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ENVIRONMENTAL RISK CHARACTERIZATION OF THE WETLANDS ADJACENT TO THE FORMER RAYTHEON FACILITY, WAYLAND, MASSACHUSETTS

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Table of Contents

Table of Tables

Table of Figures

Definitions and Acronyms

ADD_{pot}	Average potential daily dose
BAF	Bioaccumulation factor
BSAF	Biota-sediment (or soil) accumulation factor; relates the concentration of PCBs in sediment or soil to the concentration of PCBs in biota that are in contact with either the sediment or soil
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPEC	Chemical of potential ecological concern
DI	Dietary intake: the rate of intake of the chemical via the diet, generally given in units of mg chemical/kg body weight per day (mg/kg-d) or mg chemical/kg food (mg/kg)
ERA	Ecological risk assessment
ERC	Environmental risk characterization
HQ	Hazard quotient: the ratio of DI to the toxicity reference value (*i.e.*, the dose of chemical assumed to be without deleterious effect for the receptor of concern if less than 1.0, generally given in units of mg/kg-d or mg/kg
MADEP	Massachusetts Department of Environmental Protection
MSU-ATL	Michigan State University Aquatic Toxicology Laboratory
NPL	National Priorities List
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
SLERA	Screening-level ecological risk assessment
TSCA	Toxic Substances Control Act
TRV	Toxicity reference value
95% UCL	95% Upper confidence limit of the arithmetic mean
USEPA	United States Environmental Protection Agency

1.0 EXECUTIVE SUMMARY

As part of a Phase II Comprehensive Site Assessment for the former Raytheon Company (Raytheon) in Wayland, Massachusetts, an environmental risk characterization (ERC) was conducted to evaluate potential risks to ecological receptors due to historical releases of chemicals of potential ecological concern (COPECs) at the former Raytheon facility which operated from 1955 to 1995. The primary activities conducted at this facility included research and development for prototype electronic equipment, operation of a small circuit board laboratory, and operation of small-scale chemical processes. Dry and wet laboratory process included photographic developing, plating and etching circuit boards, machining, welding, woodworking, spray painting, conformal coat assembling, environmental protocol testing, hydraulic testing, radar and antenna transmitter testing, and tranformer epoxy coating and baking. This report present results of the environmental risk characterization to accompany assessment of risks to human health, safety, and public welfare and to satisfy MCP performance standards for the Phase II Comprehensive Site Assessment (Phase II).

The study area is approximately 15 acres and is part of a floodplain wetland encompassing approximately 3,000 acres (including the Great Meadows National Wildlife Refuge) that is primarily influenced by water levels in the Sudbury River. There is a drainage swale (OF-1) that transects the site and flows from the National Pollutant Discharge Elimination System (NPDES) outfall from the former Raytheon facility to the Sudbury River. The wetlands near the former Raytheon facility are periodically inundated, usually during high flows in the spring and following major storm events. Thus, the wetlands are intermittently inundated with water for a few months out of the year during times of high water levels in the Sudbury River, a wet meadow for a period of time as water levels in the Sudbury River return to lower flows, and then the majority of the wetland is non-inundated, with moisture-saturated soil for substantial amounts of time each year.

The overall objectives of the ERC are to evaluate potential current and future exposure and effects on ecological habitats and biota (receptors) and to characterize risk of harm to habitats and biota from historic chemical releases from the former Raytheon facility. To meet these objectives, the Massachusetts Contingency Plan (MCP) and Guidance for Disposal Site Risk Characterization Chapter 9 – Method 3 Environmental Risk Characterization were used as the primary guidance documents and the USEPA risk assessment framework ("Ecological Risk Assessment Guidance for Superfund: Process for designing and conducting ecological risk assessments. Interim Final. EPA 540-R-97-006"; USEPA, 1997) was utilized as a supplementary guidance document. In following MCP guidance, there is a two–tiered process for conducting a Method 3 ERC (310 CMR 40.0995). The first step is a Stage I screening-level environmental risk characterization (Stage I ERC) in which the objective is to identify and document conditions that do *not* warrant a Stage II ERC, either because of the absence of a potentially significant exposure pathway or because environmental harm is "readily apparent" and, therefore, additional assessment would be redundant. If any potentially significant exposure pathways are indicated from the Stage I ERC, then these pathways are further evaluated in a more refined assessment termed a Stage II ERC. Implementation of a Stage II ERC includes a consideration of the three major themes of an ERC, as described in the MCP, including: 1) the Stage II ERC should be conducted at the sites most likely to pose a significant risk of harm to the environment; 2) the Stage II ERC should focus on effects that are known to be caused by COPECs at the site; and 3) the level of detail of a Stage II ERC should be tailored to the site in question.

After conducting a Stage I screening-level ERC, the primary COPECs at this site were determined to be metals (including antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr+3), chromium (Cr+6), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), silver (Ag), tin (Sn), vanadium (Vd), and zinc (Zn)), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Potentially

significant exposure pathways were determined to be surface water, sediment, wetland soil, and biota. For these potentially significant exposure pathways and list of potential COPECs, a quantitative Stage II ERC was conducted. As part of the Stage I screening level assessment and as specified in MCP guidance, an evaluation was made to determine if a condition of "readily apparent harm" was present at the site. It was determined that there is an area of approximately 27,580 sq. ft. in which there is visible evidence of stressed or stunted vegetation. This same area, which is proximal to the outfall (OF-1) corresponds well with significantly elevated COPEC concentrations (*i.e.*, hot spot), including copper and chromium which are both present in this area at median and mean concentrations that are greater than 5000 mg/kg, dry weight in wetland soil (Figure 1-1). It is also in this same area that surface water concentrations exceed national ambient water quality criteria. Both of these conditions, the visible evidence of stressed vegetation and the exceedances of water quality criteria, indicate that significant environmental harm is "readily apparent" for a limited portion of the site as defined by the MCP. Thus, a full Stage II ERC was not conducted for these areas in which a condition of "readily apparent harm" was determined, in accordance with the MCP. However, for completeness, a separate Stage II ERC in the Appendix section of this report contains an evaluation of potentially current site-wide exposures for avian and mammalian wildlife receptors which includes the area of "readily apparent harm".

The main text of this report presents the Stage II ERC results for the site without the area of "readily apparent harm" as the primary assessment. The Stage II ERC results for the site including the area of "readily apparent harm" is considered an ancillary assessment presented in the Appendix. The results of both scenarios, with and without the area of "readily apparent harm", are presented to provide decision makers with all pertinent information regarding potential risk at the site.

To evaluate the site through a quantitative Stage II ERC, a conceptual site model (CSM) was developed and an ecological survey of the site was conducted. The results from the CSM and the ecological survey were subsequently utilized to select *assessment endpoints*, which are representative of those ecological resources selected for protection and *measurement endpoints*, which are environmental measurements collected to best represent an assessment endpoint to evaluate the potential risk posed by site COPECs. The following assessment endpoints (AE) and measurement endpoints (ME) represent ecological resources selected for protection at the wetlands near the former Raytheon facility:

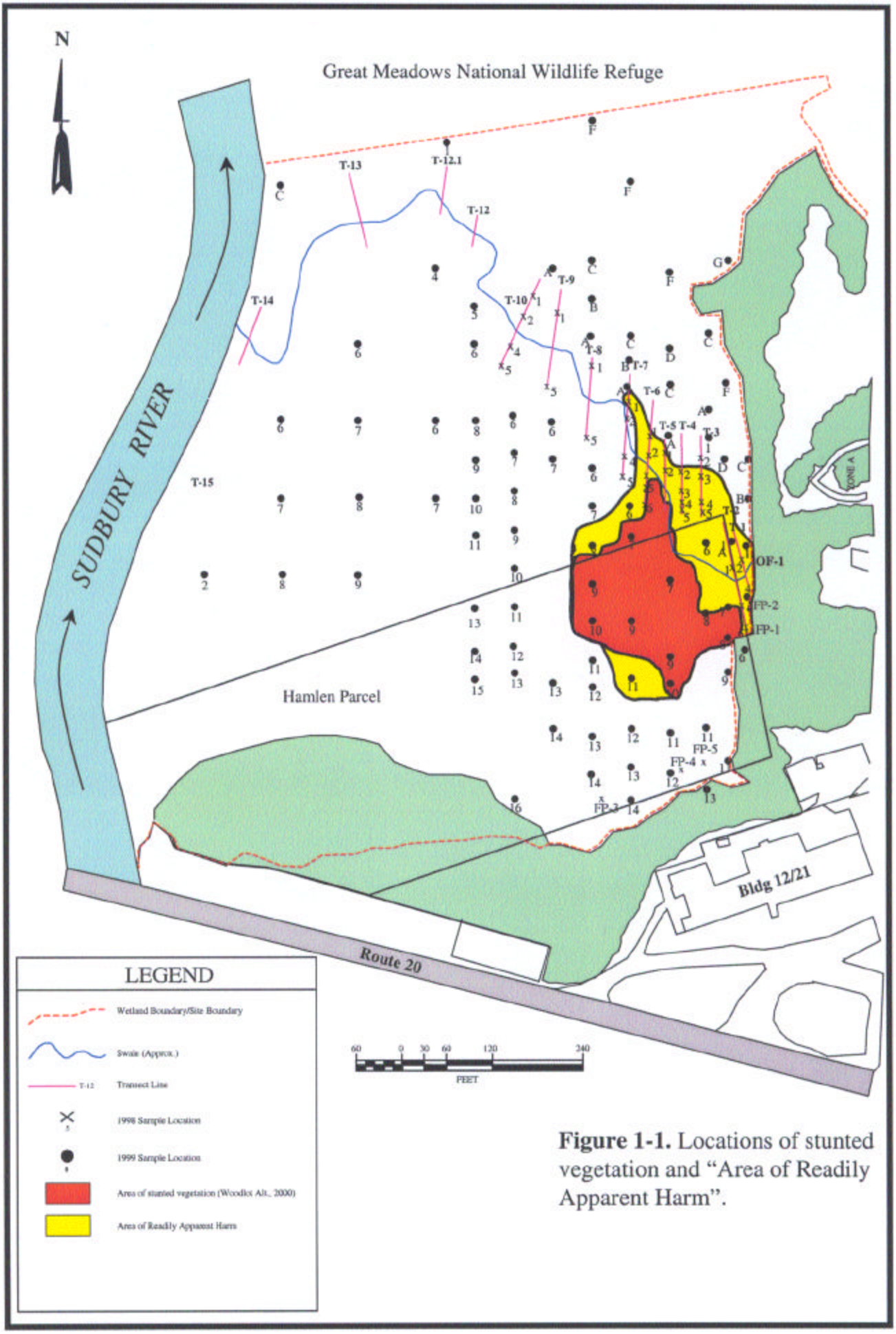

Figure 1-1. Locations of stunted vegetation and "Area of Readily Apparent Harm".

1. (AE) Protection of fish, amphibians, and aquatic invertebrate communities from adverse effects related to exposure to COPECs in surface water.
    - (ME) Comparison of concentrations of COPECs in surface water from the wetland to surface water quality criteria that are designed to be protective of aquatic organisms.
    - (ME) Comparison of concentrations of COPECs in surface water from the wetland to surface water benchmarks from literature-derived studies that were conducted under conditions of similar bioavailability to those at the site.
2. (AE) Protection of wetland vegetation from adverse effects related to exposure to COPECs in wetland soils.
    - (ME) Comparison of concentrations of COPECs in wetland soils to literature-based phytoxicity benchmarks that are reported to be protective of vegetation.
    - (ME) Comparison of concentrations of COPECs in plant tissues from the wetland to literature-based plant tissue residue effect levels that are reported to be protective of vegetation.
    - (ME) Comparison to site-specific, field-measured effect concentrations of COPECs in soil that are found in the area of stunted vegetation.
3. (AE) Protection of wetland avian and mammalian wildlife from adverse effects on reproductive success and population sustainability related to exposure to COPECs in surface water, sediment, wetland soil, and food.
    - (ME) Comparison of the average predicted daily doses of COPECs from surface water, sediment, wetland soil, and food to toxicity reference values that are designed to be protective of avian and mammalian wildlife.

This ERC does not indicate that there is a risk of adverse effects for any of the assessment endpoints when evaluating locations outside of the "Area of Readily Apparent Harm". Based on the evaluation presented in this report, the following overall conclusions can be made:

- Evaluation of site conditions indicated that significant environmental harm is "readily apparent" for a limited portion of the site as defined by the MCP [310 CMR 40.0995(3)(b)], including:
    - visual evidence of stressed biota (*e.g.*, stunted vegetation) attributable to the release at the site; and
    - the existence of COPECs attributable to the site in concentrations which exceed USEPA Ambient Water Quality Criteria
- There is no evidence of potential risk from on-site COPECs to aquatic receptors in locations outside of the "Area of Readily Apparent Harm".
- There is no evidence of potential risk from on-site COPECs to wetland plants in locations outside of the "Area of Readily Apparent Harm".
- There is no evidence of potential risk from on-site COPECs to avian and mammalian receptors in locations outside of the "Area of Readily Apparent Harm".

As described in the MCP, there are two possible outcomes of an ERC:

1) No significant risk of harm to the environment exists or has been achieved at the site. In this case, no further remediation to protect the environmental receptors is required.

2) A significant risk of harm to the environment exists, and, therefore, remedial action must be implemented, if feasible.

At this site, there is an area where there is a condition of "readily apparent harm", which may require consideration of remedial actions. The result of a Stage II ERC indicates that no significant risk of harm to environmental receptors exists at the site in locations outside of the "Area of Readily Apparent Harm".

2.0 INTRODUCTION

2.1 Purpose

The overall objective of this environmental risk characterization (ERC) is to evaluate all available and relevant lines of evidence in order to describe the potential risk of harm from exposure to chemicals of potential ecological concern (COPECs) to key ecological receptors in the wetlands near the former Raytheon facility in Wayland, Massachusetts. Following MCP guidance, evaluations of both current and potentially future exposures were conducted. This document has been prepared to provide decision makers with the most current and complete information available to evaluate potential risk at this site.

2.2 Scope

The information and conclusions contained in this report are focused on assessing the potential risk of harm to ecological receptors from site-related chemical exposures. While much of the former Raytheon site is developed and contains several buildings, parking lots and maintained lawn, these areas were not subject to detailed review during this ERC. Efforts were focused on an approximately 15-acre area that contains a floodplain wetland located between the Sudbury River to the west, Route 20 to the south, developed land to the east (*i.e.* the former Raytheon site), and additional floodplain wetland to the north (Figure 2-1). Property to the north and west is owned by the U.S. Fish and Wildlife Service and is part of Great Meadows National Wildlife Refuge (GMNWR).

2.3 Regulatory Guidance

This ERC follows the following primary regulatory guidance as set forth by the most current versions of:

- Massachusetts Contingency Plan (MADEP 1999) (MCP, 1998 with October, 1999 revisions), and
- Chapter 9 Method 3 Environmental Risk Characterization (MADEP, 1996)

While the overall approach for this ERC was based primarily on MCP guidance, this ERC is also consistent with and supplemented by USEPA guidance entitled, "Ecological Risk Assessment Guidance for Superfund" (USEPA, 1997). Refer to section 5.0 of this ERC for additional details on the overall ERC approach. The MCP ERC process and the eight step process within the USEPA ERA guidance for Superfund are both designed to focus resources on key chemicals, pathways of exposure, and receptors and to eliminate from further consideration those chemicals, pathways, and receptors that are clearly not at risk (Figures 2-2 and 2-3).

This ERC is more refined than a screening-level ERC and contains some site-specific bioavailability data. In contrast to a screening-level ERC that defines the scope of the assessment, a refined or baseline ERC uses new and existing data to provide the ecological basis for determining the need for remediation. The purposes of a refined or baseline assessment are to determine (Sample et al., 1996):

- If significant ecological effects are occurring at the site;
- If effects are observed, the causes of the effects;
- Sources of the causal agents; and
- Consequences of leaving the system unremediated.

Figure 2-1. Site map depicting the location of the wetlands adjacent to the former Raytheon facility.

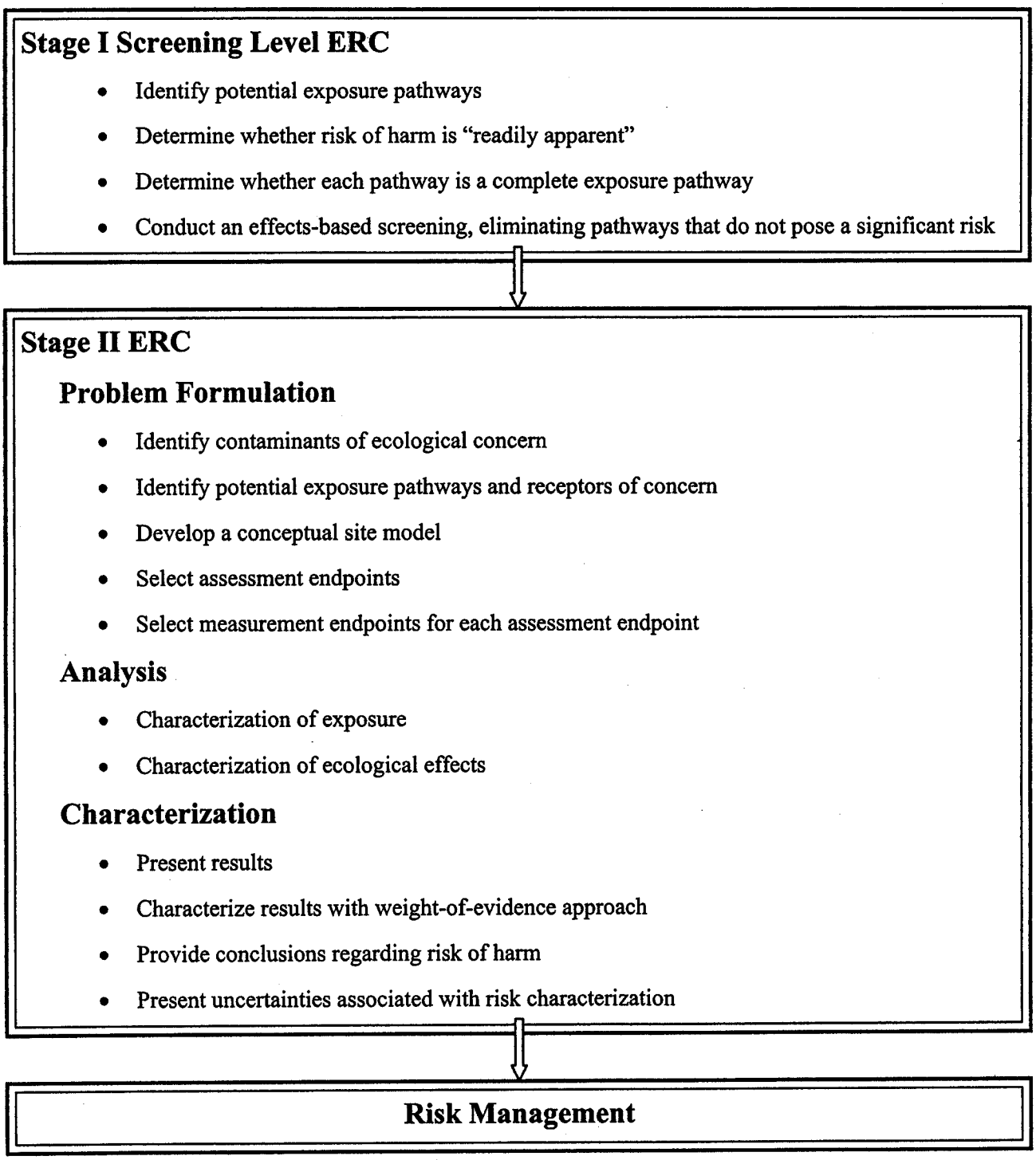

Figure 2-2. Conceptual model of steps in the ERC (based on Massachusetts Contingency Plan Guidance).

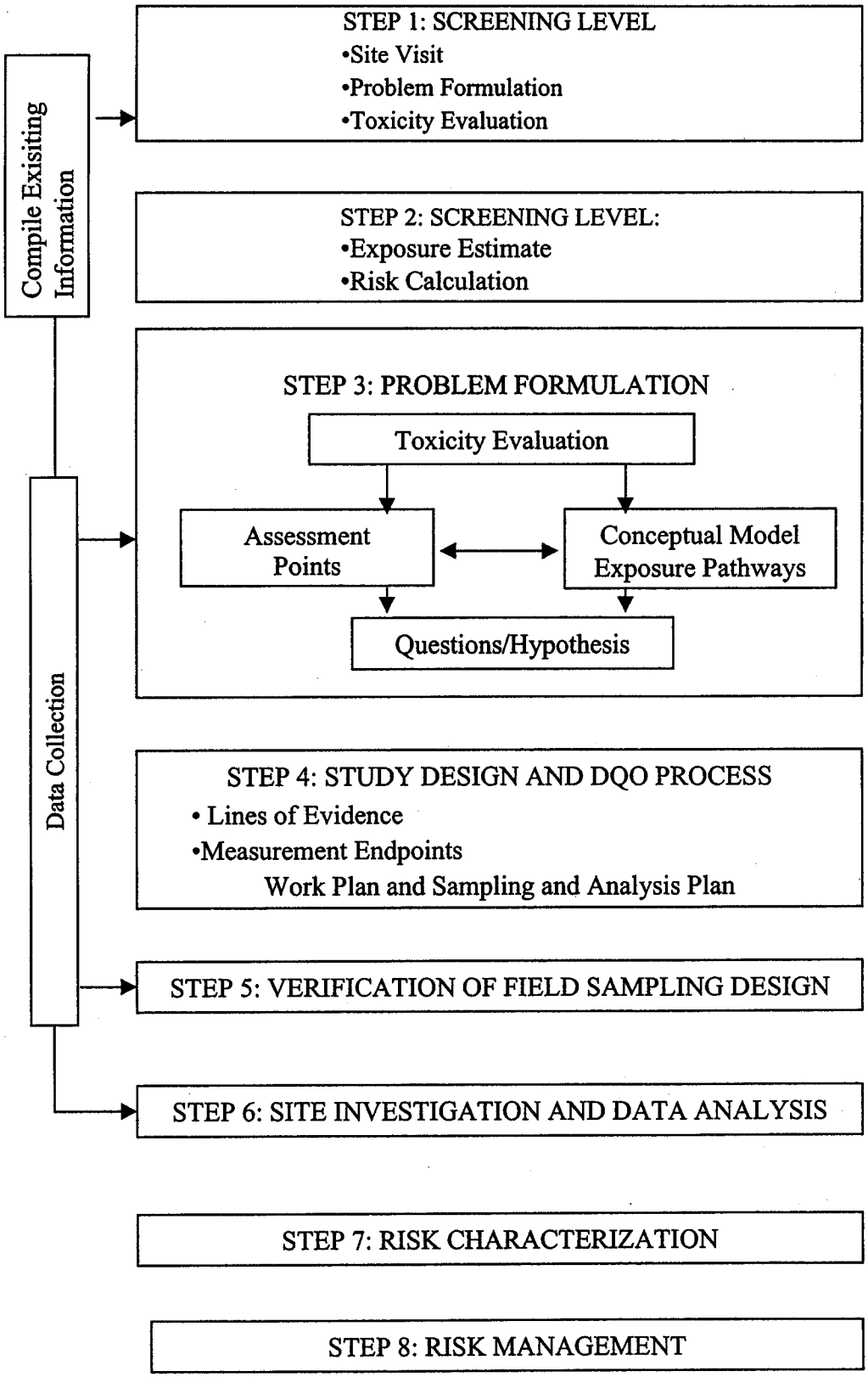

Figure 2-3. Conceptual model of steps in the ERA (based on Superfund ERA Guidance).

2.4 Report Organization

The remainder of this report is organized as follows:

Section 3.0. Site Characterization – Historical Data, Habitat Characteristics, and Species Present

Section 4.0. Site Characterization - Chemical, Physical, and Biological Data

Section 5.0. Overall ERC Approach

Section 6.0. Stage I Screening-Level ERC

Section 7.0. Stage II ERC - Problem Formulation

Section 8.0. Stage II ERC – Analysis - Exposure Assessment

Section 9.0. Stage II ERC – Analysis - Effects Assessment

Section 10.0. Stage II ERC - Risk Characterization

Section 11.0. Stage II ERC - Conclusions and Uncertainties

Section 12.0. References