Health Consultation

Final Report

Evaluation of Serum PCB Levels and Cancer Incidence Data

Parker Street Waste Site Neighborhood

(EPA FACILITY ID: MAN000105955)

New Bedford, Bristol County, Massachusetts

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EXECUTIVE SUMMARY

This report, *Health Consultation: Evaluation of Serum PCB Levels and Cancer Incidence Data, Parker Street Waste Site Neighborhood*, was first released in September 2011 as a draft for Public Comment. The health consultation was conducted in response to neighbors that live in close proximity to the Parker Street Waste Site (PSWS) and school staff at New Bedford High and Keith Middle Schools who were concerned about the presence of environmental contaminants, particularly polychlorinated biphenyls (PCBs). Interested parties were given six weeks to submit review comments on the document to the Massachusetts Department of Public Health, Bureau of Environmental Health (MDPH/BEH). MDPH/BEH received approximately 36 pages of detailed comments. MDPH/BEH has prepared a final report which includes revisions, as warranted, based on the comments received. A Response to Comments is provided as an Appendix (D) to this report.

To address community member concerns, MDPH reviewed the incidence of nine types of cancer that were either of particular concern to residents or, based on the medical literature, were suggested as possibly being associated with exposure to PCBs. The review included the five census tracts (CTs) that surround the PSWS and the City of New Bedford as a whole. In addition, MDPH offered blood testing to concerned residents to determine levels of PCBs in blood serum and to evaluate whether patterns might suggest that residence near the PSWS played a primary role in PCB exposures. (While this report focuses on residents of the PSWS, MDPH issued a separate report to address concerns specific to the indoor environment and health at the New Bedford High School.)

Serum PCB testing showed that the majority of participants who currently live or previously lived within the five CTs, as well as three non-resident participants that reported spending a significant amount of time at the PSWS, have serum PCB levels within the typical variation seen in the U.S. population and do not indicate unusual exposure opportunities to PCBs (i.e., participants fell within the 95th percentile). According to the U.S. CDC, the 95th percentile of NHANES data is helpful for determining whether levels observed in public health investigations are unusual. Three of the 45 participants have serum PCB results above this typical range. There was no consistent pattern of increasing serum PCB levels with increasing

years of residence in the neighborhood around the PSWS, suggesting that location of residence was not a primary predictor of serum PCB levels. Consistent with national patterns, serum concentrations of PCBs in participants generally increased with age but were within typical concentrations for the U.S. population for each age group evaluated. Finally, the PCB congener patterns for each age group evaluated are consistent with what is typically seen in the U.S. population, suggestive of dietary sources.

The Parker Street Waste Site is located in CT 6510.02, extending into CT 6515 on its southerly boundary. For both of these census tracts, the incidence of liver cancer, the type of cancer with the strongest association with exposure to PCBs, was approximately the same as the expected rate, with a difference of one between the number of observed and expected diagnoses for the 25-year time period. For both census tracts, the incidence of the majority of cancer types was approximately as expected and no consistent trends were seen in the incidence of any particular type of cancer over the 25-year span. Therefore, for the two census tracts in closest proximity to the Parker Street Waste Site, the incidence rates of those types of cancer possibly associated with exposure to PCBs appear to be approximately as expected based on comparisons to the cancer experience of Massachusetts as a whole. It is important to point out that a review of cancer incidence data, as was conducted in this report, applies to the population at large. This type of analysis cannot be used to determine the cause of cancer in an individual. It is used as a screening-level evaluation to assess whether further study is warranted.

For the other three census tracts surrounding the Parker Street Waste Site, the incidence of the majority of cancer types evaluated was approximately as expected for each of the five time periods evaluated. No unusual or consistent trends emerged in the three census tracts.

When cancer incidence rates for the City of New Bedford as a whole were examined, some elevations were noted, particularly in lung cancer in males. Lung cancer incidence in males was elevated in males primarily between 1997 and 2006. Based on smoking history information reported to the Massachusetts Cancer Registry, it appears that smoking played some role in the incidence of this cancer in New Bedford males.

I. INTRODUCTION

In March 2007, the City of New Bedford forwarded a petition signed by 32 individuals to the Massachusetts Department of Public Health's (MDPH) Bureau of Environmental Health (BEH).[1] The petition was signed by 21 New Bedford High School (NBHS) teachers and 11 neighbors of NBHS and Keith Middle School (KMS). The petition requested testing and/or a study of the area around the two schools because of concerns related to historical contamination, particularly polychlorinated biphenyls (PCBs), and potential health implications. NBHS occupies an area that formerly contained a city dump and across Hathaway Boulevard, KMS was constructed on fill from the former dump. The schools and the neighborhoods around the former burn dump are now part of what has become known as the Parker Street Waste Site (PSWS)[2] (TRC, 2009). To address the concerns of residents living near PSWS, BEH undertook the following:

- A review of the incidence of nine types of cancer that were either of particular concern to residents or, based on the medical literature, were suggested as possibly being associated with exposure to the major contaminants of concern at the PSWS. The review included the five census tracts (CTs) that surround the PSWS (6509, 6510.01, 6510.02, 6511, and 6515) and the City of New Bedford as a whole.

- An offer to participate in the MDPH/BEH blood testing for concerned residents and school staff to determine levels of PCBs in blood serum and whether patterns might exist to suggest that residence and/or occupation or attendance at the schools played a primary role in PCB exposures.

This report first presents a summary of the results of the serum PCB testing program for residents of the PSWS neighborhood as well as the findings of the cancer incidence data review.

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[1] This report was supported in part by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services. This document has not been reviewed and cleared by ATSDR.

[2] USEPA CERCLIS ID #: MAN000105955; MassDEP RTN: 4-0015685

A summary and conclusions for both evaluations are also provided. For the purposes of this evaluation, the PSWS neighborhood is defined as the five CTs surrounding the PSWS. (New Bedford has a total of 31 CTs.) Concerns specific to the indoor environment and health at the NBHS, including a summary of health concerns (including cancer) and the serum PCB test results for NBHS staff, are addressed in a separate BEH report entitled *Health Consultation: Evaluation of Indoor Environmental Conditions and Potential Health Impacts, New Bedford High School, 230 Hathaway Boulevard, New Bedford, MA.*

It is our understanding that in response to a petition request from Wasted Away (now Citizens Leading Environmental Action Network (CLEAN)), the federal Agency for Toxic Substances and Disease Registry (ATSDR) committed to conducting a public health assessment (PHA) of the PSWS and a Health Consultation of Walsh Field. In these assessments, ATSDR reviews the environmental sampling data from the site, evaluates the ways by which people may come into contact with contamination at the site, and then evaluates the potential for adverse health effects from exposures.

II. BACKGROUND AND COMMUNITY ENVIRONMENTAL CONCERNS

PCBs are a group of 209 different chemicals called congeners (U.S. ATSDR 2000). They are stable organic chemicals used in products from the 1940s through the late 1970s for their non-flammability and electrical insulating properties (Balfanz et al., 1993; Currado et al., 1998; Vorhees et al., 1999). PCBs were also used in a wide variety of materials in buildings constructed before the late 1970s (MacLeod et al., 1981; Kuusisto et al., 2007). By 1977, companies in the United States stopped manufacturing PCBs (U.S. ATSDR 2000). The U.S. Environmental Protection Agency (EPA) officially banned the manufacture of PCBs and their use in open systems in 1979. In New Bedford from 1947 to 1977, PCBs were used by Aerovox and Cornell-Dubilier Electronics to make transformers, capacitors and other electrical equipment (MDPH 1987; MDPH 1995). Prior to the manufacturing ban, PCBs were used for a variety of different purposes including their use in fluorescent light ballasts (Wallace et al., 1996; Staiff et al., 1974; MacLeod et al., 1981; and Currado et al., 1998) and caulking or joint sealants (Kohler et al., 2005; Herrick et al., 2004). Products made with PCBs before the ban may still be in use

today in older buildings, as the federal ban did not apply to items already in place in existing buildings at the time of the ban (Wallace et al., 1996).

The PSWS is a hazardous waste site consisting of approximately 122 acres. The site includes the New Bedford High School (NBHS), the Keith Middle School (KMS), the former Keith Middle School, Dr. Paul F. Walsh Memorial Field (Walsh Field), a state-owned ice arena (Hetland Rink), City-owned maintenance facilities, a small number of commercial properties, and nearby residential neighborhoods (U.S. EPA 2011, 2012). Some properties within the PSWS boundaries are impacted by fill contaminated with PCBs, polyaromatic hydrocarbons (PAHs), and heavy metals (including but not limited to arsenic, lead, and cadmium.) Fill material originated from a former city dump located in the vicinity of the NBHS campus. NBHS was constructed between 1968 and 1972 and soils displaced during construction may have been deposited on the lot across Hathaway Boulevard, where McCoy Field, an athletic field, was later built and where the KMS is now located (TRC 2009) (See Figures 1 and 2).

The KMS was constructed during 2004-2006 and opened in 2007. The fill used in McCoy Field consisted of sand and silt along with ash, asphalt, and other demolition debris; PCBs and PAHs were detected in this fill. In planning for construction of the KMS, the City hired a consultant to investigate contamination of the property and to evaluate potential exposures to students and school staff and the health risks associated with exposure. As a result, extensive site remediation, including the removal of contaminated soil, occurred before the KMS was built. The removal actions prompted greater concern among long-term residents whose properties abut the area. Steps were taken during school construction to prevent future exposures through the construction of a gas and liquid impermeable vapor barrier under the building and a passive vapor collection system. A Long-Term Monitoring and Maintenance Implementation Plan (MMIP) for the KMS is currently in place to monitor the exposure management barriers as well as levels of PCBs and volatile organic compounds (VOCs) in indoor air, the foundation venting system, groundwater, and wetland sediment on KMS property (BETA 2006a and b). Historical and recent reports on the KMS are available on the City's website (http://www.newbedford-ma.gov/McCoy/sitemap/nbhs.html).

Additional site investigation and clean-up activities at the PSWS and the NBHS are being conducted by the City's contractor, TRC Environmental (TRC), in collaboration with EPA and the Massachusetts Department of Environmental Protection (MassDEP). These activities are aimed at further identifying the boundaries of the PSWS, identifying and addressing any data gaps in environmental sampling data, evaluating any potential public health and/or environmental impacts, and conducting clean-up activities when indicated (U.S.EPA 2010a and b). The City's website contains numerous reports and fact sheets on on-going activities related to the PSWS. The portions of the PSWS boundary that required further evaluation are illustrated in Figure 1 (U.S. EPA 2010c).

III. PCB SERUM TESTING

A. METHODS

As previously noted, MDPH/BEH conducted blood serum PCB testing of individuals concerned about opportunities for exposures to PCBs from the PSWS.

The goal of the blood sampling offer was to determine if school staff and students at New Bedford High School and Keith Middle School had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S. population. According to CDC, biomonitoring studies of serum PCBs can provide physicians and public health officials with data to evaluate whether individuals have been exposed to higher levels of PCBs than the general population. The measurement of an environmental chemical, including PCBs, in a person's blood or urine does not by itself mean that the chemical causes disease or say anything about potential risk.

The blood serum PCB testing program consisted of two phases. The first phase consisted of the administration of an exposure assessment questionnaire designed to obtain information on risk factors that are known to or may affect serum PCB levels (e.g. age, fish consumption, occupational exposures), as well as factors specific to the PSWS, such as length of residence. Prior to completing the exposure assessment questionnaire, MDPH/BEH required that each participant (or parent, in the case of children) sign a consent form (see Appendix A). The questionnaire was administered by an MDPH contractor, the John Snow Institute (JSI) Center for

Environmental Health Studies. Interviews occurred at the Normandin Middle School in New Bedford. Interviews were conducted both in English and Portuguese, with translators trained to administer the questionnaire. BEH conducted outreach activities to publicize this offer to both English- and Portuguese speakers. Outreach included a BEH presentation at a Public Involvement Plan meeting for the PSWS, press releases, press interviews, and the distribution of fact sheets.

The original intent of the first phase was to identify approximately 100 individuals most likely to have the highest serum PCB results based upon exposure information reported in the questionnaire. MDPH/BEH planned to score each questionnaire based on its extensive experience in predicting serum PCB levels based on known or likely risk factors for PCB exposure. Due to the low level of participation in Phase I (i.e., 124 people completed the exposure assessment questionnaire), MDPH/BEH decided to offer all phase one participants the opportunity to participate in the phase two blood testing. Information collected by this questionnaire was used to evaluate serum PCB results. In particular, information regarding age, place of residence, and location and length of residency were evaluated in the report. Information including diet, other occupational exposures, and specific routes of exposure related to the PSWS were also evaluated on an individual level on a case-by-case basis.

The actual blood testing involved the collection of blood samples for serum PCB analysis by MDPH's William A. Hinton State Laboratory Institute (SLI) Division of Analytical Chemistry. BEH worked with the New Bedford Health Department (NBHD) to coordinate the blood draws. The NBHD supplied space and some basic supplies (e.g. gauze, band aides, sharps disposal) for the blood draws and assisted BEH in answering participant questions. BEH contracted with Favorite Healthcare Staffing, Inc. to provide phlebotomy services for the serum PCB testing. Two 10-milliliter (mL) red-top BD Vacutainers® of blood were collected from each participant. A fact sheet was given to each participant at the time of their appointment to explain the process for sample analysis (see Appendix B).

Results of serum PCB testing were compared with biomonitoring data for the civilian U.S. population for the most recent period available at the time of this report (2003-2004) from the U.S. Centers for Disease Control (U.S. CDC) National Health and Nutrition Examination

Survey (NHANES). These data provide health professionals with a reference range so that they can determine whether any specific individual or populations of individuals demonstrate a pattern of exposure to higher levels of PCBs than the general U.S. population.

On each day of sampling, BEH transported blood samples from the NBHD to MDPH's SLI in Jamaica Plain. Sample tracking forms were completed to accompany each shipment. SLI staff centrifuged the samples to extract, aliquot, and store the serum samples until all the samples were collected. In addition, SLI transported sample aliquots to MDPH's Lemuel Shattuck Hospital in Jamaica Plain for lipid analysis.

The method for determination of PCB congeners was developed at CDC and transferred to the SLI. The standard operating procedure (SOP AC.012) for determination of PCB congeners in human serum details a solvent extraction, silica gel clean-up and dual capillary column gas chromatographic analysis with electron capture detection.

Quality assurance measures for the method include the analysis of reagent blanks that are monitored for contamination and subtracted from the samples in each run; the analysis of fortified serum samples, the results of which are plotted on lot & instrument specific quality control charts for review to determine compliance with acceptance criteria for the batch; and individual sample fortification with surrogate analytes that are evaluated for compliance with acceptable recovery criteria. Other batch specific controls include criteria for the calibration curve and internal standard recovery.

Analysis of serum samples was conducted by SLI using a congener-specific analytical method similar to methods used by the U.S. CDC in the national survey. Serum PCB levels were reported by SLI two ways: the first is on a whole volume basis in micrograms per liter (µg/L) of serum and the second is on a lipid-adjusted basis in nanograms per gram (ng/g) of lipid. Historically, when PCBs were measured in serum, the results were reported on a whole weight basis only. Currently, with advances in analytical chemistry, they are also reported on a lipid-adjusted basis. Blood serum contains lipids (fats) and PCBs concentrate in lipid, or fatty, fractions in the blood. Because different people may have different concentrations of lipids in their blood, PCB concentrations in blood are adjusted (or normalized) based on the lipid content. This adjustment allows for comparisons of blood serum PCB levels among different people and

populations (U.S. CDC, 2009). It should be noted that NHANES currently reports whole weight results in ng/g of serum (U.S. CDC, 2009; MDPH, 2009). To compare SLI's results to NHANES results, the SLI values were converted from whole volume (µg/L) to whole weight (ng/g) using the average density of serum (1.026 g/mL) (Turner, 2006). The units, µg/L and ng/g, are both equivalent to parts per billion (ppb), which is used throughout the rest of the report for simplicity.

To compare the New Bedford results to NHANES, a total PCB concentration was calculated following NHANES methodology for each of the New Bedford participants by summing the concentrations of the 15 most commonly detected congeners which includes two pair of co-congeners reported together (U.S. CDC, 2006; U.S. CDC, 2009; Patterson, 2009). These congeners are 52, 74, 99, 105, 118, 138/158, 146, 153, 156, 170, 180, 187, 194, 196/203, and 199. It should be noted that, unlike NHANES, SLI reports congeners 138 and 158 separately.

To calculate total PCB levels, as well as summary statistics such as geometric means and percentiles, CDC assigns sample results that were not detected above the method's limit of detection (LOD) a value equal to the LOD divided by square root of 2. New Bedford participants' individual serum PCB results, as well as summary statistics (e.g., geometric means and percentiles) were calculated using this method to be comparable to CDC summary data.

The total serum PCB concentrations (whole weight and lipid-adjusted) for each participant were compared to the NHANES total PCB concentrations (whole weight and lipid-adjusted). Because it is well established that PCBs in serum increase with age, it is important to compare a participant's serum PCB level with the comparable age group from the national data (12-19 years, 20-39 years, 40-59 years, and 60+ years) (U.S. CDC, 2006; Miller et al., 1991; Patterson et al., 2009). When comparing to NHANES data, the following summary statistics are used:

- The 50th percentile value (also known as the median). The 50th percentile is the midpoint of the serum PCB levels for all NHANES participants when they are arranged in order from lowest to highest

- The 95th percentile value. The 95th percentile represents serum PCB levels below which 95% of the levels measured in NHANES participants are found; according to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual

Due to differences among individuals, you would expect to see a range of serum PCB levels in the general population. The range of concentrations reported by NHANES provides health professionals with information on the degree of variation that can be expected in the general population. According to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Based on this guidance from CDC, an individual with serum concentrations above the 50th percentile but below the 95th percentile is within the typical level of variation seen in the general U.S. population. Thus, MDPH used the 95th percentile value for comparison with the participants' serum PCB results.

In addition to quantitative comparisons, BEH also conducted a qualitative comparison of the specific congener pattern for New Bedford participant results to what is typically seen in the U.S. population based on the latest NHANES data (2003-2004) (U.S. CDC 2008). For the qualitative congener pattern evaluation, MDPH visually compared the distribution of percent contribution of the congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants to the percent contribution of these congeners for all ages from the NHANES data. In addition, a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen.

B. RESULTS AND DISCUSSION

1) *Phase I*

One hundred and twenty-four individuals completed the initial exposure assessment questionnaire originally intended as a screening mechanism to identify people who had the greatest likelihood of exposure to PCBs. Of the 124 individuals, 57 were current or former residents of the PSWS neighborhood. The majority of interviews were completed in June 2008.

A small number of interviews were conducted between July 2009 and March 2010 via phone to accommodate residents who were out of the area at the time of the interviews.

2) Phase II

On January 22, 2009, BEH sent letters to the homes of all 124 individuals offering serum PCB testing. A total of 91 individuals asked to participate in the serum PCB testing offer. Of the 33 individuals that did not participate, 21 declined the offer, 10 were lost to follow up, and two had inadequate sample volume but declined an offer to reschedule sample collection.

The majority of the participants submitted blood samples for analysis in February and March 2009 that were collected by the MDPH phlebotomy contractor, Favorite Healthcare Staffing. After the contract expired with Favorite Healthcare Staffing, three individuals submitted samples between April and June 2009 due to scheduling conflicts or the need for a sample redraw; these samples were collected independent of Favorite Healthcare Staffing due to expiration of their MDPH contract. A second questionnaire was administered at the time of the blood draw and included questions relevant to the blood draw (e.g., weight and height).

Out of the 91 participants that consented to and submitted blood samples, 42 individuals were current or former residents in the neighborhood around the PSWS and three others reported that they had spent a significant amount of time at the PSWS (Figure 4). Participants are included in this report if, at the time of the exposure assessment interview, they were among the 42 individuals living in the neighborhood around the PSWS. In addition, three other individuals that were not residents, but reported spending a significant amount of time at the PSWS were included, for a total of 45 participants in the evaluation of PCB serum analyzed in relation to outdoor PCB exposure concerns. **As mentioned earlier, results for individuals that reported working at NBHS, KMS, or the former KMS (including some current and former residents in the neighborhood around the PSWS) are included in the separate MDPH report.** Results for individuals that lived in the neighborhood around the PSWS and worked at the school are included in both reports.

As previously mentioned, the neighborhood around the PSWS includes the five census tracts (CTs) surrounding the PSWS (6509, 6510.01, 6510.02, 6511, and 6515). The location of the five CTs is illustrated in Figure 3.

The ages of the participants included in this report ranged from 14 to 84 years at the time the blood samples were collected (Figure 5). Approximately 67% of the participants were female and 33% male. NHANES comparison data are available by age group or by gender. Summary statistics are presented in this report by age group for males and females combined. Tables 1 and 2 contain summary statistics for total serum PCB concentrations as whole weight and lipid-adjusted values, respectively.

3) Serum PCB Levels Measured in Participants 12-19 Years Old

Two of the 45 participants were between the ages of 12 and 19 years at the time the blood samples were collected. The NHANES 50th percentile value for this age group is 0.155 ppb (whole weight) with a 95% confidence interval of 0.144 to 0.165 ppb and 30.8 ppb (lipid-adjusted) with a 95% confidence interval of 28.2 to 33.4 ppb (U.S. CDC 2009). The 95% confidence interval is a range of estimated values that has a 95% probability of including the true value for the population. No PCB congeners were detected in the serum samples collected from the two participants. Therefore the serum PCB results for participants between the ages of 12 and 19 years do not indicate unusual PCB exposures.

4) Serum PCB Levels Measured in Participants 20-39 Years Old

Two of the 45 participants were between the ages of 20 and 39 years at the time the blood samples were collected. The NHANES 50th percentile value for this age group is 0.322 ppb (whole weight) with a 95% confidence interval of 0.286 ppb to 0.352 ppb and 53.0 ppb (lipid-adjusted) with a 95% confidence interval of 46.9 ppb to 57.7 ppb (U.S. CDC 2009). No PCB congeners were detected in the serum samples collected from the two participants. Therefore the serum PCB results for participants between the ages of 20 and 39 years do not indicate unusual PCB exposures.

5) *Serum PCB Levels Measured in Participants 40-59 Years Old*

Twenty-one of the 45 participants were between the ages of 40 and 59 years at the time the blood samples were collected. The 50th percentile serum PCB level for participants in this age group is 1.642 ppb (whole weight), with a range of non-detect to 4.904 ppb, and 239.9 ppb (lipid-adjusted), with a range of non-detect to 823.9 ppb (Figures 6 and 7). The NHANES 50th percentile value for this age group is 0.927 ppb (whole weight) with a 95% confidence interval of 0.840 ppb - 1.058 ppb and 145.3 ppb (lipid-adjusted) with a 95% confidence interval of 128.7 ppb - 157.9 ppb (U.S. CDC 2009). Therefore, the median serum PCB levels, both whole weight and lipid-adjusted, for the participants in this age group are higher than the respective NHANES median/50th percentiles for the U.S. population.

The 95th percentile serum PCB level for participants in this age group is 2.730 ppb (whole weight) and 568.5 ppb (lipid-adjusted). The NHANES 95th percentile concentration for this age group is 2.780 ppb (whole weight) with a 95% confidence interval of 2.307 ppb to 3.663 ppb and 402.2 ppb (lipid-adjusted) with a 95% confidence interval of 325.1 to 540.2 ppb. Therefore, the New Bedford participants' 95th percentile serum PCB levels for lipid-adjusted results in this age group are higher than the NHANES 95th percentile for the U.S. population; however, the whole weight results were within the NHANES 95th percentile. The serum PCB concentrations for 19 of the 21 participants in this age group are within the 95th percentile of serum PCB levels available from the national NHANES data for both the whole weight and lipid-adjusted results. For those two individuals with serum PCB concentrations exceeding the NHANES 95th percentile, one participant's whole weight and lipid-adjusted results exceed the 95th percentile, the other participant's lipid-adjusted results exceed the 95th percentile, but the participant's whole weight results were within the 95th percentile. Participants whose results are within the 95th percentile are within the range of levels measured in the NHANES 2003-2004 survey. As stated previously in the Methods section of this report, according to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Thus, serum PCB results for 19 of the 21 participants between the ages of 40 and 59 years are within the typical variation across this age group in the U.S. population and the serum PCB levels for two of the 21 participants are above the typical range for this age group.

6) Serum PCB Levels Measured in Participants 60+ Years Old

Twenty of the 45 participants were 60 years of age or older at the time the blood samples were collected. The 50th percentile serum PCB level for participants in this age group is 2.455 ppb (whole weight), with a range of 1.276 ppb to 7.742 ppb, and 360.3 ppb (lipid-adjusted), with a range of 154.6 to 906.1 ppb (Figures 6 and 7). The NHANES median/50th percentile value for this age group is 1.805 ppb (whole weight) with a 95% confidence interval of 1.694 ppb to 1.874 ppb and 276.0 ppb (lipid-adjusted) with a 95% confidence interval of 251.2 ppb to 295.4 ppb (U.S. CDC 2009). Therefore, the median serum PCB levels for the participants, for both whole weight and lipid-adjusted results, are higher than the respective NHANES median/50th percentiles for the U.S. population.

The 95th percentile serum PCB level for participants in this age group is 5.015 ppb (whole weight) and 698.0 ppb (lipid-adjusted). The NHANES 95th percentile concentration for this age group is 5.123 ppb (whole weight) with a 95% confidence interval of 4.131 ppb to 6.556 ppb and 769.4 ppb (lipid-adjusted) with a 95% confidence interval of 600.0 to 1026.5 ppb. Therefore, the 95th percentile serum PCB levels for the participants, for both whole weight and lipid-adjusted results, are within the respective NHANES 95th percentiles for the U.S. population. The serum PCB concentrations for 19 of the 20 participants in this age group are within the 95th percentile of serum PCB levels available from the national NHANES data for both the whole weight and lipid-adjusted results. One participant's whole weight result slightly exceeded the NHANES whole weight 95th percentile; however, the participant's lipid-adjusted result is within the NHANES 95th percentile. Thus, serum PCB results for 19 of the 20 participants over 60 years of age are within the typical variation across this age group in the U.S. population and the serum PCB result for one of the 20 participants is slightly above the typical range for this age group.

7) Qualitative Congener Pattern Evaluation

In this report, data have been provided on total PCBs based on summing the most frequently detected 15 congeners. Figure 8 shows the distribution of percent contribution of 35 congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants. Percent contributions are also provided in Figure 9 for all ages from the NHANES data. The

congener patterns observed in New Bedford and NHANES are similar, suggesting similarities with what is found in the U.S. population. In addition, individual congener patterns were reviewed and a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen. CDC identified one individual's congener pattern as atypical and this information was communicated by MDPH to the individual in question. CDC noted that the congener patterns of the majority of New Bedford participants appeared to be typical; suggesting that exposure in the majority of the New Bedford participants appeared similar to that of the general U.S. population.

8) Serum PCB Levels Compared with Years of Residence

As mentioned earlier, 42 of the 45 participants reported currently or previously living within the neighborhood surrounding the PSWS (that is, within one of the five CTs surrounding PSWS). Their length of residency ranged from 3 to 63 years. To evaluate whether length of residency (and by proxy, exposure to environmental contaminants in the PSWS) was associated with higher serum levels, participants that reported currently or previously living within the five CTs were grouped into two approximately equal-sized groups by determining the median of years of residency within the five CTs or 25 years. The first group contains all participants that resided in the neighborhood around the PSWS for 3-25 years and the second group contains all participants that resided for 26-63 years. Mean serum levels were calculated for each group by age group because, as discussed, PCBs in serum generally increase with age. To allow for comparison to NHANES data, geometric means instead of arithmetic means were calculated. Calculating the geometric mean is a standard way of looking at biological and environmental data. (Geometric means are reported in the U.S. CDC's *Fourth National Report on Human Exposure to Environmental Chemicals*.) Table 3 summarizes the number of participants by years of residence in the five CTs and by age group.

Tables 4 and 5 and Figures 10 and 11 present summary statistics (geometric means) for total serum PCB concentrations by length-of-residency as whole weight and lipid-adjusted values, respectively. The geometric means by years of residency for the participants in the 12–19 year age group and the 20-30 year age group are not presented in these tables because no PCB congeners were detected in samples collected from participants in these age groups. Thus this

analysis focuses on the 40-59 and 60+ year age groups. The tables demonstrate that there is no consistent pattern of high serum concentrations with more years of residency within the five CTs. For the 40-59 year age group, both the mean whole weight and lipid-adjusted values were lower for the participants that resided in the five CTs longest by 0.138 ppb and 68.6 ppb, respectively. However, for the 60+ age group, both the mean whole weight and lipid-adjusted values were higher for the participants that resided in the five CTs longest by 0.313 ppb and 64.8 ppb, respectively. Also, as mentioned previously, there are two participants in the 40-59 year age group and one participant in the 60+ age group whose whole weight and/or lipid-adjusted serum PCB levels exceed the NHANES 95th percentile value. The two participants in the 40-59 year age group with serum PCB levels above the NHANES 95th percentile are in the lower category of years lived in the five CTs (3-25 years) and the one participant in the 60+ year age group with a serum PCB level above the NHANES 95th percentile is in the higher category of years lived in the five CTs (26-63 years). Thus, these data do not show a consistent pattern of higher serum concentrations with more years lived in the 5 CTs and they suggest that length of residence within the five CTs was not a primary indicator of serum PCB levels. It should be noted that the ability to discern differences between the groups is difficult because of the small number of participants and the likely contributions to serum PCB levels by other factors (e.g., fish consumption).

9) Serum PCB Levels Measured in Participants Diagnosed with Cancer

Based on information shared by participants during the exposure assessment interviews and a search of the Massachusetts Cancer Registry database, five of the 45 participants have been diagnosed with cancer since 1982. The serum PCB concentrations for all five participants were below the NHANES 95th percentile for their respective age groups and therefore fall within the range of levels measured in the NHANES 2003-2004 survey. Thus, serum PCB concentrations for these five individuals diagnosed with cancer are within the typical variation in the U.S. population. Among the five participants, each one was diagnosed with a different type of cancer. Based on the epidemiological literature, three of the 5 different types of cancer have no association with exposure to PCBs. More discussion on the incidence of cancer among New Bedford residents, including the two different types of cancer potentially associated with exposure to PCBs, is provided below.

IV. CANCER INCIDENCE ANALYSIS

As part of this health consultation, a review was conducted of the pattern of nine cancer types in New Bedford as well as in each of five census tracts (CTs) which surround the PSWS (Figure 3). The incidence of these cancers was compared with the cancer incidence experience of the state of Massachusetts as a whole.

Cancer incidence data were obtained from the Massachusetts Cancer Registry (MCR) for the years 1982-2006. The MCR began collecting population-based cancer incidence data in January of 1982. The 25-year time period was evaluated by assessing five time periods: 1982-1986, 1987-1991, 1992-1996, 1997-2001, and 2002-2006; this allowed for consideration of possible patterns or trends as compared to the statewide cancer experience. The nine cancer types included in this evaluation were selected for two reasons: 1) because of their possible association with exposure to PCBs, as reported in the scientific/medical literature, and 2) the concerns of residents of suspected elevations of some cancer types. The types of cancer evaluated include the following: cancers of the biliary tract[3], bladder, breast, colon/rectum, gallbladder, liver/intrahepatic bile duct (IBD), and lung and bronchus as well as melanoma and non-Hodgkin lymphoma. Concerns about the occurrence of cancer in the PSWS neighborhood and the New Bedford High School have been shared by current and former staff at the high school, by PSWS neighbors, and by members of CLEAN. A range of various types of cancer have been mentioned of concern, including some of the cancer types potentially associated with exposure to PCBs (such as breast cancer and non-Hodgkin lymphoma) as well as other types of cancer for which there is no reported association with PCBs (such as cervical and ovarian cancers). For this report, MDPH evaluated those nine types of cancer that have been identified in the medical and epidemiological literature as possibly being associated with exposure to PCBs. If exposure to PCBs at the PSWS has resulted in an increased incidence of cancer in the

[3] The biliary tract, also known as the bile duct, is the tube that connects the liver to the small intestine. The part of the biliary tract within the liver itself is known as the intrahepatic bile duct (IBD). Cancers within the liver or IBD are evaluated together in this report, consistent with the MCR methodology. Cancers within other sections of the biliary tract are referred to in this report as Other Biliary Tract cancers.

neighborhood, it is important to focus the evaluation on those types of cancer associated with PCB exposure.

In addition to calculating cancer incidence rates, a qualitative analysis of the geographic distribution of individuals diagnosed with each of the nine types of cancer was conducted by mapping their residence at time of diagnosis. This was done to assess whether the geographic pattern of any particular type of cancer in any of the census tracts of interest appeared unusual such that environmental factors were likely to play a primary role in their development. Available risk factor information from the MCR related to age at diagnosis and gender, as well as other factors related to the development of cancer such as smoking and occupation, was reviewed in those instances where the incidence rate of a particular cancer type was higher than expected. This information was evaluated to compare known or established risk factor patterns, as reported in the medical and epidemiological literature for particular cancer types, to risk factor information for individuals diagnosed in New Bedford and to assess whether any unusual patterns existed among individuals diagnosed in New Bedford.

The information described in this report is a descriptive analysis of cancer incidence data and cannot be used to establish a causal link between a particular risk factor and the development of cancer, nor can it establish the cause of any one individual's diagnosis. However, information from such descriptive analyses can be useful in determining whether or not a common etiology (or cause) of cancers is possible and can serve to identify areas where further public health investigations or actions may be warranted. Such actions may include follow-up environmental investigations or, when an excess of well-established risk factors associated with a disease in a certain geographic area has been identified, public health intervention activities (e.g., cancer screening, smoking cessation, etc).

A. METHODS

1) Case Identification/Definition

Cancer incidence data (i.e., reports of new cancer diagnoses) for New Bedford and the five census tracts included for analysis were obtained from the MCR, a division of the MDPH Bureau of Health Information, Statistics, Research and Evaluation (BHISRE). As mentioned, the

MCR is a population-based surveillance system that began collecting information in 1982 on Massachusetts residents diagnosed with cancer in the state. All newly diagnosed cancer cases among Massachusetts residents are required by law to be reported to the MCR within 6 months of the date of diagnosis (M.G.L. c.111 s.111B).

Although the medical and epidemiological evidence is sometimes conflicting for several of the cancer types evaluated in this report, and more research is needed to better understand the possible association with exposure to PCBs, most health agencies have concluded that PCBs may reasonably be expected to cause cancer. As stated earlier, nine cancer types were evaluated in this investigation, including cancers of the biliary tract, bladder, breast, colon/rectum, gallbladder, liver/intrahepatic bile duct (IBD), and lung and bronchus as well as melanoma and non-Hodgkin lymphoma. [Coding for these cancer types follows the International Classification of Diseases for Oncology (ICD-O) system. See Appendix C for the incidence coding definitions used in this report.] The strength of the scientific evidence on whether exposure to PCBs can result in an increased risk of a particular type of cancer varies significantly for the different cancer types included in this investigation. Liver cancer, by far, has the strongest evidence in the medical/epidemiological literature of an association with exposure to PCBs (U.S. ATSDR 2000). Following liver cancer, there is some evidence that the following types of cancer may also be associated with exposure to PCBs: biliary tract, melanoma, non-Hodgkin lymphoma, colo-rectal, and breast cancer (Schottenfeld and Fraumeni 2006; U.S. ATSDR 2000). The scientific evidence that exposure to PCBs may result in an increased risk of lung, gallbladder, or bladder cancer appears to be the weakest (ATSDR 2000).

In ATSDR's Toxicological Profile for Polychlorinated Biphenyls (ATSDR 2000), it summarizes its extensive review of approximately 1,800 human and animal studies that have been conducted to evaluate the potential for exposure to PCBs to cause cancer. It concludes the following:

> "Based on indications of PCB-related cancer at several sites, particularly the liver, biliary tract, intestines, and skin (melanoma), the human studies provide suggestive evidence that PCBs are carcinogenic. There is unequivocal evidence that PCBs are hepatocarcinogenic in animals."

MDPH included these four types of cancer in its evaluation as well as five additional types of cancer for which the evidence of an association with PCB exposure is not as strong. These include: non-Hodgkin lymphoma and breast, lung, gallbladder, and bladder cancers. In addition to reviewing the findings of ATSDR's Toxicological Profile for PCBs, MDPH also reviewed the evaluations of other cancer epidemiology experts on the types of cancer potentially associated with exposure to PCBs, particularly those reported in *Cancer Epidemiology and Prevention*, a comprehensive book on what is known about the risk factors and causes of a wide variety of cancers, including those associated with exposure to PCBs. In *Cancer Epidemiology and Prevention*, the authors report liver and biliary tract cancers as well as melanoma and non-Hodgkin lymphoma as types of cancer with evidence of an association with PCB exposure. As previously stated, MDPH evaluated these four types of cancer as well.

All diagnoses reported to the MCR as primary cancers were included in this analysis. Cancers that occur as the result of the metastases or the spread of a primary site cancer to another location in the body are not considered as a separate cancer and were, therefore, not included. Individuals diagnosed with cancer were selected for inclusion based on their residential address reported to the hospital or reporting medical facility at the time of diagnosis.

The term "cancer" is used to describe a variety of diseases associated with abnormal cell and tissue growth. Epidemiologic studies have revealed that different types of cancer are individual diseases with separate causes, risk factors, characteristics and patterns of survival (Berg 1996). Cancers are classified by the location in the body where the disease originated (the primary site) and the tissue or cell type of the cancer (histology). Therefore, each of the cancer types reviewed in this report was evaluated separately.

It should be noted that duplicate records have been eliminated from the MCR data used in this report. Duplicate cases are additional reports of the same primary site cancer diagnosed in an individual by another health-care provider. The decision that a case was a duplicate and should be excluded from the analysis was made by the MCR after consulting with the reporting hospital/diagnostic facility and obtaining additional information regarding the histology and/or pathology of the case. However, reports of individuals with multiple primary site cancers were included as separate cases in this report. In general, a diagnosis of a multiple primary cancer is

defined by the MCR as a new cancer in a different location in the body or a new cancer of the same histology (cell type) as an earlier cancer, if diagnosed in the same primary site (original location in the body) more than 2 months after the initial diagnosis (MCR 2003).

2) Calculation of Standardized Incidence Ratios (SIRs)

To determine whether an elevation in cancer incidence occurred among individuals diagnosed with cancer in New Bedford or the five CTs surrounding the Parker Street Waste Site, cancer incidence data were tabulated by gender according to eighteen age groups to compare the observed number of cancer diagnoses to the number that would be expected based on the statewide cancer rate. Standardized incidence ratios (SIRs) were calculated for the five time periods, for each of the nine cancer types, for the City as a whole and the five CTs, in order to evaluate patterns or trends in cancer incidence as compared to the statewide cancer experience.

To calculate an SIR, it is necessary to obtain accurate population information. The population figures used in this analysis were interpolated based on 1980, 1990, and 2000 U.S. census data for New Bedford (U.S. DOC 1980, 1990, and 2000), as well as 2010 projected census data. Midpoint population estimates were calculated for each time period evaluated (i.e., 1984, 1989, 1994, 1999, and 2004). To estimate the population between census years, an assumption was made that the change in population occurred at a constant rate throughout the ten-year interval between each census.[4]

A CT is a geographic subdivision of a city or town designated by the United States Census Bureau. Because age group and gender-specific population information is necessary to calculate incidence rates, the CT is the smallest geographic area for which cancer rates can be accurately calculated. Specifically, a CT is a smaller statistical subdivision of a county as defined by the U.S. Census Bureau. CTs usually contain between 1,500 and 8,000 persons and are designed to be homogenous with respect to population characteristics (U.S. DOC 2000). New Bedford census tracts are depicted in Figure 3.

[4] Using slightly different population estimates or statistical methodologies, such as grouping ages differently or rounding off numbers at different points during calculations, may produce results slightly different from those published in this report.

SIRs were not calculated for some cancer types in some time periods and/or CTs due to the small number of observed cases (less than five). It is standard BHISRE policy not to calculate rates with fewer than five observed diagnoses due to the instability of the rate. However, the expected number of diagnoses was calculated during each time period and for each CT, and the observed and expected numbers of diagnoses were compared to determine whether excess numbers of cancer diagnoses were occurring.

Stability in the context of an SIR refers to how the SIR changes when there are small increases or decreases in the observed or expected number of cases. Two SIRs may have the same size but not the same stability. For example, an SIR of 150 may represent 6 observed diagnoses and 4 expected diagnoses, or 600 observed diagnoses and 400 expected diagnoses. (The SIR is the ratio of the number of observed diagnoses to the number of expected diagnoses multiplied by 100. For example, six divided by 4 equals 1.5 as does 600 divided by 400; 1.5 multiplied by 100 equals 150.) Both SIRs represent a 50 percent excess of observed diagnoses. However, in the first instance, one or two fewer diagnoses would change the SIR a great deal, whereas in the second instance, even if there were several fewer diagnoses, the SIR would only change minimally. When the observed and expected numbers of diagnoses are relatively small, their ratio is easily affected by one or two diagnoses. Conversely, when the observed and expected numbers of diagnoses are relatively large, the value of the SIR is stable.

3) Interpretation of a Standardized Incidence Ratio (SIR)

An SIR is an estimate of the occurrence of cancer in a population relative to what might be expected if the population had the same cancer experience as a larger comparison population designated as "normal" or average. Usually, the state as a whole is selected to be the comparison population. Using the state of Massachusetts as a comparison population provides a stable population base for the calculation of incidence rates.

Specifically, an SIR is the ratio of the observed number of cancer diagnoses in an area to the expected number of diagnoses multiplied by 100. The statewide incidence rate is applied to the population structure of the area to calculate the number of expected cancer diagnoses. The SIR is a comparison of the number of diagnoses in the specific area (i.e., city/town or census

tract) to the statewide rate. Comparisons of SIRs between communities or census tracts are not possible because each of these areas has different population characteristics.

Population structure, in the context of the calculation of an SIR, simply refers to the age and gender breakdowns (or distributions) within the New Bedford and Massachusetts populations. Because cancer is a disease greatly affected by age, and also by gender, it is very important to account for the ages of people in the populations being studied and the numbers of males versus females. This process of accounting for differences in the ages of two populations is referred to as age adjustment or age standardization.

An SIR of 100 indicates that the number of cancer diagnoses observed in the population being evaluated is equal to the number of cancer diagnoses expected in the comparison or "normal" population. An SIR greater than 100 indicates that more cancer diagnoses occurred than were expected, and an SIR less than 100 indicates that fewer cancer diagnoses occurred than were expected. Accordingly, an SIR of 150 is interpreted as 50% more cancer diagnoses than the expected number; an SIR of 90 indicates 10% fewer cancer diagnoses than expected.

Caution should be exercised, however, when interpreting an SIR. The interpretation of an SIR depends on both the size and the stability of the SIR. Two SIRs can have the same size but not the same stability. For example, an SIR of 150 based on four expected diagnoses and six observed diagnoses indicates a 50% excess in cancer, but the excess is actually only two diagnoses. Conversely, an SIR of 150 based on 400 expected diagnoses and 600 observed diagnoses represents the same 50% excess in cancer, but because the SIR is based upon a greater number of diagnoses, the estimate is more stable. It is very unlikely that 200 excess diagnoses of cancer would occur by chance alone. As a result of the instability of incidence rates based on small numbers of diagnoses, SIRs were not calculated when fewer than five diagnoses were observed for a particular cancer type.

4) Calculation of the 95% Confidence Interval

To help interpret or measure the stability of an SIR, the statistical significance of each SIR was assessed by calculating a 95% confidence interval (95% CI) to determine if the observed number of diagnoses is “significantly different” from the expected number or if the

difference may be due solely to chance (Rothman and Boice 1982). Specifically, a 95% CI is the range of estimated SIR values that have a 95% probability of including the true SIR for the population. If the 95% CI range does not include the value 100, then the disease rate in the study population is statistically significantly different from the comparison or "normal" population. "Statistically significantly different" means there is less than a 5% chance that the observed difference (either increase or decrease) in the rate is the result of random fluctuation in the number of observed cancer diagnoses.

For example, if a confidence interval does not include 100 and the interval is above 100 (e.g., 105–130), there is a statistically significant excess in the number of cancer diagnoses. Similarly, if the confidence interval does not include 100 and the interval is below 100 (e.g., 45–96), the number of cancer diagnoses is statistically significantly lower than expected. If the confidence interval range includes 100, the true SIR may be 100. In this case, it cannot be determined with certainty that the difference between the observed and expected number of diagnoses reflects a real cancer increase or decrease or is the result of chance. It is important to note that statistical significance alone does not necessarily imply public health significance. Determination of statistical significance is just one tool used to interpret cancer patterns in a community.

In addition to the range of the estimates contained in the confidence interval, the width of the confidence interval also reflects the stability of the SIR estimate. For example, a narrow confidence interval, such as 103–115, allows a fair level of certainty that the calculated SIR is close to the true SIR for the population. A wide interval, for instance 85–450, leaves considerable doubt about the true SIR, which could be much lower than or much higher than the calculated SIR. This would indicate an unstable statistic. Again, due to the instability of incidence rates based on small numbers of diagnoses, statistical significance was not assessed when fewer than five diagnoses were observed.

5) Evaluation of Risk Factor Information

Available information reported to the MCR related to risk factors for cancer development was reviewed and compared to known or established incidence patterns for the cancer types evaluated in this report. This information is collected for each individual at the time of cancer

diagnosis and includes the individual's age at diagnosis, the stage of disease, and the individual's smoking history and occupation. One or even several factors acting over time can be related to the development of cancer. For example, tobacco use has been linked to bladder, kidney, and lung and bronchus cancers. Other cancer risk factors 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 contaminants have also been associated with certain types of cancer. Available risk factor information from the MCR was evaluated for residents of New Bedford and the five CTs for cancer types determined to be elevated when compared to Massachusetts as a whole. However, information about personal risk factors such as family history, hormonal events, diet, and other factors that may also influence the development of cancer is not collected by the MCR or any other readily accessible source; therefore, it was not possible to evaluate these factors in this investigation.

6) Determination of Geographic Distribution

In addition to calculating SIRs, the address at the time of diagnosis for each individual diagnosed with one of the nine cancer types in New Bedford was geographically mapped using a computerized geographic information system (GIS) (ESRI 2006). This allowed assignment of CT location for each individual diagnosed with cancer as well as an evaluation of the spatial distribution of the individuals at a smaller geographic level within CTs (i.e., neighborhoods). The geographic distribution was determined using a qualitative evaluation of the point pattern of cancer diagnoses in New Bedford, with a particular focus on CTs 6509, 6510.01, 6510.02, 6511, and 6515 (that is, the areas in closest proximity to the PSWS). This evaluation included consideration of the population density variability of each CT through the use of GIS-generated population density overlays. In instances where the address information from the MCR was incomplete, that is, did not include specific streets or street numbers, efforts were made to research those individuals' addresses (e.g., by using telephone books issued within 2 years of an individual's diagnosis or searching files via the Registry of Motor Vehicles). For confidentiality reasons, it is not possible to include maps in this report showing the locations of residence at diagnosis for individuals diagnosed with cancer. [Note: MDPH is bound by state and federal

patient privacy and research laws not to reveal the name or any other identifying information of an individual diagnosed with cancer and reported to the MCR.]

B. RESULTS

The following sections present cancer incidence rates for the community of New Bedford and for CTs 6509, 6510.01, 6510.02, 6511, and 6515 during the 25-year time period 1982-2006.

The Parker Street Waste Site is located in CT 6510.02, extending into CT 6515 on its southerly boundary. As mentioned, to evaluate possible trends over time as compared to the statewide cancer experience, these data were analyzed by five smaller time periods, 1982-1986, 1987-1991, 1992-1996, 1997-2001, and 2002-2006. Tables 6A through 6E summarize cancer incidence data for New Bedford as a whole, while Tables 7A through 7E summarize data for New Bedford's CT 6510.02, Tables 8A through 8E for CT 6509, Tables 9A through 9E for CT 6510.01, Tables 10A through 10E for CT 6511, and Tables 11A through 11E for CT 6515.

1) New Bedford

In the earliest time period evaluated, 1982-1986, the incidence of the nine cancer types was either about as expected, or in most instances, less than expected. For five cancer types -- breast, colorectal, lung and bronchus, melanoma, and non-Hodgkin lymphoma – the incidence was statistically significantly lower than expected. Tables 6A through 6E summarize the cancer incidence data for the City of New Bedford as a whole.

During 1987-1991, the incidence of seven of the nine types of cancer evaluated was either about as expected or less than expected (see Table 6B). For the following cancer types, the incidence was statistically significantly lower than expected: bladder, breast, colorectal, liver/IBD, and melanoma. Although an elevation in lung and bronchus cancer was seen in males during this time period, with 244 diagnoses observed compared to approximately 225 diagnoses expected, the difference was not statistically significant, meaning that it most likely represents natural variability in the number of observed diagnoses. The incidence of two types of cancer -- biliary tract and gallbladder -- was elevated in females during this time period. Ten diagnoses of biliary tract cancer were observed in females when approximately five would have been expected (SIR = 214; 95% CI: 102 - 393); this SIR is statistically significant. For gallbladder

cancer in females, 15 diagnoses were observed compared to approximately six expected. This finding is statistically significant (SIR = 255; 95% CI: 142 – 420).

Between 1992 and 1996, with a few exceptions, the incidence of the cancer types evaluated was either about as expected or less than expected (see Table 6C). The incidence of lung and bronchus cancer in females and melanoma in both genders was statistically significantly lower than expected. Elevations occurred in the numbers of diagnoses of both colorectal and liver/IBD cancers in females during this time period; however, the differences were not statistically significant.

In the time period of 1997-2001, the incidence of most of the cancer types evaluated was about as expected (see Table 6D). Breast cancer, melanoma, lung cancer (females only), and non-Hodgkin lymphoma occurred at a statistically significantly lower rate than expected during this time period. Elevations occurred in the numbers of diagnoses of both colorectal cancer in males and liver/IBD cancer in both genders; these differences were not statistically significant. A statistically significant elevation in the incidence of lung and bronchus cancer was observed among males in New Bedford during this time period, with 246 diagnoses observed compared to approximately 206 expected (SIR = 119, 95% CI: 105 – 135).

During the most recent time period evaluated, 2002-2006, with the exception of two cancer types in males (liver/IBD and lung and bronchus), the incidence of the other types of cancer evaluated was about as expected (see Table 6E). A slight elevation in biliary tract cancer occurred in females (8 diagnoses observed versus approximately 5 expected); the difference was not statistically significant. The rates of breast cancer and melanoma were statistically significantly lower than expected during this time period. As in 1997-2001, a statistically significant elevation in the incidence of lung and bronchus cancer among males was observed (227 diagnoses observed versus approximately 192 expected, SIR = 118, 95% CI: 103 – 134). A statistically significant elevation in the incidence of liver/IBD cancer in males was also observed during this time period (37 diagnoses observed versus approximately 23 expected, SIR = 163, 95% CI: 114 – 224).

2) Census Tract 6510.02

The Parker Street Waste Site is located primarily in census tract 6510.02. This census tract is south of CT 6510.01 and borders Dartmouth to the west (see Figure 3). Tables 7A through 7E summarize the cancer incidence data for CT 6510.02.

During the first two time periods evaluated, 1982-1986 and 1987-1991, the incidence of the nine cancer types evaluated was approximately as expected in CT 6510.02. For breast cancer in the earliest time period, the incidence was statistically significantly lower than expected in this census tract.

During 1992-1996, the incidence of most of the cancer types evaluated was about as expected in CT 6510.02. Breast cancer occurred somewhat more often than expected during this time period, with 27 diagnoses observed when approximately 19 would have been expected; however, this elevation was not statistically significant. Bladder cancer in males occurred more often than expected with six diagnoses observed when approximately three would have been expected; this elevation was not statistically significant.

During the last two time periods, 1997-2001 and 2002-2006, the incidence of the majority of cancer types was approximately as expected. No statistically significant differences were observed between the numbers of observed and expected diagnoses. Although the incidence of lung and bronchus cancer was somewhat elevated among females in CT 6510.02, the differences were not statistically significant and most likely represent natural variability in the numbers of observed diagnoses. Similarly, although 13 diagnoses of colorectal cancer were observed in females during the most current time period, when approximately eight would be expected, the difference was not statistically significant. During the previous time period (1997-2001), fewer females were diagnosed with colorectal cancer than expected (3 observed versus 9 expected).

3) Census Tract 6509

Census tract 6509 is located in the center of New Bedford, to the northeast of the PSWS (see Figure 3). Tables 8A through 8E summarize the cancer incidence data for CT 6509. For each of the five time periods evaluated, the incidence of the nine types of cancer was

approximately as expected. No statistically significant differences between the numbers of observed and expected diagnoses were noted during any time period. No consistent trends were noted in any of the cancer types elevated.

4) Census Tract 6510.01

Census tract 6510.01 is located to the west of CT 6509 and northwest of the Parker Street Waste Site. It borders Dartmouth to the west (see Figure 3). Tables 9A through 9E summarize the cancer incidence data for CT 6510.01.

During the first two time periods, 1982-1986 and 1987-1991, the incidence of the nine cancer types evaluated was either about as expected or less than expected in this census tract.

With the exception of colorectal cancer, during 1992-1996, the incidence of cancer was at or near expected in CT 6510.01 for the cancer types evaluated. A statistically significant elevation in the incidence of colorectal cancer was observed among males and females combined (28 diagnoses observed versus 18 expected, SIR = 156, 95% CI: 104 – 225). The incidence of colorectal cancer was elevated among both males (12 diagnoses observed versus approximately 8 expected) and females (16 diagnoses observed versus approximately 10 expected).

During the last two time periods evaluated, 1997-2001 and 2002-2006, the incidence of the majority of cancer types was approximately as expected. During 1997-2001, there was a slight elevation in the incidence of colorectal cancer among males and females combined; the elevation was due entirely to three excess diagnoses among males. In females during the 2002-2006 time period, there were three diagnoses of biliary tract cancer compared to less than one diagnosis expected. A slight elevation in lung and bronchus cancer also occurred during the 2002-2006 time period. However, no statistically significant differences in the numbers of observed versus expected diagnoses of any cancer type evaluated were observed nor were any trends observed in these time periods.

5) Census Tract 6511

Census tract 6511 is located south of CT 6509 and east of the Parker Street Waste Site (see Figure 3). Tables 10A through 10E summarize the cancer incidence data for CT 6511. With

a few exceptions, the incidence of the nine types of cancer was approximately as expected throughout the 25-year time period in this census tract.

Although the number of diagnoses of colorectal cancer in females was somewhat elevated during two time periods, with 12 diagnoses observed compared to approximately seven expected during 1987-1991 and nine diagnoses observed compared to approximately six expected during 1997-2001, these differences were not statistically significant. During the middle time period, 1992-1996, the incidence of colorectal cancer in females was about as expected with seven diagnoses observed compared to approximately six expected. During the remaining two time periods evaluated, the incidence of colorectal cancer in females in this census tract was about as expected. The incidence of breast cancer was statistically significantly lower than expected during the last two time periods evaluated; during the previous three time periods, breast cancer incidence was as expected or lower than expected.

6) Census Tract 6515

The Parker Street Waste Site extends from CT 6510.02 into CT 6515 on its southerly boundary (see Figure 3). Tables 11A through 11E summarize the cancer incidence data for CT 6515.

During 1982-1986, with the exception of breast cancer, the incidence of the cancer types evaluated was either about as expected or below expected. The incidence of breast cancer was somewhat elevated with 16 diagnoses observed when approximately 11 would have been expected; this elevation, however, was not statistically significant. During the other four time periods evaluated, the incidence of breast cancer in this census tract was either lower than expected or as expected.

During the two time periods 1987-1991 and 1992-1996, all cancer types evaluated occurred approximately at or near expected rates.

In the 1997-2001 time period, all cancer types with the exception of non-Hodgkin lymphoma occurred at or near expected rates in CT 6515. A statistically significant elevation in the incidence of NHL was observed among males and females combined (8 diagnoses observed versus approximately 3 expected, SIR = 283, 95% CI: 122 – 559).

During 2002-2006, the incidence of all cancer types evaluated was as or near expected in CT 6515 with the exception of colorectal cancer. A statistically significant elevation in the incidence of this cancer type was observed for males and females combined (15 diagnoses observed versus approximately 8 expected, SIR = 184, 95% CI: 103 – 304). Although six diagnoses were observed in males when approximately four were expected, the overall elevation was primarily due to an elevation in females with nine diagnoses observed compared to approximately four expected.

A more detailed discussion of cancer incidence and an evaluation of available risk factors for those types of cancer found to be elevated in New Bedford or any of the 5 CTs are found in the following section.

C. REVIEW OF AVAILABLE RISK FACTOR INFORMATION

1) Biliary Tract Cancer

During the 1987-1991 time period, an elevation in the incidence of biliary tract cancer was observed citywide, primarily due to an elevation among females in New Bedford (see Table 6B). The elevation was statistically significant.

According to the American Cancer Society (ACS), more than 2 out of every 3 individuals diagnosed with biliary tract cancer are over the age of 65 at diagnosis (ACS 2010a). Biliary tract cancers occur in certain bile ducts associated with the liver, some that have joined and are just leaving the liver as well as others that are located outside the liver closer to the small intestine. The major risk factors for biliary tract cancer include age, medical conditions that involve chronic inflammation of the bile duct (such as bile duct stones, ulcerative colitis, and cysts), obesity, family history, and exposure to thorotrast (a radioactive substance used in radiology until the 1950s). The ACS reports that other possible risk factors exist for biliary tract cancer that require more research to better understand their role in biliary tract cancer; these include PCBs as well as smoking, diabetes, pancreatitis, infection with hepatitis B or C virus, and exposure to asbestos, dioxins, and nitrosamines (ACS 2010a). The Agency for Toxic Substances and Disease Registry reports that, based on evidence in animal toxicity studies and some

evidence in human studies, PCBs can be expected to cause cancer in the liver and the biliary tract (U.S. ATSDR 2000).

Among females in New Bedford diagnosed with biliary tract cancer between 1987 and 1991, the average age at diagnosis was 73. Eight of the 10 females (80%) diagnosed with biliary tract cancer in the five years between 1987 and 1991 were above the age of 65 at diagnosis compared to at least 66% expected to be over 65 at diagnosis, based on national statistics for biliary tract cancer. The geographic distribution of female biliary tract cancer diagnoses between 1987 and 1991 closely followed population density patterns in New Bedford and no unusual spatial patterns or clustering of diagnoses were observed. The majority of the diagnoses were outside the five census tracts in closest proximity to the PSWS. Information on other possible risk factors for biliary cancer, such as medical conditions and family history, are not available through the MCR.

2) Colorectal Cancer

Excluding skin cancers, colorectal cancer is the third most common cancer diagnosed in both men and women in the United States. Statistically significant elevations in the incidence of colorectal cancer were observed in New Bedford census tracts 6510.01 during 1992-1996 and 6515 during 2002-2006.

According to the ACS (2010b), more than 90% of individuals diagnosed with colorectal cancer will be over the age of 50 at diagnosis. The average age at diagnosis is 72 years. Other known risk factors for colorectal cancer include family history, certain hereditary conditions (such as familial adenomatous polyposis (FAP)), personal medical conditions (such as a history of polyps or inflammatory bowel disease), and lifestyle factors (such as obesity and lack of exercise). Up to 20% of individuals who develop colorectal cancer have family members who have been affected by this disease. About 5% of individuals who develop colorectal cancer have an inherited genetic susceptibility to the disease. Other possible risk factors still under investigation include a diet high in red or processed meat, a diet low in fruits and vegetables, and smoking. (It is important to note that information on hereditary conditions, medical conditions, and most lifestyle factors is not collected by the MCR and therefore could not be assessed for the purposes of this analysis.) Although more research is needed on the possible association

between exposure to PCBs and an increased risk of colorectal cancer, some evidence points to industrial PCB exposures as being associated with colorectal cancer (U.S. ATSDR 2000).

Twenty-eight individuals in CT 6510.01 were diagnosed with colorectal cancer between 1992 and 1996 compared to approximately 18 expected. Twelve were male and sixteen were female. As previously stated, age is considered a risk factor for the development of colorectal cancer. In CT 6510.01, the average age at diagnosis of colorectal cancer during 1992-1996 was 72, and 27 of the 28 individuals diagnosed were above the age of 50. These statistics are consistent with what would be expected, based on national statistics reported by the ACS.

Smoking is also considered a possible risk for colorectal cancer. Long-term smokers are more likely than non-smokers to develop and die from colorectal cancer. Smoking is a well-known cause of lung cancer, but because some of the cancer-causing substances in tobacco are swallowed, they can increase the risk of digestive system cancers such as colorectal cancer (ACS 2010b). Smoking status was reported to the MCR for 18 of the 28 individuals in CT 6510.01 diagnosed with colorectal cancer in 1992-1996. Of these 18, 11 (61%) were current or former smokers at the time of their diagnosis. Smoking history was unknown for 10 of the 28 individuals.

The geographic distribution of colorectal cancer diagnoses in CT 6510.01 during 1992-1996 was evaluated. The distribution of diagnoses closely followed population density patterns and no unusual clustering of diagnoses was observed.

It is important to note that although the incidence of colorectal cancer was elevated in CT 6510.01 during the 1992-1996 time period, the elevation did not persist in the other four time periods evaluated. During the other time periods evaluated, the numbers of observed diagnoses of colorectal cancer were either approximately as expected or less than expected.

Fifteen individuals (both male and female) in CT 6515 were diagnosed with colorectal cancer during 2002-2006 compared to approximately eight expected. Six were male and 9 were female. The average age at diagnosis of the 15 individuals was 69 and no diagnoses were observed among individuals below the age of 50. Smoking status was known for 14 of the 15

individuals who resided in CT 6515 at the time of their diagnosis; 8 (57%) were current or former smokers at the time of their diagnosis.

The geographic distribution of the fifteen individuals diagnosed with colorectal cancer in CT 6515 during 2002-2006 was evaluated and was found to closely follow population density patterns within the CT. It is important to note that although the incidence of colorectal cancer was elevated in CT 6515 during the 2002-2006 time period, the elevation was not apparent in the earlier four time periods evaluated.

3) Gallbladder Cancer

During 1987-1991, a statistically significant elevation in the incidence of gallbladder cancer was observed citywide among New Bedford residents (males and females combined), primarily due to an elevation among females. Fifteen females were diagnosed compared to approximately six diagnoses expected. In the five CTs surrounding the Parker Street Waste Site, the incidence of gallbladder cancer was approximately as expected during the time periods evaluated.

According to the ACS, the most common risk factors for gallbladder cancer are related to chronic inflammation of the gallbladder. Older age is also a risk factor; the average age at diagnosis is 73 and 3 out of 4 individuals diagnosed with gallbladder are over the age of 65 at their diagnosis. The ACS also states that gallbladder cancer is twice as common among females as males. Other risk factors for gallbladder cancer include a history of gallstones; other medical conditions such as gallbladder polyps, calcium deposits in the gallbladder (porcelain gallbladder), and choldeochal cysts; and obesity. Because gallbladder cancer is not common, little information exists on potential environmental or occupational exposures that may increase an individual's risk of developing gallbladder cancer. Some animal studies have suggested that chemical compounds called nitrosamines may increase the risk of gallbladder cancer. Other studies have found that gallbladder cancer may be more prevalent among workers in the rubber and textile industries (ACS 2009a). ATSDR reported limited evidence of an increased risk of gallbladder cancer from exposure to PCBs based on a study of causes of death in two capacitor manufacturing plants where PCBs as well as organic solvents were used (U.S. ATSDR 2000).

Among the 15 females diagnosed with gallbladder cancer during the 1987-1991 time period, the average age at diagnosis was 73, which is consistent with national statistics published by the ACS. When the geographic distribution of residence at diagnosis was examined for the 15 females, it was observed to closely follow patterns of population density in New Bedford.

According to the ACS, more than 9 out of 10 gallbladder cancers are of the adenocarcinoma subtype. Of the adenocarcinomas, approximately 6% are papillary adenocarcinomas. Other less common subtypes of gallbladder cancer also exist. Among the 15 females diagnosed with gallbladder cancer during the 1987-1991 time period, 14 (93%) were diagnosed with the adenocarcinoma subtype.

It is important to note that although the incidence of gallbladder cancer was elevated in New Bedford females during the 1987-1991 time period, the incidence fluctuated over the remaining four time periods. Slightly fewer diagnoses were observed than expected in the 1982-1986 and 1997-2001 time periods and slightly more diagnoses were observed than expected in the 1992-1996 and 2002-2006 time periods.

4) Liver / Intrahepatic Bile Duct Cancer

A statistically significant elevation in the incidence of liver and intrahepatic bile duct (IBD) cancer was observed citywide for all New Bedford residents diagnosed during 2002-2006. The overall elevation, however, was due to an elevation among males. Thirty-seven diagnoses of liver and IBD cancer occurred in males compared to approximately 23 expected.

According to the ACS, liver cancers are more common in males than females (2009b). More than 90% of individuals diagnosed with liver and IBD cancer are older than 45 years of age, with an average age at diagnosis of 64 years. The most common form of liver/IBD cancer is hepatocellular carcinoma, accounting for 75 to 90% of all diagnoses. An additional 10–20 % of all liver/IBD cancers are intrahepatic cholangiocarcinomas. A rare form, hepatoblastoma, can occur in children and is usually diagnosed before the age of four.

Cirrhosis is a major risk factor for liver cancer and is usually due to chronic infection with either hepatitis B or C virus or heavy alcohol consumption. Other known risk factors for the development of liver and IBD cancers include certain hereditary conditions (such as

particular metabolic disorders) and exposure to thorotrast (a substance used in radiology until the 1950s). Environmental exposures with links to liver and IBD cancer include occupational exposure to vinyl chloride (a chemical used in making some kinds of plastics), PCBs, and chronic exposure to drinking water contaminated with naturally occurring arsenic. Animal studies provide strong evidence of an increased risk of liver cancer from exposure to PCBs (U.S. ATSDR 2000). In addition, although the evidence is considered suggestive, human studies in occupational settings suggest a link between liver cancer and PCBs. The chance of being exposed to arsenic depends on where you live and whether your water comes from a well or from a system that meets the drinking water standard for arsenic content. According to drinking water quality reports available for the City of New Bedford for the years 1997 through 2008, no arsenic was detected in the City water supply (City of New Bedford, 1997- 2008).

Among the 37 males in New Bedford diagnosed with liver and IBD cancer during 2002-2006, the average age at diagnosis was 60, with 95 percent of the males being over age 45 at their diagnosis. This age distribution is consistent with national statistics reported by the ACS. Seventy-eight percent of the diagnoses were hepatocellular carcinomas, which is also consistent with would be expected based on ACS statistics. The geographic distribution of liver and IBD diagnoses among New Bedford males during 2002-2006 was examined and found to follow population density patterns in the City. In other words, the addresses of New Bedford residents at the time of their diagnosis were fairly evenly spread throughout those areas of the City with the greatest number of residents.

In the earlier time periods evaluated (1982-1986, 1987-1991, and 1992-1996), fewer diagnoses of liver/IBD cancer occurred among New Bedford males than expected. During 1997-2001, more diagnoses occurred than expected with 24 observed compared to approximately 18 expected; this elevation was not statistically significant. Although not a trend over the entire 25-year time period, liver/IBD cancer incidence was elevated among New Bedford males during the last two time periods evaluated.

The incidence of liver/IBD cancer among New Bedford females fluctuated somewhat over the 25-year time period evaluated. In the first two time periods evaluated, the difference between the number of observed and expected diagnoses fluctuated between two above and three

below the expected number of diagnoses. In the third time period, 1992-1996, 11 diagnoses were observed compared to approximately six expected. In the following time period, 1997-2001, 12 diagnoses were observed compared to approximately nine expected. During the most recent time period, the incidence of liver/IBD cancer in New Bedford females was as expected (10 observed versus 10 expected).

5) Lung and Bronchus Cancer

Statistically significant elevations in the incidence of lung and bronchus cancer were observed citywide among males in New Bedford during the 1997-2001 and 2002-2006 time periods. Among New Bedford females, the incidence of lung cancer was consistently lower than expected over the 25-year time period evaluated; during the first four time periods evaluated, it was statistically significantly lower than expected.

According to the ACS, over two-thirds of people diagnosed with lung and bronchus cancer are over 65 years of age and fewer than 3% are below age 45 at diagnosis (ACS 2009c). The average age at the time of diagnosis is about 71 years. Between 85-90% of all lung and bronchus cancers are non-small cell lung cancers while 10-15% are small cell lung cancers. Forty percent of all lung cancers are adenocarcinomas, 25-30% are squamous cell carcinomas, and 10-15% are large cell carcinomas.

The greatest risk factor for lung and bronchus cancer is smoking. Almost all small cell lung cancers are caused by smoking. According to the ACS, smokers are many times more likely than non-smokers to develop lung and bronchus cancer (ACS 2009c). Approximately 87% of all lung cancers are caused directly by smoking cigarettes. The longer a person has been smoking and the more cigarettes smoked per day, the greater the risk of lung cancer. The second leading cause of lung and bronchus cancer among smokers is exposure to naturally occurring radon; among non-smokers, this is thought to be the leading cause of lung and bronchus cancer. Other known risk factors include genetics, exposure to secondhand smoke, previous radiation therapy to the chest (e.g., for the treatment of a previous cancer such as Hodgkin disease), and occupational exposure to particular chemicals such as heavy metals (arsenic, beryllium, cadmium, chromium, and nickel), vinyl chloride, mustard gas, chloromethyl ethers, diesel exhaust, silica, and coal products, as well as to radioactive ores such as uranium. ATSDR has

reported limited evidence of an association between lung cancer and exposure to PCBs based on animal studies where rats and mice were fed PCBs along with other chemicals known to be carcinogens (U.S. ATSDR 2000).

Age at diagnosis was reviewed for the 473 males diagnosed with lung and bronchus period between 1997 and 2006. Of the 473 males, 66 percent were over the age of 65 at the time of their diagnosis compared to approximately 66% nationwide. Three percent of the New Bedford males were under the age of 45 at their diagnosis, which is comparable to approximately 3% nationwide based on ACS statistics. The age at diagnosis pattern within the New Bedford male population appears to closely follow national trends.

The histologies (or tissue types) of the lung cancers among the New Bedford males were compared to what would be expected based on national statistics. Seventy-two percent of lung cancer diagnoses among New Bedford males between 1997 and 2006 were non-small cell lung cancers while 12% were small cell lung cancers; the relative percentages of non-small cell versus small cell lung cancers in these New Bedford males is consistent with the pattern of lung cancer subtypes seen nationwide. Twenty-six percent of the New Bedford diagnoses were adenocarcinomas, 27% were squamous cell carcinomas, and 7% were large cell carcinomas. Although there were slightly more squamous cell carcinomas than adenocarcinomas, the distribution of these histologies among New Bedford males approximates those reported by the ACS for the U.S. as whole.

Tobacco use history was reviewed for the male New Bedford residents diagnosed with lung and bronchus cancer during these two time periods. Of all males diagnosed between 1997 and 2006, smoking history was reported to the MCR for 362 individuals. Among the 362 individuals, 350 (97%) were reported to the MCR as current/former smokers at the time of their diagnosis while 12 were reported as non-smokers.

6) Non-Hodgkin Lymphoma

A statistically significant elevation in the incidence of NHL among males and females combined was observed in CT 6515 during 1997-2001. Eight individuals were diagnosed with

NHL during these five years, 4 men and 4 women, when approximately three diagnoses would be expected.

Overall, the risk of non-Hodgkin lymphoma is higher in men than in women, but there are certain types of non-Hodgkin lymphoma that are more common in women (ACS 2009d). The average age at diagnosis is in the 60s, and around half of patients are older than 65 at diagnosis. The risk of developing non-Hodgkin lymphoma increases throughout life. Over 85% of all NHL diagnoses are of the subtype known as B-cell lymphomas.

Major risk factors for NHL include older age, medical conditions involving a weakened immune system, and certain viral infections. Individuals who have had organ transplants or certain autoimmune diseases such as rheumatoid arthritis or lupus are at increased risk of developing NHL. Infection with particular viral agents such as the human immunodeficiency virus (HIV), the human T-cell leukemia/lymphoma virus (HTLV-1), and the Epstein-Barr virus puts individuals at increased risk of developing NHL. Although more research is needed, some studies have suggested that smoking, high-dose radiation exposures associated with atomic bombs and nuclear power plant accidents, and exposure to chemicals such as benzene, PCBs, and certain herbicides and insecticides (weed- and insect-killing substances) may be linked with an increased risk of NHL. A number of recent human studies have been conducted that evaluated non-occupationally exposed individuals, serum PCB levels, and the occurrence of NHL among participants in the studies. These studies suggest that there may be an association between PCBs, as measured in the serum of the participants, and certain more common sub-types of NHL, particularly diffuse large cell lymphoma (Engel at al. 2007).

Prior treatment for cancer can increase an individual's risk of developing NHL. Some chemotherapy drugs used to treat other cancers may increase the risk of developing leukemia or NHL many years later. Patients treated with radiation therapy for some other cancers, such as Hodgkin disease, have a slightly increased risk of developing NHL later in life. This risk is greater for patients treated with both radiation therapy and chemotherapy (ACS 2009d).

Among the eight residents of CT 6515 diagnosed with NHL during 1997-2001, the average age at diagnosis was 58, which is slightly younger than the national average reported by the ACS as being in the 60s. Three of the 8 individuals (38%) were over the age of 65 when they

were diagnosed with NHL; the ACS reports that about half of all individuals are above 65 when they are diagnosed with NHL. The age pattern at diagnosis of individuals in this census tract with NHL approximates that of the national population.

Seven of the 8 diagnoses (88%) were B-cell lymphomas, the predominant type of NHL in the U.S. population. Based on the occupational information provided by the MCR, one of the eight individuals diagnosed with NHL in CT 6515 may have been exposed to benzene in an occupational setting. In addition, one of the eight residents of CT 6515 diagnosed with NHL during 1997-2001 had a previous cancer diagnosis reported to the MCR. It is not known, however, whether this individual may have been treated with chemotherapeutic drugs or received radiation therapy for their previous cancer.

It is important to note that although the incidence of NHL was elevated during the 1997-2001 time period in census tract 6515, it occurred either about as expected or less frequently than expected during the other four time periods evaluated. Therefore, no long-term trend was noted in the incidence of NHL in this census tract.

V. DISCUSSION

Forty-five individuals, 43 of whom are current or former residents of the PSWS neighborhood and three individuals who are/were not residents but reportedly had spent a significant amount of time at the PSWS, chose to have their blood serum tested for PCBs. The majority of these individuals have serum PCB levels within the typical variation for their respective age groups in the U.S. population. Given the small numbers of participants, the MDPH/BEH cannot speak conclusively about PCB serum levels for those who were not actually tested.

For the City of New Bedford as a whole, cancer incidence data spanning the 25-year time period showed the following:

- With a few exceptions, no consistent trends in the incidence rates emerged over time. Lung cancer incidence in New Bedford males was somewhat elevated in the time period covering 1987-1996 and it was statistically significantly elevated in the last two time periods evaluated (1997-2001 and 2002-2006). Among those males whose smoking

history was reported to the MCR, 97% were current or former smokers at the time of their diagnosis. Smoking, therefore, appears to have played a role in the incidence of lung cancer among New Bedford males. The incidence of lung cancer among New Bedford females was consistently lower than expected over the 25-year time period.

- The incidence of biliary tract cancer in New Bedford females was statistically significantly elevated during the 1987-1991 time period. Incidence rates for this type of cancer, however, fluctuated over the 25-year period with no consistent trend noted.
- For both gallbladder and liver/IBD cancers, statistically significant elevations occurred in each cancer type in one time period. However, a consistent trend was not seen in either cancer type over the 25-year time period with rates fluctuating over time.
- The incidence of colorectal cancer was statistically significantly lower than expected during the first two time periods. It was elevated in the subsequent three time periods, however, it was not statistically significantly elevated.
- The incidence of four types of cancer – breast, NHL, melanoma, and lung cancer in females – was lower than expected throughout the entire time period. For most time periods, it was statistically significantly lower than expected for breast and lung cancer as well as melanoma. The incidence of bladder cancer was either lower than expected or about as expected throughout the entire time period.

MDPH reviewed cancer staging information for women diagnosed with breast cancer in New Bedford for the ten-year period 1996-2005, the most recent time period for which consistent staging methods have been used. (Breast cancer staging methods before 1996 are different from those used after 1996.) Staging describes the extent of spread of an individual's cancer. From a public health perspective, earlier breast cancer staging reflects to some extent that women are being screened early and regularly for breast cancer whereas distant staging may reflect a lack of access to early screening. In New Bedford, more women are being diagnosed with distant stage breast cancer (7%) compared to the state (4%); this difference is statistically significant and may indicate a lack of access to early screening for this disease among women in New Bedford.

For CT 6510.02, where the Parker Street Waste Site is located, the incidence of the majority of the nine cancer types was about as expected during the five time periods evaluated, constituting a 25-year span. Although breast cancer incidence was somewhat elevated (although not statistically significantly elevated) during 1992-1996, with 27 diagnoses observed versus 19 expected, in the time periods before (1982-1991) and after (1997-2006), the rate of breast cancer was below expected. Similarly, in the last two time periods, although elevations were noted in lung and bronchus cancer in females, these elevations were not statistically significant and did not represent long-term trends. Elevations in bladder cancer in males (during 1992-1996) and colorectal cancer in females (2002-2006) occurred in a single time period but did not occur in the surrounding time periods. During the five time periods, no statistically significant elevations occurred and no consistent trends were seen in the incidence of any particular type of cancer in CT 6510.02. It is important to note that the incidence of liver cancer, the type of cancer with the strongest association with exposure to PCBs, was close to expected over the 25-year period with six diagnoses reported in CT 6510.02 compared to approximately five expected. For the other five types of cancer for which there is some evidence of a link with exposure to PCBs – biliary tract, NHL, colorectal, melanoma, and breast cancer – the incidence of these cancer types over the 25-year period was below the expected rate. After liver cancer, the medical/epidemiological literature is strongest with respect to showing a possible association between these types of cancer and exposure to PCBs.

For CT 6515, which contains the southern most area of the PSWS, the incidence of the cancer types evaluated was approximately as expected for each of the five time periods evaluated with the exception of colorectal cancer and non-Hodgkin lymphoma. Although both colorectal cancer and non-Hodgkin lymphoma were statistically significantly elevated in one time period, these elevations did not persist over time and did not represent a consistent pattern. Except for the 1997-2001 time period, when eight diagnoses of NHL were observed compared to approximately three expected, the incidence of NHL was as expected or less than expected throughout the other time periods. With the exception of the most current time period, the incidence of colorectal cancer was approximately as expected throughout the other time periods.

For CT 6509, the incidence of the nine types of cancer was approximately as expected for each of the five time periods evaluated.

For CT 6510.01, with one exception, the incidence of the cancer types evaluated was approximately as expected for the five time periods. Colorectal cancer incidence was statistically significantly elevated for males and females combined during the middle time period of 1992-1996. However, this elevation did not occur in the earlier time periods nor did it persist in subsequent time periods.

For CT 6511, the incidence of the nine types of cancer was approximately as expected for each of the five time periods evaluated. The incidence of breast cancer was statistically significantly lower than expected during the last two time periods evaluated. With the exception of breast cancer, no other consistent trends emerged in other cancer types.

VI. CONCLUSIONS

Serum PCB testing conducted by BEH showed that the majority of participants who currently live or previously lived within the five CTs, as well as the three non-resident participants that reported spending a significant amount of time at the PSWS, have serum PCB levels within the 95th percentile of serum PCB levels available from the national NHANES data. Three of the 45 participants had whole weight and/or lipid-adjusted results that exceeded the NHANES 95th percentile. Thus, serum PCB results for 42 of the 45 participants are within the typical variation seen in the U.S. population and the serum PCB concentrations for three of the 45 participants are above the typical range.

Serum levels of PCBs reflect accumulated exposure and studies have shown that concentrations of PCBs in serum generally increase with age (Miller, 1991; U.S. CDC, 2009). Consistent with national patterns, serum concentrations of PCBs in participants generally increased with age but were within typical concentrations for the U.S. population for each age group evaluated. There was no consistent pattern of increasing serum PCB levels with increasing years of residence in the neighborhood around the PSWS, suggesting that location of residence was not a primary predictor of serum PCB levels. Finally, the PCB congener patterns for each age group evaluated are consistent with what is typically seen in the U.S. population, suggestive of dietary sources.

The Parker Street Waste Site is located in CT 6510.02, extending into CT 6515 on its southerly boundary. For both of these census tracts, the incidence of liver cancer, the type of cancer with the strongest association with exposure to PCBs, was approximately the same as the expected rate, with a difference of one between the number of observed and expected diagnoses for the 25-year time period. For both census tracts, the incidence of the majority of cancer types was approximately as expected and no consistent trends were seen in the incidence of any particular type of cancer over the 25-year span. Therefore, for the two census tracts in closest proximity to the Parker Street Waste Site, the incidence rates of those types of cancer possibly associated with exposure to PCBs appear to be approximately as expected based on comparisons to the cancer experience of Massachusetts as a whole. It is important to point out that a review of cancer incidence data, as was conducted in this report, applies to the population at large. This type of analysis cannot be used to determine the cause of cancer in an individual. It is used as a screening-level evaluation to assess whether further study is warranted.

For the other three census tracts surrounding the Parker Street Waste Site, the incidence of the majority of cancer types evaluated was approximately as expected for each of the five time periods evaluated. No unusual or consistent trends emerged in the three census tracts.

When cancer incidence rates for the City of New Bedford as a whole were examined, some elevations were noted, particularly in lung cancer in males. Lung cancer incidence in males was elevated in males primarily between 1997 and 2006. Based on smoking history information reported to the Massachusetts Cancer Registry, it appears that smoking played some role in the incidence of this cancer in New Bedford males.

VII. RECOMMENDATIONS

To address what may be inadequate early screening for particular types of cancer in New Bedford – notably, breast and colorectal cancers – MDPH recommends that the New Bedford Health Department work with the MDPH Comprehensive Cancer Prevention and Control Program to increase awareness in New Bedford of the importance of early screening for cancer. Most colorectal cancers are preventable with routine screening tests and, when detected early, are almost always treatable. Similarly, when breast cancer is found at an early stage, the chance of a cure is much better. Screenings, such as mammograms, can help find breast cancer early.

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FIGURES

Figure 1: EPA Parker Street Waste Site Boundaries

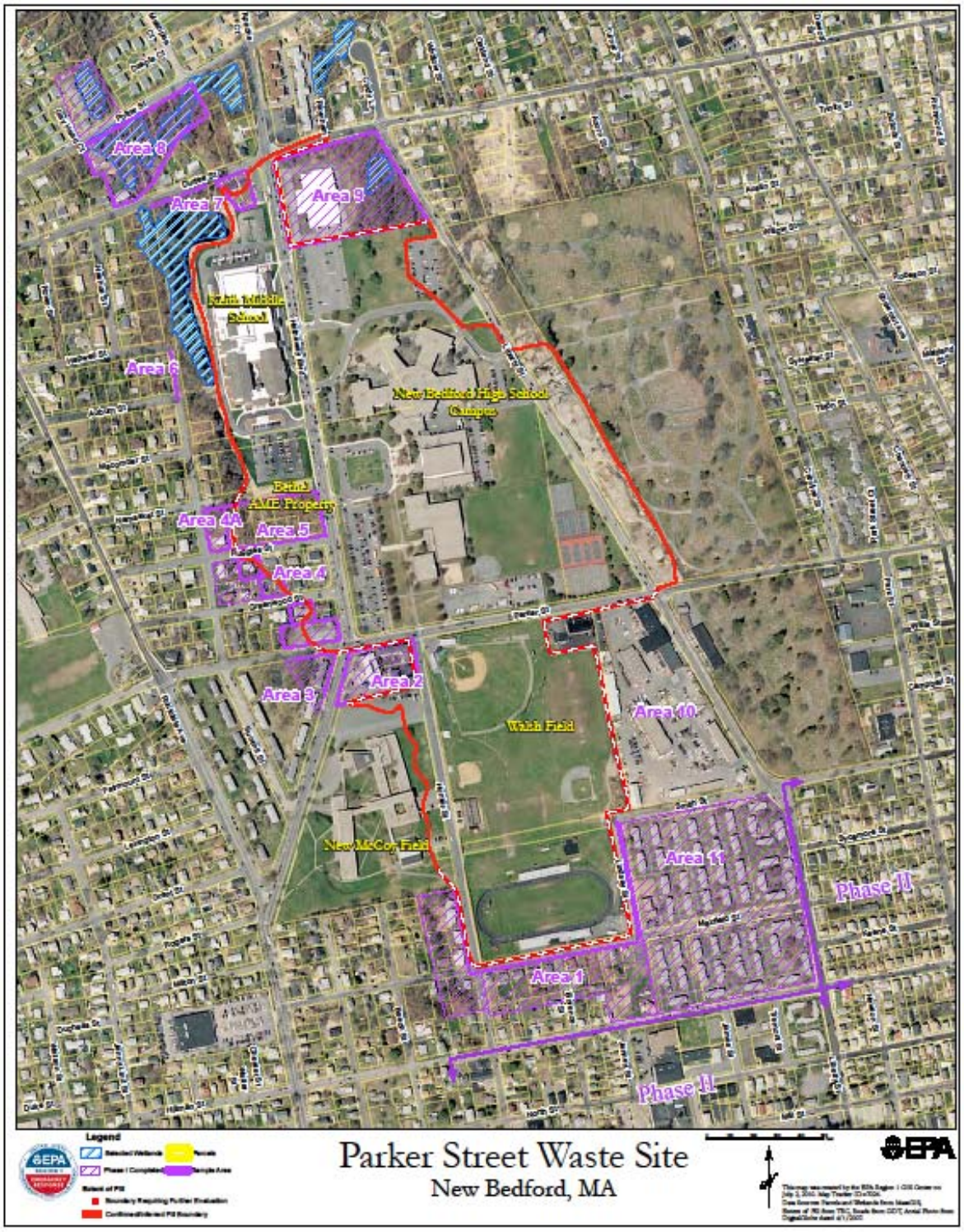


Figure 2: Location of New Bedford High School, Keith Middle School, and the Former Keith Middle School, New Bedford, Massachusetts

Figure 3: Location of Census Tracts, New Bedford, Massachusetts

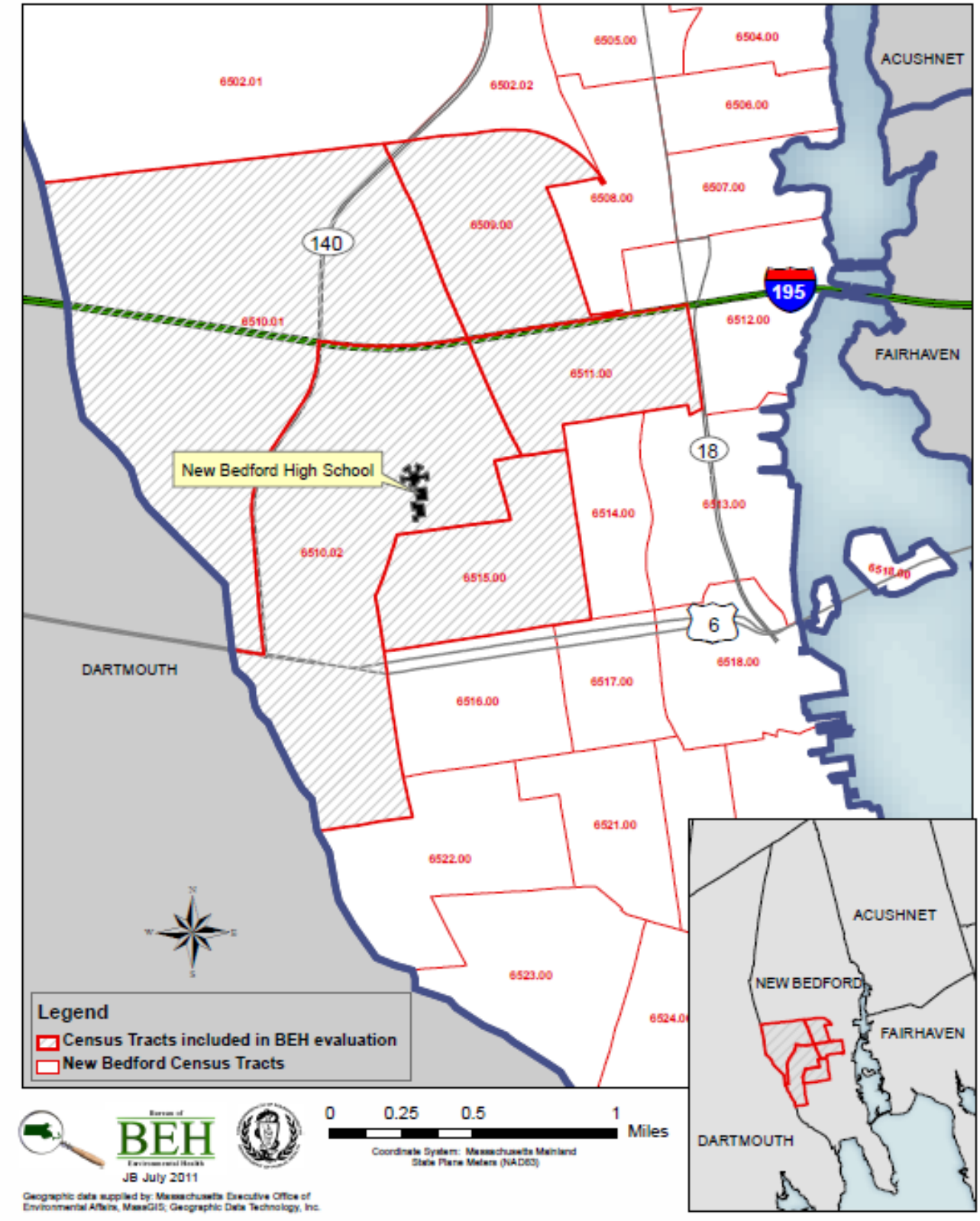


Figure 4: Residency Status for Serum PCB Testing Offer Participants (n=45)

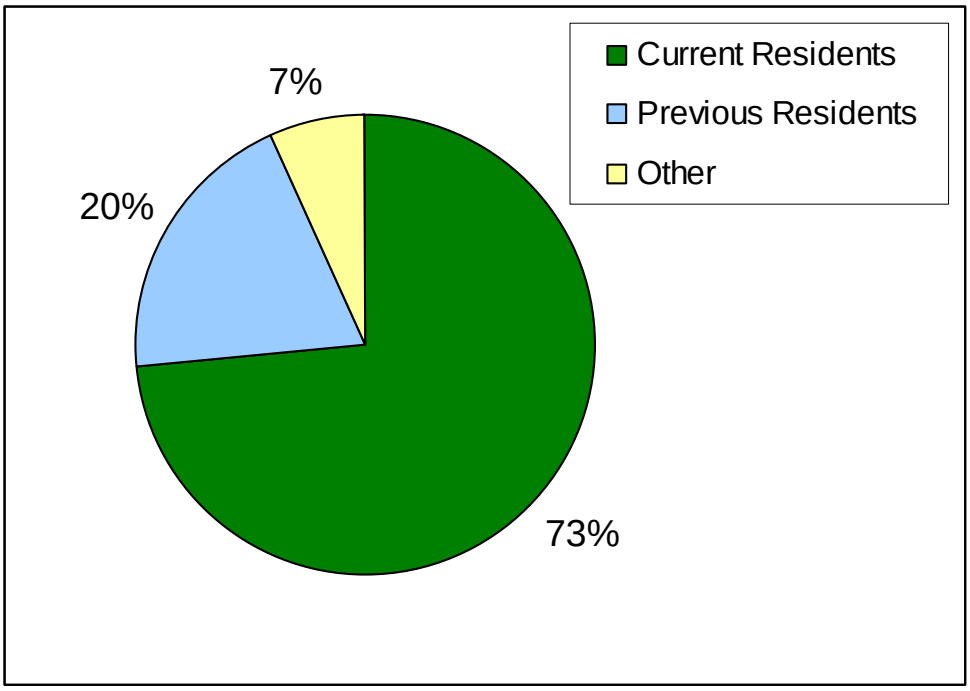


Figure 5: Age Distribution for Serum PCB Testing Offer Participants (n=45)

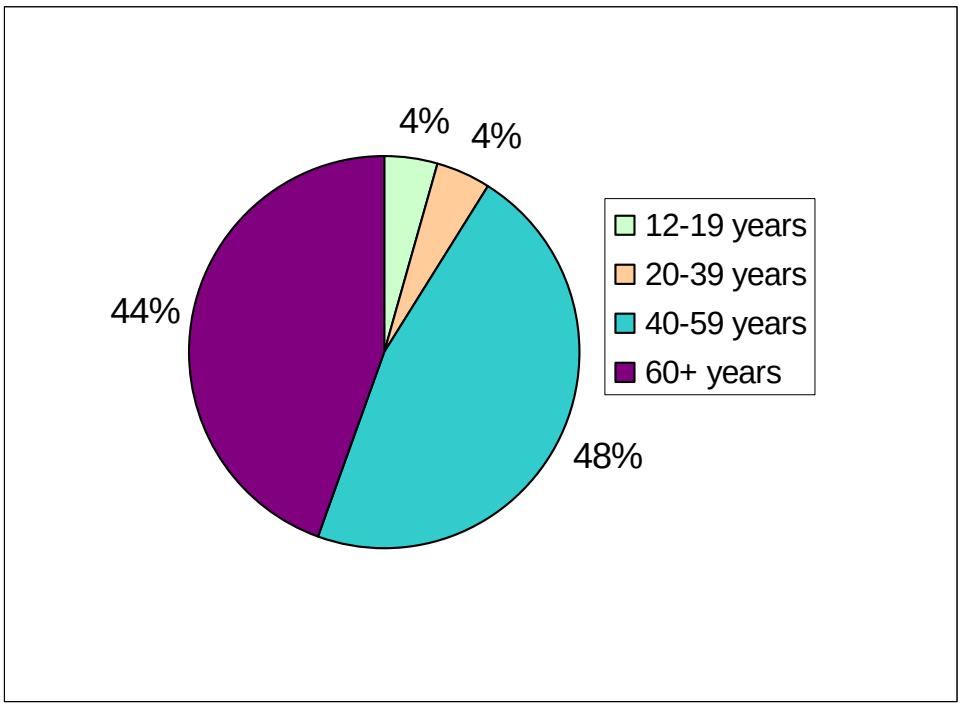


Figure 6: Serum PCB Levels – Whole Weight (ppb; n=45)

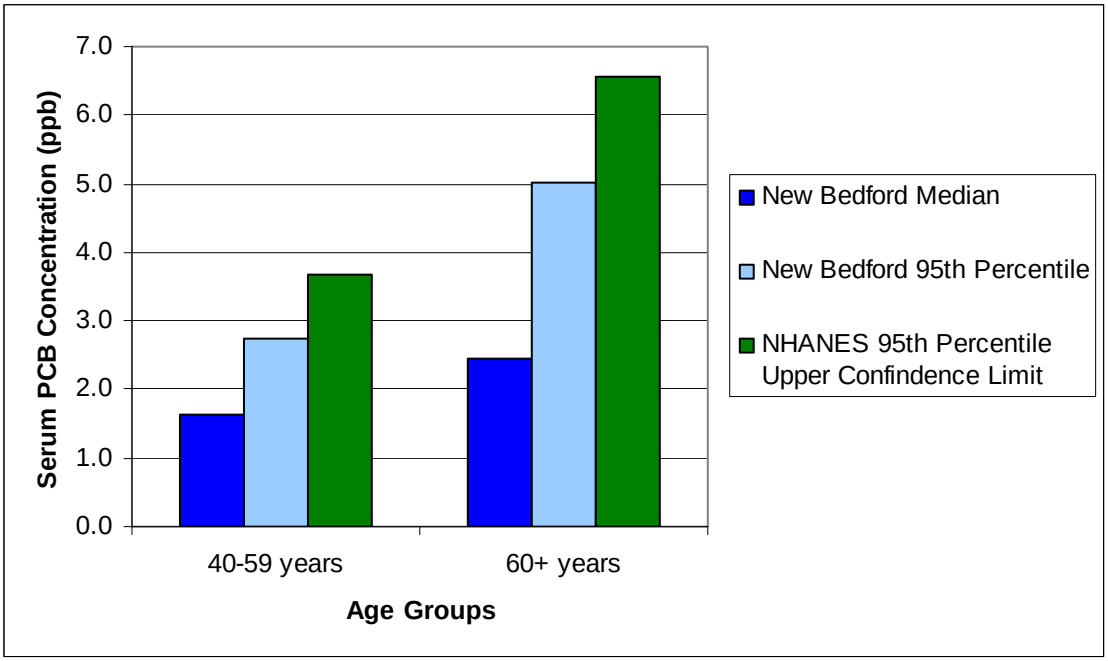


Figure 7: Serum PCB Levels – Lipid-Adjusted (ppb; n=45)

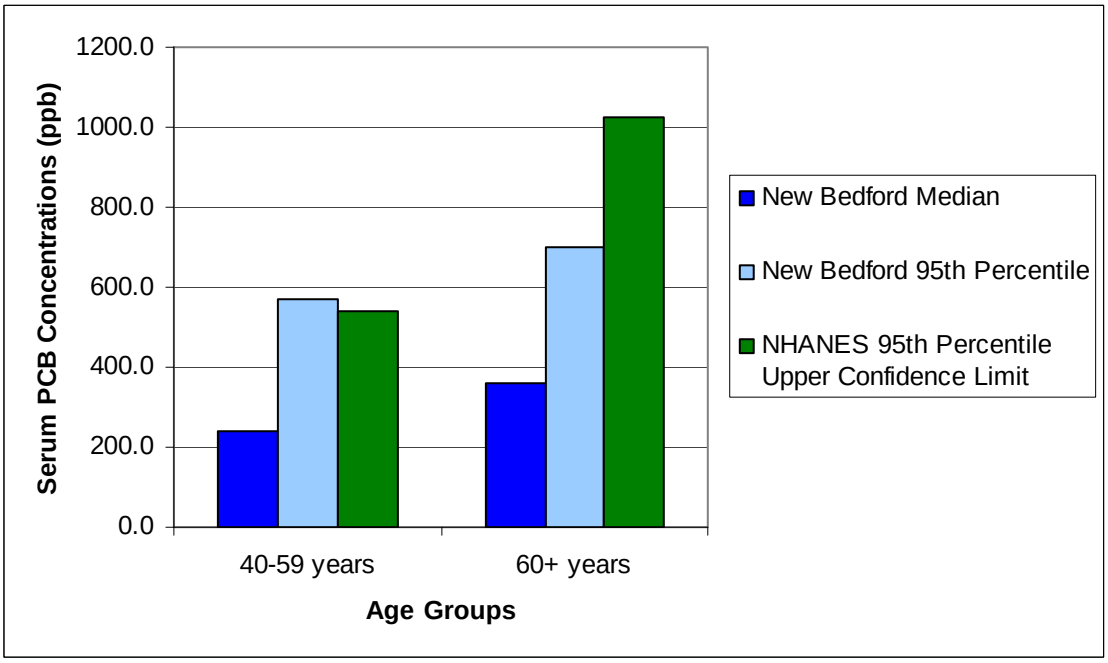


Figure 8: Serum PCB Congener Pattern for all New Bedford Participants Lipid-Adjusted (All Ages; n=91)

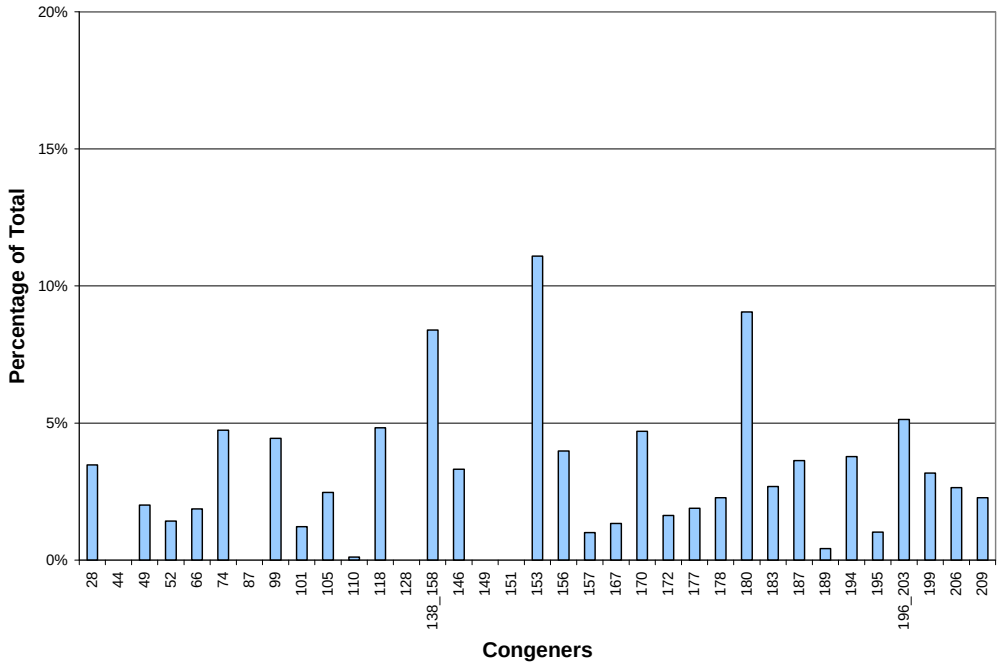


Figure 9: Serum PCB Congener Pattern for NHANES 2003-2004 Lipid-Adjusted (All Ages)

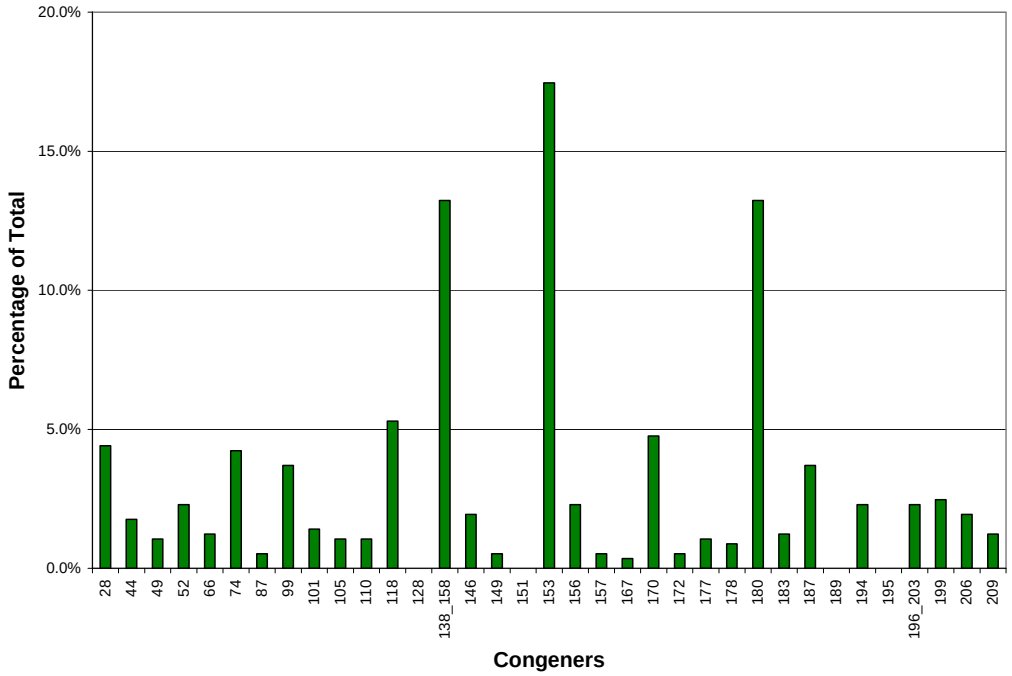


Figure 10: Geometric Mean Whole Weight Serum PCB Levels (ppb) by Years of Residency

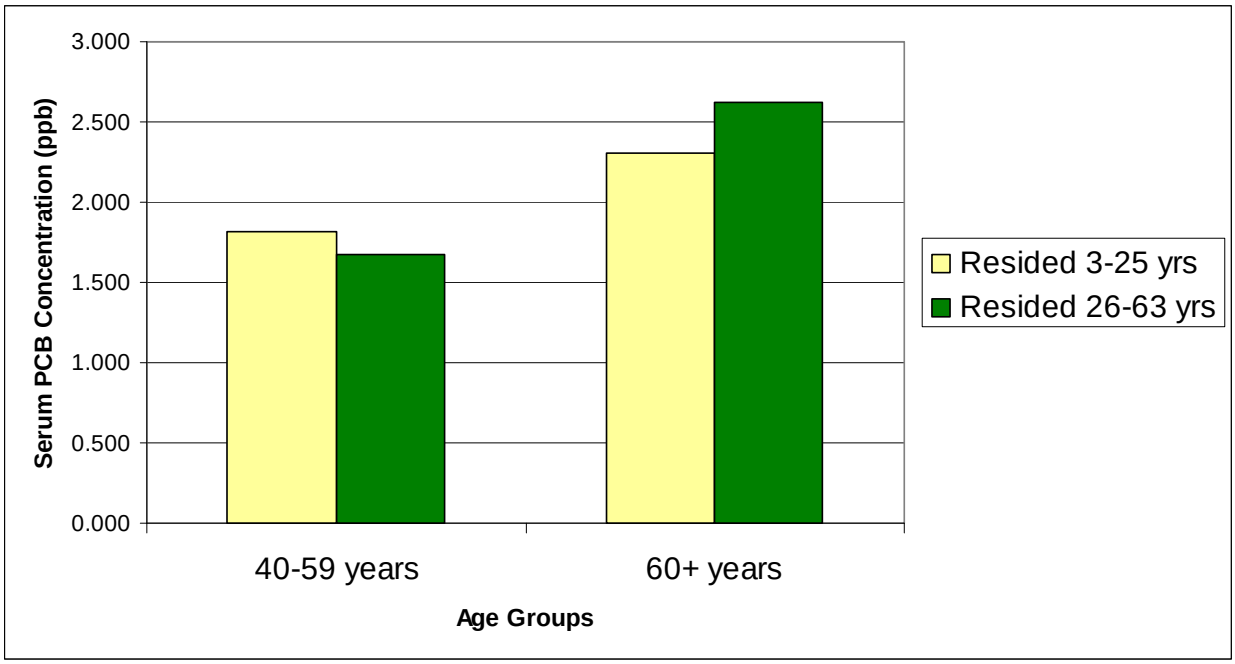
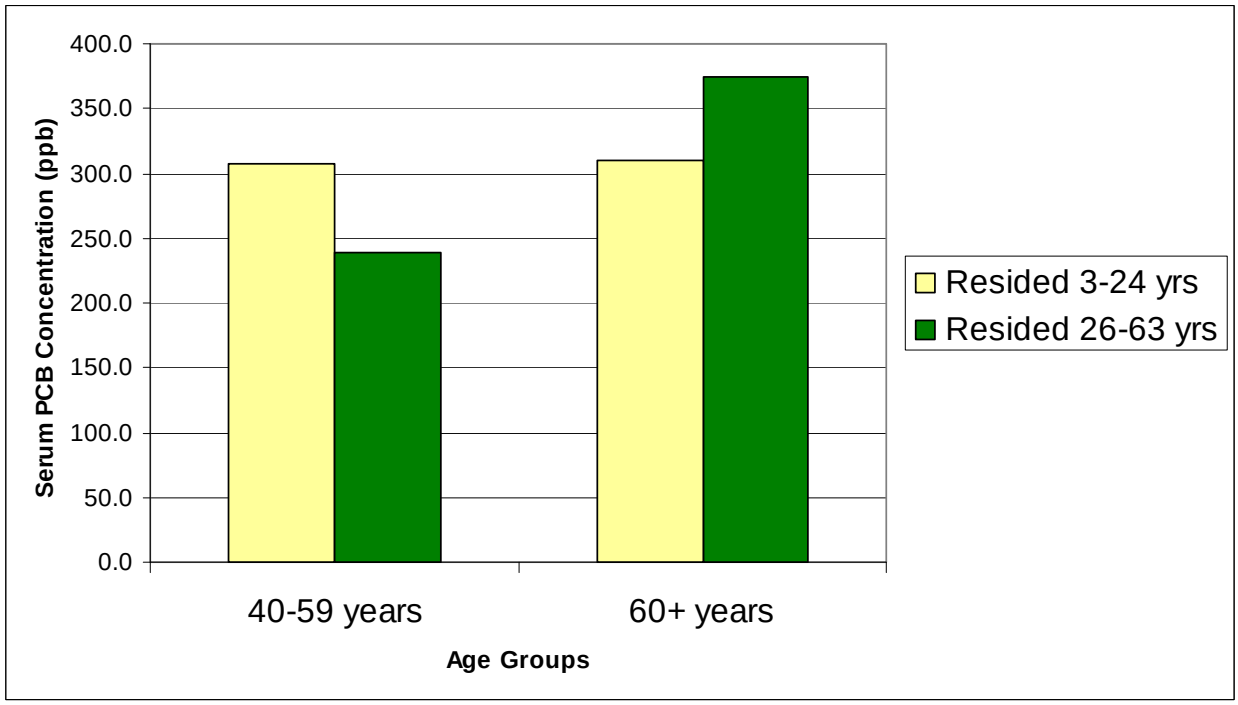


Figure 11: Geometric Mean Lipid-Adjusted Serum PCB Levels (ppb) by Years of Residency



TABLES

Table 1: Summary of Median Serum PCB Concentrations (Whole Weight)

	New Bedford Residents Median and Range (ppb) [1, 2]	NHANES Median/50th Percentile (ppb) [3]	NHANES 95th Percentile (ppb) [3]
Participants 40-59 yo (n=21)	1.642 (ND to 4.904)	0.927 (0.840, 1.058)	2.780 (2.307, 3.663)
Participants 60+ yo (n=20)	2.455 (1.276 to 7.742)	1.805 (1.694, 1.874)	5.123 (4.131, 6.556)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

1. The median concentration for the two participants between 12 and 19 years of age and the two participants between 20 and 39 years of age are not presented because no PCB congeners were detected in samples collected from the four participants in these age groups.

2. The range of serum PCB levels detected is presented in parentheses below the median for New Bedford residents.

3. The 95% confidence intervals appear in parentheses below both the NHANES median and 95th percentile values. The 95% CIs presented represent the range of estimated values that have a 95% probability of including the true value for the population.

Table 2: Summary of Median Serum PCB Concentrations (Lipid-Adjusted)

	New Bedford Residents Median and Range (ppb) [1, 2]	NHANES Median/50th Percentile (ppb) [3]	NHANES 95th Percentile (ppb) [3]
Participants 40-59 yo (n=21)	239.9 (ND to 823.9)	145.3 (128.7, 157.9)	402.2 (325.1, 540.2)
Participants 60+ yo (n=20)	360.3 (154.6 to 906.1)	276.0 (251.2, 295.4)	769.4 (600.0, 1026.5)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

1. The median concentration for the two participants between 12 and 19 years of age and the two participants between 20 and 39 years of age are not presented because no PCB congeners were detected in samples collected from the four participants in these age groups.

2. The range of serum PCB levels detected is presented in parentheses below the median for New Bedford residents.

3. The 95% confidence intervals appear in parentheses below both the NHANES median and 95th percentile values. The 95% CIs presented represent the range of estimated values that have a 95% probability of including the true value for the population.

Table 3: Number of Individuals Currently or Previously Residing within the Five Census Tracts by Years of Residency and Age[1]

Age (years)	3-25 Years of Residence (less than or equal to the 50th percentile)	26-63 Years of Residence (greater than the 50th percentile)	Total
12-19	1	0	1
20-39	1	1	2
40-59	11	8	19
60+	8	12	20
Total	21	21	42

1. Three of the 45 participants in this evaluation did not report currently or previously living in the five census tracts surrounding the PSWS and are not included in this table.

Table 4: Geometric Mean and Range of Serum PCB Concentrations (ppb; Whole Weight)

by Years of Residency in the Five Census Tracts Surrounding the PSWS [1,2]

Age Group	3-25 Years of Residence	26-63 Years of Residence
Participants[3] 40-59 yo (n=11, 7)	1.813 (1.112 to 4.904)	1.675 (0.944 to 2.432)
Participants 60+ yo (n=8, 12)	2.306 (1.493 to 4.871)	2.619 (1.276 to 7.742)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

1. Three of the 45 participants in this evaluation did not report currently or previously living in the five census tracts surrounding the PSWS and are not included in this table.

2. Geometric means for the participants in the 12-19 and 20-39 year age groups are not presented in this table because no PCB congeners were detected in samples collected from participants in these age groups.

3. One participant out of 19 between the ages of 40 and 59 years of age was not included in the geometric mean calculations because no PCB congeners were detected in this participant's sample.

Table 5: Geometric Mean and Range of Serum PCB Concentrations (ppb; Lipid-Adjusted)

by Years of Residency in the Five Census Tracts Surrounding the PSWS [1,2]

Age Group	3-25 Years of Residence	26-63 Years of Residence
Participants[3] 40-59 yo (n=11, 7)	306.9 (179.6 to 823.9)	238.3 (166.8 to 362.1)
Participants 60+ yo (n=8, 12)	309.7 (190.5 to 687.0)	374.5 (154.6 to 906.1)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

1. Three of the 45 participants in this evaluation did not report currently or previously living in the five census tracts surrounding the PSWS and are not included in this table.

2. Geometric means for the participants in the 12-19 and 20-39 year age groups are not presented in this table because no PCB congeners were detected in samples collected from participants in these age groups.

3. One participant out of 19 between the ages of 40 and 59 years of age was not included in the geometric mean calculations because no PCB congeners were detected in this participant's sample.

TABLE 6A

Cancer Incidence

New Bedford, Massachusetts

1982-1986

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	4	9.2	NC	NC	-- NC	2	3.9	NC	NC	-- NC	2	5.3	NC	NC	-- NC
Bladder	112	111.1	101	83	-- 121	78	78.6	99	78	-- 124	34	32.5	105	72	-- 146
Breast	275	375.4	73	* 65	-- 82	1	2.1	NC	NC	-- NC	274	373.3	73	* 65	-- 83
Colon/Rectum	355	417.5	85	* 76	-- 94	149	197.3	76	* 64	-- 89	206	220.1	94	81	-- 107
Gallbladder	6	8.2	73	27	-- 160	1	2.4	NC	NC	-- NC	5	5.8	86	28	-- 201
Liver / IBD	11	11.9	93	46	-- 166	5	7.6	66	21	-- 155	6	4.3	139	51	-- 302
Lung/Bronchus	273	354.5	77	* 68	-- 87	200	225.4	89	77	-- 102	73	129.1	57	* 44	-- 71
Melanoma	21	51.4	41	* 25	-- 62	17	26.2	65	38	-- 104	4	25.2	NC	NC	-- NC
Non-Hodgkin Lymphoma	57	74.6	76	* 58	-- 99	28	35.8	78	52	-- 113	29	38.8	75	50	-- 107

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 6B

Cancer Incidence

New Bedford, Massachusetts

1987-1991

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	15	9.0	166	93	274	5	4.3	115	37	269	10	4.7	214 *	102	393
Bladder	77	107.2	72 *	57	90	64	76.1	84	65	107	13	31.1	42 *	22	71
Breast	362	425.7	85 *	77	94	4	2.7	NC	NC	NC	358	423	85 *	76	94
Colon/Rectum	360	402.9	89 *	80	99	176	195.6	90	77	104	184	207.3	89	76	103
Gallbladder	17	8.1	211 *	123	338	2	2.2	NC	NC	NC	15	5.9	255 *	142	420
Liver / IBD	6	14.2	42 *	15	92	4	9.5	NC	NC	NC	2	4.7	NC	NC	NC
Lung/Bronchus	364	378.3	96	87	107	244	224.5	109	95	123	120	153.8	78 *	65	93
Melanoma	28	57.8	48 *	32	70	15	30.2	50 *	28	82	13	27.6	47 *	25	81
Non-Hodgkin Lymphoma	81	89	91	72	113	39	43.4	90	64	123	42	45.5	92	66	125

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 6C

Cancer Incidence

New Bedford, Massachusetts

1992-1996

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	10	7.3	138	66 --	254	5	3.7	137	44 --	319	5	3.6	139	45 --	325
Bladder	91	95.1	96	77 --	117	66	67	98	76 --	125	25	28.1	89	58 --	131
Breast	396	412.7	96	87 --	106	1	3.5	NC	NC --	NC	395	409.2	97	87 --	107
Colon/Rectum	377	356	106	95 --	117	173	170.2	102	87 --	118	204	185.8	110	95 --	126
Gallbladder	9	7.3	124	56 --	235	1	1.8	NC	NC --	NC	8	5.5	146	63 --	288
Liver / IBD	20	17.5	114	70 --	176	9	11.7	77	35 --	146	11	5.8	188	94 --	337
Lung/Bronchus	341	378.3	90	81 --	100	226	208.1	109	95 --	124	115	170.2	68 *	56 --	81
Melanoma	27	66.1	41 *	27 --	59	15	35.8	42 *	23 --	69	12	30.3	40 *	20 --	69
Non-Hodgkin Lymphoma	91	100.4	91	73 --	111	44	49.9	88	64 --	118	47	50.6	93	68 --	124

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 6D

Cancer Incidence

New Bedford, Massachusetts

1997-2001

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	6	7.7	78	29 --	170	2	3.8	NC	NC --	NC	4	3.8	NC	NC --	NC
Bladder	77	88.8	87	68 --	108	55	61.8	89	67 --	116	22	27	81	51 --	123
Breast	365	427.3	85 *	77 --	95	3	2.7	NC	NC --	NC	362	424.6	85 *	77 --	95
Colon/Rectum	365	351.4	104	93 --	115	182	163.1	112	96 --	129	183	188.2	97	84 --	112
Gallbladder	8	7.5	107	46 --	211	4	2.1	NC	NC --	NC	4	5.4	NC	NC --	NC
Liver / IBD	36	26.2	138	96 --	190	24	17.7	136	87 --	202	12	8.5	142	73 --	248
Lung/Bronchus	396	405.9	98	88 --	108	246	206.4	119 *	105 --	135	150	199.5	75 *	64 --	88
Melanoma	44	88.2	50 *	36 --	67	28	47.5	59 *	39 --	85	16	40.7	39 *	22 --	64
Non-Hodgkin Lymphoma	81	105.9	76 *	61 --	95	31	51.4	60 *	41 --	86	50	54.5	92	68 --	121

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 6E

Cancer Incidence

New Bedford, Massachusetts

2002-2006

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	12	10.6	113	58	197	4	5.5	NC	NC	NC	8	5.1	157	68	310
Bladder	58	67.1	86	66	112	43	46.2	93	67	125	15	20.9	72	40	118
Breast	313	391.0	80 *	71	89	3	3.2	NC	NC	NC	310	387.7	80 *	71	89
Colon/Rectum	313	308.1	102	91	113	143	144.8	99	83	116	170	163.3	104	89	121
Gallbladder	10	6.7	148	71	272	2	1.9	NC	NC	NC	8	4.9	164	71	323
Liver / IBD	47	32.3	145 *	107	193	37	22.8	163 *	114	224	10	9.6	105	50	193
Lung/Bronchus	430	400.9	107	97	118	227	192.3	118 *	103	134	203	208.6	97	84	112
Melanoma	53	118	45 *	34	59	27	62.5	43 *	28	63	26	55.5	47 *	31	69
Non-Hodgkin Lymphoma	97	110.7	88	71	107	51	54.3	94	70	123	46	56.4	82	60	109

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7A

Cancer Incidence

Census Tract 6510.02, New Bedford, Massachusetts

1982-1986

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	5	5	99	32 -- 231	3	3.6	NC	NC -- NC	2	1.4	NC	NC -- NC
Breast	8	16.1	50	* 21 -- 98	0	0.1	NC	NC -- NC	8	16	50	* 22 -- 98
Colon/Rectum	14	19	74	40 -- 124	5	9.1	55	18 -- 128	9	9.9	91	42 -- 173
Gallbladder	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	1	0.5	NC	NC -- NC	0	0.3	NC	NC -- NC	1	0.2	NC	NC -- NC
Lung/Bronchus	12	15.5	77	40 -- 135	7	10.2	69	28 -- 142	5	5.4	93	30 -- 217
Melanoma	2	2.2	NC	NC -- NC	1	1.1	NC	NC -- NC	1	1.1	NC	NC -- NC
Non-Hodgkin Lymphoma	2	3.3	NC	NC -- NC	2	1.6	NC	NC -- NC	0	1.7	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7B

Cancer Incidence

Census Tract 6510.02, New Bedford, Massachusetts

1987-1991

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	2	5.1	NC	NC -- NC	2	3.6	NC	NC -- NC	0	1.5	NC	NC -- NC
Breast	17	18.9	90	52 -- 144	0	0.1	NC	NC -- NC	17	18.8	91	53 -- 145
Colon/Rectum	17	19.3	88	51 -- 141	8	9.4	85	37 -- 168	9	9.9	91	41 -- 172
Gallbladder	2	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	2	0.3	NC	NC -- NC
Liver / IBD	0	0.7	NC	NC -- NC	0	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	11	17.1	64	32 -- 115	7	10.5	67	27 -- 138	4	6.6	NC	NC -- NC
Melanoma	1	2.6	NC	NC -- NC	1	1.4	NC	NC -- NC	0	1.2	NC	NC -- NC
Non-Hodgkin Lymphoma	1	4.1	NC	NC -- NC	1	2	NC	NC -- NC	0	2.1	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7C

Cancer Incidence

Census Tract 6510.02, New Bedford, Massachusetts

1992-1996

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	1	0.3	NC	NC -- NC	1	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	8	4.4	183	79 -- 361	6	3	198	72 -- 431	2	1.3	NC	NC -- NC
Breast	27	18.7	144	95 -- 210	0	0.2	NC	NC -- NC	27	18.5	146	96 -- 212
Colon/Rectum	11	16.6	66	33 -- 119	6	7.6	79	29 -- 171	5	9	56	18 -- 130
Gallbladder	0	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.3	NC	NC -- NC
Liver / IBD	1	0.8	NC	NC -- NC	0	0.5	NC	NC -- NC	1	0.3	NC	NC -- NC
Lung/Bronchus	15	16.8	89	50 -- 147	11	9.2	120	60 -- 214	4	7.6	NC	NC -- NC
Melanoma	1	2.9	NC	NC -- NC	1	1.6	NC	NC -- NC	0	1.4	NC	NC -- NC
Non-Hodgkin Lymphoma	6	4.5	133	49 -- 290	3	2.2	NC	NC -- NC	3	2.4	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7D

Cancer Incidence

Census Tract 6510.02, New Bedford, Massachusetts

1997-2001

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	1	3.8	NC	NC -- NC	0	2.6	NC	NC -- NC	1	1.3	NC	NC -- NC
Breast	14	19.6	72	39 -- 120	0	0.1	NC	NC -- NC	14	19.4	72	39 -- 121
Colon/Rectum	11	15.7	70	35 -- 125	8	6.7	119	51 -- 235	3	9	NC	NC -- NC
Gallbladder	0	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.3	NC	NC -- NC
Liver / IBD	2	1.1	NC	NC -- NC	1	0.7	NC	NC -- NC	1	0.4	NC	NC -- NC
Lung/Bronchus	21	17.6	119	74 -- 182	8	8.4	96	41 -- 188	13	9.3	140	75 -- 240
Melanoma	3	3.7	NC	NC -- NC	1	1.9	NC	NC -- NC	2	1.8	NC	NC -- NC
Non-Hodgkin Lymphoma	3	4.6	NC	NC -- NC	1	2.1	NC	NC -- NC	2	2.5	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 7E

Cancer Incidence

Census Tract 6510.02, New Bedford, Massachusetts

2002-2006

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	1	2.9	NC	NC -- NC	1	1.9	NC	NC -- NC	0	1	NC	NC -- NC
Breast	15	18.1	83	46 -- 137	0	0.1	NC	NC -- NC	15	18.0	83	47 -- 138
Colon/Rectum	18	13.8	130	77 -- 206	5	5.9	85	27 -- 198	13	7.9	164	87 -- 280
Gallbladder	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	2	1.4	NC	NC -- NC	2	0.9	NC	NC -- NC	0	0.5	NC	NC -- NC
Lung/Bronchus	18	17.6	102	60 -- 161	6	7.8	77	28 -- 168	12	9.9	122	63 -- 213
Melanoma	4	5	NC	NC -- NC	2	2.5	NC	NC -- NC	2	2.5	NC	NC -- NC
Non-Hodgkin Lymphoma	6	4.9	123	45 -- 268	3	2.2	NC	NC -- NC	3	2.7	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8A

Cancer Incidence

Census Tract 6509, New Bedford, Massachusetts

1982-1986

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Bladder	2	2.9	NC	NC	NC	0	2.0	NC	NC	NC	2	0.9	NC	NC	NC
Breast	7	10.2	69	28	141	0	0.1	NC	NC	NC	7	10.1	69	28	142
Colon/Rectum	5	10.9	46	15	107	5	5.1	99	32	230	0	5.8	NC	NC	NC
Gallbladder	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.2	NC	NC	NC
Liver / IBD	0	0.3	NC	NC	NC	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC
Lung/Bronchus	9	9.3	97	44	184	7	5.8	120	48	248	2	3.5	NC	NC	NC
Melanoma	0	1.4	NC	NC	NC	0	0.7	NC	NC	NC	0	0.7	NC	NC	NC
Non-Hodgkins Lymphoma	2	2.0	NC	NC	NC	2	0.9	NC	NC	NC	0	1.1	NC	NC	NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8B

Cancer Incidence

Census Tract 6509, New Bedford, Massachusetts

1987-1991

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Bladder	0	2.7	NC	NC	NC	0	2.0	NC	NC	NC	0	0.7	NC	NC	NC
Breast	4	11.1	NC	NC	NC	0	0.1	NC	NC	NC	4	11.0	NC	NC	NC
Colon/Rectum	7	9.9	70	28	145	3	5.1	NC	NC	NC	4	4.9	NC	NC	NC
Gallbladder	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Liver / IBD	0	0.4	NC	NC	NC	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC
Lung/Bronchus	11	9.8	113	56	201	7	5.8	121	48	248	4	4.0	NC	NC	NC
Melanoma	2	1.6	NC	NC	NC	2	0.8	NC	NC	NC	0	0.8	NC	NC	NC
Non-Hodgkin Lymphoma	4	2.3	NC	NC	NC	4	1.1	NC	NC	NC	0	1.1	NC	NC	NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8C

Cancer Incidence

Census Tract 6509, New Bedford, Massachusetts

1992-1996

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Bladder	1	2.3	NC	NC	NC	0	1.7	NC	NC	NC	1	0.6	NC	NC	NC
Breast	8	10.3	77	33	153	0	0.1	NC	NC	NC	8	10.2	78	34	154
Colon/Rectum	6	8.3	72	26	157	1	4.2	NC	NC	NC	5	4.1	122	39	285
Gallbladder	0	0.2	NC	NC	NC	0	0.0	NC	NC	NC	0	0.1	NC	NC	NC
Liver / IBD	0	0.4	NC	NC	NC	0	0.3	NC	NC	NC	0	0.1	NC	NC	NC
Lung/Bronchus	12	9.2	130	67	227	7	5.1	136	55	281	5	4.1	122	39	284
Melanoma	2	1.7	NC	NC	NC	1	0.9	NC	NC	NC	1	0.8	NC	NC	NC
Non-Hodgkin Lymphoma	2	2.5	NC	NC	NC	0	1.3	NC	NC	NC	2	1.2	NC	NC	NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8D

Cancer Incidence

Census Tract 6509, New Bedford, Massachusetts

1997-2001

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Bladder	1	2.0	NC	NC	NC	0	1.5	NC	NC	NC	1	0.6	NC	NC	NC
Breast	4	10.2	NC	NC	NC	0	0.1	NC	NC	NC	4	10.1	NC	NC	NC
Colon/Rectum	9	7.8	116	53	220	4	3.8	NC	NC	NC	5	3.9	127	41	297
Gallbladder	0	0.2	NC	NC	NC	0	0.0	NC	NC	NC	0	0.1	NC	NC	NC
Liver / IBD	1	0.6	NC	NC	NC	1	0.4	NC	NC	NC	0	0.2	NC	NC	NC
Lung/Bronchus	10	9.2	108	52	199	5	4.8	104	33	242	5	4.4	113	37	264
Melanoma	1	2.2	NC	NC	NC	1	1.1	NC	NC	NC	0	1.0	NC	NC	NC
Non-Hodgkin Lymphoma	1	2.5	NC	NC	NC	0	1.2	NC	NC	NC	1	1.3	NC	NC	NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 8E

Cancer Incidence

Census Tract 6509, New Bedford, Massachusetts

2002-2006

Cancer Type	Total					Males					Females				
	Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI		Obs	Exp	SIR	95% CI	
Other Biliary Tract	0	0.2	NC	NC	NC	0	0.1	NC	NC	NC	0	0.1	NC	NC	NC
Bladder	1	1.4	NC	NC	NC	1	1.0	NC	NC	NC	0	0.4	NC	NC	NC
Breast	5	9.3	54	17	125	0	0.1	NC	NC	NC	5	9.3	54	17	126
Colon/Rectum	8	6.6	122	52	239	3	3.2	NC	NC	NC	5	3.4	148	48	346
Gallbladder	0	0.2	NC	NC	NC	0	0.0	NC	NC	NC	0	0.1	NC	NC	NC
Liver / IBD	2	0.7	NC	NC	NC	2	0.5	NC	NC	NC	0	0.2	NC	NC	NC
Lung/Bronchus	12	8.6	139	72	243	7	4.2	166	67	343	5	4.4	113	36	263
Melanoma	0	2.8	NC	NC	NC	0	1.4	NC	NC	NC	0	1.4	NC	NC	NC
Non-Hodgkin Lymphoma	3	2.5	NC	NC	NC	3	1.2	NC	NC	NC	0	1.2	NC	NC	NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9A

Cancer Incidence

Census Tract 6510.01, New Bedford, Massachusetts

1982-1986

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	4	4.1	NC	NC -- NC	4	2.8	NC	NC -- NC	0	1.3	NC	NC -- NC
Breast	15	13.8	109	61 -- 179	0	0.1	NC	NC -- NC	15	13.7	109	61 -- 180
Colon/Rectum	14	15.8	89	49 -- 149	6	7.1	85	31 -- 184	8	8.7	92	40 -- 182
Gallbladder	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	0	0.4	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	7	12.8	55	22 -- 113	3	8	NC	NC -- NC	4	4.8	NC	NC -- NC
Melanoma	3	1.7	NC	NC -- NC	3	0.8	NC	NC -- NC	0	0.9	NC	NC -- NC
Non-Hodgkin Lymphoma	3	2.6	NC	NC -- NC	0	1.2	NC	NC -- NC	3	1.4	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9B

Cancer Incidence

Census Tract 6510.01, New Bedford, Massachusetts

1987-1991

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	2	4.8	NC	NC -- NC	1	3.3	NC	NC -- NC	1	1.5	NC	NC -- NC
Breast	12	18.7	64	33 -- 112	0	0.1	NC	NC -- NC	12	18.6	65	33 -- 113
Colon/Rectum	17	18.7	91	53 -- 145	6	8.5	70	26 -- 153	11	10.2	108	54 -- 193
Gallbladder	0	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.3	NC	NC -- NC
Liver / IBD	1	0.6	NC	NC -- NC	1	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	18	16.5	109	65 -- 172	11	9.5	116	58 -- 208	7	7	99	40 -- 205
Melanoma	1	2.2	NC	NC -- NC	0	1.1	NC	NC -- NC	1	1.1	NC	NC -- NC
Non-Hodgkin Lymphoma	1	3.7	NC	NC -- NC	1	1.6	NC	NC -- NC	0	2.1	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9C

Cancer Incidence

Census Tract 6510.01, New Bedford, Massachusetts

1992-1996

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	2	4.6	NC	NC -- NC	1	3.1	NC	NC -- NC	1	1.5	NC	NC -- NC
Breast	20	19.1	105	64 -- 162	0	0.2	NC	NC -- NC	20	18.9	106	64 -- 163
Colon/Rectum	28	18	156	* 104 -- 225	12	7.9	152	78 -- 265	16	10	159	91 -- 259
Gallbladder	1	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.3	NC	NC -- NC
Liver / IBD	0	0.8	NC	NC -- NC	0	0.5	NC	NC -- NC	0	0.3	NC	NC -- NC
Lung/Bronchus	20	17.6	114	69 -- 176	10	9.2	108	52 -- 199	10	8.4	120	57 -- 220
Melanoma	1	2.7	NC	NC -- NC	1	1.4	NC	NC -- NC	0	1.3	NC	NC -- NC
Non-Hodgkin Lymphoma	6	4.5	134	49 -- 292	3	2	NC	NC -- NC	3	2.5	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9D

Cancer Incidence

Census Tract 6510.01, New Bedford, Massachusetts

1997-2001

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	1	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC	1	0.2	NC	NC -- NC
Bladder	3	4.6	NC	NC -- NC	3	3.1	NC	NC -- NC	0	1.6	NC	NC -- NC
Breast	20	20.1	99	61 -- 153	1	0.1	NC	NC -- NC	19	20	95	57 -- 148
Colon/Rectum	22	18.7	118	74 -- 178	11	7.8	140	70 -- 251	11	10.9	101	50 -- 181
Gallbladder	0	0.4	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.3	NC	NC -- NC
Liver / IBD	0	1.2	NC	NC -- NC	0	0.7	NC	NC -- NC	0	0.5	NC	NC -- NC
Lung/Bronchus	18	19.9	90	53 -- 143	8	9.5	84	36 -- 165	10	10.4	96	46 -- 177
Melanoma	3	3.7	NC	NC -- NC	3	1.9	NC	NC -- NC	0	1.8	NC	NC -- NC
Non-Hodgkin Lymphoma	4	5	NC	NC -- NC	3	2.2	NC	NC -- NC	1	2.8	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 9E

Cancer Incidence

Census Tract 6510.01, New Bedford, Massachusetts

2002-2006

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	3	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC	3	0.3	NC	NC -- NC
Bladder	3	3.5	NC	NC -- NC	2	2.3	NC	NC -- NC	1	1.2	NC	NC -- NC
Breast	16	17.7	90	52 -- 147	0	0.2	NC	NC -- NC	16	17.5	91	52 -- 148
Colon/Rectum	11	16	69	34 -- 123	7	6.7	104	42 -- 214	4	9.2	NC	NC -- NC
Gallbladder	1	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.3	NC	NC -- NC
Liver / IBD	3	1.4	NC	NC -- NC	2	0.9	NC	NC -- NC	1	0.5	NC	NC -- NC
Lung/Bronchus	25	19.9	126	81 -- 186	11	8.9	123	61 -- 220	14	10.9	128	70 -- 215
Melanoma	2	4.9	NC	NC -- NC	1	2.6	NC	NC -- NC	1	2.3	NC	NC -- NC
Non-Hodgkin Lymphoma	7	5.2	134	54 -- 275	3	2.3	NC	NC -- NC	4	2.9	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10A

Cancer Incidence

Census Tract 6511, New Bedford, Massachusetts

1982-1986

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	5	3.9	127	41 -- 296	4	2.8	NC	NC -- NC	1	1.1	NC	NC -- NC
Breast	9	13.8	65	30 -- 124	0	0.1	NC	NC -- NC	9	13.7	66	30 -- 125
Colon/Rectum	10	14.7	68	33 -- 125	4	7.1	NC	NC -- NC	6	7.6	79	29 -- 172
Gallbladder	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	0	0.4	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	13	12.9	101	54 -- 172	8	8.1	98	42 -- 194	5	4.8	105	34 -- 244
Melanoma	0	2	NC	NC -- NC	0	1	NC	NC -- NC	0	1	NC	NC -- NC
Non-Hodgkin Lymphoma	1	2.7	NC	NC -- NC	0	1.3	NC	NC -- NC	1	1.4	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10B

Cancer Incidence

Census Tract 6511, New Bedford, Massachusetts

1987-1991

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	2	3.7	NC	NC -- NC	2	2.6	NC	NC -- NC	0	1.1	NC	NC -- NC
Breast	9	15.9	57	26 -- 108	0	0.1	NC	NC -- NC	9	15.8	57	26 -- 108
Colon/Rectum	18	14.1	128	76 -- 202	6	6.7	90	33 -- 196	12	7.4	163	84 -- 284
Gallbladder	1	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.2	NC	NC -- NC
Liver / IBD	1	0.5	NC	NC -- NC	1	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	14	13.6	103	56 -- 173	7	7.8	90	36 -- 186	7	5.8	120	48 -- 248
Melanoma	1	2.2	NC	NC -- NC	1	1.1	NC	NC -- NC	0	1.1	NC	NC -- NC
Non-Hodgkin Lymphoma	2	3.3	NC	NC -- NC	0	1.6	NC	NC -- NC	2	1.7	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10C

Cancer Incidence

Census Tract 6511, New Bedford, Massachusetts

1992-1996

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Bladder	3	3.2	NC	NC -- NC	3	2.3	NC	NC -- NC	0	1	NC	NC -- NC
Breast	16	15.2	105	60 -- 171	0	0.1	NC	NC -- NC	16	15	106	61 -- 173
Colon/Rectum	11	12.2	90	45 -- 162	4	5.8	NC	NC -- NC	7	6.4	110	44 -- 227
Gallbladder	1	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.2	NC	NC -- NC
Liver / IBD	1	0.6	NC	NC -- NC	0	0.4	NC	NC -- NC	1	0.2	NC	NC -- NC
Lung/Bronchus	20	13.5	148	91 -- 229	12	7.2	167	86 -- 291	8	6.3	127	55 -- 251
Melanoma	1	2.5	NC	NC -- NC	0	1.3	NC	NC -- NC	1	1.2	NC	NC -- NC
Non-Hodgkin Lymphoma	5	3.7	137	44 -- 319	4	1.8	NC	NC -- NC	1	1.8	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10D

Cancer Incidence

Census Tract 6511, New Bedford, Massachusetts

1997-2001

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Bladder	1	3	NC	NC -- NC	0	2.1	NC	NC -- NC	1	0.9	NC	NC -- NC
Breast	7	15.4	45 *	18 -- 94	0	0.1	NC	NC -- NC	7	15.3	46 *	18 -- 94
Colon/Rectum	16	11.7	137	78 -- 223	7	5.7	124	50 -- 255	9	6	150	68 -- 284
Gallbladder	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	4	0.9	NC	NC -- NC	2	0.6	NC	NC -- NC	2	0.3	NC	NC -- NC
Lung/Bronchus	17	14.1	120	70 -- 193	9	7.3	124	57 -- 235	8	6.9	117	50 -- 230
Melanoma	1	3.3	NC	NC -- NC	0	1.7	NC	NC -- NC	1	1.5	NC	NC -- NC
Non-Hodgkin Lymphoma	1	3.7	NC	NC -- NC	1	1.9	NC	NC -- NC	0	1.9	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 10E

Cancer Incidence

Census Tract 6511, New Bedford, Massachusetts

2002-2006

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.4	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.2	NC	NC -- NC
Bladder	4	2.3	NC	NC -- NC	4	1.6	NC	NC -- NC	0	0.7	NC	NC -- NC
Breast	6	14.8	41	* 15 -- 88	0	0.1	NC	NC -- NC	6	14.7	41	* 15 -- 89
Colon/Rectum	11	10.7	103	51 -- 185	5	5.3	95	31 -- 222	6	5.4	111	41 -- 242
Gallbladder	1	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.2	NC	NC -- NC
Liver / IBD	1	1.2	NC	NC -- NC	0	0.9	NC	NC -- NC	1	0.3	NC	NC -- NC
Lung/Bronchus	8	14.2	56	24 -- 111	6	6.9	86	31 -- 188	2	7.3	NC	NC -- NC
Melanoma	2	4.5	NC	NC -- NC	0	2.4	NC	NC -- NC	2	2.2	NC	NC -- NC
Non-Hodgkin Lymphoma	2	4.0	NC	NC -- NC	1	2.1	NC	NC -- NC	1	2.0	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11A

Cancer Incidence

Census Tract 6515, New Bedford, Massachusetts

1982-1986

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Bladder	2	3.1	NC	NC -- NC	2	2.2	NC	NC -- NC	0	0.9	NC	NC -- NC
Breast	16	10.8	147	85 -- 241	0	0.1	NC	NC -- NC	16	10.7	149	85 -- 242
Colon/Rectum	10	11.7	86	41 -- 158	3	5.5	NC	NC -- NC	7	6.2	114	46 -- 234
Gallbladder	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.2	NC	NC -- NC
Liver / IBD	0	0.3	NC	NC -- NC	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC
Lung/Bronchus	6	9.7	62	23 -- 135	5	6.2	81	26 -- 190	1	3.5	NC	NC -- NC
Melanoma	1	1.5	NC	NC -- NC	1	0.7	NC	NC -- NC	0	0.8	NC	NC -- NC
Non-Hodgkin Lymphoma	0	2.1	NC	NC -- NC	0	1.0	NC	NC -- NC	0	1.1	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11B

Cancer Incidence

Census Tract 6515, New Bedford, Massachusetts

1987-1991

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	1	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.1	NC	NC -- NC
Bladder	1	3.0	NC	NC -- NC	1	2.2	NC	NC -- NC	0	0.8	NC	NC -- NC
Breast	7	11.8	59	24 -- 122	0	0.1	NC	NC -- NC	7	11.8	60	24 -- 123
Colon/Rectum	14	11.0	128	70 -- 214	8	5.6	142	61 -- 280	6	5.3	113	42 -- 245
Gallbladder	1	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.1	NC	NC -- NC
Liver / IBD	0	0.4	NC	NC -- NC	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC
Lung/Bronchus	9	10.2	88	40 -- 167	5	6.3	79	26 -- 185	4	3.9	NC	NC -- NC
Melanoma	0	1.7	NC	NC -- NC	0	0.9	NC	NC -- NC	0	0.8	NC	NC -- NC
Non-Hodgkin Lymphoma	3	2.5	NC	NC -- NC	1	1.3	NC	NC -- NC	2	1.2	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11C

Cancer Incidence

Census Tract 6515, New Bedford, Massachusetts

1992-1996

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	1	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	1	0.1	NC	NC -- NC
Bladder	2	2.5	NC	NC -- NC	1	1.8	NC	NC -- NC	1	0.7	NC	NC -- NC
Breast	9	11.5	78	36 -- 148	0	0.1	NC	NC -- NC	9	11.4	79	36 -- 149
Colon/Rectum	10	9.3	108	52 -- 198	4	4.7	NC	NC -- NC	6	4.6	131	48 -- 286
Gallbladder	0	0.2	NC	NC -- NC	0	0.0	NC	NC -- NC	0	0.1	NC	NC -- NC
Liver / IBD	1	0.5	NC	NC -- NC	1	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC
Lung/Bronchus	10	10.1	99	47 -- 182	5	5.7	87	28 -- 203	5	4.3	115	37 -- 269
Melanoma	0	1.9	NC	NC -- NC	0	1.0	NC	NC -- NC	0	0.9	NC	NC -- NC
Non-Hodgkin Lymphoma	1	2.8	NC	NC -- NC	1	1.5	NC	NC -- NC	0	1.3	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11D

Cancer Incidence

Census Tract 6515, New Bedford, Massachusetts

1997-2001

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Bladder	2	2.2	NC	NC -- NC	1	1.6	NC	NC -- NC	1	0.6	NC	NC -- NC
Breast	12	12.0	100	51 -- 174	0	0.1	NC	NC -- NC	12	12.0	100	52 -- 175
Colon/Rectum	10	8.7	114	55 -- 210	6	4.2	142	52 -- 308	4	4.5	NC	NC -- NC
Gallbladder	0	0.2	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Liver / IBD	2	0.7	NC	NC -- NC	2	0.5	NC	NC -- NC	0	0.2	NC	NC -- NC
Lung/Bronchus	11	10.6	104	52 -- 186	7	5.4	129	52 -- 266	4	5.2	NC	NC -- NC
Melanoma	1	2.5	NC	NC -- NC	1	1.3	NC	NC -- NC	0	1.2	NC	NC -- NC
Non-Hodgkin Lymphoma	8	2.8	283	* 122 -- 559	4	1.4	NC	NC -- NC	4	1.4	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

TABLE 11E

Cancer Incidence

Census Tract 6515, New Bedford, Massachusetts

2002-2006

Cancer Type	Total				Males				Females			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Other Biliary Tract	0	0.3	NC	NC -- NC	0	0.1	NC	NC -- NC	0	0.1	NC	NC -- NC
Bladder	2	1.7	NC	NC -- NC	1	1.2	NC	NC -- NC	1	0.5	NC	NC -- NC
Breast	11	11.8	93	47 -- 167	0	0.1	NC	NC -- NC	11	11.7	94	47 -- 169
Colon/Rectum	15	8.1	184	* 103 -- 304	6	4.0	152	55 -- 330	9	4.2	215	98 -- 408
Gallbladder	1	0.2	NC	NC -- NC	0	0.0	NC	NC -- NC	1	0.1	NC	NC -- NC
Liver / IBD	1	0.9	NC	NC -- NC	1	0.7	NC	NC -- NC	0	0.3	NC	NC -- NC
Lung/Bronchus	10	10.9	92	44 -- 168	8	5.2	153	66 -- 301	2	5.7	NC	NC -- NC
Melanoma	1	3.5	NC	NC -- NC	1	1.8	NC	NC -- NC	0	1.7	NC	NC -- NC
Non-Hodgkin Lymphoma	2	3.1	NC	NC -- NC	2	1.5	NC	NC -- NC	0	1.5	NC	NC -- NC

Note: SIRs are calculated based on the exact number of expected diagnoses.
Expected number of diagnoses presented are rounded to the nearest tenth.
SIRs and 95% CIs are not calculated when the observed number is < 5.

Obs = Observed number of diagnoses
Exp = Expected number of diagnoses
SIR = Standardized Incidence Ratio
95% CI = 95% Confidence Interval
NC = Not calculated
* = Statistical significance

Data Source: Massachusetts Cancer Registry, Bureau of Health Information, Statistics, Research and Evaluation, Massachusetts Department of Public Health.

APPENDICES

Appendix A

New Bedford Blood Serum PCB Testing Program: PCB Serum Analysis Consent Forms

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health
250 Washington Street, Boston, MA 02108-4619
Phone: 617-624-5757 Fax: 617-624-5777
TTY: 617-624-5286

AN EVALUATION OF POTENTIAL PCB EXPOSURE AT NEW BEDFORD HIGH SCHOOL, KEITH MIDDLE SCHOOL AND SURROUNDING NEIGHBORHOOD, NEW BEDFORD, MA

ADULT CONSENT FORM FOR PARTICIPANT INTERVIEW

Purpose: The Massachusetts Department of Public Health (MDPH) is offering to administer an exposure assessment questionnaire to school administration, faculty and staff as well as to surrounding residents of the New Bedford High School and Keith Middle School who are concerned about exposure to polychlorinated biphenyls (PCBs). PCB blood serum testing will be offered to individuals who are determined to have the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood. The serum PCB results will allow MDPH to assess the magnitude of PCB exposure among participants and to address the concerns of the community. You have requested to participate in this effort.

Procedure: Your participation in the interview stage of this evaluation is voluntary and you may withdraw at any time. If you participate in the interview stage of this evaluation, you will be asked to give approximately 45 minutes of your time to respond to an interview by the Massachusetts Department of Public Health. Interviewers will ask questions regarding your residential history, occupational history, affiliation with the two schools, dietary consumption and personal contact information. These questions will be used to identify individuals with the greatest potential for exposure to PCBs.

Risks: There are no risks involved in participating in the interview stage of this evaluation.

Benefits: There are no direct benefits to you for participating in the interview phase of this evaluation other than learning more about your opportunities for exposure to PCBs. Your participation may lead to your being contacted to provide a blood sample for serum PCB analysis. Only individuals identified through this interview as having the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood will be contacted to participate in the measurement of serum PCB levels in the blood.

Alternatives: This evaluation is being conducted by the Massachusetts Department of Public Health as a public health service to the community of New Bedford, MA. You may choose not to participate in this evaluation.

Payment for Participation: You will not receive payment for your time or participation in this evaluation.

No Additional Costs: There will be no financial charge to you for your participation in this evaluation.

Confidentiality: Every effort will be made to maintain participant confidentiality. The Commissioner of the Massachusetts Department of Public Health has approved this study under the provisions outlined in M.G.L. c. 111, s. 24A, which protects the confidentiality of all information collected as part of this evaluation. Under the provisions of that statute, the Department and all of its employees and agents involved in the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* are prohibited from releasing any individually identifying information provided by you. Furthermore, Section 24A prohibits the disclosure or release through a public records request, court subpoena or any other legal process, of any personal or medical information you provide. Your information will be assigned a random identification number and all personally identifying data will be kept in locked storage files.

I have read the description of this evaluation or have had it explained to me. I have been informed of the risks and benefits involved and all of my questions have been answered to my satisfaction. I will receive a copy of this consent form.

I understand that I am free to withdraw this consent and discontinue participation in this evaluation at any time.

I voluntarily consent to participate in the interview phase of the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* with the Massachusetts Department of Public Health.

Signature of Participant Print Name Date

In addition, I agree to be re-contacted if I am selected to participate in the PCB blood serum testing phase of this evaluation.

Yes ☐ No ☐ Initial _____

Signature of Interviewer Print Name Date

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health
250 Washington Street, Boston, MA 02108-4619
Phone: 617-624-5757 Fax: 617-624-5777
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DEVAL L. PATRICK
GOVERNOR

TIMOTHY P. MURRAY
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JUDYANN BIGBY, M.D.
SECRETARY

JOHN AUERBACH
COMMISSIONER

AN EVALUATION OF POTENTIAL PCB EXPOSURE AT NEW BEDFORD HIGH SCHOOL, KEITH MIDDLE SCHOOL AND SURROUNDING NEIGHBORHOOD, NEW BEDFORD, MA

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

Purpose: The Massachusetts Department of Public Health (MDPH) is offering polychlorinated biphenyl (PCB) serum testing as a public service to select school administration, faculty and staff as well as to surrounding residents of the New Bedford High School and Keith Middle School. Blood testing for serum PCB analysis is being offered to select individuals, identified in the interview stage of the evaluation, who are determined to have the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood. Blood testing for serum PCB analysis is also being offered as a public service to other participants interviewed. The serum PCB results will allow MDPH to assess the magnitude of PCB exposure among study participants, which may help guide future activities at the two school sites as well as to address the concerns of the community. You have requested to participate in this effort.

Procedure: Your participation in the blood testing phase of this evaluation is voluntary and you may withdraw at any time. If you participate in this stage of the evaluation, a blood sample will be taken to determine the level of PCBs in your blood. The blood will be taken from a vein in your arm and will require the use of a hypodermic needle and vacutainer. Approximately 20 ml of blood will be drawn. Your blood sample will be tested for PCBs and lipids. PCB results are reported on a lipid-adjusted basis because PCBs tend to concentrate in lipid (fatty) tissue. The sample will be destroyed after the analysis and quality control measures are completed. MDPH staff will administer a short questionnaire (approximately 5 to 10 minutes) at the time of the blood draw. The purpose of the questionnaire is to collect important information that may be associated with an individual's PCB exposure and that may help with the interpretation of the results.

Risks: The blood collection procedure usually involves little pain or discomfort, but occasionally some discomfort may occur after the blood sample is obtained. Other risks, while unlikely, will be explained by the staff from Favorite Healthcare Staffing, Inc., who will be taking the blood samples.

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

Benefits: By participating in the blood serum testing stage of this evaluation, you will be notified of the results of your PCB blood test after all laboratory testing and quality control measures have been completed. If your test results indicate you have elevated serum PCBs, you understand there is no medical treatment to reduce your current PCB levels. MDPH will however offer to counsel you on behaviors to reduce your risk of future exposure.

Alternatives: This evaluation is being conducted by the Massachusetts Department of Public Health as a public health service to the community of New Bedford, MA. You may choose not to participate in this evaluation.

Payment for Participation: You will not receive payment for your time or participation in this evaluation.

No Additional Costs: There will be no financial charge to you for the blood collection and serum PCB analysis.

Confidentiality: Every effort will be made to maintain participant confidentiality. The Commissioner of the Massachusetts Department of Public Health has approved this study under the provisions outlined in M.G.L. c. 111, s. 24A, which protects the confidentiality of all information collected as part of this evaluation. Under the provisions of that statute, the Department and all of its employees and agents involved in the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* are prohibited from releasing any individually identifying information provided by you. Furthermore, Section 24A prohibits the disclosure or release through a public records request, court subpoena or any other legal process, of any personal or medical information you provide. Your information will be assigned a random identification number and all personally identifying data will be kept in locked storage files.

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

I have read the description of this evaluation or have had it explained to me. I have been informed of the risks and benefits involved and all of my questions have been answered to my satisfaction. I will receive a copy of this consent form.

I understand that I am free to withdraw this consent and discontinue participation in this evaluation at any time.

I voluntarily consent to participate in the PCB blood serum testing phase of the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* with the Massachusetts Department of Public Health.

Signature of Participant	Print Name	Date

Signature of Interviewer	Print Name	Date

Appendix B

New Bedford Blood Serum PCB Testing Program: Questions & Answers

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health
250 Washington Street, Boston, MA 02108-4619
Phone: 617-624-5757 Fax: 617-624-5777
TTY: 617-624-5286

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SECRETARY

JOHN AUERBACH
COMMISSIONER

Questions and Answers

New Bedford Blood Serum PCB Testing Program
New Bedford High School/ Keith Middle School and Neighborhood Surrounding the Schools

1. Who will analyze my blood sample for PCBs?

The Environmental Chemistry Lab at the Massachusetts Department of Public Health's (MDPH) William A. Hinton State Laboratory Institute will analyze the samples for PCBs and MDPH's Lemuel Shattuck Hospital will analyze the samples for lipids. Lipid adjustment is important because PCBs tend to concentrate in lipid (fatty) tissue.

2. When will I obtain the results of my blood test for PCBs?

Once blood sample results have been analyzed, those who gave blood samples will be sent individual letters with only their own serum PCB results. According to the State Laboratory Institute, all of the analyses will be completed by December 2009. However, MDPH will be reviewing results as they are analyzed and if an individual's serum PCB level raises any immediate health concerns, they will be contacted immediately. A final report summarizing the results of all blood samples analyzed will be prepared; however, it will not identify any individual's results.

3. How will the blood test results be evaluated?

Your results will be compared to Centers for Disease Control (CDC) National Health and Nutrition Examination Survey (NHANES) biomonitoring data for the civilian U.S. population for the period 2003-2004. NHANES is a nationally representative survey and these data provide health professionals with a reference range so that they can determine if any specific individuals have been exposed to higher levels of PCBs than the general U.S. population. Most people in the U.S. have low but detectable levels of PCBs in their serum due to diet or the general environment.

4. If I have questions, who should I contact?

You can call the MDPH Bureau of Environmental Health, Community Assessment Program at 617-624-5757 if you have additional questions.

Appendix C

ICD Codes for Selected Cancer Types

ICD CODES FOR SELECTED CANCER TYPES IN THIS REPORT

Cancer Site / Type	ICD-O-3[1]	
	Primary Site Codes	**Histology Type Codes[2]**
Other Biliary Tract	C24.0 – C24.9	all except 9590 - 9989
Urinary Bladder	C67.0 - C67.9	all except 9590 - 9989
Breast	C50.0 - C50.9	all except 9590 - 9989
Colon/Rectum	C18.0 - C18.9, C19.9, C20.9, C26.0	all except 9590 - 9989
Gallbladder	C23.9	all except 9590 - 9989
Liver and Intrahepatic Bile Ducts	C22.0, C22.1	all except 9590 - 9989
Lung/Bronchus	C34.0 - C34.9	all except 9590 - 9989
Melanoma of Skin	C44.0 - C44.9	includes 8720 - 8790
Non-Hodgkin Lymphoma	C00.0 - C80.9 all sites except C42.0, C42.1, C42.4	includes 9590 - 9595, 9670 – 9729 includes 9823, 9827

[1] *International Classification of Diseases for Oncology, 3d Ed.* (2) (includes codes added since publication)

[2] Only invasive cancers (those with invasive behaviors) are included in this report.

Appendix D

Response to Public Comments

Response to Public Comments on

Public Comment Release, Evaluation of Serum PCB Levels and Cancer Incidence Data, Parker Street Waste Site Neighborhood

RESPONSE TO COMMENTS INTRODUCTION

The PSWS neighborhood report was released as a public comment draft on September 28, 2011 and a 6-week comment period was established (e.g., through November 9, 2011). Comments were received from EPA's Technical Assistance Services for Communities (TASC) program on behalf of Citizens Leading Environmental Action Network Inc. (CLEAN) (n=35) and Dr. Robert Herrick, ScD, CIH, of the Harvard School of Public Health's Department of Environmental Health (n=2). Comments that were similar in nature were grouped together for response.

In addition to responding to comments to this report, where appropriate, MDPH made changes to the report to improve clarity or provide more information based on general comments made to the BEH report entitled *Health Consultation: Evaluation of Indoor Environmental Conditions and Potential Health Impacts, New Bedford High School, 230 Hathaway Boulevard, New Bedford, MA.* Examples of the types of changes made include:

- Addition of a glossary
- Language describing MDPH's qualitative evaluation of PCB congener patterns

GENERAL COMMENTS

Comment: "the comprehensibility of the report would be greatly improved by: (i) the addition of a clearly written executive summary, (ii) a glossary defining key scientific and technical terms (e.g., 95% confidence interval, congeners, SIRs), (iii) a section giving the basis for the various agency guidance values used in the report (e.g., whether the guidance values are health-based or technology-based), and (iv) clear graphics summarizing the biomonitoring data and providing comparative values such as the NHANES median values."

Response: To address this comment, an executive summary, a glossary, and graphs (Figures 4 through 11) have been added to the report.

It should be noted that this exact comment was made regarding MDPH's report evaluating the indoor environment at New Bedford High School (NBHS). Section iii of this comment refers to agency guideline values that appear in the NBHS report for comparison with indoor environmental samples, such as guidelines provided by the Agency for Toxic Substances & Disease Registry (ATSDR). This report does not include a similar evaluation, thus no changes were made to this report.

III. PCB SERUM TESTING

A. Methods

Comments: "Documentation is not provided to justify that methods used by the MDPH's William A. Hinton State Laboratory Institute (SLI) Division of Analytical Chemistry and methods used by the CDC produce comparable results. CLEAN may want to ask MDPH if this documentation is available for review." "Pg 5, last paragraph: In order to compare analytical results between laboratories, it is essential that the labs demonstrate that they can produce comparable results. It is unclear what is meant by SLI using "a congener-specific method similar to the methods used by the U.S. CDC...". The method used should be defined and the QA/QC process described. Evidence that the lab can produce comparable results to CDC (e.g., participation in round robin, etc.) should be provided."

Response: The phrase "a congener-specific method" refers to a laboratory method that analyzes for individual PCB congeners. PCBs refer to a class of chemical compounds with 209 possible congeners in which chlorine atoms have replaced some or all of the hydrogen atoms in the biphenyl molecule.

The following language was added to the Methods section of the report: The method for determination of PCB congeners was developed at CDC and transferred to the SLI. The standard operating procedure (SOP AC.012) for determination of PCB congeners in human serum details a solvent extraction, silica gel clean-up and dual capillary column gas chromatographic analysis with electron capture detection.

Quality assurance measures for the method include the analysis of reagent blanks that are monitored for contamination and subtracted from the samples in each run; the analysis of fortified serum samples, the results of which are plotted on lot & instrument specific quality control charts for review to determine compliance with acceptance criteria for the batch; and individual sample fortification with surrogate analytes that are evaluated for compliance with acceptable recovery criteria. Other batch specific controls include criteria for the calibration curve and internal standard recovery.

Comments: "It is unclear in the health consultation report how PCB levels below the limit of detection were handled. CDC assigns a value greater than zero to "nondetect" results. CLEAN may want to ask if this study used the same method as the CDC for handling PCB levels below the limit of detection." "Table 1 and throughout: It is absolutely essential that the report clarify how PCB levels below the limit of detection were handled. CDC assigns a value of LOD/sq rt 2. The method used for the New Bedford study would have to be the same in order to compare summed PCB levels." "Table 4: Same issue as noted previously regarding method for assigning values for measurements below the limit of detection."

Response: The following language was added to the PCB Serum Sampling Methods section of the report: To calculate total PCB concentrations, as well as summary statistics such as geometric means and percentiles, CDC assigns sample results that were not detected above the method's limit of detection (LOD) a value equal to the LOD divided by square root of 2. New Bedford participants' individual serum PCB results, as well as summary statistics (e.g., geometric means and percentiles) were calculated using this method to be comparable to CDC summary data.

Comment: A number of comments suggest that, to be consistent with the Patterson paper that reports CDC's summary of the results of the NHANES serum PCB analyses, MDPH should sum dioxin-like congeners detected in serum samples separately (Patterson 2009).

Response: MDPH's evaluation of New Bedford participants' serum PCB levels was conducted in a manner that was consistent with the goal of the serum PCB testing offer; to determine if residents in the neighborhood of the PSWS had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S. population.

New Bedford results were compared with the sum of the 15 most commonly detected congeners from NHANES 2003-2004 as provided to MDPH by CDC for this purpose. A total PCB concentration was calculated for each of the New Bedford participants by summing the concentrations of the 15 most commonly detected congeners following NHANES methodology. These congeners also include a sub-set of the dioxin-like congeners (e.g., 105, 118, and 156). Thus, the approach used by MDPH to calculate total PCB concentrations is consistent with CDC's approach and no revision was made to the report.

Comments: "Pg 6: The information on this page will be extremely difficult for anyone not well-versed in PCB terminology to interpret. If the reader was to turn to the publicly-available information in the CDC report, they would not find the summed concentrations of the congeners, but rather find tables for each individual congener. No congener-specific data are given in the report to justify the selection of the 15 congeners listed." "Pg 8, section 3: The report should clarify the source of the summed NHANES data. The community will not be able to find summed data in the National Exposure Report as data are congener-specific (not summed). I was unable to find the summed values provided in the Health Consultation in Patterson et al."

Response: In previous MDPH serum PCB blood sampling efforts, CDC had advised that the most appropriate way to compare the data is to take the most common 15 congeners identified in NHANES that were also identified in participants and compare those congeners.

New Bedford results were compared with the sum of the 15 most commonly detected congeners from NHANES 2003-2004. These NHANES summary statistics were provided to MDPH by CDC to aid in the interpretation of serum PCB results. No revision was made to the report.

B. Results and Discussion

Comments: "Pg 7, last paragraph: The description of which residents were included in this report versus the separate report is confusing."

Response: MDPH revised this paragraph as follows: Out of the 91 participants that consented to and submitted blood samples, 42 individuals were current or former residents in the neighborhood around the PSWS and three others reported that they had spent a significant amount of time at the PSWS (Figure 4). Participants are included in this report if, at the time of the exposure assessment interview, they were among the 42 individuals living in the neighborhood around the PSWS. In addition, three other individuals that were not residents, but reported spending a significant amount of time at the PSWS were included, for a total of 45 participants in the evaluation of PCB serum analyzed in relation to outdoor PCB exposure concerns. As mentioned earlier, results for individuals that reported working at NBHS, KMS, or the former KMS (including some current and former residents in the neighborhood around the PSWS) are included in the separate MDPH report. Results for individuals that lived in the neighborhood around the PSWS and worked at the school are included in both reports.

Comments: "The question I would like to raise is on the method limits of detection for the SLI measurements of serum PCB. Page 8 of the report states that no PCBs were detected in the serum of the participants aged 12-19 and 20-29. What was the limit of detection for these measurements, was it comparable to the CDC lab that did the analysis for the NHANES?" "The report should include detection limits for each congener and compare these to CDC's detection limits. This is especially critical for congeners with a large number of measurements below the limit of detection."

Response: The MDPH/SLI limits of detection are not as sensitive as those employed by CDC. For that reason MDPH asked CDC to evaluate the comparability of SLI's results to CDC's. CDC analyzed a subset of the serum samples (split samples). CDC analyzed 10 split samples out of the 91 samples collected (>10% of samples collected). Both the SLI and CDC results are presented in the table below. A comparison of the split sample

results indicates that in all cases SLI results were higher than the corresponding CDC results by between 0.176 – 0.908 ppb. SLI's results are higher due in part to higher detection limits. To calculate total PCB concentrations, CDC assigns sample results that were not detected above the method's limit of detection (LOD) a value equal to the LOD divided by square root of 2. New Bedford participants' individual serum PCB results were calculated using this method to be comparable to CDC's NHANES data. The results reported by SLI slightly over-estimate total PCB concentrations. Thus, comparing SLI results to NHANES would tend to overestimate any differences between the New Bedford results and the levels observed in the general U.S. population.

Total PCBs Split Sample Results (ppb; Whole Weight)

No.	SLI	CDC	Difference
1	4.329	4.153	0.176
4	1.276	1.002	0.274
2	1.843	1.568	0.276
3	7.742	7.463	0.279
6	2.469	2.129	0.340
7	2.911	2.545	0.366
5	1.376	0.957	0.418
8	1.053	0.546	0.507
9	0.879	0.310	0.569
10	2.224	1.318	0.907

Notes:

* Total PCBs were calculated by summing the 15 most commonly detected congeners. If a congener was not detected it was assumed to be equal to the limit of detection divided by the square root of 2. Both CDC and MDPH use this method.

CDC = U.S. Centers for Disease Control, National Center for Environmental Health, Division of Laboratory Science
Difference = SLI result (ppb) - CDC result (ppb)
No. = Number
SLI = Massachusetts Department of Public Health William A. Hinton State Laboratory

The goal of the serum PCB testing offer was to determine if residents in the neighborhood of the PSWS had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S.

population and to determine whether any patterns emerged that suggested exposures during a particular time and or in a particular area on or near the PSWS. MDPH's overestimating of participant levels would tend to exaggerate differences where the participant results exceeded typical values for the general population; therefore, MDPH's approach was health protective because any exceedances would be noted and reported as such. No revision was made to the report.

Comments: "Pg 9, section 5, first paragraph: Why is the language "median/50th %" used here and throughout? One term should be selected and defined." "Pg 10, section 7: This section is difficult to understand. Why switch from medians to means to geometric means? How is the community to interpret this?"

Response: The term 50th percentile was used because the report also discusses the 95th percentile, based on NHANES terminology; however, the term median, which is the same as 50th percentile, is more familiar to most people, and hence MDPH used both terms for clarity.

The median serum PCB levels for each age group were calculated for comparison to NHANES median levels used to characterize a population. Geometric means (another statistic used by NHANES for comparison purposes) were calculated by MDPH to compare different groups (e.g., comparisons of serum PCBs levels based on years of residency). According to CDC, a geometric mean provides a better estimate of central tendency than the arithmetic mean for data that are distributed with a long tail at the upper end of the distribution. This type of distribution is common in the measurement of environmental chemicals in blood or urine. No other averaging statistic (e.g., arithmetic mean) was used in the evaluation of serum PCB results. No revision was made to the report.

Comments: "It is not clear why the report states that those with serum PCB levels within the 95th percentile are within "typical" variation in the US population. Why is being in the 95th percentile "typical" or "usual" when only 5% of the population had higher levels? The report would be more objective if it simply noted where along the spectrum of national data the New Bedford residents blood levels are; this could be most clearly

shown in a graphic." "Pg 37, 1st paragraph: I disagree that if a serum PCB level is below the 95th % that this is "typical." It would be more objective to simply note that the levels observed for 42 of the participants were below the 95th % and three were above. The actual data for individuals in NHANES are accessible and the serum data for the individuals with the highest levels could be obtained."

Response: As mentioned in the report, the NHANES survey is designed to provide biomonitoring data that is representative of the general U.S. population.

Figures 6 and 7 were added illustrating summary statistics of serum PCB levels for the New Bedford participants and NHANES 2003-2004. Also, the following language was added to the Methods section of the report: Due to differences among individuals, you would expect to see a range of serum PCB levels in the general population. The range of concentrations reported by NHANES provides health professionals with information on the degree of variation that can be expected in the general population. According to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Based on this guidance from CDC, an individual with serum concentrations above the 50th percentile but below the 95th percentile is within the typical level of variation seen in the general U.S. population. Thus, MDPH used the 95th percentile value for comparison with the participants' serum PCB results.

Comments: The actual data for individuals in NHANES are accessible and the serum data for the individuals with the highest levels could be obtained. It would be of interest to determine whether the three New Bedford participants had levels higher than the highest NHANES levels."

Response: MDPH contacted CDC regarding this question. According to CDC the New Bedford participants did not have levels exceeding the maximum NHANES values or the NHANES 99th percentile values for their age groups. No revision was made to the report.

Comments: "Pg 10, 2nd paragraph: The data for the residents are not given and so there is no way to compare the data to the NHANES data. Please check the other sections of the report, as this is not the only section where serum data were not provided."

Response: MDPH corrected this error in the report. The following language was added to the section entitled *5) Serum PCB Levels Measured in Participants 40-59 Years Old* (existing language in italics): The 95th percentile serum PCB level for participants in this age group is 2.730 ppb (whole weight) and 568.5 ppb (lipid-adjusted). *The NHANES 95th percentile concentration for this age group is 2.780 ppb (whole weight) with a 95% confidence interval of 2.307 ppb to 3.663 ppb and 402.2 ppb (lipid-adjusted) with a 95% confidence interval of 325.1 to 540.2 ppb.* Therefore, the New Bedford participants' 95th percentile serum PCB levels for lipid-adjusted results in this age group are higher than the NHANES 95th percentile for the U.S. population; however, the whole weight results were within the NHANES 95th percentile.

The following language was added to the section entitled *6) Serum PCB Levels Measured in Participants 60+ Years Old* (existing language in italics): The 95th percentile serum PCB level for participants in this age group is 5.015 ppb (whole weight) and 698.0 ppb (lipid-adjusted). *The NHANES 95th percentile concentration for this age group is 5.123 ppb (whole weight) with a 95% confidence interval of 4.131 ppb to 6.556 ppb and 769.4 ppb (lipid-adjusted) with a 95% confidence interval of 600.0 to 1026.5 ppb.* Therefore, the 95th percentile serum PCB levels for the participants, for both whole weight and lipid-adjusted results, are within the respective NHANES 95th percentiles for the U.S. population.

Comments: "Clarify whether or not differences between serum PCB levels in New Bedford residents and the US population are statistically significantly different." "Pg 10, section 7: "…there is no justification given for the mathematical approach to examining the effect of years of residence on serum PCB levels. Why arbitrarily split the group into two components? Given the number of confounding variables, I would not expect to see any useful result using this approach. Why not use a regression to examine the data?"

Response: Serum PCB sampling was offered as a public service to address community concerns about opportunities for exposure to PCBs in the neighborhood

around the PSWS. Thus, the testing offer was not designed as an epidemiological or analytical study, where participation, for example, might have been restricted to randomly selected residents or might have included matched controls; which would have produced a representative sample of the population. Thus it is more appropriate to use CDC methodology to evaluate the results. Consistent with guidance from the CDC, MDPH compared results to the 95th percentile value from the NHANES to determine whether serum PCB levels differ from the typical range observed.

That being said, MDPH was aware that it is important to evaluate any potential relationship between length of residency and serum PCB levels. MDPH took the midpoint (or median) of the range of length of residency to compare serum PCB levels in two groups (less than or equal to the median years of residency versus more than the median years of residency). As noted in the report, these data did not show a consistent pattern of higher serum PCB concentrations with more years of residency, and they suggest that residing near the PSWS was not a primary indicator of serum PCB levels.

Comments: "Pg 11, end of section 7: Here and in other places in the report, it is noted that other factors contribute to a person's serum PCB levels. This is correct. What is confusing is that data on some of the important variables was apparently collected as part of the questionnaire phase of the study. Why were these data not examined? While it can be difficult to use questionnaire data on factors such as fish consumption, why collect these data and not at least attempt to use them?"

Response: An exposure assessment questionnaire was administered to all participants of the blood serum PCB testing offer. The exposure assessment questionnaire was designed to obtain information on risk factors that are known to or may affect serum PCB levels (e.g., age, fish consumption, occupational exposures), as well as information on factors specific to residing near the PSWS, such as years of residency.

The following language was added to the PCB Serum Testing Methods section of the report to address this comment: Information collected by this questionnaire was used to evaluate serum PCB results. In particular, information regarding age, place of residence, and location and length of residency were evaluated in the report. Information

including diet, other occupational exposures, and specific routes of exposure related to the PSWS were also evaluated on an individual level on a case-by-case basis.

Comments: "Pg 12, top: The statement "...serum concentrations for these five individuals diagnosed with cancer are within the typical variation in the US population" should be removed. The implication is that if one is within the range of concentrations observed in the NHANES data, one is not at increased risk for disease. This is most certainly not true. One of the well- documented difficulties with interpreting NHANES data has been in understanding what the serum (or urine) levels mean in terms of health. For only a very few chemicals can we do this type of interpretation. This should be made clear in the report."

Response: MDPH agrees that not enough is known about how serum PCB levels relate to cancer risk; however, the purpose of the section entitled *Serum PCB Levels Measured in Participants Diagnosed with Cancer* is to determine if there is any pattern of higher serum PCB levels in participants diagnosed with cancer and the statement referenced in the above comment simply conveys the results of this evaluation. As stated in the report, more discussion on the incidence of cancer among New Bedford residents is provided in the *Cancer Incidence Analysis* section of the report. No revision was made to the report.

Comments: "Pg 37, 2nd paragraph, end: The report does not appear to include a congener-specific comparison between New Bedford and NHANES so there is no way to corroborate this statement." "In fact, while the report states that it will provide a qualitative comparison of congener patterns in New Bedford residents to the NHANES data, it does not do this. So there is neither a quantitative nor qualitative justification for congener selection in this report."

Response: MDPH added information in the report regarding the qualitative evaluation of congener patterns to the Methods and Results sections of the report and has added example congener pattern graphs to the Figures section of the report (Figures 8 and 9).

The additional language added to the Methods section is as follows: For the qualitative congener pattern evaluation, MDPH visually compared the distribution of percent contribution of the congeners most commonly seen in serum and analyzed by SLI

for all New Bedford participants to the percent contribution of these congeners for all ages from the NHANES data. In addition, a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen.

The additional language in the Results section is as follows: In this report, data have been provided on total PCBs based on summing the most frequently detected 15 congeners. Figure 8 shows the distribution of percent contribution of the 35 congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants. Percent contributions are also provided in Figure 9 for all ages from the NHANES data. The congener patterns observed in New Bedford and NHANES are similar, suggesting similarities with what is found in the U.S. population. In addition, individual congener patterns were reviewed and a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen. CDC identified one individual's congener pattern as atypical and MDPH sent a letter to this individual communicating this information. CDC noted that the congener patterns of the majority of New Bedford participants appeared to be typical, suggesting that exposure in the majority of the New Bedford participants appeared similar to that of the general U.S. population.

IV. CANCER INCIDENCE ANALYSIS

A. Methods

Comments: Pg 12, top: "… it is stated that the five different cancer types are not associated with PCB exposure. Please include the five cancer types. In addition, the "epidemiological literature" should be cited."

Response: MDPH cannot disclose the cancer diagnoses of the five serum PCB testing offer participants due to privacy laws. No revision was made to the report.

Comments: "Pg 12, section IV, second paragraph: What are the nine cancers? Which of these were of concern to the community because of suspected elevations (I don't believe that this is ever spelled out in the report)? These should be listed here."

Response: This section provides an overview of the cancer incidence analysis. In subsequent subsections, more details are provided, including a discussion of the nine types of cancer evaluated. As requested, the nine types of cancer have been added to the introductory discussion on p.15.

"The types of cancer evaluated include the following: cancers of the biliary tract, bladder, breast, colon/rectum, gallbladder, liver/intrahepatic bile duct (IBD), and lung and bronchus as well as melanoma and non-Hodgkin lymphoma. Concerns about the occurrence of cancer in the PSWS neighborhood and the New Bedford High School have been shared by current and former staff at the high school, by PSWS neighbors, and by members of CLEAN. A range of various types of cancer have been mentioned of concern, including some of the cancer types potentially associated with exposure to PCBs (such as breast cancer and non-Hodgkin lymphoma) as well as other types of cancer for which there is no reported association with PCBs (such as cervical and ovarian cancers). For this report, MDPH evaluated those nine types of cancer that have been identified in the medical and epidemiological literature as possibly being associated with exposure to PCBs. If exposure to PCBs at the PSWS has resulted in an increased incidence of cancer in the neighborhood, it is important to focus the evaluation on those types of cancer associated with PCB exposure." (This discussion has been added to the report text.)

Evaluating types of cancer for which no association with PCB exposure has been shown or is suspected would not address the questions raised by New Bedford residents and NBHS employees. As discussed in our report, each type of cancer is its own disease with its own set of risk factors. Grouping all cancers together or including those types of cancer not associated with PCB exposure in the MDPH evaluation would not be informative and would be misleading.

Comments: "Pg 14, top: This discussion is crucial for communicating to the residents why certain cancers were investigated while others were not. Rather than simply giving a list of cancers investigated, the report should describe the weight-of-evidence for association of these cancers with PCB exposure (as is done, for example, in the ATSDR report that is cited). This does not have to be extremely lengthy, but can at least summarize the confidence that the scientific community has in the data. For example, ATSDR calls the

evidence for association between breast cancer and PCB exposure controversial and inconclusive. This kind of information is crucial to interpreting the cancer cluster results."

Response: In ATSDR's Toxicological Profile for Polychlorinated Biphenyls (ATSDR 2000), it summarizes its extensive review of approximately 1,800 human and animal studies that have been conducted to evaluate the potential for exposure to PCBs to cause cancer. It concludes the following:

> "Based on indications of PCB-related cancer at several sites, particularly the liver, biliary tract, intestines, and skin (melanoma), the human studies provide suggestive evidence that PCBs are carcinogenic. There is unequivocal evidence that PCBs are hepatocarcinogenic in animals."

MDPH included these four types of cancer in its evaluation as well as five additional types of cancer for which the evidence of an association with PCB exposure is not as strong. These include: non-Hodgkin lymphoma and breast, lung, gallbladder, and bladder cancers. In addition to reviewing the findings of ATSDR's Toxicological Profile for PCBs, a report of approximately 870 pages, MDPH also reviewed the evaluations of other cancer epidemiology experts on the types of cancer potentially associated with exposure to PCBs, particularly those reported in *Cancer Epidemiology and Prevention,* a comprehensive book on what is known about the risk factors and causes of a wide variety of cancers, including those associated with exposure to PCBs. In *Cancer Epidemiology and Prevention,* the authors report liver and biliary tract cancers as well as melanoma and non-Hodgkin lymphoma as types of cancer with evidence of an association with PCB exposure. As previously stated, MDPH evaluated these four types of cancer in our report. (This information has been added to the report text.)

The body of scientific literature on the carcinogenic potential of PCBs is huge and new studies continue to be published. It is beyond the scope of this report to discuss in detail the scientific weight of the evidence on the carcinogenicity of PCBs by individual cancer type. Rather, MDPH relied on the results of peer review panels and cancer epidemiology experts who have issued scientifically sound assessments on the

epidemiology and carcinogenic potential of PCBs. What is most important to point out is that MDPH evaluated in the New Bedford population nine different types of cancer potentially associated with PCB exposure, including those with the strongest evidence and those with weaker evidence.

Comments: "Pg 16, 2nd paragraph: "Instability" should be defined here. Two paragraphs down, "population structure" should be defined."

Response: The following language was added to the body of the report and glossary to address this comment: Stability in the context of an SIR refers to how the SIR changes when there are small increases or decreases in the observed or expected number of cases. Two SIRs may have the same size but not the same stability. For example, an SIR of 150 may represent 6 observed diagnoses and 4 expected diagnoses, or 600 observed diagnoses and 400 expected diagnoses. (The SIR is the ratio of the number of observed diagnoses to the number of expected diagnoses multiplied by 100. For example, six divided by 4 equals 1.5 as does 600 divided by 400; 1.5 multiplied by 100 equals 150.) Both SIRs represent a 50 percent excess of observed diagnoses. However, in the first instance, one or two fewer diagnoses would change the SIR a great deal, whereas in the second instance, even if there were several fewer diagnoses, the SIR would only change minimally. When the observed and expected numbers of diagnoses are relatively small, their ratio is easily affected by one or two diagnoses. Conversely, when the observed and expected numbers of diagnoses are relatively large, the value of the SIR is stable.

Population structure, in the context of the calculation of an SIR, simply refers to the age and gender breakdowns (or distributions) within the New Bedford and Massachusetts populations. Because cancer is a disease greatly affected by age, and also by gender, it is very important to account for the ages of people in the populations being studied and the numbers of males versus females. This process of accounting for differences in the ages of two populations is referred to as age adjustment or age standardization.

VI. CONCLUSIONS

Comments: “The report states that BEH undertook " ... to determine levels of PCBs in blood serum and whether patterns might exist to suggest that residence and/or occupation or attendance at the schools played a primary role in PCB exposures." In my opinion, while the investigation determined the levels of 15 PCB congeners among the study subjects, this approach was not sufficient to examine the possible role of PCB exposure resulting from residence, occupation or attendance at the schools.”

“Specifically, the selection of the 15 most abundant congeners normally found in human serum (PCBs 52, 74, 99, 105, 118, 138/158, 146, 153, 156, 170, 180, 187, 194, 199, and 204) seriously limits the interpretability of the findings, and makes it very unlikely that the role of residence, occupation or attendance at the schools can be characterized. Several investigators have proposed sets of PCB congeners in serum that may be considered markers of exposure from environmental sources, as opposed to dietary sources. These congeners include PCB 6, 8, 16, 18, 25, 26, 28, 31,33,37,41,44,47,49, 52,60, 66, 70, 84, 90/101, 97, 110, and 136. This list is compiled from the publications cited below. For example, De Caprio et.al studied a group of Akwesasne Mohawks with historical PCB exposure from diet, as well as environmental sources. He concluded that congeners 8, 18, 32/16, 31, 28, 33, 52, 44, 70, 66, 95, and 90/101 (primarily tri- and tetrachloro PCBs) reflected recent inhalation exposure. Freels et.al suggested that combinations of congener levels and their relative proportions should be considered relevant in tracking the source and route of PCB exposures.”

“So while the BEH has shown that the serum PCB levels in the subjects are comparable to the NHANES levels, the conclusion that PCB congener patterns are consistent with what is typically seen in the U.S. population, suggestive of dietary sources, is unfounded. With the exception of PCB 52, the BEH did not measure the PCB congeners that have been identified as coming for non-dietary sources of exposure.”

Response: MDPH’s serum PCB testing offer was designed as a public service and was conducted in a manner consistent with methods used by CDC to evaluate serum PCB data on a national level. The DeCaprio et. al. article mentioned by the commenter describes hypothesis-generating research that requires additional research studies for confirmation. MDPH relied primarily on established methods of evaluation currently used by public health experts to ensure valid results.

It should be noted that in response to other submitted comments, MDPH added language to the report providing additional details regarding evaluation methods; specifically, MDPH's qualitative evaluation of congener patterns. As described in the new language, congener patterns were evaluated by examining the percent contribution of 35 congeners. This is also similar to the method described by the commenter from the Freels et. al. paper as being relevant to tracking the source and route of PCB exposures. In addition, a number of the congeners identified by the commenter as possible markers of environmental exposure or as possibly reflecting recent exposure were included in the qualitative evaluation, including congeners 28, 44, 49, 52, 66, 101, and 110.

In addition to MDPH's congener pattern evaluation, a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen. CDC identified one atypical pattern, but noted that the congener patterns of the majority of New Bedford participants appeared to be typical. The results of this evaluation suggests that exposure in the majority of the New Bedford participants appeared similar to that of the general U.S. population, thus MDPH believes that its evaluation supports the report conclusions. No revisions to the report were made.

TABLES

Comments: "Table 2: I think this is a mistake – the parentheticals are 95% CIs, not 50th percentiles. Footnote: same comment as in Table 1."

Response: The footnotes for Tables 1 and 2 were revised for clarity as follows:

"2. The range of serum PCB levels detected is presented in parentheses below the median for New Bedford residents."

"3. The 95% confidence intervals appear in parentheses below both the NHANES median and 95th percentile values. The 95% CIs presented represent the range of estimated values that have a 95% probability of including the true value for the population."

APPENDICES

Comments: “Appendix B, answer to question 2: What serum PCB level would “raise immediate health concerns”? This should be clearly stated.”

Response: MDPH's past practice has been to contact someone if their serum PCB level was significantly higher than the 99th percentile (for the age group of the individual involved) reported by CDC at the time of the analysis for the general US population. Such an exceedance would warrant a more immediate need for the health care provider to consider in their typical course of treatment for their patient.

Appendix E

Glossary of Environmental Health Terms[1]

[1] Terms and definitions included in this glossary are primarily from the U.S. Agency for Toxic Substance and Disease Registry's 2005 Public Health Assessment Manual with some additional terms and definitions added by MDPH.

Glossary of Terms

This glossary defines words used in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call MDPH/BEH at 617-624-5757.

General Terms

50th percentile
The 50th percentile is also known as the median. The midpoint of a group of observations when they are arranged in order from lowest to highest.

95th percentile
The serum PCB level below which 95% of the levels measured in NHANES participants are found.

95% confidence interval
The 95% confidence interval is a range of estimated values that have a 95% probability of including the true value for the population.

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Aroclor
PCBs were commercially produced and sold in the U.S. as mixtures called Aroclors.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assessment Program.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm

case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assessment Program (CAP)
The Community Assessment Program (CAP) is a program within the Bureau of Environmental Health at the Massachusetts Department of Public Health. CAP is tasked with responding to concerns about disease patterns, evaluating the frequency and pattern of disease in populations, and assessing possible associations between environmental exposures and disease.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Congener, PCB
PCB molecules vary in how much chlorine they contain. Individual unique chlorinated biphenyl compounds are known as congeners and there are 209 possible congeners depending on number and location of chlorine atoms on the molecule. Note, the chlorine in PCBs is unrelated to the type of chlorine used in pools.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Homologue, PCB
PCB congeners that are organized into groups according to similar numbers of chlorine atoms (e.g., dichlorobiphenyls, trichlorobiphenyls, etc.) are called homologues.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Median
The median is also known as the 50th percentile value. The midpoint of the a group of observations when they are arranged in order from lowest to highest

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen

A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

PCBs
Polychlorinated biphenyls (PCBs) refer to a class of chemical compounds with 209 possible congeners in which chlorine atoms have replaced some or all of the hydrogen atoms in the biphenyl molecule. PCBs are generally odorless and colorless, very heat stable and fire resistant, non-conductive and virtually insoluble in water. PCBs were historically used in electrical components (e.g. capacitors) and in building materials (e.g. caulking), among other uses.

PCB congener
PCB molecules vary in how much chlorine they contain. Individual unique chlorinated biphenyl compounds are known as congeners and there are 209 possible congeners depending on number and location of chlorine atoms on the molecule. Note, the chlorine in PCBs is unrelated to the type of chlorine used in pools.

PCB homologue
Congeners that are organized into groups according to similar numbers of chlorine atoms (e.g., dichlorobiphenyls, trichlorobiphenyls, etc.) are called homologues.

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Population structure
Population structure, in the context of the calculation of an SIR, simply refers to the age and gender breakdowns (or distributions) within the New Bedford and Massachusetts populations. Because cancer is a disease greatly affected by age, and also by gender, it is very important to account for the ages of people in the populations being studied and the numbers of males versus females. This process of accounting for differences in the ages of two populations is referred to as age adjustment or age standardization.

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey

The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people

might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

SIR
The ratio of the observed number of cancer diagnoses in an area to the expected number of diagnoses multiplied by 100.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stability
Stability in the context of an SIR refers to how the SIR changes when there are small increases or decreases in the observed or expected number of cases. Two SIRs may have the same size but not the same stability. For example, an SIR of 150 may represent 6 observed diagnoses and 4

expected diagnoses, or 600 observed diagnoses and 400 expected diagnoses. (The SIR is the ratio of the number of observed diagnoses to the number of expected diagnoses multiplied by 100. For example, six divided by 4 equals 1.5 as does 600 divided by 400; 1.5 multiplied by 100 equals 150.) Both SIRs represent a 50 percent excess of observed diagnoses. However, in the first instance, one or two fewer diagnoses would change the SIR a great deal, whereas in the second instance, even if there were several fewer diagnoses, the SIR would only change minimally. When the observed and expected numbers of diagnoses are relatively small, their ratio is easily affected by one or two diagnoses. Conversely, when the observed and expected numbers of diagnoses are relatively large, the value of the SIR is stable.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey

A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)