5), 74.3% of cases and 66.9% of controls had ever regularly smoked cigarettes and a greater proportion of cases than controls smoked more than 20 pack-years (83.3% vs. 69.6%). More cases also smoked cigars regularly (8.6% vs. 6.3%) and a greater proportion of the cases smoked more than 20 cigar-years (100% vs. 59.5%). Fewer cases were ever regular pipe smokers (5.7% vs. 9.9%) and reported ever living with a smoker (73.5% vs. 75.9%).

Eighty-eight point two percent (88.2%) of kidney cancer cases vs. 91.9% of controls were ever regular coffee drinkers, and cases and controls drank about the same amount of coffee per day during their adult lives. Lastly, a much larger proportion of kidney cancer cases as controls reported a history of kidney infections (45.2% vs. 10.2%) and kidney or bladder stones (19.4% vs. 8.8%).

Among the pancreas cancer population (Table III.3.6), fewer cases than controls ever regularly smoked cigarettes (51.4% vs. 65.6%) and the cases tended to be lighter smokers. A history of regular pipe smoking was also less common among cases (2.7% vs. 7.1%) while regular cigar smoking was slightly more common (5.4% vs. 3.3%).

A smaller proportion of pancreatic cancer cases than controls ever drank alcoholic beverages (73.0% vs. 84.6%), and the number of years cases and controls had drank was similar. During their drinking years, cases were more likely than controls to be either almost daily drinkers or infrequent drinkers (less than a few times a month). While regular coffee drinking was similar among cases and controls (91.7% vs. 92.6%), cases tended to drink fewer cups per day during their adult lives.

Lastly, 14.7% of the pancreatic cancer cases vs. 11.8% of controls reported a history of diabetes and a slightly greater proportion of cases than controls were considered obese on the basis of a Quetlet index greater than 25 (22.6% vs. 19.2%).

Among the leukemia population (Table III.3.7), 2.9% of cases vs. 10.1% of controls reported prior medical treatment with ionizing radiation such as radiotherapy for a prior cancer, x-ray, cobalt treatment or radioisotopes for the treatment of malignant or non-malignant conditions.

Since brain and liver cancer were added to the study population after the questionnaire had been finalized and interviewing begun, we obtained data on only a few potential confounders that were already included in the interview (Tables III.3.8 and III.3.9). A history of diabetes was reported by 13.9% of the brain cancer cases and 12.6% of their controls. No brain cancer cases mentioned a prior history of breast cancer or a family history of brain cancer.

All of the liver cancer cases and 94.0% of their controls reported that they drank alcoholic beverages and a greater proportion of cases than controls drank for 40 years or more (66.7% vs. 47.1%), at least a few times a week (100% vs. 65.1%), and only liquor (0.0% vs. 62.2%). None of the liver cancer cases and controls had ever used oral contraceptives since they were all males.

B. Length and Calendar Years of Residence on the Upper Cape

We first examined the length and calendar years of residence among cases and controls to determine if these variables were related to cancer risk (Tables III.4.1 to III.4.12). With the exception of the leukemia population, the frequency distribution of length of residence was similar among cases and controls. Among all cases and controls, similar proportions of cases and controls lived on the Upper Cape for 20.5 to 30 years (9.2% vs. 11.3%) and for more than 30 years (23.3% vs. 22.0%). The mean length of residence on the Upper Cape was also similar: 17.1 years for all cases and 16.8 years for all controls. Among the leukemia population, however, more cases than controls lived on the Upper Cape for more than 30 years (33.3% vs. 22.8%) and the cases' mean length of residence was two years longer than controls (19.4 years and 17.4 years, respectively). These differences were not statistically significant.

When we examined the calendar year that cases and controls first moved to the Upper Cape, we also found that, with the exception of leukemia, similar proportions of cases and controls first moved to the Upper Cape towns in the 1940s, 1950s, 1960s, 1970s, and 1980s. A larger proportion of leukemia cases than controls first moved to the Upper Cape in the 1940s (35.3% of cases vs. 23.2% of controls) and the median year that leukemia cases first moved to the Upper Cape was four years earlier than that of the controls (1966 for cases and 1970 for controls). These differences were not statistically significant.

Smaller differences were seen in the frequency distribution of calendar year first moved among some other cancer sites. The median calendar year that brain cancer cases first moved to the Upper Cape was three years earlier than that of their controls, and the median year that colo-rectal and kidney cancer cases first moved was two years later than their controls. Differences were also observed in duration and calendar years of residence between liver cancer cases and controls; however, they are difficult to interpret since the number of cases is so small.

Most of these results were similar when we took latency into account. That is, cases and controls resided on the Upper Cape for a similar number of years during the period of time preceding the latent period. Among the leukemia and pancreas cancer population, however, cases lived on the Upper Cape for about three years longer than controls when latency was taken into account (mean number of years were 18.8 and 15.8 for leukemia cases and controls and 17.3 and 14.4 for pancreas cases and controls, respectively). These differences were not statistically significant.

Lastly, when length of residence was examined as a continuous variable in a logistic regression analysis (Table III.4.11), the relative risks associated with ten years of residence did not vary substantially from the null (1.0) for all cancers combined or the individual cancer sites (ORs: 0.94 - 1.11). These results were quite similar when confounders were controlled (Adjusted ORs: 0.92 - 1.11, Table III.4.12).

C. Geographic Distribution of Cases' and Controls' Upper Cape Residences

We next examined the geographic distribution of all the Upper Cape residences ever held by the cases and controls (Figures III.1.1 - III.1.20, III.1.25 - III.1.26), and those among long term residents (greater than 20 years and 30 years) (Figures III.1.21 - III.1.24). The 2.5% of residences that did not have sufficient information to be mapped were excluded. Each subject residence was located within one of the 1 km^2 maps squares described previously. In these computer generated maps, the placement of dots within the square is random and does not represent true spatial location within that square.

The maps of the controls indicate the distribution of the source population that gave rise to the cases. When used in conjunction with the maps that represent cases for each site they give a view of how similar or different the patterns of the cases are from the source population. In viewing these maps it is important to remember that there are usually many more controls than cases for any particular site. A formal geostatistical analysis would be needed to determine if any "hot spots" exist.

D. MMR Associated and Non-MMR Groundwater Contamination

Table III.5.1 describes the results of our analysis examining potential exposure to groundwater contamination associated with MMR and non-MMR sources. Subjects were considered exposed if they lived within the delineated plume during the relevant time period.

When the latent period was taken into account, no cases and only a few controls lived within the following plume delineations: Ashumet Valley, MW 603, MMR Landfill, UTES/BOMARC Site (CS 10), AVGAS Dump Site (FS 1), Railroad Fuel Pumping Station (FS 2), Forestdale (FS 12) and Briarwood Neighborhoods, Falmouth and Mashpee Landfills, and the J. Braden Thompson Road Site.

When the latent period was ignored, no cases were potentially exposed to the MW 603, Railroad Fuel Pumping Station (FS 2), Forestdale Neighborhood (FS 12) plumes and only a few cases and controls lived within the plumes delineated at the other sites. Two cases (one breast and one pancreas cancer) and five controls lived within the delineated Ashumet Valley plume. Two cases (one kidney and one lung cancer) and two controls lived within the MMR Landfill plume. Four cases and three controls lived within the UTES/BOMARC plume yielding an odds ratio of 1.65 (95% CI: 0.37 - 7.26). These cases included two lung, one colo-rectal and one pancreas cancer. Two cases (one lung cancer and one leukemia) and one control lived within the AVGAS Dump Site plume. One case (lung cancer) and four controls lived within the FS12/ Forestdale Neighborhood plume. One case (colo-rectal cancer) and three controls lived within the Falmouth Landfill plume and one case (lung cancer) and three controls lived within the Mashpee Landfill plume. Lastly, two cases (one colo-rectal and one brain) and no controls lived within the J Braden Thompson Road Site plume.

The six lung cancer cases and three colo-rectal cancer cases described above as residing within these plume delineations consisted of nine different individuals. When latency was ignored, the crude relative risks of all cancers combined, lung cancer and colo-rectal cancer were 0.78 (95% CI: 0.40 - 1.53), 1.23 (95% CI: 0.52 - 3.18), and 0.56 (95% CI: 0.17 - 1.86), respectively, among individuals who ever lived within a delineated plume. The corresponding adjusted relative risks were 0.73 (95% CI: 0.36 - 1.48), 1.11 (95% CI: 0.42 - 2.96), and 0.39 (95% CI: 0.10 - 1.45), respectively.

E. MMR-Associated and Non-MMR Associated Air Pollution

1. Canal Electric Plant

Tables III.6.1 to III.6.4 describe the results of the crude and adjusted regression analyses that examined the time-integrated SO2 emission concentrations from the PC GEMS model as a proxy for air pollution from the Canal Electric Plant. In these analyses, subjects whose exposure level was at the 75th percentile were compared to those at the 25th percentile. Whether or not latency was taken into account, there were no meaningful or statistically stable increases in the crude relative risk of all cancers combined or the individual cancer sites. For all cancers combined, the relative risk was 0.99 when latency was taken into account (p=0.47) and 1.08 when latency was ignored (p=0.24). All results were quite similar when confounding variables were controlled. For all cancers combined, the adjusted relative risk was 1.00 when latency was taken into account (p=0.85) and 1.09 when latency was ignored (p=0.23).

2. Barnstable Airport

Tables III.7.1 to III.7.24 describe the results of the analyses that examined the Barnstable Airport as a source of air contaminants. An individual was considered exposed if he or she lived within 3 kilometers of the airport. The tables describe the results of the crude and adjusted categorical and exposure metric analyses both with and without taking latency into account.

In the crude categorical analysis, no increase in the risk of all cancers combined was seen for subjects who lived within 3 kilometers of the airport. The odds ratio was 0.96 (95% CI: 0.73 - 1.27) when latency was taken into account and 0.95 (95% CI: 0.77 - 1.18) when latency was ignored. The risk of all cancers combined did not vary much with exposure duration or distance but did vary with direction.

Living in a southerly direction from the airport was not associated with any increases in risk but living northwest of the airport was associated with a 2.7-fold increased risk (95% CI: 0.98 - 7.49). (Most subjects lived in the southerly direction.) When the exposure metric was used to combine the distance, duration, and direction data, no increase in the risk of all cancers combined was seen (OR: 1.01 with latency and 1.00 without latency).

In parallel site-specific analyses, a modest but statistically unstable increase in the crude relative risk of brain was seen among subjects who ever lived within 3 kilometers of the airport. The relative risk of brain cancer for exposed subjects was 1.63 (95% CI: 0.66 - 3.99) with latency and 1.51 (95% CI: 0.72 - 3.17) without latency. There did not appear to be any trends in brain cancer risk with exposure duration or distance. The majority of the brain cancer cases and controls lived southwest of the airport. Reflecting this lack of trend, the increased risk of brain cancer disappeared when the exposure metric was used. The relative risks were 0.93 (p=0.80) and 0.96 (p=0.79) when exposed subjects at the 75th percentile were compared to unexposed subjects with and without the latent period, respectively.

No meaningful increases in the risk of the other cancer sites were seen among subjects who ever lived within 3 kilometers of the airport. Variations in risk of these other cancers with duration and distance were not or could not be observed due to sparse data. Living northwest of the airport was associated with modest but statistically unstable increases in the risk of breast, lung, and colo-rectal cancer.

The results of the adjusted analyses were quite similar. Modest but statistically unstable increases in the risk of brain cancer were seen for subjects who ever lived within 3 kilometers of the airport when latency was taken into account (OR: 1.62, p=0.31) and when it was ignored (OR: 1.50, p=0.30) but these risks fell to 1.01 (p=0.97) and 1.00 (p=0.99), respectively, when the exposure metric was used. No meaningful increases in the adjusted relative risks were seen for all cancers combined or for the other cancer sites.

3. MMR Runways

Tables III.8.1 to III.8.20 describe the results of the crude and adjusted analyses examining the MMR runways as a source of air contaminants. Exposed was defined as living within 3 kilometers of the nearest runway. The tables describe the results from the crude and adjusted categorical and exposure metric analyses both with and without taking latency into account.

When latency was taken into account in the categorical analysis, a similar proportion of all cases and controls had lived within 3 kilometers of the MMR runways (OR: 0.99, 95% CI: 0.39 - 2.50). Only the breast and colo-rectal cancer sites had a sufficient number of ever exposed cases to permit calculation of relative risks (ORs: 1.33 and 1.12, respectively), and the data were generally too sparse to examine duration, distance, and direction to exposure. However, modest statistically unstable increased risks were observed for all cancers combined among individuals who lived southwest of the MMR runway (OR: 1.85, 95% CI: 0.32 - 10.8), and for colo-rectal cancer among individuals who lived from 2 to 3 kilometers away (OR: 1.87, 95% CI: 0.48 - 7.37). A statistically unstable two-fold increased risk of breast cancer was also seen when exposed subjects whose metric was at the 75th percentile were compared to unexposed subjects (OR: 2.02, p=0.19).

When latency was ignored, the results for all cancers combined were similar (OR: 1.24 for ever exposed and OR: 0.95 for the exposure metric). However, a four-fold increased risk of brain cancer was seen for subjects who ever lived within 3 kilometers of the MMR runways (OR: 4.21, 95% CI: 0.98 - 13.56). All four exposed brain cancer cases were exposed for 10 years or less (OR: 7.66, 95% CI: 1.67 - 27.50) and three of the four lived northeast of the runways (OR: 12.60, 95% CI: 1.86 - 67.52).

When the exposure metric was used, however, the relative risk for brain cancer fell to 1.22 (p=0.68).

The adjusted odds ratios were quite similar to the crude odds ratios when confounding variables were controlled; most were slightly diminished. When latency was taken into account, the adjusted relative risk of breast cancer was 2.15 (p=0.17) using the exposure metric. When latency ignored, the adjusted relative risk of brain cancer was 3.98 (p=0.02) when the exposure was categorized as Ever/Never and 1.15 (p=0.82) when the exposure metric was used.

4. MMR Fire Training Areas

Tables III.9.1 to III.9.64 describe the results of the analyses that considered the MMR fire training areas (FTAs) as sources of air pollution. They describe the findings from crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. Initially, an individual was considered exposed if he or she ever lived within 3 kilometers of a FTA and the exposure window was limited to the years of operation (referred to as the usual exposure window). At the request of the Community Advisory Board, additional analyses were conducted that extended both the exposure definition to include residences within 9 kilometers of the FTAs, and the exposure window through the end of the study period (referred to as the extended exposure window). The potential for exposure after the operation of the sites was assumed to be the same as during its operation.

a. Crude Categorical Analysis: Exposure <=3 kilometers

Very few subjects were considered exposed when the exposure was defined as ever having a residence within 3 kilometers of the FTAs using either the usual or extended exposure window. When the latent period was taken into account, four cases and two controls were considered exposed with the usual exposure window and the crude relative risk of all cancers combined was 2.47 (95% CI: 0.48 - 12.80). Exposed cases included two individuals with breast cancer, and one each with colo-rectal and brain cancer. When the exposure window was extended, four cases and four controls were considered exposed and the crude relative risk of all cancers combined fell to 1.23 (95% CI: 0.31 - 4.94).

When the latent period was ignored, 9 cases and 15 controls were considered exposed with the usual exposure window and the crude relative risk of all cancers combined was 0.74 (95% CI: 0.32 - 1.69). The nine cases included three breast, two colo-rectal, and one each of lung, pancreas, kidney and brain cancer. The crude relative risk of breast cancer among these exposed subjects was not elevated (OR: 0.88, 95% CI: 0.24 - 3.28). When the exposure window was extended, 12 cases and 19 controls were considered exposed and the crude relative risks of all cancers combined and breast cancer were 0.78 (95% CI: 0.38 - 1.60) and 0.66 (95% CI: 0.19 - 2.33), respectively. Not calculated previously, the crude relative risk of lung cancer was 0.73 (95% CI: 0.22 - 2.47).

b. Crude Categorical Analysis: Exposure <=9 kilometers

When the exposure definition was extended to include residences up to 9 kilometers from a FTA, many more cases and controls were considered ever exposed. When the latent period was considered, no meaningful increases were seen in the crude relative risk of all cancers combined or any of the individual cancer sites using either exposure window (ORs ranged from 0.84 to 1.28).

However, when duration of exposure was examined, the crude relative risks of lung and breast cancer and leukemia appeared to be increased among individuals who were exposed for longer periods of time. When latency was considered and the years of operation defined the exposure window, the relative risk of lung cancer was 1.56 (95% CI: 0.83 - 2.95) among subjects exposed for 10.5 to 20.0 years. The relative risk associated with more than 20 years of exposure was not calculated since there was only one exposed lung cancer case. When the exposure window was extended, the crude relative risk of lung cancer for subjects exposed from 10.5 to 20 years was not calculated (since there was only one exposed case) and the risk of more than 20 years of exposure fell to 1.27.

An unstable modest increase in the crude risk of breast cancer was seen among subjects exposed for more than 20 years when the exposure window was extended (OR: 1.46). There were too few exposed breast cancer cases when the actual years of operation defined the exposure window. A statistically unstable 3.19-fold increase in the crude risk of leukemia was seen among subjects exposed for 10.5 to 20.0 years when the years of operation defined the exposure window (95% CI: 0.75 - 10.09). This risk fell to 1.52 among individuals exposed for more than 20 years when the years of operation were extended (95% CI: 0.57 - 4.05).

The crude relative risk of all cancers combined did not increase as distance to the FTAs decreased nor was any particular direction associated with a meaningful risk increase. Among the individual cancer sites, there were often too few exposed cases in the distance subcategories to estimate relative risk. When they could be calculated, no trends with distance were apparent for either exposure window but rather the relative risks bounced up and down and were statistically unstable.

When the direction of a subject to a FTA was examined, statistically unstable increases were seen in the risk of bladder cancer associated with living southeast and southwest of a FTA, and leukemia and brain cancer associated with living in a southwest direction (ORs ranged from 1.75 to 2.64 for both exposure windows).

When latency was ignored, there were no meaningful increases in the crude risk of all cancers combined and no trends were seen with duration, distance, or direction. With the exception of leukemia, there were also no meaningful increases in the risk of the individual cancer sites among subjects who ever resided within 9 kilometers of a FTA.

Modest unstable increases in the risk of leukemia were seen among ever exposed subjects when latency was ignored and either the usual and extended exposure windows were considered (OR: 1.68, 95% CI: 0.84 - 3.36 and OR: 1.55, 95% CI: 0.78 - 3.06, respectively). The data also suggested that leukemia risk was further increased among subjects who were exposed for longer periods of time. When the usual exposure window was used, the relative risk of leukemia was 2.57 (95% CI: 0.88 - 7.53) among subjects exposed for 10.5 to 20.0 years. There were too few cases exposed for more than 20 years to estimate risk. When the exposure window was extended, the relative risks were 3.37 (95% CI: 1.05 - 9.17) among subjects exposed for 10.5 to 20.0 years and 1.57 (95% CI: 0.66 - 3.74) among subjects exposed for more than 20 years. The number of exposed leukemia cases was generally too small to estimate the relative risk for many of the distance and direction categories. Risks that were calculated were generally elevated (ORs: 1.39 - 7.34).

Among the other cancer sites, there were no trends in crude risk according to distance from a FTA. As regards direction, there were some elevations for breast and brain cancer and the south and northeast directions, respectively.

c. **Crude Exposure Metric Analysis**

When the distance, duration, and direction data were combined into a single metric, there were no meaningful increases in the crude risks of all cancers combined or the individual cancers whether or not latency was taken into account (ORs: 0.67 - 1.13). Compared to unexposed subjects, the relative risks of leukemia among exposed subjects whose exposure metric was at the 75th percentile were 1.02 and 1.03, respectively, with and without latency.

d. **Adjusted Analysis**

When confounders were controlled, the adjusted relative risk of all cancers combined was not elevated among subjects who ever lived within 9 kilometers of a FTA. Among ever exposed subjects, the adjusted relative risks of leukemia were 1.21 (p=0.65) and 1.69 (p=0.15), respectively, with and without latency and using the exposure metric, they fell to 1.04, both with and without latency.

5. **Barnstable Fire Training Area**

Tables III.8.1 to III.8.20 describe the results of the analyses that examined the Barnstable Fire Training Area as a source of air contaminants. They describe the results of the crude and adjusted categorical and exposure metric analyses both with and without taking latency into account. An individual was considered exposed if he lived within 3 kilometers of the training area.

In the crude categorical analysis, no increases in the risk of all cancers combined was seen for subjects who lived within 3 kilometers of the fire training area whether or not latency was taken into account (ORs: 0.93 and 0.90, respectively). The risk of all cancers combined did not vary much with exposure duration or distance but did vary with direction. A greater proportion of cases than controls lived northwest and northeast of the site. However, when the exposure metric was used to combine the distance, duration, and direction data, no increases in the risk of all cancers combined was seen (OR: 0.98 and 0.96, with and without latency, respectively).

In the site-specific analyses, there was a modest but statistically unstable 1.6-fold increase in the risk of leukemia associated with living within 3 kilometers of the area when latency was taken into account (OR: 1.59, 95% CI: 0.60 - 4.20). The risk fell to 1.23 when latency was ignored (95% CI: 0.47 - 3.25). The data were generally too sparse to examine trends in leukemia risk for categories of exposure duration, distance, or direction; however, the relative risks of leukemia fell to 1.05 (p=0.91) and 1.02 (p=0.97), respectively, when the exposure metric combined these data.

No meaningful increases in the risk of the other cancers were seen among subjects who ever lived within 3 kilometers of the fire training area; and when the data were sufficient, no striking trends in risk were seen with duration and distance. When latency was ignored, statistically unstable increases in the risk of breast, lung, colo-rectal, and kidney cancer were associated with living in certain directions from the fire training area. Northerly directions were most often associated with the risk increases.

No associations were generally seen for the individual cancer sites when the exposure metric combined these data; however, a modest statistically unstable increase in the risk of kidney cancer was observed both when latency was taken into account and ignored (OR: 1.57, p=0.50 and OR: 1.46, p=0.40, respectively).

The results of the adjusted analysis were quite similar to those of the crude analysis. No increased risk was observed for all cancers combined either when the exposure was categorized or the metric was used. An unstable increase in the relative risk of leukemia was present among subjects who ever lived within 3 kilometers of the site only when latency was taken into account (OR: 1.42, p=0.49). No increases in the risk of leukemia were seen when the categorical analysis ignored latency (OR: 1.07) and when the exposure metric was used (ORs: 1.00 and 0.95 with and without latency). The adjusted relative risk of kidney cancer remained modestly increased but statistically unstable both in the categorical (OR: 1.88, p=0.34 and OR: 1.21, p=0.74) and combined metric analyses (OR: 1.89, p=0.35 and OR: 1.71, p=0.24) with and without latency.

6. MMR Propellant Bag Burning at Gun and Mortar Positions

Tables III.11.1 to III.11.25 describe the results of the analyses that considered propellant bag burning at the MMR gun and mortar positions as a source of air pollution. They describe the findings from crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. An individual was considered exposed if he ever lived within 3 kilometers of any gun and mortar position during the relevant time period.

When latency was taken into account, no increase was seen in the crude relative risk of all cancers combined among subjects who ever lived within 3 kilometers of a gun or mortar position (OR: 1.07, 95% CI: 0.73 - 1.57). However, when the individual cancer sites were examined, modest but unstable increases in the risk of breast, lung, and pancreatic cancer were seen.

Specifically, a 1.46-fold increase in the risk of breast cancer was seen among ever exposed subjects (95% CI: 0.72 - 2.99) that appeared to be directly related to the duration of exposure. The relative risks of breast cancer associated with 10.0 or less, 10.5 to 20.0, and more than 20 years of exposure were 1.12, 1.61 and 2.15, respectively. In addition, compared to those who lived more than three kilometers away, breast cancer risk was increased among those who lived from 1,001 to 2,000 meters from a position (OR: 1.92, 95% CI: 0.61 - 5.98) but not among those who lived from 2,001 to 3,000 meters away (OR: 1.25, 95% CI: 0.51 - 3.10). No breast cancer cases or controls lived less than 1,001 meters from a gun or mortar position. Lastly, the risk of breast cancer was increased among subjects who lived northeast of a position (OR: 2.42, 95% CI: 0.99 - 5.86). None of these risk increases were statistically significant.

While the crude risk of lung cancer was not increased among subjects who had ever lived within 3 kilometers of a gun or mortar position (OR: 1.2), it was increased among subjects who were exposed for more than 20 years (OR: 2.48, 95% CI: 0.83 - 6.64) and those who lived from 1,001 to 2 kilometers from a position (OR: 1.75, 95% CI: 0.69 - 4.43). Similar increases in risk were seen when men and women were examined separately.

There was also a 1.8-fold statistically unstable increase in the crude risk of pancreatic cancer among subjects who ever lived within 3 kilometers of a gun or mortar position (95% CI: 0.50 - 6.20). Since there were only three exposed pancreatic cancer cases, trends in risk could not be examined by duration, distance, and direction. However, all three exposed cases lived between 2 and 3 kilometers from a gun or mortar position and the relative risk of pancreatic cancer was 2.8 for individuals in this distance category (95% CI: 0.80 - 9.40). No increases in risk were seen for the other cancer sites; generally there were too few exposed cases to calculate odds ratios.

When the latent period was ignored, the increases in the crude risk of breast cancer remained for individuals who were exposed for more than 20 years and lived 2-3 kilometers from a position (OR: 2.44, 95% CI: 0.86 - 6.77, and OR: 1.90, 95% CI: 0.95 - 3.78, respectively). The risk associated with living northeast of a position was slightly diminished (OR: 1.63, 95% CI: 0.89 - 2.96) as was the risk of lung cancer among individuals who were exposed for more than 20 years (OR: 1.76, 95% CI: 0.82 - 3.76) and lived from 1,001 to 2 kilometers away from a position (OR: 1.56, 95% CI: 0.81-.3.01). However, a 2-fold unstable increase in risk of lung cancer emerged in association with living southeast of a site (95% CI: 0.79 - 5.19). The crude risk of pancreatic cancer among ever exposed subjects fell to 1.34 when latency was ignored (95% CI: 0.51 - 3.56).

When the distance, duration and direction data were combined into a single metric, modest unstable increases in the crude risk were observed that were similar in magnitude to that seen among ever exposed subjects. When latency was taken into account, exposed subjects whose metric was at the 75th percentile had a 1.38-fold increased risk of breast cancer (p=0.40), a 1.35-fold increased risk of lung cancer (p=0.34) and a 1.88-fold increased risk of pancreatic cancer (p=0.28) compared to unexposed subjects. When latency was ignored, the relative risks were 1.28 (p=0.18), 1.19 (p=0.25), and 1.24 (p=0.48), respectively.

When confounding factors were taken into account in the categorical analysis, the adjusted relative risk of breast cancer among subjects who ever lived within 3 kilometers of a gun or mortar position was similar to the crude relative risk (Adjusted ORs: 1.50 and 1.39, respectively, with and without latency). The corresponding adjusted relative risks for lung and pancreas cancer fell slightly to 1.17 and 1.08, and 1.64 and 0.88, respectively, with and without latency. None of these risk estimates were statistically significant.

When confounders were controlled in the exposure metric analysis, the adjusted relative risks of breast cancer rose slightly to 1.61 (p=0.23) and 1.36 (p=0.10) respectively, with and without latency. The adjusted relative risks of lung cancer remained relatively unchanged at 1.39 (p=0.37) and 1.12 (p=0.51), and the adjusted relative risks of pancreas cancer fell to 1.40 (p=0.63) and 1.07 (p=0.86), respectively.

7. MMR UTES/BOMARC Site (CS10)

Tables III.12.1 to III.12.50 describe the results of the analyses that considered the MMR UTES/BOMARC site (CS10) as a source of air pollution. They describe the findings of the crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. Initially, an individual was considered exposed if he ever lived within 2 kilometers of the site and the exposure window was limited to the years of operation (referred to as the usual exposure window). At the request of the Community Advisory Board, additional analyses were conducted that extended both the exposure definition to include residences within 9 kilometers of the site, and the exposure window through the end of the study period (referred to as the extended exposure window). The potential for exposure after the operation of the site was assumed to be the same as during its operation.

a. Crude Categorical Analysis: Exposure <=2 kilometers

Very few cases and controls were considered exposed when the exposure was defined as ever having a residence within 2 kilometers of the site using either the usual or extended exposure window. When the latent period was taken into account, no cases and one control were considered exposed both with the usual and extended exposure windows. When the latent period was ignored, 5 cases and 3 controls were considered exposed with either the usual or extended exposure window and the crude relative risk of all these cancers combined was 2.06 (95% CI: 0.51 - 8.38). Of the five exposed cases, two had lung cancer, two had colo-rectal cancer, and one had pancreas cancer.

b. Crude Categorical Analysis: Exposure <=9 kilometers

When the exposure definition was extended to include residences up to 9 kilometers from CS10, many more cases and controls were considered ever exposed. However, when the latent period was considered, no meaningful increases were seen in the crude relative risk of all cancers combined using either exposure window (ORs were both 1.10). When the individual cancer sites were examined, modest unstable increases in the risk of breast (OR: 1.48, 95% CI: 0.82 - 2.66) and pancreas cancer (OR: 1.60, 95% CI: 0.47 - 5.44) were seen among ever exposed subjects both with the usual and extended exposure windows. No trends were seen with duration of exposure for all sites combined or, when they were calculated, for the individual cancer sites.

When the latent period was taken into account, very few study subjects ever lived within 5 kilometers of the UTES/BOMARC site and relative risks were not calculated for these distance categories. The relative risk of all cancers combined tended to be higher for the distance categories 5 - 6 and 6 - 7 kilometers (ORs: 2.17 and 1.86) than for 7 - 8 and 8 - 9 kilometers (ORs: 0.78 and 1.53). Among the individual cancer sites, there were often too few exposed cases in the distance subcategories to estimate relative risk. No trends were apparent when they could be calculated.

When the subject's direction to the UTES/BOMARC site was examined, unstable increases in the risk of breast and lung cancer were associated with living southwest of the site (OR: 5.41, 95% CI: 0.76 - 60.02 and OR: 1.78, 95% CI: 0.57 - 5.56, respectively), and increases in bladder cancer risk were associated with living northwest (OR: 1.93, 95% CI: 0.57 - 6.49).

When latency was ignored, there were also no increases in the crude risk of all cancers combined using either exposure window (ORs: 0.97 and 0.96, respectively). When the actual years of operation were used to define the exposure window, there was 2.04-fold statistically unstable increase in the risk of all cancers combined among subjects who were exposed for more than 20 years (95% CI: 0.49 - 8.58) that fell to 1.43 (95% CI: 0.82 - 2.48) when the exposure window was extended. No trends among all cancers combined were apparent for distance or direction.

With the exception of modest unstable increases in the risk of pancreas and brain cancer, there were also no meaningful increases in the risk of the individual cancer sites among subjects who ever resided within 9 kilometers of the UTES/BOMARC site. When latency was ignored, the relative risk of pancreas cancer was 1.54 (95% CI: 0.69 - 3.46) with the usual exposure window and 1.52 (95% CI: 0.68 - 3.42) with the extended exposure window. The corresponding relative risks for brain cancer were 1.58 (95% CI: 0.73 - 3.41) and 1.56 (95% CI: 0.72 - 3.38), respectively. Trends in risk with duration, distance, and direction were difficult to examine since often there were too few exposed cases in the categories to estimate risk. However, living southeast of the UTES/BOMARC site was associated with an increase in pancreas cancer risk (OR: 3.37, 95% CI: 0.78 - 10.84) for the usual exposure window) and living in southeast and northeast were associated with increases in the risk of brain cancer (ORs: 3.54, 95% CI: 0.83 - 11.30 and OR: 1.77, 95% CI: 0.52 - 6.00, respectively, for the usual exposure window).

Among the remaining cancer sites, there were generally no meaningful trends in crude risk according to distance. An unstable 2.31-fold increase in the risk of breast cancer was seen for subjects living 5 - 6 kilometers from the site (95% CI: 0.90 - 5.90). As regards direction, there were modest elevations for breast and bladder cancer and the southwest and northeast directions (ORs: 1.56 and 1.62, respectively). Lastly, there was a statistically unstable 4.2-fold increase in the risk of leukemia associated with living southwest of the site (95% CI: 0.73 - 16.04).

c. Crude Exposure Metric Analysis

When the distance, duration, and direction data were combined into a single metric, there were no meaningful increases in the crude risks of all cancers combined or the individual cancers whether or not latency was taken into account (ORs: 0.42 - 1.02).

d. Adjusted Analysis

When confounders were controlled, the adjusted relative risk of all cancers combined remained unelevated among subjects who ever lived within 9 kilometers of the UTES/BOMARC site (ORs: 1.06 and 0.96 with and without latency). Nor were there meaningful or statistically stable increases in the adjusted risk of the individual cancer sites among these ever exposed subjects. The largest increases in risk were seen for pancreas and brain cancer when latency was ignored (OR: 1.61, p=0.30 and OR: 1.68, p=0.20, respectively) When adjusted analyses were conducted using the exposure metric, the relative risks comparing exposed subjects at the 75th percentile to unexposed subjects were all below the null (1.0).

8. MMR AVGAS Dump Site (FS1)

Tables III.13.1 to III.13.53 describe the results of the analyses that considered the MMR AVGAS dump site (FS1) as a source of air pollution. They describe the findings from crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. Since the AVGAS dump site ceased operation in 1969, results with and without latency were often very similar.

Initially, an individual was considered exposed if he ever lived within 2 kilometers of the site and the exposure window was limited to the years of operation (referred to as the usual exposure window). At the request of the Community Advisory Board, additional analyses were conducted that extended both the exposure definition to include residences within 9 kilometers of the site, and the exposure window through the end of the study period (referred to as the extended exposure window).

a. Crude Categorical Analysis: Exposure <=2 kilometers

Very few cases and controls were considered exposed when the exposure was defined as ever having a residence within 2 kilometers of the site using either the usual or extended exposure window. When the latent period was taken into account, one breast cancer case and two controls were considered exposed with either exposure window.

When the latent period was ignored, the results were identical with the usual exposure window. When the window was extended, 5 cases and 3 controls were considered exposed and the crude relative risk of these cancers combined was 2.06

(95% CI: 0.51 - 8.38). The exposed cases were comprised of two individuals with colo-rectal cancer, and one individual each with leukemia, breast, and brain cancer.

b. Crude Categorical Analysis: Exposure <=9 kilometers

When the exposure definition was extended to include residences up to 9 kilometers from the AVGAS dump site, a much larger number of cases and controls were considered ever exposed. However, when the latent period was considered, the relative risk of all cancers combined was decreased among ever exposed subjects using either exposure window (ORs 0.82 and 0.88, respectively). Leukemia was the only cancer site for which there was an unstable 2.12-fold elevation in risk that was present only with the usual exposure window (95% CI: 0.81 - 5.57). The relative risk of leukemia fell to 0.96 when the window was extended.

Among all cancers combined, there were no meaningful trends in crude risk as duration increased or distance decreased. Nor were any directions associated with meaningful increases in risk. Among the individual cancer sites, there were often too few exposed cases in the duration, distance, and direction subcategories to estimate relative risk. No trends were apparent when they could be calculated. When the usual exposure window was used, two of the five exposed leukemia cases were exposed for 0.5 - 10.0 years (OR not calculated) and three were exposed for 10.5 - 20.0 years (OR: 2.60, 95% CI: 0.78 - 8.67). These cases shifted to longer durations when the exposure window was extended (ORs not calculated). Three of the five exposed leukemia cases lived 7 - 8 kilometers from the site.

When latency was ignored, the crude relative risk of all cancers combined remained decreased using either exposure window (ORs: 0.83 and 0.92, respectively), and there were no meaningful trends in overall cancer risk with duration, distance, or direction. With the exception of leukemia and brain cancer, there were also no meaningful increases in the relative risk of individual cancers among subjects who ever resided within 9 kilometers of the AVGAS dump site. When latency was ignored, the relative risk of leukemia was an unstable 2.12 (95% CI: 0.81 - 5.57) with the usual exposure window and fell to 1.10 (95% CI: 0.47 - 2.57) with the extended window. The relative risk of brain cancer was not calculated using the usual exposure since there were only two exposed cases but it was an unstable 1.56 (95% CI: 0.74 - 3.29) when the window was extended.

There were generally too few exposed cases to estimate risk for most duration, distance, and direction subcategories for these two cancer sites although the data suggested that the risk of leukemia was increased with increasing duration of exposure. As seen previously when the latent period was considered, several exposed leukemia cases resided 7 - 8 kilometers from the site. When the exposure window was extended, 5 of the 10 exposed brain cancer cases lived northeast of the site (OR: 3.06, 95% CI: 0.86 - 8.74). Among the remaining cancer sites, there were generally no meaningful trends in crude risk according to distance. As regards direction, there was a modest unstable elevation in the risk of lung cancer associated with living northwest of the site that was present only with the extended exposure window (OR: 1.53, 95% CI: 0.74 - 3.15)

c. **Crude Exposure Metric Analysis**

When the distance, duration, and direction data were combined into a single metric, the crude risk of all cancers combined was slightly decreased whether or not the latent period was taken into account (ORs: 0.98 and 0.99, respectively). However, a 1.62-fold statistically unstable increase in the crude risk of leukemia was seen when exposed subjects at the 75th percentile were compared to unexposed subjects both with and without latency (p=0.19). No meaningful elevations in risk were seen for the other cancer sites.

d. **Adjusted Analysis**

When confounders were controlled, the adjusted relative risk of all cancers combined remained decreased among subjects who ever lived within 9 kilometers of the AVGAS dump site (ORs: 0.86 and 0.88, respectively, with and without latency). There was a 2.24-fold unstable increase in the adjusted relative risk of leukemia among ever exposed subjects whether or not the latent period was taken into account. When adjusted analyses were conducted using the exposure metric, the relative risk of leukemia was 1.58 when exposed subjects at the 75th percentile were compared to unexposed subjects both with and without latency (p=0.23). No meaningful elevations in the adjusted relative risks were seen for the other cancer sites.

9. **MMR Storm Drains**

Table III.14.1 describes the results of our analysis examining the study subjects' potential exposure to air emissions from MMR storm drains 1, 2, 4, and 5. Subjects were considered exposed if they lived within 2 kilometers of a drain during the relevant time period. When the latent period was taken into account, no cases and at most one control were considered exposed to any of the drains. When the latent period was ignored, only one case was considered exposed to storm drains 1, 2 and 4, and no cases were exposed to storm drain five. The case exposed to each storm drain was a single individual who had lung cancer. This person lived between 1,001 meters and 2 kilometers south of the drains and was potentially exposed for less than 10.5 years. The lung cancer case that was considered exposed to the storm drains was also exposed to FS3 but not FS2.

10. **MMR Railway Fuel Station (FS2)**

Table III.14.2 describes potential air emissions from the MMR Railway Fuel Station (FS2) using the usual and extended exposure windows. This site operated for only part of the study period (1955 - 1965). An individual was considered exposed if he or she lived within two kilometers of the site.

When the usual exposure window was used, one case of colo-rectal cancer case and no controls lived within 2 kilometers of the site, regardless of whether latency was accounted for. When the exposure window was extended, two cases (one each of lung and colo-rectal cancer) and one control were considered potentially exposed when latency was taken into account and three cases (one each of lung, colo-rectal and kidney cancer) and two controls were exposed when latency was ignored. The latter yielded a statistically unstable 1.85-fold increased risk of the three cancers combined (95% CI: 0.32 - 10.80). All exposed study subjects lived between 1,001 and 2 kilometers northeast or northwest of the site and were potentially exposed for less than 10.5 years.

11. **MMR Johns Pond Road Fuel Dump (FS3)**

Table III.14.2 describes potential air emissions from the MMR Johns Pond Road Fuel Dump (FS3) also using the two exposure windows described above since this site had operated only from 1955 until 1962. When the actual exposure window was used, one breast cancer case and one control lived within 2 kilometers of the site, regardless of whether latency was accounted for. When the exposure window was extended, the same breast cancer case and two controls were considered potentially exposed when latency was taken into account, and three cases (two breast and one lung cancer) and seven controls were considered potentially exposed when latency was ignored. The latter yielded a relative risk of 0.53 for the two types of cancer combined (95% CI: 0.14 - 1.99). Both breast cancer cases lived between 1,001 and 2 kilometers southeast of the site; one was potentially exposed for less than 10.5 years, and the other for more than 20 years. The lung cancer case lived less than 1,000 meters southeast of the site and was potentially exposed for less than 10.5 years.

12. MMR Non-Destructive Inspection Laboratory

When exposure to air emissions from the MMR Non-Destructive Inspection Laboratory (NDIL) was examined, subjects were considered exposed if they lived within 2 kilometers of the site during the relevant time period. When the latent period was taken into account, no cases or controls lived within 2 kilometers of the site; and when the latent period was ignored, only one lung cancer case and four controls lived within this distance. The lung cancer case lived between 1,001 meters and 2 kilometers southwest of the NDIL and was potentially exposed for less than 10.5 years. This case was also the same person who was considered exposed to the storm drains.

F. Other Exposures

1. MMR Base Border

Tables III.15.1 to III.15.50 describe the results of the analyses that considered the proximity to the MMR border as an exposure. They describe the findings from crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. Several analysis were also conducted that examined men and women separately.

Initially, distance was assessed only for residences within 3 kilometers of the border as this was our exposure definition. At the request of the Community Advisory Board, these assessments were extended and additional analyses were conducted. First, the distance of every subject's Upper Cape residence to the border was determined using our computerized UTM map coordinate data. Next, these data were used to conduct categorical analyses that extended the exposure definition to include residences within 11 kilometers. Third, analyses were conducted using the exposure metric developed in conjunction with Dr. Joel Feigenbaum of our Community Advisory Board that took into account the MMR base dimensions, distance, duration, and wind frequency (see methods section for details).

a. Crude Categorical Analysis: Exposure <=3 kilometers

Whether or not the latent period was taken into account, no meaningful increases were seen in the crude risk of all cancers combined or any of the individual cancer sites among subjects who ever lived within 3 kilometers of the MMR border (ORs ranged from 0.41 to 1.14). However, there were modest unstable increases in the crude risks of breast (OR: 1.61, 95% CI: 0.70 - 3.70) and lung cancer (OR: 1.87, 95% CI: 0.93 - 3.76) among subjects who were exposed for more than 20 years when the latent period was considered. These risks were reduced when the latent period was ignored (ORs: 1.34 and 1.10, respectively).

Because similar increases in the risk of breast and lung cancer were seen among subjects exposed for more than 20 years to the gun and mortar positions (when the latent period was considered), we determined the amount of overlap between exposure to the base border and the gun and mortar positions. When the latent period was considered, all subjects except for one control considered exposed to the gun and mortar positions for more than 20 years was also considered exposed to the border. The relative risks of breast and lung cancer among individuals exposed for more than 20 years to only the base border were 1.34 and 1.25, respectively.

The crude risk of all cancers combined did not vary substantially with distance, direction, or proximity to the more industrialized southern or more undeveloped northern portion of the base. (The southern portion of the base was demarcated just north of CS10.) However, modest unstable increases in the crude risks of breast and brain cancer were seen among subjects who lived very close to the border (i.e. within 2 kilometers) only when the latent period was taken into account. The relative risks of breast cancer were 1.53 for subjects who lived up to 1 kilometers from the border (95% CI: 0.64 - 3.67) and 1.64 (95% CI: 0.77 - 3.49) for subjects approximately 1,001 to 2 kilometers away. The relative risk of brain cancer was 2.36 for subjects who lived up to 1,000 meters away (95% CI: 0.70 - 7.94).

In addition, modest unstable increases in the crude risks of lung and bladder cancer were seen among subjects who lived west of the base border only when latency was taken into account (OR: 1.54 and 1.78, respectively); and proximity to the southern industrial portion of the base was associated with a 2.2-fold unstable increase in the risk of brain cancer when the latent period was ignored (95% CI: 0.83 - 5.83).

b. Crude Categorical Analysis: Exposure <=11 kilometers

Whether or not the latent period was taken into account, no meaningful or statistically stable increases in the crude risk were seen for all cancers combined or the individual cancer sites among subjects who ever lived within 11 kilometers of the MMR base border (ORs: 0.67 - 1.69). When duration of exposure was examined, there were no meaningful increases in the risks of breast and lung cancer among subjects with more than twenty years of exposure as was seen when the exposure definition was limited to residences within 3 kilometers. However, a new unstable increase in the crude risk of leukemia was seen among residents with more than 20 years of exposure both with and without latency (ORs: 1.83, 95% CI: 0.81 - 4.15 and OR: 2.09, 95% CI: 0.90 - 4.87, respectively).

The crude relative risk of all cancers combined did not increase as distance to the border decreased nor was overall risk associated with living in any particular direction. Among the individual cancer sites, there were often too few exposed cases in the distance subcategories to estimate relative risk. When they could be estimated, no trends with distance were generally apparent; almost all the distance categories were associated with usually unstable increases in the risk of one or more of the cancer sites. Certain directions were also associated with unstable increases in risk of cancer of the kidney (OR: 1.68 for the east), and bladder (OR: 1.96 for the west), and leukemia (OR: 1.89 for the east) when latency was taken into account, and leukemia (OR: 1.71 for the east and OR: 1.74 for the south) when latency was ignored.

At the suggestion of Dr. Joel Feigenbaum, the crude categorical analyses for all cancers combined, and lung and colorectal cancer were also conducted separately for men and women (Tables 15.45-15.50). No important differences were seen between the sexes except among those exposed for more than 20 years. The relative risks of all cancers combined, lung and colorectal cancer were 0.68, 0.86 and 0.41, respectively, among men and 1.41, 1.36 and 1.34, respectively, among women.

c. Crude Exposure Metric Analysis

When these data were combined into a single exposure metric, no meaningful increases were seen in the crude risk of all cancers combined or the individual cancer sites whether or not the latent period was considered. The odds ratios ranged from 0.81 to 1.19 when subjects whose exposure metric was at the 75th percentile were compared to those at the 25th percentile.

d. Adjusted Analyses

As in the crude categorical analysis, there were no meaningful or statistically stable increases in the adjusted relative risk of all cancers combined or the individual cancer sites among subjects who ever lived within 11 kilometers of the MMR border when confounders were controlled (ORs: 0.61 - 1.47). The same was true when the exposure metric compared subjects at the 75th and 25th percentiles (Adjusted ORs: 0.83 - 1.27).

At the suggestion of Dr. Joel Feigenbaum, two sets of additional adjusted analyses were conducted. The first used the original exposure metric formula and examined the relative risks of certain cancers for men and women separately. This was done to determine if proximity to the MMR border and cancer risk differed for men and women, a phenomenon known as effect modification. The relative risks among men and women, respectively, were 0.70 (p=0.00) and 0.89 (p=0.02) for all cancers combined, 1.02 (p=0.83) and 1.08 (p=0.49) for lung cancer, and 0.78 (p=0.02) and 1.00 (p=0.96) for colorectal cancer.

The second set of analyses paralleled the first but included wind velocity in the exposure metric (see methods section). Using the revised formula, the relative risks among men and women, respectively, were 0.94 (p=0.38) and 1.14 (p=0.01) for all cancers combined, 1.05 (p=0.57) and 1.07 (p=0.53) for lung cancer, 0.78 (p=0.02) and 1.00 (p=1.00) for colorectal cancer.

2. MMR Resident

During the interview, 1.1% of all cases (N=14) and 1.6% of all controls (N=21) stated that they had lived on the MMR sometime during the study period, and the relative risk of all cancers combined associated with MMR residency was 0.82 (95% CI: 0.42 - 1.62). Among the 14 cases, four subjects had lung cancer, seven had colo-rectal cancer, and one each had leukemia, and pancreas and kidney cancer. Living on the MMR was not associated with meaningful increases in the crude risks of lung or colo-rectal cancer (OR: 0.93, 95% CI: 0.32 - 2.74 for lung cancer and OR: 1.39, 95% CI: 0.58 - 3.32 for colo-rectal cancer). Odds ratios were not calculated for the other three sites since each had only one exposed case. The crude relative risks were quite similar when we took latency into account, that is, subjects were considered exposed only if they had lived on the MMR before the relevant latent period (ORs: 0.78, 0.77, 1.39 for all, lung, and colo-rectal cancer, respectively).

The calendar years of residence on the MMR were mainly the 1940s, 50s and 60s but some subjects lived there during the 1970s. The largest proportion of study subjects lived on the reservation during the 1960s. Almost all the cases and controls lived there for less than ten years; the average length of residence was approximately four years.

When confounding variables were controlled, the adjusted relative risks of all cancers combined and lung cancer were relatively unchanged (Adjusted ORS: 0.72 and 0.77 for all cancers combined and 0.65 and 0.87 for lung cancer, respectively, with and without latency); however, the adjusted relative risk of colo-rectal cancer rose to 1.93 (95% CI: 0.72 - 5.20) whether or not latency was considered. Identical results were seen with and without latency since all colo-rectal cancer cases and controls lived on the MMR at least 15 years before their diagnosis or index year.

3. Proximity to Cranberry Cultivation

Tables III.16.1 to III.16.24 describe the results of analyses that examined potential exposure to pesticides as measured by proximity to cranberry bog cultivation. They describe the findings from crude categorical and exposure metric analyses as well as parallel adjusted analyses taking potential confounders into account, all with and without considering the latent period. An individual was considered exposed if he ever lived within 2,600 feet of a bog. When a subject was "exposed" to more than one bog, we analyzed distance and direction of the nearest bog and cumulative acreage of all bogs within 2,600 feet. Duration was cumulated over all exposed residences.

Whether or not the latent period was considered, there was no meaningful increase in the risk of all cancers combined among subjects who ever lived within 2,600 feet of a bog (ORs: 1.10 and 1.11, respectively). Nor were there any trends in overall cancer risk with duration, distance, direction, or total acreage. However, when the latent period was considered, a statistically significant 2.43-fold increase in the risk of brain cancer was seen among exposed subjects (95% CI: 1.04 - 5.27). All of the exposed brain cancer cases lived near a bog for 10 years or less and the relative risk associated with this duration of exposure was 3.91 (95% CI: 1.65 - 8.61). The relative risks associated with 5 or less and 5.5 to 10 years of exposure were 5.86 and 2.07, respectively (95% CIs: 2.69 - 12.74 and 0.61 - 7.00). The relative risk associated with longer duration of exposure was zero. No substantial difference in risk was seen according to total acreage. The relative risks were 3.55 for subjects who lived near bogs whose cumulative acreage was 10 or less, and 3.00 for those near bogs whose cumulative acreage was more than 25. The average acreage of the nearest bog was slightly larger among the brain cancer cases than controls but the difference was not statistically significant (20.2 vs 15.5, $0.10 < p < 0.50$).

Compared to subjects who lived more than 2,600 feet from a bog, the relative risk was 1.63 among subjects who lived within 1,000 feet and 2.92 among subjects who lived from 1,001 to 2,000 feet away. The relative risk among subjects who lived from 2,001 to 2,600 feet away was not calculated since there were only two exposed cases. All but one of the exposed brain cancer cases lived either southeast or southwest of the nearest bog (ORs: 3.34 and 5.85, respectively). There was also no evidence of a dose response relationship between brain cancer risk and the number of bogs within 2,600 feet. The relative risks were 4.02 among subjects near one bog, 1.56 among those near two to three bogs, and 1.80 among those near four or more bogs. The calendar years of bog operation were also similar among exposed cases and controls. Lastly, examination of the histologic type of the exposed brain cancer cases did not reveal any patterns.

When the latent period was ignored, relative risk of brain cancer fell to 1.13 (95% CI: 0.57 - 2.27). In this analysis, however, brain cancer risk did vary directly with duration and acreage. The relative risks were 1.83 and 2.42 among subjects exposed for 10 years or less and 10.5 - 20.0 years, respectively, and 1.22 and 1.83 among subjects near less than 10 and more than 25 cumulative acres, respectively. As seen previously, brain cancer risk did not increase as distance decreased and living in the southeast or southwest was associated with an increased risk (ORs: 1.46 and 2.24, respectively).

Whether or not latency was considered, no meaningful increases in the risk of the other cancers were seen among ever exposed subjects. However, subjects who were exposed for more than 20 years had modest unstable increases in the risk of breast cancer and leukemia both when latency was taken into account (ORs: 1.58 and 1.83 respectively) and when it was ignored (ORs: 1.64 and 1.81, respectively). In addition, living southeast of a bog was associated with increases in the risk of lung cancer and leukemia both when the latency was taken into account and ignored.

Irrespective of the latent period, when the distance, duration, direction, and acreage data were combined into a single metric, the crude relative risk of all cancers combined was not increased (ORs: 1.01 and 1.02, respectively) nor were there increases in the risk of any of the specific cancer sites including brain cancer (OR: 0.97 and 1.04, respectively, with and without latency). When confounders were controlled, the adjusted relative risks were quite similar to the crude relative risks. The adjusted relative risk of all cancers combined among ever exposed subjects were 1.15 and 1.12, respectively, with and without latency. The adjusted relative risk of brain cancer was 2.20 when latency was taken into account and fell to 1.01 when it was ignored. When the exposure metric was used, none of the adjusted relative risks were meaningfully increased (ORs: 0.87 - 1.06).

4. Public Water Supplies

Tables III.17.1 to 17.60 describe the results of analyses that examined the public water supplies as potential sources of contaminant exposure. First, subjects who ever lived at an Upper Cape residence with any public water supply were considered exposed. Then, subjects who were ever supplied with public water in Falmouth (Falmouth Department of Public Works) or Hyannis (Barnstable Water Company), or both were considered exposed. The referent group for the latter analysis included subjects who had never lived at a residence served by either the Falmouth DPW or Barnstable Water Co.

When latency was taken into account, almost a two-fold increased was seen for brain cancer among subjects who ever had an Upper Cape public water supply (OR: 1.98, 95% CI: 0.97 - 4.05). When subjects supplied by water from the Falmouth DPW or Barnstable Water Co. were excluded, this relative risk fell to 1.78 (95% CI: 0.67 - 4.69). No meaningful elevations in risk were seen for any of the other cancer sites.

Increases in the risk of brain cancer were also seen for subjects who were ever supplied with water from either the Falmouth Department of Public Works or the Barnstable Water Company (OR: 1.80, 95% CI: 0.84 - 3.87), Falmouth Department of Public Works only (OR: 1.54, 95% CI: 0.59 - 4.03), and Barnstable Water Company only (OR: 2.14, 95% CI: 0.82 - 5.57). When latency was ignored, the risk of brain cancer was no longer increased among subjects who had ever been supplied any public water (OR: 0.76); however, there was still a 2.2-fold increased risk among subjects who were ever supplied with water from the Barnstable Water Company (95% CI: 0.99 - 4.94).

The results were quite similar when the adjusted analyses controlled for potential confounding variables. When latency was taken into account, the adjusted relative risk of brain cancer was 2.06 among subjects who ever had any Upper Cape public water supplies (p=0.06), 1.89 among those who ever had Falmouth DPW or Barnstable Company water (p=0.12), 1.52 among those who had only Falmouth DPW water (p=0.41), and 2.34 among those who had only Barnstable Company water (p=0.10). As in the crude analysis when latency was ignored, no increased risk of brain cancer was seen for subjects with any public water supply but almost a 2.3-fold increased risk was seen for subjects supplied with Barnstable Company water (OR: 2.28, 95% CI: 0.98 - 5.29). Examination of the histologic type among exposed brain cancer cases did not reveal any patterns.

These analyses excluded subjects for whom data on drinking water supply were missing. Depending on the particular analysis, from 16% to 36% of subjects were excluded. The percent dropped varied according to the specific exposure examined, the particular cancer site, and whether or not latency was considered. In particular, 33% and 19% of subjects were dropped from the brain cancer analyses with and without latency, respectively. The demographic characteristics of subjects with missing data were similar to those without missing data.

5. PCE in Public Water Distribution System

PCE exposure from public water distribution systems was examined only among three cancer sites: bladder, kidney, and leukemia. Exposure estimates in units of relative delivered dose (RDD) obtained from Dr. Halina Brown's model ranged from 0.01 to 306.8 among all subjects combined. The median and 90th percentile were 8.10 and 41.9, respectively when latency was taken into account and 9.3 and 95.1 when it was ignored.

When the latent period was taken into account, 4.6% of cases (N=6) and 5.8% of controls (N=71) were considered ever exposed. Five of the six cases had leukemia and the seventh had bladder cancer. There was a 1.67-fold statistically unstable increase in the crude relative risk of leukemia among ever exposed subjects (95% CI: 0.63 - 4.42) that rose to 2.40 among exposed subjects whose RDD was at least the 90th percentile (N=3, 95% CI: 0.72 - 8.05). The adjusted relative risks were relatively unchanged at 1.85 (95% CI: 0.68 - 5.02) and 2.42 (95% CI: 0.68 - 8.68), respectively.

When the latent period was ignored, 19.8% of cases (N=26) and 12.7% (N=155) of controls were considered ever exposed to PCE. Thirteen cases had bladder cancer, 6 had kidney cancer and 7 had leukemia and the crude relative risks of these cancers were 1.56 (95% CI: 0.83 - 2.95), 1.24 (95% CI: 0.50 - 3.05), and 1.72 (95% CI: 0.74 - 4.01), respectively, among ever exposed subjects. Again, the crude relative risk of leukemia increased further among subjects whose RDD was at least the 90th percentile (OR: 2.43, 95% CI: 0.84 - 7.04). The crude risks of bladder and kidney cancer did not increase with RDD. The risk estimates were quite similar when confounders were controlled. The adjusted relative risk among ever exposed subjects was 1.86 for bladder cancer (95% CI: 0.93-.3.74), 1.15 for kidney cancer (95% CI: 0.44 - 2.98), and 1.95 for leukemia (95% CI: 0.81 - 4.67), and the adjusted relative risk of leukemia among subjects whose RDD was at least the 90th percentile was 2.63 (0.84 - 8.20). None of these risk estimates were statistically significant.

6. Electric and Magnetic Fields from Transmission Lines and Substations

Tables III.18.1 to III.18.24 describe the results of the crude and adjusted categorical analyses that examined electric and magnetic fields (EMF) exposure from 115 Kv transmission lines and substations among cases and controls. Since we hypothesized that EMF was a cancer promoter, the analyses were conducted only without latency. The adjusted analyses for these exposures controlled not only for the usual set of potential confounders but also for occupational exposure to EMF.

An individual was considered exposed if he lived within approximately 500 feet from these sources. The distance from study subject residences to the transmission lines and substations should not be considered exact given the inaccuracies associated with the residential histories and the mapping process. For example, the dot used to represent each residence on the map was 250 feet in diameter on the map scale (see section on subject mapping).

a. 115 Kv Transmission Lines

Three point seven percent of the cases and 2.7% of controls ever lived within approximately 500 feet of 115 Kv transmission lines and the crude relative risk of all cancers combined was not substantially increased (OR: 1.39, 95% CI: 0.88 - 2.20). However, when the individual cancer sites were examined, larger unstable increases in the crude relative risks of lung and bladder cancer were seen (OR: 1.76, 95% CI: 0.93 - 3.33 and OR: 2.15, 95% CI: 0.74 - 6.19, respectively). The crude risk of lung cancer was further increased among subjects who ever lived very close to the lines, i.e. within approximately 300 feet (OR: 2.22, 95% CI: 0.98 - 5.07). There were too few exposed subjects to examine bladder cancer risk among subjects who ever lived very close to the lines, and an insufficient number of exposed lung and bladder cancer cases to examine risk associated with long periods of exposure.

The relative risks of breast and colo-rectal cancer were not substantially increased among subjects who ever lived within 500 feet of the lines (ORs: 1.14 and 0.90, respectively); the number of exposed cases among the remaining sites was too small to calculate relative risks.

When confounders were controlled, the adjusted relative risk of all cancers combined was quite similar to the crude relative risk (OR: 1.37, 95% CI: 0.82 - 2.31).

The adjusted relative risk of lung cancer fell to 1.57 (95% CI: 0.72 - 3.44) among subjects who ever lived within 500 feet of a transmission line and to 1.80 (95% CI: 0.63 - 5.10) among subjects who ever lived within 300 feet. The adjusted risk of bladder cancer among subjects who ever lived within 500 feet rose to 2.57 (95% CI: 0.78 - 8.51). The relative risks for the other cancer sites were were quite similar to the crude relative risks. None of the crude or adjusted risk estimates were statistically significant.

b. Substations

Two point four percent of cases and 1.4% of controls ever lived within 500 feet of a substation and there was a 1.8-fold increase in the crude relative risk of all cancers combined among these subjects (95% CI: 0.99 - 3.28). When the individual cancer sites were examined, a 2.66-fold increase in the crude relative risk of lung cancer was seen (95% CI: 0.96 - 6.78). More modest and statistically unstable increases were seen in the crude relative risk of breast (OR: 1.70, 95% CI: 0.66 - 4.39) and colo-rectal cancer (OR: 1.55, 95% CI: 0.64 - 3.76).

The risk of all cancers combined did not appear to be strongly related to exposure duration or distance; there were too few exposed cases among the specific cancer sites to examine risk in these subcategories. The remaining cancer sites also had an insufficient number of exposed cases to calculate any relative risks.

When confounding was controlled, the adjusted relative risk of all cancers combined among subjects who ever lived within approximately 500 feet of a substation was quite similar to the crude relative risk (OR: 1.75, p=0.09). The adjusted risk of all cancers combined did not increase with increasing exposure duration but did increase with closer distances. Subjects who lived within approximately 250 feet of a substation had a 2.84-fold statistically unstable increase in risk (p=0.17).

The adjusted relative risks of lung and breast cancer remained elevated among subjects who ever lived within 500 feet of a substation (OR: 2.78, p=0.06 for lung cancer and OR: 1.69, p=0.32 for breast cancer). The adjusted relative risk of colo-rectal cancer was no longer increased (OR: 0.93, p=0.88).

c. Distribution Wiring Configuration

We had planned to estimate magnetic flux densities (MFD) at subject residences using a regression model developed by W. Kaune based on easily obtainable data on wiring systems (61). Instantaneous MFD measurements were taken in the morning and evening outside the front door of 171 Upper Cape study subject residences to validate Kaune's formula (62). The formula had a low correlation with the averaged MFD measurements both in parametric and non-parametric analyses (Pearson's r= 0.28, p<0.001). Thus, magnetic field exposure assessments based on distribution wiring characteristics at subject residences were not available for the current study.

7. PAVEPAWS

Analyses used average field density because of sample size limitations. Regressions did not show statistically stable effects, nor was there any apparent association between exposure to microwave radiation and case-control status. When the inverse of the squared distance (ISD) was used to interpolate the case-control data, the correlation coefficient was 0.006 (p=0.73), and when kriging was used the coefficient was 0.10 (p=0.08). The slope coefficients were both less than zero indicating a non-significant decrease in risk with increasing microwave density.

8. Environmental Exposures Obtained at Interview

Tables III.19.1 to III.19.19 describe the results of analyses that examined environmental exposure data obtained at interview. Latency was not taken into account in these analyses. Overall, a similar proportion of all cases and controls reported ever being stationed at the MMR during military service; working on the MMR as a civilian; swimming in Johns, Ashumet and other Upper Cape ponds, as well as Upper Cape ocean and bay beaches; regularly eating fish from local ponds and Boston Harbor; eating lobster more than six times a year and usually consuming the tamale (the green gland); regularly using an electric blanket; regularly drinking bottled water; dying their hair; taking mostly showers (compared to mostly baths or both about equally); having a hobby that involved chemical exposure; gardening with pesticides or herbicides; operating a ham radio; having a residence treated for termites; and summering on the Upper Cape prior to moving there permanently. A very small percentage of participant's current homes had been tested for radon (0.8% of all cases and 1.3% of all controls). Only one control reported an elevated radon level.

Nevertheless, among the individual cancer sites, cases reported many of these activities more often than their controls. Most notably, more leukemia cases than controls reported ever swimming in Johns Pond (11.8% vs. 6.6%) and other Upper Cape ponds (41.2% vs. 23.1%), regularly eating fish from local ponds (14.3% vs. 6.4%), gardening with pesticides and herbicides (55.6% vs. 39.9%), and having a residence treated for termites (33.3% vs. 19.9%). More brain cancer cases reported ever swimming in Johns Pond (20.6% vs. 5.5%) and other Upper Cape ponds (33.3% vs. 23.4%), eating lobster frequently (45.5% vs. 31.5%), and gardening with pesticides and herbicides (48.5% vs. 36.9%). More breast cancer cases reported ever swimming in Ashumet Pond (3.5% vs. 1.9%) and eating the tamale from the lobster (15.0% vs. 10.5%). More kidney cancer cases reported ever working on the MMR as a civilian (11.4% vs. 7.1%) and swimming in Johns Pond (8.8% vs. 5.5%) and more pancreas cancer cases reported ever regularly eating fish from Boston Harbor (24.2% vs.

16.1%) and drinking bottled water (16.2% vs. 8.4%). Lastly, more bladder cancer cases than controls reported taking mostly showers (62.7% vs. 51.4%).

When adjusted analyses were performed for selected activities that were most pertinent to the environmental exposures under study, there was a statistically significant 2.27-fold increase in the adjusted relative risk of leukemia associated with swimming in "other" Upper Cape ponds (p=0.03) and a borderline significant 2.68-fold increase in the adjusted leukemia risk associated with eating fish from local ponds (p=0.06). Three of the five leukemia cases who reported eating fish caught in local ponds could not recall the ponds' names. One case reported eating fish from Johns and Ashumet Ponds and the other reported Wakeby Pond. The Upper Cape lakes and ponds that the leukemia cases reported swimming in were Long Pond, Wakeby Pond, Hamlet's Pond, Middle Pond, Mystic Lake, Shubael Pond, Jenkins Pond, Queensewel Pond, Herring Pond, Joshua's Pond, Goodwill Park Pond, Lake Wequaquet, Hathaway's Pond, Hog Pond, Lawrence Pond, and Crooked Pond.

While a statistically significant 3.01-fold increase in the adjusted relative risk of brain cancer was also seen in association with swimming in Johns Pond, when we asked about the frequency of swimming we found that the exposed controls actually swam there more often. 40.6% of exposed controls versus 14.3% of the exposed brain cancer cases reported swimming in Johns Pond 10 or more times. The calendar years that the cases and controls swam in Johns Pond were similar and spanned from the 1940s through the 1980s. Examination of the histologic type of the exposed brain cancer cases did not reveal any patterns.

To assess the presence of recall bias, cases and controls were asked at the end of the interview, "Do you think that the Upper Cape environment made you sick?" Overall, a similar proportion of cases and controls responded affirmatively (21.1% of all cases and 23.2% of all controls). This was also true for the individual cancer sites except for pancreas cancer where almost twice as many cases as controls responded affirmatively.

9. Multiple Exposures Among Brain Cancer Cases and Controls

Because of budgetary constraints, it was not possible to examine exposure to multiple environmental hazards in a comprehensive manner. However, because several exposures were associated with brain cancer (e.g. ever swimming in Johns Pond, proximity to cranberry bogs, MMR runways and the Barnstable Airport, and ever residing in a home supplied with water from the Barnstable Water Co.), the extent of overlap between these exposures was examined among the brain cancer cases and controls.

There was almost complete overlap between ever being supplied by the Barnstable Water Co. and proximity to the Barnstable Airport. One hundred percent of the brain cancer cases and 88.1% of their controls who were supplied by the Barnstable Water Co. also lived within 3 km of Barnstable Airport. There was also considerable overlap among the other exposures. Seventy percent of the brain cancer cases who lived near the cranberry bogs, 57.1% who ever swam in Johns Pond, and 25.0% who lived within 3 km of the MMR runways reported one or more of the other exposures. The corresponding percentages among controls were 35.2, 45.9 and 40.0, respectively.

With the exception of the two exposures with almost complete overlap (proximity to the Barnstable Airport and being served by the Barnstable Water Co.), we recalculated the relative risks of brain cancer among subjects who had a history of only one of the above exposures. Four cases and 38 controls were considered exposed only to cranberry bogs and the relative risk of brain cancer among these subjects was 3.80 (95% CI: 1.15 - 12.58). Two cases' and 10 controls' only exposure was swimming in Johns Pond and the corresponding relative risk was 7.23 (95% CI: 1.67 -

31.37). Three cases and 8 controls were exposed only to the MMR runways and the relative risk of brain cancer was 13.55 (95% CI: 4.05 - 45.38). All of these relative risks were greater than those observed in prior analyses that did not exclude subjects with multiple exposures. The relative risks were also statistically stable despite the large number of subjects dropped from these analyses.

Please note that latency was considered for proximity to cranberry bogs, the Barnstable Airport, and ever residing in a home supplied with water from the Barnstable Water Co. but was not considered for ever swimming in Johns Pond and proximity to the MMR runways. This was done because the elevated relative risks seen previously were for these particular associations (e.g. proximity to cranberry bogs was associated with brain cancer risk only when latency was considered).

IV. DISCUSSION

Factors Considered in Interpretation of Results

Many factors are taken into account when interpreting results of an epidemiologic study including the strength of the association, statistical stability (statistical "significance"), presence of a dose-response relationship, consistency with other published data, biologic plausibility, as well as the study limitations. Before commenting on the results of the Upper Cape study, we first discuss the approach we took in interpreting the results in light of the study's limitations.

Strength of Association

In epidemiologic studies, the strength of the association between a disease (e.g. cancer) and an exposure (e.g. water or air pollution) is usually expressed in terms of measure called the relative risk, that is, the risk of developing the disease in the exposed group compared to the unexposed group. In the current study design the relative risk was approximated by the odds ratio. A relative risk (or odds ratio) equal to 1.0 means that there is no association between the disease and exposure. A relative risk of 1.9 means that exposed subjects have a 90% increased risk or 1.9 times the risk of developing the disease compared to unexposed subjects. Likewise, a relative risk of 0.5 means that exposed subjects have a 50% decreased risk. Because of the statistical instabilities usual in epidemiologic studies of this size and because uncontrolled confounding factors may produce modest apparent increases or decreases, we did not place much emphasis on relative risks unless they were above 1.5 or were below 0.67.

Statistical Stability or Significance

An important tool used to help interpret and understand the data is the concept of statistical stability or significance, expressed either in terms of a p value or confidence interval. Both attempt to measure, not the strength of the association, but how stable it is, that is, to what extent one would arrive at the same estimate of the odds ratio if an entirely new sample were examined with the same characteristics and exposures as those under study.

This is something akin to flipping a coin, where one does not expect the same proportion of heads and tails to come up every time ten flips are made. Sometimes the number might be 6/4, sometimes 4/6, sometimes even 5/5. One can see that the estimate of the proportion of heads in a series of coin flips could thus vary from 60% to 40% to 50% depending upon which trial one chooses to use. In an epidemiologic study we have the opportunity for only one such trial and therefore it is important to assess how stable our estimates of the odds ratio would be if we were allowed other trials. This is what both the p value and confidence interval measure.

There is a widespread misconception that measures of association must reach an arbitrary level of stability before they are considered "real." This level is usually a p value of less than 0.05, or a 95% confidence interval that does not include 1.00. Results with a p value of less than 0.05 or a 95% confidence interval that does not include 1.0 are often referred to as "statistically significant" results. It is important to realize that this refers only to a statistical convention for stability, not public health or clinical significance.

Statistically stable results are often impossible to achieve in an environmental epidemiological study because the stability measures themselves are affected by the size of the sample and the strength of the association. Thus, if one could flip the coin 100 times instead of 10, one would get a more stable estimate of the propensity of the coin to turn up heads. In an epidemiologic study such as the one on the Upper Cape, we were not able to increase the sample size. It was given to us by events. Thus, we were limited in how stable many of our estimates could be, especially for the rarer cancer types. This did not mean, however, that we disregarded all "non-significant" results. On the contrary, it is generally accepted that statistical tools such as significance tests or confidence intervals should be used as interpretive aids, not rigid criteria to be followed slavishly. In interpreting the results, statistical significance was weighted less heavily than the strength of the association and considered in the light of other information, such as a gradient of effect with increasing exposure and consistency with the literature. The terminology statistically "stable" or "unstable" was also used to help put the issue of statistical significance in its proper perspective.

Exposure Definitions and Dose-Response Relationships

Three general methods were employed to assess a study subject's potential exposure to various contaminants and each specified a somewhat different dose-response relationship between the exposure and disease risk. To estimate exposure from groundwater plumes, residential locations were connected to impact zones defined by a plume's current and past estimated locations and subjects were simply characterized as being exposed or unexposed. This method of exposure assessment assumed that there was an all-or-none relationship between the exposure and risk of disease.

To estimate exposure for most other exposures, zones of impact were defined based on the distance from an exposure source. For some smaller sources, the impact zone was within 2 km, for larger sources it was 3 km. In some cases larger impact zones were used at the request of the Community Advisory Board. A categorical analysis was conducted in which subjects were characterized as being ever or never exposed again assuming an all-or-none relationship. Dose-response relationships with distance, duration, and wind frequency (direction) were also assessed within each exposure zone.

The construction of an exposure metric was still another variation on the dose estimation theme. Here, disease risk was given as a function of a cumulative exposure measure that was inversely related to distance and directly related to duration and wind frequency (see section on exposure assessment for details).

Without obtaining actual measurements, it is difficult to know which dose estimate is more accurate. For this reason, we weighted the results of the categorical and exposure metric analyses equally. Thus, we did not dismiss positive findings from the categorical analysis because the exposure metric results were null. Indeed, the fact that the results of the exposure metric analyses were generally closer to the null than the categorical analyses suggests a greater degree of misclassification when the metric was used to estimate exposure.

When interpreting the findings, we considered the presence of a dose-response relationship as strong evidence that an association was real when confounding was well-controlled (confounders can account for an apparent dose-response relationship). When a dose-response relationship was not seen, possible explanations were considered (such as inexact exposure assessments) and the lack of a relationship was weighed against other information such as consistency with scientific literature.

Considerably less weight was given to the analyses suggested by the Community Advisory Board that extended the exposure definition to include residences within greater distances (9 or 11 km) or extended the exposure window through the end of the study period, since these results clearly suggested a great degree of exposure misclassification.

Biological Plausibility

As described in Section II, many of the contaminants under study have been rated "possible", "probable" or "known" carcinogens on the basis of animal and human studies. While the precise biologic mechanism by which these substances might cause a cell to become cancerous are not necessarily known in detail, it is clear that it is biologically *plausible* for these and the other contaminants under study to induce such changes.

Since it was possible that the exposures under study could be either cancer initiators (early actors) or a combination of both initiators and promoters (late actors), most analyses were conducted both with and without taking the latent period for cancer into account. The results of these two analyses were weighted equally.

Consistency with the Literature

Unfortunately, little data has been published on the relationship between environmental pollution and cancer in humans, and so, for the most part, external confirmatory studies were unavailable. Extra weight was given to associations if other studies, particularly among humans, reported similar findings.

Study Limitations

All epidemiologic research has its limitations and this study is no exception. The main problems in this study stem from exposure misclassification and low statistical power, both of which tend to make it more difficult to see any real associations. Confounding, and selection and observation bias are further problems inherent in all epidemiologic research. All are discussed below in detail. The results should be examined with these qualifications in mind.

Exposure misclassification

Exposure misclassification occurs when subjects who are truly exposed are classified as unexposed and subjects who are truly unexposed are classified as exposed. Since the exposures of interest in this study often occurred many years ago, it is not possible to know with absolute certainty which cancer cases and controls were exposed. Conducting environmental monitoring would not necessarily have been helpful since current exposure levels do not necessarily reflect past ones. Only imperfect surrogate exposure measures were available, generally based on the geographic location and calendar years of residence. Even when the residential location was precisely defined, subjects were likely to spend varying amounts of time at home depending upon personal circumstances. Moreover, as detailed in Section II, potential exposures at these locations were only estimates with varying degrees of accuracy.

The inaccuracies associated with the use of these surrogate exposure measures were not likely to lead to falsely positive results, because errors in exposure classification were just as likely to have occurred for cancer cases as controls. For example, because the residence mapping was carried out without knowing who was a case or a control and the determination of the exposure zones was done independently of the mapping, the likelihood of misclassification between the two groups tended to be the same.

Another source of non-differential exposure misclassification stemmed from the use of average latent periods (15 years for the solid tumors and 5 years for leukemia) for analyses that considered exposures as cancer initiators. Since individual latent periods were likely to vary around these averages, some relevant exposures may have been missed and other non-relevant ones included in the analyses with latency.

Since non-differential misclassification generally biases the results toward finding no or a smaller association, some of the null or weak associations seen may be the result of this type of misclassification. In particular, the results of analyses requested by the Community Advisory Board that extended the distance and exposure windows suggest a greater degree of misclassification than those based on the shorter distances and the usual exposure window. Thus, risk estimates with the extended exposure definitions were often closer to the null.

Statistical Power

Another limitation concerns sample size and the closely related issue of statistical power, that is, the study's ability to detect associations if they truly exist. The Upper Cape Study had adequate power to detect two-fold increases in risk for the relatively larger case groups of lung, breast, and colorectal cancer. However, its power to detect risk increases of this size was lower for the smaller case groups. Low statistical power mainly affects the stability of results and is one of several reasons why many findings did not achieve the traditional level of statistical significance (a p value of less than 0.05).

Furthermore, in the categorical analyses the number of cases and controls in the distance and direction subcategories was often quite small. Partly in an attempt to improve the power of these analyses, the exposure metric was developed to combine these data into a single measure. Unfortunately, the metric did not achieve this goal, as evidenced by the lack of improvement in statistical stability.

The study's power may also have been increased if the many separate environmental exposures had been grouped together. This was done on a limited basis for the numerous groundwater plumes. Ideally, this sort of analysis could have been done for the air exposures using the exposure metric. This would have required additional estimates of source strength. It was not possible to do so because of budgetary and time constraints.

Confounding

It is unlikely that the results observed in this study can be accounted for by confounding. Confounding variables are independent risk factors for the disease that are also associated with the exposure. Well-known, relatively strong cancer risk factors that occurred with reasonable frequency were controlled in the multivariate analysis. Since the crude and adjusted results were generally similar, it appears there was little confounding by the controlled variables. This may be because they were not strongly related to the exposure(s) under study.

Some cancer risk factors such as nutritional variables were not controlled because of time constraints associated with the interview and uncertainties concerning the reliability of dietary histories. The small size of many case groups also precluded controlling simultaneously for a large number of variables. In fact, no adjusted analyses were performed on liver cancer since the case group consisted of only four individuals. Since little confounding was seen for the major controlled risk factors, it is unlikely that lack of control of the minor risk factors led to substantial residual confounding. In instances where several environmental exposures were associated with a cancer site (e.g. brain cancer), we attempted to eliminate confounding by examining subjects with only one exposure.

Observation Bias

Given the nature of the questionnaire and the interview setting, it was not possible to blind the interviewers to the disease status of the respondent. Since the interview was highly structured, the questions carefully written, and the interviewers well-trained and experienced, the possibility of systematic differences in soliciting, recording or interpreting information (interviewer bias) was unlikely. Also, to help achieve comparable quality of the interview data, deceased controls were included who had proxy interviews in the same fashion as deceased cases.

Since most of the environmental exposure data was assessed independently of the interview, recall bias was not an issue for most exposures. Furthermore, its presence was directly assessed by asking subjects if they thought there was something about the Upper Cape environment that made them sick. Their responses indicated that recall bias was not likely (see section III.F.8).

Selection Bias

Selection bias arising through differential surveillance, diagnosis, and referral of individuals was unlikely since the cancer cases were obtained from all incident cases from the Massachusetts Cancer Registry. Comparison with other sources indicates nearly complete reporting for the cancer sites and geographic area under study. Selection bias stemming from non-response related to both the disease and exposure was also not likely since the follow-up and interview rates were high and similar among cases and controls, and the demographic characteristics of participants and non-participants were alike. However, it should be noted that this study included only permanent full- and part-time residents of the Upper Cape and excluded non-permanent and former residents. The latter may have included individuals who moved away from the Upper Cape before being diagnosed with cancer. Omission of these individuals would bias the study results only if moving was related to both the exposure(s) and disease(s) under study. We believe that this was unlikely; however, the results may be generalizable only to permanent residents of the Upper Cape.

Discussion of Results

The Upper Cape Cancer Incidence Study was initiated because of substantial public and official concern about the elevated cancer incidence rates of the five towns of the Upper Cape as compared to statewide averages. In particular, consistently elevated mortality rates had been seen for lung cancer and leukemia for Falmouth and Bourne. In addition, since the inception of the Massachusetts Cancer Registry, statistically significant excesses had been seen in the incidence of cancers of the breast, colon/rectum, lung and blood forming organs and statistically unstable increases had been seen for cancers of the pancreas, kidney, and bladder in at least one of the Upper Cape towns. Those incidence rates have continued to be elevated, thus affirming the original concern.

In addition, there were specific features of the Upper Cape setting that suggested an inquiry into environmental factors would be useful in understanding the reason for the elevated rates.

A notable feature that sets the Upper Cape region apart from many other regions of the State is the presence of the Massachusetts Military Reservation (MMR). This very large facility has historically been the site of many unsound environmental practices (described in Section II). Independently of the study results, many of which must remain tentative because of limitations in the epidemiological method, our review and evaluation of potential exposures from the site fully justified the public concern expressed in the years prior to the inception of the study. We emphasize that nothing in our results should be construed as reason not to implement the most rigorous and speedy cleanup and remediation possible.

Groundwater Contamination

Of particular concern regarding environmental practices at the MMR and elsewhere on the Cape is the fact that much of the population receives its drinking water from a single large aquifer underlying sandy porous soil. Thus, there is great potential for contaminating the drinking water. It turned out, however, that at this point, only a few of our study subjects were potentially exposed to such contamination, at least as estimated by having a residence over a plume emanating from one of the various sites on or off the MMR (see section III.D and table III.5.1). We cannot of course say what the health effects of such exposures might be to the small number of people currently exposed or to others if and when the plumes extend to cause additional exposures. However, they do not now appear to be responsible for much, if any, of the cancer burden to the population.

Public Water Supplies

Several other aspects of public drinking water supplies were also examined (described in sections II.A.5 and II.C.5, results in sections III.F.4, tables III.17.1 to III.17.60). One involved the public supplies of the Upper Cape. The results suggest that there may be a two-fold elevation in the risk of brain cancer among subjects who were ever supplied with any Upper Cape public water. The risk, which was present only when the latent period was taken into account, was of borderline statistical significance and remained elevated after controlling for age, sex, and vital status at interview. No dose-response relationship was seen with duration of exposure.

Additional analyses specifically involved the public supplies of Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.). The former contained very modest and not unusual levels of trihalomethanes (THMs) and the latter had some indication of solvent contamination. The results also suggest an association with brain cancer. A two-fold elevation in the risk of brain cancer was seen among those who ever had a residence supplied by the Barnstable Water Co. This result was relatively stable statistically, close to the conventional criterion. The association was present with and without accounting for the latent period and after controlling for age, gender, and vital status. A more modest 1.5-fold elevation in the risk of brain cancer was seen among subjects who were ever supplied by the Falmouth DPW. This elevation was statistically unstable and seen only when the latent period was taken into account.

Because it was possible that the increased risk of brain cancer among subjects who were ever supplied with any Upper Cape public water merely reflected the associations seen with the Barnstable Water Co. and Falmouth DPW, we reexamined the former association excluding individuals served by these two suppliers. The overall strength of the association between brain cancer and the Upper Cape public water supplies was reduced but not eliminated (Odds Ratio:1.78).

There are several factors that make these associations difficult to interpret. First, details are lacking about the historical pattern of water contamination in the area. Since the brain cancer cases and controls were supplied with Upper Cape public water from the 1940s through the 1980s, it is not possible to determine if the associations reflect long ago or more recent contamination. As described earlier in this report, the public water supplies in the Upper Cape have had low levels of common industrial contaminants that, at least in the 1980s, have generally fallen below the current maximum contaminant levels set by state and federal regulations.

Second, we only know a few details about the pattern of water use of the brain cancer cases and controls. Bottled water use was uncommon, particularly among the brain cancer cases, and slightly more brain cancer cases than controls took showers (Table III.19.9).

Third, almost all of the subjects who were served by the Barnstable Water Co. also lived within 3 km. of the Barnstable Airport for which an elevation in brain cancer risk was also seen. The latter risk was not quite as high (about 1.5-fold) as that associated with the Barnstable Water Co. and was not statistically stable. However, it is impossible to separate the association with the water supply company from that of the airport. In fact, these exposures may merely be markers for still other exposures in the Hyannis area or characteristics of Hyannis residents that are associated with brain cancer.

Lastly, many subjects were not included in these water analyses because they (or their next of kin) could not state for every residence whether or not they were supplied with public water. We could not determine if a dose-response relationship was present with duration for the Barnstable Water Co. and Falmouth DPW suppliers because of the large amount of missing data.

While the demographic characteristics of subjects with and without missing data were similar, it is not clear what effect dropping the subjects with missing data had on the results. If the missing data was not systematically related to the exposure and disease variables, then dropping these subjects would have affected only the statistical stability. However, if having missing data was systematically related to exposure and/or disease, then spurious results might have arisen.

In most prior epidemiologic studies, the types of drinking water contaminants seen on the Upper Cape have been examined only in relation to gastrointestinal and urinary tract cancers. These studies have generally found associations with trihalomethane exposure, either measured directly or inferred from drinking water characteristics (e.g. surface or ground water). Positive associations have most consistently been observed for urinary tract cancer (66).

While it is biologically plausible for exposure to drinking water contaminants to cause brain cancer, only a few published studies provide data on this relationship. One study conducted in Washington County, Maryland found no association between brain cancer and chlorine exposure from residential drinking water. Adjusted brain cancer incidence rates were similar among residents supplied with chlorinated surface water compared to those supplied with nonchlorinated water from a deep well (adjusted incidence rates: 7.4 and 6.7 per 100,000, respectively) (76).

On the other hand, a positive association was seen between trihalomethane levels in drinking water and mortality from brain and other central nervous system cancers in an ecological study of over 900 urban counties across the United States (77). In addition, a case-control study from Wisconsin found an association between female brain cancer mortality and drinking water chlorination. Here, a dose-response relationship was seen between the average chlorine dose over the past twenty years and brain cancer. Compared to subjects with no chlorination, the adjusted odds ratios of brain cancer mortality were 2.48, 2.15, and 1.81 for high (1.71-

7.00 ppm), medium (1.00-1.70 ppm), and low average doses (0.01-0.99 ppm), respectively. The odds ratios were similar when chlorine doses over the past ten years were examined (78).

While the latter studies provide some support for our findings, the public drinking water results cannot be considered conclusive because of the limitations discussed earlier. Nevertheless, we believe that it would be prudent to study all current public drinking water supplies on the Upper Cape, particularly those of the Barnstable Water Co., and to identify and eliminate any currently contaminated sources. We understand that the Department of Environmental Protection has already undertaken an investigation of groundwater contamination in the Hyannis area. We strongly support these efforts.

Perchloroethylene (PCE) in Public Drinking Water Supplies

Another drinking water exposure of importance is the contamination of public water supplies from tetrachloroethylene (also called perchlorethylene, or simply PCE) in the distribution systems (water pipes) of several supplies (described in sections II.A.6 and III.C.6, results in section III.F.5). Because of time and resource limitations only three cancer types, leukemia, bladder and kidney, were analyzed since these cancers have been associated with occupational PCE exposure in other studies (79-85, 87-89). Our results indicated almost a two-fold increased risk of leukemia and bladder cancer among those supplied with water from pipes that leached PCE. The risk estimates were not statistically stable, a reflection of small numbers, but the increases are biologically plausible, consistent with the literature, and in the case of leukemia, appeared to exhibit a dose-response relationship. For these reasons, we believe our results are consistent with a hazard of PCE contamination in some of the distribution systems of the Upper Cape. We recommend continued vigilance to minimize population exposure to this contaminant.

Gun and Mortar Positions

The major exposures to Upper Cape residents were not through the water but through the air. Two results indicated associations between possible airborne exposures to residents located near the gun and mortar positions on the MMR and lung and breast cancer (site and activities described in sections II.A.1.e and II.C.3.d, results in section III.E.6, Tables III.11.1 to III.11.25). Among residents who were exposed for more than 20 years, lung and breast cancer showed modest increased risks (OR 2.48 for lung cancer and OR 2.15 for breast cancer when the latent period was taken into account). Lung cancer subjects who lived closer had increased risk (OR: 1.75 for those within 2 km of the site, OR: 1.05 for those living between 2 km and 3 km). Likewise for breast cancer cases there was an increase in risk for subjects who lived closer to the sites (OR: 1.92 within 2 km, OR: 1.25 for those 2 km to 3 km). The adjusted analyses suggested that there was no meaningful confounding. These results were not statistically stable, probably because few subjects were exposed for a long time period or lived close to the sites. In addition, we believe that the results may underestimate any real associations since existing information on the operating history of the individual positions on the MMR was not provided to us.

3 km

Potential airborne exposures associated with the gun and mortar positions arise both from artillery firing and open air burning of unused propellants. Propellants used on the MMR have several constituents including 2,4-dinitrotoluene (2,4-DNT). This substance is of concern since it has been rated a probable human carcinogen by the U.S. Environmental Protection Agency (90).

Many adverse effects from exposure to 2,4-DNT and its isomer 2,6-DNT have been observed in animal studies including death, anemia, hepatotoxicity and neurotoxicity, abnormal reproductive parameters, and cancer. Adverse pulmonary effects have not been reported, but no animal studies have been published using inhalation as the exposure route. Oral administration has produced kidney cancer in male mice and liver cancer in rats. Subcutaneous tissue fibromas and mammary gland fibroadenomas have also been observed in rats after oral administration (90). While differences in species susceptibility, route, and level of exposure must be considered, the occurrence of mammary tumors in an exposed animal species lends support to our finding of an increased risk of breast cancer among women who lived near the gun and mortar positions for more than 20 years.

Information on the human health effects of 2,4-DNT and 2,6-DNT is based solely on a small number of studies among individuals exposed in occupational settings. The observed adverse health outcomes include significant increases in deaths from ischemic heart and other circulatory diseases, adverse hematologic effects including cyanosis and anemia, and neurotoxic effects including dizziness, headaches, nausea, impaired reflexes, and muscular weakness. There are also data that suggest an adverse effect on male reproduction as measured by decreased sperm counts and abnormal sperm morphology (90).

The only information on cancer among humans is based on a small retrospective cohort study conducted at two army ammunition plants using 2,4-DNT and technical grade DNT (a mixture of 2,4-DNT and 2,6-DNT). No significant increases in mortality were reported from cancer of the liver, lung, gallbladder, kidney, or connective tissues. However, since the study had adequate power to detect only very large increases in risk (eight-fold or greater for liver or gallbladder cancer), the null findings do not rule out the possibility of moderate increases in cancer risk. According to the Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profile, the human health effects of inhalation exposure to 2,4-DNT and 2,6-DNT on either a short- or long-term basis are currently unknown (90).

Since many other combustion species are produced when propellant bags are burned (see Section II), published studies on the health effects of air pollution also provide information relevant to the interpretation of these findings. There are a great deal of published data supporting a causal relationship between air contaminants and lung cancer (e.g. urban/rural differences in lung cancer mortality rates and mortality and morbidity rates of occupational cohorts exposed to combustion products from fossil fuels) (68). While animal studies show mammary tumors from chemical exposures (91), to our knowledge, there are no published data showing an association between air pollution and breast cancer in humans. Human breast cancer studies have focussed mainly on reproductive and genetic factors, and ionizing radiation is the sole "environmental" exposure shown to increase a woman's risk (92).

Taking into consideration the strength of the associations, the presence of dose-response relationships, and information from the published literature, we believe that the association between proximity to the gun and mortar positions and lung cancer may be real. The association with breast cancer is less plausible and so we give this finding less weight; however, we do not think that it should be entirely dismissed. The results suggest that propellant bag burning should not take place so close to populated areas if it should take place at all. We note that if the MMR were not a military installation this would constitute an illegal disposal of hazardous waste under the federal Resource Conservation and Recovery Act and Massachussetts General Laws, Chapter 21c.

MMR and Barnstable Fire Training Areas

The findings involving the MMR Fire Training Areas (described in sections II.A.1.a and II.C.3.c, results in section III.E.4, tables III.9.1 to III.9.64) are more difficult to interpret. Generally, less than three subjects lived within 3 km and so relative risks were not estimated for most cancer sites. There was an increase in the risk of lung cancer and leukemia for those residing for more than 10 years within 9 km of the FTAs when the usual exposure window was used and the latent period considered. For neither lung cancer nor leukemia was there a consistent relationship with distance, making the likelihood of a real association doubtful. Residents near the Barnstable Fire Training Areas (described in sections II.A.3.a and II.C.3.c, results in section III.E.5, tables III.10.1 to III.10.24) showed very unstable and modest increases in leukemia and kidney cancer. Trends with duration and distance were not seen or difficult to assess for these cancer sites. While these analyses show some consistency in the literature for leukemia, their instability or lack of consistency with distance and duration leads us to put little weight on the findings.

MMR AVGAS Dump Site

The findings relating to exposure from the AVGAS dump site at MMR (described in sections II.A.c.ii and II.C.3.e, results in section III.E.8, tables III.13.1 to III.13.53) are also problematic. There was an increase in leukemia risk for those living within 9 km of the site using either the ever/never comparison or the exposure metric. However, examination of the distribution of the cases with distance revealed that the excess was confined to those living from 7 to 8 km from the site, with no apparent excess closer. While the exposure to fuels and solvents is plausibly related to a leukemia risk (66), we think that the pattern of cases with distance does not support an association with the site.

MMR UTES/BOMARC Site

The UTES/BOMARC site (described in sections II.A.1.c.i and II.C.2.1, results in section III.E.7, tables III.12.1 to III.12.50) showed some increase in crude risk for breast and pancreatic cancer among individuals who lived within 9 km of the site taking the latent period into account. The breast cancer risk showed no consistent pattern with distance and was slightly decreased after adjustment for confounding (OR:1.36). The exposed pancreatic cancer cases were far from the site and the risk was also reduced after adjustment for confounding. The picture was similar for pancreas and brain cancer when latency was ignored. The distances involved and slight decreased risk with adjustment for confounding lead us to doubt that these associations are meaningful.

MMR Runways and Barnstable Airport

Proximity to the runways at MMR and the Barnstable Airport (MMR runways described in sections II.A.1.f and II.C.3.b, results in section III.E.3, tables III.8.1 to III.8.20; Barnstable Airport described in sections II.A.3.b and II.C.3.b, results in section III.E.2, tables III.7.1 to III.7.24) are also difficult to interpret. With respect to the MMR runways there were generally too few cases with the required latency time to permit calculation of the relative risk for most cancer sites. When considering exposures without latency there appeared to be an increase in the risk of brain cancer associated with living within 3 km of the MMR runways. This relationship was only evident in the ever/never comparison, not with the exposure metric. However, the association was fairly strong (adjusted OR 3.98) and statistically stable (p=.02). In addition, when subjects with other exposures were eliminated (e.g. served by the Barnstable Water Co. or lived near cranberry bogs), the association between brain cancer and the MMR runways remained elevated.

While an association was also seen between brain cancer and the Barnstable Airport runways (Adjusted ORs 1.62 with latency and 1.50 without latency), it was completely confounded with that of the Barnstable Water Co. As with the MMR runways, these elevations were for the ever/never comparison and were not present when the exposure metric was used. While difficult to examine because of small numbers, there did not appear to be a gradient with duration or distance.

While brain cancer was associated with both facilities, the confounding between the Barnstable Airport and the Barnstable Water Co. make the latter finding very uncertain. To our knowledge, only one other epidemiologic study has examined the relationship between brain cancer and proximity to and work at these types of facilities. In this Swedish case-control study, living near an airfield was associated with an increased risk of astrocytoma when clinical controls with benign tumors were used as a comparison group (RR: 2.1, 95% CI: 0.9 - 4.8) but not when population controls were used (RR: 1.0, 95% CI: 0.4 - 2.3). However, work at an airfield was associated with an increased risk of astrocytoma when both the clinical (RR: 13.4, 95% CI: 2.5 - 72.2) and population controls were used (RR: 6.2, 95% CI: 0.7 - 297.9) (111). Since a potential hazard has not entirely been ruled out, we believe that further study is warranted. A first step might be an examination of brain cancer rates in other Massachusetts cities and towns with airports and runways. In the meantime, the air quality around the MMR runways and Barnstable Airport should be studied both to ensure that it meets current federal and state regulations and with respect to currently unregulated air toxics that might be related to activities at these facilities.

MMR Border

In an effort to gauge the effect of the MMR, considered as one large site, we analyzed the effect of proximity to the base border in a variety of ways (described in section II.C.3.g and results in section III.F.1, tables III.15.1 to III.15.50). There was an increased risk for lung and breast cancer among subjects who were exposed for more than 20 years when the exposure was defined as living within 3 km of the base border and latency was taken into account. For breast cancer but not for lung cancer, there was an increase in risk for those who lived closer to the base.

Since similar increases in risk were seen among long duration residents who lived within 3 km. of the gun and mortar positions, we examined the degree of overlap between these exposures. Considerable overlap was, in fact, present and when subjects near the gun and mortar positions were excluded from the analysis the risks associated with proximity to the MMR border were greatly reduced (ORs 1.34 for lung cancer and 1.25 for breast cancer). This suggests that the associations with the MMR border reflected the associations with the gun and mortar positions, with no independent association with the border itself.

MMR Residents

Few subjects actually resided on the MMR itself and so cancer risks could not be estimated for most sites because of the small numbers. There appeared to be some increase in the risk of colorectal cancer in the adjusted analyses, whether or not the latent period was considered. The adjusted analyses controlled for the major risk factors for colorectal cancer including age, sex, usual alcohol consumption, family and personal history of pertinent medical conditions, as well as a history of work in a job previously associated with colorectal cancer. A potential confounding factor that remained uncontrolled was physical activity level. Low activity levels have been associated with an increased risk of colorectal cancer (93,94). Thus, it is not clear what the meaning of the association with MMR residence might be.

Other MMR Sites

In general, there were too few subjects within an appropriate distance of the other sites on the MMR (FS2, FS3, storm drains, NDIL) to provide meaningful results. While it is unlikely that these sites contributed to the elevated cancer rates on the Upper Cape, we cannot say what the health effects would be if more people had been exposed.

PAVEPAWS

While no association was seen for the PAVEPAWS site, the available exposure data were inadequate. We strongly recommend that systematic power density measurements be taken throughout the area scanned by PAVEPAWS so that useful exposure data will be available for any future analyses of its potential health impact.

Canal Electric Power Plant

There were other sources of exposure to airborne agents besides those from the MMR. There was no apparent relation between emissions from the Canal Electric Plant and any cancer site whether or not the latent period was considered. This was not unexpected, since use of the EPA dispersion model for the plant indicated that ground level concentrations were low and uniformly spread throughout the study area.

Proximity to Cranberry Bog Cultivation

We also analyzed possible pesticide exposure associated with living near cranberry bogs (described in sections II.A.4 and II.C.4, results in section III.F.3, tables III.16.1 to 16.24). Exposure was defined as ever having a residence within a half mile of a bog. When the latent period was taken into account, an increase in the brain cancer risk was seen among individuals who ever lived within a half mile of a bog. A 2.4-fold statistically stable increase in risk was seen in the crude analysis that was virtually unchanged when confounders were controlled (Adjusted OR: 2.2). The risk also remained elevated (OR: 3.8) when subjects with other relevant exposures were excluded (e.g. residence supplied by the Barnstable Water Co., proximity to MMR runways, etc.)

However, the risks were lower for those exposed for longer vs. shorter periods of time and for those who lived closer vs. further away from the bogs. There were also no apparent trends with the cumulative acreage of all bogs within half a mile and calendar time, nor was the risk increased when latency was ignored or the exposure metric was applied. Inaccuracies in the exposure assessment methods stemming from the lack of information on the types of pesticides and methods of application used on particular bogs under study may have blurred these relationships.

While our results present a mixed picture, there are numerous studies that show a relationship between brain cancer and agricultural work, making our finding consistent with this body of literature (95-103). Increases in the risk of brain and/or central nervous system cancer have been observed among farmers and farm managers in Minnesota (95), agricultural crop production workers in Missouri (96), non-white farmers in North Carolina (97), U.S. agricultural extension agents (98), Canadian agricultural workers (99), New Zealand orchard, vineyard, tree, and shrub workers (100), Swedish agricultural workers (101), and Italian farmers (102,103). The increased risk among the Italian farmers was attributed to those who used chemicals including insecticides, fungicides, herbicides, and fertilizers (103).

In our population, a small percentage brain cancer cases and controls stated that they had ever employed in cranberry cultivation or in jobs that involved exposure to herbicides and pesticides (See Table III.2.1.9). Controlling for a history of these exposures did not materially reduce the magnitude of the association (Adjusted OR: 2.2).

Increases in brain cancer risk have also been observed among individuals non-occupationally exposed to agricultural activities and chemicals. In a Swedish case-control study, brain cancer cases were more likely than controls to have lived in the vicinity of a farm or reported exposure to pesticides and herbicides (104). A case-control study of brain tumors among children in the United States also found that a larger number of cases than controls lived on a farm and were possibly exposed to pesticides from residential insect exterminations (105).

In addition, five cases of neuroblastoma, a sarcoma of nervous system origin, have been described among children who resided in homes treated with chlordane for insect infestations either during the prenatal or postnatal period. These children represented one-third of the neuroblastoma cases diagnosed at a single pediatric hospital over a fourteen month period. It is unknown if any of the other cases had a history of chlordane exposure (106).

The biologic plausibility of our findings is supported by the results of a Danish study of organochlorine levels in the adipose tissue of patients who died of cancer and other non-cancerous diseases. Organochlorine levels were much higher among patients who died of cancer as compared to the non-cancer controls. In particular, they were approximately two times higher among glioblastoma patients as among non-cancer controls (107).

Thus, even though our data lack internal consistency, the strength and stability of the overall association and its consistency with numerous other published studies lead us to believe that the association between proximity to cranberry bog cultivation and brain cancer may be real. Since our study leaves many questions unanswered (regarding, for example, the pesticide application method), we recommend that larger, more detailed follow-up investigation be performed on the relationship between cranberry bog cultivation and brain cancer in Massachusetts. In the meantime, the various methods used to apply pesticides to cranberry bogs, particularly aerial spraying, should be reexamined with an eye towards keeping population exposure to an absolute minimum. In particular, the adequacy of the current buffer zones should be evaluated.

Transmission Lines and Substations

Electric and magnetic fields from transmission lines and electrical substations were also studied (described in sections II.A.7 and II.C.7, results in section III.F.6, tables III.18.1 and III.18.24). As noted earlier, limitations in our ability to estimate exposures did not allow examination of the distribution system as we had planned. Exposure was defined as living within 500 feet of either a 115 Kv transmission line or 500 feet of an electrical substation.

In prior residential and occupational studies, leukemia, lymphoma, and cancer of the brain and central nervous system have been associated with magnetic field exposure from residential sources and occupations involving electrical power exposures (108). Unfortunately, there were were too few exposed leukemia and brain cancer cases to allow analysis. There was an apparent increase in lung cancer risk associated with proximity to transmission lines and substations. There were also unstable increases in the risk of bladder cancer associated with the transmission lines, and breast cancer associated with the substations but not the transmission lines.

At least one other epidemiologic study of the effects of electric and magnetic fields has shown an increased risk for lung cancer. This study examined the mortality rates among people who lived near electrical substations and overhead transmission lines in East Anglia, England. Residents were considered exposed if they lived within 50 meters of an electrical substation or 30 meters of an overhead transmission line. (Almost all of the exposed residents lived near substations.) A significantly elevated mortality ratio was seen for lung cancer only among exposed women (Standardized Mortality Ratio: 175 for women and 109 for men). However, both men and women who lived very close to the electrical facilities (within 14 meters) had a significantly increased lung cancer mortality ratio (Standardized Mortality Ratio: 215). Interpretation of these results is hampered by the lack of smoking information. However, there was indirect evidence that smoking was not an important confounder since no increased mortality was seen for other respiratory diseases (109).

The biologic mechanism by which electromagnetic fields may lead to cancer is not well understood. This is true both for the low frequency current associated with high voltage transmission lines and the transient pulses associated with electrical substations. However, there is some evidence to suggest that electromagnetic fields act as cancer promoters (late actors) rather than initiators (early actors) (108). Our results should be considered along with the growing body of data that suggest that extremely low frequency electromagnetic fields might be biologically active and confirm the necessity of continued investigation and attention.

Miscellaneous Exposures

We obtained information pertinent to possible environmental exposures through the interview (section II.C.9, results in section III.F.8, tables III.19.1 to III.19.19). Associations were seen between brain cancer and swimming in Johns Pond; and leukemia and swimming in local ponds (other than Johns and Ashumet Ponds) and eating fish from local ponds. The association between brain cancer and Johns Pond remained elevated even after subjects with other exposures were excluded (e.g. lived near cranberry bogs, MMR runway, etc.)

A more detailed inquiry into these troubling findings revealed that many different ponds were involved in the leukemia associations with no apparent pattern. Thus, we give these associations relatively little weight. In addition, while more brain cancer cases than controls stated that they ever swam in Johns Pond, when we asked about the frequency of swimming we found that the exposed controls actually swam there more often. 40.6% of the exposed controls versus 14.3% of the exposed cases reported swimming in Johns Pond 10 or more times. Since the brain cancer cases and controls swam in Johns Pond from the 1940s through the 1980s, it is difficult to determine if the association reflects historical or recent exposure, or a combination of the two.

While we believe that these results are biologically plausible, we are unaware of any published data reporting a similar association. Little is currently known about the causes of brain and central nervous system cancer. Prior studies have reported associations with a wide variety of factors including head injuries, x-ray exposures, consumption of meat with high nitrite levels, barbiturate use, history of exposure to sick pets, living on farms or exposure to farm animals (66) and agricultural work (95-103).

Since our findings lack internal consistency and in the absence of external confirmatory studies, it is difficult to determine if these results implicate the pond itself. Nevertheless, we believe that it would be prudent to test thoroughly the pond water for contaminants, particularly since a groundwater plume from the MMR is in close proximity. The precise relationship between the plume and pond should also be determined.

Length and Calendar Years of Residence

Finally, we examined the length and calendar years of residence to determine if these variables were associated with cancer risk and compare the pattern of migration of cases and controls to the Upper Cape. We found that, with the exception of leukemia, cases and controls had similar average lengths of residence and moved to the Upper Cape at similar rates. A larger proportion of leukemia cases than controls (35.3% vs. 23.2%) moved to the study area in the 1940s and their length of residence was, on average, two years longer, but these differences were not statistically stable.

Thus, with the possible exception of leukemia, cancer risk was not generally related to how long or when a person resided on the Upper Cape, and cases and controls appear to have contributed equally to the population growth in the Upper Cape area. These results do not contradict the risk increases among subjects exposed for more than 20 years previously described since the latter focused on a small subset of long-term residents who lived near particular exposure zones.

Our findings regarding length of residence are not in complete agreement with those from the Massachusetts Department of Public Health (DPH) study of lung cancer and leukemia mortality among Upper Cape residents from 1969 to 1985. The DPH study found that both lung cancer and leukemia mortality were in excess among long-term residents (defined as more than 20 years). While the reasons for the lack of agreement are not readily apparent, they may be related to differences in the populations and time periods studied. The DPH study included only individuals who died over a somewhat different time period than the current study population. In addition, the DPH lung cancer analysis included only females (110).

Conclusions

This inquiry was begun because of concern about the generally increased cancer rates in the Upper Cape region. For the many reasons already noted, environmental factors were considered important possible explanations. After an extensive review of environmental factors it was clear that there was ample cause for concern. On the other hand, it was understood at the outset that epidemiological methods would be unlikely to identify all the causes of cancer in the region for reasons discussed above. However, it was hoped that a thorough investigation would narrow the large area of uncertainty surrounding possible environmental effects.

Our results suggest that there is some effect from environmental factors, although our study was unable to estimate its magnitude. On the basis of the results we obtained, and bearing in mind the many limitations, it does not appear to us that environmental factors have explained more than a small part of the elevated rates of cancer in the region. Thus, either some factor other than those we investigated is responsible, or there is some limitation of the study, most likely the unavoidable exposure misclassification, that made it undetectable, or perhaps a combination of both. It is possible that further analyses and the addition of more cases from subsequent years of the Registry might clarify some of these issues. We have identified a number of environmental factors that warrant further scrutiny or action, while others, such as current or past groundwater contamination appear not to be important contributors to the cancer increase. Among the former we would mention especially possible pesticide exposure associated with living near cranberry bogs, certain activities on the MMR such as propellent bag burning near populated areas, possible contamination of the Upper Cape public water supplies, particularly the Barnstable Water Co., PCE contamination of the distributions systems of some towns, and possible hazards associated with swimming in Johns Pond and living near airport runways both at the MMR and in Barnstable. Electrical substations and transmission lines are also areas of concern. Our study confirms the importance of the workplace environment (Tables III.2.1 to 2.10) in increasing the risk of cancer, a factor not confined to the Upper Cape, but of significance nonetheless.

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VI. APPENDICES

1. Introductory Letters to Cases, HCFA and Dead Controls

2. Non-Proxy and Proxy Questionnaires

3. Report: Cumulative dose of Tetrachloroethylene Received Between 1968 and 1985 by Massachusetts Residents from Vinyl Lined Asbestos Cement Water Distribution Pipes: An Empirically-Based Model by Thomas N. Webler and Halina S. Brown, Clark University

Letter to Cancer Cases

We need the benefit of your experience and hope that you will help us. Boston University and the University of Massachusetts are conducting an important study sponsored by the Massachusetts Department of Public Health to learn more about factors that influence people's health.

You are one of about 3,000 men and women from the Cape Cod area selected as part of a scientific sample for this study. We hope that, with your help, we will learn more about the causes of disease in this area of the state.

We will be calling you at your home within the next few weeks to ask if you would like to be interviewed for the study. The interview takes about 30 minutes and includes questions about your health, smoking habits, and work and residential history.

Let us assure you of three points. First, while your participation is, of course, voluntary the cooperation of every selected individual very important to producing accurate data. Second, all answers you give will be kept strictly confidential. Third, by giving your time you will be contributing to a project that will provide valuable information about the causes of disease.

An information sheet is enclosed which may answer questions you have about the study. Your interviewer will be glad to answer any additional questions. Or, if you prefer, you may telephone the study coordinator (name) collect at (telephone number).

Thank you in advance for your consideration.

Sincerely yours,

Ann Aschengrau, Sc.D.

David Ozonoff, M.D.

Letter to Next-of-kin of Deceased Cancer Cases

We need the benefit of your knowledge and hope that you will help us. Boston University and the University of Massachusetts are conducting an important study sponsored by the Massachusetts Department of Public Health to learn more about factors that influence people's health.

(Decedent's Name) was one of about 3,000 men and women from the Cape Cod area selected to be part of a scientific sample for the study. We are writing to you for help with this study because you are a next-of-kin. We hope that, with your assistance, we will learn more about the causes of disease in this area of the state.

We will be calling you at your home within the next few weeks to ask if you would like to be interviewed for the study. The interview takes about 30 minutes to complete and includes questions about (Name)'s medical history, smoking and residential and work history.

Let us assure you of three points. First, while your participation is, of course, voluntary your cooperation is very important to producing accurate data. Second, all answers you give will be kept strictly confidential. Third, by giving your time you will be contributing to a project that will provide valuable information about the causes of disease.

An information sheet is enclosed which may answer questions you have about the study. Your interviewer will be glad to answer any additional questions. Or, if you prefer, you may telephone our study coordinator (name) collect at (telephone number).

Sincerely yours,

Ann Aschengrau, Sc.D.

David Ozonoff, M.D.

Letter to Health Care Financing Administration Controls

The Health Care Financing Administration (HCFA) administers the Medicare program. HCFA is cooperating with the Massachusetts Department of Public Health, Boston University, and the University of Massachusetts on a study which involves Medicare beneficiaries as well as others. This study will help us learn more about the causes of disease. People living on Cape Cod who have been diagnosed with various diseases, as well as people who do not have these diseases, are included in this study.

You are one of over 30 million Americans with health insurance under the Medicare program. Your name was selected at random from Medicare beneficiaries living on Cape Cod. About 3,000 men and women who live on Cape Cod have been chosen for the study. In a short while, you will be contacted by a representative of the research team. That person will want to ask you questions about your health history, smoking habits, as well as your work and residential history. The survey takes about 30 minutes to complete and can be done by telephone or in person.

Your participation is entirely voluntary. Your Medicare benefits will not change based on whether you decide to participate, and there are no penalties if you do not want to answer particular questions. All answers you give will be kept confidential. Your answers will be combined with that provided by other persons who participate. The research team is trying to obtain a representative sample of the population in the Cape Cod area.

Very soon, a member of the study staff will contact you about the study. If you agree to participate, they will arrange to interview you at a time that is convenient to you. Meanwhile, if you have any questions about the study, please feel free to call (name of study coordinator) collect at (telephone number).

Thank you in advance for your consideration.

Sincerely,

William L. Roper, M.D.
Administrator
Health Care Financing Administration

Letter to Next-of-Kin of Deceased Controls

We need the benefit of your knowledge and hope that you will help us. Boston University and the University of Massachusetts are conducting a study sponsored by the Massachusetts Department of Public Health to investigate factors that influence people's health.

(Decedent's Name) was one of about 3,000 men and women from the Cape Cod area selected as part of a scientific sample for the study. We are writing to you for help with this study because you are a next-of-kin. We hope that, with your help, we will learn more about the causes of disease in this area of the state.

We will be calling you at your home within the next few weeks to ask if you would like to be interviewed for the study. The interview takes about 30 minutes to complete and includes questions about (Name)'s medical history, smoking and residential and work history.

Let us assure you of three points. First, while your participation is, of course, voluntary your cooperation is very important to producing accurate data. Second, all answers you give will be kept strictly confidential. Third, by giving your time you will be contributing to a project that will provide valuable information about the causes of disease.

An information sheet is enclosed which may answer questions you have about the study. Your interviewer will be glad to answer any additional questions. Or, if you prefer, you may telephone the study coordinator (name) collect at (telephone number).

Sincerely yours,

Ann Aschengrau, Sc.D.

David Ozonoff, M.D.

The Following Document Contains

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C302

FOR OFFICE USE

COVERSHEET NUMBER ________

INTERVIEWER ________________

INTERVIEWER ID# ________

UPPER CAPE CANCER STUDY

Center for Survey Research
University of Massachusetts, Boston

Boston University School of Public He[illegible]

Spring/Summer 1989

Before we begin, let me remind you of three points:

1. I want to assure you that all information you give will be completely confidential and that none of it will be released in any way that would permit identification of you or your family.

2. Your participation in this study is, of course, voluntary.

3. It is very important that you answer as honestly and as accurately as you can. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

TIME NOW: ___________

SECTION A.

DEMOGRAPHIC VARIABLES

I'd like to begin with some questions about your health.

A1. Overall, how would you rate your health - excellent, good, fair, or poor?

1 [ ] EXCELLENT

2 [ ] GOOD

3 [ ] FAIR

4 [ ] POOR

A2. Compared to most other people your age, is your health better than most, about the same as most, or worse than most?

1 [ ] BETTER

2 [ ] ABOUT THE SAME

3 [ ] WORSE

A3. I have some questions about your work history. Since you were 18 years old, have you ever held a full time job for pay?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION C)

A4. I'm going to ask you about each of the full time jobs you've had since you were 18. Let's start with the first.

	JOB 1	JOB 2	JOB 3
a. What was the (first/next) job you held for one year or longer?	______ ______	______ ______	______ ______
b. What sort of work (did/do) you do on that job?	______ ______	______ ______	______ ______
c. What sort of business or industry is that (that is, what do they make or do?)	______ ______	______ ______	______ ______
d. What was the name of the company?	______	______	______
e. In what city was it located?	______	______	______
f. In what year did you start working there?	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE
g. In what year did you stop?	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE

JOB 4	JOB 5	JOB 6
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______	______	______
______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE
______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE	______ YEAR OR ______ R'S AGE

A5. INTERVIEWER CHECK: R MENTIONED CRANBERRY BOG?

1 [ ] YES (SKIP TO A7)

2 [ ] NO

A6. Did you ever work for three months or more on a cranberry bog?

1 [ ] YES

2 [ ] NO

A7. Have you ever been in the military service?

1 [ ] YES

2 [ ] NO (SKIP TO A15)

A8. Were you ever stationed in Viet Nam?

1 [ ] YES

2 [ ] NO (SKIP TO A10)

A9. Do you think you ever came into contact with Agent Orange while you were there?

1 [ ] YES

2 [ ] NO

A10. Were you ever stationed at Otis Air Force Base?

1 [ ] YES

2 [ ] NO (SKIP TO A15)

A11. During what years were you stationed at Otis?

FROM: ________

TO: ________

A12. What were your main activities or duties at Otis?

____

____

A13. Did you work directly with <u>fuel</u> while at Otis?

1 [ ] YES

2 [ ] NO

A14. Did you participate in fire-fighting training while at Otis?

1 [ ] YES

2 [ ] NO

A15. Did you ever work at Otis Air Force Base <u>as a civilian</u>?

1 [ ] YES

2 [ ] NO (SKIP TO B1)

A16. During what years did you work there?

FROM:________

TO:________

A17. What were your main activities or duties while working at Otis?

____

____

SECTION B

B1. Now I'd like to read a list of materials. Please tell me if you ever had a job that exposed you to any of these materials? (NOTE MILITARY SERVICE IS A JOB.)

	B1. Did you ever have a job that exposed you to (READ "a")?	B2. In what years were you working in a job or jobs where you were exposed to (READ "a")?	B3. Over that time would you say you were exposed to (READ "a") often, sometimes, or rarely?
a. asbestos	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
b. ionizing radiation like x-rays or radioactive materials	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
c. beryllium	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
d. solvents or degreasers like perc or tetrachlorethylene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
e. solvents or degreasers like trichlor or trichlorethylene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
f. benzene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
g. gasoline or kerosene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
h. paint thinners	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
i. any other solvents or degreasers	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY

B1 cont.

	B1. Did you ever have a job that exposed you <u>to (READ "a")?</u>	B2. In what years were you working in a job or jobs where you were exposed <u>to (READ "a")?</u>	B3. Over that time would you say you were exposed to (READ "a") <u>often</u>, <u>sometimes</u>, <u>or rarely?</u>
j. lead	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
k. mercury	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
l. cadmium	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
m. arsenic	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
n. pesticides or herbicides	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
o. radar equipment	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
p. power lines	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY
q. microwaves other than in a microwave oven	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIME 3 [ ] RARELY
r. welding materials	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM ______ TO ______	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY

SECTION C

Now I have some questions about smoking.

C1. Have you ever smoked cigarettes regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C8)

C2. At what age did you start smoking?

__________ AGE

C3. Do you smoke now?

1 [ ] YES

2 [ ] NO (SKIP TO C5)

C4. How many cigarettes do you smoke per day now?

__________ PER DAY (SKIP TO C7)

C5. At what age did you stop smoking?

__________ AGE

C6. About how many cigarettes did you smoke a day during <u>most</u> of the time while you were a smoker?

__________ PER DAY (SKIP TO C8)

C7. About how many cigarettes have you smoked a day during most of the time since you started to smoke?

__________ PER DAY

C8. Since you were born, have you ever lived with someone who [illegible] cigarettes, cigars, or pipes regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C11)

C9. For how many years total did you live in a household with (other) smokers?

__________ TOTAL YEARS

C10. In what year did you <u>last</u> live with someone who smoked regularly?

__________ YEAR / __________ YEARS AGO OR ________R'S AGE

C11. INTERVIEWER CHECK: R IS:

1 [ ] MALE

2 [ ] FEMALE (SKIP TO SECTION D)

C12. Have you ever smoked any other tobacco products such as cigars or pipes?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION D)

C13. Have you ever smoked a pipe regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C14)

C13a. How old were you when you started smoking a pipe regularly?

__________ AGE IN YEARS

C13b. Do you still smoke a pipe?

1 [ ] YES (SKIP TO C13d)

2 [ ] NO

C13c. How old were you when you stopped smoking a pipe?

__________ AGE IN YEARS

C13d. On the average, over the entire time you (have) smoked a pipe, how many pipefuls did you smoke per day?

__________ PIPEFULS PER DAY

C14. Have you ever smoked cigars regularly?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION D)

C14a. How old were you when you started smoking cigars regularly?

__________ AGE IN YEARS

C14b. Do you still smoke cigars?

1 [ ] YES (SKIP TO C14d)

2 [ ] NO

C14c. How old were you when you stopped smoking cigars?

__________ AGE IN YEARS

C14d. On the average, over the entire time you (have) smoked cigars, how many cigars (did you/have you) smoked per day?

__________ CIGARS PER DAY

SECTION D.

D1. Now a few questions about drinking wine, beer, and liquor. Did you ever drink wine, beer, or liquor?

1 [ ] YES

2 [ ] NO (SKIP TO D6)

D1a. Do you drink beer, wine, or liquor now?

1 [ ] YES (SKIP TO D2)

2 [ ] NO

D1b. At what age did you stop drinking beer, wine, or liquor?

__________ AGE

D2. Think about the period from when you were eighteen years old until (DATE). We're interested in how much and how often you drank beer, wine, or liquor during those years.

For all of the years between when you were eighteen and (DATE), did you <u>usually</u> drink beer, wine, or liquor <u>almost every day</u>, <u>a few times a week</u>, <u>a few times a month</u>, <u>less often than a few times a month</u>, <u>or not at all</u>?

1 [ ] ALMOST EVERY DAY

2 [ ] A FEW TIMES A WEEK

3 [ ] A FEW TIMES A MONTH

4 [ ] LESS OFTEN THAN A FEW TIMES A MONTH

5 [ ] NOT AT ALL (SKIP TO D3)

D2a. On the days when you had anything to drink, about how many beers or glasses of wine or drinks of liquor did you usually have?

[ ] BEERS
[ ] GLASSES OF WINE
__________ [ ] LIQUOR

D3. Was there ever a period of six months or longer when you drank more than that?

1 [ ] YES

2 [ ] NO (SKIP TO D5)

D3a. During this period, did you drink beer, wine, or liquor <u>almost every day</u>, <u>a few times a week</u>, <u>a few times a month</u>, <u>less often than a few times a month</u>, <u>or not at all</u>?

1 [ ] ALMOST EVERY DAY

2 [ ] A FEW TIMES A WEEK

3 [ ] A FEW TIMES A MONTH

4 [ ] LESS OFTEN THAN A FEW TIMES A MONTH

5 [ ] NOT AT ALL (SKIP TO D5)

D3b. During this period on the days when you had anything to drink, about how many beers or glasses of wine or drinks of liquor did you usually have?

[ ] BEERS
[ ] GLASSES OF WINE
__________ [ ] LIQUOR

D4. At what age did you start drinking this amount?

__________ AGE

D4a. And for how many months or years did you usually drink this amount?

[ ] MONTHS
__________ [ ] YEARS

D5. Has there ever been a time when you felt you had a drinking problem?

1 [ ] YES

2 [ ] NO

D6. Have you ever drunk at least one cup of coffee per day on a regular basis for six months or longer?

1 [ ] YES

2 [ ] NO (SKIP TO D8)

D6a. At what age did you start drinking coffee regularly?

__________ AGE

D6b. Do you drink coffee regularly now?

1 [ ] YES (SKIP TO D7)

2 [ ] NO

D6c. At what age did you stop drinking coffee regularly?

__________ AGE

D7. During your adult life about how many cups of coffee (did you normally drink/have you normally drunk) per day?

__________ CUPS OF COFFEE

D8. Before 1980, did you drink decaffinated coffee such as Sanka, <u>regularly</u>, <u>only occasionally</u>, or <u>not at all</u>?

1 [ ] REGULARLY

2 [ ] ONLY OCCASIONALLY

3 [ ] NOT AT ALL

D9. Before (DATE) did you ever regularly sleep using an electric blanket, an electric heating pad, an electric mattress pad, or electric water bed heater?

1 [ ] YES

2 [ ] NO (SKIP TO D10)

D9a. For how many years total did you use any of these?

__________ YEARS

D10. Before (DATE) did you ever regularly drink bottled water instead of tap water?

1 [ ] YES

2 [ ] NO (SKIP TO D13)

D11. During what years did you regularly drink bottled water?

__________ YEAR TO _____________ YEAR

D12. Why (did/do) you drink bottled water?

____

____

D13. Before (DATE) did you ever have your hair colored or dyed on a regular basis?

1 [ ] YES

2 [ ] NO (SKIP TO E1)

D13a. Did you have it dyed, bleached or both bleached and dyed?

1 [ ] DYED

2 [ ] BLEACHED

3 [ ] BOTH BLEACHED AND DYED

SECTION E.

Now a few questions about your activities.

E1. Have you ever gone swimming in John's Pond?

1 [ ] YES

2 [ ] NO (SKIP TO E5)

E2. In what year did you first swim in John's Pond?

__________ YEAR

E3. And in what year did you last swim in John's Pond?

__________ YEAR

[ ] STILL DOES IT

E4. How often would you say you have been swimming in John's Pond -- <u>less than 10 times</u>, <u>10 to 25 times</u>, <u>26 to 50 times</u>, or <u>more than 50 times</u>?

1 [ ] LESS THAN 10 TIMES

2 [ ] 10 TO 25 TIMES

3 [ ] 26 TO 50 TIMES

4 [ ] MORE THAN 50 TIMES

E5. And what about Ashumet Pond? Have you ever gone swimming in Ashumet Pond?

1 [ ] YES

2 [ ] NO (SKIP TO E9)

E6. In what year did you first swim in Ashumet Pond?

__________ YEAR

E7. And in what year did you last swim in Ashumet Pond?

__________ YEAR

[ ] STILL DOES IT

E8. How often would you say you have been swimming in Ashumet Pond -- less than 10 times, 10 to 25 times, 26 to 50 times, or more than 50 times?

1 [ ] LESS THAN 10 TIMES

2 [ ] 10 TO 25 TIMES

3 [ ] 26 TO 50 TIMES

4 [ ] MORE THAN 50 TIMES

E9. Have you ever been swimming in any other ponds on the Upper Cape?

1 [ ] YES

Which ponds? ________________________

____

____

2 [ ] NO

E10. Before (DATE) did you ever swim at any ocean or bay beaches on the Upper Cape?

1 [ ] YES

2 [ ] NO

E11. Before (DATE) did you ever regularly eat fish caught by you or friends or relatives from local ponds such as John's or Ashumet pond?

1 [ ] YES

2 [ ] NO (SKIP TO E12)

E11a. From which ponds?

____

____

E12. Before (DATE) did you ever regularly eat fish or seafood caught by you or friends or relatives from Boston Harbor, Quincy, or Buzzards Bay?

1 [ ] YES

2 [ ] NO (SKIP TO E13)

E12a. From which bays?

____

____

E13. Before (DATE) did you ever eat lobster more than 6 times a year?

1 [ ] YES

2 [ ] NO (SKIP TO E14)

E13a. Do you usually eat the green gland or tamale from the lobster?

1 [ ] YES

2 [ ] NO

E14. Before (DATE) did you have any hobbies or things you often did in your spare time which involved contact with chemical substances like paint strippers, glues, art materials, varnishes, or welding materials?

1 [ ] YES

2 [ ] NO (SKIP TO E15)

E14a. What materials did your activities involve?

____

____

E15. Before (DATE) were you ever a ham radio operator?

1 [ ] YES

2 [ ] NO (SKIP TO E16)

E15a. In what year did you first start?

____

E16. Before (DATE) did you do gardening where you have used pesticides or herbicides?

1 [ ] YES

2 [ ] NO

SECTION F.

We are interested in all the places you have lived since (1943/SINCE YOU WERE BORN).

F1.		F2.	F3.	F4.	F5.
In what city or town were you living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was your address in [NAME OF TOWN]?	Did you have electric heat there? (IF YES) Was it just baseboard or did you have electric panel heating also?	(Did/do) you have your own well or (are/were) you on a public water supply?	In what year did you move from there?
A. 1943 OR ______ [R's YEAR OF BIRTH IF LATER]	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	______ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
B. ______ YEAR FROM F5	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	______ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
In what city or town were you living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was your address in [NAME OF TOWN]?	Did you have electric heat there? (IF YES) Was it just baseboard or did you have electric panel heating also?	(Did/do) you have your own well or (are/were) you on a public water supply?	In what year did you move from there?
C. ____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN → ADDRESS [ ] ____ DK IF UPPER CAPE TOWN → ADDRESS [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
D. ____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN → ADDRESS [ ] ____ DK IF UPPER CAPE TOWN → ADDRESS [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

	F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
	In what city or town were you living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was your address in (NAME OF TOWN)?	Did you have electric heat there? (IF YES) Was it just baseboard or did you have electric panel heating also?	(Did/do) you have your own well or (are/were) you on a public water supply?	In what year did you move from there?
E.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
F.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

	F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
	In what city or town were you living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was your address in [NAME OF TOWN]?	Did you have electric heat there? (IF YES) Was it just baseboard or did you have electric panel heating also?	(Did/do) you have your own well or (are/were) you on a public water supply?	In what year did you move from there?
G.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
H.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
In what city or town were you living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was your address in (NAME OF TOWN)?	Did you have electric heat there? (IF YES) Was it just baseboard or did you have electric panel heating also?	(Did/do) you have your own well or (are/were) you on a public water supply?	In what year did you move from there?
I. ______ YEAR FROM F5	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	______ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
J. ______ YEAR FROM F5	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	______ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

F6. INTERVIEWER CHECK: R WAS BORN BEFORE 1943 (R'S AGE IS OVER 45)

1 [ ] YES

2 [ ] NO (SKIP TO F9)

F7. Did you ever live on the upper Cape prior to 1943?

1 [ ] YES

2 [ ] NO (SKIP TO F9)

F8. In what town did you live?		F8a. In what years did you live there?		
1ST MENTION	______ TOWN	FROM	______	YEAR
		TO	______	YEAR
2ND MENTION	______ TOWN	FROM	______	YEAR
		TO	______	YEAR
3RD MENTION	______ TOWN	FROM	______	YEAR
		TO	______	YEAR

F9. INTERVIEWER CHECK:

R HAS LIVED ON UPPER CAPE CONTINUOUSLY SINCE 1943 (OR BIRTH IF YOUNGER)

1 [ ] YES (SKIP TO F14)

2 [ ] NO

F10. In the years before you moved to the (Upper) Cape (in YEAR R MOVED TO CAPE), did you ever spend the summer on the Upper Cape?

1 [ ] YES

2 [ ] NO (SKIP TO F14)

F11. In what towns did you vacation?

______ TOWN

______ TOWN

F12. In what year did you first vacation on the Upper Cape?

__________ YEAR

F13. What was the last year you vacationed on the Upper Cape?

__________ YEAR

F14. Did you mostly take showers, mostly take baths, or did you take showers and baths about equally when you were at home prior to (DATE)?

1 [ ] MOSTLY SHOWERS

2 [ ] MOSTLY BATHS

3 [ ] ABOUT EQUAL

F15. Before (DATE) did you ever live in a house that you know was treated for termites?

1 [ ] YES

2 [ ] NO

F16. Have you had your current residence tested for radon?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION G)

F16a. What was the result -- was it more or less than 4 picocuries per liter?

1 [ ] MORE THAN 4 PICOCURIES

2 [ ] LESS THAN 4 PICOCURIES

8 [ ] DON'T KNOW

SECTION G

OTHER MEDICAL CONDITIONS

Now a few questions about your medical history.

G1. Did a doctor ever tell you that you had (READ A):

G2. In what year did a doctor first tell you that you had-- (READ "A")

	G1	G2
a. a bladder infection or cystitis	[1] YES [2] NO [8] DK	____ YEAR
b. a kidney infection	[1] YES [2] NO [8] DK	____ YEAR
c. urinary bladder, kidney or renal stones (NOT GALLBLADDER)	[1] YES [2] NO [8] DK	____ YEAR
d. familial or colo-rectal polyposis (polyps)	[1] YES [2] NO [8] DK	____ YEAR
e. inflammatory bowel disease	[1] YES [2] NO [8] DK	____ YEAR
f. ulcerative colitis	[1] YES [2] NO [8] DK	____ YEAR
g. diabetes	[1] YES [2] NO [8] DK	____ YEAR

G3. Did a doctor ever tell you that you had cancer?

1 [ ] YES

2 [ ] NO (SKIP TO G10)

G4. What kind of cancer did you have?

______________________________ TYPE OF CANCER

G4a. In what year was the cancer diagnosed?

__________ YEAR

G5. INTERVIEWER CHECK:

[ ] DATE IN G4a IS <u>SAME</u> AS OR <u>LATER</u> THAN DATE ON COVERSHEET (SKIP TO G7)

[ ] <u>EARLIER</u> THAN DATE ON COVERSHEET (ASK G6)

G6. What kind of treatment did you receive for it? -- Did you have: (READ A)

	YES	NO
a. Surgery?	[1]	[2]
b. Radiation?	[1]	[2]
c. Chemotherapy?	[1]	[2]

G7. Were you ever told that you had any <u>other</u> kind of cancer?

1 [ ] YES

2 [ ] NO (SKIP TO G10)

G7a. What kind of cancer did you have?

____________________ CANCER

G7b. In what year was the cancer diagnosed?

_____________ YEAR

G8. INTERVIEWER CHECK:

[ ] DATE IN G7b IS <u>SAME</u> AS OR <u>LATER</u> THAN DATE ON COVERSHEET (SKIP TO G10)

[ ] <u>EARLIER</u> THAN DATE ON COVERSHEET (ASK G9)

G9. What kind of treatment did you receive for it? -- Did you have: (READ A)

	YES	NO
a. Surgery?	[1]	[2]
b. Radiation?	[1]	[2]
c. Chemotherapy?	[1]	[2]

G10. Did you ever receive radiation (such as x-rays, cobalt treatments or radioisotopes) as part of a medical treatment (other than what you've already told me about)?

1 [ ] YES

2 [ ] NO (SKIP TO G14)

G11. For what condition? G12. To what parts of the body?

a. ________________ a. ________________________

b. ________________ b. ________________________

G13. In what year did you receive radiation treatment?

__________ YEAR

__________ YEAR

G14. How tall are you?

________ FEET ________ INCHES

G15. How much do you weigh now?

_________ POUNDS

G16. What was your highest adult weight? (EXCLUDE PREGNANCY FOR WOMEN)

_________ POUNDS

G17. How old were you at that time?

__________ AGE

G18. And what was your usual adult weight?

_________ POUNDS

G19. Has any member of your family -- parents, siblings, or children -- ever had cancer?

1 [ ] YES

2 [ ] NO (SKIP TO H1)

G20. Which relatives had cancer? (Anyone else?)

G21. What kind of cancer did (he/she) have?

	RELATIVE	TYPE OF CANCER
a.	____________	_________________
b.	____________	_________________
c.	____________	_________________
d.	____________	_________________

H. OB/GYN HISTORY

INTERVIEWER CHECK:

[ ] R IS MALE (SKIP TO SECTION J, PAGE 32)

[ ] R IS FEMALE

H1. Have you ever been pregnant even if it did not result in a live birth?

1 [ ] YES

2 [ ] NO (SKIP TO H8)

H2. How many children have been born to you?

__________ NUMBER OF LIVE BIRTHS

[ ] NONE (SKIP TO H4)

H3. How old were you when your (first) child was born?

__________ AGE AT FIRST BIRTH

__________ OR YEAR OF FIRST BIRTH

H4. Have you ever had a stillbirth? (STILLBIRTH: ANY PREGNANCY THAT LASTED LONGER THAN SIX MONTHS WHERE THE INFANT WAS NOT BORN ALIVE)

1 [ ] YES

2 [ ] NO (SKIP TO H7)

H5. How many stillbirths have you had?

__________ NUMBER OF STILLBIRTHS

H6. How old were you when you had your (first) stillbirth?

__________ AGE AT FIRST STILLBIRTH

__________ OR YEAR OF STILLBIRTH

H7. During any pregnancy were you given DES (diethylstilbestrol)?

1 [ ] YES

2 [ ] NO

H8. Have you ever used oral contraceptives or birth control pills?

1 [ ] YES

2 [ ] NO (SKIP TO H9)

H8a. For how many years total did you take them?

__________ TOTAL YEARS

H8b. In what year did you stop taking them?

__________ YEAR

H9. Has a doctor ever told you that you had a lump or tumor in your breast?

1 [ ] YES

2 [ ] NO (SKIP TO H10)

H9a. Was the lump or tumor malignant?

1 [ ] YES

2 [ ] NO

H10. Have you ever had any other medical problem with your breasts?

1 [ ] YES

2 [ ] NO (SKIP TO H11)

H10a. Have you had: (READ "A")	YES	NO	H10b. In what year did you first ha[d] (READ "A") ...
a. Cysts or nodules?	[1]	[2]	______ YR ______ YRS
b. Fibrocystic disease?	[1]	[2]	______ YR ______ YRS
c. Fibroadenoma?	[1]	[2]	______ YR ______ YRS
d. Chronic mastitis?	[1]	[2]	______ YR ______ YRS

H

H11. Have you experienced (or are you experiencing) menopause or change of life?

1 [ ] YES

2 [ ] NO (SKIP TO H12)

H11a. In what year did it start?

________ YEAR OR ________ YEARS AGO

OR ________ R'S AGE

H11b. Have you taken any female hormone medication such as Premarin or other estrogens for hot flashes or other menopausal symptoms?

1 [ ] YES

2 [ ] NO (SKIP TO H12)

H11c. For how many years total have you used these medications?

________ YEARS

H11d. In what year did you last use them?

________ YEAR [ ] PRESENTLY USING THEM

________ OR YEARS AGO

thing

H12. Have you ever had a hysterectomy?

1 [ ] YES

2 [ ] NO (SKIP TO H13)

H12a. How old were you when you had it?

________ AGE OR ________ YEAR

OR ________ YEARS AG

H12b. Did you have both ovaries removed or not?

1 [ ] YES

2 [ ] NO

H13. How old were you when you first started your menstrual period?

________ AGE AT MENARCHE

J8. In what city, state, or country were you born?

____

J9. From what country did your family come from on your father's side (before coming to the U.S. or Canada)?

____

J10. From what country did your family come from on your mother's side (before coming to the U.S or Canada)?

____

J11. Do you own or rent your home?

1 [ ] OWN

2 [ ] RENT

J12. Finally, do you think that there is anything about the air, the water, or any other environmental factor on the Upper Cape that might have made you sick or could make you sick in the future?

1 [ ] YES

2 [ ] NO (SKIP TO END)

J12a. What is it?

____

____

TIME NOW ________

C302

FOR OFFICE USE

COVERSHEET NUMBER ___________

INTERVIEWER ______________________________

INTERVIEWER ID# ______________

UPPER CAPE CANCER STUDY

PROXY INTERVIEW

Center for Survey Research
University of Massachusetts-Boston

Boston University School of Public Health

Spring/Summer 1989

Confidential: No information shall be presented or published in any way that would permit identification of any individual.

A4. I'm going to ask you about each of the full time jobs (he/she) has had since (he/she) was 18. (If you don't know about all of his/her jobs just tell me about the ones you do know about.) Let's start with the first.

	JOB 1	JOB 2	JOB 3
a. What was the (first/next) job (he/she) held for one year or longer?	____________ ____________ [ ] DK	____________ ____________ [ ] DK	____________ ____________ [ ] DK
b. What sort of work did (he/she) do on that job?	____________ ____________ [ ] DK	____________ ____________ [ ] DK	____________ ____________ [ ] DK
c. What sort of business or industry is that (that is, what do they make or do?)	____________ ____________ [ ] DK	____________ ____________ [ ] DK	____________ ____________ [ ] DK
d. What was the name of the company?	____________ [ ] DK	____________ [ ] DK	____________ [ ] DK
e. In what city was it located?	____________ [ ] DK	____________ [ ] DK	____________ [ ] DK
f. In what year did (he/she) start working there?	______ YEAR [ ] DK OR ______ R'S AGE	______ YEAR [ ] DK OR ______ R'S AGE	______ YEAR [ ] DK OR ______ R'S AGE
g. In what year did (he/she) stop?	______ YEAR [ ] DK OR ______ R'S AGE	______ YEAR [ ] DK OR ______ R'S AGE	______ YEAR [ ] DK OR ______ R'S AGE

JOB 4	JOB 5	JOB 6
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
[ ] DK	[ ] DK	[ ] DK
____ YEAR [ ] DK OR ____ R'S AGE	____ YEAR [ ] DK OR ____ R'S AGE	____ YEAR [ ] DK OR ____ R'S AGE
____ YEAR OR ____ R'S AGE	____ YEAR OR ____ R'S AGE	____ YEAR [ ] DK OR ____ R'S AGE

A5. INTERVIEWER CHECK: R MENTIONED CRANBERRY BOG?

1 [ ] YES (SKIP TO A7)

2 [ ] NO

A6. Did (he/she) ever work for three months or more on a cranberry bog?

1 [ ] YES

2 [ ] NO

8 [ ] DK

A7. Was (he/she) ever in the military service?

1 [ ] YES

2 [ ] NO (SKIP TO A15)

8 [ ] DK (SKIP TO A15)

A8. Was (he/she) ever stationed in Viet Nam?

1 [ ] YES

2 [ ] NO (SKIP TO A10)

8 [ ] DK (SKIP TO A10)

A9. Do you think (he/she) ever came into contact with Agent Orange while (he/she) was there?

1 [ ] YES

2 [ ] NO

8 [ ] DK

A10. Was (he/she) ever stationed at Otis Air Force Base?

1 [ ] YES

2 [ ] NO (SKIP TO A15)

8 [ ] DK (SKIP TO A15)

A11. During what years was (he/she) stationed at Otis?

FROM: ________

TO: ________

[ ] DK

A12. What were (his/her) main activities or duties at Otis?

____

____

[ ] DK

A13. Did (he/she) work directly with <u>fuel</u> while at Otis?

1 [ ] YES

2 [ ] NO

8 [ ] DK

A14. Did he/she participate in firefighting training while at Otis?

1 [ ] YES

2 [ ] NO

8 [ ] DK

A15. Did (he/she) ever work at Otis Air Force Base <u>as a civilian</u>?

1 [ ] YES

2 [ ] NO (SKIP TO B1)

8 [ ] DK (SKIP TO B1)

A16. During what years did (he/she) work there?

FROM: _______

TO: _______

8 [ ] DK

A17. What were (his/her) main activities or duties while working at Otis?

____

____

[ ] DK

SECTION B

B1. Now I'd like to read a list of materials. Please tell me if (he/she) ever had a job that exposed (him/her) to any of these materials? (NOTE: MILITARY SERVICE IS A JOB.)

	B1. Did (he/she) ever have a job that exposed (him/her) <u>to (READ "a")?</u>	B2. In what years was (he/she) working in a job or jobs where (he/she) was exposed <u>to (READ "a")?</u>	B3. Over that time would you say (he/she) was exposed to (READ "a") <u>often</u>, <u>sometimes</u>, <u>or rarely?</u>
a. asbestos	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
b. ionizing radiation like x-rays or radioactive materials	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
c. beryllium	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
d. solvents or degreaser like perc or tetrachlorethylene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
e. solvents or degreaser like trichlor or trichlorethylene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
f. benzene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
g. gasoline or kerosene	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
h. paint thinners	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
i. any other solvents or degreasers	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM _______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK

B1 (Cont.)	B1. Did (he/she) ever have a job that exposed (him/her) to (READ "a")?	B2. In what years was (he/she) working in a job or jobs where (he/she) was exposed to (READ "a")?	B3. Over that time would you say (he/she) was exposed to (READ "a") often, sometimes, or rarely?
j. lead	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
k. mercury	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
l. cadmium	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
m. arsenic	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
n. pesticides or herbicides	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
o. radar equipment	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
p. power lines	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK
q. microwaves other than in a microwave oven	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIME 3 [ ] RARELY 8 [ ] DK
r. welding materials	1 [ ] YES 2 [ ] NO 8 [ ] DK	FROM______ TO _____ [ ] DK	1 [ ] OFTEN 2 [ ] SOMETIMES 3 [ ] RARELY 8 [ ] DK

SECTION C

Now I have some questions about smoking.

C1. Did (he/she) ever smoke cigarettes regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C8)

8 [ ] DK (SKIP TO C8)

C2. At what age did (he/she) start smoking?

__________ AGE OR __________ YEAR

[ ] DK

C3 & C4. OMITTED

C5. At what age did (he/she) stop smoking?

__________ AGE OR __________ YEAR

[ ] NEVER STOPPED

[ ] DK

C6. About how many cigarettes did (he/she) smoke a day during most of the time while (he/she) was a smoker?

__________ PER DAY (SKIP TO C8)

[ ] DK

C7. OMITTED

C8. Did (he/she) ever live with someone who smoked cigarettes, cigars, or pipes regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C11)

8 [ ] DK (SKIP TO C11)

C9. For how many years total did (he/she) live in a household with (other) smokers?

__________ TOTAL YEARS

[ ] DK

C10. What was the last year (he/she) lived with someone who smoked regularly?

_________ YEAR _________ YEARS AGO _______ R's AGE

[ ] DK

C11. INTERVIEWER CHECK: R WAS:

1 [ ] MALE

2 [ ] FEMALE (SKIP TO SECTION D)

C12. Did he ever smoke any other tobacco products such as cigars or pipes?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION D)

8 [ ] DK

C13. Did he ever smoke a pipe regularly?

1 [ ] YES

2 [ ] NO (SKIP TO C14)

8 [ ] DK (SKIP TO C14)

C13a. How old was he when he started smoking a pipe regularly?

_________ AGE IN YEARS

[ ] DK

C13b. OMITTED

C13c. For how many years total did he smoke a pipe regularly?

_________ TOTAL YEARS

[ ] DK

C13d. On the average, over the entire time he smoked a pipe, how many pipefuls did he smoke per day?

_________ PIPEFULS PER DAY

[ ] DK

C14. Did he ever smoke cigars regularly?

1 [ ] YES

2 [ ] NO (SKIP TO SECTION D)

8 [ ] DK (SKIP TO SECTION D)

C14a. How old was he when he started smoking cigars regularly?

__________ AGE IN YEARS

[ ] DK

C14b. OMITTED

C14b. For how many years total did he smoke cigars regularly?

__________ TOTAL YEARS

[ ] DK

C14c. How old was he when he stopped smoking cigars?

__________ AGE IN YEARS

[ ] DK

C14d. On the average, over the entire time he smoked cigars, how many cigars did he smoke per day?

__________ CIGARS PER DAY

[ ] DK

SECTION D.

D1. Now a few questions about drinking wine, beer, and liquor. Did (he/she) ever drink wine, beer, or liquor?

1 [ ] YES

2 [ ] NO (SKIP TO D6)

8 [ ] DK (SKIP TO D6)

D1a. OMITTED

D1b. For how many years total did (he/she) drink beer, wine or liquor?

__________ TOTAL YEARS

[ ] DK

D2. Think about the period from when (he/she) was between eighteen years old until (DATE). We're interested in how much and how often (he/she) drank beer, wine, or liquor during those years.

For all of the years from when (he/she) was eighteen until (DATE), did (he/she) usually drink beer, wine, or liquor almost every day, a few times a week, a few times a month, less often than a few times a month, or not at all?

1 [ ] ALMOST EVERY DAY

2 [ ] A FEW TIMES A WEEK

3 [ ] A FEW TIMES A MONTH

4 [ ] LESS OFTEN THAN A FEW TIMES A MONTH

5 [ ] NOT AT ALL (SKIP TO D3)

8 [ ] DK

D2a. On the days when (he/she) had anything to drink, about how many beers or glasses of wine or drinks of liquor did (he/she) usually have?

[ ] BEERS
[ ] GLASSES OF WINE
__________ [ ] LIQUOR

8 [ ] DK (SKIP TO D5)

D3. Was there ever a period of six months or longer when (he/she) drank more than that?

1 [ ] YES

2 [ ] NO (SKIP TO D5)

8 [ ] DK (SKIP TO D5)

D3a. During this period, did (he/she) drink beer, wine, or liquor <u>almost every day</u>, <u>a few times a week</u>, <u>a few times a month</u>, <u>less often than a few times a month</u>, <u>or not at all</u>?

1 [ ] ALMOST EVERY DAY

2 [ ] A FEW TIMES A WEEK

3 [ ] A FEW TIMES A MONTH

4 [ ] LESS OFTEN THAN A FEW TIMES A MONTH

5 [ ] NOT AT ALL (SKIP TO D5)

8 [ ] DK

D3b. During this period when she was drinking more, on the days when (he/she) had anything to drink, about how many beers or glasses of wine or drinks of liquor did (he/she) usually have?

[ ] BEERS
[ ] GLASSES OF WINE
__________ [ ] LIQUOR   [ ] DK (SKIP TO D5)

D4. At what age did (he/she) start drinking this amount?

__________ AGE   [ ] DK

D4a. And for how many months or years did (he/she) usually drink this amount?

[ ] TOTAL MONTHS
__________ [ ] TOTAL YEARS   [ ] DK

D5. Was there ever a time when (he/she) felt (he/she) had a drinking problem?

1 [ ] YES

2 [ ] NO

8 [ ] DK

D6. Did (he/she) ever drink at least one cup of coffee per day on a regular basis for six months or longer?

1 [ ] YES

2 [ ] NO (SKIP TO D8)

8 [ ] DK (SKIP TO D8)

D6a. At what age did (he/she) start drinking coffee regularly?

_______ AGE

[ ] DK

D6b. Did (he/she) ever stop drinking coffee regularly?

1 [ ] YES

2 [ ] NO (SKIP TO D7)

8 [ ] DK (SKIP TO D7)

D6c. At what age did (he/she) stop drinking coffee regularly?

__________ AGE

[ ] DK

D7. During (his/her) adult life about how many cups of coffee did (he/she) normally drink per day?

__________ CUPS OF COFFEE

[ ] DK

D8. Before 1980, did (he/she) drink decaffinated coffee such as Sanka regularly, only occasionally, or not at all?

1 [ ] REGULARLY

2 [ ] ONLY OCCASIONALLY

3 [ ] NOT AT ALL

8 [ ] DK

D9. Before (DATE) did (he/she) ever regularly sleep using an electric blanket, an electric heating pad, an electric mattress pad, or electric water bed heater?

1 [ ] YES

2 [ ] NO (SKIP TO D10)

8 [ ] DK (SKIP TO D10)

D9a. For how many years total did (he/she) use any of these?

_________ TOTAL YEARS

[ ] DK

D10. Before (DATE) did (he/she) ever regularly drink bottled water instead of tap water?

1 [ ] YES

2 [ ] NO (SKIP TO D13)

8 [ ] DK (SKIP TO D13)

D11. During what years did (he/she) regularly drink bottled water?

_________ YEAR TO _________ YEAR

[ ] DK

D12. Why did (he/she) drink bottled water?

____

____

[ ] DK

D13. Before (DATE) did (he/she) ever have (his/her) hair colored or dyed on a regular basis?

1 [ ] YES

2 [ ] NO (SKIP TO E1)

8 [ ] DK (SKIP TO E1)

D13a. Did (he/she) have it dyed, bleached, or both dyed and bleached?

1 [ ] DYED

2 [ ] BLEACHED

3 [ ] BOTH DYED AND BLEACHED

8 [ ] DK

SECTION E.

Now a few questions about (his/her) activities.

E1. **Did (he/she) ever swim in John's Pond?**

1 [ ] YES

2 [ ] NO (SKIP TO E5)

8 [ ] DK (SKIP TO E5)

E2. **In what year did (he/she) first swim in John's Pond (which is in Mashpee near Otis Air Force Base)?**

__________ YEAR OR __________ [ ] YEARS AGO

[ ] DK [ ] R's AGE

E3. **And in what year did (he/she) last swim in John's Pond?**

__________ YEAR OR __________ [ ] YEARS AGO

[ ] DK [ ] R's AGE

E4. How often would you say (he/she) swam in John's Pond -- <u>less than 10 times</u>, <u>10 to 25 times</u>, <u>26 to 50 times</u>, or <u>more than 50 times</u>?

1 [ ] LESS THAN 10 TIMES

2 [ ] 10 TO 25 TIMES

3 [ ] 26 TO 50 TIMES

4 [ ] MORE THAN 50 TIMES

8 [ ] DK

E5. And what about Ashumet Pond? Did (he/she) ever swim in Ashumet Pond (which is in Mashpee near Otis Air Force Base)?

1 [ ] YES

2 [ ] NO (SKIP TO E9)

8 [ ] DK (SKIP TO E9)

E6. In what year did (he/she) first swim in Ashumet Pond?

________ YEAR OR ________ [ ] YEARS AGO

[ ] DK [ ] R's AGE

E7. And in what year did (he/she) last swim in Ashumet Pond?

________ YEAR OR ________ [ ] YEARS AGO

[ ] DK [ ] R's AGE

E8. How often would you say (he/she) swam in Ashumet Pond -- <u>less than 10 times</u>, <u>10 to 25 times</u>, <u>26 to 50 times</u>, or <u>more than 50 times</u>

1 [ ] LESS THAN 10 TIMES

2 [ ] 10 TO 25 TIMES

3 [ ] 26 TO 50 TIMES

4 [ ] MORE THAN 50 TIMES

8 [ ] DK

E9. Did (he/she) ever swim in <u>any</u> other ponds on the Upper Cape?

1 [ ] YES

Which ponds? ____________________

____

____

[ ] DK WHICH PONDS

2 [ ] NO

8 [ ] DK

E10. Before (DATE) did (he/she) ever swim at any ocean or bay beaches on the Upper Cape?

1 [ ] YES

2 [ ] NO

8 [ ] DK

E11. Did (he/she) ever regularly eat fish that (he/she) or friends or relatives caught from local ponds such as John's or Ashumet pond?

1 [ ] YES

2 [ ] NO (SKIP TO E12)

8 [ ] DK (SKIP TO E12)

E11a. From which ponds?

____

____

[ ] DK WHICH PONDS

E12. Before (DATE) did (he/she) ever regularly eat fish or seafood (he/she) or other friends or relatives caught from Boston Harbor, Quincy, or Buzzards Bay?

1 [ ] YES

2 [ ] NO (SKIP TO E13)

8 [ ] DK (SKIP TO E13)

E12a. From which bays?

____

____

[ ] DK WHICH BAYS

E13. Before (DATE) did (he/she) ever eat lobster more than 6 times a year?

1 [ ] YES

2 [ ] NO (SKIP TO E14)

8 [ ] DK (SKIP TO E14)

E13a. Did (he/she) usually eat the green gland or tamale from the lobster?

1 [ ] YES

2 [ ] NO

8 [ ] DK

E14. Before (DATE) did (he/she) have any hobbies or things (he/she) often did in (his/her) spare time which involved contact with chemical substances like paint strippers, glues, art materials, varnishes, or welding materials?

1 [ ] YES

2 [ ] NO (SKIP TO E15)

8 [ ] DK (SKIP TO E15)

E14a. What materials did (his/her) activities involve?

____

____

[ ] DK

E15. Before (DATE) was (he/she) ever a ham radio operator?

1 [ ] YES

2 [ ] NO (SKIP TO E16)

8 [ ] DK (SKIP TO E16)

E15a. In what year did (he/she) first start?

____

[ ] DK

E16. Did (he/she) ever do gardening where (he/she) used pesticides or herbicides?

1 [ ] YES

2 [ ] NO

8 [ ] DK

SECTION F.

We are interested in all the places (he/she) lived since (1943/SINCE (HE/SHE) WERE BORN).

F1.		F2.	F3.	F4.	F5.
In what city or town was (he/she) living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was (his/her) address in [NAME OF TOWN]?	Did (he/she) have electric heat there? (IF YES) Was it just baseboard or did (he/she) have electric panel heating also?	Did (he/she) have (his/her) own well or was (he/she) on a public water supply?	In what year did (he/she) move from there?
A. 1943 OR ____ (R'S YEAR OF BIRTH IF LATER)	[ ] ________ UPPER CAPE TOWN [ ] ________ DK IF UPPER CAPE TOWN [ ] ________ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ________ ________ CROSS STREET OR LOCATOR ________ ________ ________	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
B. ____ YEAR FROM F5	[ ] ________ UPPER CAPE TOWN [ ] ________ DK IF UPPER CAPE TOWN [ ] ________ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ________ ________ CROSS STREET OR LOCATOR ________ ________ ________	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

	F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
	In what city or town was (he/she) living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was (his/her) address in [NAME OF TOWN]?	Did (he/she) have electric heat there? (IF YES) Was it just baseboard or did (he/she) have electric panel heating also?	Did (he/she) have (his/her) own well or was (he/she) on a public water supply?	In what year did (he/she) move from there?
C.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
D.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
what city or town s (he/she) living in YEAR)? ET STATE IF NOT VIOUS)		What was (his/her) address in [NAME OF TOWN]?	Did (he/she) have electric heat there? (IF YES) Was it just baseboard or did (he/she) have electric panel heating also?	Did (he/she) have (his/her) own well or was (he/ she) on a pub- lic water supply?	In what year did (he/she) move from there?
____ YEAR FROM F5	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
____ YEAR FROM F5	[ ] ______ UPPER CAPE TOWN [ ] ______ DK IF UPPER CAPE TOWN [ ] ______ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS ______ ______ CROSS STREET OR LOCATOR ______ ______ ______	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

	F1. (cont.)		F2. (cont.)	F3. (cont.)	F4. (cont.)	F5. (cont.)
	In what city or town was (he/she) living in (YEAR)? (GET STATE IF NOT OBVIOUS)		What was (his/her) address in (NAME OF TOWN)?	Did (he/she) have electric heat there? (IF YES) Was it just baseboard or did (he/she) have electric panel heating also?	Did (he/she) have (his/her) own well or was (he/she) on a public water supply?	In what year did (he/she) move from there?
G.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]
H.	____ YEAR FROM F5	[ ] ____ UPPER CAPE TOWN [ ] ____ DK IF UPPER CAPE TOWN [ ] ____ NOT UPPER CAPE TOWN (GO TO F3)	ADDRESS____ ____ CROSS STREET OR LOCATOR ____ ____ ____	1 [ ] YES 3 [ ] BASE ONLY 4 [ ] PANEL 2 [ ] NO 8 [ ] DK	[ ] OWN WELL [ ] PUBLIC [ ] DK	____ YEAR [USE IN NEXT F1] [ ] LAST ADDRESS [SKIP TO G1]

F6. INTERVIEWER CHECK: R WAS BORN BEFORE 1943 (R'S AGE IS OVER 45)

1 [ ] YES

2 [ ] NO (SKIP TO F9)

F7. Did (he/she) ever live on the Upper Cape prior to 1943?

1 [ ] YES

2 [ ] NO (SKIP TO F9)

F8. In what town did (he/she) live?		F8a. In what years did (he/she) live there?	
1ST MENTION	______ TOWN	FROM	______ YEAR
		TO	______ YEAR
2ND MENTION	______ TOWN	FROM	______ YEAR
		TO	______ YEAR
3RD MENTION	______ TOWN	FROM	______ YEAR
		TO	______ YEAR

F9. INTERVIEWER CHECK:

R HAS LIVED ON UPPER CAPE CONTINUOUSLY SINCE 1943 (OR BIRTH IF YOUNGER)

1 [ ] YES (SKIP TO F14)

2 [ ] NO

F10. In the years before (he/she) moved to the (Upper) Cape (in YEAR R MOVED TO CAPE), did (he/she) ever spend the summer on the Upper Cape?

1 [ ] YES

2 [ ] NO (SKIP TO F14)

F11. In what towns did (he/she) vacation?

______ TOWN

______ TOWN

F12. In what year did (he/she) first vacation on the Upper Cape?

____________ YEAR

F13. What was the last year (he/she) vacationed on the Upper Cape?

____________ YEAR

F14. Did (he/she) <u>mostly take showers</u>, <u>mostly take baths</u>, or did (he/she) take <u>showers and baths about equally</u> when (he/she) was at home prior to (DATE)?

1 [ ] MOSTLY SHOWERS

2 [ ] MOSTLY BATHS

3 [ ] ABOUT EQUAL

F15. Before (DATE) did (he/she) ever live in a house that you know was treated for termites?

1 [ ] YES

2 [ ] NO

F16 & F16a. OMITTED

SECTION G

OTHER MEDICAL CONDITIONS

Now a few questions about (his/her) medical history.

G1. Did a doctor ever tell (him/her) that (he/she) had (READ A):

G2. In what year did a doctor first tell (him/her) that (he/she) had-- (READ "A")

	G1	G2	
a. a bladder infection or cystitis	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
b. a kidney infection	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
c. urinary bladder, kidney or renal stones (NOT GALLBLADDER)	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
d. familial or colo-rectal polyposis (polyps)	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
e. inflammatory bowel disease	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
f. ulcerative colitis	[1] YES [2] NO [8] DK	____ YEAR	[8] DK
g. diabetes	[1] YES [2] NO [8] DK	____ YEAR	[8] DK

G3. Did (he/she) ever have cancer?

1 [ ] YES

2 [ ] NO (SKIP TO G10)

8 [ ] DK (SKIP TO G10)

G4. What kind of cancer did (he/she) have?

_______________________________ TYPE OF CANCER

[ ] DK

G4a. In what year was the cancer diagnosed?

__________ YEAR

[ ] DK (ASK G6)

G5. INTERVIEWER CHECK:

[ ] DATE IN G4a IS <u>SAME</u> AS OR <u>LATER</u> THAN DATE ON COVERSHEET (SKIP TO G7)

[ ] <u>EARLIER</u> THAN DATE ON COVERSHEET (ASK G6)

G6. What kind of treatment did (he/she) receive for it? -- Did (he/she) have: (READ A)

	<u>YES</u>	<u>NO</u>	<u>DK</u>
a. Surgery?	[1]	[2]	[8]
b. Radiation?	[1]	[2]	[8]
c. Chemotherapy?	[1]	[2]	[8]

G7. Did (he/she) ever have any <u>other</u> kind of cancer?

1 [ ] YES

2 [ ] NO (SKIP TO G10)

8 [ ] DK (SKIP TO G10)

G7a. What kind of cancer did (he/she) have?

____________________ CANCER

[ ] DK

G7b. In what year was the cancer diagnosed?

__________ YEAR OR __________ [ ] R's AGE

[ ] DK (ASK G9)

G8. INTERVIEWER CHECK:

[ ] DATE IN G7b IS <u>SAME</u> AS OR <u>LATER</u> THAN DATE ON COVERSHEET (SKIP TO G10)

[ ] <u>EARLIER</u> THAN DATE ON COVERSHEET (ASK G9)

G9. What kind of treatment did (he/she) receive for it? -- Did (he/she) have: (READ A)

	YES	NO	DK
a. Surgery?	[1]	[2]	[8]
b. Radiation?	[1]	[2]	[8]
c. Chemotherapy?	[1]	[2]	[8]

G10. Did (he/she) ever receive radiation (such as x-rays, cobalt treatments or radioisotopes) as part of a medical treatment (other than what you've already told me about)?

1 [ ] YES

2 [ ] NO (SKIP TO G14)

8 [ ] DK (SKIP TO G14)

G11. For what condition?

a. ____________ [ ] DK

b. ____________ [ ] DK

G12. To what parts of the body?

a. ____________ [ ] DK

b. ____________ [ ] DK

G13. In what year did (he/she) receive radiation treatment?

__________ YEAR

__________ YEAR

[ ] DK

G14. How tall was (he/she)?

________ FEET ________ INCHES

[ ] DK

G15. OMITTED

G16. What was (his/her) highest adult weight? (EXCLUDE PREGNANCY FOR WOMEN)

_________ POUNDS

[ ] DK (SKIP TO G18)

G17. How old was (he/she) at that time?

_________ AGE

[ ] DK

G18. And what was (his/her) usual adult weight?

_________ POUNDS

[ ] DK

G19. Has any (other) member of (his/her) family -- parents, siblings, or children -- ever had cancer?

1 [ ] YES

2 [ ] NO (SKIP TO H1)

8 [ ] DK (SKIP TO H1)

G20. Which relatives had cancer? (Anyone else?)

G21. What kind of cancer did (he/she) have?

(RELATIONSHIP TO R, NOT TO PROXY)

	RELATIVE	TYPE OF CANCER	
a.	_________	_____________	8 DK
b.	_________	_____________	8 DK
c.	_________	_____________	8 DK
d.	_________	_____________	8 DK

H. OB/GYN HISTORY

INTERVIEWER CHECK:

[ ] TARGET R IS MALE (SKIP TO SECTION J, PAGE 34)

[ ] TARGET R IS FEMALE

H1. Was she ever pregnant even if it did not result in a live birth?

1 [ ] YES

2 [ ] NO (SKIP TO H8)

8 [ ] DK (SKIP TO H8)

H2. How many children were born to her?

__________ NUMBER OF LIVE BIRTHS

[ ] NONE (SKIP TO H4)

8 [ ] DK (SKIP TO H4)

H3. How old was she when her (first) child was born?

__________ AGE AT FIRST BIRTH

8 [ ] DK

H4. Did she ever have a stillbirth? (STILLBIRTH: ANY PREGNANCY THAT LASTED LONGER THAN SIX MONTHS WHERE THE INFANT WAS NOT BORN ALIVE)

1 [ ] YES

2 [ ] NO (SKIP TO H7)

8 [ ] DK (SKIP TO H7)

H5. How many stillbirths did she have?

__________ NUMBER OF STILLBIRTHS

8 [ ] DK

H6. How old was she when she had her (first) stillbirth?

_________ AGE AT FIRST STILLBIRTH

8 [ ] DK

H7. During any pregnancy was she given DES (diethylstilbestrol)?

1 [ ] YES

2 [ ] NO

8 [ ] DK

H8. Did she ever use oral contraceptives or birth control pills?

1 [ ] YES

2 [ ] NO (SKIP TO H9)

8 [ ] DK (SKIP TO H9)

H8a. For how many years total did she take them?

_________ TOTAL YEARS

8 [ ] DK

H8b. In what year did she stop taking them?

_________ YEAR

[ ] DK

H9. Did a doctor ever find a lump or tumor in her breast?

1 [ ] YES

2 [ ] NO (SKIP TO H10)

[ ] DK (SKIP TO H10)

H9a. Was the lump or tumor malignant?

1 [ ] YES

2 [ ] NO

[ ] DK

H10. Did she ever have any other medical problem with her breasts?

1 [ ] YES

2 [ ] NO (SKIP TO H11)

[ ] DK (SKIP TO H11)

H10a. Did she have: (READ "A")	YES	NO	DK	H10b. In what year did she first have (READ "A") ...
a. Cysts or nodules?	[1]	[2]	[8]	_______ YR [8] DK
				OR _______ YRS AGO
b. Fibrocystic disease?	[1]	[2]	[8]	_______ YR [8] DK
				OR _______ YRS AGO
c. Fibroadenoma?	[1]	[2]	[8]	_______ YR [8] DK
				OR _______ YRS AGO
d. Chronic mastitis?	[1]	[2]	[8]	_______ YR [8] DK
				OR _______ YRS AGO

H11. Did she experience menopause or change of life?

1 [ ] YES

2 [ ] NO (SKIP TO H12)

8 [ ] DK (SKIP TO H12)

H11a. In what year did it start?

_________ YEAR

8 [ ] DK

H11b. Did she ever take any female hormone medication such as Premarin or other estrogens for hot flashes or other menopausal symptoms?

1 [ ] YES

2 [ ] NO (SKIP TO H12)

8 [ ] DK (SKIP TO H12)

H11c. For how many years total did she use these medications?

_________ YEARS

[ ] DK

H11d. In what year did she last use them?

_________ YEAR

[ ] DK

H12. Did she ever have a hysterectomy?

1 [ ] YES

2 [ ] NO (SKIP TO H13)

8 [ ] DK (SKIP TO H13)

H12a. How old was she when she had it?

____

[ ] DK

H12b. Did she have both ovaries removed or not?

1 [ ] YES

2 [ ] NO

8 [ ] DK

H13. How old was she when she first started her menstrual period?

_________ AGE AT MENARCHE

[ ] DK

SECTION J: DEMOGRAPHIC VARIABLES

Now we would like some background information about (him/her).

J1. What is the month and year of (his/her) birth?

__________ MONTH __________ YEAR

J2. What was (his/her) marital status (when he/she died) -- <u>married</u>, <u>widowed</u>, <u>separated</u>, <u>divorced</u>, or was (he/she) <u>never married</u>?

1 [ ] MARRIED

2 [ ] WIDOWED

3 [ ] SEPARATED

4 [ ] DIVORCED

5 [ ] NEVER MARRIED (SKIP TO J5)

8 [ ] DK

J3. Was (he/she) married more than once?

1 [ ] YES

2 [ ] NO

8 [ ] DK

J4. [During the years (he/she) was married)]/ [Thinking of the spouse (he/she) was married to longest] what was (his/her) (husband's/wife's) usual occupation? (IF PROXY IS SPOUSE: What was your usual occupation)?

______________________________ OCCUPATION

[ ] HOUSEWIFE (SKIP TO J5)

<u>1st MENTION</u>

J4a. What were (his/her/your) activities or duties?

____

____

J4b. For what kind of company did (he/she/you) work? that is what did they make or do?

____

<u>2nd MENTION</u>

J4a. What were (his/her/your) activities or duties?

____

____

J4b. For what kind of com-pany did (he/she/you) work? That is what did they make or do?

____

____

J5. What is the highest grade in school that (he/she) completed? [IF HIGH SCHOOL OR COLLEGE: Did (he/she) graduate?]

1 [ ] LESS THAN 8th GRADE

2 [ ] EIGHTH GRADE

3 [ ] 1-3 YEARS HIGH SCHOOL

4 [ ] HIGH SCHOOL GRADUATE

5 [ ] VOCATIONAL SCHOOL OR OTHER NON-COLLEGE POST

6 [ ] 1-3 COLLEGE

7 [ ] A COLLEGE DEGREE

8 [ ] GRADUATE WORK

[ ] DK

J6. What was (his/her) religious background -- Was it <u>Catholic</u>, <u>Protestant</u>, <u>Jewish</u>, or <u>something else</u>?

1 [ ] CATHOLIC

2 [ ] PROTESTANT

3 [ ] JEWISH

4 [ ] SOMETHING ELSE (SPECIFY) ____________

8 [ ] DK

J7. Which of the following best describes (his/her) background -- <u>white</u>, <u>black</u>, <u>Hispanic</u>, <u>American Indian</u>, <u>Asian</u>, <u>Cape Verdian</u>, or <u>something else</u>?

1 [ ] WHITE

2 [ ] BLACK

3 [ ] HISPANIC

4 [ ] AMERICAN INDIAN

5 [ ] ASIAN

6 [ ] CAPE VERDIAN

7 [ ] OTHER (SPECIFY) ____________________________

[ ] DK

J5. What is the highest grade in school that (he/she) completed? [IF HIGH SCHOOL OR COLLEGE: Did (he/she) graduate?]

1 [ ] LESS THAN 8th GRADE

2 [ ] EIGHTH GRADE

3 [ ] 1-3 YEARS HIGH SCHOOL

4 [ ] HIGH SCHOOL GRADUATE

5 [ ] VOCATIONAL SCHOOL OR OTHER NON-COLLEGE POST

6 [ ] 1-3 COLLEGE

7 [ ] A COLLEGE DEGREE

8 [ ] GRADUATE WORK

[ ] DK

J6. What was (his/her) religious background -- Was it Catholic, Protestant, Jewish, or something else?

1 [ ] CATHOLIC

2 [ ] PROTESTANT

3 [ ] JEWISH

4 [ ] SOMETHING ELSE (SPECIFY) ____________

8 [ ] DK

J7. Which of the following best describes (his/her) background -- white, black, Hispanic, American Indian, Asian, Cape Verdian, or something else?

1 [ ] WHITE

2 [ ] BLACK

3 [ ] HISPANIC

4 [ ] AMERICAN INDIAN

5 [ ] ASIAN

6 [ ] CAPE VERDIAN

7 [ ] OTHER (SPECIFY) ____________________________

[ ] DK

J8. In what city, state, or country was (he/she) born?

____

[ ] DK

J9. **From what country did (his/her) family come from on (his/her) father's side (before coming to the U.S. or Canada)?**

____

[ ] DK

J10. **From what country did (his/her) family come from on (his/her) mother's side (before coming to the U.S or Canada)?**

____

[ ] DK

J11. **Finally, do you think that there was anything about the air, the water, or any other environmental factor on the Upper Cape that might ever have made (him/her) sick?**

1 [ ] YES

2 [ ] NO (SKIP TO END)

8 [ ] DK (SKIP TO END)

J11a. What is it?

____

____

THANK R

CUMULATIVE DOSE OF TETRACHLOROETHYLENE RECEIVED BETWEEN 1968 AND 1985 BY MASSACHUSETTS RESIDENTS FROM VINYL LINED ASBESTOS CEMENT WATER DISTRIBUTION PIPES:

AN EMPIRICALLY-BASED MODEL

FINAL DRAFT

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Clark University
Worcester, Massachusetts

July, 1989

1 Introduction

In the late 1960s Johns-Manville Corporation introduced into the New England market a new type of pipe for municipal water distribution systems. The innovation consisted of a vinyl polymer (Piccotex) liner for asbestos cement pipes. The vinyl coating was designed to protect the widely used asbestos cement from the corrosive effects of hard New England waters. It was a welcome replacement of bituminous lining which reportedly imparted an undesirable taste to the water. The vinyl lined asbestos cement pipes (VL/AC) were sold in New England from 1968 to 1979. Approximately a thousand miles of the pipes were installed in New England, of which 70% were in Massachusetts. The most intensive installation occurred in the Upper Cape Cod region of Massachusetts, which was undergoing rapid development during the 1970s.

Late in 1979 it was discovered that the solvent used to apply the vinyl resin in the manufacturing process, tetrachloroethylene (perchloroethylene, PCE), was present in the matrix of the Piccotex lining long after the installation date of the pipes. In addition, the PCE was continuously leaching into the drinking water. PCE is a suspected carcinogen, but at that time it was not regulated under the National Interim Primary Drinking Water Regulations promulgated by the EPA under the Safe Drinking Water Act. The Massachusetts Department of Environmental Quality Engineering banned the pipes from the market in early 1980, but concerns about the health effects of long-term PCE consumption were never resolved.

Several studies on the leaching rate of PCE under various water flow rate conditions were conducted in 1980 [1-4]. These studies showed that the highest concentrations of PCE existed in dead-end pipes and in pipes where low water flow rates persisted. On the average, the concentration of PCE declined over time in an exponential manner with a half-life between one and two years. After about seven years, the PCE concentrations reached the EPA Suggested Action Guideline (SAG) of 40 parts per billion (ppb).

Risk management activities focused on immediately reducing the exposure that people in high risk situations received. This was accomplished by installing bleeder valves at dead-ends and other strategic locations to keep the water in the pipes moving. A monitoring program was also initiated to regularly measure PCE concentrations. These management efforts were immediately successful in drastically reducing human exposure to PCE after

1980; nevertheless, the possibility that adverse health effects might result from exposures during the preceding decade remained unaddressed. Therefore, it was not surprising that, when the Massachusetts Department of Public Health (MDPH) observed higher than anticipated cancer incidence rates in several of these communities in the 1980s, the question of exposure to PCE again appeared.

In 1988 the MDPH initiated an epidemiologic study into the environmental causes of these elevated cancer rates in the five Upper Cape Cod towns: Barnstable, Bourne, Falmouth, Mashpee, and Sandwich. Among other potential causal variables, past exposure to PCE was to be considered. The study encompassed 1,200 cases and 1,500 controls. For each of these subjects, exposure to PCE was to be classified according to the cumulative amount of PCE which they consumed in drinking water while in residence in these towns.

In this article we describe the methodology developed to determine the delivered dose of PCE to the 2,700 subjects of this study. We also illustrate the application of the methodology to specific hypothetical instances and discuss the uncertainties involved in the analysis.

2 Characterization of Delivered Dose

Based on existing records, interviews, and laboratory and field measurements [1-4], we assume the following exposure scenario. A freshly coated and newly installed water pipe can produce PCE concentrations in the drinking water at levels as high as several thousand parts per billion (ppb) - especially under static conditions. This level is promptly reduced with initial flushing of the pipe. Once the pipe is put in normal service, the concentration of PCE remains in the hundreds of ppb, but drops exponentially over time. The rate of decline varies upon the volume of water flowing in the pipe; greater volumes reduce the amount of PCE more quickly. In may take anywhere from one to eight years for the level of PCE in the water to reach EPA-determined safe levels. Thus, the cumulative dose that an individual receives depends upon several variables: the duration of their exposure, the timing of their exposure relative to the pipe installation date, the initial amount of PCE in the pipe lining, and the use-rate of water in their neighborhood.

2.1 Definition of Delivered Dose

We define <u>delivered dose</u> as the mass of PCE (mg) which entered a given house as a solute in drinking water over a specific time period (years). The rate at which this mass is delivered, (mg/time) we define as the <u>dose rate</u>. At any given interval of time, the delivered mass (mg) is directly proportional to the product of: volume of water x concentration of PCE (gallons x mg/gallon). Thus, the delivered dose is proportional to dose rate integrated over time. To compute the delivered dose, we first derive expressions for dose rate.

Because of the complexity of the water distribution system and the uncertainty about the initial amount of PCE in the pipes, we did not attempt to explicitly quantify the delivered dose of PCE received by the individuals under study. Instead, we chose to determine relative delivered dose. (Thus it should be understood that hereafter, "delivered dose" is really "relative delivered dose".) Although the product of the analysis is still quantitative, it should not be mistaken for a determinate value of mass delivered. The numbers are relative to the actual delivered mass, but the constants and variables assumed to be constant have been dropped from the analysis. We have done this to discourage interpretation of results without due consideration for the uncertainties implicit in the models.

2.2 Key Variables to Estimate Delivered Dose

In order to characterize the delivered dose among the affected population, we first determined the key variables needed to compute dose rate and then, based on the empirical data available, assembled these variables into a model which could be tailored to each specific instance.

The choice of variables was based on the following assumptions. First, there is a finite amount of PCE in the lining (Piccotex) of each pipe and it is distributed uniformly on the inside surface of the pipes. Second, all pipes have identical amounts of PCE per unit length at their installation date. Third, PCE leaches from the Piccotex into the water without reaching a steady state condition since the water is always flowing. Fourth, the PCE leaching rate decreases with time, because of assumptions one and three.

We assume that the initial stock of PCE in any segment of a pipe at the installation date is directly proportional to the surface area of the pipe. The latter can be computed from the length and diameter of each pipe. We also assume that the stock of PCE decreases with time elapsed since the installation date, thus, age of the pipe must be known to compute stock at any time.

Other researchers have suggested that the rate of PCE leaching from the Piccotex liner depends on water flow rate, water temperature, PCE concentration gradients, water density and viscosity, characteristics of Piccotex, and diameter of the pipe [1].

Once the PCE is in the drinking water, the flow of water throughout the distribution system is among the key affects that determine the delivered dose to any specific house.

Parameters to describe this are: network geometries, pipe diameters and lengths, and loading distributions. Network geometries describe water flow direction and mixing. Specific examples are dead-ends, circles, or circles with taps. Diameters and lengths describe how bifurcations act. Loading parameters such as number of houses upstream, number of houses downstream, distance between houses and water use per house describe PCE concentration variations as well as water flow direction and rate.

Finally, the delivered dose which an individual received depends not only on the physical setting of their residence (modeled by the variables above), but also on the duration of their residency in that particular home and its relevance to the pipe installation date.

2.2.1 Pipe Characteristics

Data on type, length, diameter, and age of water pipes was widely available, although in different forms. Some towns had up-to-date distribution maps showing the type, age, length, and diameter of every pipe. For other towns, the knowledge was "in the head" of the water superintendent.

We assembled a map for each town with the VL/AC pipes highlighted (either by referring to available data or by tapping the superintendent's memory) and their age, length, and diameter shown.

2.2.2 PCE Leaching

The physical process of diffusion of a solvent through a polymer can be described in substantial mathematical detail. Unfortunately, the complexity is too great to enable application of these microscopic models to macroscopic situations such as this. As such, "real-life" performance is much more unpredictable than laboratory experiments. Modeling the PCE leaching on a practical scale requires many assumptions and much simplification. For these reasons, we assumed water temperature, density, and viscosity and the physical parameters of the Piccotex to be constant. This is discussed in further detail in Section 3.

Because of poor quality control in the application of the Piccotex to the pipes and the variable drying period of different shipments, the amount of PCE trapped in the lining of the pipes was not consistent for all pipes. It is, however, impossible to know the original quantity of PCE that was in the pipe when it was installed. Although we expect that the variation might have been quite wide, for our purposes we assumed that each pipe had the same amount of PCE per unit area when it was installed, although the actual quantity is not known.

2.2.3 Water Distribution System

The geometry of the water distribution network is a complicated factor in the exposure assignment process. The system can be modeled as a tree - with uni-directional flow into dead-ends - but this ignores the complications brought on by shunts and circles. In some instances it is not at all clear in which direction the water flows. This is important to know because the water accumulates PCE as it flows through VL/AC pipe.

The situation is further complicated by the fact that the pattern of water flow shifts with time. Particularly in regions adjacent to seasonal communities, water flow in summer can be substantially different from winter patterns.

Despite these complexities, most water superintendents felt confident about their ability to determine water flow patterns for specific instances. But, because this information is extremely context-specific, we could not practically adopt a descriptive variable for this parameter. Instead, we decided to focus on the simple geometries (dead-end, circles, circles with taps, and in-line) on the basis that these "building blocks" could be combined in patterns to model any desired circumstance. We also developed "rules-of-thumb" to determine water flow direction in confusing situations (See Appendix A).

The loading on the water pipes is an important factor, therefore, it is described in substantial detail in our model. The number of houses connected, the year of connection, and the rate of water use per house are needed to accurately determine the volume of water and concentration of PCE over time. Most of these data were difficult, if not impossible, to obtain. Falmouth, which had the best records by far, had information on number of houses connected and dates of connection, but accessing the information was prohibitively time-consuming. Meter records on water consumption per household were available, but only to the mid-1970s. For other towns, the data gaps were wider and access more difficult.

1988 maps of the towns were available, earlier maps were not. To perform a well-balanced analysis we sought out common data which were available for each of the towns. We ended up using 1988 water distribution maps or zoning (assessor) maps with the water systems drawn in. From these we were able to extract a close estimate of the number of houses connected to each pipe.

2.2.4 Years of Exposure

Each living subject of the study reported their addresses and associated years of residency in the Upper Cape Cod region. From these data we were able to compute each person's period of exposure and relation to pipe installation dates. For the deceased subjects of the study we used ____ as the last year of exposure. For the living subjects we used ____ as the last year of exposure. Throughout we assumed no changes in the number of or location of the houses on the subject's street since the pipe installation date and that each of the houses shown on the 1988 maps were connected to the water distribution pipes promptly after the pipe was installed.

2.3 Summary of Assumptions in Modeling Delivered Dose

- o PCE leaching rate does not reach steady-state.
- o Thickness of Piccotex is constant for all pipes.
- o Mass of PCE per surface area is constant for all pipes at their installation date.
- o Any specific circumstance can be modeled as a combination of dead-ends, circles, circles with taps, or in-line.
- o All house lots shown on the supplied 1988 maps were present since pipe installation date and were connected to that pipe.
- o Each household consumes water at the same rate.
- o Water flow rate at any single point along the main is constant.

3 Development of Model for Dead-end Case

The ultimate goal of the model was to allow us to integrate the dose rate of PCE entering a subject's residence over time in order to arrive at a value for delivered dose (DD) (Section 3.4).

In Section 3.1 Independent variables: length (L), diameter (D), time (t), and water flow rate per house (q) were incorporated into a PCE leaching model to produce an expression for the dependent variable PCE leaching rate (F).

In Section 3.2 the water flow rate in the pipe is modeled by describing the physical geometry of each segment of water pipe with the dependent variables - water flow rate in main (Q) and PCE leaching rate into the main (F) - defined at each node of the model as shown in Figure 1. (A node is a point on the water main where a household connection pipe is attached.)

In Section 3.3 Independent variables: water flow rate per house (q) and total number of houses (k) were used to express loading distribution on the water main in order to compute the dose rate for any house (i) on the street.

Q = flow rate of water in the main (gallons/time)
q = flow rate of water into a house (gallons/time)
F = leaching rate of PCE into the water main (mg/time)
f = dose rate of PCE into a house (mg/time)
k = number of houses on street
i = house (node) of interest (counted from the source end)
(i-1) = number houses upstream of a node i
(k-i) = number of houses downstream of node i.

Since we assumed that each house draws the same amount of water, q, for dead-end case the water flow rate into the main, Q(0) = kq. At the end of the pipe is a dead-end, the water flow in main after the last house, Q(k) = 0.

3.1 Model of PCE Leaching

Here we sought to quantitatively model the percent of the original PCE stock remaining in the particular pipe over time.

3.1.1 Past Attempts at Models

For newly lined pipes, Johns-Manville reported empirical findings that PCE leaching rate from Piccotex into water in new pipes was dependent mainly ($R^2 = 0.76$) on the water flow rate according to the equation:

$$F\left(\frac{mg}{ft^2 \cdot min}\right) = 0.064 + 0.011\, Q\left(\frac{gal}{min}\right) \qquad \text{Eq. 1}$$

Demond agreed that this "sometimes gives a 'ball park' figure" [1, p.71], but that there was no physical basis for the function. She proposed a model based on the Fick diffusion equation and on conservation of mass that, put simply, says: the leaching rate of PCE through Piccotex and into water is directly proportional to the concentration gradient from the edge of the Piccotex liner to the water in the center of the pipe.

The ease with which the PCE molecules move through the Piccotex is represented by a diffusion coefficient. She assumed that the diffusion coefficient was a constant and that the concentration gradient was limiting the PCE leaching rate. Based on fluid dynamics, she deduced that the PCE leaching rate (F) should be proportional to the square root of the velocity of the water flowing in the pipe. Unfortunately, she was unable to verify that her hypothesis gave results much better than Johns-Mansville's.

As the pipes age, the way that PCE leaches also changes. For long-time performance, Demond assumed that the diffusion coefficient varied exponentially. In this scenario the Piccotex is presumed to limit PCE flux [1, p.105]. She then derived a relationship between the percent of PCE which had diffused out of the Piccotex and time.

Demond's work provides the basis for the deduction of such a relationship. Her solutions to the non-linear differential equations can be simplified as a two-part polynomial [1, p.119]. We have rearranged her output as percent of PCE remaining with time and have plotted these results in Figure 2. Also plotted is a first order negative exponential with a rate constant of 2.25 years. The two curves match very well (R = 0.994).

In summary, we have represented the leaching rate of PCE out of the Piccotex and into the water, over long-time periods, as a first order exponential. The PCE can be considered to have a half life of 1.56 years in the Piccotex liner of a water main in use. After 7 years, only 4% of the original amount of PCE remains in the pipe.
This is consistent with empirical data collected in the field during the risk management actions which revealed that, 6 to 7 years after the pipe installation date, PCE levels in the drinking water were acceptable [2].

3.1.2 Derivation of Formulae

We define a function, $\rho(t)$, to represent the leaching of PCE per unit area and time. Then, for section of pipe dl,

$$dF = \pi D \rho(t)\, dl \qquad \text{Eq. 2}$$

where D = diameter of pipe.

For a given length of pipe integrate both sides:

$$F_i(t) = \pi D_i l_i \rho(t) \qquad \text{Eq. 3.}$$

where $l_i = l_2 - l_1$ and subscript i refers to the specific segment of pipe between this house and the previous (upstream) house (i.e. between nodes i and i-1).

$\rho(t)$ is relative to the installation date, $\bar{t}$, since we assume pipe has been in use since its installation.
For pipe i:

$$F_i(t) = \pi D_i l_i \rho(t - \bar{t}_i) \qquad \text{Eq. 4}$$

Substituting the equation for $\rho(t)$ from Figure 1 we get,

$$F_i(t) = \pi D_i l_i C_{1i} e^{-\frac{(t-\bar{t}_i)}{r}} \qquad \text{Eq. 5}$$

where C_1 represents the original amount of PCE in the Piccotex (not known) and time is in years.

Since we are interested in determining delivered dose over some period of time, we need to compute the amount of PCE that leached into the water during that time. To normalize time with respect to the installation date, $\bar{t}$, let

$$\tau_i = t - \bar{t}_i \qquad \text{Eq. 6}$$

Then integrate Eq. 5 over this time period and sum each pipe segment along the entire pipe (from house 1 to house k):

$$F_K(t_1, t_2) = \sum_{s=1}^{K} \int_{\tau_1}^{\tau_2} \pi D_s l_s C_{1s} e^{-\frac{\tau_s}{r}} d\tau \qquad \text{Eq. 7}$$

where the summing variable, s, has replaced the specific identifying variable, i. This is how we account for all of the upstream houses. Notice that each segment of pipe may have its own diameter, length, installation date, and/or initial amount of PCE per unit surface area.

If every segment of pipe, s, is the same (the geometry is consistent), then this simplifies to

$$F_K(t_1, t_2) = -\pi r D L C_1 \left(e^{-\frac{\tau_2}{r}} - e^{-\frac{\tau_1}{r}} \right) \qquad \text{(mass)} \qquad \text{Eq. 8}$$

where L = length of entire pipe.

This gives a value for the mass of PCE that leached out of the water main which supplied water to the subject's street over the time period of interest. Note that the subject was not exposed to all of this PCE. The dose that each house received can be computed by considering water flow rates and is computed below.

3.2 Model of Water Flow Rate (Q)

The water flow rate can be estimated as follows: Summing the flows at the nodes of Figure 1:

$$Q_1 = Q_0 + F_1 - q_1 \approx Q_0 - q_1 \qquad \text{Eq. 9}$$

$$Q_2 = Q_0 - (q_1 + q_2) \qquad \text{Eq. 10}$$

$$Q_3 = Q_0 - (q_1 + q_2 + q_3)$$

Generically:

$$Q_i = Q_0 - \sum_{s=1}^{i} q_s \qquad \text{Eq. 11}$$

where s = summing variable
i = house of interest, counted from source of this particular pipe.

3.3 Model of Dose Rate

The dose rate is the mass of PCE recieved by a given house per unit of time. To compute dose rate, DR, we first determined the concentration of PCE in the water pipes serving house i, C_{PCE}. The concentration of PCE at each node cannot vary instantaneously, it must be the same in the main just before and after the node and inside the house supply pipe (see Figure 1). At any node the PCE concentration is the PCE leaching rate for that pipe segment divided by the water flow rate in the main plus the concentration of PCE in the water entering the section of pipe for which the leaching rate is being computed. The expression for leaching rate is given in Eq. 5.

By definition:

$$C_{PCE}(t) = \frac{F(t)}{Q(t)} \quad \text{at any point} \qquad \text{Eq. 12}$$

(It is assumed that the water flow rate in the main is constant.)

Starting with the first house,

$$C_{PCE_1}(t) = \frac{F_1(t)}{Q_0} \qquad \text{Eq. 13}$$

$$C_{PCE_2}(t) = \frac{F_2(t)}{Q_1} + C_{PCE_1}(t)$$

$$C_{PCE_3}(t) = \frac{F_3(t)}{Q_2} + C_{PCE_2}(t)$$

Generically,

$$C_{PCE_i}(t) = \sum_{s=1}^{i} \frac{F_s(t)}{Q_{s-1}} \qquad \text{Eq. 14}$$

Substituting Eq. 11 for the denominator and Eq. 5 for the numerator:

$$C_{PCE_i}(t) = \sum_{s=1}^{i} \frac{\pi D_s l_s C_{1s} e^{-\frac{(t-\bar{t}_s)}{r}}}{Q_0 - \sum_{z=1}^{s-1} q_z} \qquad \text{Eq. 15}$$

By definition, the dose rate that house i receives is:

$$DR_i(t) = q_i C_{PCE_i}(t) \qquad \text{(mass/time)} \qquad \text{Eq. 16}$$

3.4 Model of Delivered Dose

By integrating the dose rate over time, we compute delivered dose. This is the dose received by a given house over a specified continuous period of time.

$$DD_i(t_1,t_2) = \int_{t_1}^{t_2} DR_i(t)\,dt = \int_{t_1}^{t_2} q_i \sum_{s=1}^{i} \frac{\pi D_s l_s C_{1s} e^{-\frac{(t-\bar{t}_s)}{r}}}{Q_0 - \sum_{z=1}^{s-1} q_z}\,dt \qquad \text{Eq. 17}$$

$$DD_i(t_1,t_2) = -q_i r \pi \sum_{s=1}^{i} \frac{D_s l_s C_{1s}}{Q_0 - \sum_{z=1}^{s-1} q_z} \left[e^{-\frac{(t_2-\bar{t}_s)}{r}} - e^{-\frac{(t_1-\bar{t}_s)}{r}} \right] \qquad \text{Eq. 18}$$

To simplify, we assume that the geometry is regular, $q_z = q$, $D_s = D$, $l_s = l$, $C_{1s} = C_1$, $\bar{t}_s = \bar{t}$, where l represents the distance between any two adjacent houses. Therefore, the total pipe length, L = kl.

The denominator of Eq. 17 then becomes:

$$\sum_{z=1}^{s-1} q_z = q_1 + q_2 + q_3 + \cdots + q_{s-1} = (s-1)q \qquad \text{Eq. 19}$$

And Eq. 17 becomes,

$$DD_i(t_1,t_2) = \frac{-\pi r D L C_1}{K} \sum_{s=1}^{i} \left[\frac{1}{K-(s-1)}\right]\left[e^{-\frac{(t_2-\bar{t})}{r}} - e^{-\frac{(t_1-\bar{t})}{r}}\right] \qquad \text{Eq. 20}$$

Notice that the water use rate per house has cancelled out.

Now we focus on the last component in Eq. 20 where time is considered. With the constant C_1 brought out front, each of these two exponentials represent the percentage of PCE remaining in the water pipe at their respective times. By definition, this term is negative, because the amount of PCE at t_1 must be greater than the amount at a later point in time, t_2. The subtraction of these two quantities must then represent the total percentage of the original amount of PCE in the VL/AC pipe that has leached into the water over the particular time period (see Figure 3). We can cancel out the two negative signs in Eq. 20, then this term, T, must have a value between zero and one (see Table 1). Eq. 20 then becomes:

$$DD_i(t_1,t_2) = \frac{r \pi D L C_1}{k}\left[\sum_{s=1}^{i} \frac{1}{K-(s-1)}\right] T \qquad \text{Eq. 21}$$

To simplify the equation, and to stress that the uncertainties implicit in the model preclude the determination of absolute quantities of mass, we combine r, π, and C_1 into a constant of proportionality. We then drop this constant and arrive at this expression for (relative) delivered dose.

$$DD_i(t_1,t_2) \sim \frac{DL}{K} \sum_{s=1}^{i} \frac{1}{K-(s-1)} \; T \qquad \text{Eq. 22}$$

This represents relative delivered dose to any house, i, on a dead-end street with k houses and with a water pipe of length L and diameter D, over a given time period in years (Eqs. 15 and 16). (We shall continue to use the term "delivered dose" although it should be kept in mind that this is only a relative measure.)

3.5 Behavior of the Model

Figure 4 schematically shows an example of water flow rates and PCE concentrations in a hypothetical geometry. It is interesting to note that the percent change in concentration between the sequential houses is not consistent. This is a consequence of the summation term in Eq. 22.

Figure 5 explores this summation term in some detail. A consistent geometry is assumed, therefore, water flow rate in the main decreases step-wise, approximated here by a straight line. The mass of PCE entering sequential houses per time (dose rate) increases exponentially from house to house while the amount of PCE in the main peaks and falls to zero at the end of the pipe. Notice that the function representing percent change in PCE concentration (dose rate) from one house to the next is bowl-shaped, even as the delivered dose is exponentially increasing.

4.0 Testing of the Model

4.1 Range of Delivered Doses and Dose Categories

What is the likely range of delivered doses among the residents? To determine this, we began by comparing different loading patterns on pipe of common lengths. If we were to include length varieties, the range would be larger. We began by also assuming residency periods were idenitical for all people. For the dead-end case, we studied the town maps and found two limiting cases.

Low-dose case: k = 20, D = 0.5', and L = 1000'.

$$DD_i \sim \frac{0.5 \cdot 1000}{20} \sum_{s=1}^{i} \frac{1}{21-s} T \qquad \text{Eq. 23}$$

For the first house on the street, i = 1, and the delivered dose is:

$$DD_1 = 25 \sum_{s=1}^{1} \frac{1}{21-s} T = 1.2\,T \qquad \text{Eq. 24}$$

For the last house on the street, i = k = 20, and the delivered dose is:

$$DD_{20} = 25 \sum_{s=1}^{20} \frac{1}{21-s} T = 90\,T \qquad \text{Eq. 25}$$

High-dose case: k = 5, D = 0.67', L = 1000'.
For the first house on the street, i = 1, and the delivered dose is:

$$DD_1 = 134 \sum_{s=1}^{1} \frac{1}{6-s} T = 27T \qquad \text{Eq. 26}$$

For the last house on the street, i = k = 5, and the delivered dose is:

$$DD_5 = 134 \sum_{s=1}^{5} \frac{1}{6-s} T = 305T \qquad \text{Eq. 27}$$

Thus, we found a range in delivered doses from about 1T to 300T. When timing and duration of exposure are included, the range of delivered dose is magnified. For the low case, we chose T = 5%. This means that while the people living there, only 5% of the total amount of PCE originally in that pipe leached out. This scenario might come true if the subject's residency time was well after the pipe was installed. The low case delivered dose is then:

$$DD_{Low} \sim 1.2 \cdot 0.05 = 0.06 \qquad \text{Eq. 28}$$

For the high case, we chose T = 100%. Those people were living there during the time that 100% of the original amount of PCE in the pipe leached out. (This corresponds to a residence time of about ten years for which the beginning coincided with the pipe installation date (see Table 1).

$$DD_{HIGH} \sim 305 \cdot 1.00 = 305 \qquad \text{Eq. 29}$$

In summary, we found delivered dose levels to vary from 0.06 to 305 - about 3.7 orders of magnitude.

Based on the range of relative values of delivered dose, it may be desirable to define dose catagories according to levels of magnitude.

4.2 Sources of Error

Our model is based on several simplifying assumptions which introduce a degree of uncertainty into the estimates of delivered dose. Here we address these uncertainties qualitatively.

4.2.1 Uneven Loading Distributions

A source of error between predicted and actual delivered dose might arise if one house is using a much greater amount of water than are the others. For instance, one residence might draw water for a family of six, a vegetable garden, and a large lawn while a neighbor may live alone and draw very little water.

This error could be represented by the variance in the term, q, (if it were available) and this aspect could be incorporated into the model. It is, however, common in the literature to interpret q as a constant.

4.2.2 Random Water Flow Patterns in Mains

Water distribution systems are not simple concatinations of trunks and branches. As new streets are built, new shunts are made to the original network. In instances where water might take one of many paths to a given house, the immediate demand profile along the pipes probably determines the flow pattern. As such, an accurate assessment of delivered dose to a specific house would require probabalistic data about water use rates. Given the shear number of subjects in this study such a detailed analysis was not possible. Instead, "rules of thumb" were developed for determining the water supply path. These are given in Appendix A, "A User's Guide to the Delivered Dose Spreadsheets".

4.2.3 Non-Uniform Distribution of PCE in Pipes

We have assumed that the mass of PCE per unit inside surface area of pipe is constant for all pipes at their installation date. In reality, there is probably a substantial variance among the pipes because the Piccotex solution was sprayed onto the inside surface of the cement pipes by hand. Furthermore, the drying time and drying conditions varied widely from one batch of pipes to another.

4.2.4 Other Variable Controlling PCE Leaching Rate

We also have assumed the PCE leaching rate to be constant. Although a precise formula has not been derived to model this phenomenon we do expect the rate to be dependent upon many variables. It is difficult to say which are the most prominent, but we speculate that water temperature and pipe diameter are key. It would be simple to incorporate an expression for leaching rate into the model were such a function available. Given the amount of uncertainty regarding PCE leaching, we feel that a constant value is as appropriate as anything else.

5.0 Extention of Dead-end Model to Circle Case

To analyze this geometry, we focus on a steady-state condition where each house draws water flow rate q. Figure 6 presents an example of this case.

For symmetry, the term, l, must be re-defined as:

$$l = \frac{L}{K+1} \qquad \text{Eq. 30}$$

For this example, we computed dose rates for each of the houses. These are presented in Table 2. This was done by adapting the dead-end case model to the circle case. Each half of the circle was considered a dead-end with three houses and the flow to the last house is only 0.5q. The specific formula can be derived from Eq. 18.

$$DD_i(t_1,t_2) = -q_i r\pi \sum_{s=1}^{i} \frac{D_s l_s C_{1s}}{Q_0 - \sum_{z=1}^{s-1} q_z} \left[e^{\frac{-(t_2-\bar{t}_s)}{r}} - e^{\frac{-(t_1-\bar{t}_s)}{r}} \right] \qquad \text{Eq. 18}$$

With the assumption of consistent geometry, this becomes:

$$DD_i(t_1,t_2) = -q_i r\pi D l C_1 \sum_{s=1}^{i} \frac{1}{Q_0 - \sum_{z=1}^{s-1} q_z} T \qquad \text{Eq. 31}$$

When the constants are removed:

$$DD_i(t_1,t_2) \sim q_i D l \sum_{s=1}^{i} \frac{1}{Q_0 - \sum_{z=1}^{s-1} q_z} T \qquad \text{Eq. 32}$$

where l = L/(k+1)
and Qo = q(k - 0.5).
Simplified:

$$DD_i(t_1,t_2) \sim \frac{DL}{(k+1)} \sum_{s=1}^{i} \frac{1}{K-(s-\frac{1}{2})} T \qquad \text{Eq. 33}$$

And $DD_{K/2}$ computed is half the actual value due to symmetry.

The model suggests that the third house would receive a considerably higher delivered dose than the other houses. This is explained by the fact that a relatively small water flow rate (0.5q) exists in the pipe segments leading to the house's connection pipe and, since the PCE leaching rate is assumed constant for all pipe surface area, the concentration of PCE in the water is going to be high.

The system is sufficiently complex to disallow our making any hypotheses about dose rates in the dynamic (actual) system - where demand per house is changing and the water in the pipe become well-mixed. Nonetheless, the steady-state model above is a good approximation of the average delivered dose expected over long time periods.

6 Alteration of Model

In the work to this point, the variable, i, has been employed to represent the sequential number of the specific house under study on a given street, counting from the source end. In the model, a consistent geometry has been assumed to simplify the equations. In the actual case geometries are not consistent; houses are spaced irregularly, dead-ends are rare, pipe diameters change, and houses draw different water flow rates. The exposure level assignment algorithm had to account for this.

We accomplished this by choosing a Δl length of "adequate" resolution, and adding variables for the loading distribution along the water pipe. At each Δl segment of pipe, any loading factor can be attached. This enables the model to account for unequal spacing of loads on the pipe. The choice of what length is "adequate" for good resolution is restricted only by the availability of data.

Here we re-write some previous equations in terms of this new summation variable (length), j, which replaces i. In addition, the definition of "node" now changes to mean any of the regularly-spaced points on the water main where a load may exist. All loads must be at a node. Eq.5 becomes,

$$F_j = \pi D_j \Delta l\, C_{1j}\, e^{-\frac{(t-T_j)}{r}} \qquad \text{Eq. 34}$$

where

$$\Delta l = l_j$$

This represents the rate at which PCE leaches into the section of water pipe preceding node j. The concentration of PCE in the water at node j is this leaching rate divided by the flow rate of water in the pipe just before the node plus the initial concentration of PCE in the water. We use capital Qj to represent the water flow rate in the main just <u>after</u> node j.

$$C_{PCE_j} = \frac{\pi D_j \Delta l\, C_{1j}\, e^{-\frac{(t-T_j)}{r}}}{Q_{j-1}} + C_{PCE_{j-1}} \qquad \text{Eq. 35}$$

where Q (j-1) represents the water flow rate entering section of pipe j. Furthermore, because we can choose our Δl section of pipe to be any "adequate resolution" length, we can decree that all taps to the water main are made at the ends of these Δl sections.

The concentration in Eq. 35 above, also takes into account additions to the PCE stock from upstream sources. Unfortunately, because we have given up the convenience of consistent geometry and flow, no simple equation can be written to express concentration of PCE at any point on the water pipe. Instead, the solution can only be obtained by computing the concentrations at each upstream point and entering these into Eq. 35. This can be accomplished using the Lotus 123 spreadsheet program.

7.0 Development of Algorithm

The task of this project was to provide exposure categorizations for the 2,700 subjects of this epidemiological study. A desirable system would allow a user to assign the subjects relative delivered doses immediately, based upon parameters readily available from maps and the interviews. The parameters we employed in the development of the algorithm were: number of houses on the pipe; spacing of houses on the pipe; diameter, length, and age of the pipe; and residency years of the subject in that house (or, perhaps, date of diagnosis).

The algorithm is implimented in Lotus 123 as a spreadsheet (DE_1C.wk1). A portion of which is shown in Figure 7.

The spreadsheet can accomodate up to fifty nodes and up to three inherently different segments of pipe. Differences may be due to one or more of the following: diameter, installation date, or loading profile. It is intended that the diameter, the installation date, and the distance between nodes be constant along a particular segment of pipe; although the spreadsheet assigns values for these variables to each Δl section and the user could change a value if there were reason to do so.

Each pipe modeled should be VL/AC pipe, although it is possible to incorporate a non-VL/AC segmet of pipe into the model.

Column A represents the integer set, j, of nodes. Each entry corresponds to a node at the end of a Δl section of pipe. Nodes are numbered sequentially, from the water source-end of pipe up to (or past) the house of study. Thus, the node assignments cross boundaries of different pipe segments.

Column B contains the diameters of each pipe segment, repeated for each Δl section.

Column C represents the length of each Δl section of pipe. This is computed by dividing the total pipe segment length by the number of nodes on that segment.

Column D lists the installation date of each pipe segment, repeated for each Δl section.

Column F represents the loading profile. At every node there must be a load. The load may be 1 (one house) or more than 1 (many houses, i.e. another street, an apartment building), or no load at all. Since nodes are spaced regularly, the number of nodes (resolution) is determined by the length of the pipe and the distance between the two closest houses.

The sum of the entries in Column F represents the initial water flow rate into the water main (Q_o).

Column E (hidden) is the time factor, T. This is computed as:

$$T = -\left[e^{-\frac{(t_2-\bar{t})}{r}} - e^{-\frac{(t_1-\bar{t})}{r}}\right] \qquad \text{Eq. 36}$$

Column H (hidden) is:

$$\frac{D_j \, \Delta l_j}{Q_o - \sum_{z=1}^{j-1} q_z} T \qquad \text{Eq. 37}$$

Column I (hidden) is the summation of Column H:

$$\sum_{j=1}^{s} \frac{D_j \, \Delta l_j}{Q_o - \sum_{z=1}^{j-1} q_z} T \qquad \text{Eq. 38}$$

Column J (hidden) is the delivered dose. This is Column E multiplied with Column I:

$$\sum_{j=1}^{s} \frac{D_j \, \Delta l_j}{Q_o - \sum_{z=1}^{j-1} q_z} T \qquad \text{Eq. 39}$$

Which is Eq. 22.

9 References

1. Demond, A. H.; "A Source of Tetrachloroethylene on the Drinking Water of New England: An Evaluation of the Toxicity of Tetrachloroethylene and the Prediction of its Leaching Rates from Vinyl-Lined Asbestos-Cement Pipe", Master's Thesis in Civil Engineering at MIT, August, 1982.

2. Massachusetts Department of Environmental Quality Engineering; "Interim Report on Tetrachloroethylene Contamination of Public Drinking Water Supplies Caused by Vinly-Lined Asbestos Cement Pipe", September, 1980.

3. Wakeham, S., Davis, A., Witt, R., Tripp, B., Frew, N.; "Tetrachloroethylene Contamination of Drinking Water by Vinyl-Coated Asbestos-Cement Pipe", Bulletin of Environmental Contamination and Toxicology, 25, 639-645 (1980).

4. Yuskus, P.; " ", Journal of the New England Water Works Association, June 1983.

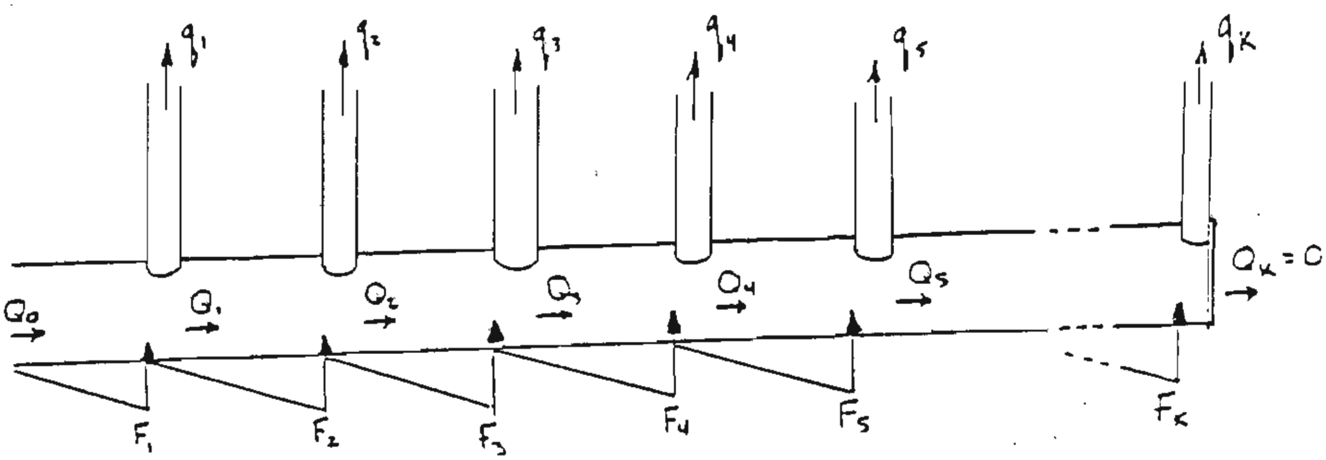

Figure 1

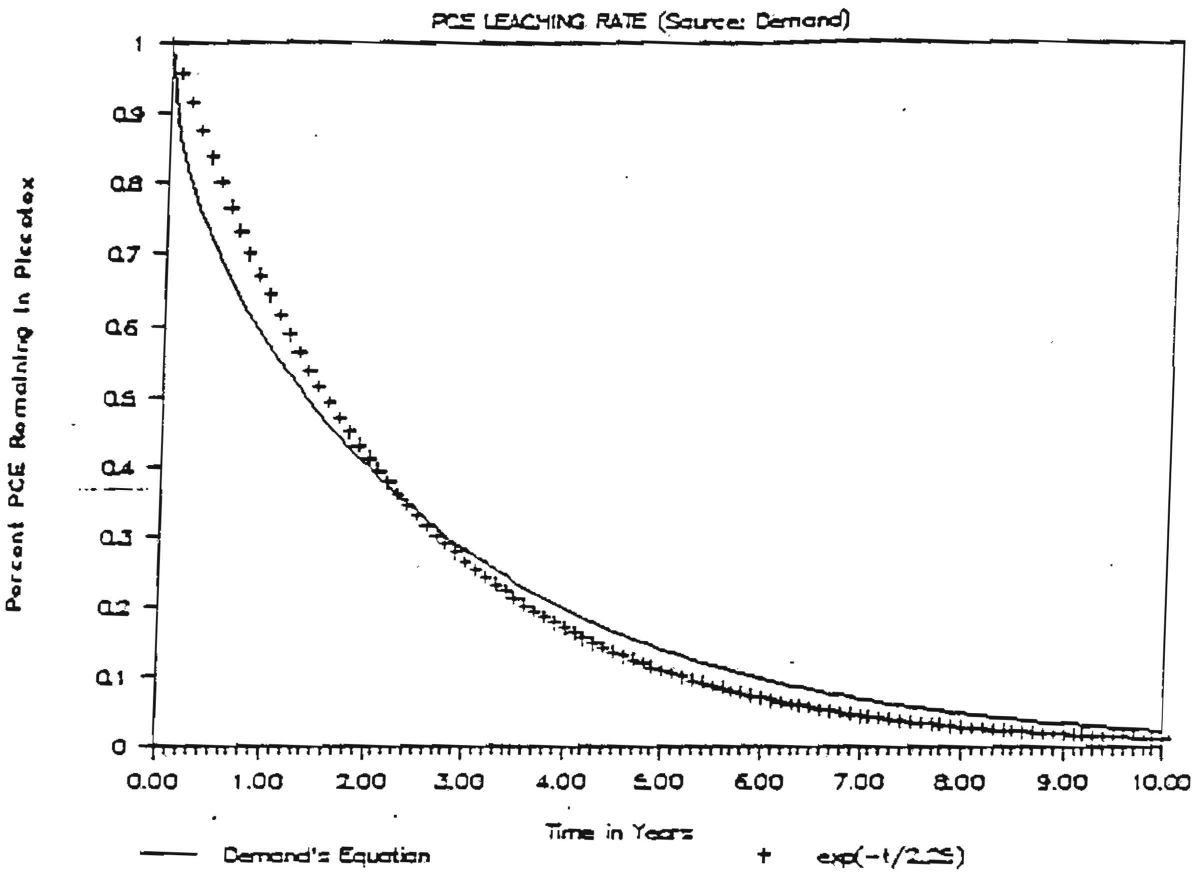
PCE LEACHING RATE (Source: Demand)
Percent PCE Remaining In Plecolex
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Time in Years
Demand's Equation
exp(-t/2.25)

Figure 2

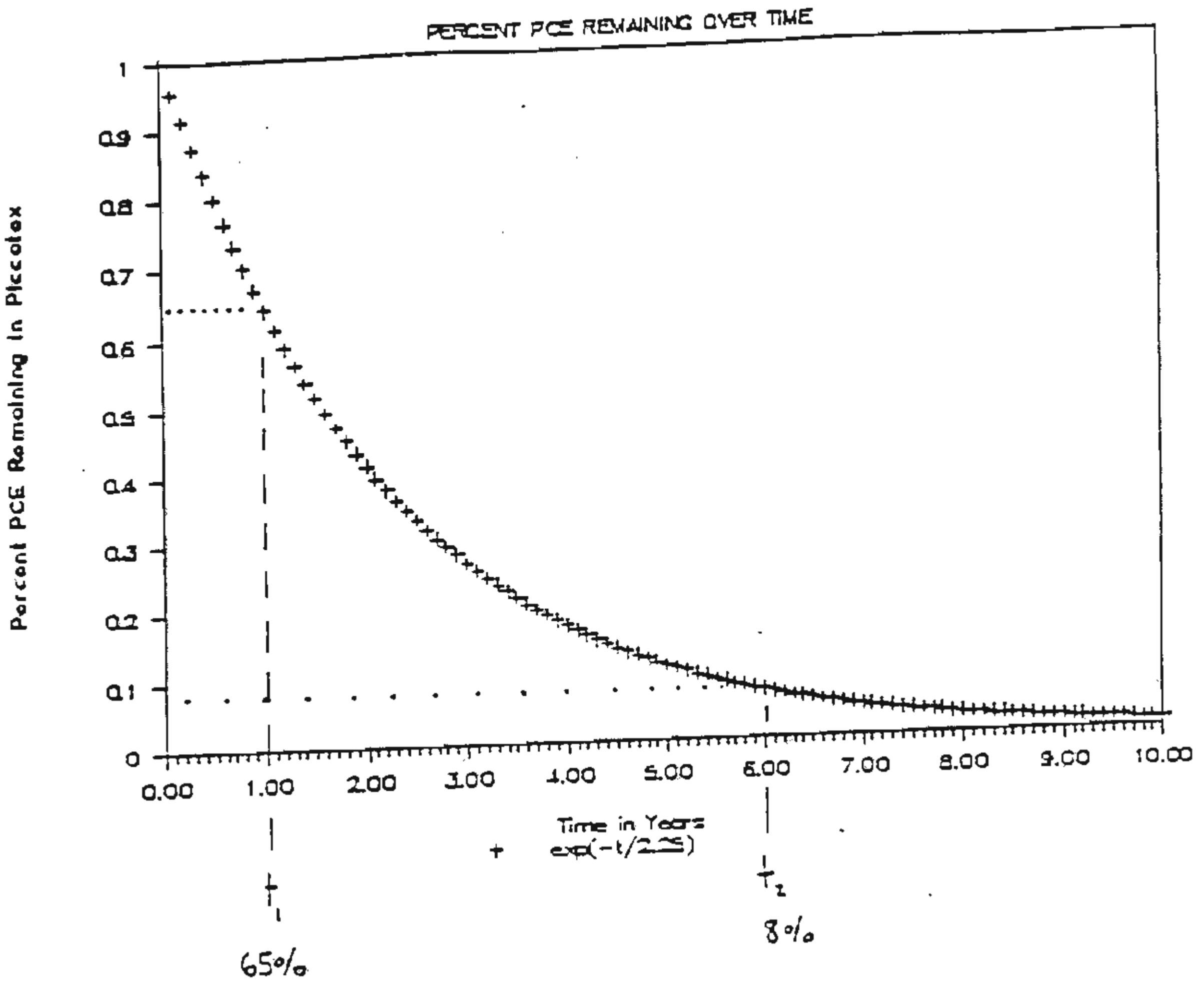
PERCENT PCE REMAINING OVER TIME
Percent PCE Remaining in Piccolox
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Time in Years
+ exp(-t/2.25)
t_1
65%
t_2
8%

Figure 3

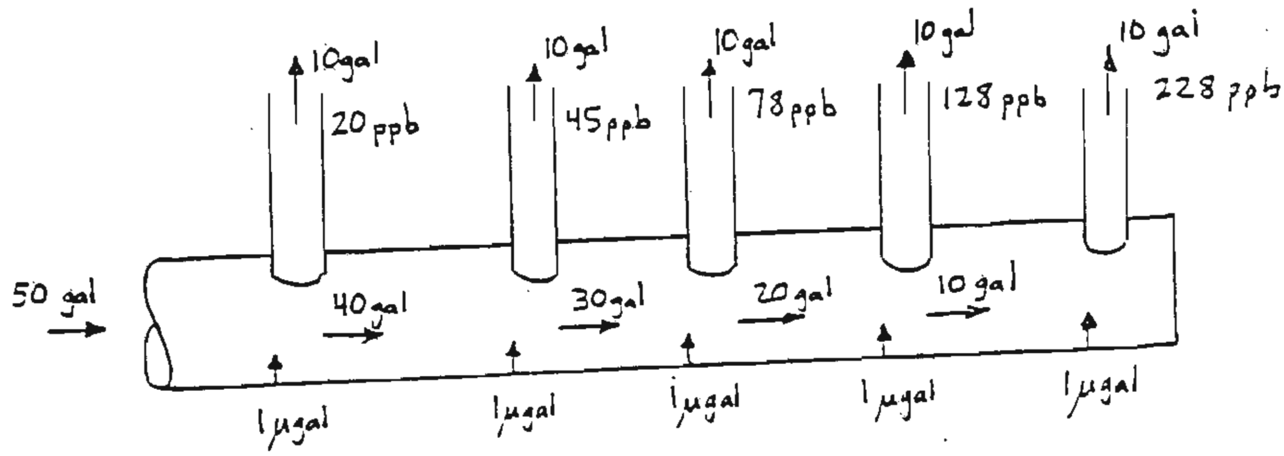
10gal
20 ppb
10 gal
45 ppb
10gal
78 ppb
10 gal
128 ppb
10 gal
228 ppb
50 gal
40 gal
30 gal
20 gal
10 gal
1 μgal
1 μgal
1 μgal
1 μgal
1 μgal

Figure 4

Explorations on Concentrations

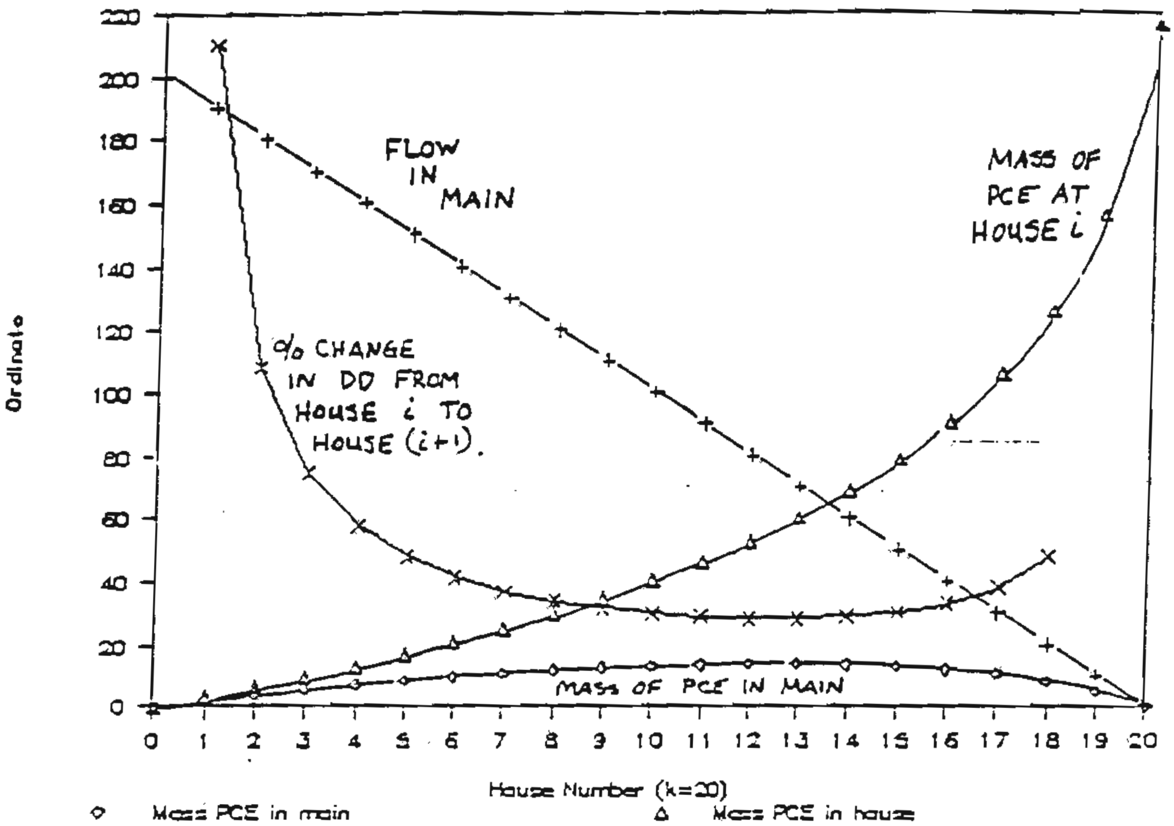

Figure 5

TABLE 1

YEAR RESIDENCY ENDED	YEAR RESIDENCY BEGAN NORMALIZED TO INSTALLATION DATE 0	1	2	3	4	5	6
18	100%	64%	41%	26%	17%	11%	7%
17	100%	64%	41%	26%	17%	11%	7%
16	100%	64%	41%	26%	17%	11%	7%
15	100%	64%	41%	26%	17%	11%	7%
14	100%	64%	41%	26%	17%	11%	7%
13	100%	64%	41%	26%	17%	11%	7%
12	100%	64%	41%	26%	16%	10%	6%
11	99%	63%	40%	26%	16%	10%	6%
10	99%	63%	40%	25%	16%	10%	6%
9	98%	62%	39%	25%	15%	9%	5%
8	97%	61%	38%	24%	14%	8%	4%
7	96%	60%	37%	22%	12%	6%	2%
6	93%	57%	34%	19%	10%	4%	
5	89%	53%	30%	16%	6%		
4	83%	47%	24%	9%			
3	74%	38%	15%				
2	59%	23%					
1	36%						
0							

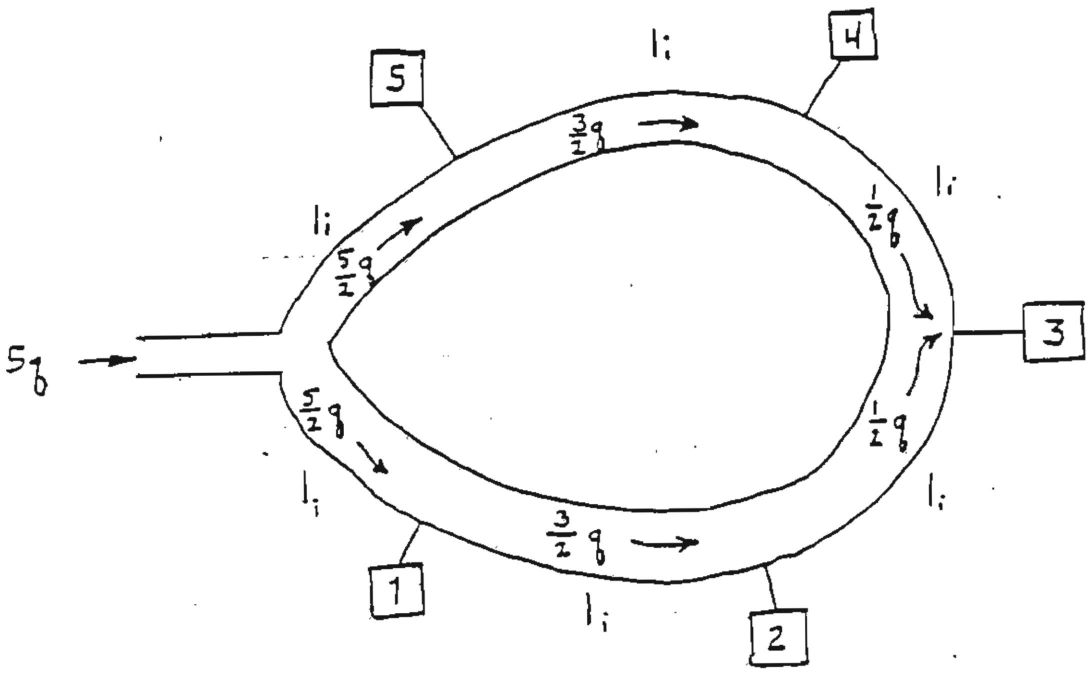

Figure 6

TABLE 2

HOUSE NUMBER	DELIVERED DOSE
1,5	18.5 T
2,4	42.3 T
3	151.2 T

```
A2: [W5] '
Setup  Input  Run  New Subject  Exit  Quit
Nodes, Diameters, Lengths, Installation Times, Loading
        A    B      C         D        F      K       L          M        N
1    NODE DIAM  LENGTH INSTALLED LOAD
2              6      50      1970      1       NAME.   low-dose case
3       2      6      50      1970      1       ADDRESS
4       3      6      50      1970      1
5       4      6      50      1970      1       DDi  =          1.25
6       5      6      50      1970      1
7       6      6      50      1970      1
8       7      6      50      1970      1       TIME1           1970
9       8      6      50      1970      1       TIME2           1999
10      9      6      50      1970      1       iNODE              1
11     10      6      50      1970      1
12     11      6      50      1970      1
13     12      6      50      1970      1
14     13      6      50      1970      1
15     14      6      50      1970      1
16     15      6      50      1970      1
17     16      6      50      1970      1
18     17      6      50      1970      1
19     18      6      50      1970      1
20     19      6      50      1970      1
03-Aug-89  10:17 AM                             CMD
```

Figure 7

Appendix A

A User's Guide to the Delivered Dose Spreadsheet

1 Preliminary

Barnstable	-	no VL/AC pipes
Bourne	-	a few pipes scattered about the town
Falmouth	-	many pipes all over town
Mashpee	-	No data available
Sandwich	-	many pipes all over town

Upon identifying the subject-address pair on the assessor maps, refer to the water maps (Falmouth, Sandwich, Bourne) or the pipe listing (Bourne).

Due to the wide amount of variation among streets, some subjective decisions will have to be made. One important thing to decide initially is: Which way is the water flowing? For dead-ends this is not difficult. But when pipes loops back into other systems, as in a large subdivision, this question can be quite disconcerting. There are a few rules of thumb which can help bring some consistency into this decision:

- o Water moves outward from its source. (In these towns there are several water supply wells or reservoirs. Some of these are marked on the water maps. Water flows away from these sources and the closest source is often the dominant one.)

- o Water flows in the direction that pipe diameters decrease. (Many pipes start as 12" and narrow to 8" and then to 6" from the source to the loads.) [Example: Falmouth Map 38, Comanche Dr. and Elvira Ave., water flows from Palmer Ave, into Comanche/Elvira, into Daniel St., to Nursery Rd., to Lyn Lane.]

- o Bleeder valves are marked on the Town of Sandwich maps, water flows toward the bleeder.

- o Pipes installed after 1981 should not be considered if they are complicating the model. The age of the pipes are marked on the water maps. [Example: Falmouth Map 40, Pheasant Lane. Houses on the VL\AC part of the street should be modeled as a dead-end because the upper part was built in 1984.]

- o In extremely complicated geometries, there probably is not a unidirectional flow. Therefore, the choice is arbitrary.

- Water will take the path of least resistance. (In a perfect circle, assume half the water flows one way and half the other - the two flows meet at the furthest house from the access road.)

- When circles are nested, water flows from the inner loops to the outer loops.

If the subject's street is not a VL/AC pipe and none of the pipes upstream - to a distance of about 1000 feet - are VL/AC, then this person probably received little or no exposure.

It is helpful to know that the highest exposures are found at last house on a long, lightly populated dead-end streets. The key variables are: long street - this means that the mass of PCE available in the pipe is high; and lightly populated dead-end - this means that the water flow rate is relatively small. The result is: a lot of PCE dissolved in very little water.

On the other hand, a household on an 12" main with 3000 houses connected downstream receives virtually no dose. Although there may be a lot of PCE, the water flow rate is so high, that the dilution adequately protects those people.

When consulting the maps, keep these things in mind and think about whether the results delivered by the program make intuitive sense or not. After doing several of these your intuitive sense should become quite excellent.

Another thing that I strongly recommend is drawing a schematic diagram for each particular subject-address pair on VL\AC pipe. Such a diagram is given in Figure A-1 below for a hypothetical case. It is best to consider as much pipe as possible, this must be traded off against efficiency. The program does, however, have a limitation of being capable of dealing with only three different segments of pipe. A segment refers to a specific pipe, and specificity is defined mainly in terms of diameter and installation date. (Loading can be considered a specific parameter, but that is up to your own discretion.)

2 Dead-End Streets and Dead-Ends With Branches

If the subject's street is a dead-end with a VL/AC water main, then consult spreadsheet DE_1C.wk1. Enter Lotus 123 and retreive the file. This is accomplished by hitting the following key sequence:

```
/
F       (select the appropriate directory)
R
DE_1C   <return>
```

Lotus menus allow the users to choose options by either striking the first letter of the menu choice command (e.g. File) or by moving the cursor over the menu choice (use the arrow keys) and hitting return.

When the file appears, a menu will be available:

SETUP   INPUT   RUN   NEW SUBJECT   EXIT   QUIT

Below each choice is a short description of what the command entails. To begin, choose **SETUP**. Upon this choice, another menu will appear:

NODES   DIAMETERS   LENGTHS   ITIME   USE RATES   MAIN MENU

Choose NODES.

You will be prompted with:

Enter the number of nodes:

Refer to the schematic drawing you made for this subject (or see Figure A-1 as an example). Consider each section of pipe in the problem separately. The nodes are points which demarcate equivalent lengths on that section of water pipe. At any node there may be one load, many loads (such as another dead-end street with several houses), or no load. The number of nodes you choose is entirely up to you, but should relate to the number of loads connected to that pipe section. The important thing is to have enough nodes so as to ensure that the model accurately reflects the situation. **The program has a limitation of accepting a maximum of 50 nodes.**

For instance, if houses are placed every 200 feet, then it doesn't make sense to put the nodes every 500 feet. It would be adequate to use 200 foot intervals.

In Figure A-1, the subject's house is on Mill Road, a dead-end branch off of Depot Road, a dead-end. Nodes on Depot Road are spaced every 500 feet. Nodes on Mill Road are spaced every 200 feet - because houses are closer together on Mill Road. The number to enter into the program at this point is 7. Even though there are more then seven nodes, we are only interested in the number of nodes sequentially between the water pipe origin and the one just after the subject's house. Do not count the node at the end of Depot Road or any of the nodes on Woodside Lane. Node 7 must be included because water continues past the subject's house. The last node - at the end of Mill Road - has been ignored because the load there can be added at node 7 (although it doesn't hurt to have node 8 included also.)

Next, the program will prompt you:

First pipe section ends at Node:

For Figure A-1, the first pipe section is the 8" pipe under Depot Road which was installed in 1969. Pipe sections can be differentiated at the user's whim, but it is important to differentiate between pipes of different diameter or age. User's may choose to differentiate pipe sections with radically different loading distributions (if one part of the pipe has a much higher density of services then does another).

The correct entry at this point is 4. At the fourth node, the first pipe section ends. (Remember - we are only interested in the sequential path to the subject's house, not the streets themselves.)

Next, another prompt will appear:

Second pipe section ends at Node:

In this example the answer is 7. Even if you use only one segment of pipe, you still must repeat the number you entered for the previous prompt: "first pipe section ends at node:". **Never give a null entry here.** Next:

Third pipe section ends at node:

There is no third pipe section in this example, but you must still enter the number of the ending node (7) (as explained above). **Never give a null entry here either.**

Then the setup menu will reappear and you should select **DIAMETER.** The program will prompt you for the diameters of the three pipe sections. These should be entered in inches. If the second and/or third section is not present, simply hit (return) without making an entry. It will take the computer a few moments to process the data and fill in the chart.

Then the setup menu will reappear and you should select **LENGTHS.** The program will prompt you for the lengths of the three pipe sections. These should be entered in feet. If the second and/or third section is not present, simply hit (return) without making an entry.

Then the setup menu will reappear and you should select **ITIME.** The program will prompt you for the installation dates of the three pipe sections. These should be entered as the year (e.g. 1969). If the second and/or third section is not present, simply hit (return) without making an entry.

For the Town of Sandwich, the pipe installation dates are not on the map. Instead, consult the green and the yellow colored pages of listings of addresses and service connection dates to VL/AC pipe. The pipe installation date can be interpreted from these data to be the earliest of the services.

These data can be used to improve the accuracy of the assessment by not including loads for house connections made much latter then the subject's residence. (For instance, if the subject's house and a few others were connected in 1973 and other houses were connected in 1980, then the 1980 houses can be dropped from the analysis under the assumption that most of the exposure occurred from 1973 - 1980 and increased loading after the fact would not reduce the exposure to the subject significantly.

Then the setup menu will reappear and you should choose USE RATES. This step is not automated, you will exit the program. To make entries in the worksheet, use the arrow keys to move the cursor to column F. Enter the load for each node by typing a number and hitting return. For the Figure 1 example these loads would be as follows:

NODE	LOAD	ROAD
1	1	Depot
2	1	Depot
3	6	Depot-Woodside
4	1	Depot-Mill
5	0	Mill
6	**1**	**Mill**
7	2	Mill

Notice that at node 3, the entire loading of Woodside Road was represented. At node 5, there was no load so zero was entered. The subject's house is highlighted for reference here.

To re-enter the program, strike:

Alt A (holding down the Alt key while hitting letter A)

The original menu will appear:

SETUP INPUT RUN NEW SUBJECT EXIT QUIT

This time choose INPUT to input the subject-specific parameters. You will be prompted:

Enter the beginning year of residence for the subject:

You enter the year (e.g. 1974) that the person moved into this house. Even if the subject's residency began before the pipe was installed, the earlier year can be included. The program assumes that the subject received no exposure until the pipe was installed. Then:

Enter the ending year of exposure for the subject:

Enter a year (e.g. 1980) that the exposure ended. This could be the year the cancer was diagnosed, the year the subject died, or the year the subject changed residence. (This should be decided by the researchers.)

Enter the node for the subject's house:

It is very important that this be correct! This is why you should draw a schematic for each subject-address pair and number the nodes. In this example the correct number is 6.

Enter the name of the subject:

Enter the name or the code number. Example: John O'Conner. Extremely long names will go off the edge of the screen, and may not come out on a print-out.

Enter the address of the subject:

This is for reference. Example: 12 Mill Road, Bourne

Now all of the data has been entered and you should choose **RUN** to complete the calculations.

When you have completed this subject's categorization, print out the screen by striking:

Shift PrtSc (hold done shift key and hit PrtSc key)

This will give you a hardcopy of what you see on the screen. An example is shown in Figure A-2.

It probably is not possible to save the worksheet for every subject - it takes about 40k bytes to store the entire worksheet.

However, it may be possible to save parts of the worksheet. It takes 17k bytes to store a live portion (changeable) of the worksheet specific to the subject (formulae, range: A2..M51); and about 8k to store a static portion (the values) specific to the subject (values, range: A2..M51).

4. A Dynamic Example of a Dead-end Case

Figures A-3 through A-9 show how hypothetical variations to a given example geometry can alter the delivered dose. In the example, there are nine houses on Willow Lane, each spaced equally and each drawing a unit load of one (standard house). The subject lives at node 8. This "baseline" case is presented in Figure A-3 and the relative delivered dose is 118.23. Note that the subject's residency began in 1962, several years before the pipe was installed. The program assumes no dose was delivered until the pipe was put in.

In Figure A-4, the user mistakenly assigned a load of zero to the subject's residence and the program reports an ERRor.

In Figure A-5, the subject's node draws five times the normal load, but the delivered dose per unit load is still 70.19, about 40% less. This might be the case if the subject lived on another street that entered Willow Lane at node 8 (of course, then the subject's address would not be WIllow Lane) or if the subject lived in a small apartment building at node 8. Those are hypothetical situations in which the subject still draws a unit load of one.

In Figure A-6, we see the effect of increased loading further downstream of the subject's house - it reduced the subject's dose significantly, to 47.37 (-60%).

In Figure A-7, we see the effect of increased loading immediately upstream of the subject - again, a reduction in dose to 80.44 (-32%).

In Figure A-8, we see the effect of loading further upstream of the subject - a minor reduction in dose to 110.84 (-7%).

In Figure A-9, we see that even a large increase in upstream loading has a relatively minor effect on the subject's dose - a reduction to 97.39 (-18%).

These cases are simply meant to provide you with some feeling for how doses may vary.

4 The Circle Case

In some instances, the subject may live on a street which has a circular structure. The worst-case example of this is probably Sailfish Drive on Falmouth Map #33. We had originally intended to provide another spreadsheet specifically for these geometries, but we found that it would be easier to use the DE_1C.wk1 spreadsheet, albeit with a different set of rules. In this section, we describe the rules for modeling these circular geometries.

The basic assumption is that, on the average, water will take the path of least resistance to the load. We also assume that the path of least resistance is most likely the shortest path - from the main pipes.

As such, we believe that it is a good rule of thumb to assume that the water flows to a given house along the same pathway that you would take if driving to that house. The reason is that the water distribution network does, to a large degree, mimic the road network. With the busiest roads having the greatest water flow rates.

In the simplest example (Figure A-10) the water flows into the loop along both directions, and the two flows meet at the apogee of the loop. As such, each half of the loop can be modeled as a dead-end, except that the last house (#4) gets half of it's water from the top loop and half from the bottom. In this symmetric example, to compute the dose for house #4, model this as a 4 node dead-end, with water use rates as follows:

NODE	USE RATE
1	1
2	1
3	1
4	0.5

Then, the delivered dose given by the program will have to be multiplied by two, because of symmetry. If the loading distribution were not perfectly symmetrical, then you would have to do two models to compute the delivered dose to house #4, the top half and the bottom half.

In the event that a node has a load of zero or more than one, then the model must be adjusted. Of central importance is: Where is the zero-flow node? If the water enters the loop along both directions, these two flows must meet somewhere. At that point the water flow rate is zero. In the above example, this point was the node where house #4 was. In Figure A-11, the zero-flow node is node 4. There are a total of 8 loads. Four loads worth must come along the top path. Three go into houses 9, 7, and 6, respectively. The last goes into the dead-end street at node 4. Likewise, four loads worth of water flow along the bottom path and goes into house 1 and 2 and then into the street at node 4. At node 4, the water flow rate is zero.

Thus, the loading distribution for the top half of example is:

NODE	LOAD
9	1
8	0
7	1
6	1
5	0
4	1

And for the bottom half:

NODE	LOAD
1	1
2	1
3	0
4	2

If you were computing delivered dose for a house at node 9, 7, or 6, use the top model. If the house is at node 1 or 2, use the second model. If the house was at node 4, then both models must be used and their results must be combined appropriately.

How to combine the two results for a house at node 4 can be confusing. In this case, the top model gives a dose for the one load of water that the top loop supplied. The bottom model gives a per unit dose for the two loads that it supplied. THere are three houses on the dead-end at node 4. We assume that the three houses are all very close together and all get the same water. Then each house gets one-third of the total load which is: one times the dose given by the top model and two times the dose given by the bottom model.

If the top model gave a delivered dose of 100 to node 4 and the bottom model gave a delivered dose of 25 to node 4, then each house at node 4 would receive: ((1)(100)+(2)(25))/(3) or 50.

If the dead-end street at node 4 was another VL/AC pipe, then each of the above two models should be expanded into models with two pipe segments.

5 General Inside Information

The worksheet has a start-up macro to clear the screen and put things in order - just in case a dirty version was re-saved. I recommend not re-saving the file - in order to keep it clean.

To discourage tampering the macros and the calculation columns have been hidden. These, however, do re-appear if the user attempts to erase, copy, or move a block of cells.

The main macro is called "A". This is initiated by holding down the Alt key and hitting the "A" key. This macro brings up the main menu.

While in the menus, movement is restricted. Basically, once you begin with a command sequence (selection) you have got to see it through. You cannot escape the sequence and go backwards - like you normally can in Lotus.

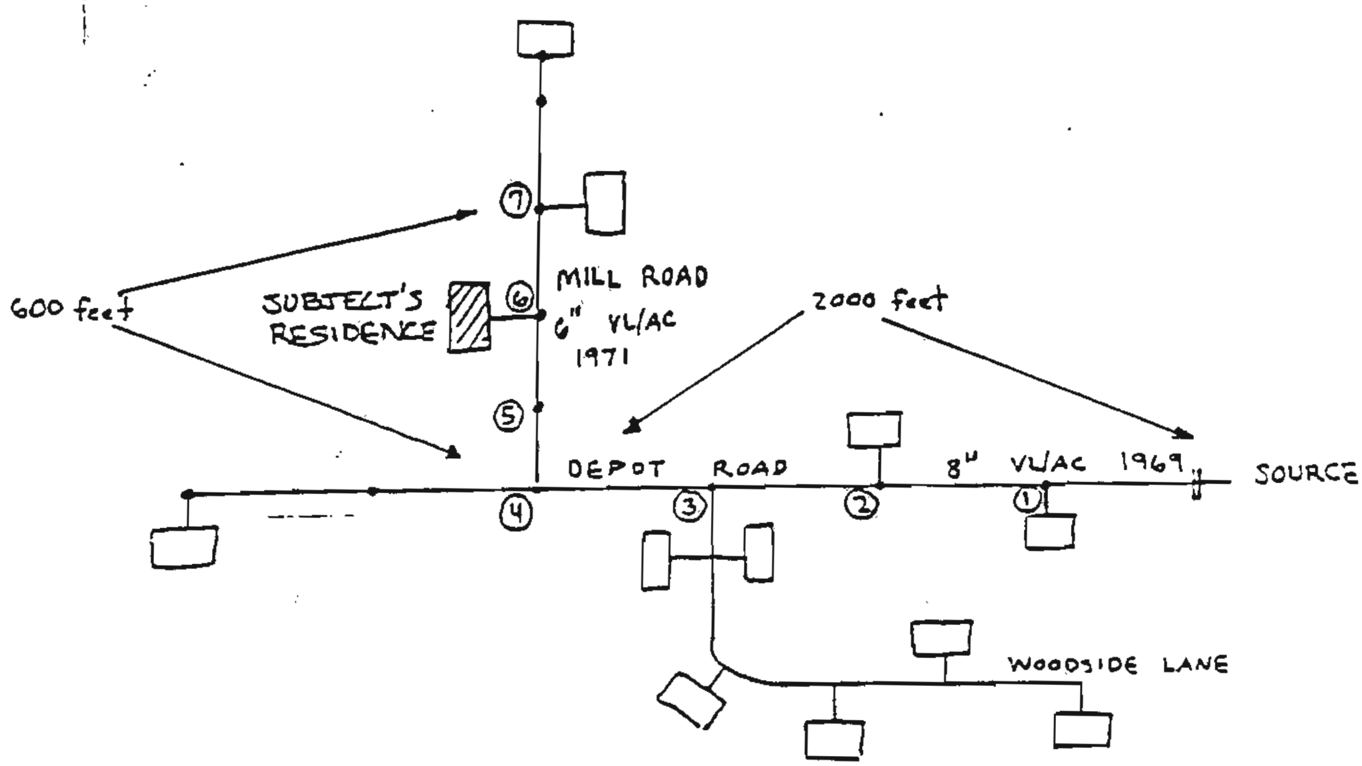

Figure A-1

```
A2: [W5] '
Setup  Input  Run  New Subject  Exit  Quit
Nodes, Diameters, Lengths, Installation Times, Loading
       A    B      C         D       F      K       L          M          N
1    NODE DIAM  LENGTH  INSTALLED  LOAD
2           8     500      1969      1        NAME       Example
3      2    8     500      1969      1        ADDRESS    17 Mill Road
4      3    8     500      1969      6
5      4    8     500      1969      1        DDi   =       33.77
6      5    6     200      1971      0
7      6    6     200      1971      1
8      7    6     200      1971      2        TIME1          1974
9                                             TIME2          1980
10                                            INODE             5
11
12
13
14
15
```

Figure A-2

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD				
2	1	8	240	1970	1		NAME	John Rockefeller	
3	2	8	240	1970	1		ADDRESS	12 Willow Street	
4	3	8	240	1970	1				
5	4	8	240	1970	1		DDi =	118.23	
6	5	8	240	1970	1				
7	6	6	300	1972	1				
8	7	6	300	1972	1		TIME1	1962	
9	8	6	300	1972	1		TIME2	1973	
10	9	6	300	1972	1		iNODE	8	
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-3

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD				
2	1	8	240	1970	1		NAME	John Rockefeller	
3	2	8	240	1970	1		ADDRESS	12 Willow Street	
4	3	8	240	1970	1				
5	4	8	240	1970	1		DDi =	ERR	
6	5	8	240	1970	1				
7	6	6	300	1972	1				
8	7	6	300	1972	1		TIME1	1962	
9	8	6	300	1972	0		TIME2	1973	
10	9	6	300	1972	1		iNODE	8	
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-4

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD				
2	1	8	240	1970	1		NAME	John Rockefeller	
3	2	8	240	1970	1		ADDRESS	12 Willow Street	
4	3	8	240	1970	1				
5	4	8	240	1970	1		DDi =	70.19	
6	5	8	240	1970	1				
7	6	6	300	1972	1				
8	7	6	300	1972	1		TIME1	1962	
9	8	6	300	1972	5		TIME2	1973	
10	9	6	300	1972	1		iNODE	8	
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-5

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD		NAME	John Rockefeller	
2	1	8	240	1970	1		ADDRESS	12 Willow Street	
3	2	8	240	1970	1				
4	3	8	240	1970	1		DOi =	47.37	
5	4	8	240	1970	1				
6	5	8	240	1970	1				
7	6	6	300	1972	1		TIME1	1962	
8	7	6	300	1972	1		TIME2	1973	
9	8	6	300	1972	1		iNODE	8	
10	9	6	300	1972	1				
11	10	6	300	1972	10				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-6

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD		NAME	John Rockefeller	
2	1	8	240	1970	1		ADDRESS	12 Willow Street	
3	2	8	240	1970	1				
4	3	8	240	1970	1		DOi =	80.44	
5	4	8	240	1970	1				
6	5	8	240	1970	1				
7	6	6	300	1972	1		TIME1	1962	
8	7	6	300	1972	5		TIME2	1973	
9	8	6	300	1972	1		iNODE	8	
10	9	6	300	1972	1				
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-7

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD		NAME	John Rockefeller	
2	1	8	240	1970	1		ADDRESS	12 Willow Street	
3	2	8	240	1970	5				
4	3	8	240	1970	1		DOi =	110.94	
5	4	8	240	1970	1				
6	5	8	240	1970	1				
7	6	6	300	1972	1		TIME1	1962	
8	7	6	300	1972	1		TIME2	1973	
9	8	6	300	1972	1		iNODE	8	
10	9	6	300	1972	1				
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-8

	A	B	C	D	F	K	L	M	N
1	NODE	DIAM	LENGTH	INSTALLED	LOAD				
2	1	8	240	1970	1		NAME	John Rockefeller	
3	2	8	240	1970	50		ADDRESS	12 Willow Street	
4	3	8	240	1970	1				
5	4	8	240	1970	1		ODi =	97.39	
6	5	8	240	1970	1				
7	6	6	300	1972	1				
8	7	6	300	1972	1		TIME1	1962	
9	8	6	300	1972	1		TIME2	1973	
10	9	6	300	1972	1		iNODE	8	
11	10	6	300	1972	1				
12									
13									
14									
15									
16									
17									
18									
19									
20									

Figure A-9

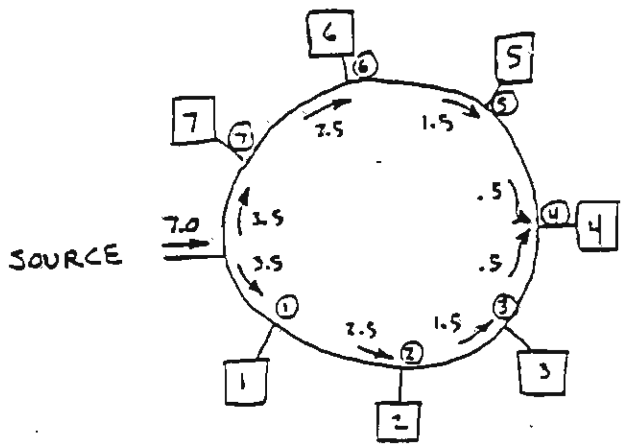

Figure A-10

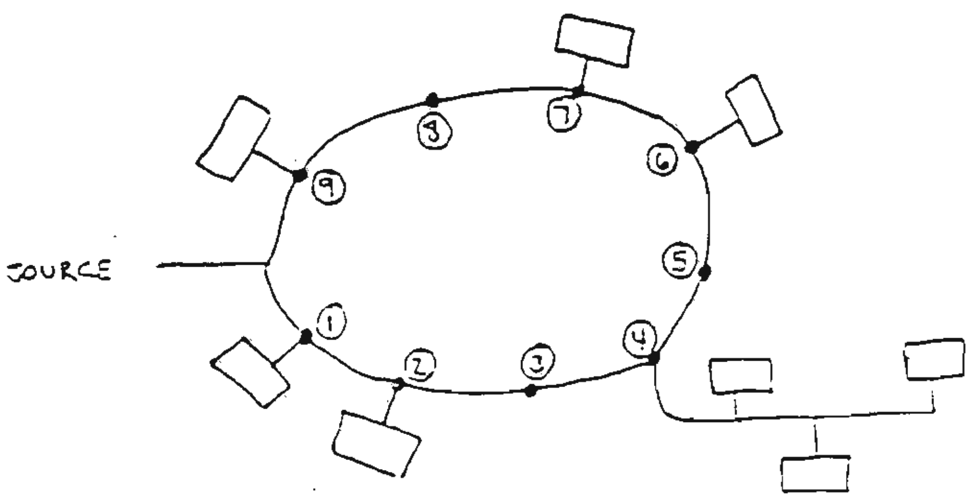

Figure A-11

APPENDIX B

Absolute Delivered Dose of PCE

In our model to this point the delivered dose has been only a relative expression of the actual dose. Here we derive an expression for the absolute delivered dose, albeit with the understanding that uncertainties preclude our assigning any acceptable degree of confidence to these expressions.

Leaving aside the assumptions of the distribution model for the moment, to determine how much PCE was in the newly installed pipes, we need to know: How much PCE was sprayed onto the pipe surface, per unit area? and, How much evaporated before the pipe was installed?

According to Johns-Manville's specifications, the Piccotex liner was applied to the inner wall of the pipes as a suspension in tetrachloroethylene (30% polymer, 70% PCE). This was followed by a 48 hour air drying period (curing) during which PCE evaporated and the liner hardened. Johns-Manville assumed that after 48 hours, less than 1% of the applied solvent remained in the liner.

Experiments performed by Avery Demond of MIT showed that, during the first three of drying, 80% of the PCE evaporated. At this point, however, the rate of evaporation dropped dramatically so that, after 18 days, as much as 9% of the applied amount of PCE remained in the liner.

The concentration of PCE left in the liner varied according to the thickness of the Piccotex applied, the shipping and storage conditions, and the pipe's age at time of installation.

In order to simplify the calculations, we assume that 6% of the PCE originally applied remained in the lining at the pipe installation date and that the solvent was uniformly distributed throughout the liner. We furthermore assume that the liner was 0.025" thick (as specified by Johns-Manville) and that the liner was uniform in all pipes.

The amount of PCE present at the installation date per square foot of pipe inside surface area is calculated as follows:

1. Volume of dry polymer per square foot:

$$\frac{1' \times 1' \times 0.025''}{12'' \text{ per ft.}} = 0.00208 \text{ ft}^3$$

2. Volume of PCE used to apply that volume of polymer:

$$\frac{0.00208 \times 70\%}{30\%} = 0.00486 \text{ ft}^3$$

3. Mass of PCE per square foot: $(G_{PCE} = 1.624 \text{ g/cm}^3)$

$$0.00486\ ft^3 = 138\ cm^3$$

$$138\ cm^3 \times 1.624\ g/cm^3 = 224\ g$$

4. Mass of residual PCE per square foot at pipe installation:

$$224\ g \times 6\% = 13.4\ g/ft^2$$

Clearly, this is a rough estimate, one only likely to be correct within an order of magnitude, at best.

This value of 13.4 g/ft represents variable C_1 in the delivered dose model. The constant of proportionality in Eq. 22 is:

$$94.7 \left(\frac{g \cdot yr}{ft^2}\right) \qquad \text{Eq. A-1}$$

Therefore, relative delivered dose can be transformed into an absolute delivered dose by mutiplying it by this constant of proportionality.

Figures and Tables

Figure III.1.1 *Geographic Distribut[illegible] of All Cancer Cases Combined.*

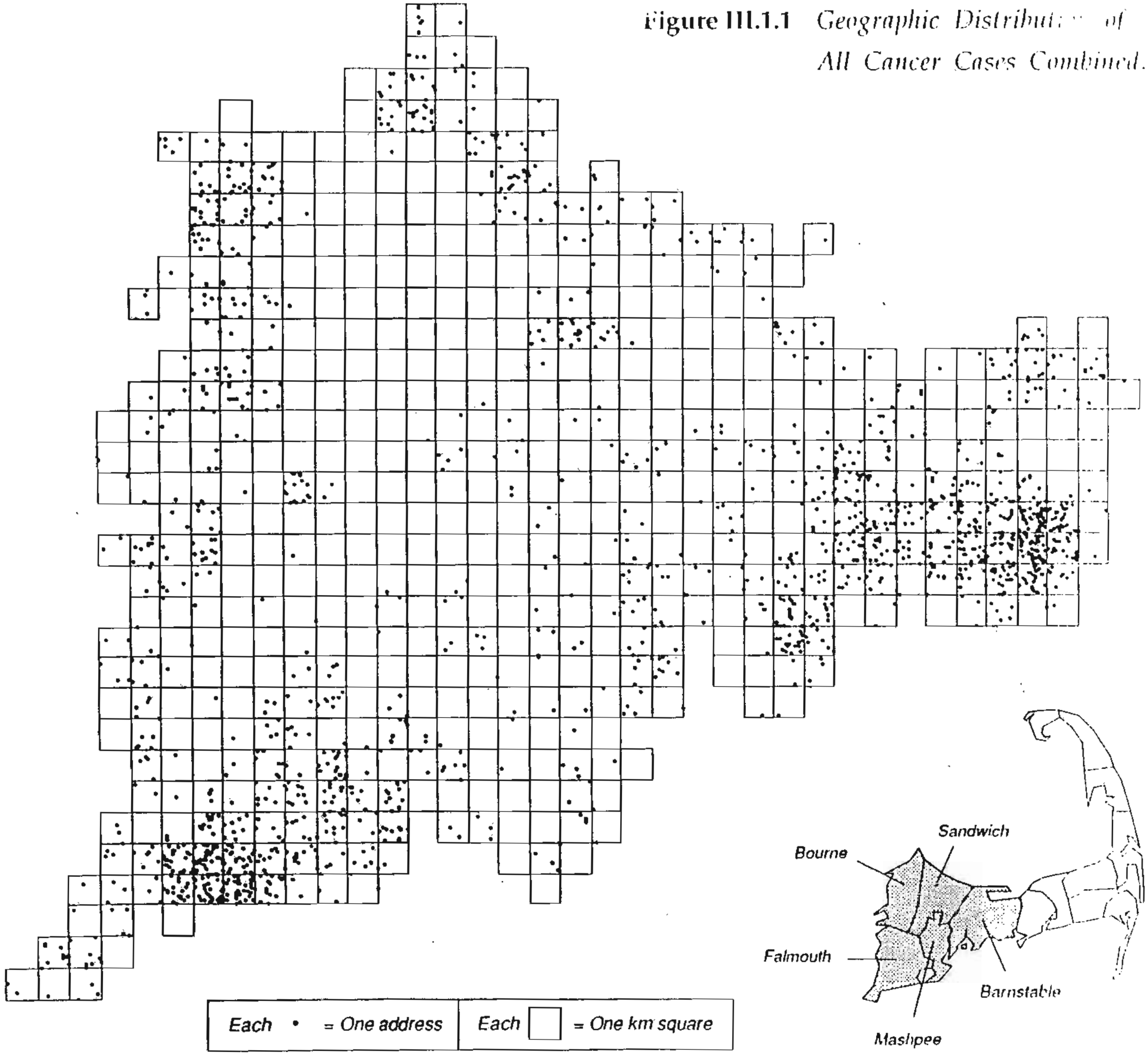

Figure III.1.2 *Geographic Distribution of All Cancer Control, Combined*

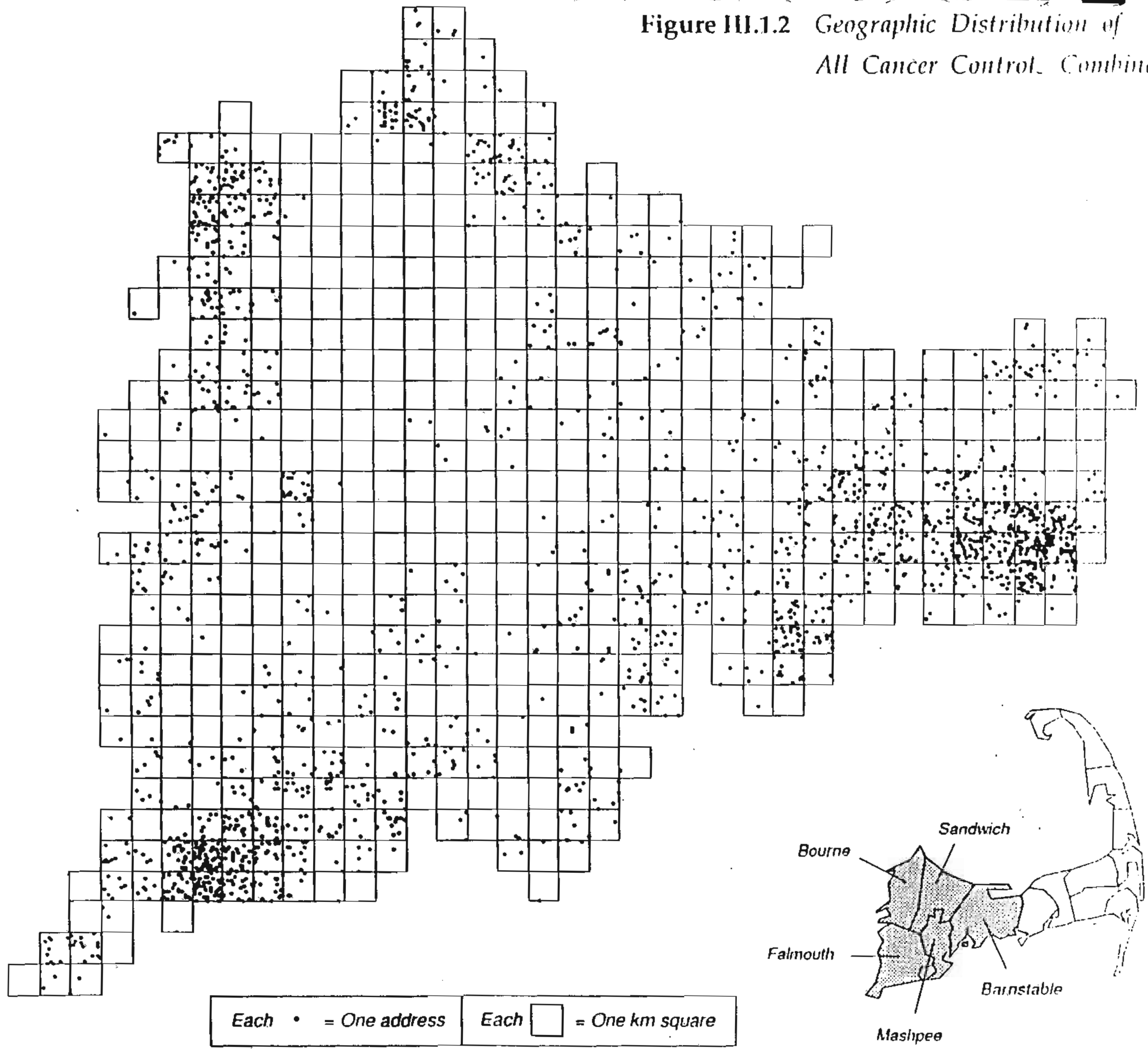

Figure III.1.3 *Geographic Distribution of Lung Cancer Cases.*

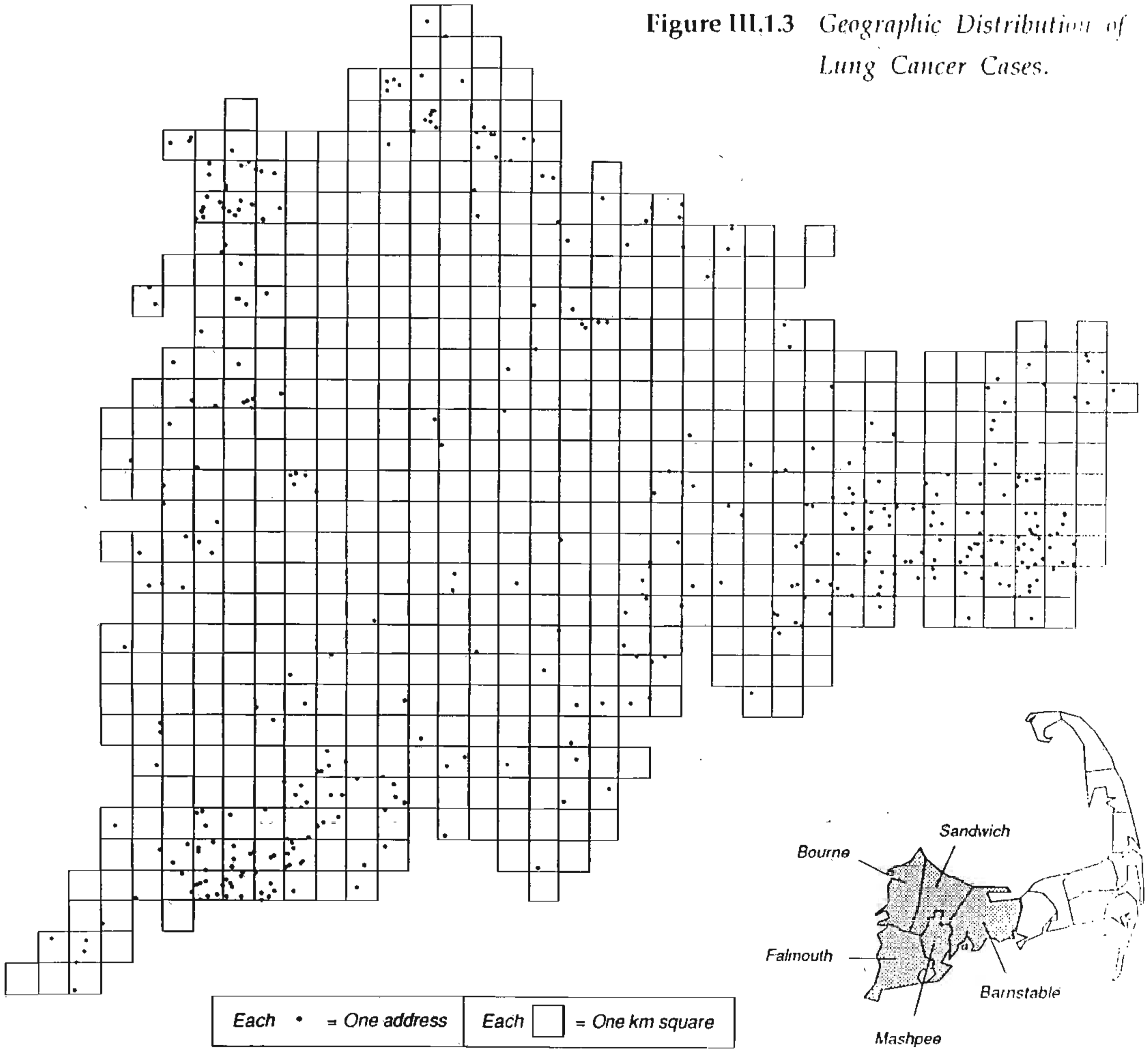

Figure III.1.4 *Geographic Distribution of Lung Cancer Controls.*

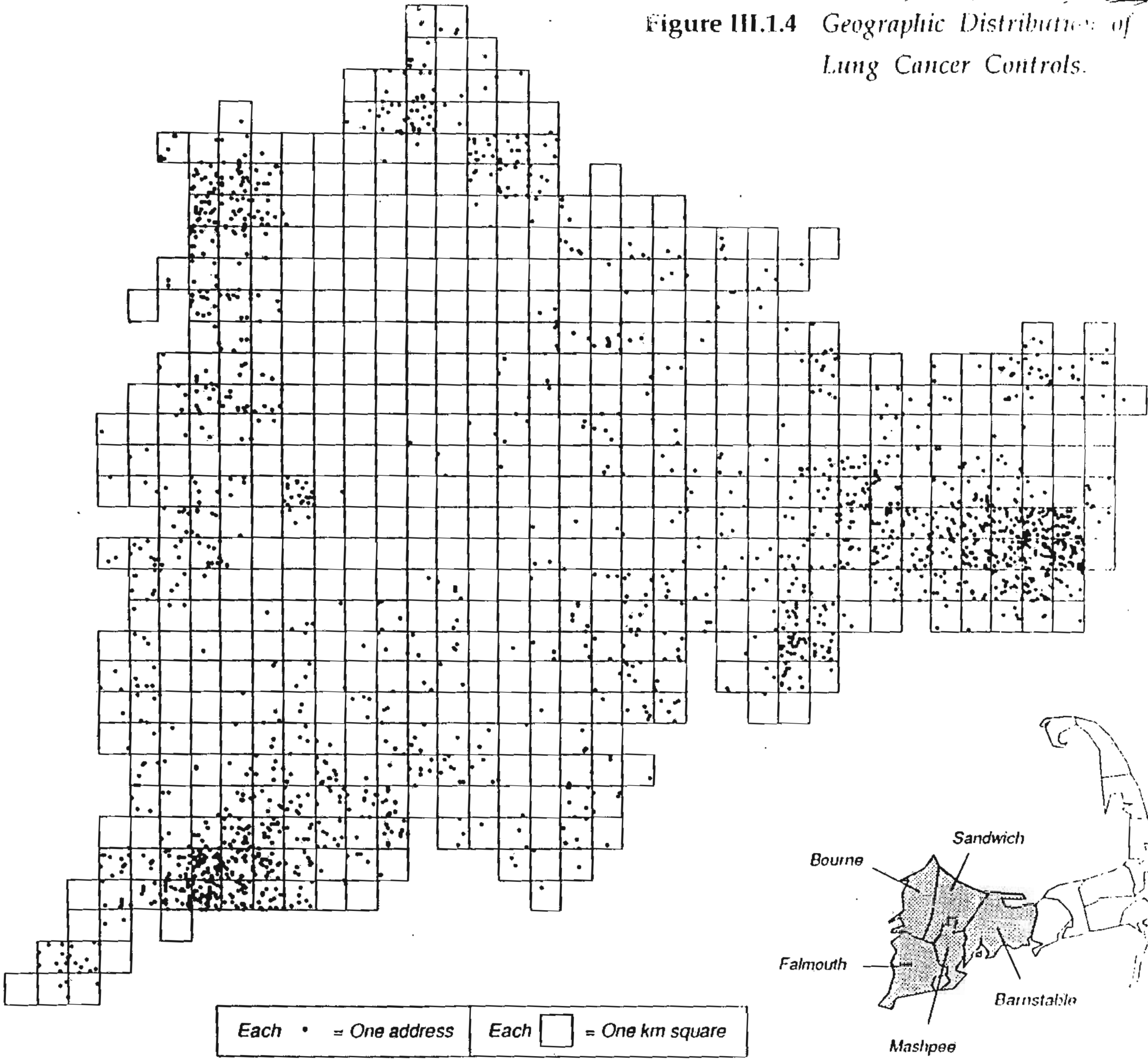

Figure III.1.5 *Geographic Distribution of Breast Cancer Cases.*

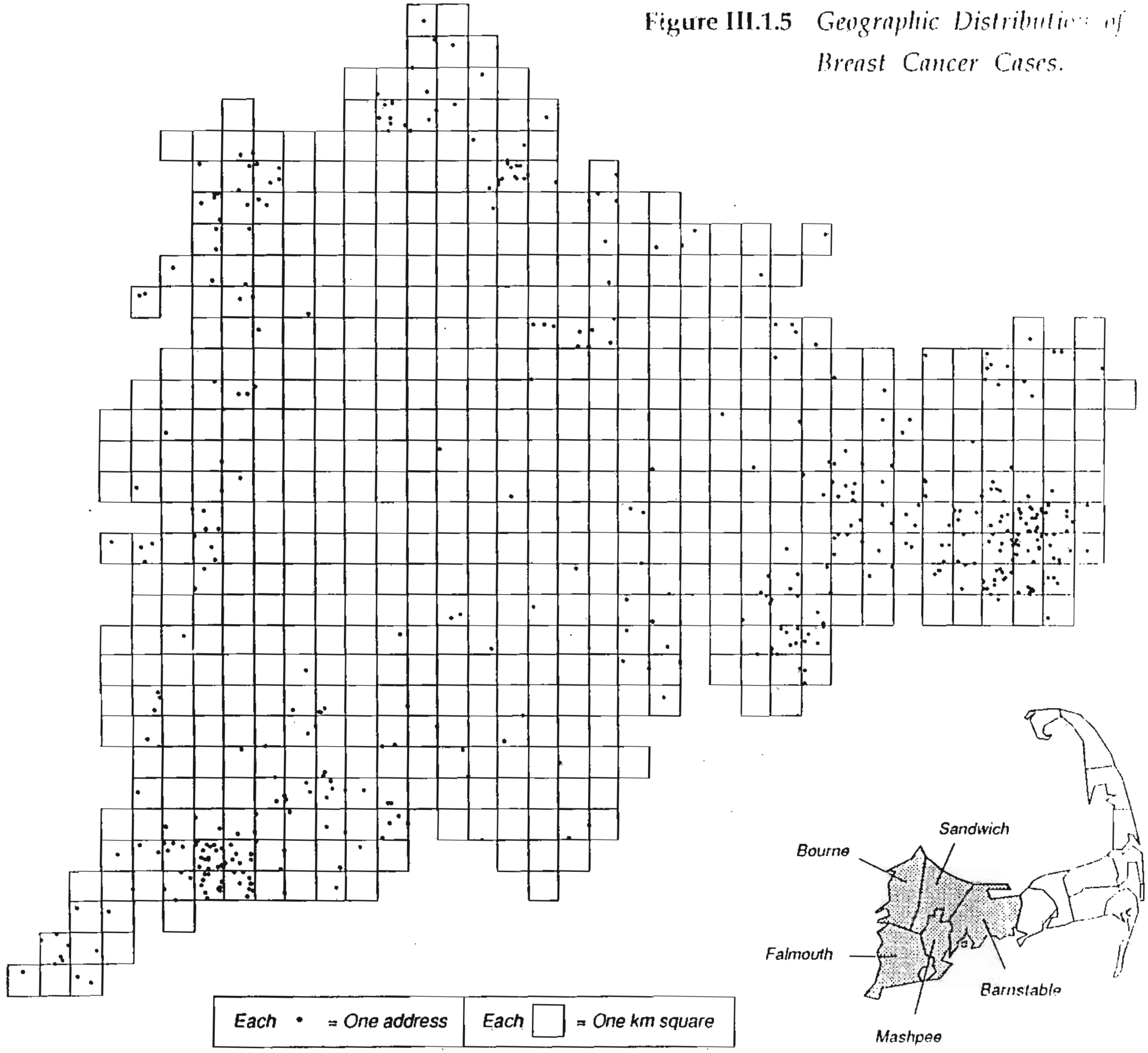

Figure III.1.6 *Geographic Distribution of Breast Cancer Controls.*

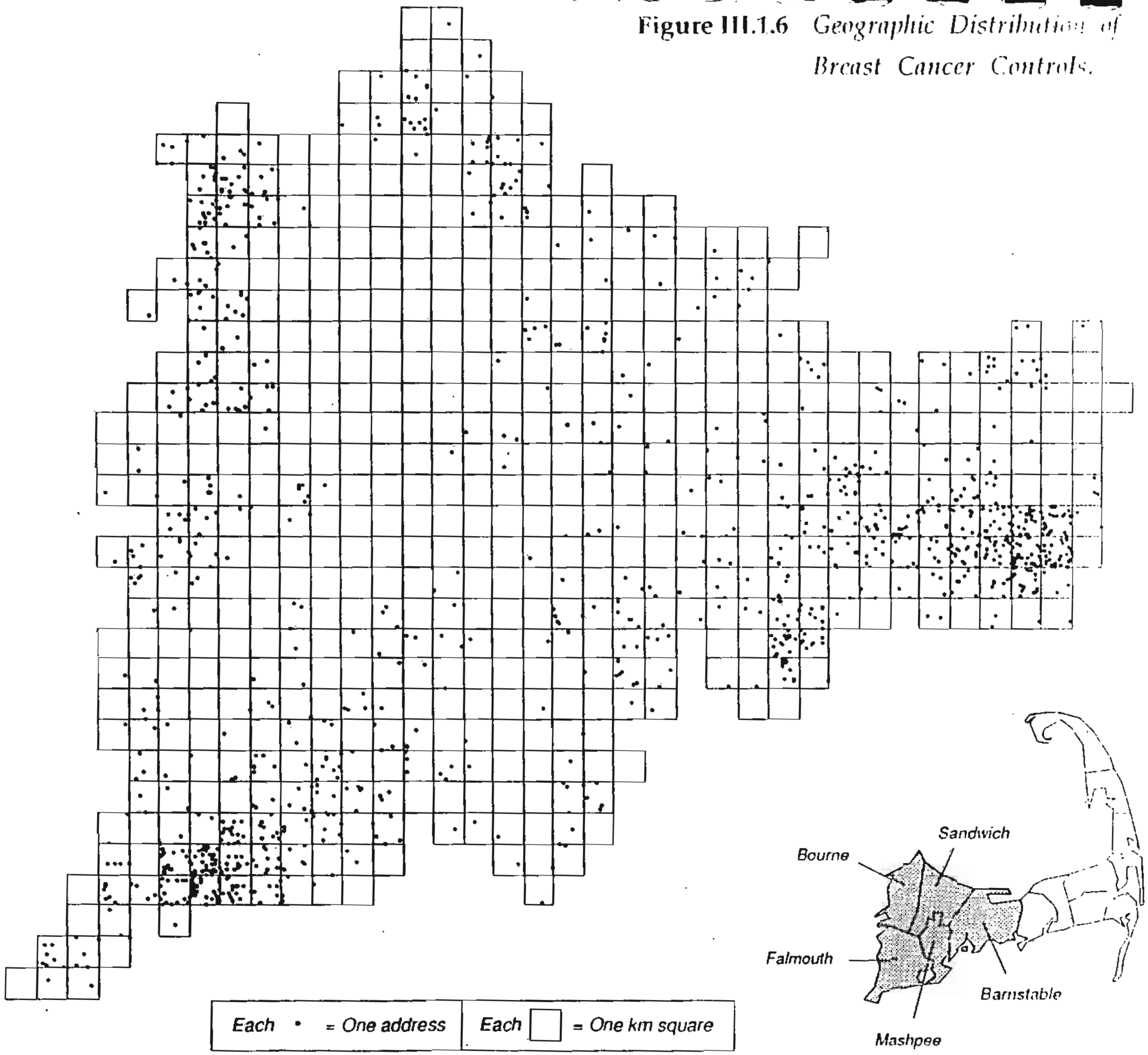

Figure III.1.7 *Geographic Distribution of Colo-rectal Cancer Cases.*

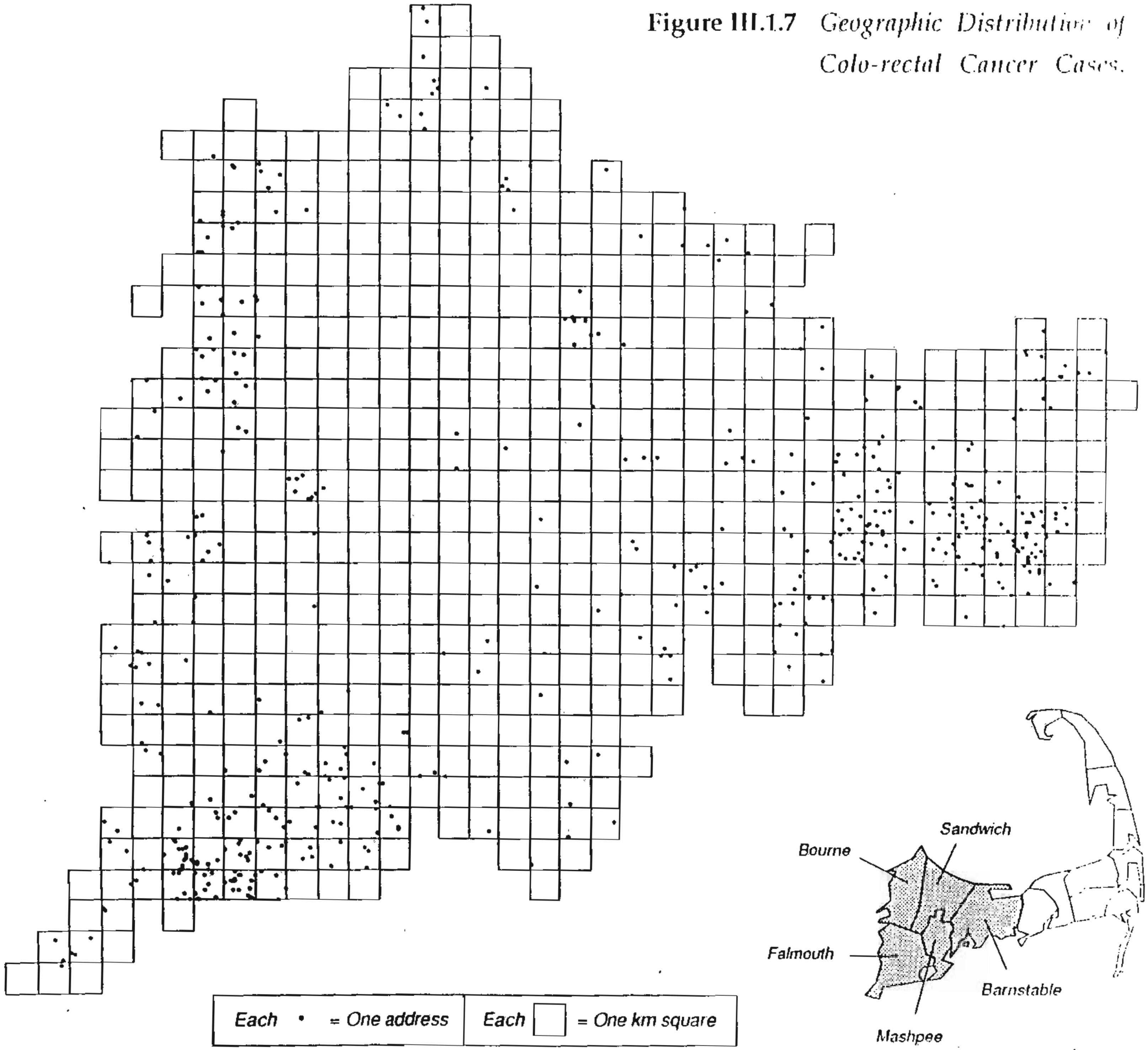

Figure III.1.8 *Geographic Distribution of Colo-rectal Cancer Controls.*

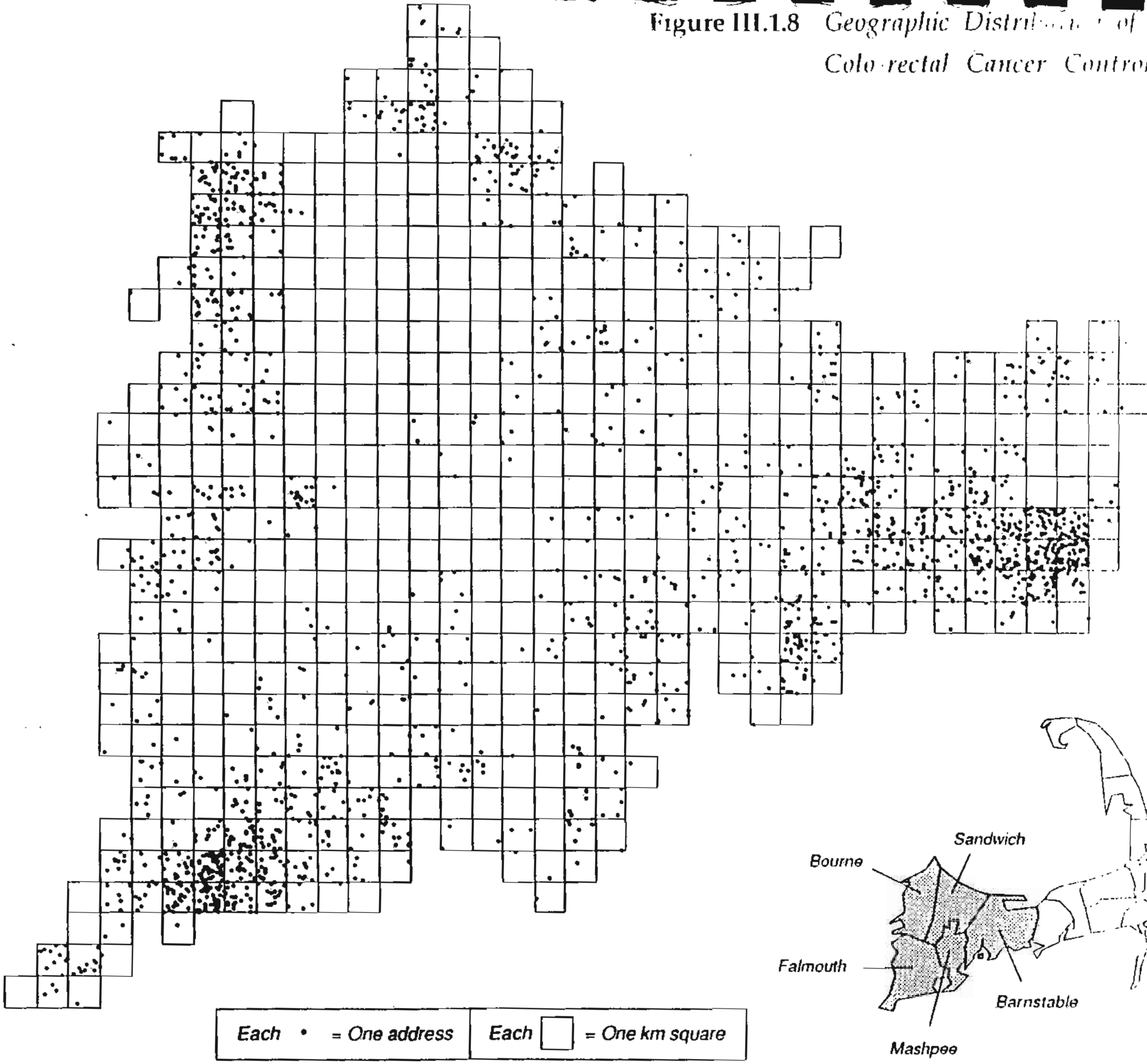

Figure III.1.9 *Geographic Distribution of Bladder Cancer Cases.*

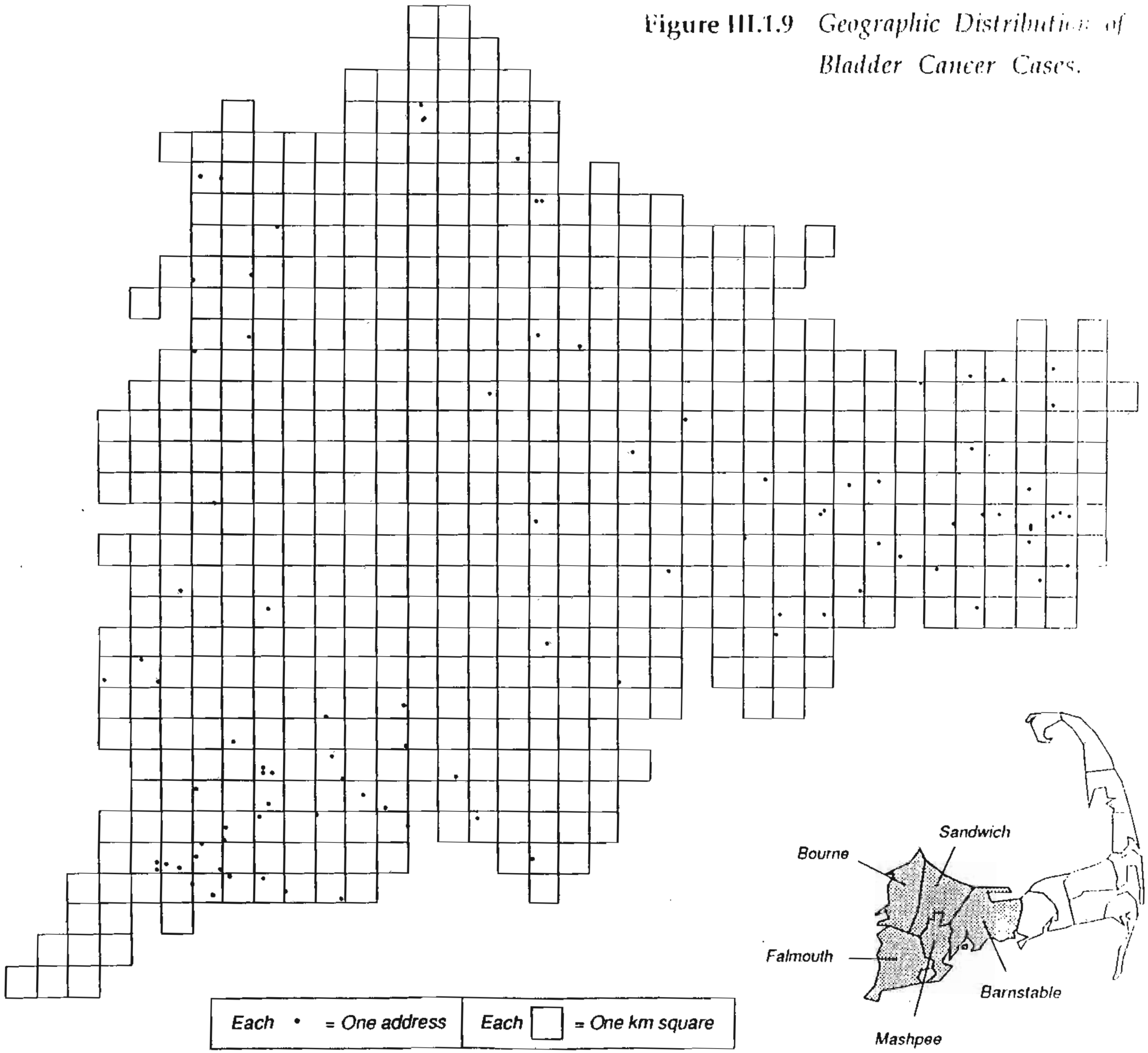

Figure III.1.10 *Geographic Distribution of Bladder Cancer Controls.*

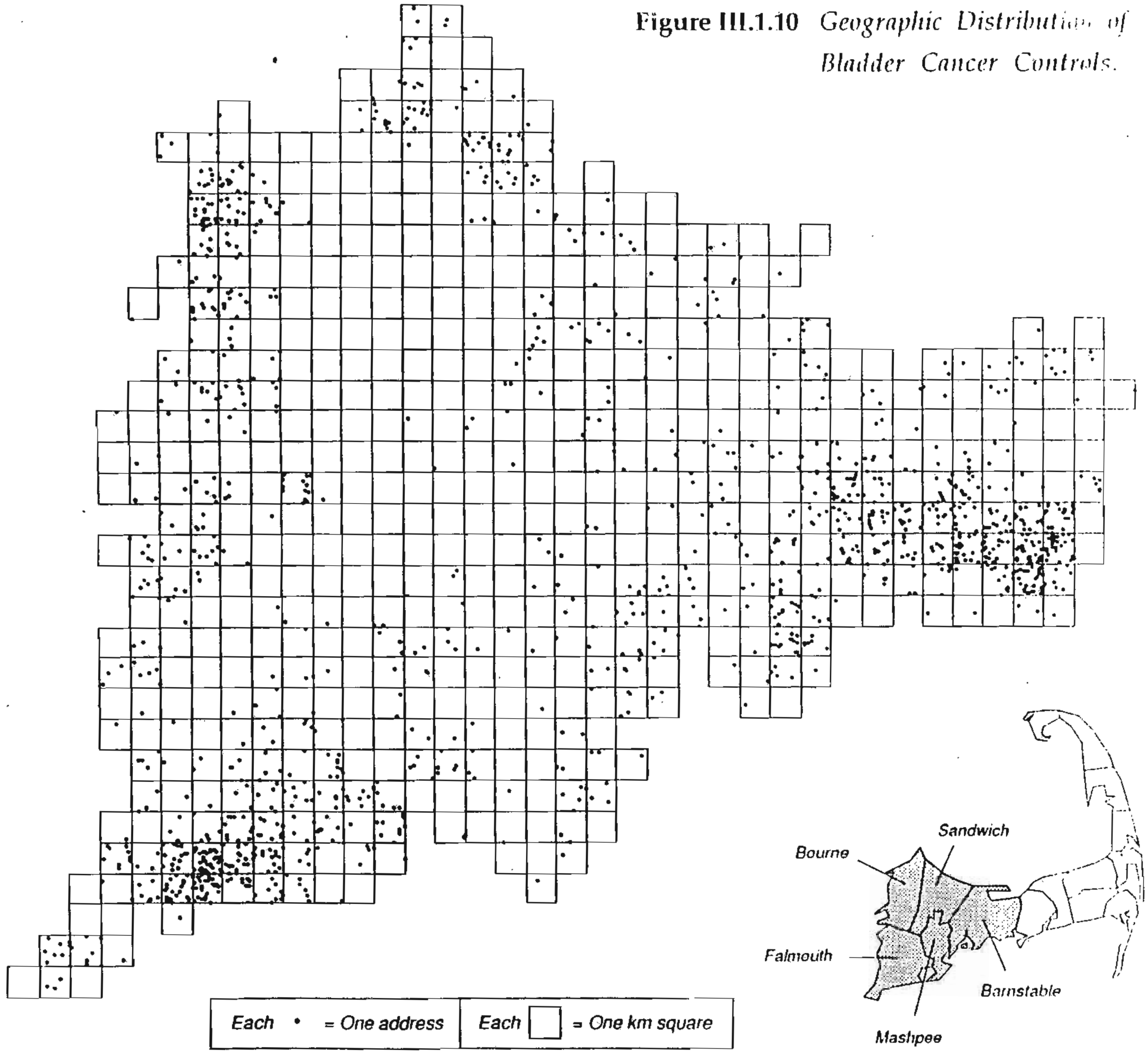

Figure III.1.11 *Geographic Distribution of Kidney Cancer Cases.*

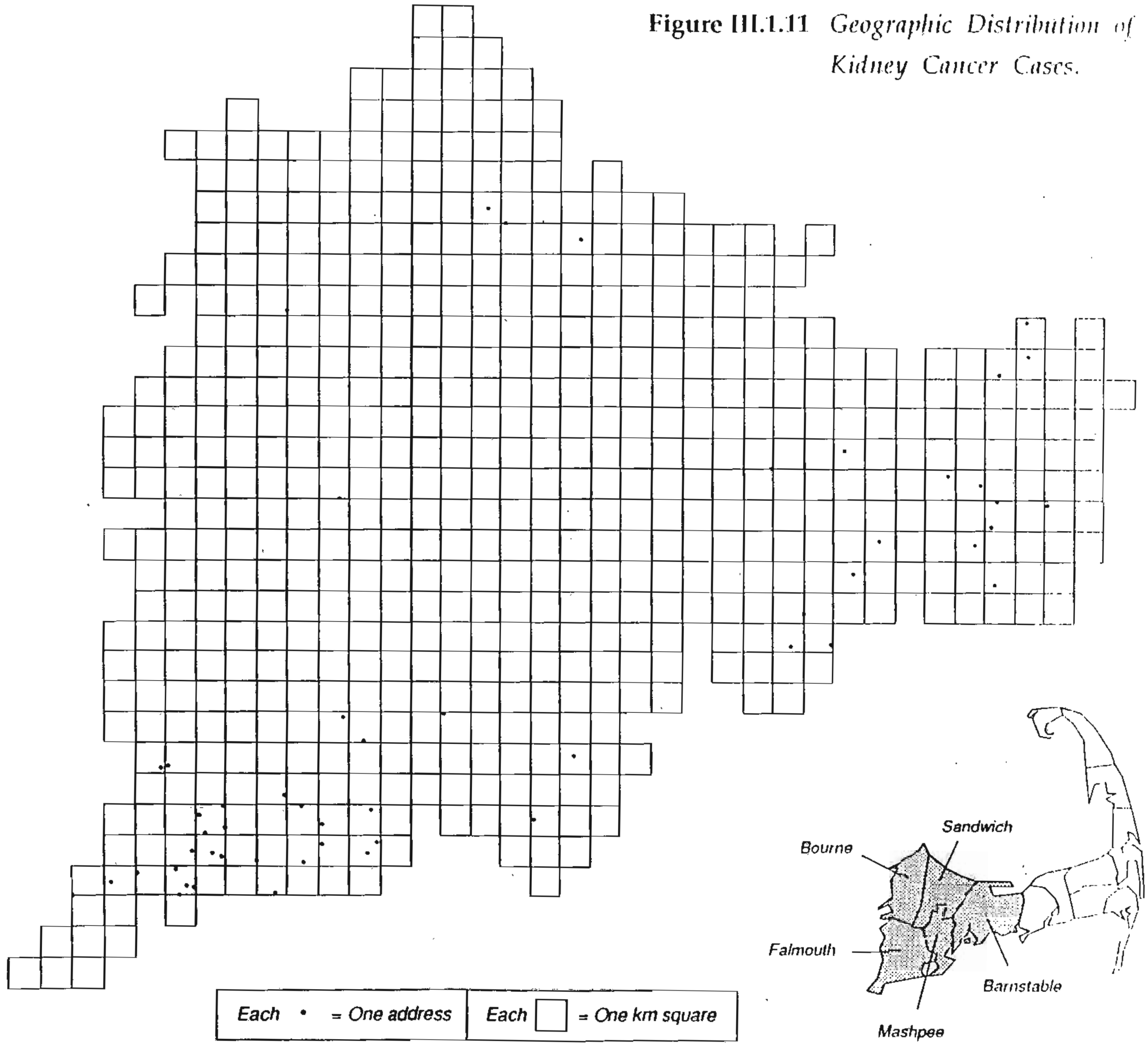

Figure III.1.12 *Geographic Distribution of Kidney Cancer Controls.*

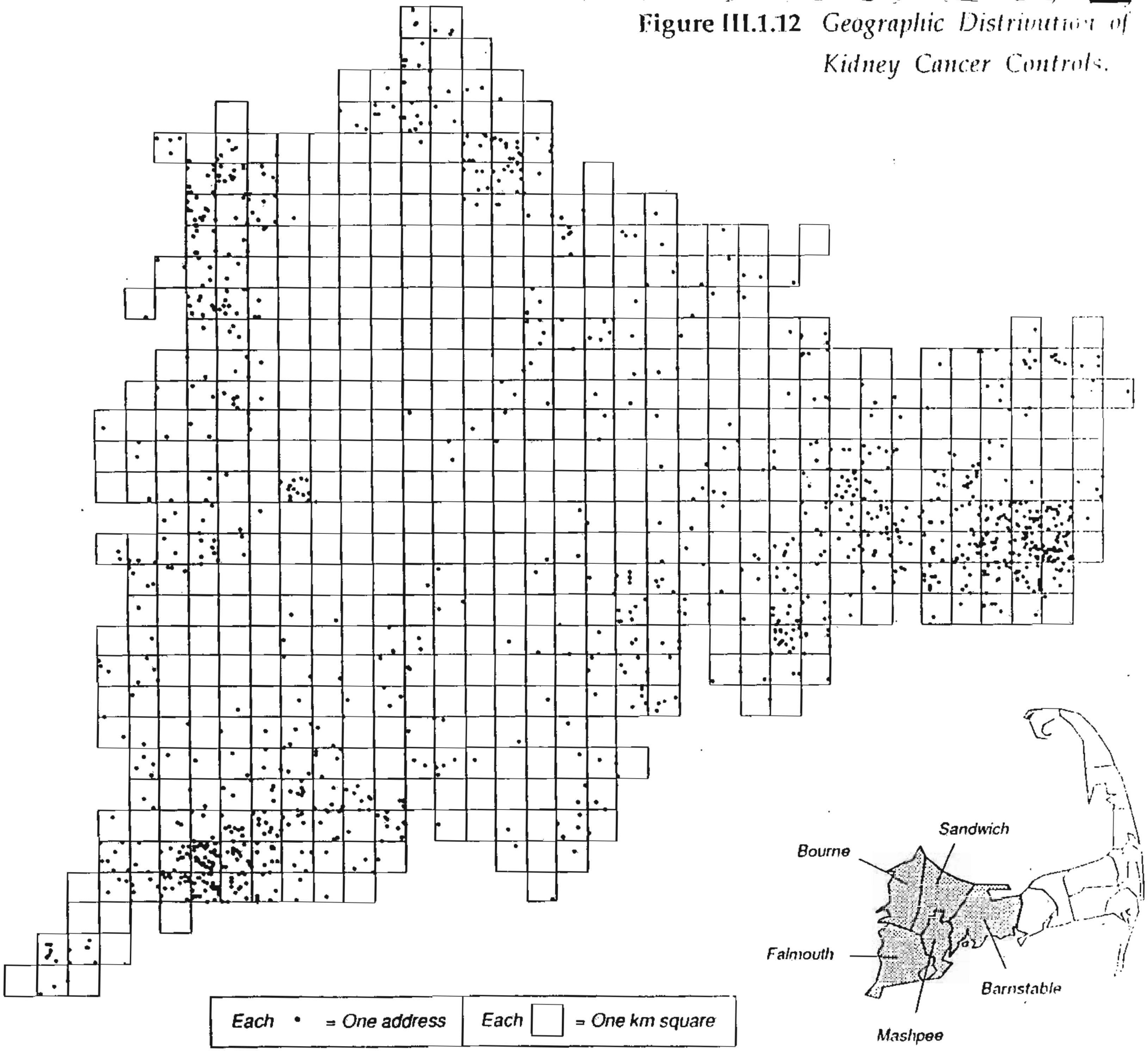

Figure III.1.13 *Geographic Distribution of Pancreas Cancer Cases.*

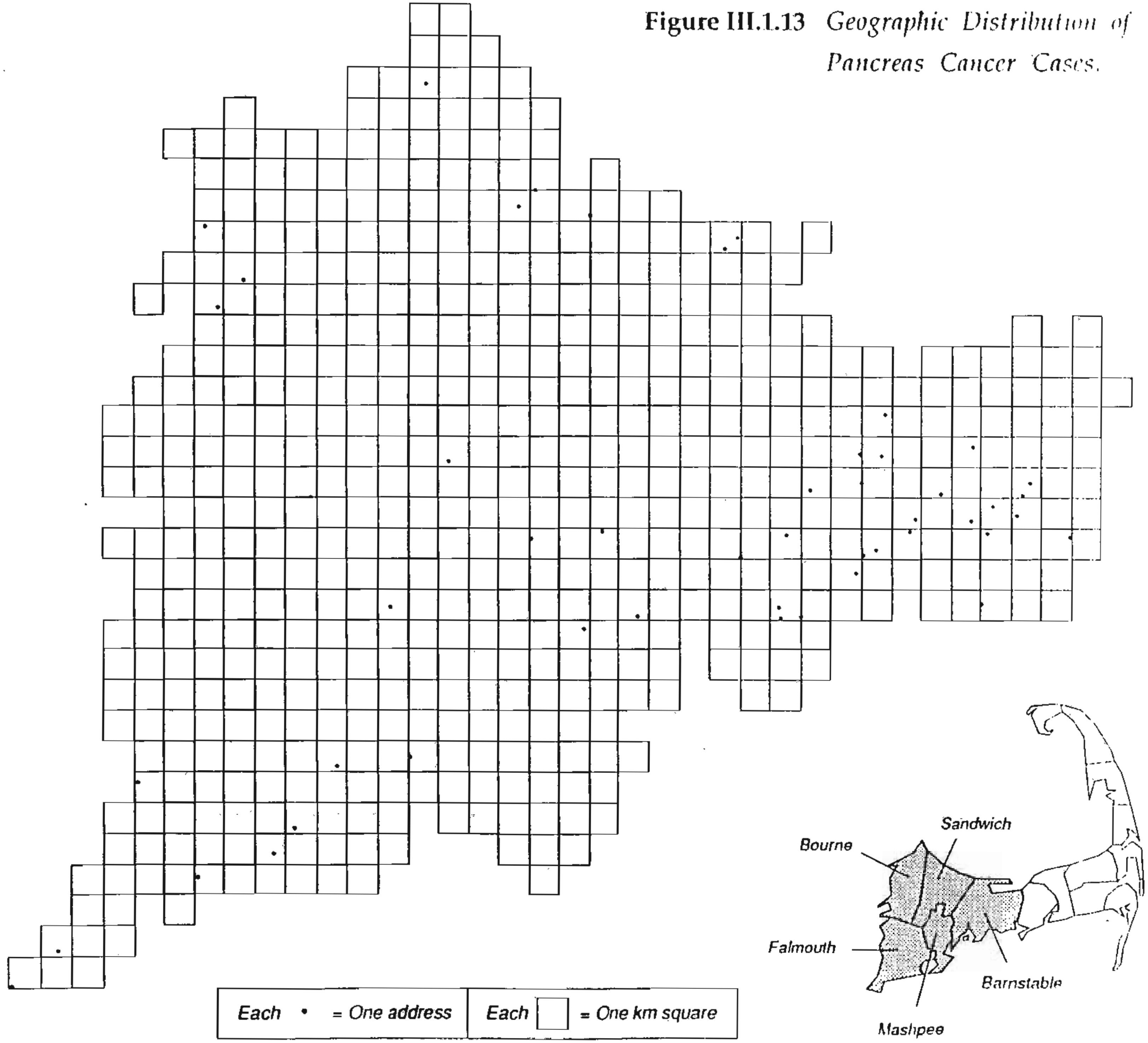

Figure III.1.14 *Geographic Distribution of Pancreas Cancer Controls.*

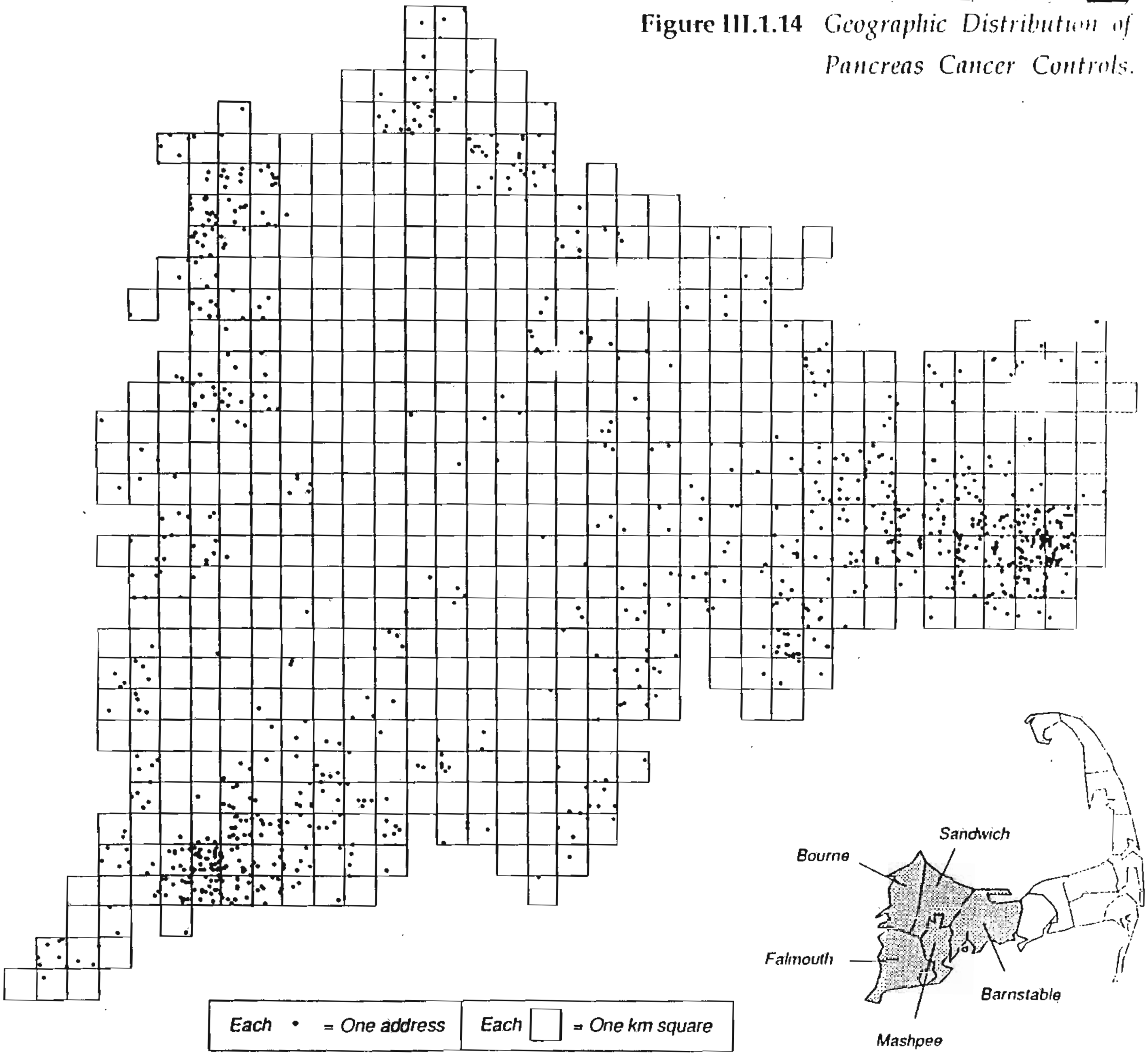

Figure III.1.15 *Geographic Distribution of Leukemia Cases.*

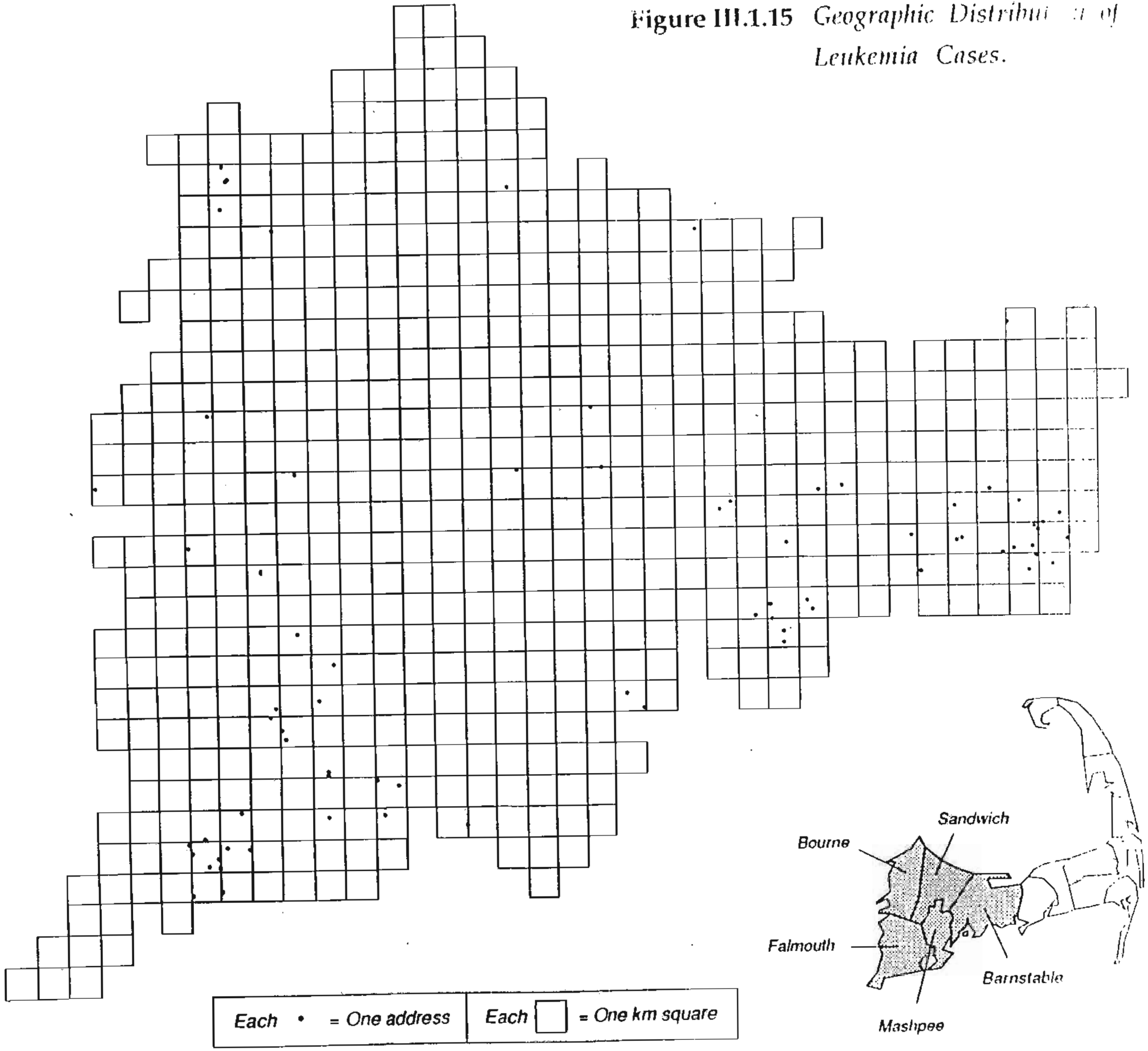

Figure III.1.16 Geographic Distribution of Leukemia Controls.

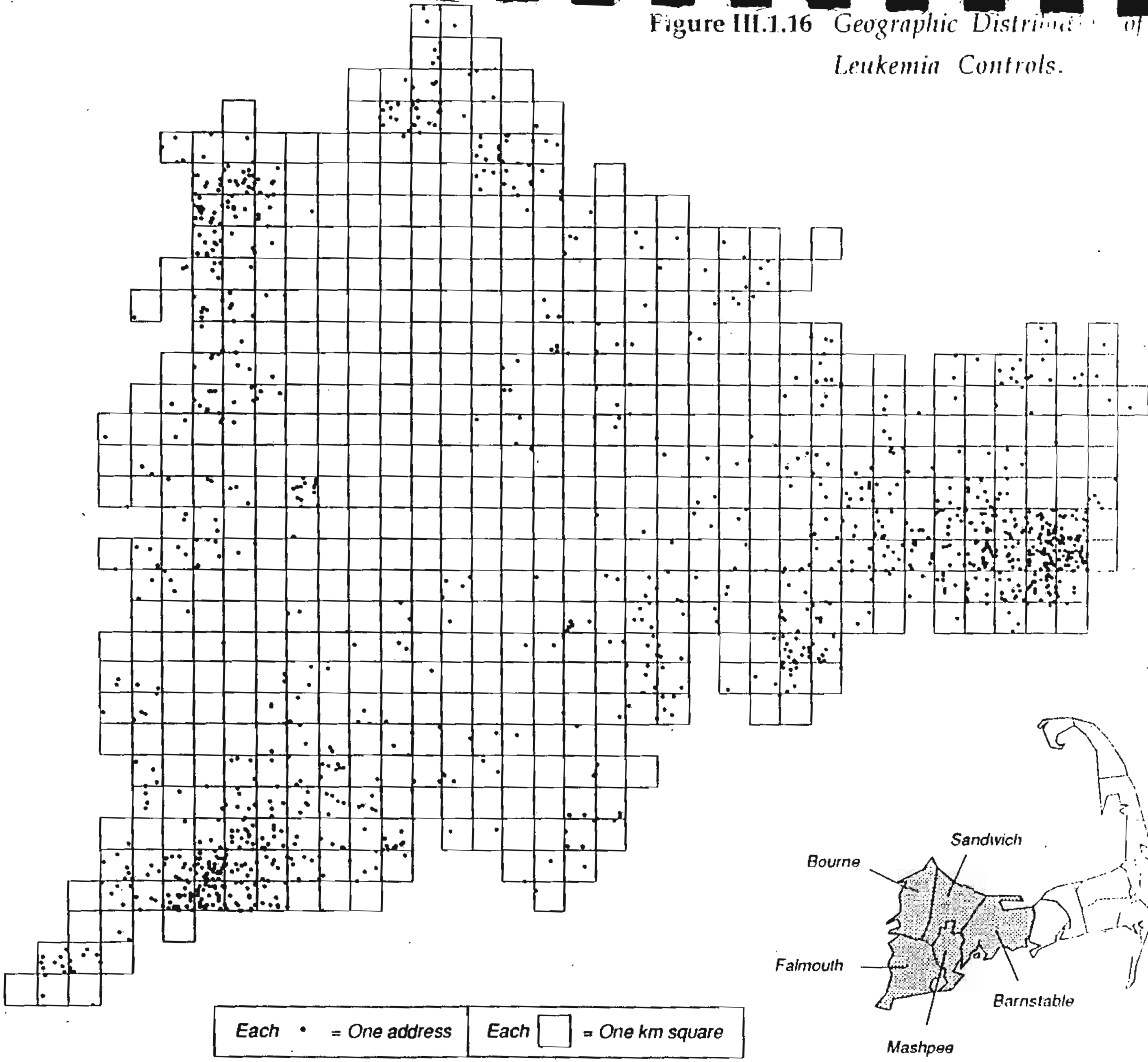

Figure III.1.17 *Geographic Distribution of Brain Cancer Cases.*

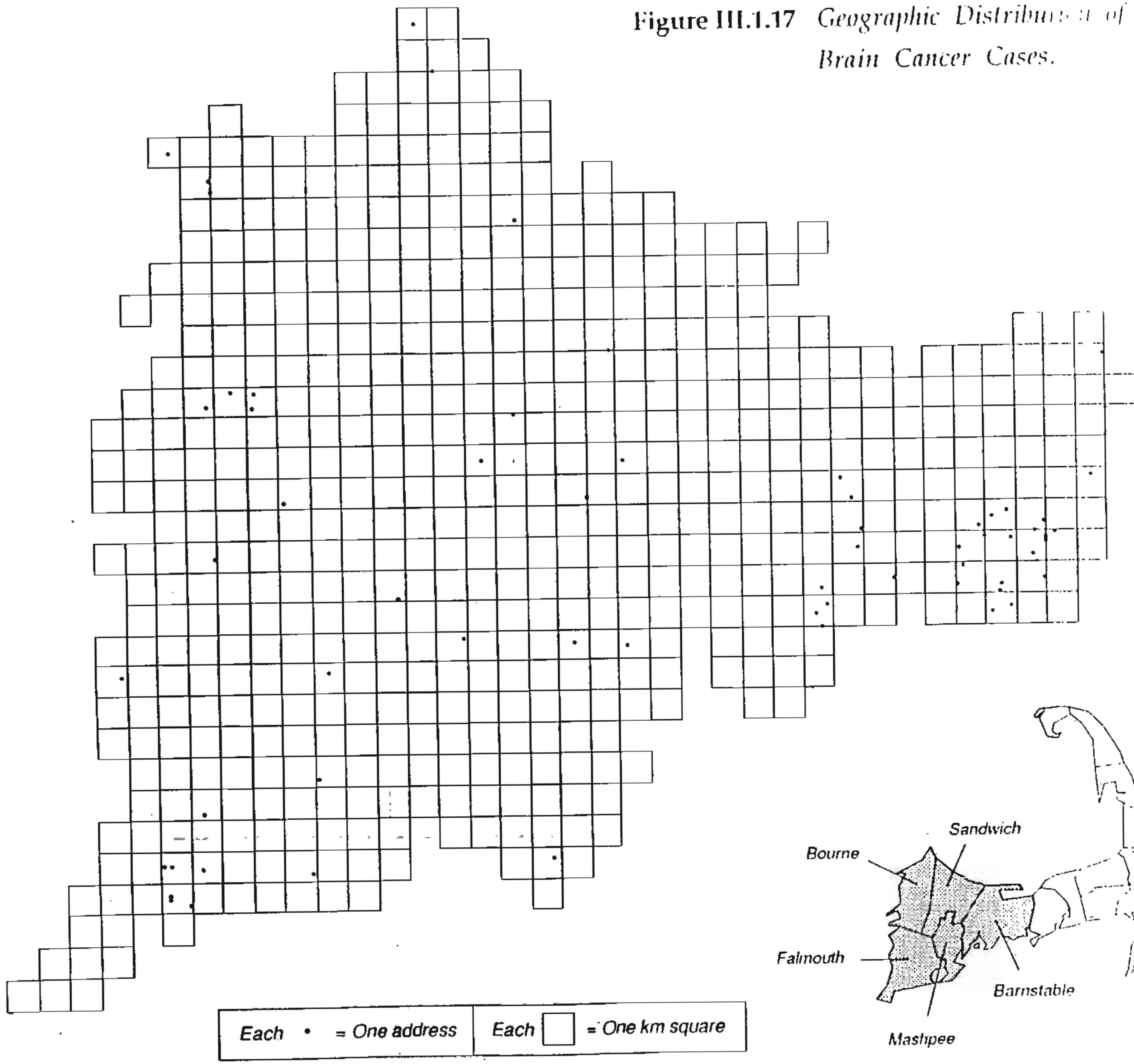

Figure III.1.18 *Geographic Distribution of Brain Cancer Controls.*

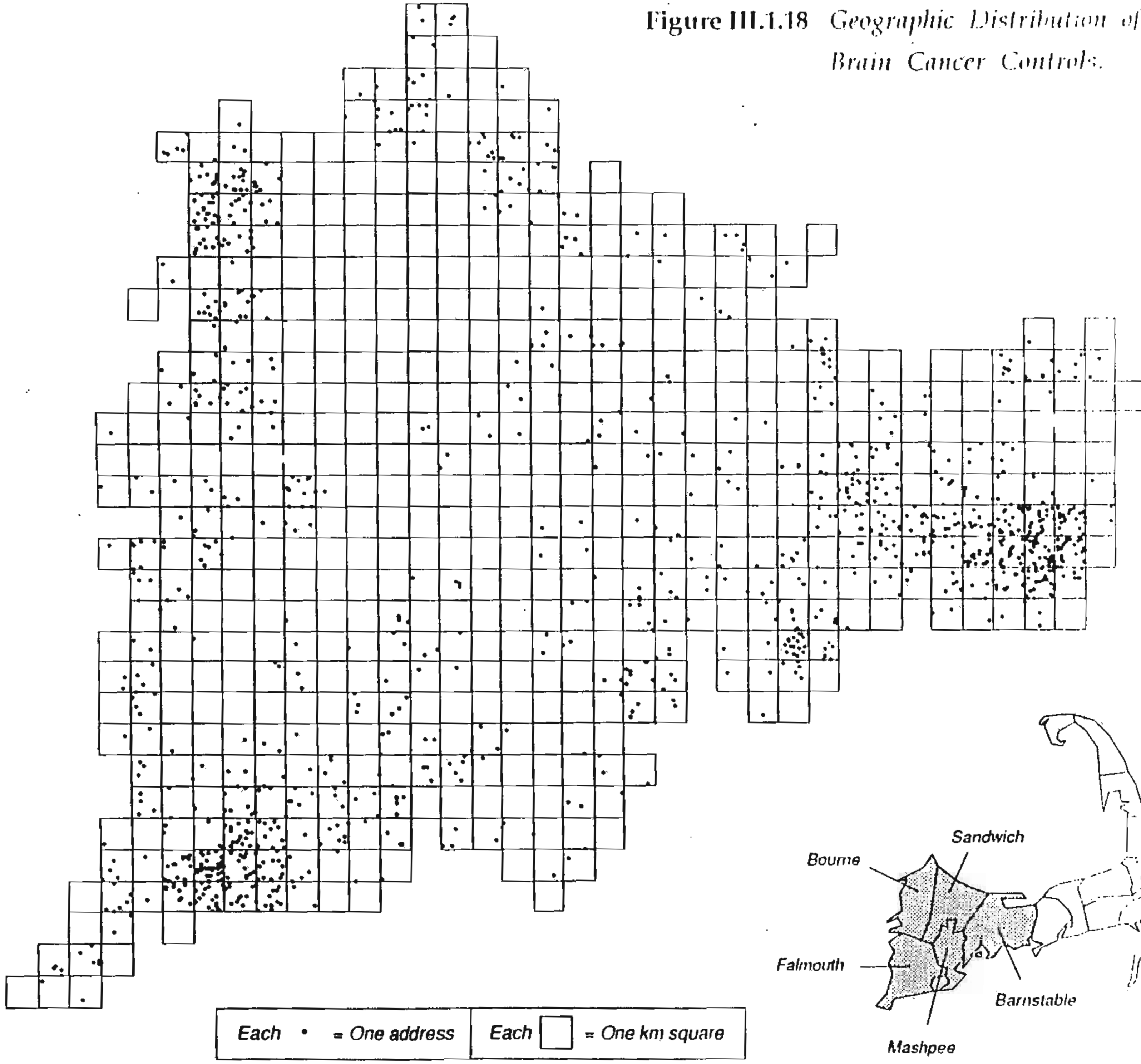

Figure III.1.19 *Geographic Distribution of Liver Cancer Cases.*

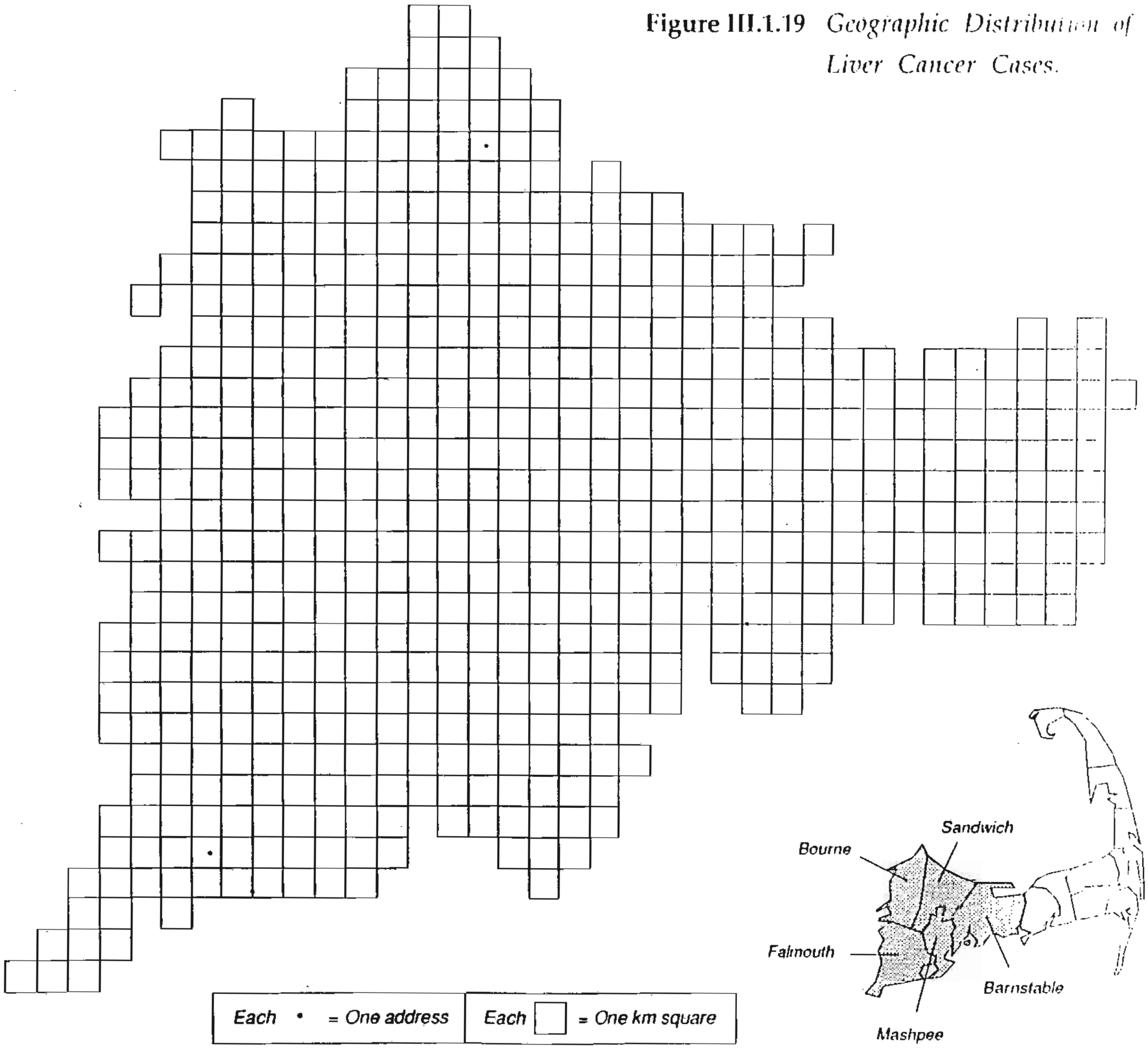

Figure III.1.20 *Geographic Distribution of Liver Cancer Controls.*

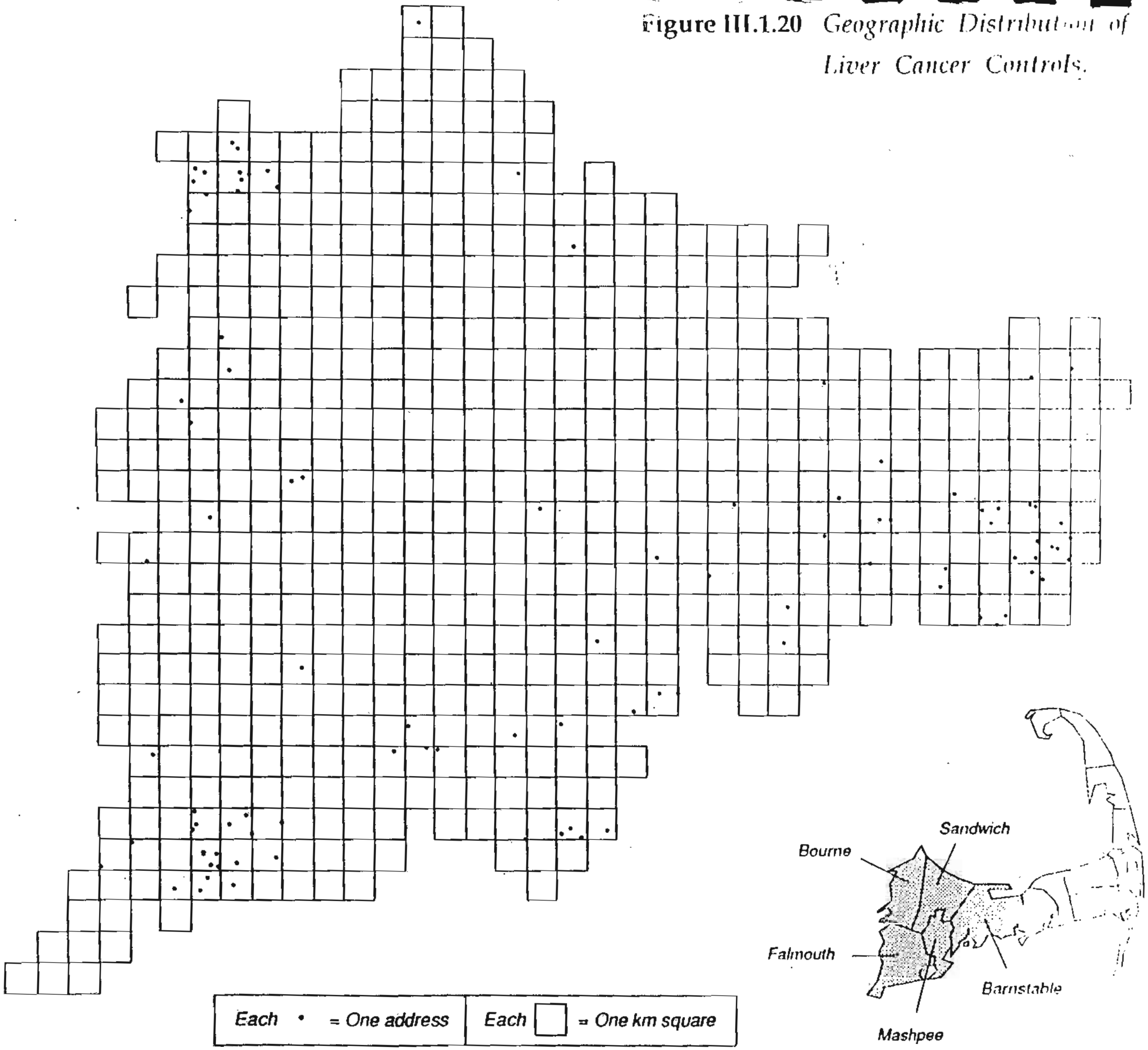

Figure III.1.21 *Geographic Distribution of Long Term Residents (greater than 20 years) Among All Cancer Cases Combined.*

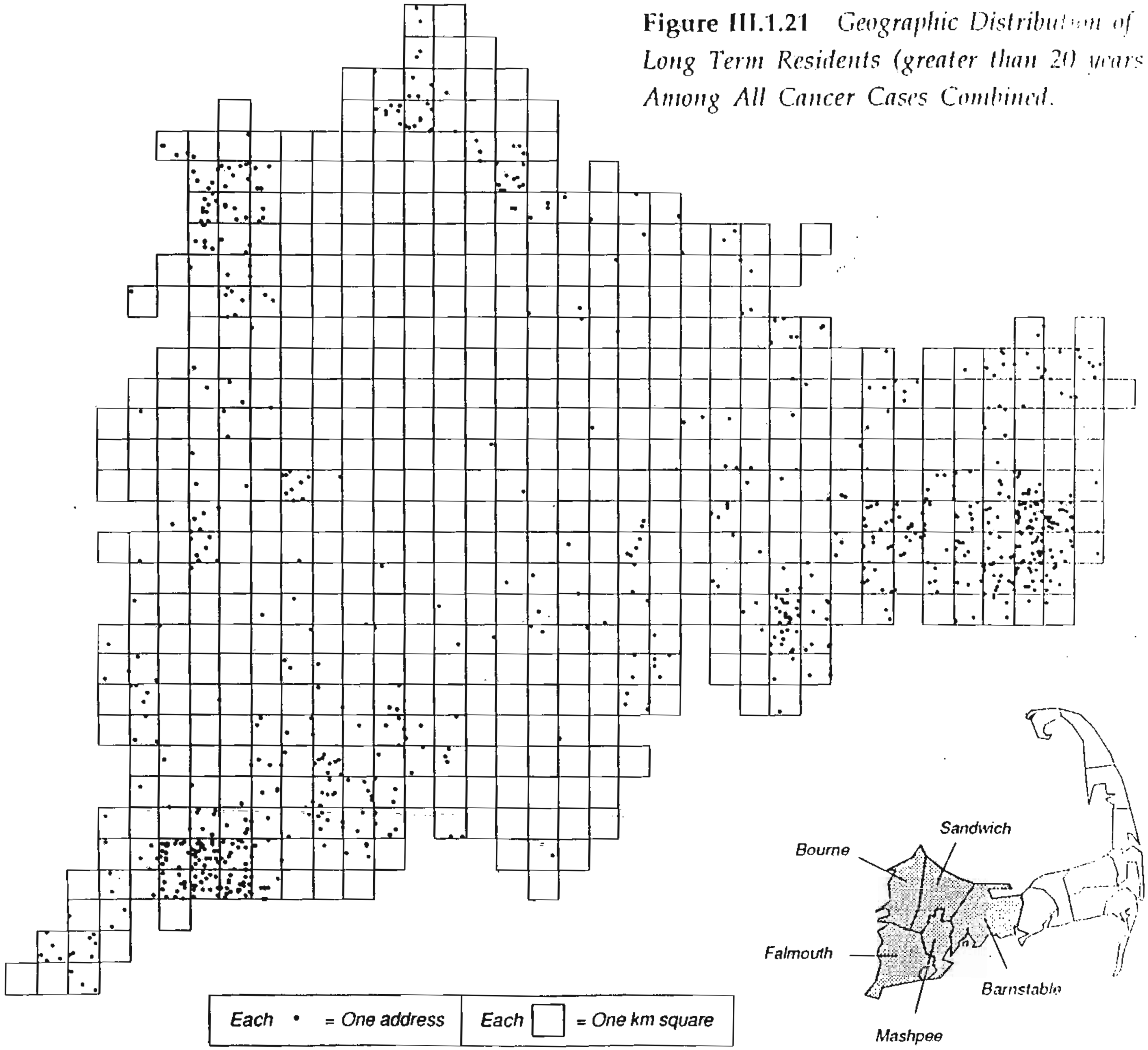

Figure III.1.22 *Geographic Distribution of Long Term Residents (greater than 20 years) Among All Cancer Controls Combined.*

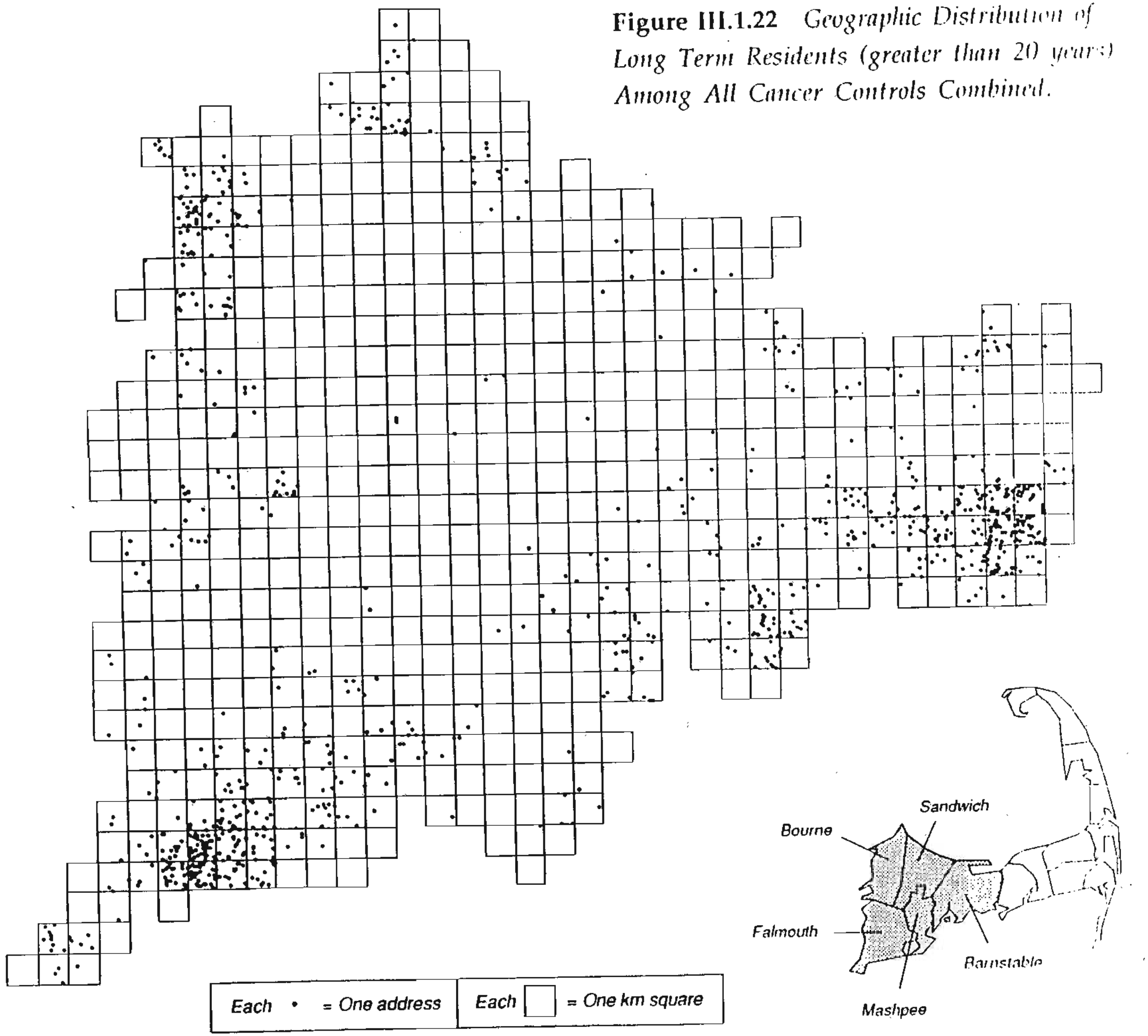

Figure III.1.23 *Geographic Distribution of Long Term Residents (greater than 30 years) Among All Cancer Cases Combined.*

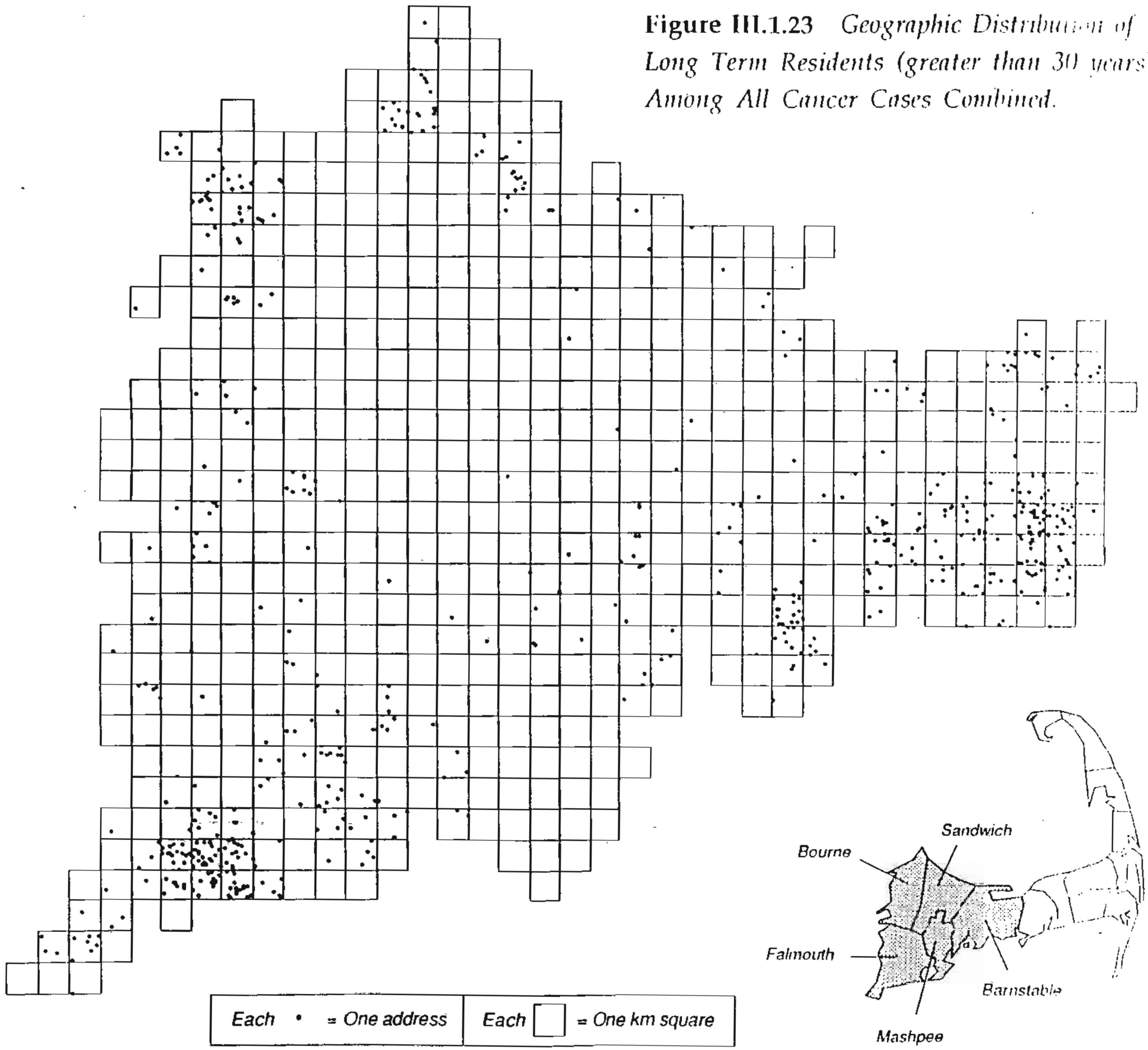

Figure III.1.24 *Geographic Distribution of Long Term Residents (greater than 30 years) Among All Cancer Controls Combined.*

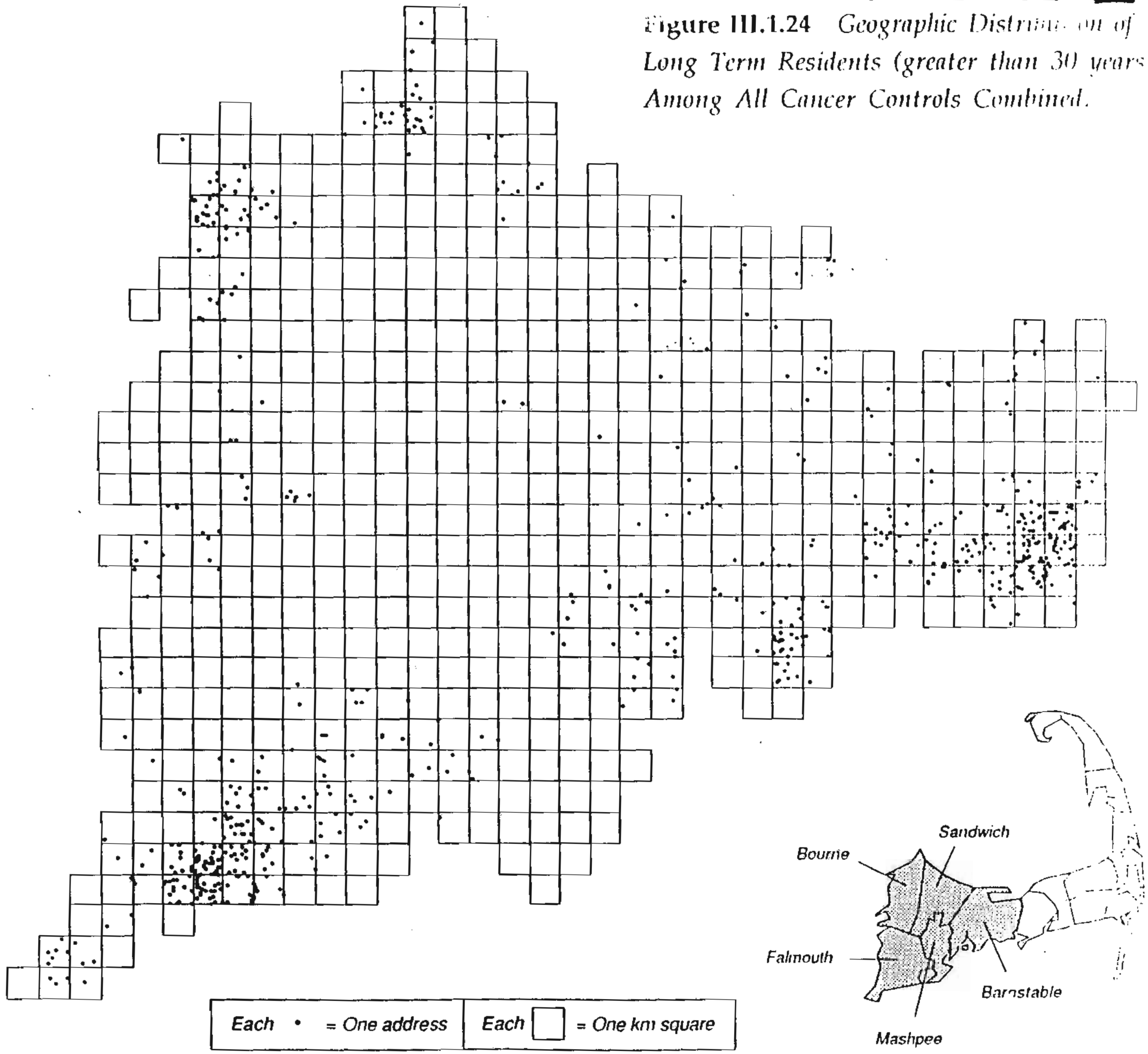

Figure III.1.25 *Geographic Distribution of Female Lung Cancer Cases.*

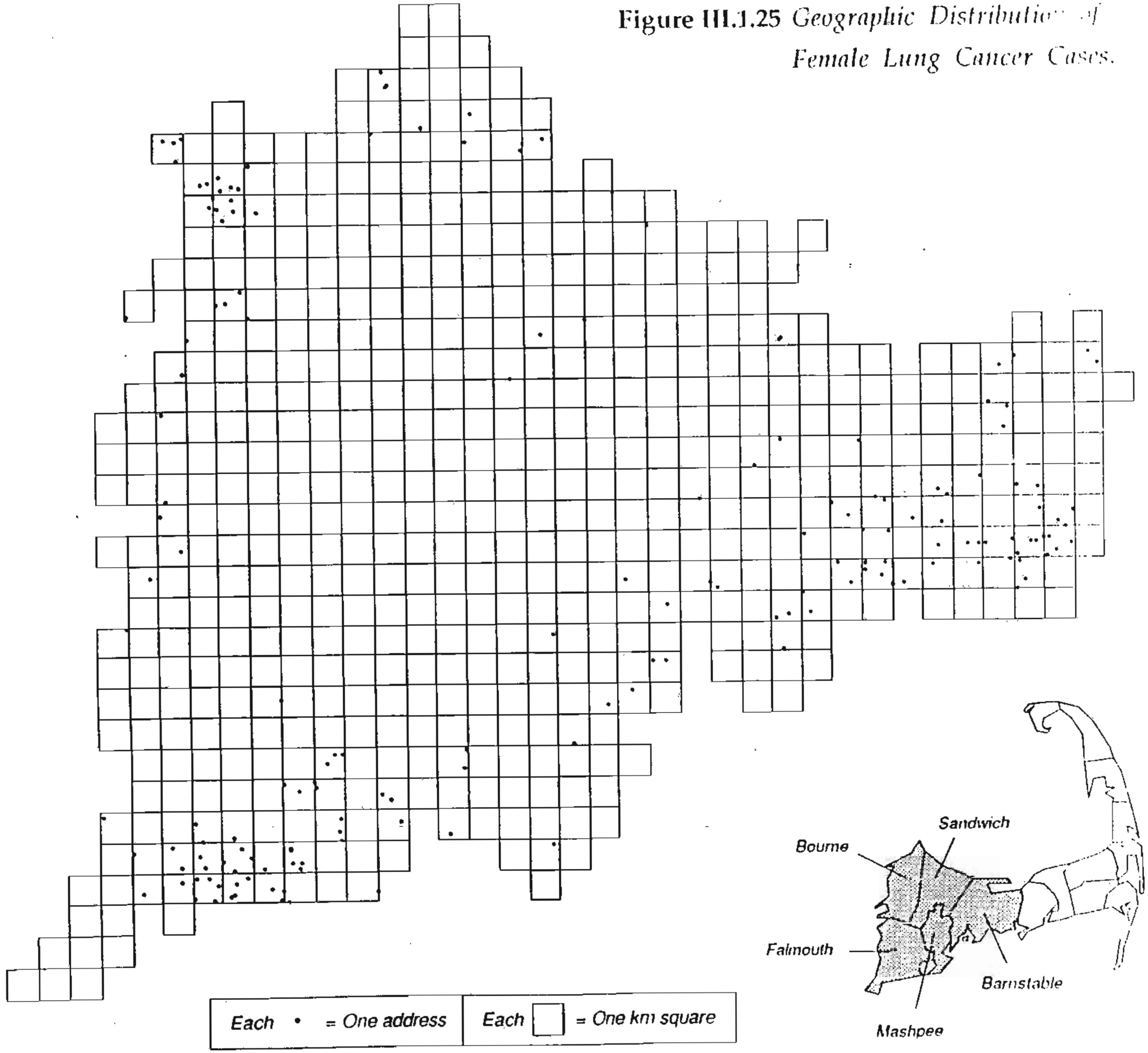

Figure III.1.26 *Geographic Distribution of Male Lung Cancer Cases.*

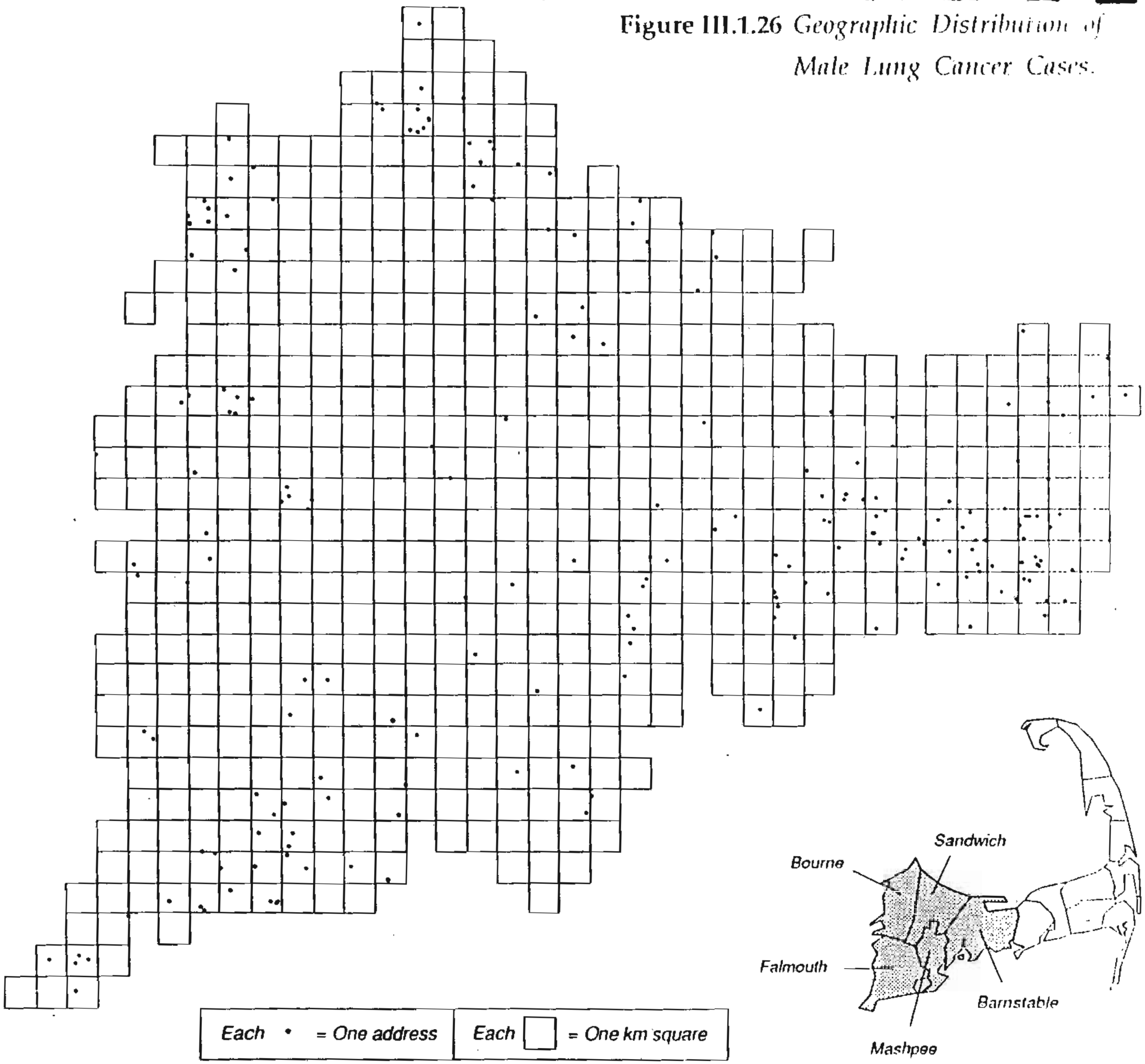

Table III.1.1 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: All Cancers

Characteristic	Cases (N=1,042)	Controls (N=1,285)
Gender		
Male	42.2	41.6
Female	57.8	58.4
Race		
White	97.0	96.5
Black	1.5	1.1
American Indian	0.6	0.7
Cape Verdean	0.6	1.2
Other	0.4	0.5
Age at Diagnosis or Index Year (years)		
1-19	0.4	0.2
20-29	0.7	0.3
30-39	1.0	1.3
40-49	4.1	4.6
50-59	11.0	10.7
60-69	30.4	33.2
70-79	36.4	31.8
80+	16.0	18.1
Current Marital Status		
Married	60.4	58.9
Widowed	26.6	27.4
Never Married	6.0	5.9
Separated/Divorced	7.0	7.8
Religion		
Catholic	47.8	47.1
Protestant	46.9	47.0
Jewish	2.6	2.7
Other	2.7	3.1
Educational Level		
Less than High School	19.9	19.2
High School Graduate	32.6	34.7
Some College	23.7	23.4
College Graduate Plus	23.8	22.7

Table III.1.1 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: All Cancers

Characteristic	Cases (N=1,042)	Controls (N=1,285)
Birthplace		
Massachusetts	62.8	62.5
Other U.S.	27.2	26.8
Foreign Country	9.9	10.7
Ever Held Full-Time Job	93.1	93.5
Ever Held Full-Time Job on the Upper Cape*	19.9	18.7
Ever in Military Service	25.2	26.2
Ever Regular Cigarette Smoker	70.1	64.2
Ever Drank Alcoholic Beverages	87.3	85.9
Alive at Interview	45.4	47.3

* Only includes subjects who ever held a full-time job

Table III.1.2 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Lung

Characteristic	Cases (N=251)	Controls (N=1,228)
Gender		
Male	59.0	42.8
Female	41.0	57.3
Race		
White	96.4	96.6
Black	1.6	1.0
American Indian	0.0	0.7
Cape Verdean	0.8	1.1
Other	1.2	0.6
Age at Diagnosis or Index Year (years)		
30-39	0.4	0.8
40-49	3.2	4.6
50-59	12.0	10.4
60-69	38.7	33.2
70-79	35.5	33.4
80+	10.4	17.5
Current Marital Status		
Married	71.2	60.4
Widowed	16.8	25.9
Never Married	2.8	5.9
Separated/Divorced	9.2	7.8
Religion		
Catholic	52.2	47.8
Protestant	43.4	46.3
Jewish	0.8	2.8
Other	3.6	3.1
Educational Level		
Less than High School	19.8	19.0
High School Graduate	35.0	35.0
Some College	23.0	23.3
College Graduate Plus	22.2	22.8

Table III.1.2 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Lung

Characteristic	Cases (N=251)	Controls (N=1,228)
Birthplace		
Massachusetts	64.1	62.9
Other U.S.	27.5	26.8
Foreign Country	8.4	10.3
Ever Held Full-Time Job	94.0	93.9
Ever Held Full-Time Job on the Upper Cape*	30.9	18.5
Ever in Military Service	36.8	27.2
Ever Regular Cigarette Smoker	93.6	66.1
Ever Drank Alcoholic Beverages	96.0	86.8
Alive At Interview	17.5	47.2

* Only includes subjects who ever held a full-time job

Table III.1.3 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Breast

Characteristic	Cases (N=265)	Controls (N=701)
Gender		
Male	0.0	0.0
Female	100.0	100.0
Race		
White	98.5	96.9
Black	0.8	1.1
American Indian	0.4	0.7
Cape Verdean	0.4	0.9
Other	0.0	0.4
Age at Diagnosis or Index Year (years)		
20-29	0.4	0.6
30-39	2.3	1.3
40-49	9.4	5.4
50-59	14.3	12.1
60-69	30.6	33.9
70-79	27.6	27.5
80+	15.5	19.3
Current Marital Status		
Married	47.7	45.3
Widowed	32.4	38.0
Never Married	9.2	7.1
Separated/Divorced	10.7	9.6
Religion		
Catholic	46.7	48.1
Protestant	47.1	46.6
Jewish	3.5	3.0
Other	2.7	2.3
Educational Level		
Less than High School	16.5	17.0
High School Graduate	36.2	40.7
Some College	27.7	23.1
College Graduate Plus	19.6	19.1

Table III.1.3 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Breast

Characteristic	Cases (N=265)	Controls (N=701)
Birthplace		
Massachusetts	58.9	63.5
Other U.S.	31.9	25.8
Foreign Country	9.1	11.7
Ever Held Full-Time Job	89.8	90.4
Ever Held Full-Time Job on the Upper Cape*	12.9	17.3
Ever in Military Service	3.3	4.2
Ever Regular Cigarette Smoker	58.9	54.2
Ever Drank Alcoholic Beverages	85.2	80.4
Alive at Interview	67.2	55.5

* Only includes subjects who ever held a full-time job

Table III.1.4 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Colo-Rectal

Characteristic	Cases (N=315)	Controls (N=1,179)
Gender		
Male	53.7	43.7
Female	46.4	56.3
Race		
White	96.2	96.3
Black	1.9	1.2
American Indian	1.3	0.8
Cape Verdean	0.3	1.3
Other	0.3	0.5
Age at Diagnosis or Index Year (years)		
20-29	0.3	0.1
30-39	0.3	0.5
40-49	1.3	2.7
50-59	8.9	10.2
60-69	26.0	34.5
70-79	41.9	33.7
80+	21.3	18.3
Current Marital Status		
Married	60.9	59.2
Widowed	29.2	28.2
Never Married	6.4	5.8
Separated/Divorced	3.5	6.8
Religion		
Catholic	45.2	46.1
Protestant	48.4	48.0
Jewish	4.1	2.7
Other	2.2	3.2
Educational Level		
Less than High School	19.6	20.7
High School Graduate	34.7	29.6
Some College	23.0	24.3
College Graduate Plus	22.7	25.3

Table III.1.4 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Colo-Rectal

Characteristic	Cases (N=315)	Controls (N=1,179)
Birthplace		
Massachusetts	64.4	62.2
Other U.S.	23.4	27.0
Foreign Country	12.2	10.8
Ever Held Full-Time Job	94.8	93.9
Ever Held Full-Time Job on the Upper Cape*	16.4	18.1
Ever in Military Service	28.9	24.1
Ever Regular Cigarette Smoker	60.6	64.2
Ever Drank Alcoholic Beverages	83.8	85.9
Alive At Interview	54.6	47.2

* Only includes subjects who ever held a full-time job

Table III.1.5 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Bladder

Characteristic	Cases (N=62)	Controls (N=867)
Gender		
Male	74.2	52.4
Female	25.8	47.6
Race		
White	98.4	96.7
Black	0.0	1.2
American Indian	0.0	0.6
Cape Verdean	1.6	1.2
Other	0.0	0.5
Age at Diagnosis or Index Year (years)		
40-49	0.0	1.5
50-59	9.7	10.3
60-69	41.9	40.0
70-79	35.5	33.7
80+	12.9	14.5
Current Marital Status		
Married	72.1	66.9
Widowed	26.2	22.9
Never Married	1.6	4.4
Separated/Divorced	0.0	5.9
Religion		
Catholic	55.0	45.9
Protestant	41.7	47.7
Jewish	0.0	2.7
Other	3.3	3.7
Educational Level		
Less than High School	31.6	18.4
High School Graduate	24.6	32.5
Some College	14.0	24.6
College Graduate Plus	29.8	24.5

Table III.1.5 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Bladder

Characteristic	Cases (N=62)	Controls (N=867)
Birthplace		
Massachusetts	70.5	61.6
Other U.S.	23.0	29.3
Foreign Country	6.6	9.1
Ever Held Full-Time Job	98.4	95.6
Ever Held Full-Time Job on the Upper Cape*	16.7	14.3
Ever in Military Service	41.0	32.9
Ever Regular Cigarette Smoker	88.7	66.7
Ever Drank Alcoholic Beverages	80.7	89.0
Alive At Interview	64.5	57.4

* Only includes subjects who ever held a full-time job

Table III.1.6 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Kidney

Characteristic	Cases (N=35)	Controls (N=792)
Gender		
Male	65.7	48.1
Female	34.3	51.9
Race		
White	94.3	96.8
Black	2.9	1.3
American Indian	0.0	0.4
Cape Verdean	2.9	1.1
Other	0.0	0.4
Age at Diagnosis or Index Year (years)		
30-39	0.0	0.4
40-49	2.9	0.9
50-59	8.6	7.1
60-69	28.6	42.7
70-79	51.4	39.4
80+	8.6	9.6
Current Marital Status		
Married	57.1	64.5
Widowed	31.4	24.8
Never Married	2.9	5.1
Separated/Divorced	8.6	5.7
Religion		
Catholic	45.7	46.0
Protestant	54.3	48.0
Jewish	0.0	2.9
Other	0.0	3.1
Educational Level		
Less than High School	20.6	16.7
High School Graduate	32.4	35.0
Some College	20.6	25.5
College Graduate Plus	26.5	22.9

Table III.1.6 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Kidney

Characteristic	Cases (N=35)	Controls (N=792)
Birthplace		
Massachusetts	54.3	63.5
Other U.S.	34.3	27.3
Foreign Country	11.4	9.3
Ever Held Full-Time Job	100.0	95.9
Ever Held Full-Time Job on the Upper Cape*	17.1	13.0
Ever in Military Service	37.1	30.3
Ever Regular Cigarette Smoker	74.3	66.9
Ever Drank Alcoholic Beverages	94.3	88.0
Alive At Interview	51.4	61.7

* Only includes subjects who ever held a full-time job

Table III.1.7 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Pancreas

Characteristic	Cases (N=37)	Controls (N=633)
Gender		
Male	35.1	38.4
Female	64.9	61.6
Race		
White	97.3	96.8
Black	0.0	1.1
American Indian	2.7	0.3
Cape Verdean	0.0	1.4
Other	0.0	0.3
Age at Diagnosis or Index Year (years)		
40-49	0.0	0.3
50-59	5.4	2.5
60-69	13.5	33.3
70-79	59.5	45.3
80+	21.6	18.5
Current Marital Status		
Married	54.1	55.9
Widowed	32.4	32.3
Never Married	0.0	5.4
Separated/Divorced	13.5	6.5
Religion		
Catholic	37.8	46.2
Protestant	56.8	48.6
Jewish	5.4	2.1
Other	0.0	3.2
Educational Level		
Less than High School	13.9	19.1
High School Graduate	36.1	37.0
Some College	19.5	21.3
College Graduate Plus	30.6	22.6

Table III.1.7 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Pancreas

Characteristic	Cases (N=37)	Controls (N=633)
Birthplace		
Massachusetts	54.1	62.2
Other U.S.	24.3	27.7
Foreign Country	21.6	10.1
Ever Held Full-Time Job	88.9	92.0
Ever Held Full-Time Job on the Upper Cape*	28.1	17.7
Ever in Military Service	21.6	24.0
Ever Regular Cigarette Smoker	51.4	65.6
Ever Drank Alcoholic Beverages	73.0	84.6
Alive At Interview	8.1	36.3

* Only includes subjects who ever held a full-time job

Table III.1.8 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Leukemia

Characteristic	Cases (N=36)	Controls (N=751)
Gender		
Male	47.2	47.0
Female	52.8	53.0
Race		
White	97.2	96.1
Black	2.8	1.3
American Indian	0.0	0.7
Cape Verdean	0.0	1.3
Other	0.0	0.5
Age at Diagnosis or Index Year (years)		
1-19	8.3	0.1
20-29	5.6	0.3
30-39	2.8	1.1
40-49	2.8	3.3
50-59	5.6	6.5
60-69	19.4	35.7
70-79	30.6	37.0
80+	25.0	16.0
Current Marital Status		
Married	61.1	58.3
Widowed	25.0	27.7
Never Married	13.9	6.8
Separated/Divorced	0.0	7.2
Religion		
Catholic	42.9	47.9
Protestant	54.3	47.3
Jewish	0.0	2.8
Other	2.9	2.0
Educational Level		
Less than High School	28.6	19.9
High School Graduate	31.4	35.7
Some College	17.2	23.1
College Graduate Plus	22.9	21.4

Table III.1.8 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Leukemia

Characteristic	Cases (N=36)	Controls (N=751)
Birthplace		
Massachusetts	72.2	65.5
Other U.S.	22.2	24.8
Foreign Country	5.6	9.7
Ever Held Full-Time Job	85.7	94.0
Ever Held Full-Time Job on the Upper Cape*	31.3	21.0
Ever in Military Service	33.3	29.9
Ever Regular Cigarette Smoker	63.9	68.8
Ever Drank Alcoholic Beverages	88.9	86.5
Alive at Interview	25.0	35.0

* Only includes subjects who ever held a full-time job

Table III.1.9 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Brain

Characteristic	Cases (N=37)	Controls (N=715)
Gender		
Male	54.0	42.4
Female	46.0	57.6
Race		
White	97.3	96.6
Black	2.7	1.0
American Indian	0.0	0.6
Cape Verdean	0.0	1.1
Other	0.0	0.7
Age at Diagnosis or Index Year (years)		
1-19	2.7	0.0
20-29	8.1	0.1
30-39	2.7	0.0
40-49	10.8	2.1
50-59	13.5	10.8
60-69	21.6	37.8
70-79	29.7	35.0
80+	10.8	14.3
Current Marital Status		
Married	59.5	60.0
Widowed	24.3	26.2
Never Married	10.8	5.7
Separated/Divorced	5.4	8.1
Religion		
Catholic	48.7	47.2
Protestant	43.2	46.2
Jewish	2.7	2.7
Other	5.4	3.9
Educational Level		
Less than High School	19.5	17.7
High School Graduate	30.6	36.1
Some College	19.5	23.0
College Graduate Plus	30.6	23.2

Table III.1.9 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Brain

Characteristic	Cases (N=37)	Controls (N=715)
Birthplace		
Massachusetts	67.6	62.3
Other U.S.	27.0	27.4
Foreign Country	5.4	10.4
Ever Held Full-Time Job	92.6	86.5
Ever Held Full-Time Job on the Upper Cape*	18.8	20.9
Ever in Military Service	24.3	30.4
Ever Regular Cigarette Smoker	62.2	68.7
Ever Drank Alcoholic Beverages	89.2	85.5
Alive At Interview	24.3	37.9

* Only includes subjects who ever held a full-time job

Table III.1.10 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls

Cancer Site: Liver

Characteristic	Cases (N=4)	Controls (N=50)
Gender		
Male	100.0	100.0
Female	0.0	0.0
Race		
White	100.0	94.0
Black	0.0	2.0
American Indian	0.0	2.0
Cape Verdean	0.0	0.0
Other	0.0	0.0
Age at Diagnosis or Index Year (years)		
40-49	0.0	12.0
50-59	25.0	14.0
60-69	25.0	18.0
70-79	25.0	24.0
80+	25.0	32.0
Current Marital Status		
Married	100.0	76.0
Widowed	0.0	10.0
Never Married	0.0	4.0
Separated/Divorced	0.0	10.0
Religion		
Catholic	75.0	52.0
Protestant	25.0	46.0
Jewish	0.0	0.0
Other	0.0	2.0
Educational Level		
Less than High School	0.0	22.9
High School Graduate	0.0	29.2
Some College	50.0	25.0
College Graduate Plus	50.0	22.9

Table III.1.10 Distribution (%) of Demographic and Personal Characteristics of Cases and Controls (continued)

Cancer Site: Liver

Characteristic	Cases (N=4)	Controls (N=50)
Birthplace		
Massachusetts	25.0	64.0
Other U.S.	75.0	26.0
Foreign Country	0.0	10.0
Ever Held Full-Time Job	100.0	100.0
Ever Held Full-Time Job on the Upper Cape*	0.0	40.0
Ever in Military Service	25.0	46.9
Ever Regular Cigarette Smoker	50.0	88.0
Ever Drank Alcoholic Beverages	100.0	94.0
Alive At Interview	0.0	0.0

* Only includes subjects who ever held a full-time job

Table III.2.1 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: All Cancers

Ever Held Job With Exposure* To:	Cases N=1,042	Controls N=1,285
Asbestos	16.1	14.8
Ionizing Radiation	5.0	6.1
Beryllium	0.7	0.9
Hydrocarbons	23.9	24.7
Benzene	4.1	4.8
Gasoline or Kerosene	13.6	13.1
Other Solvents	18.3	18.0
Lead	7.8	8.8
Mercury	2.1	3.7
Cadmium	0.7	1.5
Arsenic	1.7	1.1
Pesticides and Herbicides		
-Direct Question	5.5	5.5
-Job title	2.4	3.0
Cranberry Bog Work		
-Direct Question	1.8	2.3
Radar Equipment	4.2	5.3
Microwaves		
-Direct Question	1.1	1.3
-Job Title	0.1	0.1
Power Lines		
-Direct Question	3.2	3.7
Electromagnetic Radiation		
-Job Title	1.2	1.1
Welding Materials	8.6	9.3
Occupations Associated with Cancer Sites**	15.9	14.1

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
** See text for description

Table III.2.2 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Lung

Ever Held Job With Exposure* To:	Cases N=251	Controls N=1,228
Asbestos	29.1	15.3
Ionizing Radiation	3.7	6.0
Beryllium	1.1	0.9
Hydrocarbons	37.6	25.2
Benzene	8.7	4.8
Gasoline or Kerosene	23.0	13.5
Other Solvents	31.1	18.4
Lead	12.4	9.1
Mercury	0.5	3.7
Cadmium	0.0	1.5
Arsenic	2.5	1.2
Pesticides and Herbicides		
-Direct Question	10.3	5.5
-Job title	4.8	2.9
Cranberry Bog Work		
-Direct Question	0.8	2.2
Radar Equipment	7.3	5.5
Microwaves		
-Direct Question	2.6	1.4
-Job title	0.4	0.1
Power Lines		
-Direct Question	4.9	3.9
Electromagnetic Radiation		
-Job Title	2.0	1.1
Welding Materials	14.4	9 .
Occupations Associated With Lung Cancer**	23.9	12.1

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds Ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.3 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Breast

Ever Held Job With Exposure* To:	Cases N=265	Controls N=701
Asbestos	6.6	5.1
Ionizing Radiation	5.6	4.7
Beryllium	0.9	0.0
Hydrocarbons	13.1	10.7
Benzene	1.7	1.6
Gasoline or Kerosene	4.7	2.7
Other Solvents	9.3	8.2
Lead	2.9	2.2
Mercury	1.6	2.7
Cadmium	0.4	0.5
Arsenic	0.0	0.2
Pesticides and Herbicides		
-Direct Question	1.2	2.4
-Job title	0.4	0.7
Cranberry Bog Work		
-Direct Question	1.9	2.3
Radar Equipment	1.6	0.7
Microwaves		
-Direct Question	0.8	0.1
-Job Title	0.0	0.0
Power Lines		
-Direct Question	0.8	0.7
Electromagnetic Radiation		
-Job Title	0.0	0.0
Welding Materials	2.0	1.2

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated only if there were at least three exposed cases.

Table III.2.4 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Colo-Rectal

Ever Held Job With Exposure* To:	Cases N=315	Controls N=1,179
Asbestos	14.1	14.9
Ionizing Radiation	4.5	5.8
Beryllium	0.4	0.9
Hydrocarbons	20.9	24.5
Benzene	4.2	4.8
Gasoline or Kerosene	11.9	13.3
Other Solvents	15.2	17.6
Lead	6.1	8.9
Mercury	3.1	3.6
Cadmium	0.7	1.5
Arsenic	1.0	1.2
Pesticides and Herbicides		
-Direct Question	4.1	5.6
-Job title	2.9	3.1
Cranberry Bog Work		
-Direct Question	1.6	2.4
Radar Equipment	3.1	5.5
Microwaves		
-Direct Question	0.7	1.4
-Job title	0.0	0.1
Power Lines		
-Direct Question	3.4	3.9
Electromagnetic Radiation		
-Job Title	1.6	1.1
Welding Materials	9.4	9.5
Occupations Associated With Colorec. cancer**	8.3	7.2

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.5 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Bladder

Ever Held Job With Exposure* To:	Cases N=62	Controls N=867
Asbestos	28.9	15.7
Ionizing Radiation	7.1	6.5
Beryllium	0.0	1.3
Hydrocarbons	35.6	26.6
Benzene	4.3	5.3
Gasoline or Kerosene	25.4	14.9
Other Solvents	23.7	18.6
Lead	17.5	9.9
Mercury	5.4	3.9
Cadmium	0.0	1.6
Arsenic	3.4	1.0
Pesticides and Herbicides		
-Direct Question	6.8	5.4
-Job title	1.6	3.0
Cranberry Bog Work		
-Direct Question	3.3	2.3
Radar Equipment	1.8	5.7
Microwaves		
-Direct Question	0.0	1.5
-Job Title	0.0	0.1
Power Lines		
-Direct Question	3.4	4.0
Electromagnetic Radiation		
-Job Title	0.0	1.0
Welding Materials	13.8	10.5
Occupations Associated With Bladder Cancer**	6.4	1.4

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.6 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Kidney

Ever Held Job With Exposure* To:	Cases N=35	Controls N=792
Asbestos	14.3	15.3
Ionizing Radiation	12.1	6.0
Beryllium	3.1	1.2
Hydrocarbons	26.5	25.9
Benzene	4.8	5.0
Gasoline or Kerosene	13.8	14.2
Other Solvents	20.6	18.4
Lead	6.5	10.1
Mercury	3.1	2.9
Cadmium	3.8	2.2
Arsenic	6.7	1.2
Pesticides and Herbicides		
-Direct Question	5.9	4.5
-Job title	2.9	2.2
Cranberry Bog Work		
-Direct Question	2.9	2.3
Radar Equipment	9.1	5.4
Microwaves		
-Direct Question	0.0	1.2
-Job title	0.0	0.1
Power Lines		
-Direct Question	0.0	3.9
Electromagnetic Radiation		
-Job Title	0.0	0.9
Welding Materials	8.8	10.1
Occupations Associated With Kidney Cancer**	2.9	4.9

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.7 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Pancreas

Ever Held Job With Exposure* To:	Cases N=37	Controls N=633
Asbestos	12.5	12.2
Ionizing Radiation	0.0	4.4
Beryllium	0.0	1.0
Hydrocarbons	9.1	22.1
Benzene	0.0	5.5
Gasoline or Kerosene	6.5	11.4
Other Solvents	6.3	15.2
Lead	10.3	7.2
Mercury	3.4	3.0
Cadmium	3.4	1.8
Arsenic	3.4	0.9
Pesticides and Herbicides		
-Direct Question	9.4	4.8
-Job title	0.0	2.4
Cranberry Bog Work		
-Direct Question	5.6	2.1
Radar Equipment	0.0	3.7
Microwaves		
-Direct Question	0.0	1.2
-Job Title	0.0	0.0
Power Lines		
-Direct Question	6.5	2.5
Electromagnetic Radiation		
-Job Title	0.0	1.3
Welding Materials	3.0	8.6
Occupations Associated With Pancreas Cancer**	0.0	4.4

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated if there were at least exposed cases.
** See text for description

Table III.2.8 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Leukemia

Ever Held Job With Exposure* To:	Cases N=36	Controls N=751
Asbestos	11.1	15.2
Ionizing Radiation	3.0	5.1
Beryllium	0.0	0.9
Hydrocarbons	32.4	26.2
Benzene	0.0	3.9
Gasoline or Kerosene	18.8	14.7
Other Solvents	21.2	18.9
Lead	9.7	9.5
Mercury	0.0	2.9
Cadmium	0.0	1.0
Arsenic	3.1	1.5
Pesticides and Herbicides		
-Direct Question	9.1	6.2
-Job title	2.8	3.6
Cranberry Bog Work		
-Direct Question	0.0	2.0
Radar Equipment	9.1	5.7
Microwaves		
-Direct Question	0.0	1.3
-Job Title	0.0	0.1
Power Lines		
-Direct Question	2.9	4.6
Electromagnetic Radiation		
-Job Title	2.8	1.3
Welding Materials	12.1	9.0
Occupations Associated with Leukemia*	5.6	13.9

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.9 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Brain

Ever Held Job With Exposure* To:	Cases N=37	Controls N=715
Asbestos	10.7	15.3
Ionizing Radiation	10.0	5.6
Beryllium	0.0	1.1
Hydrocarbons	22.9	25.0
Benzene	3.4	5.5
Gasoline or Kerosene	12.1	12.3
Other Solvents	22.9	19.0
Lead	6.1	9.7
Mercury	0.0	3.8
Cadmium	3.2	1.9
Arsenic	3.0	1.0
Pesticides and Herbicides		
-Direct Question	6.1	4.9
-Job title	0.0	1.4
Cranberry Bog Work		
-Direct Question	2.8	2.0
Radar Equipment	9.1	5.5
Microwaves		
-Direct Question	3.0	1.6
-Job Title	0.0	0.0
Power Lines		
-Direct Question	6.1	3.3
Electromagnetic Radiation		
-Job Title	2.7	1.3
Welding Materials	2.9	10.1
Occupations Associated With Brain Cancer**	2.7	2.8

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
§ Odds ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.2.10 Distribution (%) of Cases and Controls According to Occupational Exposures

Cancer Site: Liver

Ever Held Job With Exposure* To:	Cases N=4	Controls N=50
Asbestos	50.0	32.1
Ionizing Radiation	0.0	17.1
Beryllium	0.0	0.0
Hydrocarbons	25.0	47.9
Benzene	0.0	11.1
Gasoline or Kerosene	33.3	27.9
Other Solvents	25.0	37.5
Lead	33.3	28.6
Mercury	0.0	5.9
Cadmium	0.0	4.0
Arsenic	33.3	5.9
Pesticides and Herbicides		
-Direct Question	25.0	13.2
-Job title	0.0	10.0
Cranberry Bog Work		
-Direct Question	0.0	2.0
Radar Equipment	33.3	19.1
Microwaves		
-Direct Question	0.0	7.0
-Job Title	0.0	0.0
Power Lines		
-Direct Question	33.3	7.0
Electromagnetic Radiation		
-Job Title	0.0	6.0
Welding Materials	25.0	22.2
Occupations Associated With Liver Cancer**	0.0	0.0

* There were two ways occupational exposure data were obtained at interview: direct questions were asked about exposure to particular materials and job title and industry were obtained. If unspecified, direct questions were the source of the data given.
$ Odds Ratios were calculated only if there were at least three exposed cases.
** See text for description

Table III.3.1 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Lung

Characteristic	Cases (N=251)	Controls (N=1,228)
Ever Regular Cigarette Smoker	93.6	66.1
Number of Cigarette Pack-Years Smoked*		
1-10	4.1	13.8
11-20	11.1	17.4
>20	84.8	68.8
Ever Regular Cigar Smoker	5.6	6.0
Number of Cigar-Years Smoked*		
1-10	25.0	19.1
11-20	25.0	14.9
>20	50.0	66.0
Ever Regular Pipe Smoker	9.6	7.8
Number of Pipe-Years Smoked*		
1-10	0.0	21.1
11-20	11.1	3.5
>20	88.9	75.4
Ever Lived With A Smoker	79.7	77.8

* Includes only smokers

Table III.3.2 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Breast

Characteristic	Cases (N= 265)	Controls (N= 701)
Prior History of Breast Cancer	3.4	6.0
Quetlet Index***		
Less than 19	1.6	2.3
19-25	84.4	79.9
More than 25	13.9	17.8
Positive History of Hormone Use for Menopausal Symptoms	26.4	24.2
Positive History of DES Use	5.0	3.8
Positive History of Oral Contraceptive Use	18.4	11.6
Positive History of Medical Treatment With Ionizing Radiation	11.3	8.4

*** Weight in kilograms/height2 in centimeters

Table III.3.3 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Colo-Rectal

Characteristic	Cases (N=315)	Control (N=1,179)
Ever Drank Alcoholic Beverages	83.8	85.9
Number of Years Drank Alcoholic Beverages*		
1-19	10.0	10.1
20-39	40.3	46.2
40 or more	49.8	43.7
Amount of Usual Consumption*		
Almost Every Day	32.8	23.9
A Few Times a Week	27.2	27.4
A Few Times a Month	22.4	25.2
Less Often Than a Few Times a Month	17.6	23.6
Type of Alcoholic Beverage Consumed*		
Beer Only	20.6	18.7
Wine Only	14.6	21.2
Liquor Only	47.6	43.8
Some Combination	17.2	16.4
Positive History of Familial Polyposis	40.9	8.4
Positive History of Inflammatory Bowel Disease	10.6	3.6
Positive History of Ulcerative Colitis	5.2	3.9
Positive Family History of Colo-rectal cancer	8.8	6.1

* Includes only alcohol drinkers

Table III.3.4 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Bladder

Characteristic	Cases (N=62)	Controls (N=867)
Ever Regular Cigarette Smoker	88.7	66.7
Number of Cigarette Pack-Years Smoked*		
1-10	9.8	12.9
11-20	12.2	15.3
>20	78.0	71.8
Ever Regular Cigar Smoker	8.2	8.0
Number of Cigar-Years Smoked*		
1-10	0.0	17.0
11-20	66.6	14.9
>20	33.3	68.1
Ever Regular Pipe Smoker	16.1	10.1
Number of Pipe-Years Smoked*		
1-10	0.0	18.9
11-20	0.0	3.8
>20	100.0	77.4
Ever Lived With A Smoker	63.8	75.7
Ever Regular Coffee Drinker	95.0	91.8
Usual Daily Coffee Consumption** (cups/day)		
1-2	41.5	57.5
3-4	45.3	30.4
5+	13.2	12.2
History of Bladder Infection	58.2	20.5
History of Bladder or Kidney Stones	15.3	8.3

* Includes only smokers
** Includes only coffee drinkers

Table III.3.5 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Kidney

Characteristic	Cases (N=35)	Controls (N=792)
Ever Regular Cigarette Smoker	74.3	66.9
Number of Cigarette Pack-Years Smoked*		
1-10	5.6	14.5
11-20	11.1	15.9
>20	83.3	69.6
Ever Regular Cigar Smoker	8.6	6.3
Number of Cigar-Years Smoked*		
1-10	0.0	27.0
11-20	0.0	13.5
>20	100.0	59.5
Ever Regular Pipe Smoker	5.7	9.9
Number of Pipe-Years Smoked*		
1-10	0.0	21.4
11-20	50.0	3.6
>20	50.0	75.0
Ever Lived With A Smoker	73.5	75.9
Ever Regular Coffee Drinker	88.2	91.9
Usual Daily Coffee Consumption** (cups/day)		
1-2	57.1	58.2
3-4	32.1	30.8
5+	10.7	11.0
History of Kidney Infection	45.2	10.2
History of Bladder or Kidney Stones	19.4	8.8

* Includes only smokers
** Includes only coffee drinkers

Table III.3.6 Distribution (%) of Cases and Controls According to Potential Confounders (continued)

Cancer Site: Pancreas

Characteristic	Cases (N=37)	Control (N=633)
Ever Regular Cigarette Smoker	51.4	65.6
Number of Cigarette Pack-Years Smoked*		
1-10	23.1	10.7
11-20	00.0	14.4
>20	76.9	74.9
Ever Regular Cigar Smoker	5.4	3.3
Number of Cigar-Years Smoked*		
1-10	0.0	30.8
11-20	50.0	0.0
>20	50.0	69.2
Ever Regular Pipe Smoker	2.7	7.1
Number of Pipe-Years Smoked*		
1-10	0.0	27.3
11-20	0.0	4.5
>20	100.0	68.2
Ever Regular Coffee Drinker	91.7	92.6
Usual Daily Coffee Consumption** (cups/day)		
1-2	71.0	60.7
3-4	19.4	31.3
5+	9.7	8.1

* Includes only smokers
** Includes only coffee drinkers

Table III.3.6 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Pancreas

Characteristic	Cases N=37	Controls N=633
Ever Drank Alcoholic Beverages	73.0	84.6
Number of Years Drank Alcoholic Beverages***		
1-19	5.6	7.2
20-39	44.4	42.1
40 or more	50.0	50.7
Amount of Usual Consumption***		
Almost Every Day	28.0	23.9
A Few Times A Week	20.0	27.7
A Few Times A Month	16.0	23.5
Less Than A Few Times A Month	36.0	24.9
Positive History of Diabetes	14.7	11.8
Quetlet Index		
Less than 19	3.2	2.1
19-25	74.2	78.7
More than 25	22.6	19.2

*** Includes only alcohol drinkers

Table III.3.7 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Leukemia

Characteristic	Cases (N=36)	Controls (N=751)
Medical Treatment with Ionizing Radiation	2.9	10.1

Table III.3.8 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Brain

Characteristic	Cases (N=37)	Controls (N=715)
Positive History of Diabetes	13.9	12.6
Positive History of Breast Cancer	0.0	8.7
Family History of Brain Cancer	0.0	1.3

Table III.3.9 Distribution (%) of Cases and Controls According to Potential Confounders

Cancer Site: Liver

Characteristic	Cases (N=4)	Control (N=50)
Ever Drank Alcoholic Beverages	100.0	94.0
Number of Years Drank Alcoholic Beverages*		
1-19	0.0	0.0
20-39	33.3	52.9
40 or more	66.7	47.1
Amount of Usual Consumption*		
Almost Every Day	33.3	37.2
A Few Times a Week	66.7	27.9
A Few Times a Month	0.0	20.9
Less Often Than a Few Times a Month	0.0	14.0
Type of Alcoholic Beverage Consumed*		
Beer only	0.0	21.6
Wine Only	0.0	2.7
Liquor Only	100.0	62.2
Some Combination	0.0	13.5
Prior Use of Oral Contraceptives	0.0	0.0

* Includes only alcohol drinkers

Table III.4.1 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: All Sites Combined

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	42.9	43.6
10.5 - 20 years	24.6	23.1
20.5 - 30 years	9.2	11.3
> 30 years	23.3	22.0

Descriptive Statistics	Cases	Controls
Mean	17.1	16.8
Standard Deviation	14.0	13.9
Median	13.0	12.8
Range	0.5 - 43.5	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	22.3	22.6
1950 - 1959	7.7	8.6
1960 - 1969	15.0	15.5
1970 - 1979	34.3	34.7
1980 - 1986	20.7	18.6

Descriptive Statistics	Cases	Controls
Median	1971	1970
Range	1943-1986	1943-1984

Table III.4.2 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Lung

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	44.6	42.7
10.5 - 20 years	23.5	24.1
20.5 - 30 years	8.4	10.9
> 30 years	23.5	22.3

Descriptive Statistics	Cases	Controls
Mean	16.8	17.1
Standard Deviation	14.0	13.9
Median	12.0	13.0
Range	0.5 - 43.5	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	21.0	21.9
1950 - 1959	9.9	8.3
1960 - 1969	14.8	15.2
1970 - 1979	30.8	33.4
1980 - 1986	23.5	21.2

Descriptive Statistics	Cases	Controls
Median	1971	1971
Range	1943-1986	1943-1985

Table III.4.3 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Breast

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	43.4	43.4
10.5 - 20 years	21.1	21.2
20.5 - 30 years	11.3	12.9
> 30 years	24.2	22.5

Descriptive Statistics	Cases	Controls
Mean	17.4	17.1
Standard Deviation	14.2	14.0
Median	12.0	13.0
Range	0.5 - 43.5	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	23.6	23.0
1950 - 1959	8.4	8.8
1960 - 1969	17.4	16.2
1970 - 1979	30.5	32.5
1980 - 1986	20.1	19.5

Descriptive Statistics	Cases	Controls
Median	1970	1970
Range	1943-1986	1943-1984

Table III.4.4 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Colorectal

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	42.2	43.1
10.5 - 20 years	27.0	22.0
20.5 - 30 years	8.9	12.0
> 30 years	21.9	22.9

Descriptive Statistics	Cases	Controls
Mean	16.7	17.1
Standard Deviation	13.8	13.9
Median	12.5	13.0
Range	0.5 - 43.0	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	22.2	23.2
1950 - 1959	7.4	8.9
1960 - 1969	10.9	15.4
1970 - 1979	39.6	33.9
1980 - 1986	19.9	18.6

Descriptive Statistics	Cases	Controls
Median	1972	1970
Range	1943-1985	1943-1984

Table III.4.5 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Bladder

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	45.2	44.5
10.5 - 20 years	27.4	23.3
20.5 - 30 years	9.7	10.5
> 30 years	17.7	21.7

Descriptive Statistics	Cases	Controls
Mean	15.9	16.8
Standard Deviation	13.1	14.0
Median	12.5	12.0
Range	0.5 - 43.0	0.5 - 42.5

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	18.0	21.9
1950 - 1959	6.6	7.6
1960 - 1969	18.0	13.9
1970 - 1979	37.7	33.8
1980 - 1986	19.7	22.8

Descriptive Statistics	Cases	Controls
Median	1972	1972
Range	1943-1984	1943-1985

Table III.4.6 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Kidney

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	42.9	44.4
10.5 - 20 years	25.7	23.4
20.5 - 30 years	8.5	10.4
> 30 years	22.9	21.8

Descriptive Statistics	Cases	Controls
Mean	17.0	16.6
Standard Deviation	13.7	13.8
Median	12.0	12.0
Range	0.5 - 43.0	0.5 - 41.5

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	20.0	22.6
1950 - 1959	8.6	7.2
1960 - 1969	8.5	15.5
1970 - 1979	48.6	35.6
1980 - 1986	14.3	19.1

Descriptive Statistics	Cases	Controls
Median	1973	1971
Range	1943-1985	1943-1984

Table III.4.7 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Pancreas

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	43.2	41.2
10.5 - 20 years	21.7	23.6
20.5 - 30 years	8.1	11.5
> 30 years	27.0	23.7

Descriptive Statistics	Cases	Controls
Mean	18.0	17.8
Standard Deviation	14.5	14.0
Median	13.0	14.0
Range	0.5 - 43.0	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	25.0	23.5
1950 - 1959	2.8	7.9
1960 - 1969	13.9	15.9
1970 - 1979	38.9	33.4
1980 - 1986	19.4	19.3

Descriptive Statistics	Cases	Controls
Median	1971	1970
Range	1943-1985	1943-1985

Table III.4.8 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Leukemia

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	41.7	41.4
10.5 - 20 years	22.2	23.8
20.5 - 30 years	2.8	12.0
> 30 years	33.3	22.8

Descriptive Statistics	Cases	Controls
Mean	19.4	17.4
Standard Deviation	16.1	13.8
Median	15.0	13.0
Range	0.5 - 43.0	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	35.3	23.2
1950 - 1959	2.9	9.0
1960 - 1969	17.7	15.5
1970 - 1979	23.5	35.3
1980 - 1986	20.6	17.0

Descriptive Statistics	Cases	Controls
Median	1966	1970
Range	1943-1986	1943-1984

Table III.4.9 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Brain

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	37.8	42.2
10.5 - 20 years	35.2	23.8
20.5 - 30 years	10.8	11.5
> 30 years	16.2	22.5

Descriptive Statistics	Cases	Controls
Mean	16.0	17.2
Standard Deviation	12.5	13.8
Median	15.0	13.0
Range	0.5 - 43.0	0.5 - 43.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	16.7	21.6
1950 - 1959	2.7	8.2
1960 - 1969	36.2	15.1
1970 - 1979	22.2	33.8
1980 - 1986	22.2	21.3

Descriptive Statistics	Cases	Controls
Median	1968	1971
Range	1943-1986	1943-1985

Table III.4.10 Frequency Distribution and Descriptive Statistics for Length and Calendar Years of Residence on the Upper Cape Among Cases and Controls

Cancer Site: Liver

Length of Residence

Frequency Distribution	% of Cases	% of Controls
0.5 - 10 years	75.0	38.0
10.5 - 20 years	0	28.0
20.5 - 30 years	0	10.0
> 30 years	25.0	24.0

Descriptive Statistics	Cases	Controls
Mean	14.2	17.9
Standard Deviation	16.3	14.1
Median	9.0	14.5
Range	1.0 - 38.0	0.5 - 41.0

Calendar Year First Moved to Upper Cape

Frequency Distribution	% of Cases	% of Controls
1943 - 1949	25.0	20.8
1950 - 1959	0.0	10.5
1960 - 1969	0.0	25.0
1970 - 1979	50.0	33.3
1980 - 1986	25.0	10.4

Descriptive Statistics	Cases	Controls
Median	1976	1968
Range	1943-1984	1943-1984

Table III.4.11 Results of Crude Logistic Regression Analysis on Length of Residence

Cancer Site*	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	0.0002	0.94	1.00	0.94 - 1.06
Lung	-0.0020	0.69	0.98	0.89 - 1.08
Breast	0.0015	0.77	1.02	0.92 - 1.12
Colorectal	-0.0024	0.61	0.98	0.89 - 1.07
Bladder	-0.0045	0.64	0.96	0.79 - 1.15
Kidney	0.0022	0.86	1.02	0.80 - 1.30
Pancreas	0.0010	0.93	1.01	0.80 - 1.28
Leukemia	0.0102	0.39	1.11	0.88 - 1.40
Brain	-0.0067	0.60	0.94	0.73 - 1.20

*Analysis was not performed on liver cancer cases.

**Odds ratios estimate relative risk for every ten years of residence.

Table III.4.12 Results of Adjusted Logistic Regression Analysis on Length of Residence

Cancer Site*	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	-0.0001	0.97	1.00	0.94 - 1.06
Lung	0.0001	0.99	1.00	0.90 - 1.11
Breast	0.0035	0.54	1.04	0.93 - 1.16
Colorectal	-0.0059	0..27	0.94	0.85 - 1.05
Bladder	-0.0017	0.87	0.98	0.80 - 1.21
Kidney	0.0077	0.57	1.08	0.83 - 1.41
Pancreas	-0.0081	0.53	0.92	0.72 - 1.19
Leukemia	0.0105	0.39	1.11	0.88 - 1.41
Brain	-0.0059	0.66	0.94	0.73 - 1.22

*Analysis was not performed on liver cancer cases.

**Odds ratios estimate relative risk for every ten years of residence.

Table III.5.1 Number and Type of Cancer Cases and Controls Who Lived Within MMR-Associated and Non-MMR Associated Groundwater Plume Delineations With and Without Taking Latency Into Account

MMR-Associated Plumes

	With Latency		Without Latency		
	No. Cases	No. Controls	No. Cases	No. Controls	Type of Cancer
Ashumet Valley	0	1	2	5	Breast Pancreas
MW 603	0	0	0	0	------
MMR Base Landfill (LF 1)	0	0	2	2	Kidney Lung
UTES/BOMARC Site (CS 10)	0	1	4	3	Lung (2) Colo-rectal Pancreas
AVGAS Dump Site (FS 1)	0	0	2	1	Lung Leukemia
Railroad Fuel Pumping Station (FS 2)	0	0	0	1	-----
Forestdale Neighborhood (FS 12)	0	1	0	2	-----
Briarwood Neighborhood	0	0	1	4	Lung

Non-MMR Associated Plumes

Falmouth Landfill	0	0	1	3	Colo-rectal
Mashpee Landfill	0	0	1	3	Lung
J. Braden Thompson Road Site	0	0	2	0	Colo-rectal Brain

Table III.6.1 Results of Crude Analysis Examining Air Emissions from the Canal Electric Power Plant* Taking Latent Period into Account

Cancer Site	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	-0.01208	0.47	0.99	0.95 - 1.02
Breast	-0.00995	0.88	0.99	0.86 - 1.13
Lung	-0.04467	0.49	0.95	0.84 - 1.09
Colorectal	-0.14956	0.03	0.85	0.74 - 0.98
Pancreas	-0.14774	0.36	0.86	0.61 - 1.19
Bladder	-0.01435	0.90	0.99	0.77 - 1.26
Kidney	-0.19260	0.31	0.82	0.55 - 1.21
Leukemia	0.01001	0.65	1.01	0.97 - 1.06
Brain	0.14435	0.27	1.16	0.89 - 1.52
Liver	-1.43588	0.24	0.22	0.02 - 2.70

Exposure = $\sum$ (average yearly exposure) (no. yrs. exposed)

**Odds ratios compared subjects whose exposure level was at the 75th percentile to subjects at the 25th percentile.

Table III.6.2 Results of Crude Analysis Examining Air Emissions from Canal Electric Power Plant* Without Taking Latent Period into Account

Cancer Site	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	0.00492	0.24	1.08	0.95 - 1.24
Breast	-0.00168	0.82	0.97	0.77 - 1.23
Lung	-0.00274	0.69	0.96	0.76 - 1.20
Colorectal	0.00252	0.70	1.04	0.84 - 1.29
Pancreas	0.00274	0.87	1.05	0.60 - 1.83
Bladder	0.01101	0.40	1.20	0.78 - 1.83
Kidney	0.00605	0.73	1.10	0.63 - 1.95
Leukemia	0.01189	0.50	1.22	0.68 - 2.17
Brain	0.01057	0.54	1.19	0.68 - 2.07
Liver	-0.11715	0.08	0.15	0.02 - 1.22

*Exposure = $\sum$ (average yearly exposure) (no. yrs. exposed)

**Odds ratios compared subjects whose exposure level was at the 75th percentile to subjects at the 25th percentile.

Table III.6.3 Results of Adjusted Analysis Examining Air Emissions from Canal Electric Power Plant* Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.00324	0.85	1.00	0.96 - 1.03
Lung	-0.03714	0.60	0.96	0.83 - 1.11
Breast	-0.02279	0.76	0.98	0.84 - 1.14
Colorectal	-0.17472	0.02	0.83	0.71 - 0.97
Bladder	-0.02958	0.82	1.03	0.78 - 1.36
Kidney	-0.15337	0.47	0.85	0.55 - 1.31
Pancreas	-0.21343	0.21	0.80	0.56 - 1.13
Leukemia	0.00521	0.82	1.01	0.96 - 1.05
Brain	0.15384	0.25	1.18	0.89 - 1.55

*Exposure = $\sum$ (average yearly exposure) (no. yrs. exposed)

**Liver cancer case group was too small to perform the adjusted analysis.

***Odds ratios compared subjects whose exposure level was at the 75th percentile to subjects at the 25th percentile.

Table III.6.4 Results of Adjusted Analysis Examining Air Emissions from Canal Electric Power Plant* Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00542	0.23	1.09	0.95 - 1.26
Lung	0.00149	0.85	1.02	0.80 - 1.32
Breast	-0.00116	0.88	0.98	0.76 - 1.27
Colorectal	-0.0027	0.97	1.00	0.78 - 1.27
Bladder	0.01394	0.35	1.26	0.78 - 2.03
Kidney	0.01461	0.47	1.27	0.67 - 2.43
Pancreas	-0.00608	0.75	0.90	0.49 - 1.68
Leukemia	0.00842	0.64	1.15	0.64 - 2.06
Brain	0.00936	0.59	1.17	0.66 - 2.05

$$*Exposure = \sum (average\ yearly\ exposure)(no.\ yrs.\ exposed)$$

** Liver cancer case group was too small to perform the adjusted analysis.

*** Odds ratios compared subjects whose exposure level was at the 75th percentile to subjects at the 25th percentile.

Table III.7.1 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Site Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	97	124	0.96	0.73 - 1.27
No. Years Exposed				
0.5 - 10.0	45	56	0.99	0.66 - 1.48
10.5 - 20.0	25	35	0.89	0.52 - 1.48
> 20	27	33	1.00	0.60 - 1.68
Distance to Exposure (m)				
1 - 1,000	36	45	0.98	0.63 - 1.54
1,001 - 2,000	33	48	0.84	0.54 - 1.33
2,001 - 3,000	28	31	1.11	0.66 - 1.86
Direction**				
Southeast	11	30	0.45	0.20 - 0.94
South	1	3	0.41	0.05 - 3.67
Southwest	73	85	1.06	0.76 - 1.46
Northwest	11	5	2.70	0.98 - 7.49
West	1	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 945 unexposed cases and 1161 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.2 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	20	126	0.76	0.46 - 1.24
No. Years Exposed				
0.5 - 10.0	8	61	0.63	0.30 - 1.32
10.5 - 20.0	7	33	1.01	0.44 - 2.32
> 20	5	32	0.74	0.29 - 1.93
Distance to Exposure (m)				
1 - 1,000	8	47	0.81	0.38 - 1.74
1,001 - 2,000	7	50	0.67	0.30 - 1.48
2,001 - 3,000	5	29	0.82	0.32 - 2.14
Direction**				
Southeast	4	29	0.66	0.23 - 1.88
South	0	3	---	---
Southwest	13	86	0.72	0.40 - 1.31
Northwest	3	7	2.04	0.54 - 7.75
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 231 unexposed cases and 1102 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.3 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	29	69	1.13	0.71 - 1.78
No. Years Exposed				
0.5 - 10.0	14	30	1.25	0.65 - 2.40
10.5 - 20.0	8	20	1.07	0.46 - 2.47
> 20	7	19	0.99	0.41 - 2.38
Distance to Exposure (m)				
1 - 1,000	11	27	1.09	0.53 - 2.23
1,001 - 2,000	10	28	0.96	0.46 - 2.00
2,001 - 3,000	8	14	1.53	0.64 - 3.67
Direction**				
Southeast	2	17	---	---
South	1	2	---	---
Southwest	22	44	1.34	0.79 - 2.28
Northwest	4	5	2.14	0.59 - 7.81
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 236 unexposed cases and 632 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.4 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	23	115	0.73	0.46 - 1.16
No. Years Exposed				
0.5 - 10.0	12	50	0.88	0.46 - 1.66
10.5 - 20.0	5	32	0.57	0.22 - 1.46
> 20	6	33	0.66	0.28 - 1.59
Distance to Exposure (m)				
1 - 1,000	8	43	0.68	0.32 - 1.45
1,001 - 2,000	6	44	0.50	0.21 - 1.16
2,001 - 3,000	9	28	1.17	0.55 - 2.51
Direction**				
Southeast	0	27	---	---
South	0	3	---	---
Southwest	20	79	0.92	0.56 - 1.53
Northwest	3	5	2.19	0.54 - 8.89
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 292 unexposed cases and 1064 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.5 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	82	0.84	0.33 - 2.15
No. Years Exposed				
0.5 - 10.0	1	36	---	---
10.5 - 20.0	1	22	---	---
> 20	3	24	1.72	0.51 - 5.81
Distance to Exposure (m)				
1 - 1,000	2	28	---	---
1,001 - 2,000	2	27	---	---
2,001 - 3,000	1	27	---	---
Direction**				
Southeast	0	19	---	---
South	0	1	---	---
Southwest	4	56	0.98	0.34 - 2.81
Northwest	1	5	2.75	0.35 - 22.0
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 57 unexposed cases and 785 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.6 Results of Crude Categorical Analysis Examining Barnstable Airport as Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	74	0.91	0.27 - 3.04
No. Years Exposed				
0.5 - 10.0	2	33	---	---
10.5 - 20.0	1	23	---	---
> 20	0	18	---	---
Distance to Exposure (m)				
1 - 1,000	1	27	---	---
1,001 - 2,000	2	31	---	---
2,001 - 3,000	0	16	---	---
Direction**				
Southeast	1	17	---	---
South	0	2	---	---
Southwest	1	50	---	---
Northwest	0	4	---	---
West	1	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 718 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.7 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	61	1.14	0.39 - 3.32
No. Years Exposed				
0.5 - 10.0	0	29	---	---
10.5 - 20.0	2	17	---	---
> 20	2	15	---	---
Distance to Exposure (m)				
1 - 1,000	1	25	---	---
1,001 - 2,000	2	22	---	---
2,001 - 3,000	1	14	---	---
Direction**				
Southeast	1	16	---	---
South	0	1	---	---
Southwest	3	41	1.27	0.37 - 4.30
Northwest	0	2	---	---
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 572 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.8 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	128	1.18	0.50 -2.74
No. Years Exposed				
0.5 - 10.0	5	64	1.68	0.63 - 4.44
10.5 - 20.0	0	25	---	---
> 20	2	39	---	---
Distance to Exposure (m)				
1 - 1,000	3	33	1.95	0.58 - 6.60
1,001 - 2,000	2	59	---	---
2,001 - 3,000	2	36	---	---
Direction**				
Southeast	1	30	---	---
South	0	3	---	---
Southwest	6	84	1.53	0.62 - 3.78
Northwest	0	8	---	---
West	0	3	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 623 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.9 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	76	1.63	0.66 - 3.99
No. Years Exposed				
0.5 - 10.0	3	38	1.63	0.48 - 5.50
10.5 - 20.0	1	22	---	---
> 20	2	16	---	---
Distance to Exposure (m)				
1 - 1,000	2	30	---	---
1,001 - 2,000	2	29	---	---
2,001 - 3,000	2	17	---	---
Direction**				
Southeast	2	17	---	---
South	0	2	---	---
Southwest	4	51	1.62	0.55 - 4.72
Northwest	0	6	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 639 unexposed controls.

** Direction of study subject to exposure site.

Table III.7.10 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Site Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	192	246	0.95	0.77-1.18
No. Yrs of Exposure				
0.5-10.0	93	117	0.97	0.73-1.29
10.5-20.0	45	51	1.08	0.72-1.63
>20	54	78	0.85	0.59-1.21
Distance to Exposure(m)				
1-1000	49	60	1.0	0.68-1.47
1,001-2,000	67	96	0.85	0.62-1.18
2,001-3,000	76	90	1.03	0.75-1.42
Direction**				
Northeast	1	1	----	----
Southeast	14	46	0.37	0.18-0.70
South	3	7	0.52	0.14-1.99
Southwest	148	167	1.08	0.85-1.38
Northwest	23	21	1.34	0.74-2.43
West	3	4	0.92	0.21-4.11

*Odds ratios were computed by comparing the number of exposed cases and controls to 850 unexposed cases and 1039 unexposed controls.

**Direction of study subject to exposure site

Table III.7.11 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	44	237	0.89	0.62-1.27
No. Yrs of Exposure				
0.5-10.0	26	109	1.14	0.73-1.80
10.5-20.0	6	53	0.54	0.23-1.26
>20	12	75	0.77	0.41-1.43
Distance to Exposure(m)				
1-1000	9	57	0.76	0.37-1.55
1,001-2,000	14	93	0.72	0.40-1.29
2,001-3,000	21	87	1.16	0.70-1.90
Direction**				
Northeast	1	1	----	----
Southeast	5	42	0.57	0.22-1.44
South	0	6	----	----
Southwest	33	164	0.96	0.64-1.44
Northwest	5	20	1.20	0.44-3.22
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 207 unexposed cases and 991 unexposed controls.

**Direction of study subject to exposure site

Table III.7.12 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminats Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	57	140	1.10	0.78-1.55
No. Yrs of Exposure				
0.5-10.0	23	65	0.95	0.58-1.58
10.5-20.0	18	30	1.62	0.89-2.95
>20	16	45	0.96	0.53-1.73
Distance to Exposure(m)				
1-1000	19	36	1.42	0.80-2.53
1,001-2,000	18	54	0.90	0.52-1.57
2,001-3,000	20	50	1.08	0.63-1.86
Direction**				
Northeast	0	0	----	----
Southeast	3	29	0.28	0.05-0.92
South	3	3	2.70	0.57-12.7
Southwest	42	94	1.20	0.81-1.79
Northwest	9	10	2.43	0.85-6.75
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 208 unexposed cases and 561 unexposed controls.

**Direction of study subject to exposure site

Table III.7.13 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	49	227	0.77	0.55-1.08
No. Yrs of Exposure				
0.5-10.0	23	108	0.76	0.48-1.22
10.5-20.0	14	44	1.14	0.62-2.11
>20	12	75	0.57	0.31-1.06
Distance to Exposure(m)				
1-1000	12	54	0.80	0.42-1.51
1,001-2,000	17	90	0.68	0.40-1.15
2,001-3,000	20	83	0.86	0.52-1.43
Direction**				
Northeast	0	1	----	----
Southeast	0	42	----	----
South	0	7	----	----
Southwest	41	153	0.96	0.66-1.39
Northwest	6	20	1.07	0.43-2.70
West	2	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 266 unexposed cases and 952 unexposed controls.

**Direction of study subject to exposure site

Table III.7.14 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	10	154	0.89	0.44-1.79
No. Yrs of Exposure				
0.5-10.0	6	71	1.16	0.48-2.79
10.5-20.0	0	31	----	----
>20	4	52	1.06	0.37-3.03
Distance to Exposure(m)				
1-1000	2	34	----	----
1,001-2,000	4	58	0.95	0.33-2.71
2,001-3,000	4	62	0.88	0.31-2.53
Direction**				
Northeast	0	1	----	----
Southeast	1	27	----	----
South	0	4	----	----
Southwest	7	103	0.93	0.41-2.11
Northwest	2	15	----	----
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 52 unexposed cases and 713 unexposed controls.

**Direction of study subject to exposure site

Table III.7.15 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	140	0.96	0.39-2.37
No. Yrs of Exposure				
0.5-10.0	3	66	1.02	0.30-3.45
10.5-20.0	2	28	----	----
>20	1	46	----	----
Distance to Exposure(m)				
1-1000	1	32	----	----
1,001-2,000	3	56	1.20	0.36-4.07
2,001-3,000	2	52	----	----
Direction**				
Northeast	0	1	----	----
Southeast	1	25	----	----
South	0	3	----	----
Southwest	4	92	0.98	0.34-2.85
Northwest	0	15	----	----
West	1	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 652 unexposed controls.

**Direction of study subject to exposure site

Table III.7.16 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	129	0.91	0.39-2.12
No. Yrs of Exposure				
0.5-10.0	3	65	0.77	0.23-2.61
10.5-20.0	0	24	----	----
>20	4	40	1.68	0.57-4.95
Distance to Exposure(m)				
1-1000	1	32	----	----
1,001-2,000	4	50	1.34	0.46-3.96
2,001-3,000	2	47	----	----
Direction**				
Northeast	0	0	----	----
Southeast	1	25	----	----
South	0	4	----	----
Southwest	5	86	0.98	0.37-2.59
Northwest	1	10	----	----
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 504 unexposed controls.

**Direction of study subject to exposure site

Table III.7.17 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	158	1.25	0.58-2.71
No. Yrs of Exposure				
0.5-10.0	5	76	1.44	0.54-3.85
10.5-20.0	2	30	----	----
>20	2	52	----	----
Distance to Exposure(m)				
1-1000	3	37	1.78	0.52-6.05
1,001-2,000	4	68	1.29	0.44-3.80
2,001-3,000	2	53	----	----
Direction**				
Northeast	0	1	----	----
Southeast	1	32	----	----
South	0	4	----	----
Southwest	8	105	1.67	0.75-3.76
Northwest	0	12	----	----
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 593 unexposed controls.

**Direction of study subject to exposure site

Table III.7.18 Results of Crude Categorical Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	10	141	1.51	0.72-3.17
No. Yrs of Exposure				
0.5-10.0	4	61	1.39	0.47-4.10
10.5-20.0	3	36	1.77	0.52-6.03
>20	3	44	1.45	0.42-4.94
Distance to Exposure(m)				
1-1000	2	35	----	----
1,001-2,000	3	49	1.30	0.38-4.43
2,001-3,000	5	57	1.86	0.70-4.96
Direction**				
Northeast	0	0	----	----
Southeast	2	23	----	----
South	0	2	----	----
Southwest	8	100	1.70	0.76-3.82
Northwest	0	16	----	----
West	0	0	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 574 unexposed controls.

**Direction of study subject to exposure site

Table III.7.19 Results of Crude Exposure Metric* Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.01638	0.68	1.01	0.96 - 1.07
Lung	-0.17627	0.36	0.88	0.68 - 1.15
Breast	-0.08586	0.63	0.94	0.73 - 1.21
Colorectal	-0.47118	0.07	0.72	0.50 - 1.03
Bladder	-0.2113	0.95	0.98	0.62 - 1.57
Kidney	-0.61537	0.53	0.65	0.16 - 2.54
Pancreas	0.12272	0.20	1.09	0.96 - 1.24
Leukemia	-0.01421	0.96	0.99	0.69 - 1.42
Brain	-0.10628	0.80	0.93	0.52 - 1.64

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.7.20 Results of Crude Exposure Metric* Analysis Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period Into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00165	0.96	1.00	0.96 - 1.05
Lung	-0.13104	0.29	0.91	0.78 - 1.08
Breast	-0.01516	0.88	0.99	0.87 - 1.13
Colorectal	-0.20601	0.13	0.87	0.72 - 1.04
Bladder	-0.03087	0.89	0.98	0.72 - 1.33
Kidney	-0.35297	0.53	0.78	0.37 - 1.68
Pancreas	0.09940	0.08	1.07	0.99 - 1.16
Leukemia	-0.02962	0.90	0.98	0.72 - 1.34
Brain	-0.06434	0.79	0.96	0.69 - 1.33

Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.7.21 Results of Adjusted Categorical Analysis* Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.07152	0.63	0.93	0.69 - 1.25
Lung	-0.45855	0.10	0.63	0.37 - 1.09
Breast	0.12001	0.64	1.13	0.69 - 1.85
Colorectal	-0.17669	0.49	0.84	0.51 - 1.39
Bladder	-0.21849	0.68	0.80	0.28 - 2.30
Kidney	0.10495	0.87	1.11	0.31 - 4.02
Pancreas	-0.05154	0.93	0.95	0.31 - 2.91
Leukemia	0.07330	0.87	1.08	0.46 - 2.53
Brain	0.48224	0.31	1.62	0.64 - 4.13

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.7.22 Results of Adjusted Categorical Analysis* Examining Barnstable Airport as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.01316	0.91	0.99	0.79 - 1.23
Lung	-0.27862	0.16	0.76	0.51 -1.12
Breast	0.10287	0.59	1.11	0.76 - 1.61
Colorectal	-0.09171	0.63	0.91	0.63 - 1.32
Bladder	-0.04443	0.91	0.96	0.45 - 2.05
Kidney	0.04809	0.92	1.05	0.40 - 2.73
Pancreas	-0.18625	0.68	0.83	0.34 - 2.01
Leukemia	0.10319	0.80	1.11	0.51 - 2.43
Brain	0.40441	0.30	1.50	0.69 - 3.23

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.7.23 Results of Adjusted Exposure Metric* Analysis Examining Barnstable Airport as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.15289	0.17	0.90	0.77 - 1.05
Lung	-0.20417	0.28	0.87	0.67 - 1.13
Breast	-0.10500	0.57	0.93	0.72 - 1.20
Colorectal	-0.48611	0.06	0.71	0.50 - 1.01
Bladder	0.11518	0.75	1.08	0.66 - 1.79
Kidney	-0.48913	0.59	0.71	0.20 - 2.48
Pancreas	0.11022	0.33	1.08	0.92 - 1.27
Leukemia	-0.04602	0.87	0.97	0.66 - 1.43
Brain	0.01665	0.97	1.01	0.59 - 1.73

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.7.24 Results of Adjusted Exposure Metric* Analysis Examining Proximity to Barnstable Airport as an Air Exposure Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.07486	0.91	0.95	0.87 - 1.04
Lung	-0.12482	0.28	0.92	0.79 - 1.07
Breast	-0.01451	0.89	0.99	0.86 - 1.14
Colorectal	-0.21058	0.11	0.87	0.73 - 1.03
Bladder	0.07484	0.76	1.05	0.76 - 1.45
Kidney	-0.25736	0.61	0.84	0.42 - 1.66
Pancreas	0.08880	0.21	1.06	0.97 - 1.17
Leukemia	-0.06508	0.80	0.96	0.68 - 1.34
Brain	0.00260	0.99	1.00	0.74 - 1.35

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.8.1 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	8	10	0.99	0.39 - 2.50
No. Years Exposed				
0.5 - 10.0	4	6	0.82	0.23 - 2.92
10.5 - 20.0	2	4	---	---
> 20	2	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	1	---	---
1,001 - 2,000	2	3	---	---
2,001 - 3,000	6	6	1.23	0.40 - 3.83
Direction**				
Northeast	1	3	---	---
Southeast	3	4	0.92	0.21 - 4.14
Southwest	3	2	1.85	0.32 - 10.80
Northwest	1	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 1034 unexposed cases and 1275 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

** Direction of study subject to exposure site.

Table III.8.2 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	9	---	---
No. Years Exposed				
0.5 - 10.0	1	6	---	---
10.5 - 20.0	0	3	---	---
> 20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	1	---	---
1,001 - 2,000	0	3	---	---
2,001 - 3,000	1	5	---	---
Direction**				---
Northeast	0	3	---	---
Southeast	0	3	---	---
Southwest	1	2	---	---
Northwest	0	1	---	

** Direction of study subject to exposure site.

Table III.8.3 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	6	1.33	0.33 - 5.32
No. Years Exposed				
0.5 - 10.0	1	4	---	---
10.5 - 20.0	1	2	---	---
> 20	1	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	1	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	2	3	---	---
Direction**				
Northeast	1	1	---	---
Southeast	1	2	---	---
Southwest	1	2	---	---
Northwest	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 262 unexposed cases and 695 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

** Direction of study subject to exposure site.

Table III.8.4 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	10	1.12	0.31 - 4.11
No. Years Exposed				
0.5 - 10.0	1	6	---	---
10.5 - 20.0	1	4	---	---
> 20	1	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	1	---	---
1,001 - 2,000	0	3	---	---
2,001 - 3,000	3	6	1.87	0.48 - 7.37
Direction**				
Northeast	0	3	---	---
Southeast	2	4	---	---
Southwest	0	2	---	---
Northwest	1	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 312 unexposed cases and 1169 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

** Direction of study subject to exposure site.

Table III.8.5 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	6	---	---
No. Years Exposed				
0.5 - 10.0	1	3	---	---
10.5 - 20.0	0	3	---	---
> 20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	1	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	0	3	---	---
Direction**				
Northeast	0	2	---	---
Southeast	0	2	---	---
Southwest	1	1	---	---
Northwest	0	1	---	---

** Direction of study subject to exposure site.

Table III.8.6 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	27	27	1.24	0.72 -2.12
No. Years Exposed				
0.5 - 10.0	21	17	1.53	0.81 - 2.90
10.5 - 20.0	2	6	0.41	0.09 - 1.95
> 20	4	4	1.24	0.31 - 4.96
Distance to Exposure (m)				
1 - 1,000	0	1	0.0	---
1,001 - 2,000	13	11	1.46	0.66 - 3.27
2,001 - 3,000	14	15	1.16	0.56 - 2.41
Direction**				
Northeast	9	7	1.59	0.60 - 4.26
Southeast	8	7	1.42	0.51 - 3.90
South	1	3	----	---
North	2	0	----	---
Southwest	4	8	0.62	0.19 - 2.04
Northwest	3	2	1.86	0.32 - 10.80

*Odds ratios were computed by comparing the number of exposed cases and controls to 1015 unexposed cases and 1258 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

**Direction of study subject to exposure site

Table III.8.7 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	28	1.05	0.43 - 2.56
No. Years Exposed				
0.5 - 10.0	5	17	1.44	0.53 - 3.92
10.5 - 20.0	1	8	----	---
> 20	0	3	----	---
Distance to Exposure (m)				
1 - 1,000	0	1	----	---
1,001 - 2,000	4	11	1.78	0.57 - 5.56
2,001 - 3,000	2	16	----	---
Direction**				
Northeast	2	7	----	----
Southeast	2	7	----	----
South	0	3	----	----
North	1	0	----	----
Southwest	1	9	----	----
Northwest	0	2	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 245 unexposed cases and 1200 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

**Direction of study subject to exposure site

Table III.8.8 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	14	0.75	0.25 - 2.30
No. Years Exposed				
0.5 - 10.0	2	10	----	----
10.5 - 20.0	0	2	----	----
> 20	2	2	----	----
Distance to Exposure (m)				
1 - 1,000	0	1	----	----
1,001 - 2,000	1	4	----	----
2,001 - 3,000	3	9	0.88	0.24 - 3.26
Direction**				
Northeast	1	4	----	----
Southeast	1	2	----	----
South	1	1	----	----
North	0	0	----	----
Southwest	1	6	----	----
Northwest	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 261 unexposed cases and 687 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

**Direction of study subject to exposure site

Table III.8.9 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	26	1.01	0.43 - 2.34
No. Years Exposed				
0.5 - 10.0	4	16	0.94	0.31 - 2.82
10.5 - 20.0	1	6	----	---
> 20	2	4	----	---
Distance to Exposure (m)				
1 - 1,000	0	1	----	----
1,001 - 2,000	3	11	1.02	0.28 - 3.68
2,001 - 3,000	4	14	1.07	0.35 - 3.27
Direction**				
Northeast	1	7	----	----
Southeast	3	7	1.60	0.41 - 6.17
South	0	3	----	----
North	0	0	----	----
Southwest	0	7	----	----
Northwest	3	2	5.61	0.63 - 67.4

*Odds ratios were computed by comparing the number of exposed cases and controls to 308 unexposed cases and 1153 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

**Direction of study subject to exposure site

Table III.8.10 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	20	----	----
No. Years Exposed				
0.5 - 10.0	2	13	----	----
10.5 - 20.0	0	6	----	----
> 20	0	1	----	----
Distance to Exposure (m)				
1 - 1,000	0	0	----	----
1,001 - 2,000	0	7	----	----
2,001 - 3,000	2	13	----	----
Direction**				
Northeast	1	5	----	----
Southeast	1	6	----	----
South	0	2	----	----
North	0	0	----	----
Southwest	0	6	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site

Table III.8.11 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	15	----	----
No. Years Exposed				
0.5 - 10.0	1	12	----	----
10.5 - 20.0	0	3	----	----
> 20	0	0	----	----
Distance to Exposure (m)				
1 - 1,000	0	1	----	----
1,001 - 2,000	1	6	----	----
2,001 - 3,000	0	8	----	----
Direction**				
Northeast	0	4	----	----
Southeast	0	2	----	----
South	0	3	----	----
North	0	0	----	----
Southwest	1	4	----	----
Northwest	0	2	----	----

**Direction of study subject to exposure site

Table III.8.12 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	12	----	----
No. Years Exposed				
0.5 - 10.0	2	6	----	----
10.5 - 20.0	0	5	----	----
> 20	0	1	----	----
Distance to Exposure (m)				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	6	----	----
2,001 - 3,000	1	6	----	----
Direction**				
Northeast	0	4	----	----
Southeast	1	1	----	----
South	0	1	----	----
North	1	0	----	----
Southwest	0	5	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site

Table III.8.13 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	13	----	----
No. Years Exposed				
0.5 - 10.0	1	7	----	----
10.5 - 20.0	0	4	----	----
> 20	0	2	----	----
Distance to Exposure (m)				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	8	----	----
2,001 - 3,000	0	5	----	----
Direction**				
Northeast	1	5	----	----
Southeast	0	2	----	----
South	0	0	----	----
North	0	0	----	----
Southwest	0	6	----	----
Northwest	0	0	----	----

**Direction of study subject to exposure site

Table III.8.14 Results of Crude Categorical Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	20	4.21	0.98 - 13.56
No. Years Exposed				
0.5 - 10.0	4	11	7.66	1.67 - 27.5
10.5 - 20.0	0	6	----	----
> 20	0	3	----	----
Distance to Exposure (m)				
1 - 1,000	0	1	----	----
1,001 - 2,000	2	8	----	----
2,001 - 3,000	2	11	----	----
Direction**				
Northeast	3	5	12.6	1.86 - 67.52
Southeast	0	4	----	----
South	0	2	----	----
North	0	0	----	----
Southwest	1	7	----	----
Northwest	0	2	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 695 unexposed controls. Odds ratios were not calculated if there were less than three exposed cases.

**Direction of study subject to exposure site

Table III.8.15 Results of Crude Exposure Metric* Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	1.10812	0.45	1.34	0.62 - 2.90
Breast	2.63942	0.19	2.02	0.70 - 5.82
Colorectal	1.10315	0.70	1.34	0.30 - 5.98

$$*\textit{Exposure Metric}: \sum \left(\frac{1}{distance^{1.5}}\right)(\textit{wind freq.})(\textit{no. years})$$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.8.16 Results of Crude Exposure Metric* Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.12804	0.83	0.95	0.57 - 1.58
Lung	-0.69814	0.60	0.74	0.24 - 2.29
Breast	0.23820	0.75	1.11	0.59 - 2.08
Colorectal	-0.25088	0.79	0.90	0.40 - 2.01
Brain	0.46471	0.68	1.22	0.47 - 3.20

***Exposure Metric:** $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose combined metric was at the 75th percentile to unexposed subjects.

Table III.8.17 Results of Adjusted Categorical Analysis* Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	-0.23547	0.68	0.79	0.25 - 2.45
Breast	0.028789	0.97	1.03	0.20 - 5.21
Colorectal	-0.17632	0.83	0.84	0.17 - 4.26

* Exposure categorized as Ever/Never.

Ever exposed subjects lived within 3,000 meters of the exposure site.

**Sites with less than three exposed cases were not analyzed.

Table III.8.18 Results of Adjusted Categorical Analysis* Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.11216	0.70	1.12	0.63 - 1.99
Lung	0.02943	0.95	1.03	0.39 - 2.73
Breast	-0.57285	0.39	0.56	0.15 - 2.06
Colorectal	-0.34459	0.49	0.71	0.27 - 1.89
Brain	1.3824	0.02	3.98	1.20 - 13.22

* Exposure categorized as Ever/Never
Ever exposed subjects lived within 3,000 meters of the exposure site.

** Sites with less than three exposed cases were not analyzed.

Table III.8.19 Results of Adjusted Exposure Metric* Analysis Examining MMR Runways as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.83730	0.56	1.25	0.57 - 2.73
Breast	2.88156	0.17	2.15	0.72 - 6.45
Colorectal	-2.30312	0.20	0.54	0.04 - 7.85

$$*\textit{Exposure Metric}: \sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$$

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.8.20 Results of Adjusted Exposure Metric* Analysis Examining MMR Runways as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.36116	0.58	0.86	0.50 - 1.48
Lung	-1.33308	0.39	0.56	0.15 - 2.07
Breast	0.29457	0.70	1.14	0.60 - 2.15
Colorectal	-1.53287	0.38	0.52	0.12 - 2.25
Brain	0.32560	0.82	1.15	0.35 - 3.83

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.9.1 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	2	2.47	0.48 - 12.8
No. Years Exposed				
0.5 - 10.0	4	1	4.94	0.68 - 35.7
10.5 - 20.0	0	1	---	---
>20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	2	1	---	---
2,001 - 3,000	2	1	---	---
Direction**				
Northeast	0	0	---	---
Southeast	2	2	---	---
South	1	0	---	---
Southwest	0	0	---	---
Northwest	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 1038 unexposed cases and 1283 unexposed controls.

** Direction of study subjects to exposure site.

Table III.9.2 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	2	---	---
No. Years Exposed				
0.5 - 10.0	2	1	---	---
10.5 - 20.0	0	1	---	---
>20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	1	1	---	---
Direction**				
Northeast	0	0	---	---
Southeast	1	2	---	---
South	1	0	---	---
Southwest	0	0	---	---
Northwest	0	0	---	---

** Direction of study subject to exposure site.

Table III.9.3 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	---	---
No. Years Exposed				
0.5 - 10.0	1	1	---	---
10.5 - 20.0	0	1	---	---
>20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	1	1	---	---
Direction**				
Northeast	0	0	---	---
Southeast	0	2	---	---
South	0	0	---	---
Southwest	0	0	---	---
Northwest	1	0	---	---

** Direction of study subject to exposure site.

Table III.9.4 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	1	---	---
No. Years Exposed				
0.5 - 10.0	1	0	---	---
10.5 - 20.0	0	1	---	---
>20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	0	0	---	---
Direction**				
Northeast	0	0	---	---
Southeast	1	1	---	---
South	0	0	---	---
Southwest	0	0	---	---
Northwest	0	0	---	---

** Direction of study subject to exposure site.

Table III.9.5 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	4	1.23	0.31-4.94
Exposure Years**				
0.5-10.0	3	3	1.23	0.25-6.11
10.1-20.0	0	0	----	----
>20.0	1	1	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	2	2	----	----
2,001-3,000	2	2	----	----
Direction***				
Northeast	0	1	----	----
Southeast	2	3	----	----
South	1	0	----	----
Southwest	0	0	----	----
Northwest	1	0	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1038 unexposed cases and 1281 unexposed controls.

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.6 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	4	----	----
Exposure Years**				
0.5-10.0	1	3	----	----
10.1-20.0	0	0	----	----
>20.0	1	1	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	1	2	----	----
Direction***				
Northeast	0	1	----	----
Southeast	1	3	----	----
South	1	0	----	----
Southwest	0	0	----	----
Northwest	0	0	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.7 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	4	----	----
Exposure Years**				
0.5-10.0	1	3	----	----
10.1-20.0	0	0	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	1	2	----	----
Direction***				
Northeast	0	1	----	----
Southeast	0	3	----	----
South	0	0	----	----
Southwest	0	0	----	----
Northwest	1	0	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.8 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
Exposure Years**				
0.5-10.0	1	1	----	----
10.1-20.0	0	0	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	1	----	----
Direction***				
Northeast	0	1	----	----
Southeast	1	1	----	----
South	0	0	----	----
Southwest	0	0	----	----
Northwest	0	0	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.9 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	15	0.74	0.32-1.69
No. Years Exposed				
0.5-10.0	9	11	1.01	0.42-2.44
10.5-20.0	0	3	----	----
>20	0	1	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	3	2	1.84	0.31-11.1
2,001-3,000	6	13	0.57	0.21-1.50
Direction**				
Northeast	0	0	----	----
Southeast	5	6	1.02	0.31-3.37
South	1	2	----	----
Southwest	1	6	----	----
Northwest	2	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1033 unexposed cases and 1270 unexposed controls.

**Direction of study subject to exposure site.

Table III.9.10 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	16	----	----
No. Years Exposed				
0.5-10.0	1	11	----	----
10.5-20.0	0	4	----	----
>20	0	1	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	0	3	----	----
2,001-3,000	1	13	----	----
Direction**				
Northeast	0	0	----	----
Southeast	1	7	----	----
South	0	2	----	----
Southwest	0	6	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site.

Table III.9.11 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	9	0.88	0.24-3.28
No. Years Exposed				
0.5-10.0	3	7	1.13	0.29-4.41
10.5-20.0	0	1	----	----
>20	0	1	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	1	----	----
2,001-3,000	2	8	----	----
Direction**				
Northeast	0	0	----	----
Southeast	2	4	----	----
South	1	1	----	----
Southwest	0	3	----	----
Northwest	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 262 unexposed cases and 692 unexposed controls.

**Direction of study subject to exposure site.

Table III.9.12 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	14	----	----
No. Years Exposed				
0.5-10.0	2	10	----	----
10.5-20.0	0	3	----	----
>20	0	1	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	2	12	----	----
Direction**				
Northeast	0	0	----	----
Southeast	0	5	----	----
South	0	2	----	----
Southwest	1	6	----	----
Northwest	1	1	----	----

**Direction of study subject to exposure site.

Table III.9.13 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	9	----	----
No. Years Exposed				
0.5-10.0	1	7	----	----
10.5-20.0	0	2	----	----
>20	0	0	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	1	8	----	----
Direction**				
Northeast	0	0	----	----
Southeast	0	2	----	----
South	0	1	----	----
Southwest	0	5	----	----
Northwest	1	1	----	----

**Direction of study subject to exposure site.

Table III.9.14 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	9	----	----
No. Years Exposed				
0.5-10.0	1	6	----	----
10.5-20.0	0	3	----	----
>20	0	0	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	7	----	----
Direction**				
Northeast	0	0	----	----
Southeast	1	4	----	----
South	0	2	----	----
Southwest	0	3	----	----
Northwest	0	0	----	----

**Direction of study subject to exposure site.

Table III.9.15 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	11	----	----
No. Years Exposed				
0.5-10.0	1	8	----	----
10.5-20.0	0	2	----	----
>20	0	1	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	3	----	----
2,001-3,000	0	8	----	----
Direction**				
Northeast	0	0	----	----
Southeast	1	4	----	----
South	0	1	----	----
Southwest	0	5	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site.

Table III.9.16 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	19	0.78	0.38-1.60
Exposure Years**				
0.5-10.0	9	8	1.38	0.53-3.58
10.1-20.0	1	3	----	----
>20.0	2	8	----	----
Distance to Exposure (m)				
1-1,000	1	4	----	----
1,001-2,000	4	3	1.64	0.37-7.23
2,001-3,000	7	12	0.72	0.28-1.82
Direction***				
Northeast	0	1	----	----
Southeast	8	9	1.09	0.42-2.84
South	1	2	----	----
Southwest	1	6	----	----
Northwest	2	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1030 unexposed cases and 1266 unexposed controls.

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.17 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	20	0.73	0.22-2.47
Exposure Years**				
0.5-10.0	2	9	----	----
10.1-20.0	0	3	----	----
>20.0	1	8	----	----
Distance to Exposure (m)				
1-1,000	1	4	----	----
1,001-2,000	0	4	----	----
2,001-3,000	2	12	----	----
Direction***				
Northeast	0	1	----	----
Southeast	3	10	1.46	0.40-5.31
South	0	2	----	----
Southwest	0	6	----	----
Northwest	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 248 unexposed cases and 1208 unexposed controls.

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.18 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	12	0.66	0.19-2.33
Exposure Years**				
0.5-10.0	1	5	----	----
10.1-20.0	1	2	----	----
>20.0	1	5	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	2	2	----	----
2,001-3,000	1	9	----	----
Direction***				
Northeast	0	1	----	----
Southeast	2	6	----	----
South	1	1	----	----
Southwest	0	3	----	----
Northwest	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 262 unexposed cases and 689 unexposed controls.

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.19 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	18	----	----
Exposure Years**				
0.5-10.0	2	8	----	----
10.1-20.0	0	3	----	----
>20.0	0	7	----	----
Distance to Exposure (m)				
1-1,000	0	4	----	----
1,001-2,000	0	3	----	----
2,001-3,000	2	11	----	----
Direction***				
Northeast	0	1	----	----
Southeast	0	8	----	----
South	0	2	----	----
Southwest	1	6	----	----
Northwest	1	1	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.20 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	11	----	----
Exposure Years**				
0.5-10.0	1	6	----	----
10.1-20.0	0	1	----	----
>20.0	0	4	----	----
Distance to Exposure (m)				
1-1,000	0	2	----	----
1,001-2,000	0	2	----	----
2,001-3,000	1	7	----	----
Direction***				
Northeast	0	1	----	----
Southeast	0	3	----	----
South	0	1	----	----
Southwest	0	5	----	----
Northwest	1	1	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.21 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	9	----	----
Exposure Years**				
0.5-10.0	1	4	----	----
10.1-20.0	0	1	----	----
>20.0	0	4	----	----
Distance to Exposure (m)				
1-1,000	0	3	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	4	----	----
Direction***				
Northeast	0	0	----	----
Southeast	1	4	----	----
South	0	2	----	----
Southwest	0	3	----	----
Northwest	0	0	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.22 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	13	----	----
Exposure Years**				
0.5-10.0	2	6	----	----
10.1-20.0	0	2	----	----
>20.0	0	5	----	----
Distance to Exposure (m)				
1-1,000	0	3	----	----
1,001-2,000	1	2	----	----
2,001-3,000	1	8	----	----
Direction***				
Northeast	0	1	----	----
Southeast	2	5	----	----
South	0	1	----	----
Southwest	0	5	----	----
Northwest	0	1	----	----

**The sum of the total number of years exposed to each FTA.

***Direction of study subject to exposure site.

Table III.9.23 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	103	129	0.98	0.74 - 1.28
No. Years Exposed				
0.5 -10.0	51	87	0.71	0.50 - 1.02
10.5 - 20.0	47	42	1.38	0.90 - 2.10
>20.0	5	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	2	1	---	---
2,001 - 3,000	2	1	---	---
3,001 - 4,000	6	17	0.44	0.18 - 1.08
4,001 - 5,000	13	9	1.78	0.76 - 4.13
5,001 - 6,000	8	19	0.52	0.23 - 1.17
6,001 - 7,000	27	26	1.28	0.74 - 2.20
7,001 - 8,000	25	28	1.10	0.64 - 1.90
8,001 - 9,000	20	28	0.88	0.49 - 1.57
Direction**				
East	1	1	---	---
Northeast	4	12	0.41	0.14 - 1.23
Southeast	28	32	1.08	0.64 - 1.80
South	2	0	---	---
North	0	0	---	---
Southwest	44	44	1.23	0.80 - 1.88
Northwest	23	40	0.71	0.42 - 1.19
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 939 unexposed cases and 1156 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.24 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	23	131	0.84	0.53 - 1.33
No. Years Exposed				
0.5 - 10.0	9	90	0.47	0.21 - 0.98
10.5 - 20.0	13	40	1.56	0.83 - 2.95
>20.0	1	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	2	17	---	---
4,001 - 5,000	3	8	1.80	0.48 - 6.73
5,001 - 6,000	0	17	---	---
6,001 - 7,000	6	28	1.03	0.42 - 2.52
7,001 - 8,000	6	30	0.96	0.40 - 2.34
8,001 - 9,000	6	29	0.99	0.41 - 2.43
Direction**				
East	1	1	---	---
Northeast	0	11	---	---
Southeast	6	32	0.90	0.37 - 2.18
South	0	0	---	---
North	0	0	---	---
Southwest	10	45	1.07	0.53 - 2.15
Northwest	6	42	0.69	0.29 - 1.63
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 228 unexposed cases and 1097 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.25 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	25	72	0.91	0.56 - 1.47
No. Years Exposed				
0.5 - 10.0	11	47	0.61	0.31 - 1.19
10.5 - 20.0	12	25	1.26	0.62 - 2.54
>20.0	2	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	1	1	---	---
3,001 - 4,000	1	9	---	---
4,001 - 5,000	3	3	2.62	0.56 - 12.3
5,001 - 6,000	4	12	0.87	0.28 - 2.74
6,001 - 7,000	5	17	0.77	0.28 - 2.11
7,001 - 8,000	7	13	1.41	0.56 - 3.57
8,001 - 9,000	3	16	0.49	0.14 - 1.66
Direction**				
East	0	0	---	---
Northeast	3	9	0.87	0.24 - 3.25
Southeast	6	15	1.05	0.40 - 2.74
South	2	0	---	---
North	0	0	---	---
Southwest	9	26	0.91	0.42 - 1.96
Northwest	5	22	0.60	0.22 - 1.58
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 240 unexposed cases and 629 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.26 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	31	126	0.90	0.60 - 1.37
No. Years Exposed				
0.5 - 10.0	17	84	0.74	0.43 - 1.26
10.5 -20.0	13	42	1.15	0.61 - 2.16
>20.0	1	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	1	1	---	---
3,001 - 4,000	3	17	0.65	0.19 - 2.23
4,001 - 5,000	3	9	1.24	0.33 - 4.59
5,001 - 6,000	2	19	---	--
6,001 - 7,000	8	26	1.14	0.51 - 2.55
7,001 - 8,000	8	26	1.14	0.51 - 2.55
8,001 - 9,000	6	27	0.82	0.34 - 2.01
Direction**				
East	0	1	---	---
Northeast	0	12	---	---
Southeast	10	30	1.24	0.60 - 2.56
South	0	0	---	---
North	0	0	---	---
Southwest	13	43	1.12	0.60 - 2.11
Northwest	7	40	0.65	0.29 - 1.46
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 284 unexposed cases and 1052 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.27 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	8	89	1.28	0.59 - 2.77
No. Years Exposed				
0.5 - 10.0	6	62	1.37	0.57 - 3.30
10.5 - 20.0	2	26	---	---
>20.0	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	0	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	11	---	---
4,001 - 5,000	0	4	---	---
5,001 - 6,000	2	12	---	---
6,001 - 7,000	1	18	---	---
7,001 - 8,000	1	20	---	---
8,001 - 9,000	4	23	2.51	0.87 - 7.24
Direction**				
East	0	1	---	---
Northeast	0	9	---	---
Southeast	3	19	2.28	0.67 - 7.68
South	0	0	---	---
North	0	0	---	---
Southwest	4	33	1.75	0.60 - 5.05
Northwest	1	27	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 54 unexposed cases and 778 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.28 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratios	95% Confidence Interval
Ever Exposed	2	75	---	---
No. Years Exposed				
0.5 - 10.0	1	50	---	---
10.5 - 20.0	1	25	---	---
>20.0	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	0	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	10	---	---
4,001 - 5,000	0	4	---	---
5,001 - 6,000	0	11	---	---
6,001 - 7,000	2	13	---	---
7,001 - 8,000	0	20	---	---
8,001 - 9,000	0	16	---	---
Direction**				
East	0	1	---	---
Northeast	0	7	---	---
Southeast	1	19	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	1	26	---	---
Northwest	0	22	---	---
West	0	0	---	---

** Direction of study subject to exposure site.

Table III.9.29 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratios	95% Confidence Interval
Ever Exposed	2	60	---	---
No. Years Exposed				
0.5 - 10.0	1	37	---	---
10.5 - 20.0	1	22	---	---
>20.0	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	0	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	2	---	---
4,001 - 5,000	1	4	---	---
5,001 - 6,000	0	8	---	---
6,001 - 7,000	1	16	---	---
7,001 - 8,000	0	13	---	---
8,001 - 9,000	0	16	---	---
Direction**				
East	0	0	---	---
Northeast	0	7	---	---
Southeast	1	11	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	0	21	---	---
Northwest	1	21	---	---
West	0	0	---	---

** Direction of study subject to exposure site.

Table III.9.30 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	8	147	1.16	0.52 - 2.61
No. Years Exposed				
0.5 - 10.0	3	96	0.67	0.20 - 2.22
10.5 - 20.0	4	27	3.19	0.75 - 10.09
>20.0	1	2	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	7	---	---
3,001 - 4,000	0	9	---	---
4,001 - 5,000	2	7	---	---
5,001 - 6,000	0	20	---	---
6,001 - 7,000	2	26	---	---
7,001 - 8,000	3	35	1.85	0.54 - 6.27
8,001 - 9,000	1	42	---	---
Direction**				
East	0	1	---	---
Northeast	1	14	---	---
Southeast	1	38	---	---
South	0	2	---	---
North	0	0	---	---
Southwest	4	47	1.84	0.63 - 5.37
Northwest	2	45	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 28 unexposed cases and 604 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.31 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	4	77	1.00	0.35 - 2.91
No. Years Exposed				
0.5 - 10.0	3	47	1.23	0.36 - 4.17
10.5 - 20.0	1	30	---	---
>20.0	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	0	0	---	---
3,001 - 4,000	0	11	---	---
4,001 - 5,000	1	6	---	---
5,001 - 6,000	0	9	---	---
6,001 - 7,000	2	20	---	---
7,001 - 8,000	0	14	---	---
8,001 - 9,000	0	16	---	---
Direction**				
East	0	0	---	---
Northeast	0	7	---	---
Southeast	0	21	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	3	22	2.64	0.78 - 8.95
Northwest	1	27	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 638 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.32 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	109	140	0.96	0.73 - 1.24
No. Years Exposed**				
0.5 - 10.0	34	52	0.80	0.52 - 1.25
10.5 - 20.0	19	29	0.80	0.45 - 1.44
>20.0	56	59	1.16	0.80 - 1.70
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	2	2	---	---
2,001 - 3,000	2	2	---	---
3,001 - 4,000	7	18	0.48	0.20 - 1.13
4,001 - 5,000	12	9	1.64	0.69 - 3.87
5,001 - 6,000	8	16	0.61	0.26 - 1.43
6,001 - 7,000	29	29	1.23	0.73 - 2.07
7,001 - 8,000	27	32	1.03	0.62 - 1.74
8,001 - 9,000	22	32	0.84	0.49 - 1.46
Direction***				
East	1	1	---	---
Northeast	6	15	0.49	0.19 - 1.25
Southeast	28	39	0.88	0.54 - 1.44
South	2	0	---	---
North	0	0	---	---
Southwest	48	46	1.28	0.85 - 1.94
Northwest	23	39	0.72	0.43 - 1.22
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 933 unexposed cases and 1145 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.33 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	26	143	0.88	0.56 - 1.36
No. Years Exposed**				
0.5 - 10.0	10	60	0.80	0.41 - 1.59
10.5 - 20.0	1	26	---	---
>20.0	15	57	1.27	0.71 - 2.28
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	0	2	---	---
3,001 - 4,000	2	18	---	---
4,001 - 5,000	3	8	1.81	0.48 - 6.74
5,001 - 6,000	0	14	---	---
6,001 - 7,000	6	31	0.93	0.38 - 2.26
7,001 - 8,000	7	34	0.99	0.43 - 2.27
8,001 - 9,000	8	34	1.14	0.52 - 2.48
Direction***				
East	1	1	---	---
Northeast	2	15	---	---
Southeast	6	39	0.74	0.31 - 1.77
South	0	0	---	---
North	0	0	---	---
Southwest	11	47	1.13	0.58 - 2.21
Northwest	6	41	0.71	0.30 - 1.58
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 225 unexposed cases and 1085 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.34 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	26	80	0.84	0.53 - 1.35
No. Years Exposed**				
0.5 - 10.0	3	33	0.24	0.04 - 0.77
10.5 - 20.0	5	15	0.87	0.31 - 2.41
>20.0	18	32	1.46	0.81 - 2.65
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	1	2	---	---
3,001 - 4,000	1	8	---	---
4,001 - 5,000	3	4	1.95	0.44 - 8.55
5,001 - 6,000	4	10	1.04	0.32 - 3.35
6,001 - 7,000	5	17	0.76	0.28 - 2.09
7,001 - 8,000	7	16	1.14	0.46 - 2.80
8,001 - 9,000	4	21	0.50	0.17 - 1.43
Direction***				
East	0	0	---	---
Northeast	3	11	0.71	0.20 - 2.55
Southeast	7	21	0.87	0.36 - 2.06
South	2	0	---	---
North	0	0	---	---
Southwest	9	26	0.90	0.41 - 1.95
Northwest	5	22	0.59	0.22 - 1.56
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and [illegible] to 239 unexposed cases and 621 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.35 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	32	137	0.86	0.57 - 1.29
No. Years Exposed**				
0.5 - 10.0	12	51	0.87	0.46 - 1.65
10.5 - 20.0	8	28	1.05	0.47 - 2.33
>20.0	12	58	0.76	0.40 - 1.44
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	1	2	---	---
3,001 - 4,000	4	18	0.82	0.28 - 2.43
4,001 - 5,000	2	9	---	---
5,001 - 6,000	2	16	---	---
6,001 - 7,000	9	29	1.14	0.54 - 2.44
7,001 - 8,000	8	30	0.98	0.44 - 2.17
8,001 - 9,000	6	31	0.71	0.30 - 1.72
Direction***				
East	0	1	---	---
Northeast	0	15	---	---
Southeast	9	37	0.90	0.43 - 1.88
South	0	0	---	---
North	0	0	---	---
Southwest	15	45	1.23	0.68 - 2.23
Northwest	7	39	0.66	0.29 - 1.49
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 283 unexposed cases and 1042 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.36 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	8	96	1.19	0.55 - 2.57
No. Years Exposed**				
0.5 - 10.0	3	43	0.99	0.30 - 3.32
10.5 - 20.0	2	15	---	---
>20.0	3	38	1.13	0.34 - 3.77
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	12	---	---
4,001 - 5,000	0	5	---	---
5,001 - 6,000	2	9	---	---
6,001 - 7,000	2	21	---	---
7,001 - 8,000	1	20	---	---
8,001 - 9,000	3	27	1.59	0.47 - 5.34
Direction***				
East	0	1	---	---
Northeast	0	11	---	---
Southeast	3	23	1.86	0.55 - 6.28
South	0	0	---	---
North	0	0	---	---
Southwest	4	34	1.68	0.58 - 4.86
Northwest	1	27	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 54 unexposed cases and 771 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.37 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratios	95% Confidence Interval
Ever Exposed	2	82	---	---
No. Years Exposed**				
0.5 - 10.0	1	31	---	---
10.5 - 20.0	0	16	---	---
>20.0	1	35	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	10	---	---
4,001 - 5,000	0	4	---	---
5,001 - 6,000	0	10	---	---
6,001 - 7,000	2	15	---	---
7,001 - 8,000	0	21	---	---
8,001 - 9,000	0	20	---	---
Direction***				
East	0	1	---	---
Northeast	0	9	---	---
Southeast	1	24	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	1	26	---	---
Northwest	0	22	---	---
West	0	0	---	---

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.38 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratios	95% Confidence Interval
Ever Exposed	2	68	---	---
No. Years Exposed**				
0.5 - 10.0	1	29	---	---
10.5 - 20.0	0	11	---	---
>20.0	1	28	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	0	---	---
3,001 - 4,000	0	3	---	---
4,001 - 5,000	1	5	---	---
5,001 - 6,000	0	6	---	---
6,001 - 7,000	1	17	---	---
7,001 - 8,000	0	16	---	---
8,001 - 9,000	0	20	---	---
Direction***				
East	0	0	---	---
Northeast	0	10	---	---
Southeast	1	17	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	0	21	---	---
Northwest	1	20	---	---
West	0	0	---	---

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.39 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	9	168	1.16	0.53 - 2.51
No. Years Exposed**				
0.5 - 10.0	2	66	---	---
10.5 - 20.0	2	31	---	---
>20.0	5	71	1.52	0.57 - 4.05
Distance to Exposure (m)				
1 - 1,000	0	3	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	0	3	---	---
3,001 - 4,000	0	11	---	---
4,001 - 5,000	2	12	---	---
5,001 - 6,000	0	18	---	---
6,001 - 7,000	2	32	---	---
7,001 - 8,000	4	43	2.01	0.68 - 5.89
8,001 - 9,000	1	44	---	---
Direction***				
East	0	1	---	---
Northeast	1	23	---	---
Southeast	1	47	---	---
South	0	2	---	---
North	0	0	---	---
Southwest	5	51	2.12	0.80 - 5.52
Northwest	2	44	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 583 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.40 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

<u>Cancer Site</u>: Brain

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	4	84	0.91	0.32 - 2.64
<u>No. Years Exposed</u>**				
0.5 - 10.0	2	30	---	---
10.5 - 20.0	1	16	---	---
>20.0	1	38	---	---
<u>Distance to Exposure (m)</u>				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	0	1	---	---
3,001 - 4,000	0	11	---	---
4,001 - 5,000	1	6	---	---
5,001 - 6,000	0	8	---	---
6,001 - 7,000	2	22	---	---
7,001 - 8,000	0	17	---	---
8,001 - 9,000	0	18	---	---
<u>Direction</u>***				
East	0	0	---	---
Northeast	0	11	---	---
Southeast	0	24	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	3	23	2.49	0.74 - 8.39
Northwest	1	26	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and [illegible] to 33 unexposed cases and 631 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.41 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	264	320	1.02	0.84 - 1.23
No. Years Exposed				
0.5 - 10.0	151	197	0.94	0.75 - 1.19
10.5 - 20.0	60	62	1.20	0.83 - 1.73
>20.0	53	61	1.08	0.74 - 1.57
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	3	2	1.86	0.32 - 10.9
2,001 - 3,000	6	13	0.57	0.22 - 1.49
3,001 - 4,000	9	26	0.43	0.20 - 0.90
4,001 - 5,000	25	17	1.82	0.99 - 3.37
5,001 - 6,000	20	35	0.71	0.42 - 1.24
6,001 - 7,000	60	62	1.20	0.83 - 1.73
7,001 - 8,000	60	72	1.03	0.72 - 1.48
8,001 - 9,000	81	93	1.08	0.79 - 1.48
Direction**				
East	1	1	---	---
Northeast	26	31	1.04	0.61 - 1.77
Southeast	64	93	0.85	0.61 - 1.19
South	4	3	1.65	0.37 - 7.30
North	0	0	---	---
Southwest	101	98	1.28	0.95 - 1.71
Northwest	62	94	0.82	0.59 - 1.14
West	6	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 778 unexposed cases and 965 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.42 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	61	324	0.89	0.65 - 1.22
No. Years Exposed				
0.5 - 10.0	37	198	0.89	0.60 - 1.30
10.5 - 20.0	10	70	0.67	0.34 - 1.32
>20.0	14	56	1.19	0.65 - 2.18
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	3	---	---
2,001 - 3,000	1	13	---	---
3,001 - 4,000	3	29	0.49	0.15 - 1.59
4,001 - 5,000	7	15	2.22	0.91 - 5.40
5,001 - 6,000	2	36	---	---
6,001 - 7,000	13	61	1.01	0.55 - 1.88
7,001 - 8,000	17	71	1.14	0.66 - 1.98
8,001 - 9,000	18	96	0.89	0.53 - 1.51
Direction**				
East	1	1	---	---
Northeast	5	31	0.77	0.30 - 1.99
Southeast	20	97	0.98	0.59 - 1.63
South	0	3	---	---
North	0	0	---	---
Southwest	20	100	0.95	0.57 - 1.58
Northwest	15	92	0.78	0.44 - 1.37
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 190 unexposed cases and 904 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.43 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	64	174	0.96	0.69 - 1.34
No. Years Exposed				
0.5 - 10.0	38	102	0.98	0.65 - 1.47
10.5 - 20.0	10	36	0.73	0.36 - 1.49
>20.0	16	36	1.16	0.63 - 2.15
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	1	---	---
2,001 - 3,000	2	8	---	---
3,001 - 4,000	1	15	---	---
4,001 - 5,000	5	7	1.87	0.60 - 5.87
5,001 - 6,000	8	20	1.05	0.45 - 2.42
6,001 - 7,000	14	41	0.90	0.48 - 1.68
7,001 - 8,000	14	31	1.18	0.62 - 2.27
8,001 - 9,000	19	51	0.98	0.56 - 1.70
Direction**				
East	0	0	---	---
Northeast	2	18	---	---
Southeast	17	49	0.91	0.51 - 1.62
South	4	2	5.24	0.74 - 58.24
North	0	0	---	---
Southwest	23	56	1.08	0.64 - 1.80
Northwest	17	49	0.91	0.51 - 1.62
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 201 unexposed cases and 527 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.44 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	85	306	1.05	0.79 - 1.39
No. Years Exposed				
0.5 - 10.0	43	187	0.87	0.60 - 1.24
10.5 - 20.0	27	60	1.71	1.01 - 2.81
>20.0	15	59	0.96	0.54 - 1.73
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	2	12	---	---
3,001 - 4,000	3	23	0.50	0.15 - 1.62
4,001 - 5,000	6	17	1.34	0.52 - 3.43
5,001 - 6,000	5	34	0.56	0.22 - 1.43
6,001 - 7,000	18	62	1.10	0.64 - 1.90
7,001 - 8,000	19	65	1.11	0.65 - 1.89
8,001 - 9,000	32	91	1.33	0.87 - 2.05
Direction**				
East	0	1	---	---
Northeast	9	31	1.10	0.52 - 2.35
Southeast	14	89	0.60	0.34 - 1.06
South	0	0	---	---
North	0	0	---	---
Southwest	35	92	1.44	0.96 - 2.19
Northwest	22	90	0.93	0.57 - 1.52
West	5	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 230 unexposed cases and 873 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.45 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	18	240	1.06	0.60 - 1.88
No. Years Exposed				
0.5 - 10.0	9	156	0.82	0.39 - 1.70
10.5 - 20.0	5	48	1.48	0.56 - 3.89
>20.0	4	36	1.58	0.54 - 4.60
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	0	10	---	---
3,001 - 4,000	1	17	---	---
4,001 - 5,000	1	12	---	---
5,001 - 6,000	2	23	---	---
6,001 - 7,000	3	44	0.97	0.29 - 3.26
7,001 - 8,000	4	52	1.10	0.38 - 3.17
8,001 - 9,000	7	80	1.25	0.54 - 2.86
Direction**				
East	0	1	---	---
Northeast	3	28	1.53	0.45 - 5.18
Southeast	4	64	0.89	0.31 - 2.56
South	0	3	---	---
North	0	0	---	---
Southwest	10	75	1.90	0.93 - 3.89
Northwest	1	69	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 44 unexposed cases and 627 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.46 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	7	201	0.73	0.32 - 1.69
No. Years Exposed				
0.5 - 10.0	5	127	0.82	0.31 - 2.17
10.5 - 20.0	1	40	---	---
>20.0	1	34	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	1	8	---	---
3,001 - 4,000	0	15	---	---
4,001 - 5,000	0	11	---	---
5,001 - 6,000	0	21	---	---
6,001 - 7,000	3	33	1.92	0.57 - 6.51
7,001 - 8,000	1	44	---	---
8,001 - 9,000	2	68	---	---
Direction**				
East	0	1	---	---
Northeast	0	21	---	---
Southeast	2	58	---	---
South	0	2	---	---
North	0	0	---	---
Southwest	3	62	1.02	0.30 - 3.46
Northwest	2	57	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 28 unexposed cases and 591 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.47 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

<u>Cancer Site:</u> Pancreas

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	6	143	0.66	0.27 - 1.61
<u>No. Years Exposed</u>				
0.5 - 10.0	5	84	0.94	0.36 - 2.49
10.5 - 20.0	0	30	---	---
>20.0	1	29	---	---
<u>Distance to Exposure (m)</u>				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	0	7	---	---
3,001 - 4,000	0	3	---	---
4,001 - 5,000	1	7	---	---
5,001 - 6,000	1	13	---	---
6,001 - 7,000	3	32	1.48	0.43 - 5.08
7,001 - 8,000	0	29	---	---
8,001 - 9,000	0	50	---	---
<u>Direction</u>**				
East	0	0	---	---
Northeast	1	16	---	---
Southeast	3	34	1.40	0.41 - 4.78
South	0	3	---	---
North	0	0	---	---
Southwest	1	46	---	---
Northwest	1	44	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 490 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.48 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	13	188	1.68	0.84 - 3.36
No. Years Exposed				
0.5 - 10.0	8	113	1.72	0.76 - 3.90
10.5 - 20.0	4	38	2.57	0.88 - 7.53
>20.0	1	37	0.66	0.09 - 4.96
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	1	---	---
2,001 - 3,000	0	9	---	---
3,001 - 4,000	0	11	---	---
4,001 - 5,000	3	10	7.34	1.20 - 30.98
5,001 - 6,000	2	22	---	---
6,001 - 7,000	2	36	---	---
7,001 - 8,000	5	42	2.91	0.82 - 8.37
8,001 - 9,000	1	57	---	---
Direction**				
East	0	1	---	---
Northeast	2	15	---	---
Southeast	2	53	---	---
South	0	3	---	---
North	0	0	---	---
Southwest	6	63	2.33	0.94 - 5.80
Northwest	3	53	1.39	0.40 - 4.75
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 23 unexposed cases and 563 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.49 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	10	181	1.09	0.52 - 2.30
No. Years Exposed				
0.5 - 10.0	6	100	1.19	0.48 - 2.95
10.5 - 20.0	3	43	1.38	0.40 - 4.71
>20.0	1	38	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	3	---	---
2,001 - 3,000	0	8	---	---
3,001 - 4,000	1	15	---	---
4,001 - 5,000	2	9	---	---
5,001 - 6,000	0	21	---	---
6,001 - 7,000	4	36	2.20	0.75 - 6.46
7,001 - 8,000	0	37	---	---
8,001 - 9,000	2	52	---	---
Direction**				
East	0	0	---	---
Northeast	4	21	3.77	0.87 - 12.27
Southeast	2	50	---	---
South	0	1	---	---
North	0	0	---	---
Southwest	3	56	1.06	0.31 - 3.61
Northwest	1	53	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 534 unexposed controls.

** Direction of study subject to exposure site.

Table III.9.50 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	319	367	1.10	0.92 - 1.32
No. Years Exposed**				
0.5 - 10.0	112	127	1.12	0.85 - 1.47
10.5 - 20.0	62	65	1.21	0.84 - 1.74
>20.0	145	175	1.05	0.83 - 1.34
Distance to Exposure (m)				
1 - 1,000	1	4	---	---
1,001 - 2,000	4	3	1.69	0.38 - 7.46
2,001 - 3,000	7	12	0.74	0.29 - 1.88
3,001 - 4,000	18	30	0.76	0.42 - 1.38
4,001 - 5,000	23	28	1.04	0.60 - 1.83
5,001 - 6,000	21	32	0.83	0.47 - 1.46
6,001 - 7,000	73	77	1.20	0.86 - 1.68
7,001 - 8,000	77	80	1.22	0.88 - 1.70
8,001 - 9,000	95	101	1.19	0.89 - 1.61
Direction***				
East	2	1	---	---
Northeast	46	53	1.10	0.73 - 1.66
Southeast	90	104	1.10	0.82 - 1.48
South	4	3	1.69	0.38 - 7.46
North	0	0	---	---
Southwest	108	113	1.21	0.92 - 1.61
Northwest	63	93	0.86	0.62 - 1.20
West	6	0	---	--

* Odds ratios were computed by comparing the number of exposed cases and controls to 723 unexposed cases and 918 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.51 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	77	372	1.02	0.76 - 1.37
No. Years Exposed**				
0.5 - 10.0	32	127	1.24	0.81 - 1.89
10.5 - 20.0	10	69	0.71	0.36 - 1.41
>20.0	35	176	0.98	0.66 - 1.46
Distance to Exposure (m)				
1 - 1,000	1	4	---	---
1,001 - 2,000	0	4	---	---
2,001 - 3,000	2	12	---	---
3,001 - 4,000	5	32	0.77	0.30 - 1.20
4,001 - 5,000	6	28	1.05	0.43 - 2.58
5,001 - 6,000	3	32	0.46	0.14 - 1.48
6,001 - 7,000	20	77	1.28	0.76 - 2.14
7,001 - 8,000	21	79	1.31	0.79 - 2.17
8,001 - 9,000	19	104	0.90	0.54 - 1.50
Direction***				
East	1	1	---	---
Northeast	11	54	1.00	0.51 - 1.96
Southeast	27	108	1.23	0.78 - 1.93
South	0	3	---	---
North	0	0	---	---
Southwest	22	115	0.94	0.58 - 1.53
Northwest	16	91	0.86	0.50 - 1.51
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 174 unexposed cases and 856 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.52 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

<u>Cancer Site</u>: Breast

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	77	201	1.02	0.75 - 1.39
<u>No. Years Exposed</u>**				
0.5 - 10.0	26	69	1.00	0.62 - 1.62
10.5 - 20.0	14	36	1.03	0.54 - 1.96
>20.0	37	96	1.02	0.68 - 1.55
<u>Distance to Exposure (m)</u>				
1 - 1,000	0	1	---	---
1,001 - 2,000	2	2	---	---
2,001 - 3,000	1	9	---	---
3,001 - 4,000	1	14	---	---
4,001 - 5,000	6	18	0.89	0.35 - 2.27
5,001 - 6,000	7	18	1.03	0.42 - 2.52
6,001 - 7,000	18	44	1.09	0.61 - 1.93
7,001 - 8,000	19	36	1.40	0.79 - 2.50
8,001 - 9,000	23	59	1.04	0.62 - 1.73
<u>Direction</u>***				
East	0	0	---	---
Northeast	8	32	0.66	0.30 - 1.46
Southeast	24	55	1.16	0.70 - 1.93
South	4	2	5.32	0.75 - 59.09
North	0	0	---	---
Southwest	23	63	0.97	0.58 - 1.61
Northwest	17	49	0.92	0.52 - 1.62
West	1	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 188 unexposed cases and 500 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.53 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	104	350	1.17	0.90 - 1.52
No. Years Exposed**				
0.5 - 10.0	34	121	1.10	0.73 - 1.66
10.5 - 20.0	22	63	1.37	0.83 - 2.28
>20.0	48	166	1.14	0.80 - 1.62
Distance to Exposure (m)				
1 - 1,000	0	4	---	---
1,001 - 2,000	0	3	---	---
2,001 - 3,000	2	11	---	---
3,001 - 4,000	7	27	1.02	0.44 - 2.37
4,001 - 5,000	4	28	0.56	0.20 - 1.60
5,001 - 6,000	4	31	0.51	0.18 - 1.42
6,001 - 7,000	21	76	1.09	0.65 - 1.80
7,001 - 8,000	25	73	1.35	0.84 - 2.17
8,001 - 9,000	41	97	1.67	1.08 - 2.50
Direction***				
East	0	1	---	---
Northeast	15	52	1.13	0.63 - 2.05
Southeast	24	98	0.96	0.60 - 1.54
South	0	3	---	---
North	0	0	---	---
Southwest	38	107	1.40	0.94 - 2.08
Northwest	22	89	0.97	0.60 - 1.59
West	5	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to unexposed cases and unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.54 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	22	274	1.19	0.69 - 2.04
No. Years Exposed**				
0.5 - 10.0	7	99	1.05	0.46 - 2.41
10.5 - 20.0	5	58	1.28	0.49 - 3.36
>20.0	10	117	1.27	0.62 - 2.60
Distance to Exposure (m)				
1 - 1,000	0	3	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	0	10	---	---
3,001 - 4,000	2	21	---	---
4,001 - 5,000	1	16	---	---
5,001 - 6,000	2	21	---	---
6,001 - 7,000	5	60	1.24	0.47 - 3.25
7,001 - 8,000	4	59	1.00	0.35 - 2.91
8,001 - 9,000	8	82	1.45	0.66 - 3.19
Direction***				
East	1	1	---	---
Northeast	5	44	1.69	0.64 - 4.44
Southeast	5	72	1.03	0.39 - 2.69
South	0	3	---	---
North	0	0	---	---
Southwest	1	69	---	---
Northwest	10	85	1.74	0.85 - 3.59
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 40 unexposed cases and 593 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9:55 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	8	231	0.72	0.32 - 1.60
No. Years Exposed**				
0.5 - 10.0	4	84	0.99	0.34 - 2.90
10.5 - 20.0	2	41	---	---
>20.0	2	106	---	---
Distance to Exposure (m)				
1 - 1,000	0	2	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	1	7	---	---
3,001 - 4,000	0	18	---	---
4,001 - 5,000	0	16	---	---
5,001 - 6,000	0	20	---	---
6,001 - 7,000	3	44	1.42	0.42 - 4.83
7,001 - 8,000	1	50	---	---
8,001 - 9,000	3	72	0.87	0.26 - 2.93
Direction***				
East	0	1	---	---
Northeast	0	35	---	---
Southeast	2	65	---	---
South	0	2	---	---
North	0	0	---	---
Southwest	4	71	1.17	0.40 - 3.44
Northwest	2	57	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 561 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.56 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

<u>Cancer Site:</u> Pancreas

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	6	174	0.51	0.21 - 1.23
<u>No. Years Exposed</u>**				
0.5 - 10.0	2	54	---	---
10.5 - 20.0	2	43	---	---
>20.0	2	77	---	---
<u>Distance to Exposure (m)</u>				
1 - 1,000	0	3	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	0	4	---	---
3,001 - 4,000	1	6	---	---
4,001 - 5,000	2	12	---	---
5,001 - 6,000	1	13	---	---
6,001 - 7,000	1	36	---	---
7,001 - 8,000	0	36	---	---
8,001 - 9,000	0	62	---	---
<u>Direction</u>***				
East	0	0	---	---
Northeast	1	31	---	---
Southeast	3	47	0.94	0.28 - 3.21
South	0	3	---	---
North	0	0	---	---
Southwest	1	50	---	---
Northwest	1	43	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 459 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.57 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	14	219	1.55	0.78 - 3.06
No. Years Exposed**				
0.5 - 10.0	1	68	---	---
10.5 - 20.0	6	43	3.37	1.05 - 9.17
>20.0	7	108	1.57	0.66 - 3.74
Distance to Exposure (m)				
1 - 1,000	0	3	---	---
1,001 - 2,000	0	2	---	---
2,001 - 3,000	0	5	---	---
3,001 - 4,000	1	14	---	---
4,001 - 5,000	2	19	---	---
5,001 - 6,000	2	21	---	---
6,001 - 7,000	2	41	---	---
7,001 - 8,000	6	53	2.74	0.86 - 7.36
8,001 - 9,000	1	61	---	---
Direction***				
East	0	1	---	---
Northeast	2	29	---	---
Southeast	2	65	---	---
South	0	3	---	---
North	0	0	---	---
Southwest	7	69	2.45	0.85 - 6.22
Northwest	3	52	1.40	0.41 - 4.80
West	2	29	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 22 unexposed cases and 532 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.58 Results of Crude Categorical Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	11	213	1.00	0.48 - 2.06
No. Years Exposed**				
0.5 - 10.0	6	73	1.59	0.64 - 3.96
10.5 - 20.0	1	35	---	---
>20.0	4	105	0.74	0.25 - 2.14
Distance to Exposure (m)				
1 - 1,000	0	3	---	---
1,001 - 2,000	1	2	---	---
2,001 - 3,000	1	8	---	---
3,001 - 4,000	1	17	---	---
4,001 - 5,000	2	17	---	---
5,001 - 6,000	2	16	---	---
6,001 - 7,000	3	48	1.21	0.35 - 4.13
7,001 - 8,000	1	42	---	---
8,001 - 9,000	0	60	---	---
Direction***				
East	0	0	---	---
Northeast	4	36	2.14	0.73 - 6.33
Southeast	3	61	0.95	0.28 - 3.23
South	0	1	---	---
North	0	0	---	---
Southwest	3	63	0.92	0.27 - 3.13
Northwest	1	52	---	---
West	0	0	--	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 26 unexposed cases and 502 unexposed controls.

** Sum of total years exposed to each FTA.

*** Direction of study subject to exposure site.

Table III.9.59 Results of Crude Exposure Metric* Anlaysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	1.35278	0.55	1.06	0.87 - 1.29
Lung	-1.21015	0.77	0.95	0.67 - 1.35
Breast	2.76584	0.32	1.13	0.89 - 1.43
Colorectal	-1.49530	0.70	0.94	0.67 - 1.31
Bladder	1.49672	0.89	1.07	0.42 - 2.71
Leukemia	0.57629	0.86	1.02	0.77 - 1.37
Brain	-9.07682	0.57	0.67	0.17 - 2.65

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.9.60 Results of Crude Exposure Metric* Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.48523	0.64	0.98	0.90 - 1.08
Lung	-1.47424	0.47	0.93	0.77 - 1.13
Breast	0.14657	0.91	1.01	0.89 - 1.14
Colorectal	-0.99371	0.57	0.95	0.81 - 1.12
Bladder	0.65166	0.87	1.03	0.72 - 1.48
Kidney	-6.23444	0.47	0.74	0.33 - 1.68
Pancreas	-3.87796	0.57	0.83	0.43 - 1.58
Leukemia	0.59616	0.81	1.03	0.81 - 1.30
Brain	-4.38830	0.50	0.81	0.44 - 1.50

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.9.61 Results of Adjusted Categorical* Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	-0.00087	1.00	1.00	0.75 - 1.33
Lung	-0.15150	0.56	0.86	0.52 - 1.42
Breast	-0.07998	0.77	0.92	0.54 - 1.56
Colorectal	-0.14515	0.54	0.86	0.54 - 1.38
Bladder	0.36981	0.40	1.45	0.62 - 3.40
Leukemia	0.18688	0.65	1.21	0.53 - 2.73
Brain	-0.22994	0.68	0.79	0.27 - 2.38

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 9,000 meters of the exposure site.

**Sites with less than three exposed cases were not analyzed.

Table III.9.62 Results of Adjusted Categorical* Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.01547	0.88	1.02	0.83 - 1.24
Lung	-0.12248	0.49	0.88	0.62 - 1.26
Breast	-0.05884	0.75	0.94	0.66 - 1.35
Colorectal	0.03216	0.84	1.03	0.76 - 1.41
Bladder	0.31110	0.32	1.36	0.74 - 2.53
Kidney	-0.34397	0.44	0.71	0.29 - 1.71
Pancreas	-0.56810	0.27	0.57	0.21 - 1.54
Leukemia	0.52430	0.15	1.69	0.83 - 3.45
Brain	-0.06821	0.86	0.93	0.43 - 2.03

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 9,000 meters of the exposure site.

**Sites with less than three exposed cases were not analyzed.

Table III.9.63 Results of Adjusted Exposure Metric* Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Taking Latnet Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	1.74011	0.47	1.08	0.88 - 1.32
Lung	-1.73710	0.67	0.93	0.66 - 1.31
Breast	2.948960	0.31	1.14	0.89 - 1.46
Colorectal	-6.71628	0.26	0.75	0.45 - 1.24
Bladder	6.35063	0.60	1.32	0.47 - 3.71
Leukemia	0.83882	0.81	1.04	0.77 - 1.39
Brain	-14.2562	0.41	0.54	0.12 - 2.33

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no. yrs.)

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.9.64 Results of Adjusted Exposure Metric* Analysis Examining the MMR Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.45657	0.68	0.98	0.88 - 1.08
Lung	-1.34659	0.49	0.94	0.78 - 1.12
Breast	-0.13644	0.93	0.99	0.85 - 1.16
Colorectal	-3.20397	0.19	0.86	0.68 - 1.08
Bladder	1.69637	0.66	1.09	0.75 - 1.57
Kidney	-5.55813	0.55	0.77	0.32 - 1.84
Pancreas	-7.92157	0.36	0.68	0.30 - 1.55
Leukemia	0.81886	0.75	1.04	0.82 - 1.33
Brain	-6.35116	0.36	0.74	0.38 - 1.43

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.10.1 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	57	75	0.93	0.66 - 1.33
No. Years Exposed				
0.5 - 10.0	31	43	0.89	0.55 - 1.42
10.5 - 20.0	24	31	0.95	0.55 - 1.63
> 20	2	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	18	16	1.38	0.70 - 2.72
2,001 - 3,000	39	59	0.81	0.54 - 1.23
Direction**				
Northeast	5	2	---	---
Southeast	20	35	0.70	0.40 - 1.22
South	0	3	---	---
North	0	0	---	---
Southwest	28	32	1.07	0.64 - 1.80
Northwest	4	2	2.46	0.48 - 12.70
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 985 unexposed cases and 1210 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.2 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

<u>Cancer Site</u>: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	14	79	0.86	0.48 - 1.54
<u>No. Years Exposed</u>				
0.5 - 10.0	9	49	0.89	0.43 - 1.84
10.5 - 20.0	5	29	0.84	0.32 - 2.18
> 20	0	1	---	---
<u>Distance to Exposure (m)</u>				
1 - 1,000	0	0	---	---
1,001 - 2,000	5	17	1.43	0.52 - 3.89
2,001 - 3,000	9	62	0.70	0.35 - 1.43
<u>Direction</u>**				
Northeast	2	2	---	---
Southeast	6	36	0.81	0.34 - 1.94
South	0	3	---	---
North	0	0	---	---
Southwest	5	35	0.69	0.27 - 1.78
Northwest	1	2	---	---
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 237 unexposed cases and 1149 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.3 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	47	0.95	0.54 - 1.69
No. Years Exposed				
0.5 - 10.0	8	29	0.73	0.33 - 1.61
10.5 - 20.0	9	18	1.32	0.59 - 2.97
> 20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	7	10	1.85	0.70 - 4.84
2,001 - 3,000	10	37	0.71	0.35 - 1.45
Direction**				
Northeast	0	1	---	---
Southeast	6	20	0.79	0.32 - 1.99
South	0	2	---	---
North	0	0	---	---
Southwest	9	22	1.08	0.49 - 2.38
Northwest	2	1	---	---
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 248 unexposed cases and 654 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.4 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	10	70	0.52	0.27 - 1.01
No. Years Exposed				
0.5 - 10.0	8	40	0.73	0.34 - 1.57
10.5 - 20.0	2	29	---	---
> 20	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	3	15	0.73	0.21 - 2.52
2,001 - 3,000	7	55	0.46	0.21 - 1.01
Direction**				
Northeast	2	2	---	---
Southeast	2	34	---	---
South	0	3	---	---
North	0	0	---	---
Southwest	5	28	0.65	0.25 - 1.68
Northwest	1	2	---	---
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 305 unexposed cases and 1109 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.5 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	46	0.91	0.27 - 3.01
No. Years Exposed				
0.5 - 10.0	0	25	---	---
10.5 - 20.0	3	20	2.09	0.62 - 7.04
> 20	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	9	---	---
2,001 - 3,000	2	37	---	---
Direction**				
Northeast	1	1	---	---
Southeast	0	25	---	---
South	0	1	---	---
North	0	0	---	---
Southwest	2	17	---	---
Northwest	0	2	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 59 unexposed cases and 821 unexposed controls.

** Direction of study subject to exposure site

Table III.10.6 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	48	1.45	0.43 - 4.89
No. Years Exposed				
0.5 - 10.0	1	30	---	---
10.5 - 20.0	2	18	---	---
> 20	0	0	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	7	---	---
2,001 - 3,000	3	41	1.70	0.51 - 5.71
Direction**				
Northeast	0	2	---	---
Southeast	3	25	2.79	0.84 - 9.25
South	0	1	---	---
North	0	0	---	---
Southwest	0	17	---	---
Northwest	0	2	---	---
West	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 744 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.7 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	37	1.42	0.42 - 4.82
No. Years Exposed				
0.5 - 10.0	1	21	---	---
10.5 - 20.0	2	15	---	---
> 20	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	9	---	---
2,001 - 3,000	2	28	---	---
Direction**				
Northeast	0	0	---	---
Southeast	1	17	---	---
South	0	1	---	---
North	0	0	---	---
Southwest	2	18	---	---
Northwest	0	1	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 596 unexposed controls.

** Direction of study subject to exposure site

Table III.10.8 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	69	1.59	0.60 - 4.20
No. Years Exposed				
0.5 - 10.0	3	34	1.94	0.58 - 6.53
10.5 - 20.0	0	18	---	---
> 20	2	17	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	14	---	---
2,001 - 3,000	4	55	1.60	0.55 - 4.66
Direction**				
Northeast	0	1	---	---
Southeast	2	32	---	---
South	0	3	---	---
North	0	0	---	---
Southwest	3	30	2.20	0.66 - 7.38
Northwest	0	3	---	---
West	0	0	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 682 unexposed controls.

** Direction of study subject to exposure site.

Table III.10.9 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	47	---	---
No. Years Exposed				
0.5 - 10.0	1	30	---	---
10.5 - 20.0	1	16	---	---
> 20	0	1	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	10	---	---
2,001 - 3,000	2	37	---	---
Direction**				
Northeast	0	0	---	---
Southeast	0	21	---	---
South	0	0	---	---
North	0	0	---	---
Southwest	2	23	---	---
Northwest	0	2	---	---
West	0	1	---	---

** Direction of study subject to exposure site.

Table III.10.10 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	103	139	0.90	0.69-1.18
No. Years Exposed				
0.5-10.0	53	75	0.86	0.60-1.24
10.5-20.0	23	30	0.94	0.54-1.62
>20	27	34	0.97	0.58-1.62
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	26	27	1.18	0.68-2.03
2,001-3,000	77	112	0.84	0.62-1.14
Direction**				
Northeast	9	6	1.83	0.66-5.08
Southeast	36	58	0.76	0.50-1.16
South	1	5	----	----
North	0	0	----	----
Southwest	47	62	0.92	0.63-1.36
Northwest	10	7	1.74	0.67-4.54
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 939 unexposed cases and 1146 unexposed controls.

**Direction of study subject to exposure site

Table III.10.11 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	21	133	0.75	0.46-1.22
No. Years Exposed				
0.5-10.0	12	70	0.82	0.44-1.53
10.5-20.0	4	29	0.66	0.23-1.87
>20	5	34	0.70	0.27-1.80
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	7	27	1.23	0.53-2.86
2,001-3,000	14	106	0.63	0.36-1.11
Direction**				
Northeast	3	5	2.86	0.72-11.3
Southeast	9	55	0.78	0.38-1.60
South	0	5	----	----
North	0	0	----	----
Southwest	6	60	0.48	0.21-1.10
Northwest	3	7	2.04	0.54-7.73
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 230 unexposed cases and 1095 unexposed controls.

**Direction of study subject to exposure site

Table III.10.12 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	33	79	1.12	0.73-1.73
No. Years Exposed				
0.5-10.0	14	38	0.99	0.52-1.86
10.5-20.0	10	20	1.34	0.62-2.90
>20	9	21	1.15	0.52-2.54
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	10	15	1.79	0.80-4.00
2,001-3,000	23	64	0.96	0.58-1.59
Direction **				
Northeast	0	2	----	----
Southeast	8	35	0.61	0.28-1.33
South	1	3	----	----
North	0	0	----	----
Southwest	21	35	1.61	0.92-2.81
Northwest	3	3	2.68	0.57-12.6
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 232 unexposed cases and 622 unexposed controls.

**Direction of study subject to exposure site

Table III.10.13 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	25	127	0.71	0.46-1.12
No. Years Exposed				
0.5-10.0	15	67	0.81	0.46-1.44
10.5-20.0	6	28	0.78	0.32-1.89
>20	4	32	0.45	0.16-1.26
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	6	23	0.95	0.38-2.35
2,001-3,000	19	104	0.66	0.40-1.09
Direction**				
Northeast	4	6	2.42	0.70-8.30
Southeast	9	54	0.60	0.30-1.23
South	0	5	----	----
North	0	0	----	----
Southwest	9	55	0.59	0.29-1.21
Northwest	3	6	1.81	0.46-7.16
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 290 unexposed cases and 1052 unexposed controls.

**Direction of study subject to exposure site

Table III.10.14 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	86	0.97	0.41-2.33
No. Years Exposed				
0.5-10.0	3	49	0.85	0.26-2.82
10.5-20.0	0	14	----	----
>20	3	23	1.82	0.54-6.14
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	15	----	----
2,001-3,000	5	71	0.98	0.38-2.53
Direction**				
Northeast	1	5	----	----
Southeast	2	40	----	----
South	0	2	----	----
North	0	0	----	----
Southwest	3	34	1.23	0.37-4.13
Northwest	0	5	----	----
West	0	0	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 56 unexposed cases and 781 unexposed controls.

**Direction of study subject to exposure site

Table III.10.15 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	84	1.40	0.53-3.70
No. Years Exposed				
0.5-10.0	2	46	----	----
10.5-20.0	2	20	----	----
>20	1	18	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	0	13	----	----
2,001-3,000	5	71	1.66	0.63-4.38
Direction**				
Northeast	0	5	----	----
Southeast	4	36	2.62	0.91-7.55
South	0	2	----	----
North	0	0	----	----
Southwest	0	35	----	----
Northwest	1	5	----	----
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 708 unexposed controls.

**Direction of study subject to exposure site

Table III.10.16 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	66	1.34	0.51-3.56
No. Years Exposed				
0.5-10.0	3	34	1.56	0.46-5.32
10.5-20.0	0	12	----	----
>20	2	20	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	14	----	----
2,001-3,000	4	52	1.36	0.47-3.99
Direction**				
Northeast	0	0	----	----
Southeast	2	29	----	----
South	0	2	----	----
North	0	0	----	----
Southwest	3	31	1.72	0.50-5.83
Northwest	0	4	----	----
West	0	0	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 567 unexposed controls.

**Direction of study subject to exposure site

Table III.10.17 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	87	1.23	0.47-3.25
No. Years Exposed				
0.5-10.0	3	48	1.34	0.40-4.52
10.5-20.0	0	18	----	----
>20	2	21	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	1	17	----	----
2,001-3,000	4	70	1.22	0.42-3.56
Direction**				
Northeast	0	3	----	----
Southeast	2	37	----	----
South	0	4	----	----
North	0	0	----	----
Southwest	3	40	1.61	0.48-5.43
Northwest	0	3	----	----
West	0	0	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 664 unexposed controls.

**Direction of study subject to exposure site

Table III.10.18 Results of Crude Categorical Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	78	0.72	0.22-2.39
No. Years Exposed				
0.5-10.0	1	42	----	----
10.5-20.0	1	15	----	----
>20	1	21	----	----
Distance to Exposure				
1-1,000	0	0	----	----
1,001-2,000	0	15	----	----
2,001-3,000	3	63	0.89	0.27-2.99
Direction**				
Northeast	1	1	----	----
Southeast	0	27	----	----
South	0	2	----	----
North	0	0	----	----
Southwest	2	42	----	----
Northwest	0	5	----	----
West	0	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 637 unexposed controls.

**Direction of study subject to exposure site

Table III.10.19 Results of Crude Exposure Metric* Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.12312	0.90	0.98	0.67 - 1.42
Lung	-1.25014	0.48	0.78	0.39 - 1.55
Breast	1.21850	0.43	1.27	0.70 - 2.30
Colorectal	-3.83876	0.08	0.47	0.20 - 1.10
Bladder	1.28939	0.61	1.30	0.48 - 3.45
Kidney	2.28619	0.50	1.57	0.42 - 5.90
Pancreas	0.86307	0.79	1.18	0.34 - 4.17
Leukemia	0.24101	0.91	1.05	0.47 - 2.36

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no. yrs.)

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.10.20 Results of Crude Exposure Metric* Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.14308	0.75	0.96	0.73 - 1.26
Lung	-0.57674	0.48	0.84	0.52 - 1.36
Breast	0.31118	0.66	1.10	0.72 - 1.68
Colorectal	-1.41796	0.12	0.65	0.38 - 1.11
Bladder	0.72993	0.55	1.25	0.60 - 2.59
Kidney	1.24876	0.40	1.46	0.60 - 3.55
Pancreas	0.49386	0.75	1.16	0.46 - 2.96
Leukemia	0.07498	0.97	1.02	0.35 - 2.96
Brain	-1.08024	0.64	0.72	0.18 - 2.84

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.10.21 Results of Adjusted Categorical Analysis* Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.07634	0.69	0.93	0.64 - 1.35
Lung	-0.24816	0.46	0.78	0.40 - 1.52
Breast	-0.16479	0.61	0.85	0.45 - 1.60
Colorectal	-0.47600	0.20	0.62	0.30 - 1.28
Bladder	0.10062	0.88	1.11	0.30 - 4.05
Kidney	0.63391	0.34	1.88	0.52 - 6.89
Pancreas	0.25816	0.69	1.29	0.36 - 4.70
Leukemia	0.34788	0.49	1.42	0.53 - 3.81

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.10.22 Results of Adjusted Categorical Analysis* Examining Barnstable Fire Training Areas as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	0.00023	1.00	1.00	0.75 - 1.33
Lung	-0.30445	0.15	0.74	0.43 - 1.26
Breast	0.05234	0.83	1.05	0.66 - 1.69
Colorectal	-0.13039	0.60	0.88	0.54 - 1.43
Bladder	0.10611	0.83	1.11	0.43 - 2.86
Kidney	0.19270	0.74	1.21	0.39 - 3.74
Pancreas	0.33686	0.52	1.40	0.50 - 3.90
Leukemia	0.06326	0.90	1.07	0.40 - 2.86
Brain	-0.41958	0.50	0.66	0.19 - 2.24

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.10.23 Results of Adjusted Exposure Metric* Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	0.18715	0.85	1.04	0.71 - 1.53
Lung	-1.23677	0.50	0.78	0.39 - 1.59
Breast	0.29164	0.87	1.06	0.53 - 2.13
Colorectal	-3.88016	0.08	0.47	0.20 - 1.10
Bladder	1.84149	0.52	1.44	0.48 - 4.31
Kidney	3.23490	0.35	1.89	0.49 - 7.29
Pancreas	1.15125	0.73	1.25	0.34 - 4.66
Leukemia	0.01538	0.99	1.00	0.43 - 2.34

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.10.24 Results of Adjusted Exposure Metric* Analysis Examining Barnstable Fire Training Area as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	0.03927	0.93	1.01	0.76 - 1.35
Lung	-0.78479	0.39	0.79	0.46 - 1.35
Breast	0.10427	0.90	1.03	0.64 - 1.67
Colorectal	-1.16869	0.20	0.70	0.40 - 1.21
Bladder	1.11828	0.40	1.41	0.63 - 3.15
Kidney	1.75961	0.24	1.71	0.70 - 4.20
Pancreas	0.56519	0.73	1.19	0.45 - 3.15
Leukemia	-0.16641	0.93	0.95	0.31 - 2.89
Brain	-0.76748	0.75	0.79	0.19 - 3.37

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.11.1 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	52	60	1.07	0.73 - 1.57
No. Years Exposed				
0.5 - 10.0	27	35	0.96	0.57 - 1.59
10.5 - 20.0	9	11	1.01	0.42 - 2.45
> 20	16	14	1.41	0.69 - 2.90
Distance to Exposure				
1 - 1,000	0	0	---	---
1,001 - 2,000	15	17	1.09	0.54 - 2.10
2,001 - 3,000	37	43	1.06	0.68 - 1.67
Direction**				
Northeast	26	26	1.24	0.71 - 2.14
Southeast	2	3	---	---
Southwest	18	26	0.86	0.47 - 1.57
Northwest	6	5	1.48	0.45 - 4.84

* Odds ratios were computed by comparing the number of exposed cases and controls to 990 unexposed cases and 1225 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.2 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	16	64	1.20	0.70 - 2.20
No. Years Exposed				
0.5 - 10.0	7	38	0.90	0.40 - 2.10
10.5 - 20.0	2	12	---	---
> 20	7	14	2.48	0.83 - 6.64
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	6	17	1.75	0.69 - 4.43
2,001 - 3,000	10	47	1.05	0.52 - 2.12
Direction**				
Northeast	8	28	1.42	0.64 - 3.13
Southeast	2	4	---	---
Southwest	6	27	1.10	0.45 - 2.70
Northwest	0	5	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 235 unexposed cases and 1164 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.3 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	22	1.46	0.72 - 2.99
No. Years Exposed				
0.5 - 10.0	5	12	1.12	0.39 - 3.21
10.5 - 20.0	3	5	1.61	0.39 - 6.70
> 20	4	5	2.15	0.59 - 7.82
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	5	7	1.92	0.61 - 5.98
2,001 - 3,000	7	15	1.25	0.51 - 3.10
Direction**				
Northeast	9	10	2.41	0.99 - 5.86
Southeast	0	1	---	---
Southwest	1	9	---	---
Northwest	2	2	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 253 unexposed cases and 679 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.4 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	13	57	0.85	0.46 - 1.57
No. Years Exposed				
0.5 - 10.0	10	33	1.13	0.55 - 2.31
10.5 - 20.0	2	10	---	---
> 20	1	14	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	3	16	0.70	0.20 - 2.40
2,001 - 3,000	10	41	0.91	0.45 - 1.83
Direction**				
Northeast	3	24	0.46	0.14 - 1.51
Southeast	0	3	---	---
Southwest	8	26	1.14	0.51 - 2.55
Northwest	2	4	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 302 unexposed cases and 1122 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.5 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	52	---	---
No. Years Exposed				
0.5 - 10.0	1	33	---	---
10.5 - 20.0	1	9	---	---
> 20	0	10	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	15	---	---
2,001 - 3,000	2	37	---	---
Direction**				
Northeast	1	26	---	---
Southeast	0	2	---	---
Southwest	0	21	---	---
Northwest	1	3	---	---

** Direction of study subject to exposure site.

Table III.11.6 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	40	---	---
No. Years Exposed				
0.5 - 10.0	0	24	---	---
10.5 - 20.0	0	7	---	---
> 20	1	9	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	11	---	---
2,001 - 3,000	1	29	---	---
Direction**				
Northeast	1	17	---	---
Southeast	0	1	---	---
Southwest	0	19	---	---
Northwest	0	3	---	---

** Direction of study subject to exposure site.

Table III.11.7 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	29	1.80	0.50 - 6.20
No. Years Exposed				
0.5 - 10.0	1	15	---	---
10.5 - 20.0	0	7	---	---
> 20	2	7	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	10	---	---
2,001 - 3,000	3	19	2.80	0.80 - 9.40
Direction**				
Northeast	2	15	---	---
Southeast	0	3	---	---
Southwest	1	10	---	---
Northwest	0	1	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 604 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.8 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	72	0.86	0.26 - 2.86
No. Years Exposed				
0.5 - 10.0	2	48	---	---
10.5 - 20.0	0	10	---	---
> 20	1	14	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	0	24	---	---
2,001 - 3,000	3	48	1.29	0.38 - 4.34
Direction**				
Northeast	1	35	---	---
Southeast	0	6	---	---
Southwest	1	23	---	---
Northwest	1	8	---	---

* Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 679 unexposed controls.

** Direction of study subject to exposure site.

Table III.11.9 Results of Crude Categorical Analysis Examining Propellant Bag Burning At MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	35	---	---
No. Years Exposed				
0.5 - 10.0	1	20	---	---
10.5 - 20.0	1	7	---	---
> 20	0	8	---	---
Distance to Exposure (m)				
1 - 1,000	0	0	---	---
1,001 - 2,000	1	8	---	---
2,001 - 3,000	1	27	---	---
Direction**				
Northeast	1	12	---	---
Southeast	0	4	---	---
Southwest	1	16	---	---
Northwest	0	3	---	---

** Direction of study subject to exposure site.

Table III.11.10 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	116	140	1.02	0.79-1.33
No. Years Exposed				
0.5-10	73	87	1.04	0.75-1.43
10.5-20	16	28	0.71	0.38-1.31
>20	27	25	1.34	0.77-2.31
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	39	41	1.18	0.75-1.84
2,001-3,000	77	99	0.96	0.71-1.31
Direction**				
Northeast	51	63	1.00	0.68-1.46
Southeast	14	15	1.15	0.55-2.40
North	0	1	----	----
Southwest	33	41	0.99	0.62-1.59
Northwest	18	20	1.11	0.58-2.12

*Odds ratios were computed by comparing the number of exposed cases and controls to 926 unexposed cases and 1145 unexposed controls.

**Direction of study subject to exposure site

Table III.11.11 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	36	138	1.32	0.89-1.96
No. Years Exposed				
0.5-10	21	84	1.27	0.77-2.09
10.5-20	6	28	1.09	0.44-2.66
>20	9	26	1.76	0.82-3.76
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	12	39	1.56	0.81-3.01
2,001-3,000	24	99	1.23	0.77-1.96
Direction**				
Northeast	16	62	1.31	0.74-2.31
Southeast	6	15	2.03	0.79-5.19
North	0	1	----	----
Southwest	11	40	1.39	0.71-2.75
Northwest	3	20	0.76	0.22-2.57

*Odds ratios were computed by comparing the number of exposed cases and controls to 215 unexposed cases and 1090 unexposed controls.

**Direction of study subject to exposure site

Table III.11.12 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	30	64	1.27	0.80-2.01
No. Years Exposed				
0.5-10	17	41	1.12	0.63-2.02
10.5-20	4	13	0.83	0.27-2.58
>20	9	10	2.44	0.86-6.77
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	14	20	1.90	0.95-3.78
2,001-3,000	16	44	0.99	0.54-1.78
Direction**				
Northeast	18	30	1.63	0.89-2.96
Southeast	3	8	1.02	0.27-3.87
North	0	0	----	----
Southwest	5	17	0.80	0.29-2.18
Northwest	4	9	1.20	0.37-3.94

*Odds ratios were computed by comparing the number of exposed cases and controls to 235 unexposed cases and 637 unexposed controls.

**Direction of study subject to exposure site

Table III.11.13 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	26	133	0.71	0.46-1.10
No. Years Exposed				
0.5-10	19	82	0.84	0.50-1.40
10.5-20	3	27	0.40	0.13-1.28
>20	4	24	0.60	0.21-1.73
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	7	39	0.65	0.29-1.46
2,001-3,000	19	94	0.73	0.44-1.22
Direction**				
Northeast	5	60	0.30	0.09-0.76
Southeast	2	15	0.48	0.11-2.06
North	0	1	----	----
Southwest	12	39	1.11	0.58-2.16
Northwest	7	18	1.41	0.58-3.39

*Odds ratios were computed by comparing the number of exposed cases and controls to 289 unexposed cases and 1046 unexposed controls.

**Direction of study subject to exposure site

Table III.11.14 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	103	0.94	0.42-2.13
No. Years Exposed				
0.5-10	5	61	1.14	0.44-2.95
10.5-20	1	23	----	----
>20	1	19	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	2	36	----	----
2,001-3,000	5	67	1.04	0.40-2.68
Direction**				
Northeast	3	44	0.95	0.28-3.15
Southeast	2	12	2.32	0.53-10.20
North	0	1	----	----
Southwest	1	32	----	----
Northwest	1	14	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 55 unexposed cases and 765 unexposed controls.

**Direction of study subject to exposure site

Table III.11.15 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	98	1.18	0.45-3.11
No. Years Exposed				
0.5-10	4	63	1.47	0.50-4.28
10.5-20	0	18	----	----
>20	1	17	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	2	28	----	----
2,001-3,000	3	70	0.99	0.29-3.33
Direction**				
Northeast	2	45	----	----
Southeast	0	11	----	----
North	0	1	----	----
Southwest	1	28	----	----
Northwest	2	13	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 694 unexposed controls.

**Direction of study subject to exposure site

Table III.11.16 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	66	1.34	0.51-3.56
No. Years Exposed				
0.5-10	3	39	1.36	0.40-4.63
10.5-20	0	13	----	----
>20	2	14	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	0	20	----	----
2,001-3,000	5	46	1.93	0.73-5.10
Direction**				
Northeast	3	33	1.61	0.47-5.48
Southeast	1	9	1.97	0.25-15.40
North	0	0	----	----
Southwest	1	17	----	----
Northwest	0	7	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 567 unexposed controls.

**Direction of study subject to exposure site

Table III.11.17 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	86	0.70	0.21-2.33
No. Years Exposed				
0.5-10	2	51	----	----
10.5-20	0	18	----	----
>20	1	17	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	0	26	----	----
2,001-3,000	3	60	1.01	0.30-3.38
Direction**				
Northeast	1	40	----	----
Southeast	0	9	----	----
North	0	0	----	----
Southwest	1	25	----	----
Northwest	1	12	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 665 unexposed controls.

**Direction of study subject to exposure site

Table III.11.18 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	84	0.66	0.20-2.19
No. Years Exposed				
0.5-10	1	54	----	----
10.5-20	2	15	----	----
>20	0	15	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	1	22	----	----
2,001-3,000	2	62	----	----
Direction**				
Northeast	2	33	----	----
Southeast	0	11	----	----
North	0	1	----	----
Southwest	1	24	----	----
Northwest	0	15	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 631 unexposed controls.

**Direction of study subject to exposure site

Table III.11.19 Results of Crude Categorical Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	5	----	----
No. Years Exposed				
0.5-10	1	3	----	----
10.5-20	0	1	----	----
>20	0	1	----	----
Distance to Exposure(m)				
1-1,000	0	0	----	----
1,001-2,000	1	0	----	----
2,001-3,000	0	5	----	----
Direction**				
Northeast	1	2	----	----
Southeast	0	0	----	----
North	0	0	----	----
Southwest	0	3	----	----
Northwest	0	0	----	----

**Direction of study subject to exposure site

Table III.11.20 Results of Crude Exposure Metric* Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.10352	0.84	1.05	0.67 - 1.64
Breast	0.71356	0.40	1.38	0.65 - 2.93
Lung	0.65857	0.34	1.35	0.73 - 2.48
Colorectal	-1.35212	0.21	0.54	0.21 - 1.42
Pancreas	1.39439	0.28	1.88	0.59 - 5.96
Leukemia	-2.13483	0.47	0.38	0.03 - 5.34

$$*\text{Exposure Metric} = \left(\frac{1}{\text{distance}^{1.5}}\right)(\text{wind freq.})(\text{no. yrs.})$$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.11.21 Results of Crude Exposure Metric* Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00971	0.97	1.00	0.81 - 1.24
Breast	0.64443	0.18	1.28	0.89 - 1.82
Lung	0.45856	0.25	1.19	0.89 - 1.60
Colorectal	-1.28580	0.06	0.61	0.37 - 1.03
Pancreas	0.57666	0.48	1.24	0.68 - 2.27
Bladder	-0.72008	0.53	0.76	0.32 - 1.82
Kidney	-0.04142	0.97	0.98	0.40 - 2.41
Leukemia	-2.57471	0.39	0.38	0.04 - 3.42
Brain	-0.31158	0.81	0.89	0.34 - 2.31

$$*Exposure\ Metric = \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.11.22 Results of Adjusted Categorical Analysis* Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.00330	0.99	1.00	0.67 - 1.49
Lung	0.15310	0.64	1.17	0.61 - 2.23
Breast	0.40355	0.30	1.50	0.70 - 3.19
Colorectal	-0.26042	0.47	0.77	0.38 - 1.56
Pancreas	0.49341	0.49	1.64	0.41 - 6.57
Leukemia	-0.17063	0.79	0.84	0.25 - 2.87

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.11:23 Results of Adjusted Categorical Analysis* Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.03772	0.79	0.96	0.73 - 1.27
Lung	0.07415	0.75	1.08	0.69 - 1.69
Breast	0.32575	0.19	1.39	0.85 - 2.26
Colorectal	-0.31548	0.20	0.73	0.45 - 1.19
Bladder	-0.09083	0.84	0.91	0.38 - 2.20
Kidney	0.11173	0.83	1.12	0.40 - 3.11
Pancreas	-0.13336	0.82	0.88	0.28 - 2.69
Leukemia	-0.45641	0.47	0.63	0.19 - 2.16
Brain	-0.51348	0.41	0.60	0.18 - 2.04

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 3,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.11.24 Results of Adjusted Exposure Metric* Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00834	0.99	1.00	0.64 - 1.58
Lung	0.72628	0.37	1.39	0.68 - 2.86
Breast	1.04382	0.23	1.61	0.74 - 3.48
Colorectal	-1.61974	0.16	0.48	0.17 - 1.33
Pancreas	0.74555	0.63	1.40	0.35 - 5.58
Leukemia	-2.11454	0.47	0.38	0.03 - 5.11

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.11.25 Results of Adjusted Exposure Metric* Analysis Examining Propellant Bag Burning at MMR Gun and Mortar Positions as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.04948	0.87	0.98	0.79 - 1.22
Lung	0.30672	0.51	1.12	0.80 - 1.58
Breast	0.80865	0.10	1.36	0.94 - 1.96
Colorectal	-1.50466	0.04	0.57	0.33 - 0.97
Baldder	-1.13784	0.34	0.65	0.27 - 1.59
Kidney	0.05361	0.97	1.02	0.39 - 2.65
Pancreas	0.17435	0.86	1.07	0.53 - 2.17
Leukemia	-2.58387	0.40	0.38	0.04 - 3.59
Brain	-0.52398	0.68	0.82	0.32 - 2.08

*Exposure Metric: $\sum\left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.12.1 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	3	2.06	0.51-8.38
No. Years Exposed				
0.5-10.0	5	2	3.09	0.65-14.70
10.5-20.0	0	1	----	----
>20	0	0	----	----
Distance to Exposure(m)				
1-1,000	1	2	----	----
1,001-2,000	4	1	4.94	0.68-35.70
Direction**				
Northeast	1	2	----	----
Southeast	4	1	4.94	0.68-35.70

*Odds ratios were computed by comparing the number of exposed cases and controls to 1037 unexposed cases and 1282 unexposed controls.

**Direction of study subject to exposure site

Table III.12.2 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	3	----	----
No. Years Exposed				
0.5-10.0	2	2	----	----
10.5-20.0	0	1	----	----
>20	0	0	----	----
Distance to Exposure(m)				
1-1,000	1	2	----	----
1,001-2,000	1	1	----	----
Direction**				
Northeast	0	2	----	----
Southeast	2	1	----	----

**Direction of study subject to exposure site

Table III.12.3 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	3	----	----
No. Years Exposed				
0.5-10.0	2	2	----	----
10.5-20.0	0	1	----	----
>20	0	0	----	----
Distance to Exposure(m)				
1-1,000	0	2	----	----
1,001-2,000	2	1	----	----
Direction**				
Northeast	1	2	----	----
Southeast	1	1	----	----

**Direction of study subject to exposure site

Table III.12.4 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	1	----	----
10.5-20.0	0	1	----	----
>20	0	0	----	----
Distance to Exposure(m)				
1-1,000	0	1	----	----
1,001-2,000	1	1	----	----
Direction**				
Northeast	0	1	----	----
Southeast	1	1	----	----

**Direction of study subject to exposure site

Table III.12.5 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	3	2.06	0.51-8.38
No. Years Exposed				
0.5-10.0	3	2	----	----
10.1-20.0	2	0	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	1	2	----	----
1,001-2,000	4	1	----	----
Direction**				
Northeast	1	2	----	----
Southeast	4	1	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1037 unexposed cases and 1282 unexposed controls.

**Direction of study subject to exposure site

Table III.12.6 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	3	----	----
No. Years Exposed				
0.5-10.0	1	1	----	----
10.1-20.0	1	1	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	1	2	----	----
1,001-2,000	1	1	----	----
Direction**				
Northeast	0	2	----	----
Southeast	2	1	----	----

**Direction of study subject to exposure site

Table III.12.7 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	3	----	----
No. Years Exposed				
0.5-10.0	1	2	----	----
10.1-20.0	1	0	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	2	----	----
1,001-2,000	2	1	----	----
Direction**				
Northeast	1	2	----	----
Southeast	1	1	----	----

**Direction of study subject to exposure site

Table III.12.8 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	0	----	----
10.1-20.0	0	1	----	----
>20.0	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	1	1	----	----
Direction**				
Northeast	0	1	----	----
Southeast	1	1	----	----

**Direction of study subject to exposure site

Table III.12.9 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	56	63	1.10	0.76-1.59
No. Years Exposed				
0.5-10.0	30	30	1.24	0.74-2.07
10.5-20.0	24	30	0.99	0.58-1.71
>20	2	3	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	2	9	----	----
4,001-5,000	0	1	----	----
5,001-6,000	7	4	2.17	0.65-7.21
6,001-7,000	9	6	1.86	0.67-5.16
7,001-8,000	12	19	0.78	0.38-1.62
8,001-9,000	26	21	1.53	0.86-2.73
Direction**				
East	0	0	----	----
Northeast	8	12	0.83	0.34-2.03
Southeast	10	11	1.13	0.48-2.66
South	0	0	----	----
Southwest	13	11	1.46	0.66-3.27
Northwest	25	29	1.07	0.62-1.84

*Odds ratios were computed by comparing the number of exposed cases and controls to 986 unexposed cases and 1222 unexposed controls.

**Direction of study suject to exposure site

Table III.12.10 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	14	66	1.04	0.57-1.88
No. Years Exposed				
0.5-10.0	5	28	0.88	0.34-2.29
10.5-20.0	9	35	1.26	0.60-2.65
>20	0	3	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	1	9	----	----
4,001-5,000	0	2	----	----
5,001-6,000	2	6	----	----
6,001-7,000	1	5	----	----
7,001-8,000	3	19	0.77	0.23-2.63
8,001-9,000	7	22	1.56	0.66-3.67
Direction**				
East	0	0	----	----
Northeast	2	15	----	----
Southeast	1	10	----	----
South	0	0	----	----
Southwest	4	11	1.78	0.57-5.56
Northwest	7	30	1.14	0.50-2.64

*Odds ratios were computed by comparing the number of exposed cases and controls to 237 unexposed cases and 1162 unexposed controls.

**Direction of study subject to exposure site

Table III.12.11 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	18	33	1.48	0.82-2.66
No. Years Exposed				
0.5-10.0	13	17	2.07	1.00-4.26
10.5-20.0	4	14	0.77	0.25-2.36
>20	1	2	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	2	----	----
4,001-5,000	0	1	----	----
5,001-6,000	2	2	----	----
6,001-7,000	4	3	3.61	0.88-14.8
7,001-8,000	3	12	0.68	0.19-2.40
8,001-9,000	9	12	2.03	0.86-4.79
Direction**				
East	0	0	----	----
Northeast	2	6	----	----
Southeast	5	10	1.35	0.46-3.98
South	0	0	----	----
Southwest	4	2	5.41	0.76-60.02
Northwest	7	15	1.26	0.51-3.13

*Odds ratios were computed by comparing the number of exposed cases and controls to 247 unexposed cases and 668 unexposed controls.

**Direction of study subject to exposure site

Table III.12.12 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	61	0.54	0.27-1.09
No. Years Exposed				
0.5-10.0	6	29	0.76	0.31-1.83
10.5-20.0	3	29	0.38	0.12-1.20
>20	0	3	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	1	9	----	----
4,001-5,000	0	1	----	----
5,001-6,000	2	4	----	----
6,001-7,000	1	6	----	----
7,001-8,000	2	17	----	----
8,001-9,000	3	21	0.52	0.16-1.73
Direction**				
East	0	0	----	----
Northeast	0	12	----	----
Southeast	3	11	1.00	0.28-3.60
South	0	0	----	----
Southwest	2	11	----	----
Northwest	4	27	0.54	0.19-1.54

*Odds ratios were computed by comparing the number of exposed cases and controls to 306 unexposed cases and 1118 unexposed controls.

**Direction of study subject to exposure site

Table III.12.13 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	48	1.18	0.41-3.37
No. Years Exposed				
0.5-10.0	1	22	----	----
10.5-20.0	3	26	1.63	0.48-5.48
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	8	----	----
4,001-5,000	0	2	----	----
5,001-6,000	0	5	----	----
6,001-7,000	1	4	----	----
7,001-8,000	2	15	----	----
8,001-9,000	1	13	----	----
Direction**				
East	0	0	----	----
Northeast	1	11	----	----
Southeast	0	7	----	----
South	0	0	----	----
Southwest	0	8	----	----
Northwest	3	22	1.93	0.57-6.49

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 819 unexposed controls.

**Direction of study subject to exposure site

Table III.12.14 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	43	----	----
No. Years Exposed				
0.5-10.0	1	20	----	----
10.5-20.0	0	23	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	8	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	2	----	----
6,001-7,000	0	5	----	----
7,001-8,000	0	12	----	----
8,001-9,000	1	14	----	----
Direction**				
East	0	0	----	----
Northeast	1	10	----	----
Southeast	0	6	----	----
South	0	0	----	----
Southwest	0	9	----	----
Northwest	0	18	----	----

**Direction of study subject to exposure site

Table III.12.15 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	33	1.60	0.47-5.44
No. Years Exposed				
0.5-10.0	2	16	----	----
10.5-20.0	1	16	----	----
>20	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	4	----	----
6,001-7,000	0	4	----	----
7,001-8,000	1	9	----	----
8,001-9,000	2	10	----	----
Direction**				
East	0	0	----	----
Northeast	1	9	----	----
Southeast	1	4	----	----
South	0	0	----	----
Southwest	0	2	----	----
Northwest	1	18	----	----

*Odds ratios were computed by comparing the number of exposed cases and [illegible] to 34 unexposed cases and 600 unexposed controls.

**Direction of study subject to exposure site

Table III.12.16 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	93	1.14	0.43-3.01
No. Years Exposed				
0.5-10.0	2	71	----	----
10.5-20.0	3	21	3.03	0.91-10.10
>20	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	11	----	----
4,001-5,000	0	0	----	----
5,001-6,000	0	14	----	----
6,001-7,000	2	13	----	----
7,001-8,000	1	23	----	----
8,001-9,000	2	30	----	----
Direction**				
East	0	2	----	----
Northeast	1	26	----	----
Southeast	0	17	----	----
South	0	0	----	----
Southwest	2	11	----	----
Northwest	2	37	----	----

*Odds ratios were computed by comparing the number of exposed cases and [illegible] to 31 unexposed cases and 658 unexposed controls.

**Direction of study subject to exposure site

Table III.12.17 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	42	----	----
No. Years Exposed				
0.5-10.0	0	18	----	----
10.5-20.0	1	21	----	----
>20	1	3	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	5	----	----
4,001-5,000	0	1	----	----
5,001-6,000	1	5	----	----
6,001-7,000	0	1	----	----
7,001-8,000	0	12	----	----
8,001-9,000	1	15	----	----
Direction**				
East	0	0	----	----
Northeast	0	11	----	----
Southeast	0	5	----	----
South	0	0	----	----
Southwest	1	7	----	----
Northwest	1	19	----	----

**Direction of study subject to exposure site

Table III.12.18 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	56	63	1.10	0.76-1.59
No. Years Exposed				
0.5-10.0	54	63	1.06	0.73-1.54
10.5-20.0	2	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	2	9	----	----
4,001-5,000	0	1	----	----
5,001-6,000	7	4	2.17	0.65-7.21
6,001-7,000	9	6	1.86	0.67-5.16
7,001-8,000	12	19	0.78	0.38-1.62
8,001-9,000	26	21	1.53	0.86-2.73
Direction**				
East	0	0	----	----
Northeast	8	12	0.83	0.34-2.03
Southeast	10	11	1.13	0.48-2.67
South	0	0	----	----
Southwest	13	11	1.47	0.66-3.27
Northwest	25	29	1.07	0.62-1.94

*Odds ratios were computed by comparing the number of exposed cases and controls to 986 unexposed cases and 1222 unexposed controls.

**Direction of study subject to exposure site

Table III.12.19 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	14	66	1.04	0.57-1.88
No. Years Exposed				
0.5-10.0	14	66	1.04	0.57-1.88
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	1	9	----	----
4,001-5,000	0	2	----	----
5,001-6,000	2	6	----	----
6,001-7,000	1	5	----	----
7,001-8,000	3	19	0.77	0.23-2.63
8,001-9,000	7	22	1.56	0.66-3.67
Direction**				
East	0	0	----	----
Northeast	2	15	----	----
Southeast	1	10	----	----
South	0	0	----	----
Southwest	4	11	1.78	0.57-5.56
Northwest	7	30	1.14	0.50-2.64

*Odds ratios were computed by comparing the number of exposed cases and controls to 237 unexposed cases and 1162 unexposed controls.

**Direction of study subject to exposure site

Table III.12.20 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	18	33	1.48	0.82-2.66
No. Years Exposed				
0.5-10.0	18	33	1.48	0.82-2.66
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	2	----	----
4,001-5,000	0	1	----	----
5,001-6,000	2	2	----	----
6,001-7,000	4	3	3.61	0.88-14.80
7,001-8,000	3	12	0.68	0.19-2.40
8,001-9,000	9	12	2.03	0.86-4.79
Direction**				
East	0	0	----	----
Northeast	2	6	----	----
Southeast	5	10	1.35	0.46-3.98
South	0	0	----	----
Southwest	4	2	5.41	0.76-60.02
Northwest	7	15	1.26	0.51-3.13

*Odds ratios were computed by comparing the number of exposed cases and controls to 247 unexposed cases and 668 unexposed controls.

**Direction of study subject to exposure site

Table III.12.21 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	61	0.54	0.27-1.09
No. Years Exposed				
0.5-10.0	9	61	0.54	0.27-1.09
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	1	9	----	----
4,001-5,000	0	1	----	----
5,001-6,000	2	4	----	----
6,001-7,000	1	6	----	----
7,001-8,000	2	17	----	----
8,001-9,000	3	21	0.52	0.16-1.73
Direction**				
East	0	0	----	----
Northeast	0	12	----	----
Southeast	3	11	1.00	0.28-3.60
South	0	0	----	----
Southwest	2	11	----	----
Northwest	4	27	0.54	0.19-1.54

*Odds ratios were computed by comparing the number of exposed cases and controls to 306 unexposed cases and 1118 unexposed controls.

**Direction of study subject to exposure site

Table III.12.22 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	48	1.18	0.41-3.38
No. Years Exposed				
0.5-10.0	4	48	1.18	0.41-3.38
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	8	----	----
4,001-5,000	0	2	----	----
5,001-6,000	0	5	----	----
6,001-7,000	1	4	----	----
7,001-8,000	2	15	----	----
8,001-9,000	1	13	----	----
Direction**				
East	0	0	----	----
Northeast	1	11	----	----
Southeast	0	7	----	----
South	0	0	----	----
Southwest	0	8	----	----
Northwest	3	22	1.93	0.57-6.49

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 819 unexposed controls.

**Direction of study subject to exposure site

Table III.12.23 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	43	----	----
No. Years Exposed				
0.5-10.0	1	43	----	----
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	8	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	2	----	----
6,001-7,000	0	5	----	----
7,001-8,000	0	12	----	----
8,001-9,000	1	14	----	----
Direction**				
East	0	0	----	----
Northeast	1	10	----	----
Southeast	0	6	----	----
South	0	0	----	----
Southwest	0	9	----	----
Northwest	0	18	----	----

**Direction of study subject to exposure site

Table III.12.24 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	33	1.60	0.47-5.44
No. Years Exposed				
0.5-10.0	3	33	1.60	0.47-5.44
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	4	----	----
6,001-7,000	0	4	----	----
7,001-8,000	1	9	----	----
8,001-9,000	2	10	----	----
Direction**				
East	0	0	----	----
Northeast	1	9	----	----
Southeast	1	4	----	----
South	0	0	----	----
Southwest	0	2	----	----
Northwest	1	18	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 600 unexposed controls.

**Direction of study subject to exposure site

Table III.12.25 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

<u>Cancer Site</u>: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	5	94	1.13	0.43-2.97
<u>No. Years Exposed</u>				
0.5-10.0	3	73	0.87	0.26-2.92
10.5-20.0	2	21	----	----
>20	0	0	----	----
<u>Distance to Exposure (m)</u>				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	11	----	----
4,001-5,000	0	0	----	----
5,001-6,000	0	16	----	----
6,001-7,000	2	13	----	----
7,001-8,000	1	23	----	----
8,001-9,000	2	29	----	----
<u>Direction**</u>				
East	0	0	----	----
Northeast	1	26	----	----
Southeast	0	16	----	----
South	0	2	----	----
Southwest	2	11	----	----
Northwest	2	39	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 657 unexposed controls.

**Direction of study subject to exposure site

Table III.12.26 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	42	----	----
No. Years Exposed				
0.5-10.0	2	42	----	----
10.5-20.0	0	0	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	5	----	----
4,001-5,000	0	1	----	----
5,001-6,000	1	5	----	----
6,001-7,000	0	1	----	----
7,001-8,000	0	12	----	----
8,001-9,000	1	15	----	----
Direction**				
East	0	0	----	----
Northeast	0	11	----	----
Southeast	0	5	----	----
South	0	0	----	----
Southwest	1	7	----	----
Northwest	1	19	----	----

**Direction of study subject to exposure site

Table III.12.27 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

<u>Cancer Site</u>: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	165	209	0.97	0.78-1.21
<u>No. Years Exposed</u>				
0.5-10.0	117	157	0.91	0.71-1.18
10.5-20.0	43	49	1.08	0.71-1.64
>20	5	3	2.04	0.49-8.58
<u>Distance to Exposure (m)</u>				
1-1,000	1	2	----	----
1,001-2,000	4	1	4.91	0.68-35.50
2,001-3,000	2	3	----	----
3,001-4,000	7	14	0.61	0.25-1.51
4,001-5,000	2	4	----	----
5,001-6,000	29	26	1.37	0.80-2.34
6,001-7,000	36	41	1.08	0.68-1.70
7,001-8,000	41	53	0.95	0.62-1.44
8,001-9,000	43	65	0.81	0.55-1.20
<u>Direction**</u>				
East	0	2	----	----
Northeast	46	57	0.99	0.66-1.48
Southeast	39	47	1.02	0.66-1.57
South	0	0	----	----
Southwest	18	23	0.96	0.52-1.79
Northwest	62	80	0.95	0.67-1.34

*Odds ratios were computed by comparing the number of exposed cases and [illegible] to 377 unexposed cases and 1076 unexposed controls.

**Direction of study subject to exposure site

Table III.12.28 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	40	205	0.95	0.65-1.37
No. Years Exposed				
0.5-10.0	27	150	0.87	0.56-1.35
10.5-20.0	12	51	1.14	0.60-2.18
>20	1	4	---	----
Distance to Exposure (m)				
1-1,000	1	2	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	3	----	----
3,001-4,000	4	14	1.38	0.45-4.23
4,001-5,000	0	3	----	----
5,001-6,000	8	26	1.49	0.67-3.32
6,001-7,000	4	42	0.46	0.17-1.27
7,001-8,000	9	51	0.86	0.42-1.76
8,001-9,000	13	63	1.00	0.54-1.85
Direction**				
East	0	2	----	----
Northeast	11	55	0.97	0.50-1.88
Southeast	9	49	0.89	0.43-1.84
South	0	0	----	----
Southwest	5	23	1.05	0.40-2.80
Northwest	15	76	0.96	0.54-1.70

*Odds ratios were computed by comparing the number of exposed cases and [illegible] to 211 unexposed cases and 1023 unexposed controls.

**Direction of study subject to exposure site

Table III.12.29 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	38	112	0.88	0.59-1.31
No. Years Exposed				
0.5-10.0	22	80	0.71	0.43-1.17
10.5-20.0	15	30	1.30	0.69-2.45
>20	1	2	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	6	----	----
4,001-5,000	1	4	----	----
5,001-6,000	8	9	2.31	0.90-5.90
6,001-7,000	8	22	0.94	0.41-2.15
7,001-8,000	10	32	0.81	0.39-1.68
8,001-9,000	11	37	0.77	0.39-1.54
Direction**				
East	0	2	----	----
Northeast	11	32	0.89	0.44-1.80
Southeast	7	29	0.63	0.27-1.44
South	0	0	----	----
Southwest	6	10	1.56	0.56-4.30
Northwest	14	39	0.93	0.50-1.75

*Odds ratios were computed by comparing the number of exposed cases and controls to 227 unexposed cases and 589 unexposed controls.

**Direction of study subject to exposure site

Table III.12.30 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

<u>Cancer Site</u>: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	48	199	0.88	0.63-1.25
<u>No. Years Exposed</u>				
0.5-10.0	41	150	1.00	0.69-1.45
10.5-20.0	6	46	0.48	0.21-1.11
>20	1	3	----	----
<u>Distance to Exposure (m)</u>				
1-1,000	0	2	----	----
1,001-2,000	2	1	----	----
2,001-3,000	0	3	----	----
3,001-4,000	2	13	----	----
4,001-5,000	0	4	----	----
5,001-6,000	8	26	1.13	0.51-2.52
6,001-7,000	18	40	1.65	0.94-2.91
7,001-8,000	10	49	0.75	0.38-1.50
8,001-9,000	8	61	0.48	0.23-1.00
<u>Direction**</u>				
East	0	2	----	----
Northeast	10	55	0.67	0.34-1.32
Southeast	12	46	0.96	0.50-1.83
South	0	0	----	----
Southwest	2	21	----	----
Northwest	24	75	1.18	0.73-1.90

*Odds ratios were computed by comparing the number of exposed cases and controls to 267 unexposed cases and 980 unexposed controls.

**Direction of study subject to exposure site

Table III.12.31 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	155	1.10	0.57-2.12
No. Years Exposed				
0.5-10.0	10	120	1.19	0.59-2.40
10.5-20.0	2	34	----	----
>20	0	1	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	1	----	----
2,001-3,000	1	2	----	----
3,001-4,000	0	10	----	----
4,001-5,000	0	4	----	----
5,001-6,000	2	24	----	----
6,001-7,000	3	35	1.22	0.36-4.10
7,001-8,000	3	40	1.07	0.32-3.58
8,001-9,000	3	38	1.12	0.33-3.77
Direction**				
East	0	1	----	----
Northeast	5	44	1.62	0.62-4.23
Southeast	2	36	----	----
South	0	0	----	----
Southwest	1	17	----	----
Northwest	4	57	1.00	0.35-2.87

*Odds ratios were computed by comparing the number of exposed cases and controls to 50 unexposed cases and 712 unexposed controls.

**Direction of study subject to exposure site

Table III.12.32 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	137	0.62	0.22-1.76
No. Years Exposed				
0.5-10.0	3	104	0.61	0.18-2.01
10.5-20.0	1	33	----	----
>20	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	11	----	----
4,001-5,000	0	2	----	----
5,001-6,000	1	19	----	----
6,001-7,000	0	28	----	----
7,001-8,000	1	32	----	----
8,001-9,000	2	41	----	----
Direction**				
East	0	1	----	----
Northeast	3	45	1.41	0.42-4.76
Southeast	0	26	----	----
South	0	0	----	----
Southwest	0	18	----	----
Northwest	1	47	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 655 unexposed controls.

**Direction of study subject to exposure site

Table III.12.33 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	8	96	1.54	0.69-3.46
No. Years Exposed				
0.5-10.0	5	68	1.36	0.51-3.62
10.5-20.0	2	27	----	----
>20	1	1	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	4	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	17	----	----
6,001-7,000	1	22	----	----
7,001-8,000	3	19	2.92	0.86-9.89
8,001-9,000	3	30	1.85	0.54-6.32
Direction**				
East	0	1	----	----
Northeast	2	29	----	----
Southeast	4	22	3.37	0.78-10.84
South	0	0	----	----
Southwest	0	7	----	----
Northwest	2	37	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 537 unexposed controls.

**Direction of study subject to exposure site

Table III.12.34 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	119	1.06	0.43-2.61
No. Years Exposed				
0.5-10.0	2	90	----	----
10.5-20.0	4	27	3.12	0.74-9.79
>20	0	2	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	12	----	----
4,001-5,000	1	0	----	----
5,001-6,000	0	17	----	----
6,001-7,000	2	21	----	----
7,001-8,000	2	27	----	----
8,001-9,000	1	40	----	-----
Direction**				
East	0	2	----	----
Northeast	1	34	----	----
Southeast	1	24	----	----
South	0	0	----	----
Southwest	3	15	4.21	0.73-16.04
Northwest	1	44	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 632 unexposed controls.

**Direction of study subject to exposure site

Table III.12.35 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	121	1.58	0.73-3.41
No. Years Exposed				
0.5-10.0	7	83	1.79	0.76-4.18
10.5-20.0	1	34	----	----
>20	1	4	----	----
Distance to Exposure (m)				
1-1,000	0	2	----	----
1,001-2,000	0	1	----	----
2,001-3,000	1	3	----	----
3,001-4,000	1	7	----	----
4,001-5,000	0	2	----	----
5,001-6,000	2	19	----	----
6,001-7,000	0	25	----	----
7,001-8,000	3	25	2.55	0.76-8.53
8,001-9,000	2	37	----	----
Direction**				
East	0	1	----	----
Northeast	3	36	1.77	0.52-6.00
Southeast	4	24	3.54	0.83-11.30
South	0	0	----	----
Southwest	1	14	----	----
Northwest	1	46	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 28 unexposed cases and 594 unexposed controls.

**Direction of study subject to exposure site

Table III.12.36 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	166	211	0.96	0.77-1.20
No. Years Exposed				
0.5-10.0	106	138	0.94	0.72-1.23
10.5-20.0	32	49	0.80	0.51-1.26
>20	28	24	1.43	0.82-2.48
Distance to Exposure (m)				
1-1,000	1	2	----	----
1,001-2,000	4	1	4.90	0.68-35.50
2,001-3,000	2	3	0.82	0.14-4.89
3,001-4,000	7	14	0.61	0.25-1.51
4,001-5,000	2	4	----	----
5,001-6,000	31	28	1.36	0.81-2.28
6,001-7,000	36	41	1.08	0.64-1.70
7,001-8,000	41	54	0.93	0.61-1.41
8,001-9,000	42	64	0.80	0.54-1.20
Direction**				
East	0	2	----	----
Northeast	46	57	0.99	0.66-1.47
Southeast	38	46	1.01	0.65-1.57
South	0	0	----	----
Southwest	18	24	0.92	0.50-1.70
Northwest	64	82	0.96	0.68-1.34

*Odds ratios were computed by comparing the number of exposed cases and controls to 876 unexposed cases and 1074 unexposed controls.

**Direction of study subject to exposure site

Table III.12.37 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	41	207	0.96	0.67-1.39
No. Years Exposed				
0.5-10.0	26	129	0.98	0.63-1.53
10.5-20.0	9	55	0.80	0.39-1.63
>20	6	23	1.27	0.51-3.15
Distance to Exposure (m)				
1-1,000	1	2	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	3	----	----
3,001-4,000	4	14	1.39	0.46-4.24
4,001-5,000	0	3	----	----
5,001-6,000	9	28	1.56	0.73-3.34
6,001-7,000	4	42	0.46	0.17-1.27
7,001-8,000	9	52	0.84	0.41-1.73
8,001-9,000	13	62	1.02	0.55-1.89
Direction**				
East	0	2	----	----
Northeast	11	55	0.97	0.50-1.89
Southeast	9	48	0.91	0.44-1.89
South	0	0	----	----
Southwest	5	24	1.01	0.38-2.69
Northwest	16	78	1.00	0.57-1.74

*Odds ratios were computed by comparing the number of exposed cases and controls to 210 unexposed cases and 1021 unexposed controls.

**Direction of study subject to exposure site

Table III.12.38 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

<u>Cancer Site</u>: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	38	113	0.87	0.58-1.30
<u>No. Years Exposed</u>				
0.5-10.0	21	73	0.74	0.45-1.24
10.5-20.0	6	24	0.65	0.26-1.60
>20	11	16	1.78	0.82-3.86
<u>Distance to Exposure (m)</u>				
1-1,000	0	0	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	6	----	----
4,001-5,000	1	4	----	----
5,001-6,000	9	10	2.33	0.96-5.67
6,001-7,000	8	22	0.94	0.41-2.15
7,001-8,000	10	33	0.78	0.38-1.62
8,001-9,000	10	36	0.72	0.35-1.47
<u>Direction**</u>				
East	0	2	----	----
Northeast	11	32	0.89	0.44-1.80
Southeast	6	28	0.56	0.23-1.34
South	0	0	----	----
Southwest	6	11	1.41	0.52-3.85
Northwest	15	40	0.97	0.53-1.79

*Odds ratios were computed by comparing the number of exposed cases and controls to 227 unexposed cases and 588 unexposed controls.

**Direction of study subject to exposure site

Table III.12.39 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	48	201	0.88	0.62-1.23
No. Years Exposed				
0.5-10.0	32	129	0.91	0.60-1.37
10.5-20.0	13	49	0.97	0.52-1.82
>20	3	23	0.48	0.15-1.56
Distance to Exposure (m)				
1-1,000	0	2	----	----
1,001-2,000	2	1	----	----
2,001-3,000	0	3	----	----
3,001-4,000	2	13	----	----
4,001-5,000	0	4	----	----
5,001-6,000	8	28	1.05	0.47-2.32
6,001-7,000	18	40	1.65	0.94-2.91
7,001-8,000	10	50	0.73	0.37-1.46
8,001-9,000	8	60	0.49	0.23-1.02
Direction**				
East	0	2	----	----
Northeast	10	55	0.67	0.34-1.32
Southeast	12	45	0.98	0.51-1.87
South	0	0	----	----
Southwest	2	22	----	----
Northwest	24	77	1.14	0.71-1.84

*Odds ratios were computed by comparing the number of exposed cases and controls to 267 unexposed cases and 978 unexposed controls.

**Direction of study subject to exposure site

Table III.12.40 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	157	1.08	0.56-2.09
No. Years Exposed				
0.5-10.0	9	99	1.29	0.62-2.70
10.5-20.0	1	42	----	----
>20	2	16	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	1	----	----
2,001-3,000	1	2	----	----
3,001-4,000	0	10	----	----
4,001-5,000	0	4	----	----
5,001-6,000	2	25	----	----
6,001-7,000	3	35	1.22	0.36-4.09
7,001-8,000	3	41	1.04	0.31-3.48
8,001-9,000	3	38	1.12	0.33-3.76
Direction**				
East	0	1	----	----
Northeast	5	44	1.61	0.62-4.22
Southeast	2	36	----	----
South	0	0	----	----
Southwest	1	18	----	----
Northwest	4	58	0.98	0.34-2.81

*Odds ratios were computed by comparing the number of exposed cases and controls to 50 unexposed cases and 710 unexposed controls.

**Direction of study subject to exposure site

Table III.12.41 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	138	0.61	0.21-1.74
No. Years Exposed				
0.5-10.0	3	88	0.72	0.22-2.39
10.5-20.0	0	33	----	----
>20	1	17	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	11	----	----
4,001-5,000	0	2	----	----
5,001-6,000	1	20	----	----
6,001-7,000	0	28	----	----
7,001-8,000	1	32	----	----
8,001-9,000	2	41	----	----
Direction**				
East	0	1	----	----
Northeast	3	45	1.41	0.42-4.76
Southeast	0	26	----	----
South	0	0	----	----
Southwest	0	18	----	----
Northwest	1	48	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 654 unexposed controls.

**Direction of study subject to exposure site

Table III.12.42 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	8	97	1.52	0.68-3.42
No. Years Exposed				
0.5-10.0	4	62	1.19	0.41-3.50
10.5-20.0	1	22	----	----
>20	3	13	4.26	0.73-16.71
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	4	----	----
4,001-5,000	0	1	----	----
5,001-6,000	0	19	----	----
6,001-7,000	1	22	----	----
7,001-8,000	3	19	2.92	0.86-9.87
8,001-9,000	3	29	1.91	0.56-6.52
Direction**				
East	0	1	----	----
Northeast	2	29	----	----
Southeast	4	21	3.52	0.82-11.40
South	0	0	----	----
Southwest	0	7	----	----
Northwest	2	39	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 536 unexposed controls.

**Direction of study subject to exposure site

Table III.12.43 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	120	1.05	0.43-2.58
No. Years Exposed				
0.5-10.0	4	76	1.11	0.38-3.23
10.5-20.0	0	33	----	----
>20	2	11	----	----
Distance to Exposure (m)				
1-1,000	0	1	----	----
1,001-2,000	0	0	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	12	----	----
4,001-5,000	1	0	----	----
5,001-6,000	0	19	----	----
6,001-7,000	2	21	----	----
7,001-8,000	2	27	----	----
8,001-9,000	1	39	----	----
Direction**				
East	0	2	----	----
Northeast	1	34	----	----
Southeast	1	23	----	----
South	0	0	----	----
Southwest	3	15	4.21	0.73-16.01
Northwest	1	46	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 631 unexposed controls.

**Direction of study subject to exposure site

Table III.12.44 Results of Crude Categorical Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	122	1.56	0.72-3.38
No. Years Exposed				
0.5-10.0	7	75	1.98	0.85-4.61
10.5-20.0	2	30	----	----
>20	0	17	----	----
Distance to Exposure (m)				
1-1,000	0	2	----	----
1,001-2,000	0	1	----	----
2,001-3,000	1	3	----	----
3,001-4,000	1	7	----	----
4,001-5,000	0	2	----	----
5,001-6,000	2	21	----	----
6,001-7,000	0	25	----	----
7,001-8,000	3	25	2.54	0.75-8.56
8,001-9,000	2	36	----	----
Direction**				
East	0	1	----	----
Northeast	3	36	1.76	0.52-5.99
Southeast	4	23	3.68	0.86-11.82
South	0	0	----	----
Southwest	1	14	----	----
Northwest	1	48	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 28 unexposed cases and 593 unexposed controls.

**Direction of study subject to exposure site

Table III.12.45 Results of Crude Exposure Metric* Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-5.04619	0.27	0.85	0.64 - 1.13
Lung	-4.80075	0.50	0.86	0.55 - 1.34
Breast	-0.36756	0.96	0.99	0.65 - 1.51
Colorectal	-27.31782	0.07	0.42	0.16 - 1.07
Bladder	-8.49316	0.64	0.76	0.25 - 2.32
Pancreas	-1.86716	0.84	0.94	0.53 - 1.66
Leukemia	-0.99592	0.86	0.97	0.68 - 1.39

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.12.46 Results of Crude Exposure Metric* Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.47559	0.58	0.98	0.92 - 1.05
Lung	-0.14550	0.89	0.99	0.92 - 1.08
Breast	-3.25513	0.46	0.88	0.63 - 1.23
Colorectal	-2.31744	0.44	0.91	0.73 - 1.15
Bladder	-0.13745	0.97	0.99	0.72 - 1.37
Kidney	-5.00126	0.64	0.82	0.37 - 1.85
Pancreas	0.49288	0.66	1.02	0.94 - 1.11
Leukemia	-0.37077	0.90	0.98	0.79 - 1.23
Brain	0.08828	0.96	1.00	0.89 - 1.14

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.12.47 Results of Adjusted Categorical Analysis* Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Sites**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	0.05511	0.78	1.06	0.72 - 1.56
Lung	0.05120	0.88	1.05	0.54 - 2.05
Breast	0.30868	0.36	1.36	0.70 - 2.65
Colorectal	-0.73917	0.07	0.48	0.22 - 1.06
Bladder	0.09774	0.87	1.10	0.35 - 3.48
Pancreas	0.19529	0.77	1.22	0.33 - 4.47
Leukemia	0.25104	0.62	1.29	0.48 - 3.46

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 9,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.12.48 Results of Adjusted Categorical Analysis* Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.04183	0.73	0.96	0.76 - 1.21
Lung	-0.08809	0.68	0.92	0.60 - 1.39
Breast	-0.23176	0.30	0.79	0.51 - 1.23
Colorectal	-0.16590	0.40	0.85	0.58 - 1.24
Bladder	0.11085	0.76	1.12	0.55 - 2.26
Kidney	-0.64184	0.25	0.53	0.17 - 1.59
Pancreas	0.47930	0.30	1.61	0.65 - 3.99
Leukemia	0.12020	0.80	1.13	0.45 - 2.82
Brain	0.52034	0.20	1.68	0.75 - 3.75

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 9,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.12.49 Results of Adjusted Exposure Metric* Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-6.06304	0.24	0.83	0.60 - 1.14
Lung	-4.89841	0.49	0.86	0.55 - 1.33
Breast	-2.37910	0.76	0.93	0.57 - 1.50
Colorectal****	----	----	----	----
Bladder	-2.31646	0.92	0.93	0.23 - 3.75
Pancreas	-2.66245	0.81	0.92	0.46 - 1.85
Leukemia	-1.32800	0.76	0.96	0.73 - 1.26

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

**** Because of a small sample problem, the adjusted beta coefficient could not be estimated.

Table III.12.50 Results of Adjusted Exposure Metric* Analysis Examining MMR UTES/BOMARC Site (CS10) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.69828	0.49	0.97	0.90 - 1.05
Lung	-0.68870	0.54	0.97	0.89 - 1.06
Breast	-4.97359	0.32	0.83	0.57 - 1.21
Colorectal	-4.22275	0.28	0.85	0.63 - 1.14
Bladder	-0.62939	0.86	0.98	0.74 - 1.29
Kidney	-3.78253	0.72	0.86	0.39 - 1.93
Pancreas	-0.73602	0.83	0.97	0.75 - 1.26
Leukemia	-0.77896	0.76	0.97	0.80 - 1.18
Brain	-0.39736	0.79	0.98	0.88 - 1.10

*Exposure Metric: $\sum\left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.13.1 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5 - 10.0	1	2	----	----
10.5 - 20.0	0	0	----	----
Distance to Exposure				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

** Direction of subject to exposure site.

Table III.13.2 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5 - 10.0	1	2	----	----
10.5 - 20.0	0	0	----	----
Distance to Exposure				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

** Direction of subject to exposure site.

Table III.13.3 Results of Crude Categorical Analysis Examining MMR AVGAS Dump site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	2	----	----
10.1-20.0	0	0	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site

Table III.13.4 Results of Crude Categorical Analysis Examining MMR AVGAS Dump site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	2	----	----
10.1-20.0	0	0	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site

Table III.13.5 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5 - 10.0	1	2	----	----
10.5 - 20.0	0	0	----	----
Distance to Exposure				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

** Direction of subject to exposure site.

Table III.13.6 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5 - 10.0	1	2	----	----
10.5 - 20.0	0	0	----	----
Distance to Exposure				
1 - 1,000	0	0	----	----
1,001 - 2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

** Direction of subject to exposure site.

Table III.13.7 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	3	2.06	0.51-8.38
No. Years Exposed				
0.5-10.0	5	2	3.09	----
10.1-20.0	0	1	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	5	3	2.06	0.51-8.38
Direction**				
Northeast	4	1	----	----
Northwest	1	2	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1037 unexposed cases and 1282 unexposed controls.

**Direction of study subject to exposure site

Table III.13.8 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 2 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	1	----	----
10.1-20.0	0	1	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	1	----	----

**Direction of study subject to exposure site

Table III.13.9 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	3	----	----
No. Years Exposed				
0.5-10.0	2	2	----	----
10.1-20.0	0	1	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	2	3	----	----
Direction**				
Northeast	1	1	----	----
Northwest	1	2	----	----

**Direction of study subject to exposure site

Table III.13.10 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	1	----	----
No. Years Exposed				
0.5-10.0	1	1	----	----
10.1-20.0	0	0	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	1	----	----
Direction**				
Northeast	1	1	----	----
Northwest	0	0	----	----

**Direction of study subject to exposure site

Table III.13.11 Results of Crude Categorical Analysis Examining MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 2 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	2	----	----
No. Years Exposed				
0.5-10.0	1	0	----	----
10.1-20.0	0	2	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
Direction**				
Northeast	1	0	----	----
Northwest	0	2	----	----

**Direction of study subject to exposure site

Table III.13.12 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Comnbined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	59	88	0.82	0.58-1.15
No. Years Exposed				
0.5-10.0	27	49	0.67	0.42-1.08
10.5-20.0	32	39	1.00	0.62-1.61
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	4	5	0.97	0.26-3.64
4,001-5,000	1	5	----	----
5,001-6,000	14	16	1.06	0.52-2.19
6,001-7,000	2	6	----	----
7,001-8,000	19	29	0.80	0.44-1.43
8,001-9,000	18	22	1.00	0.53-1.87
Direction**				
East	0	0	----	----
Northeast	8	17	0.57	0.25-1.32
Southeast	20	29	0.84	0.47-1.49
South	0	0	----	----
Southwest	21	22	1.16	0.64-2.12
Northwest	10	20	0.61	0.29-1.30

*Odds ratios were computed by comparing the number of exposed cases and controls to 983 unexposed cases and 1197 unexposed controls.

**Direction of study subject to exposure site

Table III.13.13 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	86	0.67	0.36-1.23
No. Years Exposed				
0.5-10.0	6	49	0.58	0.25-1.37
10.5-20.0	6	37	0.78	0.32-1.85
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	0	4	----	----
4,001-5,000	0	5	----	----
5,001-6,000	4	16	1.20	0.40-3.60
6,001-7,000	1	6	----	----
7,001-8,000	3	29	0.49	0.15-1.60
8,001-9,000	4	21	0.91	0.31-2.68
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	5	28	0.85	0.33-2.23
South	0	0	----	----
Southwest	3	22	0.65	0.20-2.18
Northwest	3	19	0.75	0.22-2.56

*Odds ratios were computed by comparing the number of exposed cases and controls to 239 unexposed cases and 1142 unexposed controls.

**Direction of study subject to exposure site

Table III.13.14 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	45	1.00	0.56-1.78
No. Years Exposed				
0.5-10.0	6	24	0.66	0.27-1.63
10.5-20.0	11	21	1.39	0.66-2.91
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	1	----	----
3,001-4,000	2	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	3	8	0.99	0.26-3.77
6,001-7,000	0	6	----	----
7,001-8,000	7	15	1.23	0.50-3.06
8,001-9,000	4	8	1.32	0.40-4.42
Direction**				
East	0	0	----	----
Northeast	4	9	1.77	0.36-3.85
Southeast	5	13	1.02	0.36-2.88
South	0	0	----	----
Southwest	7	14	1.32	0.53-3.31
Northwest	1	9	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 248 unexposed cases and 656 unexposed controls.

**Direction of study subject to exposure site

Table III.13.15 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	87	0.72	0.42-1.22
No. Years Exposed				
0.5-10.0	7	49	0.52	0.24-1.15
10.5-20.0	10	38	0.96	0.47-1.96
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	2	5	----	----
4,001-5,000	0	5	----	----
5,001-6,000	6	16	1.37	0.54-3.53
6,001-7,000	0	6	----	----
7,001-8,000	1	28	----	----
8,001-9,000	8	22	1.33	0.59-3.02
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	6	28	0.78	0.32-1.91
South	0	0	----	----
Southwest	6	22	1.00	0.40-2.49
Northwest	4	20	0.73	0.25-2.15

*Odds ratios were computed by comparing the number of exposed cases and controls to 298 unexposed cases and 1092 unexposed controls.

**Direction of study subject to exposure site

Table III.13.16 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	55	1.02	0.36-2.91
No. Years Exposed				
0.5-10.0	3	33	1.27	0.38-4.26
10.5-20.0	1	22	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	4	----	----
5,001-6,000	0	12	----	----
6,001-7,000	1	3	----	----
7,001-8,000	2	15	----	----
8,001-9,000	1	15	----	----
Direction**				
East	0	0	----	----
Northeast	1	14	----	----
Southeast	1	15	----	----
South	0	0	----	----
Southwest	1	11	----	----
Northwest	1	15	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 812 unexposed controls.

**Direction of study subject to exposure site

Table III.13.17 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	53	----	----
No. Years Exposed				
0.5-10.0	1	29	----	----
10.5-20.0	0	24	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	0	----	----
3,001-4,000	0	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	0	12	----	----
6,001-7,000	0	5	----	----
7,001-8,000	1	17	----	----
8,001-9,000	0	12	----	----
Direction**				
East	0	0	----	----
Northeast	0	14	----	----
Southeast	0	15	----	----
South	0	0	----	----
Southwest	1	12	----	----
Northwest	0	12	----	----

**Direction of study subject to exposure site

Table III.13.18 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	34	----	----
No. Years Exposed				
0.5-10.0	0	18	----	----
10.5-20.0	1	16	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	1	----	----
5,001-6,000	1	4	----	----
6,001-7,000	0	3	----	----
7,001-8,000	0	11	----	----
8,001-9,000	0	10	----	----
Direction**				
East	0	0	----	----
Northeast	0	10	----	----
Southeast	1	10	----	----
South	0	0	----	----
Southwest	0	7	----	----
Northwest	0	7	----	----

**Direction of study subject to exposure site

Table III.13.19 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	53	2.12	0.81-5.57
No. Years Exposed				
0.5-10.0	2	27	----	----
10.5-20.0	3	26	2.60	0.78-8.67
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	1	4	----	----
5,001-6,000	0	10	----	----
6,001-7,000	0	3	----	----
7,001-8,000	3	18	3.75	0.67-13.85
8,001-9,000	1	13	----	----
Direction**				
East	0	0	----	----
Northeast	1	12	----	----
Southeast	2	19	----	----
South	0	0	----	----
Southwest	2	11	----	----
Northwest	0	11	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 698 unexposed controls.

**Direction of study subject to exposure site

Table III.13.20 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	54	----	----
No. Years Exposed				
0.5-10.0	2	29	----	----
10.5-20.0	0	25	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	2	----	----
5,001-6,000	0	10	----	----
6,001-7,000	0	5	----	----
7,001-8,000	2	18	----	----
8,001-9,000	0	13	----	----
Direction**				
East	0	0	----	----
Northeast	0	11	----	----
Southeast	0	17	----	----
South	0	0	----	----
Southwest	1	14	----	----
Northwest	1	12	----	----

**Direction of study subject to exposure site

Table III.13.21 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	63	88	0.88	0.63-1.22
No. Years Exposed				
0.5-10.0	28	49	0.70	0.44-1.12
10.5-20.0	33	39	1.04	0.65-1.66
>20.0	2	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	4	5	0.98	0.26-3.65
4,001-5,000	1	5	----	----
5,001-6,000	14	16	1.07	0.52-2.20
6,001-7,000	3	6	0.61	0.16-2.42
7,001-8,000	21	29	0.88	0.50-1.56
8,001-9,000	19	22	1.06	0.57-1.96
Direction**				
East	0	0	----	----
Northeast	9	17	0.65	0.29-1.45
Southeast	21	29	0.88	0.50-1.56
South	0	0	----	----
Southwest	22	22	1.22	0.67-2.22
Northwest	11	20	0.67	0.32-1.40

*Odds ratios were computed by comparing the number of exposed cases and controls to 979 unexposed cases and 1197 unexposed controls.

**Direction of study subject to exposure site

Table III.13.22 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	14	91	0.74	0.41-1.32
No. Years Exposed				
0.5-10.0	7	53	0.63	0.29-1.40
10.5-20.0	7	38	0.88	0.39-2.00
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	0	4	----	----
4,001-5,000	0	5	----	----
5,001-6,000	4	16	1.20	0.40-3.62
6,001-7,000	2	7	----	----
7,001-8,000	4	30	0.64	0.22-1.82
8,001-9,000	4	24	0.80	0.28-2.32
Direction**				
East	0	0	----	----
Northeast	0	0	----	----
Southeast	5	28	0.86	0.33-2.24
South	0	0	----	----
Southwest	4	22	0.87	0.30-2.55
Northwest	3	21	0.68	0.20-2.30

*Odds ratios were computed by comparing the number of exposed cases and controls to 237 unexposed cases and 1137 unexposed controls.

**Direction of study subject to exposure site

Table III.13.23 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	45	1.00	0.56-1.78
No. Years Exposed				
0.5-10.0	6	24	0.66	0.27-1.63
10.5-20.0	11	21	1.39	0.66-2.91
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	1	----	----
3,001-4,000	2	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	3	8	0.99	0.26-3.77
6,001-7,000	0	6	----	----
7,001-8,000	7	15	1.23	0.50-3.06
8,001-9,000	4	8	1.32	0.40-4.42
Direction**				
East	0	0	----	----
Northeast	4	9	1.18	0.36-3.85
Southeast	5	13	1.02	0.36-2.88
South	0	0	----	----
Southwest	7	14	1.32	0.53-3.31
Northwest	1	9	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 248 unexposed cases and 656 unexposed controls.

**Direction of study subject to exposure site

Table III.13.24 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	19	87	0.81	0.48-1.34
No. Years Exposed				
0.5-10.0	9	49	0.68	0.33-1.39
10.5-20.0	10	38	0.97	0.48-1.97
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	2	5	----	----
4,001-5,000	0	5	----	----
5,001-6,000	6	16	1.38	0.54-3.55
6,001-7,000	0	6	----	----
7,001-8,000	2	28	----	----
8,001-9,000	9	22	1.51	0.69-3.30
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	7	28	0.92	0.40-2.13
South	0	0	----	----
Southwest	6	22	1.01	0.40-2.50
Northwest	5	20	0.92	0.34-2.48

*Odds ratios were computed by comparing the number of exposed cases and controls to 296 unexposed cases and 1092 unexposed controls.

**Direction of study subject to exposure site

Table III.13.25 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	60	0.93	0.33-2.64
No. Years Exposed				
0.5-10.0	3	37	1.13	0.34-3.77
10.5-20.0	1	23	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	4	----	----
5,001-6,000	0	12	----	----
6,001-7,000	1	4	----	----
7,001-8,000	2	16	----	----
8,001-9,000	1	18	----	----
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	1	15	----	----
South	0	0	----	----
Southwest	1	11	----	----
Northwest	1	17	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 807 unexposed controls.

**Direction of study subject to exposure site

Table III.13.26 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	53	----	----
No. Years Exposed				
0.5-10.0	0	29	----	----
10.5-20.0	1	24	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	0	----	----
3,001-4,000	0	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	0	12	----	----
6,001-7,000	0	5	----	----
7,001-8,000	1	17	----	----
8,001-9,000	0	12	----	----
Direction**				
East	0	0	----	----
Northeast	0	14	----	----
Southeast	0	15	----	----
South	0	0	----	----
Southwest	1	12	----	----
Northwest	0	12	----	----

**Direction of study subject to exposure site

Table III.13.27 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	38	----	----
No. Years Exposed				
0.5-10.0	0	22	----	----
10.5-20.0	1	16	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	1	----	----
5,001-6,000	1	4	----	----
6,001-7,000	0	4	----	----
7,001-8,000	0	12	----	----
8,001-9,000	0	12	----	----
Direction**				
East	0	0	----	----
Northeast	0	13	----	----
Southeast	1	10	----	----
South	0	0	----	----
Southwest	0	7	----	----
Northwest	0	8	----	----

**Direction of study subject to exposure site

Table III.13.28 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	108	0.96	0.36-2.52
No. Years Exposed				
0.5-10.0	1	70	----	----
10.5-20.0	2	16	----	----
>20.0	2	22	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	6	----	----
3,001-4,000	0	4	----	----
4,001-5,000	1	10	----	----
5,001-6,000	0	17	----	----
6,001-7,000	0	14	----	----
7,001-8,000	3	29	2.15	0.64-7.23
8,001-9,000	1	27	----	----
Direction**				
East	0	0	----	----
Northeast	1	30	----	----
Southeast	2	36	----	----
South	0	0	----	----
Southwest	2	27	----	----
Northwest	0	15	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 643 unexposed controls.

**Direction of study subject to exposure site

Table III.13.29 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	57	----	----
No. Years Exposed				
0.5-10.0	2	31	----	----
10.5-20.0	0	26	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	2	----	----
5,001-6,000	0	10	----	----
6,001-7,000	0	6	----	----
7,001-8,000	2	18	----	----
8,001-9,000	0	15	----	----
Direction**				
East	0	0	----	----
Northeast	0	13	----	----
Southeast	0	17	----	----
South	0	0	----	----
Southwest	1	14	----	----
Northwest	1	13	----	----

**Direction of study subject to exposure site

Table III.13.30 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	60	88	0.83	0.59-1.17
No. Years Exposed				
0.5-10.0	27	49	0.67	0.42-1.08
10.5-20.0	33	39	1.03	0.64-1.65
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	4	5	0.98	0.26-3.64
4,001-5,000	1	5	----	----
5,001-6,000	15	16	1.14	0.56-2.32
6,001-7,000	2	6	----	----
7,001-8,000	19	29	0.80	0.45-1.43
8,001-9,000	18	22	1.00	0.53-1.87
Direction**				
East	0	0	----	----
Northeast	8	17	0.57	0.25-1.32
Southeast	20	29	0.84	0.47-1.49
South	0	0	----	----
Southwest	21	22	1.16	0.64-2.13
Northwest	11	20	0.67	0.32-1.40

*Odds ratios were computed by comparing the number of exposed cases and controls to 982 unexposed cases and 1197 unexposed controls.

**Direction of study subject to exposure site

Table III.13.31 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	13	86	0.72	0.40-1.32
No. Years Exposed				
0.5-10.0	7	49	0.68	0.31-1.52
10.5-20.0	6	37	0.78	0.32-1.86
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	0	4	----	----
4,001-5,000	0	5	----	----
5,001-6,000	5	16	1.50	0.55-4.11
6,001-7,000	1	6	----	----
7,001-8,000	3	29	0.50	0.15-1.60
8,001-9,000	4	21	0.91	0.31-2.69
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	5	28	0.86	0.33-2.24
South	0	0	----	----
Southwest	3	22	0.65	0.20-2.19
Northwest	4	19	1.01	0.34-2.98

*Odds ratios were computed by comparing the number of exposed cases and controls to 238 unexposed cases and 1142 unexposed controls.

**Direction of study subject to exposure site

Table III.13.32 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	45	1.00	0.56-1.78
No. Years Exposed				
0.5-10.0	5	24	0.55	0.21-1.44
10.5-20.0	12	21	1.51	0.74-3.10
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	1	----	----
3,001-4,000	2	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	3	8	0.99	0.26-3.77
6,001-7,000	0	6	----	----
7,001-8,000	7	15	1.23	0.50-3.06
8,001-9,000	4	8	1.32	0.40-4.42
Direction**				
East	0	0	----	----
Northeast	4	9	1.18	0.36-3.85
Southeast	5	13	1.08	0.36-2.88
South	0	0	----	----
Southwest	7	14	1.32	0.53-3.31
Northwest	1	9	1.18	0.36-3.85

*Odds ratios were computed by comparing the number of exposed cases and controls to 248 unexposed cases and 656 unexposed controls.

**Direction of study subject to exposure site

Table III.13.33 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Usual Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	17	87	0.72	0.42-1.22
No. Years Exposed				
0.5-10.0	7	49	0.52	0.24-1.15
10.5-20.0	10	38	0.96	0.47-1.96
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	3	----	----
3,001-4,000	2	5	----	----
4,001-5,000	0	5	----	----
5,001-6,000	6	16	1.37	0.54-3.53
6,001-7,000	0	6	----	----
7,001-8,000	1	28	----	----
8,001-9,000	8	22	1.33	0.59-3.02
Direction**				
East	0	0	----	----
Northeast	1	17	----	----
Southeast	6	28	0.78	0.32-1.91
South	0	0	----	----
Southwest	6	22	1.00	0.40-2.49
Northwest	4	22	0.73	0.25-2.15

*Odds ratios were computed by comparing the number of exposed cases and controls to 298 unexposed cases and 1092 unexposed controls.

**Direction of study subject to expsure site

Table III.13.34 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	55	1.02	0.36-2.91
No. Years Exposed				
0.5-10.0	3	33	1.27	0.38-4.26
10.5-20.0	1	22	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	4	----	----
5,001-6,000	0	12	----	----
6,001-7,000	1	3	----	----
7,001-8,000	2	15	----	----
8,001-9,000	1	15	----	----
Direction**				
East	0	0	----	----
Northeast	1	14	----	----
Southeast	1	15	----	----
South	0	0	----	----
Southwest	1	11	----	----
Northwest	1	15	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 812 unexposed controls.

**Direction of study subject to exposure site

Table III.13.35 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	53	----	----
No. Years Exposed				
0.5-10.0	1	29	----	----
10.5-20.0	0	24	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	0	0	----	----
3,001-4,000	0	2	----	----
4,001-5,000	0	3	----	----
5,001-6,000	0	12	----	----
6,001-7,000	0	5	----	----
7,001-8,000	1	17	----	----
8,001-9,000	0	12	----	----
Direction**				
East	0	0	----	----
Northeast	0	14	----	----
Southeast	0	15	----	----
South	0	0	----	----
Southwest	1	12	----	----
Northwest	0	12	----	----

**Direction of study subject to exposure site

Table III.13.36 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	34	----	----
No. Years Exposed				
0.5-10.0	0	18	----	----
10.5-20.0	1	16	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	1	----	----
5,001-6,000	1	4	----	----
6,001-7,000	0	3	----	----
7,001-8,000	0	11	----	----
8,001-9,000	0	10	----	----
Direction**				
East	0	0	----	----
Northeast	0	10	----	----
Southeast	1	10	----	----
South	0	0	----	----
Southwest	0	7	----	----
Northwest	0	0	----	----

**Direction of study subject to exposure site

Table III.13.37 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	53	2.12	0.81-5.57
No. Years Exposed				
0.5-10.0	2	27	----	----
10.5-20.0	3	26	2.60	0.78-8.67
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	1	----	----
3,001-4,000	0	3	----	----
4,001-5,000	1	4	----	----
5,001-6,000	0	10	----	----
6,001-7,000	0	3	----	----
7,001-8,000	3	18	3.75	0.67-13.85
8,001-9,000	1	13	----	----
Direction**				
East	0	0	----	----
Northeast	1	12	----	----
Southeast	2	19	----	----
South	0	0	----	----
Southwest	2	11	----	----
Northwest	0	11	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 698 unexposed controls.

**Direction of study subject to exposure site

Table III.13.38 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Usual Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	54	----	----
No. Years Exposed				
0.5-10.0	2	29	----	----
10.5-20.0	0	25	----	----
>20.0	0	0	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	1	----	----
2,001-3,000	0	2	----	----
3,001-4,000	0	3	----	----
4,001-5,000	0	2	----	----
5,001-6,000	0	10	----	----
6,001-7,000	0	5	----	----
7,001-8,000	2	18	----	----
8,001-9,000	0	13	----	----
Direction**				
East	0	0	----	----
Northeast	0	11	----	----
Southeast	0	17	----	----
South	0	0	----	----
Southwest	1	14	----	----
Northwest	1	12	----	----

**Direction of study subject to exposure site

Table III.13.39 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	178	235	0.92	0.74-1.14
No. Years Exposed				
0.5-10.0	115	154	0.91	0.70-1.17
10.5-20.0	27	39	0.84	0.51-1.38
>20.0	36	42	1.04	0.66-1.64
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	5	3	2.02	0.50-8.26
2,001-3,000	9	11	0.99	0.41-2.41
3,001-4,000	11	12	1.11	0.49-2.54
4,001-5,000	8	25	0.39	0.15-0.90
5,001-6,000	25	31	0.98	0.57-1.67
6,001-7,000	36	45	0.97	0.62-1.52
7,001-8,000	45	56	0.98	0.65-1.46
8,001-9,000	39	52	0.91	0.60-1.39
Direction**				
East	0	0	----	----
Northeast	51	59	1.05	0.71-1.54
Southeast	65	81	0.98	0.70-1.37
South	0	1	----	----
Southwest	37	61	0.74	0.49-1.12
Northwest	25	33	0.92	0.54-1.56

*Odds ratios were computed by comparing the number of exposed cases and controls to 864 unexposed cases and 1050 unexposed controls.

**Direction of study subject to exposure site

Table III.13.40 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	49	239	1.00	0.71-1.41
No. Years Exposed				
0.5-10.0	35	151	1.13	0.76-1.69
10.5-20.0	6	47	0.62	0.27-1.47
>20.0	8	41	0.96	0.44-2.07
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	3	----	----
2,001-3,000	4	11	1.78	0.57-5.56
3,001-4,000	2	10	----	----
4,001-5,000	3	28	0.52	0.16-1.71
5,001-6,000	7	33	1.04	0.45-2.38
6,001-7,000	10	44	1.11	0.55-2.25
7,001-8,000	12	59	1.00	0.53-1.89
8,001-9,000	11	51	1.06	0.54-2.06
Direction**				
East	0	0	----	----
Northeast	9	61	0.72	0.35-1.47
Southeast	23	80	1.41	0.87-2.29
South	0	1	----	----
Southwest	7	65	0.53	0.24-1.15
Northwest	10	32	1.53	0.74-3.15

*Odds ratios were computed by comparing the number of exposed cases and controls to 202 unexposed cases and 989 unexposed controls.

**Direction of study subject to exposure site

Table III.13.41 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	44	128	0.89	0.61-1.30
No. Years Exposed				
0.5-10.0	28	86	0.84	0.54-1.33
10.5-20.0	3	23	0.34	0.11-1.08
>20.0	13	19	1.77	0.87-3.62
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	0	5	----	----
3,001-4,000	3	5	1.56	0.37-6.50
4,001-5,000	0	18	----	----
5,001-6,000	5	14	0.93	0.33-2.60
6,001-7,000	13	29	1.16	0.59-2.28
7,001-8,000	11	32	0.89	0.44-1.80
8,001-9,000	11	23	1.24	0.59-2.58
Direction**				
East	0	0	----	----
Northeast	13	36	0.94	0.49-1.80
Southeast	15	39	1.00	0.54-1.85
South	0	1	----	----
Southwest	13	37	0.91	0.48-1.75
Northwest	3	15	0.52	0.15-1.77

*Odds ratios were computed by comparing the number of exposed cases and controls to 221 unexposed cases and 573 unexposed controls.

**Direction of study subject to exposure site

Table III.13.42 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	49	225	0.78	0.56-1.09
No. Years Exposed				
0.5-10.0	27	146	0.66	0.43-1.02
10.5-20.0	14	38	1.32	0.71-2.47
>20.0	8	41	0.70	0.32-1.51
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	2	3	----	----
2,001-3,000	2	11	----	----
3,001-4,000	2	12	----	----
4,001-5,000	1	24	----	----
5,001-6,000	10	30	1.20	0.58-2.48
6,001-7,000	8	42	0.68	0.32-1.47
7,001-8,000	12	54	0.80	0.42-1.51
8,001-9,000	12	49	0.88	0.46-1.67
Direction**				
East	0	0	----	----
Northeast	17	57	1.07	0.61-1.87
Southeast	17	78	0.78	0.45-1.34
South	0	1	----	----
Southwest	8	57	0.50	0.24-1.05
Northwest	7	32	0.78	0.34-1.79

*Odds ratios were computed by comparing the number of exposed cases and controls to 266 unexposed cases and 954 unexposed controls.

**Direction of study subject to exposure site

Table III.13.43 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	176	0.94	0.49-1.81
No. Years Exposed				
0.5-10.0	9	119	1.04	0.50-2.18
10.5-20.0	1	35	0.40	----
>20.0	2	22	1.26	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	1	8	----	----
3,001-4,000	1	8	----	----
4,001-5,000	0	19	----	----
5,001-6,000	1	26	----	----
6,001-7,000	4	32	1.73	0.60-5.02
7,001-8,000	3	41	1.01	0.30-3.38
8,001-9,000	2	40	----	----
Direction**				
East	0	0	----	----
Northeast	5	51	1.36	0.52-3.54
Southeast	3	56	0.74	0.22-2.44
South	0	1	----	----
Southwest	3	40	1.04	0.31-3.47
Northwest	1	28	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 50 unexposed cases and 691 unexposed controls.

**Direction of study subject to exposure site

Table III.13.44 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure $\leq$ 9 Kilometers
Extended Exposure Window

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	150	0.40	0.13-1.28
No. Years Exposed				
0.5-10.0	2	101	----	----
10.5-20.0	0	26	----	----
>20.0	1	23	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	3	----	----
2,001-3,000	0	5	----	----
3,001-4,000	0	8	----	----
4,001-5,000	1	11	----	----
5,001-6,000	0	24	----	----
6,001-7,000	0	35	----	----
7,001-8,000	1	34	----	----
8,001-9,000	1	30	----	----
Direction**				
East	0	0	----	----
Northeast	0	42	----	----
Southeast	0	52	----	----
South	0	0	----	----
Southwest	1	35	----	----
Northwest	2	21	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 642 unexposed controls.

**Direction of study subject to exposure site

Table III.13.45 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	104	0.62	0.22-1.76
No. Years Exposed				
0.5-10.0	3	67	0.72	0.22-2.39
10.5-20.0	0	19	----	----
>20.0	1	18	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	0	2	----	----
2,001-3,000	1	5	----	----
3,001-4,000	2	7	----	----
4,001-5,000	1	7	----	----
5,001-6,000	0	13	----	----
6,001-7,000	0	23	----	----
7,001-8,000	0	26	----	----
8,001-9,000	0	21	----	----
Direction**				
East	0	0	----	----
Northeast	0	33	----	----
Southeast	3	35	1.37	0.40-4.68
South	0	0	----	----
Southwest	0	23	----	----
Northwest	1	13	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 529 unexposed controls.

**Direction of study subject to exposure site

Table III.13.46 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	135	1.10	0.47-2.57
No. Years Exposed				
0.5-10.0	3	82	0.78	0.23-2.60
10.5-20.0	1	24	----	----
>20.0	3	29	2.20	0.65-7.42
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	1	----	----
2,001-3,000	0	7	----	----
3,001-4,000	0	4	----	----
4,001-5,000	1	16	----	----
5,001-6,000	0	20	----	----
6,001-7,000	0	25	----	----
7,001-8,000	3	34	1.87	0.55-6.34
8,001-9,000	2	28	----	-----
Direction**				
East	0	0	----	----
Northeast	2	37	----	----
Southeast	2	50	----	----
South	0	0	----	----
Southwest	3	33	1.93	0.57-6.53
Northwest	0	15	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 616 unexposed controls.

Table III.13.47 Results of Crude Categorical Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Exposure ≤ 9 Kilometers
Extended Exposure Window

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio *	95% Confidence Interval
Ever Exposed	10	137	1.56	0.74-3.29
No. Years Exposed				
0.5-10.0	8	77	2.22	0.99-4.98
10.5-20.0	2	30	----	----
>20.0	0	30	----	----
Distance to Exposure (m)				
1-1,000	0	0	----	----
1,001-2,000	1	2	----	----
2,001-3,000	1	7	----	----
3,001-4,000	1	7	----	----
4,001-5,000	1	14	----	----
5,001-6,000	2	19	----	----
6,001-7,000	1	28	----	----
7,001-8,000	3	33	1.95	0.57-6.61
8,001-9,000	0	27	----	----
Direction**				
East	0	0	----	----
Northeast	5	35	3.06	0.86-8.74
Southeast	2	46	----	----
South	0	0	----	----
Southwest	2	34	----	----
North	1	22	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 578 unexposed controls.

**Direction of study subject to exposure site

Table III.13.48 Results of Crude Exposure Metric* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.51877	0.86	0.98	0.74 - 1.28
Lung	-7.43984	0.31	0.70	0.36 - 1.39
8reast	5.44315	0.20	1.29	0.87 - 1.93
Colorectal	-2.44748	0.62	0.89	0.56 - 1.41
Bladder	-15.30669	0.44	0.48	0.08 - 3.09
Leukemia	10.19266	0.19	1.62	0.78 - 3.36

$$*\textit{Exposure Metric}: \sum \left(\frac{1}{distance^{1.5}}\right)(\textit{wind freq.})(\textit{no. yrs.})$$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.13.49 Results of Crude Exposure Metric* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.28050	0.92	0.99	0.75 - 1.30
Lung	-7.40360	0.31	0.70	0.36 - 1.38
Breast	5.58258	0.19	1.30	0.88 - 1.94
Colorectal	-1.96459	0.68	0.91	0.58 - 1.42
Bladder	-14.76474	0.45	0.50	0.08 - 3.06
Leukemia	10.19266	0.19	1.62	0.78 - 3.36

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.\ yrs.)$

**Sites with less than 3 exposed cases were not analyzed

***Odds ratios compared exposure subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.13.50 Results of Adjusted Categorical* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.14694	0.42	0.86	0.60 - 1.24
Lung	-0.40841	0.23	0.66	0.34 - 1.29
Breast	0.02456	0.94	1.02	0.54 - 1.96
Colorectal	-0.42168	0.17	0.66	0.36 - 1.20
Bladder	0.18236	0.75	1.20	0.38 - 3.76
Leukemia	0.80594	0.12	2.24	0.81 - 6.16

* Exposure categorized as Ever/Never.
Ever exposed subjects lived within 9,000 meters of the site.

** Sites with less than three exposed cases were not analyzed.

Table III.13.51 Results of Adjusted Categorical* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	-0.12866	0.48	0.88	0.62 - 1.26
Lung	-0.30800	0.35	0.73	0.38 - 1.40
Breast	0.02456	0.94	1.02	0.54 - 1.96
Colorectal	-0.42168	0.17	0.66	0.36 - 1.20
Bladder	0.18236	0.75	1.20	0.38 - 3.76
Leukemia	0.80594	0.12	2.24	0.81 - 6.16

* Exposure categorized as Ever/Never.
  Ever exposed subjects lived within 9,000 meters of the site.

** Sites with less than three exposed cased were not analyzed.

Table III.13.52 Results of Adjusted Exposure Metric* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.93053	0.78	0.96	0.70 - 1.30
Lung	-8.69802	0.25	0.66	0.33 - 1.34
Breast	6.69010	0.16	1.37	0.88 - 2.15
Colorectal	-7.66674	0.25	0.69	0.37 - 1.29
Bladder	-9.72350	0.67	0.63	0.08 - 5.22
Leukemia	9.63078	0.23	1.58	0.75 - 3.34

*Exposure Metric: $\sum \left(\frac{1}{distance^{1.5}}\right)$ (wind freq.) (no.yrs)

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.13.53 Results of Adjusted Exposure Metric* Analysis Examining the MMR AVGAS Dump Site (FS1) as a Source of Air Contaminants Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	-0.70205	0.83	0.97	0.71 - 1.31
Lung	-8.65130	0.24	0.66	0.33 - 1.32
Breast	6.78811	0.16	1.38	0.88 - 2.16
Colorectal	-7.25659	0.27	0.71	0.39 - 1.30
Bladder	-9.13249	0.68	0.65	0.08 - 5.19
Leukemia	9.63078	0.23	1.58	0.75 - 3.34

$$*Exposure\ Metric: \sum\left(\frac{1}{distance^{1.5}}\right)(wind\ freq.)(no.yrs)$$

** Sites with less than three exposed cases were not analyzed.

*** Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.14.1 Number and Type of Cancer Cases and Controls Who Lived Within 2,000 Meters of the MMR Storm Drains With and Without Taking Latency Into Account

	With Latency		Without Latency		
	No. Cases	No. Controls	No. Cases	No. Controls	Type of Cancer
Storm Drain One (Runway Aircraft Maintenance)	0	1	1	5	Lung
Storm Drain Two (Runway Aircraft Maintenance/ Petrol Fuel Storage Area)	0	1	1	5	Lung
Storm Drain Four (Runway Aircraft Maintenance/ Hangar 128)	0	0	1	4	Lung
Storm Drain Five (Aquafarm Drainage Swale)	0	0	0	0	None

Table III.14.2 Number and Type of Cancer Cases and Controls who Lived Within 2,000 Meters of MMR Railroad Fuel Pumping Site (FS2) and Johns Pond Road Fuel Pumping Station (FS3) With Usual and Extended Exposure Windows and With and Without Taking Latency into Account

	With Latency		Without Latency		Type of Cancer
	Usual Window	Extended Window	Usual Window	Extended Window	
Railroad Fuel Pumping Site (FS2)	1 case 0 controls	2 cases 1 control	1 case 0 controls	3 cases 2 controls	Colorectal Lung Kidney
Johns Pond Road Fuel Pumping Station (FS3)	1 case 1 control	1 case 2 controls	1 case 1 control	3 cases 7 controls	Breast (2) Lung

Table III.15.1 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	83	119	0.85	0.63 - 1.14
No. Years Exposed				
0.5 - 10.0	36	62	0.71	0.46 - 1.07
10.5 - 20.0	15	26	0.70	0.37 - 1.33
>20	32	31	1.26	0.76 - 2.07
Distance to Exposure (m)				
1 - 1,000	24	33	0.88	0.52 - 1.51
1,001 - 2,000	30	29	1.26	0.75 - 2.11
2,001 - 3,000	29	57	0.62	0.40 - 0.97
Direction**				
East	5	10	0.61	0.21 - 1.77
South	13	16	0.99	0.47 - 2.06
North	31	47	0.80	0.51 - 1.27
West	34	46	0.90	0.57 - 1.41
Base Section				
North	60	86	0.85	0.60 - 1.19
South	23	33	0.85	0.49 - 1.45

*Odds ratios were computed by comparing the number of exposed cases and controls to 959 unexposed cases and 1166 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.2 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	27	122	1.09	0.70 - 1.70
No. Years Exposed				
0.5 - 10.0	14	69	1.00	0.55 - 1.81
10.5 - 20.0	2	24	---	---
>20	11	29	1.87	0.93 - 3.76
Distance to Exposure (m)				
1 - 1,000	8	33	1.20	0.55 - 2.62
1,001 - 2,000	6	31	0.96	0.39 - 2.32
2,001 - 3,000	13	58	1.11	0.60 - 2.05
Direction**				
East	2	11	---	---
South	2	16	---	---
North	9	50	0.89	0.43 - 1.83
West	14	45	1.54	0.83 - 2.83
Base Section				
North	23	91	1.25	0.77 - 2.01
South	4	31	0.64	0.22 - 1.81

*Odds ratios were computed by comparing the number of exposed cases and controls to 224 unexposed cases and 1106 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.3 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	26	61	1.14	0.70 - 1.85
No. Years Exposed				
0.5 - 10.0	11	30	0.98	0.48 - 1.99
10.5 - 20.0	6	16	1.00	0.39 - 2.60
>20	9	15	1.61	0.70 - 3.70
Distance to Exposure (m)				
1 - 1,000	8	14	1.53	0.64 - 3.67
1,001 - 2,000	11	18	1.64	0.77 - 3.49
2,001 - 3,000	7	29	0.65	0.28 - 1.49
Direction**				
East	1	5	---	---
South	5	13	1.03	0.36 - 2.92
North	14	20	1.87	0.94 - 3.73
West	6	23	0.70	0.28 - 1.73
Base Section				
North	18	39	1.24	0.69 - 2.20
South	8	22	0.97	0.43 - 2.22

*Odds ratios were computed by comparing the number of exposed cases and controls to 239 unexposed cases and 640 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.4 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	16	112	0.51	0.27 - 0.89
No. Years Exposed				
0.5 - 10.0	5	57	0.31	0.09 - 0.79
10.5 - 20.0	4	25	0.57	0.20 - 1.63
>20	7	30	0.83	0.36 - 1.91
Distance to Exposure (m)				
1 - 1,000	4	32	0.45	0.16 - 1.24
1,001 - 2,000	7	28	0.89	0.39 - 2.06
2,001 - 3,000	5	52	0.34	0.10 - 0.87
Direction**				
East	1	10	---	---
South	4	16	0.89	0.30 - 2.69
North	5	43	0.42	0.17 - 1.03
West	6	43	0.50	0.21 - 1.16
Base Section				
North	10	79	0.45	0.20 - 0.89
South	6	33	0.65	0.27 - 1.55

*Odds ratios were computed by comparing the number of exposed cases and controls to 299 unexposed cases and 1067 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.5 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	5	83	0.83	0.32 - 2.12
No. Years Exposed				
0.5 - 10.0	3	47	0.89	0.26 - 2.91
10.5 - 20.0	1	14	---	---
>20	1	22	---	---
Distance to Exposure (m)				
1 - 1,000	0	25	---	---
1,001 - 2,000	3	23	1.79	0.53 - 6.06
2,001 - 3,000	2	35	---	---
Direction**				
East	0	8	---	---
South	0	9	---	---
North	1	35	---	---
West	4	31	1.78	0.61 - 5.13
Base Section				
North	4	61	0.90	0.32 - 2.57
South	1	22	---	---

*Odds ratios were computed by comparing the number of exposed cases and controls to 57 unexposed cases and 784 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.6 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	69	---	---
No. Years Exposed				
0.5 - 10.0	0	41	---	---
10.5 - 20.0	0	10	---	---
>20	1	18	---	---
Distance to Exposure (m)				
1 - 1,000	1	18	---	---
1,001 - 2,000	0	20	---	---
2,001 - 3,000	0	31	---	---
Direction**				
East	0	5	---	---
South	0	8	---	---
North	1	31	---	---
West	0	25	---	---
Base Section				
North	1	55	---	---
South	0	14	---	---

** Direction of study subject to exposure site.

Table III.15.7 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	60	---	---
No. Years Exposed				
0.5 - 10.0	1	32	---	---
10.5 - 20.0	0	9	---	---
>20	1	19	---	---
Distance to Exposure (m)				
1 - 1,000	0	19	---	---
1,001 - 2,000	2	14	---	---
2,001 - 3,000	0	27	---	---
Direction**				
East	0	7	---	---
South	0	8	---	---
North	1	22	---	---
West	1	23	---	---
Base Section				
North	2	46	---	---
South	0	14	---	---

** Direction of study subject to exposure site.

Table III.15.8 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	136	0.41	0.13 - 1.31
No. Years Exposed				
0.5 - 10.0	1	87	---	---
10.5 - 20.0	1	20	---	---
>20	1	29	---	---
Distance to Exposure (m)				
1 - 1,000	0	44	---	---
1,001 - 2,000	1	38	---	---
2,001 - 3,000	2	54	---	---
Direction**				
East	0	17	---	---
South	1	19	---	---
North	0	49	---	---
West	2	51	---	---
Base Section				
North	1	103	---	---
South	2	33	---	---

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 615 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.9 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	73	0.78	0.23 - 2.58
No. Years Exposed				
0.5 - 10.0	1	38	---	---
10.5 - 20.0	1	16	---	---
>20	1	19	---	---
Distance to Exposure (m)				
1 - 1,000	3	24	2.36	0.70 - 7.94
1,001 - 2,000	0	13	---	---
2,001 - 3,000	0	36	---	---
Direction**				
East	1	7	---	---
South	1	10	---	---
North	0	27	---	---
West	1	29	---	---
Base Section				
North	1	54	---	---
South	2	19	---	---

*Odds ratios were computed by comparing the number of exposed cases and controls to 34 unexposed cases and 642 unexposed controls.

** Direction of study subject to exposure site.

Table III.15.10 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	218	292	0.90	0.74-1.10
No. Years Exposed				
0.5-10.0	126	161	0.94	0.73-1.21
10.5-20.0	40	69	0.70	0.47-1.04
>20	52	62	1.01	0.69-1.48
Distance to Exposure(m)				
1-1,000	56	79	0.85	0.60-1.22
1,001-2,000	82	92	1.07	0.79-1.47
2,001-3,000	80	121	0.80	0.59-1.07
Direction**				
East	42	42	1.20	0.78-1.87
South	27	47	0.59	0.43-1.12
North	71	97	0.88	0.64-1.21
West	78	106	0.89	0.66-1.20
Base Section				
North	159	215	0.89	0.71-1.12
South	59	77	0.92	0.65-1.31

*Odds ratios were computed by comparing the number of exposed cases and controls to 624 unexposed cases and 993 unexposed controls.

**Direction of study subject to exposure site

Table III.15.11 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	63	291	1.08	0.79-1.48
No. Years Exposed				
0.5-10.0	35	157	1.11	0.75-1.65
10.5-20.0	15	75	1.00	0.56-1.77
>20	13	59	1.10	0.59-2.04
Distance to Exposure(m)				
1-1,000	17	78	1.09	0.63-1.88
1,001-2,000	24	94	1.27	0.79-2.04
2,001-3,000	22	119	0.92	0.57-1.49
Direction**				
East	11	41	1.34	0.68-2.64
South	5	51	0.49	0.19-1.22
North	23	97	1.18	0.73-1.91
West	24	102	1.17	0.73-1.88
Base Section				
North	51	212	1.20	0.85-1.69
South	12	79	0.76	0.40-1.42

*Odds ratios were computed by comparing the number of exposed cases and controls to 188 unexposed cases and 937 unexposed controls.

**Direction of study subject to exposure site

Table III.15.12 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

<u>Cancer Site:</u> Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	61	152	1.08	0.77-1.51
<u>No. Years Exposed</u>				
0.5-10.0	33	85	1.04	0.68-1.61
10.5-20.0	10	32	0.84	0.41-1.74
>20	18	35	1.34	0.77-2.49
<u>Distance to Exposure(m)</u>				
1-1,000	19	37	1.38	0.78-2.45
1,001-2,000	24	52	1.24	0.75-2.07
2,001-3,000	18	63	0.77	0.44-1.33
<u>Direction</u>**				
East	8	24	0.90	0.40-2.03
South	9	31	0.78	0.37-1.67
North	26	45	1.56	0.94-2.58
West	18	52	0.93	0.53-1.63
<u>Base Section</u>				
North	43	106	1.09	0.74-1.61
South	18	46	1.05	0.60-1.86

*Odds ratios were computed by comparing the number of exposed cases and controls to 204 unexposed cases and 549 unexposed controls.

**Direction of study subject to exposure site

Table III.15.13 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	56	277	0.70	0.50-0.98
No. Years Exposed				
0.5-10.0	34	151	0.78	0.53-1.16
10.5-20.0	11	66	0.58	0.30-1.11
>20	11	60	0.64	0.33-1.23
Distance to Exposure(m)				
1-1,000	8	77	0.36	0.18-0.74
1,001-2,000	21	87	0.84	0.51-1.38
2,001-3,000	27	113	0.83	0.54-1.29
Direction**				
East	12	41	1.02	0.53-1.97
South	8	45	0.62	0.29-1.32
North	11	90	0.43	0.23-0.79
West	25	101	0.86	0.54-1.36
Base Section				
North	41	202	0.71	0.49-1.01
South	15	75	0.70	0.39-1.23

*Odds ratios were computed by comparing the number of exposed cases and controls to 259 unexposed cases and 902 unexposed controls.

**Direction of study subject to exposure site

Table III.15.14 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers

<u>Cancer Site:</u> Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	14	206	0.94	0.51-1.73
<u>No. Years Exposed</u>				
0.5-10.0	10	113	1.22	0.60-2.48
10.5-20.0	1	52	----	----
>20	3	41	1.01	0.30-3.38
<u>Distance to Exposure(m)</u>				
1-1,000	3	62	0.67	0.20-2.19
1,001-2,000	6	68	1.22	0.50-2.94
2,001-3,000	5	76	0.91	0.35-2.35
<u>Direction</u>**				
East	4	32	1.72	0.59-5.01
South	2	37	----	----
North	3	65	0.64	0.19-2.08
West	5	72	0.96	0.37-2.48
<u>Base Section</u>				
North	10	147	0.94	0.46-1.90
South	4	59	0.93	0.32-2.68

*Odds ratios were computed by comparing the number of exposed cases and controls to 48 unexposed cases and 661 unexposed controls.

**Direction of study subject to exposure site

Table III.15.15 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	186	0.42	0.15-1.17
No. Years Exposed				
0.5-10.0	3	106	0.55	0.17-1.31
10.5-20.0	0	45	----	----
>20	1	35	----	----
Distance to Exposure(m)				
1-1,000	3	51	1.15	0.34-3.89
1,001-2,000	1	67	----	----
2,001-3,000	0	68	----	----
Direction**				
East	0	30	----	----
South	0	27	----	----
North	3	71	0.83	0.25-2.77
West	1	58	----	----
Base Section				
North	4	143	0.55	0.19-1.55
South	0	43	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 606 unexposed controls.

**Direction of study subject to exposure site

Table III.15.16 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure $\leq$ 3 Kilometers

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	136	0.85	0.37-1.98
No. Years Exposed				
0.5-10.0	3	75	0.66	0.20-2.21
10.5-20.0	2	30	----	----
>20	2	31	----	----
Distance to Exposure(m)				
1-1,000	1	39	----	----
1,001-2,000	3	47	1.06	0.31-3.60
2,001-3,000	3	50	0.99	0.29-3.38
Direction**				
East	2	22	----	----
South	0	23	----	----
North	3	43	1.16	0.34-3.94
West	2	48	----	----
Base Section				
North	5	103	0.80	0.30-2.12
South	2	33	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 30 unexposed cases and 497 unexposed controls.

**Direction of study subject to exposure site

Table III.15.17 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

<u>Cancer Site</u>: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
<u>Ever Exposed</u>	4	164	0.45	0.16-1.25
<u>No. Years Exposed</u>				
0.5-10.0	2	87	----	----
10.5-20.0	0	45	----	----
>20	2	32	----	----
<u>Distance to Exposure(m)</u>				
1-1,000	1	48	----	----
1,001-2,000	1	50	----	----
2,001-3,000	2	66	----	----
<u>Direction</u>**				
East	1	23	----	----
South	1	25	----	----
North	0	57	----	----
West	2	59	----	----
<u>Base Section</u>				
North	1	124	----	----
South	3	40	1.38	0.40-4.57

*Odds ratios were computed by comparing the number of exposed cases and controls to 32 unexposed cases and 587 unexposed controls.

**Direction of study subject to exposure site

Table III.15.18 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	8	167	0.90	0.41-2.02
No. Years Exposed				
0.5-10.0	5	90	1.05	0.40-2.78
10.5-20.0	1	37	----	----
>20	2	40	----	----
Distance to Exposure(m)				
1-1,000	3	53	1.07	0.32-3.63
1,001-2,000	2	45	----	----
2,001-3,000	3	69	0.82	0.24-2.77
Direction**				
East	4	25	3.02	0.71-9.60
South	2	25	----	----
North	1	54	----	----
West	1	63	----	----
Base Section				
North	3	124	0.46	0.14-1.48
South	5	43	2.20	0.83-5.83

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 548 unexposed controls.

**Direction of study subject to exposure site

Table III.15.19 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 3 Kilometers

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	13	----	----
No. Years Exposed				
0.5-10.0	1	7	----	----
10.5-20.0	0	5	----	----
>20	0	1	----	----
Distance to Exposure(m)				
1-1,000	1	0	----	----
1,001-2,000	0	4	----	----
2,001-3,000	0	9	----	----
Direction**				
East	0	2	----	----
South	0	1	----	----
North	1	3	----	----
West	0	7	----	----
Base Section				
North	1	11	----	----
South	0	2	----	----

**Direction of study subject to exposure site

Table III.15.20 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

<u>Cancer Site</u>: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	320	377	1.07	0.89-1.28
<u>No. Years Exposed</u>				
0.5 - 10.0	151	167	1.14	0.89-1.45
10.5 - 20.0	50	71	0.89	0.61-1.29
>20.0	119	139	1.08	0.83-1.40
<u>Distance to Exposure(km)</u>				
0 - 1.0	33	49	0.85	0.54-1.33
1.01 - 2.0	44	45	1.23	0.80-1.88
2.01 - 3.0	31	40	0.98	0.60-1.57
3.01 - 4.0	35	39	1.13	0.71-1.80
4.01 - 5.0	14	21	0.84	0.42-1.66
5.01 - 6.0	12	14	1.08	0.50-2.34
6.01 - 7.0	31	27	1.44	0.86-2.44
7.01 - 8.0	27	31	1.10	0.65-1.85
8.01 - 9.0	22	25	1.11	0.62-1.98
9.01 - 10.0	12	31	0.49	0.25-0.94
10.01 - 11.0	59	55	1.35	0.92-1.97
<u>Direction</u>**				
East	65	61	1.34	0.93-1.92
South	149	183	1.02	0.81-1.30
North	47	67	0.88	0.60-1.30
West	59	66	1.12	0.78-1.62

*Odds ratios were computed by comparing the number of exposed cases and controls to 722 unexposed cases and 908 unexposed controls.

**Direction of study subject to exposure site

Table III.15.21 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

<u>Cancer Site</u>: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	83	383	1.09	0.82-1.46
<u>No. Years Exposed</u>				
0.5 - 10.0	42	178	1.19	0.82-1.73
10.5 - 20.0	13	71	0.92	0.50-1.70
>20.0	28	134	1.05	0.68-1.63
<u>Distance to Exposure(km)</u>				
0 - 1.0	7	50	0.70	0.32-1.57
1.01 - 2.0	14	45	1.56	0.84-2.90
2.01 - 3.0	14	41	1.72	0.92-3.20
3.01 - 4.0	11	42	1.32	0.67-2.61
4.01 - 5.0	2	21	----	----
5.01 - 6.0	2	15	----	----
6.01 - 7.0	7	25	1.41	0.60-3.30
7.01 - 8.0	5	32	0.79	0.30-2.04
8.01 - 9.0	6	28	1.08	0.44-2.64
9.01 - 10.0	2	32	----	----
10.01 - 11.0	13	52	1.26	0.67-2.35
<u>Direction</u>**				
East	17	64	1.34	0.76-2.34
South	30	179	0.84	0.55-1.28
North	18	70	1.29	0.75-2.23
West	18	70	1.29	0.75-2.23

*Odds ratios were computed by comparing the number of exposed cases and controls to 168 unexposed cases and 345 unexposed controls.

**Direction of study subject to exposure site

Table III.15.22 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	79	218	0.94	0.69-1.28
No. Years Exposed				
0.5 - 10.0	34	95	0.93	0.61-1.42
10.5 - 20.0	12	47	0.66	0.34-1.27
>20.0	33	76	1.13	0.73-1.76
Distance to Exposure(km)				
0 - 1.0	8	21	0.99	0.43-2.27
1.01 - 2.0	14	23	1.58	0.80-3.12
2.01 - 3.0	6	22	0.71	0.28-1.77
3.01 - 4.0	8	25	0.83	0.37-1.87
4.01 - 5.0	5	14	0.93	0.33-2.61
5.01 - 6.0	0	8	----	----
6.01 - 7.0	6	17	0.92	0.36-2.36
7.01 - 8.0	8	18	1.15	0.49-2.70
8.01 - 9.0	5	13	1.00	0.35-2.84
9.01 - 10.0	3	19	0.41	0.12-1.35
10.01 - 11.0	16	38	1.10	0.50-2.31
Direction**				
East	15	41	0.95	0.51-1.75
South	34	107	0.82	0.54-1.25
North	14	30	1.21	0.63-2.34
West	16	40	1.04	0.57-1.90

*Odds ratios were computed by comparing the number of exposed cases and controls to 196 unexposed cases and 483 unexposed controls.

**Direction of study subject to exposure site

Table III.15.23 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	85	363	0.83	0.63-1.10
No. Years Exposed				
0.5 - 10.0	37	156	0.84	0.57-1.24
10.5 - 20.0	16	70	0.81	0.46-1.42
>20.0	32	137	0.83	0.55-1.25
Distance to Exposure(km)				
0 - 1.0	10	49	0.72	0.36-1.45
1.01 - 2.0	10	41	0.86	0.43-1.75
2.01 - 3.0	5	36	0.49	0.20-1.25
3.01 - 4.0	7	39	0.64	0.28-1.43
4.01 - 5.0	3	21	0.51	0.15-1.68
5.01 - 6.0	6	14	1.52	0.58-3.98
6.01 - 7.0	8	25	1.14	0.50-2.55
7.01 - 8.0	12	31	1.37	0.70-2.71
8.01 - 9.0	5	25	0.71	0.27-1.87
9.01 - 10.0	3	31	0.34	0.11-1.08
10.01 - 11.0	16	51	1.11	0.62-1.99
Direction**				
East	17	58	1.04	0.59-1.82
South	48	179	0.95	0.67-1.35
North	9	62	0.52	0.26-1.04
West	11	54	0.61	0.32-1.17

*Odds ratios were computed by comparing the number of exposed cases and controls to 230 unexposed cases and 816 unexposed controls.

**Direction of study subject to exposure site

Table III.15.24 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	21	265	1.16	0.67-2.01
No. Years Exposed				
0.5 - 10.0	13	123	1.55	0.81-2.97
10.5 - 20.0	1	46	----	----
>20.0	7	96	1.07	0.47-2.46
Distance to Exposure(km)				
0 - 1.0	0	40	----	----
1.01 - 2.0	3	28	1.57	0.46-5.34
2.01 - 3.0	2	27	----	----
3.01 - 4.0	3	29	1.52	0.45-5.16
4.01 - 5.0	1	9	----	----
5.01 - 6.0	0	13	----	----
6.01 - 7.0	7	19	5.41	1.90-14.37
7.01 - 8.0	1	23	----	----
8.01 - 9.0	1	21	----	----
9.01 - 10.0	1	16	----	----
10.01 - 11.0	2	40	----	----
Direction**				
East	3	46	0.96	0.29-3.21
South	12	123	1.43	0.73-2.80
North	0	51	----	----
West	6	45	1.96	0.80-4.79

*Odds ratios were computed by comparing the number of exposed cases and controls to 41 unexposed cases and 602 unexposed controls.

**Direction of study subject to exposure site

Table III.15.25 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

<u>Cancer Site</u>: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	10	231	0.97	0.46-2.06
<u>No. Years Exposed</u>				
0.5 - 10.0	4	105	0.86	0.29-2.51
10.5 - 20.0	2	37	----	----
>20.0	4	89	1.01	0.34-2.97
<u>Distance to Exposure(km)</u>				
0 - 1.0	2	32	----	----
1.01 - 2.0	0	28	----	----
2.01 - 3.0	0	18	----	----
3.01 - 4.0	0	24	----	----
4.01 - 5.0	0	11	----	----
5.01 - 6.0	2	13	----	----
6.01 - 7.0	0	16	----	----
7.01 - 8.0	0	19	----	----
8.01 - 9.0	4	21	4.27	0.98-14.[illegible]
9.01 - 10.0	0	14	----	----
10.01 - 11.0	2	35	----	----
<u>Direction</u>**				
East	3	40	1.68	0.49-5.74
South	6	110	1.22	0.49-3.05
North	1	46	----	----
West	0	35	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 26 unexposed cases and 561 unexposed controls.

**Direction of study subject to exposure site

Table III.15.26 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

<u>Cancer Site:</u> Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	9	205	0.67	0.31-1.44
<u>No. Years Exposed</u>				
0.5 - 10.0	4	94	0.65	0.22-1.89
10.5 - 20.0	1	34	----	----
>20.0	4	77	0.79	0.27-2.33
<u>Distance to Exposure(km)</u>				
0 - 1.0	2	25	----	----
1.01 - 2.0	1	19	----	----
2.01 - 3.0	1	20	----	----
3.01 - 4.0	1	27	----	----
4.01 - 5.0	1	7	----	----
5.01 - 6.0	0	9	----	----
6.01 - 7.0	0	14	----	----
7.01 - 8.0	0	18	----	----
8.01 - 9.0	0	16	----	----
9.01 - 10.0	1	18	----	----
10.01 - 11.0	2	32	----	----
<u>Direction</u>**				
East	2	37	----	----
South	3	91	----	----
North	2	31	----	----
West	2	46	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 28 unexposed cases and 428 unexposed controls.

**Direction of study subject to exposure site

Table III.15.27 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	21	410	1.16	0.59-2.29
No. Years Exposed				
0.5 - 10.0	7	211	0.75	0.30-1.88
10.5 - 20.0	4	75	1.21	0.39-3.76
>20.0	10	124	1.83	0.81-4.15
Distance to Exposure(km)				
0 - 1.0	1	49	----	----
1.01 - 2.0	2	49	----	----
2.01 - 3.0	3	47	1.45	0.41-5.17
3.01 - 4.0	2	49	----	----
4.01 - 5.0	1	19	----	----
5.01 - 6.0	2	17	----	----
6.01 - 7.0	2	35	----	----
7.01 - 8.0	1	34	----	----
8.01 - 9.0	0	30	----	----
9.01 - 10.0	1	35	----	----
10.01 - 11.0	6	46	2.96	0.89-8.58
Direction**				
East	7	84	1.89	0.76-4.73
South	9	178	1.15	0.49-2.68
North	2	72	----	----
West	3	76	0.90	0.25-3.18

*Odds ratios were computed by comparing the number of exposed cases and controls to 15 unexposed cases and 341 unexposed controls.

**Direction of study subject to exposure site

Table III.15.28 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	225	1.04	0.51-2.12
No. Years Exposed				
0.5 - 10.0	10	99	1.98	0.93-4.20
10.5 - 20.0	1	44	----	----
>20.0	1	82	----	----
Distance to Exposure(km)				
0 - 1.0	3	31	1.90	0.55-6.51
1.01 - 2.0	0	24	----	----
2.01 - 3.0	0	21	----	----
3.01 - 4.0	3	30	1.96	0.57-6.72
4.01 - 5.0	1	13	----	----
5.01 - 6.0	0	9	----	----
6.01 - 7.0	1	12	----	----
7.01 - 8.0	0	16	----	----
8.01 - 9.0	1	15	----	----
9.01 - 10.0	1	26	----	----
10.01 - 11.0	2	28	----	----
Direction**				
East	1	38	----	----
South	7	102	1.34	0.57-3.19
North	1	38	----	----
West	3	47	1.25	0.37-4.29

*Odds ratios were computed by comparing the number of exposed cases and controls to 25 unexposed cases and 490 unexposed controls.

**Direction of study subject to exposure site

Table III.15.29 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	690	824	1.10	0.92-1.30
No. Years Exposed				
0.5 - 10.0	320	386	1.09	0.89-1.33
10.5 - 20.0	176	192	1.20	0.94-1.54
>20.0	194	246	1.03	0.82-1.31
Distance to Exposure(km)				
0 - 1.0	62	88	0.92	0.65-1.31
1.01 - 2.0	100	113	1.16	0.86-1.57
2.01 - 3.0	69	107	0.84	0.61-1.18
3.01 - 4.0	60	90	0.87	0.61-1.24
4.01 - 5.0	44	37	1.56	0.99-2.46
5.01 - 6.0	31	36	1.13	0.68-1.86
6.01 - 7.0	73	72	1.33	0.93-1.89
7.01 - 8.0	62	58	1.40	0.96-2.05
8.01 - 9.0	47	55	1.12	0.74-1.69
9.01 - 10.0	48	67	0.94	0.63-1.39
10.01 - 11.0	94	101	1.22	0.89-1.67
Direction**				
East	163	187	1.14	0.89-1.47
South	310	348	1.17	0.95-1.43
North	93	136	0.90	0.66-1.21
West	124	153	1.06	0.81-1.40

*Odds ratios were computed by comparing the number of exposed cases and controls to 352 unexposed cases and 461 unexposed controls.

**Direction of study subject to exposure site

Table III.15.30 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	174	823	1.11	0.83-1.49
No. Years Exposed				
0.5 - 10.0	86	378	1.20	0.85-1.68
10.5 - 20.0	41	207	1.04	0.69-1.58
>20.0	47	238	1.04	0.70-1.54
Distance to Exposure(km)				
0 - 1.0	15	86	0.92	0.50-1.67
1.01 - 2.0	30	111	1.42	0.89-2.27
2.01 - 3.0	21	103	1.07	0.63-1.82
3.01 - 4.0	17	90	0.99	0.56-1.76
4.01 - 5.0	6	40	0.79	0.32-1.92
5.01 - 6.0	9	36	1.32	0.61-2.84
6.01 - 7.0	18	69	1.37	0.78-2.43
7.01 - 8.0	13	62	1.10	0.58-2.10
8.01 - 9.0	11	57	1.02	0.51-2.02
9.01 - 10.0	11	69	0.84	0.42-1.66
10.01 - 11.0	23	100	1.21	0.72-2.02
Direction**				
East	40	185	1.14	0.75-1.73
South	72	354	1.07	0.75-1.52
North	30	133	1.19	0.74-1.89
West	32	151	1.12	0.71-1.75

*Odds ratios were computed by comparing the number of exposed cases and controls to 77 unexposed cases and 405 unexposed controls.

**Direction of study subject to exposure site

Table III.15.31 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	173	453	1.03	0.76-1.38
No. Years Exposed				
0.5 - 10.0	82	204	1.08	0.76-1.54
10.5 - 20.0	38	106	0.97	0.62-1.50
>20.0	53	143	1.00	0.67-1.48
Distance to Exposure(km)				
0 - 1.0	19	40	1.28	0.71-2.32
1.01 - 2.0	25	58	1.16	0.69-1.97
2.01 - 3.0	17	61	0.75	0.42-1.35
3.01 - 4.0	13	52	0.67	0.35-1.29
4.01 - 5.0	14	24	1.57	0.78-3.16
5.01 - 6.0	4	18	0.60	0.20-1.80
6.01 - 7.0	16	38	1.14	0.60-2.14
7.01 - 8.0	18	37	1.31	0.71-2.42
8.01 - 9.0	10	26	1.04	0.48-2.24
9.01 - 10.0	11	36	0.82	0.40-1.69
10.01 - 11.0	26	63	1.11	0.66-1.86
Direction**				
East	39	105	1.00	0.64-1.55
South	71	196	0.98	0.68-1.40
North	30	69	1.17	0.72-1.92
West	33	83	1.07	0.67-1.71

*Odds ratios were computed by comparing the number of exposed cases and controls to 92 unexposed cases and 248 unexposed controls.

**Direction of study subject to exposure site

Table III.15.32 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	206	780	0.97	0.74-1.26
No. Years Exposed				
0.5 - 10.0	89	357	0.91	0.67-1.25
10.5 - 20.0	65	182	1.31	0.92-1.86
>20.0	52	241	0.79	0.55-1.14
Distance to Exposure(km)				
0 - 1.0	14	84	0.61	0.34-1.11
1.01 - 2.0	29	108	0.98	0.62-1.56
2.01 - 3.0	19	97	0.72	0.42-1.22
3.01 - 4.0	18	87	0.76	0.44-1.31
4.01 - 5.0	15	36	1.53	0.81-2.88
5.01 - 6.0	13	33	1.44	0.74-2.83
6.01 - 7.0	18	66	1.00	0.57-1.75
7.01 - 8.0	26	57	1.67	0.95-2.85
8.01 - 9.0	14	52	0.99	0.53-1.85
9.01 - 10.0	16	65	0.90	0.50-1.62
10.01 - 11.0	24	95	0.93	0.56-1.52
Direction**				
East	47	176	0.98	0.66-1.44
South	97	331	1.07	0.79-1.46
North	21	125	0.62	0.37-1.02
West	41	148	1.01	0.68-1.52

*Odds ratios were computed by comparing the number of exposed cases and controls to 109 unexposed cases and 399 unexposed controls.

**Direction of study subject to exposure site

Table III.15.33 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure $\leq$ 11 Kilometers

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	42	596	0.96	0.55-1.66
No. Years Exposed				
0.5 - 10.0	19	292	0.88	0.46-1.69
10.5 - 20.0	11	145	1.03	0.48-2.21
>20.0	12	159	1.02	0.49-2.15
Distance to Exposure(km)				
0 - 1.0	2	68	----	----
1.01 - 2.0	8	73	1.48	0.63-3.50
2.01 - 3.0	2	76	----	----
3.01 - 4.0	4	67	0.81	0.27-2.44
4.01 - 5.0	3	18	2.26	0.63-8.07
5.01 - 6.0	0	28	----	----
6.01 - 7.0	10	52	2.61	1.02-6.23
7.01 - 8.0	2	47	----	----
8.01 - 9.0	3	44	0.92	0.26-3.24
9.01 - 10.0	2	46	----	----
10.01 - 11.0	6	77	1.06	0.41-2.72
Direction**				
East	11	146	1.02	0.48-2.19
South	22	252	1.18	0.63-2.22
North	1	90	----	----
West	8	108	1.00	0.43-2.35

*Odds ratios were computed by comparing the number of exposed cases and controls to 20 unexposed cases and 271 unexposed controls.

**Direction of study subject to exposure site

Table III.15.34 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	22	542	0.78	0.39-1.57
No. Years Exposed				
0.5 - 10.0	9	264	0.66	0.28-1.55
10.5 - 20.0	6	131	0.88	0.33-2.37
>20.0	7	147	0.92	0.36-2.35
Distance to Exposure(km)				
0 - 1.0	3	58	1.00	0.27-3.61
1.01 - 2.0	2	78	----	----
2.01 - 3.0	0	63	----	----
3.01 - 4.0	0	57	----	----
4.01 - 5.0	0	23	----	----
5.01 - 6.0	3	27	2.14	0.59-7.77
6.01 - 7.0	1	42	----	----
7.01 - 8.0	2	42	----	----
8.01 - 9.0	7	42	3.21	1.01-9.22
9.01 - 10.0	2	44	----	----
10.01 - 11.0	2	66	----	----
Direction**				
East	4	132	0.58	0.19-1.80
South	15	224	1.29	0.60-2.76
North	2	94	----	----
West	1	92	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 13 unexposed cases and 250 unexposed controls.

**Direction of study subject to exposure site

Table III.15.35 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	22	408	0.81	0.41-1.59
No. Years Exposed				
0.5 - 10.0	10	175	0.86	0.38-1.96
10.5 - 20.0	5	102	0.74	0.26-2.07
>20.0	7	131	0.80	0.32-2.02
Distance to Exposure(km)				
0 - 1.0	3	39	1.15	0.32-4.18
1.01 - 2.0	2	55	----	----
2.01 - 3.0	4	45	1.33	0.42-4.20
3.01 - 4.0	2	46	----	----
4.01 - 5.0	1	18	----	----
5.01 - 6.0	0	16	----	----
6.01 - 7.0	3	34	1.32	0.36-4.81
7.01 - 8.0	0	34	----	----
8.01 - 9.0	1	36	----	----
9.01 - 10.0	2	33	----	----
10.01 - 11.0	4	52	1.15	0.37-3.62
Direction**				
East	9	97	1.39	0.59-3.28
South	7	169	0.62	0.25-1.55
North	3	61	0.74	0.21-2.62
West	3	81	0.56	0.16-1.94

*Odds ratios were computed by comparing the number of expo[illegible]d cases and controls to 15 unexposed cases and 225 unexposed controls.

**Direction of study subject to exposure site

Table III.15.36 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	26	490	1.38	0.66-2.91
No. Years Exposed				
0.5 - 10.0	12	218	1.44	0.61-3.38
10.5 - 20.0	2	122	0.43	0.10-1.90
>20.0	12	150	2.09	0.90-4.87
Distance to Exposure(km)				
0 - 1.0	2	54	----	----
1.01 - 2.0	2	66	----	----
2.01 - 3.0	3	53	1.48	0.40-5.52
3.01 - 4.0	2	58	----	----
4.01 - 5.0	2	22	----	----
5.01 - 6.0	2	22	----	----
6.01 - 7.0	4	48	2.18	0.67-7.04
7.01 - 8.0	1	40	----	----
8.01 - 9.0	0	36	----	----
9.01 - 10.0	2	41	----	----
10.01 - 11.0	6	50	3.13	0.88-9.99
Direction**				
East	7	107	1.71	0.64-4.56
South	14	210	1.74	0.76-3.96
North	2	83	----	----
West	3	90	0.87	0.23-3.23

*Odds ratios were computed by comparing the number of exposed cases and controls to 10 unexposed cases and 261 unexposed controls.

**Direction of study subject to exposure site

Table III.15.37 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	22	477	0.73	0.37-1.43
No. Years Exposed				
0.5 - 10.0	10	214	0.74	0.33-1.68
10.5 - 20.0	8	110	1.15	0.48-2.80
>20.0	4	153	0.42	0.14-1.24
Distance to Exposure(km)				
0 - 1.0	4	54	1.18	0.38-3.68
1.01 - 2.0	1	61	----	----
2.01 - 3.0	3	53	0.90	0.25-3.22
3.01 - 4.0	4	53	1.20	0.38-3.76
4.01 - 5.0	3	28	1.70	0.47-6.17
5.01 - 6.0	0	19	----	----
6.01 - 7.0	3	40	1.19	0.33-4.30
7.01 - 8.0	0	30	----	----
8.01 - 9.0	1	35	----	----
9.01 - 10.0	1	47	----	----
10.01 - 11.0	2	57	----	----
Direction**				
East	5	115	0.69	0.25-1.94
South	11	198	0.88	0.40-1.96
North	3	73	0.65	0.18-2.30
West	3	91	0.52	0.15-1.82

*Odds ratios were computed by comparing the number of exposed cases and controls to 15 unexposed cases and 238 unexposed controls.

**Direction of study subject to exposure site

Table III.15.38 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Exposure ≤ 11 Kilometers

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	3	32	1.69	0.16-17.43
No. Years Exposed				
0.5 - 10.0	3	12	4.50	0.47-43.10
10.5 - 20.0	0	9	----	----
>20.0	0	11	----	----
Distance to Exposure(km)				
0 - 1.0	0	2	----	----
1.01 - 2.0	1	8	----	----
2.01 - 3.0	0	2	----	----
3.01 - 4.0	0	2	----	----
4.01 - 5.0	0	1	----	----
5.01 - 6.0	0	3	----	----
6.01 - 7.0	0	3	----	----
7.01 - 8.0	0	2	----	----
8.01 - 9.0	0	4	----	----
9.01 - 10.0	1	3	----	----
10.01 - 11.0	1	2	----	----
Direction**				
East	1	5	----	----
South	1	16	----	----
North	1	7	----	----
West	0	4	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 1 unexposed cases and 18 unexposed controls.

**Direction of study subject to exposure site

Table III.15.39 Results of Crude Exposure Metric* Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Cancer Site	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	0.00048	0.22	1.05	0.97 - 1.13
Lung	0.00014	0.82	1.01	0.90 - 1.15
Breast	0.00042	0.54	1.04	0.92 - 1.18
Colorectal	-0.00045	0.48	0.96	0.85 - 1.08
Bladder	0.00104	0.46	1.91	0.69 - 1.19
Kidney	-0.00132	0.32	1.13	0.89 - 1.44
Pancreas	0.00119	0.34	1.12	0.88 - 1.43
Leukemia	0.00027	0.83	1.03	0.82 - 1.30
Brain	-0.00148	0.42	0.86	0.61 - 1.22
Liver	-0.00209	0.78	0.82	0.21 - 3.31

**Exposure Metric*: $\sum \left(\frac{L}{\sqrt{dist.+L} + \sqrt{dist.}} \right) (wind\ freq.)(no.\ yrs.)$

L and distance were calculated on an individual basis

**Odds ratios compared subjects whose exposure metric was at the 75th percentile to subjects whose metric was at the 25th percentile.

Table III.15.40 Results of Crude Exposure Metric* Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Cancer Site	Beta Coefficient	P-value	Odds Ratio**	95% Confidence Interval
All Cancers	0.00032	0.24	1.06	0.95 - 1.18
Lung	-0.0000002	0.99	1.00	0.85 - 1.18
Breast	-0.00034	0.47	1.06	0.89 - 1.27
Colorectal	-0.00024	0.58	0.96	0.83 - 1.10
Bladder	0.00040	0.68	0.93	0.65 - 1.33
Kidney	-0.00099	0.28	1.19	0.86 - 1.65
Pancreas	0.00098	0.26	1.19	0.86 - 1.65
Leukemia	0.00010	0.93	1.02	0.68 - 1.51
Brain	-0.00097	0.43	0.84	0.54 - 1.29
Liver	-0.00117	0.79	0.81	0.17 - 3.94

*Exposure Metric: $\sum \left(\frac{L}{\sqrt{dist.+L} + \sqrt{dist.}}\right)(wind\ freq.)(no.\ yrs.)$

L and distance were calculated on an individual basis

**Odds ratios compared subjects whose exposure metric was at the 75th percentile to subjects whose metric was at the 25th percentile.

Table III.15.41 Results of Adjusted Categorical* Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.03539	0.71	1.04	0.86 - 1.25
Lung	0.11728	0.47	1.12	0.82 - 1.54
Breast	0.06144	0.72	1.06	0.76 - 1.48
Colorectal	-0.28569	0.08	0.75	0.55 - 1.03
Bladder	0.17728	0.56	1.19	0.66 - 2.17
Kidney	0.13467	0.74	1.14	0.52 - 2.52
Pancreas	-0.48809	0.23	0.61	0.27 - 1.37
Leukemia	0.20653	0.56	1.23	0.62 - 2.45
Brain	0.00240	0.99	1.00	0.49 - 2.06

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 11 kilometers of the border.

**Liver cancer case group was too small to perform adjusted analyses.

Table III.15.42 Results of Adjusted Categorical* Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.03459	0.71	1.04	0.86 - 1.24
Lung	0.01575	0.92	1.02	0.73 - 1.41
Breast	0.11444	0.49	1.12	0.81 - 1.55
Colorectal	-0.10762	0.47	0.90	0.67 - 1.21
Bladder	0.10938	0.73	1.12	0.60 - 2.07
Kidney	-0.07612	0.85	0.93	0.42 - 2.05
Pancreas	-0.17153	0.64	0.84	0.41 - 1.72
Leukemia	0.38704	0.31	1.47	0.69 - 3.13
Brain	-0.31847	0.36	0.73	0.37 - 1.45

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 11 kilometers.

**Liver cancer case group was too small to perform adjusted analyses.

Table III.15.43 Results of Adjusted Exposure Metric* Analysis Examining Proximity as an Exposure Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00054	0.19	1.05	0.97 - 1.14
Lung	0.00045	0.53	1.04	0.91 - 1.19
Breast	0.00073	0.33	1.07	0.93 - 1.24
Colorectal	-0.00108	0.13	0.90	0.79 - 1.03
Bladder	-0.00083	0.57	0.92	0.70 - 1.21
Kidney	0.00175	0.18	1.18	0.92 - 1.52
Pancreas	-0.00006	0.96	0.99	0.77 - 1.28
Leukemia	0.00039	0.75	1.04	0.82 - 1.31
Brain	-0.00140	0.46	0.87	0.61 - 1.25

*Exposure Metric: $\sum \left(\frac{L}{\sqrt{dist.} + L + \sqrt{dist.}} \right)$ (wind freq.) (no. yrs.)

L and distance were calculated on an individual basis.

**Liver cancer case group was too small to perform the adjusted analysis.

***Odds ratios compared subjects whose exposure metric was at the 75th percentile to subjects at the 25th percentile.

Table III.15.44 Results of Adjusted Exposure Metric* Analysis Examining Proximity to MMR Border as an Exposure Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00031	0.27	1.06	0.96 - 1.17
Lung	0.00028	0.58	1.05	0.88 - 1.25
Breast	0.00055	0.27	1.10	0.92 - 1.32
Colorectal	-0.00093	0.06	0.85	0.71 - 1.01
Bladder	-0.00028	0.77	0.95	0.67 - 1.34
Kidney	0.00134	0.15	1.27	0.92 - 1.77
Pancreas	0.00016	0.86	1.03	0.75 - 1.41
Leukemia	0.00024	0.84	1.04	0.69 - 1.57
Brain	-0.00103	0.42	0.83	0.53 - 1.30

*Exposure Metric: $\sum \left(\frac{L}{\sqrt{dist.} + L + \sqrt{dist.}}\right)(wind\ freq.)(no.\ yrs.)$

L and distance were calculated on an individual basis.

**Liver cancer case group was too small to perform the adjusted analysis.

***Odds ratios compared subjects whose exposure metric was at the 75th percentile to subjects at the 25th percentile.

Table III.15.45 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Men

Exposure $\leq$ 11 Kilometers

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	125	153	0.99	0.75 - 1.31
No. Years Exposed				
0.5 - 10.0	69	68	1.23	0.85 - 1.78
10.5 - 20.0	22	24	1.11	0.61 - 2.02
> 20.0	34	61	0.68	0.43 - 1.05
Distance to Exposure (km)				
0 - 1.0	15	28	0.65	0.34 - 1.23
1.01 - 2.0	17	19	1.08	0.55 - 2.12
2.01 - 3.0	14	16	1.06	0.51 - 2.21
3.01 - 4.0	13	14	1.13	0.52 - 2.43
4.01 - 5.0	5	7	0.87	0.27 - 2.76
5.01 - 6.0	8	6	1.62	0.56 - 4.67
6.01 - 7.0	12	10	1.46	0.62 - 3.40
7.01 - 8.0	9	13	0.84	0.35 - 2.00
8.01 - 9.0	8	12	0.81	0.33 - 2.00
9.01 - 10.0	4	12	0.40	0.13 - 1.22
10.01 - 11.0	20	16	1.52	0.78 - 2.96
Direction**				
East	27	19	1.72	0.95 - 3.14
South	62	75	1.00	0.69 - 1.45
North	17	34	0.61	0.33 - 1.10
West	19	25	0.92	0.50 - 1.70

*Odds ratios were computed by comparing the number of exposed cases and controls to 315 unexposed cases and 382 unexposed controls.

**Direction of study subject to exposure site

Table III.15.46 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Men

Exposure ≤ 11 Kilometers

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	45	158	1.02	0.68 - 1.51
No. Years Exposed				
0.5 - 10.0	25	75	1.19	0.72 - 1.96
10.5 - 20.0	6	25	0.86	0.34 - 2.14
> 20.0	14	58	0.86	0.46 - 1.60
Distance to Exposure (km)				
0 - 1.0	5	26	0.69	0.26 - 1.82
1.01 - 2.0	10	19	1.88	0.85 - 4.12
2.01 - 3.0	6	18	1.19	0.46 - 3.07
3.01 - 4.0	7	16	1.56	0.62 - 3.87
4.01 - 5.0	2	7	----	----
5.01 - 6.0	2	7	----	----
6.01 - 7.0	3	10	1.07	0.29 - 3.96
7.01 - 8.0	2	13	----	----
8.01 - 9.0	2	14	----	----
9.01 - 10.0	0	13	----	----
10.01 - 11.0	6	15	1.42	0.54 - 3.75
Direction**				
East	11	21	1.87	0.88 - 3.96
South	14	75	0.67	0.36 - 1.22
North	12	35	1.22	0.61 - 2.44
West	8	27	1.06	0.46 - 2.40

*Odds ratios were computed by comparing the number of exposed cases and controls to 103 unexposed cases and 367 unexposed controls.

**Direction of study subject to exposure site

Table III.15.47 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Men

Exposure ≤ 11 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	41	152	0.76	0.51 - 1.14
No. Years Exposed				
0.5 - 10.0	22	67	0.93	0.55 - 1.57
10.5 - 20.0	10	24	1.18	0.55 - 2.54
> 20.0	9	61	0.41	0.21 - 0.85
Distance to Exposure (km)				
0 - 1.0	7	28	0.71	0.30 - 1.66
1.01 - 2.0	2	18	----	----
2.01 - 3.0	4	6	0.71	0.23 - 2.15
3.01 - 4.0	2	14	----	----
4.01 - 5.0	2	7	----	----
5.01 - 6.0	2	6	----	----
6.01 - 7.0	3	10	0.85	0.23 - 3.14
7.01 - 8.0	7	13	1.53	0.60 - 3.89
8.01 - 9.0	2	12	----	----
9.01 - 10.0	2	12	----	----
10.01 - 11.0	8	16	1.42	0.60 - 3.38
Direction**				
East	8	19	1.19	0.51 - 2.79
South	26	75	0.98	0.60 - 1.60
North	3	34	0.25	0.08 - 0.76
West	4	24	0.47	0.16 - 1.36

*Odds ratios were computed by comparing the number of exposed cases and controls to 128 unexposed cases and 363 unexposed controls.

**Direction of study subject to exposure site

Table III.15.48 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Women

Exposure $\leq$ 11 Kilometers

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	195	224	1.12	0.89 - 1.42
No. Years Exposed				
0.5 - 10.0	82	99	1.07	0.78 - 1.47
10.5 - 20.0	28	47	0.77	0.47 - 1.25
> 20.0	85	78	1.41	1.00 - 1.96
Distance to Exposure (km)				
0 - 1.0	18	21	1.11	0.58 - 2.11
1.01 - 2.0	27	26	1.34	0.77 - 2.33
2.01 - 3.0	17	24	0.92	0.48 - 1.73
3.01 - 4.0	22	25	1.14	0.63 - 2.05
4.01 - 5.0	9	14	0.84	0.36 - 1.94
5.01 - 6.0	4	8	0.65	0.20 - 2.14
6.01 - 7.0	19	17	1.44	0.74 - 2.81
7.01 - 8.0	18	18	1.29	0.66 - 2.51
8.01 - 9.0	14	13	1.39	0.65 - 2.98
9.01 - 10.0	8	19	0.54	0.24 - 1.24
10.01 - 11.0	39	39	1.29	0.82 - 2.05
Direction**				
East	38	42	1.17	0.74 - 1.85
South	87	108	1.04	0.76 - 1.42
North	30	33	1.18	0.71 - 1.96
West	40	41	1.26	0.80 - 1.99

*Odds ratios were computed by comparing the number of exposed cases and controls to 407 unexposed cases and 526 unexposed controls.

**Direction of study subject to exposure site

Table III.15.49 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Women

Exposure ≤ 11 Kilometers

<u>Cancer Site</u>: Lung

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	38	225	1.24	0.81 - 1.91
<u>No. Years Exposed</u>				
0.5 - 10.0	17	103	1.21	0.68 - 2.16
10.5 - 20.0	7	46	1.12	0.48 - 2.58
> 20.0	14	76	1.36	0.72 - 2.53
<u>Distance to Exposure (km)</u>				
0 - 1.0	2	24	----	----
1.01 - 2.0	4	26	1.13	0.38 - 3.35
2.01 - 3.0	8	23	2.56	1.13 - 5.80
3.01 - 4.0	4	26	1.13	0.38 - 3.35
4.01 - 5.0	0	14	----	----
5.01 - 6.0	0	8	----	----
6.01 - 7.0	4	15	1.96	0.64 - 5.98
7.01 - 8.0	3	19	1.16	0.33 - 4.03
8.01 - 9.0	4	14	2.10	0.69 - 6.43
9.01 - 10.0	2	19	----	----
10.01 - 11.0	7	37	1.39	0.60 - 3.24
<u>Direction**</u>				
East	6	43	1.03	0.42 - 2.51
South	16	104	1.13	0.63 - 2.03
North	6	35	1.26	0.51 - 3.11
West	10	43	1.71	0.82 - 3.54

*Odds ratios were computed by comparing the number of exposed cases and controls to 65 unexposed cases and 478 unexposed controls.

**Direction of study subject to exposure site

Table III.15.50 Results of Crude Categorical Analysis Examining Proximity to MMR Border as an Exposure Taking Latent Period into Account and Including Only Women

Exposure ≤ 11 Kilometers

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratios*	95% Confidence Interval
Ever Exposed	44	211	0.93	0.63 - 1.37
No. Years Exposed				
0.5 - 10.0	15	89	0.75	0.42 - 1.35
10.5 - 20.0	6	46	0.58	0.24 - 1.38
> 20.0	23	76	1.34	0.81 - 2.24
Distance to Exposure (km)				
0 - 1.0	3	21	0.63	0.19 - 2.15
1.01 - 2.0	8	23	1.54	0.68 - 3.53
2.01 - 3.0	1	20	----	----
3.01 - 4.0	5	25	0.89	0.33 - 2.38
4.01 - 5.0	1	14	----	----
5.01 - 6.0	4	8	2.22	0.68 - 7.30
6.01 - 7.0	5	15	1.48	0.53 - 4.14
7.01 - 8.0	5	18	1.23	0.45 - 3.40
8.01 - 9.0	3	13	1.02	0.29 - 3.67
9.01 - 10.0	1	19	----	----
10.01 - 11.0	8	35	1.02	0.46 - 2.26
Direction**				
East	9	39	1.02	0.48 - 2.18
South	22	104	0.94	0.56 - 1.56
North	6	28	0.95	0.38 - 2.36
West	7	40	0.78	0.34 - 1.78

*Odds ratios were computed by comparing the number of exposed cases and controls to 102 unexposed cases and 453 unexposed controls.

**Direction of study subject to exposure site

Table III.16.1 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	172	196	1.10	0.88 - 1.37
<u>No. Years Exposed</u>				
0.5 - 10.0	102	114	1.12	0.85 - 1.48
10.5 - 20.0	35	45	0.97	0.62 - 1.53
>20.0	35	37	1.18	0.74 - 1.90
<u>Total Acreage</u>				
1 - 10	58	58	1.25	0.86 - 1.82
11 - 25	48	67	0.90	0.61 - 1.31
>25	66	71	1.16	0.82 - 1.65
<u>Distance to Bog (ft)</u>				
1 - 1,000	62	76	1.02	0.72 - 1.45
1,001 - 2,000	86	86	1.25	0.92 - 1.71
2,001 - 2,600	24	34	0.88	0.52 - 1.50
<u>Direction**</u>				
Northeast	30	41	0.92	0.57 - 1.48
Southeast	60	56	1.34	0.92 - 1.95
Southwest	36	48	0.94	0.60 - 1.46
Northwest	46	51	1.13	0.75 - 1.70

*Odds ratios were computed by comparing the number of exposed cases and controls to 870 unexposed cases and 1089 controls.

**Direction of study subject to exposure site

Table III.16.2 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	46	195	1.19	0.83 - 1.69
No. Years Exposed				
0.5 - 10.0	31	115	1.36	0.89 - 2.07
10.5 - 20.0	10	46	1.10	0.54 - 2.21
>20.0	5	34	0.74	0.29 - 1.91
Total Acreage				
1 - 10	13	61	1.07	0.58 - 1.99
11 - 25	13	65	1.01	0.55 - 1.86
>25	20	69	1.46	0.87 - 2.45
Distance to Bog (ft)				
1 - 1,000	19	76	1.26	0.75 - 2.13
1,001 - 2,000	22	86	1.29	0.79 - 2.11
2,001 - 2,600	5	33	0.76	0.30 - 1.97
Direction**				
Northeast	10	42	1.20	0.59 - 2.43
Southeast	19	54	1.77	0.97 - 3.12
Southwest	9	46	0.99	0.48 - 2.04
Northwest	8	53	0.76	0.36 - 1.62

*Odds ratios were computed by comparing the number of exposed cases and controls to 205 unexposed cases and 1033 controls.

**Direction of study subject to exposure site

Table III.16.3 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	47	106	1.21	0.83 - 1.76
No. Years Exposed				
0.5 - 10.0	25	65	1.05	0.64 - 1.71
10.5 - 20.0	11	22	1.36	0.65 - 2.86
>20.0	11	19	1.58	0.74 - 3.36
Total Acreage				
1 - 10	17	29	1.60	0.87 - 2.96
11 - 25	13	36	0.99	0.51 - 1.89
>25	17	41	1.13	0.63 - 2.03
Distance to Bog (ft)				
1 - 1,000	18	41	1.20	0.67 - 2.13
1,001 - 2,000	23	50	1.26	0.75 - 2.11
2,001 - 2,600	6	15	1.09	0.42 - 2.85
Direction**				
Northeast	8	27	0.81	0.36 - 1.81
Southeast	13	30	1.18	0.60 - 2.31
Southwest	10	24	1.14	0.54 - 2.42
Northwest	16	25	1.75	0.92 - 3.31

*Odds ratios were computed by comparing the number of exposed cases and controls to 218 unexposed cases and 595 controls.

**Direction of study subject to exposure site

Table III.16.4 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	44	191	0.84	0.59 - 1.20
No. Years Exposed				
0.5 - 10.0	23	110	0.76	0.48 - 1.22
10.5 - 20.0	7	44	0.58	0.26 - 1.29
>20.0	14	37	1.38	0.74 - 2.58
Total Acreage				
1 - 10	17	57	1.09	0.62 - 1.90
11 - 25	14	66	0.77	0.43 - 1.40
>25	13	68	0.70	0.38 - 1.28
Distance to Bog (ft)				
1 - 1,000	16	72	0.81	0.46 - 1.41
1,001 - 2,000	22	85	0.94	0.58 - 1.54
2,001 - 2,600	6	34	0.64	0.27 - 1.54
Direction**				
Northeast	8	41	0.71	0.33 - 1.53
Southeast	17	54	1.15	0.66 - 2.01
Southwest	7	47	0.54	0.25 - 1.20
Northwest	12	49	0.89	0.47 - 1.70

*Odds ratios were computed by comparing the number of exposed cases and controls to 271 unexposed cases and 988 controls.

**Direction of study subject to exposure site

Table III.16.5 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	6	140	0.56	0.24 - 1.30
No. Years Exposed				
0.5 - 10.0	4	77	0.67	0.24 - 1.90
10.5 - 20.0	2	33	----	----
>20.0	0	30	----	----
Total Acreage				
1 - 10	1	41	----	----
11 - 25	2	50	----	----
>25	3	49	0.79	0.24 - 2.62
Distance to Bog (ft)				
1 - 1,000	2	50	----	----
1,001 - 2,000	3	67	0.58	0.18 - 1.88
2,001 - 2,600	1	23	----	----
Direction**				
Northeast	0	30	----	----
Southeast	1	41	----	----
Southwest	2	34	----	----
Northwest	3	35	1.11	0.33 - 3.73

*Odds ratios were computed by comparing the number of exposed cases and controls to 56 unexposed cases and 727 controls.

**Direction of study subject to exposure site

Table III.16.6 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	122	0.71	0.25 - 2.04
No. Years Exposed				
0.5 - 10.0	3	71	0.91	0.27 - 3.07
10.5 - 20.0	1	25	----	----
>20.0	0	26	----	----
Total Acreage				
1 - 10	0	32	----	----
11 - 25	2	44	----	----
>25	2	46	----	----
Distance to Bog (ft)				
1 - 1,000	0	47	----	----
1,001 - 2,000	4	50	1.73	0.60 - 5.03
2,001 - 2,600	0	25	----	----
Direction**				
Northeast	0	21	----	----
Southeast	2	41	----	----
Southwest	0	29	----	----
Northwest	2	31	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 31 unexposed cases and 670 controls.

**Direction of study subject to exposure site

Table III.16.7 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	4	98	0.66	0.23 - 1.90
No. Years Exposed				
0.5 - 10.0	2	59	----	----
10.5 - 20.0	0	23	----	----
>20.0	2	16	----	----
Total Acreage				
1 - 10	1	32	----	----
11 - 25	0	30	----	----
>25	3	36	1.35	0.40 - 4.61
Distance to Bog (ft)				
1 - 1,000	1	31	----	----
1,001 - 2,000	3	54	0.90	0.27 - 3.04
2,001 - 2,600	0	13	----	----
Direction**				
Northeast	2	20	----	----
Southeast	0	28	----	----
Southwest	0	19	----	----
Northwest	2	31	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 535 controls.

**Direction of study subject to exposure site

Table III.16.8 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	10	195	1.00	0.52 - 2.32
No. Years Exposed				
0.5 - 10.0	3	114	0.56	0.17 - 1.86
10.5 - 20.0	4	46	1.86	0.63 - 5.46
>20.0	3	35	1.83	0.54 - 6.25
Total Acreage				
1 - 10	4	68	1.26	0.43 - 3.70
11 - 25	3	59	1.09	0.32 - 3.70
>25	3	68	0.94	0.28 - 3.21
Distance to Bog (ft)				
1 - 1,000	3	67	0.96	0.28 - 3.25
1,001 - 2,000	3	91	0.71	0.21 - 2.36
2,001 - 2,600	4	37	2.31	0.79 - 6.76
Direction**				
Northeast	2	44	----	----
Southeast	4	52	1.64	0.56 - 4.85
Southwest	2	41	----	----
Northwest	2	58	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 26 unexposed cases and 556 controls.

**Direction of study subject to exposure site

Table III.16.9 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Exposure ≤ 2,600 feet

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	11	106	2.43	1.04 - 5.27
No. Years Exposed				
0.5 - 10.0	11	66	3.91	1.65 - 8.61
10.5 - 20.0	0	25	----	----
>20.0	0	15	----	----
Total Acreage				
1 - 10	5	33	3.55	0.99 - 10.22
11 - 25	1	34	----	----
>25	5	39	3.00	0.85 - 8.54
Distance to Bog (ft)				
1 - 1,000	3	43	1.63	0.48 - 5.56
1,001 - 2,000	6	48	2.92	0.93 - 7.74
2,001 - 2,600	2	15	----	----
Direction**				
Northeast	0	25	----	----
Southeast	4	28	3.34	0.79 - 10.60
Southwest	6	24	5.85	1.79 - 16.37
Northwest	1	29	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 26 unexposed cases and 609 controls.

**Direction of study subject to exposure site

Table III.16.10 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	355	408	1.11	0.93 - 1.32
No. Years Exposed				
0.5 - 10.0	212	250	1.08	0.88 - 1.33
10.5 - 20.0	70	84	1.06	0.76 - 1.48
>20.0	73	74	1.26	0.90 - 1.77
Total Acreage				
1 - 10	137	161	1.09	0.85 - 1.39
11 - 25	103	119	1.11	0.83 - 1.47
>25	115	128	1.15	0.88 - 1.50
Distance to Bog (ft)				
1 - 1,000	125	137	1.17	0.90 - 1.51
1,001 - 2,000	162	193	1.07	0.85 - 1.35
2,001 - 2,600	68	78	1.11	0.79 - 1.56
Direction**				
Northeast	70	90	0.99	0.72 - 1.38
Southeast	123	109	1.44	1.08 - 1.92
Southwest	78	99	1.01	0.74 - 1.38
Northwest	84	110	0.98	0.72 - 1.32

*Odds ratios were computed by comparing the number of exposed cases and controls to 687 unexposed cases and 877 controls.

**Direction of study subject to exposure site

Table III.16.11 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	96	400	1.28	0.97 - 1.70
No. Years Exposed				
0.5 - 10.0	62	238	1.39	1.00 - 1.93
10.5 - 20.0	17	92	0.99	0.57 - 1.70
>20.0	17	70	1.30	0.74 - 2.26
Total Acreage				
1 - 10	36	157	1.23	0.82 - 1.83
11 - 25	27	118	1.22	0.78 - 1.92
>25	33	125	1.41	0.93 - 2.14
Distance to Bog (ft)				
1 - 1,000	33	137	1.29	0.85 - 1.95
1,001 - 2,000	47	186	1.35	0.94 - 1.94
2,001 - 2,600	16	77	1.10	0.63 - 1.95
Direction**				
Northeast	20	88	1.21	0.73 - 2.03
Southeast	35	111	1.68	1.07 - 2.59
Southwest	24	96	1.34	0.83 - 2.15
Northwest	17	105	0.87	0.50 - 1.48

*Odds ratios were computed by comparing the number of exposed cases and controls to 155 unexposed cases and 828 controls.

**Direction of study subject to exposure site

Table III.16.12 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure ≤ 2,600 feet

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	90	213	1.18	0.87 - 1.59
No. Years Exposed				
0.5 - 10.0	53	130	1.14	0.79 - 1.63
10.5 - 20.0	14	44	0.89	0.47 - 1.66
>20.0	23	39	1.64	0.96 - 2.83
Total Acreage				
1 - 10	41	81	1.41	0.93 - 2.13
11 - 25	22	62	0.99	0.59 - 1.66
>25	27	70	1.08	0.67 - 1.73
Distance to Bog (ft)				
1 - 1,000	37	76	1.36	0.89 - 2.08
1,001 - 2,000	36	104	0.97	0.64 - 1.46
2,001 - 2,600	17	33	1.44	0.78 - 2.64
Direction**				
Northeast	17	56	0.85	0.48 - 1.50
Southeast	30	52	1.61	1.00 - 2.60
Southwest	21	44	1.33	0.77 - 2.30
Northwest	22	61	1.01	0.60 - 1.69

*Odds ratios were computed by comparing the number of exposed cases and controls to 175 unexposed cases and 488 controls.

**Direction of study subject to exposure site

Table III.16.13 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	106	386	1.04	0.80 - 1.35
No. Years Exposed				
0.5 - 10.0	60	233	0.97	0.70 - 1.34
10.5 - 20.0	25	79	1.19	0.74 - 1.92
>20.0	20	74	1.02	0.61 - 1.71
Total Acreage				
1 - 10	36	150	0.91	0.61 - 1.34
11 - 25	40	115	1.31	0.89 - 1.94
>25	29	121	0.91	0.59 - 1.40
Distance to Bog (ft)				
1 - 1,000	32	128	0.94	0.62 - 1.43
1,001 - 2,000	52	183	1.07	0.76 - 1.51
2,001 - 2,600	21	75	1.06	0.64 - 1.76
Direction**				
Northeast	22	85	0.98	0.60 - 1.60
Southeast	37	104	1.34	0.90 - 2.01
Southwest	18	95	0.72	0.42 - 1.21
Northwest	28	102	1.04	0.66 - 1.62

*Odds ratios were computed by comparing the number of exposed cases and controls to 210 unexposed cases and 793 controls.

**Direction of study subject to exposure site

Table III.16.14 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	18	288	0.82	0.47 - 1.45
No. Years Exposed				
0.5 - 10.0	12	171	0.92	0.48 - 1.79
10.5 - 20.0	3	60	0.66	0.20 - 2.18
>20.0	3	57	0.69	0.21 - 2.30
Total Acreage				
1 - 10	7	109	0.85	0.37 - 1.93
11 - 25	5	89	0.74	0.29 - 1.91
>25	6	90	0.88	0.36 - 2.12
Distance to Bog (ft)				
1 - 1,000	7	88	1.05	0.46 - 2.40
1,001 - 2,000	9	146	0.81	0.39 - 1.70
2,001 - 2,600	2	54	----	----
Direction**				
Northeast	4	60	0.88	0.31 - 2.53
Southeast	3	80	0.49	0.15 - 1.63
Southwest	5	77	0.85	0.33 - 2.22
Northwest	6	71	1.11	0.46 - 2.70

*Odds ratios were computed by comparing the number of exposed cases and controls to 44 unexposed cases and 579 controls.

**Direction of study subject to exposure site

Table III.16.15 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	8	256	0.62	0.28 - 1.38
No. Years Exposed				
0.5 - 10.0	5	155	0.64	0.24 - 1.68
10.5 - 20.0	1	53	----	----
>20.0	2	48	----	----
Total Acreage				
1 - 10	2	102	----	----
11 - 25	3	72	0.83	0.25 - 2.79
>25	3	82	0.73	0.22 - 2.44
Distance to Bog (ft)				
1 - 1,000	2	81	----	----
1,001 - 2,000	5	117	0.85	0.32 - 2.25
2,001 - 2,600	1	58	----	----
Direction**				
Northeast	1	52	----	----
Southeast	3	73	0.82	0.24 - 2.75
Southwest	1	67	--	----
Northwest	3	64	0.93	0.27 - 3.16

*Odds ratios were computed by comparing the number of exposed cases and controls to 27 unexposed cases and 536 controls.

**Direction of study subject to exposure site

Table III.16.16 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	13	195	1.22	0.61 - 2.44
No. Years Exposed				
0.5 - 10.0	9	116	1.42	0.64 - 3.13
10.5 - 20.0	1	44	----	----
>20.0	3	35	1.56	0.45 - 5.45
Total Acreage				
1 - 10	5	74	1.23	0.46 - 3.33
11 - 25	2	57	----	----
>25	6	64	1.71	0.67 - 4.35
Distance to Bog (ft)				
1 - 1,000	5	59	1.55	0.57 - 4.18
1,001 - 2,000	4	100	0.73	0.25 - 2.15
2,001 - 2,600	4	36	2.03	0.68 - 6.04
Direction**				
Northeast	4	41	1.78	0.60 - 5.31
Southeast	4	55	1.33	0.45 - 3.96
Southwest	1	42	----	----
Northwest	4	57	1.28	0.43 - 3.82

*Odds ratios were computed by comparing the number of exposed cases and controls to 24 unexposed cases and 438 controls.

**Direction of study subject to exposure site

Table III.16.17 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	241	1.06	0.52 - 2.15
No. Years Exposed				
0.5 - 10.0	5	141	0.75	0.28 - 2.01
10.5 - 20.0	3	53	1.20	0.35 - 4.13
>20.0	4	47	1.81	0.60 - 5.43
Total Acreage				
1 - 10	4	89	0.96	0.32 - 2.82
11 - 25	3	66	0.97	0.28 - 3.30
>25	5	86	1.24	0.46 - 3.33
Distance to Bog (ft)				
1 - 1,000	5	82	1.30	0.48 - 3.49
1,001 - 2,000	3	113	0.56	0.17 - 1.88
2,001 - 2,600	4	46	1.85	0.62 - 5.47
Direction**				
Northeast	2	55	----	----
Southeast	6	66	1.93	0.77 - 4.83
Southwest	2	52	----	----
Northwest	2	68	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 24 unexposed cases and 510 controls.

**Direction of study subject to exposure site

Table III.16.18 Results of Crude Categorical Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Exposure $\leq$ 2,600 feet

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	13	231	1.13	0.57 - 2.27
No. Years Exposed				
0.5 - 10.0	6	145	0.83	0.33 - 2.08
10.5 - 20.0	6	50	2.42	0.94 - 6.20
>20.0	1	36	----	----
Total Acreage				
1 - 10	6	99	1.22	0.49 - 3.07
11 - 25	1	66	----	----
>25	6	66	1.83	0.72 - 4.65
Distance to Bog (ft)				
1 - 1,000	4	80	1.01	0.34 - 2.99
1,001 - 2,000	6	109	1.11	0.44 - 2.78
2,001 - 2,600	3	42	1.44	0.42 - 4.96
Direction**				
Northeast	0	51	----	----
Southeast	5	69	1.46	0.54 - 3.94
Southwest	6	54	2.24	0.90 - 5.60
Northwest	2	57	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 24 unexposed cases and 484 controls.

**Direction of study subject to exposure site

Table III.16.19 Results of Crude Exposure Metric* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00058	0.81	1.01	0.94 - 1.08
Lung	0.00219	0.45	1.03	0.95 - 1.12
Breast	-0.00094	0.82	0.99	0.88 - 1.11
Colorectal	-0.00025	0.94	1.00	0.91 - 1.09
Bladder	-0.00591	0.62	0.92	0.66 - 1.29
Kidney	-0.01195	0.64	0.84	0.42 - 1.70
Pancreas	-0.00227	0.82	0.97	0.74 - 1.27
Leukemia	-0.00190	0.80	0.97	0.79 - 1.20
Brain	-0.00180	0.89	0.97	0.69 - 1.38

*Metric: $\sum\left(\frac{1}{distance}\right)(acreage)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared subjects whose exposure metric was at the 75th percentile to unexposed subjects.

Table III.16.20 Results of Crude Exposure Metric* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-value	Odds Ratio***	95% Confidence Interval
All Cancers	0.00103	0.43	1.02	0.98 - 1.06
Lung	0.00095	0.61	1.01	0.96 - 1.07
Breast	-0.00093	0.70	0.99	0.92 - 1.06
Colorectal	0.00073	0.66	1.01	0.96 - 1.06
Bladder	-0.00162	0.72	0.98	0.86 - 1.11
Kidney	-0.00041	0.94	0.99	0.85 - 1.16
Pancreas	0.00165	0.62	1.03	0.93 - 1.13
Leukemia	0.00011	0.98	1.00	0.88 - 1.14
Brain	0.00288	0.42	1.04	0.94 - 1.16

*Metric: $\sum \left(\frac{1}{distance}\right)(acreage)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed

***Odds ratios compared subjects whose exposure metric was at the 75th percentile to unexposed subjects.

Table III.16.21 Results of Adjusted Categorical* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	0.1144	0.34	1.12	0.88 - 1.42
Lung	0.1861	0.35	1.20	0.81 - 1.79
Breast	0.2076	0.33	1.23	0.81 - 1.86
Colorectal	-0.2287	0.27	0.80	0.53 - 1.19
Bladder	-0.6805	0.15	0.51	0.20 - 1.27
Kidney	-0.2841	0.62	0.75	0.24 - 2.33
Pancreas	-1.0867	0.15	0.34	0.08 - 1.50
Leukemia	0.0634	0.87	1.07	0.49 - 2.30
Brain	0.7878	0.05	2.20	0.99 - 4.88

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 2,600 feet of a bog.

**Sites with less than three exposed cases were not analyzed.

Table III.16.22 Results of Adjusted Categorical* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio	95% Confidence Interval
All Cancers	0.1438	0.13	1.15	0.96 - 1.39
Lung	0.1886	0.25	1.21	0.88 - 1.66
Breast	0.1657	0.33	1.18	0.85 - 1.64
Colorectal	0.0960	0.53	1.10	0.82 - 1.49
Bladder	-0.1543	0.62	0.86	0.46 - 1.59
Kidney	-0.4422	0.31	0.64	0.27 - 1.51
Pancreas	-0.1055	0.80	0.90	0.40 - 2.04
Leukemia	0.0186	0.96	1.02	0.49 - 2.11
Brain	0.0118	0.98	1.01	0.48 - 2.13

*Exposure categorized as Ever/Never.
Ever exposed subjects lived within 2,600 feet of a bog.

**Sites with less than three exposed cases were not analyzed.

Table III.16.23 Results of Adjusted Exposure Metric* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	0.0002	0.95	1.00	0.93 - 1.08
Lung	0.0003	0.93	1.00	0.90 - 1.13
Breast	-0.0001	0.97	1.00	0.89 - 1.12
Colorectal	-0.0022	0.60	0.97	0.86 - 1.09
Bladder	-0.0055	0.66	0.93	0.66 - 1.30
Kidney	-0.0102	0.68	0.87	0.43 - 1.74
Pancreas	-0.0101	0.64	0.87	0.47 - 1.59
Leukemia	-0.0001	0.99	1.00	0.80 - 1.24
Brain	-0.0012	0.93	0.98	0.66 - 1.46

*Exposure Metric: $\sum \left(\frac{1}{distance}\right)(acreage)(wind\ freq.)(no.\ years)$

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.16.24 Results of Adjusted Exposure Metric* Analysis Examining Proximity to Cranberry Bogs as an Exposure Source Without Taking Latent Period into Account

Cancer Site**	Beta Coefficient	P-Value	Odds Ratio***	95% Confidence Interval
All Cancers	0.0012	0.39	1.02	0.98 - 1.06
Lung	0.0008	0.75	1.01	0.94 - 1.08
Breast	-0.0003	0.89	0.99	0.92 - 1.07
Colorectal	0.0002	0.90	1.00	0.95 - 1.06
Bladder	-0.0010	0.84	0.99	0.86 - 1.13
Kidney	0.0009	0.87	1.01	0.87 - 1.19
Pancreas	0.0003	0.94	1.01	0.88 - 1.14
Leukemia	0.0018	0.70	1.03	0.89 - 1.18
Brain	0.0036	0.35	1.06	0.94 - 1.18

*Exposure Metric: $\sum \left(\frac{1}{distance}\right)$ (acreage) (wind freq.) (no. years)

**Sites with less than three exposed cases were not analyzed.

***Odds ratios compared exposed subjects whose metric was at the 75th percentile to unexposed subjects.

Table III.17.1 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	356	418	1.10	0.92-1.32
No. Yrs. Exposed				
0.25-10.0	154	183	1.09	0.85-1.39
10.5-20.0	88	96	1.18	0.87-1.62
>20.0	114	139	1.06	0.80-1.39

*Odds ratios were computed by comparing the number of exposed cases and controls to 495 unexposed cases and 639 unexposed controls.

Table III.17.2 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	87	431	0.95	0.70-1.29
No. Yrs. Exposed				
0.25-10.0	37	196	0.89	0.60-1.33
10.5-20.0	27	97	1.32	0.82-2.10
>20.0	23	138	0.79	0.49-1.28

*Odds ratios were computed by comparing the number of exposed cases and controls to 123 unexposed cases and 581 unexposed controls.

Table III.17.3 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	96	250	1.17	0.85-1.61
No. Yrs. Exposed				
0.25-10.0	44	103	1.30	0.86-1.97
10.5-20.0	18	64	0.86	0.49-1.51
>20.0	34	83	1.25	0.80-1.97

*Odds ratios were computed by comparing the number of exposed cases and controls to 112 unexposed cases and 342 unexposed controls.

Table III.17.4 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	90	399	0.80	0.60-1.06
No. Yrs. Exposed				
0.25-10.0	33	170	0.68	0.45-1.03
10.5-20.0	26	93	0.99	0.62-1.58
>20.0	31	136	0.80	0.52-1.23

*Odds ratios were computed by comparing the number of exposed cases and controls to 160 unexposed cases and 565 unexposed controls.

Table III.17.5 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	18	293	0.81	0.45-1.46
No. Yrs. Exposed				
0.25-10.0	12	133	1.19	0.60-2.37
10.5-20.0	1	60	----	----
>20.0	5	100	0.66	0.25-1.72

*Odds ratios were computed by comparing the number of exposed cases and controls to 33 unexposed cases and 435 unexposed controls.

Table III.17.6 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	253	0.93	0.44-1.93
No. Yrs. Exposed				
0.25-10.0	6	110	1.07	0.42-2.72
10.5-20.0	4	56	1.40	0.46-4.22
>20.0	2	87	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 20 unexposed cases and 391 unexposed controls.

Table III.17.7 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	12	228	0.68	0.33-1.39
No. Yrs. Exposed				
0.25-10.0	3	97	0.40	0.12-1.30
10.5-20.0	3	57	0.68	0.20-2.32
>20.0	6	74	1.04	0.41-2.66

*Odds ratios were computed by comparing the number of exposed cases and controls to 22 unexposed cases and 282 unexposed controls.

Table III.17.8 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	21	460	0.87	0.39-1.93
No. Yrs. Exposed				
0.25-10.0	7	223	0.60	0.22-1.62
10.5-20.0	7	93	1.43	0.52-3.95
>20.0	7	144	0.92	0.33-2.54

*Odds ratios were computed by comparing the number of exposed cases and controls to 9 unexposed cases and 171 unexposed controls.

Table III.17.9 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	19	244	1.98	0.97-4.05
No. Yrs. Exposed				
0.25-10.0	12	111	2.75	1.10-6.75
10.5-20.0	2	56	----	----
>20.0	5	77	1.65	0.58-4.73

*Odds ratios were computed by comparing the number of exposed cases and controls to 13 unexposed cases and 331 unexposed controls.

Table III.17.10 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	18	----	----
No. Yrs. Exposed				
0.25-10.0	0	8	----	----
10.5-20.0	0	5	----	----
>20.0	1	5	----	----

There were 3 unexposed cases and 20 unexposed controls.

Table III.17.11 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	206	246	1.01	0.81-1.26
Ever on Falmouth public supply only	124	145	1.03	0.79-1.35
Ever on Hyannis public supply only	83	104	0.96	0.71-1.32

*Odds ratios were computed by comparing the number of exposed cases and controls to 495 unexposed cases and 598 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.12 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	44	250	0.76	0.52-1.10
Ever on Falmouth public supply only	27	148	0.78	0.50-1.23
Ever on Hyannis public supply only	17	106	0.69	0.40-1.19

*Odds ratios were computed by comparing the number of exposed cases and controls to 132 unexposed cases and 568 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.13 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	54	149	0.98	0.67-1.42
Ever on Falmouth public supply only	30	89	0.91	0.57-1.44
Ever on Hyannis public supply only	25	62	1.09	0.65-1.81

*Odds ratios were computed by comparing the number of exposed cases and controls to 121 unexposed cases and 326 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.14 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	60	236	0.97	0.69-1.36
Ever on Falmouth public supply only	40	140	1.09	0.73-1.62
Ever on Hyannis public supply only	20	98	0.78	0.46-1.30

*Odds ratios were computed by comparing the number of exposed cases and controls to 141 unexposed cases and 538 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.15 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	12	168	1.00	0.50-2.01
Ever on Falmouth public supply only	8	104	1.08	0.48-2.43
Ever on Hyannis public supply only	4	67	0.84	0.28-2.45

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 406 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.16 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	7	147	1.15	0.46-2.88
Ever on Falmouth public supply only	4	86	1.13	0.36-3.48
Ever on Hyannis public supply only	3	63	1.15	0.32-4.10

*Odds ratios were computed by comparing the number of exposed cases and controls to 15 unexposed cases and 363 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.17 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	7	135	0.63	0.27-1.50
Ever on Falmouth public supply only	3	81	0.45	0.14-1.50
Ever on Hyannis public supply only	4	54	0.90	0.30-2.72

*Odds ratios were computed by comparing the number of exposed cases and controls to 23 unexposed cases and 281 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.18 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	9	256	0.71	0.31-1.62
Ever on Falmouth public supply only	5	155	0.65	0.24-1.79
Ever on Hyannis public supply only	4	105	0.77	0.25-2.34

*Odds ratios were computed by comparing the number of exposed cases and controls to 16 unexposed cases and 322 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.19 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	12	140	1.80	0.84-3.87
Ever on Falmouth public supply only	6	82	1.54	0.59-4.03
Ever on Hyannis public supply only	6	59	2.14	0.82-5.57

*Odds ratios were computed by comparing the number of exposed cases and controls to 16 unexposed cases and 336 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.20 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

<u>Cancer Site</u>: Liver

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	1	13	----	----
Ever on Falmouth public supply only	1	8	----	----
Ever on Hyannis public supply only	0	5	----	----

There were 2 unexposed cases and 21 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.21 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	750	902	1.28	0.98-1.67
No. Yrs. Exposed				
0.25-10.0	329	413	1.22	0.92-1.63
10.5-20.0	194	196	1.52	1.08-2.12
>20.0	227	293	1.19	0.88-1.61

*Odds ratios were computed by comparing the number of exposed cases and controls to 101 unexposed cases and 155 unexposed controls.

Table III.17.22 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	185	894	0.98	0.62-1.55
No. Yrs. Exposed				
0.25-10.0	86	402	1.01	0.62-1.65
10.5-20.0	47	203	1.09	0.64-1.87
>20.0	52	289	0.85	0.50-1.43

*Odds ratios were computed by comparing the number of exposed cases and controls to 25 unexposed cases and 118 unexposed controls.

Table III.17.23 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	186	526	1.06	0.64-1.77
No. Yrs. Exposed				
0.25-10.0	77	235	0.98	0.57-1.70
10.5-20.0	45	108	1.25	0.69-2.27
>20.0	64	183	1.05	0.60-1.84

*Odds ratios were computed by comparing the number of exposed cases and controls to 22 unexposed cases and 66 unexposed controls.

Table III.17.24 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	221	852	1.00	0.65-1.55
No. Yrs. Exposed				
0.25-10.0	96	386	0.96	0.60-1.53
10.5-20.0	60	182	1.27	0.77-2.10
>20.0	65	284	0.88	0.54-1.44

*Odds ratios were computed by comparing the number of exposed cases and controls to 29 unexposed cases and 112 unexposed controls.

Table III.17.25 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	45	640	1.03	0.43-2.49
No. Yrs. Exposed				
0.25-10.0	24	305	1.15	0.46-2.91
10.5-20.0	12	141	1.25	0.45-3.45
>20.0	9	194	0.68	0.24-1.96

*Odds ratios were computed by comparing the number of exposed cases and controls to 6 unexposed cases and 88 unexposed controls.

Table III.17.26 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	28	570	0.91	0.31-2.66
No. Yrs. Exposed				
0.25-10.0	12	265	0.84	0.26-2.68
10.5-20.0	9	132	1.26	0.38-4.24
>20.0	7	173	0.75	0.21-2.63

*Odds ratios were computed by comparing the number of exposed cases and controls to 4 unexposed cases and 74 unexposed controls.

Table III.17.27 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	27	456	0.46	0.19-1.08
No. Yrs. Exposed				
0.25-10.0	11	198	0.43	0.16-1.13
10.5-20.0	6	105	0.44	0.14-1.35
>20.0	10	153	0.50	0.18-1.37

*Odds ratios were computed by comparing the number of exposed cases and controls to 7 unexposed cases and 54 unexposed controls.

Table III.17.28 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	27	567	1.02	0.30-3.45
No. Yrs. Exposed				
0.25-10.0	12	248	1.03	0.28-3.78
10.5-20.0	6	135	0.95	0.23-3.92
>20.0	9	184	1.04	0.27-3.98

*Odds ratios were computed by comparing the number of exposed cases and controls to 3 unexposed cases and 64 unexposed controls.

Table III.17.29 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	27	504	0.76	0.28-2.04
No. Yrs. Exposed				
0.25-10.0	8	227	0.50	0.16-1.55
10.5-20.0	9	105	1.22	0.39-3.79
>20.0	10	172	0.83	0.27-2.50

*Odds ratios were computed by comparing the number of exposed cases and controls to 5 unexposed cases and 71 unexposed controls.

Table III.17.30 Results of Crude Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	4	33	----	----
No. Yrs. Exposed				
0.25-10.0	3	12	----	----
10.5-20.0	0	10	----	----
>20.0	1	11	----	----

There were 0 unexposed cases and 5 unexposed controls.

Table III.17.31 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

<u>Cancer Site</u>: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	400	489	1.00	0.84-1.20
Ever on Falmouth public supply only	233	289	0.99	0.80-1.22
Ever on Hyannis public supply only	170	205	1.02	0.80-1.29

*Odds ratios were computed by comparing the number of exposed cases and controls to 449 unexposed cases and 551 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.32 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	90	483	0.82	0.61-1.10
Ever on Falmouth public supply only	51	290	0.77	0.54-1.10
Ever on Hyannis public supply only	39	199	0.86	0.58-1.28

*Odds ratios were computed by comparing the number of exposed cases and controls to 120 unexposed cases and 526 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.33 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	97	293	0.90	0.65-1.23
Ever on Falmouth public supply only	52	173	0.81	0.56-1.19
Ever on Hyannis public supply only	48	123	1.06	0.71-1.58

*Odds ratios were computed by comparing the number of exposed cases and controls to 110 unexposed cases and 298 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.34 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

<u>Cancer Site</u>: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	124	462	1.07	0.81-1.42
Ever on Falmouth public supply only	78	275	1.13	0.82-1.56
Ever on Hyannis public supply only	46	191	0.96	0.66-1.40

*Odds ratios were computed by comparing the number of exposed cases and controls to 125 unexposed cases and 499 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.35 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	26	346	1.14	0.64-2.01
Ever on Falmouth public supply only	17	220	1.17	0.62-2.22
Ever on Hyannis public supply only	9	130	1.05	0.48-2.31

*Odds ratios were computed by comparing the number of exposed cases and controls to 25 unexposed cases and 379 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.36 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	17	295	1.33	0.65-2.70
Ever on Falmouth public supply only	11	182	1.39	0.63-3.09
Ever on Hyannis public supply only	6	116	1.19	0.45-3.15

*Odds ratios were computed by comparing the number of exposed cases and controls to 15 unexposed cases and 346 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.37 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	12	244	0.59	0.29-1.22
Ever on Falmouth public supply only	7	143	0.59	0.25-1.40
Ever on Hyannis public supply only	5	102	0.59	0.22-1.59

*Odds ratios were computed by comparing the number of exposed cases and controls to 22 unexposed cases and 265 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.38 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	14	320	0.84	0.41-1.76
Ever on Falmouth public supply only	8	189	0.82	0.34-1.95
Ever on Hyannis public supply only	6	135	0.86	0.33-2.24

*Odds ratios were computed by comparing the number of exposed cases and controls to 16 unexposed cases and 309 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.39 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	18	261	1.54	0.76-3.15
Ever on Falmouth public supply only	7	152	1.03	0.41-2.61
Ever on Hyannis public supply only	11	111	2.22	0.99-4.94

*Odds ratios were computed by comparing the number of exposed cases and controls to 14 unexposed cases and 313 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.40 Results of Crude Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Liver

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	2	17	----	----
Ever on Falmouth public supply only	2	9	----	----
Ever on Hyannis public supply only	0	8	----	----

*Odds ratios were computed by comparing the number of exposed cases and controls to 2 unexposed cases and 21 unexposed controls. Unexposed cases and controls never lived at a residence on either Falmouth or Hyannis public water supply.

Table III.17.41 Results of Adjusted Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water contaminants Taking Latent Period into Account

Cancer Site*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.08347	0.40	1.09	0.90 - 1.32
Lung	0.02060	0.90	1.02	0.73 - 1.43
Breast	0.17371	0.33	1.19	0.84 - 1.69
Colorectal	-0.27621	0.10	0.76	0.55 - 1.05
Bladder	-0.40197	0.24	0.67	0.34 - 1.30
Kidney	0.09808	0.81	1.10	0.50 - 2.43
Pancreas	-0.48542	0.22	0.62	0.29 - 1.33
Leukemia	-0.12219	0.77	0.88	0.39 - 2.00
Brain	0.72481	0.06	2.06	0.98 - 4.36

*No adjusted analyses were performed for liver cancer.

Table III.17.42 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.03303	0.78	1.03	0.82 - 1.30
Ever on Falmouth public supply only	0.07331	0.61	1.08	0.81 - 1.43
Ever on Hyannis public supply only	-0.04662	0.78	0.95	0.69 - 1.32

Table III.17.43 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Lung

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.21447	0.31	0.81	0.54 - 1.22
Ever on Falmouth public supply only	-0.17511	0.49	0.84	0.51 - 1.37
Ever on Hyannis public supply only	-0.33300	0.28	0.72	0.39 - 1.31

Table III.17.44 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

<u>Cancer Site</u>: Breast

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.00374	0.98	1.00	0.66 - 1.52
Ever on Falmouth public supply only	-0.02609	0.92	0.97	0.58 - 1.63
Ever on Hyannis public supply only	0.08104	0.78	1.08	0.62 - 1.91

Table III.17.45 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Colorectal

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.04030	0.84	1.04	0.71 - 1.52
Ever on Falmouth public supply only	0.16400	0.47	1.18	0.75 - 1.84
Ever on Hyannis public supply only	-0.17193	0.55	0.84	0.48 - 1.48

Table III.17.46 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Bladder

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.11041	0.78	0.90	0.41 - 1.96
Ever on Falmouth public supply only	0.06754	0.89	1.07	0.42 - 2.73
Ever on Hyannis public supply only	-0.38871	0.53	0.68	0.20 - 2.27

Table III.17.47 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Kidney

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.20812	0.68	1.23	0.46 - 3.33
Ever on Falmouth public supply only	0.08324	0.89	1.09	0.32 - 3.64
Ever on Hyannis public supply only	0.24095	0.73	1.27	0.32 - 5.09

Table III.17.48 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Pancreas

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.54874	0.25	0.58	0.23 - 1.46
Ever on Falmouth public supply only	-0.77213	0.24	0.46	0.12 - 1.70
Ever on Hyannis public supply only	-0.32260	0.59	0.72	0.22 - 2.35

Table III.17.49 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Leukemia

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.23612	0.59	0.79	0.15 - 4.15
Ever on Falmouth public supply only	-0.23260	0.66	0.79	0.28 - 2.26
Ever on Hyannis public supply only	-0.26928	0.64	0.76	0.26 - 2.36

Table III.17.50 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Taking Latent Period into Account

Cancer Site: Brain

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.63466	0.12	1.89	0.84 - 4.22
Ever on Falmouth public supply only	0.42175	0.41	1.52	0.56 - 4.16
Ever on Hyannis public supply only	0.84844	0.10	2.34	0.85 - 6.44

Table III.17.51 Results of Adjusted Categorical Analysis Examining the Upper Cape Public Water Supplies as Potential Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
All Cancers	0.26279	0.06	1.30	0.98 - 1.72
Lung	0.00572	0.98	1.01	0.61 - 1.66
Breast	0.00992	0.97	1.01	0.59 - 1.73
Colorectal	0.08839	0.72	1.09	0.67 - 1.77
Bladder	-0.02020	0.97	0.98	0.37 - 2.56
Kidney	-0.23106	0.69	0.79	0.25 - 2.47
Pancreas	-0.70839	0.17	0.49	0.18 - 1.36
Leukemia	0.00822	0.99	1.01	0.29 - 3.45
Brain	-0.22321	0.67	0.80	0.29 - 2.20

*No adjusted analyses were performed for liver cancer.

Table III.17.52 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: All Cancer Sites Combined

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.02419	0.80	1.02	0.85 - 1.24
Ever on Falmouth public supply only	-0.00200	0.99	1.00	0.80 - 1.25
Ever on Hyannis public supply only	0.05786	0.65	1.06	0.83 - 1.36

Table III.17.53 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Lung

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.12839	0.45	0.88	0.63 - 1.22
Ever on Falmouth public supply only	-0.13884	0.49	0.87	0.59 - 1.28
Ever on Hyannis public supply only	-0.11508	0.49	0.86	0.55 - 1.33

Table III.17.54 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

<u>Cancer Site</u>: Breast

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.13729	0.43	0.87	0.62 - 1.23
Ever on Falmouth public supply only	-0.20265	0.34	0.82	0.54 - 1.24
Ever on Hyannis public supply only	-0.00432	0.98	1.00	0.64 - 1.54

Table III.17.55 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

<u>Cancer Site</u>: Colorectal

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.13256	0.40	1.14	0.84 - 1.56
Ever on Falmouth public supply only	0.16066	0.38	1.17	0.82 - 1.68
Ever on Hyannis public supply only	0.07019	0.74	1.07	0.70 - 1.64

Table III.17.56 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Bladder

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.13158	0.68	1.14	0.61 - 2.13
Ever on Falmouth public supply only	0.18561	0.61	1.20	0.59 - 2.46
Ever on Hyannis public supply only	-0.05451	0.94	0.91	0.38 - 2.35

Table III.17.57 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Kidney

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.19713	0.62	1.22	0.56 - 2.64
Ever on Falmouth public supply only	0.15082	0.74	1.16	0.48 - 1.81
Ever on Hyannis public supply only	0.22428	0.68	1.25	0.44 - 3.58

Table III.17.58 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Pancreas

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.55060	0.16	0.58	0.27 - 1.24
Ever on Falmouth public supply only	-0.48610	0.30	0.62	0.24 - 1.55
Ever on Hyannis public supply only	-0.68012	0.21	0.51	0.17 - 1.47

Table III.17.59 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Leukemia

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	-0.14417	0.70	0.86	0.41 - 1.82
Ever on Falmouth public supply only	-0.08550	0.85	0.92	0.38 - 2.23
Ever on Hyannis public supply only	-0.21865	0.66	0.80	0.30 - 2.13

Table III.17.60 Results of Adjusted Categorical Analysis Examining the Falmouth (Falmouth Department of Public Works) and Hyannis (Barnstable Water Co.) Public Water Supplies as Sources of Water Contaminants Without Taking Latent Period into Account

Cancer Site: Brain

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever on Falmouth or Hyannis public supply	0.41820	0.26	1.52	0.73 - 3.16
Ever on Falmouth public supply only	0.00700	0.99	1.01	0.39 - 2.60
Ever on Hyannis public supply only	0.82437	0.05	2.28	0.98 - 5.29

Table III.18.1 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Intervals
Ever Exposed	39	35	1.39	0.88 - 2.20
No. Years Exposed				
0.5 - 10.0	35	29	1.50	0.92 - 2.47
10.5 - 20.0	4	6	0.83	0.23 - 2.95
Distance to Lines (ft)				
1 - 300	17	18	1.18	0.60 - 2.29
301 - 500	22	17	1.61	0.86 - 3.04

*Odds ratios were computed by comparing the number of exposed cases and controls to 1003 unexposed cases and 1250 unexposed controls.

Table III.18.2 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Intervals
Ever Exposed	13	37	1.76	0.93 - 3.33
No. Years Exposed				
0.5 - 10.0	11	32	1.72	0.86 - 3.43
10.5 - 20.0	2	5	---	---
Distance to Lines (ft)				
1 - 300	8	18	2.22	0.98 - 5.07
301 - 500	5	19	1.32	0.49 - 3.55

*Odds ratios were computed by comparing the number of exposed cases and controls to 238 unexposed cases and 1191 unexposed controls.

Table III.18.3 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Intervals
Ever Exposed	9	21	1.14	0.52 - 2.52
No. Years Exposed				
0.5 - 10.0	9	20	1.20	0.54 - 2.66
10.5 - 20.0	0	1	---	---
Distance to Lines (ft)				
1 - 300	2	11	---	---
301 - 500	7	10	1.86	0.71 - 4.87

*Odds ratios were computed by comparing the number of exposed cases and controls to 256 unexposed cases and 680 unexposed controls.

Table III.18.4 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Intervals
Ever Exposed	8	33	0.90	0.41 - 1.98
No. Years Exposed				
0.5 - 10.0	7	28	0.93	0.40 - 2.16
10.5 - 20.0	1	5	---	---
Distance to Lines (ft)				
1 - 300	3	16	0.70	0.20 - 2.40
301 - 500	5	17	1.10	0.40 - 3.00

*Odds ratios were computed by comparing the number of exposed cases and controls to 307 unexposed cases and 1146 unexposed controls.

Table III.18.5 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Bladder

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Intervals
Ever Exposed	4	27	2.15	0.74 - 6.19
No. Years Exposed				
0.5 - 10.0	4	24	2.41	0.84 - 6.96
10.5 - 20.0	0	3	---	---
Distance to Lines (ft)				
1 - 300	2	14	---	---
301 - 500	2	13	---	---

*Odds ratios were computed by comparing the number of exposed cases and controls to 58 unexposed cases and 840 unexposed controls.

Table III.18.6 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Intervals
Ever Exposed	1	14	---	---
No. Years Exposed				
0.5 - 10.0	1	11	---	---
10.5 - 20.0	0	3	---	---
Distance to Lines (ft)				
1 - 300	0	6	---	---
301 - 500	1	8	---	---

Table III.18.7 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

<u>Cancer Site</u>: Leukemia

	No. Cases	No. Controls	Odds Ratio	95% Confidence Intervals
Ever Exposed	2	24	---	---
<u>No. Years Exposed</u>				
0.5 - 10.0	1	19	---	---
10.5 - 20.0	1	5	---	---
<u>Distance to Lines (ft)</u>				
1 - 300	0	11	---	---
301 - 500	2	13	---	---

Table III.18.8 Results of Crude Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Intervals
Ever Exposed	2	22	---	---
<u>No. Years Exposed</u>				
0.5 - 10.0	2	19	---	---
10.5 - 20.0	0	3	---	---
<u>Distance to Lines (ft)</u>				
1 - 300	2	10	---	---
301 - 500	0	12	---	---

Table III.18.9 Results of Adjusted Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: All Cancer Sites Combined

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	0.3168	0.23	1.37	0.82 - 2.31
No. Years Exposed				
0.5 - 10.0	0.3984	0.16	1.49	0.86 - 2.58
10.5 - 20.0	-0.3969	0.65	0.67	0.12 - 3.67
Distance to Lines (ft)				
1 - 300	0.0933	0.81	1.10	0.52 - 2.33
301 - 500	0.5183	0.15	1.68	0.82 - 3.42

Table III.18.10 Results of Adjusted Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Lung

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	0.4519	0.26	1.57	0.72 - 3.44
No. Years Exposed				
0.5 - 10.0	0.4428	0.30	1.56	0.68 - 3.58
10.5 - 20.0*	----	----	----	----
Distance to Lines (ft)				
1 - 300	0.5866	0.27	1.80	0.63 - 5.10
301 - 500	0.2909	0.62	1.34	0.42 - 4.29

*Adjusted results are not presented if there were less than three exposed cases in a given category.

Table III.18.11 Results of Adjusted Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Breast

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	0.2045	0.64	1.23	0.52 - 2.87
No. Years Exposed				
0.5 - 10.0	0.2690	0.54	1.31	0.55 - 3.09
10.5 - 20.0*	----	----	----	----
Distance to Lines (ft)				
1 - 300*	----	----	----	----
301 - 500	0.6036	0.25	1.83	0.65 - 5.16

*Adjusted results are not presented if there were less than three exposed cases in a given category.

Table III.18.12 Results of Adjusted Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Colorectal

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	-0.2341	0.63	0.79	0.31 - 2.04
No. Years Exposed				
0.5 - 10.0	-0.0581	0.91	0.94	0.36 - 2.49
10.5 - 20.0*	----	----	----	----
Distance to Lines (ft)				
1 - 300	-0.1552	0.82	0.86	0.22 - 3.31
301 - 500	-0.3052	0.65	0.74	0.20 - 2.72

*Adjusted results are not presented if there were less than three exposed cases in a given category.

Table III.18.13 Results of Adjusted Categorical Analysis Examining 115 Kv Transmission Lines as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Bladder

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	0.9449	0.12	2.57	0.78 - 8.51
No. Years Exposed				
0.5 - 10.0	1.0379	0.09	2.82	0.84 - 9.53
10.5 - 20.0*	----	----	----	----
Distance to Lines (ft)				
1 - 300*	----	----	----	----
301 - 500*	----	----	----	----

*Adjusted results are not presented if there were less than three exposed cases in a given category.

Table III.18.14 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: All Cancer Sites Combined

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	26	18	1.80	0.99-3.28
No. Years Exposed				
0.5-10.0	15	10	1.87	0.85-4.13
10.5-20.0	5	3	2.08	0.51-8.45
>20	6	5	1.50	0.46-4.88
Distance to Substation (ft)				
1-250	5	3	2.08	0.51-8.45
251-500	21	15	1.75	0.90-3.38

*Odds ratios were computed by comparing the number of exposed cases and controls to 1016 unexposed cases and 1267 unexposed controls.

Table III.18.15 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Lung

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	8	15	2.66	0.96-6.78
No. Years Exposed				
0.5-10.0	6	8	3.74	1.05-12.42
10.5-20.0	1	3	----	----
>20	1	4	----	----
Distance to Substation (ft)				
1-250	2	3	----	----
251-500	6	12	2.49	0.96-6.50

*Odds ratios were computed by comparing the number of exposed cases and controls to 243 unexposed cases and 1213 unexposed controls.

Table III.18.16 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Breast

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	11	1.70	0.66-4.39
No. Years Exposed				
0.5-10.0	3	7	1.15	0.29-4.46
10.5-20.0	2	1	----	----
>20	2	3	----	----
Distance to Substation (ft)				
1-250	1	1	----	----
251-500	6	10	1.60	0.58-4.42

*Odds ratios were computed by comparing the number of exposed cases and controls to 258 unexposed cases and 690 unexposed controls.

Table III.18.17 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Colorectal

	No. Cases	No. Controls	Odds Ratio*	95% Confidence Interval
Ever Exposed	7	17	1.55	0.64-3.76
No. Years Exposed				
0.5-10.0	4	9	1.68	0.52-5.41
10.5-20.0	1	3	----	----
>20	2	5	----	----
Distance to Substation (ft)				
1-250	2	3	----	----
251-500	5	14	1.35	0.48-3.76

*Odds ratios were computed by comparing the number of exposed cases and controls to 308 unexposed cases and 1162 unexposed controls.

Table III.18.18 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Pancreas

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	2	9	----	----
No. Years Exposed				
0.5-10.0	0	4	----	----
10.5-20.0	1	1	----	----
>20	1	4	----	----
Distance to Substation (ft)				
1-250	0	2	----	----
251-500	2	7	----	----

Table III.18.19 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Leukemia

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	12	----	----
No. Years Exposed				
0.5-10.0	1	5	----	----
10.5-20.0	0	3	----	----
>20	0	4	----	----
Distance to Substation (ft)				
1-250	0	3	----	----
251-500	1	9	----	----

Table III.18.20 Results of Crude Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Brain

	No. Cases	No. Controls	Odds Ratio	95% Confidence Interval
Ever Exposed	1	11	----	----
No. Years Exposed				
0.5-10.0	1	6	----	----
10.5-20.0	0	2	----	----
>20	0	3	----	----
Distance to Substation (ft)				
1-250	0	2	----	----
251-500	1	9	----	----

Table III.18.21 Results of Adjusted Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: All Cancer Sites Combined

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	0.5579	0.09	1.75	0.91 - 3.35
No. Years Exposed				
0.5 - 10.0	0.5531	0.21	1.74	0.73 - 4.13
10.5 - 20.0	0.5026	0.54	1.65	0.33 - 8.27
>20	0.5991	0.34	1.82	0.53 - 6.22
Distance to Substation (ft.)				
1 - 250	1.0427	0.17	2.84	0.64 - 12.61
251 - 500	0.4412	0.23	1.55	0.76 - 3.20

Table III.18.22 Results of Adjusted Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure ≤ 500 feet

Cancer Site: Lung

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	1.0230	0.06	2.78	0.97 - 7.96
No. Years Exposed				
0.5 - 10.0	1.3031	0.04	3.68	1.08 - 12.52
10.5 - 20.0*	----	----	----	----
>20*	----	----	----	----
Distance to Substation (ft.)				
1 - 250*	----	----	----	----
251 - 500	0.9379	0.12	2.55	0.77 - 8.46

*Adjusted analyses are not presented if there are less than three exposed cases in a given category.

Table III.18.23 Results of Adjusted Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

<u>Cancer Site</u>: Breast

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
<u>Ever Exposed</u>	0.5228	0.32	1.69	0.61 - 4.68
<u>No. Years Exposed</u>				
0.5 - 10.0	0.3403	0.64	1.41	0.33 - 5.94
10.5 - 20.0*	----	----	----	----
>20*	----	----	----	----
<u>Distance to Substation (ft.)</u>				
1 - 250*	----	----	----	----
251 - 500	0.4004	0.47	1.49	0.50 - 4.45

*Adjusted analyses are not presented if there are less than three exposed cases in a given category.

Table III.18.24 Results of Adjusted Categorical Analysis Examining Substations as a Source of Electromagnetic Radiation Without Taking Latent Period into Account

Exposure $\leq$ 500 feet

Cancer Site: Colorectal

	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Exposed	-0.0753	0.88	0.93	0.34 - 2.53
No. Years Exposed				
0.5 - 10.0	-0.1950	0.78	0.82	0.21 - 3.15
10.5 - 20.0*	----	----	----	----
>20*	----	----	----	----
Distance to Substation (ft.)				
1 - 250*	----	----	----	----
251 - 500	-0.3307	0.57	0.72	0.23 - 2.28

*Adjusted analyses are not presented if there are less than three exposed cases in a given category.

Table III.19.1 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: All Cancers

Characteristic	Cases (N=1,042)	Controls (N=1,285)	Crude Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	4.0	3.8	1.06	0.69-1.61
Ever Worked on MMR as Civilian	7.1	7.6	0.93	0.68-1.28
Ever Swam in Johns Pond	4.6	6.8	0.66	0.44-0.97
Ever Swam in Ashument Pond	2.7	2.3	1.21	0.71-2.06
Ever Swam in Other Upper Cape Ponds	22.8	23.6	0.96	0.78-1.17
Ever Swam in Upper Cape Ocean or Bay Beaches	66.0	66.6	0.97	0.82-1.16
Ever Regularly Ate Fish From Local Ponds	6.1	6.5	0.95	0.67-1.33
Ever Regularly Ate Fish From Boston Harbor etc	15.9	16.5	0.96	0.76-1.20
Ever Ate Lobster More Than 6 Times a Year	30.7	30.7	1.00	0.83-1.19
Usually Ate Tamale From Lobster	12.4	11.3	1.12	0.86-1.44
Ever Used Electric Blanket Regularly	42.3	39.6	1.12	0.95-1.33

Table III.19.1 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: All Cancers

Characteristic	Cases (N=1,042)	Controls (N=1,285)	Crude Odds Ratio	95% Confidence Interval
Ever Drank Bottled Water Regularly	9.2	8.4	1.11	0.83-1.48
Ever Dyed Hair Regularly	22.1	22.0	1.00	0.82-1.22
Usual Bathing Habits Mostly Showers	49.9	46.8	1.13*	0.96-1.33
Ever Had Hobby With Chemical Exposure	24.1	24.7	0.97	0.80-1.17
Ever Gardened With Herbicides or Pesticides	38.0	38.2	0.99	0.84-1.18
Ever Operated Ham Radio	1.3	1.5	0.84	0.41-1.71
Ever Spent Summers on Upper Cape	23.5	24.4	0.89	0.73-1.08
Any Residence Ever Treated for Termites	21.7	21.4	1.02	0.83-1.25
Present Residence Tested For Radon	0.8	1.3	0.58	0.25-1.36
Thought that the Upper Cape environment made them sick	21.1	23.2	0.95	0.78-1.17

* Referent category combined mostly baths and about equal.

Table III.19.2 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Lung

Characteristic	Cases (N=251)	Controls (N=1,228)	Crude Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	4.8	3.9	1.23	0.65-2.36
Ever Worked on MMR as Civilian	8.4	7.6	1.12	0.68-1.84
Ever Swam in Johns Pond	3.1	6.9	0.42	0.16-0.94
Ever Swam in Ashument Pond	2.6	2.2	1.17	0.48-2.88
Ever Swam in Other Upper Cape Ponds	21.4	24.0	0.86	0.61-1.21
Ever Swam in Upper Cape Ocean or Bay Beaches	64.8	67.3	0.89	0.67-1.19
Ever Regularly Ate Fish From Local Ponds	6.2	6.5	0.96	0.54-1.69
Ever Regularly Ate Fish From Boston Harbor, etc	18.0	16.6	1.10	0.76-1.59
Ever Ate Lobster More Than 6 Times a Year	33.6	31.3	1.11	0.83-1.49
Usually Ate Tamale From Lobster	14.4	11.6	1.28	0.86-1.91
Ever Used Electric Blanket Regularly	42.9	39.9	1.13	0.86-1.49

Table III.19.2 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Lung

Characteristic	Cases (N=251)	Controls (N=1,228)	Crude Odds Ratio	95% Confidence Interval
Ever Drank Bottled Water Regularly	8.2	8.5	0.95	0.58-1.57
Ever Dyed Hair Regularly	17.0	22.2	0.72	0.50-1.03
Usual Bathing Habits Mostly Showers	54.5	47.8	1.31*	0.99-1.72
Ever Had Hobby With Chemical Exposure	28.7	25.0	1.21	0.89-1.64
Ever Gardened With Herbicides or Pesticides	41.5	38.7	1.12	0.84-1.49
Ever Operated Ham Radio	2.0	1.6	1.28	0.47-3.47
Ever Spent Summers on Upper Cape	24.1	23.7	1.02	0.74-1.41
Any Residence Ever Treated for Termites	24.9	21.8	1.19	0.85-1.66
Present Residence Tested For Radon	0.8	1.4	0.57	0.13-2.45
Thought that the Upper Cape environment made them sick	22.2	24.7	0.87	0.61-1.24

* Referent category combined mostly baths and about equal.

Table III.19.3 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Breast

Characteristic	Cases (N=265)	Controls (N=701)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	0.8	0.6	----	----
Ever Worked on MMR as Civilian	5.3	4.8	1.12	0.59-2.12
Ever Swam in Johns Pond	3.5	5.9	0.58	0.28-1.22
Ever Swam in Ashument Pond	3.5	1.9	1.88	0.79-4.45
Ever Swam in Other Upper Cape Ponds	25.8	24.6	1.06	0.76-1.48
Ever Swam in Upper Cape Ocean or Bay Beaches	67.8	68.6	0.96	0.71-1.31
Ever Regularly Ate Fish From Local Ponds	5.9	5.9	1.00	0.54-1.84
Ever Regularly Ate Fish From Boston Harbor, etc	13.3	16.6	0.77	0.51-1.17
Ever Ate Lobster More Than 6 Times a Year	31.0	30.3	1.03	0.76-1.41
Usually Ate Tamale From Lobster	15.0	10.5	1.50	0.98-2.28
Ever Used Electric Blanket Regularly	44.2	42.9	1.05	0.79-1.41

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.3 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Breast

Characteristic	Cases (N=265)	Controls (N=701)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	10.8	9.0	1.22	0.76-1.96
Ever Dyed Hair Regularly	37.0	36.0	1.05	0.78-1.41
Usual Bathing Habits Mostly Showers	39.3	31.9	1.08*	0.80-1.47
Ever Had Hobby With Chemical Exposure	24.8	21.7	1.19	0.85-1.66
Ever Gardened With Herbicides or Pesticides	31.4	33.2	0.92	0.67-1.25
Ever Operated Ham Radio	0.4	0.3	-----	-----
Ever Spent Summers on Upper Cape	19.8	25.5	0.72	0.51-1.03
Any Residence Ever Treated for Termites	26.0	22.2	1.23	0.88-1.73
Present Residence Tested For Radon	1.2	1.0	1.17	0.30-4.55
Thought that the Upper Cape environment made them sick	28.3	28.2	1.01	0.72-1.40

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.4 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Colorectal

Characteristic	Cases (N=315)	Controls (N=1,179)	Crude Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	5.4	4.0	1.37	0.77-2.41
Ever Worked on MMR as Civilian	7.4	7.7	0.96	0.59-1.54
Ever Swam in Johns Pond	4.3	6.0	0.71	0.39-1.31
Ever Swam in Ashument Pond	1.0	1.9	0.53	0.16-1.80
Ever Swam in Other Upper Cape Ponds	19.9	23.0	0.83	0.61-1.14
Ever Swam in Upper Cape Ocean or Bay Beaches	64.4	66.3	0.92	0.71-1.20
Ever Regularly Ate Fish From Local Ponds	5.7	6.5	0.86	0.50-1.48
Ever Regularly Ate Fish From Boston Harbor, etc	17.2	16.9	1.02	0.73-1.44
Ever Ate Lobster More Than 6 Times a Year	27.9	30.4	0.89	0.67-1.18
Usually Ate Tamale From Lobster	10.4	11.7	0.88	0.58-1.32
Ever Used Electric Blanket Regularly	41.8	39.5	1.10	0.85-1.42

Table III.19.4 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Colorectal

Characteristic	Cases (N=315)	Controls (N=1,179)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	8.1	8.4	0.97	0.61-1.53
Ever Dyed Hair Regularly	17.9	20.7	0.84	0.60-1.15
Usual Bathing Habits Mostly Showers	51.3	46.5	1.21*	0.94-1.56
Ever Had Hobby With Chemical Exposure	19.9	24.3	0.78	0.57-1.06
Ever Gardened With Herbicides or Pesticides	38.0	38.7	0.97	0.75-1.26
Ever Operated Ham Radio	1.3	1.5	0.83	0.28-2.47
Ever Spent Summers on Upper Cape	20.9	23.8	0.85	0.62-1.15
Any Residence Ever Treated for Termites	16.3	21.2	0.72	0.51-1.02
Present Residence Tested For Radon	0.6	1.4	----	----
Thought that the Upper Cape environment made them sick	19.0	22.7	0.80	0.57-1.12

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.5 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Bladder

Characteristic	Cases (N=62)	Controls (N=867)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	4.9	5.0	0.99	0.30-3.28
Ever Worked on MMR as Civilian	8.2	7.3	1.13	0.44-2.92
Ever Swam in Johns Pond	1.6	6.3	-----	-----
Ever Swam in Ashument Pond	3.3	1.8	-----	-----
Ever Swam in Other Upper Cape Ponds	15.0	22.9	0.60	0.29-1.23
Ever Swam in Upper Cape Ocean or Bay Beaches	65.0	68.1	0.87	0.50-1.51
Ever Regularly Ate Fish From Local Ponds	5.0	6.2	0.80	0.24-2.65
Ever Regularly Ate Fish From Boston Harbor, etc	10.2	17.0	0.55	0.23-1.31
Ever Ate Lobster More Than 6 Times a Year	21.7	30.2	0.64	0.34-1.20
Usually Ate Tamale From Lobster	6.5	12.2	0.50	0.18-1.40
Ever Used Electric Blanket Regularly	35.0	38.1	0.88	0.51-1.52

$ Odds Ratios were not calculated if there were less than three exposed cases.

Table III.19.5 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Bladder

Characteristic	Cases (N=62)	Controls (N=867)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	11.9	9.3	1.32	0.58-3.01
Ever Dyed Hair Regularly	15.3	19.4	0.75	0.36-1.55
Usual Bathing Habits Mostly Showers	62.7	51.4	1.59*	0.92-2.74
Ever Had Hobby With Chemical Exposure	23.0	25.5	0.87	0.47-1.61
Ever Gardened With Herbicides or Pesticides	40.7	39.6	1.05	0.61-1.79
Ever Operated Ham Radio	1.6	1.9	-----	-----
Ever Spent Summers on Upper Cape	21.7	23.9	0.88	0.47-1.66
Any Residence Ever Treated for Termites	12.1	21.3	0.51	0.23-1.14
Present Residence Tested For Radon	1.6	1.9	-----	-----
Thought that the Upper Cape environment made them sick	25.0	25.3	0.99	0.53-1.84

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.6 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Kidney

Characteristic	Cases (N=35)	Controls (N=792)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	2.9	5.0	----	-----
Ever Worked on MMR as Civilian	11.4	7.1	1.68	0.57-4.93
Ever Swam in Johns Pond	8.8	5.5	1.67	0.49-5.69
Ever Swam in Ashument Pond	3.0	1.6	-----	-----
Ever Swam in Other Upper Cape Ponds	18.2	22.8	0.75	0.31-1.85
Ever Swam in Upper Cape Ocean or Bay Beaches	65.7	69.5	0.84	0.41-1.72
Ever Regularly Ate Fish From Local Ponds	3.0	6.6	-----	-----
Ever Regularly Ate Fish From Boston Harbor, etc	9.1	17.5	0.47	0.14-1.57
Ever Ate Lobster More Than 6 Times a Year	31.4	32.1	0.97	0.47-2.01
Usually Ate Tamale From Lobster	8.6	12.6	0.65	0.20-2.16
Ever Used Electric Blanket Regularly	45.7	38.3	1.36	0.69-2.68

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.6 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Kidney

Characteristic	Cases (N=35)	Controls (N=792)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	5.9	9.3	----	----
Ever Dyed Hair Regularly	11.4	21.8	0.46	0.16-1.33
Usual Bathing Habits Mostly Showers	51.4	51.1	1.01*	0.51-2.00
Ever Had Hobby With Chemical Exposure	22.9	25.8	0.85	0.38-1.90
Ever Gardened With Herbicides or Pesticides	35.3	38.9	0.86	0.42-1.76
Ever Operated Ham Radio	0.0	1.4	0.00	------
Ever Spent Summers on Upper Cape	11.8	24.6	0.41	0.14-1.18
Any Residence Ever Treated for Termites	24.2	20.8	1.22	0.54-2.76
Present Residence Tested For Radon	0.0	1.5	-----	-----
Thought that the Upper Cape environment made them sick	29.6	25.6	1.22	0.53-2.84

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.7 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Pancreas

Characteristic	Cases (N=37)	Controls (N=633)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	2.7	3.5	----	----
Ever Worked on MMR as Civilian	2.7	7.2	----	-----
Ever Swam in Johns Pond	2.9	4.2	----	-----
Ever Swam in Ashument Pond	5.7	1.7	----	-----
Ever Swam in Other Upper Cape Ponds	26.5	19.6	1.48	0.67-3.24
Ever Swam in Upper Cape Ocean or Bay Beaches	62.9	62.9	1.00	0.49-2.02
Ever Regularly Ate Fish From Local Ponds	5.9	6.0	-----	-----
Ever Regularly Ate Fish From Boston Harbor, etc	24.2	16.2	1.66	0.73-3.76
Ever Ate Lobster More Than 6 Times a Year	32.5	32.5	1.00	0.49-2.03
Usually Ate Tamale From Lobster	14.3	13.6	1.06	0.40-2.82
Ever Used Electric Blanket Regularly	38.9	39.6	0.97	0.49-1.94

$ Odds ratios w...e not calculated if there were less than three exposed cases.

Table III.19.7 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Pancreas

Characteristic	Cases (N=37)	Controls (N=633)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	16.2	8.4	2.11	0.86-5.19
Ever Dyed Hair Regularly	18.9	22.4	0.81	0.35-1.88
Usual Bathing Habits Mostly Showers	50.0	42.9	1.33*	0.68-2.63
Ever Had Hobby With Chemical Exposure	24.3	23.7	1.04	0.47-2.25
Ever Gardened With Herbicides or Pesticides	31.3	38.2	0.74	0.34-1.58
Ever Operated Ham Radio	2.7	1.1	-----	-----
Ever Spent Summers on Upper Cape	16.2	24.0	0.62	0.25-1.49
Any Residence Ever Treated for Termites	18.8	19.2	0.97	0.39-2.41
Present Residence Tested For Radon	0.0	0.8	-----	-----
Thought that the Upper Cape environment made them sick	29.6	17.0	2.06	0.89-4.76

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.8 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Leukemia

Characteristic	Cases (N=36)	Controls (N=751)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	5.7	4.3	----	-----
Ever Worked on MMR as Civilian	2.8	8.1	-----	-----
Ever Swam in Johns Pond	11.8	6.6	1.88	0.63-5.55
Ever Swam in Ashument Pond	5.7	2.2	-----	-----
Ever Swam in Other Upper Cape Ponds	41.2	23.1	2.33	1.06-4.98
Ever Swam in Upper Cape Ocean or Bay Beaches	72.2	63.9	1.47	0.70-3.09
Ever Regularly Ate Fish From Local Ponds	14.3	6.4	2.45	0.91-6.60
Ever Regularly Ate Fish From Boston Harbor etc	9.7	16.1	0.56	0.17-1.87
Ever Ate Lobster More Than 6 Times a Year	31.4	31.3	1.01	0.48-2.09
Usually Ate Tamale From Lobster	8.6	11.9	0.69	0.21-2.31
Ever Used Electric Blanket Regularly	41.7	40.7	1.04	0.53-2.05

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.8 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Leukemia

Characteristic	Cases (N=36)	Controls (N=751)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	11.1	9.0	1.27	0.43-3.69
Ever Dyed Hair Regularly	11.1	20.6	0.48	0.17-1.39
Usual Bathing Habits Mostly Showers	51.4	47.9	1.15*	0.58-2.27
Ever Had Hobby With Chemical Exposure	27.8	24.9	1.16	0.55-2.45
Ever Gardened With Herbicides or Pesticides	55.6	39.9	1.88	0.96-3.69
Ever Operated Ham Radio	2.9	1.8	-----	-----
Ever Spent Summers on Upper Cape	16.7	22.2	0.70	0.29-1.71
Any Residence Ever Treated for Termites	33.3	19.9	2.01	0.95-4.25
Present Residence Tested For Radon	0.0	0.7	----	-----
Thought that the Upper Cape environment made them sick	23.5	21.1	1.15	0.51-2.59

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.9 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Brain

Characteristic	Cases (N=37)	Controls (N=715)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	5.4	4.1	1.34	0.31-5.85
Ever Worked on MMR as Civilian	8.1	8.4	0.97	0.29-3.25
Ever Swam in Johns Pond	20.6	5.5	4.5	1.54-11.48
Ever Swam in Ashument Pond	5.9	2.0	----	-----
Ever Swam in Other Upper Cape Ponds	33.3	23.4	1.64	0.80-3.34
Ever Swam in Upper Cape Ocean or Bay Beaches	72.2	65.8	1.30	0.61-2.75
Ever Regularly Ate Fish From Local Ponds	8.6	6.7	1.30	0.38-4.41
Ever Regularly Ate Fish From Boston Harbor, etc	21.6	16.3	1.41	0.63-3.18
Ever Ate Lobster More Than 6 Times a Year	45.5	31.5	1.81	0.90-3.66
Usually Ate Tamale From Lobster	14.3	11.4	1.30	0.49-3.45
Ever Used Electric Blanket Regularly	41.7	38.1	1.16	0.59-2.29

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.9 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Brain

Characteristic	Cases (N=37)	Controls (N=715)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	5.6	8.1	0.66	0.16-2.84
Ever Dyed Hair Regularly	24.3	22.3	1.12	0.52-2.42
Usual Bathing Habits Mostly Showers	55.6	48.0	1.36*	0.69-2.66
Ever Had Hobby With Chemical Exposure	19.4	24.6	0.74	0.32-1.71
Ever Gardened With Herbicides or Pesticides	48.5	36.9	1.61	0.80-3.25
Ever Operated Ham Radio	0.0	1.6	----	-----
Ever Spent Summers on Upper Cape	25.0	22.7	1.14	0.52-2.47
Any Residence Ever Treated for Termites	21.2	22.9	0.91	0.39-2.13
Present Residence Tested For Radon	0.0	1.3	----	-----
Thought that the Upper Cape environment made them sick	22.6	21.9	1.04	0.44-2.47

$ Odds ratios were not calculated if there were less than three exposed cases.
* Referent category combined mostly baths and about equal.

Table III.19.10 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Liver

Characteristic	Cases (N=4)	Controls (N=50)	Crude Odds Ratio$	95% Confidence Interval
Ever Stationed at MMR During Service	25.0	6.1	-----	-----
Ever Worked on MMR as Civilian	25.0	16.3	-----	-----
Ever Swam in Johns Pond	0.0	9.3	----	-----
Ever Swam in Ashument Pond	0.0	4.3	----	-----
Ever Swam in Other Upper Cape Ponds	0.0	26.7	----	-----
Ever Swam in Upper Cape Ocean or Bay Beaches	75.0	71.1	1.22	0.11-13.94
Ever Regularly Ate Fish From Local Ponds	0.0	6.3	----	-----
Ever Regularly Ate Fish From Boston Harbor, etc	25.0	13.0	-----	-----
Ever Ate Lobster More Than 6 Times a Year	25.0	32.7	-----	-----
Usually Ate Tamale From Lobster	0.0	15.2	----	-----
Ever Used Electric Blanket Regularly	50.0	30.0	-----	-----

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.10 Results of Crude Analysis Examining Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account (continued)

Cancer Site: Liver

Characteristic	Cases (N=4)	Controls (N=50)	Crude Odds Ratio$	95% Confidence Interval
Ever Drank Bottled Water Regularly	0.0	4.1	----	-----
Ever Dyed Hair Regularly	0.0	4.0	----	-----
Usual Bathing Habits Mostly Showers	50.0	70.2	-----	-----
Ever Had Hobby With Chemical Exposure	50.0	42.9	-----	-----
Ever Gardened With Herbicides or Pesticides	50.0	52.0	-----	-----
Ever Operated Ham Radio	0.0	4.4	----	-----
Ever Spent Summers on Upper Cape	50.0	18.4	-----	-----
Any Residence Ever Treated for Termites	25.0	18.6	-----	-----
Present Residence Tested For Radon	0.0	0.0	-----	-----
Thought that the Upper Cape environment made them sick	25.0	19.6	-----	-----

$ Odds ratios were not calculated if there were less than three exposed cases.

Table III.19.11 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: All Cancer Sites Combined

Exposure	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	0.0905	0.70	1.09	0.69 - 1.75
Ever Worked on MMR as Civilian	-0.0459	0.78	0.96	0.69 - 1.33
Ever Swam in Johns Pond	-0.3877	0.05	0.68	0.46 - 1.00
Ever Swam in Ashumet Pond	0.0808	0.78	1.08	0.62 - 1.89
Ever Swam in Other Upper Cape Ponds	-0.0398	0.71	0.96	0.78 - 1.18
Ever Swam in Upper Cape Ocean or Bay Beaches	-0.0364	0.71	0.96	0.80 - 1.16
Ever ate Fish Regularly from Local Ponds	-0.1196	0.52	0.89	0.62 - 1.28
Ever Spent Summers on the Upper Cape	-0.1943	0.07	0.82	0.67 - 1.01

Table III.19.12 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Lung

Exposure	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	0.0609	0.87	1.06	0.52 - 2.19
Ever Worked on MMR as Civilian	-0.1382	0.62	0.87	0.50 - 1.51
Ever Swam in Johns Pond	-0.8541	0.04	0.43	0.19 - 0.97
Ever Swam in Ashumet Pond	0.0644	0.90	1.07	0.40 - 2.84
Ever Swam in Other Upper Cape Ponds	-0.0838	0.66	0.92	0.63 - 1.34
Ever Swam in Upper Cape Ocean or Bay Beaches	0.0446	0.79	1.05	0.75 - 1.45
Ever ate Fish Regularly from Local Ponds	-0.1847	0.56	0.83	0.45 - 1.55
Ever Spent Summers on the Upper Cape	0.1732	0.33	1.19	0.84 - 1.69

Table III.19.13 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Breast

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	----	----	----	----
Ever Worked on MMR as Civilian	0.0883	0.80	1.09	0.56 - 2.13
Ever Swam in Johns Pond	-1.0031	0.03	0.37	0.15 - 0.89
Ever Swam in Ashumet Pond	0.4241	0.37	1.53	0.60 - 3.89
Ever Swam in Other Upper Cape Ponds	-0.1016	0.59	0.90	0.63 - 1.30
Ever Swam in Upper Cape Ocean or Bay Beaches	-0.3177	0.07	0.73	0.51 - 1.03
Ever ate Fish Regularly from Local Ponds	-0.0103	0.98	0.99	0.52 - 1.90
Ever Spent Summers on the Upper Cape	-0.3990	0.04	0.67	0.46 - 0.98

*Adjusted analyses were not performed if there were less than three exposed cases.

Table III.19.14 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Colorectal

Exposure	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	0.1689	0.62	1.18	0.61 - 2.31
Ever Worked on MMR as Civilian	0.0569	0.83	1.06	0.62 - 1.80
Ever Swam in Johns Pond	-0.2109	0.53	0.81	0.42 - 1.55
Ever Swam in Ashumet Pond	-0.8869	0.18	0.41	0.11 - 1.49
Ever Swam in Other Upper Cape Ponds	-0.1635	0.36	0.85	0.60 - 1.21
Ever Swam in Upper Cape Ocean or Bay Beaches	-0.1431	0.36	0.87	0.64 - 1.17
Ever ate Fish Regularly from Local Ponds	-0.1129	0.71	0.89	0.49 - 1.61
Ever Spent Summers on the Upper Cape	-0.2062	0.23	0.81	0.58 - 1.14

Table III.19.15 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Bladder

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	-0.1703	0.80	0.84	0.23 - 3.14
Ever Worked on MMR as Civilian	-0.1608	0.76	0.85	0.30 - 2.41
Ever Swam in Johns Pond	----	----	----	----
Ever Swam in Ashumet Pond	----	----	----	----
Ever Swam in Other Upper Cape Ponds	-0.5342	0.18	0.59	0.27 - 1.27
Ever Swam in Upper Cape Ocean or Bay Beaches	-0.2679	0.39	0.76	0.41 - 1.42
Ever ate Fish Regularly from Local Ponds	-0.2465	0.71	0.78	0.21 - 2.88
Ever Spent Summers on the Upper Cape	-0.1157	0.66	0.86	0.43 - 1.71

*Adjusted analyses were not performed if there were less than three exposed cases.

Table III.19.16 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Kidney

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	----	----	----	----
Ever Worked on MMR as Civilian	0.5355	0.36	1.71	0.54 - 5.43
Ever Swam in Johns Pond	0.5292	0.43	1.70	0.46 - 6.25
Ever Swam in Ashumet Pond	----	----	----	----
Ever Swam in Other Upper Cape Ponds	-0.1511	0.76	0.86	0.33 - 2.23
Ever Swam in Upper Cape Ocean or Bay Beaches	-0.1313	0.74	0.88	0.40 - 1.92
Ever ate Fish Regularly from Local Ponds	----	----	----	----
Ever Spent Summers on the Upper Cape	-1.0192	0.07	0.36	0.12 - 1.09

*Adjusted analyses were not performed if there were less than three exposed cases.

Table III.19.17 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Pancreas

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	----	----	----	----
Ever Worked on MMR as Civilian	----	----	----	----
Ever Swam in Johns Pond	----	----	----	----
Ever Swam in Ashumet Pond	----	----	----	----
Ever Swam in Other Upper Cape Ponds	0.2331	0.60	1.26	0.53 - 3.01
Ever Swam in Upper Cape Ocean or Bay Beaches	0.1296	0.74	1.14	0.53 - 2.45
Ever ate Fish Regularly from Local Ponds	----	----	----	----
Ever Spent Summers on the Upper Cape	-0.3625	0.45	0.70	0.27 - 1.80

*Adjusted analyses were not performed if there were less than three exposed cases.

Table III.19.18 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Leukemia

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	----	----	----	----
Ever Worked on MMR as Civilian	----	----	----	----
Ever Swam in Johns Pond	0.6091	0.29	1.84	0.59 - 5.72
Ever Swam in Ashumet Pond	----	----	----	----
Ever Swam in Other Upper Cape Ponds	0.8218	0.03	2.27	1.09 - 4.75
Ever Swam in Upper Cape Ocean or Bay Beaches	0.4579	0.25	1.58	0.73 - 3.43
Ever ate Fish Regularly from Local Ponds	0.9850	0.06	2.68	0.96 - 7.48
Ever Spent Summers on the Upper Cape	-0.3148	0.49	0.73	0.30 - 1.80

*Adjusted analyses were not performed if there were less than three exposed cases.

Table III.19.19 Results of Adjusted Analysis Examining Selected Miscellaneous Exposures Among Cases and Controls Without Taking Latency into Account

Cancer Site: Brain

Exposure*	Beta Coefficient	P-value	Odds Ratio	95% Confidence Interval
Ever Stationed at MMR During Service	0.0962	0.90	1.10	0.24 - 5.12
Ever Worked on MMR as Civilian	-0.3457	0.59	0.71	0.20 - 2.47
Ever Swam in Johns Pond	1.0006	0.03	3.01	1.14 - 7.94
Ever Swam in Ashumet Pond	----	----	----	----
Ever Swam in Other Upper Cape Ponds	0.2872	0.46	1.33	0.63 - 2.84
Ever Swam in Upper Cape Ocean or Bay Beaches	0.1524	0.70	1.16	0.53 - 2.55
Ever ate Fish Regularly from Local Ponds	0.0726	0.91	1.08	0.30 - 3.82
Ever Spent Summers on the Upper Cape	0.3003	0.46	1.35	0.61 - 2.99

*Adjusted analyses were not performed if there were less than three exposed cases.