Health Consultation

Assessment of Environmental Concerns and
Evaluation of Cancer Incidence in New Bedford's South End 1982-1998

RODNEY METALS
(a/k/a ALLEGHENY RODNEY STRIP DIVISION)
EPA FACILITY ID: MAD001067941

AND

BRITTANY DYEING AND PRINTING CORPORATION
EPA FACILITY ID: MAD001014612

NEW BEDFORD, BRISTOL COUNTY, MASSACHUSETTS

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Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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Prepared by:

Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Community Assessment Program
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Assessment of Environmental Concerns:
Rodney Metals and Brittany Dyeing and Printing Corporation and
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I. BACKGROUND AND STATEMENT OF ISSUES

At the request of concerned residents, Representative Antonio Cabral, and the New Bedford Health Department, the Community Assessment Program (CAP) of the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of cancer incidence in the South End area of New Bedford, Massachusetts. Specifically, this evaluation was initiated based on community concerns about the possible role that environmental exposures related to the Allegheny Rodney Company (also known as Rodney Metals) and Brittany Dyeing and Printing Corporation (a.k.a. Brittany Dye) may play in the incidence of cancer in the neighborhoods adjacent to the facilities. Rodney Metals and Brittany Dye are located in the South End area of New Bedford, census tract 6528, on East Rodney French Boulevard to the south of Butler Street and east of Swan Street. Refer to Figure 1 for the location of the two facilities and the adjacent neighborhood.

II. OBJECTIVES

This investigation provides a review of potential exposure pathways to chemicals from Rodney Metals and Brittany Dye as well as a review of the pattern of cancer in the South End area of New Bedford through comparison of the incidence of eight cancer types with the incidence of these cancers in the state of Massachusetts as a whole. Additionally, available information about risk factors, including environmental factors, related to the development of cancer was evaluated. To evaluate concerns about potential environmental exposures from Rodney Metals and Brittany Dye, MDPH contacted the Massachusetts Department of Environmental Protection (MDEP) to obtain and review available environmental data for these companies.

This report provides a descriptive evaluation of the occurrence of cancer in census tract 6528 in the city of New Bedford during the years 1982–1998, the time period for which the most recent and complete cancer incidence data were available from the Massachusetts Cancer Registry (MCR) at the initiation of this analysis. The city of New Bedford is divided into 30 smaller geographic areas or census tracts (CTs). The South End area of New Bedford as well as Rodney Metals and Brittany Dye are located in CT 6528, on the southern peninsula of the city. New Bedford CT 6528 comprises an area of approximately 1.8 square kilometers and has a total

population of 3,405 (U.S. DOC 2000). The location and boundaries of CT 6528 are also shown in Figure 1. A census tract is a smaller geographic subdivision of a city or town designated by the U.S. Census Bureau. Because age group and gender specific population information is necessary to calculate incidence rates, the census tract is the smallest geographic area for which cancer rates can be accurately calculated.

The results of this descriptive analysis can be useful in identifying cancer patterns or trends in a geographic context, to determine if a common cause or etiology is possible, and can serve to identify areas where further public health investigations or actions may be warranted. Descriptive analyses may also indicate that an excess of known risk factors associated with a disease, such as environmental exposures, exists in a certain geographic area. This descriptive analysis of cancer incidence data cannot be used to establish a causal link between a particular risk factor (either environmental or non-environmental) and the development of cancer. In addition, this analysis cannot determine the cause of any one individual's cancer diagnosis. The purpose of this evaluation is to report the findings on the patterns of cancer in the South End area of New Bedford and discuss them in the context of the available environmental information to determine whether recommendations for further public health action are needed. The specific objectives of this investigation were as follows:

- To evaluate opportunities for environmental exposure(s) to nearby residents to chemicals from Rodney Metals and Brittany Dye;

- To evaluate the incidence of eight cancer types (cancers of the bladder, breast, kidney, liver, lung, pancreas, leukemia, and non-Hodgkin's lymphoma) in New Bedford CT 6528 and specifically neighborhoods near Rodney Metals and Brittany Dye to determine if cancer is occurring more or less often than expected;

- To evaluate the geographic distribution of cancer in CT 6528 by mapping individual cases to determine whether any indication of an atypical pattern of cases exists in this area of the city, particularly in relation to possible exposure opportunities to chemicals from Rodney Metals or Brittany Dye;

- To review available descriptive information from the Massachusetts Cancer Registry (MCR) related to non-environmental risk factors for individuals diagnosed with cancer in New Bedford CT 6528; and

- To discuss the results of this evaluation in the context of the available scientific and medical literature on the eight types of cancer evaluated to determine whether further investigation or public health action is warranted.

III. COMMUNITY ENVIRONMENTAL CONCERNS

In order to address community environmental concerns, the MDEP Southeast Regional Office was contacted to obtain and review available environmental information pertaining to Rodney Metals and Brittany Dye. In addition to reviewing environmental data for the two facilities, information regarding other potential environmental sources located in the South End area of New Bedford and listed with MDEP as a location of a hazardous release or spill was reviewed (MDEP 2003a).

A. Rodney Metals

Rodney Metals was originally formed as Modern Venetian Blinds, which, in 1941, moved to 1357 East Rodney French Boulevard, on the east side of the peninsula of land separating Clarks Cove and New Bedford Harbor. The facility originally produced wooden slatted venetian blinds and over time introduced steel and aluminum to the product. Through this work, the company started rolling and selling strip and by the late 1950s, the venetian blind end of the business dwindled while the metal producing division expanded. In 1961, Rodney Metals was incorporated and continued to operate the Consumer Products Division, which housed the venetian blind part of the business. Teledyne, Inc. purchased Rodney Metals in 1967. In late 1999, the Rodney Metals Division became Allegheny Rodney. Today, operations consist of rolling steel in mills to various thicknesses, cutting the rolled steel to different lengths and widths, and coating the steel with mineral oil (Innovative Engineering Solutions, Inc. 2002).

The Rodney Metals facility is situated on one parcel of land approximately 8 acres in area and consists of a two-story building with a concrete floor. Landscaping and pavement compose the

remaining portions of the property. To the west, the facility is abutted by residential properties along Milbury Street. To the north is a parking lot located on Butler Street and currently used by employees of Rodney Metals. To the east, across East Rodney French Boulevard, are thin strips of undeveloped land and New Bedford Harbor. Brittany Dye abuts the Rodney Metals property to the south.

Rodney Metals first became air quality permitted by MDEP in 1987. The permit requires the facility to meet specific emission limits for particular pollutants. MDEP reviews permit applications and issues air quality permits based on emission control technologies and the standards set by the U.S. Environmental Protection Agency (EPA) for criteria pollutants such as nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), particulates, and volatile organic compounds (VOCs). As established under the permit, stack emissions testing can be required at the time the permit is granted and/or if there is an opacity violation (e.g. a measurement of air quality), odor complaint, or other problem indicating the need for testing. According to MDEP Bureau of Waste Prevention, the Rodney Metals facility has received several notices of non-compliance in the past and has made adjustments as necessary to comply with their permit, including stack testing (MDEP 2003b).

In addition to air emissions, Rodney Metals has experienced some milling/mineral oil releases and at least one release of chlorinated VOCs resulting in contamination of soil and groundwater beneath the surface of the property and contamination of surface water of New Bedford Harbor. Evidence of subsurface oil contamination was first discovered during excavation activities for a new mill within the Rodney Metals building conducted in June 1994. The excavation site, located on the north side of the building, is approximately 60 feet from the parking lot to the north and approximately 200 feet from New Bedford Harbor to the east (Earth Tech 1995). Site assessments and remedial measures, including collection of groundwater and oil samples, revealed that the extent of the contamination was generally limited to the area beneath the sidewalk adjacent to the northern portion of the Rodney Metals facility. A passive oil recovery trench with an impermeable barrier was placed on the down-gradient side of the excavation trench to restrict oil and/or any other contaminants possibly present in oil from migration away from the release area (Innovative Engineering Solutions, Inc. 2000, 2002).

In 1997, during site assessment and remedial activities, VOCs were detected in groundwater from a monitoring well located up-gradient from the impermeable barrier and from a location adjacent to the building and across East Rodney French Boulevard. The source of the VOCs is suspected to be from a release of 66 gallons of 1,1,1-trichloroethane (TCA) that occurred near the former solvent storage area in October 1989 and migrated through groundwater (Innovative Engineering Solutions, Inc. 2002). In November 2001, during construction of a new drainage system in another area of the facility, another mineral oil release was discovered. Investigations of subsurface soils and groundwater indicated that the oil did not appear to be migrating significantly from the area (Innovative Engineering Solutions, Inc. 2002).

B. Brittany Dye

The Brittany Dye facility is located at 1357 East Rodney French Boulevard directly south of the Rodney Metals property on the New Bedford peninsula. Brittany Dye has operated for more than 100 years in the fabric dying and coating business and operates on an international scale (MDEP 2003b). In addition to Rodney Metals and residential areas to the north, Brittany Dye is abutted by New Bedford Harbor to the east, residential areas to the west, and a parking lot and undeveloped land directly to the south.

Brittany Dye has multiple emission stacks, and the facility is often in operation 24 hours a day. Four releases or spills of hazardous materials on the premises of Brittany Dye have been reported to MDEP (MDEP 2003a). These spills either occurred or were reported to MDEP between 1985 and 1991. One spill involved an unrecorded amount of dye from a drum; another involved an unknown amount of dye wastewater from a pipe or hose on the premises. Available information did not characterize the other two spills with respect to type of material released, amount of material released, or source of release. No environmental sampling data associated with the four releases could be located.

Brittany Dye is permitted by MDEP for air stack emissions and has received notices of non-compliance from MDEP periodically since the first air quality permit was issued in 1988. Similar to Rodney Metals, the air emissions permit granted to Brittany Dye sets limits for specific air emissions associated with their operations based on emission control technologies

and Massachusetts' compliance status with ambient air quality standards set by EPA such as NO_x, SO_x, CO, VOCs, and particulates. Air emissions testing at the facility can be required at the time the permit is issued by MDEP, and/or at subsequent times should opacity violations, odor complaints, and/or other problems associated with their operations occur (MDEP 2003b).

C. MDEP 21E Hazardous Material and Oil Releases in the New Bedford South End Area

In 1983, the Massachusetts Legislature established a statewide hazardous waste site cleanup program (the state Superfund program) under Chapter 21E of Massachusetts General Laws (M.G.L c21E, 310 CRM 40.0000). Under this legislation, the Massachusetts Department of Environmental Protection (MDEP) administers investigation and cleanup of hazardous material and oil release sites, known as "21E sites," in the Commonwealth.

The 21E sites are characterized by one or more releases of oil or other hazardous material. Releases can result from a variety of sources, including trucks/vehicles, underground storage tanks, and aboveground storage drums. Releases vary widely with respect to materials involved, the relative amount of materials released, and the geographic extent of contamination. Information on hazardous material and oil releases, including assessment and remedial response measures is available from 1977 – present from the MDEP Bureau of Waste Site Cleanup (MDEP 2003a).

MDPH reviewed the most recent information regarding hazardous material and/or releases located in the South End of New Bedford, CT 6528, and mapped the approximate location of sites with sufficient address information using a geographic information system (ESRI 2002). According to the most current information, there are several sites in CT 6528 characterized by more than one release (Figure 2). These sites include Rodney Metals (four releases, two of which were discussed previously), Brittany Dye (four releases), Fort Rodman at the southern tip of the New Bedford peninsula (nine releases), the New Bedford Water Pollution Control Facility located within the geographic boundaries of Fort Rodman (six releases), and 127 West Rodney French Boulevard (three releases). Four other sites, each characterized by one release, are located along West Rodney French Boulevard. Information specific to each release is provided in Table 1.

IV. REVIEW OF ENVIRONMENTAL SAMPLING DATA

To address concerns about possible environmental exposures associated with the two facilities, MDPH reviewed information from several reports on file with MDEP as well as the Toxics Chemical Release Inventory (TRI) data available from the U.S. Environmental Protection Agency (USEPA). Available environmental sampling data were reviewed, and a screening evaluation was conducted to identify substances that are either not expected to result in adverse health effects or substances that need to be considered for further analysis to determine whether they may be of potential health concern. The screening analysis identifies maximum concentrations of contaminants detected in various types of environmental media (i.e., air, soil, water) and compares these concentrations to health-based comparison values established by the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) (ATSDR 2002a, 2002b). For this analysis, the maximum concentration of a substance detected in a particular environmental medium was used to compare to the appropriate health-based comparison value in order to conduct a conservative screening evaluation. If an ATSDR comparison value was not available for a specific chemical, the maximum detected concentration of that chemical was compared to the appropriate Method 1 groundwater or soil clean-up standards developed by MDEP (MDEP 1999).

The ATSDR comparison values are specific concentrations of a chemical for air, soil, or water that are used by health assessors to identify environmental contaminants that require further evaluation. These comparison values are developed based on health guidelines and assumed exposure situations that represent conservative estimates of human exposure. Chemical concentrations detected in environmental media that are less than a comparison value are not likely to pose a health threat. However, chemical concentrations detected in environmental media above a comparison value do not necessarily indicate that a health threat is present. In order for a compound to impact one's health, it must not only be present in the environmental media, but one must also come in contact with the compound. Therefore, if a concentration of a chemical is greater than the appropriate comparison value, the potential for exposure to the chemical should be further evaluated to determine whether exposure is occurring and whether health effects might be possible as a result of that exposure. The factors related to exposure that are unique to the

specific situation under investigation need to be considered to determine if an adverse health effect from this chemical could occur.

Rodney Metals Subsurface Sampling History

As discussed, in June 1994, an initial release of oil was encountered during excavation for a new mill at the Rodney Metals facility. The excavation site, located on the north side of the facility, is approximately 60 feet from the parking lot to the north and approximately 200 feet from New Bedford Harbor to the east (Earth Tech 1995). During field investigation activities in May 1995 oil was detected in three groundwater monitoring wells (MW-101, MW-102, and MW-109) situated in the northeast corner of the Rodney Metals facility where the rolling operations are based.

In 1997, analysis of samples taken from the groundwater and the subsurface milling oil at Rodney Metals indicated the presence of several chlorinated VOCs, specifically 1,1,1-trichloroethane (1,1,1-TCA), trichloroethylene (TCE), and several breakdown products of these VOCs, including vinyl chloride, 1,1-dichloroethane (1,1-DCA), and 1,1-dicloroethene (1,1-DCE). As previously stated, the source of the chlorinated VOCs in groundwater was speculated to be from a release of 66 gallons of 1,1,1-TCA that occurred in October 1989 in the eastern portion of the facility. According to New Bedford Fire Department records, at the time of the 1989 release, 46 gallons of the 1,1,1-TCA were recovered, and the remaining material was contained with absorbent. These vapor-degreasing solvents have not been used at the facility since 1995, when vapor-degreasing operations were replaced by the use of aqueous cleaning solutions (Earth Tech 1997, Innovative Engineering Solutions, Inc. 2000, 2002). In addition, chlorinated VOCs were detected in off-site surface water samples taken from New Bedford Harbor.

Groundwater Monitoring Wells

A sample of oil was obtained from MW-101, the only monitoring well that contained separate phase product. This sample was analyzed for PAHs and VOCs (Innovative Engineering Solutions, Inc. 2002). Several PAHs, including benzo(a)pyrene, fluoranthene, fluorene, 2-methylnaphthalene, and naphthalene were detected at concentrations exceeding ATSDR

comparison values for drinking water. In addition, the laboratory results of the oil sample indicated the presence of two VOCs, toluene (which is a component of mineral oil) and tetrachloroethene (PCE). Toluene was detected at a concentration of 100,000 ppb, and PCE was detected at a concentration of 3,200 ppb. The concentrations of both these compounds in the oil sample exceeded ATSDR drinking water comparison values, federal and state Maximum Contaminant Levels (MCL) for drinking water, and MDEP's Method 1 GW-2 standards. Refer to Table 2. It is important to note that MW-101 is located upgradient of the passive oil recovery trench, and therefore, migration of these compounds in the oil beyond the trench is not likely.

Due to the presence of PAHs and VOCs in the oil sample collected from MW-101, groundwater samples from each of the installed monitoring wells were analyzed for the presence of these two classes of compounds. PAHs were not detected in any of the groundwater samples; however, several VOCs, including 1,1,1-TCA and TCE, were detected at concentrations exceeding ATSDR comparison values and state and federal standards for drinking water. It is important to note that New Bedford's drinking water comes from surface water sources, and groundwater near Rodney Metals is not a source of drinking water. Therefore, use of comparison values established based on a drinking water exposure scenario represents a conservative approach. In MW-107, located across East Rodney French Boulevard and generally downgradient from MW-101, analytical results indicated the maximum detected concentrations of 1,1-dichloroethene (1,1-DCE) (30,000 ppb), 1,1,1-TCA (200,000 ppb), and TCE (29,000 ppb). All three of these detected VOCs exceeded their representative drinking water comparison value. Other VOCs detected in groundwater that exceeded drinking water comparison values were methylene chloride (3,200 ppb) in MW-106 and vinyl chloride (7 ppb) in MW-201. In MW-103, chlorobenzene and 1,1-DCA were detected at maximum concentrations of 2 ppb and 17 ppb, respectively. The detected concentrations of these VOCs did not exceed health based comparison guidelines. Further, no contaminants were detected in either MW-104 (situated in the northwest corner of the site) or MW-202 (located across East Rodney French Boulevard near the edge of New Bedford Harbor just northeast of the Rodney Metals building).

Subsurface Soil

During investigation activities in 1994, oil in soil located more than 3 feet below ground surface encountered during the construction of the mill within the Rodney Metals facility, was collected and analyzed. The results of the analysis indicated that Total Petroleum Hydrocarbons (TPH) was present at concentrations in subsurface soil ranging from 4,700 ppm (parts per million) to 34,000 ppm. Analytical results also indicated the presence of two metals, chromium (total) and lead. The maximum concentration of chromium detected was 6.3 ppm and lead was 5 ppm. Neither of these metals was detected at concentrations that exceeded their representative health-based comparison values, and both were below background levels for soils in the northwestern U.S. (ATSDR 1993). Refer to Table 3.

Surface Water

Because the Rodney Metals facility sits across from New Bedford Harbor, surface water samples were collected at two separate locations adjacent to the site, at low and high tide. Specifically, samples were taken to evaluate whether migration of VOCs via groundwater had occurred and if so, whether VOCs on the surface water posed a potential imminent hazard. The analytical results of the surface water samples indicated that 1,1,1-TCA was detected at 12 ppb and TCE was detected in surface water at 2 ppb. Both VOCs were below drinking water comparison values. Use of drinking water comparison values represents a conservative approach because the surface water from this area is not a source of drinking water. In addition, these concentrations are well below ambient water quality criteria (of 31,200 ppb for 1,1,1-TCA and 2,000 ppb for TCE), indicating that the VOCs present in surface water of New Bedford Harbor are not posing an imminent hazard and are not likely posing an unacceptable risk for people who might contact them in the surface water. Refer to Table 4.

Underground Utilities

To determine whether underground utilities (i.e., gas lines, electrical lines, storm sewer, sanitary sewer, water lines) were acting as a preferential migration pathway for the oil release, access points, such as manholes and electrical vaults, for the underground utilities located along East Rodney French Boulevard, near the facility, were visually inspected for the presence of oil. No

oil or sheen was visible in the samples collected for qualitative analysis. In addition, using an oxygen/explosion meter and a photoinonization detector (PID), the air, within each electrical vault and sanitary sewer that was checked, was screened from the ground surface. No readings of contaminants above background or ambient conditions were detected (Innovative Engineering Solutions, Inc. 2002).

In 2000, the Department of Public Works for the city of New Bedford installed new water lines along East Rodney French Boulevard in the vicinity of the Rodney Metals facility. In order to install these new water lines, soils were excavated to depths up to 12 feet below ground surface. Prior to the excavation activities, Rodney Metals notified the Department of Public Works of the possibility of encountering milling oil and chlorinated VOC-affected soils. During the excavation activities, no chlorinated VOCs or oil were encountered, indicating that the underground utilities along East Rodney French Boulevard were not acting as preferential migration pathways for the releases at the Rodney Metals facility (Innovative Engineering Solutions, Inc. 2002).

Rodney Metals and Brittany Dye Air Emissions Information

There are no ambient air sampling data available for the areas in the immediate vicinity of Rodney Metals or Brittany Dye. Both facilities operate with air quality stack emissions permits from MDEP. The most recent stack test was performed at Rodney Metals in November 1997. Routine stack sampling is not required under the air permitting program, and follow-up sampling is only triggered when it is determined to be necessary to address opacity, odors or other air quality problems associated with the facilities. Emission limits for pollutants such as NO_x, SO_x, CO, VOCs, and particulates were determined at the time the permits were issued and were established based on cost and availability of emission controls at the time of review as well as Massachusetts' level of attainment with EPA ambient air quality standards. According to MDEP, the agency is not aware of any existing non-compliance issues at either Rodney Metals or Brittany Dye. All notices of non-compliance issued to either facility in the past have been addressed (MDEP 2003b).

However, because air emissions from Rodney Metals and Brittany Dye are one of the main environmental concerns expressed by residents in the area surrounding the two facilities, a review of the Toxic Chemical Release Inventory database (TRI) was conducted. The TRI is a surveillance system within EPA, which estimates the annual releases of toxic chemicals to the environment. The system evolved from the Emergency Planning and Community Right-to-Know Act (EPCRA) and requires businesses to report the locations and quantities of chemicals stored on-site to state and local agencies to help communities prepare to respond to potential chemical spills and emergency releases (USEPA 2003). Although TRI annual release estimates cannot be used to specifically evaluate whether individuals living near the two facilities are actually being exposed to air emissions, the information can be helpful when evaluating the pattern of cancer and the likelihood that environmental factors may have played a role in their development in this area of New Bedford.

Review of TRI data for Rodney Metals as far back as 1987 indicates that the facility has reported several stack and/or fugitive (non-stack) emissions to the air including hydrogen fluoride, methyl ethyl ketone, methyl isobutyl ketone, and nitric acid (USEPA 2003). The compound 1,1,1-TCA was reported as a fugitive emission at the facility from 1987 through 1995, but was not reported as an emission after 1995. This is likely attributed to the facility's implementation of an aqueous cleaning operation in replacement of 1,1,1-TCA usage reported during that year. Although not included in the TRI information reviewed, TCE was used at the Rodney Metals facility prior to 1982 (Innovative Engineering Solutions, Inc. 2002), and it is possible that this compound may have also been emitted to the air in that time period. According to the TRI data, Brittany Dye reported stack and/or fugitive emissions of 1,1,1-TCA from 1987 to 1994 and fugitive emissions of TCE from 1995 through 2000 (USEPA 2003).

V. EVALUATION OF POTENTIAL COMMUNITY EXPOSURE PATHWAYS

An evaluation of potential pathways of exposure was conducted to determine whether releases or activities at the Rodney Metals and Brittany Dye sites could have impacted residents in the South End area. It is important to note that chemical concentrations detected in the environment do not necessarily represent a health threat. In order for a compound to impact one's health, it must not

only be present in a certain environmental media (i.e., air, soil or water), but one must also come into contact with the compound via the contaminated media through ingestion, inhalation, or skin absorption. Therefore, the presence of contaminants at a site alone does not necessarily constitute exposure. The exposure pathway analysis is an evaluation of the environmental and human components that could lead to contact with contaminants in the environment. The pathway analysis consists of five elements: a source of contamination, transport through an environmental medium (e.g., air, soil, water), a point of exposure, a route of human exposure, and an exposed population.

Exposure to a chemical must first occur before any potential adverse health effects can result. Five conditions must be present for exposure to occur. First, there must be a source of that chemical. Second, an environmental medium must be contaminated by either the source or by chemicals transported away from the source. Third, there must be a location where a person can potentially contact the contaminated medium. Fourth, there must be a means by which the contaminated medium could enter a person's body, such as ingestion, inhalation, and dermal absorption. Finally, the chemical must actually reach the target organ susceptible to the toxic effects caused by that particular substance at a sufficient dose and for a sufficient exposure time for an adverse health effect to occur (ATSDR 1993).

A completed exposure pathway indicates that exposure to humans occurred in the past, is occurring in the present, or will occur in the future. A completed exposure pathway exists when all of the five elements are present. A potential exposure pathway exists when one or more of the five elements is missing or uncertain and indicates that exposure to a contaminant could have occurred in the past, could be occurring in the present, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will not likely be present in the future. The discussion that follows incorporates only those exposure pathways that are important and relevant to this evaluation in New Bedford.

A. Exposure to Groundwater and Soil

For residents living adjacent to the Rodney Metals facility, it is unlikely that past, present, and future exposures to contaminated groundwater and subsurface soil resulting from historical releases at the property are occurring. Groundwater flow is away from residential areas, and no

contamination was detected in the upgradient monitoring well located closest to the neighborhood (MW-104). Since groundwater in the area is not being used as a source of drinking water, ingestion is not a possible route of exposure for residents living in this part of New Bedford. Also, because the oil and VOC-affected groundwater is located below the concrete floor of the Rodney Metals facility, dermal contact to the contaminated groundwater is not a likely source of exposure for residents living adjacent to or in the vicinity of the Rodney Metals facility. Like groundwater, it is not likely that residents living in neighborhoods adjacent to the Rodney Metals facility would contact oil and VOC-affected soil. Investigations at the site indicated that contaminated soil is confined beneath the surface underneath the concrete floor of the facility. Furthermore, the pavement in the area also acts as a protective barrier precluding human contact to oil and VOC-affected soil. Therefore, for individuals residing in the vicinity of Rodney Metals, potential exposures via contaminated groundwater and subsurface soil have been eliminated.

Past exposure to oil may have been possible for workers who directly participated in subsurface activities associated with the construction of the mill at the facility in 1994. Such activity would have allowed the opportunity for workers to come in contact with contaminants in subsurface groundwater or any volatile contaminants contained in subsurface groundwater that could have been released to ambient air. Therefore, inhalation and dermal contact are the principle routes of exposure by which workers at the facility may have been potentially exposed in the past to oil-contaminated groundwater. Since the completion of this excavation activity and the affected area is below the foundation for the mill, future exposure through direct contact with contaminated groundwater is not likely for employees at the Rodney Metals facility. Furthermore, vapor-degreasing solvents, such as 1,1,1-TCA and TCE, have not been used at the facility since 1995; therefore, future releases of these chemicals are not expected to occur. However, future exposures to oil and chlorinated VOCs in groundwater may still be possible for workers if future excavation actions are undertaken at the facility in this area.

Like groundwater, past exposure to subsurface soil through inhalation of dust and dermal contact may have been possible for Rodney Metal workers involved in subsurface activities related to excavation for a new mill at the site in 1994. In addition, future exposures via inhalation and dermal contact may be possible if remedial activities are conducted in this area of the Rodney

Metals facility in the future. However, while past and future exposures to subsurface soils by workers represent potential exposure pathways, it is important to note that both lead and chromium were detected below health-based comparison values in subsurface soils.

Past results of investigations conducted at the manholes along East Rodney French Boulevard indicated that underground utilities did not appear, at the time, to be acting as a preferential migration pathway for the releases away from the Rodney Metals property. Further, in 2000, when the New Bedford Department of Public Works was installing new water lines in East Rodney French Boulevard in the vicinity of the Rodney Metals facility, soils were excavated up to 12 feet below ground surface. It was noted at this time that neither milling oil nor chlorinated VOCs were encountered during excavation activities. Therefore, it is suggested that the underground utilities are not acting as a migration pathway for the releases at Rodney Metals, and any potential exposures pathways associated with the underground utilities may be eliminated.

B. Exposure to Indoor Air

Volatilization of groundwater contaminants is possible in areas where basement flooding and/or vapor infiltration occur(s) from an underlying groundwater plume. Although chlorinated VOC vapors have the potential to migrate via groundwater into indoor air, as do some constituents of oil, this route of exposure does not appear likely for residents in the nearby neighborhood since all residents abutting the Rodney Metals facility are upgradient of the contaminated portion of the facility. As discussed, the groundwater at the Rodney Metals property flows east-northeasterly of the facility towards New Bedford Harbor and away from residential areas, and if the contamination were to migrate away from the property through groundwater, it would travel toward New Bedford Harbor, and not to the west where some of the residential neighborhoods are situated. In addition, results of the analysis of groundwater samples collected from the northwest corner of the facility and closest to the adjacent neighborhood (MW 104) did not indicate the presence of VOCs, PAHs, or total petroleum hydrocarbons (TPH). Based on available information reported in Innovative Engineering Solutions (2002) and discussed earlier, it does not appear that vapors from the groundwater contamination are migrating through underground utility channels, either.

Past, present, and future exposures to indoor air contaminated with oil constituents or chlorinated VOCs via volatilization from groundwater are possible for workers at the Rodney Metals facility. Because there is evidence of groundwater contamination beneath the northern and eastern portion of the facility, vapor permeation may be a source of exposure for workers at the facility. However, facilities equipped with ventilation systems would help to reduce the potential for indoor air exposures as a result of vapor permeation. In addition, although chlorinated VOCs are no longer used at the facility, these compounds as well as their metabolites generally slowly degrade in groundwater (unlike their presence in air, where breakdown occurs rapidly). Therefore, it is possible that chlorinated VOCs could remain in the subsurface media, such as groundwater and soil, for an extended period of time. Further, over time, intermittent exposure to these compounds may occur if there were to be volatilization to indoor air, particularly in poorly ventilated areas.

C. Exposure to Surface Water

Past exposure to surface water contaminated with chlorinated VOCs may have occurred for individuals who had contact with New Bedford Harbor, located east of the Rodney Metals facility, at the time of the release. The limited surface water sampling that was undertaken in New Bedford Harbor indicated that the presence of two chlorinated VOCs, 1,1,1-TCA and TCE, were detected below drinking water guidelines. Therefore, at the levels detected in surface water, adverse health effects would not be anticipated to occur if the area was/is used as a recreational area. The dominant fate of VOCs released to surface water is volatilization to the air (predicted half-life for TCE is minutes to hours), and bioconcentration in fish and other edible aquatic biota is not thought to be a dominant or significant fate process (ATSDR 1997, Wu and Schaum 2000). Further, due to concerns about polychlorinated biphenyl compound (PCB) contamination in New Bedford Harbor, MDPH promulgated regulations to close this area to commercial fishing in September 1979 (MGL 105 CMR 260.00). In addition, information from past MDPH studies have found that the majority of the general public in the greater New Bedford area was not catching and eating fish from these areas (MDPH 1987).

D. Exposure to Ambient Air

Past, current, and future exposures to contaminants emitted from Rodney Metals and Brittany Dye are possible from the ambient air surrounding the sites. However, it should be noted that exposures from inhalation and, to a lesser extent, dermal contact to contaminants in outdoor air would be appreciably less than exposures experienced in indoor or confined areas. This is because dilution factors and environmental parameters, such as seasonal variation and wind direction, would, to a much greater extent, affect the presence and levels of contaminants in outdoor air compared to indoor air resulting in lower potential for exposure to occur from outdoor versus indoor air. Nevertheless, potentially impacted populations in this area of New Bedford would include workers on site at Rodney Metals and Brittany Dye, residents abutting the facilities, and visitors to residential homes in adjacent neighborhoods, particularly those residential neighborhoods that might be downwind from the facilities. However, with the exception of air sampling conducted within manhole covers and catch basin grates, no on- or off-site ambient air monitoring data are available to evaluate potential inhalation exposures associated with emissions at these two facilities. While stack emission limits are established for both facilities through MDEP permits, other than TRI data, there are little to no data available to evaluate ambient air levels of the emissions released from these facilities over time and no way to specifically evaluate potential impacts these emissions may be having to air quality in the surrounding area.

During warmer months, exposure opportunities via solvent evaporation and stack emissions may be greater for residents in the area because individuals are more likely to open windows and doors or use air conditioners permitting outdoor air to enter homes. However, the physiochemical properties attributed to VOCs complicate this potential inhalation exposure scenario. For example, during the warmer months, interactions with the atmosphere cause the VOCs in ambient air to be broken down, resulting in lower levels and less persistence of VOCs in air and minimizing exposure potential. Furthermore, due to the high vapor pressures of VOCs, these compounds are expected to primarily exist in the vapor phase of the atmosphere rather than attached to particulate matter present in ambient air and, thus, would not tend to settle, aggregate, or linger (Wu and Schaum 2000).

VI. ANALYSIS OF CANCER INCIDENCE IN NEW BEDFORD CT 6528

A. Methods for Analyzing Cancer Incidence

1. Case Identification/Definition

Cancer incidence data, reports of new cancer diagnoses, for the years 1982–1998 were obtained for the city of New Bedford from the MCR, a division of the Bureau of Health Statistics, Research and Evaluation within MDPH. Eight cancer types were evaluated in this investigation and include cancers of the bladder, breast, kidney, leukemia, liver, lung, non-Hodgkin's lymphoma, and pancreas. These cancer types were selected for evaluation based on elevations that were observed at the city level in a preliminary review of cancer rates in New Bedford and resident concern over suspected elevations in some of these cancer types in the South End area. Only cases reported to the MCR as a primary cancer for one of the eight cancer types and diagnosed among a resident of New Bedford CT 6528 were included in the analysis. Cases were selected for inclusion based on the address reported to the hospital or reporting medical facility at the time of diagnosis. Cases for which census tract designation was not possible were excluded from the analysis.

The MCR is a population based surveillance system that began collecting information on Massachusetts residents diagnosed with cancer in the state in 1982. All newly diagnosed cancer cases among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L. c.111s.111B). The 17-year period 1982–1998 constitutes the period for which the most recent and complete cancer incidence data were available from the MCR at the time of this analysis.

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. Cancers that occur as the result of the metastasis or the

spread of a primary site cancer to another location in the body are not considered as separate cancers and therefore, were not included in this analysis.

It should be noted that the MCR research file might contain duplicate reports of individuals diagnosed with cancer. Duplicate cases are additional reports of the same primary site cancer case. In New Bedford CT 6528, no duplicate reports were identified during the years 1982–1998. However, reports of individuals with multiple primary site cancers were included as separate cases in the analyses in this report. A multiple primary cancer case 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 two months after the initial diagnosis (MCR 1996).

2. Calculation of Standardized Incidence Ratios (SIRs)

To determine whether elevated numbers of cancer cases occurred in New Bedford CT 6528, the South End area, cancer incidence data were tabulated by gender according to six age groups to compare the observed number of cancer cases to the number that would be expected based on the statewide cancer rate. Standardized incidence ratios (SIRs) were then calculated for the period 1982–1998 for each of the eight primary cancer types for New Bedford CT 6528. SIRs were also calculated for three smaller time periods, 1982–1986, 1987–1994, and 1995–1998, in order to evaluate patterns or trends in cancer incidence over time.

In order to calculate SIRs, 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 CT 6528 (U.S. DOC. 1980, 1990, 2000). Midpoint population estimates were calculated for each time period evaluated (i.e., 1984, 1990 and 1996). 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.

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 cases in an area to the expected number of cases multiplied by 100. The population structure of each town is adjusted to the statewide incidence rate to calculate the number of expected cancer cases. The SIR is a comparison of the number of cases in the specific area (i.e., city, CT) to the statewide rate. Comparisons of SIRs between towns or census tracts are not possible because each community has different population characteristics.

An SIR of 100 indicates that the number of cancer cases observed in the population being evaluated is equal to the number of cancer cases expected in the comparison or "normal" population. An SIR greater than 100 indicates that more cancer cases occurred than were expected, and an SIR less than 100 indicates that fewer cancer cases occurred than were expected. Accordingly, an SIR of 150 is interpreted as 50% more cancer cases than the expected number; an SIR of 90 indicates 10% fewer cancer cases 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 cases and six observed cases indicates a 50% excess in cancer, but the excess is actually only two cases. Conversely, an SIR of 150 based on 400 expected cases and 600 observed cases represents the same 50% excess in cancer, but because the SIR is based upon a greater number of cases, the estimate is more stable. It is very unlikely that 200 excess cases of cancer would occur by chance alone. As a result of the instability of incidence rates based on small numbers of cases, SIRs were not calculated when fewer than five cases 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 cases 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 study population is significantly different from the comparison or "normal" population. "Significantly different" means there is less than a 5% chance that the observed difference (either increase or decrease) is the result of random fluctuation in the number of observed cancer cases.

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 cases. Similarly, if the confidence interval does not include 100 and the interval is below 100 (e.g., 45–96), the number of cancer cases 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 cases reflects a real cancer increase or decrease or is the result of chance. It is important to note that statistical significance does not necessarily imply public health significance. Determination of statistical significance is just one tool used to interpret SIRs.

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. Due to the instability of incidence rates based on small numbers of cases, statistical significance was not assessed when fewer than five cases were observed.

5. Evaluation of Cancer 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 age at diagnosis, stage of disease, smoking status 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 lung, bladder, and kidney 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. The available risk factor information from the MCR was evaluated for individuals diagnosed with cancers that were elevated in New Bedford CT 6528. However, information about personal risk factors that might include family history, hormonal events, diet, and similar factors that may also influence the development of cancer is not collected by the MCR, and therefore, it was not possible to evaluate them in this investigation.

6. Determination of Geographic Distribution of Cancer Cases

In addition to calculation of SIRs, address at the time of diagnosis for each individual diagnosed with cancer was mapped using a computerized geographic information system (GIS) (ESRI 1999). This allowed assignment of census tract location for each case as well as an evaluation of the spatial distribution of individual cases at a smaller geographic level within a census tract (i.e., neighborhoods). The geographic pattern was determined using a qualitative evaluation of the point pattern of cases in New Bedford CT 6528. 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 cases using telephone books and city residential lists issued within two years of an individual's diagnosis. For confidentiality reasons, it is not possible to include maps showing the locations of individuals diagnosed with cancer in this report. [Note: MDPH is bound by law not to reveal the name or identifying information of an individual diagnosed with cancer whose case is reported to the MCR.]

B. Results of Cancer Incidence Analysis

The following section presents cancer incidence rates for New Bedford CT 6528 during the 17-year time period 1982–1998. These data are summarized in Tables 3 through 6. To evaluate possible trends over time, these data were also analyzed by three smaller time periods, 1982–1986, 1987–1994, and 1995–1998. SIRs were not calculated for some cancer types in smaller time periods due to the small number of observed cases (less than five). However, the expected

number of cases was calculated during each time period, and the observed and expected number of cases was compared to determine whether excess numbers of cancer cases were occurring.

1. Cancer Incidence in New Bedford CT 6528

During the overall time period 1982–1998, cancer incidence in New Bedford CT 6528 occurred approximately at or near the expected rate for the eight cancer types evaluated. Some rates were higher or lower but generally, not at a level of statistical significance. The exceptions included lung cancer, which occurred statistically significantly less often than expected among males and females combined as well as among females, and leukemia, which was statistically significantly elevated in this area of New Bedford among females.

Bladder cancer occurred at approximately the expected rate in New Bedford CT 6528 during each time period evaluated and during the overall 17-year time period 1982–1998 (14 cases observed vs. 16 expected). During the most recent time period, 1995–1998, four individuals were diagnosed with bladder cancer versus 3.5 expected.

The incidence of breast cancer was about as expected during 1982–1998 (56 cases observed vs. 57.5 expected). One male was diagnosed with breast cancer during the 17-year period. During the earliest time period 1982–1986, 15 individuals were diagnosed with breast cancer compared to 14.8 expected. During 1987–1994, breast cancer occurred slightly less often than expected (24 cases observed vs. 27.9 expected). Finally, during the most recent time period, 1995–1998, more individuals in New Bedford CT 6528 were diagnosed with breast cancer than expected (17 cases observed vs. 13.7 expected, SIR=124). However, this elevation was based on approximately 3 additional cases over the expected number and was not statistically significant (95% CI =72–199).

The incidence of kidney cancer was greater than expected in CT 6528 based on the state rate for the overall time period 1982–1998 (12 cases observed vs. 8.7 expected, SIR=139). During the earlier time periods 1982–1986 and 1987–1994, kidney cancer occurred about as often as expected in CT 6528. The elevation observed in the overall time period 1982–1998 was primarily due to an increase in diagnoses among males in this census tract during the most recent time period 1995–1998 (5 cases observed vs. 1.3 expected, SIR=380, 95% CI=123–887).

Although this result was statistically significant, it was based on a relatively small number of cases and the wide 95% confidence interval indicate that the increased SIR is somewhat unstable. Therefore, it is uncertain, based on this data, whether the increase represents a true elevation in the incidence of kidney cancer among males in this area of New Bedford. Females experienced kidney cancer approximately at or near the rate expected during each time period.

Leukemia occurred more often than expected in New Bedford CT 6528 during the 17-year time period 1982–1998 (12 cases observed vs. 7 expected, SIR=171, 95% CI=88–299). This elevation was due to a statistically significant elevation in the incidence of this cancer type among females during 1982–1998 (8 cases observed vs. 2.9 expected, SIR=272, 95% CI=117–537). When leukemia incidence rates were evaluated over time, in general, males were diagnosed with leukemia at approximately the rate expected while females were diagnosed slightly more often than expected during each time period. However, these elevations were based on approximately one to two additional cases during each smaller time period, and the elevations were not statistically significant. Of note, no diagnoses of leukemia were reported among children in CT 6528 during the 17-year time period 1982–1998.

Residents of New Bedford CT 6528 experienced liver cancer at about the rate expected during 1982–1998 (2 cases observed vs. 2 expected) and during each smaller time period evaluated, 1982–1986, 1987–1994, and 1995–1998.

Overall, during the 17-year time period 1982–1998, the incidence of lung cancer was statistically significantly lower than expected among males and females combined in this area of the city (41 cases observed vs. 58.1 expected, SIR=71, 95% CI=51–96) and among females when evaluated separately by gender (10 cases observed vs. 22.2 expected, SIR=45, 95% CI=22–83). Although not statistically significant, males in New Bedford CT 6528 also experienced a lower than expected rate of lung cancer during this time period (31 cases observed vs. 36 expected, SIR=86). Similar trends were observed when incidence rates were evaluated for lung cancer over time.

Non-Hodgkin's lymphoma (NHL) occurred slightly less often than expected in New Bedford CT 6528 during 1982–1998 (10 cases observed vs. 12.9 expected, SIR=77). Further, this trend was consistent when males and females were evaluated separately (5 cases among males observed vs.

6.8 expected; 5 cases among females observed vs. 6.1 expected). During each of the smaller time periods evaluated, (1982–1986, 1987–1994, and 1995–1998), NHL occurred approximately at or below the expected rate. However, during 1987–1994, five females in CT 6528 were diagnosed with NHL where three cases were expected. This slight elevation was not statistically significant. Moreover, the incidence of NHL among females has declined in the most recent time period 1995–1998 (0 cases observed vs. 1.6 expected).

A slight elevation in the incidence of pancreatic cancer was observed in New Bedford CT 6528 during the 17-year time period 1982–1998 (10 cases observed vs. 8.4 expected). However, this slight elevation was based on about one additional case over the expected number and was not statistically significant. Similar rates were observed when males and females were evaluated separately by gender (5 cases observed among males vs. 4.1 expected; 5 cases observed among females vs. 4.2 expected). During 1982–1986 and 1987–1994, pancreatic cancer occurred at about the rates expected. However, during the most recent time period, 1995–1998, a slight elevation was observed where four individuals were diagnosed with pancreatic cancer and two cases were expected. The two additional cases were diagnosed among females (3 cases observed vs. 1 expected). Again, this slight elevation was based on an increase of two cases over the expected number and was not statistically significant.

2. Review of Cancer Risk Factor Information

As previously mentioned, cancer is not just one disease but is a term used to describe a variety of different diseases. As such, studies have generally shown that different cancer types have different causes, patterns of incidence, risk factors, latency periods (period between exposure and development of disease), characteristics, and trends in survival. Available information from the MCR related to age and gender, as well as other factors related to the development of cancer such as smoking and occupation, were reviewed for those cancer types that had statistically significant elevations in incidence in New Bedford CT 6528. These cancer types included leukemia and kidney cancer. Information for each of these cancer types was compared to known or established incidence trends to assess whether any unexpected patterns exist among these cases. For detailed information regarding risk factors associated with these and the other six cancer types evaluated in this report, please refer to Appendix A.

Age and gender are risk factors in many types of cancers, including leukemia and kidney cancer. A review of age-group specific SIRs by census tract was not possible because of the small numbers of cases in each group. However, where there was a statistically significant elevation of cancer cases in New Bedford CT 6528, the distribution of cases by age was reviewed.

Tobacco use is also a known or suggested causal risk factor in several types of cancer, including kidney cancer. The smoking status of individuals diagnosed with this cancer in New Bedford CT 6528 during the years 1982–1998 was reviewed. However, results of smoking status analysis should be interpreted with caution because of the number of individuals for which smoking status was unknown.

In some studies, an association has been found with exposures to specific occupations and an increase in incidence of kidney cancer and leukemia. Therefore, occupational information as reported by the MCR at the time of diagnosis was reviewed for individuals diagnosed with these two cancer types in CT 6528 to determine the role that occupational factors may have played in the development of these cancers in this area of New Bedford. It should be noted, however, that occupational data reported to the MCR are generally limited to job title and often do not include specific job duty information that could further define exposure potential for individual cases. Further, these data are often incomplete as occupational information can be reported as unknown, at home, or retired.

As described below, leukemia describes a group of different cancers that occur in the blood-forming organs and is classified by cell type. The different types of leukemia occur with different frequencies in the general population. Therefore, histologic (cell type) distribution was reviewed for diagnoses of leukemia in New Bedford CT 6528. Patterns of disease were compared to known or established incidence trends to assess whether any unusual patterns exist in these areas.

1. Leukemia

(a) Histology, Age, and Gender Distribution

During the period 1982–1998, a statistically significant elevation in the incidence of leukemia among females was noted in New Bedford CT 6528. Leukemia is classified into four main sub-

types: acute lymphoid leukemia (ALL), acute myeloid leukemia (AML), chronic lymphoid leukemia (CLL), and chronic myeloid leukemia (CML). There are also several rare types of leukemia (e.g., hairy cell leukemia, myelomonocytic leukemia). In the state of Massachusetts during the time period 1982–1998, 30.8% of all leukemias diagnosed among females were AML, 23.2% were CLL, 13.8% were ALL, 11.5% were CML, and 20.7% were not classifiable or were other histology types. Among females diagnosed with leukemia in New Bedford CT 6528 during the same time period, three were diagnosed as CLL (37.5%), two were diagnosed as ALL (25.0%), one was diagnosed as CML (12.5%), and two were not classified as one of the four major subtypes (25.0%).

The four main leukemia sub-types have different risk factors suspected to be associated to their development and occur with different frequency among adults and children. ALL occurs predominantly among children (peaking between ages 2 and 3 years). An elevation in the incidence of ALL is also seen among older individuals, which typically begins at approximately 40–50 years of age and peaks at about age 85 (Linet M.S. and Cartwright R.A. 1996). Among females in New Bedford CT 6528, no children were diagnosed with leukemia (of any subtype). Two individuals were diagnosed with ALL. Both were over the age of 65. CLL is chiefly an adult disease; ninety percent of individuals diagnosed with CLL are over the age of 50 (Miller et al. 1990). In New Bedford CT 6528, three females were diagnosed with CLL and all were over the age of 60 with an average age at diagnosis of 80 years. AML is the most common leukemia among adults, with an average age at diagnosis of 65 years (ACS 2000). In addition, it is more common among males than females. In New Bedford CT 6528, no females were diagnosed with AML. CML can occur at any age; however, it is most frequently diagnosed between the ages of 40 and 50 years (ACS 1999). One female was diagnosed with CML in New Bedford CT 6528 during 1982–1998. The remaining two females were not diagnosed with one of the major four sub-types of leukemia but were diagnosed with less common types of leukemia. Therefore, based on the information reviewed, it appears that the majority of leukemia diagnoses among females in this area of New Bedford represented a variety of different cell types with varying sets of risk factors. The average age of diagnosis for all leukemia subtypes combined was 67 years.

(b) Occupation

Several occupational exposures have been identified as playing a role in the development of leukemia. For example, exposures to particular chemicals are thought to increase the risk of developing certain kinds of leukemia. Exposure to ionizing radiation, chronic, high-dose exposure to pesticides, and other chemicals such as benzene, have also been suggested as possible risk factors for leukemia (Linet and Cartwright 1996). Chronic occupational exposure to benzene has been established as a cause of AML. High doses of radiation among survivors of atomic bomb blasts or nuclear reactor accidents are associated with an increased incidence of AML, CML, and ALL, but no association has been established for lower doses such as those used in medical diagnostics.

Among the eight females diagnosed with leukemia in New Bedford CT 6528, occupation was unknown for half of the individuals. Of the remaining four, none indicated a job that has been associated with an increased risk of leukemia.

2. Kidney Cancer

(a) Age and Gender Distribution

While kidney cancer occurred more often than expected in New Bedford CT 6528 overall, in the most recent time period, 1995–1998, males in this area experienced a statistically significant elevation in the incidence of kidney cancer. Females experienced kidney cancer at approximately the rate expected during all three smaller timer periods evaluated.

Kidney cancer most often occurs in the fifth and sixth decades of life (50–70 year age group) and occurs about twice as often in males versus females (ACS 2001). In New Bedford CT 6528, the ages at diagnosis among males during the 1995–1998 time period ranged from 48 to 79 years. The average age at diagnosis (68 years) was consistent with the established age pattern for this cancer type and a higher incidence among older age groups.

(b) Smoking Status

Cigarette smoking is the most important known risk factor for kidney cancer. Smoking increases the risk of developing kidney cancer by 30% to 100% (ACS 2001). In both males and females, a statistically significant dose response relationship between smoking and this cancer type has

been observed. That is, a greater risk of developing kidney cancer exists among individuals who smoke more. Approximately one-third of kidney cancers in men and one-quarter in women may be caused by cigarette smoking (ACS 2001).

Of the five males diagnosed with kidney cancer in CT 6528 during 1995–1998, only one reported a smoking status (non-smoker), and the remaining four had an unknown smoking status. In Massachusetts as a whole, 47% of males diagnosed with kidney cancer during 1995–1998 were current or former smokers at the time of diagnosis, 25% were non-smokers, and 28% had unknown smoking status (see Figure 3). Because smoking status was unknown for four out of the five males diagnosed with this disease in CT 6528 between 1995 and 1998, the role smoking may have played in the development of kidney cancer among these individuals cannot be determined in this report.

(c) Occupation

Although kidney cancer is not generally considered an occupationally associated cancer, some studies have suggested that environmental and occupational factors may be associated with its development. Some studies have shown an increased incidence of this cancer type among leather tanners, shoe workers, and workers exposed to asbestos. In addition, exposure to cadmium is associated with an increased incidence of kidney cancer, particularly among men who smoke. In addition, workplace exposure to organic solvents, such as trichloroethylene (TCE), may increase the risk of this cancer (ACS 2001). More recently, renal cell carcinoma (RCC), the most common type of kidney cancer, has been suggested to be associated with occupational exposure to petroleum, tar, and pitch products. However, studies of oil refinery workers and petroleum products distribution workers have not identified a definitive relationship between exposure to gasoline or other petroleum products and kidney cancer (Lineham et al. 1997; McLaughlin et al. 1996).

Review of occupational information reported to the MCR for the five males diagnosed with kidney cancer in New Bedford CT 6528 during 1995–1998 did not reveal any jobs where exposures associated with the development of kidney cancer would have been likely. One individual reported an occupation as "retired." It is important to note that job title information reported to the MCR is generally limited in nature. However, information gathered from death

records and/or town residence lists indicated that workplace exposures may have been possible for two of these individuals.

C. Analysis of Geographic Distribution of Cancer Incidence

In addition to determining census tract-specific incidence rates for each cancer type, an evaluation was conducted to determine whether any specific cancer type appeared to be concentrated in any one area of New Bedford CT 6528 during the time period evaluated in this report, (1982–1998). Place of residence at the time of diagnosis was mapped for all individuals diagnosed with cancer in this area to assess any possible geographic concentration of cases. To address cancer concerns in relation to Rodney Metals and Brittany Dye, this review also specifically focused on the geographic pattern of cancer cases in neighborhoods close to the two facilities. In addition, the pattern of cancer in the areas surrounding all 21E sites identified in New Bedford CT 6528 was also considered.

As previously mentioned, cancer is one word that describes many different diseases. Therefore, the occurrence of different types of cancer among individuals in a particular geographic area is not indicative of an unusual or atypical pattern. For the purposes of this evaluation, the geographic distribution of each cancer type was evaluated separately to determine whether an atypical pattern of any one type occurred. In addition, cancers that may be associated with specific environmental exposures of concern were also evaluated geographically to determine whether any atypical patterns of cases exist that may suggest an association with a potential environmental factor.

For the majority of cancer types evaluated, review of the geographic distribution of cancer diagnoses in New Bedford CT 6528 revealed no apparent spatial patterns at the neighborhood level that could not be attributed to factors such as areas of higher population density. For example, although a statistically significant elevation of leukemia among females was observed in this area during 1982–1998, the diagnoses were fairly evenly distributed throughout CT 6528 and seemed to coincide closely with the pattern of population in these areas. However, the five males diagnosed with kidney cancer during 1995–1998 appeared to be concentrated in the northeast corner of the census tract where both Rodney Metals and Brittany Dye are located. Specifically, all five males diagnosed with kidney cancer between the years 1995–1998 resided

in relatively close proximity to these facilities at the time of diagnosis. Review of specific case information available through the MCR did not suggest a single common risk factor for these individuals other than place of residence. Finally, no apparent geographic concentrations of individuals with cancer were noted in areas near any of the other MDEP 21E sites.

VII. DISCUSSION

Six of the eight cancer types evaluated in this report in New Bedford CT 6528 during the time period 1982–1998 were approximately at or slightly above or below the expected rates. Statistically significant elevations in incidence were observed for leukemia among females in this area during the overall time period 1982–1998. In addition, males experienced kidney cancer more often than expected in the most recent time period 1995–1998. This elevation was also statistically significant. However, a number of cancer types occurred less often than expected in New Bedford CT 6528. For example, lung cancer occurred statistically significantly less often than expected based on state rates during 1982–1998.

In addition to the cancer incidence analyses performed in New Bedford CT 6528, an analysis of available information to determine possible sources of environmental contamination in this area and whether these sources could result in environmental exposures to nearby residents was conducted. As a result of this part of the investigation, it was determined that some of the chemicals used at Brittany Dye and, at one time, Rodney Metals belong to a class of compounds called chlorinated volatile organic compounds (VOCs). These compounds are found throughout the environment mostly as a result of industrial activities (ATSDR 1997). Due to some of their chemical characteristics (high vapor pressures), VOCs easily disperse into air and, therefore, the most likely way for people to be exposed to these chemicals is volatilization to air. Exposures to VOCs are typically expected to occur in certain individuals and under specific conditions. Some examples include inhalation exposures to workers involved in degreasing operations, inhalation and ingestion exposures to individuals who use private wells located near disposal/contamination sites, and inhalation by consumers who use products containing VOCs in areas of poor ventilation (Wu and Schaum 2000).

At Rodney Metals, two specific VOCs, TCE and 1,1,1-TCA, as well as several of their chlorinated breakdown products (i.e., 1,1-DCE and vinyl chloride) were detected in groundwater below the surface as well as in surface water samples taken from New Bedford Harbor. Sampling of groundwater monitoring wells, MW-106 and MW-107, situated on the eastern-northeastern side of the Rodney Metals facility, away from residential neighborhoods, showed the highest concentrations of TCE and 1,1,1-TCA. These two chlorinated VOCs were detected at levels exceeding health-based guidelines for drinking water. However, although TCE, 1,1,1-TCA and several of their breakdown products exceeded drinking water screening values in groundwater in this area, exposure to contaminated groundwater is unlikely for individuals residing in neighborhoods abutting the Rodney Metals facility. As discussed, groundwater in this area is not being used for drinking water purposes, and therefore, ingestion of contaminated groundwater would not be expected. In addition, groundwater underneath the Rodney Metals facility flows in an east-northeasterly direction away from residences adjacent to the facility. Therefore, exposure to VOCs through inhalation and dermal contact related to groundwater also would not be expected to occur for residents who live near the facility. Further, even though chemical contaminants may be present at concentrations exceeding health based comparison values or standards, they are located below ground surface, and contact with either the chemicals themselves or the environmental media where these chemicals were detected is not likely. Based on this information, it is unlikely that adverse health effects associated with subsurface contamination identified at the Rodney Metals facility would occur for nearby residents.

Like VOCs, there are a variety of ways that polycyclic aromatic hydrocarbons (PAHs) enter the environment. For example, PAHs are contained in tobacco smoke, wood smoke, and a variety of foods, particularly smoked foods. As a result, the greatest sources of exposure to PAHs for most of the United States population are through contaminated air and ingestion of the compounds in foodstuffs, including cereals, grains, flour, bread, vegetables, fruits, meat, and processed or pickled foods. In addition, the general population may be exposed to PAHs in drinking water, through skin contact with soot and tars, and via ingestion and inhalation (during cooking) of grilled or smoked foods (ATSDR 1995a). Mineral oil and several of its constituents, including toluene and a variety of PAHs that included benzo(a)pyrene, fluoranthene, and naphthalene were detected in groundwater and subsurface soil at the Rodney Metals facility. Although some of these compounds were detected at concentrations exceeding health-based/clean-up standards, the

area of contamination was confined to the northeast corner of the facility. Similar to the VOCs detected on the eastern-northeastern side of the Rodney Metals facility, direct contact with the mineral oil (and the PAHs and toluene present in the mineral oil) by individuals residing in neighborhoods abutting the facility appears to be unlikely. This is because the contamination is located below the surface, and groundwater flows away from the residential areas.

Therefore, although releases of contaminants to the subsurface occurred at Rodney Metals in the past, currently, there is no information to suggest that the contaminants detected in subsurface media at the Rodney Metals facility and surface water across East Rodney French Boulevard are posing a health threat to individuals visiting or residing in neighborhoods adjacent to the facility.

It has been reported that stack and/or fugitive releases of VOCs to the air from both Rodney Metals and Brittany Dye have occurred in the past. Specifically, review of TRI release data from 1987 to 2000 indicates that Rodney Metals released 1,1,1-TCA to the air prior to 1996. Brittany Dye has reported release of 1,1,1-TCA to the air prior to 1995 and release of TCE to the air for the years 1995 to 2000 (USEPA 2003). However, there are no sampling data available to determine whether these emissions resulted in concentrations of VOCs in the ambient air in the vicinity of these facilities. While available information indicates that the prevailing wind direction in the city of New Bedford is generally from the west (City of New Bedford 2003), specific data on environmental conditions such as wind direction and speed in areas immediately surrounding Rodney Metals and Brittany Dye were unavailable. Therefore, causal conclusions cannot be drawn regarding whether or not emission releases from the two facilities, particularly emissions of chlorinated VOCs, could contribute to the development of health effects reported by individuals living in the vicinity of the two facilities of concern. Nevertheless, although it is not possible to determine whether individuals residing in the vicinity of Rodney Metals and Brittany Dye are being exposed to air emissions, information pertaining to possible health effects from inhalation exposure to TCE and 1,1,1-TCA was further investigated.

Occupational studies of workers exposed to unmeasured levels of TCE in air have been unable to provide definitive evidence for an increased cancer risk and are often limited by multiple chemical exposures and small numbers of study participants. In general, evidence that TCE is carcinogenic to humans is inconclusive and requires further study. While some studies have

shown no association between inhalation exposure to TCE and cancer, others have found slight increases in a number of cancer types including cancers of the kidney, stomach, liver, prostate, bladder and NHL. However, problems with study design were often reported, and associations were often based on small numbers of individuals and complicated by confounding factors (ATSDR 1997).

As observed in several toxicological investigations in experimental mice and rats, TCE has been shown to cause liver, lung, and kidney cancer and, to a lesser extent, lymphomas and leukemia; however, there are limitations to using these types of studies when evaluating potential health effects to humans. For example, animal studies frequently use relatively high concentrations of chemicals that are several orders of magnitude higher than those to which humans may be exposed either in occupational or environmental settings and therefore, often do not represent human exposure conditions (Wartenberg et al. 2000, Lash et al. 2000, ATSDR 1997).

Available information does not indicate that 1,1,1-TCA causes cancer. No studies were located that showed an association between inhalation of 1,1,1-TCA among humans and cancer. Studies conducted in both rats and mice exposed to 1,1,1-TCA in air demonstrated no evidence of cancer health effects (ATSDR 1995b).

As discussed, although kidney cancer in New Bedford CT 6528 occurred approximately at or below expected rates during the two earlier time periods examined (1982–1986 and 1987–1994), the incidence of kidney cancer among males was statistically significantly elevated in CT 6528 during the most recent time period evaluated 1995–1998. Furthermore, the individuals that were diagnosed with this disease during this time period resided, at the time of diagnosis, within relatively close proximity to the two facilities evaluated in this report. Individuals diagnosed with kidney cancer during the earlier time periods were generally more evenly distributed throughout the census tract. As discussed, although somewhat inconclusive, some epidemiologic evidence has shown support for an association between occupational exposure to TCE and kidney cancer, liver cancer, and, to a lesser extent, for NHL. Therefore, if the incidence of kidney cancer in this area of the South End of New Bedford were to be attributed to an environmental exposure to TCE, then it might be expected that NHL and, in particular, liver cancer also would be occurring at a greater incidence in this area. Close review of the spatial

distribution of these diseases in relation to Rodney Metals and Brittany Dye revealed no unusual patterns of liver cancer or NHL in the vicinity of the two facilities throughout the entire 17-year period evaluated; in general, diagnoses of liver cancer and NHL were fairly evenly distributed throughout CT 6528. Also, the incidence of liver cancer and NHL in CT 6528 was either less than or equal to the expected rates during 1982–1998.

Leukemia among females also occurred at a rate that was statistically significantly elevated in CT 6528 from 1982–1998. However, among males, the incidence of leukemia was approximately equal to the rate expected during this time. The pattern of leukemia did not indicate a concentration or an atypical distribution of individuals diagnosed in the area surrounding Rodney Metals or Brittany Dye, and most individuals did not reside in this area of the census tract. No clear evidence, in experimental animal or human studies, points to an association between exposure to TCE in ambient air and the development of leukemia. While there is some evidence in the epidemiologic literature that suggests an association between exposure to TCE in drinking water (when mixed with other contaminants) and childhood leukemia (ATSDR 1997, MDPH 1997, Cohn et al. 1994, Fagliano et al. 1990, Wartenberg et al. 2000), the groundwater in the area of Rodney Metals and Brittany Dye is not a drinking water source. Further, there were no cases of childhood leukemia in New Bedford CT 6528 where Rodney Metals and Brittany Dye are located. For these reasons, it does not appear likely that the increased occurrence of leukemia observed among females residing in New Bedford CT 6528 from 1982–1998 is likely associated with past or current activities related to the two facilities. Moreover, as previously discussed, leukemia is not one type of cancer but is classified into four main types of disease; each type of leukemia has different risk factors suspected to be associated with their development. In CT 6528, a variety of different types of leukemia were diagnosed among individuals in this area with no pattern of any one type occurring. Therefore, this information suggests that leukemia among females in CT 6528 is not likely related to a common environmental factor in this area but more likely related to the presence of individual known or suspected risk factors for the specific subtypes of leukemia among these persons.

For the majority of cancer types evaluated, analysis of the geographic distribution of residences of individuals in New Bedford CT 6528 diagnosed with cancer during 1982–1998 did not reveal any atypical spatial patterns of disease. Specifically, the distribution of cancer diagnoses varied

geographically and seemed to coincide closely with the pattern of population in this census tract. However, males diagnosed with kidney cancer during the most recent time period evaluated appeared to be concentrated in the northeast corner of the census tract. Specifically, all five individuals diagnosed with kidney cancer between 1995–1998 were located in close proximity to the two facilities. No apparent geographic concentrations of individuals with cancer were noted in areas near any of the other MDEP 21E sites.

Available risk factor information for cancer types that demonstrated a statistically significant elevation during 1982–1998, leukemia and kidney cancer, was compared to known or established incidence trends to assess whether any unexpected patterns exist in New Bedford CT 6528. The age distribution of individuals diagnosed with these cancer types was generally consistent with disease patterns described in the epidemiological literature. Review of available information from the MCR on smoking indicated that smoking status was unknown for four out of five of the individuals diagnosed with kidney cancer during the most recent time period. While information reported to the MCR on occupation for these five individuals was somewhat limited, information gathered from death records and/or town residence lists indicated that workplace exposures may have contributed to the disease for two of these individuals. Of these five males diagnosed with kidney cancer during this time period, three had lived at their address for more than 30 years at the time of their cancer diagnosis, one was a short-term resident of the area, and residential history information could not be confirmed for the remaining individual, making it more likely that he lived at the reported address for a short period of time. Finally, the role that other personal risk factors, such as genetics and diet, may have played in the incidence of kidney cancer among these individuals could not be evaluated in this report.

Residents of the South End area of New Bedford near Rodney Metals and Brittany Dye also conveyed concerns about acute non-cancer health outcomes, such as upper respiratory irritation, nausea, and headaches. In 1995, Rodney Metals switched to cleaner technologies to reduce waste generation, and degreasing operations using chlorinated VOCs were replaced by aqueous based processes using several acidic chemicals like hydrofluoric and nitric acids (USEPA 2003). TRI data indicates that from 1995 to 2000 Brittany Dye emitted TCE and prior to 1995, the facility emitted 1,1,1 TCA. As a result, individuals in the area immediately surrounding the facilities have the potential to detect several distinctive odors attributed to these chemicals. For

example, hydrofluoric and nitric acids have strong acidic, irritating odors; while several of the chlorinated VOCs, namely TCE and 1,1,1-TCA, have overpoweringly sweet, chloroform-like odors (HSDB 2002a-e). In addition, it is possible that some residents living in close proximity to the two facilities could experience some irritant effects associated with VOCs in ambient air. It is important to note that some individuals, particularly those with pre-existing conditions such as asthma and allergies may experience irritant reactions that would not necessarily impact the general population similarly. Studies of workers chronically exposed to TCE in air have reported sleepiness, dizziness, headaches, and nausea, and there is some suggestion that people who breath high levels of TCE may develop damage to the nerves in the face (ATSDR 1997). Inhalation of air containing high levels of 1,1,1-TCA for a short period of time can cause dizziness, lightheadedness and a possible loss of coordination (ATSDR 1995b).

Based on the environmental information reviewed in this evaluation, including environmental data for the Rodney Metals and Brittany Dye facilities, it does not appear that environmental exposures played a major role in the incidence of most cancers in New Bedford CT 6528 during the 17-year time period 1982–1998. However, it is important to note that data regarding ambient air concentrations of emissions associated with these two facilities are not available. Therefore, without these data, it is not possible to evaluate whether there are elevated levels of VOCs present in the ambient air adjacent to these facilities and whether they may be contributing to cancer or non-cancer health effects experienced by residents in this area. In addition, this evaluation cannot determine the exact cause (either environmental or otherwise) of any one individual's cancer diagnosis. Although some individuals diagnosed with kidney cancer were more geographically concentrated in the vicinity of the Rodney Metals and Brittany Dye facilities, it is not possible to determine whether exposures from these two facilities may in fact be related to the development of kidney cancer among these individuals.

VIII. CHILD HEALTH ISSUES

ATSDR and MDPH, through ATSDR's Child Health Initiative, recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their environment. Children are at a greater risk than adults from certain kinds of exposure to hazardous substances emitted from waste sites. They are more likely to be

exposed because they play outdoors and because they often bring food into contaminated areas. Because of their smaller stature, they might breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, resulting in higher doses of contaminant exposure per body weight. The developing body systems of children can sustain permanent damage if certain toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care. The incidence and patterns of cancer among children in New Bedford CT 6528 is discussed in Section VI ("Analysis of Cancer Incidence in New Bedford CT 6528") of this report. No exposures were identified that would indicate that children are being impacted by the facilities; however, air data are not available to determine whether exposures to chemicals released into the air could be possible.

IX. LIMITATIONS

This assessment is an investigation that analyzes descriptive health outcome data for cancer to determine whether the pattern or occurrence of selected cancers is unusual. The purpose of this investigation is to evaluate the patterns of cancer in a geographical context in relation to available information about factors, including environmental factors, related to cancer to see whether further investigation seems warranted. Information from descriptive analyses, which may suggest that a common etiology (or cause) is possible, can serve to identify areas where further public health actions may be warranted. Inherent limitations in this type of analysis and the available data make it impossible to determine the precise causal relationships or synergistic roles that may have played a part in the development of individual cancers in these communities. Also, this type of analysis cannot determine what may have caused any one individual's cancer. Cancers in general have a variety of risk factors known or suggested to be related to the etiology (cause) of the disease that could not be evaluated in this report. It is believed that many cancers are related largely to behavioral factors such as cigarette smoking, diet, and alcohol consumption. Other factors associated with cancer are socioeconomic status, heredity/genetics, race, and geography. It is beyond the scope of this report to determine the causal relationship of these factors and the development of cancer or other health outcomes in New Bedford CT 6528.

Like the analysis of descriptive health outcome data, there are several limitations encountered when analyzing the environmental data. As a result, these limitations make it impossible to determine the role potential exposures to specific contaminants or to environmental media harboring those contaminants may have played in the development of an individual's cancer. That is, due to historical and analytical data gaps in the environmental data, this type of evaluation cannot conclude what may have caused any one individual's cancer, whether it be environmental, behavioral, viral, genetic or a combination of these elements.

X. CONCLUSIONS

- ATSDR requires that one of five conclusion categories be used to summarize findings of a health consultation. These categories are as follows: (1) Urgent Public Health Hazard; (2) Public Health Hazard; (3) Indeterminate Public Health Hazard; (4) No Apparent Public Health Hazard; (5) No Public Health Hazard. A category is selected from site-specific conditions such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, presence of physical hazards, and community health concerns. Although no indication was found that people are currently exposed to chemicals from the Rodney Metals or Brittany Dye facilities, data regarding ambient air concentrations of emissions associated with these two facilities are unavailable making it difficult to evaluate whether chemicals are being released into the air that might be harmful. Therefore, ATSDR classifies the Rodney Metals and Brittany Dye facilities, in the past, present, and future, as posing an Indeterminate Public Health Hazard.

- Of the eight cancer types evaluated in the community of New Bedford CT 6528 during 1982–1998, the majority occurred approximately at or near the expected rate. The exceptions included statistically significant elevations in the incidence of leukemia among females during the overall time period 1982–1998 and kidney cancer among males during the most recent time period 1995–1998. The rate of lung cancer in this area was statistically significantly lower than expected during this time.

- With the exception of kidney cancer, review of the geographic distribution of cancer in New Bedford CT 6528 revealed no apparent spatial patterns at the neighborhood level that could not be attributed to factors such as areas of higher population density. Further, no unexpected concentrations of diagnoses were observed close to the Rodney Metals and Brittany Dye properties or other environmental release sites in this area.

- A concentration of five individuals diagnosed with kidney cancer was observed within close proximity to the Rodney Metals and Brittany Dye facilities. Available data on smoking and occupation were limited, and the possible role of these and other risk factors could not be evaluated for these individuals. It is important to note, however, that contaminants of concern have been suggested in some studies to be associated with kidney cancer, liver cancer, and, to a lesser extent, NHL. Neither NHL nor liver cancer displayed similar geographic patterns of incidence.

- In the past, two releases of mineral oil and one release of chlorinated VOCs occurred at the Rodney Metals facility. However, based on the data reviewed, it does not appear that individuals living in the vicinity of Rodney Metals are being exposed to this subsurface contamination, and these releases are not likely related to cancer among residents of the surrounding neighborhoods. Chlorinated VOCs were also detected in surface water in New Bedford Harbor. However, based on the levels of VOCs detected in surface water, the potential for adverse health effects associated with recreational use of surface water is not likely.

- No ambient air sampling data exist, and therefore, it cannot be determined if individuals residing in the vicinity of Rodney Metals and Brittany Dye are being exposed to elevated levels of chlorinated VOCs, namely TCE and 1,1,1-TCA. However, for seven of the eight cancer types evaluated, no unusual patterns of incidence or unexpected trends were observed in this area of New Bedford.

- Residents of the South End area of New Bedford near Rodney Metals and Brittany Dye also conveyed concerns about acute non-cancer health outcomes, such as upper respiratory irritation, nausea, and headaches. It is possible that some residents living in close proximity to these facilities could experience some irritant effects associated with

VOCs in ambient air or nuisance odors, particularly those with pre-existing medical conditions such as asthma or allergies. Such individuals may experience irritant reactions that would not necessarily impact the general population similarly.

- Analysis of environmental and non-environmental risk factors, as well as an evaluation of the geographic distribution of cases, did not reveal a clear pattern suggesting that environmental exposures to chemicals from Rodney Metals or Brittany Dye contributed to the incidence of most cancers in New Bedford CT 6528 during the 17-year time period 1982–1998. Moreover, the available data do not show a common pattern that would suggest that any single risk factor (environmental or otherwise) is likely to be responsible for the incidence of cancer in this community. Rather, a combination of factors such as smoking, diet, and exercise may be contributing to incidence rates in this area of New Bedford.

XI. RECOMMENDATIONS

- MDPH should further characterize opportunities for exposure if additional environmental data on air emissions or ambient air quality in the vicinity of Rodney Metals and Brittany Dye become available.

- Due to the unpleasant odors and nuisance conditions being reported by individuals residing in and visiting areas surrounding the two facilities, MDPH recommends that the MDEP work with both Rodney Metals and Brittany Dye to determine any additional actions that could reduce potential impacts to residents in the surrounding neighborhoods.

- The New Bedford Health Department should continue to work with the community and the BEHA's Environmental Health Education Program to provide educational information and conduct outreach activities to New Bedford residents about ways to reduce their risk of cancer. This could be in concert with ongoing health education and outreach activities currently underway by MDPH and EPA in New Bedford.

- The MDPH/BEHA should continue to monitor the incidence of all cancer types in the city of New Bedford through the Massachusetts Cancer Registry.

XII. PUBLIC HEALTH ACTION PLAN

The Public Action Plan for the neighborhood surrounding Rodney Metals and Brittany Dye in the South End of New Bedford, Massachusetts, contains recommendations for actions to be taken at and in the vicinity of the above-mentioned facilities subsequent to the completion of this health consultation on cancer incidence assessment and possible exposure to chemicals released from Rodney Metals and Brittany Dye. The purpose of the Public Health Action Plan is to ensure that this health consultation not only identifies potential public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the ATSDR/MDPH to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by ATSDR/MDPH are as follows:

- If additional environmental data on air emissions or ambient air quality in the vicinity of Rodney Metals and Brittany Dye become available, MDPH will continue efforts to provide a more comprehensive review of potential exposures to residents living near these facilities.

- Based on the observed geographic concentration of kidney cancer diagnoses in proximity to the Rodney Metals and Brittany Dye facilities during the most recent time period, 1995–1998, the MDPH will provide additional follow-up for all individuals diagnosed with this cancer type in New Bedford CT 6528 over the seventeen years evaluated, 1982–1998. Specifically, these 12 individuals (or their families) who provide informed consent will have the opportunity for personal interviews and/or medical records review by an environmental/occupational physician to determine any possible environmental or other factors that may have contributed to their diagnosis.

- The MDPH/BEHA will continue to monitor the incidence of all cancer types in the city of New Bedford through the Massachusetts Cancer Registry.

- At the request of the New Bedford Health Department, BEHA's Environmental Health Education Program could work to incorporate activities aimed at cancer risk reduction into their existing education and outreach efforts.

- ATSDR and MDPH will reevaluate and expand the Public Health Action Plan when needed. New environmental, toxicological, or health outcome data may determine the need for additional actions at the focus area.

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FIGURES

TABLES

PREPARER

This document was prepared by the Bureau of Environmental Health Assessment of the Massachusetts Department of Public Health. If you have any questions about this document, please contact Suzanne K. Condon, Assistant Commissioner of BEHA/MDPH at 250 Washington Street, 7th Floor, Boston, MA 02108.

Appendix A

Risk Factor Information for Selected Cancer Types

Appendix B

ATSDR Glossary of Environmental Health Terms

CERTIFICATION

The Health Consultation on *Assessment of Environmental Concerns: Rodney Metals and Brittany Dyeing and Printing Corporation and Evaluation of Cancer Incidence in New Bedford's South End 1982-1998* was prepared by the Massachusetts Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

for Roberta Erlwein, M.P.H.
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