

SECTION 5.0 – BASELINE HUMAN HEALTH RISK ASSESSMENT

5.0	BASELINE HUMAN HEALTH RISK ASSESSMENT	7
5.1	Methodology	7
5.2	Site Characterization	9
5.3	Hazard Assessment	11
5.3.1	115kV Switchyard.....	13
5.3.2	Personnel Buildings and Parking Lot Areas	14
5.3.3	Plant Area.....	14
5.3.4	Warehouse 2/3	15
5.3.5	345 kV Transmission Line Area	16
5.3.6	Bailey Farmhouse.....	16
5.3.7	ISFSI	17
5.3.8	Shoreline Sediments	18
5.3.9	Shellfish.....	18
5.3.10	Groundwater.....	20
5.3.11	Produce.....	20
5.4	Exposure Assessment.....	21
5.4.1	Exposure Point Concentrations	21
5.4.2	Exposure Scenarios.....	22
5.5	Toxicity Assessment.....	27
5.5.1	Non-Carcinogens.....	27
5.5.2	Carcinogens	29
5.5.3	Other Issues.....	30
5.6	Risk Characterization	32
5.6.1	Remedial Action Guidelines	32
5.6.2	Baseline Human Health Risk Assessment	32
5.6.3	Summary of the Risks from Exposure to Soils	34
5.6.4	Summary of the Risks from Exposure to Lead in Soils	40
5.6.5	Summary of the Risks from Exposure to Shoreline Sediments.....	40
5.6.6	Summary of the Risks from Ingestion of Shellfish Tissue	41
5.6.7	Summary of the Risks from Exposure to Groundwater	42
5.6.8	Summary of the Risks from Ingestion of Produce	43
5.7	Comparison of Groundwater Constituents to MCLs and MEGs.....	43
5.8	Total Site Risks.....	43
5.9	Summary and Conclusions.....	44
5.10	Uncertainties and Limitations	49

LIST OF TABLES

5-1A Occurrence, Distribution and Selection of COPCs – 115 kV Switchyard

- 5-1B Occurrence, Distribution and Selection of COPCs – Personnel Building and Parking Lot Areas
- 5-1C Occurrence, Distribution and Selection of COPCs – Plant Area
- 5-1D Occurrence, Distribution and Selection of COPCs – Warehouse 2/3
- 5-1E Occurrence, Distribution and Selection of COPCs – 345 kV Transmission Line Area
- 5-1F Occurrence, Distribution and Selection of COPCs – Bailey Farmhouse
- 5-1G Occurrence, Distribution and Selection of COPCs – ISFSI
- 5-1H Occurrence, Distribution and Selection of COPCs – Sediments
- 5-1I Occurrence, Distribution and Selection of COPCs – Shellfish Tissue
- 5-1J Occurrence, Distribution and Selection of COPCs – Groundwater
- 5-2 Values Used for Daily Intake/Absorbed Dose Calculations – Soil - On-Site Worker
- 5-3 Values Used for Daily Intake/Absorbed Dose Calculations – Soil - Construction Worker
- 5-4 Values Used for Daily Intake/Absorbed Dose Calculations – Soil - Residential Scenario
- 5-5 Values Used for Daily Intake/Absorbed Dose Calculations – Produce – Resident
- 5-6 Values Used for Daily Intake/Absorbed Dose Calculations –Sediment
- 5-7 Values Used for Daily Intake/Absorbed Dose Calculations – Shellfish Tissue - Resident
- 5-8 Values Used for Daily Intake/Absorbed Dose Calculations – Groundwater - Residential Scenario
- 5-9 Dose-Response Toxicity Data and Screening Concentrations
- 5-10A Comparison of Remedial Action Guidelines to Soil COPCs – 115 kV Switchyard
- 5-10B Comparison of Remedial Action Guidelines to Soil COPC – Personnel Buildings and Parking Lot Areas
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – Resident - CT
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – Resident - RME
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – Child - RME
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – On- Site Worker - CT
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – On-Site Worker - RME
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – Construction Worker – Surface Soils
- 5-10C Calculation of Non Cancer Hazards – Exposure to Soils – Plant Area – Construction Worker – Subsurface Soils
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – Resident - CT
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – Resident - RME
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – Child
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – On- Site Worker - CT

- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – On-Site Worker - RME
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse 2/3 – Construction Worker – Surface Soils
- 5-10D Calculation of Non Cancer Hazards – Exposure to Soils – Warehouse – Construction Worker – Subsurface Soils
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – Resident - CT
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – Resident - RME
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – Child
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – On- Site Worker - CT
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – On-Site Worker - RME
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area – Construction Worker – Surface Soils
- 5-10E Calculation of Non Cancer Hazards – Exposure to Soils – 345 kV Transmission Line Area - Construction Worker – Subsurface Soils
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – Resident - CT
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – Resident - RME
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – Child
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – On-Site Worker - CT
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – On-Site Worker - RME
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse – Construction Worker – Surface Soils
- 5-10F Calculation of Non Cancer Hazards – Exposure to Soils – Bailey Farmhouse - Construction Worker – Subsurface Soils
- 5-10G Comparison of Remedial Action Guidelines to Soil COPCs – ISFSI

- 5-10H Calculation of Non Cancer Hazards – Exposure to Sediments – Shellfisherman -CT
- 5-10H Calculation of Non Cancer Hazards – Exposure to Sediments – Shellfisherman - RME
- 5-10H Calculation of Non Cancer Hazards – Exposure to Sediments –Resident- RME

- 5-10I Calculation of Non Cancer Hazards – Ingestion of Clams – Resident – CT
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Clams – Resident – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Clams – Child – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Mussels – Resident – CT

- 5-10I Calculation of Non Cancer Hazards – Ingestion of Mussels – Resident – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Mussels – Child – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Lobsters – Resident – CT
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Lobsters – Resident – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Lobsters – Child – RME
- 5-10I Calculation of Non Cancer Hazards – Ingestion of Lobster Tomalley – Resident – CT
- 5-10I Calculation of Non Cancer Hazards – Exposure to Lobster Tomalley – Resident – RME
- 5-10I Calculation of Non Cancer Hazards – Exposure to Lobster Tomalley – Child – RME
- 5-10I Calculation of Non Cancer Hazards – Exposure to Clams (Reference Locations) – Resident – RME
- 5-10I Calculation of Non Cancer Hazards – Exposure to Mussels (Reference Locations) – Resident – RME
- 5-11C Calculation of Cancer Risks – Exposure to Soils – Plant Area – Resident - CT
- 5-11C Calculation of Cancer Risks – Exposure to Soils – Plant Area – Resident - RME
- 5-11C Calculation of Cancer Risks – Exposure to Soils – Plant Area – On- Site Worker - CT
- 5-11C Calculation of Cancer Risks - Exposure to Soils – Plant Area – On-Site Worker – RME
- 5-11C Calculation of Cancer Risks – Exposure to Surface Soils – Plant Area – Construction Worker
- 5-11C Calculation of Cancer Risks – Exposure to Subsurface Soils – Plant Area – Construction Worker
- 5-11D Calculation of Cancer Risks – Exposure to Soils – Warehouse 2/3 – Resident - CT
- 5-11D Calculation of Cancer Risks – Exposure to Soils – Warehouse 2/3 – Resident - RME
- 5-11D Calculation of Cancer Risks – Exposure to Soils – Warehouse 2/3 – On- Site Worker - CT
- 5-11D Calculation of Cancer Risks – Exposure to Soils – Warehouse 2/3 – On-Site Worker - RME
- 5-11D Calculation of Cancer Risks – Exposure to Surface Soils – Warehouse 2/3 – Construction Worker
- 5-11D Calculation of Cancer Risks – Exposure to Subsurface Soils – Warehouse 2/3 – Construction Worker
- 5-11E Calculation of Cancer Risks – Exposure to Soils – 345 kV Transmission Line Area – Resident - CT
- 5-11E Calculation of Cancer Risks – Exposure to Soils – 345 kV Transmission Line Area – Resident - RME
- 5-11E Calculation of Cancer Risks – Exposure to Soils – 345 kV Transmission Line Area – On- Site Worker - CT
- 5-11E Calculation of Cancer Risks – Exposure to Soils – 345 kV Transmission Line Area – On-Site Worker - RME
- 5-11E Calculation of Cancer Risks – Exposure to Surface Soils – 345 kV Transmission Line Area – Construction Worker

- 5-11E Calculation of Cancer Risks – Exposure to Subsurface Soils – 345 kV Transmission Line Area – Construction Worker
- 5-11F Calculation of Cancer Risks – Exposure to Soils – Bailey Farmhouse – Resident - CT
- 5-11F Calculation of Cancer Risks – Exposure to Soils – Bailey Farmhouse – Resident - RME
- 5-11F Calculation of Cancer Risks – Exposure to Soils – Bailey Farmhouse – On- Site Worker - CT
- 5-11F Calculation of Cancer Risks – Exposure to Soils – Bailey Farmhouse – On-Site Worker - RME
- 5-11F Calculation of Cancer Risks – Exposure to Surface Soils – Bailey Farmhouse – Construction Worker
- 5-11F Calculation of Cancer Risks – Exposure to Subsurface Soils – Bailey Farmhouse – Construction Worker
- 5-11H Calculation of Cancer Risks – Exposure to Sediments – Shell fisherman - CT
- 5-11H Calculation of Cancer Risks – Exposure to Sediments – Shell fisherman - RME
- 5-11H Calculation of Cancer Risks – Exposure to Sediments – Resident - RME
- 5-11I Calculation of Cancer Risks – Ingestion of Clams – Resident – CT
- 5-11I Calculation of Cancer Risks – Ingestion of Clams – Resident – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Clams – Child – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Mussels – Resident – CT
- 5-11I Calculation of Cancer Risks – Ingestion of Mussels – Resident – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Mussels – Child – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Lobsters – Resident – CT
- 5-11I Calculation of Cancer Risks – Ingestion of Lobsters – Resident – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Lobsters – Child – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Lobster Tomalley – Resident – CT
- 5-11I Calculation of Cancer Risks – Ingestion of Lobster Tomalley – Resident – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Lobster Tomalley – Child – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Clams (Reference Locations) – Resident – RME
- 5-11I Calculation of Cancer Risks – Ingestion of Mussels (Reference Locations) – Resident – RME
- 5-11J Calculation of Cancer and Non Cancer Risks – Residential Exposure to Groundwater – CT
- 5-11J Calculation of Cancer and Non Cancer Risks – Residential Exposure to Groundwater – RME
- 5-11KC Calculation of Cancer and Non Cancer Risks – Residential Ingestion of Produce – Plant Area
- 5-11KD Calculation of Cancer and Non Cancer Risks – Residential Ingestion of Produce – Warehouse 2/3
- 5-11KE Calculation of Cancer and Non Cancer Risks – Residential Ingestion of Produce – 345 kV Transmission Line Area

- 5-11KF Calculation of Cancer and Non Cancer Risks – Residential Ingestion of Produce –
Bailey Farmhouse
- 5-12 Comparison of Shellfish Tissue Samples – Site vs. Reference Locations
- 5-13 Comparison of Groundwater Constituents to MEGs and MCLs
- 5-14 Total Site Non Carcinogenic Risks
- 5-15 Total Site Carcinogenic Risks

LIST OF FIGURES

- 5-1A Soil Exposure Areas
- 5-1B Soil Exposure Areas
- 5-2 Site Conceptual Model

5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section presents the Human Health Risk Assessment (HHRA) for the Bailey Point portion of the Maine Yankee facility required as part of the RFI for this site. Two types of risk assessments are presented in this section. The first is a semi-quantitative risk evaluation conducted using the MDEP Remedial Action Guidelines for the areas within Bailey Point minimally impacted by industrial operations. The second is a quantitative evaluation of baseline risks using standard MDEP and USPEA methodology for the areas within Bailey Point impacted by industrial operations. Both were conducted to evaluate potential human health risks associated with exposure to residual chemical contamination in soil, sediment, groundwater, and biota associated with the industrial portion of the facility. An Ecological Risk Assessment (ERA) is presented in **Section 6.0** of this RFI. A separate risk assessment was conducted for the “Backlands” portion of the site and is presented in *Backlands RCRA Facility Investigation Report* (MY, 2004). The results of the HHRA and ERA will be combined with other information comprising the RFI to determine the need, if any, for further corrective actions.

The specific objectives of this HHRA are to provide:

- an evaluation of potential human health risks due to exposure to residual contamination in soils, sediment, groundwater and biota;
- a basis for determining the need for further corrective actions;
- a basis for determining the appropriate remedial target cleanup levels, as necessary; and
- a basis for comparing the health impacts of various proposed corrective actions.

This HHRA was based on analytical data collected as part of the RFI and developed to assist Maine Yankee, USEPA and MDEP in determining what actions are necessary to reduce risks at this site to acceptable levels.

5.1 Methodology

Based on guidance provided by MDEP/BOH, the site history and results of the RFI, Bailey Point was divided into 10 discrete areas for purposes of site and risk characterization (see **Section 4.0**). These contiguous areas are shown in **Figures 5-1A and 1B** and described as follows:

1. Foxbird Island – includes the 11.3-acre peninsula south of the plant Forebay under which the diffuser pipeline is buried.
2. Forebay – is a 4.2-acre engineered structure where water was discharged to the diffuser system.
3. Former Truck Maintenance Garage – is the 6.1-acre location of the former truck maintenance garage that was used during plant construction.

4. 115kV Switchyard – is a 0.5-acre switchyard located west of the Restricted Area (RA) and south of Warehouse 2/3.
5. Personnel Buildings and Parking Lot Areas – includes the Fire Pond, Parking Lots, Information Center and Personnel Building. This is a 21.6-acre contiguous area running east to west through the center of Bailey Point.
6. Plant Area – includes the 19.5-acre RA and Industrial Area of the plant.
7. Warehouse 2/3 – is a 2.9-acre area located on the southwest side of Bailey Point and was used to receive and store chemicals used in plant operations.
8. 345 kV Transmission Line Area – includes the 345 kV Switchyard, Silt Spreading Area, Ball Field and Pre-Op Cleaning Basin. This area is 45.9 acres and is located in the northern portion of Bailey Point and received several episodes of dredged fill material and land clearing debris associated with plant construction.
9. Bailey Farmhouse Area – is an 8.4-acre area that includes the septic system/leach field and gray water leach field associated with the Farmhouse.
10. ISFSI – is a 9.5-acre bermed area making up the dry spent fuel storage facility.

The risks associated with exposure to soils at Foxbird Island, the Forebay, and the Former Truck Maintenance Garage were not evaluated as part of this risk assessment. These areas have either not been impacted by industrial operations and have chemical concentrations consistent with PALs (Foxbird Island), have been remediated (Forebay) or require additional site characterization to assess potential remedial options (Former Truck Maintenance Garage).

The risks associated with exposure to soils at the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas and ISFSI were evaluated by comparing detected concentrations to the MDEP Remedial Action Guidelines concentrations. These concentrations are chemical specific guidelines that are used to assist MDEP in making remedial decisions at hazardous substance sites. They are presented in “*Division of Remediation Guidance – Implementation of Remedial Action Guidelines*” (MDEP, 1997) and are discussed in more detail in **Section 5.6.1**. Soils present at concentrations at or below the Remedial Action Guidelines generally do not require remedial action. This type of risk evaluation was considered appropriate as sampling and analytical results support the conclusion that these areas have not been adversely impacted by industrial site activities.

The risks associated with soil exposure at the Plant Areas, Warehouse 2/3, the 345 kV Transmission Line Area and the Bailey Farmhouse Area were evaluated in accordance with the Draft Human Health Exposure Assessment (HHEA) Work Plan for conducting a baseline Human Health Risk Assessment (**Appendix H-1**) and correspondence between Maine Yankee, MBOH, MDEP and USEPA (CH2MHill, 2001a and 2003a; MDEP, 2003b and 2003d; MY, 2003c and 2003e; and USEPA 2003). The HHEA document was based on current MDEP and USEPA methodology and guidance for conducting risk assessments and implementing corrective action at RCRA facilities, and presents the site-specific exposure assumptions to be used in this baseline HHRA (CH2MHill, 2003a, MDEP, 1994 and USEPA,

1996e). The following documents were used and provide the procedures, assumptions, methods, and format for conducting a baseline risk assessment:

- *Guidance Manual for Human Health Risk Assessment at Hazardous Waste Sites* (MDEP, 1994).
- *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation, Part A* (USEPA, 1989b); *Part B*, (USEPA, 1991b); and *Part E, Supplemental Guidance for Dermal Assessment, Interim Guidance* (USEPA, 2001a).
- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA, 2002a).
- *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (USEPA, 1991a).
- *USEPA Region I Waste Management Division Risk Update No. 1* (December 1992), *No. 2* (August 1994), *No. 3* (August 1995), *No. 4* (November 1996), and *No. 5* (September 1999).
- *Exposure Factors Handbook, Volumes I through III* (USEPA, 1997b).
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2001b).
- The *Integrated Risk Information System* – USEPA managed database for toxicological information.

Additional guidance documents were used in the HHRA and are cited where appropriate.

5.2 Site Characterization

The site characterization presented in this section is a summary of the information provided in detail in **Sections 1.3** (Site Description), **1.4** (Site History) and **3.1** (Site Setting) of this report. Information in this section provides the basis for identifying potential human receptors and the exposure pathways by which these receptors may come in contact with site-related chemicals.

The Maine Yankee site consists of approximately 820 acres. Approximately 670 acres of the site located north of Old Ferry Road and west of Bailey Cove, referred to as the “Backlands,” has seen no industrial activity and is virtually undeveloped. The industrial portion of the site is located on approximately 150 acres south of Old Ferry Road and east of Bailey Cove and referred to as Bailey Point. The site also includes terrestrial, wetland and near shore environments. The near shore environment supports populations of clams and mussels that may be commercially harvested and consumed by area residents.

The Maine Yankee facility generated power in the present location for approximately 26 years (1972-1997). The majority of the site disturbance on the 150-acre Bailey Point peninsula has been associated with industrial activities consistent with the operation of the facility. During the time of operation minor spills and releases of primarily petroleum products occurred as did a few significant releases that required remediation and/or additional studies (see **Section 1.5**).

The plant is in the process of being decommissioned, with most plant structures scheduled to be demolished and removed.

As part of the RFI, an extensive sampling and analysis program was conducted throughout Bailey Point and included the collection of soil, concrete, sediment, groundwater, surface water and/or tissue samples for laboratory analysis. The analytical data indicate the presence of metals, SVOCs, PCBs and pesticides and/or VOCs suggesting that exposure to these media may present human health risks.

The plant is in the process of being decommissioned, with most plant structures scheduled to be demolished and removed. However, some structures will remain including the ISFSI, the two electrical switchyards (115 kV and 345 kV) and transmission lines. Maine Yankee has indicated their intention to implement institutional controls to limit future development of Bailey Point to industrial/commercial land-use. This restriction and the presence of the ISFSI will effectively restrict any future residential development on Bailey Point.

Based on the preliminary site understanding, a schematic site conceptual model relating the primary and secondary sources at the site to potential pathways and receptors is shown in **Figure 5-2**. Potential receptors to residual soil contamination include future construction workers employed during the redevelopment of the site, and office and/or landscape workers employed by future commercial or industrial enterprises. Construction worker may be exposed to residual soil contamination through three primary pathways: inhalation of fugitive dust, and incidental ingestion and direct contact exposure to soil. The on-site worker may be exposed to residual contamination through the same exposure pathways. However, as will be discussed, the duration and intensity of exposure differs for these two receptors.

Due to the presence of the near shore environment, other potential receptors include commercial and recreational fishermen and other recreational users who may be exposed to residual sediment contamination while wading in the intertidal and subtidal zones. Potential routes of exposure include direct contact with and incidental ingestion of sediment. Also, because of the potential for contaminant uptake by biota, the ingestion of shellfish represents another exposure pathway to be evaluated.

Because land-use restrictions will limit the development of Bailey Point, Maine Yankee initially did not include a future residential land use scenario in the HHEA. However, at the request of MDEP and MBOH, a residential land use scenario was included. Potential exposure pathways include inhalation and ingestion of and direct contact exposure with soil, sediment and groundwater and ingestion of shellfish. Because of the potential for contaminant uptake in vegetables, the ingestion of homegrown produce is also considered a potential exposure pathway for soil contaminants. A more detailed discussion of the magnitude and extent of exposure to a future resident is presented in **Section 5.4** of this report.

5.3 Hazard Assessment

The objective of the hazard assessment is to present a summary of the analytical data for each study area and to identify Chemicals of Potential Concern (COPCs). The COPCs are a subset of all contaminants detected in each medium and are selected to focus the risk assessment on those compounds that may present the greatest health concern. The COPCs in this HHRA were selected using the criteria presented in the HHEA Work Plan (**Appendix H-1**) and the data set presented in **Sections 3.0 and 4.0** of this RFI report.

The analytical results from samples collected within each study area/medium were subjected to standard USEPA data validation and quality control review and were used to select COPCs consistent with the HHEA Work Plan and USEPA guidance as discussed below.

- Flagged data. Laboratory data flagged with “J” indicate that the reported concentrations are estimated values, generally falling between the IDL and PQL. Other inconsistencies in sample management and analysis may also result in flagged sample results. Consistent with USEPA guidance, the “J” flagged data was used in the risk assessment at the estimated concentrations (USEPA, 1992a). Laboratory data flagged with “U” indicate that the contaminant was undetected, and the concentrations reported represent the PQLs. The “U” flagged data are considered as “non-detects” as discussed below. Some compounds are identified as part of the data validation process as being laboratory contaminants and are flagged as “R”. These data were not included in the selection of COPCs or evaluation of risk (USEPA, 1992a).
- Non-Detects. Chemicals that are not detected are flagged with “U” and reported at the PQL. One-half the detection limit (i.e., PQL) was used as the concentration for each non-detect value when calculating the arithmetic mean of each COPC (USEPA, 2002a).
- Duplicate samples. Duplicate soil, sediment, tissue and groundwater samples were collected to evaluate inherent variability of contaminant distribution and the sampling procedures. Duplicate sample results were averaged and included as a single data point.

COPCs were selected for soils, sediment, shellfish and groundwater in accordance with the process outlined in USEPA’s Risk Updates (1995 and 1999). Only those chemicals that met the following criteria were eliminated as COPCs.

- PAH and PCB compounds. The concentration of each of the seven carcinogenic PAH compounds (i.e., benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene) was modified by its toxic equivalent factor (TEF) and summed to yield a benzo(a)pyrene equivalent concentration (see **Section 5.5.3** for a discussion of TEFs).

This benzo(a)pyrene equivalent concentration was used to select COPCs and estimate carcinogenic risks associated with exposure to PAHs. It is referred to as “carcinogenic PAHs (cPAHs)” in the text. The individual aroclor concentrations were summed to yield a total PCB concentration. This total PCB concentration was used to select COPCs and calculate noncarcinogenic and carcinogenic risks associated with exposure to PCBs.

- Frequency of Detection. Consistent with USEPA guidance (USEPA, 1989b), compounds detected at a low frequency of detection (i.e. less than 5%), were eliminated as a COPC and apply only to data sets with more than a total of 20 samples. Compounds detected in less than 5% of samples but at concentrations greater than their respective regulatory guidance or risk based screening criteria were retained as COPCs.
- Comparison to Risk Based Concentrations. Consistent with USEPA Region I Guidance, compounds detected in various media at concentrations below appropriate risk-based concentrations were eliminated as COPCs. Risk based concentrations are media-specific chemical concentrations derived using standard exposure assumptions and set at a cancer risk of 1×10^{-6} or a hazard index (HI) of 1. The risk based concentrations used in this HHRA were obtained from one of the following sources: USEPA Region 9 Preliminary Remediation Guidelines (PRGs); Maine Bureau of Health (MBOH) Fish Tissue Action Levels (FTAL) or USEPA Region 3 Risk Based Concentrations (RBCs) (USEPA, October, 2002 and Maine Bureau of Health, 2001). Per USEPA guidance, the noncarcinogenic criteria were modified to one-tenth their risk-based concentration making them equivalent to an HI of 0.1. In addition, the FTALs were modified to reflect a 1×10^{-6} risk level. The risk based concentrations used to select COPCs are referred to as “Screening RBC”.

The USEPA Region 9 “Residential Soil” PRGs were used to select soil and sediment COPCs. These concentrations are considered protective of human health based on residential exposure through ingestion, inhalation and dermal contact to soil. The USEPA Region 9 “Tap Water” PRGs used to select groundwater COPCs. These concentrations are considered protective of human health based on residential exposure through inhalation and ingestion of water. The lower of the MBOH FTALs or USEPA Region 3 RBCs were used to select COPCs in shellfish tissue. These concentrations are considered protective of human health based on the consumption of shellfish.

All compounds having an oral/dermal ratio of greater than 10 percent (as listed in Appendix B-3 of USEPA, 2001a) were retained as groundwater COPCs for the dermal route of exposure.

- Essential Nutrients. Several of the metals detected in soil and sediment at the Maine Yankee Facility are essential human nutrients and include magnesium, calcium, and

potassium (USEPA, 1989b). According to USEPA guidance these chemicals can be eliminated from consideration in the quantitative risk assessment (USEPA, 2003). As such, magnesium, calcium and potassium are not included as COPCs.

- Insufficient Toxicity Information. Some of the chemicals detected at the site lack sufficient toxicity information to complete a quantitative risk evaluation. These compounds are identified as COPCs, carried forward in the risk evaluation and discussed in the Uncertainty and Limitations Section.
- Reference Concentrations. Reference soil samples were collected from areas outside the influence of Maine Yankee and used to compare concentrations of chemicals detected in the various study areas. Reference concentrations for the TAL metals detected in soils were identified and discussed in **Section 4.1** and presented in **Table 4-2**. Of particular interest in this risk assessment are the presence of arsenic and iron in the soils. These metals are naturally occurring elements present in all soils in this area. Neither metal is related to plant operations. Although reference concentrations were not used in selecting COPCs, potential risks attributable to reference conditions are considered in this risk assessment.

The analytical data including the occurrence and distribution of all detected chemicals and the criteria used to identify the COPCs for each study area and media of concern are presented in **Tables 5-1A through 5-1J**¹ and are discussed in the following subsections.

5.3.1 115kV Switchyard

Composite soil samples were collected from test pits excavated to evaluate stained surface soils and a surface soil sample was collected from a drainage ditch within the 115kV Switchyard and analyzed for VOCs, SVOCs, PCBs and pesticides, EPH and metals. A summary of the analytical data for constituents detected in these soil samples is presented in **Table 5-1A**.

A total of thirty five compounds were detected in the surface soils from the 115 kV Switchyard. Of these, eight compounds were retained as COPCs because they were detected at concentrations exceeding their Residential Soil Screening RBC or lacked toxicity based screening criteria. These compounds include: aluminum, arsenic, iron, manganese, sodium, cPAHs, benzo[g,h,i]perylene and phenanthrene. The remaining constituents were eliminated as COPCs because they were either detected at concentrations below their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to surface soils at the 115kV Switchyard are evaluated by comparing the maximum detected

¹ Due to the number of areas being evaluated, each Study Area was assigned a unique alphabetical suffix as follows: A – 115 kV Switchyard, B – Personnel Buildings and Parking Lot Areas, C – Plant Area, D - Warehouse 2/3, E - 345 kV Transmission Lines, F – Bailey Farmhouse, G – ISFSI; H – Shoreline Sediments, I- Shellfish Tissue, J – Groundwater and K - Produce. This suffix is used in numbering the data summary tables and subsequent Non-Cancer Hazard and Cancer Risk Tables. For example, the summary of data for the 115 kV Switchyard is found in Table 5-1A, all subsequent tables specific to 115 kV Switchyard will have the “A” suffix in the Table number.

concentration of each COPC to its MDEP Remedial Action Guideline concentration. This evaluation is presented in **Section 5.6**.

5.3.2 Personnel Buildings and Parking Lot Areas

Surface and subsurface soil samples were collected from the Fire Pond, Parking Lots Information Center and Personnel Buildings. These are all areas of limited industrial activity and are primarily support areas of the facility. Soil samples were analyzed for VOCs, SVOCs, PCBs and pesticides, EPH and metals. A summary of the analytical data for constituents detected in surface and subsurface soil samples including the criteria and rationale for selecting soil COPCs is presented in **Table 5-1B**.

Twenty-four compounds were detected in the surface soil samples around the Personnel Buildings and Parking Lot Areas. Of these, six compounds were retained as COPCs because they either were present at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity-based screening criteria. The surface soil COPCs include; aluminum, arsenic, iron, lead, manganese, and sodium. All other constituents were eliminated as COPCs because they were either detected at concentrations less than their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to surface soil around the Personnel Buildings and Parking Lot Area are evaluated for the area resident using the MDEP Remedial Action Guideline concentrations and presented in **Section 5.6**.

Thirty-five compounds were detected in subsurface soil samples around the Personnel Buildings and Parking Lot Areas. Of these, 11 compounds were retained as COPCs because they either were present at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity-based screening criteria. The subsurface soil COPCs include the 6 surface soil COPCs and vanadium, cPAHs, benzo(g,h,i)perylene, phenanthrene and trichloroethene. The risks associated with exposure to subsurface soil are evaluated for the area resident by comparing the maximum detected concentration of each COPC to its MDEP Remedial Action Guideline concentration. This evaluation is presented in **Section 5.6**.

5.3.3 Plant Area

The Plant Area consists of the southern portion of Study Area 5, including the restricted and industrial area where the majority of plant operations occurred. Surface and subsurface soil samples were collected from within this area to characterize potential impacts from plant operations. These samples were typically analyzed for VOCs, SVOCs, PCBs and pesticides, metals, and EPH. As discussed in **Section 4.8**, PAHs, PCBs, pesticides, and EPH were detected in the soil. A summary of the analytical data for constituents detected in these samples including the criteria and rationale for selecting soil COPCs is presented in **Table 5-1C**.

A total of 60 constituents were detected in the surface soil samples collected from within the Plant Area. Of these, 17 were retained as COPCs because they were present at

concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria. The surface soil COPCs include, aluminum, arsenic, copper, iron, manganese, thallium, vanadium, total PCBs, cPAHs, phenanthrene, carbazole, benzo(g,h,i)perylene, 2-methylnaphthalene, endrin aldehyde, sodium, lead, and DRO. The remaining constituents were eliminated as COPCs because they were detected at concentration below their respective Residential Soil Screening RBC or considered essential nutrients. The risks associated with exposure to surface soils around the Plant Area are evaluated for the resident, on-site worker and construction worker and are presented in **Section 5.6**.

A total of 62 constituents were detected in subsurface samples collected from within the Plant Area. Of these, 17 were retained as COPCs because they were detected at concentrations exceeding their respective Residential Soil Screening RBC or lacked sufficient toxicity screening criteria. These COPCs are the same as those identified for surface soils. All other compounds were eliminated as COPCs because they were detected at concentrations below their respective Residential Soil Screening RBC or considered essential nutrients. The risks associated with exposure to subsurface soils from the Plant Area are evaluated for the construction worker and are presented in **Section 5.6**.

5.3.4 Warehouse 2/3

Surface and subsurface soil samples were collected from around the Warehouse 2/3 area to characterize potential impacts from previous drum handling, paint waste and sand blast grit disposal activities at this location. These samples were analyzed for VOCs, SVOCs, PCBs and pesticides, EPH and metals. As discussed in **Section 4.8**, elevated levels of PAHs and PCBs were detected in soils from the northwest side of the Warehouse 2/3 and elevated levels of VOCs (xylenes, ethylbenzene and toluene) were detected in soils from the southwest side of Warehouse 2/3. A summary of the analytical data for constituents detected in surface and subsurface soil samples including the criteria and rationale for selecting soil COPCs is presented in **Table 5-1D**.

A total of 44 constituents were detected in the surface soil samples collected around Warehouse 2/3. Of these, 11 compounds were retained as COPCs because they were present at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria. The COPCs for surface soils include: aluminum, arsenic, iron, lead, manganese, sodium, total PCBs, cPAHs, benzo(g,h,i)perylene, carbazole, and phenanthrene. The remaining constituents were eliminated as COPCs because they were detected at concentration less than their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to surface soil around Warehouse 2/3 are evaluated for the resident, on-site worker and construction worker and are presented in **Section 5.6**.

A total of 57 constituents were detected in the subsurface soil samples collected around Warehouse 2/3. Of these, 16 constituents were retained as COPCs because they were present

at concentrations exceeding their Residential Soil Screening RBC or lacked toxicity based screening criteria. The subsurface COPCs include the 11 surface soil COPCs, and vanadium, 2-methynaphthalene, ethylbenzene, m,p-xylene, and o-xylene. One compound, 2-hexanone, was not selected as a COPC because it was detected in only 1 of 61 soil samples collected (i.e. 2 percent of all samples). All other compounds were eliminated as COPCs because they were either detected at concentrations below their respective Residential Soil Screening RBC or considered essential nutrients. The risks associated with exposure to these subsurface COPCs are evaluated for the construction worker and are presented in **Section 5.6**.

5.3.5 345 kV Transmission Line Area

The 345 kV Transmission Line Area is in the northern portion of Bailey Point and includes the Silt Spreading Area, 345 kV Switchyard, Ball Field and the Pre-Op Cleaning Basin. During plant construction fill was placed in much of this study area and a portion of the area was used for silt spreading during plant operation. Surface and subsurface soil samples were collected to evaluate the potential impact of plant operations (i.e., 345 kV switchyard and silt fill/spreading activities). Soil samples were analyzed for VOCs, SVOCs, PCBs and pesticides, EPH and metals. A summary of the analytical data for constituents detected in surface and subsurface soil samples including the criteria and rationale for selecting soil COPCs is presented in **Table 5-1E**.

A total of 43 constituents were detected in the surface soils samples. Of these, 11 were retained as COPCs because they either were present at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria. The surface soil COPCs include; aluminum, arsenic, iron, manganese, sodium, thallium, vanadium, cPAHs, benzo(g,h,i)perylene, carbazole and phenanthrene. All other constituents were eliminated as COPCs because they were either detected at concentrations below their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to surface soil around the 345 kV Transmission Line Area are evaluated for the resident, on-site worker and construction worker and are presented in **Section 5.6**.

Fifty-four constituents were detected in the subsurface soils samples collected around the 345 kV Transmission Line Area. Of these, 13 constituents were retained as soil COPCs and include the 11 surface soil COPCs, lead, and PCBs. All other constituents were eliminated as COPCs because they were either detected at concentrations below their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to subsurface soil around the 345 kV Transmission Line Area are evaluated for the resident and on-site worker and are presented in **Section 5.6**.

5.3.6 Bailey Farmhouse

Soil samples were collected from two soil borings and three test pits excavated in the former leach fields of the Bailey Farmhouse. These samples were analyzed for VOCs, SVOC, PCBs and pesticides, EPH and metals. A summary of the analytical data for constituents detected in

these samples including the criteria and rationale for selecting soil COPCs is presented in **Table 5-1F**.

Twenty constituents were detected in the surface soil samples collected from the Bailey Farmhouse. Of these, six metals were retained as COPCs because they were detected at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria. The soil COPCs includes aluminum, arsenic, iron, lead, manganese and sodium. All other constituents were detected at concentrations less than their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to surface soil from the Bailey Farmhouse are evaluated for the resident, on-site worker and construction worker and are presented in **Section 5.6**.

Twenty-four constituents were detected in subsurface soil samples collected from the Bailey Farmhouse. Of these, six constituents were retained as COPCs because they were detected at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria and include aluminum, arsenic, iron, lead, manganese and sodium. All other constituents were detected at concentrations less than their respective Residential Soil Screening RBC or are considered essential nutrients. The risks associated with exposure to subsurface soil from the Bailey Farmhouse are evaluated for the construction worker and are presented in **Section 5.6**.

5.3.7 ISFSI

As discussed in **Section 4.3**, soil samples were collected as part of two separate investigations of the ISFSI; one to support the RFI and one to support the MDEP Site Location of Development Order L-17973-26-Q-M associated with the ISFSI construction activities. The RFI sampling included the collection of two composite soil samples from a test pit excavated to confirm the removal of oil-contaminated soils. These samples were analyzed for SVOCs, PCBs and EPH. The Site Location sampling included the collection of two subsurface soil samples taken from utility trenches on the southern and eastern portions of ISFSI. These samples were analyzed for VOCs, RCRA-8 metals, and DRO.

A summary of the analytical data for constituents detected in these samples including the criteria and rationale for selecting soil COPCs are presented in **Table 5-1G**.

Seven SVOCs were detected in the soil samples collected from the ISFSI. Concentrations of all detected compounds were less than 0.5 ug/kg confirming the removal of oil-contaminated soils. All compounds were detected well below their Residential Soil Screening RBC and eliminated as COPCs. Benzo(g,h,i)perylene lacks sufficient toxicity screening criteria and is retained as a COPC.

Five metals were detected in the surface soil samples collected from the trenches excavated in the ISFSI. Concentrations of all metals except arsenic were detected below their Residential

Soil Screening RBC and eliminated as COPCs. Arsenic was detected at concentrations exceeding its Residential Soil Screening RBC and is retained as a COPC.

5.3.8 Shoreline Sediments

Sediment samples were collected from the intertidal and subtidal zones around the Bailey Point area to assess the impact of industrial area stormwater discharge to the Back River and Bailey Cove environments. These samples were analyzed for VOCs, SVOCs, PCBs and pesticides, EPH and metals. As discussed in **Section 4**, elevated levels of PAHs were detected in the outfall sediments. A summary of the analytical data for constituents detected in these samples including the criteria and rationale for selecting sediment COPCs are presented in **Table 5-1H**.

A total of 50 constituents were detected in the sediment samples. Of these, 11 constituents were retained as COPCs because they were detected at concentrations exceeding their respective Residential Soil Screening RBC or lacked toxicity based screening criteria. The sediment COPCs include aluminum, arsenic, iron, manganese, sodium, 2-methylnaphthalene, acenaphthylene, cPAHs, benzo(g,h,i)perylene, carbazole, and phenanthrene. Thirty four compounds were eliminated as COPCs because they were detected at concentration below their respective Residential Soil Screening RBC or are considered essential nutrients. Endrin aldehyde was detected in only 1 of 33 samples and was eliminated as a COPC based on low frequency of detection. The risks associated with exposure to sediment are evaluated for the Commercial Shellfisherman who is exposed to sediments while harvesting shellfish or worms and the area resident who is exposed to sediment while recreating in the area. These risks are presented in **Section 5.6**.

5.3.9 Shellfish

Tissue samples were collected from shellfish in the intertidal and subtidal zones around Bailey Point to assess the impact of stormwater discharge to biota in the Back River and Bailey Cove environments. Samples were collected from mussels, clams, lobster, and lobster tomalley and analyzed for metals, PCBs, pesticides, and SVOCs. Tissue samples were also collected from clams and mussels in the intertidal and subtidal zones from a reference location and analyzed for metals, PCBs, pesticides and SVOCs. A summary of the analytical data for constituents detected in shellfish tissue, including the criteria and rationale for selecting COPCs, is presented in **Table 5-1I**.

A total of 56 constituents were detected in mussels. Of these, 17 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for mussels include: aluminum, arsenic, cadmium, iron, lead, mercury, sodium, alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane, endosulfan II, endosulfan sulfate, endrin ketone, 2-methylnaphthalene, acenaphthylene, cPAHs, benzo(g,h,i)perylene, and phenanthrene. The remaining constituents were eliminated as COPCs because they were detected at concentrations below their

respective Screening RBC or are considered essential nutrients (i.e., calcium, magnesium and potassium).

A total of 67 constituents were detected in clams. Of these, 23 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for clams include: aluminum, arsenic, copper, iron, lead, manganese, mercury, sodium, vanadium, total PCBs, alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin aldehyde, endrin ketone, 4-chloro-3-methylphenol, acenaphthylene, cPAHs, benzo(g,h,i)perylene, and phenanthrene. The remaining constituents were eliminated as COPCs because they were detected at concentrations below their respective Screening RBC or considered essential nutrients.

A total of 47 constituents were detected in lobsters. Of these, 10 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for lobsters include: arsenic, copper, lead, mercury, sodium, alpha-hexachlorocyclohexane, dieldrin, endosulfan sulfate, 4-chloro-3-methylphenol and acenaphthylene. The remaining constituents were eliminated as COPCs because they were detected at concentrations below their respective Screening RBC or are considered essential nutrients.

A total of 55 constituents were detected in lobster tomalley. Of these, 19 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for lobster tomalley include: arsenic, cadmium, copper, lead, mercury, selenium, sodium, total PCBs, 4,4'-DDE, alpha-hexachlorocyclohexane, dieldrin, endrin aldehyde, endrin ketone, heptachlor epoxide, 4-chloro-3-methylphenol, acenaphthylene, cPAHs, benzo(g,h,i)perylene, and phenanthrene. The remaining constituents were eliminated as COPCs because they were detected at concentrations below their respective Screening RBC or considered essential nutrients.

A total of 62 constituents were detected in clams obtained from the reference locations. Of these, 19 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for the reference clams include: aluminum, antimony, arsenic, copper, iron, lead, manganese, mercury, sodium, vanadium, total PCBs, delta-hexachlorocyclohexane, endosulfan sulfate, endrin ketone, acenaphthylene, cPAHs, benzo(g,h,i)perylene, phenanthrene and 4-chloro-3-methylphenol. All other compounds were eliminated as COPCs because they were detected at concentrations below their respective Screening RBC or considered essential nutrients.

A total of 46 constituents were detected in mussels obtained from the reference locations. Of these, 11 were retained as COPCs because they were present at concentrations exceeding their respective Screening RBC or lacked toxicity based screening criteria. The COPCs for the reference mussels include: arsenic, cadmium, iron, lead, mercury, sodium, vanadium, endosulfan

sulfate, endrin ketone, acenaphthylene, and cPAHs. All other compounds were eliminated as COPCs because they were detected at concentrations below their respective Screening RBC or considered essential nutrients.

The risks associated with exposure to shellfish tissue are evaluated for the area resident and are presented in **Section 5.6**.

5.3.10 Groundwater

Groundwater samples were collected from monitoring wells placed throughout Bailey Point and analyzed for VOCs, SVOCs, PCBs and pesticides, metals and DRO/EPH. A summary of the analytical data for constituents detected in these samples including the criteria and rationale for selecting groundwater COPCs is presented in **Table 5-1J**.

A total of 54 constituents were detected in the groundwater monitoring wells. Of these, 24 constituents were retained as COPCs because they were detected at concentrations exceeding their Residential Tap Water Screening RBC or Maine MEG. These compounds include: DRO, aluminum, arsenic, barium, boron, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, sodium, thallium, dieldrin, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, benzene, chloroform, o-xylene, vinyl chloride and nitrate. Eleven compounds were detected in less than 5 percent of groundwater samples, however, at concentrations greater than their respective Residential Tap Water Screening RBC or MEG concentration. These compounds were retained as COPCs and include: heptachlor, bis(2-ethylhexyl)phthalate, naphthalene, 1,1,2-trichloroethane, 1,2-dichloroethane, bromodichloromethane, bromomethane, chloromethane, ethylbenzene, m/p xylene, and trichloroethene. Six additional compounds were retained as COPCs based on their dermal /oral ratio and include beryllium, cadmium, chromium, vanadium, di-n-butyl-phthalate and toluene (USEPA, 2001a). All other compounds were eliminated as COPCs because they were either detected below screening criteria, considered essential nutrients or had dermal/oral ratios less than 10 percent (USEPA, 2001a). The risks associated with exposure to groundwater is evaluated for the area resident and presented in **Section 5.6**.

5.3.11 Produce

Although there is currently no exposure to contaminated produce grown on-site, a vegetable uptake scenario was developed to evaluate the potential for soil contaminants to be concentrated in both above and below ground produce. Given the lack of site-specific produce to analyze, contaminant concentrations in produce were estimated using the methodology presented in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, 1998f). This guidance document provides chemical-specific bioconcentration factors for both root vegetables and above ground produce (USEPA, 1998f). Because there are no soil screening RBC for produce, the compounds retained as surface soil COPCs based on ingestion and dermal contact for each area were retained as produce COPCs (refer to **Table 5-1A through 5-1F**). Chemical-specific bioconcentration factors were used to

estimate contaminant concentrations in produce. Bioconcentration factors are not available for all compounds detected in soil, as such, only those compounds for which bioconcentration factors are available are quantitatively evaluated. The risks associated with ingestion of contaminated produce are evaluated for the area resident and presented in **Section 5.6**.

5.4 Exposure Assessment

The purpose of the Exposure Assessment is to estimate the type and magnitude of potential exposure to site-related chemicals present at, or migrating from, the site. A quantitative exposure assessment was conducted for the four areas evaluated as part of the baseline HHRA (i.e., Plant Area, Warehouse 2/3, 345 kV Transmission Line Area and Bailey Farmhouse). This assessment was conducted in accordance with USEPA and MDEP methodology and guidance (USEPA, 1989b, 1990, 1991a and b, 1997b, 2001 a and b, and 2002, and MDEP, 1994) and is consistent with the HHEA Work Plan (**Appendix H-1**). These guidance documents provide standard exposure scenarios and default values for many exposure parameters and were used, as appropriate, in this assessment. This quantitative exposure information was combined with the exposure point concentrations (EPCs) for each COPC to quantitatively estimate exposure under each scenario. The methods for deriving EPCs and the exposure assumptions used in the Baseline HHRA are discussed below.

5.4.1 Exposure Point Concentrations

The EPC represents the concentration of a chemical that a human receptor is reasonably expected to contact at a point of exposure (USEPA, 1992 and USEPA, 2002). EPCs are generally used to derive a quantitative estimate of exposure under both a reasonable maximum exposure (RME) and central tendency (CT) exposure. The RME exposure is defined as the highest exposure that is reasonably expected to occur at the site. The CT exposure provides a less conservative estimate of exposure that may occur at the site. USEPA guidance states that the EPC for each soil COPC under the RME and CT be set at the 95% Upper Confidence Level (UCL) of the arithmetic mean concentration. The maximum detected concentration should be used as the EPC when the 95% UCL concentration exceeds the maximum detected concentration (USEPA, 1992).

The USEPA has established guidance for calculating the 95% UCL concentration. This guidance, however, is only applicable to randomly sampled data sets (USEPA, 2002a). Because the soil data collected as part of the RFI was biased to areas of known or suspected contamination as described in the approved QAPP, no method or approach presented in USEPA guidance was applicable to the soil data collected as part of this RFI. To overcome the limitations placed on the biased sampling dataset, a tiered approach for identifying site-specific COPCs and calculating appropriate EPCs for these compounds was developed in concert with MDEP and USEPA and described in the following paragraphs.

For areas where greater than 10 samples were collected (i.e., Plant Area, Warehouse 2/3 and 345 kV Transmission Line), preliminary risk estimates were developed for each soil COPCs

retained after screening (see **Tables 5-1A through 1F**). Carcinogenic risk estimates were based on exposure to the maximum detected soil concentration (all depths) assuming the residential RME exposure scenario. Noncarcinogenic risk estimates were based on exposure to the maximum detected soil concentration (all depths) assuming a 6-year childhood residential exposure scenario. These scenarios result in the greatest potential exposure and therefore, are considered protective of other exposure conditions.

Compounds present in soil at concentrations associated with an HI = 0.1 or 1×10^{-6} or greater risk were considered primary COPCs. The statistical distribution of these COPCs was determined (i.e. normal, log normal or non-parametric) and the 95% UCL on the mean concentration was calculated based on the appropriate test method presented in *Calculating the Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* and using the USEPA sponsored ProUCL software (USEPA, 2002b and USEPA, 2003b). The analytical data presented in **Section 4.0** were used as inputs to the ProUCL calculations.. The mean concentration, the standard deviation, the statistical distribution and EPC calculated using the ProUCL software for each COPC is presented in **Appendix H-2**. For compounds having neither a normal nor lognormal distribution, the ProUCL program provides five non-parametric results (CLT, Jackknife, Standard Bootstrap, Bootstrap-t, and Chebyshev). The most conservative (i.e., highest) non-parametric result was selected as the EPC.

COPCs present in soils at concentrations associated with less than an HI = 0.1 or 1×10^{-6} risk level were retained as COPCs and their EPC set at the maximum detected concentration. The distribution of the primary COPCs and their respective EPCs are presented in **Appendix H-2** and discussed in more detail in **Section 5.6.3**.

The USEPA guidance also discusses the uncertainty of deriving a mean concentration and 95% UCL based on a small data sets stating, “if the number of samples is small ($n < 5$), no method will work well” (USEPA, 2002a). Although the guidance does not state that the maximum concentration be used, USPEA Region 1 and MBOH have stated their preference for defaulting to the maximum concentration as the EPC, for data sets with less than 10 samples. Maine Yankee has agreed to use this approach for areas where less than 10 samples were taken. As such, the EPC for evaluating exposure to soils at the Bailey Farmhouse are set at the maximum detected concentration.

Consistent with EPA guidance, the EPC for groundwater contaminants was set at the average and maximum detected concentration for the CT and RME scenarios, respectively (USEPA Region 1, 1992)

5.4.2 Exposure Scenarios

Exposure scenarios describe the unique way(s) by which an individual or population may be exposed to contaminants at or originating from a site. These scenarios generally include more

than one route of exposure. Common routes of exposure include ingestion of, dermal contact with, or inhalation of contaminated media. A quantitative estimate of exposure (e.g., an exposure dose) is generated for each route of exposure by combining the EPC with standard exposure parameters.

Potential receptors and exposure scenarios are based on current and future site use. Currently, the site is in the process of being decommissioned, with most plant structures scheduled to be demolished and removed. Future land use at the site will most likely be industrial/commercial as Maine Yankee has indicated their intention to implement deed restrictions to limit future development of Bailey Point to industrial/commercial land use. Potential receptors to residual soil and groundwater contamination include future on-site workers and construction workers. Other potential receptors include commercial and recreational shellfish harvesters, worm diggers, and other recreational users who may be exposed to residual sediment and shellfish tissue contamination. Because land use restrictions will limit the development of Bailey Point, Maine Yankee initially did not include residents as potential receptors. However, at the request of MDEP and MBOH, residential exposure to soil and groundwater is being evaluated in this risk assessment. Maine Yankee considers the residential scenario to be an overly conservative evaluation of future potential exposure and does not propose making risk management decisions based on this assumed future land-use.

The standard exposure equations and parameters for each exposure scenario are presented and referenced in **Tables 5-2 through 5-8** and are discussed below.

Surface Soils

Site-related compounds were detected in surface soils from all areas of interest. Because commercial/industrial zoning is the most likely future land-use for Bailey Point, the exposure assessment focused on evaluating future potential exposure to an on-site worker and a construction worker. The on-site worker is assumed to have long-term exposure to incidental soil contamination (e.g. dust) and the construction worker is assumed to have short-term intense exposure to surface and subsurface soils (USEPA, 2001b). Although it is extremely unlikely that this area could and/or would be developed for residential land-use, a residential exposure scenario was evaluated at the request of MBOH and MDEP for purposes of supporting the Cumulative Risk Assessment (CH2MHill, 2003b). The residential scenario is based on long-term repetitive exposure to soils by both children and adults.

The routes of exposure evaluated for the residential and worker scenarios include ingestion and dermal contact with soils. The residential scenario also includes exposure to soil contaminants through the ingestion of homegrown produce. The inhalation route of exposure was initially not included in this risk assessment based on a comparison of the maximum detected soil concentration (all depths) to USEPA Region 9 inhalation PRGs. These route-specific PRGs are derived based on standard USEPA exposure parameters and toxicity information and set at an HI of 1 or cancer risk of 10^{-6} . All chemicals detected in soil throughout Bailey Point are present

at concentrations below their respective inhalation PRG suggesting that inhalation is not a significant route of exposure at this site.

At the request of MBOH, two focused risk evaluations were conducted to evaluate the potential risk to human health from inhalation exposure to fugitive dust; a quantitative risk evaluation calculating the noncancer hazards and incremental cancer risks associated with exposure to fugitive dust based on less-than-lifetime exposure and an evaluation of projected long term fugitive dust concentrations assuming continuous lifetime exposure (USEPA, 1991a and USEPA 2002b). Both scenarios were based on exposure to the maximum detected concentration of all compounds present in soil (all depths). This is the most conservative exposure assumption possible and is considered to be protective of more refined and site-specific exposure assumptions. The inhalation and fugitive dust risk evaluations are presented in **Appendix H-3**. The carcinogenic risks estimates are 2.0×10^{-8} , 1.4×10^{-8} , 2.0×10^{-6} for the residential, the on-site worker and the construction worker scenarios, respectively and 1.8×10^{-7} for continuous lifetime exposure to predicted fugitive dust concentrations. The non cancer HI's were all below 1.0 and are 0.006 for the on-site worker, 0.007 for the resident, 0.02 for the child, 0.05 for the construction worker and 0.03 for lifetime exposure to predicted fugitive dust concentrations. All risk estimates were below MDEP target risk levels.

Inhalation of volatile compounds was not considered to be a significant route of exposure and was not quantitatively evaluated. Warehouse 2/3 was the only area where VOCs were detected in subsurface soils. The area of VOC soil contamination was limited to a small area (i.e., 40 ft x 50 ft) and appropriate response actions are being evaluated for these soils to protect groundwater quality. These actions will result in a decrease of VOC soil concentrations to levels below those considered to present a health risk. Based on these results, the inhalation route of exposure was not evaluated for the individual sub areas.

In summary the following soil exposure scenarios were evaluated as part of this risk assessment and are consistent the HHEA work plan:

- On-Site Workers (adults) exposed to surface soils (i.e., 0 to 0.5 feet) through direct contact and incidental ingestion. The RME scenario is reflective of an employee working outdoors and the CT scenario is reflective of an employee working indoors (USEPA, 2001b). The on-site worker is assumed to ingest 50 mg soil/day (CT) and 100 mg soil/day (RME). The exposure frequency is 150 days per year, for 25 years (RME) and 6.6 years (CT) exposure duration. Additional exposure parameters for this scenario are presented in **Table 5-2**.
- Construction Worker (adults) exposed to surface soils through direct contact and incidental ingestion. This worker is assumed to have very high and intense exposure to soils during construction activities (USEPA, 2001b). Because of the unique manner in which this worker is assumed to contact soil only the RME scenario is evaluated. The construction worker is assumed to ingest 330 mg soil/day, with an exposure frequency

of 173 days/year corresponding to 5 days/week for 8 months over a 1 year duration. An exposed surface area of 3,300 cm² is assumed. Additional exposure parameters for this scenario are presented in **Table 5-3**.

- Residents (children and adults) exposed to surface soils through direct contact and incidental ingestion. A time-weighted ingestion rate and dermal factor was used to combine the child and adult exposure to soils. The exposure frequency is 150 days per year for both the RME and CT scenarios (USEPA, 1994). Exposure duration under the RME is assumed to be 30 years and includes 6-year exposure as a child and 24-year exposure as an adult (USEPA, 1991a). Exposure duration under the CT is assumed to be 9 years and includes 2-year exposure as a child and 7-year exposure as an adult (USEPA, 1994). A separate exposure evaluation was conducted to evaluate the non-carcinogenic risks to a child from a 6-year residential soil exposure. Additional exposure parameters for this scenario are presented in **Table 5-4**.

Ingestion of home-grown produce was also evaluated as part of the Residential scenario and assumes a person ingests 71 grams dry weight of produce (14 % root crops and 86% above ground produce) for 350 days per year (USEPA, 1998f). An exposure duration of 30 years is assumed consistent with the long-term resident. Only the RME scenario was evaluated for this route of exposure. Additional exposure parameters for this scenario are presented in **Table 5-5**. The input values for estimating contaminant concentration in produce are presented in **Appendix H-4**.

Sub-Surface Soil

Site related compounds have been detected in subsurface soils from these study areas. Exposure to these soils was evaluated for the construction worker only. It is not expected that an on-site worker or resident would have long-term repetitive exposure to soils below 0.5 feet bgs. The same exposure assumptions used to evaluate the Construction Worker exposure to surface soils are assumed for the Construction Worker exposure to sub-surface soil. The EPC for the subsurface soils was based on both surface and subsurface soils concentrations.

Sediments

Site-related compounds and/or naturally occurring inorganic elements were detected in sediment samples in the shoreline outfall areas. Consistent with the HHEA Work Plan, potential receptors likely to frequent this area include teenagers and adults trespassing or harvesting shellfish and/or worms (MY, 2003a). The Commercial Fisherman harvesting shellfish was selected as the potential receptor for this exposure pathway. This receptor receives the greatest potential exposure and would, therefore, be protective of less frequent or casual users (i.e., trespasser). Although, young children (0 to 6 years) are not expected to frequent this area of the site based on limited access and lack of recreational beaches suitable for swimming, a sediment exposure scenario was developed for the area resident to assist in estimating the total

site risk. Routes of exposure evaluated in this assessment include dermal contact and ingestion of sediments. Dermal contact with marine surface water is not considered to be a significant route of exposure given the large influx of tidal water into the bay twice each day. Constituents potentially discharging from the outfalls are dissipated by tidal flushing and are not expected to accumulate in marine surface water. Exposure to sediments is assumed to occur as follows:

- An adult Commercial Shellfisherman is exposed to sediments through direct contact and incidental ingestion while harvesting clams or worms. The frequency of contact is assumed to be 52 and 104 days per year for CT and RME exposure, respectively (MY, 2003c) for a 30-year (RME) and 9 year (CT) exposure duration. It is assumed that the adult ingests 50 mg (CT) to 100 mg (RME) sediment per exposure (USEPA 1991a). The exposed surface area is assumed to be 5,700 cm² which corresponds to the face, forearm, hands, and lower legs. This scenario is considered to be the most conservative of receptors likely to access shoreline sediments and is considered protective of the more casual trespasser. Additional exposure parameters for this scenario are presented in **Table 5-6**.
- An area resident is exposed to sediments through direct contact and incidental ingestion while wading along the shoreline sediments. The frequency of contact is assumed to be 2 times per week for the 13 summer weeks for a 30-year exposure duration (6 years as a child and 24 years as an adult). An age weighted ingestion rate of 114 mg-yr/kg-day and an age weighted dermal factor of 360 mg-yr/kg-event is assumed for this scenario. Additional exposure parameters for this scenario are presented in **Table 5-6**.

Shellfish Tissue

Site-related compounds were detected in clams, mussels and lobsters obtained from the Back River. Ingestion of potentially contaminated tissue was evaluated for each species for the area resident as follows:

- A resident (child and adult) is exposed to site-related contaminants through ingestion of shellfish. An adult is assumed to ingest 0.034 kg/day (RME) and 0.016 kg/day (CT) and a child is assumed to ingest 0.008 kg/day (MBOH, 2001 and USEPA, 1999d). The consumption rate under the RME scenario is the upper estimate of sport fish consumption and is used by the Maine Bureau of Health to establish FTALs. The consumption rate under the CT scenario is the recommended default rate presented in *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (USEPA, 1999d). The consumption rate for children is based on the USEPA Fish Consumption Advisories that recommends one 2-ounce meal of cooked fish per week for a small child (USEPA, 2001c). An exposure frequency of 365 days/year is assumed for an exposure duration of either 30 years (RME) or 9 years (CT). Additional exposure parameters for this scenario are presented in **Table 5-7**.

Groundwater

Site-related compounds have been detected in groundwater beneath Bailey Point. Although Maine Yankee does not use the groundwater at the facility for potable purposes, exposure to groundwater was evaluated under a residential land use scenario. The routes of exposure evaluated include ingestion of groundwater and inhalation of VOCs during showering. Dermal exposure was also evaluated for those compounds that are identified in Appendix B-3 to the *Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001a) as compounds that may contribute “significantly” to the total exposure dose received under a residential groundwater scenario. The USEPA considers a “significant” contribution to be more than 10 percent of the assumed exposure dose estimated under a standard residential groundwater ingestion scenario (USEPA, 2001a). In summary, the following exposure scenario was evaluated:

- Residents exposed to groundwater through ingestion, dermal contact, and inhalation of volatiles. Residents are assumed to ingest 1.4 liters (CT) to 2 liters (RME) of water per day, 350 days per year, for either a 9-year (CT) or 30-year (RME) exposure duration. Inhalation exposure to VOCs is assumed to be equal to the exposure attributed to the ingestion pathway (USEPA 1991b). Exposure through dermal contact was evaluated using the USEPA *Interim Risk Assessment Guidance for Dermal Exposure* (USEPA, 2001a). Additional exposure parameters for this scenario are presented in **Table 5-8**.

5.5 Toxicity Assessment

The purpose of the toxicity assessment is to provide current toxicological information for each COPC. This information includes the potential for a specific COPC to cause adverse effects in humans, and characterizes the relationship between the dose of a chemical and the incidence of adverse health effects in the exposed population. The purpose of this assessment is to identify dose-response values that can be used to quantitatively evaluate potential health risks as a function of chemical exposure. The USEPA’s Integrated Risk Information System (IRIS) database maintains a current listing of all the verified toxicity values and was the primary source of information for this section. Toxicity information for compounds not listed on IRIS was obtained from USEPA Region I, the National Center of Environmental Assessment (NCEA), or Health Effects Summary Tables (HEAST) as presented in USEPA Region 9 PRG table (USEPA, 2003, USEPA NCEA website, April 2003, and USEPA Region 9 website, October 2002). The non-carcinogenic and carcinogenic toxicity factors used in this HHRA are discussed below.

5.5.1 Non-Carcinogens

Non-carcinogens are compounds that may damage an organ or organ systems, but do not cause cancer. Unlike carcinogens, non-carcinogens are believed to have threshold dosage levels below which adverse effects are not expected. Carcinogens may also have non-

carcinogenic effects and these effects are considered and included with the effects of non-carcinogenic compounds.

USEPA's preferred criterion for quantifying non-carcinogenic risk from oral and dermal exposure is the reference dose (RfD), which corresponds to USEPA's identification of the threshold effects level with an added margin of safety. RfDs are expressed in units of milligrams (mg) of a chemical per kilogram (kg) of body weight per day (mg/kg-day). Various types of RfDs are available depending on the exposure route (oral or inhalation) and length of exposure being evaluated (chronic, subchronic, or acute) as discussed below:

Chronic Oral RfDs. The chronic oral RfD is defined as an estimate of an average daily exposure level below which significant, adverse non-carcinogenic health effects are not expected. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound (i.e., seven years to a lifetime) (USEPA, 1989). Chronic RfDs were available for the majority of the COPC and used in this HHRA to evaluate potential risks to the resident and on-site worker from chronic ingestion and dermal contact exposure. **Section 5.10** discusses the uncertainties associated with evaluating noncarcinogenic hazards for compounds for which no chronic RfDs were available.

Chronic Inhalation RfDs. USEPA's preferred criterion for quantifying non-carcinogenic risk from chronic inhalation exposure is the Reference concentration (RfC). These concentrations are expressed in units of mg/m³ and are estimates of a continuous inhalation exposure to a population that is likely to be without an appreciable risk of harmful effects during a lifetime. RfCs can be converted to units of mg/kg-day (i.e., Inhalation RfDs) using the following equation:

$$RfC (mg/m^3) \times 20m^3/day \times 1/70 kg = Inhalation RfD (mg/kg-day)$$

Chronic Inhalation RfCs were used to evaluate non cancer risks to the resident and on-site worker from the inhalation of fugitive dust (see **Appendix H-3**). RfC and RfDs were obtained from IRIS, NCEA or USEPA Region 1.

Sub Chronic Oral RfDs. The subchronic RfD is used to evaluate less than lifetime exposure. The USEPA defines the subchronic RfD as an estimate of a daily exposure level that is likely to be without deleterious effects during a portion of a lifetime (i.e., two weeks to seven years) (USEPA, 1989). Subchronic RfDs are available for many of the COPCs and were used in this HHRA to evaluate potential risks to the construction worker from direct contact and ingestion exposure to soil. **Section 5.10** discusses the uncertainties associated with evaluating noncarcinogenic hazards for compounds for which no subchronic RfDs were available

Sub Chronic Inhalation RfDs. The USEPA is currently reevaluating its approach to characterizing risk from less than lifetime (i.e., subchronic) inhalation exposure (USEPA, 2002b). Applying toxicity values currently available for inhalation exposures to scenarios other

than residential (i.e., construction worker) may not be appropriate (USEPA, 2002b). At the request of the MDEP, the long term predicted fugitive dust air concentrations were compared directly to the inhalation RfC concentration. This evaluation is presented in **Appendix H-3**.

5.5.2 Carcinogens

The USEPA Carcinogen Assessment Group (CAG) has developed Carcinogenic Slope Factors (CSFs) for compounds classified as known, potential, or possible human carcinogens. CSFs are developed to estimate the theoretical, upper-bound, excess lifetime cancer risks associated with oral and dermal exposures to potential human carcinogens. The USEPA has also developed Unit Risk Factors (URFs) to evaluate carcinogenic risks from the inhalation route of exposure (see **Appendix H-3**). URFs are expressed in units of $(\mu\text{g}/\text{m}^3)^{-1}$ and are defined as the upper bound excess lifetime cancer risk estimated from continuous exposure to a chemical at a concentration of $1 \mu\text{g}/\text{m}^3$. URFs can be converted to units of $(\text{mg}/\text{kg}\cdot\text{day})^{-1}$ (i.e., inhalation CSFs) using the following equation:

$$URF (\text{m}^3/\mu\text{g})^{-1} \times \text{day}/20\text{m}^3 \times 70 \text{ kg} \times 10^3 \mu\text{g}/\text{mg} = \text{Inhalation CSF } 1/(\text{mg}/\text{kg}\cdot\text{day})$$

The inhalation URFs are based on continuous lifetime exposure and, therefore, may not be appropriate for evaluating sub chronic exposure durations. To address this limitation, at the request of MDEP the long term predicted fugitive dust air concentrations were multiplied by the URF with no adjustment for frequency and duration of exposure (USEPA, 2002b). This evaluation is presented in **Appendix H-3**.

CSFs and URFs for the carcinogenic COPCs were obtained from the IRIS, NCEA or USEPA Region 1.

The CAG uses a weight-of-evidence classification system to identify compounds as carcinogens. The USEPA is currently in the process of revising the guidelines for evaluating carcinogenic effects. The proposed guidelines will result in changes, including how the USEPA evaluates the mode of action of suspected carcinogens, the descriptors for classifying carcinogenic potential, and the subsequent hazard and risk characterization. Until these guidelines are final, USEPA continues to rely on existing assessments.

Currently carcinogens are categorized according to the weight of scientific evidence:

- **Group A - Human Carcinogen** - This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer in humans.
- **Group B - Probable Human Carcinogen** - This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of positive data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

- **Group C - Possible Human Carcinogen** - This category indicates that there is limited evidence of carcinogenicity in animals, in the absence of positive human data.
- **Group D - Not Classified** - This category indicates that there was no data to evaluate or that the evidence for carcinogenicity in humans and in animals was inadequate.
- **Group E - No Evidence of Carcinogenicity to Humans** - This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies.

5.5.3 Other Issues

Toxicity data for the dermal route of exposure was reviewed using the *Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001a), and the equations outlined in *Risk Assessment Guidance - Part B* (USEPA, 1991b). Based on current guidance, the oral RfD for cadmium was adjusted for the dermal risk evaluation (USEPA, 2001a). An oral absorption efficiency of 5% is assumed for cadmium, which leads to an estimated dermal reference dose of 2.5E-4.

The Dermally Absorbed Dose (DAD) for groundwater contact (standard residential assumptions) was calculated using the chemical specific Absorbed Dose/event (DA_{event}) factors presented in Table B-3 of the *Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001a).

Cancer slope factors for PCBs were obtained from the USEPA Guidance *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (USEPA, 1996e). This document presents a range of CSFs for PCB mixtures based on potential health risks and persistence in the environment. A CSF of $2.0 \text{ (mg/kg-day)}^{-1}$ was selected for evaluating PCB exposure to soils and groundwater. This CSF is the upper end of the range of possible CSFs and is based on the most persistent and toxic aroclors (USEPA, 1996). Because the CSF is based on total PCBs, the individual detected aroclor concentrations were summed to provide an estimate of total PCB exposure.

The RfD for Aroclor 1254 was used as a surrogate RfD to evaluate the noncarcinogenic risks from exposure to all PCBs (USEPA, 2003).

The risk from incidental ingestion and dermal contact exposure to carcinogenic PAHs in soils was evaluated using toxic equivalence factors (TEFs) developed based on the relative potency of benzo(a)pyrene (B(a)P) (USEPA Region I Risk Update, 1994). The concentration of each of the six carcinogenic PAHs was modified using the following

TEFs to yield a benzo(a)pyrene equivalent concentration:

Compound	TEF
benzo(a)anthracene	0.1
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.01
chrysene	0.001
dibenzo(a,h)anthracene	1.0
indeno(1,2,3-cd)pyrene	0.1

The CSF derived for B(a)P of $7.3 \text{ (mg/kg-day)}^{-1}$ was used to evaluate oral and dermal risk from exposure to carcinogenic PAHs. There is insufficient information regarding the application of TEFs in evaluating potential risks from the inhalation of PAHs in fugitive dust. As a conservative measure, the URF for benzo(a)pyrene was used as a surrogate URF to evaluate potential risks from inhalation exposure to other carcinogenic PAHs (see **Appendix H-2**).

The seafood consumption assessment assumes that the arsenic detected in the shellfish samples exists as inorganic arsenic. The Agency for Toxic Substances and Disease Registry (ATSDR) reported that 80 to 99 percent of arsenic in seafood is present in the nontoxic organic form of arsenic (ATSDR, 2000). The USEPA has not yet developed default values to assess the risk from the toxic inorganic portion of total arsenic in seafood. As such, the risk estimated for exposure to arsenic through seafood consumption may be overestimated by as much as an order of magnitude or more.

Toxicity information was not available for some of the compounds detected at the site, including DRO, carbazole, sodium, endrin aldehyde, benzo(g,h,i)perylene and pyrene. These chemicals can not be quantitatively evaluated; however, these compounds are carried forward in the risk assessment and appear in the risk tables. In addition, subchronic RfDs or RfCs were not available for many of the soil COPCs.

Although quantitative risk estimates were not developed for the different EPH fractions, the risk from exposure to petroleum hydrocarbons is assessed as part of the quantitative risk estimates generated for the target SVOCs. Soil samples collected and analyzed for EPH typically contained the heavier C19 to C36 aliphatic and C11 to C22 aromatic fractions. With the exception of the Former Truck Maintenance Garage Area, the lighter fraction (i.e., C9 to C18 aliphatics) were typically either not detected or were present at concentrations less than the heavier aliphatic and aromatic fractions. The heavier aromatic fraction of petroleum hydrocarbons is associated with the PAHs included in the standard SVOC analysis. Areas with elevated EPH concentrations also had elevated PAH concentrations (i.e., Plant Area). Quantitative risk estimates were developed for PAHs and are presented in **Section 5.6**.

A summary of the current toxicity information and regulatory standards and guidelines for the COPCs used in this HHRA is presented in **Table 5-9**.

5.6 Risk Characterization

This section presents the risk characterization for the Bailey Point RFI. Section 5.6.1 presents the MDEP Remedial Action Guideline methodology used to evaluate existing conditions at two areas within Bailey Point having minimal impact from industrial activities. Section 5.6.2 presents the methodology used to conduct a baseline HHRA for the remaining areas of Bailey Point and for media impacted by site activities. Quantitative risk estimates were generated by combining the numerical exposure dose estimates with the quantitative dose-response data. It should be emphasized that the risk estimates are based on numerous conservative exposure assumptions and likely overestimate actual risk. Both non-carcinogenic and carcinogenic risk estimates were derived consistent with the HHEA work plan and as described below. The non-carcinogenic risk estimates include non-carcinogenic effects from exposure to carcinogens. The results of the risk assessment are presented for each media in **Sections 5.6.3 through 5.6.8**.

5.6.1 Remedial Action Guidelines

MDEP has developed Remedial Action Guidelines for contaminated soils that are derived using specific standard exposure scenarios and are considered to be protective of human health (MDEP, 1997). The Remedial Action Guidelines are set at a noncancer HI of 1.0 and an incremental cancer risk of 1×10^{-5} . These guidelines can be used to determine if an acceptable level of total site risk has been achieved by comparing the ratios of residual contaminant concentrations to chemical specific cleanup guidelines to a value of 1.

Three areas within Bailey Point were evaluated using this type of risk evaluation and include the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas and the ISFSI. The site history indicates these areas received minimal impact from historical site operations and was confirmed by the sampling program and analytical results (see **Section 4**). A summary of the analytical data and rationale for selecting COPCs for the 115 kV Switchyard, Personnel Building and Parking Lot Areas and ISFSI are presented in **Tables 5-1A, 5-1B and 5-1G**. A comparison of the maximum detected concentration of each soil COPC to its respective Remedial Action Guideline is presented in **Table 5-10A, 10B and 5-10G** for the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas, and ISFSI, respectively.

5.6.2 Baseline Human Health Risk Assessment

The risks associated with exposure to soils, sediments, shellfish tissue and groundwater constituents detected within and around Bailey Point were estimated as part of the baseline HHRA. Both noncarcinogenic and carcinogenic risk estimates were derived as described in the HHEA Work Plan and summarized below.

Non-Carcinogenic Hazards

Non-carcinogenic risks are estimated by dividing the exposure dose of each COPC by its respective RfD to yield a Hazard Quotient (HQ). The non-carcinogenic risks from exposure to each medium are quantified in terms of a Hazard Index (HI), which is calculated by summing the HQs for each COPC.

$$HQ = \text{Exposure Dose (mg/kg-day)} / \text{RfD (mg/kg-day)}$$

$$HI_{\text{pathway}} = HQ_{\text{chemical 1}} + HQ_{\text{chemical 2}} + HQ_{\text{chemical n}}$$

The resulting cumulative non-carcinogenic risks are then compared to the USEPA target HI of 1. If the HI is less than or equal to 1, no adverse health effects are anticipated from the predicted exposure dose level. If the HI is greater than 1, the predicted exposure dose level could potentially cause adverse effects (USEPA, 1989b).

The quantitative risk estimates for non cancer hazards for the RME and CT evaluation of each exposure scenario are provided in **Tables 5-10C through 5-10I** and discussed along with the carcinogenic risk estimates in the following section. The noncarcinogenic risks for ingestion of groundwater and produce are presented with their respective carcinogenic risks in **Tables 5-11J and 5-11K**.

Carcinogenic Risks

Carcinogenic risks are estimated by multiplying the estimated exposure dose by the CSF to obtain an estimate of incremental risk, as follows:

$$\text{Carcinogenic Risk} = \text{Exposure Dose (mg/kg-day)} \times \text{CSF (mg/kg-day)}^{-1}$$

The CSF converts the estimated daily intake of a chemical averaged over a lifetime of exposure (i.e., 70 years) to an incremental risk of an individual developing cancer. The CSF used in these calculations is often the upper 95-percentile confidence limit of the probability of a response based on experimental data. As such, the carcinogenic risk estimates presented in this assessment are considered to be an upper-bound estimate of risk. The “true risk” to an individual is likely to be much less than predicted in this assessment (USEPA, 1989b).

The cumulative carcinogenic risk for each medium was estimated by summing the carcinogenic risks of each COPC. The resulting cumulative risk estimate was then compared to the USEPA target risk range of 1×10^{-6} to 1×10^{-4} (USEPA, 1990) and MDEP upper bound risk level of 1×10^{-5} .

The calculations of cancer risks for the RME and CT evaluation of each exposure scenario are presented in **Tables 5-11C through 5-11K**

5.6.3 Summary of the Risks from Exposure to Soils

The Remedial Action Guideline Ratios for the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas and ISFSI are presented in **Tables 5-10A, 10B and 10G**. The non cancer and cancer risk estimates associated with exposure to soils throughout other portions of Bailey Point are presented in **Tables 5-10C through F** and **Tables 5-11C through F** and are discussed by sub area in this section.

115kV Switchyard

This risk assessment evaluated exposure to soils from the 115kV Switchyard by comparing the maximum detected soil concentration of each COPC to its MDEP Remedial Action Guideline concentration. The guideline concentrations are derived to be protective of human health under a residential land use.

The Risk Ratio based on residential exposure to soils from the 115kV Switchyard is 1.4 and slightly exceeds the target ratio of 1.0 (see **Table 5-10A**). The major contributor to this ratio is arsenic. Arsenic was detected at the 115 kV Switchyard at concentrations consistent with background conditions (see **Section 4.7.1**). Removing arsenic from the calculation results in a ratio of 0.2, below the target risk level of 1.0.

Personnel Buildings and Parking Lot Areas

This risk assessment evaluated exposure to surface and subsurface soil around the Personnel Buildings and Parking Lot Areas by comparing the maximum detected soil concentration of each COPC to its MDEP Remedial Action Guideline concentration. The guideline concentrations are derived to be protective of human health under a residential land use.

The Personnel Building and Parking Lot Area includes the location of the former Fire Pond, Personnel Buildings and Parking Lots where limited industrial activity occurred. The primary contaminants detected in soils from this area are PAHs and metals. The COPCs selected for this area include metals and individual PAH compounds consistent with the primary contaminants detected at the site.

The Risk Ratios based on residential exposure to surface and subsurface soils from the Personnel Building and Parking Lot Areas are 3.8 and 4.0, respectively (see **Table 5-10B**). These ratios slightly exceed the target ratio of 1.0. The major contributors to these ratios are lead and arsenic.

Lead was initially detected at a maximum concentration of 969 mg/kg in a soil sample collected from below the slab of the Information Center. This concentration compared to its Remedial

Action Guideline concentration of 375 mg/kg lead results in a risk ratio greater than 1.0. Fifteen additional soil samples were collected in October 2003 within the immediate area of the elevated lead concentration to better delineate the extent of contamination (see **Section 4.4.9**). The high lead concentration was not replicated in any of the soil samples. The total lead concentrations for these samples ranged from 14.4 mg/kg to 22.2 mg/kg (see **Table 4-17**) consistent with background conditions. Risk ratios for lead based on the October 2003 sampling data are all below 1.0 indicating that lead does not present a health risk at this site. (Additional discussion of the health risks associated with lead in soil is presented in **Section 5.6.4**).

The presence of arsenic in soil also leads to a risk ratio greater than 1.0. As discussed in **Section 4.7.1**, arsenic was detected in soils from this area at concentrations consistent with background conditions. Removing arsenic and lead from the calculation results in ratios of 0 and 0.2 for surface and subsurface soils, respectively.

ISFSI

This risk assessment evaluated exposure to soils from the ISFSI by comparing the maximum detected soil concentration of each COPC to its MDEP Remedial Action Guideline concentration. The guideline concentrations are derived to be protective of human health under a residential land use. Only arsenic and benzo(g,h,i)perylene were retained as COPCs for the ISFSI and of these only arsenic has a Remedial Action Guideline Concentration. There is insufficient toxicity information to develop a Remedial Action Guideline Concentration for benzo(g,h,i)perylene. However, this compound is present at concentrations less than the Remedial Action Guidelines developed for other PAH compounds (i.e., benzo(a)pyrene).

The Risk Ratio based on residential exposure to soils from the ISFSI is 0.8 and below the target ratio of 1.0 (see **Table 5-10G**). Arsenic is the only contributor to this ratio. Arsenic was detected at the ISFSI at concentrations consistent with background conditions and is not considered to be present as a result of any industrial activities (see Section 4.7.1).

Plant Area

This risk assessment evaluated exposure to surface and subsurface soils around the Plant Area. As discussed in **Section 5.4.1**, primary soil COPCs were identified based on the noncancer and cancer risk estimates associated with exposure to the maximum detected concentration of each COPC (see **Table 5-1C**). **Appendix H-2, Table H-2C1 and HC2** present the noncarcinogenic and carcinogenic screening risk estimates associated with exposure to soil at the Plant Area. The statistical distribution of the primary COPCs was determined and the 95% UCL concentration calculated using the formula appropriate for the particular distribution as presented in the USEPA guidance (USEPA, 2002a). The EPCs for the Plant Area surface and subsurface soils are presented in **Appendix H-2, Table H-2C3**.

The Plant Area is comprised of the Industrial and Restricted Areas and is the center of all industrial activities at this site. PAHs, pesticides and PCBs were identified in surface and subsurface soils from this area. The COPCs selected for the Plant Area include metals, pesticide and PAH compounds and adequately reflect the primary contaminants detected in the Plant Area (see **Section 4.8.1**).

Three scenarios were developed to evaluate the carcinogenic and non-carcinogenic risks from exposure to surface soil and include exposure under a residential land-use, exposure to an on-site worker, and exposure to a construction worker. The non-carcinogenic risks to a child (i.e., 6-year exposure duration) resulting from exposure to soil under a residential scenario were also evaluated (see **Tables 5-10C and 5-11C**). Non-carcinogenic and carcinogenic risks from exposure to subsurface soils were evaluated for the construction worker.

The non-carcinogenic risks for the residential, on-site and construction worker scenarios are all below an HI of 1.0 and ranged from an HI of 0.05 for the construction worker (subsurface exposure) to 0.8 for childhood exposure (RME exposure).

The carcinogenic risks for the on-site and construction worker scenarios are within the USEPA target risk range and ranged from 1.6×10^{-6} for the construction worker (subsurface soils) to 1.9×10^{-5} for the on-site worker (RME exposure). The on-site worker (RME exposure) is slightly above the MDEP target risk level of 1×10^{-5} . Constituents present in soils at a concentration associated with an individual cancer risk greater than 1×10^{-6} include arsenic (on-site worker RME exposure), and cPAHs (on-site worker CT and RME exposure and construction worker surface soils).

The carcinogenic risks for the CT and RME residential scenarios are within the USEPA target risk range and greater than the MDEP target risk for the RME scenario. The risks are 6.5×10^{-6} (CT) and 4.8×10^{-5} (RME). Arsenic and cPAHs are present in soils at concentrations associated with a greater than 1×10^{-6} risk level and cPAHs are the only constituents present in soil at concentrations associated with a greater than 1×10^{-5} risk level. The risk from exposure to cPAHs under the residential RME scenario is 3.6×10^{-5} (see **Table 5-11C**).

A significant contributor to the carcinogenic risk estimates for exposure to soil in the Plant Area is arsenic. As discussed in **Section 4.7.1**, arsenic was detected in the Plant Area at concentrations consistent with background conditions. Eliminating arsenic from the risk calculations results in a reduction of the cancer risk to 3.7×10^{-5} for the residential RME scenario and 1.5×10^{-5} for the on-site worker RME scenario.

Warehouse 2/3

This risk assessment evaluated exposure to surface and subsurface soils at Warehouse 2/3. Primary soil COPCs were identified based on the noncancer and cancer risk estimates associated with exposure to the maximum detected concentration of each COPC (see **Table 5-**

1D) Appendix H-2, Tables H-2D1 and 2D2 present the noncarcinogenic and carcinogenic screening risk estimates associated with exposure to soil at the Warehouse 2/3 area. The statistical distribution of the primary COPCs was determined and the 95 % UCL concentration calculated using the formula appropriate for each distribution as presented in the USEPA guidance (USEPA, 2002a). The EPCs for the Warehouse 2/3 soil COPCs are presented in **Appendix H-2, Table H-2D3**.

Warehouse 2/3 was used to receive and store chemicals used in plant operations. As discussed in **Section 4.8.1**, soils on the northwest side of the warehouse contained elevated levels of PAHs and PCBs and pesticides were also detected in the soil. Soils on the southwest side of the warehouse contained elevated levels of VOCs. The COPCs for this area include metals, and individual PAH, and PCBs and adequately reflect the contamination at this site.

Three scenarios were developed to evaluate the carcinogenic and noncarcinogenic risks from exposure to surface and subsurface soil and include exposure under a residential land-use, exposure to an on-site worker and exposure to a construction worker. The non-carcinogenic risks to a child (i.e., 6-year exposure duration) resulting from exposure to soil under a residential scenario were also evaluated (see **Tables 5-10D and 5-11D**). Noncarcinogenic and carcinogenic risks from exposure to subsurface soils were evaluated for the construction worker.

The noncarcinogenic risks for exposure to soils from the Warehouse 2/3 area are at or below an HI of 1.2 for all exposure scenarios and ranged from 0.06 for the on-site worker (CT exposure) to 1.2 for the child (RME exposure). All individual HIs are below 1.0.

Arsenic and iron are the metals that contribute significantly to the overall HI for childhood exposure to soil. As discussed in **Sections 4.7.1 and 4.8.1.1**, iron and arsenic are present in soils at Warehouse 2/3 at concentrations consistent with background conditions. Eliminating iron and arsenic from the HI calculation results in a reduction of the noncancer risks to 0.5 for the child residential RME scenario.

The carcinogenic risks from exposure to soil around the Warehouse 2/3 area are at or below the MDEP target risk level of 10^{-5} for the on-site worker and construction worker scenarios.. The cancer risks ranged from 8.8×10^{-7} for the construction worker (subsurface soils) to 1.5×10^{-5} for the on-site worker (RME exposure). The carcinogenic risk for the CT and RME residential scenarios are within the USPEA target risk range and exceeded the MDEP target risk for the RME scenario. The risk estimates are 5.2×10^{-6} and 3.8×10^{-5} for CT and RME exposure, respectively. Constituents present in soil at concentrations associated with individual cancer risks greater than 10^{-6} include arsenic (resident RME and CT exposure and on-site worker RME exposure), cPAHs (resident RME and CT exposure and on-site worker RME exposure) and total PCBs (resident RME exposure). Arsenic and cPAHs are present at concentrations associated with an incremental risk greater than 10^{-5} and are estimated to be 1.4

$\times 10^{-5}$ (arsenic) and 2.3×10^{-5} (cPAHs) under the residential RME scenario (see **Table 5-11D**).

A significant contributor to the carcinogenic risk estimates for exposure to soil in the Warehouse 2/3 area is arsenic. As discussed in **Section 4.7.1**, arsenic is present in soils at Warehouse 2/3 at concentrations consistent with background conditions. Eliminating arsenic from the risk calculations results in a reduction of the cancer risk to 9.9×10^{-6} for the on-site worker (RME exposure). The total site risks for the resident (RME exposure) still exceeds the MDEP target risk level and is estimated at 2.4×10^{-5} .

345 kV Transmission Line Area

This risk assessment evaluated exposure to surface and subsurface soil around the 345 kV Transmission Line Area. Primary soil COPCs were identified based on the noncancer and cancer risk estimates associated with exposure to the maximum detected concentration of each COPC (see **Table 5-1E**). **Appendix H-2, Table H-2E1 and 2E2** presents the noncarcinogenic and carcinogenic screening risk estimates associated with exposure to soils at the 345 kV Transmission Line Area. The statistical distribution of the primary COPCs was determined and the 95 % UCL concentration calculated using the formula appropriate for each distribution as presented in the USEPA guidance (USEPA, 2002a). The EPCs for the 345 kV Transmission Line Area COPCs are presented in **Appendix H-2, Table H-2E3**.

The 345 kV Transmission Line Area is located in the northern portion of Bailey Point and received several episodes of fill material and debris associated with plant construction. Contaminants detected in these soils include metals and individual PAH, PCB and pesticide compounds. The COPCs selected for the 345 kV Transmission Line Area reflect the soil data and include metals and PAH compounds.

Three scenarios were developed to evaluate the carcinogenic and noncarcinogenic risks from exposure to surface soil and include exposure under a residential land-use, exposure to an on-site worker and exposure to a construction worker. The non-carcinogenic risks to a child (i.e., 6-year exposure duration) resulting from exposure to soil under a residential scenario were also evaluated (see **Tables 5-10E and Tables 5-11E**). Noncarcinogenic and carcinogenic risks from exposure to subsurface soils were evaluated for the construction worker.

The noncarcinogenic risks for exposure to soils from the 345 kV Transmission Line Area are at or below an HI of 1.1 for all scenarios. The HI's based on the on-site and construction worker and residential scenarios ranged from 0.05 for the construction worker (surface soil) to 0.3 for the resident (RME exposure). The risk for the 6-year child exposure duration was 1.1 slightly above the target HI of 1.0. No constituent had an individual HI greater than 1.0.

The significant contributors to the overall HI for childhood exposure to soil are arsenic and iron. As discussed in **Sections 4.7.1 and 4.8.1.1**, arsenic and iron are present in soils at the 345 kV

Transmission Line Area at concentrations consistent with background conditions. Eliminating arsenic and iron from the HI calculation results in a reduction of the noncancer risks from 1.1 to 0.3 for the child residential RME scenario.

The carcinogenic risks associated with exposure to soil in this area are all within the USEPA target risk range and ranged from 5.9×10^{-7} for the on-site worker (CT exposure) to 1.5×10^{-5} for the resident (RME exposure). Arsenic was the only constituent present in soil at concentrations associated with an individual cancer risk greater than 1×10^{-5} . Eliminating arsenic from the risk estimates results in a reduction of the cancer risks to 2.9×10^{-6} for the resident (RME exposure). This risk estimate is below the MDEP risk level. Constituents present in soil at concentrations associated with a cancer risk greater than 10^{-6} include arsenic (onsite worker – RME exposure and resident CT and RME exposure) and cPAHs (resident – RME exposure).

Bailey Farmhouse

This risk assessment evaluated exposure to soils collected from the Bailey Farmhouse Area. All COPCs selected and presented in **Table 5-1F** were retained as final COPCs. The EPCs were set at the maximum detected concentration as the sampling data set consisted of less than 10 samples.

The Bailey Farmhouse had been used as a residence by the former landowners. Of interest in this area, was residual contamination remaining in the leach fields and below an oil tank. Soil samples collected from these areas contained EPH, PCBs and VOCs.

Three scenarios were developed to evaluate the carcinogenic and noncarcinogenic risks from exposure to surface soil and include exposure under a residential land-use, exposure to an on-site worker and exposure to a construction worker. The non-carcinogenic risks to a child (i.e., 6-year exposure duration) resulting from exposure to soil under a residential scenario were also evaluated (see **Tables 5-10F and Tables 5-11F**). Noncarcinogenic and carcinogenic risks from exposure to subsurface soils were evaluated for the construction worker.

The noncarcinogenic risks for exposure to soils from Bailey Farmhouse are below an HI of 1.0 for all exposure scenarios and ranged from 0.04 for the construction worker (surface and subsurface soil) to 0.7 for the child (RME exposure).

Arsenic was the only carcinogenic compound retained as a soil COPC for the Bailey Farmhouse and as such, the following cancer risks are attributed entirely to arsenic. The carcinogenic risks for on-site and construction worker scenarios were within or below the USEPA target risk range and below the MDEP target risk of 1×10^{-5} . The carcinogenic risks ranged from 3.1×10^{-7} for the on-site worker (CT exposure) to 2.7×10^{-6} for the on-site worker (RME exposure). The residential risk scenarios were within the USEPA target risk

range and below the MDEP target risk. The risks are 1.2×10^{-6} for the CT exposure and 7.9×10^{-6} for the RME exposure. .

5.6.4 Summary of the Risks from Exposure to Lead in Soils

The risks from exposure to lead could not be quantitatively evaluated. As discussed in **Section 5.5**, exposure to lead is to be qualitatively evaluated using the Interim Soil Lead Screening Concentration of 400 mg/kg. This soil concentration is considered to be protective of lead exposure under a residential land use. Lead was detected in 175 soil samples throughout Bailey Point at concentrations ranging from 3.4 mg/kg to 969 mg/kg. Sample location MS05SS75 (0 – 0.5 ft), a soil sample collected beneath the concrete slab of the former Information Center, was the only location where lead was reported at a concentration exceeding 400 mg/kg. However, the results of fifteen additional soil samples collected from the area immediately around MS05SS75 reported lead at concentrations ranging from 14.4 to 22.2 mg/kg. These concentrations are consistent with background conditions and are well below the 400 mg/kg screening concentration. Two other locations, MY05TP02 and MY05TP107A, reported lead at 397 mg/kg and 396 mg/kg, respectively. The remaining 175 locations reported lead at concentrations ranging from 3.4 mg/kg to 62.2 mg/kg.

In addition to the comparison of lead concentrations to the screening level, the USEPA evaluated the potential risks to children from lead exposure using the Integrated Exposure Uptake Biokinetic (IEUBK) Model. This model predicts possible blood lead levels based on site-specific data. The USEPA used groundwater and soil data collected from Bailey Point to evaluate site-specific lead risks. The results of the IEUBK model are presented in **Appendix H-5** and indicate that 99.9% of the population would have blood lead levels below the Center for Disease Control and USEPA goal of 10 micrograms lead per deciliter blood. The USEPA concluded that the soils at Bailey Point do not require remediation based on detected lead concentration (USEPA, 2004).

5.6.5 Summary of the Risks from Exposure to Shoreline Sediments

This risk assessment evaluated exposure to sediment by both a Commercial Shell fisherman exposed to sediments while harvesting clams, shellfish or worms and an area resident exposed to sediments while recreating around the intertidal and subtidal zones around Bailey Point (see **Tables 5-10H and Tables 5-11H**). PAHs were the primary contaminant in sediments. The estimated cancer and non-cancer risks for sediment exposure were below the MDEP target risk level of 10^{-5} and HI of 1.0 and within the USEPA target risk range of 10^{-4} to 10^{-6} . The estimated non-cancer HIs are 0.01 and 0.05 for the Commercial Shell fisherman CT and RME scenarios, respectively and 0.03 for the area resident. The estimated cancer risks for the Commercial Shell fisherman are 1.7×10^{-6} and 1.4×10^{-5} for the CT and RME scenarios, respectively and 6.0×10^{-6} for the area resident. CPAHs and arsenic were present in sediment at concentrations associated with individual cancer risks greater than 10^{-6} (RME exposures only). No constituents were present at concentrations associated with an individual cancer risk greater than 10^{-5} .

5.6.6 Summary of the Risks from Ingestion of Shellfish Tissue

This risk assessment evaluated future residential exposure to shellfish, including mussels, clams, lobsters and lobster tomalley obtained from the intertidal and subtidal zones around Bailey Point. Cancer and non-cancer risks were evaluated for a CT and RME exposure to residents, based on age-weighted factors to account for both childhood and adult exposure. In addition, non-cancer risks were also evaluated for a residential RME exposure for children (i.e. 6-year exposure duration) (see **Tables 5-10I and Tables 5-11I**).

The noncarcinogenic risks were greater than an HI of 1 for all species and ranged from 6 to 10 for the clam; 2 to 3 for the mussel; 3 to 5 for lobster and 7 to 12 for lobster tomalley. Individual constituents present in shellfish tissue at concentrations exceeding an HI of 1 include arsenic in all species (CT and RME exposure), iron in clams (CT and RME exposure), vanadium in clams (child RME exposure), and total PCBs in lobster tomalley (CT and RME exposure).

The carcinogenic risk estimates for ingestion of shellfish exceed both the MDEP target risk level of 10^{-5} and the USEPA target risk range of 10^{-6} to 10^{-4} for all species. The carcinogenic risks ranged from 2.0×10^{-4} to 1.1×10^{-3} for ingestion of clams; 7.2×10^{-5} to 4.0×10^{-4} for ingestion of mussels; 1.6×10^{-4} to 9.0×10^{-4} for ingestion of lobster and 2.6×10^{-4} to 1.4×10^{-3} for ingestion of lobster tomalley. Constituents present in shellfish tissue at concentrations exceeding an individual cancer risk of 10^{-5} included arsenic in all species, cadmium in mussels, and total PCBs in tomalley (RME exposure). The only constituent present in shellfish tissue exceeding an individual cancer risk of 10^{-4} was arsenic in all species (RME exposure). As discussed in **Section 5.5.3**, the assumption that arsenic in shellfish is in the toxic inorganic form overestimates the potential risk as 80 to 99 percent of arsenic is present in shellfish in the nontoxic organic form (ATSDR, 2000).

Reference samples of clams and mussels were collected from areas outside the influence of Maine Yankee and used to compare the concentration of chemicals detected in the clams and mussels collected from the Back River. Quantitative risk estimates were generated based on exposure to the average detected concentration of each COPC and age-weighted factors to account for both childhood and adult exposure (see **Tables 5-10I and Tables 5-11I**).

The noncarcinogenic risks associated with exposure to ingestion of shellfish tissue from reference locations were greater than an HI of 1 for both clams (HI of 10) and mussels (HI of 3). Individual constituents present in shellfish tissue at concentrations exceeding an HI of 1 include arsenic (clam and mussels) and iron (clam).

The carcinogenic risk estimates for ingestion of clams and mussels exceed both the MDEP target risk level of 10^{-5} and the USEPA target risk range of 10^{-6} to 10^{-4} . The carcinogenic risks ranged from 4.9×10^{-4} for ingestion of mussels to 1.1×10^{-3} for ingestion of clams. Constituents

present in clams and mussels at concentrations exceeding an individual cancer risk of 10^{-5} included arsenic.

The noncarcinogenic and carcinogenic risk estimates based on exposure to the contaminants in the reference samples are similar to the risk estimates based on exposure to contaminants in the site samples. Many of the contaminants detected in the clams and mussels collected from the Back River were also detected at similar concentrations in clams and mussels collected from the reference locations. **Table 5-12** presents the COPCs and average contaminant concentration for site and reference clam and mussels samples. The relative percent difference between the average reference and average site concentrations was calculated and presented in **Table 5-12**.

A comparison of the site and reference clam data shows the presence of the same metals and PAHs in both site and reference samples (see **Table 5-12**). All contaminant concentrations were greater in the reference samples with the exception of copper, sodium, and 4-chloro-3-methylnaphthalene. The site samples reported more individual pesticide compounds, but both the reference and site samples contained the same classes of pesticides. A comparison of the site and reference mussel data shows a similar trend. Similar compounds were detected in both the site and reference mussel locations with the reference samples having slightly higher concentrations of most contaminants. Fewer individual pesticides were detected in reference mussel samples; however, the common pesticides were detected at higher concentrations in the reference locations.

5.6.7 Summary of the Risks from Exposure to Groundwater

This risk assessment evaluated groundwater exposure under a future potential residential land use scenario. As stated, it is unlikely that Bailey Point will support future residential land use suggesting that the calculated risk estimates are an overestimate of actual future risks from exposure to groundwater. The estimated cancer and non-cancer risks for groundwater exposure exceed the MDEP target risk level of 10^{-5} and an HI of 1 for both the CT and RME scenario (see **Tables 5-10J and Tables 5-11J**). The estimated cancer risk ranged from 5.1×10^{-5} to 6.1×10^{-4} for the CT and RME scenario, respectively. The estimated HIs were 4 and 80 for the CT and RME scenarios, respectively.

Arsenic is present in groundwater at concentrations that are associated with an individual carcinogenic risk greater than a 10^{-4} risk level. The EPC for arsenic under the RME exposure scenario is 23 ug/L and is associated with an incremental cancer risk level of 4×10^{-4} . Dieldrin, heptachlor, trichloroethene and vinyl chloride are present in groundwater at concentrations associated with individual cancer risk estimates greater than 10^{-5} (RME exposure). Arsenic, iron, manganese and molybdenum had individual HIs greater than 1.0 under the RME exposure and iron had an individual HI greater than 1.0 under the CT exposure. All other compounds had individual HIs less than one.

5.6.8 Summary of the Risks from Ingestion of Produce

This risk assessment evaluated the potential risks to soil contaminants through the uptake and ingestion of above and below ground produce. Because no produce is grown on-site, contaminant concentrations in produce were estimated using chemical-specific bioconcentration factors (USEPA, 1998f). The exposure scenario assumed that an area resident consumed produce over a 30-year exposure duration. The estimated contaminant concentration in produce is presented in **Appendix H-4**. Noncancer and cancer risks were estimated for this route of exposure (see **Tables 5-11K**). The noncarcinogenic hazards ranged from 0.2 for produce grown in soils from Bailey Farmhouse to 1.3 for produce grown in soils from Warehouse 2/3. The carcinogenic risks were all above the MDEP target risk level and ranged from 2.9×10^{-5} for produce grown in soils from the Bailey Farmhouse to 2.2×10^{-4} for produce grown in soils from the Plant Area. Constituents estimated to be present in produce and associated with an individual cancer risk greater than 10^{-6} include arsenic (all areas) and cPAHs (Plant Area, Warehouse 2/3 and 345 kV Transmission Line). Constituents estimated to be present in produce and associated with an individual cancer risk greater than 10^{-5} include cPAHs (Plant Area, Warehouse 2/3 and 345 kV Transmission Line).

5.7 Comparison of Groundwater Constituents to MCLs and MEGs

A comparison of the maximum detected groundwater concentrations to federal MCLs and Maine Maximum Exposure Guidelines (MEGs) was made to identify compounds present in groundwater above federal primary drinking water standards or state guidelines. Groundwater contaminants and their respective MEGs and MCLs are presented in **Table 5-13**.

Eighteen groundwater constituents were identified as being present at concentrations greater than their respective standard or guideline concentration and include 9 metals (aluminum, arsenic, boron, lead, manganese, molybdenum, silver, sodium and thallium), two pesticides (dieldrin and heptachlor) six organic compounds (4-methylphenol, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, ethylbenzene and vinyl chloride) and DRO.

5.8 Total Site Risks

Future residential land use is unlikely for Bailey Point, since it is Maine Yankees' intention to limit future land use in the Bailey Point area to industrial/commercial activities. Estimates of total site risks (i.e., the sum of risks from various exposure pathways) were developed at the request of MDEP and MBOH and are presented in **Table 5-14** and **Table 5-15** for non cancer and cancer risks, respectively. These risk estimates are based on the assumption that an area resident or site/construction worker may experience exposure to site related contaminants through multiple exposure pathways (i.e., direct contact and ingestion of soil and sediment and ingestion of home grown produce). It is important to note that the total residential site risks presented for Bailey Point are biased high as a result of compounding or summing sequentially conservative exposure assumptions. Risk estimates based on a more probabilistic model of

total exposure will be lower than those presented in **Table 5-14** and **Table 5-15**. Total site risks are summarized below by land use scenarios.

Industrial/Commercial Land Use: The total site risks to the on-site and construction workers are based on concurrent ingestion and direct contact exposure to soil, and are consistent with an industrial/commercial future land use. The total site non cancer risks to the on-site worker and construction were all below an HI of 1.0 (see **Table 5-14**). The total site cancer risks to the on site worker (including arsenic) ranged from 3.1×10^{-7} for Bailey Farmhouse (CT) to 1.9×10^{-5} for the Plant Area (RME). The total site risks to the construction worker (including arsenic) ranged from 3.4×10^{-7} for Bailey Farmhouse to 1.9×10^{-6} for the Plant Area (surface soils). Removing arsenic from the risk calculation results in lower risk levels for the site/construction worker. The total site risk estimates associated with an exposure consistent with industrial/commercial future land use are at or below the MDEP target risk of 1×10^{-5} (see **Table 5-15**).

Residential Land Use: The total site non cancer risks to the future resident are all below and HI of 1.0 except for Warehouse 2/3. The non cancer risks based on exposure in this area are 1.5 (CT) and 1.6 (RME) (see **Table 5-14**). The total site cancer risks for the future resident are all above the MDEP target risk and range from 3.6×10^{-5} for the Bailey Farmhouse (CT) to 2.7×10^{-4} for the Plant Area (RME). Total site risks for the future resident excluding the contribution from arsenic were still above the target risk for all areas except Bailey Farmhouse and ranged from 1.7×10^{-5} for the 345 kV Transmission Line Area (CT) to 2.2×10^{-4} for the Plant Area (RME). The risk from the ingestion of homegrown produce contributes the most to the total site risks. For residents who may also ingest shellfish total site risks may be increased by 7.2×10^{-5} to 1.4×10^{-3} depending upon the type of shellfish. It should be noted that the risk from ingestion of shellfish collected around Bailey Point are indistinguishable from background risks and are not attributed to activities conducted at Maine Yankee.

5.9 Summary and Conclusions

The purpose of this baseline HHEA was to evaluate potential human health risks due to exposure to residual contamination in soils, sediment, shellfish tissue and groundwater at or surrounding the industrial portion of the Maine Yankee Facility. Based on the site history and results of the RFI (see **Section 4**), the site was divided into 10 discrete areas for purposes of site and risk characterization. The risks associated with exposure to soils in three of these areas were not evaluated as part of this risk assessment. These areas have either not been impacted by historical land use and have chemical concentrations consistent with PALs (Foxbird Island), have been remediated (Forebay) or require additional site characterization to assess potential remedial options (Former Truck Maintenance Garage). The risks associated with exposure to soils at the 115 kV Switchyard, Personnel Buildings and Parking Lot Areas and ISFSI were evaluated by comparing detected concentrations to the MDEP Remedial Action Guidelines concentrations. This approach was considered appropriate for these areas as sampling and

analytical results support the conclusion that these areas have not been adversely impacted by historical site activities. The risks associated with exposure at the Plant Areas, Warehouse 2/3, the 345 kV Transmission Line Area and the Bailey Farmhouse were evaluated in accordance with MDEP and USEPA methodology as presented in the Draft HHEA Work Plan.

Based on the site background and site conceptual model, exposure to contaminated media was evaluated for shoreline sediment, shellfish tissue, groundwater and soil and homegrown produce from four areas within Bailey Point. Exposure to soils within each study area was evaluated for a construction worker, on-site worker and resident. Exposure to sediment, fish tissue, groundwater and homegrown produce was evaluated for a hypothetical resident on the Maine Yankee site. COPCs were selected for each study areas based on USEPA screening criteria. EPCs were calculated for each COPC and used to estimate an exposure dose concentration for each exposure pathway. The exposure dose concentrations were combined with toxicity information to quantitatively estimate non-carcinogenic and carcinogenic risks. Estimated cancer risks were compared to the USEPA risk range of 10^{-4} to 10^{-6} and MDEP target risk level of 10^{-5} . Non-carcinogenic risks were compared to an HI of 1. The quantitative risk estimates were based on assumptions to render the final risk estimates as overly conservative.

A summary of the non-carcinogenic and carcinogenic risks associated with each exposure scenario is discussed below by media.

Soils

Residual soil contamination was detected throughout Bailey Point. The source of and primary contaminants detected within each study area are presented and discussed in **Sections 4.4 and 4.8.1**. In general, EPH and PAH compounds were detected most frequently and at elevated concentrations in soils. PCBs, pesticides and VOC were also detected but sporadically throughout the site. The risk assessment focused on a subset of all compounds detected in soils. Primary COPCs were selected for each study area by comparing the maximum detected concentration to appropriate risk-based screening concentrations. Final COPCs were selected based on a conservative screening of noncancer and cancer risks. EPCs for soil contaminants were calculated using appropriate formulae presented in USEPA guidance (USEPA, 2002a). The COPCs selected for and evaluated in the risk assessment were an accurate reflection of the key contaminants at each site.

Noncarcinogenic and carcinogenic risks associated with exposure to soil were evaluated for the on-site worker, construction worker and resident. A residential scenario was included at the request of MBOH although future residential land-use at this site is considered unlikely. Maine Yankee has indicated their intention to implement deed restrictions to limit future development of Bailey Point to industrial/commercial land-use. This restriction and the presence of the ISFISI suggest that future residential development on Bailey Point is highly unlikely. Therefore, the risk estimates developed for the residential scenario should not be considered to reflect future

potential risks and should not be the sole basis for risk management decisions. A summary of the non cancer and cancer risks are provided below.

Non Cancer Risks

A summary of the noncarcinogenic risks associated with exposure around Bailey Point is presented in **Table 5-14**. The noncarcinogenic risks for all exposure scenarios except the child residential exposure scenario were at or below an HI of 1.0. The HI based on a 6-year childhood exposure duration was slightly above 1.0 for the Warehouse 2/3 (HI of 1.2) and 345 kV Transmission Lines (HI of 1.1). Exposure to arsenic and iron account for the majority of the non-carcinogenic risks in this area. Arsenic and iron are naturally occurring elements and are not related to plant activities. They are present in soils at concentrations associated with background conditions. Eliminating the risks associated with exposure to arsenic and iron results in a lowering of the noncarcinogenic risk estimate to below an HI of 1.0. The noncarcinogenic risks from exposure to soils throughout the Bailey Point are below levels considered to present a non cancer hazard to human health.

Cancer Risks

A summary of the carcinogenic risks associated with exposure around Bailey Point is presented in **Table 5-15**. Carcinogenic risks associated with exposure to soil were evaluated for the construction worker, on-site worker and resident and are discussed below.

The carcinogenic risks associated with exposure to soil for the construction worker scenarios were all at or below the lower end of the USEPA target risk range (i.e., below 10^{-6}) and below MDEP target risk level of 10^{-5} . No individual constituents were present in soils at concentrations associated with an individual cancer risk level greater than 1×10^{-6} risk. These risk estimates indicate that short-term intense exposure to both surface and subsurface soils throughout the Bailey Point does not present a significant health risk.

The carcinogenic risks associated with exposure to soil for the on-site worker were at or below the MDEP target risk level and within or below the USEPA target risk range. Carcinogenic risks ranged from 3.1×10^{-7} for the Bailey Farmhouse (CT exposure) to 1.9×10^{-5} for Plant Area (RME exposure). Only two constituents are present in soil at concentrations associated with individual risk level greater than 10^{-6} and include arsenic and cPAHs. No constituents are present in soils at a concentration associated with an individual risk level greater than 10^{-5} .

Exposure to arsenic presents the greatest risk to the on-site worker. As discussed in **Section 4.7.1** arsenic has been detected throughout Bailey Point at concentrations associated with background conditions. Arsenic was not utilized or produced by any plant-related activities. Removing arsenic from the risk calculations results in lower carcinogenic risk estimates to be between 9.9×10^{-8} for 345 kV Transmission Line to 1.5×10^{-5} for the Plant Area. CPAHs becomes the only constituent present in soils at concentrations associated with individual cancer

risks greater than 10^{-6} (Plant Area and Warehouse 2/3), and no constituents are present in soils at concentrations associated with individual cancer risks greater than 10^{-5} . These risk estimates indicate that long-term exposure to soil by an on-site worker does not present a significant health risk.

The carcinogenic risks based on direct contact and incidental ingestion of soil under the residential scenario were within the USEPA target risk range. The residential risks under the CT exposure scenarios were all below the MDEP target risk of 1×10^{-5} and ranged from 1.2×10^{-6} (Bailey Farmhouse) to 6.5×10^{-6} (Plant Area). The residential risks under the RME exposure scenarios exceeded the MDEP target risk level of 1×10^{-5} for all areas except Bailey Farmhouse and ranged from 7.9×10^{-6} (Bailey Farmhouse) to 4.8×10^{-5} (Plant Area) (see **Table 5-15**). CPAHs and arsenic are present in soils at concentrations associated with a greater than a 10^{-6} risk level

The risk estimates developed for the construction and on-site worker scenarios indicate that future exposure to soils at Bailey Point under a commercial/industrial land use do not present a significant health risk. Although some compounds were detected in these soils at concentrations greater than their PAL, the risks based on site-specific exposure considerations are below levels of concern. Arsenic and cPAHs are the only constituents present in soils at concentrations associated with an incremental cancer risk to the on-site or construction worker greater than 1×10^{-6} and no constituents are present at concentrations associated with an incremental cancer risk to the on-site or construction worker greater than 1×10^{-5} . Based on these risk estimates, no additional actions are considered necessary to reduce human health risks from exposure to surface soils at this site.

Subsurface Soils

Residual contamination was detected in subsurface soils at the Plant Area, Warehouse 2/3, 345 kV Transmission Line Area, and Bailey Farmhouse. Key contaminants present in these soils include PAHs and EPH. A hypothetical construction worker scenario was developed consistent with USEPA guidance to evaluate potential risks from exposure to subsurface soil. The scenario assumes short-term but intense exposure to soil. The noncarcinogenic risk estimates for this scenario were all below an HI of 1.0 (see **Table 5-14**). The carcinogenic risks for this scenario were all below the MDEP target risk level of 1×10^{-5} and ranged from 3.9×10^{-7} (Bailey Farmhouse) to 1.6×10^{-6} (Plant Area) (see **Table 5-15**). No compounds were present at concentrations associated with an individual cancer risk above 1×10^{-6} . These risk estimates indicate that future exposure to subsurface soils at Bailey Point do not present a significant health risk. No additional actions are considered necessary to reduce human health risks from exposure to subsurface soils at this site.

Sediments

Residual contamination was detected in sediments collected from the intertidal and subtidal portion of the Back River and Bailey Cove. PAH compounds were the key contaminants

present in sediment. Risk estimates were developed for the Commercial Shellfisherman and the area resident. The routes of exposure included ingestion and dermal contact with sediment.

The carcinogenic risk estimates for both receptors were within and below the USEPA target risk range and at or below the MDEP target risk level (see **Table 5-15**). The noncarcinogenic risks were all below a target HI of 1.0 (see **Table 5-14**). These risk estimates indicate that future exposure to sediments within the Back River do not present a significant health risk. No additional actions are considered necessary to reduce human health risks from exposure to sediments at this site.

Shellfish Tissue

This risk assessment evaluated the ingestion of shellfish, including mussels, clams, lobsters, and lobster tomalley. The carcinogenic risk estimates for this route of exposure exceed both the MDEP target risk level of 10^{-5} and the USEPA target risk range of 10^{-6} to 10^{-4} for all species. The carcinogenic risks ranged from 7.2×10^{-5} for ingestion of mussels (CT exposure) to 1.4×10^{-3} for ingestion of tomalley (RME exposure) (see **Table 5-15**). The noncarcinogenic risks were greater than an HI of 1 for all species and ranged from 2 for the mussel (CT exposure) to 12 for the lobster tomalley (RME exposure) (see **Table 5-14**). As discussed in **Section 5.5.3**, the carcinogenic risks from the ingestion of arsenic in seafood may be overestimated by an order of magnitude.

Carcinogenic and noncarcinogenic risks from ingestion of clams and mussels obtained from the reference locations were greater than the MDEP target risk level of 10^{-5} and the USEPA target risk range of 10^{-6} to 10^{-4} USEPA and exceeded an HI of 1.0 (see **Tables 5-14 and 5-15**). No lobsters were collected from reference locations.

Similar contaminants were detected in site and reference clam and mussel samples with the majority of contaminants being present at greater concentrations in the reference samples (see **Table 5-12**). The concentration of individual PAH compounds, the primary contaminant in the outfall sediments, were actually greater in the reference samples. There does not appear to be a significant difference between the chemical composition of the site and reference samples. As such, the risks from ingestion of biota appear to be the result of background conditions.

Groundwater

Residual contamination was detected in the groundwater collected from Bailey Point. A residential groundwater scenario was evaluated to estimate potential risks from groundwater exposure under future unrestricted land use. The EPC were set at the average and maximum detected concentration for both the CT and RME scenarios, respectively. The exposure pathways included ingestion, inhalation and dermal contact with groundwater.

The carcinogenic and noncarcinogenic risk estimates exceeded both the USEPA target risk range and the MDEP target risk level. Exposure to arsenic was associated with an individual

carcinogenic risk greater than 10^{-4} . Exposure to dieldrin, heptachlor, trichloroethene and vinyl chloride was associated with individual carcinogenic risk estimates greater than 10^{-5} . Exposure to arsenic, iron, manganese and molybdenum were associated with noncarcinogenic HIs greater than 1.0.

The following groundwater constituents were detected at concentrations greater than their respective MCL or MEG concentration: aluminum, arsenic, boron, lead, manganese, molybdenum, silver, sodium, thallium, dieldrin, heptachlor, 4-methylphenol, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, ethylbenzene vinyl chloride and DRO (see **Table 5-13**).

These risk estimates indicate that exposure to groundwater from the Bailey Point may present health risks. As such, the CMS should evaluate potential corrective actions to either reduce exposure to or reduce contaminant concentrations in groundwater.

Produce

This risk assessment evaluated the potential risks from contaminant uptake and ingestion of homegrown produce. Contaminant concentrations in produce were estimated using chemical specific bioconcentration factors and site-specific surface soil concentrations (USEPA, 1998f). The noncarcinogenic risks were all below an HI of 1.0 except for Warehouse 2/3 and ranged from 0.2 for produce grown in at Bailey Farmhouse to 1.3 for produce grown in the Warehouse 2/3 area (see **Table 5-14**). The carcinogenic risks were all above the MDEP target risk level and ranged from 2.9×10^{-5} for produce grown in the Bailey Farmhouse to 2.2×10^{-4} for produce grown in the Plant Area (see **Table 5-15**).

The risks from ingestion of homegrown produce presents the greatest risks to the future resident and in some areas is up to two orders of magnitude greater than the risks associated with direct contact and incidental ingestion exposure to soil (see **Table 5-15**).

5.10 Uncertainties and Limitations

The quantitative risk estimates are based on a considerable number of assumptions, extrapolations and uncertainties. Areas of uncertainty are associated with most aspects of the project including sampling and analysis, data evaluation, estimating exposure point concentrations, quantifying exposure parameters and quantifying toxicity dose-response evaluations. Each of these areas may result in an under- or overestimate of risk as described below.

The data used to estimate EPC were from sampling data biased high. Soil, sediment and groundwater samples were collected from known or suspected areas of contamination and may not accurately reflect actual exposure to various receptors. In addition, long term exposure was evaluated based on current conditions with no correction for chemical dilution, dispersion or

degradation. It is extremely unlikely that site conditions will remain unchanged for the next 25 to 30 years.

Arsenic and iron were retained as COPCs and carried through in the risk assessment. As discussed in **Sections 4.7.1 and 4.8.1.1**, these metals are naturally occurring and were present at the site typically within reference concentrations (see **Tables 4-2 and 4-6 through 4-20**). A significant portion of the estimated carcinogenic risk is attributed to exposure to arsenic and would be present regardless of the impacts of previous site activities.

Exposure parameters used to estimate frequency, duration and intensity of exposure were typically based on conservative exposure assumptions (i.e., 95 percentile ingestion rates, surface areas, etc.). However, many exposure parameters are based on limited scientific data (i.e., adherence factors and dermal absorption factors) and are only estimates of what may actually be occurring.

The toxicity data used in this evaluation is based on uncertainty as reflected in the use of modifying and uncertainty factors. Some toxicity factors were based on route-to-route extrapolations and from sub-chronic to chronic effects. The effect of these uncertainties is not known and may under- or over-estimate risk. Toxicity data were not available for all compounds detected at the site and therefore exposure may have been underestimated. This was most apparent in evaluation the dermal route of exposure. Chronic toxicity factors were used to evaluate subchronic childhood exposure to soils and therefore, may have overestimated the potential risks to this population.

Sufficient quantitative toxicity information was not available for seven organic compounds detected in soil and sediment including acenaphthalene, 2-hexanone, benzo(g,h,i)perylene, phenanthrene, endrin aldehyde, 2-methylnaphthalene and carbazole. These compounds were carried through as COPCs but the risk from exposure to these constituents could not be quantified. Of these, two compounds were detected at very low frequency and at very low concentrations and are not considered to be site related. These compounds are 2-hexanone (detected in 1 of 61 soil samples and no sediment samples) and endrin aldehyde (detected in 2 of 34 soil and 1 of 33 sediment samples). The remaining five compounds were commonly present throughout the site and included, acenaphthalene, 2-methylnaphthalene, benzo(g,h,i)perylene, phenanthrene and carbazole. The lack of sufficient toxicity information for these compounds may underestimate the total risk, however, these compounds were associated, both in their distribution and concentration, with other PAH compounds that were quantitatively evaluated

These same compounds and some additional pesticide compounds lacking sufficient quantitative toxicity information were also detected in shellfish. However, the distribution and concentration of these compounds were indistinguishable from reference samples and are attributed to background conditions.

There are limited scientific data to quantify the uptake of soil contaminants in produce. The bioconcentration factors used in this risk assessment are conservative values and likely overestimate the contaminant concentration in produce. Bioconcentration factors however, were not available for all compounds detected in soils and therefore may underestimate the total contaminant concentration in produce.

The risks from ingestion of seafood are likely overestimated because of the assumption that the arsenic present in these samples is in the toxic inorganic form. The ATSDR reports that 80 to 99 percent of arsenic in seafood is present in the nontoxic organic form.

These are some of the uncertainties inherent in this baseline HHRA. Their effect on the overall risk estimates cannot be quantified. However, the standard assumptions developed by the regulatory agencies and used in this risk assessment are selected to render the final risk estimates as conservative in part to offset the uncertainties.