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Department
Of
Public Health

Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachusetts 1982-1998

Response to Public Comments and Additional Analyses

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I. Introduction/Background

In February 2002, the Community Assessment Program (CAP) of the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment (MDPH/BEHA) released for public comment the report *Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachusetts 1982-1998* (MDPH 2002). This investigation was conducted in response to requests by concerned residents, Senator Michael Morrissey, and the local boards of health, to address concerns about suspected increases in cancer incidence in the four towns and the possible relationship to environmental contamination, specifically the South Weymouth Naval Air Station (SWNAS). The report provided an evaluation of eight cancer types in the four towns and the census tracts that comprise the towns over three time periods (1982-1986, 1987-1994, and 1995-1998). Cancers of the bladder, brain, kidney, liver, lung, and pancreas as well as leukemia and non-Hodgkin's lymphoma were selected for evaluation based on elevations noted in a preliminary review of town level cancer rates in the four communities and/or to address specific concerns raised by residents over suspected elevations in certain cancer types in neighborhoods surrounding the SWNAS. Appendix A contains an information booklet summarizing the report.

The findings of the February 2002 report indicated that during the seventeen years 1982-1998 most of the eight cancer types evaluated occurred at or near the expected rates in the four towns of Weymouth, Abington, Hingham and Rockland. Analysis of cancer rates by smaller geographic area (i.e., census tracts) within the four towns also showed that, with the exception of lung cancer, most cancer types occurred at or below the expected rates. Elevations in pancreatic cancer and leukemia were noted in Weymouth during certain smaller time periods evaluated, however none of the cancer types were elevated in a consistent pattern over time or in any one area within the four towns.

The study also found that lung cancer was elevated at a statistically significant level in three of the four towns during the 17 years evaluated. In both Weymouth and Rockland lung cancer incidence increased relative to the state rate over the three time periods examined. In Abington, lung cancer was elevated at a statistically significant level during the first time period evaluated, 1982-1986, but rates have generally leveled off since that time. Lung cancer rates in

Hingham were statistically significantly lower than expected over time. Review of available risk factor information from the Massachusetts Cancer Registry (MCR) for individuals diagnosed with lung cancer showed that smoking likely played an important role in elevated rates of lung cancer in these towns as a whole. For example, among Rockland females diagnosed with lung cancer during 1987-1994, 98% reported being current or former smokers. Although available occupational information was limited, review of this data suggested that for some individuals occupation also likely played a role in lung cancer incidence in the four town area. At a smaller geographic level, statistically significant elevations in the incidence of lung cancer occurred in some census tracts in certain time periods and lung cancer appeared to be increasing over time in a number of census tracts in Weymouth, Abington and Rockland. In particular, a pattern of increasing lung cancer was noted for census tracts near the SWNAS. When data on smoking were reviewed at the census tract level, a large number of individuals had an unknown smoking status. Therefore, unlike lung cancer rates at the town level, the role of smoking in the incidence of lung cancer for these census tracts was less clear.

In addition to calculating cancer incidence rates, an evaluation of the geographic patterns of cancer was conducted at the neighborhood level by mapping the address reported for each person diagnosed with cancer. The mapping of the residence of each individual diagnosed with cancer in the four towns allowed for analysis of potential geographic clustering or concentrations of cancer diagnoses at the neighborhood level without the influence of census tract or town boundaries. Because of confidentiality concerns, maps of individuals diagnosed with cancer cannot be shown. Although the incidence of lung cancer was elevated in census tracts near the SWNAS, no unusual geographic concentrations of individuals with cancer were observed in neighborhoods in proximity to the SWNAS property. Specifically, no atypical concentrations of cancer were observed in areas where possible contact with base contamination could occur including private drinking water wells, surface water bodies (Old Swamp River, French's Stream, and the Mill Pond Tributary), and historical flight paths. In addition, based on the available information reviewed to date, no specific spatial or geographic pattern of cancer was observed in any areas of the four towns that indicated a pattern related to a potential environmental exposure source. In certain census tracts where cancer was elevated, the geographic pattern of these individuals did not suggest a concentration of cases in relation to each other or in proximity to potentially hazardous waste sites in the area.

Based on the findings released in the February 2002 report, the CAP recommended further investigation of lung cancer in the four communities to determine whether a clearer pattern related to environmental or other potential risk factors for this cancer would emerge. Specifically, it was recommended that the length of residence for each individual diagnosed with lung cancer be evaluated, with a particular focus on non-smokers residing in close proximity to the SWNAS. Since lung cancer generally has a long period of development, the possible role of a common historical exposure among individuals with lung cancer would be more likely among long term residents of the area. In addition, since cancer incidence data for the years 1995-1998 became available just prior to completion of the original investigation, data for these years were evaluated separately and added to the evaluation as a third time period. As a follow-up analysis, lung cancer incidence rates were calculated for the overall seventeen year period, 1982-1998, and recalculated for three new smaller time periods, 1982-1987, 1988-1993, 1994-1998 to see if trends in lung cancer remained the same over more proportional year groups. To determine whether individuals diagnosed with lung cancer are more likely to reside in census tracts near the SWNAS than in census tracts located not near to the base, an additional analysis of the relative risk of lung cancer diagnoses in the four towns was conducted.

This report contains a summary of the follow-up analyses of lung cancer incidence in the four towns as well as responses to comments received during the public comment period for the original February 2002 report. Public comments on the February report were accepted for a period of 30 days through March 14, 2002. A listing of comments received during the public comment period and the responses to these comments are attached as Appendix B. In addition, based on the findings of the February report, the Weymouth Board of Health (BOH) requested the MDPH/BEHA provide two additional analyses as part of the follow-up work. Specifically, the Weymouth BOH requested an additional investigation of lung cancer in Weymouth broken down by different histological subtypes as well as an evaluation of the incidence of esophageal cancer in the town. Results of these additional analyses are also summarized below.

II. Follow-Up Analyses

A. Lung Cancer Residential History Evaluation

Solid tumors such as lung cancer generally have a long period of development, or latency period, that ranges from at least 10 to 20 years and may possibly be as long as 50 years (Levy and Wegman 1995; Patterson 1999). Although it is not possible to determine what may have caused any one person's diagnosis with cancer, the length of time in which that individual lived in a particular geographic area can help determine the importance that their residential location might have in terms of exposure to a potential environmental source. The SWNAS operated as a federal facility from 1941 to 1997. The existence of a common historical exposure among those diagnosed with lung cancer would be more plausible if the majority of individuals near the base were considered long term residents of the area. Given the relatively long latency period for lung cancer, an individual was considered to be a long term resident if they lived near the SWNAS for 20 years or more prior to their diagnosis. Conversely, if those diagnosed with lung cancer lived in their residence at diagnosis for shorter periods of time (e.g. less than 20 years), then given what is known about latency for cancer development and the historical nature of exposure at the SWNAS, it would be less likely that a common environmental factor related to the base played a role in their cancer.

In order to determine how long the individuals with lung cancer resided at the residence recorded at the time of diagnosis, CAP staff reviewed the town lists and census information located at public libraries for the towns and census tracts contiguous to the SWNAS where lung cancer was elevated. Residential histories were constructed for all individuals diagnosed with lung cancer (smokers and non-smokers) between 1982-1998 in Weymouth CTs 4221 and 4222 (n=163). Based on the information reviewed, of the 163 individuals diagnosed with lung cancer in Weymouth CTs 4221 and 4222 between 1982-1998, 82 (50%) lived at their reported address for 20 or more years prior to diagnosis. Sixty two (38%) individuals with lung cancer lived at their reported address for less than 20 years prior to diagnosis. Nineteen (12%) of the individuals diagnosed with lung cancer could not be found in the annual residential lists and therefore it is likely that they lived in the area for a short period of time. Based on this residential history information and the long latency period expected for lung cancer, place of

residence remains a possible factor related to lung cancer for 50% (n=82) of individuals who lived at their reported residence for 20 or more years prior to their diagnoses. However, the actual lengths of residence differed among these individuals and the dates of diagnosis were not concentrated during any particular time over the seventeen years evaluated. In addition, 65 (79%) of residents who met the residency and latency criteria reported themselves as current or former smokers. At least nine of these individuals also reported occupations where exposures related to lung cancer might have been possible. Therefore, the importance of an individual's length of residence relative to other established risk factors for lung cancer is unknown for 79% of those individuals with lung cancer who lived at their reported residence for 20 years or more.

To remove the possible effects of smoking, residential histories were also constructed for all non-smokers diagnosed with lung cancer in Weymouth CTs 4221 and 4222, Abington CT 5202.01, and Rockland CT 5022 (n=10) over the seventeen years 1982-1998. Based on the information reviewed, four of the ten individuals with a non-smoking status lived at their address for 20 or more years prior to diagnosis. As indicated in the February 2002 report, none of the ten individuals with lung cancer who resided in census tracts near the SWNAS and reported a non-smoking status were concentrated in any one area or located in close proximity to areas where potential contact with base contamination could occur.

B. Lung Cancer Incidence for New Time Periods

Since cancer incidence data for the years 1995-1998 became available just prior to completion of the original cancer incidence investigation, data for these years were evaluated separately and included in the February 2002 report as a third time period. In an effort to best evaluate trends over time and to ensure that the patterns observed for lung cancer were not affected by uneven time periods, standardized incidence ratios (SIRs) were re-calculated for three new time periods 1982-1986, 1987-1992, and 1993-1998 for each census tract in Weymouth, Abington, Hingham, and Rockland (census tract locations are shown in Figure 1). These time periods, representing periods of 5, 6, and 6 years, respectively, were chosen for the follow-up analysis to allow for a more meaningful review of SIR estimates across more

proportional time periods. SIRs were also calculated for the overall 17-year time period 1982-1998, which were not included in the original analysis. In general, the trends observed for lung cancer remain the same, however, any differences in rates of lung cancer that were statistically significantly higher or lower than expected are summarized below. Please see Tables 1 through 16 for the complete results of these analyses. In addition, choropleth maps showing lung cancer rates by census tract are provided to illustrate spatial trends in lung cancer over time (refer to Figures 2 through 5).

During the overall 17-year time period 1982-1998, statistically significant elevations in the incidence of lung cancer were observed in the town of Weymouth among males and females combined, and among males and females separately. In the town of Rockland, a statistically significant elevation in lung cancer was observed among males and females combined and among females alone. In Abington, lung cancer was statistically significantly elevated among males and females combined and among males alone.

As shown in the choropleth map for the overall 17-year time period 1982-1998 (Figure 2), statistically significant elevations were observed in a variety of census tracts in the four towns, both near and more distant to the SWNAS. Individual census tracts with statistically significant elevations in lung cancer during the overall time period 1982-1998 included Weymouth CT 4222 (among females and males and females combined), CT 4225 (among females and males and females combined), and CT 4227 (among males and females separately and combined). In Rockland, statistically significant elevations in lung cancer were observed in CT 5021 among females and males and females combined. In Abington, a statistically significant elevation in lung cancer was observed in CT 5202.02 among males and males and females combined. Hingham experienced a statistically significant decrease in lung cancer town-wide among males and females combined and among males and a statistically significant decrease in CT 5012 (located adjacent to the SWNAS) among males and females combined and among males when evaluated separately by gender.

While in general the trends observed for lung cancer over time remained the same, there were some differences in rates of lung cancer when this cancer type was re-evaluated for three smaller time periods made up of more proportional year groups (as described previously). As

shown in Table 3, lung cancer was elevated town-wide in Weymouth and in Weymouth CTs 4222, 4223, 4225, and 4227 during the second time period evaluated in this follow-up analysis 1987-1992. However, none of these elevations were statistically significant. This result is in contrast to the observations during the original analysis which evaluated the eight year time period 1987-1994. In the original analysis a statistically significant elevation was observed town-wide and in CT 4227 during the original middle time period 1987-1994. Results for the third time period 1993-1998 showed statistically significant elevations town-wide in Weymouth and in CTs 4222, 4223, 4224, and 4227 (see Table 4). This is in contrast to results observed in the original analysis for the period 1995-1998, where CTs 4224 and 4227 were not statistically significantly elevated and CT 4228 was statistically significantly elevated.

In Rockland, lung cancer was statistically significantly elevated town-wide during 1987-1992 as it was during the original analysis for the period 1987-1994. In addition, a statistically significant elevation was observed in CT 5021 during the follow-up analysis of the period 1987-1992 that was not observed during 1987-1994. Consistent with results observed in the original analysis, during the most recent time period 1993-1998, lung cancer was statistically significantly elevated town-wide and in both Rockland CTs. (Refer to Tables 6 through 8).

In Abington, lung cancer was statistically significantly elevated among males during 1993-1998 but not during 1995-1998 (Table 12). In Hingham, no changes in the trends in lung cancer incidence were noted during the new time periods evaluated.

C. Relative Risk Calculation for Lung Cancer

To measure whether individuals living in census tracts surrounding the SWNAS (i.e., Weymouth CTs 4221, 4222, Abington CT 5202.01, and Rockland CT 5022) had a greater probability of developing lung cancer relative to the probability of developing lung cancer when living in CTs not close to the base, a statistic called the Relative Risk (RR) was applied. The RR estimates the magnitude of an association between exposure and disease and indicates the likelihood of developing a disease in the exposed group relative to those who are not exposed (Hennekens and Buring, 1987). Although it has not been clearly established that people with

lung cancer living near the base have been exposed to environmental contamination associated with the base, the RR was used to determine whether the probability of developing lung cancer was associated with a particular geographic factor (i.e., residing in a census tract near the base vs. not near the base). Relative risk calculations are presented in Appendix C.

A relative risk close to 1.0 would indicate that the lung cancer incidence rates in both groups are essentially the same and that based on the data, there is no difference between living in any one particular census tract (either near or away from the SWNAS) and developing lung cancer. A value greater than 1.0 would indicate a positive association, or an increased risk of having lung cancer and residing in a census tract near the base. Conversely, a value less than one would indicate that the likelihood of having lung cancer and living in census tracts close to the base was less than having lung cancer and living in census tracts away from the base. The degree to which a RR value is greater than or less than 1.0 indicates the strength of the association. For example, a RR value of 2.0 would indicate that individuals diagnosed with lung cancer are twice as likely to reside in a census tract near the base. Similar to the SIR calculations, a 95% confidence interval (95% CI) measures the range of possible RR values. If the 95% CI range does not include the value 1.0, then the risk of having lung cancer and living near the base is statistically significantly different than the risk of having lung cancer and living away from the base. As previously stated, the RR does not determine whether potential exposures from the SWNAS caused lung cancer in individuals living in these areas.

A crude estimate of the relative risk was slightly greater for individuals with lung cancer who reside in census tracts near the SWNAS when compared to individuals with lung cancer residing in census tracts away from the base over the seventeen years (RR=1.06; 95% CI = 0.93-1.21). However, from a statistically standpoint, since the 95% confidence interval for the crude RR estimate includes a value of 1.0, it does not appear that living in the four census tracts near the SWNAS poses an increased risk of having lung cancer compared to living in other census tracts in the four communities surrounding the base. Since crude RR estimates do not take into account census tract specific age and gender characteristics that may confound results, RRs were also calculated to adjust for these population characteristics. The adjusted RR results were essentially the same as the crude estimates. Specifically, over the 17-year time period 1982-1998, the age and gender adjusted RR was 1.10 indicating that the relative risk of having lung

cancer and living in census tracts close to the SWNAS is slightly greater than the risk of having lung cancer and residing in those census tracts more distant to the base.

Importantly, a crude RR estimate was also calculated to evaluate the risk of being a non-smoker with lung cancer and residing in census tracts near the SWNAS relative to being a non-smoker with lung cancer and residing in census tracts away from the SWNAS. The relative risk was 0.8 (95% CI = 0.41-1.62), indicating that individuals with lung cancer who are non-smokers are not more likely to live in census tracts near the base than in other census tracts in the four towns. These results indicate that there is no strong geographical factor related to developing lung cancer in those census tracts near the base when compared to other areas of the four towns.

D. Lung Cancer Histology in Weymouth

Different histologies (cell types) of lung cancer occur with different frequencies in the population. The American Cancer Society estimates that approximately 40% of all lung cancers are adenocarcinomas, 30% are squamous cell carcinomas, 20% are small cell carcinomas, and 10% are large cell carcinomas (ACS 2000). Rates in Massachusetts are very similar to those seen nationally. However, as indicated in the February 2002 report, a slightly higher proportion of large cell carcinoma was noted in the town of Weymouth during the time period 1995-1998. Specifically, of the lung cancer diagnoses with specific histology classification, 35% were adenocarcinomas, 19% were squamous cell carcinomas, 20% were small cell carcinomas, and 23% were large cell carcinomas. The Weymouth Board of Health requested that the MDPH/BEHA further evaluate different histological subtypes of lung cancer in Weymouth to determine whether any other patterns were observed that might help explain elevations in lung cancer in the town and in some census tracts near the SWNAS. Although some differences in the proportional distributions of histology subtypes of lung cancer were noted in other towns as part of the February 2002 report (e.g. Abington), these generally occurred in census tracts away from the SWNAS.

When the histology distribution of lung cancer subtypes was evaluated over the entire seventeen year period 1982-1998 in Weymouth, a slightly larger proportion of large cell

carcinoma was observed than would be expected based on national trends for lung cancer. This trend appears to be the result of the increase in large cell carcinoma in Weymouth during more recent years. Specifically, when the histology distribution was evaluated for the three smaller time periods investigated in this report, proportions of lung cancer subtypes were similar to national trends during the first two time periods, but a slightly larger proportion of large cell carcinoma than expected was observed during the most recent time period 1993-1998. Of the lung cancer diagnoses with specific histology classification during 1993-1998, 32% were adenocarcinomas, 22% were squamous cell carcinomas, 19% were small cell carcinomas, and 27% were large cell carcinomas.

It is important to note that this histology distribution pattern does not provide an explanation for increasing lung cancer rates in Weymouth. Although examination of the proportion of subtypes suggests that large cell carcinoma comprises relatively more of the total number of lung cancer diagnoses, crude incidence rates for different histology types indicate that elevated rates of lung cancer during more recent years are due to increases in three of the four major subtypes of lung cancer (i.e., adenocarcinoma, small cell carcinoma, and large cell carcinoma).

It is unclear why the proportional distribution of lung cancer types in Weymouth is slightly different from trends seen in the general population during the most recent time period. However, it is possible that the histology distribution pattern observed in Weymouth may be the result of variations in classification methods of lung cancer histology type. Fluctuations in the proportions of individual subtypes over time are apparent in the scientific literature and there appears to be some inconsistency in the trends reported (Ginsberg et al. 1997, Blot and Fraumeni 1996). Epidemiologic data suggest that classification of specific histology type for lung cancer remains a challenge despite improvements in diagnostic techniques. One reason is that lung cancer often exhibits two or more histology types. Proper classification may also depend on the adequacy of the cell sample as well as on the training and experience of the pathologist.

While it is likely that smoking has played an important role in increased rates of lung cancer in the town, it does not appear to explain the slightly higher proportion of large cell carcinoma observed in Weymouth. When the histology distribution was evaluated for

individuals diagnosed with lung cancer who reported themselves as current or former smokers, similar proportions of subtypes were observed. In addition, studies have shown that smoking is a risk factor for all lung cancer subtypes (Khuder 2001).

When the proportional distribution of histology subtypes was evaluated for Weymouth census tracts 4221 and 4222 closest to the SWNAS, the proportion of large cell carcinoma was higher than trends observed nationally during the most recent time period, but less than the proportion observed town-wide. Further, analysis of the geographic distribution of individuals with large cell carcinoma (or any other specific subtype) revealed no apparent concentration or other spatial pattern in any Weymouth census tracts near or not near the SWNAS property that would indicate the presence of a common environmental factor.

E. Esophageal Cancer Incidence in Weymouth

Esophageal cancer has no known environmental risk factors. The most important factors associated with development of this cancer type in the U.S. are tobacco and alcohol use (ACS 1999). Based on the findings of the February 2002 report regarding lung cancer in census tracts near the SWNAS and the possible role of smoking as a risk factor, the Weymouth Board of Health inquired about the patterns of other smoking-related cancers in the town of Weymouth. Specifically, the Weymouth BOH requested that the MDPH/BEHA evaluate the incidence of esophageal cancer in the town as a whole and by smaller geographic areas to see whether a similar pattern was presented for this cancer type.

Esophageal cancer incidence rates were calculated for the town of Weymouth as a whole and the census tracts that comprise the town for the overall seventeen year period 1982-1998, and the three smaller time periods 1982-1986, 1987-1992, and 1993-1998 (refer to Tables 17 through 20). An elevation in cancer of the esophagus was observed among males and females combined for the town of Weymouth as a whole during the seventeen year period 1982-1998 (61 cases observed vs. 51 cases expected; SIR=120). This increase did not represent a statistically significant elevation in number of cases above the expected. Slight elevations were also observed when males and females were evaluated separately during this time period (see Table

17). When cancer of the esophagus was evaluated by individual census tracts over the seventeen years, slight elevations were observed among males and females combined in CTs 4221, 4223, 4225, 4226, and 4227. None of the elevations observed for the overall time period were statistically significant.

When esophageal cancer rates were evaluated for three smaller time periods, a statistically significant elevation was observed for the town of Weymouth as a whole among males alone and among males and females combined during the most recent time period 1993-1998. Thirty-three individuals were diagnosed with cancer of the esophagus whereas approximately 20 would have been expected (SIR=161) [see Table 20]. A statistically significant elevation was also observed among males in CT 4223 during the most recent time period (7 cases observed vs. 2.4 cases expected; SIR=288). Esophageal cancer generally occurred less than or equal to the rates expected during the earlier two time periods evaluated and no statistically significant elevations were observed. When the locations of each individual diagnosed with esophageal cancer between 1982-1998 were evaluated geographically, no unusual concentrations of cases were observed at the neighborhood level and individuals were distributed somewhat evenly throughout the town. Similar to the pattern of lung cancer observed in Weymouth, the locations of individuals diagnosed with esophageal cancer matched closely with the pattern of population density.

Consistent with nationwide trends, the incidence of esophageal cancer was much lower than that observed for lung cancer (i.e., less people in Weymouth were diagnosed with esophageal cancer than lung cancer). In contrast to the consistent increase over time observed for lung cancer in the town of Weymouth as a whole, fewer esophageal cancer cases occurred during the middle time period 1987-1992 (SIR = 80). However, the statistically significant elevation in cancer of the esophagus observed among males and females combined during the most recent time period is similar to the statistically significant elevation of lung cancer during this time and suggests that esophageal cancer rates may also be increasing in Weymouth. While rates of esophageal cancer by census tract are somewhat unstable due to small numbers of cases, it is also important to note that the census tracts with elevations in esophageal cancer also had elevations in lung cancer. Similar to lung cancer, the number of census tracts with elevated rates

in esophageal cancer increased over time in the town of Weymouth, and elevations in esophageal cancer were also observed in census tracts near the SWNAS, particularly among women.

Since data on the rates of smoking among the entire population in Weymouth are unavailable, it is not possible to determine with a level of certainty the extent to which the pattern observed for lung cancer is a result of the pattern of smoking among residents of the town. However, since esophageal cancer has no known environmental risk factors, the similarities observed between the patterns of lung cancer and esophageal cancer strengthen the importance of smoking as a common factor among those diagnosed with these cancer types and may explain the pattern observed for lung cancer in Weymouth.

III. Conclusions and Recommendations

In general, the follow-up analyses further confirm the findings of the original report with respect to demonstrating that smoking played some role in the incidence of lung cancer but provides no additional information that would suggest that the pattern of lung cancer is associated with a specific environmental source. The importance of smoking as a risk factor related to increases of lung cancer in the town of Weymouth is strengthened by the similar patterns observed for esophageal cancer, a cancer type with no known environmental risk factors.

Residential histories constructed for individuals diagnosed with lung cancer near the SWNAS indicated that half of the individuals were long term residents. However, the actual lengths of residence differed among the long term residents and the dates of diagnosis for these individuals were not clustered during any particular time over the seventeen years evaluated. In addition, the majority of these individuals were current or former smokers and some reported occupations where exposures related to lung cancer might have been possible making it difficult to rule out the possible role of other established risk factors for the disease. While there were non-smokers diagnosed with lung cancer in census tracts adjacent to the SWNAS, the long term residents (n=4) who reported being non-smokers were not located in close proximity to each other or concentrated in any one area within these census tracts. While the existence of a

location-specific factor related to a person's diagnosis with lung cancer is more difficult to rule out for long term residents, particularly non-smokers, the information reviewed did not suggest the existence of a common exposure that might help to explain a pattern of increasing lung cancer observed for some census tracts near the SWNAS.

Relative Risks calculated for those diagnosed with lung cancer over the 17-year time period 1982-1998 indicated that the risk of being diagnosed with lung cancer and living in census tracts close to the SWNAS was no greater than the risk of being diagnosed with lung cancer while residing in census tracts not near to the base. When relative risk was evaluated for non-smokers with lung cancer, no increased risk was observed for individuals residing near the base when compared to non-smokers with lung cancer residing in other census tracts in the four towns. So while the extent to which smoking plays a role in increased lung cancer rates in census tracts near the base remains unclear, these results indicate that there is no strong geographical factor related to developing lung cancer in CTs near the base when compared to other areas of the four towns.

When lung cancer rates were evaluated overall for the seventeen year time period, 1982-1998, statistically significant elevations were observed in a variety of census tracts in the four towns, both near and distant to the SWNAS. However, when lung cancer rates were reevaluated for three smaller time periods with more proportional year groups, the general trends in this cancer type were the same as those observed in the original report. Specifically, while there were some differences in which census tracts had statistically and non-statistically significant rates of lung cancer, rates still appear to be increasing in both Weymouth and Rockland, particularly for some census tracts close to the base. Consistent with the findings of the original report, while lung cancer rates for some census tracts near the base appear to be increasing, the geographic pattern of individuals diagnosed with lung cancer, particularly non-smokers, within these census tracts did not appear unusual.

Review of lung cancer by histology type did not provide an explanation for why lung cancer rates are increasing in Weymouth. Although a slightly larger proportion of large cell carcinoma of the lung was observed during the most recent time period, it is possible that this was due to variations in disease reporting. Analysis of the geographic distribution of individuals

diagnosed with lung cancer both near and distant to the SWNAS revealed no apparent spatial pattern for any histology subtype that would indicate the presence of some other common factor.

Evaluation of esophageal cancer rates in the town of Weymouth revealed a similar pattern to that observed for lung cancer strengthening the role of smoking as an explanation for increasing rates of lung cancer in the town. Census tracts with elevated rates of esophageal cancer also had elevations in lung cancer and, similar to lung cancer, the number of census tracts in Weymouth with elevations in esophageal cancer also seemed to increase over the three time periods.

In summary, while smoking has played a role in increased lung cancer rates in Weymouth, the contribution at the census tract level is not as clear. The similarities observed between the patterns of lung cancer and esophageal cancer in the town of Weymouth suggest that smoking habits of the population provide some explanation for increasing lung cancer rates observed over the seventeen years 1982-1998. In addition, the relative risk estimates do not suggest that a factor in census tracts near the SWNAS is playing a role in increasing rates of lung cancer relative to other areas in the four towns.

In light of the results of these additional analyses, the MDPH continues to support the recommendations made in the February 2002 report. Specifically, MDPH/BHEA will continue to monitor cancer incidence in the four towns through the Massachusetts Cancer Registry, with a particular focus on lung cancer. In addition, the MDPH supports the efforts of the Weymouth Board of Health in conducting the Weymouth Health Needs Assessment. And finally, based on all of the information reviewed regarding the incidence of lung cancer and smoking, as well as the increasing rates of esophageal cancer observed in the town of Weymouth, the MDPH recommends that tobacco control efforts be focused accordingly.

IV. References

ACS 1999. Esophageal Cancer. Available at http://www3.cancer.org/cancerinfo.

ACS 2000. Lung Cancer. Available at: http://www3.cancer.org/cancerinfo.

Blot WJ and Fraumeni JF, Jr. Cancers of the lung and pleura. In: Cancer Epidemiology and Prevention. 2nd Ed, edited by Schottenfeld D, Fraumeni. JF. New York: Oxford Press University: 1996.

Brodkin A, McCullough J, Stover B, Balmes J, Hammar S, Omenn GS, Checkoway H, and Barnhart S. 1997. Lobe of origin and histologic type of lung cancer associated with asbestos exposure in the carotene and retinal efficacy trial (CARET). *Am J Industrial Medicine* 32(6):582-91.

de Klerk NH, Musk AW, Eccles JL, Hansen J, and Hobbs MST. 1996. Exposure to crocidolite and the incidence of different histological types of lung cancer. *Occup Environ Med* 53(3):157-159.

Ebihara I and Kawami M. 1990. Carcinoma of the lung and silicosis: pathological study. National Institute of Occupational Safety and Health: Sep:730-737; (NIOSH) 90-108.

Ger LP, Hsu WL, Chen KT, and Chen CJ. 1993. Risk factors of lung cancer by histological category in Tawain. *Anticancer Research* 13(5A):1491-1500.

Ginsberg RJ, Vokes EE, and Raben A. Non-small cell lung caner. In: Cancer: Principles and Practice of Oncology, 5th Ed, edited by Devita V, Hellman S, Rosenberg S. Philadelphia: Lippincott-Raven Publishers: 1997.

Hennekens CH and Buring JE. *Epidemiology in Medicine.* Boston: Little, Brown and Company, 1987.

Ihde DC, Pass HI, and Glatstein E. Small cell lung cancer. In: Cancer: Principles and Practice of Oncology, 5th Ed, edited by Devita V, Hellman S, Rosenberg S. Philadelphia: Lippincott-Raven Publishers: 1997.

Khuder SA. 2001. Effect of cigarette smoking on major histological types of lung cancer: a meta-analysis. *Lung Cancer* 31(2-3):139-48.

Kreuzer M, Muller KM, Brachner A, Gerken M, Grosche B, Wiethege T, and Wichmann HE. 2000. Histopathologic findings of lung carcinoma in German uranium miners. *Cancer* 89(12):2613-21.

Levy and Wegman 1995. Barry S. Levy, M.D., M.P.H. and David H. Wegman, M.D., M.S. (eds). *Occupational Health: Recognizing and Preventing Work-Related Disease*. Third Edition. Boston, New York, Toronto, London: Little, Brown and Company, 1995.

MDPH 2002. Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachusetts 1982-1998: Public Comment Release. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Community Assessment Program. February 2002.

Patterson 1999. Letter from William B. Patterson, M.D., M.P.H., Medical Director Occupational Health and Rehabilitation Inc. January 11, 1999.

Appendix A

INFORMATION BOOKLET
Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachsetts 1982-1998 – Public Comment Release

Appendix B

Response to Public Comments on *Assessment of Cancer Incidence in Weymouth, Abington Hingham, and Rockland, Massachusetts 1982-1998*

Response to Public Comments

Listed below are comments received from the public regarding the report *Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachusetts 1982-1998,* released for public comment on February 14, 2002. The 30-day public comment period for this report ended on March 14, 2002. Where appropriate, comments of a similar nature have been listed together and a single response is provided. Comments are provided exactly as stated in written correspondence to MDPH.

In addition to comments submitted regarding the cancer incidence report, comments were received regarding the Weymouth Health Needs Assessment survey being conducted by the John Snow Institute (JSI) with funding support from the Town of Weymouth. Although MDPH involvement with the latter study is limited to providing technical epidemiologic support, these comments are summarized in Section II below.

I. Comments Regarding MDPH Cancer Incidence Analysis:

COMMENT #1: *"While I am admittedly no expert at this, I fail to understand the logic behind the compilation of data on a town-by-town basis, and its further fragmentation into census tracts. (I can see how this may be effective in gathering information initially, but once gathered, I believe the town lines should be ignored)[sic]."*

COMMENT #2: *"…[sic] I would ask that when you study health issues in the area further, that once your data is obtained, you include in your assessment of this data a simple map which plots the incidences of the various illnesses studied by geographic location; something like sticking colored pins on the map for each different type of illness, where each is found. As a visually-oriented person I can understand this sort of presentation a lot more easily than I can tables of data. It might be a very simple idea, but it might be one worth using. To me it would say a lot more than data fragmented by town, further fragmented and analyzed to death by microscopic examination of census tracts."*

COMMENT #3: *"…[sic] I half expected that privacy was the reason we haven't seen the sort of maps I described. I don't suppose there is any chance people would be willing to sign some sort of release of such information?*"

COMMENT #4: *"Look at the elevated incidence of lung cancer in Rockland and Weymouth. Look at where they've mainly occurred. They occurred [sic] along the flight path of planes that used the north/south runway at the base. Standing in the middle of a room looking at a map of this I see a pattern. When I zoom in to the microscopic level within the various census tracts I lose the big picture, and suddenly nothing seems to be going on. I may be oversimplifying this; I may be missing something. This is simply how it looks to my untrained eye."*

RESPONSE: Cancer incidence rates were calculated for all four towns and census tracts within the towns to evaluate whether more or less cancer occurred than would be expected based on the state-wide cancer experience. In order to evaluate the incidence of a disease like cancer at a smaller geographic level than the town, rates of disease are calculated to determine whether the incidence in the area of concern might be higher or lower than expected based on population size. To calculate cancer rates for smaller geographic areas it is necessary to obtain accurate age-group and gender specific population data. This is because different diseases occur with different frequency (either higher or lower) among different age groups and by gender. The census tract is the smallest geographic area for which accurate counts of population by age-group and gender necessary for calculating cancer incidence rates are available.

Our evaluation not only included a quantitative analysis, but also a qualitative analysis of cancer incidence in the four towns surrounding the South Weymouth Naval Air Station (SWNAS) over a seventeen year period. In addition to calculating cancer incidence rates, a key portion of our analysis included an evaluation of the geographic pattern of all people diagnosed with cancer at the neighborhood level regardless of whether cancer rates were statistically significantly elevated in a particular town or census tract. By plotting the address reported for each person diagnosed with cancer on a map we were able to evaluate the patterns of individuals diagnosed with each cancer type at both the large-scale and smaller neighborhood level without the influence of town and census tract boundaries. However, due to the confidential nature of the information contained within the Massachusetts Cancer Registry (MCR) data files, we are unable to provide the maps showing the individual locations of people diagnosed with cancer to the public. State confidentiality laws prohibit MDPH staff from releasing MCR data in any way that would identify a person with cancer (including contacting them directly to sign a release of their information).

The combination of calculating cancer rates by town and census tract together with an evaluation of the geographic patterns of cancer at a smaller geographic level provided us with a comprehensive picture of the pattern of cancer in the four towns surrounding the SWNAS. Specifically, as stated in our report and presented at the February 2002 public meeting, when we looked at the pattern of cancer and flight paths at the base in the most recent time period (i.e., 1995-1998) we observed that census tracts close to the base had elevations of lung cancer. However, since census tracts cover a wide area, when we looked more closely at the flight paths within the census tracts together with the specific locations of people diagnosed with lung cancer at the neighborhood level, particularly non-smokers, we did not see a clear pattern of cancer diagnoses suggesting a relationship specific to the pattern of former flight paths at the base.

As part of the follow-up work associated with the cancer incidence evaluation, the MDPH/BEHA further investigated lung cancer in neighborhoods and census tracts near the SWNAS to see whether a clearer pattern related to environmental or other risk factors may

emerge. These additional analyses included an evaluation of the length of residence for those individuals who have been diagnosed with lung cancer in these areas, particularly non-smokers (MDPH 2002).

***COMMENT #5**: "During about a two-year period, from 1988 to 1990, there were other cases of cancer on Tilden Road in Weymouth [sic]. ...[sic] I know there were also more cases of cancer that evolved after this time [*sic]. …[sic] I hope you will still keep in mind the excessive amount of cancer found on one street *in such a short amount of time."*

***COMMENT #6:** I'm aware of an incidence of a type of [sic] cancer in one census tract in Weymouth…[sic] on Tilden Road, which was not considered significant in this study, as it was seen as an isolated case. Meanwhile, just down the street, (but across the town line) a former resident [sic] had the same type of cancer [sic] too. The town of Rockland is less than two hundred feet away ... [sic] in the other direction, away from Weymouth. Who knows who has it over there? The doctors, sure. MDPH probably does too. But if, as in the one Weymouth case that I know about, the case was ignored for purposes of the study, then what we have is far from an accurate picture.*

RESPONSE: As previously explained (see response to Comments 1-4), in addition to calculating cancer incidence rates for the four towns and the census tracts within those four towns, a key portion of our analysis included an evaluation of the geographic pattern of all people diagnosed with cancer at the neighborhood level. By plotting the address reported for every person diagnosed with cancer on a map, we were able to evaluate the patterns of individuals diagnosed with each cancer type at both the large-scale and smaller neighborhood level without the influence of town and census tract boundaries. All eight cancer types were evaluated at the neighborhood level throughout the four towns, regardless of whether cancer rates were statistically significantly elevated in a particular census tract, and no individual diagnosed with cancer was ignored.

When interpreting the results of the analyses, it is important to keep in mind that cancer is a common disease. According to the American Cancer Society statistics, cancer is the second leading cause of death in Massachusetts and the United States. Not only will one out of three people develop cancer in their lifetime, but also this tragedy will affect three out of every four families. For this reason, cancers often appear to occur in "clusters," and it is understandable that someone may perceive that there are an unusually high number of cancer cases in their surrounding neighborhoods or towns. Upon close examination, many of these "clusters" are not unusual increases, as first thought, but are related to such factors as local population density, variations in reporting or chance fluctuations in occurrence. In other instances, the "cluster" in question includes a high concentration of individuals who possess related behaviors or risk factors for cancer.

Understanding that cancer is not one disease, but a group of diseases is also very important. Research has shown that there are more than 100 different types of cancer, each with different causative (or risk) factors. In addition, cancer of a certain tissue type in one organ may have a number of causes. Cancer may also be caused by one or several factors acting over time.

For example, tobacco use has been linked to lung and bladder cancers. Other factors related to cancer may include lack of crude fiber in the diet, high fat consumption, alcohol abuse, and reproductive history. Heredity, or family history, is an important factor for several cancers. To a lesser extent, some occupational exposures, such as jobs involving contact with asbestos, have been shown to be carcinogenic (cancer causing). Environmental contamination has also been associated with certain types of cancer.

Tilden Road is located in Weymouth CT 4222. Although we examined the geographic distribution of all individuals diagnosed with cancer at a neighborhood level in all four towns, the patterns of cancer in the area around Tilden Road in Weymouth and nearby streets in Hingham and Rockland were reexamined throughout the 17 years evaluated to address specific concerns about cancer in this particular area. In general, our review found no atypical pattern of cancer on Tilden Road or in the surrounding neighborhoods. There were a variety of types of cancer diagnosed among individuals in the neighborhood that includes Tilden Road and in neighboring areas outside of Weymouth between 1982-1998, representing the occurrence of different diseases. In addition, no atypical patterns with respect to place of residence or diagnoses over time emerged for any one cancer type that would suggest a cluster or a common factor, including exposure to a specific environmental source.

COMMENT #7: *"As the recently updated cancer studies document, Weymouth has been found to have had an elevated number of leukemia cases over the period 1987 [sic]-1994. Subsets of this data should be examined. Again; keying on geographical and chronological occurrence in regards to peak military aviation activity, and JP-8 usage. Abington and Rockland leukemia incidence should be reexamined with these same factors examined closely.*

RESPONSE: An important component of the cancer incidence investigation was an evaluation of the geographic and chronological patterns of all eight cancer types, including leukemia, in all four towns and their census tracts. As presented in our report and at the February 2002 public meeting, leukemia occurred at approximately the rate expected in the town of Weymouth during the first of the three time periods examined (1982-1986), was statistically significantly elevated during the middle time period evaluated (1987-1994), and occurred slightly less than expected in the most recent time period, 1995-1998. When leukemia rates were evaluated by census tract during the middle time period, more diagnoses of leukemia than expected were observed in some areas throughout the four towns, including Weymouth census tracts 4221 and 4222 located near the SWNAS. Leukemia was statistically significantly elevated in CT 4222 during 1987-1994 (11 individuals were diagnosed with leukemia whereas approximately five would have been expected). Leukemia was also elevated in CT 4221, although this elevation was not statistically significant (seven individuals were diagnosed whereas approximately three would have been expected). Leukemia occurred equal to or below the rates expected in both of these census tracts during the earliest and most recent time periods.

In the town of Abington as a whole, leukemia was slightly elevated in the first of the three time periods (1982-1986), and occurred at approximately the rate expected in the latter two time periods. Leukemia was not particularly elevated among census tracts in Abington, and due

to the instability of rates based on small numbers (i.e., less than five), meaningful census tract rates were not able to be calculated for the three smaller time periods. In the town of Rockland, leukemia occurred approximately less than or equal to the rate expected during all three time periods. When leukemia was evaluated by census tract, the rates were mostly equal to or below what would be expected. A slight elevation was observed in Rockland CT 5022 (the southern portion of Rockland not near the SWNAS) during the last of the three time periods evaluated, 1995-1998 (five individuals were diagnosed with leukemia whereas approximately three would have been expected). This elevation was not statistically significant.

In addition to evaluating leukemia rates for specific time periods, as with the other cancer types, the individual locations of people diagnosed with leukemia were examined at the neighborhood level regardless of whether rates were statistically significantly elevated. The pattern of leukemia in all four towns was examined geographically and over time, with a particular focus on those individuals living near the SWNAS. Additionally, since different subtypes of leukemia tend to occur with different frequency among adults and children and each have unique risk factors associated with their development, the patterns of different leukemia subtypes were also evaluated separately. There were no apparent geographic or chronological distribution patterns observed for leukemia in general or for any of the leukemia subtypes at the neighborhood level in any of the four towns during the 17 years evaluated. Further, there were no apparent concentrations of individual's with leukemia in neighborhoods near the SWNAS that would suggest a relationship to historical flight paths at the base.

The BEHA is aware of concerns about the incidence of leukemia particularly among children and possible exposures to jet fuels such as JP-8 in other areas of the country (i.e., investigations being conducted in Fallon, NV). To address concerns that there might be a peak in the incidence in leukemia near the SWNAS over time, the chronological distribution of all types of leukemia were reexamined by individual year in those census tracts that abut the base, with particular focus on Weymouth CT 4222 where a statistically significant elevation was observed during the middle time period 1987-1994. Between 1982-1998, there were no specific peaks in the incidence of leukemia for individual years or smaller groups of years that would suggest the possibility of a common exposure during an isolated window of time. In addition, we did not see an unusual number of children with leukemia during smaller year groups and there was no preponderance of any one subtype of leukemia in these census tracts either geographically or over time. Although leukemia was statistically elevated in Weymouth CT 4222 during the middle time period 1987-1994, the individual cases were distributed somewhat evenly within the CT and over these years.

COMMENT #8: *"In a community based study in Grantsville, Tooele County, [sic] Utah performed in 1996, a private citizens health survey located 201 incidences of cancer in the vicinity of a military installation. This house to house survey by private citizens located these 201 cancer incidences among 650 households, or roughly ½ the town of Grantsville. The State Cancer Registry showed only slightly more total cancers (237), for the entire population of the town. Either the citizen study proximity to the toxic sites play into effect here, or the States data gathering appears greatly flawed. I bring this up as a plea for the State to take every precaution that data reported is gathered in the most viable way possible."*

RESPONSE: The Community Assessment Program was able to look at the patterns of cancer in the four communities surrounding the SWNAS by using data collected by the Massachusetts Cancer Registry (MCR), a division within the MDPH Bureau of Health Statistics Research and Evaluation. The MCR is a population-based surveillance system that collects information on all Massachusetts residents diagnosed with cancer, and state law requires that all new cancer diagnoses be reported to the MCR within six months of diagnosis. Estimates of MCR completeness in reporting have increased steadily since the registry was established in 1982. In its early years, the MCR was estimated to include 90-95% of all *reportable* cancer cases in Massachusetts. More recently, efforts to improve case ascertainment by the Cancer Registry have increased completeness to more than 100%, and the MCR is considered by the North American Association of Central Cancer Registries to be 'complete'.

It is difficult to compare results of cancer incidence studies that use cancer registry data with those from door-to-door surveys that collect reports of cancer such as that conducted by private citizens in Tooele County, Utah. Similar to the CAP evaluation of cancer incidence in the four towns surrounding the SWNAS, the study conducted by the Tooele County Health Department and the State of Utah Department of Public Health was based on data obtained from the Utah Cancer Registry (Coombs 2002). Cancer registries typically collect information on all primary (new) cancer diagnoses and do not generally include metastatic cancers that develop as a result of cancer spread from another location within a person's body. Also, individuals are typically reported to cancer registries based on their address at the time they are diagnosed with cancer and would not include people who were diagnosed prior to moving to a particular area. Door-to-door surveys that ask participants to identify all family members who have cancer may include those with metastatic cancers and/or people diagnosed when living elsewhere. This may be a factor in the cancer evaluations conducted in Utah.

COMMENT #9: *"Citing the fact that the State Executive Office of Environmental Affairs has reported that asthma hospitalizations in our towns are among the highest in the state. Rockland, where the foot of the Southern Runway is sited, has the highest level of asthma hospitalizations in a Massachusetts community, bar none.[sic] This [sic] should concern all of us. Increased incidence of lung cancer [sic] reported by your office in all three of our towns (Abington, Rockland, Weymouth), should likewise concern us. As teams of scientists are currently at work proving a connection between JP-8 Jet Fuel and respiratory disease, I am very concerned. …[sic] Once again, the study should be particularly scrutinizing a subset of data collected that addresses proximity (all families that have moved into the study neighborhoods after 1995 should be omitted from study inclusion). Years having the maximum number of sorties (…1994+…?) would seem to be a key subset. The in utero factor should be explored as well."*

RESPONSE: *The State of Our Environment* report produced by the Massachusetts Executive Office of Environmental Affairs in April 2000 includes a map showing asthma hospitalization rates for Massachusetts cities and towns for the year 1997 (EOEA 2000). As indicated in this map and elsewhere, asthma hospitalization rates are highest in many urban areas for which hospitalization data are available, including the cities of Boston, New Bedford, Lawrence, and

Springfield. According to this same map, the town of Rockland was also in the highest of five asthma hospitalization rate categories during the same year. The towns of Weymouth and Abington were in the second highest category and the town of Hingham was in the second to lowest category.

Nationwide increases in asthma rates represent an important public health issue, and there is much research being conducted to identify and reduce risk factors for this disease. Known risk factors for asthma include exposure to allergens (molds, pollen, dust, pet dander), household products, air pollutants and irritants, smoking and exposure to second-hand smoke, respiratory infections, physical exertion and cold air. However, similar to our cancer incidence investigation, asthma hospitalizations data cannot be used to establish what may have caused a person's asthma diagnosis.

There are several other important considerations to keep in mind when evaluating data on asthma. Unlike cancer data, there is currently no registry for asthma to determine with more certainty whether asthma rates in specific communities are higher or lower than would be expected for a particular city or town. Without an asthma registry, there is also no way to get an accurate picture of where people with asthma live. In addition, use of hospitalizations data to predict true rates of asthma has been shown to be unreliable for several reasons including that individuals who have control of their asthma are generally not counted because they are not being hospitalized. It is worthwhile to note that the MDPH has recently been awarded federal funds to establish a statewide tracking system for pediatric asthma. This effort is expected to be implemented over the next three years.

Although lung cancer rates increased over the 17 years in both Weymouth and Rockland, particularly in those census tracts near the base, our evaluation did not show a specific geographic pattern of diagnoses that would suggest a clear relationship to the SWNAS. Our investigation of available information on risk factors for individuals diagnosed with lung cancer in the four towns surrounding the SWNAS showed that smoking and in some cases occupation both played an important role in increased lung cancer rates in the four town area.

There is some indication that respiratory effects may occur as a result of inhalation of jet fuel vapor, but a stronger association has been demonstrated when jet fuels are aspirated into the lungs following ingestion (ATSDR 2001). It is not possible to determine whether use of fuels at the SWNAS such as JP-8 had an effect on the respiratory health of people living near the base. However, as part of the follow-up analyses associated with the cancer incidence investigation, an evaluation was conducted to evaluate whether individuals living in census tracts surrounding the SWNAS had a greater probability of developing lung cancer relative to the probability of developing lung cancer when living in CTs distant to the base. Results from this analysis indicated that there was no strong geographical factor related to developing lung cancer near the base when compared to other areas of the four towns. In addition, no increased risk was observed for non-smokers diagnosed with lung cancer and living near the base when compared with non-smokers with lung cancer residing in other census tracts in the four towns. Please refer to the follow-up report for a discussion of these results (MDPH 2002).

Finally, the Town of Weymouth has contracted with JSI Research and Training Institute to conduct a Health Needs Assessment and Intervention Program to identify the health needs of

the Town of Weymouth and to design programs to improve the health of residents. To help address continuing concerns about health issues other than cancer from residents of Abington and Rockland who live near the SWNAS, the Weymouth Health Needs Assessment was expanded to survey randomly selected households within a half-mile radius of the base. Results from the Health Needs Assessment will be used to better evaluate the prevalence of asthma in those areas surveyed.

II. Comments Regarding the Weymouth Health Needs Assessment, Being Conducted for the Town of Weymouth by the John Snow Institute (JSI):

COMMENT #10: *"I also do not agree with the idea of sending out random surveys to people in Weymouth, Abington, and Hingham. I think [sic] the surveys should be sent out to all the residents of the three towns. If it is sent out randomly, it could miss several people who have a lot to say about the study. It could also go to a lot of people who do not care and have nothing to say about the study."*

COMMENT #11: *"I am alarmed at the use of the word "random" I've heard in connection with the intended methodology for obtaining information for this study. I sincerely hope that the complete picture this study is designed to capture will be derived from a house-by-house questionnaire. Anything less than this would be at best a scattershot effort, and would surely miss critical pieces of this puzzle."*

COMMENT #12: *"I would also like to see the study area extended to at least two miles out from the base. I live fairly close to the base property, yet even I would barely meet the criteria to be included in the study if it's limited to half a mile out from the base fence. I have neighbors all the way up the street with serious health concerns. They've wondered for years if they were related to the base."*

COMMENT #13: *"Will you attempt to track people who moved away [sic] down? For the sake of a complete and accurate picture, I believe it's necessary to. (Records, even if the forwarding time has expired, may be obtained from the local post office.) The people living in these neighborhoods may be helpful in supplying you with information as well. Many have lived here all their lives, and know the histories of their neighbors as well as their own."*

COMMENT #14: *"In addition, I believe it's important to capture more than a single frame of this picture.. or even a few frames. What you need to get, I think, is closer to a movie clip…something that spans <u>at least the last fifteen years</u>. For even though the base has been inactive since 1997, the effects of exposure to the chemicals released into the air and water could still be developing. People I know who live here are still coming down with cancer. People I know in other towns, living close to the base, are still being diagnosed with MS… with non-Hodgkin's lymphoma.. with other illnesses that may have an environmental link. To arbitrarily limit the window of time studied to anything less than at least the last fifteen years would leave*

too many people out of it. And they deserve to be counted. TOGETHER [sic], as well as in separate time spans."

COMMENT #15: *"I would also suggest you include in your survey a section where people might write their own non-quantifiable comments; where they might address other things that have concerned them but which your study will not cover. A place for anecdotal information, if you will...[sic]"*

COMMENT #16: *"Towards that noble end, I would like to see a non-partisan or private group of environmental health professionals join in this process. I don't believe it's possible to completely remove politics from such a study, but I believe with so many questions surrounding military base closure on a national level, it is of real importance to the credibility of these efforts, that politics as much as possible be removed from the process. I would suggest your office contact the Environmental Health branch of the PEW Commission and employ their assistance with this study, both in establishing the most valid protocol, and subsequent follow-up."*

COMMENT #17: *"From my own limited online explorations of base closures, I would suggest this study pay particular attention to those neighborhoods in geographical proximity to runway ends, and waterways."*

COMMENT #18: *"...[sic] I believe it is important to establish protocol that would document the cases of undiagnosed neurological illness, which can manifest itself in a large number of ways. These varied manifestations should be included in this study to chronicle any emerging patterns of illness."*

COMMENT #19: *"[sic] It is known that JP-8 jet fuel was used extensively at SWNAS, but only during the last years of its operation. I believe an important subset of data could be, much like it was in the famous Woburn Massachusetts "Civil Action" case; children in utero, who's mothers may have been chronically exposed to JP-8 Jet Fuel, around the peak years of JP-8 usage. Sorties have been reported by the Navy, to have peaked in 1994 (25,000 sorties). The MDPH should establish with the Navy, what years (through 1995 when the base closed) maximized citizens' [sic] exposures to this fuel product. Again, geographical proximity to runway ends and stream banks should be scrutinized."*

COMMENT #20: *"All diseases of the auto-immune system should be featured in your study."*

COMMENT #21: *"The MDPH should further survey the geographical occurrences of a number of other physical conditions that are currently being linked to environmental causes. These would include ADHD, ADD, Autism, other learning disabilities, birth defects, still birth."*

COMMENT #22: *"I would hope that the MDPH form a citizen's advisory council to assist is establishing study protocol. Politically based studies suffer credibility problems."*

RESPONSE: As described at the MDPH public meeting on February 14, 2002, the Weymouth Health Needs Assessment and Intervention Program is not an MDPH activity but a community

health study being conducted by the Weymouth Health Department. The Town of Weymouth has contracted with JSI Research and Training Institute, an independent health research and consulting firm, to conduct the study. However, MDPH has provided significant technical assistance to the Town of Weymouth Board of Health. The primary purpose of the Weymouth Health Needs Assessment and Intervention Program is to identify the health needs of the Town of Weymouth and to design programs to improve the health of residents.

Based on continuing concerns about health issues other than cancer from residents of Abington and Rockland who live near the SWNAS, the MDPH asked the Weymouth Health Department to expand the Weymouth Health Needs Assessment to the neighborhoods in Abington, Rockland and Hingham that are located in close proximity to the SWNAS. Therefore, the Weymouth Health Needs Assessment includes distribution of the survey to randomly selected households within a half-mile radius of the SWNAS.

It is important to note the Weymouth Health Needs Assessment was not intended to be a comprehensive health study of all health outcomes of concern and the potential relationship to contamination detected at the SWNAS. Rather, the Weymouth Health Needs Assessment was expanded to provide as assessment of certain health outcomes other than cancer (auto-immune disease, neurological disorders, multiple sclerosis) in neighborhoods near the SWNAS in Weymouth as well as the three other communities of Abington, Rockland and Hingham. Expansion of the Weymouth Health Needs Assessment to areas outside of Weymouth, and the inclusion of questions to address additional health outcomes of concern in these areas were both attempts to provide the community with some preliminary answers to questions raised in a much quicker timeframe so that it could be determined whether additional study may be necessary. Subsequent to this, the MDPH has also been awarded federal funds to further investigate multiple sclerosis (MS) and Amyotrophic Lateral Sclerosis (ALS) prevalence in proximity to the SWNAS and in Middleborough and Raynham where the state identified hazardous waste sites were of concern.

In specific response to Comment #15, the Weymouth Health Needs Assessment Survey includes a place where participants can write in any additional information or comments that they feel are important and were not specifically addressed by the questionnaire.

III. References

ATSDR 2001. Interaction Profile for Arsenic, Hydrazines, Jet Fuels, Strontium, and Trichloroethylene. U.S. Department of Health and Human Services, Atlanta, GA, December 2001.

Coombs 2002. Personal Communication with Jeff Coombs, Director, Tooele County Health Department. October 11, 2002.

EOEA 2000. The State of Our Environment. Executive Office of Environmental Affairs, Commonwealth of Massachusetts. April, 2000.

MDPH 2002. Assessment of Cancer Incidence in Weymouth, Abington, Hingham, and Rockland, Massachusetts 1982-1998: Response to Public Comments and Additional Analyses. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Community Assessment Program. November 2002.

Appendix C

Relative Risk Calculation for Lung Cancer

Relative Risk Calculation for Lung Cancer

Methods

To evaluate the risk of being diagnosed with lung cancer and living in census tracts near the SWNAS relative to the risk of being diagnosed with lung cancer and living in census tracts defined as not near the SWNAS, a statistic called the Relative Risk (RR) was applied. A crude estimate of the relative risk for developing lung cancer over the seventeen years 1982-1998 was calculated using the following formula:

$$\textit{Relative Risk} = \frac{\text{\# of lung cancer cases in SWNAS CTs / total population at risk in SWNAS CTs}}{\text{\# of lung cancer cases in other CTs / total population at risk in other CTs}}$$

Where:

SWNAS CTs include:	Weymouth CTs 4221 and 4222 Abington CT 5202.01 Rockland CT 5022
Other CTs include:	Weymouth CTs 4223 through 4228 Abington CTs 5201 and 5202.02 Rockland CT 5021 Hingham CTs 5011.01, 5011.02 and 5012

The total population at risk over the seventeen years was calculated by subtracting the number of individuals diagnosed with lung cancer between 1982-1998 from the total population of each group using data from the U.S. Census. The true population at risk would exclude those diagnosed with lung cancer prior to 1982 since one is generally not diagnosed with lung cancer twice. However, since cancer incidence data for years prior to 1982 were not available, the formula has been slightly modified.

Results

	Relative Risk	*95% Confidence Interval*
All individuals with lung cancer	1.06	0.93 – 1.21
Non-smokers with lung cancer	0.8	0.41 – 1.62