FINAL

Study Design

Ecological Investigative Activities In Support of the Baseline Ecological Risk Assessment

CE Windsor Site
2000 Day Hill Road
Windsor, Connecticut

Prepared for:

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Windsor, Connecticut 06095

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Portland, Maine 04112

June 2001

Harding ESE
A MACTEC COMPANY

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1.0 INTRODUCTION

1.1 OBJECTIVES

This Study Design document presents the objectives and technical methods for sampling and analytical activities to be performed in support of the Baseline Ecological Risk Assessment (BERA) at the Combustion Engineering (CE) Windsor Site in Windsor, Connecticut, as well as the methodology that will be used to perform the BERA.

The risk assessment process at the Windsor Site follows that prescribed in the United States Environmental Protection Agency (USEPA) *Ecological Risk Assessment Guidance For Superfund, Process for Designing and Conducting Ecological Risk Assessments, 1997* (the Process Document). Steps 1 and 2 of the Process Document were followed in preparing the *First Interim Deliverable, Screening Level Ecological Risk Assessment* (Harding Lawson Associates [HLA], 2000), submitted to USEPA on May 31, 2000. Step 3 of the Process Document was followed in preparing the *Baseline Ecological Risk Assessment Problem Formulation* (Harding ESE, 2000), submitted on December 21, 2000. These two previous submittals were used to develop the Study Design presented in this document; this Study Design is consistent with Step 4 of the Process Document. Steps 5 and 6 are verification of field sampling design, and Step 6 is the Site investigation and data analysis; these steps will be implemented as described in this Study Design. Step 7 of the Process Document is the Risk Characterization; preparation and completion of the BERA are consistent with Step 7. The final step of ecological risk characterization as described in the Process Document is Risk Management. The BERA will be used to help make risk management decisions at the CE Windsor Site.

1.2 PREVIOUS INVESTIGATIONS

As part of the Voluntary Corrective Action (VCA) Program, HLA has completed the following activities and reports:

- Historical Review Report (HRR) [ABB Environmental Services, Inc. (ABB-ES), 1998] - Described the Site history as well as identified 24 Areas of Concern (AOCs) where chemical materials may have impacted environmental conditions.

- Limited Field Investigation (LFI) Report (HLA, 1999a) - Investigation activities performed to initially investigate the environmental conditions at each AOC. AOC 25 was identified

during the development of the Limited Field Investigation Work Plan (LFIWP), and AOC 26 was identified during the LFI. No sampling occurred at AOC 26 during the LFI.

- Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) Report (HLA, 2000) – Investigation to address data gaps identified during the LFI. During the RFI program, AOC 27 was identified and investigated.

- First Interim Deliverable (FID) – Ecological Risk Assessment (HLA, 2000) – Screening ecological risk assessment; identified contaminants of concern (COCs) to carry through a focused Baseline Ecological Risk Assessment. Conclusions/recommendations of the FID [and subsequent response to USEPA comments (HLA 2000)]are discussed below.

- Baseline Ecological Risk Assessment Problem Formulation (Harding ESE, 2000) – Defines the primary endpoints and objectives of the BERA, identifies the primary stressors likely to have the greatest impact on the ecosystem, and refines the conceptual Site models (CSMs) including primary exposure pathways for ecological receptors.

1.3 REPORT ORGANIZATION

This Study Design is organized as follows: Section 2.0 presents a brief Site description, focusing on the regional and local physical setting; Section 3.0 presents a summary of the FID and recommendations from that report, the subsequent response to comments, and the problem formulation/CSM; Section 4.0 contains the details of the proposed sampling and analysis program to be completed in support of the BERA; and Section 5.0 presents the BERA methodology, including a discussion of how existing and new Site information will be integrated to characterize potential ecological risks at the Site.

2.0 SITE DESCRIPTION

The CE Windsor Site is located in the Town of Windsor, eight miles north of Hartford, Connecticut. The Site is characterized as an industrial property that includes more than 600 acres. Nearby land uses are primarily commercial, agricultural, and industrial. Approximately one-third of the property is developed with buildings, infrastructure, and maintained landscaping. The remaining two-thirds of the property are wooded. Parts of the wooded areas have also been excavated for fill, used to stage drums, and/or used as a historic disposal area.

The AOCs at the CE Windsor Site, including building locations, paved areas, and property boundaries, are shown in Figure 1. Surface water bodies on Site include: Great Pond, located on the southwestern end of the property; Small Pond, located east of the Site buildings; and Goodwin Pond and the Site brook, located on the northern portion of the property. The Site brook drains northwest into the Farmington River at the northwest property boundary. A more detailed description of each AOC is included in the FID (HLA, 2000).

3.0 SUMMARY OF FID AND PROBLEM FORMULATION/CSM

The FID presents the approach and findings of the screening-level Ecological Risk Assessment (ERA) for surface soil, surface water, and sediment at the Site. Recommendations are refined and primary COCs are identified in the Problem Formulation/CSM. Findings of the screening-level ERA are summarized below, along with the rationale for proposed additional activities. A two-phased approach is proposed for conducting additional activities, as it will enable CE to avoid time-consuming tasks that may be unnecessary (e.g., certain toxicity tests or tissue sampling). Details of the proposed field activities (e.g., sample locations, analytes) are discussed in Section 4. Figures 2 through 4 present flow diagrams that outline the process for surface soil, surface water, and sediment evaluations.

3.1 SURFACE SOIL

As summarized in the FID, several AOCs (1, 3, 6, 10, 13, 24, and 27) had levels of polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and/or metals detected in surface soil that exceed ecological screening benchmarks. The PAH screening benchmarks that are exceeded are based on terrestrial invertebrate values obtained from the published literature. The inorganic screening benchmarks that are exceeded are based on both terrestrial invertebrate and plant values. AOCs 4 and 27 had maximum concentrations of PCBs and several metals that exceeded wildlife toxicity benchmarks. These values are considered to be conservative, and although appropriate for a screening level ERA, may overestimate risks. The following activities are proposed as part of the BERA to better define risks to receptor groups at the terrestrial AOCs; however, some details of the Phase II activities (e.g., prey tissue analysis) are contingent upon results of the Phase I evaluation:

Phase I

- Revise COC screening for surface soils to consider conditions following Interim Corrective Measures (ICMs) at selected AOCs (2, 6, 10, 15, and 16) and expected conditions following ICMs at AOCs 1, 3, 22, and 24;
- Conduct a qualitative habitat survey to identify specific habitat types and receptors that will be evaluated in the BERA; and
- Review wildlife toxicity and exposure assumptions in the food chain model used to develop Protective Contaminant Levels (PCLs).

Phase II

- Conduct Site-wide surface soil (plant and invertebrate) toxicity testing; and
- Conduct prey tissue analysis at selected AOCs.

Each of these recommended activities is discussed in greater detail below. Figure 2 presents the process flow diagram for each phase of the surface soil evaluation.

3.1.1 Phase I Soil Activities

3.1.1.1 Revise COC Screening (Post ICM)

Soil removal ICMs have been completed at several AOCs (2, 6, 10, 15, and 16) since the completion of the draft FID. The surface soil data set will be revised to exclude samples excavated as part of the ICMs and to incorporate confirmatory sample data as appropriate. As the ICMs have focused on removing hot spots and areas of elevated concentrations, revising the COC screening may reduce the magnitude of benchmark exceedences, decrease the number of COCs that must be carried through the rest of the BERA, and provide more up-to-date information for selecting locations for any additional toxicity testing or sampling.

3.1.1.2 Qualitative Habitat Survey

A qualitative habitat survey will be completed to identify specific habitats and wildlife receptors that will be evaluated in the BERA. The survey will identify habitat groupings across AOCs; these habitat groupings will be used to group data and estimate exposure point concentrations in the BERA.

3.1.1.3 Food Chain Sensitivity Analysis

Wildlife toxicity and exposure assumptions used in the food chain to develop wildlife screening benchmarks (PCLs) will be reviewed. The purpose of this review will be to identify the most critical assumptions in the food chain model. For instance, if literature-derived accumulation factors or other conservative exposure assumptions are the driving factor in the conservative benchmarks used in the FID, tissue sampling may be needed to provide a more accurate measure of bioaccumulation of COCs in prey items. On the other hand, if soil ingestion is the driving factor, then tissue sampling is unlikely to affect the results of the food chain assessment. It is also possible that some of the benchmarks used in the FID are based on sensitive receptors that do not occur at or are unlikely to use a particular AOC. The receptors used to develop food chain based-benchmarks in the FID will be reviewed relative to their likely occurrence at or use of various terrestrial AOCs.

3.1.2 Phase II Soil Activities

Following completion of the Phase I activities, decisions will be made as to where and what activities will take place in Phase II. Resummarizing the surface soil data in Phase I to reflect ICMs will decrease the exposure point concentrations for terrestrial plants and invertebrates. However, given the conservative nature of the screening benchmarks for these receptor groups, soils concentrations for at least some COCs will still likely exceed benchmarks. Therefore, Phase II soil activities have been formulated and will include surface soil toxicity testing using plants and invertebrates. The second potential Phase II soil activity is prey tissue sampling and analysis. This activity will be completed if the food chain sensitivity analysis indicates that tissue concentrations estimated using literature-derived bioaccumulation factors (BAFs), and not direct soil ingestion, are resulting in average Hazard Quotients (HQs) of greater than 5.

3.1.2.1 Site-Wide Surface Soil Toxicity Testing

Plant and invertebrate screening values used in the FID are based on limited information and tend to be very conservative. For metals, screening values are often below commonly occurring background concentrations. For both organic and inorganic chemicals, use of these screening values often leads to preliminary conclusions of potentially significant risk. These values are generally based on limited information and do not take into account the numerous Site-specific factors that influence bioavailability and toxicity. Therefore, plant and invertebrate toxicity testing will be completed to obtain empirical data on risks to these receptor groups.

Tests will be conducted at Site locations encompassing a range of contaminant levels for chemicals likely to contribute most significantly to potential risk. For plants, these include chromium, copper, vanadium, zinc, boron, and arsenic. For soil invertebrates, these include chromium, copper, zinc, and PAHs. Collecting samples from a range of contaminant levels will assist in the identification of COCs contributing to any observed toxicity, and may also help identify any concentration/response relationship for those chemicals.

3.1.2.2 Prey Tissue Analysis

If results of the food chain sensitivity analysis indicate that soil ingestion is the pathway contributing the most to terrestrial wildlife risk estimates, then no tissue sampling will be required. However, if results indicate that literature-derived BAFs are a driving factor in the food chain model (rather than soil ingestion), tissue sampling will be conducted to provide a more accurate measure of bioaccumulation of COCs in prey items. Potential prey items that will be sampled, if necessary, include earthworms and plants. Both the plant and invertebrate toxicity

tests mentioned above can be easily modified to provide tissue samples for analysis. It is currently assumed that no plant bioaccumulation testing will be conducted, and that earthworm bioaccumulation testing will be conducted at one-half of the toxicity test locations.

3.2 SURFACE WATER

There are four surface water bodies where COCs have been identified (the Site brook, Farmington River, Small Pond, and Great Pond). No organic COCs were identified in surface water, but several inorganic COCs were identified in each of the water bodies. There are currently no background data for surface water, and therefore it is not known to what degree these inorganic COCs are Site-related. The following activities have been proposed as part of the BERA to better define risks to receptor groups in surface water; however, some details of the Phase II activities (e.g., the need for and locations of surface water toxicity testing) are contingent upon results of the Phase I evaluation:

Phase I:

- Characterize local background surface water conditions;
- Characterize conditions in the unnamed tributary to Goodwin Pond;
- Conduct additional sampling for cyanide in the Site brook surface water; and
- Review wildlife toxicity and exposure assumptions in the food chain model used to develop PCLs.

Phase II:

- Characterize conditions upstream and downstream in the Farmington River;
- Conduct surface water toxicity testing; and
- Conduct aquatic prey tissue sampling and analysis.

Each of these recommended activities is discussed in greater detail below. Figure 3 presents the process flow diagram for each phase of the surface water evaluation.

3.2.1 Phase I Surface Water Activities

3.2.1.1 Local Background Surface Water Sampling

Background surface water samples will be collected from representative background surface water bodies located in the vicinity of the Site. Analytical data from these samples will be used in the BERA to identify COCs in Site surface water bodies that are elevated above background and therefore potentially Site-related. Proposed potential background sampling locations are identified in Section 4.

3.2.1.2 Characterize Conditions In Unnamed Tributary To Goodwin Pond

To date, no samples have been collected from the unnamed tributary that flows from Small Pond to Goodwin Pond. To address this data gap, surface water samples will be collected in the tributary. Analytical data from these samples will be used in the BERA to evaluate if contaminants from Small Pond are being transported to Goodwin Pond. Sampling locations and analytical parameters are identified in Section 4.

3.2.1.3 Additional Characterization of the Site Brook

There are limited data regarding the presence of cyanide in the Site brook surface water and sediment. To address this data gap, surface water samples will be collected in Site brook and analyzed for cyanide. The AWQC for cyanide was derived for the bioavailable fraction of total cyanide that is dissociated in the water column (i.e., free cyanide), and amenable cyanide is the best measure of free cyanide in surface water. Therefore, surface water samples will be analyzed for both total and amenable cyanide. Sampling locations are identified in Section 4.

3.2.2 Phase II Surface Water Activities

Following completion of the Phase I activities, decisions will be made as to where and what activities will take place in Phase II. Additional sampling in the Farmington River will also be conducted as part of Phase II activities to characterize conditions upstream and downstream. If the background data collected as part of Phase I activities indicate that inorganic concentrations in Site surface water are elevated above background concentrations, surface water toxicity testing will be conducted to determine if surface water at the Site is toxic to aquatic organisms. The third potential Phase II surface water activity is prey tissue sampling and analysis. This activity will be completed if the food chain sensitivity analysis indicates that tissue concentrations estimated using literature-derived bioconcentration factors (BCFs) are resulting in average HQs of greater than 5.

3.2.2.1 Characterize Conditions Upstream and Downstream in the Farmington River

Only one upstream sample has been collected from the Farmington River, and the extent of elevated metals concentrations downstream has not been completely characterized. Therefore, additional samples will be collected both upstream and downstream in the Farmington River in order to complete this characterization per USEPA comments (see Section 4). This sampling effort will be conducted during Phase II activities at the same time as other river sampling events, in order to limit the number of mobilizations (and associated extra equipment) needed in the river.

3.2.2.2 Surface Water Toxicity Testing

Maximum concentrations of several metals exceeded screening benchmarks in the screening assessment. To put the exceedances in perspective, Site surface water data will be compared to representative background surface water data. If this evaluation indicates that metals in surface water bodies at the Site are elevated, surface water toxicity testing will be conducted. A review of AWQC documents for the primary surface water COCs at the CE Windsor Site indicates that invertebrates are equally as sensitive if not more sensitive than fish species tested. Therefore the tests will be conducted using the invertebrate water flea *Ceriodaphnia dubia*. If the surface water is not toxic to this invertebrate, the assumption is made that it is unlikely to be toxic to other invertebrates or vertebrates that occur in Site surface water bodies.

3.2.2.3 Aquatic Prey Tissue Sampling

Results of the screening assessment indicated that semi-aquatic life may be adversely affected by ingesting prey items that have accumulated mercury from Small Pond surface water. If the mercury in Small Pond is elevated relative to background concentrations, sampling of aquatic organisms in Small Pond will be conducted. The objective of this sampling will be to obtain tissue concentrations that can be used to quantify Site-related exposures to semi-aquatic wildlife from ingesting contaminated prey items. Aquatic organisms that will be sampled will include fish and amphibians. Small Pond is considered to represent a worst-case exposure scenario for mercury in the aquatic environments at the Site due to the generally anoxic conditions in the pond that are conducive to mercury methylation. If methylmercury is not detected in tissue of aquatic prey in this pond, it is unlikely to exist elsewhere at the Site. Details of the aquatic prey tissue sampling are discussed in Section 4.

Additional fish tissue samples will also be collected to support the final Human Health Risk Assessment. (See Section 4.)

3.3 SEDIMENT

COCs have also been identified in sediment samples obtained from the four surface water bodies (the Site brook, Farmington River, Small Pond, and Great Pond). Both organic and inorganic COCs were identified in sediment. There are currently no background data for sediment, and therefore it is not known to what degree these inorganic COCs are Site-related. The following activities will be conducted in order to better define Site-related risks to receptor groups from exposure to sediment:

Phase I

- Characterize local background sediment conditions;
- Characterize conditions in unnamed tributary to Goodwin Pond;
- Conduct additional sampling for cyanide in the Site brook sediment;
- Re-collect AVS:SEM sample from SD-1901 in Small Pond due to a potential sampling artifact in the 1999 sample; and
- Evaluate AVS:SEM results.

Phase II

- Characterize conditions upstream and downstream in the Farmington River;
- Conduct sediment toxicity testing; and
- Conduct aquatic prey tissue sampling and analysis.

Each of these recommended activities is discussed in greater detail below. Figure 4 presents the process flow diagram for each phase of the sediment evaluation.

3.3.1 Phase I Sediment Activities

3.3.1.1 Local Background Sediment Sampling

Background sediment samples will be collected from representative background surface water bodies located in the vicinity of the Site. Analytical data from these samples will be used in the BERA to identify COCs in Site sediment that are elevated above background and therefore potentially Site-related. Potential background sampling locations and analytical parameters are identified in Section 4.

3.3.1.2 Characterize Conditions In Unnamed Tributary To Goodwin Pond

To date, no samples have been collected from the unnamed tributary that flows from Small Pond to Goodwin Pond. To address this data gap, sediment samples will be collected in the tributary.

Analytical data from these samples will be used in the BERA to evaluate if contaminants from Small Pond are being transported to Goodwin Pond. Sampling locations and analytical parameters are identified in Section 4.

3.3.1.3 Additional Characterization of the Site Brook

Additional characterization of potential cyanide contamination is needed in the Site brook sediments, as existing samples were not analyzed for cyanide. Additional sediment samples will be collected and analyzed for cyanide in upstream and downstream locations in order to address this data gap. Sampling locations are identified in Section 4.

3.3.1.4 Re-collection of AVS:SEM sample from SD-1901 in Small Pond

The 1999 AVS:SEM results for SD-1901, located in Small Pond, are considered questionable due to potential sampling artifact. Therefore, another AVS:SEM sample will be collected from this location. This sampling location is identified in Section 4.

3.3.1.5 Evaluation of AVS:SEM results

AVS:SEM results will be evaluated along with the new background data in order to determine if and/or where inorganic COCs (specifically, divalent cations) are bioavailable. At locations where metals are the primary COCs, decisions regarding the necessity of toxicity testing will be based on these results. If divalent inorganic COCs are bioavailable (i.e., SEM:AVS ratios greater than 2), and there are significant benchmark exceedances (i.e., average HQs greater than 5), sediment toxicity testing will be conducted as part of Phase II activities. Although the AVS:SEM evaluation is specific to divalent metals, it is reasonable to assume that if divalent metals are not bioavailable, other metals are also likely to not be bioavailable. However, AVS:SEM ratios will not be used as the sole basis for evaluating risks from sediment-associated COCs; other factors (e.g., benchmark comparisons, other published toxicity data) will be considered in the risk evaluation.

3.3.2 Phase II Sediment Activities

Following completion of the Phase I activities, decisions will be made as to where and what activities will take place in Phase II. Additional sampling in the Farmington River will also be conducted as part of Phase II activities to characterize conditions upstream and downstream. If the background data collected as part of Phase I activities indicate that metals in sediment are elevated and are bioavailable (SEM:AVS ratios greater than 2), and either organic or inorganic COCs significantly exceed benchmarks (average HQs greater than 5), sediment toxicity testing will be conducted. The third potential Phase II sediment activity is prey tissue sampling and

analysis. This activity will be completed if the food chain sensitivity analysis indicates that tissue concentrations estimated using literature-derived BAFs are resulting in average HQs of greater than 5.

3.3.2.1 Characterize Conditions Upstream and Downstream in the Farmington River

Only one upstream sample has been collected from the Farmington River, and the extent of elevated metals concentrations downstream has not been completely characterized. Therefore, additional sediment samples will be collected both upstream and downstream in the Farmington River in order to complete this characterization per USEPA comments (see Section 4). This sampling effort will be conducted during Phase II activities at the same time as other river sampling events, in order to limit the number of mobilizations (and associated extra equipment) needed in the river.

3.3.2.2 Sediment Toxicity Testing (Freshwater Invertebrates)

Comparison of sediment concentrations with sediment screening benchmarks suggests that benthic invertebrates could potentially be at risk from the presence of PAHs, pesticides, and/or metals in sediments. For both organic and inorganic chemicals, use of these screening values often leads to preliminary conclusions of potentially significant risk. These values are based on limited information and do not take into account the numerous Site-specific factors that influence bioavailability and toxicity. Although evaluation of background data and AVS:SEM data may result in a conclusion that divalent metals are either consistent with background or are not bioavailable, the presence of organic COCs necessitates sediment toxicity tests in Small Pond, the Site brook and the Farmington River in order to obtain empirical data on risks to aquatic receptors. Concentrations are lower in Great Pond and therefore no toxicity testing will be performed in this water body; results of toxicity tests from other ponds will be used qualitatively in the risk evaluation for Great Pond. Tests will be conducted using the amphipod *Hyalella azteca*. This invertebrate does well in the variety of aquatic habitats found at the CE Windsor Site and is known to be sensitive to both organic and inorganic contaminants. Additional details of the toxicity testing program, and proposed sampling locations, are presented in Section 4.

3.3.2.3 Aquatic Prey Tissue Sampling

Results of the screening assessment indicated that semi-aquatic life could be adversely affected by ingestion of prey items that have bioaccumulated pesticides, PCBs, and mercury from Site sediments. In Small Pond, the primary bioaccumulating COCs are pesticides (e.g., DDT) and mercury. In the Site brook, PCBs and mercury have been detected at levels exceeding screening values. In the Farmington River, cadmium is the only COC detected in sediment that could

potentially bioaccumulate although it is possible that the additional characterization of the Farmington River could identify additional bioaccumulative chemicals.

Aquatic prey tissue sampling in Small Pond and the Site brook is necessary, due to the presence of organic COCs (pesticides and PCBs) as well as inorganic analytes. However, an aquatic accumulation study in the Farmington River will be only be proposed if the additional background data and AVS:SEM results indicate that cadmium in sediment is elevated above background and is bioavailable.

Tissue sampling will provide a Site-specific indication of potential bioaccumulation of these bioaccumulating compounds to better characterize exposures and risks to semi-aquatic wildlife from ingesting contaminated prey items. Collection of amphibians and/or fish from Small Pond and the Site brook will be conducted. For the Farmington River, the primary pathway of concern is semi-aquatic wildlife ingestion of fish; however, tissue samples of native fish in the Farmington River would represent their exposures to chemicals both from the Site and from other sources up and downstream. Fish collected might also be from stocked, and not native, populations and therefore might not represent native fish exposures; in this case it would be difficult to relate any measured fish tissue concentrations to contaminant levels in local river sediments. Therefore, if tissue data for the Farmington River are needed, they will be obtained from a bioaccumulation test using the freshwater oligochaete worm *Lumbriculus variegatus* exposed to sediment samples that will be collected from the Farmington River. This will ensure that organisms are only exposed to sediments in the vicinity of the Site.

4.0 SAMPLING AND ANALYSIS PLAN

This section of the Study Design document discusses the field activities required in order to address data gaps and support completion of the BERA. The field activities will be completed in two phases, with the second phase building on information gathered during the first phase. Tables 1 through 4 present sampling objectives and specific sample locations for surface soil, surface water, sediment, and biological tissue sampling events. Figures 6 through 14 present proposed locations.

Sampling methods will be consistent with those described in the Site's Quality Assurance Project Plan (QAPP)(HLA, 1999); relevant sections of the QAPP are included here as Appendix A. Sample identification numbers are also included in Appendix A.

The following subsections describe the Phase I and Phase II field activities for surface soil, surface water, and sediment.

4.1 SURFACE SOIL

Surface soil sampling objectives are summarized in Table 1.

4.1.1 Phase I Activities

As discussed in Section 3, a qualitative habitat survey will be completed to identify specific habitats and wildlife receptors that will be evaluated in the BERA. The survey will identify habitat groupings across AOCs; these habitat groupings will be used to group data and estimate exposure point concentrations in the BERA. No additional field sampling activities for surface soil will be required as part of Phase I.

4.1.2 Phase II Activities

As stated in Section 3, some of the Phase II field activities (e.g., biological tissue analysis) will be performed only if the results of the Phase I activities indicate they are necessary (see Figure 2). Details of the toxicity testing methodologies are included in Appendix B.

4.1.2.1 Earthworm Toxicity Tests

Surface soil will be collected from 5 locations at AOCs 1, 3, 10, and 24 for earthworm toxicity testing. Surface soil will also be collected from 1 reference location (SSBG22). Based on current analytical data presented in the FID, the five proposed sample locations include SS0107, SS0109,

SS0302, TP1009, and SS2403(RFI). The general locations of all proposed samples are shown in Figure 6. Figures 9 through 12 show the Site sample locations, and Figure 13 shows the reference location in greater detail. These locations were selected to represent the upper end of the range of concentrations for risk-driving COCs for soil invertebrates based on magnitude of exceedance of invertebrate benchmarks. These are chromium, copper, zinc, and PAHs. SS0107 (AOC 1) has the highest chromium concentration. SS0109 (AOC 1) has the highest copper and second highest zinc concentration. SS0302 (AOC 3) has the highest zinc concentration relative to other samples. TP1009 (AOC 10) has elevated PAH concentrations. SS2403(RFI) (AOC 24) has elevated PAHs.

The reference location (SSBG22) was selected from among background surface soil samples collected as part of RFI. This location was chosen because concentrations detected most closely resemble the average concentrations for all background locations combined, and because it is located in an area not associated with any AOCs.

A 1-liter (1 L) surface soil sample will be collected at each of the 6 sampling locations (5 Site and 1 background) using a stainless steel shovel or auger, placed in plastic bags, packed on ice, and submitted to the toxicological laboratory.

A separate aliquot of each sample will be shipped to the analytical laboratory and analyzed for PAHs, metals, and total organic carbon.

4.1.2.2 Plant Toxicity Tests

Surface soil will be collected from 5 locations at AOCs 1, 3, and 17 for plant toxicity testing. Surface soil will also be collected from 1 reference location (SSBG22). Based on analytical data presented in the FID, proposed sample locations include SS0107, SS0109, SS0302, SS0307, and SS1709. The general locations of all proposed samples are shown in Figure 6. Figures 9, 10, and 14 show the precise sample locations for samples located at AOCs 1, 3, and 17, respectively. These locations were selected to cover the range of concentrations for risk-driving COCs for plants based on magnitude of exceedance of phytotoxicity benchmarks. These are chromium, copper, vanadium, zinc, boron, and arsenic. SS0107 (AOC 1) has the highest chromium concentration. SS0109 (AOC 1) has elevated copper, lead, and zinc concentrations, and SS0302 (AOC 3) has the highest zinc concentration. SS0317 (AOC 3) has elevated boron concentrations relative to other samples. SS1709 (AOC 17) has elevated vanadium.

A one-liter (1L) surface soil sample will be collected at each of the 6 sampling locations (5 Site and 1 background) using a stainless steel shovel or auger, placed in plastic bags, packed on ice, and submitted to the toxicological laboratory.

A separate aliquot of each sample will be shipped to the analytical laboratory and analyzed for PAHs, metals, and total organic carbon.

4.1.2.3 Biological Tissue

Table 4 presents the sampling objectives for both terrestrial and aquatic biological tissue sampling programs. If bioaccumulation is determined to be a potentially significant contributor to terrestrial wildlife exposures, earthworm tissue samples will be used to provide a direct measure of bioaccumulation in soil invertebrates. Earthworm tissue samples will be obtained from earthworms used in the toxicity tests, rather than from field collected organisms. It is currently assumed that earthworm tissue samples will be required from 3 of the 5 Site locations at which earthworm toxicity testing is conducted. Locations will be determined based on initial toxicity test results. At the end of the toxicity tests, the earthworms from the selected toxicity test samples will be submitted to the analytical laboratory for chemical analysis. Samples will be analyzed for PAHs and metals.

4.2 SURFACE WATER

Table 2 presents surface water sampling objectives and specific sample locations for tasks described below.

4.2.1 Phase I Activities

4.2.1.1 Background/Reference Areas

Surface water data from nearby unimpacted surface water bodies will be used to determine whether metals and other anthropogenic chemicals (e.g., PAHs) detected in Site surface water bodies are representative of typical local conditions or are elevated and potentially Site-related. Potential locations will be visually inspected in the field, and representative locations will be selected and sampled. Potential locations and analytical methods are discussed below.

Identify Background Locations. A review of topographic maps and field notes was completed in order to identify potential reference areas for collection of surface water and sediment samples. Background data will be obtained from two different habitat types (stream and pond) in order to provide data sets for comparison with Site surface water bodies. The following areas have been

identified as potential reference locations: Silver Birch Pond, Parcel B Pond, an unnamed pond in North Bloomfield, Mill Brook, and other tributaries to the Farmington River. These areas will be visually inspected in the field to identify and/or confirm the available habitat and substrate types, and then one or two areas of each habitat type (pond and stream) of similar substrate characteristics will be selected for sampling. Attempts will be made to collect samples from more than one stream and pond; however, due to private ownership in surrounding areas, access issues may prohibit this type of representation. Potential background sampling locations are shown in Figure 5.

Sample Collection. Background surface water samples will be collected from a total of 5 pond and 5 stream locations. Sample collection methods will be consistent with methodologies presented in the QAPP (HLA, 1999b). Background surface water samples will be labeled SWBG-01 through SWBG-10.

Analytical Methods. Surface water samples will be analyzed for PAHs, pesticides, PCBs, filtered and unfiltered metals, and hardness. Analytical methods for each of the analytes described above will be consistent with the methodologies presented in the QAPP (HLA, 1999b) (see Appendix A).

4.2.1.2 Unnamed Tributary To Goodwin Pond

Three surface water samples will be collected from the unnamed tributary to Goodwin Pond. Samples will be collected from locations between the outlet of Small Pond and the access road to the Knolls Atomic Power Laboratory Inc. (KAPL) facility. These samples will be analyzed for PAHs, pesticides, PCBs, filtered and unfiltered metals, and hardness. Figure 6 shows these surface water sample locations; the precise locations will be determined in the field by identifying depositional areas near the locations shown in Figure 6.

4.2.1.3 Additional Characterization of the Site Brook

Two samples will be collected from the upper end of the Site brook near Goodwin Pond and outfalls (near TS-1422) and near the mouth of the Site brook at the Farmington River (near SD-1419). Samples will be analyzed for total and amenable cyanide. Figure 6 shows the general locations of these samples; Figure 7 shows the detailed locations.

4.2.2 Phase II Activities

4.2.2.1 Characterize Conditions Upstream and Downstream in the Farmington River

Four additional surface water samples will be collected (2 upstream, in the general vicinity of SD-1422, and 2 downstream of SD-1425) in the Farmington River in order to further characterize

conditions upstream and downstream in the Farmington River. This sampling effort will be conducted during Phase II activities at the same time as other river sampling events, in order to limit the number of mobilizations (and associated extra equipment) needed in the river. Samples will be analyzed for VOCs, metals, and hardness. Figure 7 shows the approximate locations of these samples, although the precise locations will be determined in the field.

4.2.2.2 Surface Water Toxicity Tests

If Phase I activities conclude that metals in surface water are elevated above background and exceed benchmark values, surface water toxicity tests will be used to obtain a Site-specific indication of surface water toxicity. Surface samples will be collected and submitted to a toxicity testing laboratory for a 3 brood reproductive/survival bioassays using *Ceriodaphnia dubia*. Approximately 1 liter (1L) of water will be collected from each location and submitted to the toxicity testing laboratory. Details of the toxicity testing methodologies are included in Appendix B.

A separate aliquot of each sample will be shipped to the analytical laboratory and analyzed for metals and hardness.

4.3 SEDIMENT

Table 3 presents the sediment sampling objectives and specific sampling locations for tasks described below.

4.3.1 Phase I Activities

4.3.1.1 Background/Reference Areas

Sediment data from nearby unimpacted surface water bodies will be useful in determining if metals and other anthropogenic chemicals (e.g., PAHs) detected in Site sediments are representative of typical local conditions or are elevated and potentially Site-related. Background sediment samples will be paired with surface water samples described above. Sediment samples will be collected from a total of 5 pond and 5 stream locations. Sample collection methods will be consistent with methodologies presented in the QAPP (HLA, 1999b).

Sediment samples will be analyzed for PAHs, pesticides, PCBs, metals, TOC, and AVS:SEM. Analytical methods for each of the analytes described above will be completed consistent with the methodologies presented in the QAPP (HLA, 1999b). Background sediment samples will correspond with surface water samples described above and will be labeled SDBG-01 through SDBG-10.

4.3.1.2 Unnamed Tributary To Goodwin Pond

Three sediment samples will be collected from the unnamed tributary to Goodwin Pond. Samples will be collected from the same locations as surface water samples described above; locations will be between the outlet of Small Pond and the access road to the KAPL facility. These samples will be analyzed for PAHs, pesticides, PCBs, metals, TOC, and AVS:SEM. Figure 6 shows these sediment sample locations.

4.3.1.3 Additional Characterization of the Site Brook

Two samples will be collected from the upper end of the Site brook near Goodwin Pond and outfalls (near TS-1422) and near the mouth of the Site brook at the Farmington River (near SD-1419). As requested by USEPA, samples will be analyzed for cyanide. Figure 6 shows the general locations of these samples; Figure 7 shows the detailed locations.

4.3.1.4 Re-Collection Of An AVS:SEM Sample From SD-1901 In Small Pond

The 1999 AVS:SEM results for SD-1901, located in Small Pond, are considered questionable due to a potential sampling artifact. Therefore, another AVS:SEM sample will be collected from this location. Collection and analysis of AVS:SEM samples will be consistent with the methodologies presented in the QAPP (HLA, 1999b). Figure 8 shows this sampling location.

4.3.2 Phase II Activities

As stated in Section 3, some of the Phase II activities (e.g., sediment bioaccumulation testing in the Farmington River) will be performed only if the results of the Phase I activities indicate they are necessary (see Figure 4).

4.3.2.1 Characterize Conditions Upstream and Downstream in the Farmington River

Four additional sediment samples will be collected (2 upstream, in the general vicinity of SD-1422, and 2 downstream of SD-1425) in the Farmington River in order to further characterize conditions upstream and downstream in the Farmington River. This sampling effort will be conducted during Phase II activities at the same time as other river sampling events, in order to limit the number of mobilizations (and associated extra equipment) needed in the river. Samples will be analyzed for VOCs, PAHs, pesticides, PCBs, metals, TOC, and AVS:SEM. Figure 7 shows the approximate locations of these samples, although the precise locations will be determined in the field based on substrate characteristics.

4.3.2.2 Sediment Toxicity Testing

Toxicity testing will be performed on samples from Small Pond, Site brook, and the Farmington River. Three samples in Small Pond will be collected from the following locations: SD-1909 (the southern end), SD-1903 (the western side), and SD-1902 (at the northern end near the outlet). Three samples in Site brook will be collected from TS-1422 (the upper end of the Site brook near Goodwin Pond and outfalls), SD-1408 (midway between Goodwin Pond and the Farmington River), and SD1405 (near the mouth of the Site brook at the Farmington River). Samples in the Farmington River will be collected from the vicinity of SD-1422 (upstream), SD1416 (mid-river, beyond the mouth of the Site brook), and SD-1424 (across and slightly downstream of the Site brook). Sample locations for the Site brook and Farmington River are shown in Figure 7. Sample locations for Small Pond are shown in Figure 8. A 1-liter (1L) sediment sample will be collected at each of the sampling locations. Samples will be preserved at 4°C and shipped to the toxicity testing laboratory. Details of the toxicity testing methodologies are included in Appendix B.

A separate aliquot of the sample will be collected and submitted for chemical analysis for PAHs, pesticides, PCBs, metals, and TOC. The sediment samples from Small Pond will also be analyzed for methyl mercury.

4.3.2.3 Sediment Bioaccumulation Testing (Farmington River)

If results of the sensitivity analysis indicate that cadmium bioaccumulation is determined to be the most important contributor to semiaquatic wildlife exposure, then bioaccumulation testing will be conducted using sediments collected from the river.

If needed, three sediment bioaccumulation tests in the Farmington River will be performed at the same locations as toxicity tests (SD-1422, SD-1416, and SD-1424). A 1-liter (1 L) sediment sample will be collected at each of the sampling locations. Samples will be preserved at 4°C and shipped to the toxicity testing laboratory.

A separate aliquot of the sample will be collected and submitted to an analytical laboratory for chemical analysis for PAHs, pesticides, PCBs, metals, and TOC.

4.3.2.4 Biological Tissue

Tissue data for most aquatic prey items will be obtained by collecting organisms directly from the Site. Target organisms include fish and amphibians. Collection of biological tissue samples from the Site will provide Site-specific tissue levels to incorporate into the food chain model to

evaluate potential risks to semiaquatic wildlife. Samples will be collected from Small Pond and the Site brook as described below. The number and type of tissue samples may vary based on availability. Locations within each water body have not been designated, as they will depend upon habitat conditions at the time of sampling and prey availability.

Small Pond. Three fish and three amphibian samples will be collected from Small Pond using methods described in the QAPP (HLA 1999b). These samples will be submitted to the analytical laboratory and analyzed for pesticides, mercury, methylmercury, and percent lipids.

Additional fish samples will be collected from Small Pond to help support the final Human Health Baseline Risk Assessment. Details of this effort are discussed in Appendix D.

Site Brook. A total of three fish or amphibian samples will be collected from the Site brook using methods described in the QAPP (HLA 1999b). These samples will be submitted to the analytical laboratory and analyzed for pesticides, PCBs, mercury, and percent lipids.

5.0 BASELINE ECOLOGICAL RISK ASSESSMENT

The BERA approach for the CE Windsor Site is consistent with the *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments* (Process Document) (USEPA, 1997) and guidance provided in the USEPA memorandum *Implementation of a Voluntary RCRA Corrective Action Program* (USEPA, 1997), as well as other current guidance documents (*Guidelines for Ecological Risk Assessment* [USEPA, 1998], *Framework for Ecological Risk Assessment* [USEPA, 1992], and *Risk Assessment Guidance for Superfund - Environmental Evaluation Manual* [USEPA, 1989]). In addition, various EcoUpdates (published since 1991) and other sources of literature (Suter, 1993; Maughan, 1993) will be consulted.

The BERA will be completed to evaluate the potential risk of ecological harm associated with Site-related contaminants. Site-related COCs have already been screened as part of the FID; however, information regarding local background concentrations of contaminants in surface water and sediment will be presented and used to further refine and evaluate these Site-related COCs in the BERA.

As described in the Process Document, a tiered approach has been adopted for risk assessment activities at the CE Windsor Site. The tiers in the ERA process are determined by the amount of information available and the complexity of studies followed. Assessments completed at either tier have essentially the same structure: problem formulation, analysis, risk characterization, and uncertainty analysis. The primary difference between the tiers is the level of complexity and the number/types of additional studies incorporated into the assessment.

Tier I of the ERA process typically involves a literature search and screening level assessment of ecological risks from exposures to contaminants in Site media, using available ecotoxicological benchmarks and/or regulatory standards. The FID completed for the CE Windsor Site was consistent with Tier I. Based on the findings presented in the FID, a Tier II assessment (BERA) is required. The BERA builds upon information and findings presented in the FID and is intended to determine if specific areas or media (surface soil, surface water, sediment) represent a significant risk to ecological receptors, and for those areas that do, identify preliminary remediation goals to consider in developing remedial options.

This Study Design describes the methodology for evaluating the biological and chemical data, and estimating potential ecological risks. The types of samples to be collected in support of the BERA are described in detail in Section 4.0.

Each step of the BERA process (including problem formulation, analysis, risk characterization, and uncertainty analysis) is discussed in greater detail in the following subsections.

5.1 PROBLEM FORMULATION

The problem formulation and CSM for the Site were submitted for regulatory review on December 21, 2000 (Harding ESE, 2000) (see Appendix C-1).

As part of the BERA, additional tasks will be completed to further refine the CSMs and problem formulation for the Site. The CSMs and problem formulation will also be revised in the BERA to reflect USEPA comments (see Appendix C-2).

The BERA report will contain a section presenting the problem formulation, which will include data summarization, receptor selection, CSMs, and assessment and measurement endpoints. These tasks are described below.

5.1.1 Data Evaluation and Identification of Contaminants of Concern

The problem formulation submitted to USEPA on December 21, 2000 identified the contaminants that are likely to be of most concern in surface soil, surface water, and sediment. This section of the BERA will present summary statistics that will be generated for each medium for both the Site and background samples. Statistics will be reported only for detected analytes, and will include: the frequency of detected analytes; the arithmetic mean, the minimum and maximum detected concentrations; and the 95% upper confidence limit (UCL) on the arithmetic mean.

Data Summarization The following guidelines will be used in summarizing the data. Rejected data will be excluded from the data set. Duplicate pairs will be averaged prior to generating summary statistics. For chemicals detected at least once in a particular medium, one-half the sample quantitation limit (SQL) will be used to represent non-detects when calculating arithmetic averages. For duplicate pairs that have one detect and one non-detect reported, the average of the

detected concentration and ½ the SQL will be used to represent the detect. These data summary procedures are consistent with USEPA guidance (USEPA, 1992).

Selection of Contaminants of Concern (COCs) COCs have already been selected in the FID. Additional screening of surface water and sediment data will be completed in order to incorporate background data that will be collected for this BERA. Any analytes that are determined to be consistent with background data will not be considered further in the BERA. Additional screening of surface soil data will be completed in order to take into account changes in soil contaminant levels as a result of ICMs that have been completed at several AOCs. These additional screening steps may result in the elimination of some of the COCs presented in the FID.

5.1.2 Selection of Receptors

The receptors that are likely at risk from exposure to contaminated media at the Site include aquatic receptors exposed to surface water and sediment, and semi-aquatic receptors exposed to contaminated prey. A qualitative habitat survey will be completed in order to identify specific wildlife receptors that will be evaluated in the BERA. Two aquatic species of concern are known or suspected to occur in the Farmington River in the vicinity of the Site: Atlantic salmon (*Salmo salar*) and the eastern pond mussel (*Ligunia nasuta*). Additional information regarding the occurrence of these and any other protected species will be obtained; and special consideration will be given to each of these species in the BERA. When evaluating endangered species, the assumption is made that adverse impacts at the individual level of organization could be detrimental to the viability of the local populations.

5.1.3 Conceptual Site Models of Ecological Exposures

As a first step in the problem formulation phase, CSMs have been developed based on consideration of the ecological community or components potentially at risk, stressor characteristics, and exposure pathways. The exposure scenarios evaluated in the CSMs consider contaminant sources, environmental transport mechanisms, partitioning of the analytes between various environmental media, identification of exposure routes, and the types of ecological receptors that could be potentially exposed. The CSMs for different portions of the Site are presented in the Problem Formulation which is included as Appendix C-1 (see Figures 1, 2, and 3 in Appendix C-1). These CSMs will be further refined during the BERA as Phase I and/or Phase II activities are completed.

5.1.4 Selection of Assessment and Measurement Endpoints

An important step in the problem formulation process is the identification of assessment and measurement endpoints, which must be completed before exposure, toxicity, or risk can be estimated. Endpoints are used in the ecological risk assessment to define the ecological attributes to be protected (assessment endpoints) and to define measurable characteristics of those attributes that can be used to gauge the degree of impact that may occur (measurement endpoints).

A typical assessment endpoint is an ecological attribute that, if found to be significantly affected, is significant enough to warrant remediation. Assessment endpoints most often relate to attributes of biological populations or communities (e.g., abundance, richness, productivity); individual-based assessment endpoints typically are relevant only if endangered species are present.

The overall objective of the BERA is to determine if there are adverse impacts to the growth, survival, or reproduction of ecological receptor populations (or individuals of special status species). This may be caused either by direct mortality of a significant percentage of a population, or by adverse reproductive or growth effects. These assessment endpoints will be measured using a weight of evidence approach that will consider analytical data, available toxicity data, and Site-specific toxicity test results. A higher weight will be given to toxicity test results as they are considered to provide the best indication of potential risks to ecological receptors at the Site.

A second objective of the BERA is to determine if there is a bioaccumulation hazard to higher trophic levels (i.e., piscivorous mammals and birds). This will be measured by collecting and analyzing fish or amphibian tissue samples contingent on results of Phase I activities. These data will then be used directly in food-web models to evaluate potential risks.

Table 5 presents the assessment and measurement endpoints that will be used in the BERA to assess ecological risks.

5.2 ANALYSIS

The analysis phase of the BERA consists of an exposure assessment, in which exposure pathways are identified and quantified, and an effects assessment, in which toxicological effects data that most closely relate to the assessment endpoints are summarized. The literature-derived and Site-specific effects data used to gauge the risk to receptors will also be described.

5.2.1 Exposure Assessment

The purpose of the ecological exposure assessment is to evaluate the likelihood and magnitude of ecological receptor exposures to contaminated media at the Site. The ecological exposure assessment develops the information collected during problem formulation to evaluate and quantify exposure levels. Components of the exposure assessment include identification of ecological exposure pathways, and quantification of exposure. Each of these components of the exposure assessment is discussed below.

5.2.1.1 Identification of Ecological Exposure Pathways

Aquatic organisms may be exposed to COCs in sediment and surface water via direct dermal contact with, and/or assimilation of sediment-sorbed contaminants or contaminants in the water column. Contaminants may then enter the circulatory system via partitioning through respiratory epithelial tissues (e.g., gill membranes) or the gastrointestines following ingestion of contaminated food items. Both invertebrates and vertebrates in direct contact with surface water or riverbed soil may serve as contaminant vectors for indirect exposure to higher trophic levels through food chain transfer.

Semi-aquatic wildlife receptors that utilize the water bodies at the Site (i.e., wading birds, raccoons) may be exposed to contamination through several exposure pathways. These pathways include dermal contact with and incidental ingestion of sediment, or ingestion of prey items that have bioaccumulated or bioconcentrated contaminants in their tissue. Food chain exposures will be quantified using food-web models.

Terrestrial receptors include plants, invertebrates, and wildlife. Terrestrial plants may be exposed by direct contact and root uptake of contaminated soil. Terrestrial invertebrates may be exposed by ingestion and direct contact with contaminated soil. The primary exposure pathway for terrestrial wildlife receptors is presumed to be ingestion of contaminated prey items.

5.2.1.2 Estimation of Exposure Point Concentrations

For aquatic habitat, data for each surface water body will be evaluated separately. For terrestrial habitat, data will be grouped across AOCs according to habitat (e.g., forest, field, maintained grass). For each COC in each data group, 95% UCLs and average concentrations will be used to represent exposure point concentrations. 95% UCLs are assumed to represent a worst-case exposure scenario, whereas average concentrations are assumed to represent the most likely exposure scenario. 95% UCLs are only utilized for data groups of 10 or more samples; if a data

group contains less then 10 samples, the maximum concentration is used as the worst-case exposure point concentration.

5.2.2 Effects Assessment

This section of the BERA will identify and describe the regulatory criteria/guidelines and other ecotoxicological benchmarks that will be used to evaluate COCs, and the Site-specific toxicity studies that have been implemented at the Site. The types of data that will be used for each medium are discussed below.

5.2.2.1 Surface Soil

Toxicological benchmarks used to evaluate COCs in surface soil will be derived from the literature. The values selected will be based on growth, reproductive, or mortality endpoints for plants, soil invertebrates, and wildlife.

In addition to the toxicological benchmarks, toxicity tests measuring effects on earthworm survival, growth, and reproduction will be performed. If tissue data are required, earthworms will be sent to an analytical laboratory for chemical analysis to determine contaminant uptake into earthworm tissue upon completion of the test.

5.2.2.2 Sediment

Several different sources of benchmarks and criteria will be used for screening COCs and to estimate potential risks to aquatic receptors. The benchmarks will be derived from the U.S. Environmental Protection Agency sediment criteria and guidelines (USEPA, 1993a, b, c, d, e; 1998), the Ontario Ministry of the Environment (OME) Lowest Effect Levels (LELs) (Persaud, 1996), the National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ERL) values (Long and Morgan, 1995), and other appropriate sediment benchmarks.

In addition to the toxicological benchmark evaluation, toxicity test and AVS:SEM data will be used in the effects assessment. 10-day toxicity tests measuring effects on benthic invertebrate growth/reproduction and survival will be performed. The amphipod, *Hyalella azteca* will be used in the toxicity tests, as this organism does well in a variety of aquatic habitats such as are present at the Site, and it is known to be sensitive to both organic and inorganic contaminants.

AVS:SEM data are available for several AOCs. These data will be summarized and evaluated to determine the bioavailability of inorganic analytes in Site sediments. In general, when the

SEM:AVS ratio is less than one, the majority of divalent metals are likely to be bound with sulfides and thus less bioavailable and less toxic. For this BERA, if the SEM:AVS ratio is greater than two, some portion of divalent metals is assumed to be potentially bioavailable. This information will be used to help identify metals that may be bioavailable to aquatic organisms, and to focus further toxicity testing or accumulation studies on those areas.

5.2.2.3 Surface Water

Several sources of criteria or guidelines for chronic exposures will be used for screening COCs and to evaluate risks to aquatic organisms, including the chronic AWQC (USEPA, 1991), Connecticut Water Quality Standards (Connecticut Department of Environmental Protection [CTDEP], 1997), and chronic freshwater ecotoxicity thresholds (ETs) (USEPA, 1996). These criteria will be used as toxicity effects endpoints at both the individual and community levels for pelagic (i.e., water column) species. If no AWQC or ETs are available for a particular analyte, the Aquatic Information Retrieval (AQUIRE) database and other readily available sources will be consulted to derive an appropriate benchmark value.

In addition to the toxicological benchmark evaluation, surface water toxicity tests measuring effects on the invertebrate *Ceriodaphnia dubia* will be performed if necessary to obtain Site-specific data on the toxicity to aquatic receptors.

5.3 RISK CHARACTERIZATION

The BERA will combine the results of the exposure and effects assessments, completed during the analysis phase, to characterize the risks to ecological receptors from exposure to COCs.

A HQ method will be used to quantify potential risks to terrestrial and semi-aquatic wildlife from food chain exposures. By this method, calculated exposure doses from the food web models will be compared to the appropriate reference toxicity values (RTVs). The results of any earthworm or oligochaete bioaccumulation studies, as well as fish or amphibian tissue data, if needed, will be used directly in the food web model to calculate wildlife receptor exposure doses. If an exposure dose is greater than an RTV (i.e., an HQ is greater than 1), the potential may exist for adverse ecological effects to receptors and a discussion of the ecological significance of the HQs comprising the HI will be completed. These discussions will address the extent to which the Hazard Indices (HIs) are driven by particular COCs, or "risk drivers", and by specific "hot spots" for any key risk drivers. If a toxicity value is exceeded, adverse effects to ecological receptors may not automatically be implied;

however, as the magnitude of the exceedance increases, the probability of adverse effects also increases. These results are then extrapolated to potential effects on the population.

If an HQ is less than 1, it is assumed that the chemical exposure is not associated with adverse effects on receptors, and there is no risk to ecological receptors. HIs will be determined for each receptor and for each class of chemical compounds (i.e., PAHs, pesticides, and metals) by summing the HQs for all COCs (i.e., it is assumed that risks are additive).

This hazard ranking scheme evaluates potential ecological effects to individual organisms and does not evaluate potential population-wide effects. Contaminants may cause population reductions by affecting birth and mortality rates, immigration, and emigration (USEPA, 1989a). In many circumstances, effects may occur to individual organisms with little population or community level impacts; however, as the number of individual organisms experiencing toxic effects increases, the probability that population effects will occur also increases. The number of affected individuals in a population presumably increases with increasing HQ or HI values; therefore, the likelihood of population level effects occurring is generally expected to increase with higher HQ or HI values.

Risks to terrestrial and semiaquatic wildlife receptors will also be evaluated by using the toxicity test results for plants, earthworms and aquatic organisms. If significant mortality or growth effects are observed for earthworms or plants exposed to surface soils, or to aquatic organisms exposed to surface water or sediment, then the potential impact of those effects on higher trophic level organisms that rely on them for food will be discussed.

The conclusions regarding overall risk to ecological receptors are made by considering various lines of evidence from the results of all components of the assessment (i.e., the approach integrates results of physical, biological, and toxicological data to draw risk-based conclusions). A qualitative weight-of-evidence approach will be employed to integrate multiple measurement endpoints in making conclusions about the risks to the selected receptor groups.

5.4 UNCERTAINTY ASSESSMENT

The interpretation of risk estimates is subject to a number of uncertainties that result from the use of conservative assumptions and the lack of necessary information to quantify actual exposure and effects concentrations. In this section of the BERA, uncertainties associated with the BERA will be identified. The possible implications of these uncertainties on the conclusions of the BERA will also be discussed.

6.0 DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

The results of the BERA will be used in the development of Preliminary Remediation Goals (PRGs) for protection of ecological receptors for any areas or media determined to pose a significant risk.

PRGs will be developed consistent with guidance from the Process Document and other USEPA guidance (1998, 1999).

7.0 SCHEDULE

Phase I activities are scheduled to begin in mid-June 2001. As soon as Phase I analytical data have been received and evaluated, Phase II activities will proceed. It is anticipated that Phase II activities will commence in August 2001, and that a draft BERA report will be submitted for regulatory review in the fall of 2001.

LIST OF ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
AOC	Area of Concern
AQUIRE	Aquatic Information Retrieval
AVS:SEM	
AWQC	Ambient Water Quality Criteria
BAFs	bioaccumulation factors
BCFs	bioconcentration factors
BERA	Baseline Ecological Risk Assessment
CE	Combustion Engineering
COC	Contaminant of Concern
CSMs	conceptual site models
CTDEP	Connecticut Department of Environmental Protection
ERA	Ecological Risk Assessment
ERL	Effects Range-Low
ET	ecotoxicity thresholds
FID	First Interim Deliverable
HI	Hazard Indices
HLA	Harding Lawson Associates
HQs	Hazard Quotient
HRR	Historical Review Report
ICMs	Interim Corrective Measures
KAPL	Knolls Atomic Power Laboratory Inc.
LEL	Lowest Effect Levels
LFI	Limited Field Investigation
LFIWP	Limited Field Investigation Work Plan
NOAA	National Oceanic and Atmospheric Administration
OME	Ontario Ministry of the Environment
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCLs	Protective Contaminant Levels
PRGs	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation Recovery Act
RFI	RCRA Facility Investigation
RTVs	reference toxicity values

SAP	Sampling and Analysis Plan
SQL	sample quantitation limit
TOC	total organic carbon
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VCA	Voluntary Correction Action

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FIGURES

AREAS OF CONCERN	
AOC #	DESCRIPTION
AOC-1	WOODS AREA
AOC-2	ZIRCONIUM BURNING GROUND, MAGNESIUM - THORIUM BURNING GROUND, AND LEACH FIELD
AOC-3	PDU AND LT-90 DAY RCRA STORAGE AREA
AOC-4	GREATER THAN 90 DAY STORAGE AREA AND WASTE PAD AREA
AOC-5	AREAS AROUND BUILDINGS 1, 1A, 2, 2A, AND 2M
AOC-6	AREAS AROUND BUILDING 6A
AOC-7	AREAS AROUND BUILDING 7
AOC-8	AREAS AROUND BUILDING 5 AND LT-90 DAY RCRA STORAGE AREA
AOC-9	AREAS AROUND BUILDING 3 AND LT-90 DAY RCRA STORAGE AREA
AOC-10	AREAS AROUND BUILDING 20, INCLUDING THE EQUIPMENT STORAGE YARD
AOC-11	WASTE WATER TREATMENT PLANT
AOC-12	INDUSTRIAL WASTE LINES
AOC-13	ACCESS ROAD AREA, NEAR OUTFALL
AOC-14	SITE BROOK
AOC-15	AREAS AROUND BUILDINGS 17 AND 21 AND LT-90 DAY RCRA STORAGE AREA
AOC-16	COAL STORAGE AND STORM WATER BASIN
AOC-17	STORM DRAIN LINES
AOC-18	TANK FARM AND PIPING TO BUILDING 3
AOC-19	SMALL POND
AOC-20	DIGESTER SLUDGE
AOC-21	DRUM BURIAL PIT
AOC-22	GRAVEL PIT AND DEMOLITION DEBRIS AREA
AOC-23	AREAS AROUND BUILDING 14 LOADING DOCK
AOC-24	DRAINAGE DITCH OUTFALL TO GREAT POND
AOC-25	HISTORIC DISPOSAL AREA
AOC-26	FORMER TARGET RANGES
AOC-27	CLAMSHELL WASTE PILE

LEGEND

- AOC BOUNDARY
- EXISTING STRUCTURE
- FORMER STRUCTURE
- PROPERTY LINE
- WATER
- UNIMPROVED ROAD
- GROUND SURFACE CONTOUR (ELEVATION, FEET MSL)

NOTE:
BASE MAP PROVIDED BY METROPOLITAN DISTRICT COMMISSION.

0 300 600 1200 FEET
(NOT TO SCALE)

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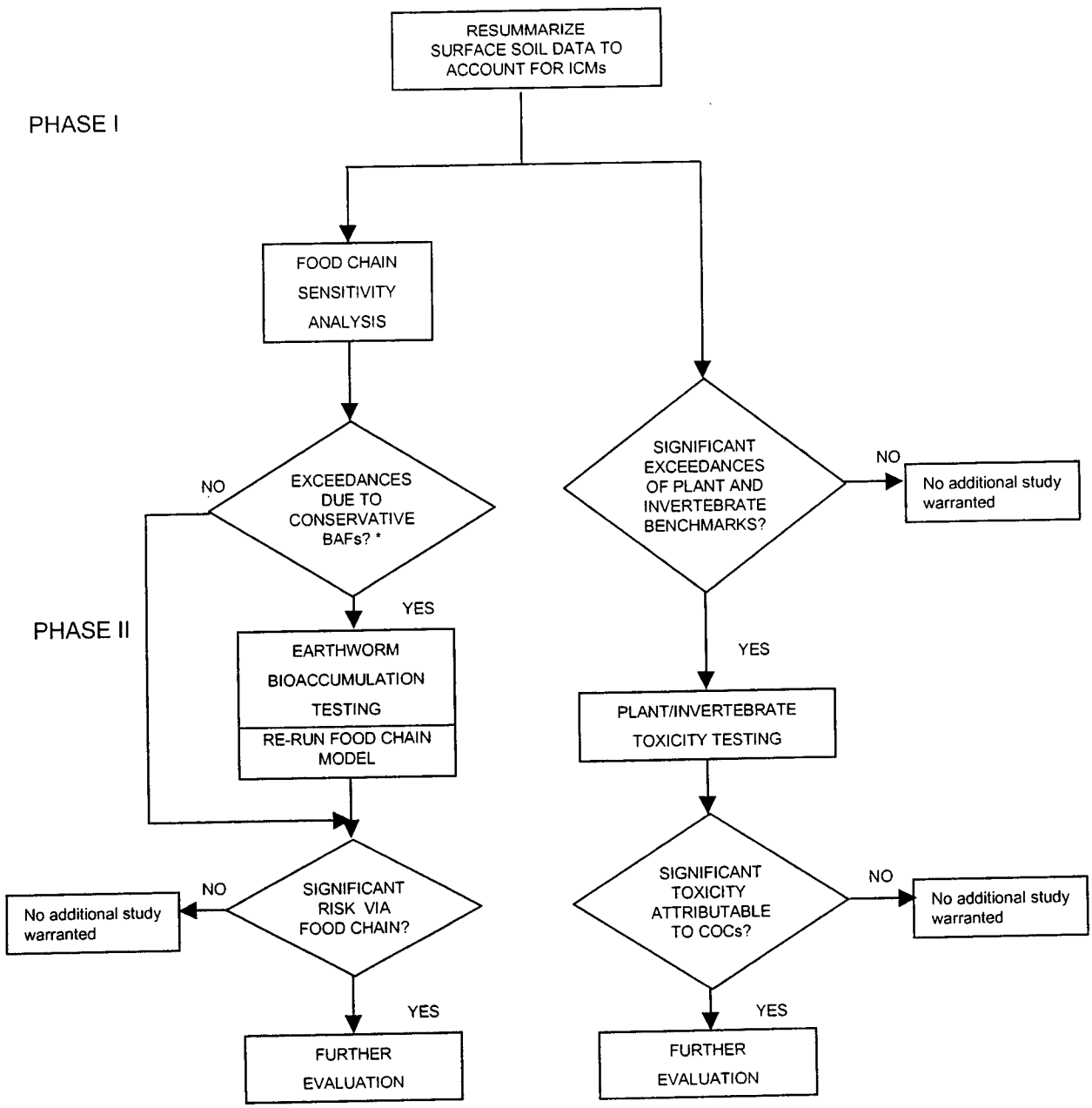
FIGURE 1
AREAS OF CONCERN
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE



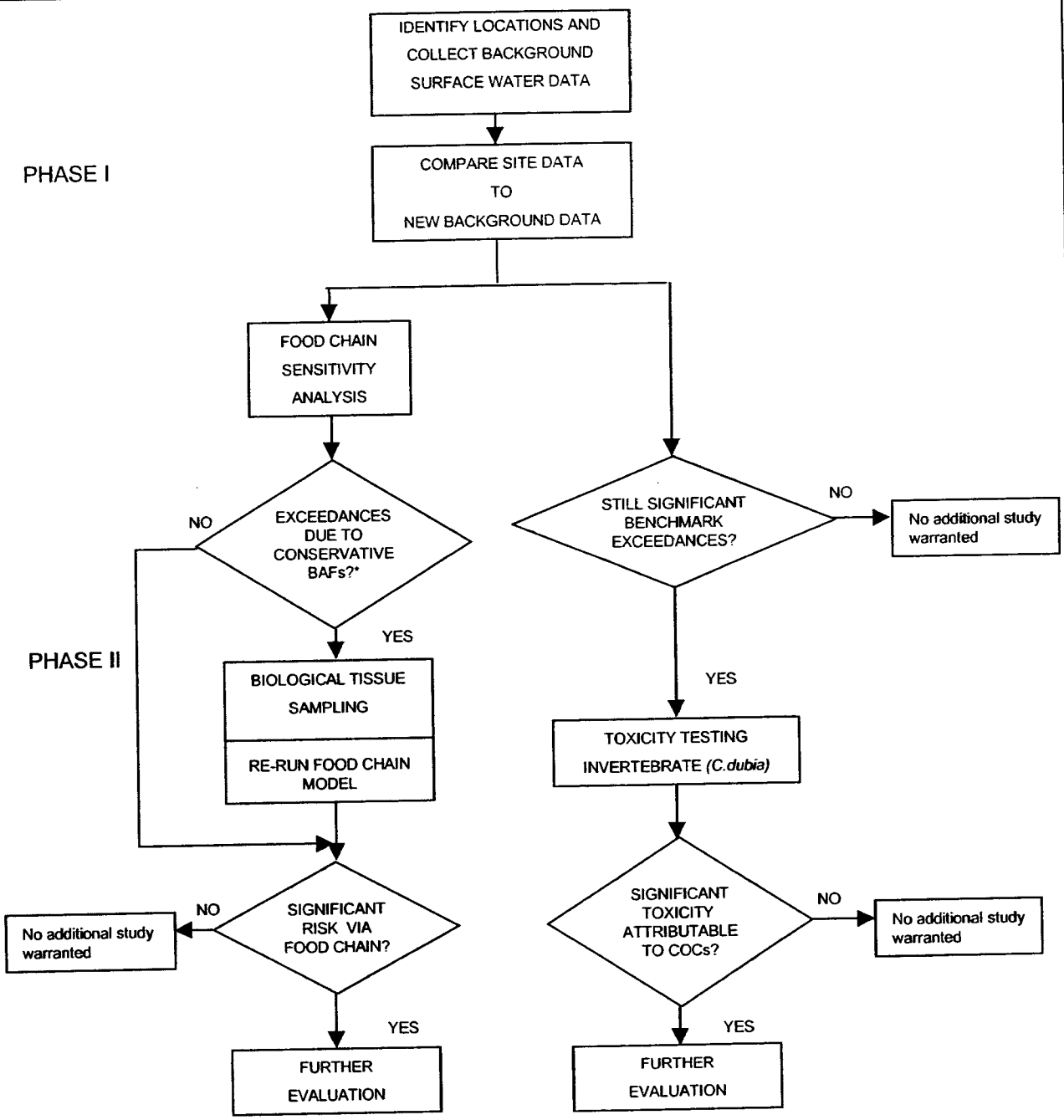
* If exceedances due to toxicity benchmarks or other food chain assumptions, no further sampling will be required but additional assessment will be completed as part of the risk characterization.

BAF - Bioaccumulation Factor
COCs - Chemicals of Concern
ICM - Interim Corrective Measures

FIGURE 2
SURFACE SOIL PROCESS FLOW DIAGRAM
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE
A MACTEC COMPANY

PROCESSFLOW



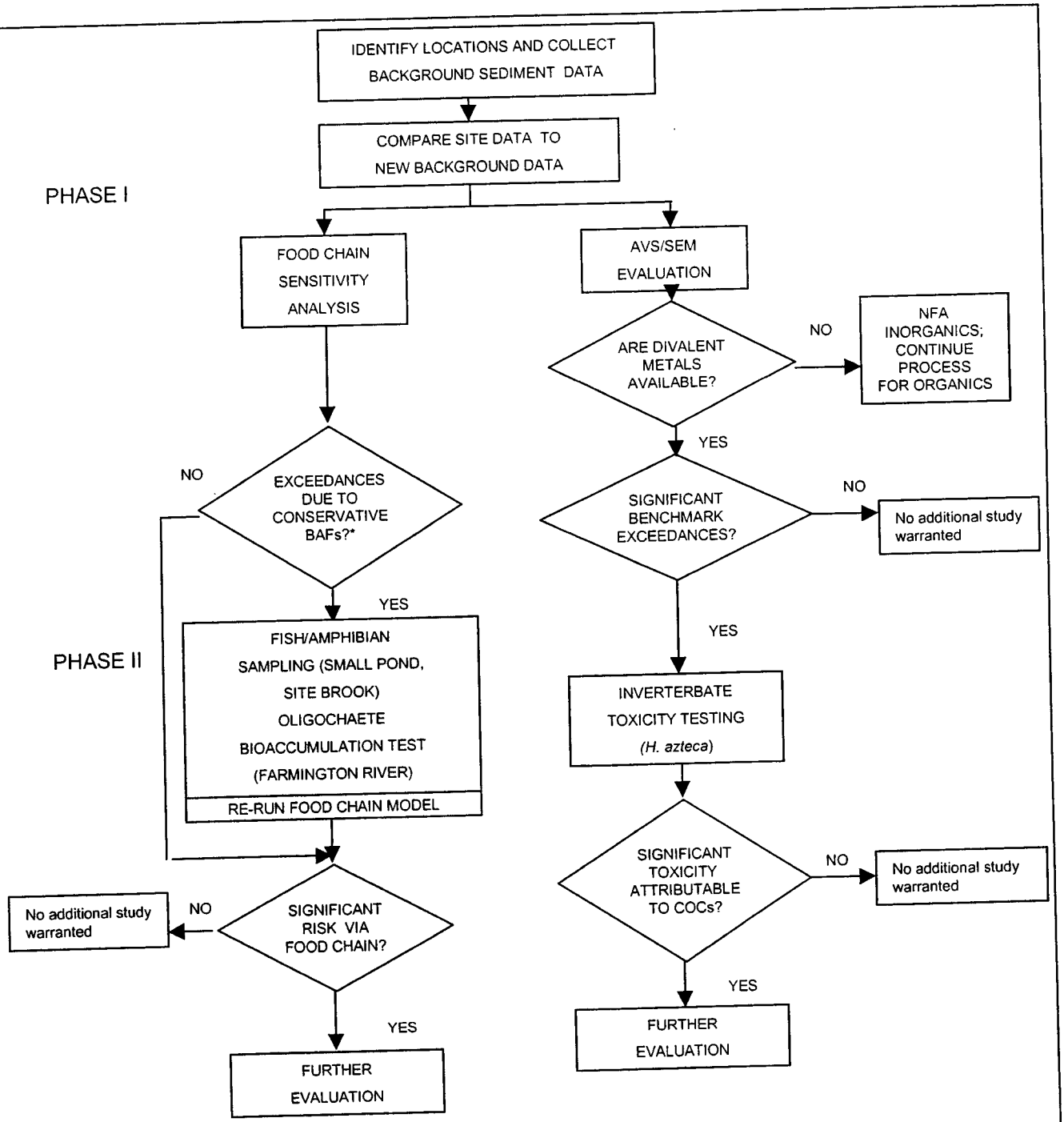
* If exceedances due to toxicity benchmarks or other food chain assumptions, no further sampling will be required but additional assessment will be completed as part of the risk characterization.

BAF - Bioaccumulation Factor
COCs - Chemicals of Concern

FIGURE 3
SURFACE WATER PROCESS FLOW DIAGRAM
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE
A MACTEC COMPANY

PROCESSFLOW



* If exceedances due to toxicity benchmarks or other food chain assumptions, no further sampling will be required but additional assessment will be completed as part of the risk characterization.

BAF - Bioaccumulation Factor
COCs - Chemicals of Concern

FIGURE 4
SEDIMENT PROCESS FLOW DIAGRAM
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE
A MACTEC COMPANY

PROCESSFLOW

FIGURE 5
POTENTIAL BACKGROUND SURFACE WATER LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE

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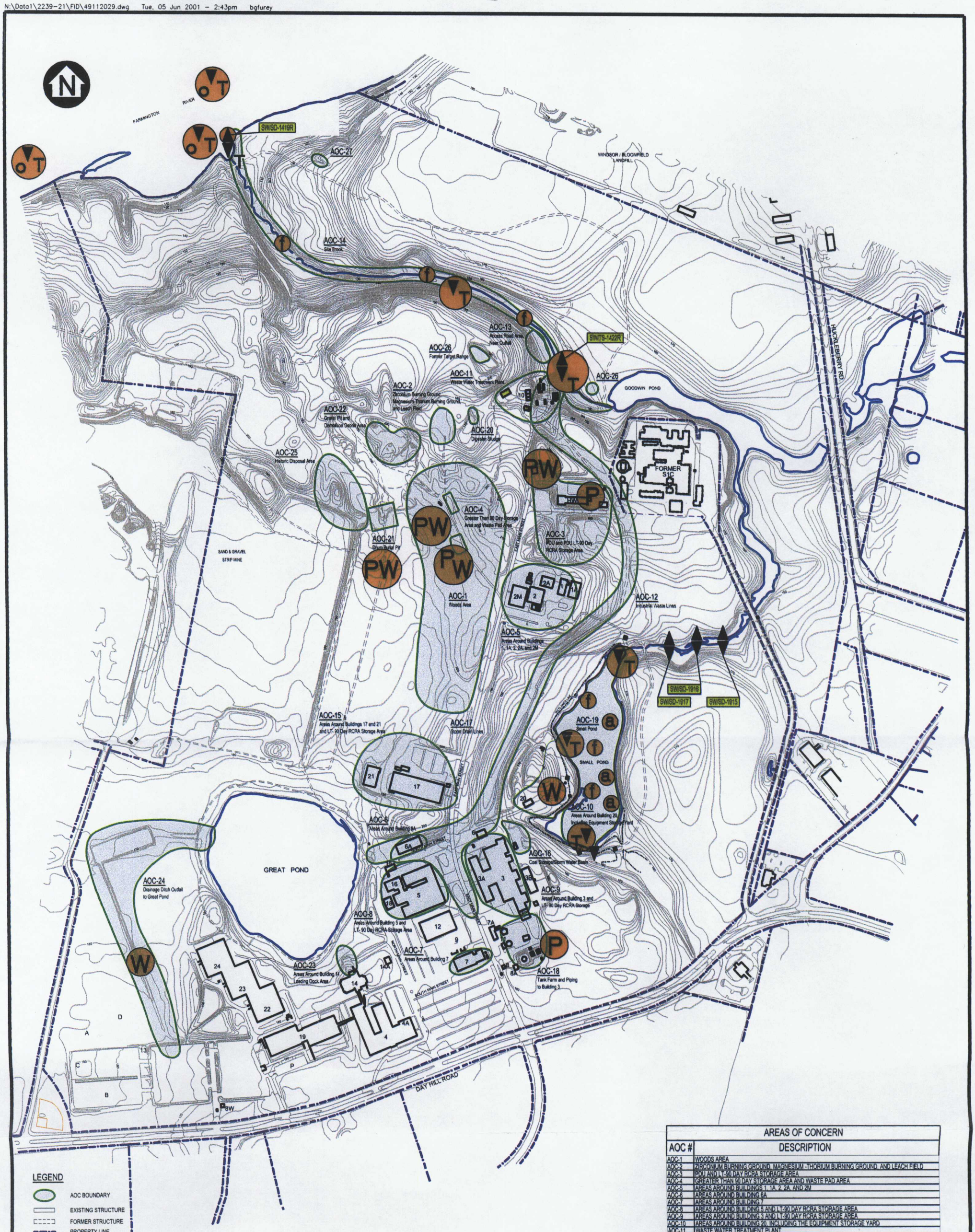

AREAS OF CONCERN	
AOC #	DESCRIPTION
AOC-1	WOODS AREA
AOC-2	ZIRCONIUM BURNING GROUND, MAGNESIUM -THORIUM BURNING GROUND, AND LEACH FIELD
AOC-3	PDU AND LT-90 DAY RCRA STORAGE AREA
AOC-4	GREATER THAN 90 DAY STORAGE AREA AND WASTE PAD AREA
AOC-5	AREAS AROUND BUILDINGS 1, 1A, 2, 2A, AND 2M
AOC-6	AREAS AROUND BUILDING 6A
AOC-7	AREAS AROUND BUILDING 7
AOC-8	AREAS AROUND BUILDING 5 AND LT-90 DAY RCRA STORAGE AREA
AOC-9	AREAS AROUND BUILDING 3 AND LT-90 DAY RCRA STORAGE AREA
AOC-10	AREAS AROUND BUILDING 20, INCLUDING THE EQUIPMENT STORAGE YARD
AOC-11	WASTE WATER TREATMENT PLANT
AOC-12	INDUSTRIAL WASTE LINES
AOC-13	ACCESS ROAD AREA, NEAR OUTFALL
AOC-14	SITE BROOK
AOC-15	AREAS AROUND BUILDINGS 17 AND 21 AND LT-90 DAY RCRA STORAGE AREA
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AOC-17	STORM DRAIN LINES
AOC-18	TANK FARM AND PIPING TO BUILDING 3
AOC-19	SMALL POND
AOC-20	DIGESTER SLUDGE
AOC-21	DRUM BURIAL PIT
AOC-22	GRAVEL PIT AND DEMOLITION DEBRIS AREA
AOC-23	AREAS AROUND BUILDING 14 LOADING DOCK
AOC-24	DRAINAGE DITCH OUTFALL TO GREAT POND
AOC-25	HISTORIC DISPOSAL AREA
AOC-26	FORMER TARGET RANGES
AOC-27	CLAMSHELL WASTE PILE

LEGEND

- AOC BOUNDARY
- EXISTING STRUCTURE
- FORMER STRUCTURE
- PROPERTY LINE
- WATER
- UNIMPROVED ROAD
- GROUND SURFACE CONTOUR (ELEVATION, FEET MSL)
- SURFACE WATER
- SEDIMENT
- T — TOXICITY TEST
- P — PROPOSED PLANT TOXICITY TEST
- W — PROPOSED EARTHWORM TOXICITY TEST
- f — FISH
- a — AMPHIBIAN
- o — OLIGOCHAETE
- SD1906R — PHASE I ACTIVITY
- SD1906R — PHASE II ACTIVITY

0 300 600 1200 FEET

NOTES:

1. BASE MAP PROVIDED BY METROPOLITAN DISTRICT COMMISSION.
2. ALL LOCATIONS ARE APPROXIMATE, NOT TO SCALE.

FIGURE 6
PROPOSED ADDITIONAL SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE

SW/SD1426 SW/SD1427

SW/SD1426 SW/SD1427

(DOWNSTREAM LOCATIONS TO BE FIELD DETERMINED)

SITE KEY PLAN

RIVER

FARMINGTON

SD-1423 SD-1402 SD-1424 SD1424R

SD-1425

SD-1418 SW-1418

SD-1417 SW-1417

SD-1416 SW-1416 SD1416R

SD-1414 SW-1414

SD-1422 (REFERENCE) SD1422R

SD-1415

SD-1403

SW-1401 SD-1401

SW-1419 SD-1419 SW/SD1419R

SD-1404

SD-1405 SD1405R

SD1429

SD1428

TS-1401

SD-1406

SD-1407

SW-1420

SD-1408 SD1408R

SD-1409

SD-1410

TS1422R SW1422

SW-1411 SD-1411

SW-1421 SD-1421

GOODWIN POND

10

EAST MAIN STREET

AOC-14

Site Brook

LEGEND

- AOC BOUNDARY
- EXISTING STRUCTURE
- PROPERTY LINE
- WATER
- UNIMPROVED ROAD
- SURFACE WATER SAMPLE
- SEDIMENT SAMPLE
- PROPOSED SURFACE WATER
- PROPOSED SEDIMENT SAMPLE
- T TOXICITY TEST
- SW1422R PHASE I ACTIVITY
- SD1416R PHASE II ACTIVITY

0 150 300 600

FIGURE 7

AOC 14 - SITE BROOK AND FARMINGTON RIVER
PROPOSED SURFACE WATER AND
SEDIMENT SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE

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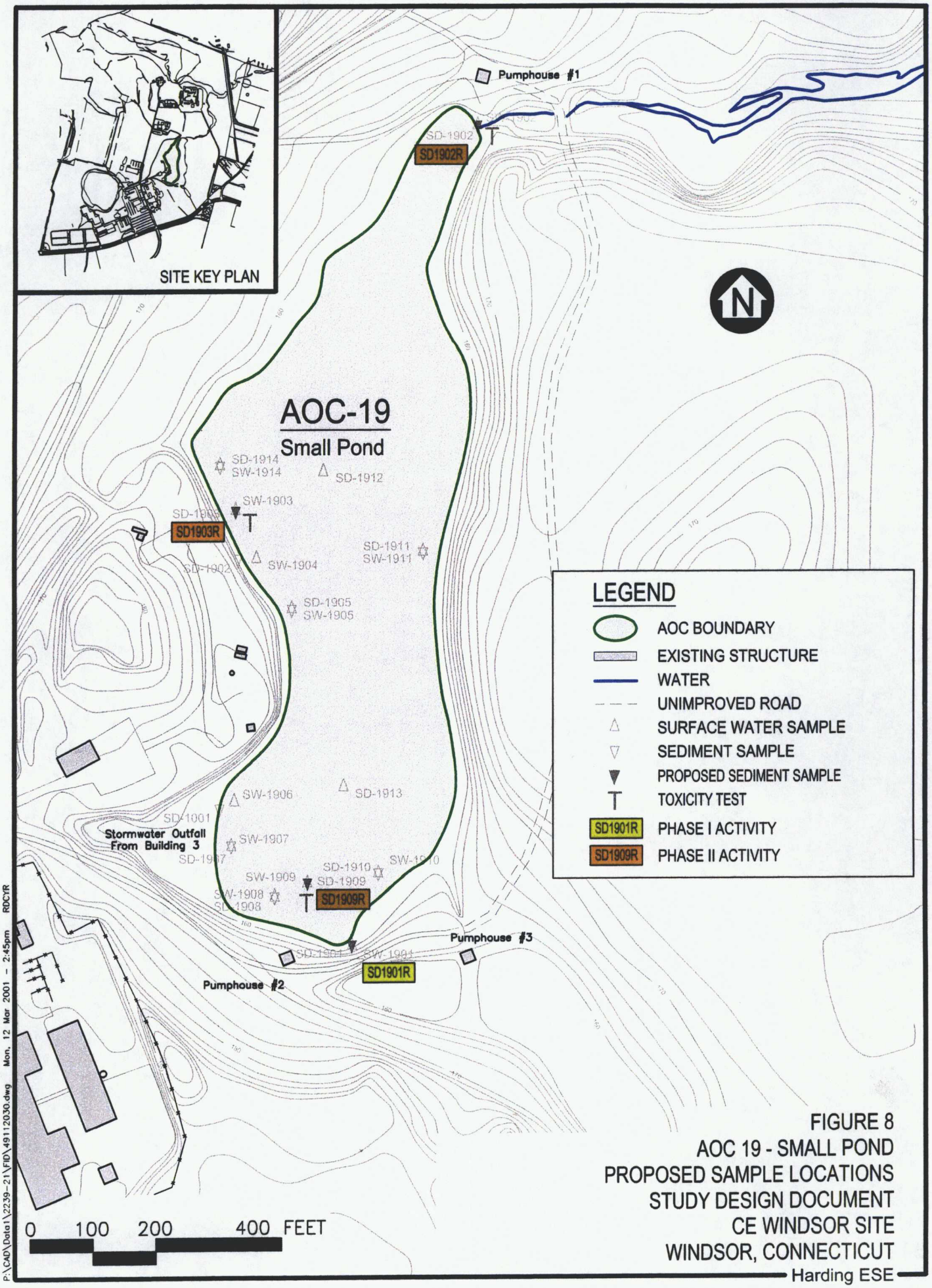


FIGURE 8
AOC 19 - SMALL POND
PROPOSED SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE

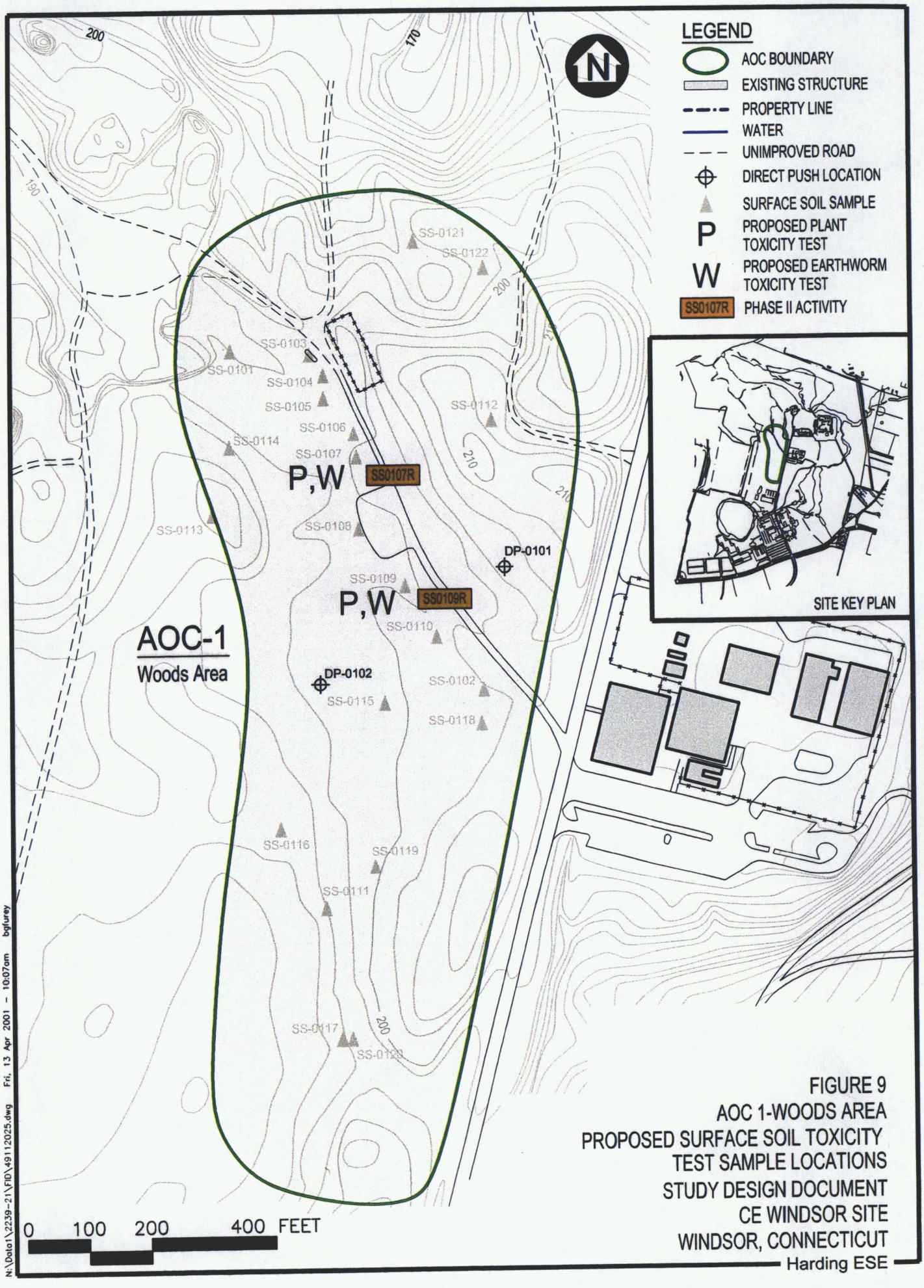


FIGURE 9
AOC 1-WOODS AREA
PROPOSED SURFACE SOIL TOXICITY
TEST SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE

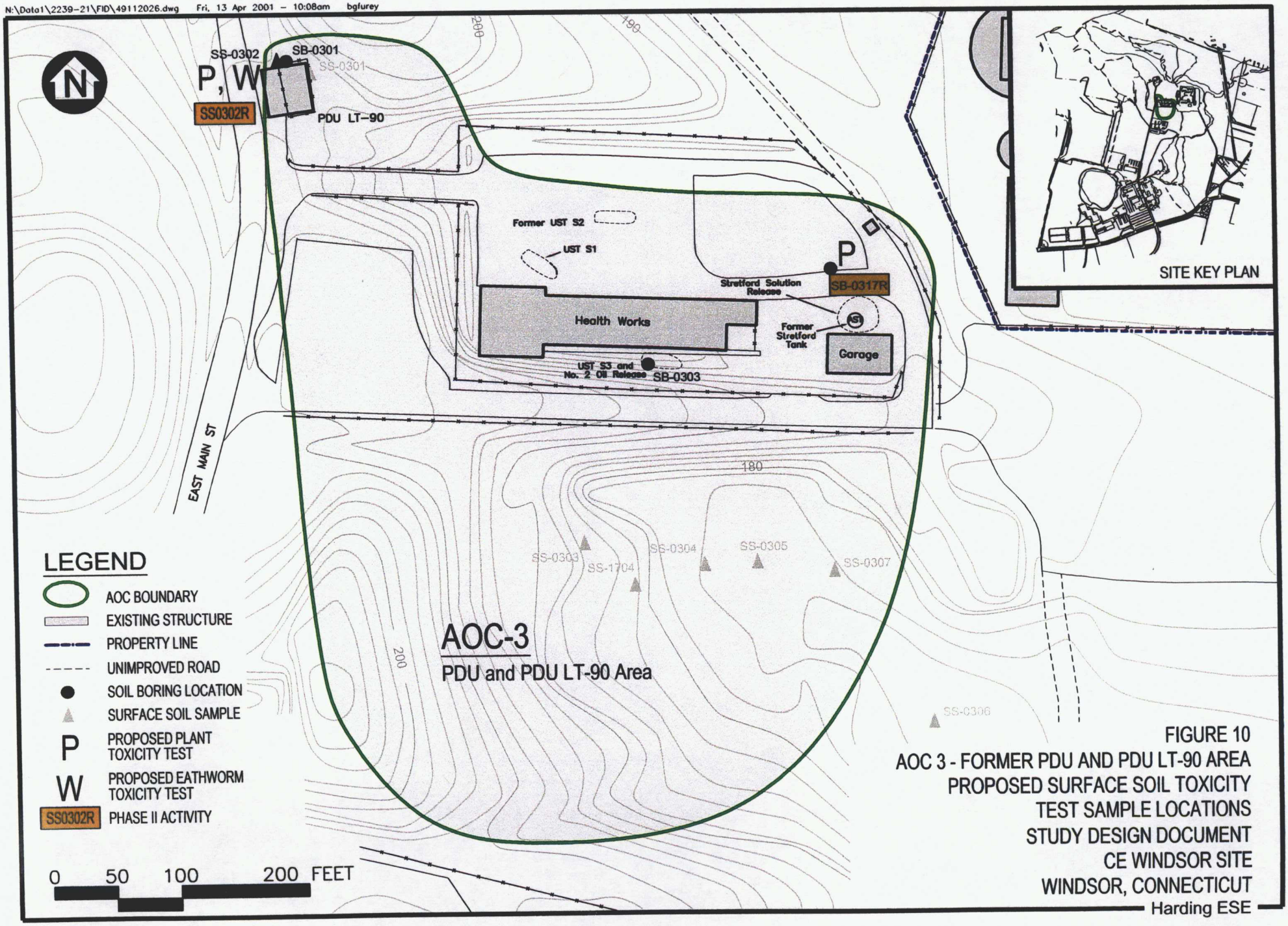
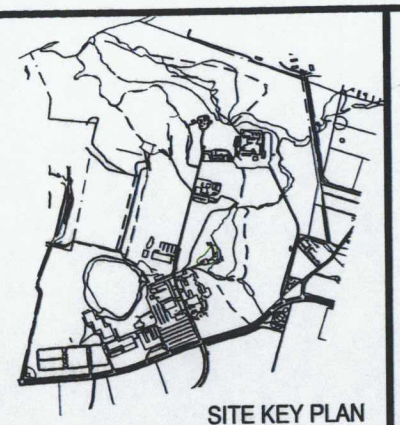


FIGURE 10
AOC 3 - FORMER PDU AND PDU LT-90 AREA
PROPOSED SURFACE SOIL TOXICITY
TEST SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE



SITE KEY PLAN

LEGEND

- AOC BOUNDARY
- EXISTING STRUCTURE
- WATER
- UNIMPROVED ROAD
- SURFACE SOIL SAMPLE
- TEST PIT LOCATION
- W — PROPOSED EARTHWORM TOXICITY TEST
- TP1009R — PHASE II ACTIVITY

AOC-10

Areas Around Building 20, Including Equipment Storage Yard

EAST MAIN STREET

Small Pond

SS-1004
SS-1005
SS-1006
SS-1002
SS-1001
SS-1003

TP-1006
TP-1005
TP-1007
TP-1008
TP-1010
TP-1014
TP-1011
TP-1013
TP-1012

TP-1009
W
TP1009R

Debris Storage

Equipment Storage Yard

Former AST's W1, W2, W3

BUILDING 20

Approximate Location of Dry Well

Vehicle Maintenance

Fire Training Area

BUILDING 6

170
180
160
160

N

0 50 100 200 FEET

FIGURE 11
AOC 10 - AREAS AROUND BUILDING 20
AND THE EQUIPMENT STORAGE YARD
PROPOSED SURFACE SOIL TOXICITY
TEST SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE

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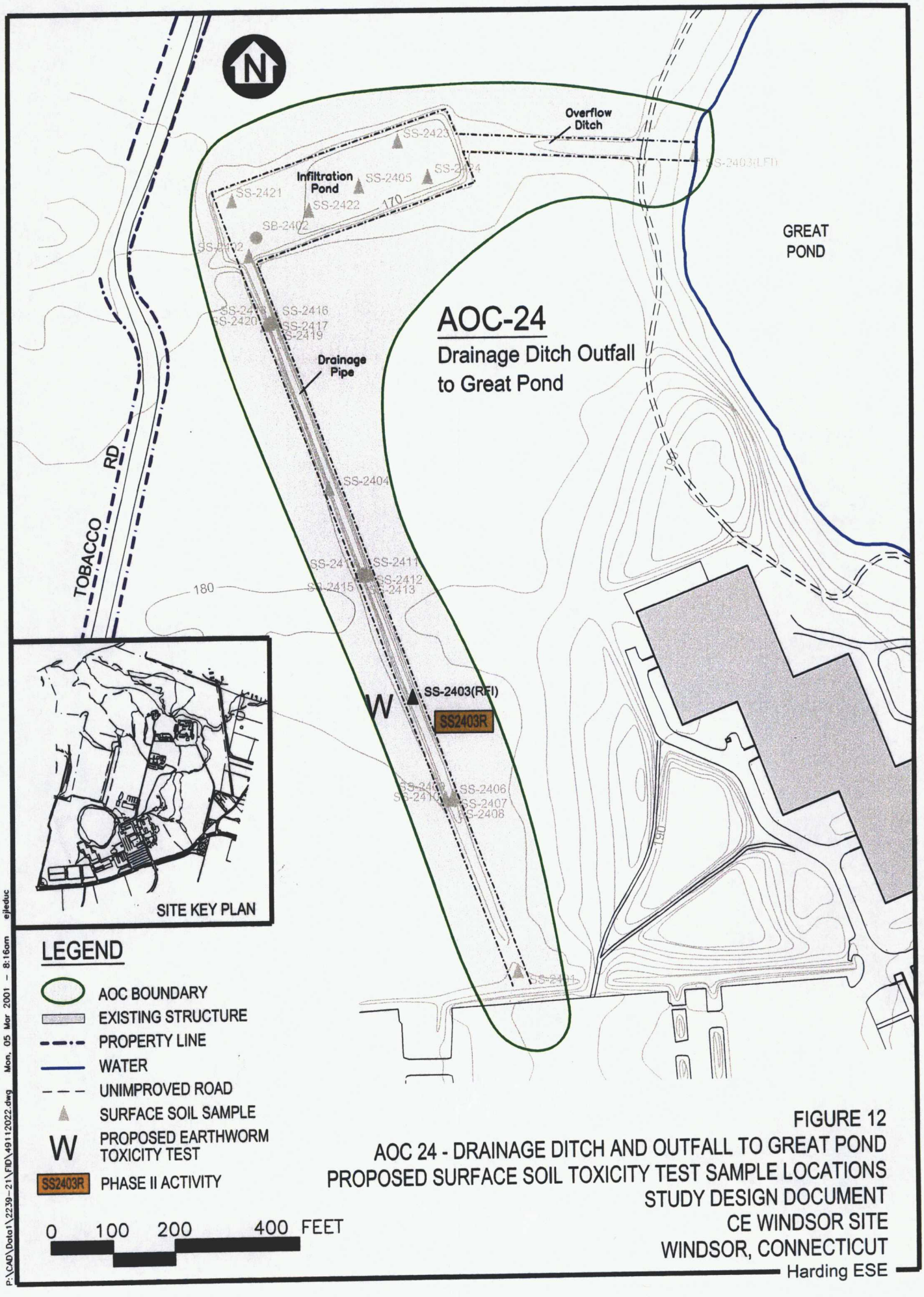

FIGURE 12
AOC 24 - DRAINAGE DITCH AND OUTFALL TO GREAT POND
PROPOSED SURFACE SOIL TOXICITY TEST SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE

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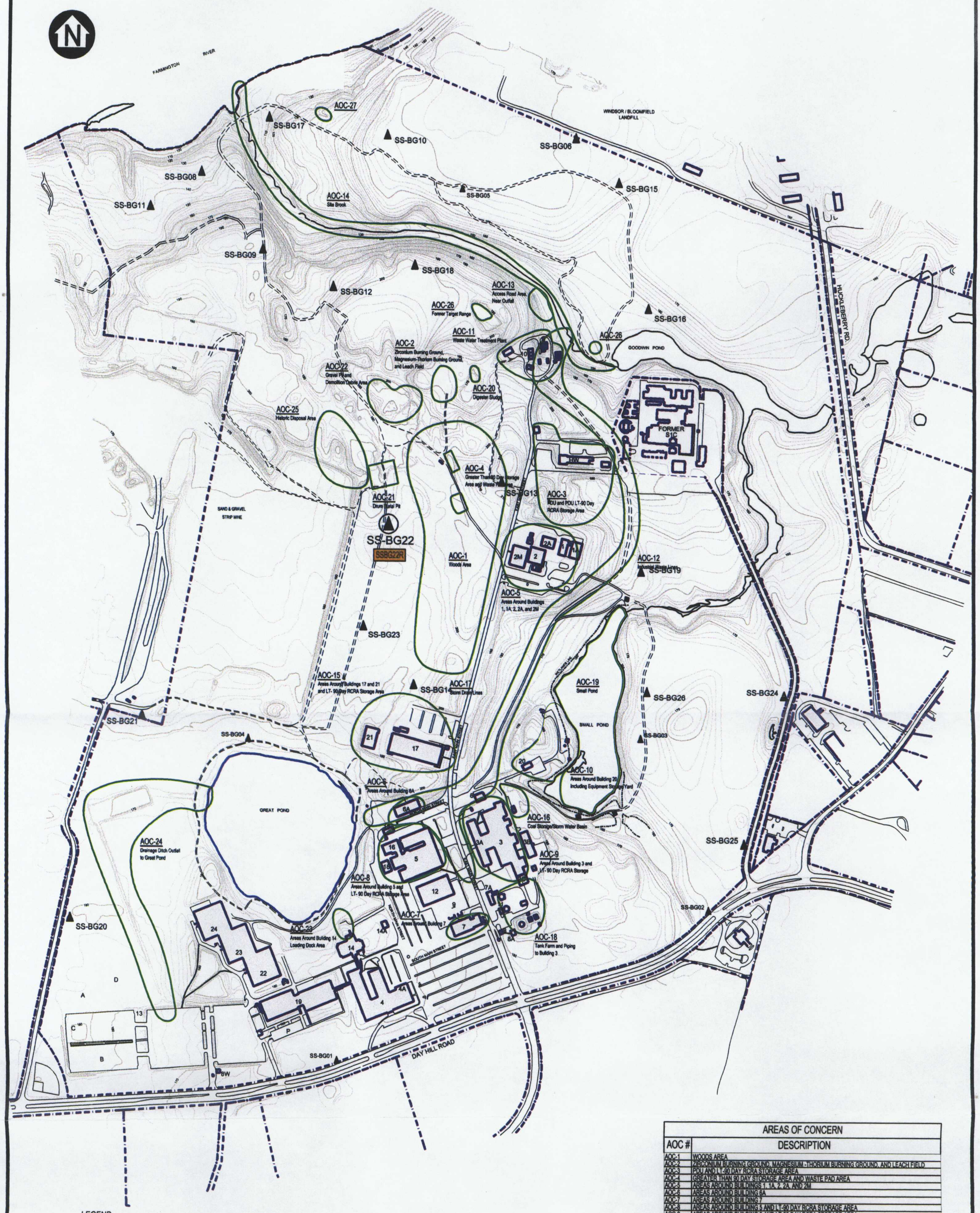

LEGEND

- AOC BOUNDARY
- EXISTING STRUCTURE
- PROPERTY LINE
- WATER
- UNIMPROVED ROAD
- GROUND SURFACE CONTOUR (ELEVATION, FEET MSL)
- SS-BG22 BACKGROUND TOXICITY TEST LOCATION
- LFI SUPPLEMENTAL RFI — BACKGROUND SURFACE SOIL SAMPLE
- SSBG22R PHASE II ACTIVITY

NOTES:

1. BASE MAP PROVIDED BY METROPOLITAN DISTRICT COMMISSION.
2. MONITORING WELL LOCATIONS SURVEYED BY ALFORD ASSOCIATES, AUGUST 1998 AND NOVEMBER 1999, MESSIER & ASSOCIATES, JUNE 1999, AND FUSS AND O'NEILL, JULY 1999 AND JANUARY 2000.
3. ALL SAMPLING LOCATIONS (EXCEPT FOR MONITORING WELLS) SURVEYED BY HARDING LAWSON ASSOCIATES USING GLOBAL POSITIONING SYSTEM, AUGUST 1998.

0 150 300 600 FEET

AREAS OF CONCERN	
AOC #	DESCRIPTION
AOC-1	WOODS AREA
AOC-2	ZIRCONIUM BURNING GROUND, MAGNESIUM -THORIUM BURNING GROUND, AND LEACH FIELD
AOC-3	IDU AND LT-90 DAY RCRA STORAGE AREA
AOC-4	GREATER THAN 90 DAY STORAGE AREA AND WASTE PAD AREA
AOC-5	AREAS AROUND BUILDINGS 1, 1A, 2, 2A, AND 2M
AOC-6	AREAS AROUND BUILDING 6A
AOC-7	AREAS AROUND BUILDING 7
AOC-8	AREAS AROUND BUILDING 5 AND LT-90 DAY RCRA STORAGE AREA
AOC-9	AREAS AROUND BUILDING 3 AND LT-90 DAY RCRA STORAGE AREA
AOC-10	AREAS AROUND BUILDING 20, INCLUDING THE EQUIPMENT STORAGE YARD
AOC-11	WASTE WATER TREATMENT PLANT
AOC-12	INDUSTRIAL WASTE LINES
AOC-13	ACCESS ROAD AREA, NEAR OUTFALL
AOC-14	SITE BROOK
AOC-15	AREAS AROUND BUILDINGS 17 AND 21 AND LT-90 DAY RCRA STORAGE AREA
AOC-16	COAL STORAGE AND STORM WATER BASIN
AOC-17	STORM DRAIN LINES
AOC-18	TANK FARM AND PIPING TO BUILDING 3
AOC-19	SMALL POND
AOC-20	DIGESTER SLUDGE
AOC-21	DRUM BURIAL PIT
AOC-22	GRAVEL PIT AND DEMOLITION DEBRIS AREA
AOC-23	AREAS AROUND BUILDING 14 LOADING DOCK
AOC-24	DRAINAGE DITCH OUTFALL TO GREAT POND
AOC-25	HISTORIC DISPOSAL AREA
AOC-26	FORMER TARGET RANGES
AOC-27	CLAMSHELL WASTE PILE

FIGURE 13
BACKGROUND SURFACE SOIL SAMPLE LOCATION FOR TOXICITY TESTS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE

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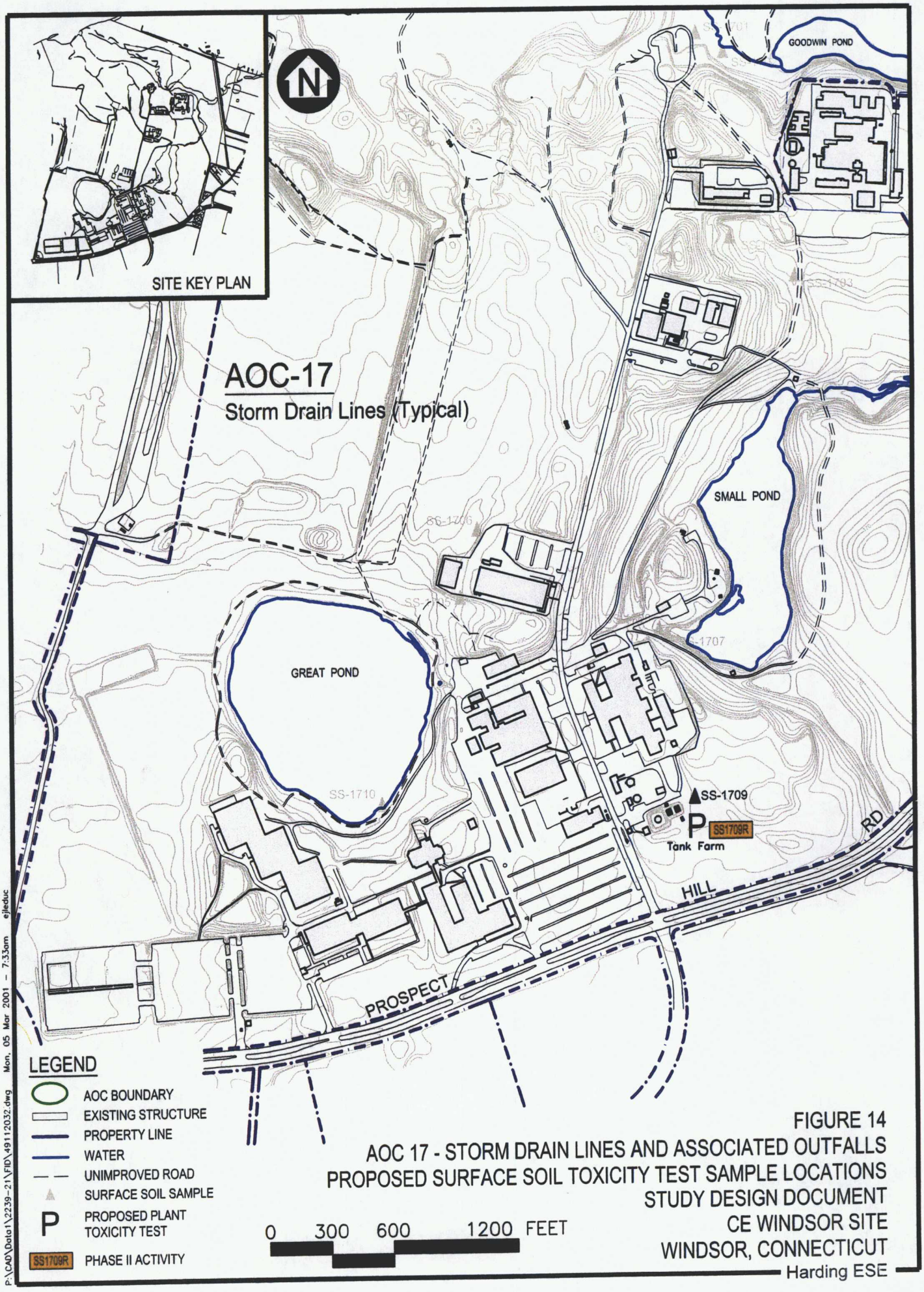

FIGURE 14
AOC 17 - STORM DRAIN LINES AND ASSOCIATED OUTFALLS
PROPOSED SURFACE SOIL TOXICITY TEST SAMPLE LOCATIONS
STUDY DESIGN DOCUMENT
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding ESE

TABLES

TABLE 1
SURFACE SOIL SAMPLING OBJECTIVES

Study Design
CE Windsor Site
Windsor, Connecticut

Activity	Objective	Locations	Rationale
PHASE I			
No sampling needed			
PHASE 2			
Collect surface soil samples for toxicity testing using earthworm *Eisenia foetida*	Obtain site-specific invertebrate toxicity data to address uncertainties regarding COC bioavailabililty and toxicity in soil	SS0107 SS0109 SS0302 TP1009 SS2403(RFI) SSBG22	elevated Cr elevated Cu; Zn elevated Zn elevated PAHs elevated PAHs background
Collect surface soil samples for toxicity testing using lettuce seed *Lactuca sativa*	Obtain site-specific plant toxicity data to address uncertainties regarding COC bioavailabililty and toxicity in soil	SS0107 SS0109 SS0302 SB0317 SS1709 SSBG22	elevated Cr elevated Cu, Pb, Zn elevated Zn elevated B elevated V background

TABLE 2
SURFACE WATER SAMPLING OBJECTIVES

Study Design
CE Windsor Site
Windsor, Connecticut

Activity	Objective	Locations	Rationale
PHASE I			
Collect background/upgradient surface water samples	Obtain background data from 2 different habitat types	TBD; 5 Pond 5 Stream	Characterize filtered/unfiltered metals concentrations typical of non-impacted portions of the site.
Collect surface water samples from unnamed tributary to Goodwin Pond	Collect samples for chemical analysis	3 samples between outlet of Small Pond and KAPL access road	Evaluate potential migration of COCs into Goodwin Pond from Small Pond
Collect surface water samples from Site brook for CN analysis	Collect samples for cyanide analysis from upstream and downstream locations in Site brook	TS-1422 SD-1419	Characterize cyanide occurrence in Site brook; samples will correspond with sediment sample locations - Near Goodwin Pond and outfalls - Near mouth of Site brook
PHASE 2			
Collect surface water samples from Farmington River	Collect samples from the Farmington River upstream and downstream from the Site	2 upstream in vicinity of SD-1422 2 downstream of SD-1425	Charcterize upstream and downstream concentrations of COCs in Farmington River
Collect surface water samples for toxicity testing using freshwater invertebrate (*Ceriodaphnia dubia*)	Obtain surface water toxicity data from the site	TBD	Obtain site-specific indication of surface water toxicity and determine if toxicity is attributable to site-related COCs.

TBD - to be determined based on outcome of background evaluation.

TABLE 3
SEDIMENT SAMPLING OBJECTIVES

Study Design
CE Windsor Site
Windsor, Connecticut

Activity	Objective	Locations	Rationale
PHASE I			
Collect background/upgradient sediment samples	Obtain background data from 2 different habitat types	TBD; 5 Pond 5 Stream	Characterize metals concentrations typical of non-impacted portions of the site
Re-collect sediment sample at SD-1901 for AVS:SEM analysis	Obtain AVS:SEM data	SD-1901 (Small Pond)	1999 sample had a potential sampling artifact
Collect sediment samples from unnamed tributary to Goodwin Pond	Collect samples for chemical analysis	3 samples between outlet of Small Pond and KAPL access road	Evaluate potential migration of COCs into Goodwin Pond from Small Pond
Collect sediment samples from Site Brook for CN analysis	Collect samples for cyanide analysis from upstream and downstream locations in Site brook	TS-1422 SD-1419	Characterize cyanide occurrence in Site brook. - Near Goodwin Pond and outfalls - Near mouth of Site brook
PHASE 2			
Collect sediment samples from Farmington River	Collect samples from the Farminton River upstream and downstream from the Site	2 upstream in vicinity of SD-1422 2 downstream of SD-1425	Characterize upstream and downstream concentrations of COCs in Farmington River
Collect sediment samples for toxicity testing using freshwater invertebrate	Obtain sediment toxicity data from the site	<u>Small Pond</u> SD-1909 SD-1903 SD-1902 <u>Site Brook</u> TS-1422 SD-1408 SD-1405 <u>Farmington River</u> SD-1422 SD-1416 SD-1424	Obtain site-specific indication of sediment toxicity and determine if toxicity is attributable to site-related COCs: elevated Cu, Hg, and PAHs western side of Small Pond elevated PAHs Near Goodwin Pond and outfalls Midway between Goodwin Pond and Farmington River; elevated Cu, Hg, Zn Near mouth of Site brook; elevated Cu, Hg, Zn Upstream Beyond Site brook;Elevated Ag Downstream of Site brook; Elevated Cd, Zn
Collect sediment samples for laboratory bioaccumulation/toxicity testing using freshwater oligochaete (*Lumbriculus variegatus*)	Obtain sediment toxicity data from the Site.	Farmington River; same locations as above	Obtain site-specific indication of bioavailability and toxicity of contaminants in river sediment.

Metals analysis should include TAL metals and zirconium

TABLE 4
BIOLOGICAL TISSUE SAMPLING OBJECTIVES

Study Design
CE Windsor Site
Windsor, Connecticut

Activity	Objective	Locations	Organism	Rationale
PHASE 1				
No tissue samples proposed				
PHASE 2				
Tissue data from earthworm toxicity test	Obtain site-specific tissue levels	TBD; 3 samples	Earthworms from the toxicity tests	Evaluate food chain risks
Collect fish/amphibian tissue samples	Obtain site-specific tissue data	Small Pond	3 fish, 3 amphibians	Evaluate food chain risks. Type of organism collected will depend upon habitat; availability
		Site Brook	3 fish/amphibians	Evaluate food chain risks. Type of organism collected will depend upon habitat; availability
Tissue data from oligochaete bioaccumulation test	Obtain biological tissue data associated with exposure to contaminants in Farmington River	Farm. River	TBD; 3 composite oligochaete from bioaccumulation test	Evaluate food chain risks. ***Will be conducted only if foodchain sensitivity analysis indicates bioaccumulation is the most important contributor to semiaquatic wildlife exposure***

TABLE 5
ECOLOGICAL RISK ASSESSMENT ENDPOINTS

Study Design
CE Windsor Site
Windsor, Connecticut

Medium	Primary COCs	Receptor (Exposure Pathway)	Assessment Endpoint	Measurement Endpoint
TERRESTRIAL AOCs				
Surface Soil	PAHs, inorganics	Terrestrial plants (direct contact, root uptake)	Protection and maintenance of terrestrial plant populations	14-d lettuce seedling survival and weight gain.
Surface Soil	PAHs, inorganics	Soil invertebrates (direct contact – oral and dermal uptake)	Maintenance of soil invertebrate prey base	28-d earthworm toxicity (survival, weight gain, and cocoon production).
Surface Soil	PAHs, inorganics	Wildlife (incidental soil ingestion; consumption of contaminated prey)	Protection and maintenance of small mammals and bird populations	Comparison of estimated oral exposure doses to oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
SMALL POND				
Surface Water	Mercury, other inorganics	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Comparison of surface water chemistry with literature-based surface water toxicological benchmarks. Laboratory 3-brood survival/reproduction *C. dubia* toxicity tests.
Surface Water	Mercury	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses to oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
Sediment	PAHs, pesticides, copper, mercury	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Comparison of sediment chemistry with literature-based sediment toxicological benchmarks. Laboratory 10-d survival/growth amphipod toxicity tests.

TABLE 5
ECOLOGICAL RISK ASSESSMENT ENDPOINTS

Study Design
CE Windsor Site
Windsor, Connecticut

Medium	Primary COCs	Receptor (Exposure Pathway)	Assessment Endpoint	Measurement Endpoint
SMALL POND (Continued)				
Sediment	Pesticides, mercury	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses to oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
SITE BROOK				
Surface Water	Inorganics	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Comparison of surface water chemistry with literature-based surface water toxicological benchmarks. Laboratory 3-brood survival/reproduction *C. dubia* toxicity tests.
Surface Water	Inorganics	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses to oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
Sediment	PAHs, PCBs, inorganics	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Laboratory 10-d survival/growth amphipod toxicity tests; comparison of sediment chemistry with literature-based sediment toxicological benchmarks.
Sediment	PCBs, mercury	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
FARMINGTON RIVER				

TABLE 5
ECOLOGICAL RISK ASSESSMENT ENDPOINTS

Study Design
CE Windsor Site
Windsor, Connecticut

Medium	Primary COCs	Receptor (Exposure Pathway)	Assessment Endpoint	Measurement Endpoint
Surface Water	Inorganics	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Comparison of surface water chemistry with literature-based surface water toxicological benchmarks. Laboratory 3-brood survival/reproduction *C. dubia* toxicity tests.
FARMINGTON RIVER (Continued)				
Surface Water	Inorganics	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses to oral threshold effect doses derived from published studies reporting adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
Sediment	PAHs, cadmium, silver	Aquatic Receptors	Protection and maintenance of invertebrate, amphibian, and fish populations	Laboratory 10-d survival/growth amphipod toxicity tests; comparison of sediment chemistry with literature-based sediment toxicological benchmarks.
Sediment	Cadmium	Semi-Aquatic Wildlife (consumption of contaminated prey)	Protection and maintenance of semi-aquatic wildlife populations	Comparison of estimated oral exposure doses to oral threshold effect doses based on measured adverse effects on survival, growth, or reproduction of mammalian or avian laboratory test organisms.
Sediment	PAHs, cadmium, silver	Rare, Threatened, or Endangered species – Atlantic salmon and eastern pond mussel	Protection of individuals of these species	Extrapolation of results of toxicity tests and tissue data

APPENDIX A

APPENDIX A-1

SAMPLING AND ANALYSIS PROGRAM

TABLE A-1
SURFACE SOIL SAMPLING AND ANALYSIS PROGRAM

Study Design
CE Windsor Site
Windsor, Connecticut

APPENDIX A - SAMPLE LABELS AND PARAMETERS

Surface Soil

Location	Sample ID	PAHs	Pesticide/ PCBs	Metals	TOC	Dupl	MS	MSD	Earthworm Toxicity Test	Plant Toxicity Test
									(1 L)	(1 L)
Phase I										
No phase I surface soil samples proposed										
Phase II										
SS0107	SS010700R	X		X	X				X	X
SS0109	SS010900R	X		X	X				X	X
SS0302	SS030200R	X		X	X				X	X
SB0317	SB0317R	X		X	X					X
TP1009	TP100900R	X		X	X				X	
SS1709	SS170900R	X		X	X					X
SS2403 (RFI)	SS240300R	X		X	X	X	X	X	X	
SSBG22	SSBG2200R	X		X	X				X	X

TABLE A-2
SURFACE WATER SAMPLING AND ANALYSIS PROGRAM

Study Design
CE Windsor Site
Windsor, Connecticut

APPENDIX A - SAMPLE LABELS AND PARAMETERS

Surface Water

Location	Sample ID	VOCs	PAHs	Pesticide/ PCBs	Metals		Cyanide		Hardness	Dupl	MS	MSD	Toxicity Test
					Filtered	Unfiltered	Total	Amenable					(1 L)
Phase I													
Background Pond	SWBG01		X		X	X			X				
	SWBG02		X		X	X			X				
	SWBG03		X		X	X			X				
	SWBG04		X		X	X			X				
	SWBG05		X		X	X			X				
Background Stream	SWBG06		X		X	X			X	X	X	X	
	SWBG07		X		X	X			X				
	SWBG08		X		X	X			X				
	SWBG09		X		X	X			X				
	SWBG10		X		X	X			X				
Unnamed Tributary to Goodwin Pond	SW1915		X		X	X			X				
	SW1916		X		X	X			X				
	SW1917		X		X	X			X				
Site brook SW1419	SW1419R						X	X					
SW1422	SW1422						X	X					
Phase II													
Farmington River	SW1426	X			X	X			X				
	SW1427	X			X	X			X				
	SW1428	X			X	X			X				
	SW1429	X			X	X			X				
C.dubia toxicity test	TBD												

TBD = To Be Determined. Necessity for and location of surface water toxicity tests to be determined based on outcome of Phase I evaluation.

TABLE A-3
SEDIMENT SAMPLING AND ANALYSIS PROGRAM

Study Design
CE Windsor Site
Windsor, Connecticut

APPENDIX A - SAMPLE LABELS AND PARAMETERS

Sediment

Location	2001 Sample ID	VOCs	PAHs	Pesticides	PCBs	Metals	Methyl Mercury	Cyanide	sem:avs	TOC	Dupl	MS	MSD	Hyalella Toxicity Test (1 L)	Lumbriculus Bioaccumulation Test (1 L)
Phase I															
Background Pond	SDBG0100		X			X			X	X	X	X	X		
	SDBG0200		X			X			X	X					
	SDBG0300		X			X			X	X					
	SDBG0400		X			X			X	X					
	SDBG0500		X			X			X	X					
Background Stream	SDBG0600		X			X			X	X					
	SDBG0700		X			X			X	X					
	SDBG0800		X			X			X	X					
	SDBG0900		X			X			X	X					
	SDBG1000		X			X			X	X					
SD1901	SD190100R								X						
Unnamed Tributary to Goodwin Pond	SD191500		X	X	X	X			X	X					
	SD191600		X	X	X	X			X	X					
	SD191700		X	X	X	X			X	X					
Site brook SD1419	SD141900R							X							
TS1422	TS142200R							X							
Phase II															
Small Pond	SD190900R		X	X	X	X	X				X	X	X	X	
	SD190300R		X	X	X	X								X	
	SD190200R		X	X	X	X								X	
Site brook	TS142200R		X	X	X	X								X	
	SD140800R		X	X	X	X								X	
	SD140500R		X	X	X	X								X	
Farmington River	SD142200R		X		X	X								X	TBD*
	SD141600R		X		X	X								X	TBD*
	SD142400R		X		X	X									
	SD142600	X	X	X	X	X			X	X					
	SD142700	X	X	X	X	X			X	X					
	SD142800	X	X	X	X	X			X	X					
	SD142900	X	X	X	X	X			X	X				X	TBD*

* To Be Determined based on outcome of Phase I evaluation.

TABLE A-4
BIOLOGICAL TISSUE SAMPLING AND ANALYSIS PROGRAM

Study Design
CE Windsor Site
Windsor, Connecticut

APPENDIX A - SAMPLE LABELS AND PARAMETERS

Biological Tissue

Tissue Sample ID	Organism	Field or Laboratory (F/L)?	PAHs	Pesticides	PCBs	Metals	Mercury	Methyl mercury	% Lipid	Dupl	MS	MSD
Terrestrial[1]												
EW_____	earthworm	L	X			X						
EW_____	earthworm	L	X			X						
EW_____	earthworm	L	X			X						
Aquatic												
Small Pond:												
FI1901	fish	F		X	X		X	X	X	X	X	X
FI1902	fish	F		X	X		X	X	X			
FI1903	fish	F		X	X		X	X	X			
AM1901	amphibian	F		X	X		X	X	X			
AM1902	amphibian	F		X	X		X	X	X			
AM1903	amphibian	F		X	X		X	X	X			
Site Brook[2]:												
FI1401	fish	F		X	X		X		X			
FI1402	fish	F		X	X		X		X			
FI1403	fish	F		X	X		X		X			
Farmington River[3]*:*												
OG1401	*oligochaete*	*L*		*X*	*X*	*X*						
OG1402	*oligochaete*	*L*		*X*	*X*	*X*						
OG1403	*oligochaete*	*L*		*X*	*X*	*X*						

TABLE A-4
BIOLOGICAL TISSUE SAMPLING AND ANALYSIS PROGRAM

Study Design
CE Windsor Site
Windsor, Connecticut

NOTES:

Tissue samples will be labeled as follows:

EW Earthworm
FI Fish
AM Amphibian (frog or salamander)

Plant and Earthworm Tissue samples will be assigned the same number as the soil sample ID. (e.g., if from SS0107, will be called EW0107 and/or PL0107).

Fish and Amphibian Tissue samples will be assigned a number to reflect the AOC (14 or 19). (e.g., fish from Small Pond will be labeled FI1901through 1903, amphibians from Small Pond will be labeled AM1901, etc.)

1 No plant tissue samples are currently planned. If Phase I surface soil results indicate necessary, plant tissue samples will be analyzed and labeled accordingly.

2 Organism type for samples in the Site brook will be determined based on availability; fish will be collected from the Site brook if available.

3 Oligochaete bioaccumulation test/tissue analysis to be determined based on outcome of Phase I evaluation.

APPENDIX A-2

EXCERPTS FROM THE QUALITY ASSURANCE PROJECT PLAN

QAPP Insert – June 2001

In response to USEPA comments received 5/24/01, the following insert is provided:

Surface water (see p. 4-40 for additional direction):

1. Surface water samples are collected by immersing a capped sampled container into the surface water body and uncapping the container once it is submerged.

2. For samples with preservatives, or if the surface water body is too shallow to submerse the container, samples will be collected using a secondary vessel and transferring by gently pouring to the sample jar.

3. Collection depth for all samples will be recorded on the Field Data Record (see Figure 4-4).

Sediment (see p. 4-40 for additional direction)

1. Unless otherwise specified, grab or composite samples will be obtained from the surface (upper 10 cm) of the sediment.

2. Collection depth for all samples will be recorded on the Field Data Record (see Figure 4-4).

COPY

Quality Assurance Project Plan
RCRA Voluntary Corrective Action

Volume I of II

CE Windsor Site
2000 Day Hill Road
Windsor, Connecticut 06095

Prepared for:

Combustion Engineering, Inc.
2000 Day Hill Road
Windsor Connecticut 06095

Prepared by:

Harding Lawson Associates
511 Congress Street
Portland, Maine 04112

August 1999

HLA

4.1.3 Special Sampling and Analytical Requirements

4.1.3.1 Sampling. Some samples will be collected from known or suspected areas of radiological contamination. Therefore, provisions for the ALARA philosophy and the intent of CE's RPP have been included in this QAPP. Radiological field screening methods will be employed for health and safety purposes, and may be found in the Site's HASP (HLA, 1998b.).

4.1.3.2 Analytical. In addition to the environmental sampling requirements mentioned throughout the QAPP and Site Work Plans, environmental samples collected for chemical analysis from AOCs which are known or suspected to be impacted with low level radioactive residues will also be submitted for on-site radiochemistry analysis. For aqueous samples, an additional aliquot of sample will be collected from each location that is scheduled for chemical analysis. This additional aqueous aliquot and all soil samples will be sent to the on-site CE radiochemistry laboratory where they will undergo radiation screening to determine whether samples can be shipped off-site. If sample containers are found to exceed CE's NRC license for loose surface release limits, they will be decontaminated in accordance with CE's RPP procedures. Furthermore, in accordance with CE's NRC license, if sample containers cannot be decontaminated or re-packaged so that radiation activity is below loose surface release limits, samples will not be shipped off-site. Otherwise, samples will be sent to an off-site testing laboratory capable of receiving low-level radiological materials. Samples with detectable levels of radiation activity will be documented both in accordance with CE's RPP and noted on the chain-of-custody documentation.

4.2 SAMPLE CONTAINERS

HLA will acquire sample containers directly from the laboratory contracted to conduct the sample analyses for the Site. Sample containers will be I-Chem 300 Series, or the equivalent, which are cleaned for the specific analyses according to USEPA specifications and each lot is analyzed to document cleanliness. Immediately after sample collection, sample containers will be maintained at 4°C. Sample containers will be shipped to the analytical testing laboratory within 48 hours of sample collection. Sample container specifications are located in Table 4-2.

4.3 SAMPLE SITE LOCATION

The rationale and purpose of each sample site location will be identified in relevant site work plans. To permit proper evaluation of the sample analysis results, it is important that the actual location of the samples be properly documented. A CT- licensed surveyor will survey monitoring well locations for horizontal and vertical location. If possible, sample locations will be marked in the field with stakes or flagging. All sample site locations will be recorded using a Global Positioning System (GPS) unit and accurately identified on the base map. Photographs of sample locations may be taken to document Site conditions.

To maintain consistency and comparability of sample location identification throughout the course of the VCA program, samples will be labeled by sample type, AOC No., and exploration location. Sample types are described below:

TABLE 4-2
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME REQUIREMENTS[1]

Quality Assurance Project Plan
CE Windsor Site
Windsor, Connecticut

PARAMETER	MATRIX	CONTAINER	PRESERVATIVE	HOLDING TIME
Volatile Organics (plus TICs)	Aqueous	2, 40 ml G vials with Teflon-lined septa	2 drops HCλ; cool 4°C;	14 days. If not preserved, aromatic compounds must be analyzed within 7 days.
	Solid	4 oz. G with Teflon-lined septa	20 ml P&T methanol Cool 4°C	14 days
Semivolatile Organics (plus TICs)	Aqueous	2, 1000 ml amber G, Teflon-lined lid	Cool, 4°C	Extract within 7 days, analyze within 40 days.
	Solid	4 oz. Soil Jar, Teflon-lined lid	Cool, 4°C	Extract within 14 days, analyze within 40 days.
Metals	Aqueous	500 ml P, G.	HNO_3 to pH <2; Cool, 4°C	6 months
	Solid	4 oz. Soil Jar	Cool, 4°C	6 months
Mercury	Aqueous	250 ml P, G	HNO_3 to pH <2; Cool, 4°C	28 days
	Solid	Same 4 oz. Soil Jar (as for metals)	Cool, 4°C	28 days
Hexavalent Chromium	Solid	Same 4 oz. Soil Jar (as for metals)	Cool, 4°C	Extract within 14 days, analyze within 24 hours.
Cyanide	Aqueous	1000 ml P, G.	NaOH to pH >12, Cool, 4°C	14 days
	Solid	Same 4 oz. Soil Jar (in conjunction with metals)	Cool, 4°C	14 days

continued

TABLE 4-2
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME REQUIREMENTS[1]

Quality Assurance Project Plan
CE Windsor Site
Windsor, Connecticut

PARAMETER	MATRIX	CONTAINER	PRESERVATIVE	HOLDING TIME
Wet Chemistry Parameters				
Total Organic Carbon	Aqueous	2-40 ml vials	H2SO4 to pH <2; Cool, 4°C	28 days
Sulfide	Aqueous	400 ml G	Cool, 4°C, 2 ml ZnAc, NaOH to pH>9	7 days
AVS:SEM	Solid	Sealed air-tight cores or 4 oz. Soil jar (wide mouth with Teflon-lined lid) under inert gas (nitrogen or argon)	Cool, 4°C	14 days
PCBs/Pesticides/Herbicides (one set of bottles for EACH parameter)	Aqueous	2-1000 ml Amber G	Cool, 4°C	Extract within 7 days, Analyze within 40 days
	Solid	4 oz. Soil Jar	Cool, 4°C	Extract within 14 days, Analyze within 40 days
Total Petroleum Hydrocarbons (TPH)	Aqueous	2-1000 ml Amber G	H_2SO_4 to pH <2; Cool 4°C	28 days
	Solid	4 oz. Soil Jar	Cool, 4°C	Extract within 14 days, Analyze within 40 days
TCLP Extraction				
Volatile Organics	Solid	300 g – Soil Jar	Cool, 4°C	14 days *
Metals, Extractable Organics	Solid	300 g – Soil Jar	Cool, 4°C	7 days *
Metals Only	Solid	200 g – Soil Jar	Cool, 4°C	28 days*

continued

TABLE 4-2
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME REQUIREMENTS[1]

Quality Assurance Project Plan
CE Windsor Site
Windsor, Connecticut

PARAMETER	MATRIX	CONTAINER	PRESERVATIVE	HOLDING TIME
SPLP Extraction				
Metals	Solid	200 g – Soil Jar	Cool, 4°C	28 days *
PCBs	Solid	200 g – Soil Jar	Cool, 4°C	7 days *
Cyanide	Solid	100 g – Soil Jar	Cool, 4°C	14 days *

Notes:

[1]Requirements according to USEPA SW-846, December 1996. Bottle size may vary depending upon laboratory availability.
[2]Samples may be filtered through 0.45 µm membrane filter prior to preservation for dissolved analysis, depending on site conditions.

P = Polyethylene
G = Glass
HCλ = hydrochloric acid
HNO_3 = nitric acid
NaOH = sodium hydroxide
* = Holding time refers to extraction procedure only.

TICs = Tentatively Identified Compounds
ZnAc/L = zinc acetate per liter
P&T = purge and trap grade
H_2SO_4 = sulfuric acid
AVS:SEM = Acid Volatile Sulfide: Simultaneously Extractable Metals

Sample Type	Sample Prefix Identification
surface soil	SS
direct push soil	DP
soil boring (SB) and associated groundwater grab (GW)	SB, GW
test pit soil	TP
groundwater obtained from monitoring well	MW
groundwater obtained from a temporary well point	WP
surface water	SW
sediment	SD
sediment obtained from a transect location	TS
excavated soil	EX
soil sample taken beneath a floor	FS
soil gas	SG

For example, a soil and groundwater grab sample collected from a soil boring at AOC 1 would be labeled SB101 and GW101, respectively. The last two digits in the sample identification represent the exploration location within the AOC. For soil samples, the depth of sample collection below ground surface (bgs) will be included with the sample identification. Samples not associated with an AOC (e.g., Sitewide Groundwater) will be designated with S, E, N, or W to represent the overall area of the site the sample is located.

4.4 HEALTH AND SAFETY MONITORING

Monitoring will be conducted to evaluate air quality and radioactivity conditions during intrusive site work (i.e., drilling borings, excavating test pits) for the protection of the workers as part of the project HASP requirements. All real-time monitoring results will be recorded in appropriate field logbooks.

If the slowest rate of pumping is greater than the recharge rate of the well, then a slug test will be performed to estimate the hydraulic conductivity. During a slug test, a transducer is carefully lowered into the well. A weighted slug, or sealed PVC piping filled with sand, will then be lowered into the well, taking care not to disturb the transducer. The water elevation will be allowed to stabilize (return to static conditions). Once static conditions are achieved, the slug will be quickly removed from the well and the rate of recharge will be measured using the transducer and a Hermit 2000™ data logger.

If the rate of recharge is slow enough, the rate of recovery may also be measured by hand using a Slope Indicator™ water level meter.

The data will then be either hand entered into the field logbook or downloaded, via electronic output. The data will then be used to estimate the hydraulic conductivity using the Bouwer-Rice method (1976) for unconfined aquifers and the Cooper, Bredehoeft, and Papadopulos (Cooper et. al.) (1967) method for confined aquifers. These methods will be used in conjunction with the Aqtesolv™ computer program.

All water will be managed as IDW in accordance with Section 4.11.

4.8 SURFACE WATER AND SEDIMENT SAMPLING

The surface water and sediment sampling program for the LFI and RFI are described in detail in Sections 4 and 6 of the relevant Work Plans (HLA, 1998a) (HLA, 1999). Sediment samples are usually collected in conjunction with surface water samples to help define the partitioning of the contaminants between the sediment and water. Surface water and sediment sampling locations will be clearly noted on a Site plan or aerial photograph and marked in the field with flagging and wooden stakes. The stakes will be labeled with the sample location identifier.

If both water and sediment samples will be collected at a given location, the water samples will be collected prior to the sediment samples. Special sampling and analytical requirements for samples being submitted for off-site chemical analysis are discussed in Section 4.1.3. The samples will be collected in the following manner:

1. The sampler will select the sample site, locate it on a map or photo, and set the wooden stake.

2. Surface water samples are collected by immersing a clean beaker into the surface water body. If a stream sample is being sampled, collect the sample upstream of the sampling devise with the opening of the devise oriented upstream and avoiding any floating debris. Samples obtained along a stream reach will be collected starting with the sample location most downstream and then proceeding upstream so as not to collect samples downstream of disturbed locations.

3. Fill appropriate sample containers by transferring the surface water from the beaker to the sample containers. In the event small amounts of surface water is available for collection, fill sample containers directly taking extreme care not to displace any preservative in the container. Cap and seal container(s).

4. Measure the field parameters in-situ (pH, temperature, dissolved oxygen, specific conductance, any other site-specific measurement required) directly in the water body or transfer a portion of water into a beaker.

5. Where sediments are to be obtained in wetlands, a grab sample will be obtained in the immediate vicinity of any associated surface water sample. Unless otherwise specified, grab or composite samples will be obtained from the surface of the sediment. Each sample will be collected using a stainless steel trowels and/or hand auger. Sediment samples will be collected

using the same procedure outlined for surface soil samples in Section 4.6.2.

6. After sample containers are filled, and if samples are collected within an AOC with radioactive residues, survey the external portion of the sample container(s) for loose surface radiation and document the survey. If the container(s) are found to be contaminated (greater than CE's NRC license for loose surface contamination), decontaminate and record the results. If decontamination efforts are not successful, contact the CE RSO.

7. Complete the required records (field logbook, Surface Water/Sediment FDR, Figure 4-4) and initiate COC procedures (refer to Section 5).

4.9 SOIL GAS SAMPLING

Soil gas samples will be collected to assess the presence of target volatile organics in vadose zone soils. Sample collection will be documented in the field logbook. The primary technology that will be used to characterize soil gas concentrations will be the EMFLUX® passive sampling device from Quaddrel, Inc. This technology is suited to the data needs because it is well-tested for the primary contaminants of interest tetrachloroethene, trichloroethene (PCE, TCE), and because it seeks to define potential maximum concentrations. This is done by collecting data over a period of theoretically maximum soil gas movement. The collector is placed in a borehole for a period of 72 hours and then sent back to the vendor where the collection media is desorbed and analyzed by gas chromatography/mass spectroscopy (GC/MS) (Method 8260B). The sample concentration is then combined with the calculated flux over the emplacement period to arrive at a soil gas concentration in mg/m^3. For this work, the devices will be placed at a maximum depth of 4 feet. Devices will be placed by hand and samples will be collected following the vendor's recommendations.

Harding Lawson Associates

PAGE ___ OF ___

FIELD DATA RECORD - SURFACE WATER/ SEDIMENT SAMPLING

PROJECT CE Windsor VCA JOB NUMBER 2239- DATE

FIELD SAMPLE NUMBER ACTIVITY TIME START END BOTTLE TIME

QC SAMPLES COLLECTED

SURFACE WATER DATA

WATER DEPTH AT LOCATION ___ FT SPEC. COND ___ UMHOS/CM

DEPTH OF SAMPLE FROM SURFACE ___ FT D.O. ___ PPM

TEMPERATURE ___ DEG C

PH ___ UNITS ASSOCIATED TRIP BLANK RINSATE BLANK

EQUIPMENT USED
- ☐ BEAKER
- ☐ PACS BOMB
- ☐ PERISTALTIC PUMP
- ☐ FILTER/ NUMBER ___
- ☐ OTHER

TYPE OF SURFACE WATER
- ☐ STREAM/ RIVER
- ☐ LAKE/ POND
- ☐ SEEP
- ☐ MARSH
- ☐ OTHER ___

DECON FLUIDS USED:
- ☐ DI WATER N2 PURGE
- ☐ POTABLE WATER
- ☐ ___

SEDIMENT DATA ASSOCIATED TRIP BLANK RINSATE BLANK

DEPTH OF SEDIMENT

TYPE OF SAMPLE
- ☐ DISCRETE
- ☐ COMPOSITE

SAMPLE OBSERVATIONS
- ODOR ___
- COLOR ___

TYPE OF SEDIMENT:
- ☐ ORGANIC
- ☐ SAND
- ☐ GRAVEL
- ☐ CLAY
- ☐ OTHER ___

EQUIPMENT FOR COLLECTION
- ☐ HAND CORER
- ☐ S.S. SPOON
- ☐ ALUMINIUM PAN
- ☐ S.S. SPATULA
- ☐ OTHER ___

DECON FLUIDS USED
- ☐ DI WATER N2 PURGE
- ☐ POTABLE WATER
- ☐ LIQUINOX
- ☐ OTHER ___

ANALYTICAL PARAMETERS WATER

	METHOD NUMBER	FILTERED	PRESERVATION METHOD	BOTTLE TYPE VOLUME REQUIRED	SAMPLE COLLECTED
☐					☐
☐					☐
☐					☐
☐					☐
☐					☐
☐					☐
☐					☐
☐					☐
☐					☐

ANALYTICAL PARAMETERS SOIL

	METHOD NUMBER	PRESERVATION METHOD	BOTTLE TYPE VOLUME REQUIRED	SAMPLE COLLECTED
☐				☐
☐				☐
☐				☐
☐				☐
☐				☐
☐				☐
☐				☐

NOTES

SIGNATURE: ___

RECEIVED BY: ___

FIGURE 4-4
SURFACE WATER AND SEDIMENT FIELD DATA RECORD
QUALITY ASSURANCE PROJECT PLAN
CE WINDSOR SITE
WINDSOR, CONNECTICUT

4. As a quality-control check during emplacement and retrieval, take an ambient-air control sample and record the date, time, and location of each.

5. Once all EMFLUX® Collectors have been deployed, schedule Collector recovery (approximately 72 hours after emplacement).

6. Retrieve the Collectors at the end of the 72-hour exposure period. At each location, withdraw the Collector from its hole and wipe the outside of the vial clean using gauze cloth. Remove the Sampling Cap, remove wire with wire cutters, and clean threads of the vial with a clean gauze cloth. Screw the solid plastic cap onto the vial and label the vial with the sample location. Record sample location, date, and time of withdrawal in the field logbook and initiate COC procedures.

7. Refill sampling holes with local soil.

8. If samples are collected within an AOC with radioactive residues, survey external portion of the container for loose surface radiation and document the survey. If the container is found to be contaminated (greater than CE's NRC license for loose surface contamination), decontaminate and record the results. If decontamination efforts are not successful, contact the CE RSO.

4.10 EQUIPMENT DECONTAMINATION

Decontamination of sampling equipment will be performed for all equipment that will be used for sampling media for chemical and/or radiological characterization. Decontamination procedures will depend largely upon sample site location and applicable radiological conditions.

For samples collected within an AOC known or suspected to have radiation residues, the following procedure is performed.

1. Immediately after sample collection, CE Health Physics personnel will survey equipment and sample containers for loose surface radiation using a radiation meter and document results.

2. If the equipment and/or containers are found to exceed release limits specified in CE's NRC license for loose surface contamination, CE personnel will decontaminate the object by means of wiping surface of object with a clean paper towel. If decontamination efforts are not successful, contact the CE RSO for appropriate action.

3. If equipment and/or containers do not have loose surface radiation, objects are decontaminated following procedures described below. Decontamination materials are managed in accordance with the Site's IDW (see Section 4.11).

For samples collected outside of AOCs suspected or known to have above background levels of radioactivity, decontamination will be performed as follows:

1. Wipe remaining surface debris, if any, with clean paper towel (or equivalent material),
2. Flush object with tap water (one or two times).
3. Wash object with a non-phosphate detergent plus tap water wash.
4. Flush with tap water.
5. Rinse object with distilled/deionized water.

Heavy equipment used during intrusive activities will be steam cleaned after each sampling location to eliminate the potential for cross contamination.

5.0 SAMPLE CUSTODY

A program of sample COC will be initiated in the laboratory and followed during sample handling activities in both field and laboratory operations. This program is designed to assure that each sample is accounted for at all times. The appropriate sampling and laboratory personnel will complete sample FDRs; COC Records, and laboratory receipt sheets.

The objective of sample custody identification and control is to assure, to the extent practicable, that:

- all samples scheduled for collection, as appropriate for the data required, are uniquely identified;
- the correct samples are analyzed and are traceable to their records;
- important sample characteristics are preserved;
- samples are protected from loss or damage;
- any alteration of samples (e.g., filtration, preservation) is documented; and
- a record of sample integrity is established for legal purposes.

5.1 FIELD ACTIVITIES SAMPLE CUSTODY

The primary objective of sample custody procedures is to obtain an accurate written record that can trace the handling of all samples during the sample collection process, through analysis, until final disposition. Field logbooks will be used to record field collection activities: information pertaining to sample locations, numbers/types of samples, field measurements, sampling conditions and observations will be documented in indelible ink.

5.1.1 Sample Chain-Of-Custody

Sample custody for samples collected during each sampling event will be maintained by the FOL or the personnel collecting the samples. Each sampler is responsible for documenting each sample transfer, maintaining sample custody until samples are shipped off-site, and sample shipment. The COC protocol followed by the sampling crews involves:

- documenting procedures and amounts of reagents or supplies (e.g., filters) which become an integral part of the sample from sample preparation and preservation;
- recording sampling locations, sample bottle identification, and specific sample acquisition measures on the appropriate forms;
- using sample labels to document all information necessary for effective sample tracking; and
- completing sample FDR forms to establish sample custody in the field before sample shipment.

Prepared labels are normally developed for each sample prior to sample collection. At a minimum, each label will contain:

- sample location;
- sample type and depth;
- date and time collected;
- project and sample designations;
- sampler identification, and;
- analyses requested and applicable preservative

A COC Record (shown in Figure 5-1) is initiated at the time of sample collection. The COC Record documents:

- sample handling procedures including sample location, sample number and number of containers corresponding to each sample number;
- the requested analysis and applicable test method;
- the dates and times of sample collection;
- the names of the sampler(s) and the person shipping the samples;
- the date and time that the samples were delivered for shipping;
- the names of those responsible for receiving the samples at the laboratory; and
- may note removals of various aliquots for analysis, as necessary.

CHAIN OF CUSTODY RECORD/ANALYTICAL REQUEST

1. Project Name: **CE Windsor**	4. Project Manager:	7. Prepared by:
2. Project No.:	5. Manager's Phone No.:	8. Form checked before shipping by:
3. SDG No.:	6. Work Release No.:	9. Airbill No.:
Samplers (Print names):	[Analysis/Method]	Harding Lawson Associates Office Address: Phone: Fax: Remarks: (Include MS/MSD information, composite or grab sample information, etc.)

Date	Time	Water	Soil	Sample ID Number	Total No. of Containers:										

10. Date Shipped:	11. Date Received:	12. Date Shipped:
13. Relinquished by: Date/Time	14. Received by: Date/Time	15. Relinquished by: Date/Time
16. Received by: Date/Time	17. Relinquished by: Date/Time	18. Received for Disposal by: Date/Time

19. Comments (Special instructions):

FIGURE 5-1
CHAIN OF CUSTODY RECORD
QUALITY ASSURANCE PROJECT PLAN
CE WINDSOR SITE
WINDSOR, CONNECTICUT

5.1.2 Sample Container Packing

Sample containers are generally packed in metal or plastic coolers for shipment. Bottles are to be packed tightly so that no motion is possible. Styrofoam, vermiculite, and "bubble pack" are suitable as packing materials for most instances. Samples that exhibit radiation above the Site's NRC license for loose surface contamination will not be shipped off-site (refer to Section 4). Ice is placed in double "Ziploc" bags or blue ice is used and added to the cooler along with all paperwork in a separate "Ziploc" bag. A temperature blank provided by the laboratory is placed in each cooler prior to shipment to verify the cooler was maintained at 4°C (+/- 2°C) during sample shipment. Custody seals will then be placed on the cooler prior to shipment to the laboratory. Cooler custody seals will be used to determine whether the coolers may have been tampered with.

5.1.3 Sample Shipment

The standard procedure that should be followed for shipping environmental samples to the analytical laboratory is provided below. In AOCs where radioactive residues are present, sample containers will be screened for loose surface contamination and radioactivity content prior to shipment.

- Shipping of environmental samples will be done through Federal Express or equivalent overnight delivery service, or through the use of laboratory courier services.

- Prior to leaving for the field, the person responsible for sample collection must notify the analytical laboratory of the number, type and approximate collection and shipment dates for the samples. If the number, type or date of shipment changes due to site constraints or program changes, the task leader must notify the analytical laboratory of the changes. This

notification from the field also needs to occur if sample shipments are scheduled to arrive on Saturdays.

- If prompt arrival of the samples cannot be guaranteed, the samplers will be responsible for proper storage of the samples until adequate transportation arrangements can be made.

5.2 LABORATORY RECEIPT AND CUSTODY

Once the samples are received at the analytical laboratory, the field COC is completed and signed by the laboratory's sample custodian. The sample custodian will then initiate laboratory COC protocols (comparing sample bottle labels against COC Record and noting any discrepancies).

After sample receipt information is checked and recorded, the sample analysis information is entered into the laboratory's information system. The laboratory provides a unique sample identification number to each environmental sample for internal laboratory sample custody. The internal COC will document the transfer of samples from the storage location to the analyst for analysis and subsequently through final disposition.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 CALIBRATION PROCEDURES FOR LABORATORY EQUIPMENT

Calibration of analytical instruments is required to verify the analytical system is operating properly and functioning at the desired sensitivity to meet the specific DQOs for the task. In general, reference standards used by the laboratory will bracket the expected concentration of the samples. To meet this objective, calibration standards are generally prepared at three to five different concentrations to demonstrate the instrument's linearity and range of quantitation. Calibration of an instrument must be performed prior to sample analysis and at periodic time intervals during sample analysis to verify the instrument is still calibrated in the linear range initially established.

The analytical laboratory will employ the test methods found in the following USEPA chemical analysis manuals:

- "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," SW-846, Third Edition, June 1997; and

- "Methods for Chemical Analysis of Water and Wastes," USEPA 600/4-79-020, March 1979, rev. 1984 (MCAWW).

- "Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment"; Office of Science and Technology; Health and Ecological Criteria Division; December 1991.

- American Society for Testing and Materials (ASTM) D422-63, "Standard Test Method for Particle-Size Analysis of Soils", 1998.

The calibration procedures, frequencies, acceptance criteria, and corrective actions for these methods are discussed in the laboratory-specific SOPs and in the analytical method. In the event

other accepted USEPA methods are used during the course of the VCA program, the QAPP will be revised to include such changes and any associated QA/QC information.

6.2 CALIBRATION PROCEDURES AND FREQUENCY FOR FIELD INSTRUMENTS

Field measurements will be limited to water quality measurements (pH, specific conductance, Eh, turbidity, dissolved oxygen, and temperature), water and product level measurements, geophysical testing, and health and safety monitoring for total VOCs and radiation. Each piece of equipment will be calibrated prior to each day's use following procedures described in the manufacturer's recommendation. Manufacturer usage guidelines are kept with each instrument in the field. Field instrument calibration data is recorded in the field logbook and on a form similar to that shown as Figure 6-1.

Calibration Records must include:

- person's name performing calibration;
- instrument name, model no.;
- date and time calibrated;
- standard used and source;
- temperature;
- results of calibration; and
- corrective action taken, if applicable.

Calibration procedures, frequency, acceptance criteria, and conditions that require re-calibration, as described by the manufacturer, will be followed. In addition, prior to use, and at the end of each day of use, the instrument will be cleaned, checked for damage, and repaired, if needed, in accordance with manufacturer's specifications. These activities will also be documented in a field logbook.

FIELD INSTRUMENTATION & QUALITY ASSURANCE RECORD

PAGE_____ OF_____

PROJECT: CE Windsor VCA | JOB NUMBER: | DATE:

FIELD INSTRUMENTATION CALIBRATION DATA

INSTRUMENT TYPE / I.D. # | CALIBRATION INFORMATION

CREW # 1

	USE	TEMP COMP.	BUFFERS USED / METER VALUE	CONDUCTIVITY READINGS
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DRY_____ STANDARD VALUE_____ METER VALUE_____
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DRY_____ STANDARD VALUE_____ METER VALUE_____
_____	PHOTOIONIZATION AIR QUALITY MONITORING DEVICE		☐ ZERO W/ BACKGROUND ☐ ZERO W/ ZERO AIR	SPAN GAS VALUE _____ METER VALUE_____
_____	_____		_____	

CREW # 2

	USE	TEMP COMP.	BUFFERS USED / METER VALUE	CONDUCTIVITY READINGS
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DRY_____ STANDARD VALUE_____ METER VALUE_____
_____	☐ pH ☐ TEMPERATURE ☐ CONDUCTIVITY	☐ YES ☐ NO	☐ pH 4 _____ ☐ pH 7 _____ ☐ pH 10 _____	METER VALUE DRY_____ STANDARD VALUE_____ METER VALUE_____
_____	PHOTOIONIZATION AIR QUALITY MONITORING DEVICE		☐ ZERO W/ BACKGROUND ☐ ZERO W/ ZERO AIR	SPAN GAS VALUE _____ METER VALUE_____
_____	_____		_____	

FLUIDS / MATERIALS RECORD

DEIONIZED WATER SOURCE: ☐ HLA STAGING ☐ PORTABLE SYSTEM ☐ OTHER_____

DECONTAMINATION FLUIDS: ☐ LIQUI-NOX ☐ TSP SOLUTION ☐ 20 % HNO3 LOT NO._____ ☐ OTHER_____ LOT NO._____

CALIBRATION FLUIDS: ☐ pH BUFFER 4 LOT NO._____ 7 LOT NO._____ 10 LOT NO._____ ☐ COND. STANDARD LOT NO._____

FILTRATION PAPER ID: ☐ IN LINE MANUF._____ LOT NO._____ ☐ VACUUM MANF._____ LOT NO._____ ☐ PRESSURE MANF._____ LOT NO._____

☐ HNO3 LOT NO._____
☐ H2SO4 LOT NO._____
☐ HCL LOT NO._____
☐ NaOH LOT NO._____
☐ ZnAOC LOT NO._____
☐ NaTHIO LOT NO._____
☐ MnSO4 LOT NO._____
☐ ALK.IODIDE LOT NO._____
☐ _____ LOT NO._____
☐ _____ LOT NO._____

SAMPLE CREW ID

CREW # 1 TYPE__GW_____ NAMES:_____

CREW # 2 TYPE__SW/SD__ NAMES:_____

_____ SIGNATURE

FIGURE 6-1
FIELD INSTRUMENTATION QUALITY ASSURANCE RECORD
QUALITY ASSURANCE PROJECT PLAN
CE WINDSOR SITE
WINDSOR, CONNECTICUT
Harding Lawson Associates

7.0 ANALYTICAL PROCEDURES

The CE Windsor VCA program will involve the analysis of samples collected from various environmental media (e.g., groundwater, surface water, sediment, soils). Based on information presented in the Historical Review Report (HRR) (ABB-ES, 1998), samples may be analyzed for physical, chemical, and/or waste characterization parameters. Table 4-1 presents the anticipated analytical program. The justification and rationale for the selected analyses is presented in Section 4 of the LFIWP (HLA, 1998a), Section 6 of the RFIWP (HLA, 1999), the Supplemental RFI WP (HLA 1999) and future Site Work Plans.

7.1 CHEMICAL ANALYSIS PROCEDURES

7.1.1 On-Site Field Screening Analysis

The on-site field GC procedure that will be used for chemical analyses during the VCA program is presented in Table 3-1. Field GC screening will be performed to identify and quantify the presence of selected VOCs (PCE and the related degradation products TCE, DCE, and vinyl chloride). On-site field GC analysis will be performed in accordance with the SOP presented in Appendix D (modified SW-846 method 8021B).

Field screening measurements are based on USEPA methods and will be performed in accordance with the manufacturer's recommendations. Instrument standardization will be performed. QA criteria for these parameters will also follow manufacturer specifications.

7.1.2 Off-Site Laboratory Analysis

7.1.2.1 Routine Chemical Analysis. The laboratory procedures that will be used for chemical analysis during the VCA program are presented in Table 4-1, and in general, are

the target compound and target analyte lists of chemicals following USEPA SW-846 analytical methods. Chemical analyses include one or more of the following: target compound list (TCL) VOCs; TCL SVOCs; pesticides; herbicides; PCBs; target analyte list (TAL) metals, including zirconium, thallium, boron, and/or lithium; total petroleum hydrocarbons (TPH); and water quality parameters (e.g., chloride, sulfate, ammonia, nitrate). The Synthetic Precipitation Leaching Procedure (SPLP) will also be performed for soil samples for metals, PCBs, and cyanide analyses for comparison with the CTDEP RSRs. The level of analytical quality required for the VCA program requires the use of the methods that are presented in the USEPA SW-846 for water and soil samples. These methods include required QC procedures, acceptance criteria, and corrective actions so that comparable data is produced by the analytical laboratories throughout the duration of the VCA program.

7.1.2.2 Acid Volatile Sulfide and Simultaneously Extractable Metals. Sediment samples may be collected for acid volatile sulfide and simultaneously extractable metals (AVS/SEM) analysis to assess the bioavailability of metals present in the sediments at selected sampling locations. The analysis will be completed in accordance with procedures published by the USEPA Office of Science and Technology (USEPA, 1991). The procedure includes acidification of the sediments and release of sulfide in the form of hydrogen sulfide gas. The concentration of sulfide in the sediment is determined by trapping the sulfide in an aqueous solution with subsequent analysis of the solution. The concentration of released metals from the sediment is determined by analysis of the aqueous portion obtained during the acidification process.

The AVS:SEM method (USEPA, 1991) provides analytical results for concentrations of sulfide and a list of selected metals (cadmium, copper, lead, mercury, nickel, and zinc). These selected metals are primarily divalent cations that are known to bind with sulfide

and form insoluble compounds. As such, these metals will be used to assess the availability of sulfide in the sediments.

AVS plays a critical role in evaluating the potential for partitioning and bioavailability of some metals in sediment. Most divalent metals will exists as insoluble metal sulfides if adequate sulfide exists in the sediments. Metal sulfides are generally insoluble, and if sediments contain high concentration of sulfide ions, metals will react with the sulfide and precipitate from solution. In metal contaminated sediment, metals will bind with AVS in order of increasing solubility (copper, lead, cadmium, zinc, and nickel). In addition to the metals specified in the method, SEM data will be generated for other elements that are interpreted to be of potential concern at the site. The additional elements include antimony, chromium, arsenic, silver, and zirconium. Results reported for these metals will be used as supplemental data in assessing the metals bioavailability and site conditions where sediments were collected.

In accordance with the method, the AVS and SEM results are converted to units of micromole per gram (μmole/g). A molar ratio of sulfide to the metal is calculated. The molar ratios are then used to assess the chemical characteristics of the sediment and to make interpretations on the bioavailablity of the metals.

During sample collection, contact with oxygen must be avoided until the sample is analyzed. Samples should be collected in sealed cores that are air tight, or samples must be maintained under inert gas such as nitrogen or argon (see Table 4-2).

7.1.2.3 Toxicity Testing and Bioaccumulation Study. As part of the sediment sampling program, toxicity testing and a bioaccumulation study may be performed to determine whether contaminant exposures could adversely affect ecological receptors and to

characterize spatial patterns in toxicity. Toxicity test species used to measure growth and survival effects in benthic macroinvertebrates will include either Chironomus tentans (midge) or Hyalella azteca (amphipod). The 1994 USEPA guidance (EPA/600/R-94/024) will be used in the conduct of these tests. The sediment bioaccumulation study will include *Lumbriculus variegatus* (a freshwater oligochaete) to measure potential food chain impacts. In addition, a fish embryo (species to be determined) sediment elutriate toxicity test may also be used to evaluate survival, growth, hatchling, and developmental effects on fish.

***Chironomus tentans* or *Hyalella azteca* – 10-day survival and growth bioassays**. Approximately 1 L of sediment will be collected from up to 8 depositional areas within the AOC interest. Two of these 8 samples will be collected from suitable reference areas. In addition to the reference samples, the toxicological laboratory will also employ a negative control. Sediment collection equipment may include a corer, Ekman and/or Ponar dredge, a plastic corer, and/or stainless steel or plastic sampling spoons depending on substrate characteristics and water depth. Divers may be used to collect sediment from the Farmington River. Sediment from one reference area per AOC, with similar physical characteristics (i.e., grain size, TOC) will also be collected. Sediment samples will be kept on ice (4 ^{0}C) until test commencement. To minimize disturbance to the sediment (which could result in an alteration of the sediment metals chemistry), the sediment will not be sieved. Alternative methods for removing potential predators, large organic matter, and stones will be evaluated.

***Lumbriculus variegatus* - 28-day bioaccumulation study**. Approximately 1 L of sediment will be collected from up to 8 depositional areas within the AOC of interest concurrently with the midge or amphipod toxicity test sample for the

oligochaete (worm) bioaccumulation study. Sample handling will be the same as described for the *H. azteca* or *C. tentans* toxicity test. As with the toxicity tests, two samples will be collected from a reference area exhibiting similar sediment characteristics, and the laboratory will provide a negative control. Test procedures will follow the 1994 USEPA guidance (EPA/600/R-94/024) and samples will be analyzed for total TAL metals analysis (plus zirconium) and percent lipids.

7.1.2.4 Fish and Amphibian Tissue Sample Collection and Analysis. Fish and amphibian tissue sampling program may be performed to evaluate potential food chain impacts to wildlife. Fish and amphibian tissue samples for whole body and fillet analysis may be collected and analyzed for the bioaccumulating contaminants that exceed toxicity benchmarks to evaluate the potential fish and amphibian contamination. Sampling locations will be chosen based on the physical characteristics of the AOC of interest (i.e., discrete physical habitats and/or proximity to source areas). A reference location will also be identified from another waterbody with similar habitat and substrate characteristics. Data collected will be compared to the reference location, and used in the ecological risk assessment.

Sampling Equipment and Procedures. The methods for collecting fish and amphibian samples will be determined based on accessibility and conditions of the areas to be sampled. Fish and amphibian samples for tissue analysis will be collected primarily with active and/or passive capture techniques. Passive sampling gear may include gill nets and/or minnow traps, and active fish capture methods include use of nylon haul seines, haul lines, and rod and reel.

Another technique that may be used is electrofishing, using a qualified subcontractor. This technique employs an electric current to immobilize fish, which are then captured with a net. This technique may also be useful for collecting amphibians in shallow areas.

Captured organisms will be kept alive in a holding tank or live well until time of shipment. Fish and amphibians selected for samples will be identified to species, and the number of individuals of each species collected will be recorded on the field data record. Organisms not selected for laboratory sample preparation will be released.

Laboratory Sample Preparation Handling and Shipping. All organisms will be kept alive until shipping to the laboratory. Nitrile rubber gloves will be used at all times to handle the fish or amphibians. The number of individual fish and/or amphibians collected per laboratory sample is dependent on a number of factors, including:

- the species and sizes captured;
- the volume of tissue required by the laboratory, including tissue required for laboratory quality control samples; and
- the distribution and relative abundance of organisms within individual sampling areas.

One large organism, or several smaller organisms, will comprise a single laboratory sample. If more than one organism is required to meet the volume requirements, a composite will be prepared for either whole body or fillet analysis. No fillets will be prepared in the field; rather, fish will be prepared in the laboratory for fillet analysis. To estimate proper sample volume for fillet analysis, the following protocol will be used:

- fillets of large fish (i.e., >150 grams) will be assumed to comprise one-half the total body weight;

- fillets of small fish (i.e., <150 grams) will be assumed to comprise one-third the total body weight.

In general, 15 grams will be required for total metals analysis and percent lipids. Samples designated as matrix spikes will need to have twice the volume (i.e., minimum of 30 grams of tissue). If more than one fish is needed for a sample, all fish in a sample group should be the same relative size. For samples containing more than one fish, the smallest fish should be no less than 75 percent of the total length of the largest fish in the sample group.

Samples will be placed in heavy-duty aluminum foil (dull side toward specimen). The samples should be double wrapped in aluminum foil and sealed in double freezer bags (one inside the other). Sample labels will be affixed to the sample package and taped with clear plastic packaging tape. Sample labels will be attached to each sample submitted for laboratory analysis. The sample identification, date and time of collection, and name(s) of field personnel will be recorded on each label. Each sample collected will be assigned a unique sample identification as described below.

Once sample packaging is complete, samples will be frozen. Samples will remain frozen until shipment to the laboratory. Frozen samples will be placed on dry ice in an insulated cooler when shipped to the laboratory. Samples and dry ice will be layered within each cooler to ensure samples remain frozen. Sufficient dry ice will be present in each cooler to ensure that samples remain frozen until delivered to the laboratory. Typically, an amount of dry ice equal to one-third of the total cooler volume will be adequate for this purpose.

Sample Designation. Each sample submitted for laboratory analysis will be assigned a unique sample identification. The sample identification will be an alpha-numeric code consistent with details provided in Section 4.

8.0 CHEMICAL DATA VALIDATION, REDUCTION, AND REPORTING

8.1 VALIDATION

Validation of measurements is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. For the VCA program, a tiered validation approach will be performed by an independent party in accordance with the "Region I, USEPA-New England Data Validation Functional Guidelines For Evaluating Environmental Analyses, Parts I and II" (USEPA, 1996b). This validation guidance document does not include validation guidelines for pesticides, PCBs, or inorganic analytes. Until such time that updated guidance is available for these parameters, USEPA "Region I Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses," will be used for pesticides/PCBs and "Region I Data Validation Functional Guidelines for Evaluating Inorganic Analyses," will be used for metals. For chemical methods that do not have published data validation guidelines (e.g., wet chemistry and radionuclide analyses), method-specific QC protocols and professional judgment will be used in qualifying the data.

A Tier III data validation (includes review of raw data and supporting documentation) will be performed for each parameter class (e.g., volatiles, semivolatiles, metals, etc.) on the first one or two laboratory deliverable packages for a given sampling event (i.e., LFI, RFI). This level of validation will allow the validator to uncover any potential data quality issues pertaining to laboratory analysis in the beginning of each project. If severe non-compliant QC issues are identified, the laboratory will be required to correct the problem. Tier III validation will also be performed when chemical results will be used to define an important site boundary, prove compliance with clean-up goals, or serve a basis for remediation decisions (i.e., data collected to represent background conditions).

All remaining data will undergo a Tier II validation (review of case narrative, QC summary forms, sample re-analyses and secondary dilutions).

Data validation qualifier codes that will be used are:

J - Indicates an estimated concentration

U - Indicates compound was analyzed for but not detected above the sample quantitation limit (SQL).

UJ - Estimated SQL

R - Indicates result is unusable because quality control criteria were grossly exceeded.

To satisfy a Tier II or Tier III data validation effort, a full CLP-type data deliverable will be generated by the laboratory (complete reporting of QC samples and associated raw data). A full CLP-type deliverable will consist of (but not limited to) all calibration (initial and continuing) data, mass spectra tuning data, instrument printouts, and associated method quality control summary forms.

Tier II data validation is performed mainly using the laboratory narrative, QC forms provided with the package, and COC Records. A Tier III data validation is equivalent to a full CLP-type validation which includes a detailed review of all raw data to check for technical, calculation, analyte identification/quantitation, and transcription errors.

A data validation report will be generated to document that the data was validated according to the aforementioned protocols, will include the data validation findings, and summarize the PARCC parameters.

8.2 REDUCTION

Data reduction is the process of converting measurement system outputs to an expression of the parameter that is consistent with the comparability objective. Calculations made during data reduction are described in the referenced analytical methods.

During field operations, only trained, qualified field technicians will record direct-reading instrumentation (e.g., PID, FID, pH, temperature, etc.) measurements in the field logbook and/or on the sample data records at the time of sampling.

Upon receipt, laboratory analytical data are reduced to standard data tabulations. This reduction may occur in one of three ways:

- the data are manually entered into data table templates;
- the data are downloaded directly from the laboratory computer; and
- the data are loaded from an electronic disk deliverable supplied with the data package by the laboratory.

In all cases, the electronic version of the standard data tabulation is checked against the hard copy data package.

Final validated data tabulations will be generated for inclusion into various investigative reports. Raw laboratory data and validated data tables will be stored along with the original data packages. The original data, tabulations, and magnetic media are stored in a secure and retrievable fashion. This information will be offered to USEPA prior to disposal.

8.3 REPORTING

In general, all aqueous data generated by the analytical laboratory will be reported as µg/L (organic analytes and metals) or mg/L (wet chemistry parameters). All soil/solid data will be reported as µg/kg (organic analytes) or mg/kg (metals) and reported on a dry-weight basis.

Validated data will be tabulated and made available to the project team for use in evaluation and interpretation. Validated data tables will be the formal presentation of analytical data for various reports. These tables will generally be included in the investigation report appendix and will include the following information:

- Sample Identification;
- Date Sampled;
- Analyte Name;
- Reporting Units;
- Quantitation Limit;
- Analytical Results;
- Validation Qualifiers; and
- Any Required Footnotes.

9.0 INTERNAL QUALITY CONTROL

9.1 MEASUREMENT SYSTEMS

The purpose of the internal quality control program is to detect potential problems, and if necessary, correct the deficiency. Quality control procedures have been established for both field and laboratory activities. Field QC activities will be used to monitor sampling technique, reproducibility (precision) in sampling methods, and cleanliness (accuracy) in samples submitted for analysis. Quality control data generated in the laboratory will also monitor reproducibility (precision in laboratory methods) and cleanliness (accuracy in samples analyzed), and in addition, accuracy and precision of the method for a particular matrix.

9.1.1 Field Quality Control Checks

Field QC activities include the use of calibration standards and blanks for pH, specific conductance, dissolved oxygen, turbidity, temperature, and PID or FID measurements. Field QC samples will also be collected to monitor the data quality as it is affected by field procedures and conditions. Field QC samples provide a quantitative basis for evaluating the reported data. Field QC samples submitted to the laboratory will include the following:

Source Water Blank - Source water will be collected to assess the quality of deionized/distilled water used for decontamination activities. One source water blank will be collected for each sampling event, or for each source of water used for decontamination procedures, whichever is more frequent. The source water sample will be collected directly from the water supply into laboratory-provided bottles. The samples will be submitted for laboratory analysis for the same parameters as environmental samples.

Trip Blanks - Trip blanks are required to assess the potential for external VOC contamination occurring during sample shipment and storage. The trip blank will originate at the laboratory and will accompany each cooler containing VOC samples. One trip blank (2 vials) will accompany each shipment of samples submitted to the laboratory.

Field (Equipment Rinsate) Blanks - Field blanks are required to evaluate the cleanliness of decontaminated sampling equipment, and to assess potential cross contamination of samples from the sampling equipment. Field blank samples will be prepared by collecting a sample of source water that has been passed through the sampling apparatus after it has been decontaminated. The frequency for field blank collection is provided below:

- For soil and sediment samples: field blanks will be collected at a rate of ten (10) percent of the number of samples collected during a sampling event, or a minimum of one (1) blank per week of sampling, whichever is more frequent.

- Field blanks for groundwater samples will be collected at a rate of one (1) for each group of 20 investigative samples or a minimum of one (1) blank per week of sampling, whichever is more frequent.

The blanks will be handled, stored, and transported in the same manner as investigative samples, and will be analyzed for the same parameters as associated samples.

Field Duplicates or Replicates - Two sets of samples from a single sample location are collected, labeled with unique sample numbers, and submitted for laboratory analysis to assess sample representativeness and analytical precision. Samples collected for VOCs are, by definition, considered replicates since they cannot be homogenized. Field duplicates/replicates will be submitted for analysis of all parameters specified for the original samples at a rate of ten percent of

the number of samples collected per medium (frequency of 1:10).

Matrix Spike (MS)/Matrix Spike Duplicates (MSD) and Laboratory Duplicate (LD) Samples- The sampling crew will collect aliquots of sample for MS, MSD, and LD QC analyses. A MS/MSD pair will be used for organic analyses, whereas, a MS/LD is used for metals and wet chemistry analyses. The MS/MSD and MS/LD will be used to determine accuracy and precision information of the analytical method specific to CE Windsor sample matrices. MS/MSD and MS/LD samples will be submitted for analysis of all parameters specified for the original samples at a rate of five (5) percent of the number of samples collected per medium (frequency of 1:20).

Completeness - Completeness of scheduled sample collection will be controlled in the field by comparing a computer generated label inventory with samples actually collected each day. Daily checking of field data sheets and comparison of transport and COC Records will provide further control on documentation and completeness.

9.1.2 Laboratory Quality Control Checks

All laboratory QC activities are specified in the analytical method. In general, laboratory QC checks include, but are not limited to: method blanks to assess contamination during sample analysis; calibration and surrogate standards (for organics) for assessing accuracy; MS/MSD or MS/LD to assess accuracy, precision, and presence of matrix effects; method 8082 QC check samples for PCB analyses, endrin/DDT degradation checks for pesticide analyses, and second dissimilar column confirmation for GC analyses; and laboratory control samples to determine instrument accuracy. Control limits for these laboratory QC checks are generally defined in the respective analytical method, and may be updated by the laboratory to reflect more accurate and precise limits.

APPENDIX B

APPENDIX B

TOXICITY TEST AND ECOLOGICAL TISSUE COLLECTION METHODS

APPENDIX B
TOXICITY TEST AND ECOLOGICAL TISSUE COLLECTION METHODS

Toxicity tests and tissue collection methods are described below.

1.1 EARTHWORM TOXICITY TEST

28-d survival, growth, and reproductive bioassays will be conducted using the earthworm *Eisenia foetida*. Test procedures will follow ASTM E 1676 –95 (ASTM, 1995). In the laboratory, soil samples will be screened to remove oversize material, and pH and soil moisture content will be determined. Soil moisture will be adjusted as necessary. Negative control soil will consist of 10% sphagnum, 20% kaolin clay, and 70% silica sand.

Ten adult worms (i.e., >300 mg [wet weight]) will be placed in each 500 ml test chamber containing 200 grams (dry weight) of soil material. A total of three replicates per sample location is required. A soil volume of one liter (1 L) soil per sample location will be adequate to meet these requirements. Surviving organisms will be counted after 14 days and at the completion of the exposure period (28 days). The ASTM guidance describes the methodology for estimating weight gain over the exposure period; defined as the difference in pre- and post-exposure weights of depurated and washed worms. The number of cocoons produced during the test interval will also be recorded. An ANOVA and either Bonferroni's T-Test or Dunnett's Mean Comparison Test will be used to analyze for significant effects among treatments. An LC_{50} (mortality) and EC_{50} (growth, reproduction) will be calculated using the probit, moving average, or binomial methods as described in Stephan (1977).

If earthworm tissue residue analysis is warranted, the number of organisms used in the above bioassay will be increased to ensure adequate material. The specific volume will be dependent upon the selected analytical parameters to be analyzed. Surviving earthworms will be collected, washed, and depurated for 24 hours prior to packaging and shipment to the analytical laboratory.

1.2 LETTUCE TOXICITY TEST

Twenty-eight-day lettuce seed (*Lactuca sativa*) survival and growth (weight gain) bioassays will be conducted to determine if surface soils at the CE Windsor site contain levels of inorganics and PAHs that pose a risk to terrestrial plants. Test procedures will follow ASTM E 1598-94 (ASTM 1998) and USEPA (1989) protocols. Soil moisture will be measured and adjusted as necessary, and temperature, pH, and soil conductivity determined in each experimental soil prior to preparing replicates. The experiment will commence by adding five graded seeds to each experimental unit (i.e., peat planting trays; 15 cm x 12 cm x 5 cm). A total of 3 replicates per sampling location is required. A soil volume of one liter (1 L) soil per sample location will be adequate to meet these requirements.

Test chambers will be maintained in the dark for 48 hours, followed by a 16-hour/8-hour light/dark photoperiod. Light intensity will be maintained at 4300 +/- 430 lux during the light period throughout the experiment. The number of germinated seeds in each replicate will be determined by counting each seedling that protrudes above the soil surface. Statistical analysis of significant treatment effects will follow that described in USEPA guidance.

At the end of the 28-day exposure period, the above-ground portion of the plant (shoots) and below-ground portion (roots) will be collected, dried, and weighed. Shoots and roots are dried for 24 hours at 80°C.

1.3 SURFACE WATER TOXICITY TESTING (FRESHWATER INVERTEBRATE)

Three-brood reproductive/survival bioassays will be conducted using *Ceriodaphnia dubia* following the ASTM guidance (E 1295-89). Neonate water fleas will be exposed to surface water collected from the site. Approximately 1L of water will be collected and submitted to a toxicological laboratory. Each treatment will consist of 10 replicate water fleas maintained in individual 30-ml cups. Reconstituted fresh water with pH, hardness, alkalinity similar to the test medium will be used in the dilutions. Medium will be changed daily using the stock preparations. A control treatment using the dilution water will be included. Biological data including death of test organisms and the number of neonates produced during the preceding 24-hour period will be recorded at the time of exposure medium renewal. Water quality parameters (i.e., hardness, alkalinity, pH, conductivity, and DO) and temperature shall be recorded throughout the exposure period as specified in the ASTM guidance. ASTM criteria for test acceptability will be strictly followed.

After test organisms have produced three broods, or it is apparent that organisms would not do so given additional time, the survival and brood production data will be summarized by treatment and statistically compared. Any necessary data transformations will be conducted to meet model assumptions. An Analysis of Variance (ANOVA) will be conducted with the brood count data to determine whether among treatment effects exist. If the F statistic is significant, Dunnet's procedure will be used to control the experiment-wide acceptance level.

1.4 SEDIMENT TOXICITY TESTING

Sediment toxicity testing will be conducted to investigate two potential ecological risks: direct toxicity to sediment-dwelling freshwater invertebrates, and indirect impacts to semi-aquatic organisms from decreased prey abundance. Whole sediment toxicity tests will be conducted to evaluate direct toxicity, and sediment bioaccumulation tests may be conducted to evaluate bioaccumulation in the aquatic food chain.

Freshwater Invertebrate

As part of the sediment sampling program, toxicity testing will be performed to determine whether contaminant exposures could adversely affect ecological receptors. The amphipod *Hyalella azteca* will be used to measure growth and survival effects in benthic macroinvertebrates. The bioassays will consist of 10-day survival and growth following the 2000 USEPA guidance (EPA/600/R-99/064)(USEPA, 2000).

Approximately 1 L of sediment will be collected from each location. Sediment from a reference area with similar physical characteristics (i.e., grain size, TOC) will also be collected. In addition to the reference sample, the toxicological laboratory will also use their own negative control.

Sediment collection equipment may include a corer, Ekman and/or Ponar dredge, a plastic corer, and/or stainless steel or plastic sampling spoons depending on substrate characteristics and water depth. Divers may be used to collect sediment from the Farmington River. Sediment samples will be kept on ice (4^0 C) until test commencement. To minimize disturbance to the sediment (which could result in an alteration of the sediment metals chemistry), the sediment will not be sieved.

Bioaccumulation (Freshwater Oligochaete)

A 28-day sediment bioaccumulation study will be conducted using *Lumbriculus variegatus* (a freshwater oligochaete) to measure potential food chain impacts. Approximately 1 L of sediment

will be collected at each sample location for the oligochaete (worm) bioaccumulation study. Sample handling will be the same as described above for the *H. azteca* toxicity test. As with the toxicity tests, a sample will be collected from a reference area exhibiting similar sediment characteristics, and the laboratory will provide a negative control. Test procedures will follow the 2000 USEPA guidance (EPA/600/R-99/064)(USEPA, 2000).

1.5 TISSUE COLLECTION AND ANALYSIS

Fish and amphibian tissue sampling may be required at some AOCs to provide a more site-specific indication of potential food chain exposures for semi-aquatic wildlife. The methods that will be used to collect fish and amphibians are described below.

Sampling Equipment and Procedures. The methods for collecting fish and amphibian samples will be determined based on accessibility and conditions of the areas to be sampled. Fish and amphibian samples for tissue analysis will be collected primarily with active and/or passive capture techniques. Passive sampling gear may include gill nets and/or minnow traps, and active fish capture methods include use of nylon haul seines, haul lines, and rod and reel. Another technique that may be used is electrofishing, using a qualified subcontractor. This technique employs an electric current to immobilize fish, which are then captured with a net. This technique may also be useful for collecting amphibians in shallow areas.

Captured organisms will be kept alive in a holding tank or live well until time of shipment. Fish and amphibians selected for samples will be identified to species, and the number of individuals of each species collected will be recorded on the field data record. Organisms not selected for laboratory sample preparation will be released.

Laboratory Sample Preparation Handling and Shipping. All organisms will be kept alive until shipping to the laboratory. Nitrile rubber gloves will be used at all times to handle the fish or amphibians. The number of individual fish and/or amphibians collected per laboratory sample is dependent on a number of factors, including:

- the species and sizes captured;
- the volume of tissue required by the laboratory, including tissue required for laboratory quality control samples; and
- the distribution and relative abundance of organisms within individual sampling areas.

One large organism, or several smaller organisms, will comprise a single laboratory sample. If more than one organism is required to meet the volume requirements, a composite will be prepared.

In general, 15 grams will be required for total metals analysis and percent lipids. Samples designated as matrix spikes will need to have twice the volume (i.e., minimum of 30 grams of tissue). If more than one organism is needed for a sample, all organisms in a sample group should be the same relative size. For samples containing more than one organism, the smallest organism should be no less than 75 percent of the total length of the largest organism in the sample group.

Samples will be placed in heavy-duty aluminum foil (dull side toward specimen). The samples should be double wrapped in aluminum foil and sealed in double freezer bags (one inside the other). Sample labels will be affixed to the sample package and taped with clear plastic packaging tape. Sample labels will be attached to each sample submitted for laboratory analysis. The sample identification, date and time of collection, and name(s) of field personnel will be recorded on each label. Each sample collected will be assigned a unique sample identification as described below.

Once sample packaging is complete, samples will be frozen. Samples will remain frozen until shipment to the laboratory. Frozen samples will be placed on dry ice in an insulated cooler when shipped to the laboratory. Samples and dry ice will be layered within each cooler to ensure samples remain frozen. Sufficient dry ice will be present in each cooler to ensure that samples remain frozen until delivered to the laboratory. Typically, an amount of dry ice equal to one-third of the total cooler volume will be adequate for this purpose.

APPENDIX C

APPENDIX C-1

BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION

Harding ESE
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December 21, 2000

Mr. Robert O'Meara
Office of Site Remediation and Restoration
U.S. Environmental Protection Agency
New England Region
J.F.K. Federal Building (HBT)
Boston, Massachusetts 02203

Subject: **Baseline Ecological Risk Assessment Problem Formulation**
CE Windsor Site - Windsor, Connecticut

Dear Mr. O'Meara:

Enclosed are two copies of the Baseline Ecological Risk Assessment Problem Formulation for Combustion Engineering Inc.'s (CE) Windsor Site, located at 2000 Day Hill Road, in Windsor, Connecticut. This document satisfies Step 3 of the ecological risk assessment (ERA) process, in which the primary endpoints and objectives of the baseline ERA are further defined using the results of the screening level ERA. The baseline ERA is being completed as part of the Resource Conservation and Recovery Act (RCRA) Voluntary Corrective Action (VCA) at the CE Windsor Site.

The conceptual site models for Site-wide surface soil, and surface water and sediment at four aquatic areas (including Great Pond, Small Pond, the Site brook, and the Farmington River) identify the exposure pathways and receptors that are of primary concern at the Site. These have been chosen based on the contaminants of concern (COCs) identified for these areas and the likely receptor exposure pathways. CE will collect additional data to support the baseline ERA; the additional data collection activities will be outlined in a sampling and analysis plan (SAP).

It is CE's intent to submit the SAP early next year, and following agency approval, to begin additional field activities in April of 2001. We would like to arrange a meeting or conference call with you in mid January 2001 to discuss this memorandum and our proposed scope for activities to include in the SAP. We understand that you will forward any initial comments prior to our meeting in order for both Harding ESE and CE to be fully prepared for the discussions.

We appreciate your involvement on this project, and if you have any questions, please call me at (207) 775-5401.

Sincerely,
HARDING ESE

Nelson Walter

Nelson Walter, P.E.
Project Manager

cc: Elaine Hammick – CE (2 copies)
John Conant - CE
Connie Crossley – BAH (2 copies)
Beverly Lawrence, USACE (2 copies)
William Taylor, USACE
Dennis Waskiewicz – USACE
Gil Richards – CTDEP
Norm Richardson – Harding ESE

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BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION FOR TERRESTRIAL AND AQUATIC AREAS OF CONCERN

CE Windsor Site
Windsor, Connecticut

INTRODUCTION AND BACKGROUND

This technical memorandum presents the baseline ecological risk assessment (ERA) problem formulation for the terrestrial and aquatic areas of concern (AOCs) at Combustion Engineering Inc.'s (CE) Windsor Site, located at 2000 Day Hill Road, in Windsor, Connecticut. This discussion draws on the conclusions of the screening level ecological risk assessment (ERA) presented in the First Interim Deliverable (FID) (HLA, 2000), and the letter outlining CE's responses to U.S. Environmental Protection Agency (USEPA) comments on the FID (dated November 21, 2000).

The screening level ERA and response to comment letter identified contaminants of concern (COCs) for surface soil, surface water, and sediment by comparing maximum concentrations detected in each medium with conservative screening benchmarks by AOC. Based on the screening level ERA conclusions, the following AOCs were eliminated from further evaluation in the baseline ERA: AOCs 2, 5, 7, 8, 9, 11, 12, 15, 18, 21, 22, 23, and 25. The benchmarks used to select COCs were in accord with the broad screening level assessment endpoints of survival and maintenance of receptor populations at the CE Windsor Site. As outlined in the USEPA *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments, 1997* (the Process Document), multiple conservative assumptions are applied to the screening benchmarks to ensure that only those chemicals that pose a negligible risk are removed from further consideration in the baseline ERA. It is likely that many chemicals retained as COCs do not pose a significant risk to ecological receptors, and this will be demonstrated in the baseline ERA.

PURPOSE

As discussed in the Process Document (USEPA, 1997), the goal of the problem formulation is to focus on those stressors that will likely have the greatest impact on the ecosystem. By focusing on these stressors, additional data collection activities may be identified to provide a means of measuring the assessment endpoints of the baseline ERA. With USEPA concurrence, this refinement will facilitate a meaningful evaluation of risk.

This memorandum serves two purposes:

- Identify the primary stressors most likely to have the greatest impact in the ecosystem, and
- Refine the conceptual site model (CSM) considering the ecological receptors most likely to be affected from exposure to these stressors.

A discussion of the baseline ERA assessment endpoints and a characterization of the specific effects associated with primary stressors will be provided in a Sampling and Analysis Plan.

PRIMARY STRESSOR IDENTIFICATION

As shown in Tables 1 and 2, the screening level ERA indicated that the following chemicals may have the greatest potential impacts in terrestrial and/or aquatic ecosystems (respectively):

- Polynuclear aromatic hydrocarbons (PAHs) and several metals in surface soil at various terrestrial AOCs;
- Mercury in Small Pond surface water;
- PAHs, pesticides, copper, and mercury in Small Pond sediment;
- PAHs, polychlorinated biphenyls (PCBs), copper, mercury, silver, zinc, and zirconium in Site brook sediment; and
- PAHs, cadmium, and silver in Farmington River sediment.

Table 1 summarizes information for surface soil presented in the FID. Table 2 summarizes information for sediment and surface water presented in Attachments A and D (respectively) of the response to comment letter. The shaded chemicals in Tables 1 and 2 are the primary stressors that represent the greatest impact to ecological receptors, on which additional data collection activities will be focused.

Chemicals without shading in Tables 1 and 2 are not considered to be primary stressors at the CE Windsor Site for the following reasons:

- the maximum concentrations detected in environmental media do not exceed conservative toxicological benchmarks by greater than an order of magnitude;
- the specific benchmarks employed to identify COCs are particularly conservative, assigned a low degree of confidence by the authors, or are of questionable applicability to receptors and habitats known to occur at the Site; and
- the benchmark exceedances occur infrequently and are not widespread in distribution.

These include many of the metals detected in surface soil and sediment (including chromium and vanadium at most AOCs), PCBs in surface soil and sediment at some AOCs, and barium and boron in surface water. Volatile organic compounds (VOCs) are not identified as primary stressors in any medium in the baseline ERA. Data presented in the screening level ERA suggest that VOCs are generally less toxic to ecological receptors than other classes of compounds (e.g., metals, pesticides, and PCBs). In addition, VOCs do not readily bioaccumulate. Although all COCs identified in the FID will be evaluated in the baseline ERA, the following discussion provides rationale for not focusing additional data collection activities on these particular chemicals.

Those metals detected in surface soil, surface water, and sediment at maximum concentrations greater than ten times the most conservative benchmarks are listed individually in Tables 1 and 2, whereas the metals detected at maximum concentrations less than ten times the most conservative benchmarks are grouped together as "other metals". Given the conservative nature of the screening process, these other metal COCs are unlikely to contribute significantly to any ecological risk at these AOCs.

Surface Soil. For surface soil (Table 1), PCBs were not identified as primary stressors at AOCs 4 or 27. While PCBs readily bioaccumulate in the food chain and are associated with reproductive

effects in carnivorous mammals, the concentrations of PCBs in soil at these AOCs only slightly exceed the selected wildlife benchmark (i.e., by less than a factor of 2 in both cases). Also, it is evident that chromium and vanadium repeatedly exceeded screening benchmarks by more than a factor of 10 across many of the terrestrial AOCs. There are no current or historical known Site uses of chromium, and vanadium releases have only occurred at AOC 3. Further investigation reveals that the authors of the toxicity studies on which these benchmarks are based assigned a low level of confidence in these benchmarks due to the limited availability of toxicity data. Therefore, chromium and vanadium are not considered primary stressors in soil (with the exception of vanadium at AOC 3 and chromium at AOC 27).

Surface Water. Unfiltered metals were excluded from the list of primary stressors for surface water in Table 2. This pertains primarily to Small Pond, where unfiltered metals concentrations were associated with highly turbid samples. The fact that many of these metals were either not detected in filtered samples, or were not retained as COCs for filtered surface water suggests that they are not bioavailable to ecological receptors. In addition, barium and boron were not identified as primary stressors in surface water at the Site due to uncertainties associated with the higher detected concentrations in filtered samples than in unfiltered samples (believed to be an artifact of the field filtering process). Background surface water data for metals retained as COCs will be collected to further evaluate these issues in the baseline ERA. The background surface water data will also be used to determine if the iron and manganese concentrations in Small Pond surface water reflect naturally occurring levels.

Sediment PCBs were not identified as primary stressors in Farmington River or Small Pond sediment due to the low magnitude of benchmark exceedance (i.e., less than factors of 3 in both cases). There are no primary stressors identified for Great Pond sediment because the few benchmark exceedances were of low magnitude and these COCs do not appear to be associated with site activities. Finally, a number of inorganic analytes were identified as COCs in the Site Brook, the Farmington River and Small Pond. These analytes also appear to have little likelihood of substantially affecting aquatic biota in these habitats based on the magnitude and spatial distribution of benchmark exceedances. Background sediment data for metals will be collected to further clarify the status of these COCs in the baseline ERA.

REFINED CONCEPTUAL SITE MODELS

CSMs for the terrestrial and aquatic exposure pathways are presented in Figures 1 through 3 of this memorandum. Figure 1 presents the CSM for all terrestrial AOCs, Figure 2 presents the CSM for Great Pond, and Figure 3 presents the CSM for Small Pond, the Site brook, and the Farmington River (the critical exposure pathways for these aquatic bodies are essentially the same).

The exposure pathways shown in the CSMs include:

- sources of contamination,
- release mechanisms to environmental media (e.g.,, overland transport, deposition, discharges),
- contaminated media (e.g., surface soil, surface water, sediment, or groundwater),
- exposure routes (e.g., ingestion, direct contact, or root uptake), and
- terrestrial and aquatic receptors (e.g., invertebrates, plants, wildlife, fish).

Terrestrial Exposure Pathways

As shown in Figure 1, the primary exposure pathways of concern at the terrestrial AOCs include direct contact and ingestion for soil invertebrates, and direct contact and root uptake for terrestrial plants. Significant effects on the growth, reproduction, or survival of terrestrial plants and/or invertebrates may result in a reduced forage base for mammals or birds. A secondary concern at the terrestrial AOCs includes food chain exposures for mammals and birds (i.e., bioaccumulation of chemicals from soil into prey items, and subsequent ingestion by higher trophic level organisms). However, few bioaccumulating chemicals were identified as primary stressors.

Aquatic and Semi-Aquatic Exposure Pathways

As shown in Figure 2, there does not appear to be a significant exposure pathway for aquatic receptors in Great Pond primarily because chemicals were detected at low concentrations relative to screening benchmarks. However, potential risks to aquatic receptors need to be further discussed in the baseline ERA to put these concentrations into perspective (relative to background concentrations).

The primary exposure pathways of concern for chemicals detected in Site brook, Farmington River, and Small Pond sediment (Figure 3) include direct contact and/or ingestion for fish, invertebrates, and amphibians, and bioaccumulation of mercury, cadmium, and pesticides (respectively) in the food chain for semi-aquatic wildlife.

The primary exposure pathways of concern for chemicals detected in Small Pond surface water (Figure 3) include direct contact and/or ingestion for fish, invertebrates, and amphibians, and bioconcentration of mercury in the food chain for semi-aquatic wildlife.

Significant effects on the growth, reproduction, or survival of fish, invertebrates, and amphibians may result in a reduced forage base for semi-aquatic mammals or birds. Bioaccumulation and/or bioconcentration in the food chain may result in impaired reproductive success for semi-aquatic wildlife.

Groundwater discharge may represent a complete exposure pathway at the Site brook or Small Pond, however surface water and sediment concentrations likely represent realistic exposures posed by groundwater discharging to these media. Therefore, groundwater will not be evaluated in the baseline ERA.

SUMMARY AND RECOMMENDATIONS

The identification of primary stressors and exposure pathways for ecological receptors will be used to guide the next step in the ERA process, which is the development of a sampling and analysis plan (SAP). The SAP will explain the rationale and approach for collecting any additional site-specific data necessary to support the baseline ERA. Based on the information outlined in this memorandum, additional data collection activities will be focused on the following:

Terrestrial AOCs

- reduced growth, reproduction, and survival of soil fauna from exposure to PAHs in soil at AOCs 3, 6, 10, and 24, and the secondary effects this may have on terrestrial wildlife due to a reduced prey base; and
- reduced growth and/or reproduction, and survival of terrestrial plants and/or soil fauna from exposure to metals in soil at AOCs 1, 3, 13, and 27, and the secondary effects this may have on terrestrial wildlife due to a reduced prey base. This analysis should be focused on the incremental effects of Site-related stressors with respect to background.

Small Pond

- reduced reproductive success of semi-aquatic wildlife from ingestion of amphibians and/or fish that have bioconcentrated mercury from Small Pond surface water in their tissue;
- reduced growth, reproduction, and survival of invertebrates, amphibians, and/or fish from exposure to PAHs, pesticides, copper, and mercury in Small Pond sediment, and the secondary effects this may have on semi-aquatic wildlife due to a reduced prey base; and
- reduced reproductive success of semi-aquatic wildlife from ingestion of amphibians and/or fish that have bioaccumulated pesticides and/or mercury from Small Pond sediment in their tissue.

Site Brook

- reduced growth, reproduction, and survival of invertebrates, amphibians, and/or fish from exposure to PAHs, PCBs, copper, mercury, silver, zinc, and zirconium in Site brook sediment, and the secondary effects this may have on semi-aquatic wildlife due to a reduced prey base; and
- reduced reproductive success of semi-aquatic wildlife from ingestion of amphibians and/or fish that have bioaccumulated PCBs and mercury from Site brook sediment in their tissue.

Farmington River

- reduced growth, reproduction, and survival of invertebrates and/or fish from exposure to PAHs, cadmium, and silver in Farmington River sediment, and the secondary effects this may have on semi-aquatic wildlife due to a reduced prey base;
- reduced reproductive success of semi-aquatic wildlife from ingestion of fish that have bioaccumulated cadmium from Farmington River sediment in their tissue; and
- extrapolating the results to consider potential impacts to rare, threatened or endangered species and/or species of special concern (e.g., Atlantic salmon [*Salmo salar*] and the eastern pond mussel [*Ligumia nasuta*]).

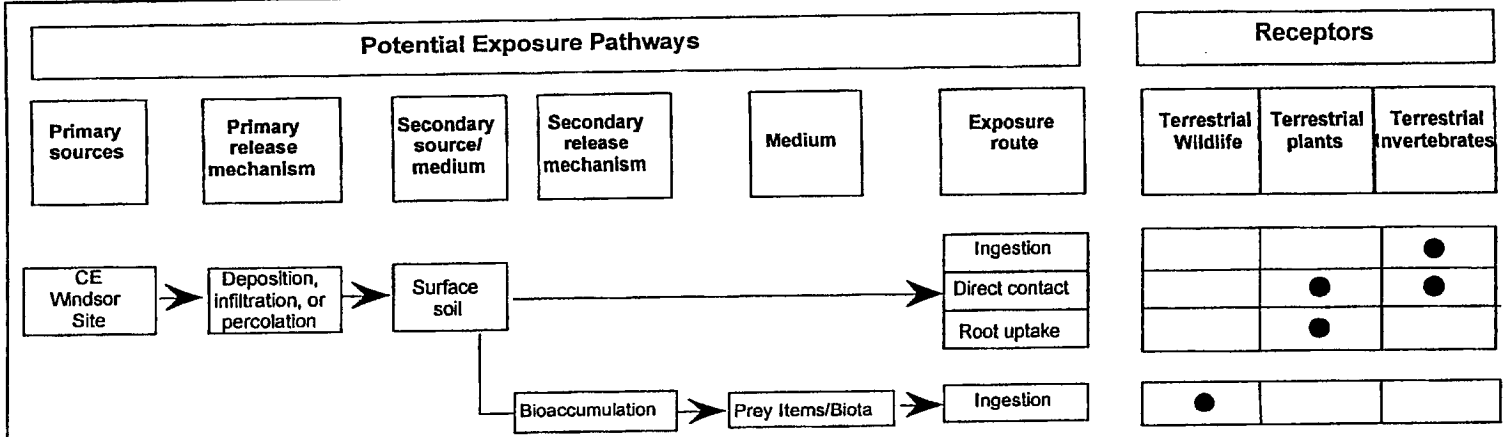

FIGURE 1
CONCEPTUAL SITE MODEL FOR
ECOLOGICAL RECEPTORS EXPOSED TO SURFACE SOIL

CE WINDSOR SITE
WINDSOR, CONNECTICUT

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CSM - SS(2)

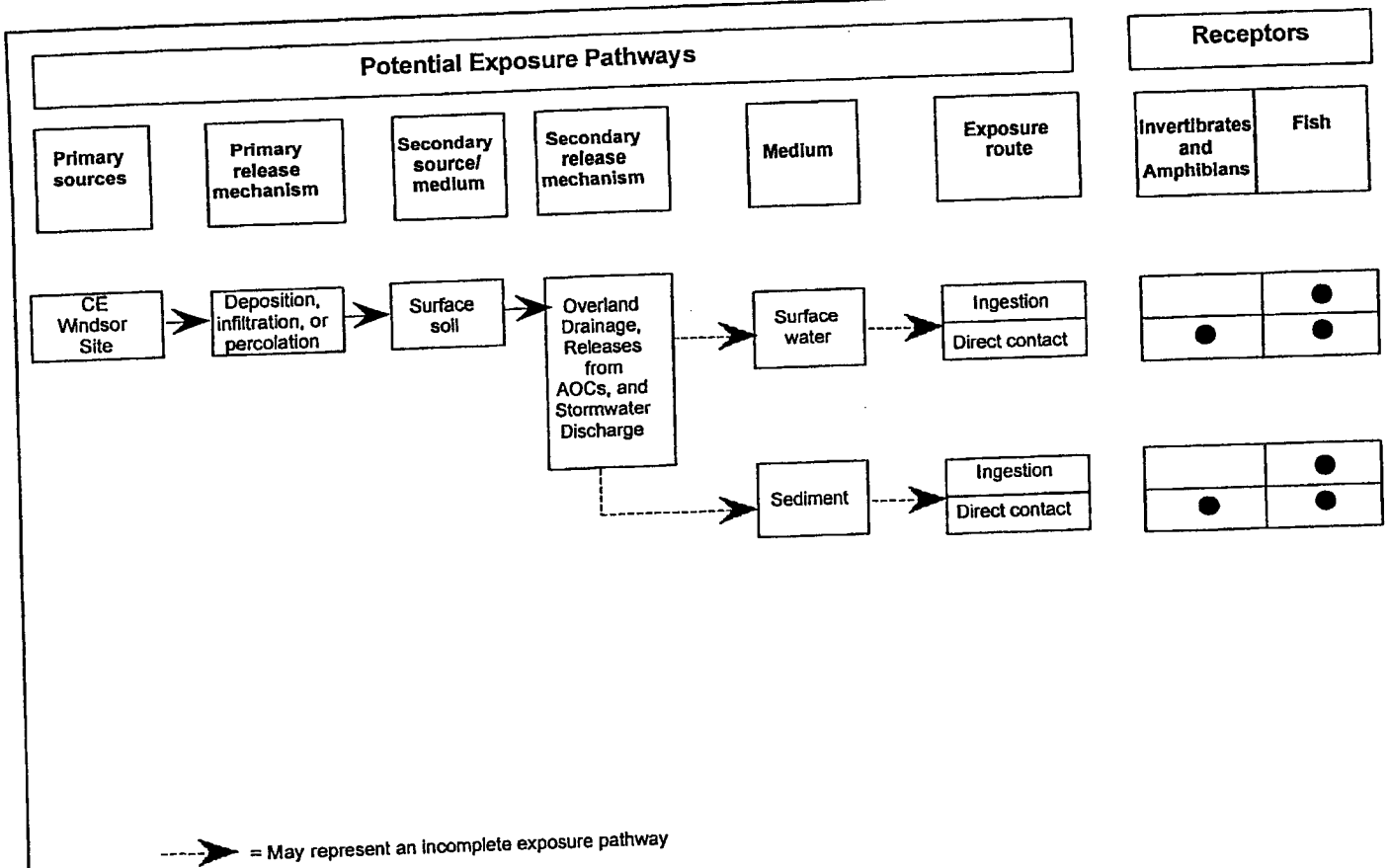
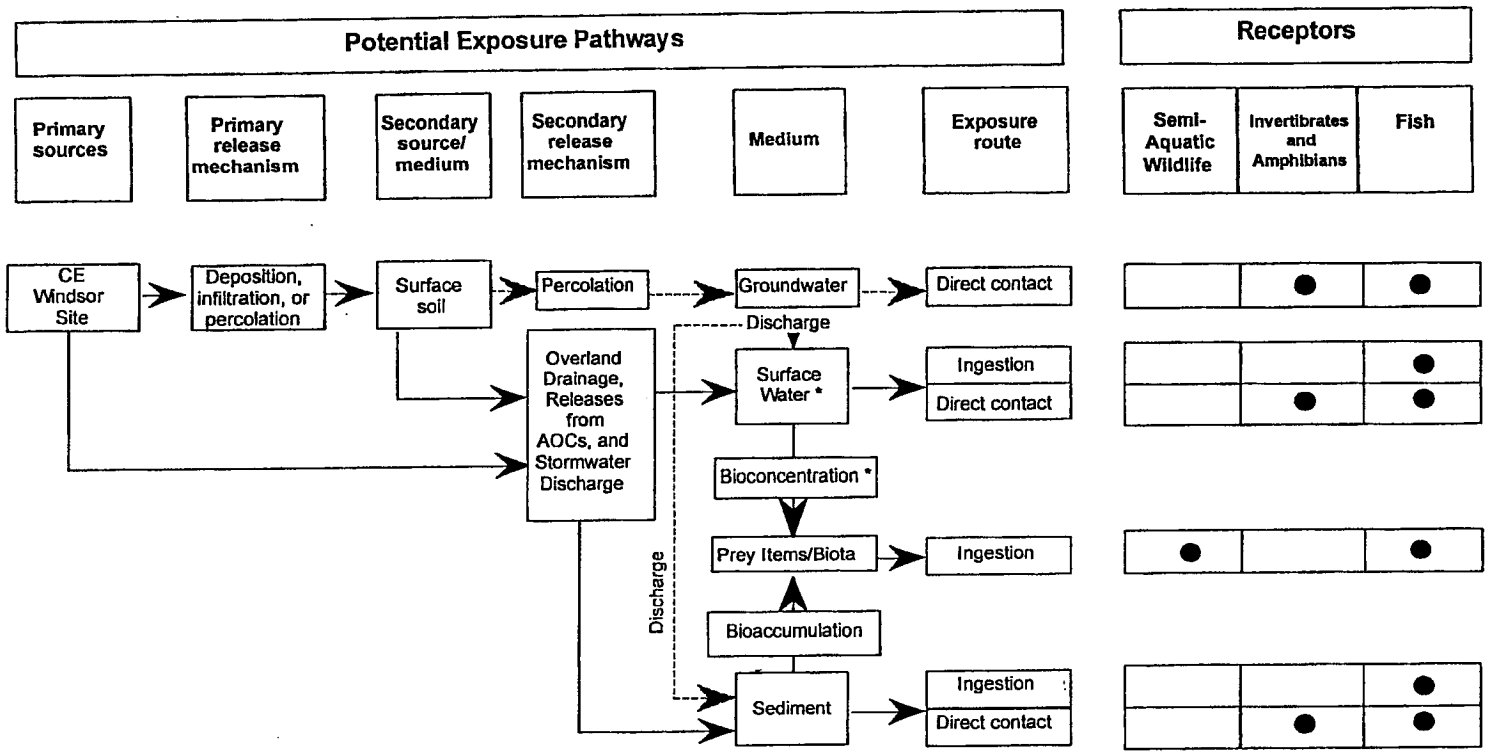


FIGURE 2
CONCEPTUAL SITE MODEL FOR
ECOLOGICAL RECEPTORS EXPOSED TO SURFACE WATER,
AND SEDIMENT IN GREAT POND
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE
A MACTEC COMPANY

CMS - Great Pond(2).ppt



* These exposure pathways are only a concern for Small Pond

------> = May represent an incomplete exposure pathway

FIGURE 3
CONCEPTUAL SITE MODEL FOR
ECOLOGICAL RECEPTORS EXPOSED TO SURFACE WATER AND SEDIMENT
IN SMALL POND, THE SITE BROOK, AND THE FARMINGTON RIVER
CE WINDSOR SITE
WINDSOR, CONNECTICUT

Harding ESE
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TABLE 1
SUMMARY OF SCREENING LEVEL ERA FOR TERRESTRIL AOCs

CE Windsor Site
Windsor, Connecticut

Area Of Concern	Surface Soil COCs	Sensitive Receptors		
		Plants*	Soil Fauna	Wildlife
AOC 1 - Woods Area	Chromium	X	X**	
	Copper	X	X**	X
	Vanadium	X**	X	X
	Zirconium			X**
	Other Metals	X	X	X
AOC 3 - Former PDU and PDU LT-90	PAHs		X	
	Arsenic	X	X	X**
	Boron	X**	X	
	Vanadium	X**	X	X
	Zinc	X	X**	X
	Other Metals	X	X	X
AOC 4 - Greater Than 90 Day Storage Area And Waste Pas Area	PCBs			X
	Chromium	X	X**	
	Other Metals	X	X	X
AOC 6 - Areas Around Building 6A	PAHs		X	
	Chromium	X	X**	
	Other Metals	X	X	X
AOC 10 - Areas Around Building 20 And Equipment Storage Yard	PAHs		X	
	Chromium	X	X**	
	Vanadium	X**	X	X
	Other Metals	X	X	X
AOC 13 - Access Road Area, Near Outfall	Zirconium			X**
	Other Metals	X		X
AOC 16 - Coal Storage And Storm Water Basin	Chromium	X	X**	
	Vanadium	X**	X	X
	Other Metals	X	X	X
AOC 17 - Storm Drain Lines	Chromium	X	X**	
	Vanadium	X**	X	X
	Other Metals	X	X	X
AOC 20 - Digester Sludge	Metals	X		
AOC 24 - Drainage Ditch Outfall To Great Pond	PAHs		X	
	Lead***	X		X**
AOC 26 - Former Target Ranges	Lead***	X		X**

TABLE 1
SUMMARY OF SCREENING LEVEL ERA FOR TERRESTRIL AOCs

CE Windsor Site
Windsor, Connecticut

Area Of Concern	Surface Soil COCs	Sensitive Receptors		
		Plants*	Soil Fauna	Wildlife
AOC 27 - Clam Shell Waste Pile				
	PCBs			X
	Chromium	X	X**	
	Copper	X	X**	X
	Silver	X**	X	
	Zinc	X	X**	X
	Zirconium			X**
	Other Metals	X	X	X

Notes:

* = Plants were typically the most sensitive to metals, as represented by the greatest number of benchmark exceedances for metals in general.

** = The most sensitive receptor, based on the lowest benchmark.

*** = Lead was the only metal COC at AOCs 24 and 26

= Primary stressor representing greatest impact to receptor; additional data collection needed for

Unshaded COCs are not considered to pose significant risk; further evaluation during baseline ERA.

TABLE 2
SUMMARY OF SCREENING LEVEL ERA FOR AQUATIC AOCs

CE Windsor Site
Windsor, Connecticut

Area Of Concern	Surface Water COCs	Sensitive Receptors		Sediment COCs	Sensitive Receptors	
		Water-Column Invertebrates and/or Fish	Wildlife*		Sediment Invertebrates	Wildlife
6 (Great Pond)				PAHs	X	
	Barium	X				
	Boron	X				
	Other Metals	X	X	Metals	X	X
14 (Site Brook)				PAHs	X**	X
				PCBs	X	
	Barium	X				
	Boron	X				
				Chromium	X	
				Copper	X**	X
				Mercury	X**	X
				Silver	X	
				Vanadium		X
				Zinc	X	X**
				Zirconium		X
	Other Metals	X	X	Other Metals	X	X
14 (Farmington River)				PAHs	X	
				Aroclor-1260	X	
	Barium	X				
	Boron	X				
				Cadmium	X**	X
				Silver	X	
				Zinc	X	X**
	Other Metals	X	X	Other Metals	X	X
19 (Small Pond)				PAHs	X	X
				DDD/DDE/DDT	X	X
				PCBs	X	
	Barium	X				
	Boron	X				
				Copper	X**	X
	Iron	X				
	Manganese	X	X			
	Mercury	X	X	Mercury	X**	X
				Vanadium		X
				Zinc	X	X**
	Other Metals	X	X	Other Metals	X	X

Notes:

* = Surface water COCs were selected for wildlife based on a BCF screening value of 300. However, the majority of analytes retained as COCs based on this screen were detected at concentrations lower than benchmarks for aquatic life.

** = The most sensitive receptor, based on the lowest benchmark.

= Primary stressor representing greatest impact to receptor; additional data collection needed for the baseline ERA.

Unshaded COCs are not considered to pose significant risk; further evaluation during baseline ERA.

APPENDIX C-2

USEPA TECHNICAL REVIEW OF THE NOVEMBER 2000, RESPONSE TO COMMENTS ON THE DRAFT FIRST INTERIM DELIVERABLE SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT, AND THE DECEMBER 21, 2000 BASELINE ECOLOGICAL RISK ASSESSMENT PROBLEM FORMULATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

February 22, 2001

Elaine Hammick,
ABB Support Services
Combustion Engineering, Inc.
P.O. Box 500
2000 Day Hill Rd.
Windsor, CT 06095

Subject: Combustion Engineering, Inc. Windsor, Connecticut. Technical Review of the November 2000, Response to Comments, Draft First Interim Deliverable Screening-Level Ecological Risk Assessment, and the December 21, 2000, Baseline Ecological Risk Assessment Problem Formulation.

Dear Ms. Hammick :

Attached please find our review of ABB Combustion Engineering's (CE) November 2000, Response to Comments, Draft First Interim Deliverable Screening-Level Ecological Risk Assessment (FID), and the December 21, 2000, Baseline Ecological Risk Assessment Problem Formulation (BERA PF).

In general, CE has adequately responded to the majority of comments on the FID. Recommendations for the BERA Report are provided in the evaluation of the FID comment responses and in specific comments on the BERA PF.

If you have any questions, contact me at (617) 918-1360.

Sincerely,

Robert A. O'Meara
RCRA Facility Manager

cc: N. Walter

TECHNICAL REVIEW

NOVEMBER 2000, RESPONSE TO COMMENTS
DRAFT FIRST INTERIM DELIVERABLE
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

COMBUSTION ENGINEERING
WINDSOR, CONNECTICUT

February 22, 2001

GENERAL COMMENTS

1. The response is adequate.

2. The response is adequate. See Specific Comment No. 3 .

SPECIFIC COMMENTS

3.1.4 Complete Exposure Pathways

1. The response is adequate. However, Combustion Engineering (CE) must reevaluate the protective contaminant level (PCL) for poly chlorinated biphenyls (PCBs) in sediment in the Baseline Ecological Risk Assessment (BERA). The aquatic invertebrate to sediment accumulation factor (BSAF) for PCBs used by CE to derive the PCL appears to be too low. An alternative BSAF for PCBs can be found in:

   Bechtel Jacobs Company. 1998. *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation.* BJC/OR-112. US Department of Energy. http://www.hsrd.ornl.gov/ecorisk/reports.html

   An additional source of BSAFs for polycyclic aromatic hydrocarbons (PAHs) that should be considered in the BERA is:

   EPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.* Peer Review Draft. August 1999. US Environmental Protection Agency, EPA 530-D-99-001A. http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/slerap.htm

   No revisions to the screening-level assessment are needed.

3.2 Screening-Level Effects Evaluation

2. The response is adequate.

3. The response is adequate. CE must evaluate the risks of total petroleum hydrocarbons (TPH) in soil in the BERA because screening specific analytes (e.g., polycyclic aromatic hydrocarbons, PAHs) may not adequately characterize risks. The Oak Ridge National Laboratory (ORNL) has recently compiled a peer reviewed list of plant and soil benchmarks for TPH that is categorized by the type of oil product (e.g., fuel oil, crude, weathered). CE should attempt to obtain this information from R. Efroympson of ORNL (t:423-574-7397; e:7re@ornl.gov), who is the author of the manuscript reporting these data. If CE requires assistance obtaining the information please contact EPA.

   CE must also evaluate risks of TPH in surface water in the BERA because ecotoxicity values are available for a variety of petroleum products in:

   > Markarian, R. K., J. P. Nicolette, T. Barber and L. Giese. 1995. *A Critical Review of Toxicity Values and an Evaluation of the Persistence of Petroleum Products for Use in Natural Resource Damage Assessments.* American Petroleum Institute Publication Number 4594, January.

   Additionally, weathered oil low in PAHs can be toxic to aquatic organisms, as documented in:

   > Barron, M.G., T. Podrabsky, S. Ogle, and R.W. Ricker. 1999. *Do Aromatic Hydrocarbons Determine Petroleum Toxicity to Aquatic Organisms?* Aquat. Toxicol. 46:253-268.

   This article can be provided at CE's request. Reliable benchmarks for TPH in sediment are not currently available and do not have to be included in the BERA. No revisions to the screening-level assessment are needed.

4. The response is adequate.

5. The response is adequate.

6. The response is adequate.

3.3.1 Exposure Concentrations

7. The response is adequate.

4.2 AOC 2

8. The response is adequate.

4.3 AOC 3

9. The response is adequate.

4.6 AOC 6

10. The response is adequate.

4.12 AOC 12

11. The response is adequate.

4.14 AOC 14

12. The response is adequate.

13. The response is adequate. CE must include an evaluation of spatial gradients of contaminants in the Farmington River in the BERA (i.e., evaluate whether site related contaminant concentrations increase downstream of Site Brook). In addition, CE should evaluate whether the downstream extent of contamination has been adequately characterized in the BERA (e.g., whether contaminant concentrations decline to upstream levels; whether there is potential for areas downstream of the site to be contaminated from site releases). No revisions to the screening-level assessment are needed.

14. The response is adequate.

15. The response is adequate. CE must evaluate methylmercury risks to piscivorous wildlife in the BERA. If CE does not want to assume mercury concentrations in aquatic organisms are present as methylmercury, CE should evaluate the presence of methylmercury in fish. This approach is necessary as fish will likely have a higher proportion of methylmercury than aquatic invertebrates. If only samples in Small Pond will be collected, the sampled locations must represent the highest potential exposures to methylmercury at the site (highest total mercury concentrations in sediment; greatest potential for methylmercury accumulation in aquatic organisms). No revisions to the screening-level assessment are needed.

4.15 AOC 15

16. The response is adequate.

17. The response is adequate.

4.19 AOC 19

18. The response is adequate.

19. The response is adequate.

20. The response is adequate.

21. The response is adequate. See Specific Comment No. 5.

4.22 AOC 22

22. The response is adequate.

4.24 AOC 24

23. The response is adequate. In the BERA, CE must provide the rationale for concluding that there is no potential PCB contamination in Great Pond. No revisions to the screening-level assessment are needed.

24. The response is adequate. In the BERA, CE must provide the rationale for concluding that there is no potential methylmercury exposure to piscivorous wildlife in Great Pond. No revisions to the screening-level assessment are needed.

4.25 AOC 25

25. The response is adequate.

5.0 Discussion of Screening-Level ERA Results and Uncertainties

26. The response is adequate.

27. The response is adequate.

28. The response is adequate.

6.0 Summary and Recommendations

29. The response is adequate.

DECEMBER 21, 2000,
BASELINE ECOLOGICAL RISK ASSESSMENT
PROBLEM FORMULATION

GENERAL COMMENTS

1. CE has provided a baseline ecological risk assessment problem formulation (BERA PF). The BERA PF provided by CE is a brief document that summarizes the primary contaminants of concern (COCs) identified in the screening-level assessment provided in the FID and CE's responses to EPA comments. The BERA PF does not include all of the elements necessary in the problem formulation phase of a BERA that are noted in EPA guidance (EPA, 1997; EPA, 2000; listed below). In reporting the BERA, CE should provide a revised problem formulation section that describes the environmental setting, contaminants and other stressors at the site, contaminant fate and transport, ecological receptors, types of effects of stressors on receptors, measurement and assessment endpoints, exposure pathways, and the revised ecological conceptual site model (see General Comment No. 3). These issues should be addressed in the BERA report and do not require revisions to the problem formulation section at this time.

2. The BERA PF does not address all items previously agreed to or noted by CE, including:

   (A) additional investigations are needed in the unnamed tributary to Goodwin Pond (agreed to by CE);

   (B) tissue sampling of aquatic organisms may be performed to determine potential methylmercury exposure to piscivorous wildlife (noted by CE);

   (C) Re-evaluation of some BSAFs (PCBs, PAH), consideration of additional contaminant screening (TPH), evaluation of spatial gradients of contaminants in the Farmington River, and additional rationale and justification for not considering potential PCB and methylmercury exposure to piscivorous wildlife in Great Pond (noted in the FID response evaluations above);

   (D) additional evaluation of the proposed ecological conceptual site model (CSM) (see General Comment No. 3).

   These issues should be addressed in the BERA report. Revisions to the problem formulation section are not required at this time.

3. The conceptual models provided in the BERA PF do not consider incidental soil or sediment ingestion by wildlife. Incidental ingestion of soil or sediment may be significant for some species (e.g., 30% of diet; Beyer et al., 1994). In finalizing the CSMs for the BERA, CE must consider the potential for incidental soil/sediment

ingestion by site wildlife, and include this as an exposure route where appropriate. These issues should be addressed in the BERA report. No revisions to the problem formulation section are required at this time.

Literature Cited

Beyer, W.N., E.E. Connor and S. Gerould. 1994. *Estimates of Soil Ingestion by Wildlife.* J. Wildlife Manage. 58:375-382.

EPA. 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments,* EPA 540-R-97-006. US Environmental Protection Agency, Edison, NJ.

EPA. 2000. *Ecological Risk Assessment at Superfund and RCRA Corrective Action Sites.* ECO UPDATE. US Environmental Protection Agency, Washington, DC.

APPENDIX D

APPENDIX D

COLLECTION OF FISH TISSUE FOR

FINAL HUMAN HEALTH BASELINE RISK ASSESSMENT

Appendix D
Collection of Fish Tissue for Final Human Health Baseline Risk Assessment

Rationale

The technical review comments submitted by USEPA on the June 2000 Draft Human Health Risk Assessment recommended that the revised human health risk assessment evaluate fish ingestion from on-site water bodies if fish tissue data are collected in support of the ecological risk assessment. Among the surface water bodies in the vicinity of the Site, fish tissue samples to support the ecological risk assessment are proposed for collection from Small Pond and Site Brook. The sampling plan to support the ecological risk assessment calls for collection of three fish samples from each of these two surface water bodies. The fish samples proposed for collection to support of the ecological risk assessment are not species that would be caught and consumed by humans during recreational angling (e.g., *pumpkin seeds*). However, Small Pond is inhabited by small mouth bass, which is a fish species that could be caught and consumed by anglers; Site Brook is not inhabited by game fish. Therefore, to evaluate human consumption of fish associated with recreational angling at Small Pond, bass samples will be collected from Small Pond.

Sample Collection and Analysis

Three small mouth bass will be collected from Small Pond during the field program that is proposed to support the ecological risk assessment. Fillet samples from each fish will be submitted for laboratory analysis. The fillet is the portion of the fish that humans may consume; whole body analysis will not be performed because humans do not consume the offal. Fillets will be analyzed for pesticides, PCBs, mercury, and methyl mercury.

No fillets will be prepared in the field; rather, fish will be prepared in the laboratory for fillet analysis. To estimate proper sample volume for fillet analysis, the following protocol will be used:

- fillets of large fish (i.e., >150 grams) will be assumed to comprise one-half the total body weight;
- fillets of small fish (i.e., <150 grams) will be assumed to comprise one-third the total body weight.

In general, 15 grams will be required for total metals analysis and percent lipids. Samples designated as matrix spikes will need to have twice the volume (i.e., minimum of 30 grams of tissue). If more than one organism is needed for a sample, all organisms in a sample group should be the same relative size. For samples containing more than one organism, the smallest organism should be no less than 75 percent of the total length of the largest organism in the sample group.

Samples will be placed in heavy-duty aluminum foil (dull side toward specimen). The samples should be double wrapped in aluminum foil and sealed in double freezer bags (one inside the other). Sample labels will be affixed to the sample package and taped with clear plastic packaging tape. Sample labels will be attached to each sample submitted for laboratory analysis. The sample identification, date and time of collection, and name(s) of field personnel will be recorded on each label. Each sample collected will be assigned a unique sample identification as described below.

Once sample packaging is complete, samples will be frozen. Samples will remain frozen until shipment to the laboratory. Frozen samples will be placed on dry ice in an insulated cooler when shipped to the laboratory. Samples and dry ice will be layered within each cooler to ensure samples remain frozen. Sufficient dry ice will be present in each cooler to ensure that samples remain frozen

until delivered to the laboratory. Typically, an amount of dry ice equal to one-third of the total cooler volume will be adequate for this purpose.